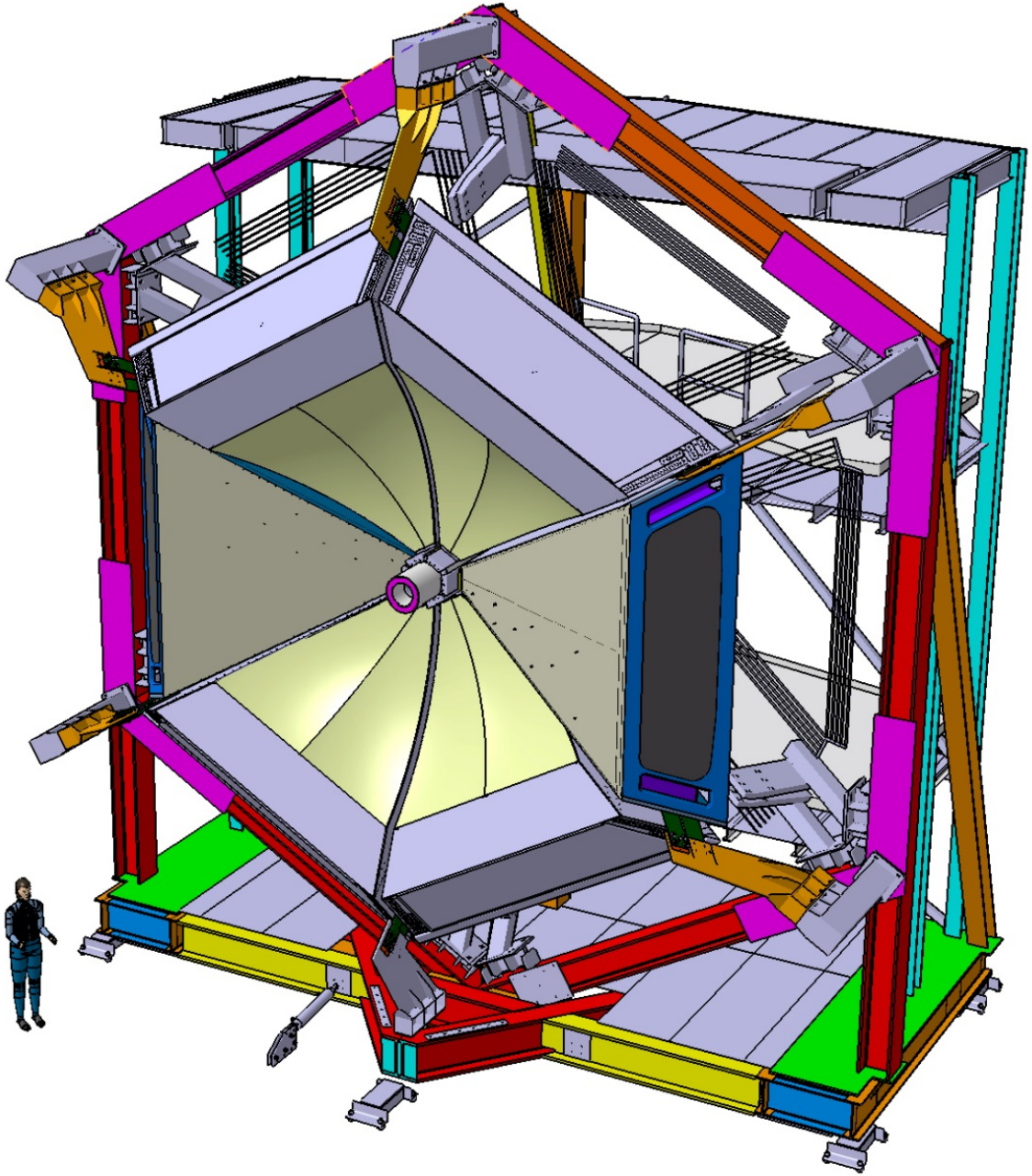


CLAS12-RICH Status-Report

May 5th 2014

Aerogel

The Manufacture Engineering Phase by the Russian vendors at Novosibirsk to improve and stabilize large tiles production yield has been completed:

- large tiles yield acceptable for mass production has been achieved
- new tiles with optical improved surface delivered for test
- visit of the manufactures from Novosibirsk in Ferrara: March 17-23, 2014

Work in progress….

Aerogel Radiator

Rafractive index: 1.05
Area: 20x20 cm^2
Thickness: 3 cm
Scattering Length: greater than 50 mm

GEMC Simulations

Many different versions:

- Ferrara: GEMC 1.8 (frozen in 2012)
- Frascati: GEMC 1.8 (summer 2013) No optical photons ! ✔
- JLab: GEMC 1.8 (standard) No optical photons ! ✔
  GEMC 2.0 (devel) No materials/volumes ✔

To do list:

* Re-check previous results ??
* Update the material budget studies for the Mechanic Review
* Update the geometry (need to define the proper way/version)
* X-check optical properties of materials with ray-tracing algorithms
* Update materials (need to define the proper way/version)
* Re-organize the Like-lihood analysis

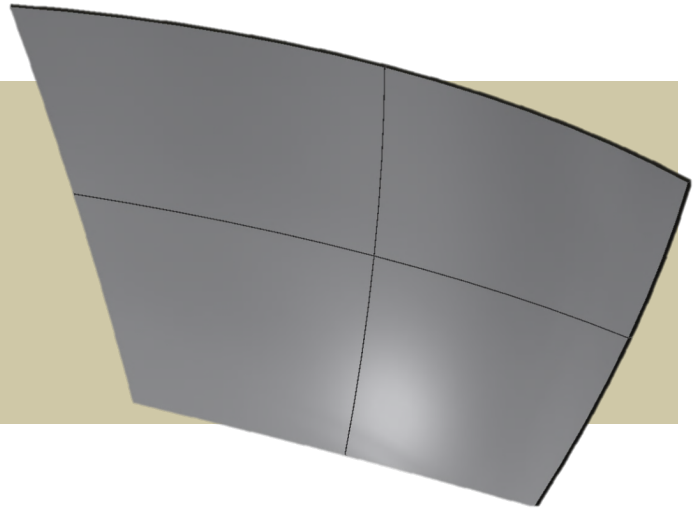
Mirrors

Milestone: Identification of Mirror Technical Specification (3/31/14) **achieved (2/28/14)**

Manufacture Engineering Phase ongoing with companies in Italy and USA
In contact with CERN laboratory for mirror characterization

CFRP SPHERICAL Mirror

Radius tolerance <= 1%
Surface accuracy: 5 µm RMS
Surface Quality: 3 nm RMS
D0 < 5 mm
Reflectivity > 90%



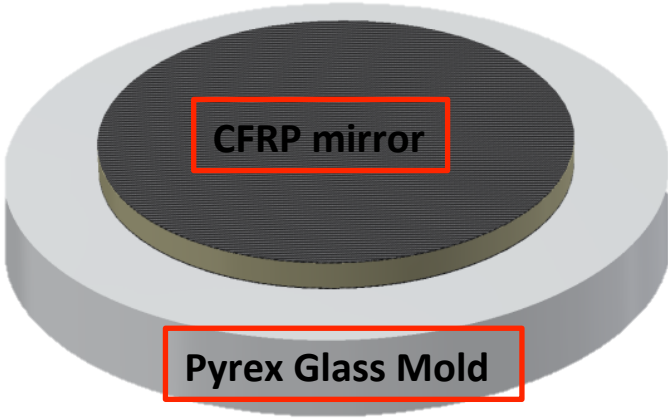
CFRP Spherical Mirror: Mandrel Demo

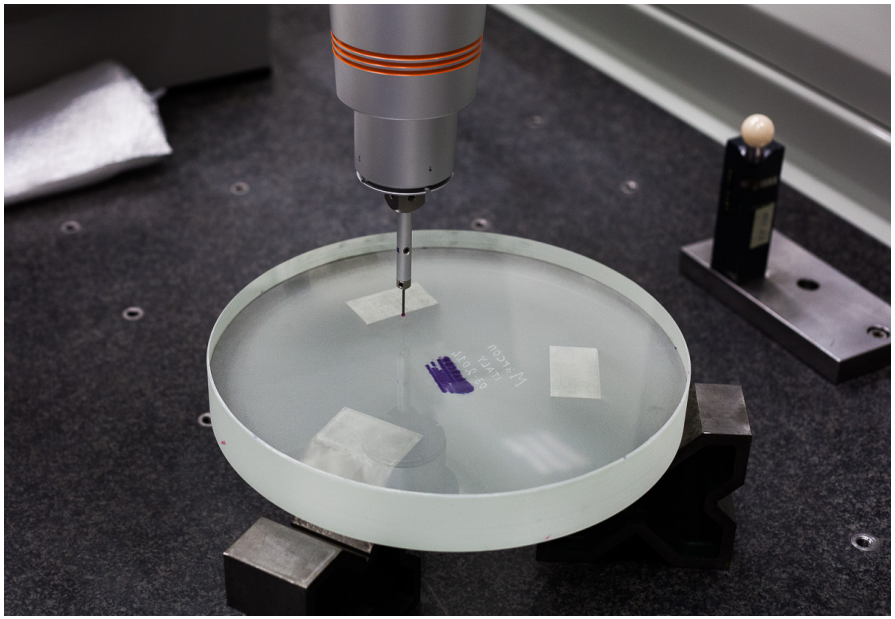
Mandrel demo in preparation at Marcon (Italy) :

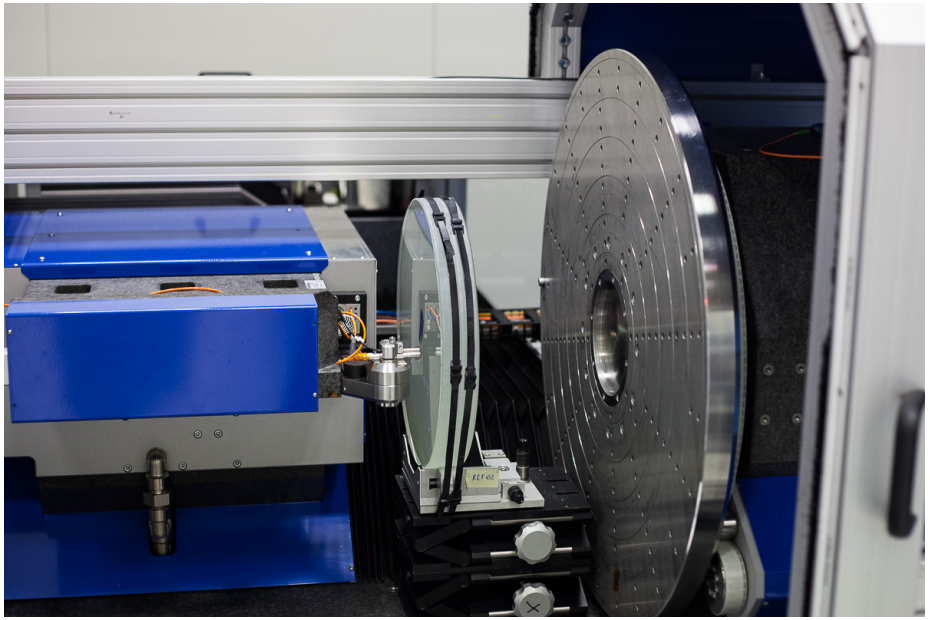
- supremax (borosilicate glass) material
- spherical shape, 4 m radius, 35 cm diameter

