Update on the BIPM ensemble of mass standards

Estefanía de Mirandés

Mass Department

BIPM

Acknowledgments

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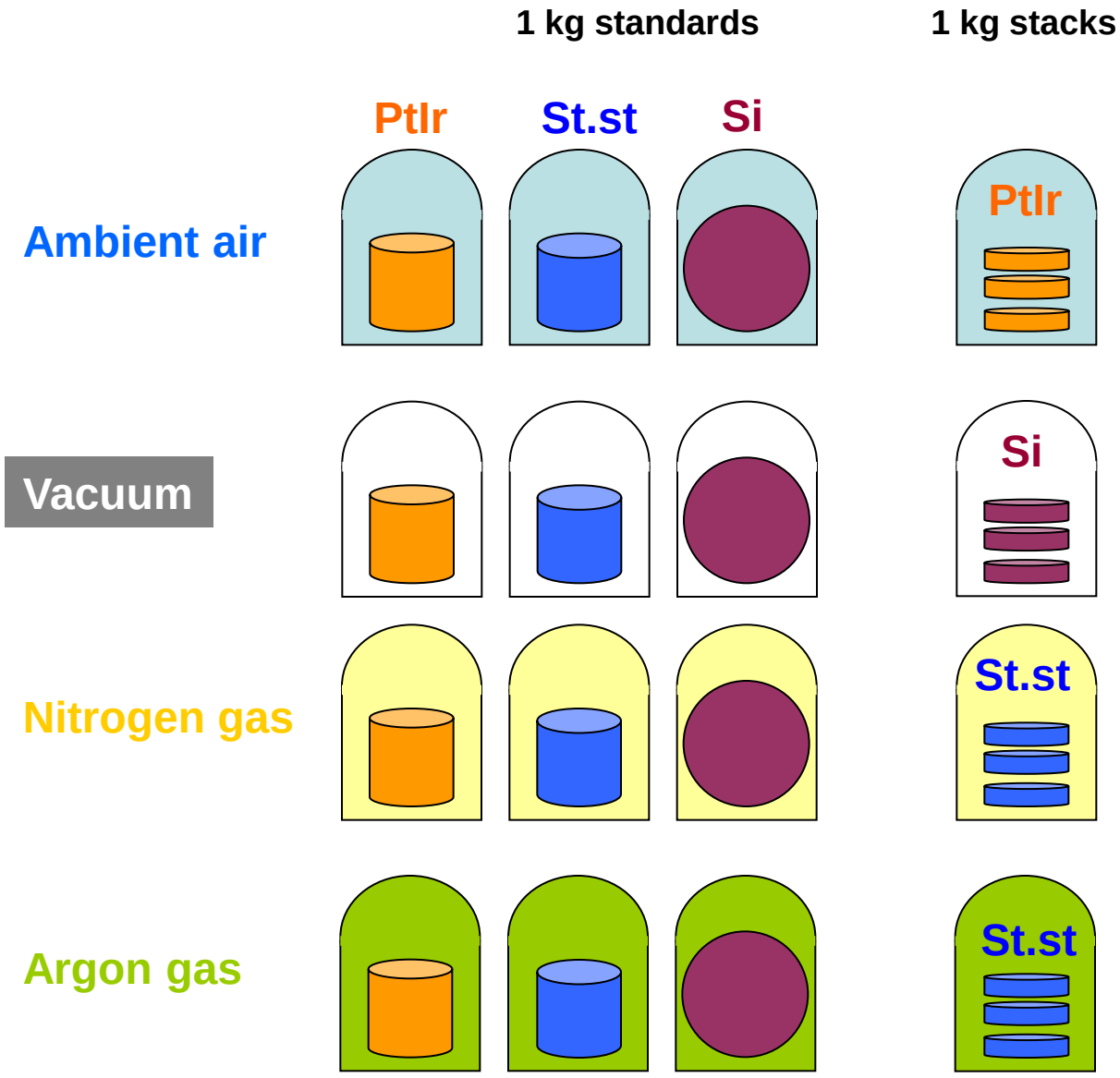
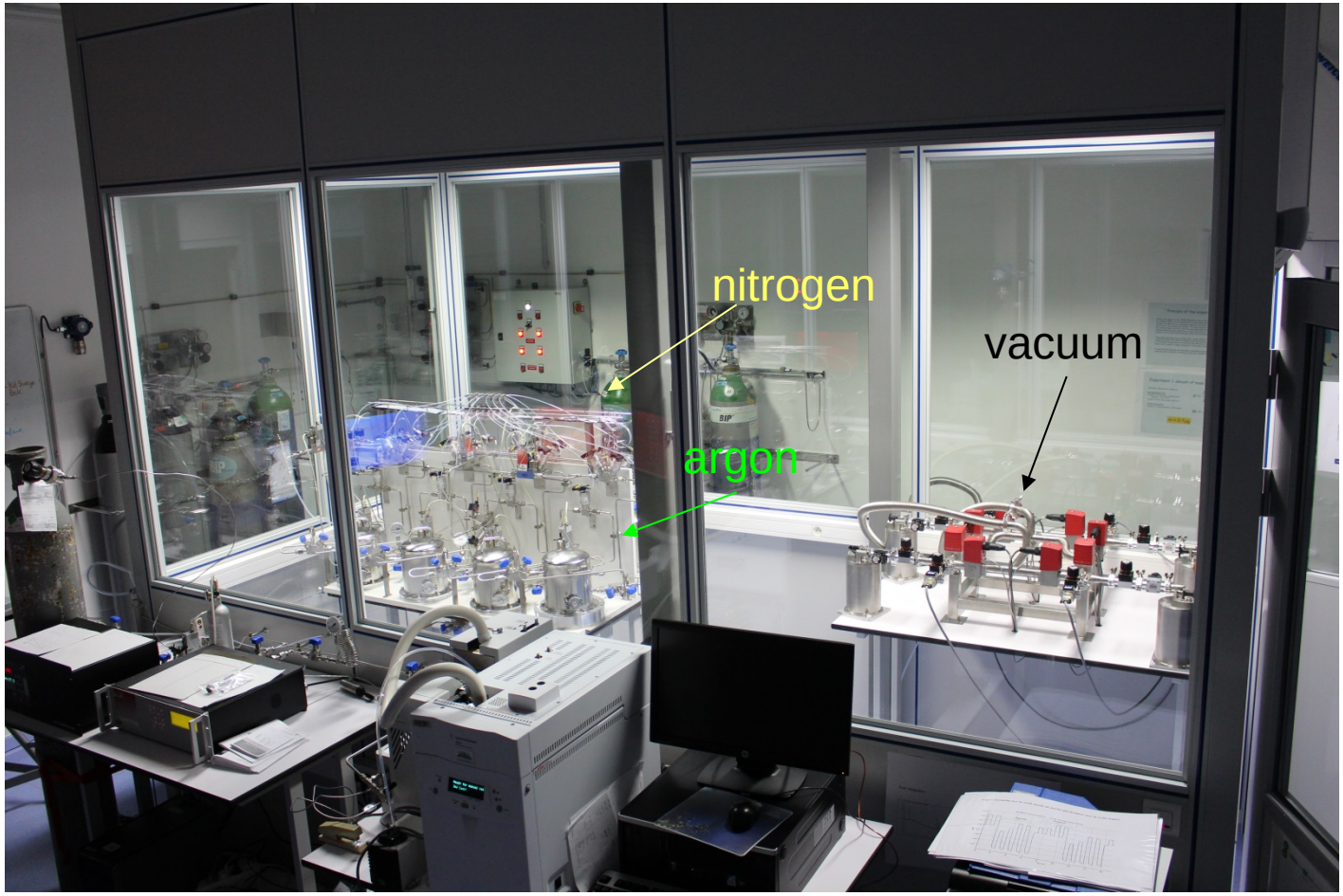
BIPM mechanical workshop

