THE GRAVITATIONAL VOICE

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APRIL 2011

News from EGO and VIRGO

A Payload in Lyon!

News from the site:

Heating for compensating thermal effects
Correcting miror curvature radius with CHRoCC

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EDITORIAL

Writing this editorial, my feelings are dominated by the sadness generated by the loss of Stefano Braccini. Our memories of this great person are recalled in the article by Francesco Fidecaro, reproducing what he said in the commemoration ceremony held in the EGO auditorium.

My personal memories go back to Stefano as a child, playing cards with my newly-married wife in a mountain chalet in Verbier, in 1972, and continue through all of the moments mentioned by Francesco. These memories are reinforced further by having been Stefano's thesis advisor on two occasions.

Our collective memory goes to the unavoidable tears during the reading, at the funeral, of the list of beautiful things in his life, which had been written by Stefano himself. Virgo was there, so were the superattenuators, along with Paolo Ruggi in the control room.

Virgo really was a part of Stefano's life. Stefano will always be part of the story of Virgo.

C. BRADASCHIA

Photo credit of the front page: Ville de Vaulx-en-Velin, Studio Gaudin Ramet.
A Virgo payload at "Ouf d'Astro", Vaulx-en-Velin (Lyon, France).

IN REMEMBRANCE OF STEFANO

We publish the speech of Francesco Fidecaro, pronounced on February 22nd in the EGO auditorium.

Stefano in Australia some months ago.

Dear colleagues,

I had hoped that such a moment would never come; being here together remembering a friend and a dear colleague, suddenly departed.

Stefano obtained his degree in physics under the supervision of Carlo Bradaschia in 1992 and achieved the "Perfezionamento" (PhD) at the Scuola Normale in 1996, under the supervision of C. Bradaschia and Jean-Yves Vinet. The results presented in the thesis constituted the bases for the design of the system of baffles, used to counter diffused light in Virgo.

Later, Stefano concentrated his efforts on the development of the Superattenuator, having the responsibility for its development and for the construction and characterisation of the first full prototype responding to the Virgo requirements. In this period we abandoned the gas springs, replacing them with mechanical springs, coupled to the magnetic anti-springs. The famous Maraging steel was "discovered", allowing us to beat the creep noise thanks to a special heat treatment, developed for the purpose. Extreme sensitivity and low-noise sensors and actuators were designed and built. The achieved performances proved also to be sufficient for second generation interferometers. All this work, including installation and first operation, was concluded in 2003, with the first locks of the Fabry Perot cavities.
The capabilities of the Superattenuators were first demonstrated in 2001, when operating the "Central Interferometer", and definitively with the VSR2 run. All this would have not been achieved without Stefano.

In 2005, Stefano was appointed as Locking Coordinator, providing relevant contributions to the realisation of the automatic locking sequence presently used in Virgo. He contributed both to progression in analysis and to engineering studies. He was co-chair of the continuous signal committee and participated to the development of an original method to search for such signals. On the other hand, he studied the creep process and the behaviour of metals under stress. In recent times he was a strenuous fighter in the definition of the best lay-out for Advanced Virgo.

Stefano also participated with enthusiasm to the life of the INFN. In the period between 2002 and 2009 he was coordinator of astroparticle physics activities in Pisa and, from 2007, was the leader of the Pisa Virgo group. At national level, Stefano was a member of the astroparticle physics national committee, contributing to the definition of the INFN roadmap for gravitational wave research.

All of us will forever remember Stefano as a gentle, honest, generous man.

Correcting mirror curvature radius with CHRoCC

In Virgo we use an awful lot of acronyms, which sometimes makes it difficult to understand what's going on. In the last few months you may have heard a new one: CHRoCC (pronounced krok ?). This acronym stands for Central Heating Radius of Curvature Correction. This device has just been installed in the North and West End towers. Heating the centre of the end mirrors changes their shape (Radius of Curvature) and helps to improve the performance of the interferometer. In this article I will talk about what makes an ideal interferometer, and then I will explain the problems that we have been having with our current interferometer mirrors. Finally, I will show how CHRoCC works and how it has helped to make our mirrors better.

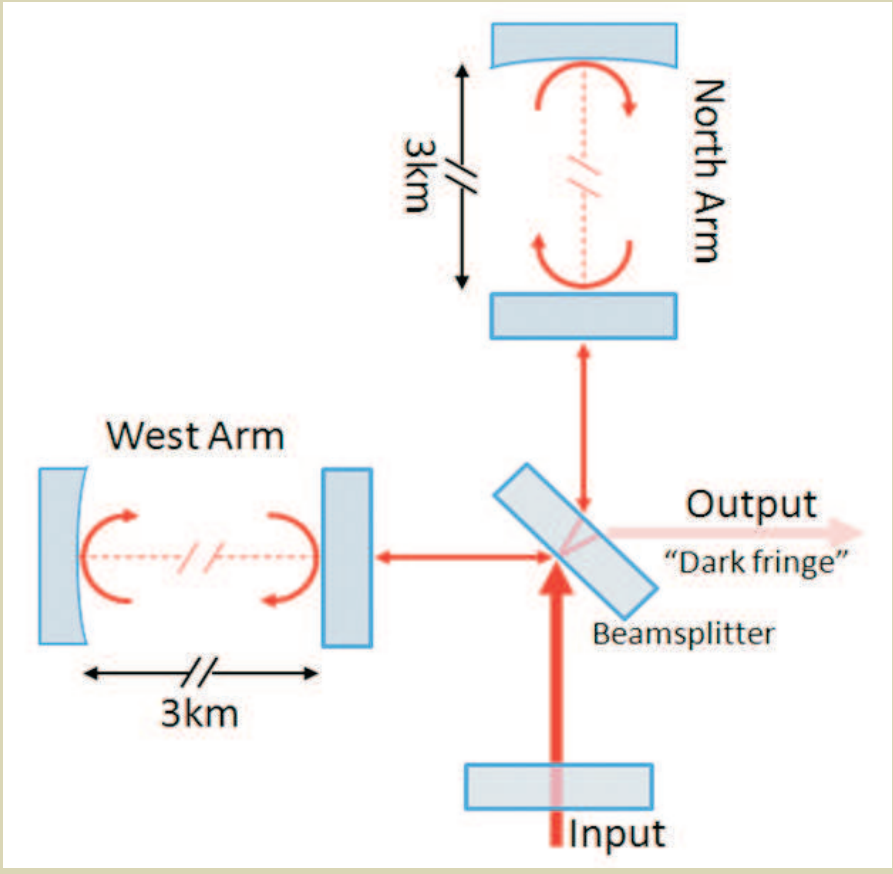
So, let's start by reminding ourselves how our beloved interferometer works. In figure 1 we see a diagram of the Virgo interferometer. The beam comes into the interferometer and at the beam splitter half of the light goes to the West arm and half goes to the North arm. The light is then reflected back from each arm and meets again at the beam splitter. These two beams then interfere (that's where the word "interferometer" comes from) either constructively (producing lots of light) or destructively (producing no light). The kind of interference depends on how we adjust the mirrors in the interferometer. We choose to adjust the mirrors so that we have no light (called the "dark fringe") at the output of the interferometer (see figure 1). Now we're ready to detect a gravitational wave. When the gravitational wave passes by, it makes one arm slightly longer and the other slightly shorter and vice-versa, alternatively. The change in arm lengths means that momentarily we do not have a perfect destructive interference and we see a little bit of light on the dark fringe and we know that we've just seen a gravitational wave!