⇨ Delivered at the end of March

Mechanics is fulfilling specs







Mandrel Demo: Shape Accuracy

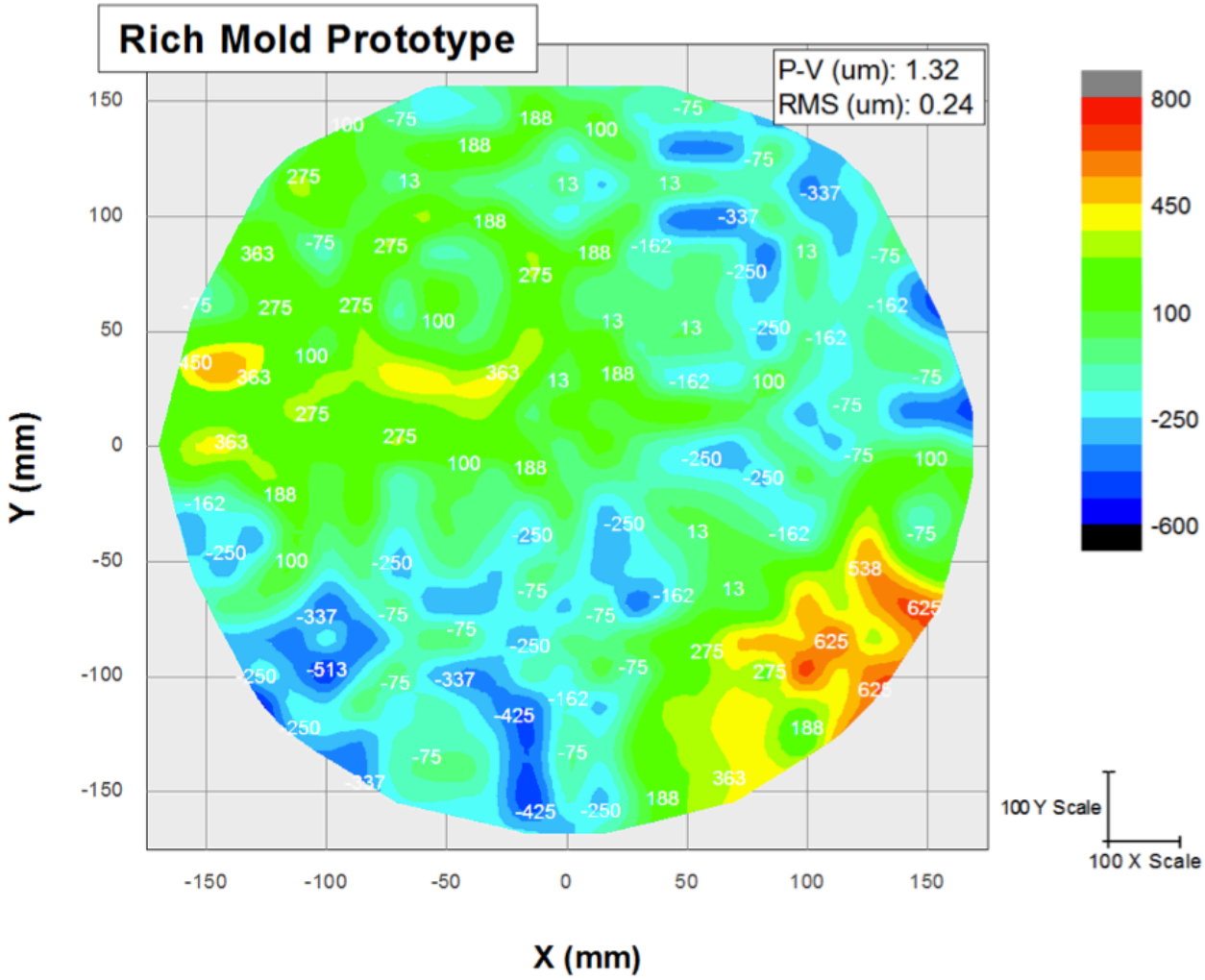


Figure 1 – Residual plot from CMM measurements

Mandrel Demo: Surface Cleanliness

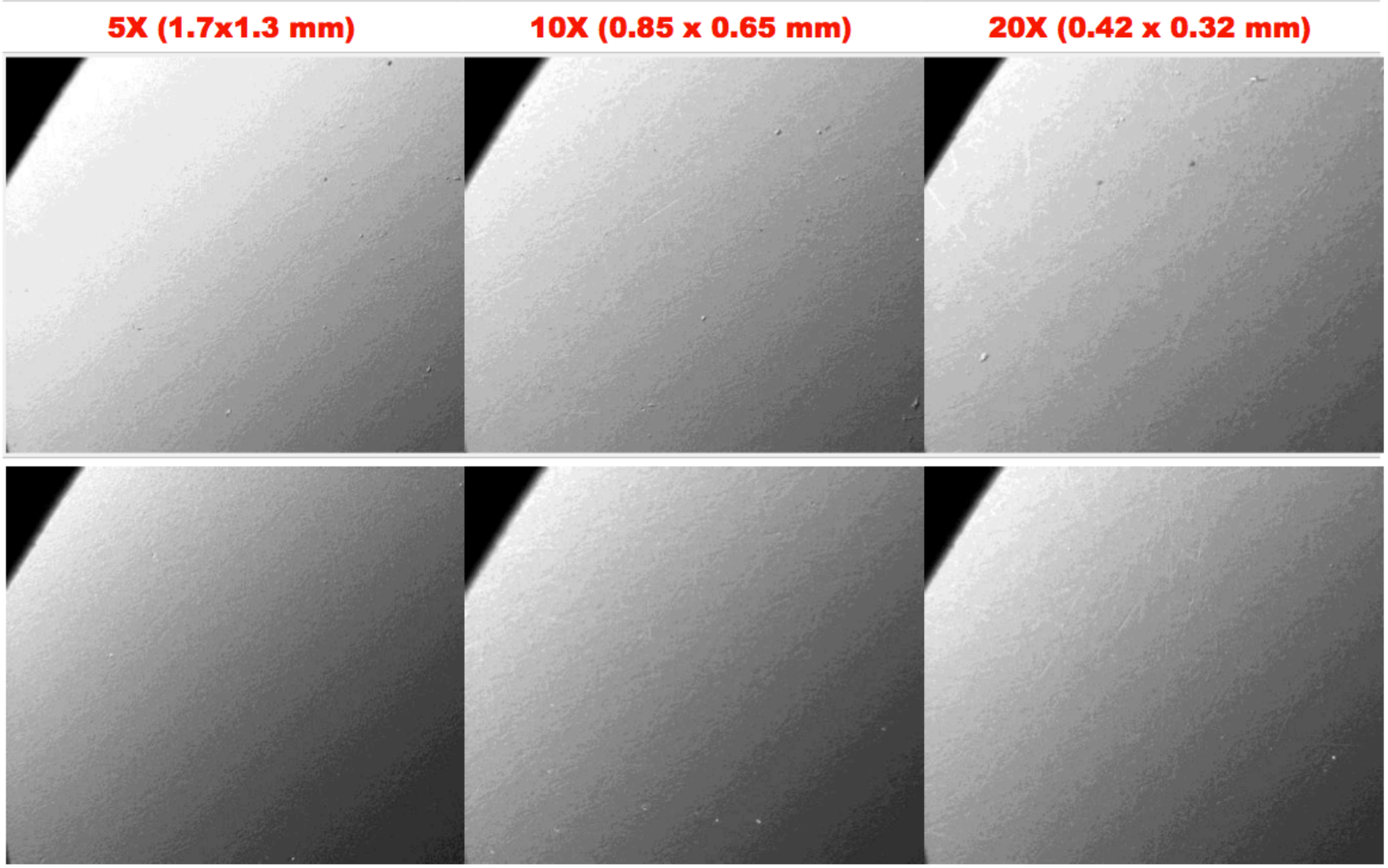
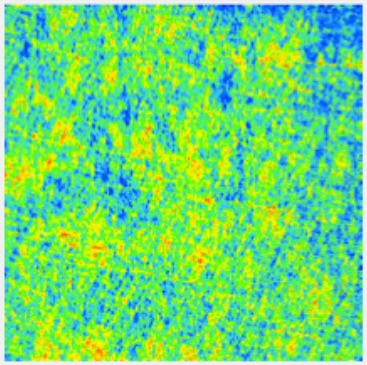
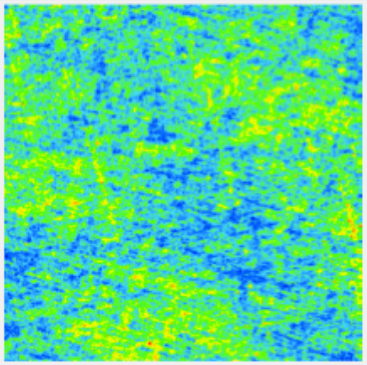
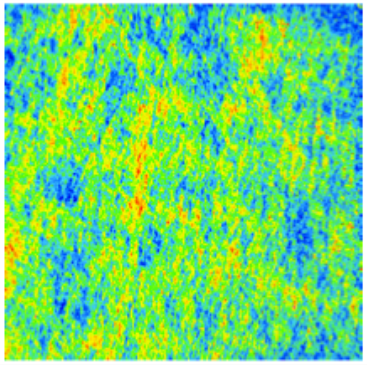
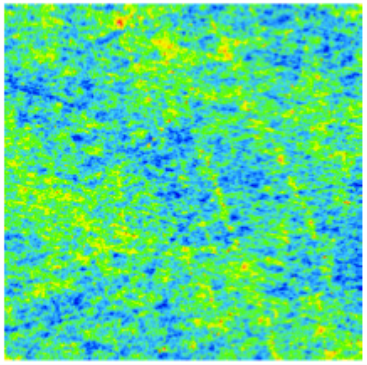
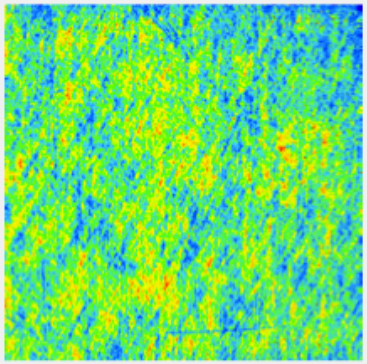
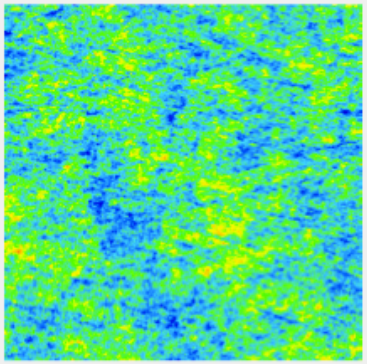


Figure 4 - Nomarski images before (upper row) and after cleaning (lower row)

Mandrel Demo: Roughness

	10X	50X	
Height Parameters **Sq** 0.524 nm **Sp** 1.88 nm **Sv** 1.30 nm **Sz** 3.18 nm **Sa** 0.422 nm			Height Parameters **Sq** 0.896 nm **Sp** 5.56 nm **Sv** 2.32 nm **Sz** 7.88 nm **Sa** 0.713 nm
Height Parameters **Sq** 0.547 nm **Sp** 2.87 nm **Sv** 1.32 nm **Sz** 4.19 nm **Sa** 0.439 nm			Height Parameters **Sq** 0.927 nm **Sp** 9.53 nm **Sv** 2.83 nm **Sz** 12.4 nm **Sa** 0.719 nm
Height Parameters **Sq** 0.502 nm **Sp** 2.11 nm **Sv** 1.24 nm **Sz** 3.35 nm **Sa** 0.403 nm			Height Parameters **Sq** 0.863 nm **Sp** 4.35 nm **Sv** 2.63 nm **Sz** 6.98 nm **Sa** 0.689 nm

Mandrel Demo: Characterization

Table 5 – Integrated bandwidth roughness from WLI

Interval	Integrated Roughness
1 mm ÷ 20 μm	0.73 nm
20 μm ÷ 1 μm	0.48 nm
1 mm ÷ 1 μm	0.87 nm

Conclusions

The glass prototype mold has been measured to assess shape errors and roughness.

- The deviation of the radius of curvature is below 1% from the nominal value.
- Roughness is below 1 nm in all requested spatial ranges.
- Measured shape accuracy is 1.32 μm P-V and 0.24 μm RMS.

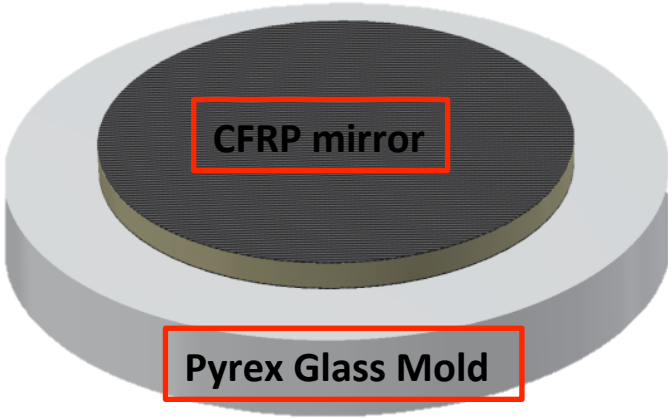
CFRP Spherical Mirror

Two mirrors demo in preparation at CMA (USA) :

- CFRP skin and rohacell core
- spherical shape, 30 cm diameter
- 1st demo: 3.5 m radius, LHCb finish, from a CMA mandrel

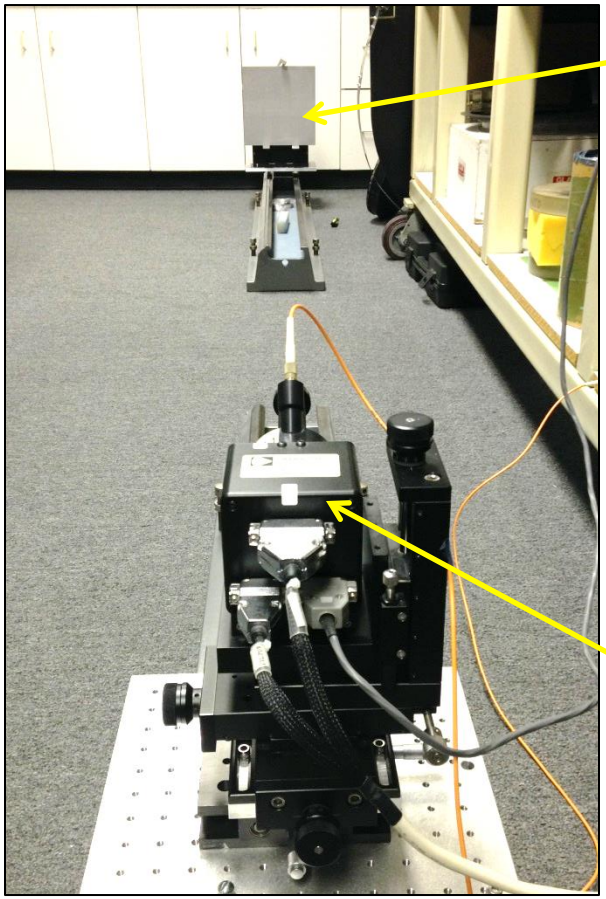
not fulfilling specs. ⇨ to be redone by the end of May

