LIGO Scientific Collaboration

10 Years of LIGO MAGAZINE

issue 21 9/2022

O4 Commissioning

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21 issues of the LIGO Magazine already?!

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Front cover

A flattened 360 degree picture inside a KAGRA cryostat hosting the input test mass for the X-arm. On either side, chamber gates (with a window in the centre) and a window are shown. Yokozawa-san is holding the camera beside the test mass and Washimi-san is operating the camera remotely outside the right side gate window. Article on pp. 6-11.

Top inset: Celebrating 10 years of LIGO Magazine. The photo is the main image from the cover of the first edition of the LIGO Magazine (issue 1, 2012) www.ligo.org/magazine. It shows small magnets being precisely glued to optic holders in an ultra clean-environment. Article on pp. 12-17.
Bottom inset: Martina De Laurentis and Valeria Sequino at work on one of the Squeezer benches at Virgo. Article on pp. 28-29.
Bottom left (diagonal) inset: Prototypes of two LIGO India vacuum chambers loaded onto a single truck for the long journey (over 1300 km) from the factory to the LIGO India site. Article on pp. 18-22.

Image credits

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Cover: Main image: Tatsuki Washimi. Top inset: see LIGO Magazine issue 1 www.ligo.org/magazine. Bottom inset: Valeria Sequino. Bottom-left (diagonal): LIGO India/V. Bedakihale/S. Sunil.

p. 3 Antimatter comic strip by Nutsinee Kijbunchoo.
pp. 6-11 Inside a KAGRA cryostat photo by Tatsuki Washimi (pp. 6-7). Green laser beam photo by R. Bonnand (LAPP) (p. 9). HAM7 optics installation group photo by Camilla Compton (top, p. 11). 'Same same but different' photos by Michael Fyffe and Sheila Dwyer (middle and bottom, p. 11).
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Antimatter

Welcome to the 21th issue of the LIGO Magazine!

Hannah Middleton
Editor-in-Chief

Anna Green
Deputy Editor-in-Chief

Welcome to the twenty-first issue of the LIGO Magazine, and a very happy 10th anniversary! In this issue, we celebrate reaching this important milestone, explore commissioning work across the collaborations as Observing Run 4 approaches, and consider the importance of recognition in science on both an individual and collaboration level.

With Observing Run 4 on the horizon, we catch up with what's been happening at the LIGO, Virgo, and KAGRA sites in "Commissioning: Going from O3 to O4". One of the major changes will be the use of frequency dependent squeezing, but what does that mean? All is explained in "O4: A Tighter Squeeze". At LIGO-India, we hear how the all important vacuum chamber prototyping has been going. We also take a look back to the April 2020 GEO-KAGRA run in "Memories of a busy time", and learn more about short gamma ray bursts like those seen during the run on the back cover.

Last year, the LIGO-Virgo-KAGRA (LVK) collaborations took part in a mental health survey and Kamiel Janssens discusses the preliminary results and important steps to improve mental wellbeing for our community, particularly in terms of work recognition. Scientific recognition is important both for individuals and collaborations. In the scientific literature, it is often the case that the discoveries of the LVK collaborations have been mis-represented as LIGO-only achievements and the LVK Equity in the Scientific Literature team describe their efforts to reduce these misconceptions.

And finally, we celebrate the 10th anniversary of the LIGO Magazine with reflections on the early days from Andreas Freise and Gaby González, plus memories from other members of the editorial team. The LIGO Magazine would not be possible without the enthusiasm and commitment of the whole team, all of whom are volunteers – thank you all! Take a look inside the back cover of every issue to see the names of all our editors, as well as the supporters we are indebted to (the AEI and CalTech) and of course Milde International Science Communication for our design and production.

The LIGO Magazine is a place to share stories and experiences from all around our community and, over the years, so many of you have contributed your stories, perspectives, artwork, photographs, and more. It has been wonderful to see these snapshots of our community and the changes that have happened over the past decade (including of course the first detection). Keep the contributions coming and let's look forward to the next ten years!

As always, please send comments and suggestions for future issues to magazine@ligo.org.

Hannah Middleton and Anna Green, for the Editors

News from the spokesperson

The September 2022 LIGO-Virgo-KAGRA (LVK) Collaboration meeting will be hosted by Cardiff University and will be our first in-person Collaboration meeting since 2019. On the whole, our Collaboration has weathered the pandemic well. At the individual level, however, many of us have suffered loss, setbacks, and isolation. I am looking forward to reconnecting with longtime collaborators, to meeting some of you for the first time, and to discussing our research progress and plans in person.

With the wide range of intellectual and social interactions ahead, we should all reacquaint ourselves with our Code of Conduct (https://dcc.ligo.org/LIGO-M1900037) and reflect on practical ways to create a collegial, inclusive, and professional environment during Collaboration meetings. I find the following norms of collaborative work to be helpful: 1) pausing to think before answering or asking questions; 2) paraphrasing another person's point can help a group come to a common understanding; 3) posing questions to explore and specify thinking; 4) sharing ideas with the group to interact with, develop and possibly adopt; 5) providing data to help build a shared understanding; 6) paying attention to self and others, for example, being aware of what we are saying, how we are saying it, and how others hear it helps facilitate meaningful dialog; 7) presuming positive intentions to support a non-judgemental atmosphere. (These norms were first suggested by Garmston and Wellman.)

We anticipate that the next observing run (O4) will begin in March 2023. By then, the detector groups will have completed upgrades that may increase the compact binary detection rate to one per two or three days. With every substantial improvement in sensitivity, we can extract more science from the compact binary signals we detect and have the possibility of detecting new sources of gravitational waves.

The Operations and Observational Science Divisions are now focused on preparations for O4. The low-latency working group led the implementation of mock data challenges in which data from O3, with many simulated signals added, is repeatedly replayed through our analysis environment and used to test our readiness for the upcoming run. Watch for updates on this and the work of the calibration, detector characterization, computing & software, and open data working groups during the LVK meeting.

For the past year, the post-O5 study group and other instrument scientists have been studying potential instrumental upgrades to follow the fifth observing run. The draft report is now available for comment and discussion. This internal study will inform proposals to funding agencies over the next year or two. The goal is to identify an instrumental upgrade path that approaches the limits of the current facilities, continues to provide observational science gains, and dovetails with the implementation of next generation facilities.

Congratulations to the editors and all the contributors on the ten years of LIGO Magazine!

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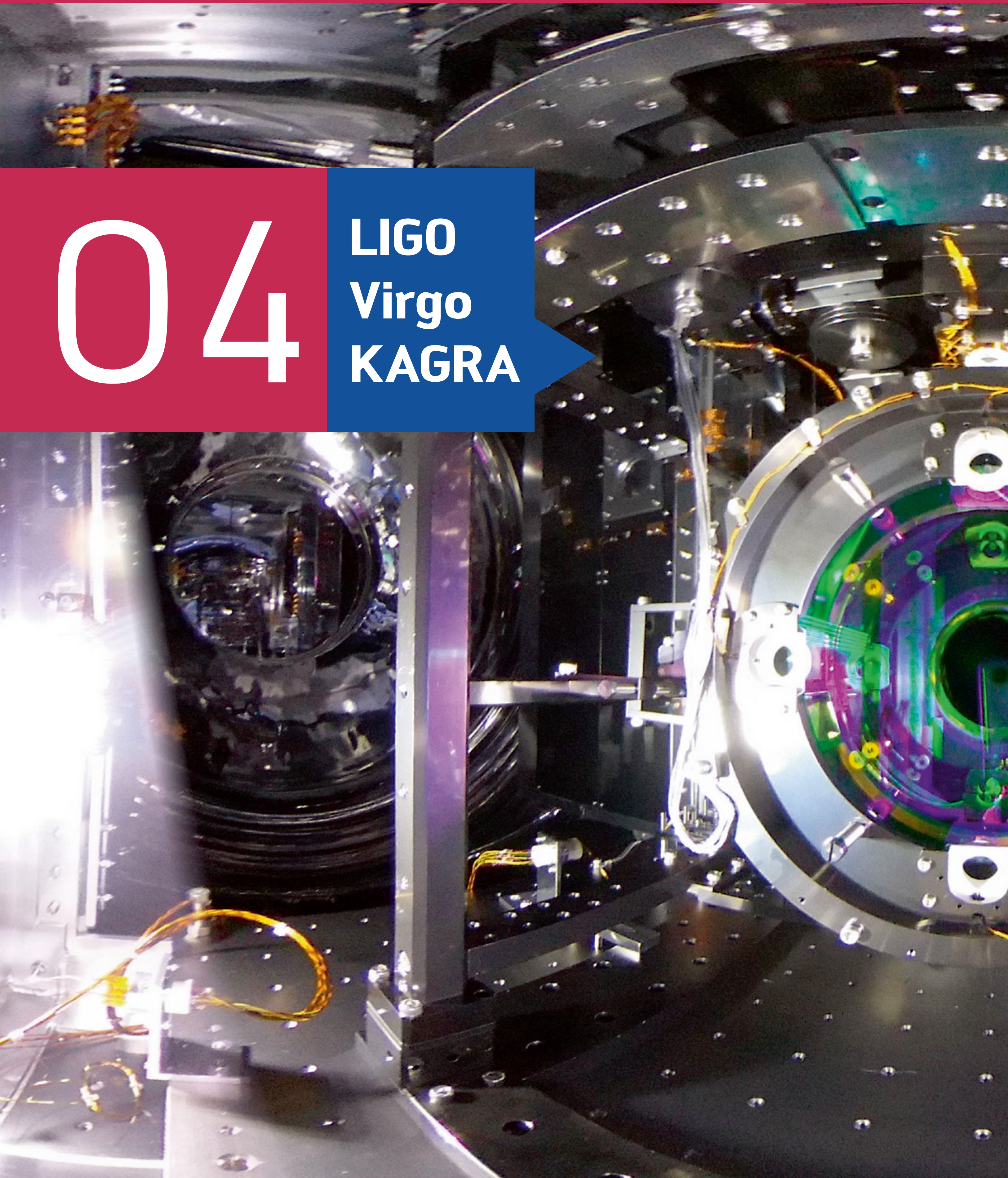
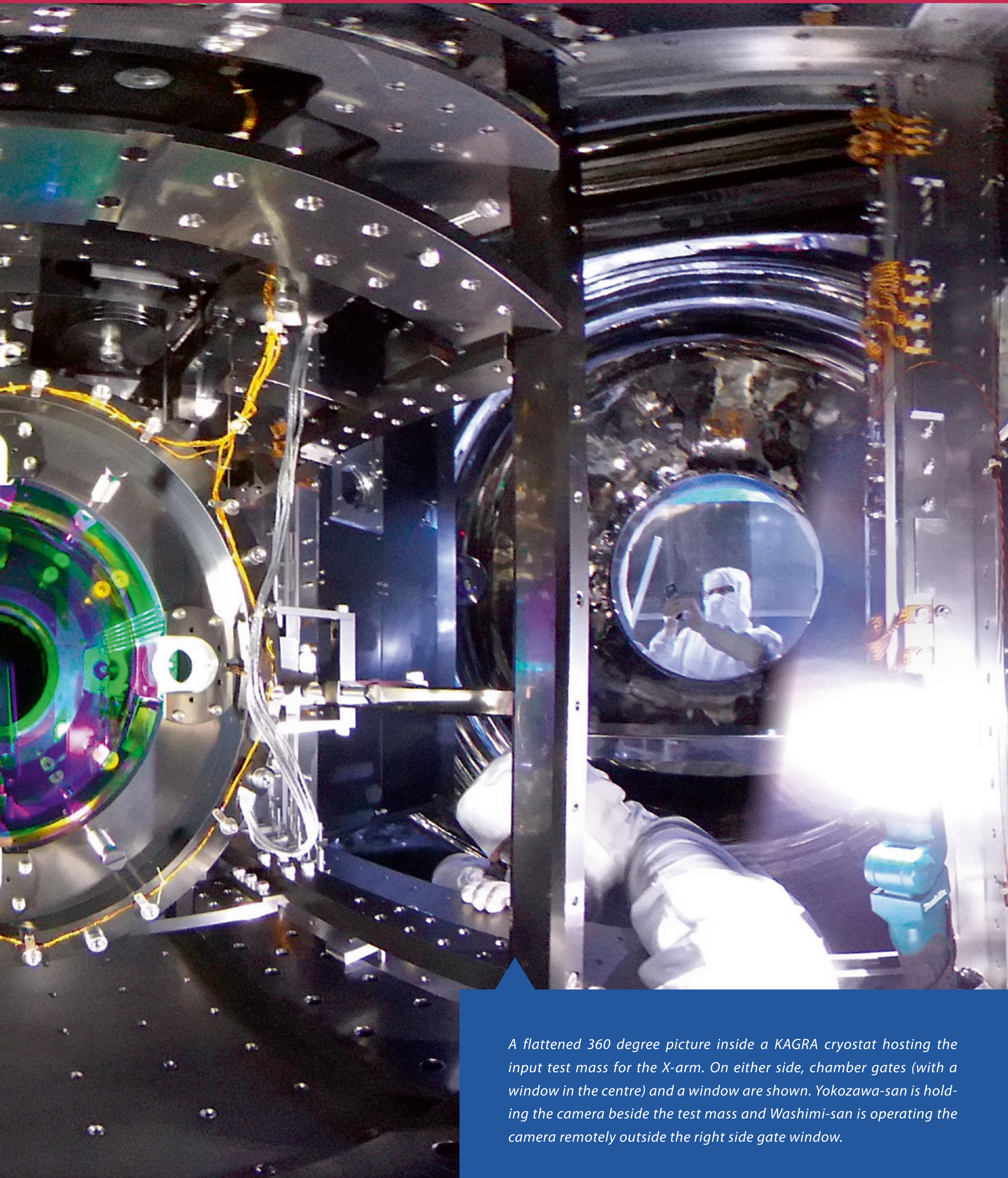
Patrick Brady
LSC Spokesperson



O4

LIGO
Virgo
KAGRA



A flattened 360 degree picture inside a KAGRA cryostat hosting the input test mass for the X-arm. On either side, chamber gates (with a window in the centre) and a window are shown. Yokozawa-san is holding the camera beside the test mass and Washimi-san is operating the camera remotely outside the right side gate window.