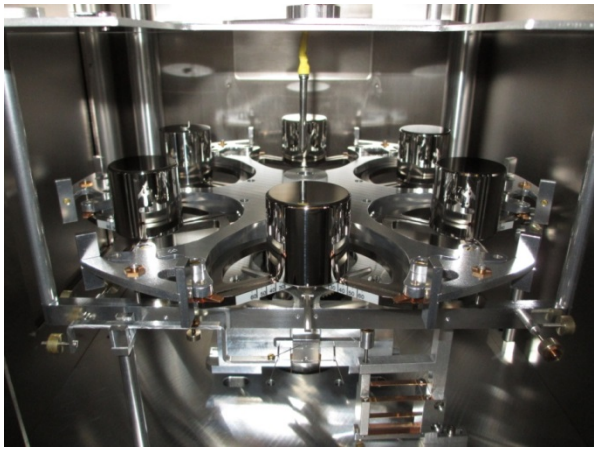
Present Configuration: reminder

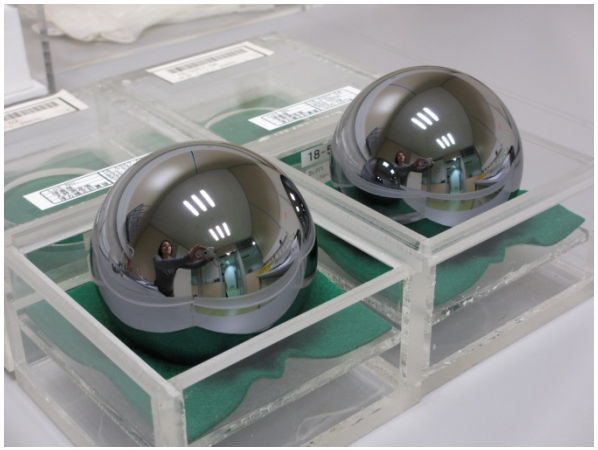


Laboratory housing the ensemble of mass standards



Current status of the standards of the ensemble



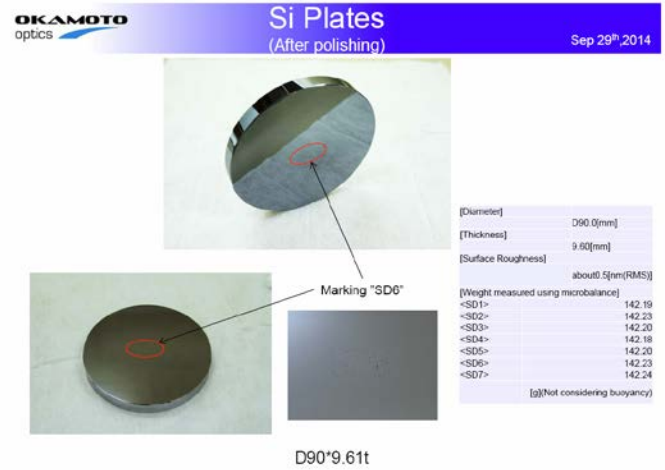


Standards

- 4 PtIr cylinders ✓
- 4 Stainless steel cylinders ✓
- 4 natural silicon spheres
  etched by PTB, new oxide layer being grown.

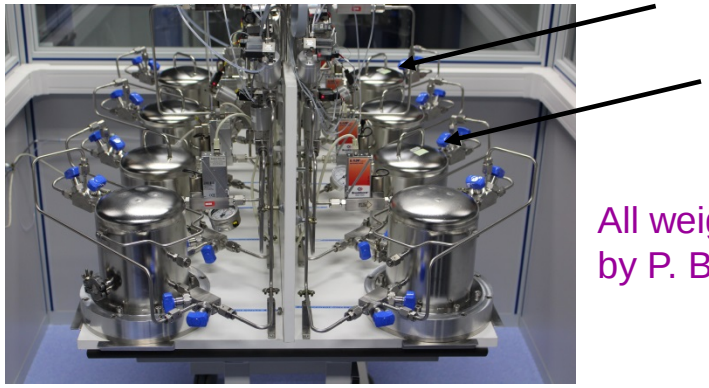
Stacks of disks

- 1 PtIr stack of disks ✓
- 2 Stainless steel stack of disks
  density of one of them measured by NPL.
- 1 nat. silicon stack of disks
  density being measured by NMIJ



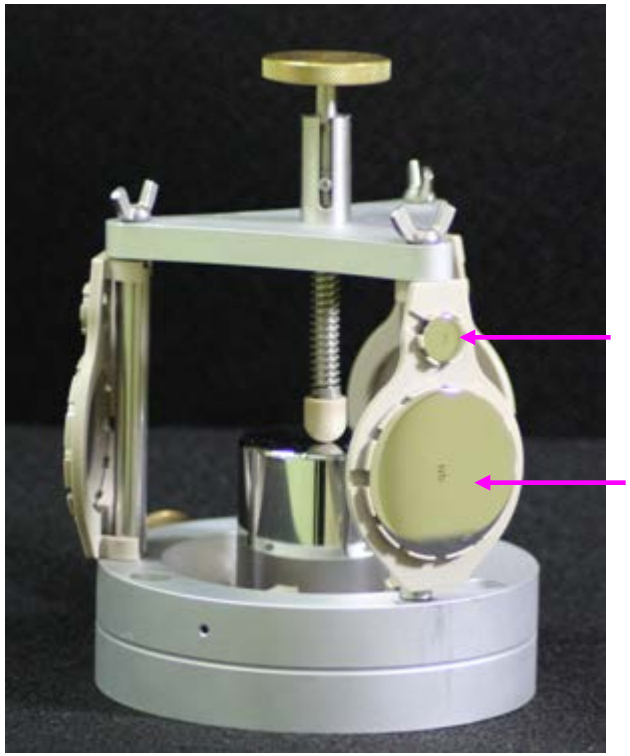
Weighing measurements carried out with the standards of the ensemble