- 2nd demo: 4 m radius, CLAS12 finish, from the Marcon mandrel

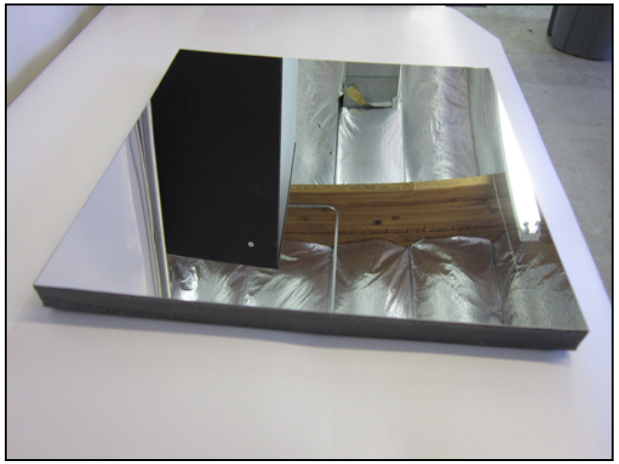


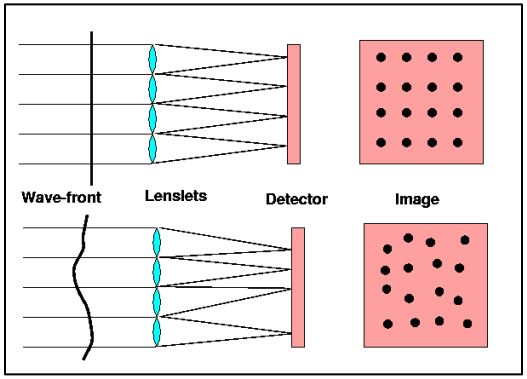
Wavefront Data

The mirror was measured with a Shack-Hartmann wavefront sensor as shown in the image below. The test is a radius of curvature test.



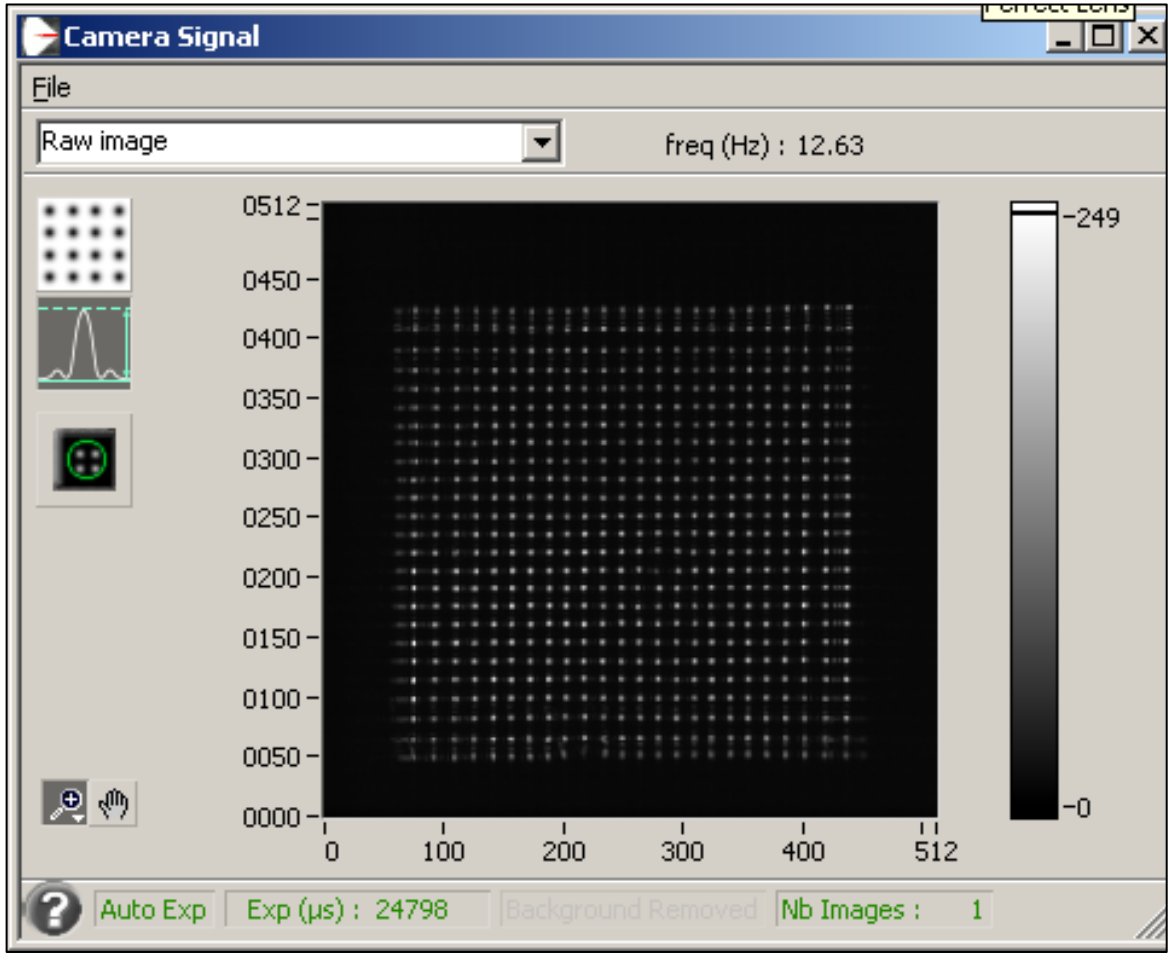
CFRP Coated Mirror





Wavefront Data

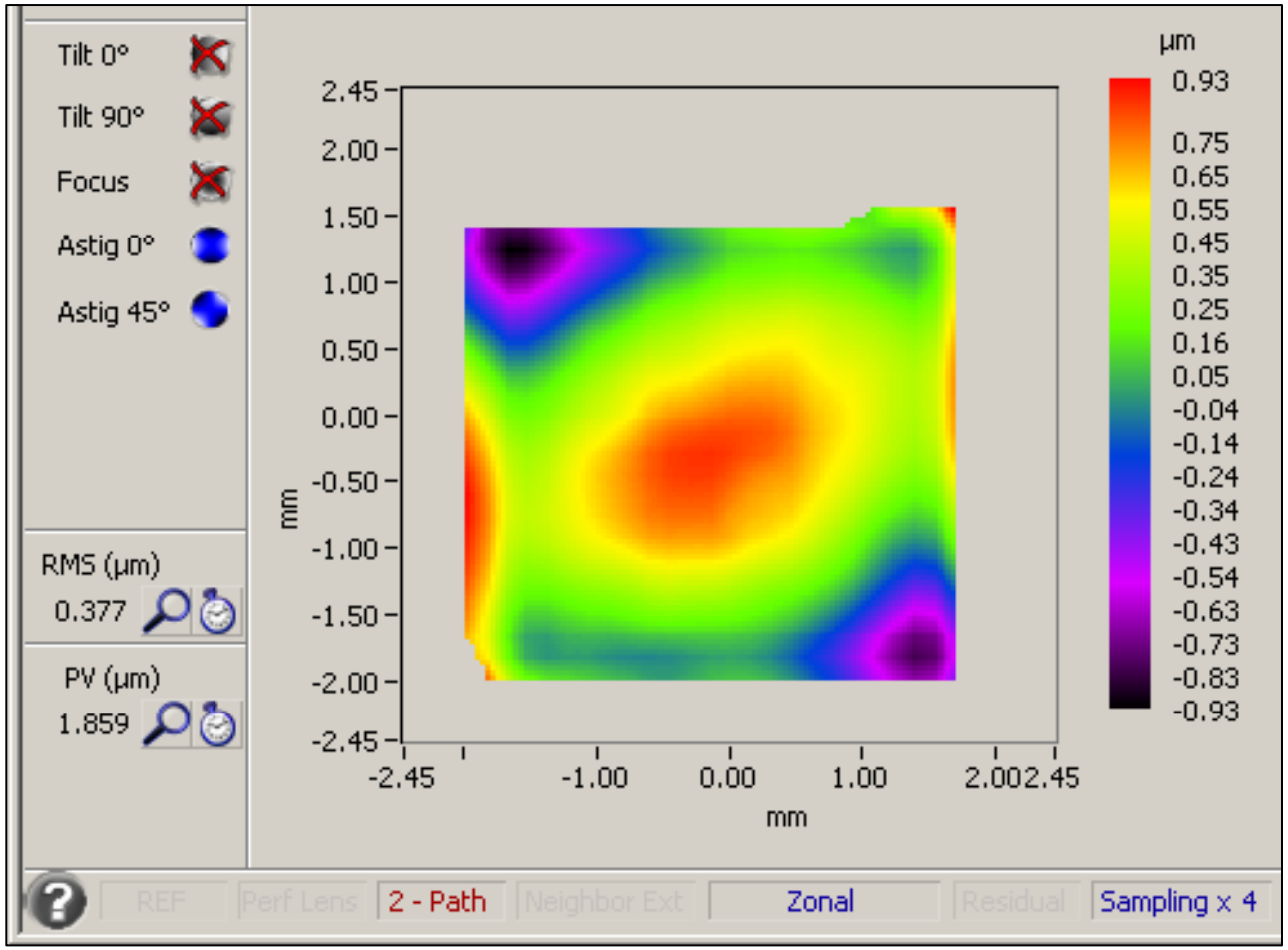
Camera signal showing the microlens array for slope measurements.



Camera Image, Raw data of full aperture of the CFRP mirror.

Wavefront Data

Surface map of the CFRP mirror shows errors of 1.86μm p-v surface, below the 2.5 μm p-v surface requirement.

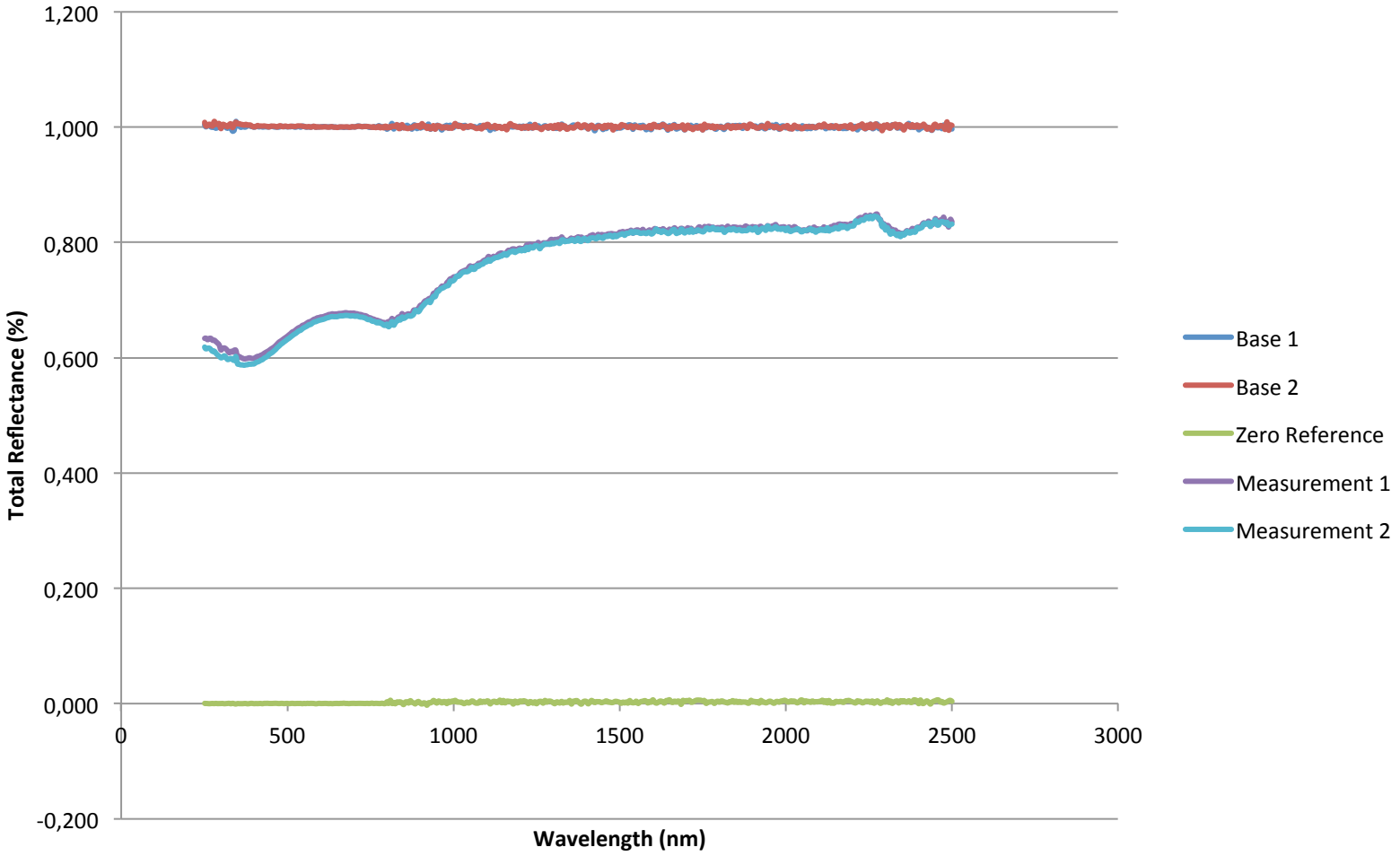


Surface Map of the full aperture of the CFRP mirror. Only tip, tilt and focus removed.