Since Observation run 3 (O3) ended in early 2020, we have been looking forward to Observation run 4 (O4). Between observation runs, on-site commissioners have been working hard to install upgrades to the detectors and increase our view into the Universe. In this article we hear about what changes are being made at each site between O3 and O4.

KAGRA

Ready to join O4a

In April 2020, at the end of O3, KAGRA took a first joint observation with GEO 600 for two weeks (called O3GK - see page 24), operating at room temperature with a sensitivity below 1 Mpc (Megaparsecs). In general, the sensitivity was limited by various noises coupled through the control scheme ('controls noises') at low frequencies, scattered light at intermediate frequencies, and shot noise at high frequencies. The KAGRA O4 plan is to participate in O4a, with cryogenic cooling, for the first month, then continue commissioning to improve the sensitivity. After the commissioning, gaining as much sensitivity as possible, KAGRA plans to participate in O4b for three months (or longer). The sensitivity for O4a will be 1-3 Mpc, and our goal is to improve it to 3-10 Mpc in O4b.

In KAGRA, the most time-consuming upgrade after O3 comes from all the mirror suspension systems. The low-frequency noise limits come from the control noise of several mirror suspension systems. Therefore, KAGRA has optimised the control scheme for the test mass suspensions, including upgrading and expanding the types of sensors (new optical levers and accelerometers) and improving the control loops' designs. The measurement of suspension mechanical transfer functions and spectra (called a 'suspension health check' in KAGRA) helps to reveal particular issues about components rubbing and fiber scopes have been introduced to help inspect rubbing components. Once KAGRA is cryogenic, ribbon heaters will be used to maintain the vertical vibration isolation stage positioning.

Yuhang Zhao

is a post-doc at ICRR, the University of Tokyo working on frequency dependent squeezing. He likes endurance running and recently enjoyed reading 'Le Petit Prince'.

During O4, KAGRA won't use signal recycling or squeezing, so the signal recycling mirror has been replaced with a 100% transmissive optic. In addition, the output mode cleaner has been re-designed to increase its throughput from 80% to 95%. A new high-power (up to 60W) laser has been installed to reduce shot noise at high frequencies, and many mid-size 'baffles' have been installed around the main optics of the input mode cleaner and core interferometer to reduce scattered light.

KAGRA O3 commissioning explored the advanced usage of a large-scale cryogenic system and crystalline mirrors. This was an invaluable experience for KAGRA O4 commissioning and future planned cryogenic gravitational wave detectors. For example, for cryogenic operation we found that vacuum leakage must be kept very low (<10^{-10} Pa m^3/s) . We also developed a cooling strategy which has been proven to prevent frosting and keep the KAGRA arm's optical performance stable for over a month. For the crystalline (sapphire) mirrors, KAGRA worked extensively on simulations, manufacturing choices, and absorption/birefringence characterization. Although the mirror fabrication and characterization are aimed for Observing Run 5, all the mirror studies are helping us to understand the impact of mirror defects on interferometer control and sensitivity in O4.

Currently, we have two 3km arms in vacuum, and the central area will be pumped down soon. We expect the commissioning of the interferometer to happen in October. We will also cool down the mirrors as early as possible to benefit from the higher thermal conductivity and quality factor of sapphire at cryogenic temperature. Now, the X-arm end test mass has reached around 81 K, while other mirrors will be cooled down soon. For KAGRA, O4 will be its first joint observation run with LIGO and Virgo. We are very excited about this new underground cryogenic detector joining O4!

Haoyu Wang

is a postdoc at the University of Tokyo working on mirror birefringence issues for KAGRA. He likes travelling and music, and is a big fan of Jay Chou.

Julia Casanueva is a researcher at EGO (European Gravitational Observatory) working on the Virgo and ET Sensing and Control teams. She is currently very busy with the Commissioning of Advanced Virgo+ but she dedicates any time she can find to sewing and board games.

Virgo

Upgrades of the AdVirgo+ detector for O4

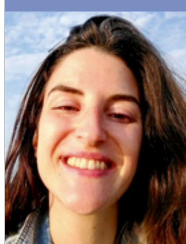
After suspending Observation Run 3 (O3) early on March 27, 2020 due to the pandemic emergency, upgrading for Advanced Virgo+ (AdVirgo+) began.

Addition of a SR mirror

The first major goal was to increase the sensitivity of the interferometer by adding the Signal Recycling Cavity (SRC). The Signal Recycling mirror was installed in July 2020. This addition introduces an extra degree of freedom to control, and thus the entire lock acquisition process has to be changed.

The new strategy is based on the use of auxiliary lasers, similar to the one successfully implemented by LIGO and KAGRA. These green auxiliary beams are used to control the length of the long arm cavities, keeping them far from the main beam resonance. Effectively, we are removing two degrees of freedom, leaving only the three of the central interferometer, which can be controlled simultaneously. At this point, we can slowly bring the arm cavities into resonance with the main infrared beam to obtain control of the full detector. In Virgo, the auxiliary lasers are generated by sending a pick-off of the main laser to the end buildings which then gets frequency doubled (converting from infrared to green) before being injected into the interferometer through the end mirrors.

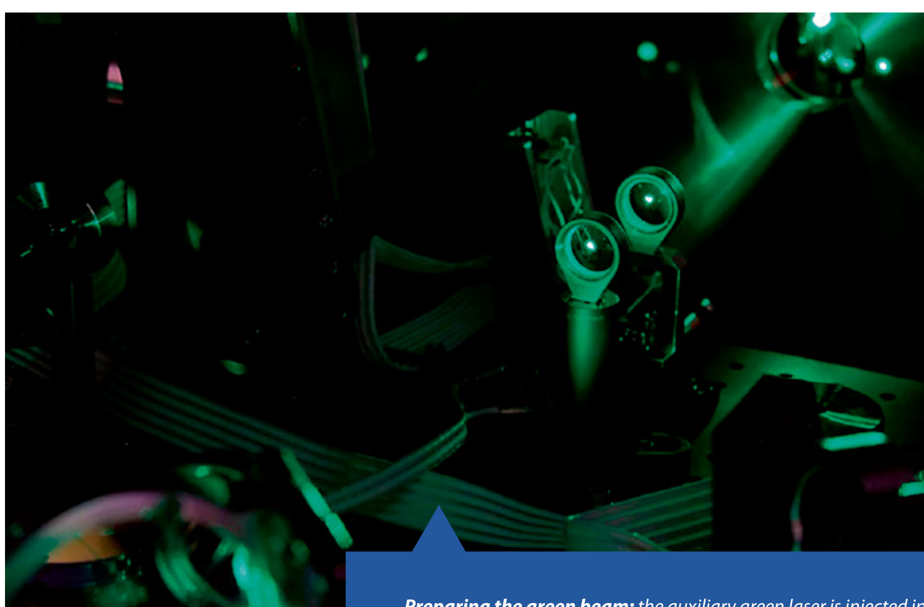
The main difference between the recycling cavities in AdVirgo+ versus at LIGO/KAGRA is that they are marginally stable. This means that any imperfections, such as misalignments, mismatch, or other defects, will produce a distorted beam shape that is still resonant inside these cavities. This has a large impact on the quality of the control signals, making it very challenging to reach the optimal working point and maintain it in a stable way. Furthermore, the interaction between the SRC length and the Differential Arm degree of freedom (DARM) has also proven to be critical, since it increases the coupling of these imperfections into the interferometer frequency response. We're working our way through this challenge.



Antonella Bianchi is a PhD candidate at VU University (Amsterdam) happily working at Nikhef. She mostly does optical simulations to help Advanced Virgo commissioning (currently on site for one year) and for the Einstein Telescope. In her spare time she is writing a fantasy book, visits art museums and attempts to keep a regular yoga practice.

Increase of the input power

The second target is to increase the input power to 40W which will reduce the shot noise that dominates at high frequencies. However, the power resonating inside the long arm cavities is now so high that thermal effects start to spoil the performance of the whole instrument. The Thermal Compensation System (TCS) work then becomes key to control the interferometer since it has to compensate for both cold defects, due to the residual



Preparing the green beam: *the auxiliary green laser is injected into the terminal suspended bench that prepares the shape of the beam before it is injected into the interferometer through the end mirror.*

lenses on the different optics, and hot defects, such as the thermal lenses induced by the power build-up inside the different cavities.

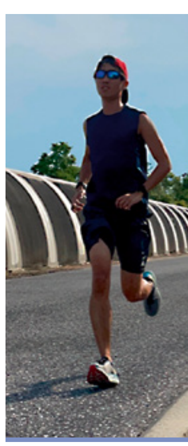
Frequency-Dependent Squeezing

The third big update to O4 regards the squeezing system (find out more about squeezing on page 28). Squeezing was already used in Advanced Virgo, improving sensitivity by 3dB. For AdVirgo+, a new method to further reduce quantum noise in the full frequency bandwidth is used. To achieve Frequency Dependent Squeezing (FDS) we have installed a 300m filter cavity with suspended mirrors. The goal of this new cavity is to rotate the squeezing angle in a frequency dependent way, simultaneously reducing the radiation pressure noise that affects the low frequency range (under 50 Hz) and the shot noise present in the high frequency range. The new system also includes auxiliary benches to inject the squeezed light first into the filter cavity and then into the interferometer itself, and additional sensors for monitoring the squeezing beam and controlling the new cavity. We're currently improving the frequency dependent squeezing level which is measured in stand-alone configuration by using an external homodyne detector. Once this step is completed, the squeezing vacuum state will be injected into the interferometer.

Georgia Mansell is a Research Assistant Professor at Syracuse University and the LIGO Hanford Observatory, working on gravitational-wave detector instrumentation and commissioning. Her main hobbies lately are rock climbing (like many physicists!), biking, and hiking.

LIGO
Unique challenges at each site

Between O3 and O4 both LIGO sites are nominally undergoing similar upgrades. However, the sites are not identical, and each site faces unique challenges. Both sites are installing a filter cavity for frequency dependent squeezing, but there are very slight differences in the optical layouts. Both sites are replacing test masses which were contaminated with point absorbers. At LIGO Livingston (LLO) the end test masses are being swapped, while at LIGO Hanford (LHO) an input test mass was swapped in late 2020. LLO will be replacing their output mode cleaner cavity which had high optical loss, and both sites have installed a brand new output Faraday isolator. We try to stagger new upgrades, so that we can learn from the experiences of the first site. For example, at the time of writing LHO has already installed the new pre-stabilized laser amplifier, increasing the power deliverable to the interferometer up to 110W. LLO plans to complete this upgrade later this year.



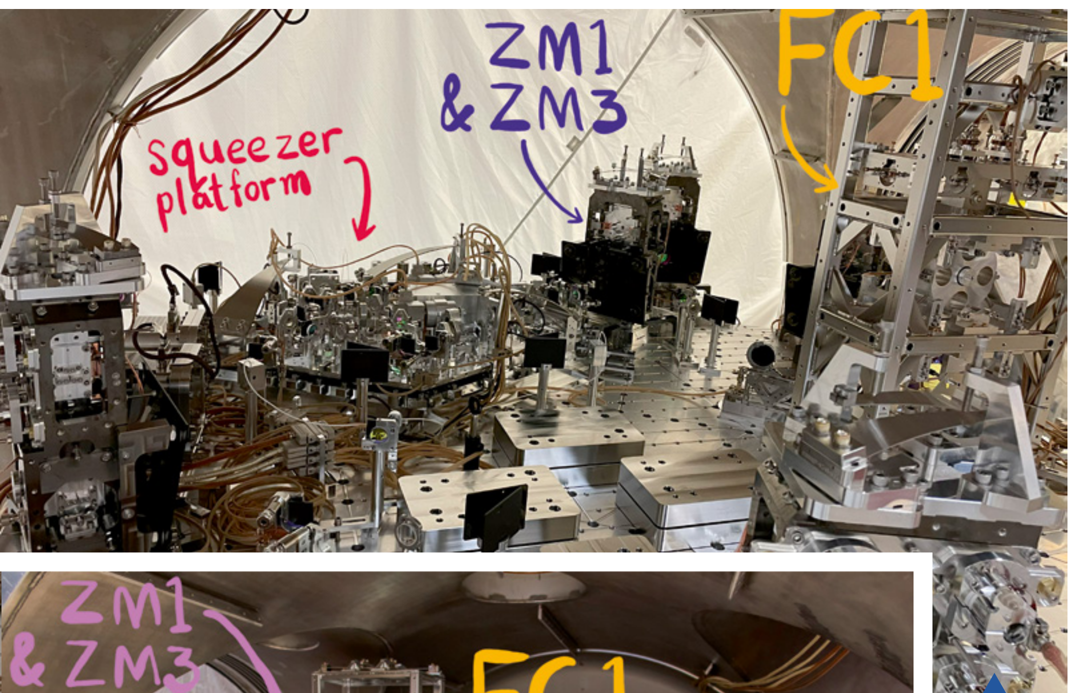
Masayuki Nakano is a post-doc at LIGO Livingston Observatory working on installing the squeezed light subsystem and commissioning the interferometer. He loves to run, and runs on LLO's arm almost every weekday.

