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THE GRAVITATIONAL VOICE

number 23

MARCH 2013

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"h - The Gravitational Voice" is an internal publication of the European Gravitational Observatory (EGO) and the Virgo Collaboration.

The content of this newsletter does not necessarily represent the opinion of the management.

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Published in electronic format on the EGO Web:
www.ego-gw.it

EDITORIAL

As an Editorial on this issue of our newsletter I have the pleasure in publishing a congratulation letter that I received recently as corresponding author of "the Virgo Paper" from an engineer of the Thorlabs company. This is for all of us!

----------- Original Message -----------
Subject: Your Paper
Date: Fri, 12 Oct 2012 06:10:41 +0000
From: Shanshan Song <SSong@thorlabs.com>
To: carlo.bradaschia@pi.infn.it<carlo.bradaschia@infn.pi.it>

Dear Bradaschia,

I am writing regarding your publication on Virgo: a laser interferometer to detect gravitational waves, which was recently published in Journal of Instrumentation magazine.

I have recently seen this paper and wanted to congratulate you on your work and on publishing your results. The growth of our field depends on continued research and publications, and it is encouraging to see your successful results.

Wishing you continued success!

Best regards,
Shanshan Song, Ph.D.
Thorlabs Inc. www.thorlabs.com

C. BRADASCHIA
Editor-in-Chief

A sensitive and compact inclinometer for Virgo

With improving sensitivity the presence of ground tilt motion, which means ground rotation around horizontal axes, may become a problem for the SuperAttenuator control system. This is because currently we do not have sensors able to measure this phenomenon. However we have indirect evidence that this kind of motion is present on the Virgo site in case of adverse weather conditions, which is a few days per month. Its magnitude is in the nanoradian regime.

The reason why we are blind to this ground rotation is that the accelerometers used in the SuperAttenuator cannot distinguish between linear acceleration and tilt because of the gravity acceleration, as can be seen in Fig. 1. If the external frame of the accelerometer is tilted then the effect of gravity on the spring-mass system is identical to that of a linear acceleration ***a***.

To sense the ground tilt motion it is necessary to have a sensor which responds to rotation but which is insensitive to translation as much as possible. Such an instrument is usually called a "gyroscope". In the past many different types of gyroscopes have been developed: spinning wheel gyroscopes, laser gyroscopes and vibratory gyroscopes are the main families.

Spinning wheel gyroscopes are composed of a rotor with a high angular momentum as we can see in Fig.2. A torque applied around an axis (the "input axis") can change the direction of that angular momentum creating a non zero angular velocity of the wheel around an other axis (the "output axis"). Laser gyroscopes, instead, work in a similar way to an interferometer. In Fig. 3 a laser beam is divided and injected at both ends of an optical fiber coil; if this looped cable is put into rotation around the coil axis, then the optical paths of the clockwise and counterclockwise beams are different in the rotating reference frame; this leads to a change in the interference pattern on the detector and, using that phenomenon, the magnitude of the rotation speed Ω can be measured.

The last family, formed by vibrating gyroscopes, is the one to which "Hemispherical Resonator Gyroscopes" (HRG) belong. This device is built using a bell-shaped quartz resonator, as in Fig. 4, fixed to an external frame. Electrodes

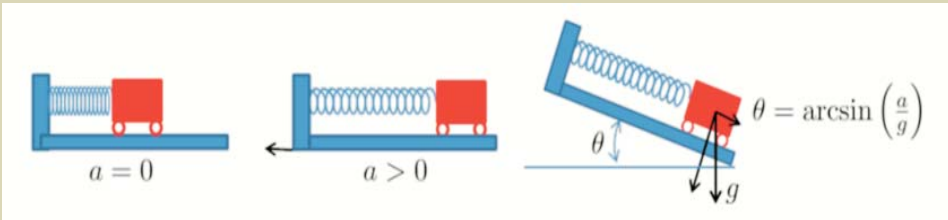


Figure 1 (above): Behavior of a simple accelerometer consisting of a mass attached to a spring.

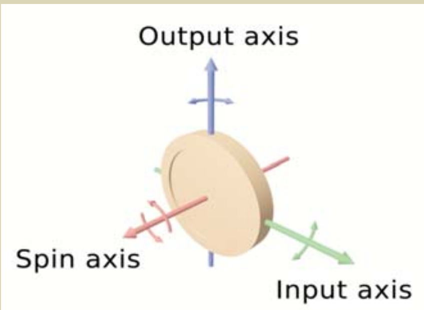


Figure 2 (left): Behavior of a spinning rotor gyroscope.

Figure 3 (left below): Working principle of a laser gyroscope; the vector Ω, entering the plane of the drawing represents the angular velocity of a clockwise rotation.

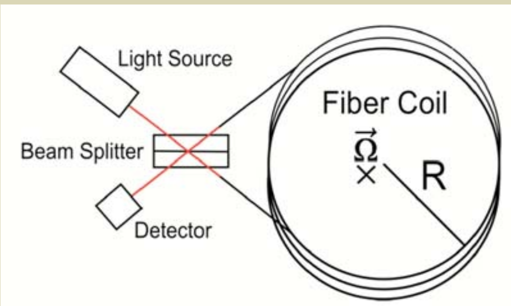
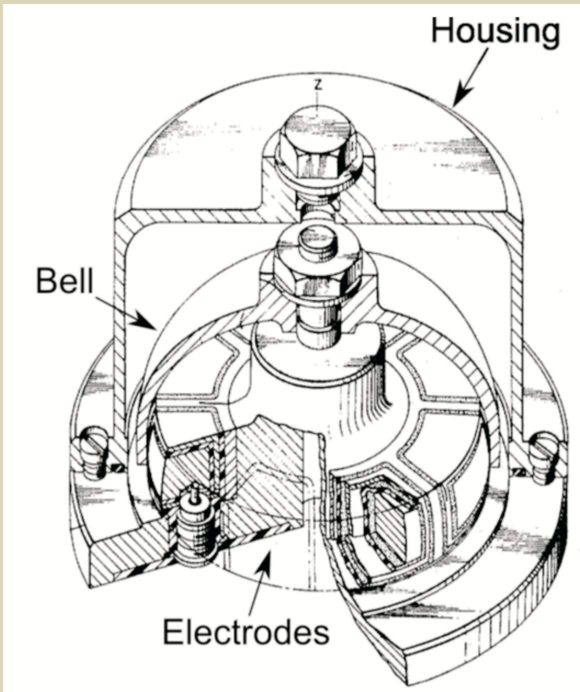


Figure 4 (right): A Hemispherical Resonator Gyroscope (HRG): a high quality quartz bell vibrates being stimulated by electrodes.



under the bell put it in vibration and sense the displacement of the bell rim: they are both actuators and sensors.

The principle of operation is the following. The input electrode causes the quartz bell to vibrate. The vibrating pattern has a shape similar to that in Fig. 5. The blue arrows represent the velocity of the points corresponding to the maximum outward and inward vibration amplitude. In presence of rotation the Coriolis force, represented by the red arrows, acts in the rotating reference frame on every point of the vibrating bell. It turns out that the modulus of the Coriolis force, for points 90 degrees apart, is exactly the same so that its effect is bigger for points farther from the center: the net effect is to produce a drift of the vibration pattern relative to the rotating reference frame.

The bell is fixed to the external housing so it rotates with it. An external observer sees the bell spinning at an angular velocity Ω and the vibration pattern turning with an angular velocity which can be computed to be approximately 3/5 of that of the bell. This last phenomenon is called "Bryan Effect". The electrodes fixed to the housing can also reveal the motion of the bell electrostatically.