However, if the beams reflected back from each arm are not identical in size and power then we cannot get a perfectly destructive interference and there will be a lot of light, even if a gravitational wave is not going past. This unwanted light is a problem for a number of reasons:

• Any noise that is common to both arms is no longer cancelled out.
• All of this light is wasted so the interferometer is less sensitive.
• This light can even bounce back into the interferometer making it noisier.

So we can see that it is very important that both beams reflected from the arms are as similar as possible. But when the input beam was split into two and sent to the arms, these two beams were both identical. So what happened in the arms to make them different? In order to answer this question we need to take another look at figure 1. We see that each arm is not just one mirror, but two mirrors, 3km apart. These two mirrors make up an optical cavity. This optical cavity means that the light spends much more time in the arm because it goes back and forth between the two mirrors. It is for this reason that Virgo is so sensitive. However, it is this optical cavity that decides the shape and power of the beam.

Figure 1: Schematic diagram of Virgo+ interferometer



1. The size of the beam that will circulate in an optical cavity depends on the distance between the two mirrors and the shape (Radius of Curvature) of the two mirrors. Therefore the beam size reflected by the arm does not depend on the size of the beam sent into the arm.

2. If the mirrors are bumpy they can literally throw light out of the cavity which creates losses and means that the reflected beam is not so powerful.

3. When the mirrors have a certain radius of curvature they can sometimes create complicated beam patterns called Higher Order Modes (HOM). These HOM can also throw light out of the cavity and can make it difficult to align the interferometer.

So we see that the shape of the mirrors in the arm cavity is very important to obtain a dark fringe that is nice and dark.

So everything that we have discussed so far is nothing new. What has changed to make us think that we need a CHRoCC now? One of the most important changes that was made for Virgo+ is the installation of the monolithic suspensions. This is the famous mirror suspension using welded glass wires in order to reduce thermal noise and make the most sensitive interferometer in the world. Part of this installation was new mirrors in the arm cavities. We installed these new mirrors at the beginning of last year. As soon as we saw the shape of the mirrors we were worried about our dark fringe not being dark any more. Remember that we said that it is the mirrors of the arm cavities that decide the shape and power of the beam. Unfortunately, we saw that the end mirrors had very different radii of curvature. We decided that something had to be done. The solution was CHRoCC!

As with all materials, glass expands when it is heated. Therefore, if we heat the middle of the end mirrors (which are made of glass) then the middle will expand and its radius of curvature will change. This is where CHRoCC comes into the story. CHRoCC is an extremely simple device that is shown in figure 2. You can imagine CHRoCC as a big (and expensive) version of a spot light that you may find in your bathroom or kitchen. The only difference is that the CHRoCC doesn't send visible light but sends infrared light that heats the mirror. The source is a piece of ceramic which can be heated up to 1200°C. As with any hot object (even the human body) this heater emits infrared radiation. This infrared light is focused by the reflector onto the center of the mirror. Even though the heat source is very hot, the mirror only increases in temperature by a few degrees but this is enough to expand the glass and get the change in radius of curvature that we want. In figure 3 we see a picture of the CHRoCC in action. In figure 4 we see what the temperature of the mirror looks like when we set the CHRoCC to 500°C.

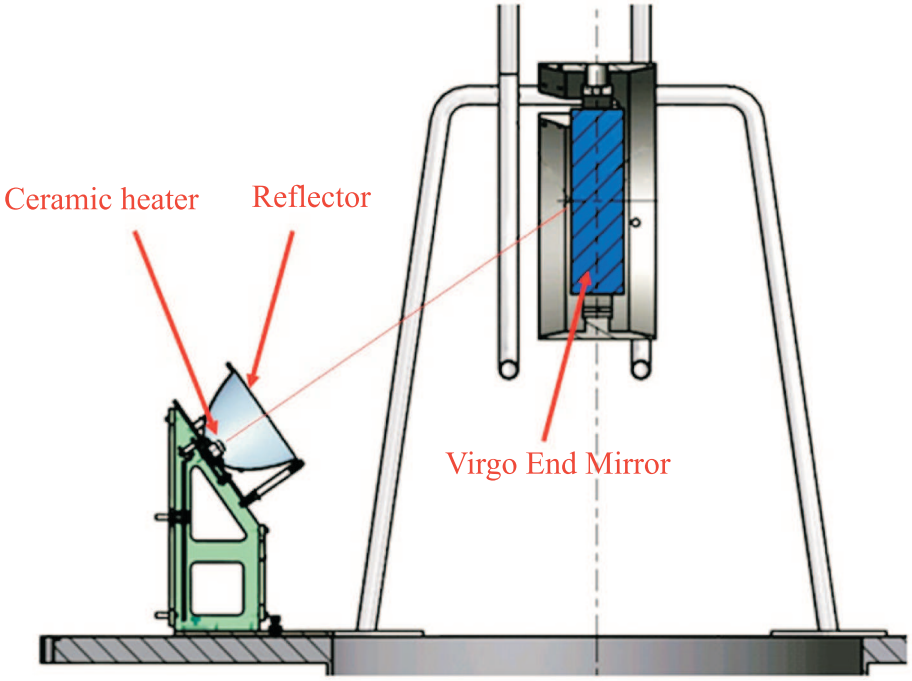
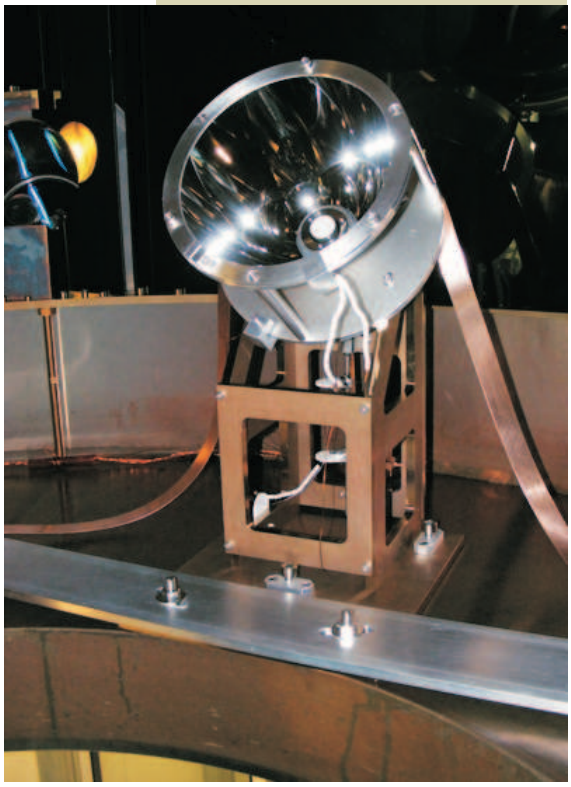


Figure 2: CAD of CHRoCC heating end mirror (T. Zelenova, EGO)

The first CHRoCC was installed just before Christmas 2010 on the North End. It did a very good job of