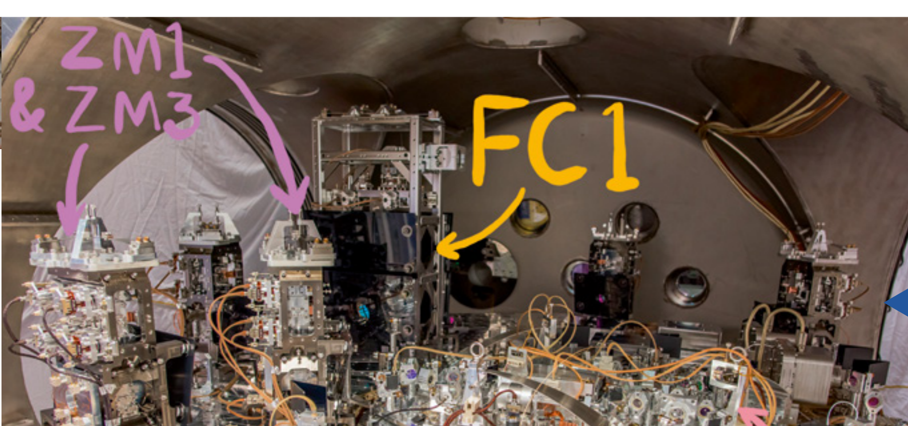
The main upgrade for O4 is the 300m filter cavity for frequency-dependent squeezing (FDS) – not that the authors are biased! The filter cavity is a major facilities upgrade, including the construction of a new end station, surveying for the placement of the new vacuum tube and vacuum chambers, preparation of new seismic isolation platforms, new optics, electronics, and models. The filter cavity upgrade has involved almost everyone on-site in some way (even from an unexpected visitor, see p.33)!

To effectively improve sensitivity using FDS, it is essential to improve the performance of the signal readout port of the interferometer. One of the major challenges in improving sensitivity by using squeezing is to reduce optical losses. If optical losses exist in the path of the squeezed vacuum, they mix with the un-squeezed vacuum and reduce the squeezing level. As a result, the sensitivity improvement by the squeezing vacuum gets degraded, so it is important to eliminate optical losses as much as possible. For more on squeezing, see page 28.

The main components of the signal readout port of an interferometric gravitational wave observatory like LIGO are the Output Faraday Isolator (OFI) and the Output mode cleaner (OMC). The OFI transmits the interferometer light to the output port, while coupling the

Sheila Dwyer, Camilla Compton. and Georgia Mansell installing optics into Horizontal Access Module 7 at LIGO Hanford Observatory.





Same same but different: *Horizontal Access Module 7 at LLO (above) viewed from the -Y door, and at LHO (left) viewed from the +Y door. The filter cavity input coupler suspension (FC1) is labelled in yellow, the squeezer platform in pink, and double suspension steering mirrors (ZM1 and ZM3) shown in purple.*

squeezed vacuum into the interferometer. To reduce this loss, both sites are replacing the existing OFI with an improved one to achieve better squeezing. The new OFI, developed by the University of Florida, has improved the optical loss from about 6% to 1~1.5%. Although we had a problem with Faraday crystals becoming unfastened and needing to be replaced again in LLO, the new low-loss and high-isolation OFI has now been successfully installed.

The OMC is another important component in the signal readout port. The output light from the interferometer, including the gravitational wave signal, is cleaned by the OMC to filter the garbage light before being sent to the photodetector. Losses at the OMC are also undesirable for squeezing, but LLO has observed that OMC losses became a few percent larger after O3. As this loss will reduce the squeezing level, LLO is planning OMC replacement work before O4 begins.

These kinds of commissioning projects maximize the use of the main FDS upgrade and are a major part of the work during this commissioning period between O3 and O4. Commissioning to bring the LIGO detectors from O3 to O4 has been challenging, but fun, and we're looking forward to commencing O4 in the next year!

10 YEARS

... and counting!

It is 10 years since the first issue of the LIGO Magazine came out in September 2012. Founders Gaby (Gabriela) González and Andreas Freise chat about those early days. Interviewed by current Editor-in-Chief Hannah Middleton and Deputy Editor-in-Chief Anna Green.

Q: How did the idea of a LIGO Magazine come about?

Gaby: In 2012, I visited Virgo and I saw that they have this nice magazine, the "h Magazine"[1], it was a printed newsletter, and I liked it. The year before I had been elected spokesperson of the LIGO Scientific Collaboration (LSC). I was working together with Marco Cavaglià and we wanted to improve communication within the LSC as it was getting large. We came up with this idea of having an internal magazine for LSC members. It would be public, but not advertising LIGO to the external community. We wanted something to share stories, something different and international, with articles written by younger people.

So, we began floating the idea and people liked it, but many were skeptical. We had tried a web page with news items before, but it had not worked very well, so we thought a magazine was worth trying. Initially we thought about producing three or four issues a year.

Andreas, we contacted you and you liked the idea – so we were very optimistic! Then you led the march from the very beginning.

Q: How did that first issue go? Were there any surprises along the way?

Andreas: The first issue was the most interesting one. When you do something new it's always exciting. We spent a lot of time thinking long term and what could we sustain for many years. That's one of the reasons I negotiated Gaby and Marco down to only two issues per year.

Looking back, those months planning were time well spent. Gaby and Marco had this idea that as a magazine, it should be graphically more than a newsletter. So we tested lots of formats including ebooks and webpages.

▲ *One of the earlier mature designs for the Magazine - while not bad it was ultimately considered too rigid.*

Nothing really convinced us. In the end we decided on having a PDF that looks shiny on an ipad, but you can also print it. Sascha Rieger deserves a lot of praise for the look and almost every issue he makes small edits and improvements to the design.

When we were getting the team together we had many volunteers, but everybody had different expectations. Some people thought that the editorial team was yet another committee, others thought it was a working group with specific rules and regulations, and others didn't want any of that, they just wanted to get the job done! And you have to bring them all together.

The surprises were more in the negatives, let's say. We underestimated the amount of work. I was worried about this from the beginning as we were working towards a real deadline and a lot of people in our community are not used to hard deadlines. You can almost always do it at the last minute or a week later. But we wanted a printed copy at the LIGO-Virgo Collaboration (LVC) meeting, so they needed to be printed some days before and the content needs to be fixed several days before that. Therefore I was worried, but of course not worried enough, and we were almost too late. Milde Marketing were very good at flexible working, and they did some copies on a temporary printer and were flying them personally to the meeting. So we had some copies, not all of them, but some that I could show. I had hoped we could have done this better, but it worked – nobody noticed!

Another surprise was that the costs were surprisingly high for some of us. It caused a little bit of a stir. But in the end that was an easy problem to fix, it was just a surprise.

The other surprise was at the meeting where we presented the first issue. We had done the usual thing – people had written articles and we sent them to somebody else in the collaboration to review. And then we printed the Magazine and then somebody got very angry at the meeting, which was a very tense time.

Gaby: Yes, I got into a very bad fight…

Andreas: Sometimes people take it very personally when you write about their work. This was an article written by someone on the sidelines of the work,

[1] *www.ego-gw.it/newsletter/*

who pointed out all the funny things that happened. But the person who did the work, who had put their blood and sweat into it, felt it was not a good representation of them and the way they work. For an hour during the social evening of that LVC meeting some of us were sought out for some very direct negative feedback. For me it was not so bad because I was senior enough, but one editor involved was very young at that time, so we tried to mitigate that situation as quickly as we could. I hadn't expected this at all, because so many people had seen us working on the texts. But you sometimes get these surprises when you are not paying special attention, and we have since changed how we do things. It was a good learning experience for the editors themselves.

Gaby: Yes, they were worried about future funding opportunities as this was public. It was something we hadn't appreciated.

Andreas: What was really nice was the teamwork of the editors. For example, I was a bit disappointed with the overall reception of the LSC, which was very underwhelming. I gave the talk presenting the Magazine and people were reacting with "what is this, yet another extra initiative from Gaby and Marco". But in the team we knew that we were doing something good. The appreciation in the LSC came over a longer period as people started to realise what it is and how much fun it can be to have this provided for free by somebody else regularly, but in the beginning that was not the case.

Gaby: Yes, I think it was lumped with other initiatives. It was the same meeting when we created the diversity committee, to which the response was not just underwhelming but resisted by some, so maybe that spilled over to the Magazine.

Getting absorbed by the stories: there was much interest in the first edition at the September 2012 LSC meeting.

But when people read it, we got a lot of good feedback informally, especially from young people. I remember some people saying "oh this looks nice". My impression was that senior people did not read it, but younger people did, and liked it because it had different voices and diversity of people and topics. I do remember seeing people with it in their hands at the meeting and stopping to read these long two, three page stories.

Andreas: Yes, outside the meeting room, there were people not talking to each other, but instead reading the Magazine. That was the first sign that it had worked, people were getting sucked into reading the stories.

Gaby: The group of editors was a really nice team of people working together. I remember after that first issue we went out for dinner together. We each had a copy of the printed Magazine, and we all signed our names on each of the copies - one of the things I regret the most is that I lost that copy at the meeting.

Andreas: I also remember it was presented in September, around the same day when Apple typically announces their new products. So I thought I would use Keynote and copy the Steve Jobs announcement style with the same background, same animation. But then Gaby, you forbid me to use it. You said the presentation had to be a PDF file and that's it! And all my hours of making fireworks and animations of numbers counting things went down the drain.

Gaby: I don't remember that! Maybe it would have improved the reception. The presentation needed to be in DCC…

Andreas: Well, I only asked you 10 minutes before the session started and you were already in your spokesperson-mode. Anyway, now I think it was probably one of these silly ideas that you try out to make your talk different, but then backfires because the audience doesn't get the joke. But in that moment I was a bit disappointed.

Gaby: Afterwards we got emails from people outside the collaboration, like the editor of CQG, Adam Day contacted us saying "I liked it, how do I subscribe?".

Andreas: Ah yes, we got emails from all over the planet asking how they could subscribe and people offering to pay for it, which of course we couldn't do.

Q: How did you find keeping the momentum going?

Andreas: I think the working style was pretty much the same in the sense that you have a subgroup of a few people that are really energetic and want to try things and have ideas and the rest of the group that you can use as a sounding board or to farm out tasks, but for them it is not a priority in their daily lives, so when they come to the editorial meeting they have to start their brains in that direction. But I think we were lucky to always have this small group of enthusiastic and effective people in the editorial team, sometimes just two people, but most of the time three or four.

The hardest part of the work is always to get people to actually write down their stories. From the beginning we always knew that would be the difficult part and would require pushing people. But on the other hand the LSC community is very positive about feedback. One of my favourite examples was in the first issue when it was still difficult for us to explain clearly what we wanted. We had asked for an article from David Shoemaker about installing Advanced LIGO, but it had turned out more technical than we had expected and did not really speak to the non-instrumentalists as much as we hoped. So we said, "sorry David, that's not what we wanted, can you write it differently?" and explained how. He said “okay, I can try again” and went and wrote a second version. That's the most memorable, as we were asking for a lot of extra work. But generally when we gave feedback, people would try again or add something more and that's what made it fun – we could unearth interesting things just by asking. Then getting people to do it by the deadline is harder of course.

Gaby: And many of the things from the first issue are still there, like the back page explaining things. The bios is another thing – Andreas or somebody in the team had the idea that we shouldn't just have where the writers work, but some little tidbits about what else they do. I think those kind of details made it succeed and last.

Q: Back then, the aims of the Magazine were for it to be for us, fun to read, and a place for people to find out more about other parts of the collaboration. Have the aims changed?

Gaby: One of the things I thought was a problem, and may still be a problem now, is that as a large collaboration we weren't communicating between the people working on instrumentation, data analysis and theory. We had become a bit too technical because we needed to be technical, but you could tell at collaboration meetings which people were paying attention to which talks and I think that still happens. We wanted the Magazine to be different and understood by everybody independent of their speciality. So the tone had to be important.

Andreas: I'm proud of how we delivered on these targets that Gaby and Marco gave us. Then as soon as you have people read it, to some extent you have to play to that audience. We had more readers from outside the collaboration that I expected. Our aims have not changed, we still achieve the same goals as before, but now also want it to be useful for the outside audience. For example, our gravitational-wave detections: you cannot not talk about them, external people would always expect to find information about the most recent detections.

Gaby: Yes, the detection results need to be included in the Magazine. We might have been sick of hearing about them, but they had to be there.

Q: What about our community, how has that changed over the years and has the Magazine changed with it?

Gaby: The community has changed. In the beginning, of course we were sure there would be detections, but we didn't know when. Now, the community has changed in their expectations: the people who come to work in it now are not just expecting to be able to see signals, but to see more signals. The Magazine has reflected that change in that the topics have changed, but it hasn't changed the spirit of the Magazine: it's not about the black holes and the technology, it's about the people discovering the black holes and working on the technology. I think that was true from the beginning.