The Coriolis force is also responsible of the rotation of the oscillation plane of the Focault pendulum and of the vortex shape of cyclones, anticlockwise north of the equator and clockwise south of it (1).

Historically the gyroscopic effect which allows the operation of HRG was first noticed by G.H. Bryan in 1890. He struck a wineglass and heard beats while twisting it around. This can be explained using the theory stated above: indeed a rotating vibration pattern with respect to the air, which transports the sound waves to our ears, can be interpreted as a superposition of two stationary vibrations with different frequencies.

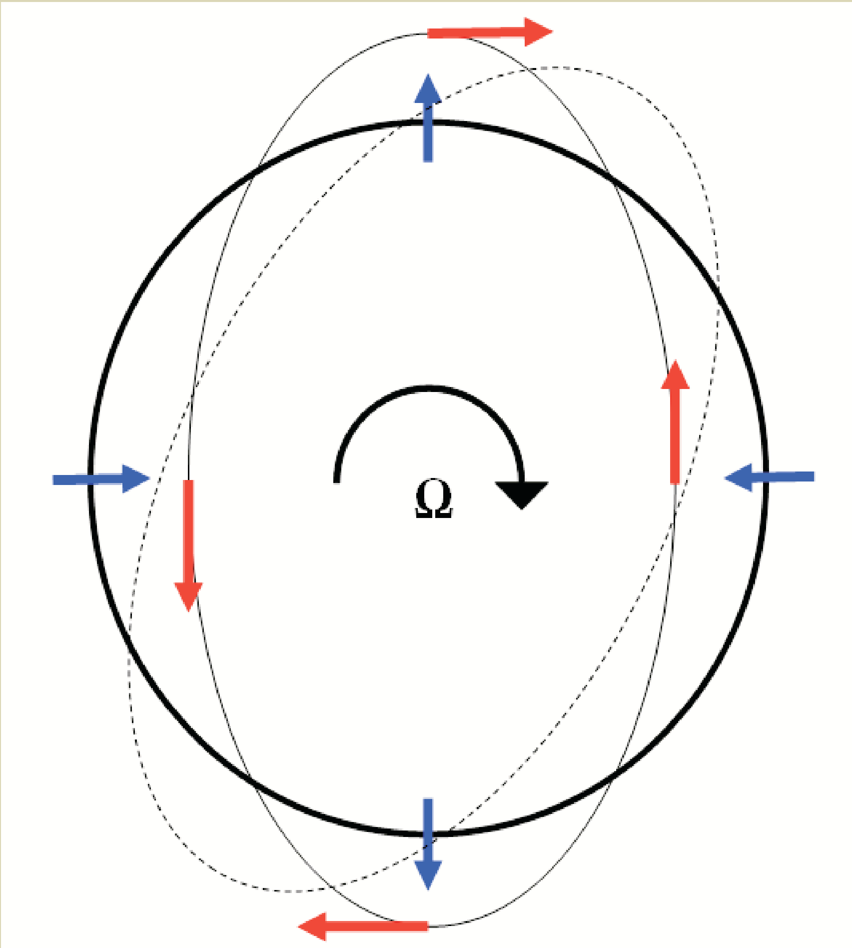


Fig. 5: Shape of the vibrating bell. The blue arrows represent the velocity of the points corresponding to the maximum outward and inward vibration amplitude. If the bell turns around its axis with an angular speed Ω, the Coriolis force, represented by the red arrows, appears in the rotating reference frame and forces the bell towards the dashed shape.

The conversion of this idea into a real device didn't progress smoothly. In 1965 the idea resurfaced at the Delco Company in the US, where a research and development stage started. Four years later the first HRG prototype was ready; however, in those years, the other kinds of gyroscopes were more competitive on the market. The usage of HRG didn't begin until about 1975, when these gyroscopes were used in the inertial navigation systems of tactical missiles.

The excellent performances pushed forward the research on these devices leading to the application of HRG for space missions during the 90s. It is worth mentioning that this kind of gyroscope was applied with 100% success on the Cassini spacecraft, launched to Saturn, on the Huygens Probe, designed to penetrate Titan's atmosphere. They were also used on Messenger, for the mapping of Mercury, and on Deep Impact, a spacecraft built to land on a comet. An interesting paper on HRG is available at http://www.es.northropgrumman.com/solutions/hrg/assets/hrg.pdf.

The high sensitivity of HRG is connected to the fact that the oscillation induced on the high quality quartz bell lasts for a long time. The lower the energy dissipation during this motion, the higher is the precision of this sensor.

The low dissipation is due mainly to the quality of the materials used. The choice of quartz is fundamental because it has a very low thermal conduction coefficient and a very low thermal expansion coefficient. This reduces a lot thermoelastic effects, which are the most harmful from the point of view of dissipation. The fabrication of the bell resonator is based on ion beam etching, a process where mass removal is reached using scattering of heavy ions on the quartz surface; using this technique a control on the mass balance of the order of the nanogram can be obtained. The perfect balance of the bell is very important to avoid mode non-degeneracy in the resonator operation.

How do you compare the performances of HRG with respect to other gyroscopes? This is usually done by measuring the so called "angular random walk" (ARW). Even if a gyroscope is not subject to rotation, because of its intrinsic noise, its output is not strictly zero but it fluctuates in a random fashion. If we integrate this apparent angular velocity signal for some time, we obtain an overall false angular displacement. This effect, known as "angular random walk" should be as small as possible and it is usually reported in a commercial device datasheet. In Tab. 1 the magnitude of this effect is written for the best commercial gyroscopes available: FOG refers to "Fiber-Optic gyroscope" explained in Fig. 3, RLG to "Ring Laser Gyroscope", similar to FOG but with an optical cavity instead of a fiber, and DTG refers to "Dynamically Tuned Gyroscope", the most precise spinning wheel available gyroscope.

Other parameters useful to compare gyroscopes performances are: "bias stability", which is the maximum variation of the continuous component of the output, "scale factor stability" and "scale factor linearity", which are connected with the precision of the scale factor, which means the ratio between output and rotation rate of the instrument. As can be deduced from Tab. 1, the HRG has the best characteristics among commercial gyroscopes.

From the previous description it is clear that one HRG can measure the angular velocity around the bell axis, so two of these devices with orthogonal axes are needed in the case we would like to measure rotations around the two horizontal axes.

As mentioned earlier, a gyroscope is an object which, ideally, does not give a response in the presence of linear acceleration. This is not strictly true for a real device. For example the quartz bell in a HRG is slightly deformed if an external acceleration appears, this leads to an output which may be confused with a rotation. The sensitivity of a gyroscope to a linear acceleration is named "g-Sensitivity" and for the HRG this quantity turns out to be sufficiently low to decouple ground tilt motion from seismic translation.

In conclusion, high precision gyroscopes open the possibility of measuring ground tilt motion in the millihertz range, a phenomenon not yet well known in the field of gravitational waves detection. On the other hand, seismologists are mainly interested in ground rotation at lower frequencies because they usually take measurements of the ground tilt with a detection rate of days or weeks. HRG could benefit both these fields and it could give the temporal evolution of the ground tilt motion which will be used to compensate in SuperAttenuators this degree of freedom that, until now, has not been considered in Virgo.

HRG are the best gyroscopes to be installed in Virgo, on the SA base rings, under vacuum. This is due to their very small size, the absence of moving parts and the possibility of sealing them in a tight clean box the size of a one liter milk carton. A prototype of such a device was recently developed by a Russian firm under specification of the INFN Pisa group. The device which is at present undergoing a preliminary test phase, has a bell vibrating at 7450.85 Hz with a quality factor of 4.2 10^6. The oscillation amplitude is 3.4 micrometers.