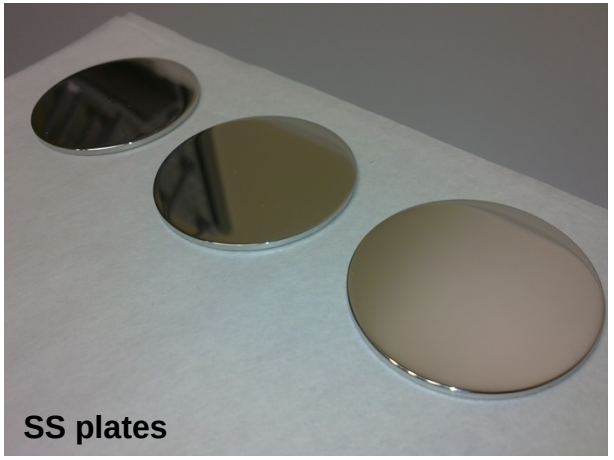
- The standards have been regularly calibrated in air for some years with respect to the BIPM working standards. They show a good mass stability.
- In 2014 the standards (excepting the Si spheres) have been directly calibrated against the IPK during the extraordinary verification. The spheres will be linked to them in short.
- During one year we have stored for a test two stainless steel BIPM standards in the nitrogen network. They have been weighed before and after with respect to other BIPM SS standards kept in air. They were found to be remarkably stable ($\Delta m < 2$ µg)

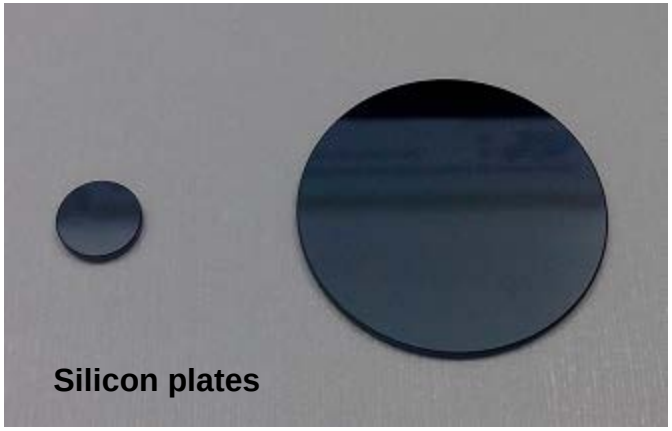


All weighing measurements carried out by P. Barat (Mass Department)

Current status of the samples to be stored with the standards of the ensemble





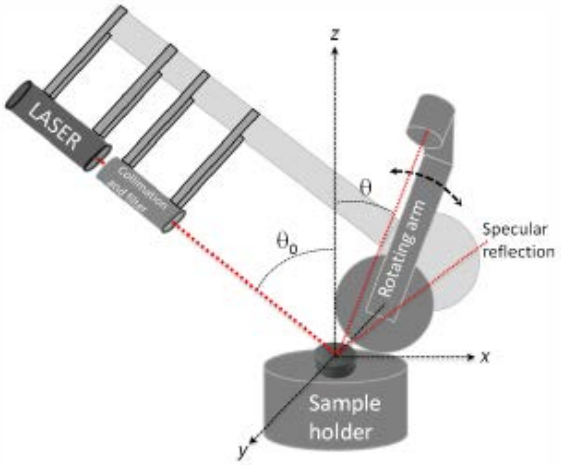


- Stainless steel samples: manufactured, density and roughness measurements completed
- PtIr samples: being manufactured at the BIPM
- Silicon samples: manufactured, density and roughness measurements to be done

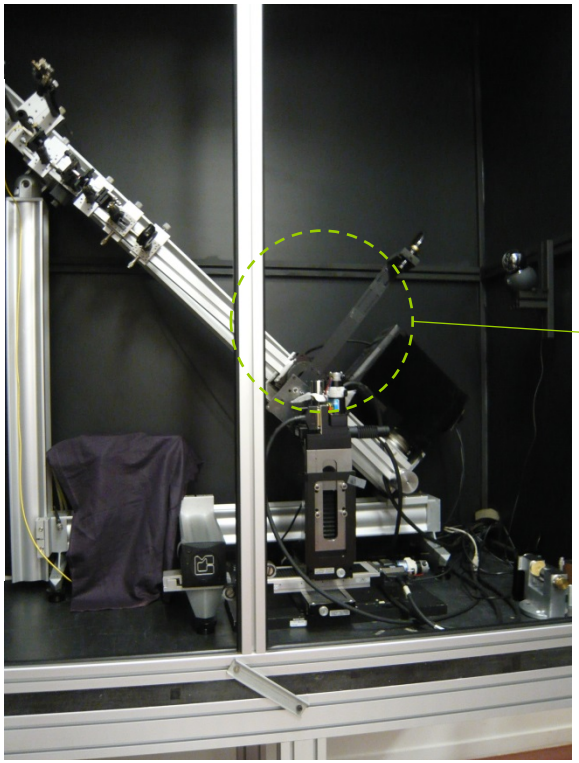
Surface roughness measurements (I)

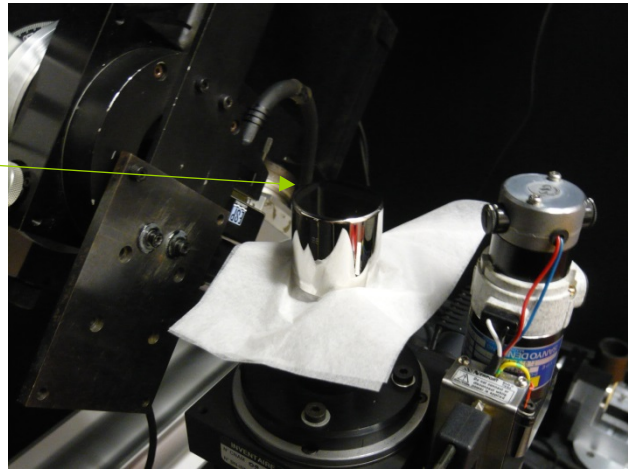
Ongoing collaboration with Z. Silvestri and P. Pinot from the Laboratoire commun de métrologie LNE-Cnam to determine the surface roughness of the standards, stacks and samples of the pool.