Andreas: The biggest change for the community came from the detection and becoming successful, being recognized by other fields. We now face different

The editorial team celebrating the first issue. On the right: Cristina Torres, Gaby González and Andreas Freise.

Susanne Milde, Sascha Rieger and Tobin Fricke.

expectations and we have changed the way we approach our work. It's not such an open-ended adventure now, instead we have to deliver on the next targets that have become more real, so you have to change the way you work. And then of course the world changes and that is always reflected in the community.

However, the Magazine has not changed so much. For me, it's a bit of an echo of the past because it keeps the spirit that was more common in the LSC in the past, more familiar and friendly. It's a little bit nostalgic.

Gaby: We have become more business-like that's for sure, by necessity. But I don't think the Magazine has, and we should keep it that way.

Q: Do you have any articles that you are particularly fond of?

Andreas: My favourites are very obvious. We were all very proud of the detection issue, because it was different. For example, the timeline of the signal arrival came together very nicely and was exactly what the Magazine tries to be: it had interesting facts but also the personal stories of both the people that were in the centre of it all and also the people who are just working on their thing in a corner of the collaboration. The other thing I'm most proud of is Nutsinee Kijbunchoo's comics.

Gaby: yes, Nutsinee's comics are my favourite part and the detection one was a two-page comic, that was great.

Q: Are there any articles that you would love to see or regret not being able to share?

Andreas: There's no particular big one that we missed, it's more that there are a lot of smaller stories, especially when you have a success as a PhD student, those moments are happening all the time, but people don't think they can be a story in the Magazine. They feel that once it's edited in a glossy magazine, it looks more important than it is. We missed hundreds of stories, and that's always a bit of a nagging feeling.

Gaby: I particularly enjoyed the articles written by Richard Isaacson about the early days. I think that is the kind of thing we miss. We tried and sometimes got interviews from the more senior people, but we didn't have many of those longer stories about the history written by the protagonists.

Q: What are you looking forward to? Both for the Magazine and the community.

Gaby: For the community, I think we are in a transition phase. LIGO is not a static observatory, I don't think it will ever be. I was saying we are becoming a bit more business-like as we have tight observing run schedules and expectations of these observing runs. But future observations with current detectors and multi-messenger astronomy are very exciting, and there is a transition to new detectors, not just the ground based ones, space based too. In the long term, I hope there will still be some kind of community, like the LIGO collaboration, that is developing technology and analysing the data.

Andreas: Personally I'm quite optimistic about the future at the moment. I always feel that despite our success, we haven't really reached a stable state where we know we can provide gravitational-wave data to the astronomical and fundamental physics community on a regular basis in the long term. For me, this is almost more interesting than the discovery itself. Maybe it's because I'm an experimentalist who likes to make things work not just once, but all the time. We are not there yet. I think we need the next generation of detectors such as the Einstein Telescope or Cosmic Explorer before we will have really established a self-sustained long-term community. But, the development of these future detectors is moving along quite fast now.

Gaby: I still think communication is important to keep us working towards the same goal and getting it to work like we did, and that's not easy. We are more international and globalisation is a bad word sometimes, but I think in our case it's a good thing. Maybe one day we will have a "Gravitational Wave Magazine'.

But for the future of the LIGO Magazine, I would like to see it going as it is – having young voices, diverse voices, people explaining to each other what they mean. There will always be new stories.

LIGO 2022

Contributions by various editors past and present

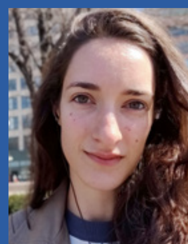
One of my favorite parts of working with the LIGO Magazine was gaining a deeper understanding of the work being done in other areas of the collaboration. Collecting memories of GW170817 and piecing them together in a timeline really highlighted the rollercoaster of close calls as everything came together to make such high stakes rapid announcements for the first time. Another favorite memory is interviewing

Annamaria Effler about commissioning. She exemplified the deep and interconnected understanding of the instrument that the commissioners had to develop. It was always really satisfying to work with Collaboration members on Magazine stories and to help them share their unique perspective and expertise with the bigger community. - ***Jocelyn Read***

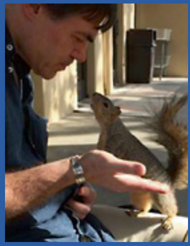
The memories of the early days of the LIGO Magazine have become quite fuzzy by now. So I had to open what is now a time capsule of emails from the time I was assistant spokesperson (remember when we used to meet in EVO!?) What a nice surprise to read the first emails, when Gaby, Andreas and I were discussing setting up an svn repository for the Magazine, thinking about the first associate editors, tossing up the first ideas for content. Our plan was to strike a balance between LIGO science and "fun" content so the Magazine could be an interesting read for LSC members as well as the general public. I think we succeeded, thanks to Andreas and the many editors who worked with and after him. It is so rewarding to see that the Magazine is still going strong! My best memory? The feeling of touching the first printed edition!

- ***Marco Cavaglia***

The Magazine captures a slice of life from our collaborations over the last 10 years. I started out working with Andreas on the Magazine in 2015 (16 issues ago... I can hardly believe how time flies!). I think the Magazine is a unique place where we can include personal perspectives and tell the interesting human stories of the people in our community, many of which are stories that would otherwise have been lost to the aether. I always love seeing those first layouts of each issue so beautifully put together by Sascha. And what a great team to work with – thank you to all the editors past and present for your enthusiasm! - ***Hannah Middleton***



The Magazine connects our community together both in a social and scientific sense. I can think of several occasions where I've reached for a back cover to start understanding a concept outside my specialty, and love that many of our pieces let us hear those "smaller" stories behind the big announcements. During the height of the pandemic I particularly appreciated working on the Magazine to hear how everyone was doing (aside from the many zooms…). It's always a real joy to be able to celebrate all of the projects and hobbies our community do, from art to puzzles to outreach, as well as highlighting important topics both for ourselves and the wider scientific community, such as Steve Penn's recent piece on classism. - ***Anna Green***



When Andreas asked us to help develop a magazine for the LSC we were immediately enthusiastic. We were convinced that it would be great for its goal of improving communications within the LSC, but we also believed that the publication would have enormous potential to reach external groups such as other scientific communities, students,

policy makers and funding agencies and even the general public if done right. To our mind, these two aims went hand in hand. Everyone would be reading the papers and journals in their field to keep up, so in-depth scientific articles would be unnecessary and research news, overviews and background stories would be more appropriate to inform LSC people of the current state of the collaboration. Additional general "human interest" content would help foster community feeling, and so it would not be a big step to increase the appeal of the Magazine for a wider audience.

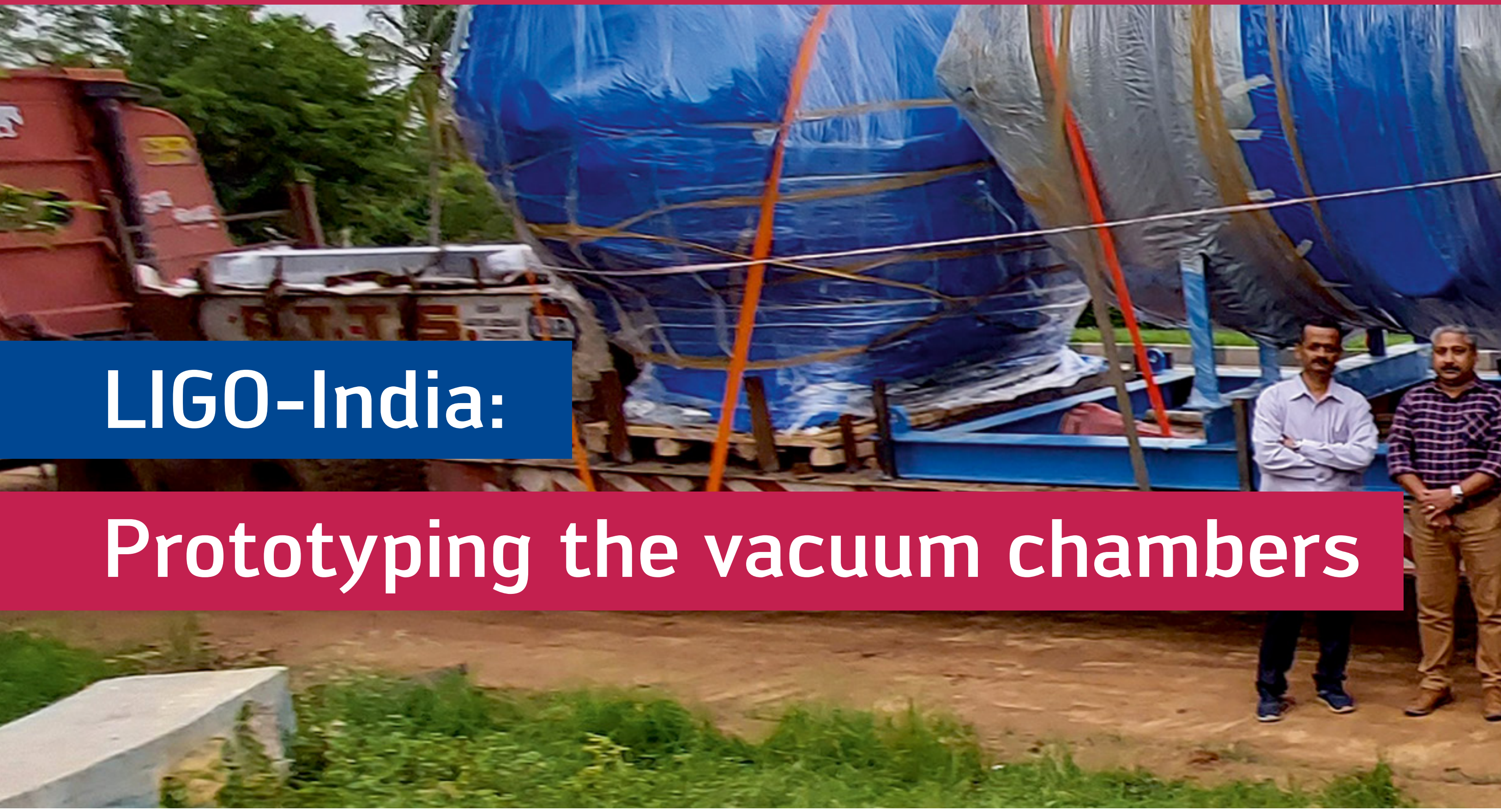
Andreas, being an old outreach hand, was open to this idea. Ultimately, we only needed three ingredients to achieve it: as the best way to increase identification with a story is to put a human face on it, we suggested adding very short and fun author bios including a picture. We also had a few short intro paragraphs for each article: this would allow scientists with little time to skim over the content but also inform non-specialists about some of the important aspects. And finally, because a picture is worth a 1000 words, we tried to have beautiful images wherever possible in addition to the graphs and figures beloved by scientists.

This approach is still the cornerstone of each LIGO Magazine. We try to evolve the design a bit with each edition to keep the Magazine fresh and interesting. There are so many exciting topics, great news and inspiration from the growing and ever busier community. It is a joy to work on each edition!

- ***Sascha Rieger & Susanne Milde***

LIGO-India:

Prototyping the vacuum chambers



The BSC and HAM were loaded onto a single truck for transportation from the factory to the site.

The LIGO-India project began with the dream of realizing the full potential of gravitational-wave astrophysics through the construction of a third Advanced LIGO detector in India. To be located in the Aundha district in the eastern part of the state of Maharashtra, LIGO-India will enable a host of new scientific targets, from better sky localization of compact binary inspirals, to tests of General Relativity [1].

Vijay Bedakihale

is a Mechanical Engineer working with the LIGO-India vacuum team at the Institute for Plasma Research. He loves to go on long drives in the countryside, to refresh and be a part of nature.

LIGO-India is currently in the pre-project, prototyping phase. This is the first step in transforming the conceptualized design into a real physical form for evaluation. Recently LIGO-India completed the prototyping task for two types of vacuum chambers (1:1 full scale), namely the Basic Symmetric Chamber (BSC) and the Horizontal Access Module (HAM). This task helps the project establish the manufacturing process, and evaluate how the chambers perform by testing different working aspects in operational scenarios.

Gravitational-wave detectors require ultra-high vacuum

In gravitational-wave detectors, the detector components are housed inside BSC and HAM chambers. The vacuum system layout comprises six HAM chambers and five BSC placed in a specific configuration, among them three BSC are placed nearby while remaining two BSC are placed 4 km apart in a L shaped geometry and connected by 4 km-long beam tubes. This entire arrangement is evacuated and maintained in ultra-high vacuum to achieve the exquisite sensitivity needed to detect gravitational waves.

Sensitivity is achieved by controlling the residual gas inside the vacuum system. Residual gas particles flying through the laser beam produce stochastic scintillation – an effect which is like white noise

[1] *The Science Case for LIGO India* https://iopscience.iop.org/article/10.1088/1361-6382/ac3b99

by Vijay Bedakihale & S Sunil

LIGO division members at IPR, who were part of the vacuum work, ready to handle the next big challenge! Left to right: Arnab Dasgupta, Hitesh Gulati, Vijay Bedakihale, Amit Srivastava, Atul Prajapati, Naresh Gupta, Rakesh Kumar, Sunil Susmithan & Subroto Mukherjee.