Figure 3: Picture of CHRoCC installed in West End vacuum tower



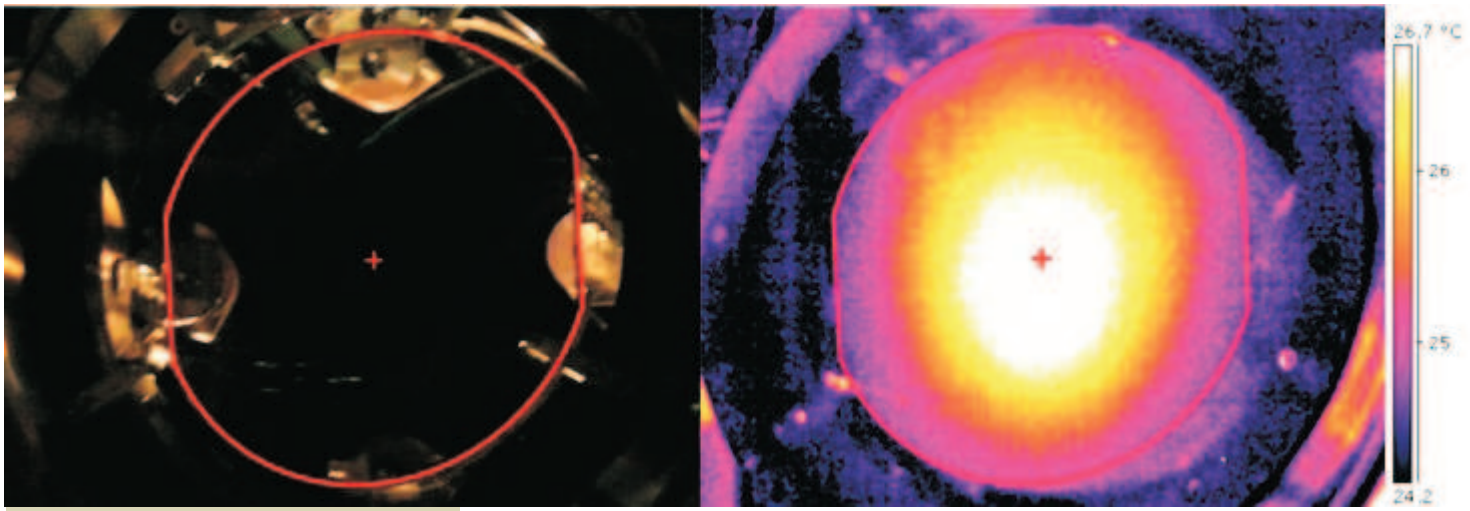


Figure 4:
Normal photograph of end mirror (left). Thermal image of same mirror with CHRoCC at temperature of 500°C (right).

increasing the radius of curvature (RoC) and it was possible to make the RoC of both the North and West end almost identical. We saw the dark fringe getting much darker straight away. Unfortunately, this did not solve all the problems. We found that both mirrors were at a RoC which created a lot of higher order modes. Remember that we said that higher order modes can increase losses and make the alignment of the interferometer harder to control. We therefore decided that to make things better we needed to change the RoC of both end mirrors. So we set about installing a second CHRoCC on the West end. This was successfully achieved at the beginning of March. We are now using the CHRoCC on both the North End and the West End with temperatures of about 600°C. Now we have managed to get a dark fringe that is even darker than before. And, thanks to the fact that we are not bothered by higher order modes any more, we do not have as many losses, so the useful power in the interferometer has increased by about 50%. In addition, it is much easier to align the interferometer, making life for the commissioning team less difficult.

The installation of the CHRoCC has been a real success and thanks to the hard work of more than twenty people in the EGO group it was installed in record time. We all hope that the CHRoCC will play its role making Virgo the most sensitive Gravitational Wave detector in the world!

R. DAY
on behalf of the CHRoCC team

A thermal compensation for Virgo mirrors

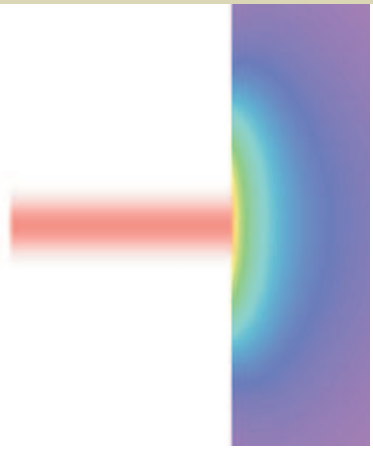
Even if made from the best and purest optical materials, our mirrors absorb a tiny fraction of the light power stored in the interferometer. The level of the absorptions is of the order of a few parts per million, which means that the mirrors take in a few milliwatts of laser power and their temperature slightly increases. However, since the laser beam has a Gaussian power distribution and hits the centre of the mirror and since the substrate material has a very low thermal conductivity, the temperature increase is far from being uniform (see figure 1).

The temperature field itself would not be a concern, if it wasn't for the fact that the index of refraction of fused silica depends on temperature.

In Optics, the optical path length (OPL) is defined as the product of the test mass thickness by the refraction index. So, if the latter is not uniform anymore then the optical path length is also not uniform: this is the same as putting a lens in the mirror which generates aberrations in the sidebands and makes it impossible to lock the interferometer at high input powers. Figure 2 shows, on the left, an example of a non-uniform OPL change and, on the right, a distorted sideband.

Another effect of the absorption is a thermal expansion of the high reflectivity surface of the mirrors, that changes the RoC of the test masses: this is negligible in Virgo, but it will not be such in Advanced Virgo.

Figure 1:
Temperature field inside the Virgo mirror due to absorption.



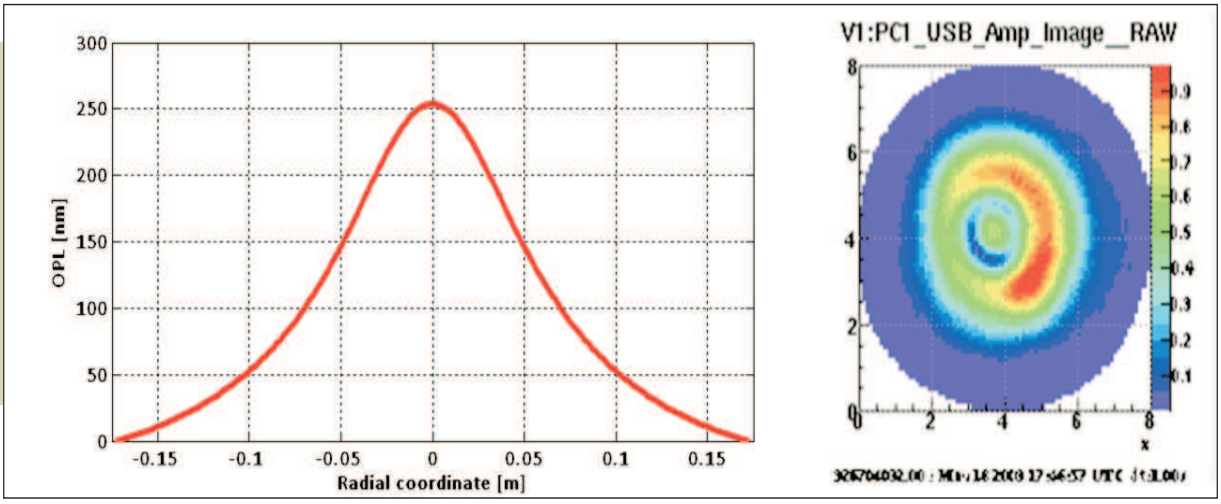


Figure 2: Optical path length increase inside the mirror substrate (left). Distorted sideband (right).