- PtIr and SS standards measured
- SS samples measured
- Pt Ir samples to be done
- Silicon stacks and samples to be done



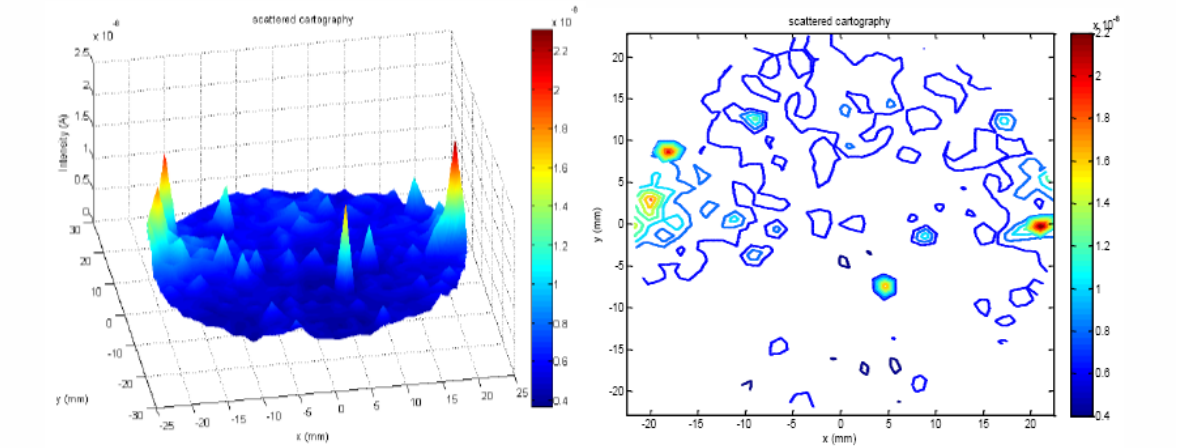
Scheme of the light scattering geometry





LNE-Cnam optical roughness meter, determining surface roughness from the power spectral density of the laser light scattered by the surface asperities

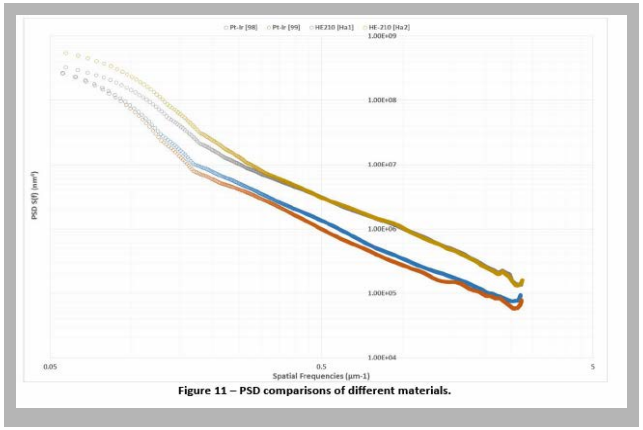
Surface roughness measurements (II)



Scattered light mapping for one of the BIPM stainless steel standards of the pool, top surface, providing information on the homogeneity of the surface. Left: 3D view. Right: iso view. Using this map, interesting sites are detected for further investigation with PSD measurements.

Current findings:

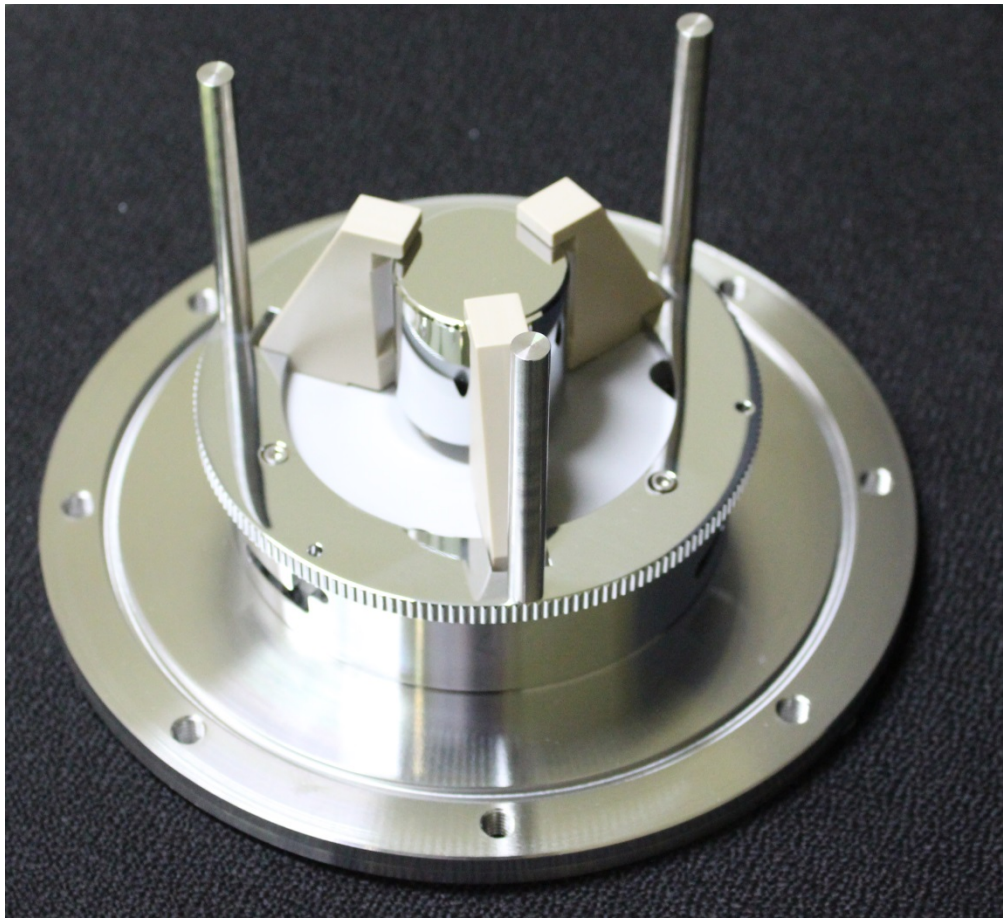
- SS standards and big SS samples (Φ = 39 mm) have a comparable roughness *rms* height ~ 4 nm.
- Small SS samples (Φ = 39 mm) roughness *rms* height ~ 6 nm
- PtIr standards roughness *rms* height ~ 2.5 nm



Roughness spectrum: PSD $S(f)$ of PtIr and SS mass standands of the ensemble for the spatial frequency domain [0.1 - 2.7] μm^{-1}. From this spectrum, roughness (*rms* height and correlation length) can be determined

measurements and graphs from Z. Silvestri, LCM-LNE-Cnam

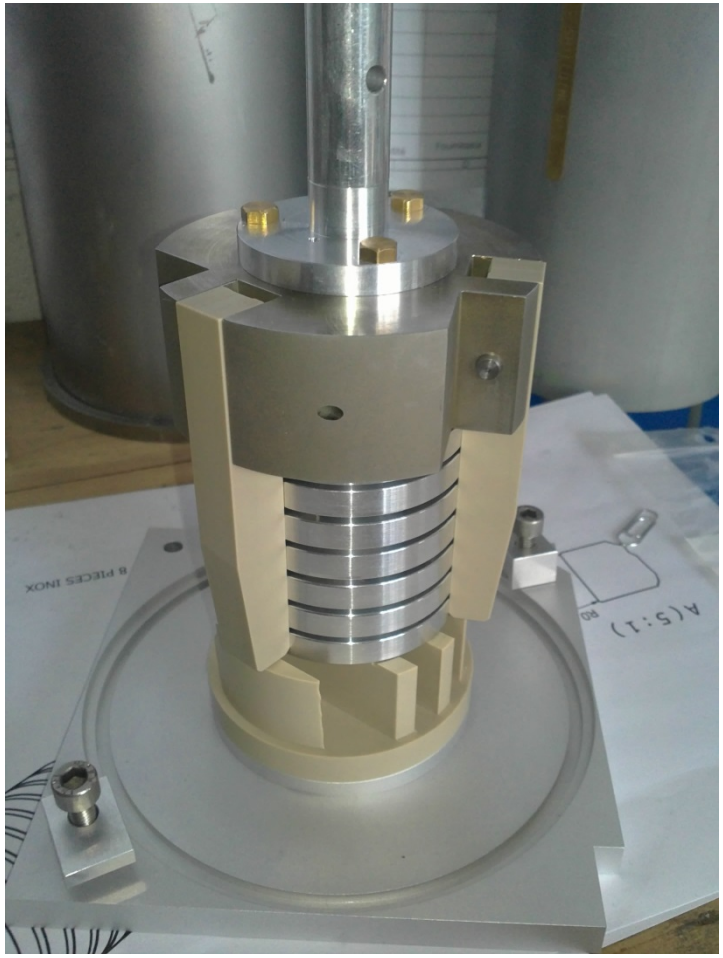
New mass holders for the standards kept in gas