In the first performance evaluation it has been found a noise spectrum in the order of 2 10^{-7} rad/s/ $Hz^{1/2}$ almost flat down to 100 mHz, corresponding to an Angular Random Walk of about 0.0006 °/ $hr^{1/2}$ and comparable to what we expect from seismic tilt noise in 'good weather' conditions. The

	HRG	RLG	FOG	DTG
ARW ($^o/\sqrt{hr}$)	0.00006	0.0035	0.0002	0.0004
Bias Stability (^{o}/hr)	0.0005	0.0035	0.002	0.003
Scale Factor Stability (ppm)	1	5	<15	
Scale Factor Linearity (ppm)	1	5	<10	

Table 1: Comparison of quality parameters of HRG and other gyroscopes.

Figure 6: The Russian HRG prototype after removing the cover box.

sensitivity is so high that the maximum measurable angular speed before saturation is 0.12°/s i.e. one complete rotation in 50 minutes. The Russian HRG prototype is shown in figure 6 after removing the cover. The sensor is the small metallic cylinder close to the coin. In the box there is space for a total of three sensors, aligned along the three Cartesian axes, and for the corresponding electronics.

N. GRILLI
INFN Pisa

(1) Note by h

In ancient times the Aristotelian argument that a falling stone was not deviated eastward was used to argue against the hypothesis of earth rotation. It is interesting to note that the influence of earth rotation on many phenomena was first correctly understood and formalized by Laplace and Gauss only in the early 19th century and later thoroughly studied also experimentally by Coriolis, Focault and Reich (by dropping stones into a 158 m deep mine shaft).

Surprisingly the rotation of the pendulum oscillation plane was measured unequivocally in 1660 by Viviani of the Accademia del Cimento and attributed not to earth rotation, but to some unknown disturbance. It was eliminated by suspending the pendulum with two ropes arranged in V shape.

All this is told in more detail in an article by Theo Gerkema and Louis Gostiaux on the March-April 2012 issue of Europhysics News (http://dx.doi.org/10.1051/epn/2012202).

Cryolinks for Advanced Virgo

The sensitivity of Advanced Virgo of about 4 x 10^{-24} $Hz^{-1/2}$ at 200 – 400 Hz may be limited by numerous noise sources and care must be taken that the finite pressure of the residual gas in the interferometer (ITF) arms does not represent such a limitation. The phase noise for YAG light scattering from the residual gas (especially water vapour is important due to its high molecular polarizability) in the ITF arms can be lowered by a 150° C bake-out, improving the operating vacuum levels to the 10^{-10} mbar region with a gas composition dominated by hydrogen. At present the system operates at about 10^{-7} mbar and the composition is dominated by the partial pressure of water.

Cryolinks (cover figure by Marco Kraan, Nikhef) are a classical solution to reduce migration of water from the unbaked towers to the baked ITF arms. A small cryotrap (1 m long, 150 mm aperture) was installed several years ago, to stop water molecules migrating from DET tower to SR. For Advanced Virgo four cryolinks will be installed to provide a vacuum transition from the mirror-towers to the ITF arms. These cryolinks will freeze out any water vapour from these towers making a subsequent bake out of the ITF arms meaningful. This combination of bake out of the arms and the water traps is an excellent way to remove water and to transform Advanced Virgo into an ultra-high vacuum (UHV) system with the required pressure.

The design of the links involved many aspects. Thermal modelling was needed not only to determine the performance of the cryolink (e.g. liquid nitrogen consumption) and the design of the cryostat (e.g. design of the radiation shields), but also to estimate the thermal effects on the radius of curvature of input- and end-mirrors through radiative heat transfer. Thermo-mechanical finite element simulations by the Rome Tor Vergata and Nikhef groups showed that such effects can be handled. Optical modelling was carried out by Jean Yves Vinet and by the EGO optics team to determine the contribution of diffused radiation. This demonstrated that the cryolink diameter was acceptable and also set the design parameters for the location of the anti-reflection coated glass baffles. The vacuum, control and safety systems were designed by Nikhef in close collaboration with EGO's vacuum group (Antonio Pasqualetti is the responsible subsystem coordinator of this project). Finally, extensive Monte Carlo simulations have been carried out by the Genoa and Nikhef groups to model the performance of the system based on geometry and expected sticking coefficients of molecules. The Genoa group is also responsible for the liquid nitrogen storage systems that need to be placed outside of the various buildings. Isolated transfer lines will carry the liquid nitrogen to phase separators and provide the liquid via controlled needle valves to the cryolinks.

The mechanical design of the cryolink features a stainless steel outer vacuum vessel in which a cylinder-shaped aluminium vessel is suspended by two sets of air springs. The cryostat is positioned in a non-concentric geometry to provide a relatively large surface area for gas boil-off (dimensions have been chosen to guarantee laminar flows in order to minimize displacement noise). The suspension system is designed to suppress boiling noise from the cryostat to the outer vessel. It is based on sets of air-bellows with a resonance frequency of 3.5 Hz. The aluminium vessel is filled with liquid nitrogen and thereby cooled to a temperature of 77K. The vacuum system is evacuated by a turbo-molecular drag pump and a dry scroll pump. Two titanium-sublimation pumps are used during normal UHV service. There is sufficient space available to install the four cryolinks in between the mirror-towers and the existing DN1000 valves. The vacuum vessels of the cryolinks will have different lengths, depending on their location. Adapter pieces are used to connect each cryostat to the tower.

The liquid nitrogen is transferred from large storage tanks to the phase separators that are located in the vicinity of each cryolink. In the phase separator evaporated nitrogen is separated from the liquid nitrogen that will be transferred to the aluminium vessel. A slight height difference in the phase separator outlet and the cryolink nitrogen inlet reduces the amount of gas bubbles in the liquid flow. To reduce seismic noise, the liquid nitrogen flows via a slide into the nitrogen bath. The nitrogen level is controlled with an accuracy of 5 mm by a pneumatic valve and capacitive level sensors in the vessel. The cryostat is equipped with two level sensors, one differential pressure sensor and ten temperature sensors. Various safety systems are installed such as overpressure valves, rupture disks and oxygen-concentration sensors.

The cryolinks need to be regenerated by bake out on a regular basis. Simulations show that over a period of 1 year an ice layer of about 1 micron thickness may build up. The formed ice layer causes an increase in liquid nitrogen consumption (nominally 5 l/h) due to an increase in the emissivity of the cryostat surface and it may be advantageous to regenerate the cryolink. The exact schedule for such regenerations will be set in the future and will likely coincide with maintenance periods of the ITF.

The order for the production of the cryolink prototype (which is anticipated to be installed at a later stage in the North arm) was allocated to Alca Technologies, a company in Schio, Italy. Factory acceptance tests by scientists and technicians from Nikhef and EGO have been successfully performed. After

Figure: The first cryolink at Alca Company in Schio (Vicenza), ready for bake-out test

acceptance, the prototype has been transported to Nikhef to be subjected to an extensive testing program during the first half of 2013. Special attention will be paid to determine the quality of the vacuum, quantification of seismic noise and bubble noise, and measurement of liquid nitrogen consumption and trapping performance for various gas loads. Finally, control and safety systems will be installed and tested. In parallel the EU tendering procedure of the remaining 3 cryolinks will take place.