S Sunil

PhD, is an Experimental Physicist working as Scientific Officer with the LIGO-India team at the Institute for Plasma Research developing methodologies for improving the vacuum system of LIGO-India. He enjoys driving, photography and visiting places.

in the detector output. Inside the vacuum chambers, residual gas between the mirror and its surroundings kicks the mirror around randomly, masking gravitational-wave signals at low frequencies. The vacuum chambers must also be exceedingly clean to prevent the buildup of contaminants on the mirror surface – dirty mirrors absorb too much of the laser power leading to nanometer-scale thermal distortions of the mirror surface.

LIGO India: A Gravitational Wave Detector in India

LIGO-India has been proposed as a mega-science project, jointly funded by the Department of Atomic Energy (DAE) and the Department of Science and Technology (DST) of India. The four nodal institutions: Institute for Plasma Research (IPR), Raja Ramanna Centre for Advanced Technology (RRCAT), Directorate of Construction, Services and Estate Management (DCSEM), and The Inter-University Centre for Astronomy and Astrophysics (IUCAA), share project execution responsibilities, in which the vacuum system procurement and installation responsibilities are assigned to IPR.

Challenges in making vacuum chambers

A gravitational-wave observatory like LIGO is an integrated facility, in which multiple parts are put together in a precise layout. Constituent parts must follow precise dimensional requirements and need to be fabricated with due diligence.

Basic parts for LIGO-India's beam tubes and chambers, formed from steel sheets and plates, need to be manufactured within a few micrometers accuracy. The welding processes used to join parts need great care to produce joints with low distortion without affecting the raw material properties. Ultra-high vacuum operation means that the cleanliness of the surrounding environment and personnel involved play a vital role in preventing contamination of the manufactured parts and their assembly. The use of cleanrooms is essential to maintain cleanliness, which necessitates getting accustomed to cleanroom work culture.

During the pre-qualification phase, specifications are made for details such as the type of raw material, the joining process used, tolerances on dimensions, the surface finish, and contamination control. Taking surface finish as an example: a very smooth interior surface would lead to unwanted scattering of the laser beam due to reflections from the surface which requires the surface roughness to be specified. This ensures beam scattering is minimized.

Once all functional requirements are finalized, the specifications are used to establish a quality assurance plan to be followed in part fabrication, assembly and testing.

Why prototype the vacuum system constituents for LIGO-India?

One question may come to the mind of readers is why a prototype is necessary when LIGO-India is based on LIGO-US design which has been built and commissioned already? LIGO-India vacuum system is entirely manufactured in India (chambers, bellows, spools, adaptors, 80K pump and beam tubes), as nothing is coming from LIGO-US.

In India, the metric system is followed for dimensions, while the US follows the imperial unit system. Therefore, dimensions of existing LIGO-US vacuum system layout are entirely converted into the metric system in preparing LIGO-India design drawings which itself is a major task.

In addition, certain processes (e.g. welding, material cutting etc.) are continuously evolving technologically over the last couple of decades since the LIGO-US system was constructed, which further needed to be adapted and qualified for production.

In a nutshell, at the end of prototyping we will essentially have 1) decided on the material specs (size) and source for supply; 2) established the cutting and joining process with qualification: 3) design of tools and fixtures adopted in handling, guiding and transportation; and 4) ensured the level of manufacturing accuracies and precision metrology.

The BSC and HAM assembled in the workshop.

Metrology of BSC prototype in progress.

Next step – finding a vendor

After finalizing the manufacturing feasible design, our next major step is to identify vendors to manufacture the vacuum equipment. Our objectives in the vendor selection process are to maximize value, minimize purchase risk, and develop a good long-term relationship with the vendors.

It was challenging to identify a vendor with on-premises facilities capable of meeting our various processing needs. Our central focus was to identify a vendor who: has access to essential processing facilities locally, recognises the specifications associated with procurement, has sound financial backup, and is able to form a team of members from procurement, design, production, quality and logistics catering solutions covering the scope of prototyping. After a careful selection process, the chosen contractor delivered the large vacuum chambers on schedule despite COVID constraints!

"Factory acceptance testing of the HAM and BSC were carried out during the small window of relaxation given to the states during the COVID period, even though it was tough to find suitable accommodation in hotels. At times we spent nights at the factory, 25 km away from the hotel due to travel restrictions late at night" – Sunil

Factory testing of the HAM Chamber.

The prototype BSC and HAM after delivery to RRCAT, Indore.

Difficulties during COVID-19

The COVID-19 pandemic set in soon after the contract was awarded, leading to breaks just when activities were set to gain momentum. It meant constraints on access to contractors' facilities, on raw material procurement, on interaction to exchange information, etc. Despite these odds, a proactive approach from both sides paved the way to slow but steady progress. As the situation improved, a manufacturing schedule was planned to overcome the lost time, followed by inspection, testing and dispatch to accomplish timely shipment of the chambers.

The behind-the-scenes coordination of work and logistics schedules, and efficient communication, were critical in making this all work, and we commend the teams on both sides for their success. The timely review and approvals by the technical experts committee supported by the working groups was of immense help to accomplish scheduled tasks of this contract.

When Planning Meets the Real World

The fabrication of the HAM and BSC was like a script written for a Bollywood movie. The award of the contract had occurred in parallel with the COVID-19 pandemic spreading across the nation, and the shipping of the chambers was another interesting chapter.

How could we transport the two chambers over the 1300 km journey from the vendor to the delivery site? Ultimately we used a custom built transport frame for the BSC and a base supporting structure for the HAM, with both on a single trailer. During transit, the chambers were filled with high purity Nitrogen gas at 1.2 bar (abs) to preserve cleanliness and precision geometry.

"We were apprehensive that, during transit, the internal pressure may deteriorate through the O-ring seal joints. But the pressure sustained till it reached the delivery site having passed through different climatic terrain." – Vijay

The pandemic gave us an opportunity to learn lessons in overcoming adverse conditions and managing work. Good collaboration among team members helped maintain a planned work schedule.

Dimensions: check!

The integrated system of LIGO-India will operate at its aimed sensitivity so long as the constituent elements meet their designed accuracy. During prototype manufacturing, special tools, jigs and fixtures were developed and used to limit distortions during welding and handling.

There is great onus on the metrology we do to confirm that the part dimensions are within specified tolerances. Sophisticated metrology instruments are needed such as laser trackers to record vacuum chamber dimensions within a few micrometer accuracies. The resulting prototype vacuum chambers confirm that our manufacturing procedures, tools & fixtures, metrology equipment selection met the required precision.

Pressure: check!

Once the fabrication of the chambers was completed and they were standing in front of us, our minds were racing to take up the next challenging task – to have one-billionth of atmospheric pressure inside them!

We needed different sets of vacuum pumps to reduce pressure inside the chambers and reach ultra-high vacuum. How long it takes depends on the internal volume of the chamber, surface cleanliness, pump speed, and the quality of the weld joint and vacuum seal joint. Some preliminary estimates gave us an idea of how long it should take to reach the desired pressure.

The chambers have ports designed for connecting pumps and monitoring equipment (like vacuum gauge, residual gas analyser etc.). Initially we pumped down from atmospheric pressure to one millionth of that using a screw pump, then a turbo-molecular pump took it to one billionth of atmospheric pressure.

"HAM chamber was first selected for evacuation. Reaching the rough vacuum was accomplished as expected, but reaching the ultra-high vacuum was delayed. We were anxiously watching the gauge readings but throughout the night, the gauge did not display the magic number (1×10^{-7} millibar), increasing our anxiety." – Sunil

After a long wait, these magic numbers were achieved in less than 100 hours, which was indeed a successful and delightful achievement as it matched our estimations.

Hardly any leaking

As chambers are pumped down to low pressure, a large pressure difference occurs on the chamber wall. It is important that there are no cracks in the wall and welding joints nor any leaks through the vacuum seals. The chambers undergo leak detection testing to ensure they have a leak rate less than one part per billion. The chambers have been tested and certified thereby demonstrating the quality of the manufacturing work.

Looking forward

With the prototyping of the vacuum chambers complete, our focus shifts to the next tasks. This includes manufacturing the cryopump which will reduce the instrument's temperatures to 80 K (about -193 °C), and fabrication of two 10 m long cylindrical stainless steel vacuum vessels. The vessels will be connected together with intermediate bellows, allowing assembly and operational alignment requirements. Additionally we will develop the vacuum control and monitoring system for setting up the integrated facility which will be used to test the 80K cryopump performance.

At present manufacturing of 1) 80K Cryopump prototype (1:1 scale) and; 2) 2 X 10 m vacuum vessels are in progress at two different locations in India.

Once these tasks are accomplished, the LIGO-India team will be prepared to enter into the production phase of the vacuum system!

LIGO 2022

Acknowledgements

The team would like to acknowledge Jon Feicht, Dennis Coyne, Michael Zucker, Rana Adhikari, Fred Raab, David Reitze and other members in LIGO-US for discussions and timely inputs to take the work to its logical conclusion demonstrating fulfillment of functional specifications. The team also extends their gratitude to The Director, IPR; to the Convenor & The Chair of PMB; to the technical expert committee and supporting working groups for sustained support throughout Pre-Project activities.

LVK and equity in the scientific literature

***Authors (clockwise):** Livia Conti, Pablo Barneo, Giuseppe Cabras, Pierre-Francois Cohadon, Davide Guerra, Edoardo Milotti, Jerome Novak, Agata Trovato, Andrea Virtuoso, Martin Hendry, Hisaaki Shinkai.*

Impact factors and citation counts are more and more important in the lives of scientists. Bibliometry has steadily expanded its reach to quantify both the productivity and the impact of individual scientists. Career and funding opportunities strongly depend on them, however the general feeling is that these numbers do not capture the whole picture. Peer recognition also reflects on the attribution of intellectual property to a given researcher.

This attitude affects individuals and scientific collaborations alike. Here we examine the case of the LIGO-Virgo-KAGRA (LVK) Collaborations. About 18 months ago, one of us was reading a new scientific paper and was startled by a few sentences referring to the gravitational waves (GWs) detected from merging black holes (BH) as 'LIGO measurements'. This shed light on what turned out to be a not so uncommon trend in the narrative of papers in scientific journals citing results of the LIGO-Virgo (LV) and LVK Collaborations.

With encouragement from the Scientific and Technical Advisory Committee of the European Gravitational Observatory (which hosts Advanced Virgo), we started monitoring papers appearing daily on the electronic preprint repositories (arxiv/gr-qc, arxiv/astro-ph). Using an automatic script, we collected papers containing the word 'LIGO' and searched the text for instances where 'LIGO' is not associated with 'Virgo'. We manually checked each paper and found about 7 new papers per week contain major issues, such as '...the population of BHs currently probed by LIGO...The event GW170814 allows the LIGO collaboration to determine that ...LIGO has observed a large number of BH-BH or BH-neutron star merging phenomena...'.

In early 2022 we moved to a more active approach. We began contacting the paper submitters and describing the issues in their papers, explaining that a biased narrative of the scientific developments can produce detrimental effects on the work of hundreds of people and the future funding of the field, at least in Europe. We asked for the paper to be edited and so far, we have received a large majority of positive replies. Authors are open to recognize the issues: 'Many thanks for flagging this up!', 'You are absolutely right. I apologize for my inaccuracy'. They declare to be willing to edit the papers, at least those that have not already gone to print. Many authors' replies indicate that they do not know the wider LVK Collaboration: 'We just naïvely thought readers will realise LIGO means all LIGO-like detectors including LIGO, VIRGO and KAGRA'. Some are disoriented: 'We did make an effort to get this right, but aspects of this are confusing (is the preferred reference to the "LIGO/Virgo Collaboration", "LIGO/Virgo Collaborations", "LIGO and Virgo Collaborations", or something else?)'. We hope that our efforts will spread the word to the wider scientific community, not just to a few scientists and we plan to continue this effort for at least this year.

We reported these findings at the LVK meeting in March 2022 and started a discussion on how best to support and complement this work. A set of actions were envisaged, including

- add our abbreviation LVK or LV to our top webpage, and describe what the LVK means in Wikipedia
- ask our internal reviewers to check that citations to LVK work be properly referenced
- let major journal editors know of this issue and ask them to correct it while proofreading

These actions were explicitly approved by the spokespersons of the three collaborations and we are now in the process of starting their implementation.

Let's hope that all together we can make an impact on the broader scientific community: this time not with our scientific results but by correcting bad habits and making Science more equitable.

The O3 GEO-KAGRA Observing Run

We celebrate completing the O3GK run without any serious troubles!

With the KAGRA detector in Japan ready to join the international gravitational wave network, in April 2020 it undertook its first joint observing run with GEO600 (GEO) in Germany whilst in the midst of the COVID-19 pandemic. Joint measurements were taken over two weeks in the O3 GEO-KAGRA (O3GK) run, and whilst no gravitational wave detection took place, several gamma-ray bursts (see the back page for more!) were observed. The results were released this past March[1]. Here, Hirotaka Yuzurihara (KAGRA) and Fabio Bergamin (GEO600) recount their memories of being part of O3GK.

Hirotaka Yuzurihara

is a postdoc at ICRR, The University of Tokyo, working on detector characterization for KAGRA. Every day he enjoys driving his favorite car, Suzuki Jimmy.