Let's go back to the temperature field in the substrate (figure 1). We can clearly identify two gradients: one in the radial direction and one in the direction of the thickness of the test mass. Fortunately for the people designing thermal compensation systems (TCS), the only one that matters is the gradient in the radial direction. So, the principle of TCS is straightforward: eliminate the gradient in the radial direction to flatten the optical path length (see figure 3). Thus, the task of compensation is achieved by heating the peripheral surface of the input mirrors. How this is done, is only a matter of convenience. For instance, Ryan Lawrence (LIGO) used a ring heater placed in front of the mirror during the measurements for his Ph.D. thesis.

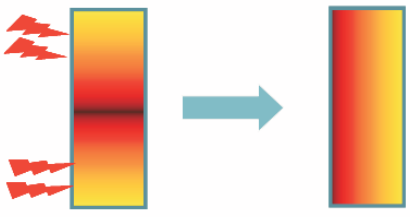


Figure 3: TCS concept, heat the peripheral surface of the mirror to cancel the radial temperature gradient.

An important question is: what is the region where we need to flatten the OPL? The answer is that only the part of the mirror which is hit by the interferometer beam is important, up to a radius which is approximately 1.5 times the size of the beam on the input test mass. In Virgo, we decided to use CO2 lasers to generate the heating pattern for several (good) reasons: an optical system is much more flexible and precise than a thermal source and the apparatus is outside vacuum, so any upgrade can be made without venting the towers. During the TCS commissioning, we have been able to modify the heating pattern just by moving one lens on the optical bench. Also, the installation of the intensity stabilization system and of the infrared cameras took place with no downtime of the interferometer. Finally, the wavelength of CO2 lasers (10.6 μm) is completely absorbed by fused silica. As we will see later, the possibility of generating heating profiles with high precision will be of great importance for Advanced Virgo.

The conversion of the laser Gaussian beam into a donut shaped beam is achieved by using a special optic component called axicon: the difference with respect to standard optics is that one of the surfaces of he axicon has a conical shape. An axicon and the resulting annular beam are shown below in figure 4.

The Virgo TCS proved to be very effective and was capable of reducing most of the thermal lensing in the input mirror to the level required for the operation of the interferometer. Moreover, the results of the measurements agree very well with the outcome of the thermal finite element model of the TCS. In figure 5 (on the next page) one of the measurements taken by the Commissioning crew is shown: this provides a comparison of the shape of the sideband when TCS is off and on.

Most of the issues of the TCS are related to the temperature stability of the CO2 lasers. These proved to be very sensitive to temperature changes, both in the laser itself and in the environment. Noise instabilities arise due to the fact that

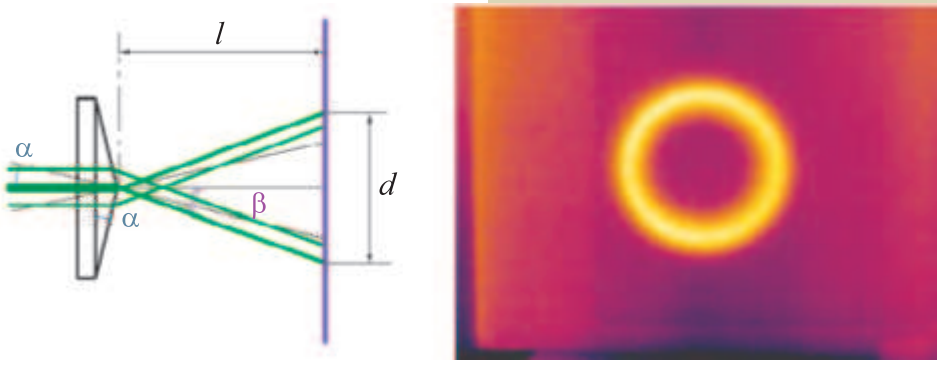


Figure 4: Ray-tracing model of an axicon (left). Thermal image of the annular beam obtained with an axicon (right).

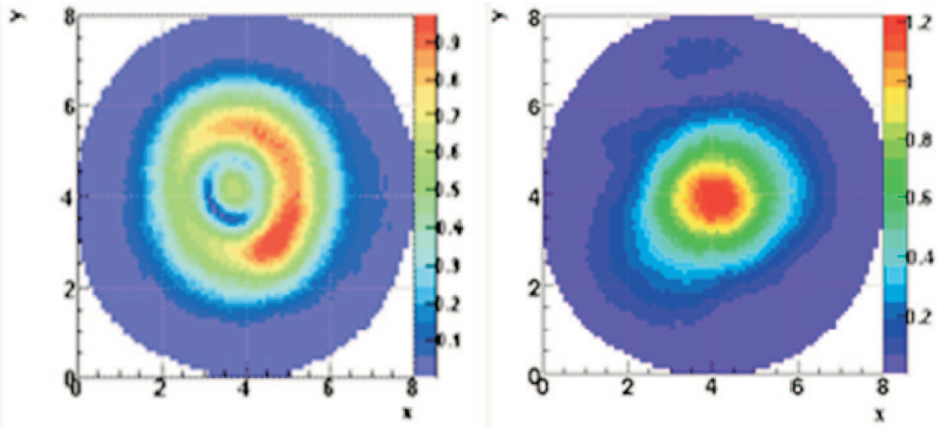


Figure 5: Comparison between a distorted sideband (left) and a "thermally compensated" one.

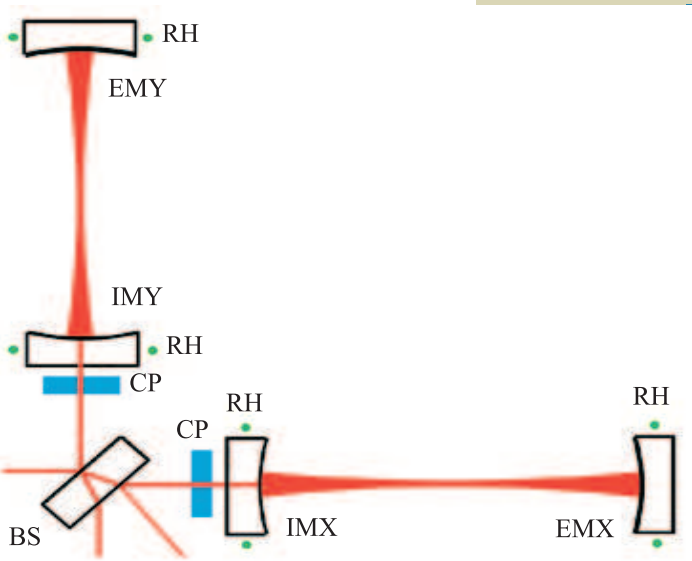
the laser emits one particular wavelength rather than another. In some cases the pointing of the beam can also change with temperature. Our operators know that very well, since they often try to chase down these instabilities by changing the laser chillers temperature set point.

What about TCS in Advanced Virgo? Well, the concept will not change much but there are some new technical details. First of all, TCS will have to take care also of the thermal expansion of the mirrors. So, there will be a new actuator, a ring heater, around each test mass to recover the initial RoCs of the test masses. Moreover, even with intensity stabilization, the CO2 laser is too noisy to directly heat the mirrors, this is why the auxiliary heating laser is shone on to compensation plates (CP). A conceptual layout of the Advanced Virgo TCS is shown in figure 6. CPs are transmissive optics suspended independently on the back of the input mirrors. With CPs in the recycling cavity, hence outside the arm cavities, all the noise due to CO2 laser instabilities is reduced by a factor close to the Finesse of the Fabry-Perot cavity. So CPs can be subjected to CO2 radiation with no fear of re-introducing noise into the detector. A non-negligible advantage of the introduction of CPs is that it is possible to independently correct the thermal lensing and the RoC. For example, the thermal lensing in the beam splitter, if needed, can be compensated on the CPs, leaving the RoC of the ITM unperturbed.