Error is 1.86 μm p-v on the surface.

Reflectivity Data

The second measurement indicates just above 60% reflectivity at 450nm



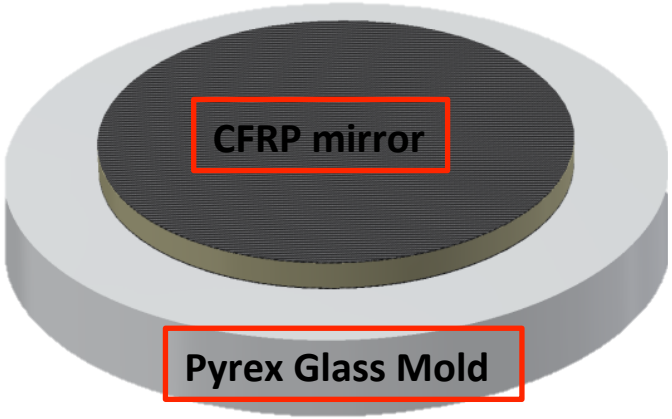
CFRP Spherical Mirror

Two mirrors demo in preparation at CMA (USA) :

- CFRP skin and rohacell core
- spherical shape, 30 cm diameter
- 1st demo: 3.5 m radius, LHCb finish, from a CMA mandrel

mechanics fulfilling specs. but coating process not reliable

- 2nd demo: 4 m radius, CLAS12 finish, from the Marcon mandrel



CMA can do the wanted CFRP substrate but not the coating

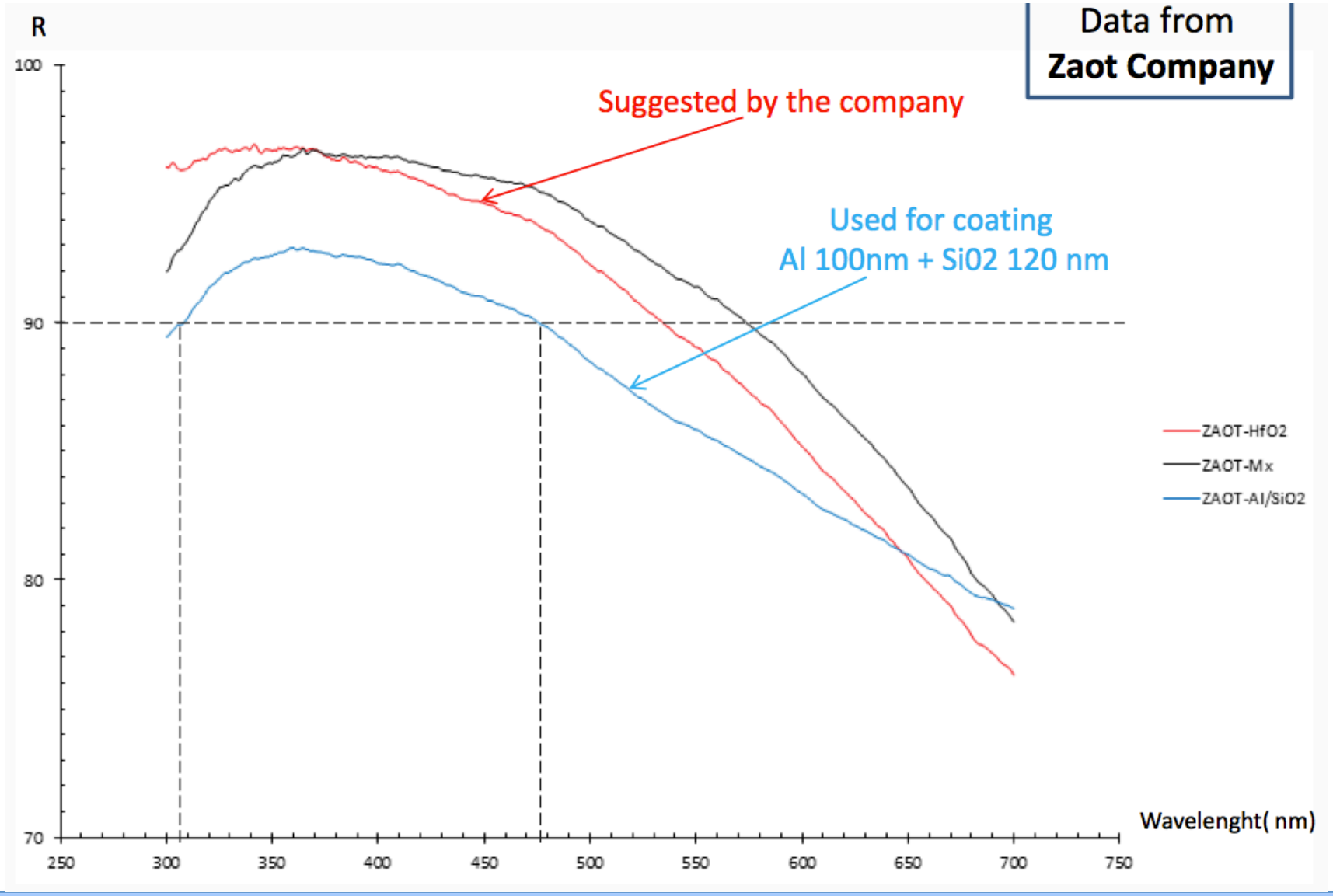
For coating we have contacted

* SESO-Thales (France)
  made the coating for LHCb, max allowed mirror diameter 1.8 m

* Zaot (Italy)
  coating the planar mirrors for Media-Lario, max allowed mirror diameter 1.8 m,
  in principle able to reach 92-95% reflectivity in the 300-600 nm wavelength range

Glass Skin Mirror

Suitable coating with room for improvement



Mirrors

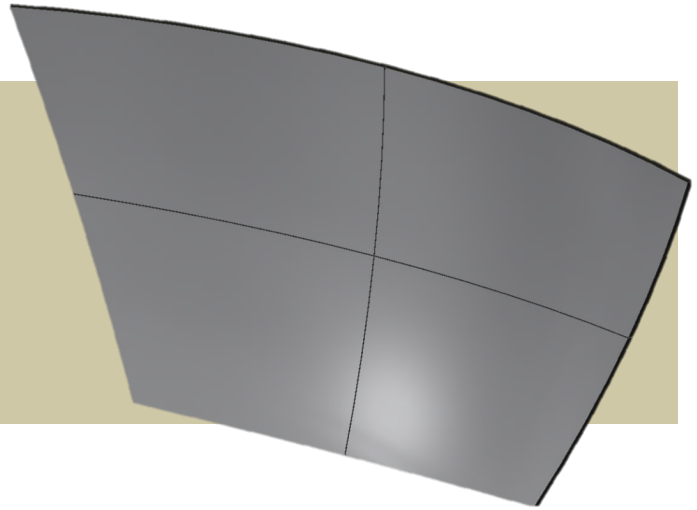
Milestone: Identification of Mirror Technical Specification (3/31/14)

Manufacture Engineering Phase ongoing with companies in Italy and USA

In contact with CERN laboratory for mirror characterization

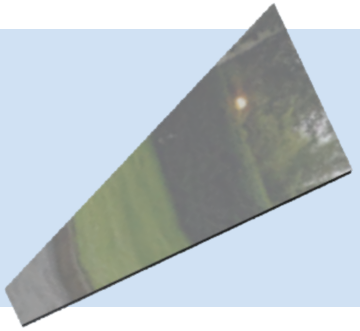
CFRP SPHERICAL Mirror

Radius tolerance <= 1%
Surface accuracy: 5 µm RMS
Surface Quality: 3 nm RMS
D0 < 5 mm
Reflectivity > 90%



Planar Glass Mirror

Planarity tolerance <= 0.1 mm
Surface accuracy: 5 µm RMS
Surface Quality: 3 nm RMS
Reflectivity > 90%

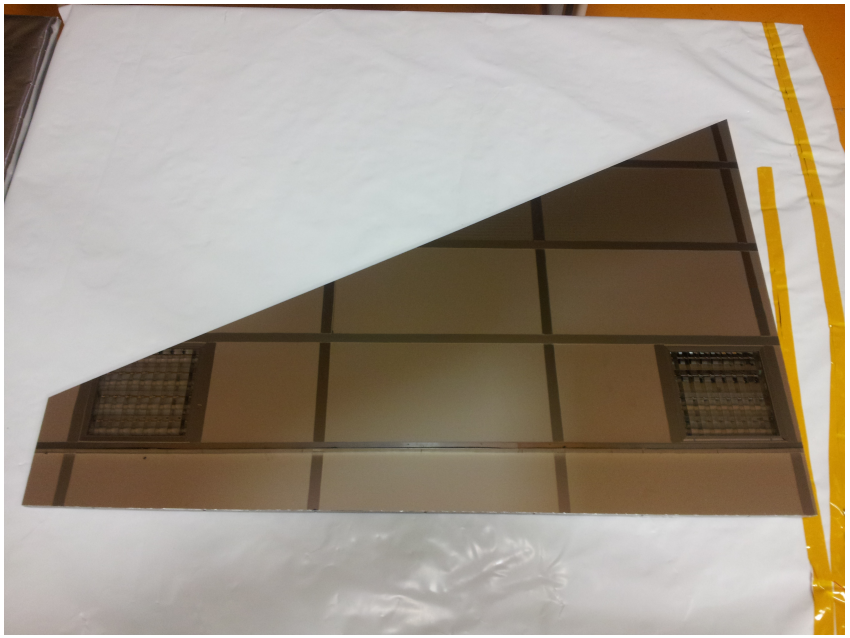


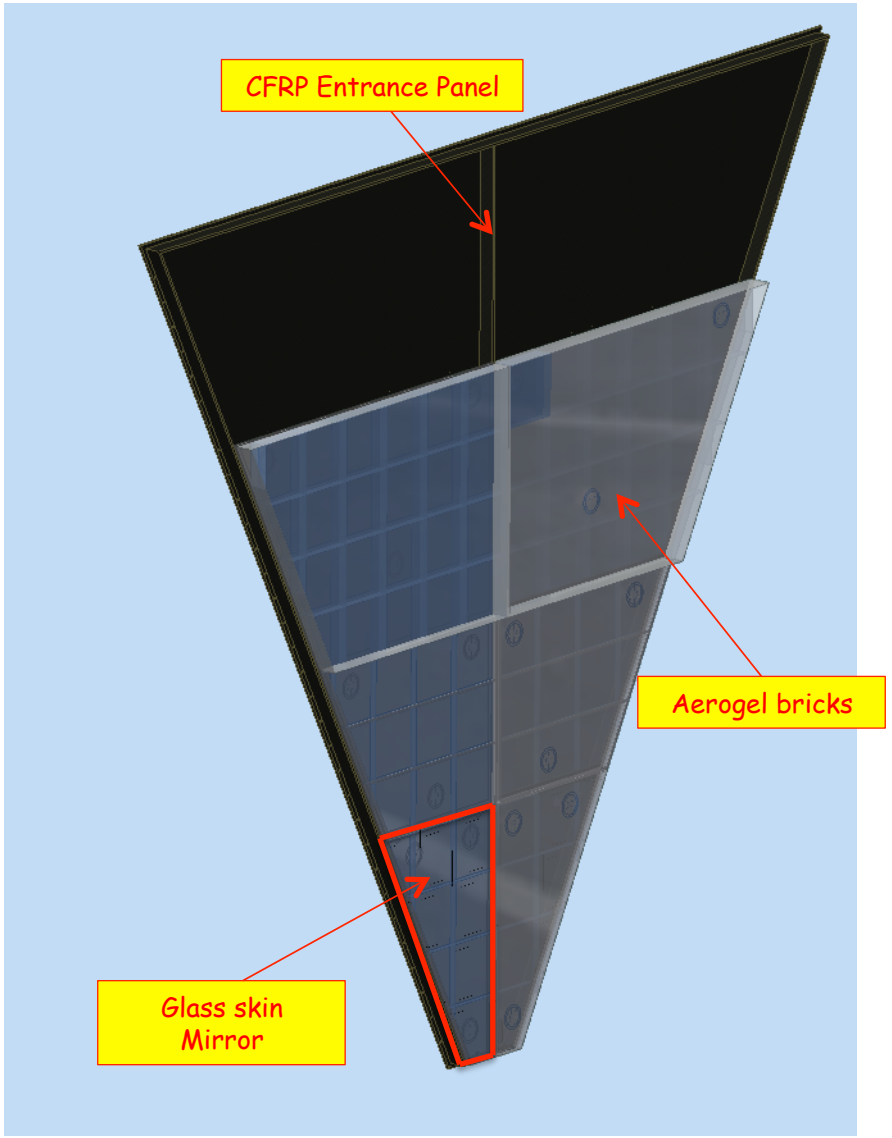
Glass Skin Mirror

Two demos under preparation at Media-Lario (Italy) :