The O3GK run was a tough and busy period, and as it was two years ago my memories of that time are blurry at best. So, I dug through notes, online logbooks, and emails and remembered what a hectic and novel experience it was. In this article I will summarize some small stories before and during O3GK.

At the time of March 2020, I was a postdoc in Kashiwa, which is 400km away from the KAGRA site, and worked mainly on data analysis and developing web-based tools for use in data characterisation. The tool in question is called Pastavi (Past Data viewer), which can analyze KAGRA data online using several methods and produces timeseries, whitened timeseries, frequency spectrum, spectrogram and Q-transform.

At the end of March, KAGRA achieved 1 Mpc sensitivity in binary neutron star range and joined the global gravitational-wave observatory network, ready to start a joint observing run with GEO between April 7th - 21st 2020.

During the observing run, we conducted a 'three-shift-day', with daytime, evening, and midnight shifts, to maintain and monitor the interferometer from the domestic or foreign lab

However, at that time traveling to the site was not recommended due to COVID-19, so instead, the interferometer was maintained by commissioners working at the KAGRA site (less than 20 people). I was called to join the shift as a `super substitute` and worked on the midnight shift for three weeks.

Each shift was performed in pairs with one operator who is an interferometer expert, and a co-operator. At any time one person must be in the control room to watch the interferometer and note any problems. Most of the time, the interferometer needed little attention, and we could spend time working on our other research.

The KAGRA site in Mozumi, Gifu and the dormitory in Toyama are 20km apart - around a 30 drive. After the midnight shift, it was always tough to sleep in the morning sun.

A number of unexpected things happened during O3GK. At the beginning of the run, incorrect calibration parameters were applied and the inspiral range was conse-

[1] *Find out more about O3GK at https://www.ligo.org/science/Publication-O3GEO-KAGRA/*

quently doubled. Then in the middle of the run, due to the strong seismic activity, the interferometer didn't lock for two days. As for daily life, due to COVID-19 the restaurants around the dormitory had closed and because of a landslide there was a road diversion on the national route to reach KAGRA site. The most surprising thing on the astrophysics side was the observation of gamma ray burst GRB200415A. The data analysis of O3GK data including the GRB target search was done and recently the collaboration paper with GEO was published.

We finished the O3GK run without serious issues, even though a state of emergency was declared in Japan in the middle of April. Then ten months later, I started working at the KAGRA site, where we are working hard to obtain the best sensitivity in Observing Run 4.

Good news though for those people who join for future shifts. A new dormitory has now opened at the KAGRA site which is only a few minutes walk away. No need now for the long drive!

Fabio Bergamin

is a PhD student at AEI Hannover, mainly working on the commissioning of squeezing at GEO600 and the development of a sub-carrier technique to lock the signal-recycling cavity. In his free time he likes to ride his bike and play music with his band, the DSC.

GEO, the German-British gravitational wave detector located near Hannover, has been operating in an "astrowatch" mode since November 2007. This means that the detector generates calibrated gravitational wave strain data around the clock, typically active 70% of the time, and otherwise used by scientists and operators on site conducting scientific research or commissioning the instrument. The automated locking and alignment of the detector, along with the ability to remotely control it, allowed operations to continue even during the hard times of the pandemic.

That said, it is not surprising that GEO was the perfect candidate for a dedicated observation run with KAGRA when the O3b run had to be suspended on March 27, 2020 due to the COVID-19 crisis. The Japanese team had made tremendous efforts to build and commission the detector in just ten years and they were ready to join the detector network before the end of the third observation run. It would have been a pity if KAGRA had to wait until O4.

The news of the extraordinary two week observation run in April 2020 was greeted with great enthusiasm by our team. Once again, GEO was able to demonstrate its importance in the international detector network, despite its lower sensitivity with respect to the larger detectors. At that early stage in fact, KAGRA had a similar sensitivity to that of GEO. On the KAGRA side, it had an opportunity to be tested in simultaneous data taking and follow-up data analysis. It was a win-win situation!

The two weeks went rather smoothly, with only some minor issues like computer crashes or a scroll pump replacement that did not prevent GEO from reaching 80% active observing time. Squeezed light was injected 98% of the time, with squeezing levels close to 6dB. The quiet of those early spring days was disturbed only by a thunderstorm on day 6 that caused a day of downtime. Quite ironically, that was the only observed coincident event between the two detectors.

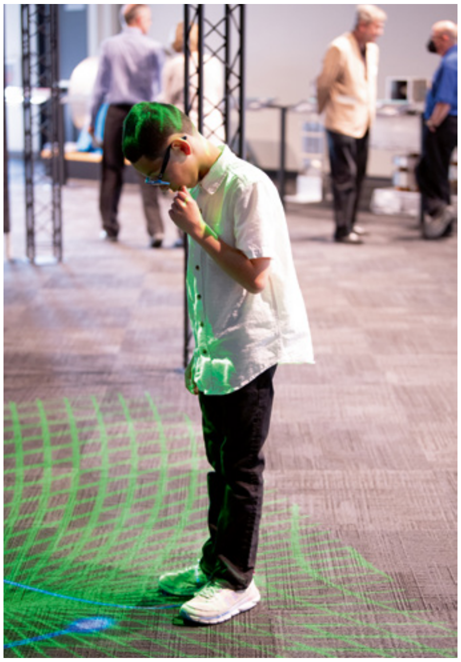
For my part, I was required to keep an eye on the control monitors when I was on site. This way, I could focus on my research in the background. Actually, the hardest part of those two weeks was to not touch the interferometer. At GEO we are used to testing new technologies every week, and when the interferometer runs in instrument science mode the chance to "play" with the detector is a unique experience for a PhD student like me. I just had to wait patiently before continuing my experiments, at that time I was involved in measurements related to the backscattered light that affects the squeezer performance.

Unlike when we had vacuum fix operations in 2019 and 2021, no night shifts were required during O3GK. I was very grateful to the generations of scientists who worked at GEO before me, making a fully automated machine. All of us have peaceful dreams because we can be sure of one thing: GEO never sleeps!

The north tube of GEO during a beautiful summer day. The fields of corn, wheat, canola and sugar-beet are as beautiful to the eye as they are harmful to the stability of the instrument during farming activities. Fortunately, during O3GK it was still early for sowing.

Grand Opening!

LExC, the new LIGO Exploration Center at LIGO Hanford in Washington State, provides a home for LIGO's outreach mission, welcoming students and families to learn more about gravitational-wave science. On the 2nd of June 2022, LExC hosted scientists, educators, and policy makers for the Grand Opening event.



Top: *Amber Strunk (LIGO Hanford) cuts the ribbon. Also pictured (left to right): David Tirrell (CalTech), Sean Jones (NSF), Chris Reykdal (OSPI), and Michael Landry (LIGO Hanford).*

Above: *Guests including (right to left) Governor of Washington Jay Inslee, Rainer Weiss (MIT), Linnea Avallone (NSF), Sean Jones, David Tirrell, and Chris Reykdal.*

Top left: *Warped space time in the Gravity Floor exhibit.*

Below left: *Nobel Laureate Rainer Weiss speaks with Governor Jay Inslee.*

Close left: *David Tirrell, Caltech Provost, and wife Jane Tirrell learn about previous LIGO technology.*

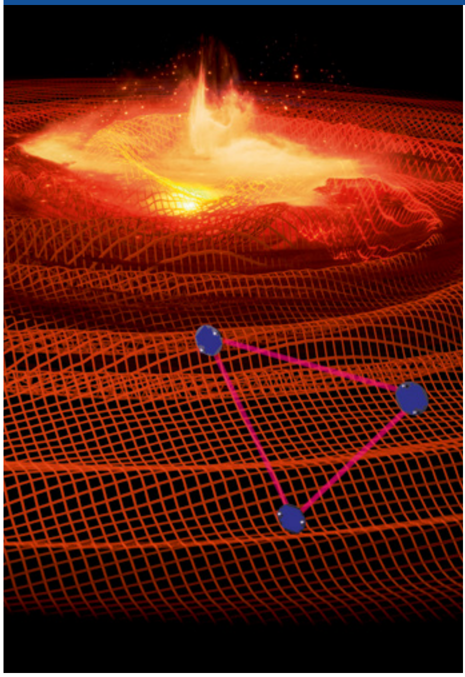
The LISA Data Challenges

by Quentin Baghi

Some have argued that “LISA is not LIGO in space” [1]. This statement is pretty accurate, even if we can find common aspects. Like LIGO, Virgo and KAGRA (LVK), the future space-based observatory will use laser interferometry. And like LVK, gravitational waves passing through the detector create a local distortion of spacetime, affecting the phase of the laser light in some distinctive way. However, LISA will measure gravitational-wave signals with wavelengths 100000 times larger than those measured by ground-based observatories, opening new ears to the gravitational universe.

To achieve this measurement, we must have a large detector, much larger than the size of the Earth. We must also send it far away to avoid Earth disturbances. These requirements have driven the mission design to be a constellation of 3 satellites orbiting the Sun 50 million kilometres away from the Earth, forming a network of interferometers exchanging light beams over distances covering 2.5 million kilometres, which is nearly 200 times the diameter of the Earth!

Unlike telescopes, we cannot point gravitational-wave detectors towards a particular region of the sky. Instead, we "listen" to the whole sky simultaneously. This makes analysing the data a difficult task. Scientists have to scan the data streams by comparing them to thousands of waveform templates, assuming that the gravitational waves could be coming from any direction. This analysis is done routinely by the LVK collaborations, which detects merging black holes or neutron stars every month during the observing runs. However, LISA data will differ from LVK in at least two ways.



▲ *An artistic representation of LISA, the Laser Interferometer Space Antenna.*

First, during the four-year mission, LISA will measure various different sources to those observed by the LVK, from tens of thousands of pairs of compact stars in our Galaxy to hundreds of merging supermassive black hole binaries. These black holes will have masses one thousand times to one million times larger than the most massive LVK sources. LISA will also reveal multiple binary systems with high mass ratios that we call "extreme mass ratio inspirals" (or EMRIs for short). In an EMRI, a low mass compact object like a star or a small black hole is in orbit around a much higher mass black hole and LISA will see many orbits over the mission lifetime. All these sources will create a cacophony, as their numerous signals will superimpose in the data. Separating and identifying all of them is a crucial and challenging issue, which does not concern LVK data where detected signals are isolated mergers.

[1] *Neil Cornish, American Astronomical Society meeting #235, id. 376.02. Bulletin of the American Astronomical Society, Vol. 52, No. 1, January 2020.*

Quentin Baghi

is a postdoctoral researcher at the French Atomic Energy Commission (CEA) in Paris Saclay, working on various data analysis aspects of LISA and is also a co-chair of the LISA Data Challenges. During spare time, Quentin likes making and editing short films, which are totally unrelated to science!

Second, the time scales at play are very different. While the loudest signals last fractions of seconds or minutes in LVK detectors, LISA will continuously measure sources like compact Galactic binaries or EMRIs throughout the entire mission duration, as the signals are caught in their inspiraling phase, long before they merge. Hidden under all these loud signals, cosmologists expect to see the traces of a stochastic gravitational-wave background, a sum of incoherent "sounds" coming from the Universe's dark ages. Hence, the wealth and features of LISA sources require scientists to rethink how they analyse data and develop new, ingenious methods to sift through all these detections. LVKs experience gives them a formidable place to start, but extracting the full scientific potential of this unprecedented mission will require a great effort.

These challenges have led LISA scientists to undertake a series of blind tests, called the LISA Data Challenges. They consist of simulated data sets where gravitational-wave signals have been included, but the details of the signals are not disclosed to the challenge participants, so that they do not know in advance what they are looking for. Such synthetic data will help researchers to invent and test prototype methods. They are working hard to get ready by the time LISA flies, and they happily welcome newcomers; so if you feel up to the challenge, it is time to join them on their playground!

Find out about the LISA Data Challenge at https://lisa-ldc.lal.in2p3.fr/

Frequency-Dependent Quantum Squeezing will optimize O4 sensitivity

▲ *Martina De Laurentis and Valeria Sequino at work on one of the Squeezer benches at Virgo.*

Further reading:

- Abbott, et al., "Prospects for observing and localizing gravitational-wave transients with Advanced LIGO, Advanced Virgo and KAGRA", Living Reviews in Relativity, 23, 3 (2020)
- Tse, et al., "Quantum-enhanced Advanced LIGO Detectors in the Era of Gravitational-Wave Astronomy", Phys. Rev. Lett. 123, 231107 (2019).
- Acernese, et al., "Increasing the Astrophysical Reach of the Advanced Virgo Detector via the Application of Squeezed Vacuum States of Light", Phys. Rev. Lett. 123, 231108 (2019)
- Zhao, et al., "Frequency-Dependent Squeezed Vacuum Source for Broadband Quantum Noise Reduction in Advanced Gravitational-Wave Detectors", Phys. Rev. Lett. 124, 171101 (2020)
- McCuller, et al., "Frequency-Dependent Squeezing for Advanced LIGO", Phys. Rev. Lett. 124, 171102 (2020)

Quantum Squeezing is an experimental technique where a "squeezed" state of light is used to achieve a lower noise. The noise reduced here is not technical noise such as the intensity fluctuations of laser light or the voltage noise of electronic devices. It is instead a fundamental noise originating from quantum vacuum fluctuations that are limited by the famous Heisenberg Uncertainty Principle of quantum mechanics. The amplitude and phase of a light wave cannot both be observed with infinite precision at the same time. The light emitted from a laser would have an equal amount of fuzziness when you measure its phase or amplitude. Squeezed light, however, makes it possible to reduce such quantum fuzziness.