Another important change concerns the heating pattern to be applied to the compensation plates. Through optical simulations, it has been shown that a simple annular pattern (as it is in Virgo) could not be enough for Advanced Virgo. This is mostly due to the larger beam size on the input mirrors, which, as previously said, constrains the portion of the OPL that needs to be flattened. For this reason, a finite element model was developed to find the heating pattern that would perfectly correct thermal effects. The result of this search is the blue curve of figure 7. To generate this heating profile, one could think of using a scanning system or diffractive optical elements, both methods requiring some time for investigation.

So we studied the possibility of approximating the optimal heating pattern with a Double Axicon System (DAS). The idea is to split the laser beam into two independent beams, each "arm" would generate an annulus with the desired characteristics and finally recombine the two rings. The conceptual scheme of this set up is shown in

Figure 6: left picture shows the conceptual design of the Advanced Virgo TCS, blue rectangles represent the CPs and green dots the ring heaters. Right picture shows the input payload: on the right is the mirror with the heating ring, on the left the CP.



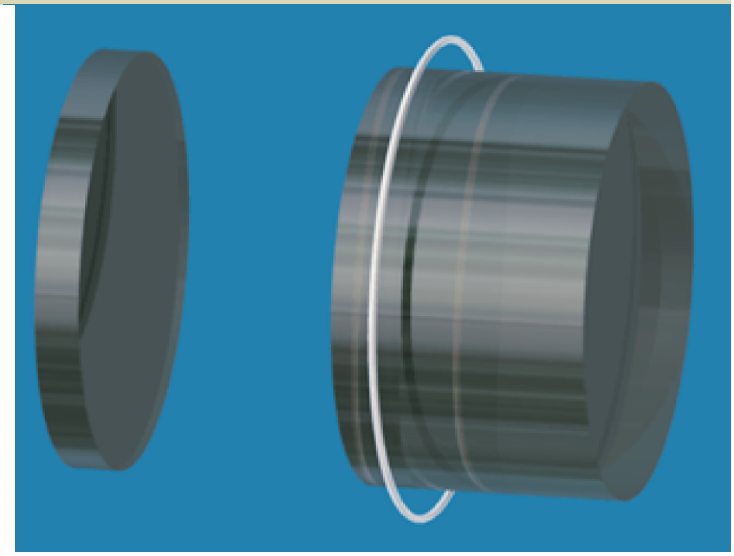


figure 8 and the resulting heating pattern is the green curve in figure 7. The feasibility of this system has been investigated in the Tor Vergata optical lab and a good agreement with the simulations has been found.

The TCS benches of Advanced Virgo will also take care of the thermal instabilities found in the present set up. The CO2 laser will be housed in a temperature controlled box, so to better stabilize its temperature and eliminate its sensitivity to changes in the temperature of the environment. Moreover, an automatic alignment system, made of a galvo (mirror steering device) and a quadrant photodiode, will be used to keep the beam always well aligned onto the axicons.

The results obtained so far are encouraging and increase our confidence that in Advanced Virgo thermal effects will be successfully managed.

Let me finish by thanking all the EGO colleagues that made the installation and the operation of the TCS a success and the Tor Vergata group who, with their hard work, made this paper possible.

A. ROCCHI
on behalf of the Tor Vergata Group

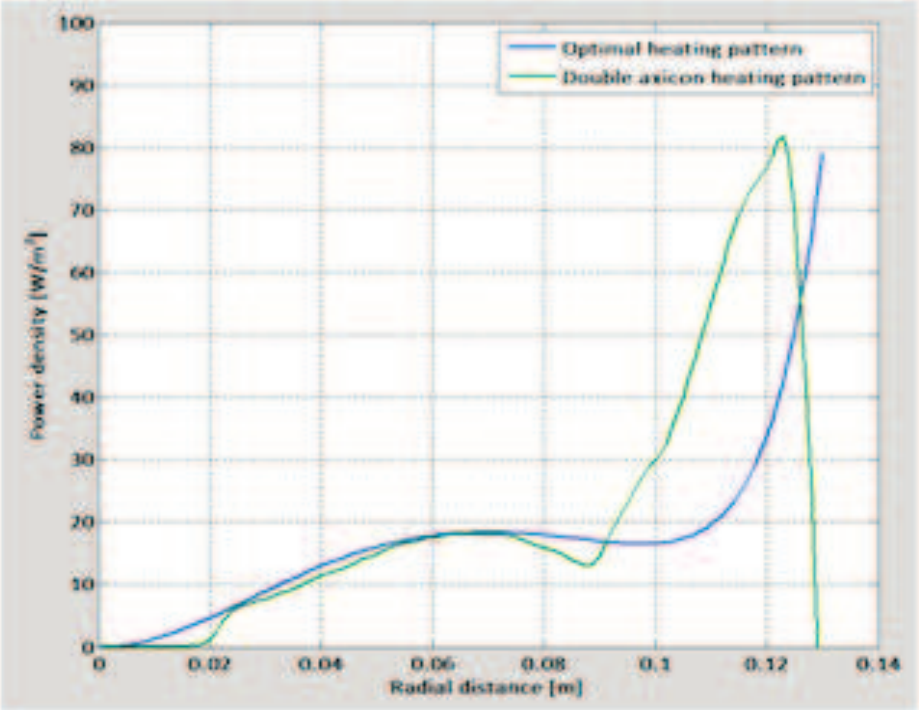


Figure 7:
Comparison between the optimized heating pattern (blue curve) and that given by the DAS (green curve).