pre-2014 version

- adjustable distance arms - standard
- easy to manipulate in a glove box

Specific mass holders for the stacks of the ensemble

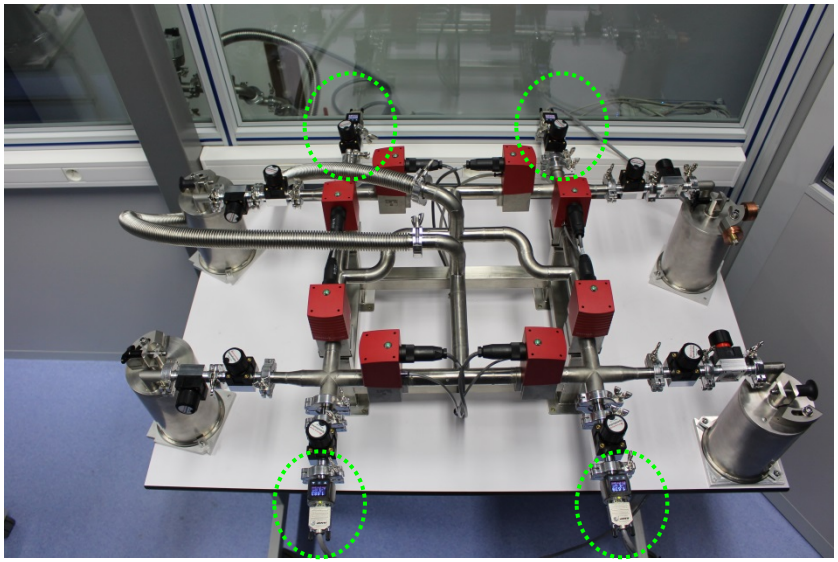


Their design allows to transfer the stacks from their storage network to the mass comparator while keeping them in their storage medium.

Second version of the vacuum network (2013-2014) finished and operational

The first version of the vacuum network had:

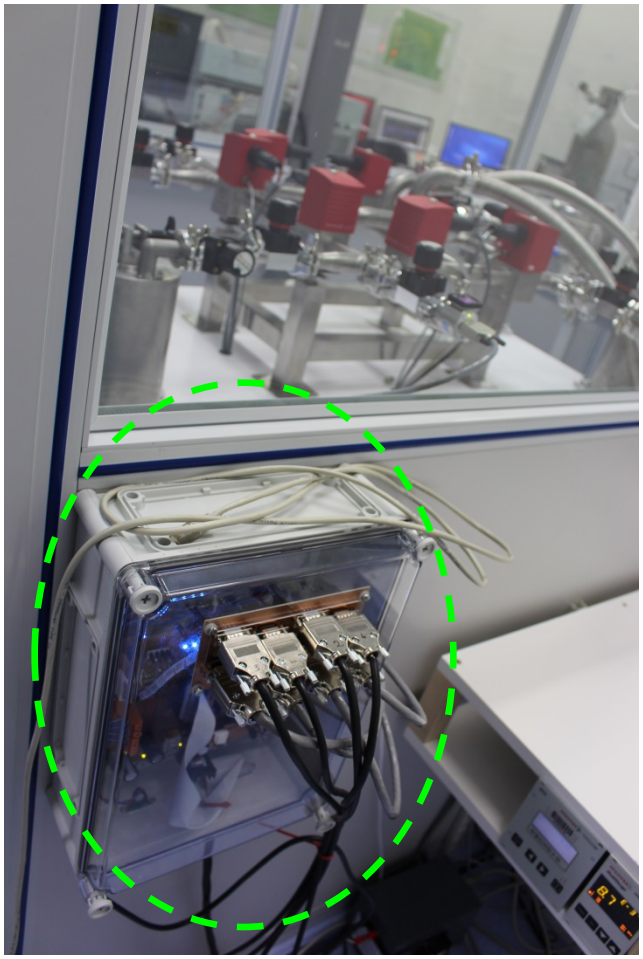
1. manual isolation valves
2. containers not compatible with our VTS
3. several non-soldered connections (susceptible to leak)



The second version of the vacuum network is now operational. It has

1. automated isolation valves
2. soldered connections
3. containers compatible with our VTS
4. Pressure gauges for each container
5. Electronic security system to isolate containers in case of vacuum leak.