Unlike the laser light which is a coherent state of light, the squeezed state of light has lowered noise in one of phase or amplitude but increased noise in the other without violating the Uncertainty Principle. Since the interferometers like LIGO, Virgo, and KAGRA (LVK) essentially translate gravitational waves into phase signals of the laser, a reduced phase noise with squeezing can enable us to see some buried gravitational-wave signals that lay undetected before.

In Observing Run 3 (O3), LIGO and Virgo deployed squeezing and successfully achieved 3 dB (factor of 1.4) reduction of the noise above 50 Hertz. With this, coupled with other upgrades in O3, observing gravitational waves suddenly became weekly news. However, there was room to do better yet – the noise below 50 Hertz did not benefit from squeezing. This is because the anti-squeezed or increased amplitude noise became radiation pressure noise on the mirror. There are still very crucial signals below 50 Hertz, for example, inspiral of binary neutron stars.

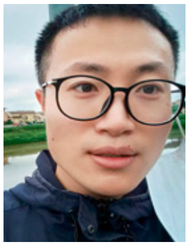
Wenxuan Jia

is a Ph.D. candidate and Mathworks Fellow in MIT LIGO Lab supervised by Professor Matthew Evans. His research focuses on precision measurement and quantum optics, specifically experimental and theoretical problems on reducing the fundamental quantum noise of gravitational-wave detectors.

Valeria Sequino

is a post-doc at the University of Naples "Federico II", working on quantum noise reduction starting from 2012. Since she was very young, she has been fond of Indian culture and enjoys cooking (and eating!) Indian food.

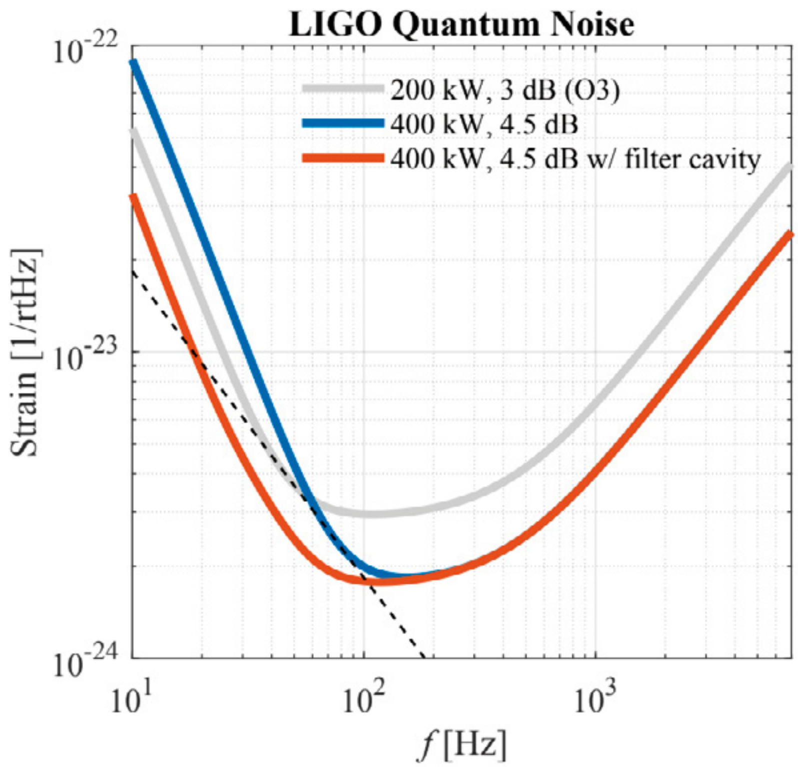
Yuhang Zhao



is a post-doc at the Institute for Cosmic Ray Research (ICRR) at the University of Tokyo working on frequency dependent squeezing. He likes endurance running and recently enjoyed reading 'Le Petit Prince'.

Antonella Bianchi

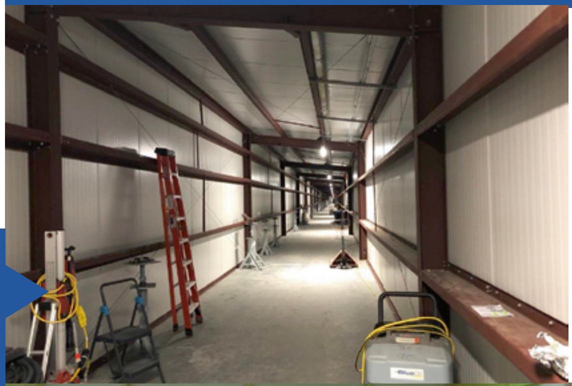
is a PhD candidate at VU University (Amsterdam) happily working at Nikhef. She mostly does optical simulations to help Advanced Virgo commissioning (currently on site for one year) and for Einstein Telescope. In her spare time she is writing a fantasy book, visits art museums and attempts to keep a regular yoga practice.



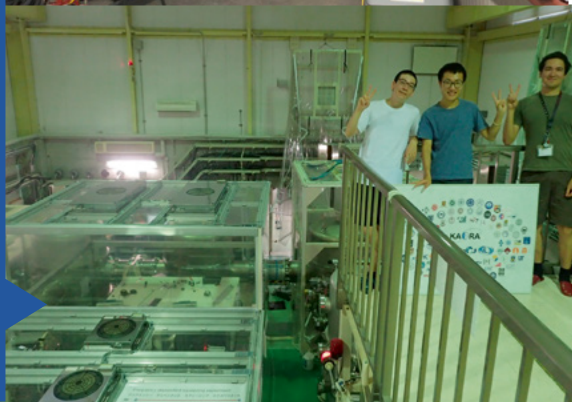
Strain sensitivity curve of LIGO with/without filter cavity for frequency-dependent squeezing. The low-frequency quantum radiation pressure noise would be reduced thanks to the new filter cavity.

In the upcoming Observing Run 4 (O4) for LVK, LIGO and Virgo are constructing and commissioning new filter cavities to achieve a broadband reduction of quantum noise using frequency-dependent squeezing. The new 300 meter-long cavity at LIGO, when detuned with respect to a squeezed state, has the capability to rotate the squeezing angle in a frequency-dependent way. It is important that this rotation occurs at a particular frequency where quantum shot noise equals quantum radiation pressure noise. At this point, the status of minimum quantum noise is achieved (also known as standard quantum limit). The value of this frequency depends on the interferometer configuration and, for the present gravitational-wave detectors, it is of the order of a few tens of Hertz.

The use of frequency-dependent squeezing combined with the reduction of other noise sources at both low and high frequencies will allow us to probe a deeper universe. The expected LIGO sensitivity upgrade is from 110-130 (O3) to 160-190 Mega Parsec (MPc) (O4). Virgo aims to reach 90-120 MPc in O4 compared to 50 MPc in O3. This means about three times more frequent detection is expected in O4 compared with O3 (see Abbott et al., 2020).



Interior of the new 300m squeezing filter cavity building at LIGO Livingston.

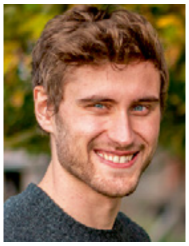


A 300m filter cavity prototype located in NAOJ, Japan, using the infrastructure of TAMA300. An in-air squeezer produces frequency independent squeezing and goes to an in-vacuum 300m filter cavity to become frequency dependent squeezing. The squeezer is in the cleanroom on the lower left side of this photo. The door for the filter cavity is in the middle of this photo. (Marc Eisenmann, Yuhang Zhao, Michael Page).

A Crucial Part of our Wellbeing

Mental Health. **It is a topic that many people shy away from. Maybe because they deliberately don't want to think or talk about it. Or maybe just because they aren't consciously aware of it. I was one of those people until three years ago. Just before the Covid-19 pandemic hit Europe my two year-long relationship stranded very unexpectedly. It turned my protected life upside down, but very soon I also realized the great opportunity it offered. Imagine stumbling upon hints of violations of general relativity. For sure it will shake your world, but it also opens up a whole new range of options to start thinking about.**

Kamiel Janssens



is a PhD student in Antwerp, Belgium and a member of Virgo. He searches for a stochastic gravitational wave background and contributes to environmental noise monitoring. In his free time, he likes rock climbing and learning more about psychology and mental health issues.

The importance of mental health

Mental health is a crucial part to our sense of wellbeing and functioning. Furthermore there is (bi-directional) interplay between one's mental and physical health. For instance, the US Centers for Disease Control and Prevention (CDC) and National institute of mental health (NIMH) indicate that depression can lead to long-lasting conditions such as diabetes and heart disease [1,2].

Apart from affecting our physical health, our mental wellbeing can affect so many other aspects of our daily life such as our interactions with people around us, our own sense of happiness, quality of life and productivity.

The numbers of people experiencing mental illness are astounding. Half the world population will at some point in their life be diagnosed with a mental illness or disorder [3]. Each year one in five of the US population will experience a mental illness [4]. People in academia often experience higher levels of mental distress compared to the general population. Have a look at this interesting overview article on mental health in academia by Prof. Ivy Bourgeault [5]. The global Covid-19 pandemic of the last years amplified many of the already existing issues even more.

The LVK mental health survey

After suggesting to organize a mental health survey in the LIGO, Virgo and KAGRA (LVK) community, the idea was quickly endorsed by both the management and a large number of collaboration members.

Following many months of preparation the survey was distributed between August 24th and September 30th 2021.

The goal of the LVK mental health survey is multifold. First of all it opens up the discussion on mental wellbeing. In that way we try to make the subject discussable and break the taboo about it. Secondly, we want to understand the unique situation people in the LVK collaborations (or academia in general) might be experiencing and how this interfaces with their mental health. Third and finally we could hope that by gaining insight in this matter we could come up with ideas to implement changes in the collaboration life in order to increase the mental well-being of our members.

Preliminary results

Slightly over 400 people participated in the survey with a participation rate of about 20% across all collaborations. Whereas there is still plenty of room to improve the participation rate, the number of participants is sufficient to gain some first insights into the mental wellbeing of LVK members.

Of the participants 205 (49,2%) were junior scientists [1] and 197 (47,3%) senior scientists [2]. 68,11% of the respondents was cis-male and 26,14% cis-female [3]. 1,68% identify themselves with a different gender and the remaining participants

[1] *In the junior scientist category we consider: bachelor/master students, PhD students and postdocs.*
[2] *In the senior scientist category we consider: staff scientist/engineer, tenure and tenured track professor.*
[3] *Definition cis-gender: describing or connected with people whose sense of personal identity and gender is the same as their birth sex (Oxford Dictionaries).*

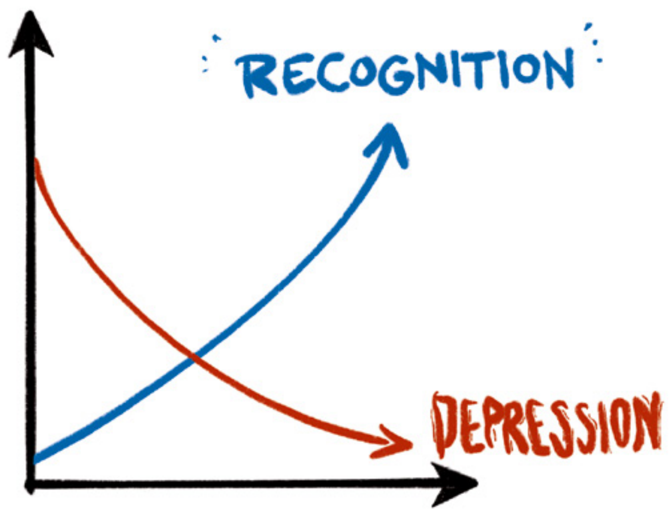
preferred not to share this information. 10,1% considers themselves to be part of a minoritized group within the collaboration and another 16,1% within both the collaboration as well as their country of residence. 62,1% find their work (very) meaningful, however on the other hand 36,9% of the participants consider leaving the collaboration/academia at least once a month.

In the survey we used a validated set of nine questions (PHQ-9 [6]) to probe the level of depression. A more detailed discussion of this will follow in an 'analysis document' of the survey, currently in preparation. One item we already want to point out in the preliminary analysis is that we found a strong anti-correlation between reported levels of depression and recognition. That is, people reporting to be properly recognized in- and/or outside the collaboration for their work, reported lower levels of depression.

What comes next?

Based on the preliminary results presented to the LVK collaborations some discussion has already started on, for example, improving recognition both within and outside the collaboration.

Finally we are gearing up to have a repetition of the survey to monitor the changes over time. The effect of the Covid-19 pandemic and subsequent lockdowns could be expected to decrease on the next edition of the survey as restrictions are less strict across the world. Other collaborations in the field of multi-messenger astronomy have expressed their interest to join the effort and we are looking for possible synergies reaching beyond the LVK community.



Preliminary analysis of the LVK mental health survey shows a strong anti-correlation between reported levels of depression and recognition.

References

[1] https://www.cdc.gov/mentalhealth/learn/index.htm

[2] https://www.nimh.nih.gov/health/publications/chronic-illness-mental-health Bethesda, MD: National Institutes of Health, National Institute of Mental Health. 2015.