K. de Roo, L. Jansen, B. Munneke, M. Doets and J. van den Brand from Nikhef Institute

AdV-ancement

As with the Biblical Temples in Jerusalem, any construction is preceded by destruction. The main activity towards Advanced Virgo, in the Central Building, has been preceded by an extended dismounting and decommissioning. In particular, the Injection and Detection labs have been emptied of all instrumentation and all technological services have been removed, right down to the crude concrete.
Those activities had to be included in the civil works framework (the so called AdV "Cantiere 1"). A document summarising them was handed over to the Coordinator for Safety in order to prepare a corresponding "Coordination and Safety Plan".
"Cantiere 1" activities are now almost concluded and the foreseen planning has been well respected. The areas where the Laser and

Detection labs once used to be, are shown in the two impressive pictures above, taken after the “Cantiere 1 works” and before the modification of the areas started for adapting them to the new AdV layout.

These heavy civil works, contained in the “Cantiere 2” framework, were started after the installation of dust confinement walls for the protection of, as much as possible, the cleanliness of the Central Building; inside the confinement, the old walls were demolished and new ones built, in order to enlarge the Injection and Detection labs. These works are now being finished with the installation of metallic frames assuring the structural stability.
In the meantime, the Vacuum Subsystem activities have also progressed well. All the towers have been disconnected from each other, dismounting all the link pipes, including the Injection-Power Recycling Brewster link and the Detection/Signal Recycling Cryotrap. All of the electronics racks of the vacuum control system have

been disconnected to be sent to LAL for full renewal.
Also, the 4 m long, 1.2 m diameter pipes connecting the large valves to the Fabry-Perot towers have been dismounted, except the one on the North End tower, which has been kept operative in order to test the new Separating Roof prototype. These pipes will be replaced by the large cryotraps, the prototype of which has already been successfully tested in the factory.

The North Input tower has been opened and fully uncabled in order to ready it for the transfer of the complete Superattenuator (SA) and its safety structure to the SR tower. All Fabry-Perot SA will be modified to accept the new Payloads, being prepared by the Roma I group. For the same reason, the West Input SA has been completely dismounted and the components carefully stored on the top balcony of the Central Building.

In order to displace the long towers and in preparation Cryotrap installation it was mandatory to dismount some of the existing CB tower scaffolding. As, in any case, these scaffoldings will need to be substituted by those currently being designed, it was considered preferable to remove all of them. The work was completed in two weeks, following the foreseen procedure, and all the resulting material was transported outside via the "locale camion" and stored in the CB vicinity for recycling. Now, all Central Building towers have been displaced to their final AdV position.

As a last remark, we should report that keeping an adequate level of cleanliness during dismounting and heavy civil works is one of the major challenges of the Advanced Virgo upgrades. A dedicated measurement campaign with particle counters to monitor air quality has been made and a short list of recommendations for cleanliness preservation has been defined (in particular to be handed over to external companies).

The smooth and effective achievement of this first part of the path towards Advanced Virgo is surely due to the common effort of all the involved EGO departments and groups of the Collaboration.

F. CARBOGNANI
On-site works coordinator

IndIGO, LIGO-India and visit to EGO-Virgo

Over two decades, since the early nineties, research in India in the areas related to gravitational waves (GW) mainly focussed on two significant fronts: source modeling at Raman Research Institute and data analysis at Inter University Centre for Astronomy and Astrophysics (IUCAA). In 2009, the IndIGO Consortium was formed to consolidate these efforts towards an integrated national participation in the LSC and more importantly to extend this to participation in the global GW experimental efforts. In meetings under an Indo-Australian project on Establishing Australia-India collaboration in GW Astronomy at Kochi, Pune, Shanghai, Perth and Delhi over 2009-11 with ACIGA and the global GW community, IndIGO redefined, reoriented and responded to the global (GWIC) strategies for setting up the International GW Network.

Thus, it naturally evolved from participation in AIGO to collaboration in LIGO-Australia. In this period sub-system expertise for GW experiments in various DAE Labs, Research Institutes, IITs, IISERs, Universities and past projects were identified. Enthusiasm and consensus for participation in GW experiments was built and funding of a 3m prototype at TIFR, to be operational by 2014, happened.

A multi-disciplinary IndIGO consortium, currently consisting of eleven Indian institutions interested in GW experiments, related technology and GW Astronomy, took shape and worked to convince the scientific community and funding agencies that with the first generation GW detectors achieving design sensitivity and the promise of GW astronomy in the coming decades, it was indeed the right time for Indian participation in the global GW detection efforts. In 2011, the above efforts led to the LIGO-India proposal: the construction and operation of an Advanced LIGO Detector in India in collaboration with the LIGO Lab by relocating the third Advanced LIGO detector (H2) to India. LIGO-India is planned to achieve design sensitivity by 2020 and to be operated thereafter for 10 years as part of the LIGO (International GW) Network. The entire hardware components of the aLIGO detector along with designs and software is to be provided by LIGO-USA and its UK, German and Australian partners (costed at $120 M including R&D). The entire infrastructure including UHV, Labs and clean rooms, as well as the team to build and operate will be the Indian responsibility ($250 M, 15 yrs). The geographical relocation of the second Hanford detector is strategic for GW astronomy. It leads to increased event rates, improved duty cycle, detection confidence, sky coverage, and determination of the two GW polarizations. More importantly, LIGO-India also leads to improved source location, crucial for multi-messenger astronomy. A fourth site, not in the plane formed by the two US LIGO sites and Virgo, and far from them greatly improves the source localization ability of the network. Inclusion of LIGO-India in the existing LIGO and Virgo network would improve angular resolution four times on average and in some directions by a factor of 10-20. With KAGRA in Japan scheduled to be operational in similar time frames, a global GW network will be realized in the coming decade.

Over the last year the LIGO-India proposal has made impressive progress on all the fronts required for its realization. On the Indian side, the project has been included in the list of Mega Projects under consideration by the DAE-DST consortium in the coming Five year plan. Three institutions from the Consortium, Institute of Plasma Research (IPR), IUCAA and Raja Ramanna Centre for Advanced Technology (RRCAT), have agreed to be the nodal leads for LIGO-India. LIGO-India has been discussed at the highest level in the Department of Atomic Energy and is being referred to the Government of India to seek in-principle approval and signing of MOUs. On the US side the process has also moved ahead. Four senior level visits from the LIGO-Lab to the LIGO-India lead institutions for technical assessment and discussions were followed by three in-depth reviews by an NSF panel. All this culminated in a review by the National Science Board, USA, in August 2012 and the following resolution: “RESOLVED, that the National Science Board authorize the Deputy Director at her discretion to approve the proposed Advanced LIGO Project change in scope, enabling plans for the relocation of an advanced detector to India.”

Prof. Bala Iyer, from the Raman Research Institute in India who is Chair of the IndIGO Consortium (http://www.gw-indigo.org/).

I visited EGO during Sept 17-19, 2012 after the LVC meeting in Rome to share with colleagues in EGO the status of LIGO-India. Moreover, the aim was to take a guided tour of the Virgo site, detector infrastructure and experimental labs and make contact with colleagues in Virgo working on different aspects of the experiment and to share their experience. Federico Ferrini kindly arranged a series of very useful meetings that allowed me to efficiently gather what I needed. Carlo Bradaschia provided a thorough visit to the facility and shared with me his insights on the facility. I met with the noise monitoring team of Elena Cuoco and Irene Fiori to get inputs on issues to pay attention to, during site selection. Carlo and Antonio Pasqualetti explained about issues related to the vacuum system. Franco Carbognani and his team showed me the various aspects of interferometer operations. Jean-Yves Vinet and Giovanni Losurdo discussed the complex project management aspects. Federico Fidecaro and Franco Frasconi showed me around the various labs in Pisa, including the suspensions lab.