- soda-line mm glass skin and Al honeycomb core
- reinforced frame for aerogel holder
- 1st demo: 1.6 mm (standard) glass skin thicknesses

Surface quality: 40 μm p-v, 8-9 μm rms
- not perfect Al mold (20 μm p-v)
- not optimized vacuum process
- gravity (to be studied by FEM simulation)

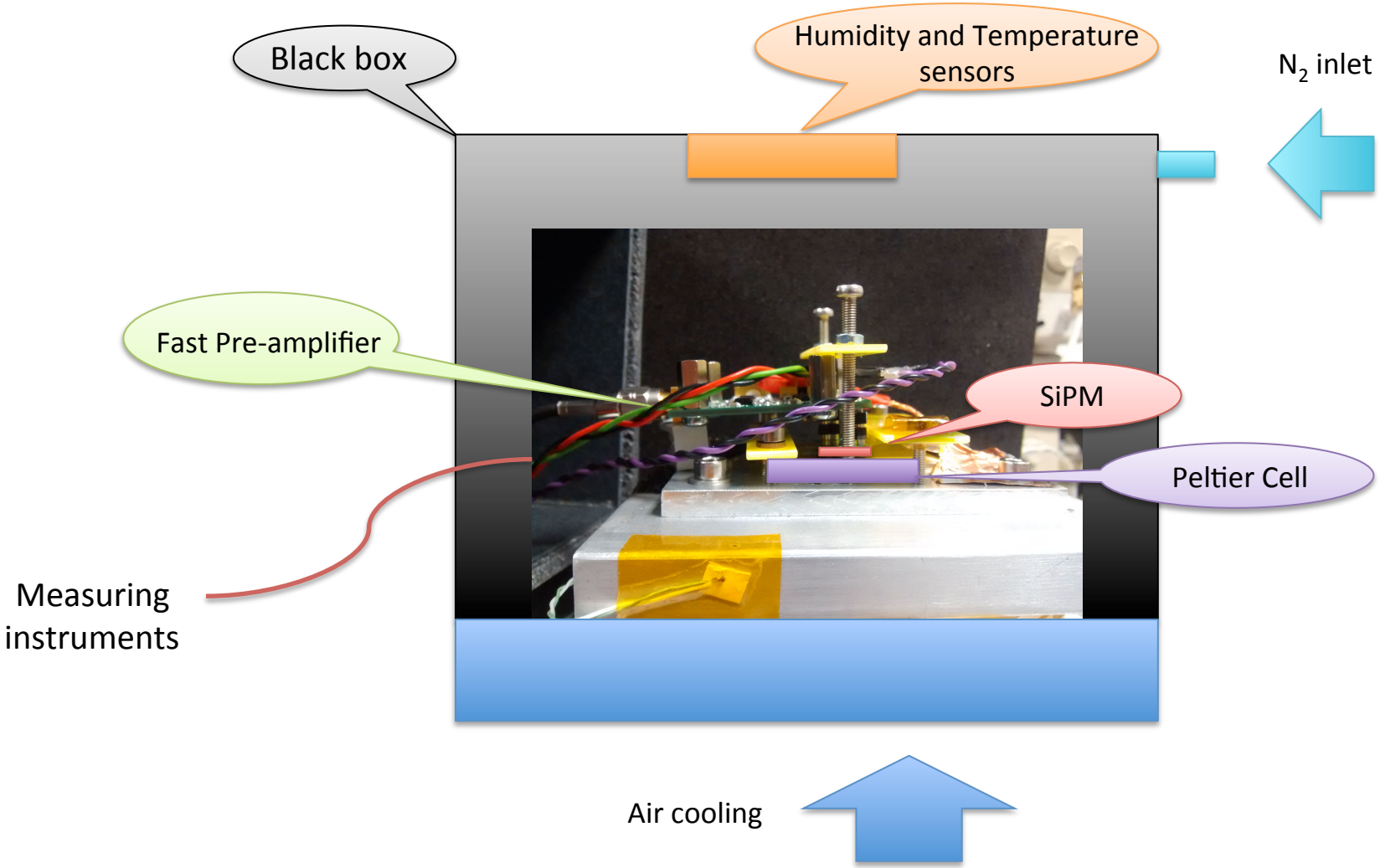




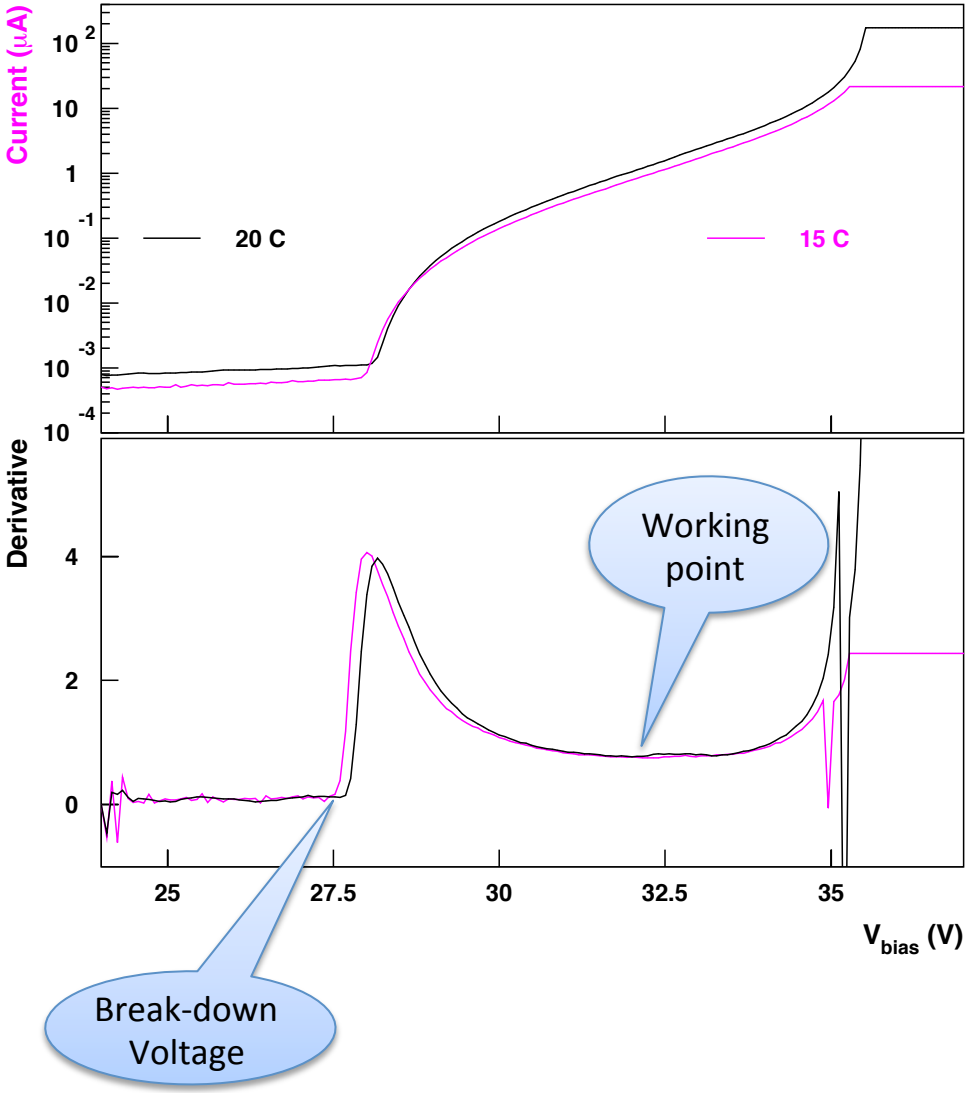
SiPM Test Bench

For SiPM temperature stability is crucial, temperature variation is important

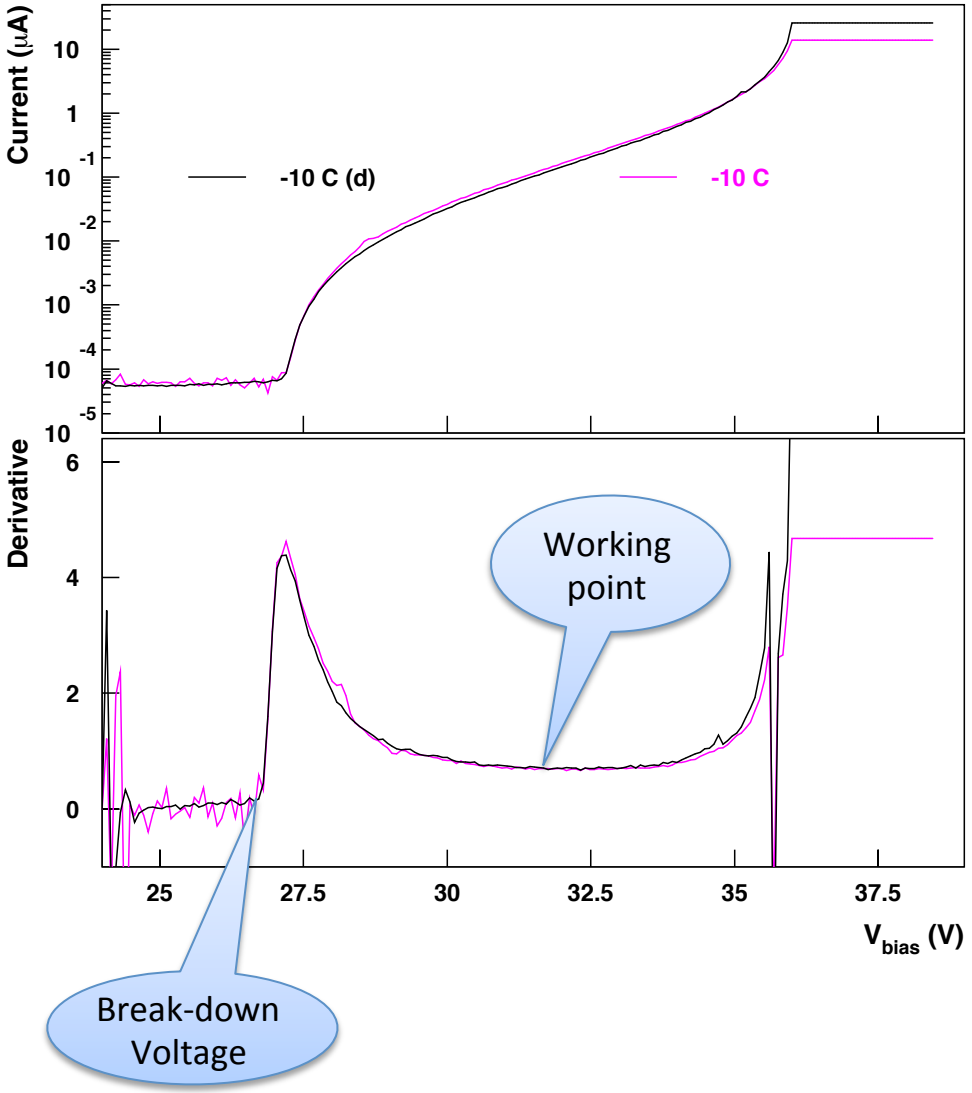
At the moment working from -10 C to 60 C with 0.1 C resolution/stability