[3] Kessler RC, Angermeyer M, Anthony JC, et al. Lifetime prevalence and age-of-onset distributions of mental disorders in the World Health Organization's World Mental Health Survey Initiative. World Psychiatry. 2007;6(3):168-176.

[4] Key substance use and mental health indicators in the United States: Results from the 2015 National Survey on Drug Use and Health. Rockville, MD: Center for Behavioral Health Statistics and Quality. Substance Abuse and Mental Health Services Administration. 2016.

[5] https://academicmatters.ca/mental-health-in-academia-the-challenges-faculty-face-predate-the-pandemic-and-require-systemic-solutions/

[6] Kroenke K, Spitzer RL, Williams JB. The PHQ-9: validity of a brief depression severity measure. J Gen Intern Med. 2001 Sep;16(9):606-13. doi: 10.1046/j.1525-1497.2001.016009606.x. PMID: 11556941; PMCID: PMC1495268.

Do I miss Physics?
Back to Nature

▲
Sydney Chamberlin is a Project Manager for Climate & Nature-based Solutions with The Nature Conservancy (TNC) in California. She holds a PhD from UW-Milwaukee. When she is not working, Sydney enjoys spending time in nature and with her dog, Nova.

"It can be challenging to find a signal in data, whether it's a gravitational wave or a good solution to a hard policy problem. In physics, I tackled this problem across the gravitational-wave spectrum, first exploring stochastic backgrounds with pulsar timing arrays and later detecting compact binary coalescences with LIGO using GstLAL".

While I enjoyed research, my real passion lies in facilitating social impact through science. So, at the end of my postdoc with the LIGO group at Penn State, I took a leap of faith and applied for a science policy fellowship with the California Council on Science and Technology, a nonpartisan nonprofit working to strengthen California's policies with science. A few months and several interviews later, I found myself in a suit, walking into my new office at the California State Capitol.

Here, I spent a month in "policy boot camp" learning the ins and outs of California policy before being placed as a consultant with the Senate Committee on Natural Resources and Water. In this role, my job was to sift through vast amounts of information and decide, for bills assigned to the Committee, whether the proposed legislation was a good policy solution – in many ways like gleaning a signal from noise.

It was a steep but enjoyable learning curve. Instead of writing code, I read "code" – the California codes of law – and consulted with legislators, legislative staff, agency staff, the Governor's office, and a wide array of advocates from NGOs, businesses, and academia to get into the heart of policy issues.

Policy work is fast-paced and complex – I thought relativity was hard until I learned about water policy! – but there's something extremely satisfying about seeing the results of your work play out in real time. At the end of my fellowship, I realized the bills I'd most enjoyed were those involving climate change, so I accepted a climate policy job with environmental nonprofit The Nature Conservancy.

It's now been almost three years, and I love my work, which involves bridging the gap between scientists and policymakers. I work on a suite of climate solutions called nature-based solutions, which are tools rooted in conservation, land management, and restoration. There's a tremendous amount of potential for these solutions to help us tackle climate change, but work is needed to scale and accelerate their use. I spend my time leading teams, building coalitions, and engaging with California policymakers to explore pathways for these solutions and find ways to address barriers for their implementation. My work is challenging and interesting, and I'm always learning new things.

Sometimes folks ask me if I miss physics. I've found that what I loved most about physics – thinking about interesting and complex problems, studying beautiful systems, and working with great people – are still features of my professional experience. Climate change is an immensely challenging problem – but having witnessed the detection of gravitational waves, I'm optimistic.

At the end of the day, maybe the tough problems are all just like finding signals in noisy data.

An Unexpected Visssitor at LHO

Commissioner/snake catcher Keita Kawabe poses with a gopher snake during June's vacuum incursion at LHO.

Career Updates

Preet Baxi, who recently received her bachelors in Mechanical Engineering in India, will be starting her PhD at University of Michigan this Fall 2022 semester. She has also started working as a research assistant to Prof. Keith Riles and research student of Prof. Karan Jani.

Paolo Cremonese, Pierre Mourier, Lucy Strang and Isabel Suarez will join the University of the Balearic Islands (UIB) gravity group as postdoctoral fellows this fall.

Hector Estellés, University of the Balearic Islands (UIB), defended his PhD on "Accurate models of gravitational wave signals from precessing black holes", supervised by Dr. Sascha Husa and Dra. Marta Colleoni on July 28th 2022.

Carl-Johan Haster began a new job as Assistant Professor of Astrophysics at the University of Nevada, Las Vegas at the end of August.

Anna Heffernan has been selected as the new co-chair of the LISA Waveform Work Package Team in the LISA Science Group, where she will join fellow co-chairs Harald Pfeiffer and Leor Barack.
https://lisa.pages.in2p3.fr/consortium-userguide/g_lsg.html

Philip Koch from the AEI Hannover has finished his PhD. His thesis covered a range of topics including suspension design, low-loss output mode cleaners, and optics characterisation.

Sean Leavey has moved from the AEI 10 m prototype group in Hannover, Germany to a permanent staff scientist position at the UK Astronomy Technology Centre in Edinburgh, UK where he'll be helping (among other things) to assemble the optical benches for the LISA mission.

Timesh Mistry defended his Ph.D. thesis at The University of Sheffield, and has started a postdoc at Nikhef on gravitational wave instrumentation.

Guido Mueller has accepted a position as the new director of the Albert Einstein Institute in Hannover. Together with Karsten Danzmann, he will co-lead the LISA effort at the AEI. He also maintains his appointment at the University of Florida.
https://www.aei.mpg.de/941513/professor-guido-mueller-appointed-as-new-director

Philippe Nguyen successfully defended his PhD thesis at University of Oregon on July 22. His work with the LSC included development of techniques for environmental coupling measurements and analysis, and being on the analysis and/or paper writing teams for several LVK papers, in particular the GRB-GW searches. He has accepted a position with Zap Energy, a nuclear fusion research company located in Seattle.

Matthew Pitkin has left his position at Lancaster University and stood down as the LSC CW group co-chair. He will be moving into industry to work as an Audio Algorithm Researcher for CEDAR Audio Ltd in Cambridge, UK.

Surabhi Sachdev, currently a postdoc at University of Wisconsin-Milwaukee, will be starting at Georgia Tech as an Assistant Professor starting Nov 1, 2022.

Susan Scott (Distinguished Professor at the Centre for Gravitational Astrophysics, ANU) has been elected a Fellow of the International Society on General Relativity and Gravitation (ISGRG). She is the first Australian to join this elite Fellowship comprising approximately 50 top international scientists in the field of gravity.
https://www.anu.edu.au/news/all-news/anu-physicist-making-waves-in-space-joins-top-global-society

Alicia Sintes ranked among the best 10 female scientists in Spain according to Google Scholar
https://diari.uib.cat/Hemeroteca/Alicia-Sintes-entre-les-10-investigadores-amb-mes.cid702943
https://www.webometrics.info/en/investigadoras

Teng Zhang has become an assistant professor at the University of Birmingham.

Awards

Thomas Corbitt was selected as a 2022 recipient of the LSU Rainmaker Award in the Mid-Career Scholar, Science, Technology, Engineering & Mathematics category. https://www.lsu.edu/physics/news/2022/corbitt_rainmaker.php

Lynn Cominsky (Sonoma State University) has been selected as a Sigma Xi Distinguished Lecturer for July 1, 2023 - June 30, 2025. Sigma Xi is a US-based scientific research honor society.

Benjamin Grace (PhD student at the Centre for Gravitational Astrophysics, ANU) has been awarded First Prize and the People's Choice Award in the 3 minute thesis talk competition of the Research School of Physics, ANU with his talk "How I Got My Surfer Hair".

Stephen McGuire, Southern University Endowed Professor of Physics Emeritus, has received the honor of being named a 2022 Louisiana Public Broadcasting (LPB) "Louisiana Legend" in recognition of his contributions to science.
https://www.lpb.org/friends/friends-home/louisiana-legends/louisiana-legends-bios

Albert Kong was awarded the Outstanding Research Award by the Ministry of Science and Technology of Taiwan for his leadership in developing gravitational wave research in Taiwan.

Sumeet Kulkarni was awarded the AAAS Mass Media Science & Engineering Fellowship to report science news for the Los Angeles Times.
https://www.aaas.org/programs/mass-media-fellowship/sumeet-kulkarni

Maite Mateu Lucena and Luana Michela Modafferi received international awards for their posters at the 765th WE-Heraeus-Seminar on Gravitational Wave and Multimessenger Astronomy, 25-28th April 2022, Physikzentrum Bad Honnef.
https://www.we-heraeus-stiftung.de/veranstaltungen/gravitational-wave-and-multimessenger-astronomy/

New LSC positions

Jade Powell was elected as Burst co-chair.

Jenne Driggers was re-elected as LSC Management Committee Elected Member.

John Whelan and David Keitel were elected as Continuous Wave co-chairs.

Other News

Anna Heffernan gave a course to high-school students in Portugal at the Astro-Camp during August
https://astrocamp.astro.up.pt/en/

Cosmic Ripples, the first gravitational-wave exhibition in Taiwan, combining popular science, technology and art, is being held at National Tsing Hua University. https://nthu-en.site.nthu.edu.tw/p/406-1003-230526,r8773.php
5-min virtual tour:
https://tinyurl.com/4utttkj7

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Dancing Spaces - Spazi Danzanti by Anna Lucia Sansò (2022).
Riccardo Buscicchio is a postdoc at Università di Milano-Bicocca working on gravitational-wave observations with LIGO/Virgo and LISA. After endless conversations explaining gravitational waves to his mother (Anna Lucia Sansò), she brought them to life; sculpting space and time, dancing around a neutron-star black-hole binary, her own interpretation of such a catastrophic astrophysical event. Matter to space, back to matter.

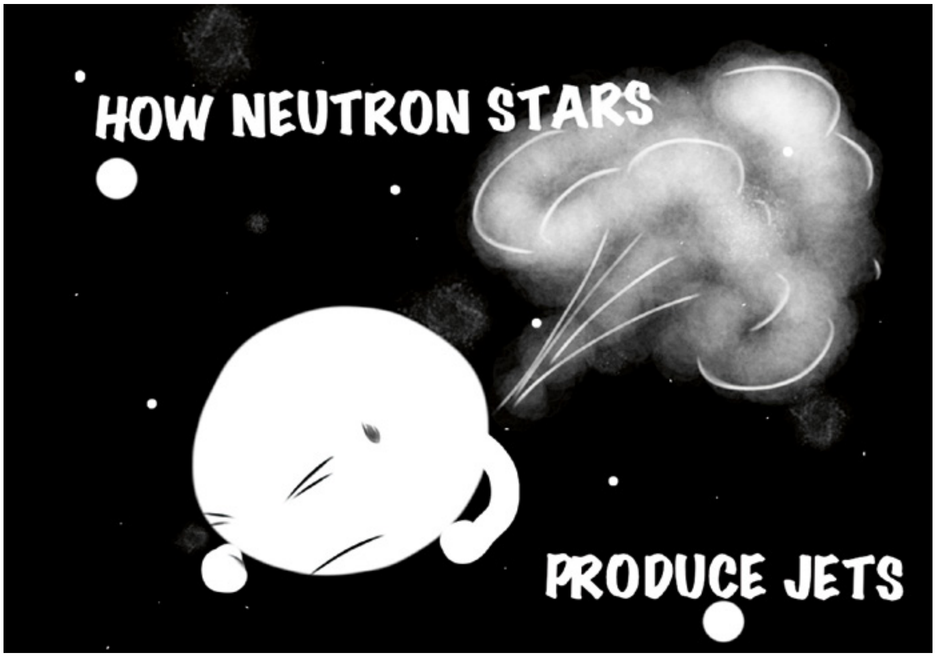
What are Short Gamma Ray Bursts?

As the distinctive gravitational-wave chirp of binary neutron star merger GW170817 faded, gamma-ray telescopes in orbit around the Earth were dazzled with a bright flash of gamma-rays from a short gamma-ray burst.

Short gamma-ray bursts (or 'sGRBs' for short) are imaginatively named flashes of high energy gamma-ray photons that last anywhere from mere milliseconds up to 2 seconds. We now know they originate from a powerful relativistic jet generated by the merger of neutron stars, but we didn't know for sure until GW170817. All of the energy of the neutron star merger is focussed into narrow jets of gamma-rays, and particles that have been accelerated close to the speed of light. Most theories involve fluctuations in the powerful magnetic fields of the neutron stars - a process similar to those that create solar flares, but on a vastly larger, more extreme and energetic scale. By connecting the gravitational wave emission associated with GW170817 with its sGRB counterpart, we were able to confirm they are produced by merging pairs of neutron stars.

By combining observations like those of GW170817 we can obtain complementary information to learn more about binary neutron star mergers. While the gravitational wave signal tells us about the moments leading up to and after merger, the sGRB can be used in combination with these observations to reveal the speed of gravity, or what kind of remnant may be left behind (although scientists have developed models that can successfully explain the relativistic jet we observe with the sGRB originating from a newborn black hole or a more massive neutron star). Over the next few years, LIGO-Virgo-KAGRA will bring us lots of opportunities to observe more neutron star mergers with both gravitational waves and gamma-rays, allowing us to solve the remaining mysteries about these events.

Before the observation of GW170817 there was no conclusive proof on how neutron stars produce short gamma ray bursts…



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