My discussions with Federico Ferrini and colleagues in EGO also explored potential areas of cooperation for mutual benefit and possible mechanisms to support it.

An important area could be the assistance in the training of manpower for LIGO-India by hosting Ph.D. students/Post-doctoral fellows/LIGO-India team members in Advanced Virgo during its installation and commissioning, taking advantage of the staggered LIGO-India time-line relative to Advanced Virgo. There is a window of opportunity here with mutual benefits, and possible avenues to explore to facilitate mutual visits in connection with the International GW Network and research in associated technology. Some of these include (i) an Indo-Italian Exchange program, (ii) a joint annual fellowship at EGO, (iii) a collaborative Ph.D. program, (iv) regular joint workshops on specific subsystems so that the Indian team can benefit from the experience of the EGO-Virgo collaboration and a knowledge network can be established for them to access when needed, (v) loaning/donating any equipment/setup or material (substrates/coatings) not being used or that can be spared.

Even from my brief visit, it was clear that interactions of the IndIGO team for LIGO-India with EGO-Virgo, (and similarly GEO, KAGRA) can play a useful mentoring role to the new Indian GW research program and provide multiple inputs to it on infrastructure, technology, management and outreach in the coming years.

Eugenio Coccia 2012 Occhialini Medallist

In 2007 the Italian Physical Society together with the Institute of Physics instituted an award to honor the memory of Giuseppe Occhialini.
The prize has been promoted jointly by the two Societies on occasion of the Centenary of the birth of Giuseppe Occhialini with the aim to commemorate the eminent scientist as well as to strengthen the relationship between the two societies. The award is made alternately by the Councils of one of the two societies to a physicist selected from a list of nominees submitted by the other.

Terms

The award shall be made for distinguished work carried out within the 10 years preceding the award. The award is to be made to physicists in alternating years who work in Italy (even dated years) or the UK or Ireland (odd dated years). The medal will be silver and accompanied by a prize of €3000.

The ***h*** newsletter is happy to report the motivation for the assignment of the 2012 Occhialini Prize and Medal to our friend Eugenio Coccia:

"*Occhialini Medal and Prize Awarded jointly with the Italian Physical Society.*
Prof. Eugenio Coccia
University of Rome "Tor Vergata" and Istituto Nazionale di Fisica Nucleare.
For his major contribution to the realisation of the first long-term observatories with cryogenic and ultracryogenic detectors of gravitational waves and for his international role in the gravitational-wave community and in the broader community of astroparticle physics."

Travels of a Director

Recently, a long journey kept me away from our site.
EGO has the task of promoting cooperation worldwide in the field of gravitational wave research. This reinforces the image that EGO and Virgo have with respect to National Institutions and is in accordance with the recent recommendations by the Italian Ministry for Education, University and Research.

The first stop was in Perth, at the University of Western Australia (UWA). In Gingin – a name of Aboriginal origin, probably meaning "place of many women"(1) – located some 50 km from the city, the School of Physics at the UWA lead by David Blair has created an R&D facility and a large centre for the promotion of gravitational research.

(1) - Sometimes it is quoted as meaning "place of many streams", but this was refuted by David Blair, with the argument that there are not many streams around. Indeed, nowadays there is not even a large population around.

The workshop "Physics for the Future: International Workshop on the Australian Gravitational Wave Observatory" took place at the UWA on 27-28 September to discuss the perspectives for an international gravitational wave detector in Gingin. The location could be ideal allowing for very efficient sky coverage within the network of interferometers which are currently operating and are under construction.

The subject evokes passion and the presence of another 2nd generation interferometer in the southern hemisphere could substantially enrich the global community. The meeting was attended by a large representation of the Australian GW community and by members of the international community (GWIC, LIGO, Virgo, EGO and China), as well as by regional politicians and representatives of important industrial groups. The first session, held on the morning of the 27th, was addressed to the authorities and demonstrated the international interest and the validity of the proposed ideas.

This was my first opportunity, as Salesman, to offer a good product to stakeholders. This role of salesman was also adopted at a subsequent meeting at the Parliament of Western Australia. I was impressed by the attention that Regional politicians are giving to the development of science and technology. Consider that the Region is largely uninhabited, but is the same size as 3/5 of the European Union, with impressive resources from mining and agriculture. The one and half days were characterised by lively discussions among the participants aimed at finalising a strategy for the development of a common project. A long road lies ahead and for the moment EGO and Virgo can only offer their moral support.

I then flew to Japan, just ahead of a typhoon that struck Tokyo a few hours later. There was also an earthquake not far from the north coast of Japan, slightly further inland than the devastating one of March 2011. But this is Japan and it is always surprising how our Japanese colleagues maintain an unshaken commitment toward ambitious objectives, notwithstanding severe difficulties.
On October 3rd and 4th the First general meeting of the ELiTES collaboration took place in Tokyo, with a large body of Japanese and European colleagues. The ELiTES project is a European-Japanese collaboration, supported by the European Commission under FP7-People. It is coordinated by EGO and focuses on the cryogenic technologies for the future gravitational wave detectors KAGRA and ET.
The progress of the GW projects and future activities were discussed. I was very impressed by the level of collaboration and consideration between the two communities. The session of the 3rd of October was hosted by the Delegation of the European Union to Japan and this provided me with another opportunity to reprise my salesman role for the non-physicist attendees. I wanted to convey how exciting, full of perspective and effective our research field is.
I hope that the investment of time and energy (fortunately not money, having been sponsored by the Italian Embassy in Canberra, UWA and ELiTES) will bring to EGO not only a return in terms of image, but also the opportunity to host some colleagues from Oceania and Asia who wish to work for some time on our site and take part in our exciting adventure.

While proofs of ***h*** are almost ready, I add a very short note on a more recent trip, this time as "sales clerk": the first meeting of the EGO Council Working Group to discuss candidature for the status of ERIC(*), of common interest for CNRS and INFN, was held in Paris at the CNRS Headquarters, on January 25th. EGO (myself along with Veronica and Séverine) was charged with the responsibility of organising the meeting, which was open to the representatives of national communities that had expressed an interest in proposing candidatures for an ERIC for Gravitational Waves and an ERIC for underground Astro-Particle laboratories.
Beyond France and Italy, representatives attended from Hungary, the Netherlands, Poland, Spain and the United Kingdom, while the delegate from Germany was only prevented from attending by a strike at Frankfurt airport. It is interesting to note that all European countries in which Gravitational Waves research is active were represented. Further meetings will be held, toward a European objective, which would surely be positive for the whole community. I did my best to sell this concept to all colleagues around the table!

(*) Main features of an ERIC (from http://ec.europa.eu/research/infrastructures/index_en.cfm?pg=eric5)
An ERIC has a legal personality based on EU law (Article 171 of the EC Treaty). Its main tasks are to establish and operate a research infrastructure. The ERIC is an easy-to-use legal instrument providing:
- *the spirit of a truly European venture (also allowing for the participation of non-European countries);*
- *a legal personality recognised in all EU Member States;*
- *flexibility to adapt to the specific requirements of each infrastructure;*
- *some privileges/exemptions, allowed for inter-governmental organisations;*
- *a faster and more cost-efficient process than creating an international organisation.*

An ERIC can benefit from exemptions from VAT and excise duty in all EU Member States and it may adopt its own procurement procedures, which have to respect the principles of transparency, non-discrimination and competition, but are not subject to public procurement procedures. Members will be states and inter-governmental organisations.