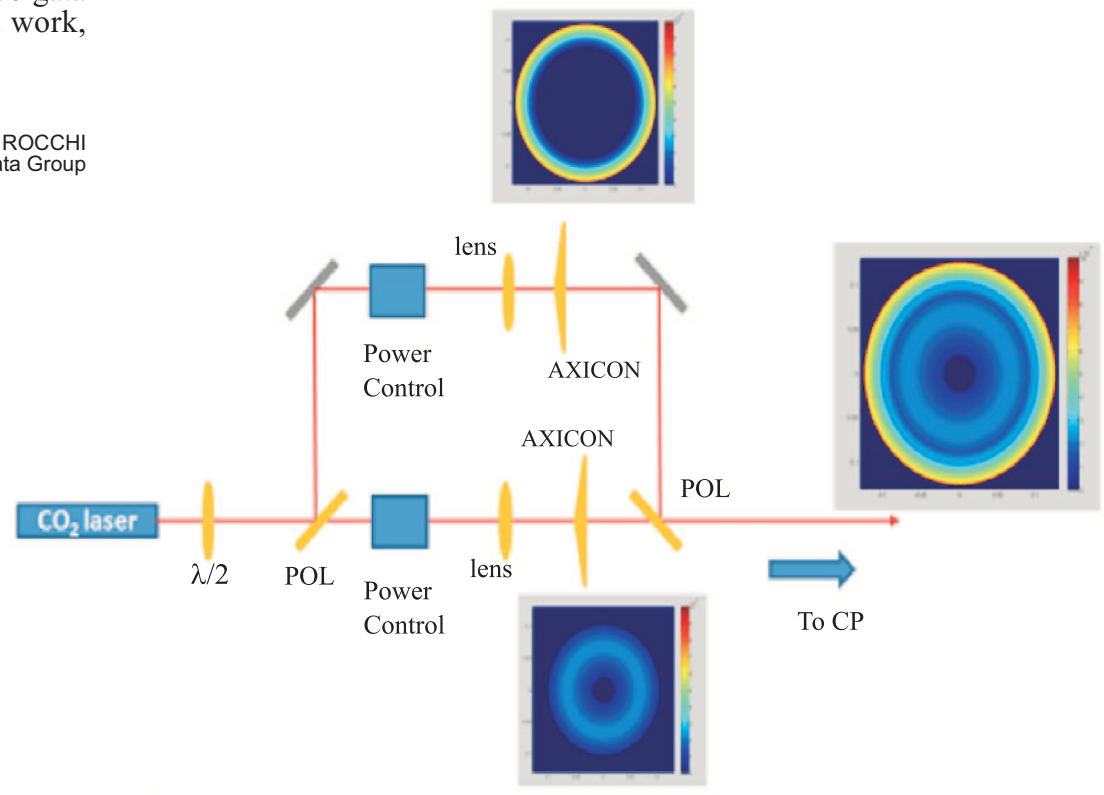


Figure 8:
Conceptual layout of the DAS. Splitting and recombining the beams with polarisers ensures that no interference fringes will be generated.

Crazy about Astronomy

"Ouf d'astro", a series of exhibitions, art performances and seminars organised by the planetarium of Vaulx en Velin, a city next to Lyon, took place between the 21st and 27th of February. The theme for this year was gravity and a dedicated exhibition was set up to encourage discussion between people and researchers. During the week, more than 450 students and around 1600 people interacted with CNRS/IN2P3 staff to talk about dark matter, galaxy formation, and the fate of black holes or gravitational waves.

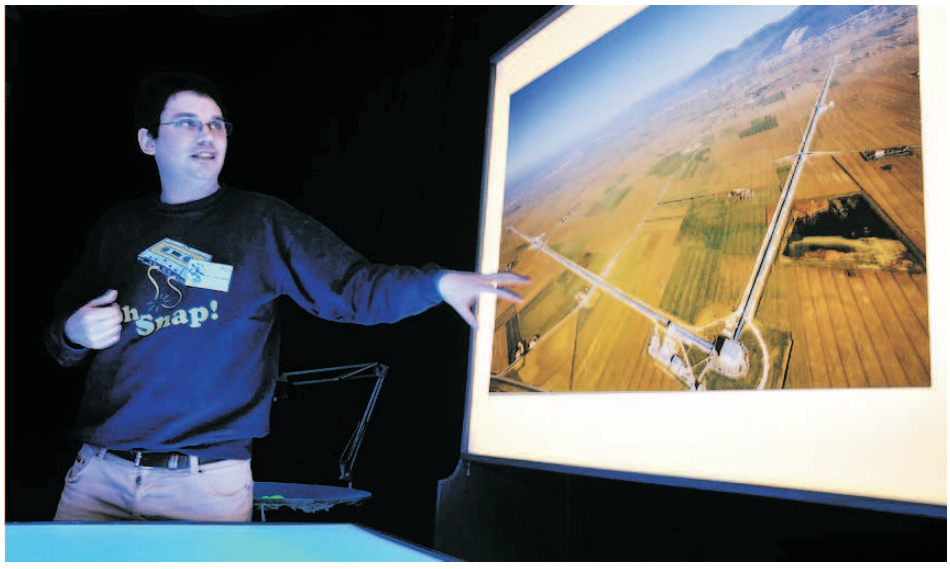
The Virgo booth was a real success thanks to the presence of an actual Virgo mirror from Cascina, a model of the suspension system, a large backlight picture of Virgo and enthusiastic people from the LAPP and LMA. But, before describing the atmosphere there, let's go back to the Friday before the opening, and the arrival of the large Virgo payload (shown on the front page).

The payload arrived at the exhibition site 3 days before the opening, thanks to Nicola Menzione and Michele Bazzi who brought it back from Cascina. Moving a 200 kg object is not a trivial task, since even 2 little steps can easily delay the installation, as we learned. It took almost half a day to install the payload and its protective plexiglass cover in its definite place. And what a place! An imaginary clean room made of white walls, blue UV shining from the floor and pictures of the actual LMA clean room displayed all around. The whole area of the exhibition was relatively open and dark with just a well of light and a symbolic structure delimiting each research area.

Everything installed and prepared, the flock of little heads can arrive. Not always easy to manage a group of high school kids but, overall, the interaction was good. The goal clearly stated by the organisers was to talk informally about what we were doing, and not to lecture about gravitational waves (to be banned: "since 1916 and Einstein's theory of general relativity...").
The Virgo test mass was a good starting point, since the coating is transparent to visible light, so we could surprise people when saying "The piece of glass in the middle is an almost perfect mirror". Then we follow with cool stuff from invisible laser light to massive black hole collision. We do not yet have a light-saber but we are working on it...keep in touch.

To finish, 3 little anecdotes gathered from our time with the public:
- A kid first described the payload as the drum of a washing machine. Where's the light-saber when we need it ?
- For smaller children, the elastic tissue with balls of different weight used to represent the curvature of space time was a real magnet. Moreover, with a little bit of practice, we can show different types of orbits or explain how the star can fall into the black hole.
- An older person seemed to be alarmed that gravitational waves are everywhere and may cross our body without being noticed ("again, more waves"). Luckily we did not speak about gravitational wave RADIATION.

Jérôme DEGALLAIX, LMA
Photo credit: Ville de Vaulx-en-Velin, Studio Gaudin Ramet.



NB: The name of the exhibit "Ouf d'Astro" is partly built on the French popular language called verlan, which consists of inverting the syllables of a word and for smaller words the letters.
Therefore, fou meaning crazy becomes Ouf. Indeed the word "verlan" refers to "parler à l'envers" (to speak backwards) and becomes verlan when inverted.

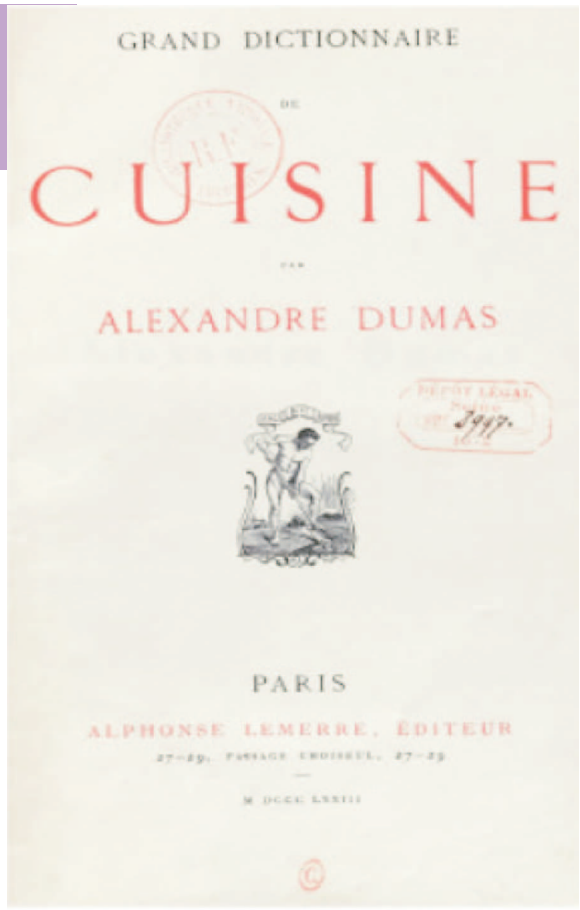
Le Grand Dictionnaire de Cuisine

by Alexandre Dumas (Père)

The Three Musketeers, The Count of Monte Cristo, Queen Margot: the most famous works of Alexandre Dumas, which come to mind while thinking of this prolific author.