SiPM Dark Current



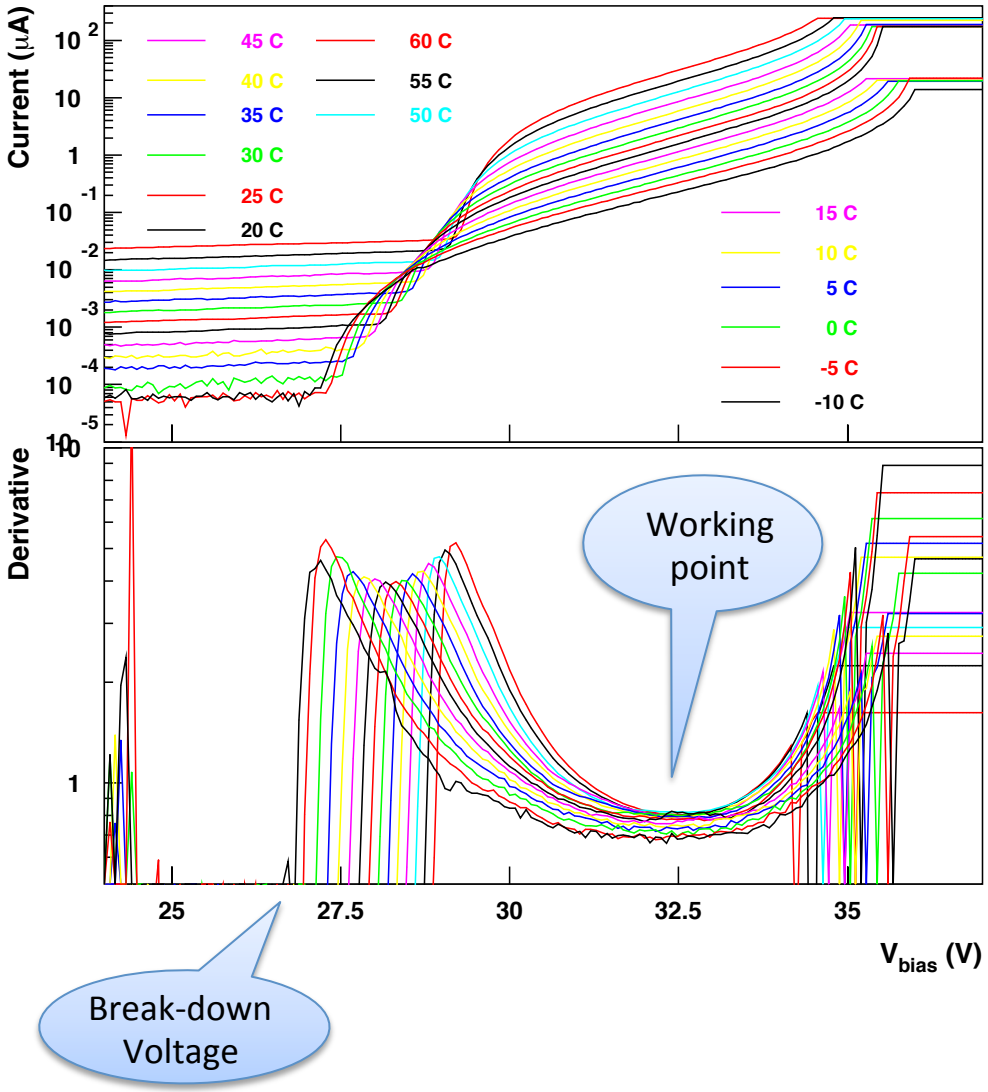
SiPM Dark Current



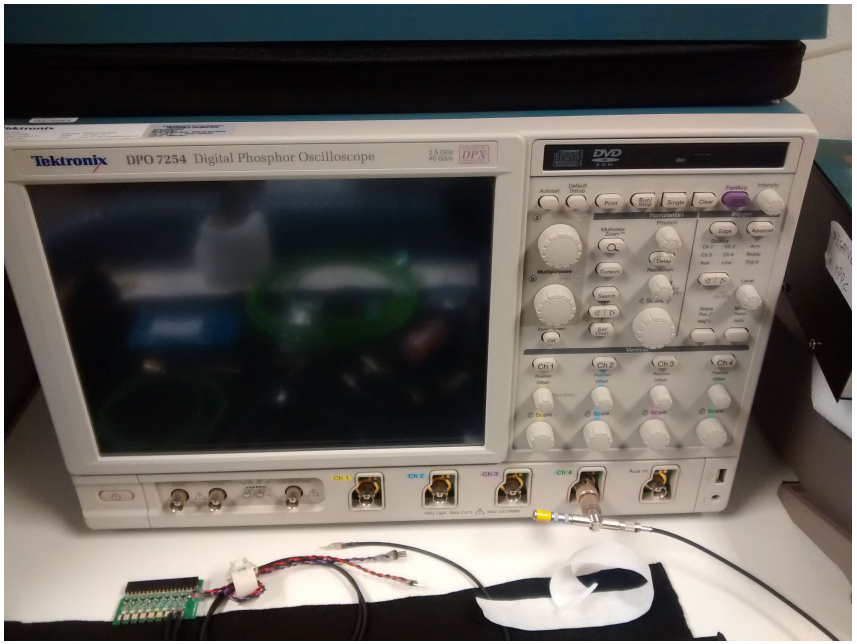
SiPM Dark Current

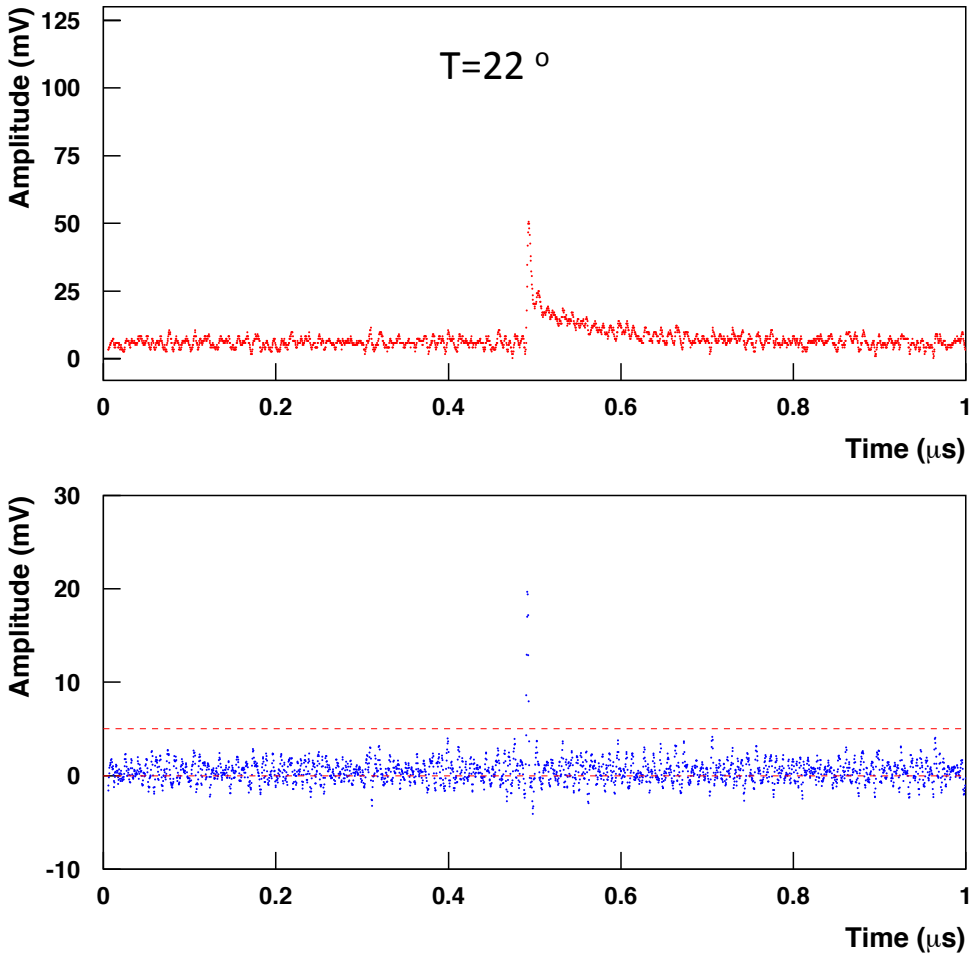
With temperature increase:

- Break-down voltage increases
- Working range decreases



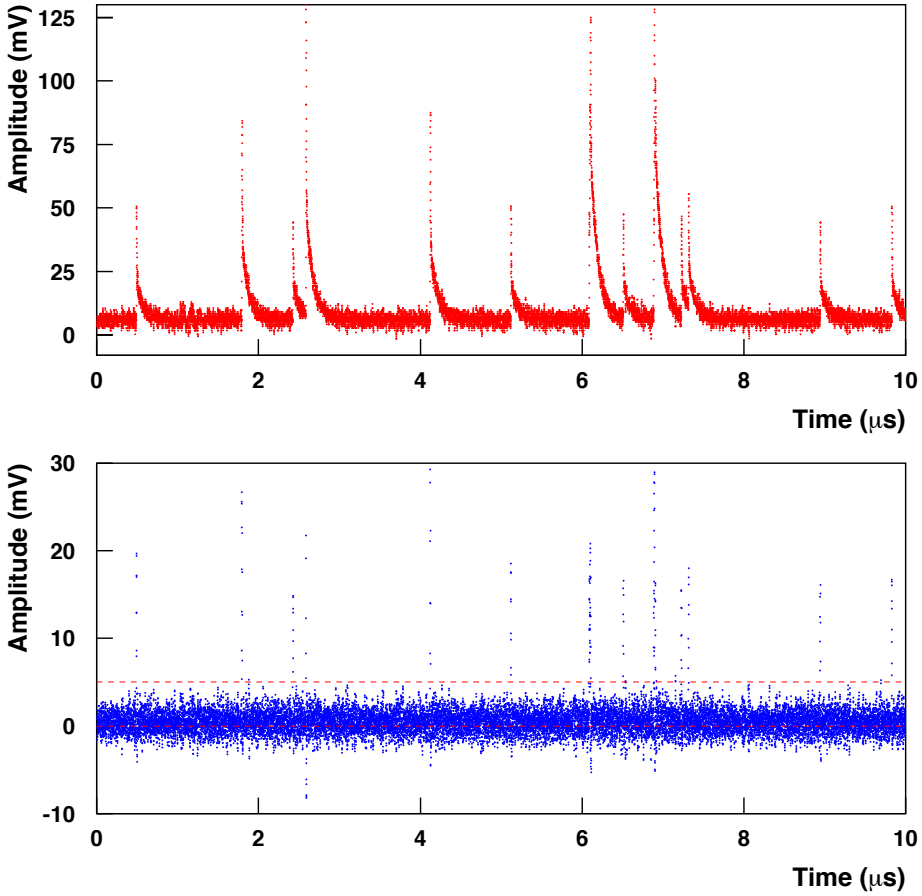
SiPM Signal Sampling





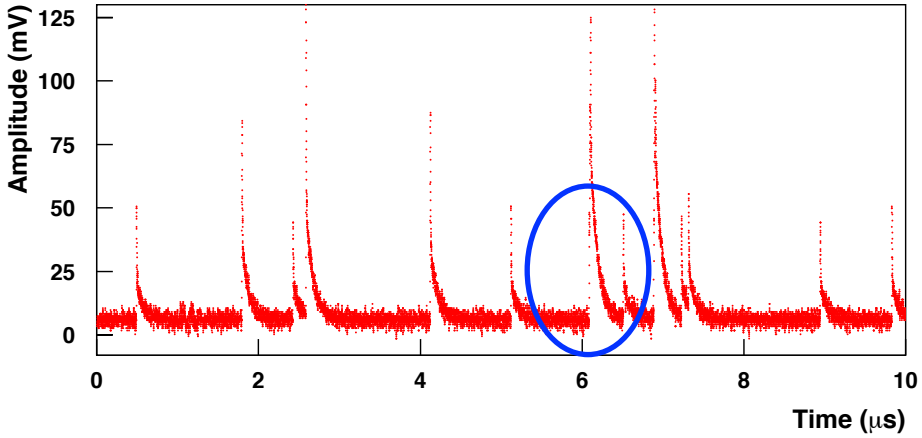
SiPM Signal Sampling

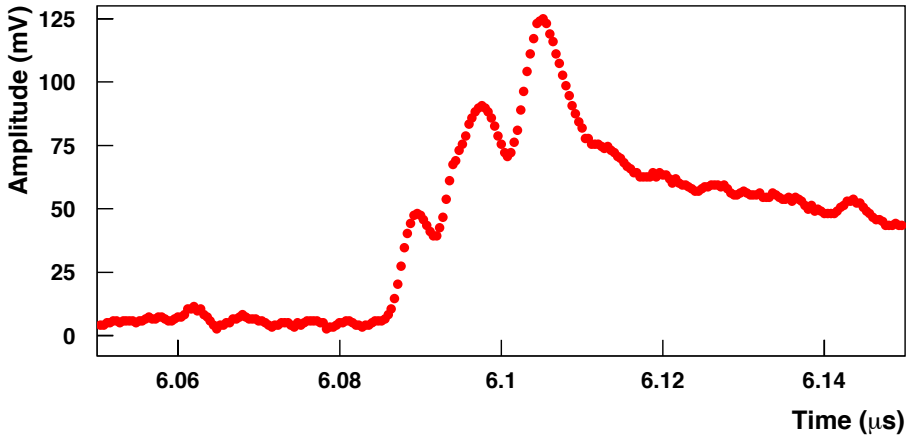
T=22 °

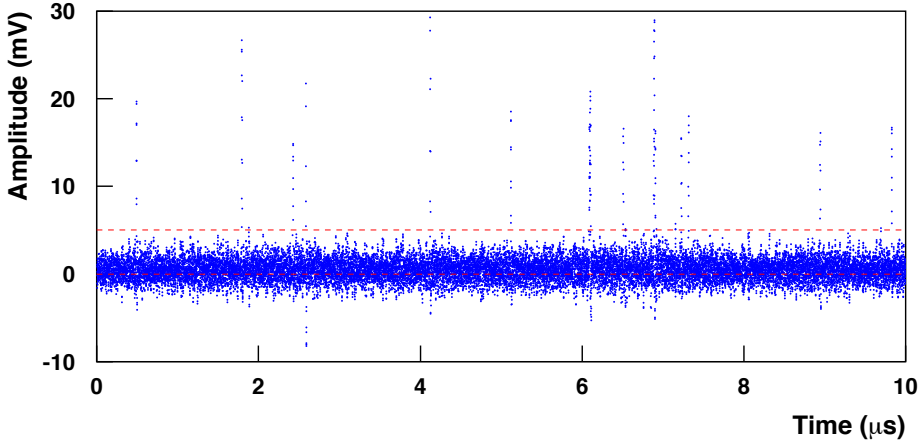


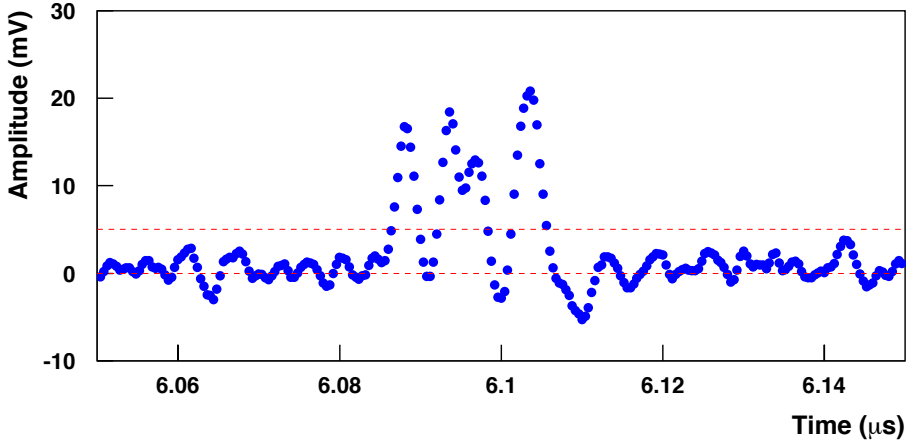
SiPM Signal Sampling

T=22 °

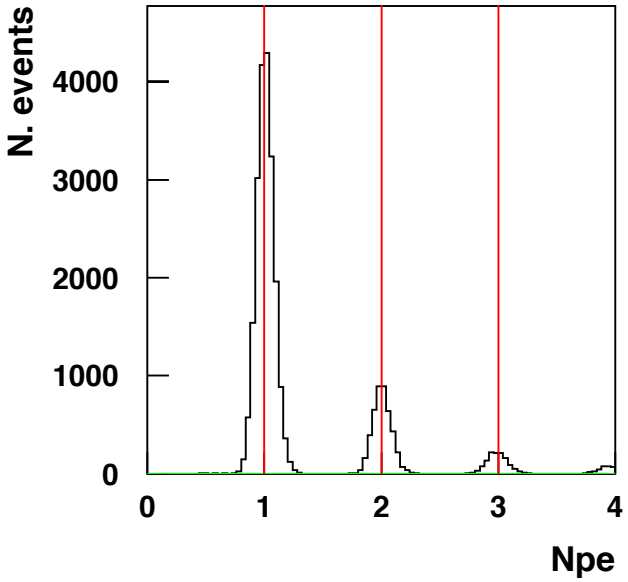


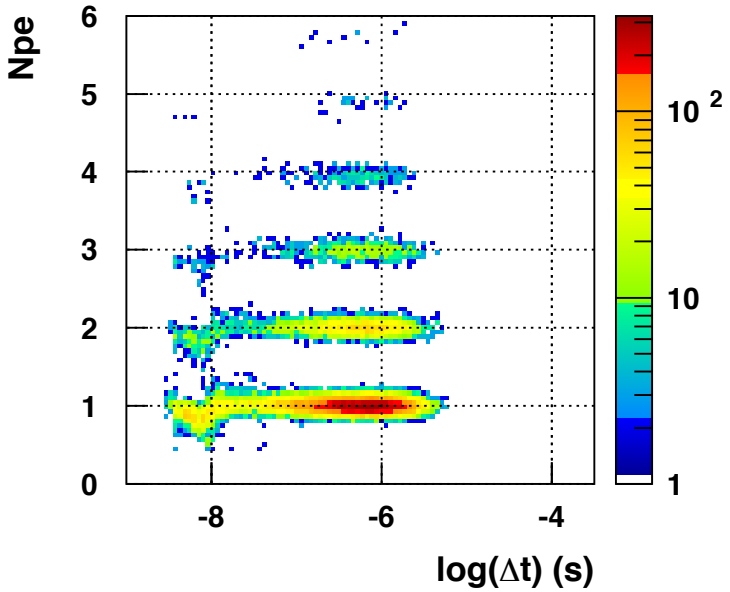


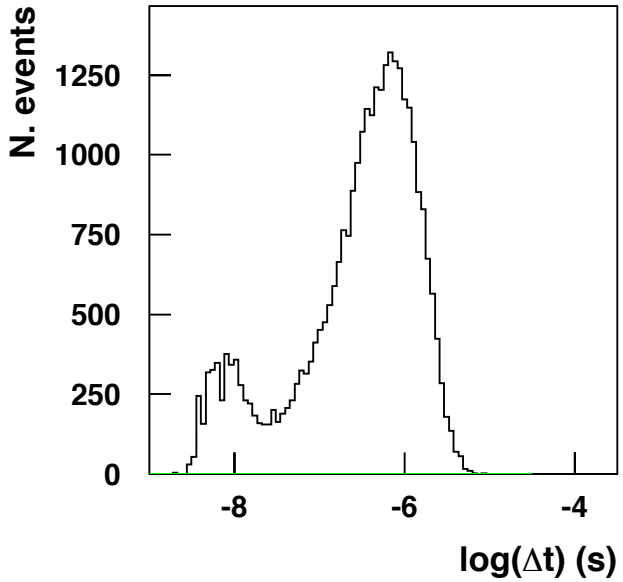