F. FERRINI

2012 Stefano Braccini Prize

2012 Stefano Braccini Prize We have the pleasure to announce that the 2012 Stefano Braccini Prize for a doctoral thesis on Gravitational Wave physics or related arguments received eight candidate theses.

This year the funds are offered by the friends of Stefano and by the Associazione Ricerca Fondamentale in Fisica, which is a free association of INFN Pisa scientists promoting research in fundamental physics. The full announcement has been kindly distributed through the GWIC and is still available on the Virgo web page.

We cannot refrain from publishing the e-mail that Rana Adhikari sent after receiving the announcement: “It is great to have something like this in Stefano's memory. I wish that we could have more scientists to work with who had his wonderful spirit and approach to science.”

C. BRADASCHIA

Testing with Tango

The vacuum control system is being updated for advanced Virgo. Several control systems were investigated to find a replacement for the custom vacuum control system and Tango was selected. This is a mature open source system whose users are typically technically savvy scientists. Development of this software was started around the year 2000 by engineers at the ESRF synchrotron in France and the system was subsequently adopted by other European organisations,

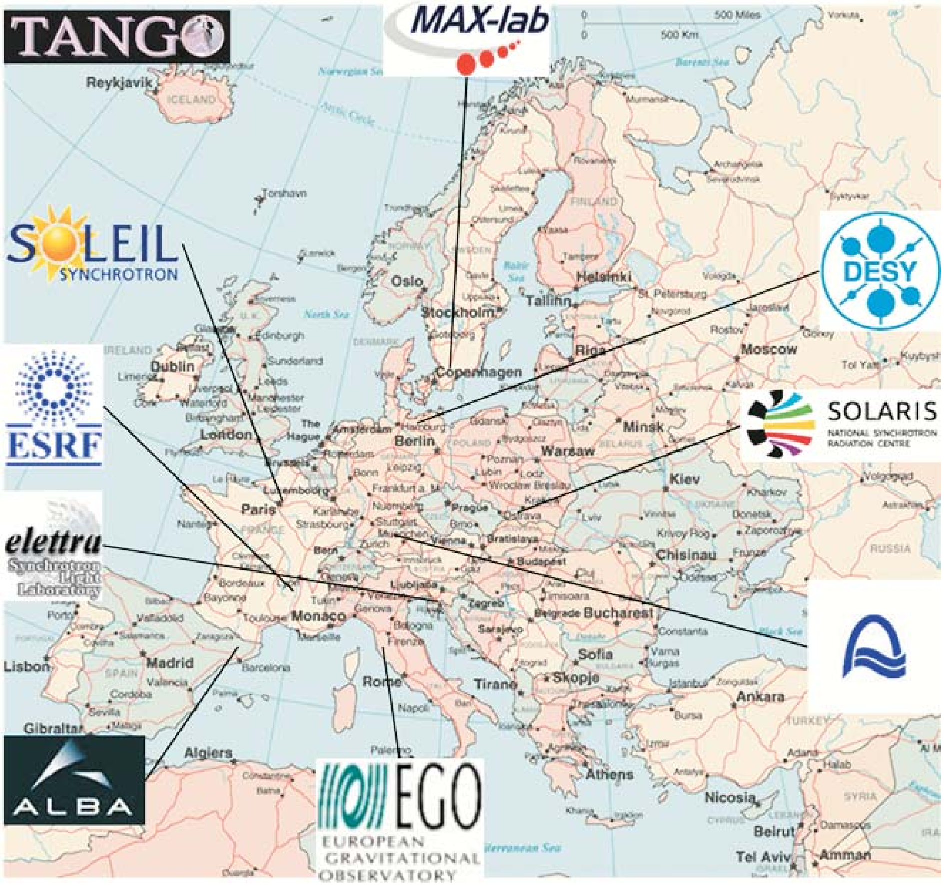


Fig. 1: Location of Tango Collaboration members in relation to EGO.

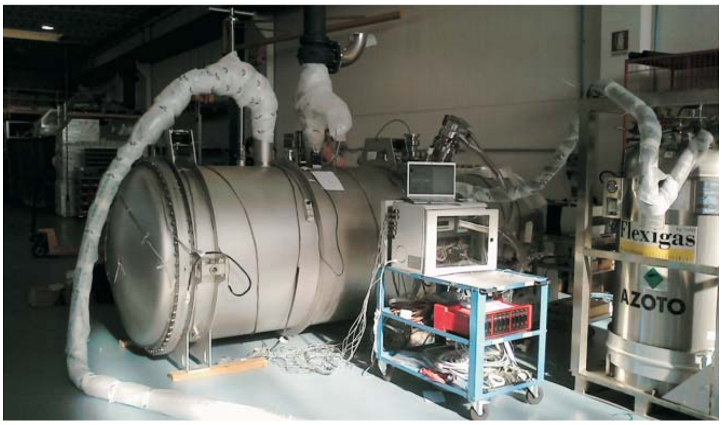
mostly synchrotrons. Currently the eight organisations shown in figure 1 are actively developing and supporting Tango.

Synchrotron radiation at the ESRF is produced by electrons moving through a vacuum ring with an 844 metre circumference and EGO sends laser light through two vacuum arms of 3000 metre length each. The equipment used to control and monitor the vacuum at the ESRF is similar to the vacuum equipment at EGO.

The LIGO gravitational wave detector uses a similar control software called EPICS, which was also considered but Tango proved more attractive especially as there already exists some experience with Tango in the Virgo collaboration.

Tango is being used in testing the new cryotrap which is being built for advanced Virgo. The Cryotrap (figure 2) which is placed at the extremes of the vacuum tubes is used to trap unwanted water vapour. The EGO electronics is in the white box and the tango software is running on the laptop sitting on top of this box.

Fig. 2: The new cryotrap under test at the manufacturer’s location.



A Programmable Logic Controller (PLC) was chosen to control the cryotrap. The PLC is a small industrial computer with many inputs and outputs. The PLC was programmed to monitor attributes such as temperature, pressure and various other states using sensors. The same PLC was programmed to send commands to move valves and start pumps using relays.

A Tango system consists of Tango device servers which access the hardware (PLC) and Tango clients which provide the interface to users. Servers and clients communicate using the "Tango Software bus"

Cryotrap test setup using Tango required several steps. Initially the Virgo vacuum group provided a design detailing control system requirements. Test equipment was setup by the electronics group at EGO based on this design. A PLC was then programmed by the EGO software group so that the electronics could be controlled by reading and writing to registers in modbus format (1). The Tango device server was then created to read/write to the PLC. The Tango device server converts modbus values to Tango attributes and commands which are accessible via the Tango software bus. Finally several Tango clients were configured to monitor and control the cryotrap.

The gory hardware details (such as modbus) are hidden from the user. The end user (Tango client) sees all information as attributes and commands. To monitor values such as pressure the user must only know the Tango device name and the attribute name. The hardware could even be replaced without the client knowing as long as the new device server uses the same Tango names for the new hardware.

The Tango collaboration likes dance names and users will come across tools such as Mambo, Jive and Pogo. The Mambo client shown in figure 4 presents Tango attributes graphically or in tabular form. In the figure Pressure1 to Pressure6, shown graphically, represent the pressure in mbar measured at 6 points on the cryotrap. V1, V2, V22 etc…represent the state of valves (open, closed or moving) and are listed in tabular form under the other mambo tab ("Strings and State Scalars").