Very few, however, know that, besides writing a myriad of vaudevilles, prose tragedies, historical adventure novels, Dumas also collected and gathered, in the later years of his life, plenty of recipes, illustrated with magnificent coeval engravings, in a manuscript called "The Great Dictionary of Cuisine".

Published after Dumas' death in 1873, the book is a kind of legacy from the author who also exposed his views on the "art de vivre". In the introduction it is particularly interesting to read the differentiations that Dumas conceives behind the French word "gourmandise": as a capital sin for those looking for quantity, as a virtue typical of "delicate spirits" preferring quality to quantity in order to savour the food served and, lastly, as the expression of an inextinguishable primary instinct which makes the worst of mankind.



Frontispiece of the "Great Dictionary of Cuisine" by A. Dumas, 1873

Approaching the Easter celebration, we offer you the chance to discover Dumas's version of the traditional lamb described in his manuscript.

Pascaline d'agneau à la royale
by A. Dumas

The tradition of serving a whole lamb on Easter Sunday was followed in France until the time of Louis XIV and even Louis XV. Here is how people used to make the dish for the royal family, which came directly to us from the feasts of the early Christians.

The collar of a six month-old lamb is boned . The breast, in which the shoulders are bridled with strings, is broken; the leg holders are also broken in the same way. It is then filled with a stuffing of pounded lamb meat, hard-boiled egg yolks, stale bread crumbs and chopped herbs, and seasoned with 'four spices'. The flesh of the lamb is finely larded, it is then roasted at a high heat and served, in its entirety, on a large plate and after the soup, or on a green sauce with pistachios, or on a truffle stew served with a ham sauce.

The serving of this ancient dish to royal diners on Easter Sunday has, as has already been mentioned, long been perpetuated in the French court and is still followed in the large houses in which the aristocratic and religious traditions of the 18th century have been maintained.

Original recipe

Voici comment on confectionnait ce plat qui nous venait directement des agapes des premiers chrétiens. On désossait le collet d'un agneau de six mois. On brisait la poitrine dans laquelle on ajustait les épaules bridées avec des ficelles; on brisait les deux manches des gigots qu'on assujettissait de même. On le remplissait d'une farce composée de chair d'agneau pilée, de jaunes d'oeufs durs, de mie de pain rassis et de fines herbes hachées et assaisonnées des quatre épices. On lardait finement la chair de l'agneau, on le faisait rôtir à grand feu et on le servait tout entier pour gros plat, en relevé de potage, soit sur une sauce verte avec des pistaches, soit sur un ragoût de truffes, au coulis de jambon.

April fool - i.e.: Majorana mystery goes on

Have a look at: http://www.rai.tv/dl/RaiTV/programmi/media/ContentItem-59d4c4b9-58c1-4fc7-a9a0-49ce6cd0ad3f.html?p=15

In 2008, the Italian TV series, "Chi l'ha visto?" (RAI 3), broadcast a "very stimulating" interview in which a genuine Italian emigrant to Venezuela, a Mr. F. Fasan, talks about a Mr. Bini, a sober gentleman from Argentina. Mr. Bini was quite polite and educated, but also taciturn. He used to hide his genius in a yellow American sports-car, which was filled with sheets of paper covered by mathematical formulae.

We are lucky because Mr. Fasani has a picture, which he showed to the interviewer. It is useless to compare Majorana to Mr. Bini since, the less they resemble one another, the more the mutation of the great scientist becomes plausible. Anyhow, the Public Prosecutor's Office of Rome decided that upon such a concrete basis there is sufficient material to re-open the case. In Italian national newspapers on April 1st and 2nd (Il Tempo, La Repubblica and a few others) detectives declared that there is no crime to be solved (just some differential equations with sixteen components), but a page of history to be re-written (which is probably easier).
The same interview was repeated on April the 6th. Italian decadence is permeating everywhere, but we trust in the Institutions. God Save the Queen.

E. MAJORANA

Open Door at EGO / Virgo

On May 7, as has already been announced on EGO and Virgo websites, we will have our traditional "Open Door Day".

The event will start at 15:00 and will end at midnight. The night part is necessary to allow for the astronomical observations, which have proved to be so appealing to visitors in the past. There will also be the "Science Café", with scientists answering questions while sharing a drink together. Take the opportunity to invite your friends and family.
Please remember that booking the visit is requested, at:
http://outeach.ego-gw.it

The Outreach team

Sport and Fun at EGO

We like to respect traditions, and two opportunities are coming soon, so be ready!

The EGO/Virgo Biathlon will take place on July 19, on the Tuesday afternoon of the Summer Virgo Week, and will be followed by a sumptuous buffet offered by the EGO Director (that's a tradition, too).

Also, the Spring Excursion is being organised. As tradition dictates, we found a walking/swimming location; suggestions are welcome. A Doodle enquiry has been launched to choose the preferred date.

C. BRADASCHIA

The taps of Cascina

The availability and control of drinking water will likely become a more critical issue than oil in the future. March the 22nd was actually World Water Day (http://www.worldwaterday.org/), and Italy has been called to a referendum concerning the privatisation of the, at present public, water administration. It is maybe because of the topical relevance of this subject that the Italian review "Le Scienze" is in the process of publishing several articles about drinking water. In the December 2010 edition of "Le Scienze", in an article entitled "Acqua di casa nostra" ("Household water", http://lescienze.espresso.repubblica.it/articolo/Acqua_di_casa_nostra/1345805) the tap water from many Italian local administrations were analysed and compared. Cascina is one of the involved locations.

The study refers to the mineral residue of many tap waters, in particular those present in small quantities ("in tracce"), making a comparison with the regulator-prescribed thresholds. Guidelines for the evaluation of drinking water have been defined by the World Health Organization (WHO). These guidelines have been adopted by the Italian "Decreto Legislativo

31/2001" (D.L. 31/2001, http://legxv.camera.it/parlam/leggi/deleghe/testi/01031dl.htm), adopting the European Directive 98/83/CE (http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:1998:330:0032:0054:IT:PDF), defining the criteria water must satisfy to be classified as drinking water. In the article, results concerning several elements are reported. Overall, 157 samples of different waters from different localities were examined. Minerals like aluminum, arsenic, barium, chlorine, iron, phosphor, etc., which are normally necessary to the organism, but usually very risky if high in concentration, are analysed in terms of their presence in the water, together with a short description of possible dangerous effects to health.