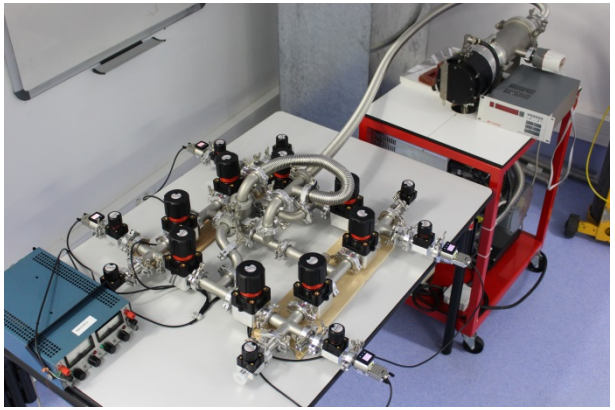
Electronic system to protect the containers in case of a vacuum leak



•The card compares the pressure measured by each gauge with a fixed threshold pressure. In case of a measured too low pressure, the card forces the corresponding electric valves to close, isolating the container(s).

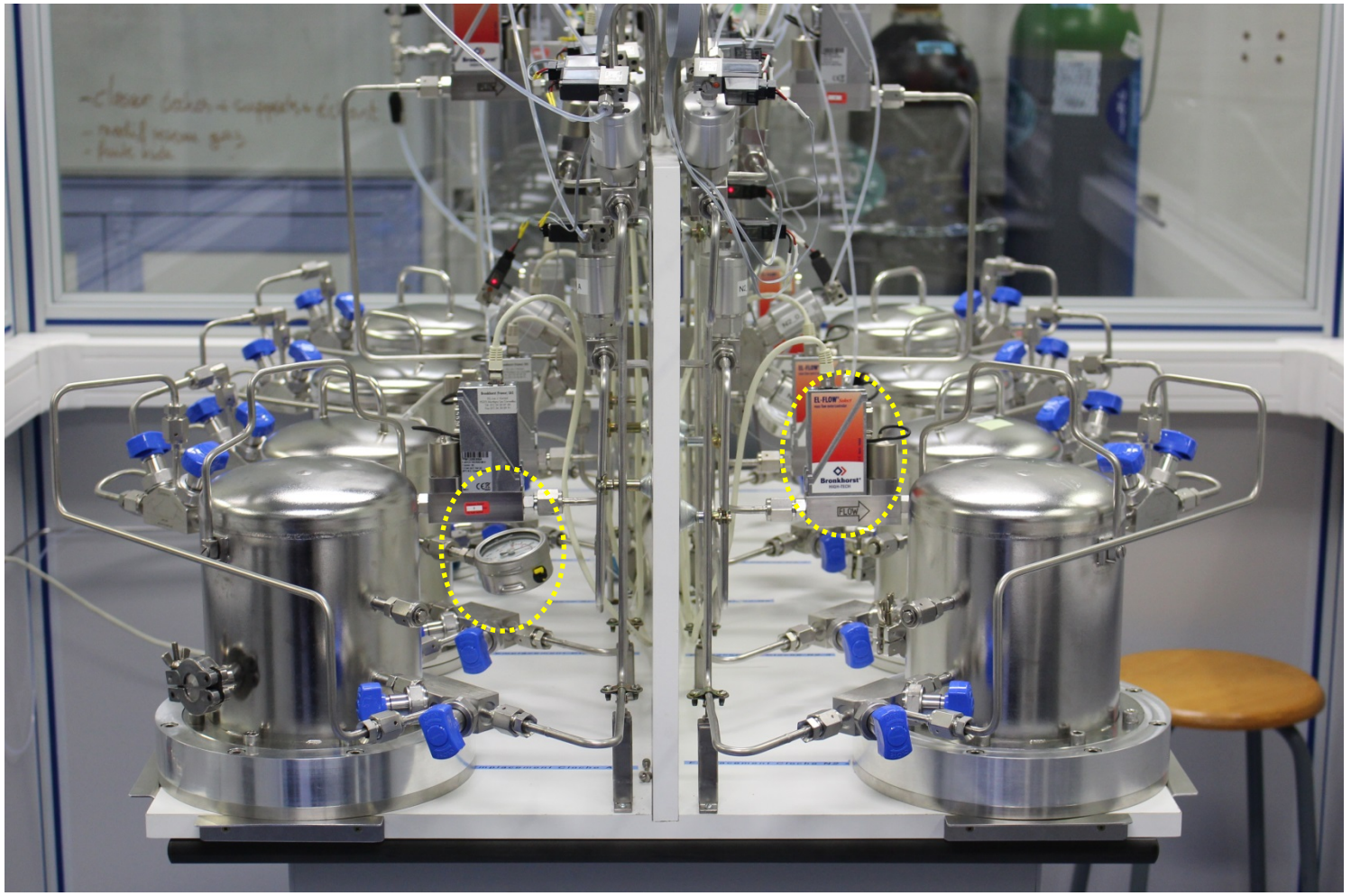
•An alarm signal is then sent to the computer, which sends an e-mail to us.

•In case of a generalized vacuum leak, the standards would be transferred to the first version of the vacuum network which runs continuously in parallel with an independent pump



Electronic card made by B. Rolland (BIPM electricity department)

Gas network provided with mass flowmeters and pressure gauges for each container



Outlook on the next steps for the ensemble of standards