Many other clients are also available and they access devices in the same way as Mambo using the same names for attributes and commands. If you do not like the clients produced by one institute there is probably a similar client available from one of the other institutes in the Tango collaboration. Tango interfaces to third party clients are also available such as the Python programming language or commercial packages like Matlab and Labview.

Tango servers are more complicated than clients as they must be tailored to the hardware device. Over the last 12 years the engineers in the Tango collaboration have written many device servers to control devices. If you want to integrate a new camera or motor often the device server to control it is already available on the ESRF web site. As Tango has become more popular some commercial manufacturers even provide equipment with

(1) - Modbus is a standard communication protocol used to communicate with PLCs.

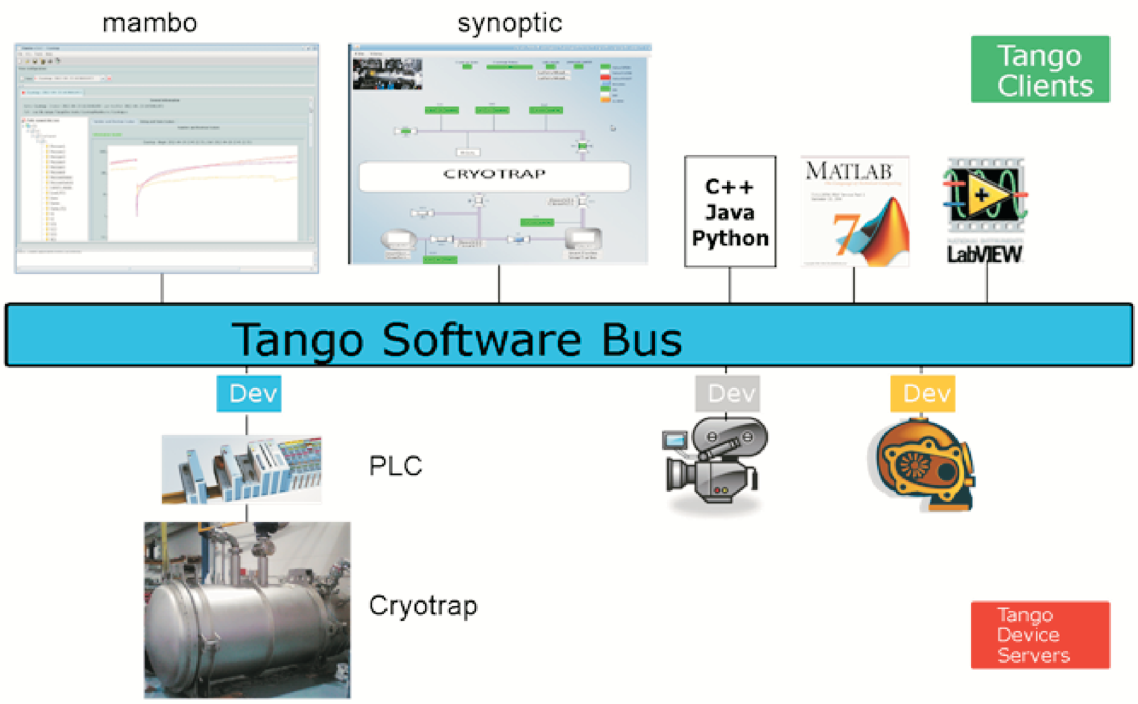


Figure 3: The Tango Software Bus

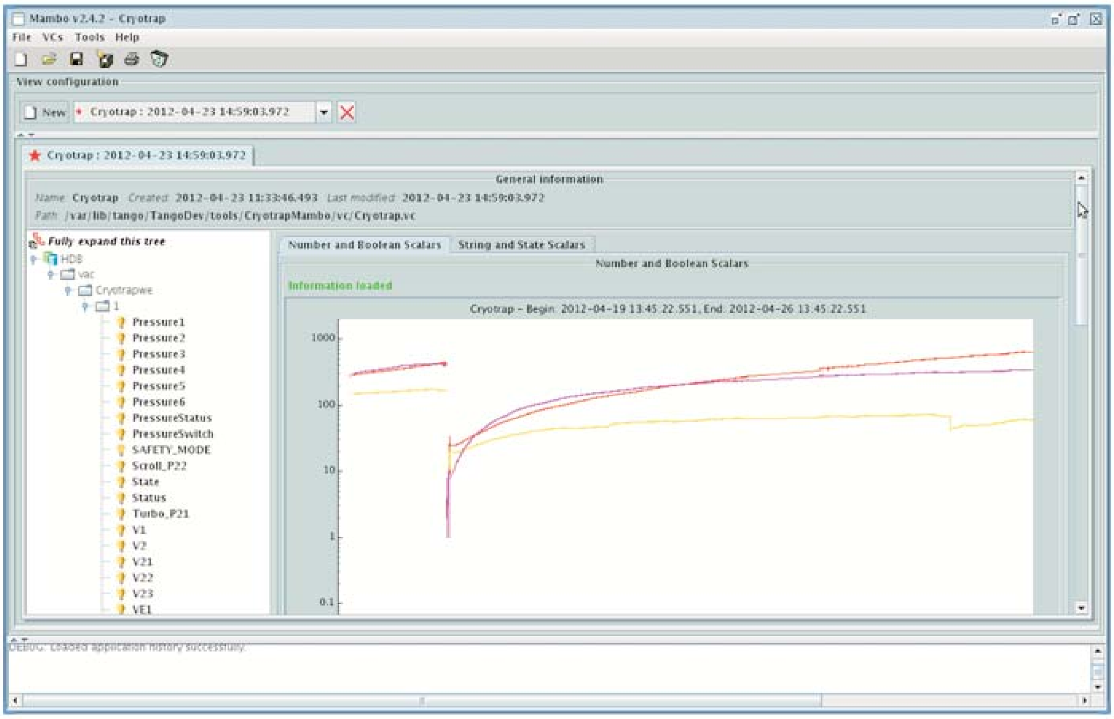


Figure 4: The Mambo tool used to display Tango attributes

inbuilt Tango device servers. Control systems can be complicated and obscure beasts whose inner workings are known only to a selected pool of experts. Open source standards such as Tango make the process of setting up systems clearer, quicker and more reliable. If there are problems or questions there is also a wide pool of engineers and scientists in the Tango collaboration who are willing and able to help.

M. MOHAN
EGO Software Group

Researchers' Night 2012

The eighth Researchers' Night in Europe - the fourth for EGO and Virgo participation – recently took place and again this year the region of Galileo answered with enthusiasm, saturating an offer that was much larger than in the previous years.