There are several localities where the threshold values, either as suggested by the WHO or by Italian law, are exceeded. In particular, the Virgo reader may be surprised to find that, in the report concerning manganese, the water of the Comune di Cascina exceeds the threshold established in the D.L. 31/2001. The threshold, 50 μg/litre, is only slightly exceeded, at least in the analysis reported,in which the value of 51.8 μg/litre is reported. Just to be clear, this is the tap water of Cascina that is used at EGO for things in everyday life, such as washing and cooking (but not in the water distributors and coffee machines). The excess of manganese is openly admitted by the Comune di Cascina in: http://www.acque.net/qualita_acque/cascina.htm in which the composition of the Cascina tap water is reported. The tap water of Cascina is, altogether, pretty good water. The only element exceeding the prescription of D.L.n.31/2001 is manganese. The report of the Comune of Cascina says that: "*as far as manganese is concerned, the concentration of which is sometimes higher than the parameters of D.L. n.31/2001, article 14 of this ordinance is applied, since this quantity does not present any kind of hygienic-sanitary effect*". Article 14 of D.L.n.31/2001 indeed prescribes that, if any threshold is exceeded, the local authority is compelled to take corrective measures if the ASL retains there is risk to human health. The local ASL (ASL Pisa) has in this case not considered the the elevated presence to be harmful to human health.

Manganese is one of the most abundant metals in the earth's crust. It is essential for life: for humans, manganese is necessary for the synthesis of many enzymes. If under-exposure is very uncommon, over-exposure is more likely. In general, toxicity after over-exposure is associated to nervous effects. The mutagenic potential of manganese exposure in humans or other animals is not known. No studies are available on the potential carcinogenicity of manganese.

Regarding what is known, the WHO is quite complete in dealing with the subject (http://www.who.int/water_sanitation_health/dwq/chemicals/manganese/en/). The document WHO/SDE/WSH/03.04/104 of 2004: "Manganese in Drinking-water: Background document for development of WHO Guidelines for Drinking-water Quality" concerns the problem of manganese consumption. It is first stated that "*... A number of countries have set standards for manganese of 0.05 mg/litre, above which problems with discoloration may occur.*"

Concerning the effects of over-exposure, several laboratory and epidemiological tests are then described. It is well established for example that "*... the syndrome known as "manganism*" is caused by exposure to very high levels of manganese dusts or fumes and is characterized by a "Parkinson-like syndrome," including weakness, anorexia, muscle pain, apathy, slow speech, monotonous tone of voice, emotionless "masklike" facial expression and slow, clumsy movement of the limbs. In general, these effects are irreversible." Effects of long term consumption, even of small concentrations in water, are examined later in the document, using the results of several epidemiological studies performed all over the world. An ambiguous Japanese study (1941!) describes the effects in a community exposed to quite high manganese concentrations (28 mg/litre) coming from 400 dry-cell batteries buried in a drinking-water well. Lethargy, increased muscle tone, tremor and mental disturbances were observed, especially in most elderly people. A 10 year-long study carried out in Greece (1989), with a comparison of effects of concentrations between about 10 μg/litre, 81-250 g/litre and 1800-2300 μg/litre, led the investigator conclude that "*progressive increases in the manganese concentration in drinking-water are associated with a progressively higher prevalence of neurological signs of chronic manganese poisoning and higher manganese concentrations in the hair of older persons.*" Another study in North Germany (1995) found "*no neurological effects of manganese at a level of at least 0.4 mg/litre*". Other studies in Japan (1966, 1970 and 1994) are also ambiguous in terms of results: from one side "*a manganese concentration of 0.75 mg/litre in the drinkingwater supply had no apparent adverse effects on the health of consumers. No signs of toxicity were observed in patients given 30 mg of manganese citrate (9 mg of manganese) per day for many months*", but on the other side: "*The incidence of motor neuron disease in a small Japanese town*

was positively correlated with a significantly increased manganese concentration in local rice and a low magnesium concentration in the drinking-water."
Other studies report neurological effects in 11-13-year-old children exposed to Manganese, also through ingestion of contaminated water: a comparison was made between 0.241 mg/litre levels with 0.04 mg/litre. In particular, the conclusion was that "*oral uptake of environmental manganese together with a deficiency of other minerals was suggested as a possible contributory factor to explain the enhanced incidence of neurological symptoms in isolated populations on Guam and the Kii Peninsula in East Asia*".

In general, all these results seem however to suggest that it's true that manganese is potentially dangerous, but concentrations would need to be quite high, compared to those detected in Cascina water. In the end, the WHO suggested guidelines for a typical western diet is of 0.4 mg/litre: "*a health-based guideline value of 0.4 mg/litre should be adequate to protect public health.*" But immediately after, it is also said that: "*Concentrations below 0.05 mg/litre are usually acceptable to consumers*", with a word of caution: "*although this may vary with local circumstances*". This is the origin of the value adopted in the European and Italian normative.
Therefore, it seems that the 0.050 mg/litre prescribed by the European and Italian law is a quite conservative and precautionary safety margin, that the studies do not detect any real effect above some 100 μg/litre of water contamination, and therefore that the Comune of Cascina and the ASL of Pisa are right when accepting the 51 μg/litre as not dangerous at all, even if the Italian (and European) law is exceeded. In the USA even less precaution is taken. In Connecticut, for example (http://www.ct.gov/dph/lib/dph/drinking_water/pdf/manganese.pdf) it is admitted that "*exposure to high concentrations of manganese over the course of years has been associated with toxicity to the nervous system, producing a syndrome that resembles Parkinsonism ...*", on the other side: "*Manganese is unlikely to produce other types of toxicity such as cancer or reproductive damage*", and eventually "*health effects from manganese are not a concern until concentrations are approximately 10 times higher.*" The safe threshold for consumption through water in many U.S. states is therefore set as 0.5 mg/l.

Hence, it is not to be considered worthwhile to lend an ear to what is reported in sites like http://www.crimine.net/wp/?p=42, where it is said that "*an excess of Manganese reduces the cerebral levels of neurotransmitters like serotonin and dopamine, while the levels of serotonin increase in the other parts of the organism. Studies, both on human beings and animals show a link between low levels of serotonin in brain and impulsive violence, and altered levels of dopamine are implied in vast range of aberrant behaviors.*" Not too much credit has to be given to what is stated by Roger Masters of Dartmouth College in Hanover, New Hampshire, after analysing a wide range of statistics including crime figures from the FBI and information on industrial discharges of lead and manganese ("Environmental toxicology: Current developments", edited by J. Rose, published 1998 by Gordon and Breach Science Publishers in Australia): "*After controlling for conventional variables such as income and population density ...*" Masters founds that "*... environmental pollution seems to have an independent effect on the rate of violent crimes - defined as homicide, aggravated assault, sexual assault and robbery. Countries with the highest levels of lead and manganese pollution typically have crime rates three times the national average, says Masters ...* " (see also http://thechemicaledge.com/2009/02/09/toxins-brain-chemistry-and-behavior/). Actually, nothing of this kind has ever been reported in the EGO environment, in already more than 10 years of epidemiological studies, no strange, excessive, violent behavior, to say nothing of symptoms like "... apathy, slow speech, monotonous tone of voice, emotionless "masklike" facial expression ...": who has ever seen something like that at Virgo? So, the people working on the Virgo site, who may be worried by the results of the analysis of the manganese concentration in Cascina tap water, can be fully reassured: no problem, at least not from manganese.

P. LA PENNA (ESO)

GOOD NEWS!

Welcome to Stella, born on February 27, and who has been lightening her parents', Virginie Bornes and Fabio Bronzini, lives ever since.

And welcome to Emanuele, born on March 9, a new entry in the Dattilo household. Vincenzo and Innocenza already have 3 children!