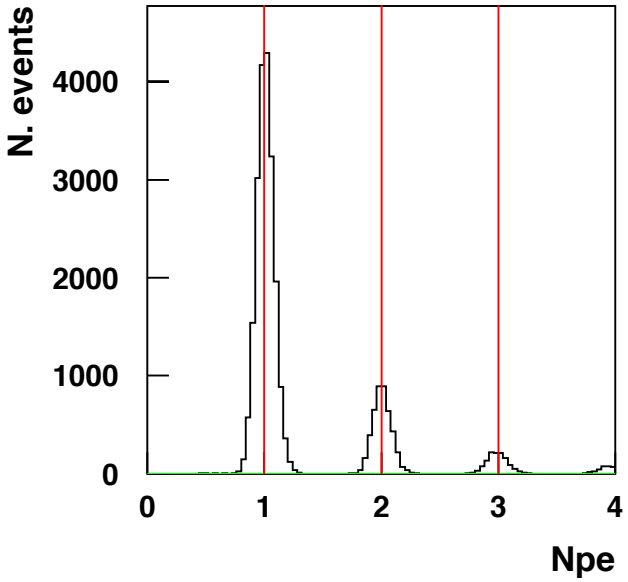
SiPM Signal Analysis

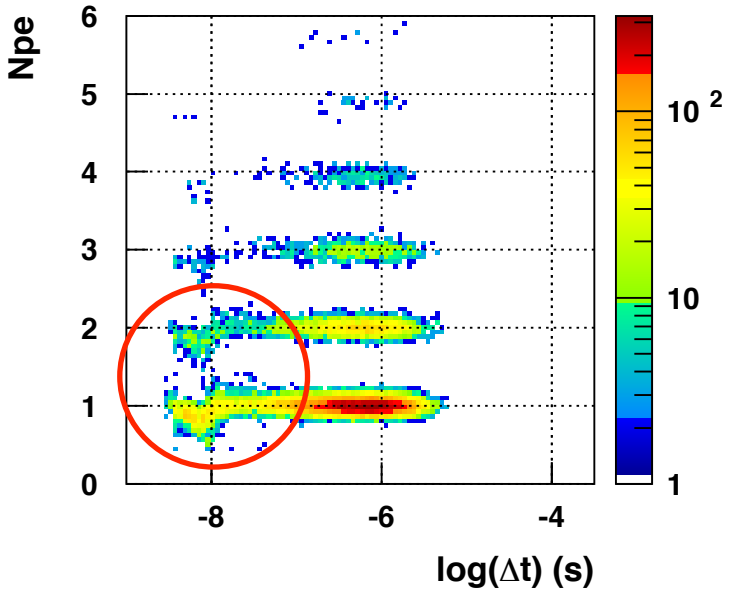


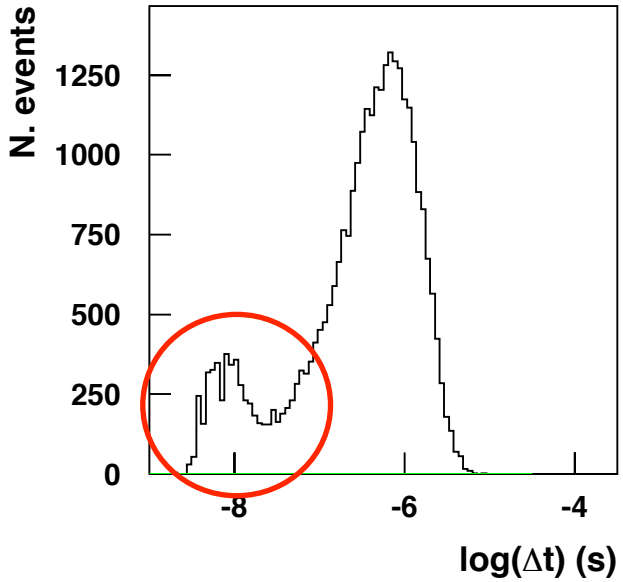




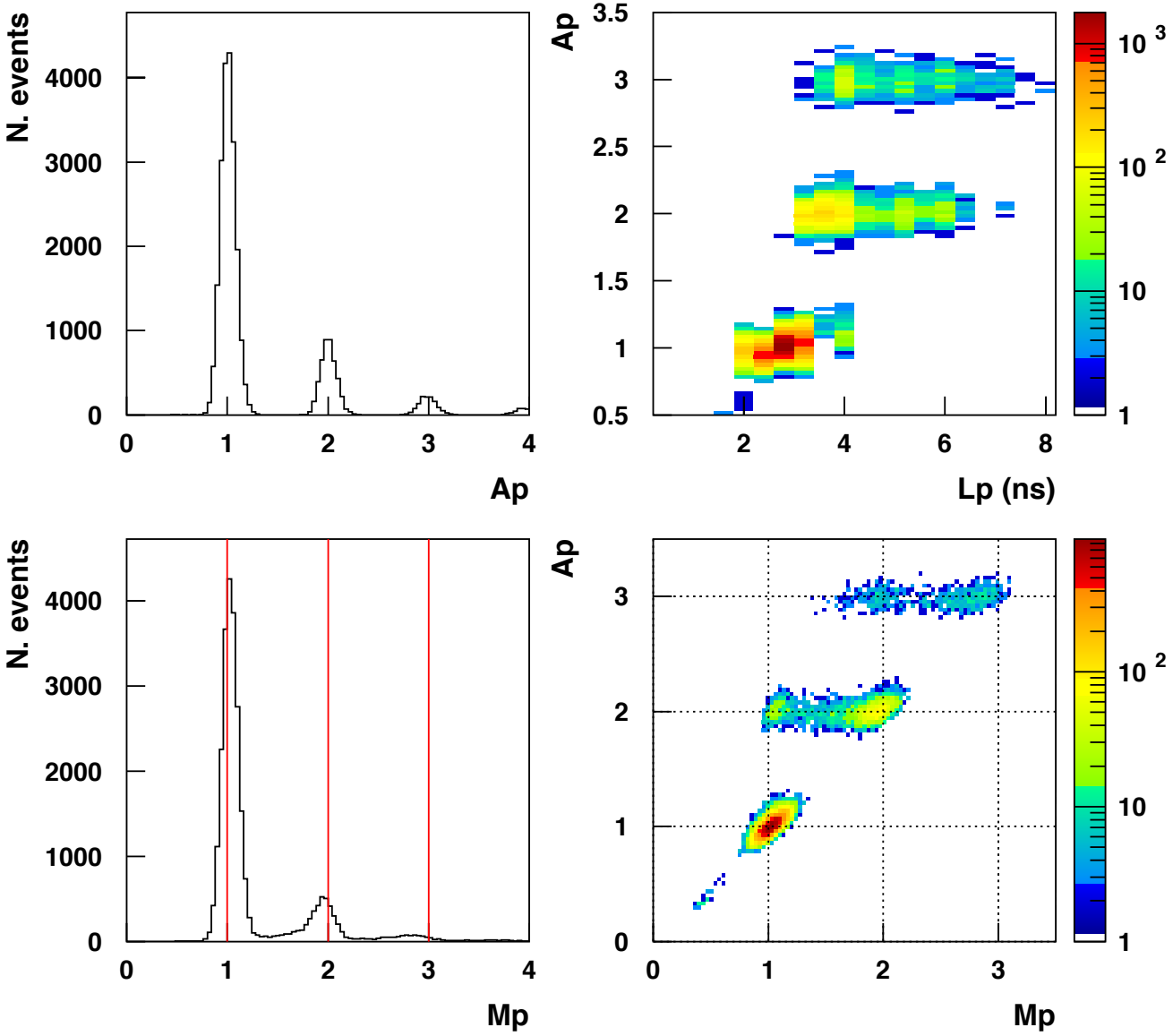
SiPM Signal Analysis



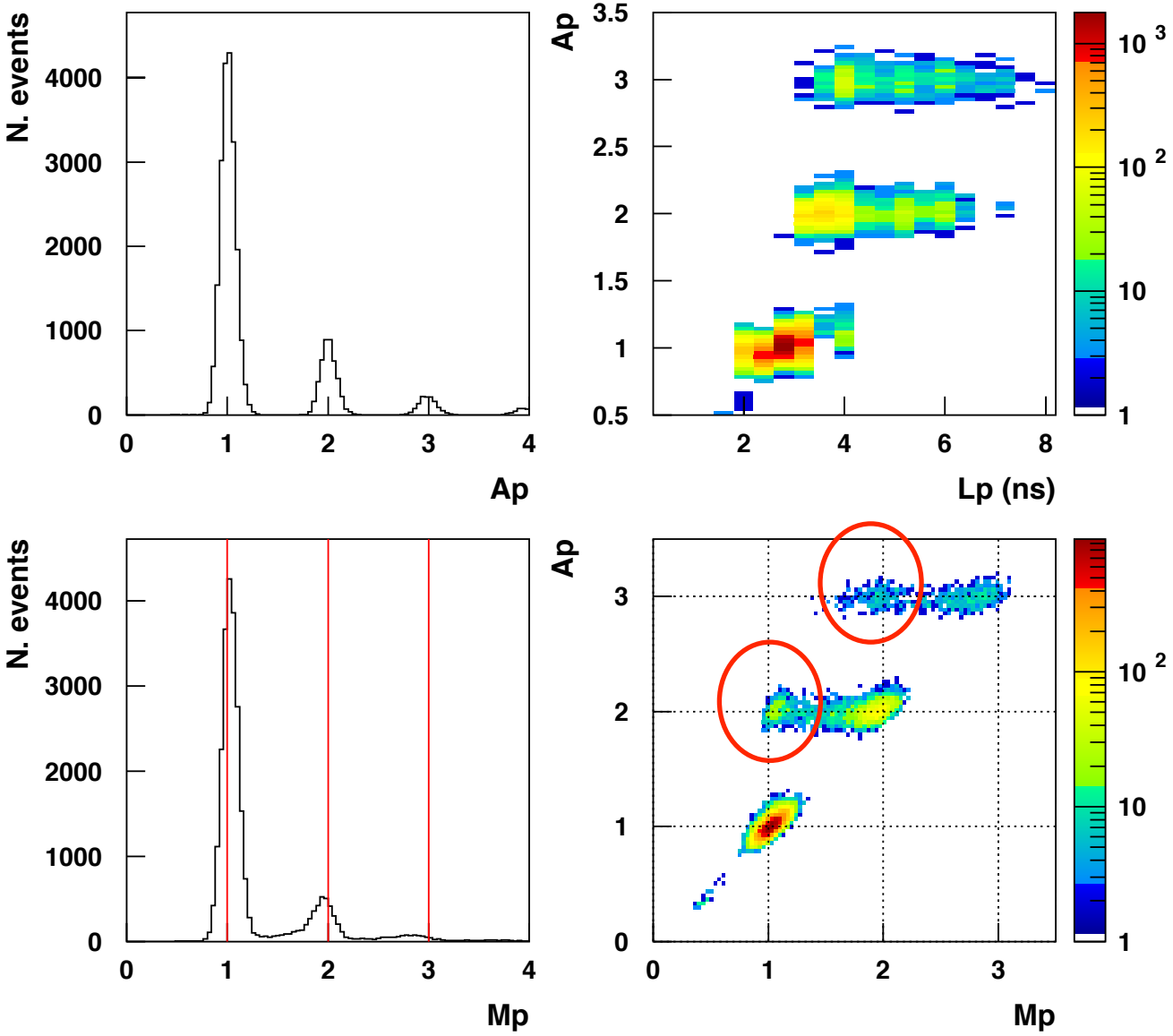




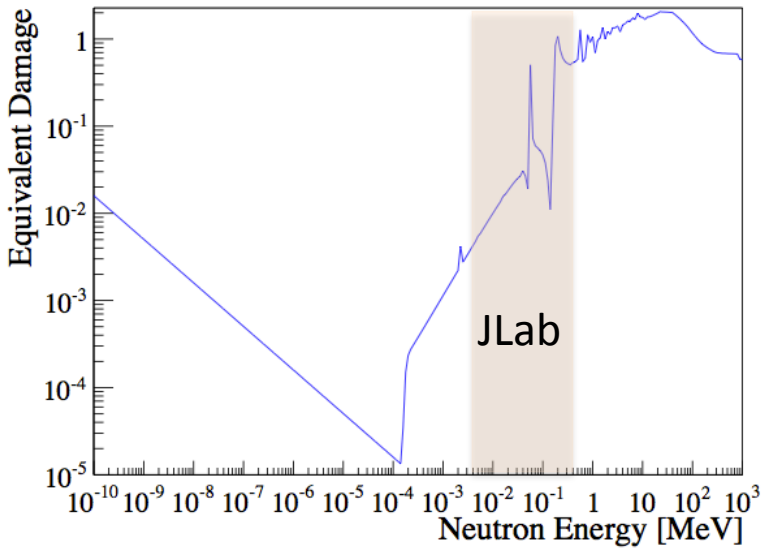
Dark Current

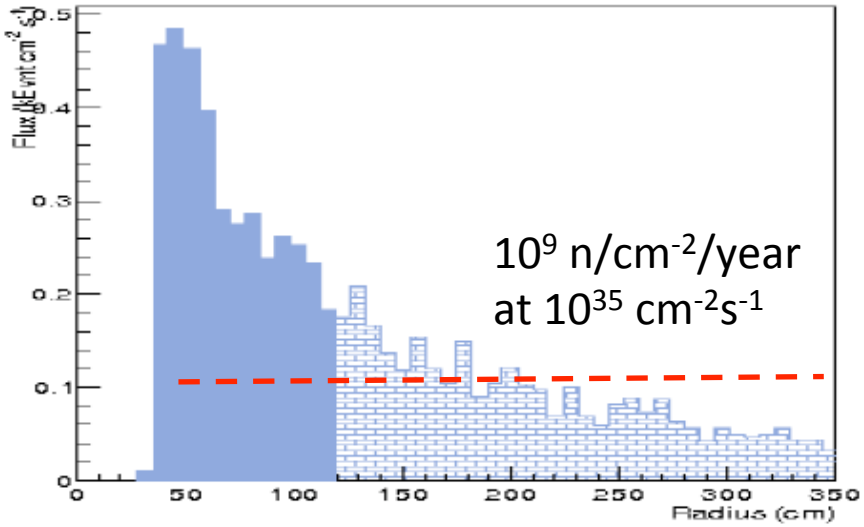


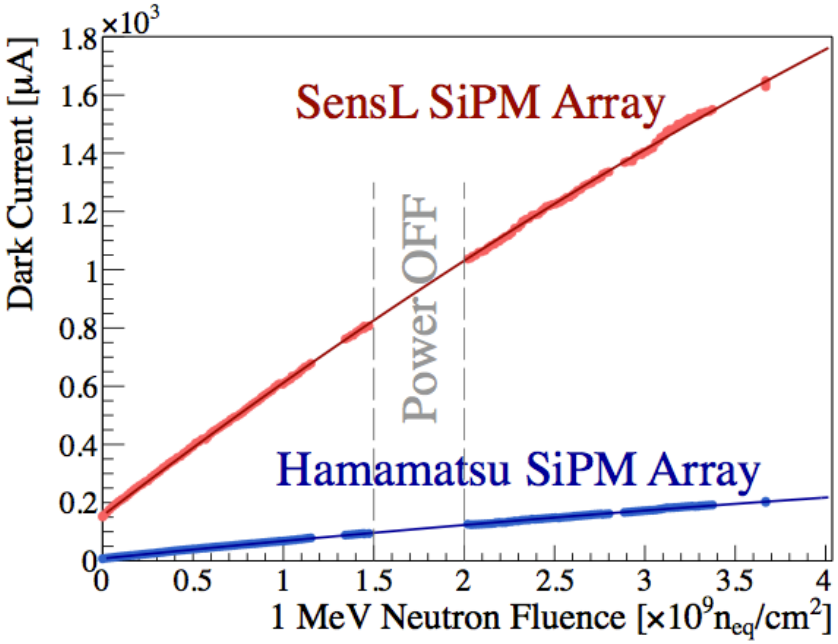
Dark Current



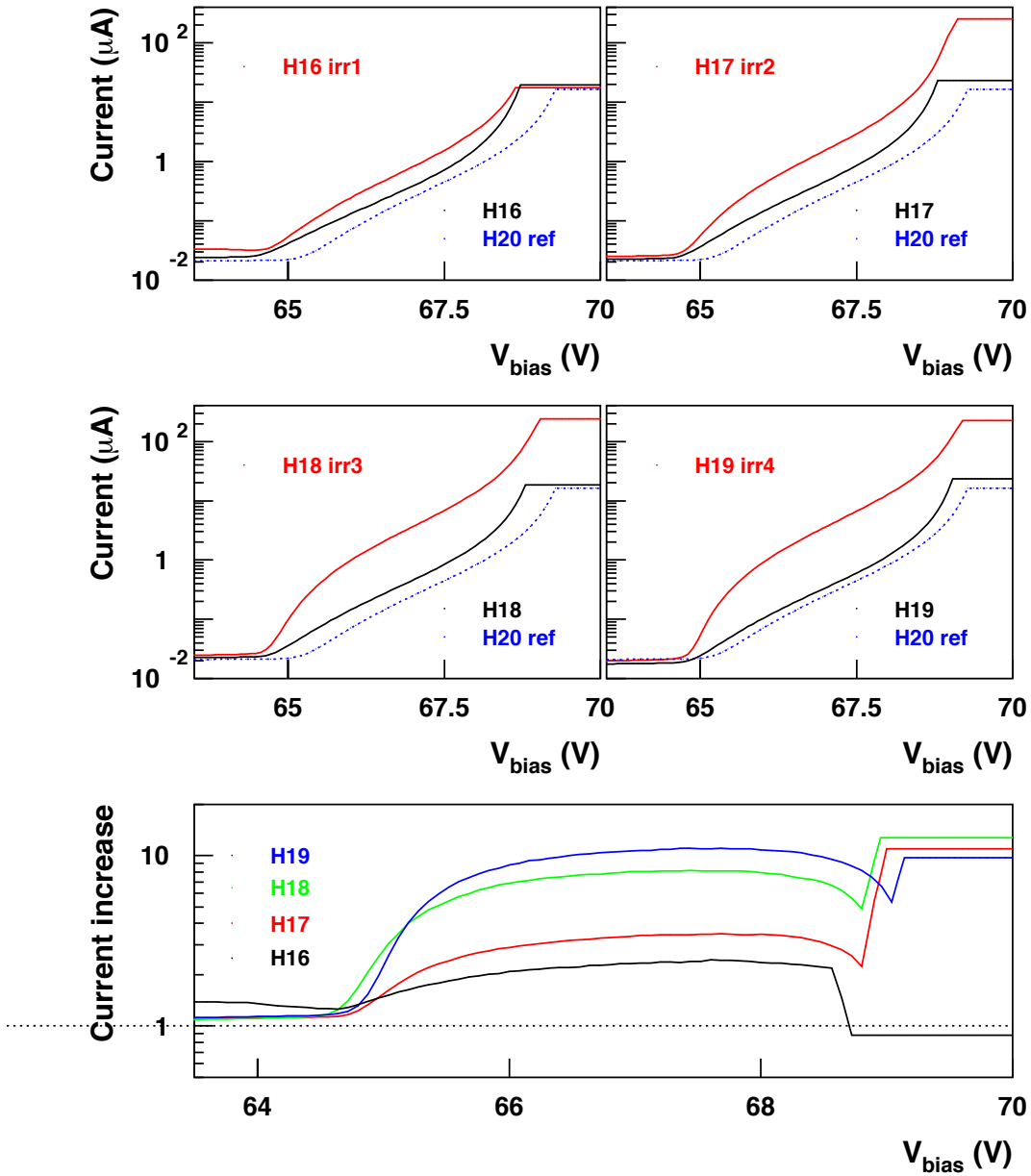
SiPM Signal Sampling







SiPM Irradiation



SiPM Irradiation