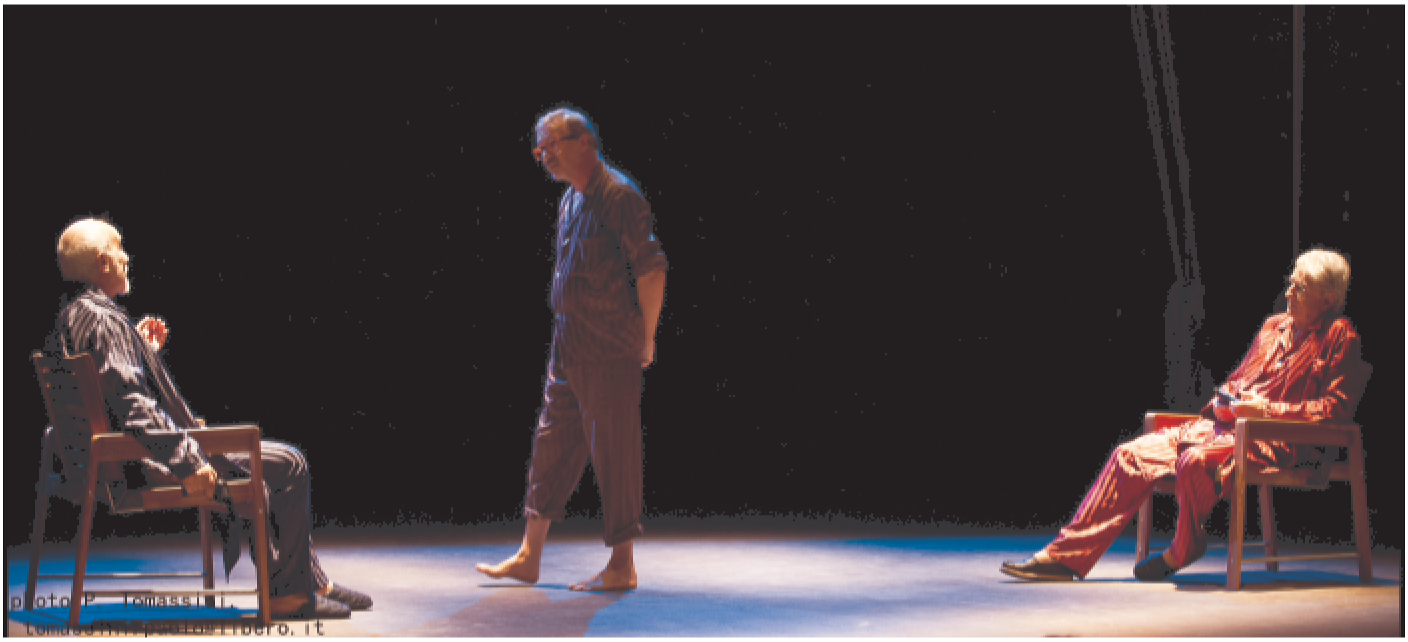
The Regione Toscana, a couple of months before the Night, realised the existence of this event and decided to participate. A small group of engineers from the University of Pisa, led by Professor Giuseppe Iannaccone, was tasked with the management of the adventure and they succeeded in stimulating a consistent programme of events in Florence, Siena, Grosseto and, of course, in Pisa (http://www.shine2012.eu/programma/).

For us it was a double effort: we had our traditional programme in Cascina, but we could not be absent in Pisa either. We quickly arranged a large stand that we shared with our mother institution, INFN: we had a working interferometer model, a TV screen with videos and a slideshow and several posters in the main hall at La Limonaia, a well known science dissemination association in Pisa. We also got a seat in a "talk show" at the Limonaia conference hall, cleverly defended by Giovanni Losurdo. Thanks to the downtown location and also to the reduced dimensions of the Limonaia, both events were really crowded to the limit.

Students at work, building their own mini-interferometer.

As far as "our" Researchers' Night is concerned, I dare to say that it was a bright success. The programme was classical: two guided visits and an interferometer building workshop each afternoon, the 28^{th} and 29^{th}.

On the first night the foreseen astro-observations were not possible due to the clouds, but were replaced by a very successful virtual astro-show in the auditorium, which Gabriele has been asked to repeat three times and is now available on our website (http://outreach.ego-gw.it/index.php?option=com_webplayer&view=default&Itemid=89&lang=en).



Pictures taken during the representation of The Physicists at the Theater La Citta' del Teatro in Cascina.

Contemporary to the astro-show there was a "Science Café", or, better, a "Science Bar", where visitors could ask questions to the scientists while sharing a drink. Small groups were accompanied to visit the site, the control room, the telescopes of the Galilei association (pointing, in the lack of stars, from inside the Main Building to some street lights). The vacuum free-fall machine was one of the most attractive and visited exhibits.

The second night, at the Citta' del Teatro in Cascina, was dedicated to "Die Physiker" (The Physicists) by the Swiss playwright Friedrich Dürrenmatt. Besides the beauty of the plot, the peculiarity of the event was that the three mad men, all three believing themselves to be famous physicists (Newton, Einstein and Möbius), were interpreted by three true physics professors (from the university of Rome) and two nurses were interpreted by our colleagues Luca and Nicola.

Some statistics can give you a measure of the 2012 Night performance. For visits and interferometer workshops we had a total of about 190 persons, out of 240 not-cancelled bookings. Maybe, in light of this, we can next year allow a 10% overbooking, given a total acceptable number of 260. At the astronomical night we had more than 100 people in attendance, out of 140 reservations; but this is more than what we expected, given the meteorological conditions. Finally, at the theatre we had an attendance of 190 out of a fully-booked total of 198 seats.

C. BRADASCHIA

Kim jest Adam Kutynia? *

*Who is Adam Kutynia?

Interview by
Frédéric Richard
on behalf of ***h***

FR: Dear Adam, it is now quite a while since people on the site first encountered you and asked about your Polish-plated car, so it is high time to remove any doubts about your stay among us: so, let me begin this interview with two natural questions: who is Adam and how did you end up in the Virgo Community?

AK: Dear Fred, even if you already know a little bit about me as we performed the introductory safety tour together, here are the essential things about me:
Indeed I am Polish, graduated as an electronics engineer and have worked up to now within the Polish Wroclaw University of Technology where I worked designing Electron Paramagnetic Resonance Spectrometers and Magnetic Field Controllers. I heard about the opportunity through the POLGRAW group to work for at least one year on the Virgo project within the Pisa group to test new sensors and design cards for the Advanced Virgo project.

FR: It is true that together with your referees (Franco Frasconi and Alberto Gennai) we dealt with your duties from a safety perspective, but I and we would like to know a little bit more about you: for instance what have you appreciated up to now in Virgo, same thing for what you have not appreciated (if you dare!)

AK: In Poland, I have worked on electronic circuits where "accuracy" and "precision" were the two predominant terminologies used as of a paramount importance. Here in Virgo, the focus is put on "noise", "bandwidth": so a different kind of vocabulary to describe the same thing. So I would reply to you that I appreciate the different perspective proposed by people and the project to reach the same goal.
What I have not appreciated… uhhmm….Nothing related to Virgo, but I still find difficulty in speaking with people outside of the Virgo community. After a short stay in an English native-speaking EGO colleague's house, I have found a small apartment in Pisa, and I hope to develop my Italian language as I would like for instance to seize the opportunity of being close to the seaside to sail, within a team for instance.

FR: It is true Adam that, in such an activity, you will need to know the minimal Italian sailing survival vocabulary… Tell us more about this activity:

AK: I like sailing and I have just come from a two week journey in the Canary Islands surroundings and would like to discover the beautiful small islands along the Tyrrhenian sea.

FR: Dear Adam, I am sure you will find a few people on the EGO site that will be eager to sail with you. As for the electronic stuff, different vocabulary but same goal. Let me conclude this interview with a crucial question: what (the hell) are you doing with a removable car roof in Poland? Do you rent it for use in Italy during the summer?

AK: Fred, I thank you for this relevant question: I bought this car two years ago and have avoided removing its roof up to now, as you may know, it is too cold in Poland. Conversely, it is too hot in Italy during the summer, so I prefer to stick with what is written on the car's manual: "Air-conditioning is better functioning with the roof on".

FR: Adam, thanks for such an interesting introduction to yourself and I invite all EGO/Virgo sailing lovers to get in touch with you.

PERSONNEL MOVEMENTS

Arrival

Gabriel Pillant

Trainee at EGO in the Optics Group

Departure

Matteo Tacca

Physicist in the Commissioning team left EGO to work at the French laboratory AstroParticule et Cosmologie (in Paris) since January 2013