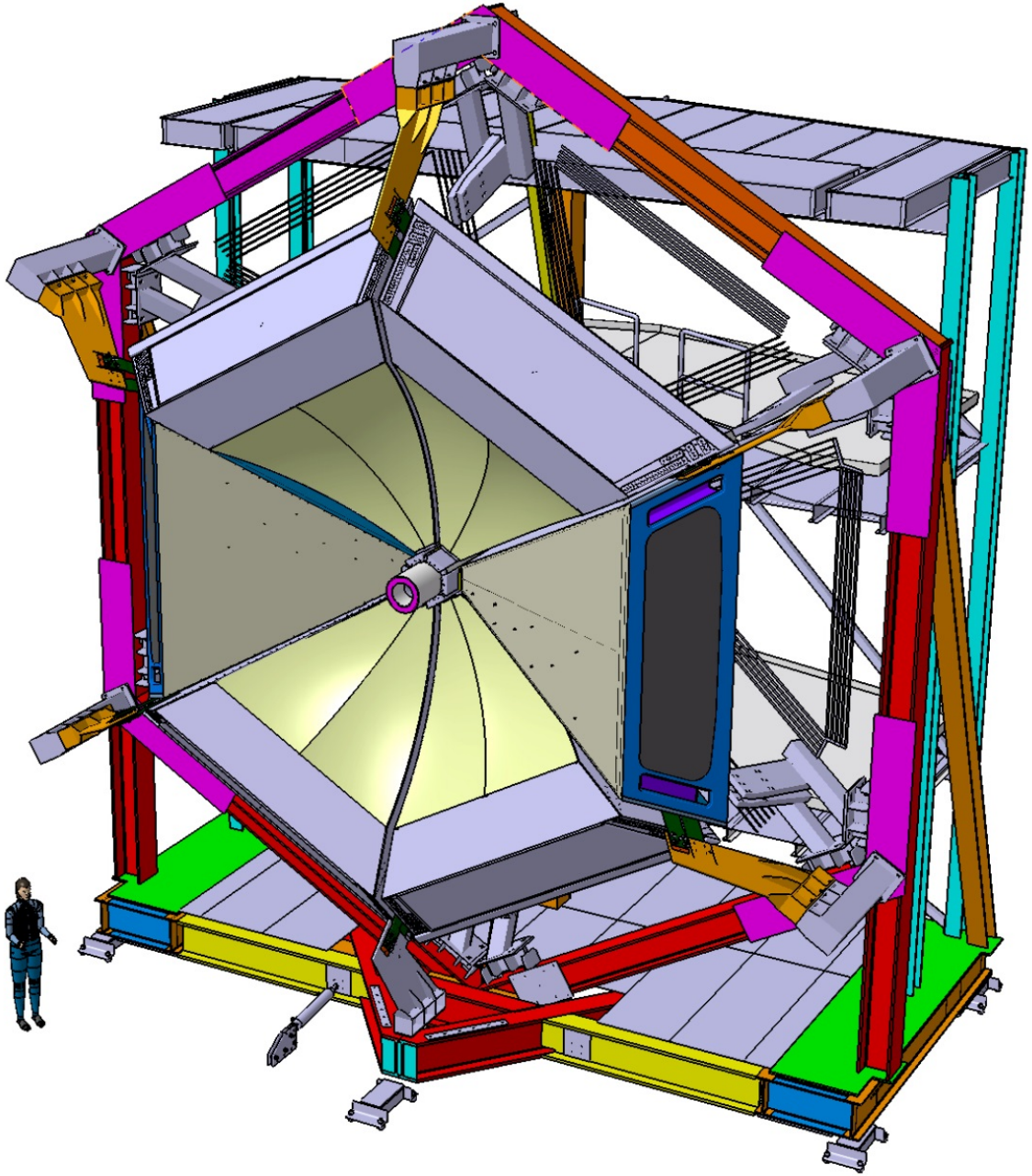
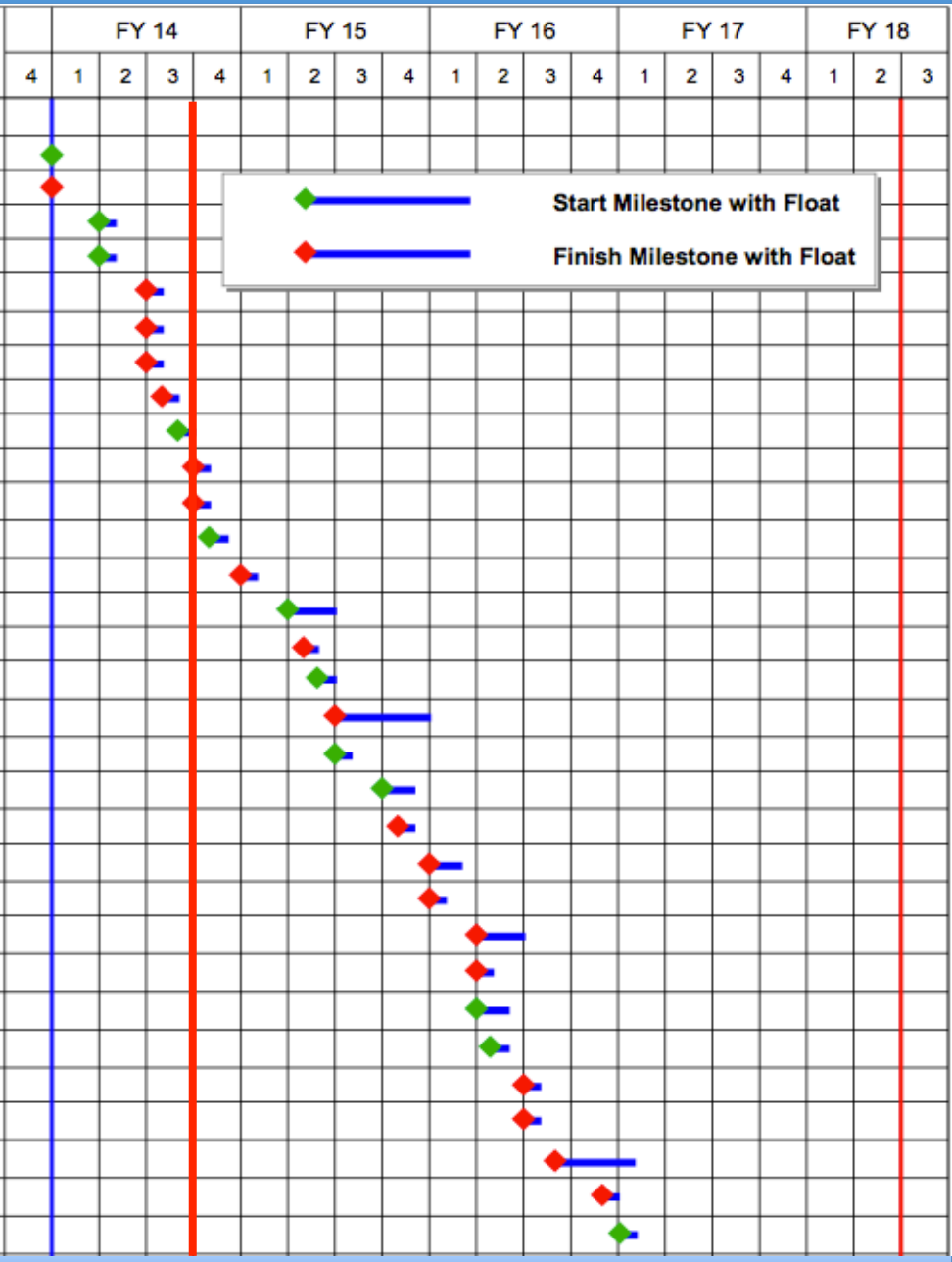


CLAS12-RICH Status-Report

August 8th 2014

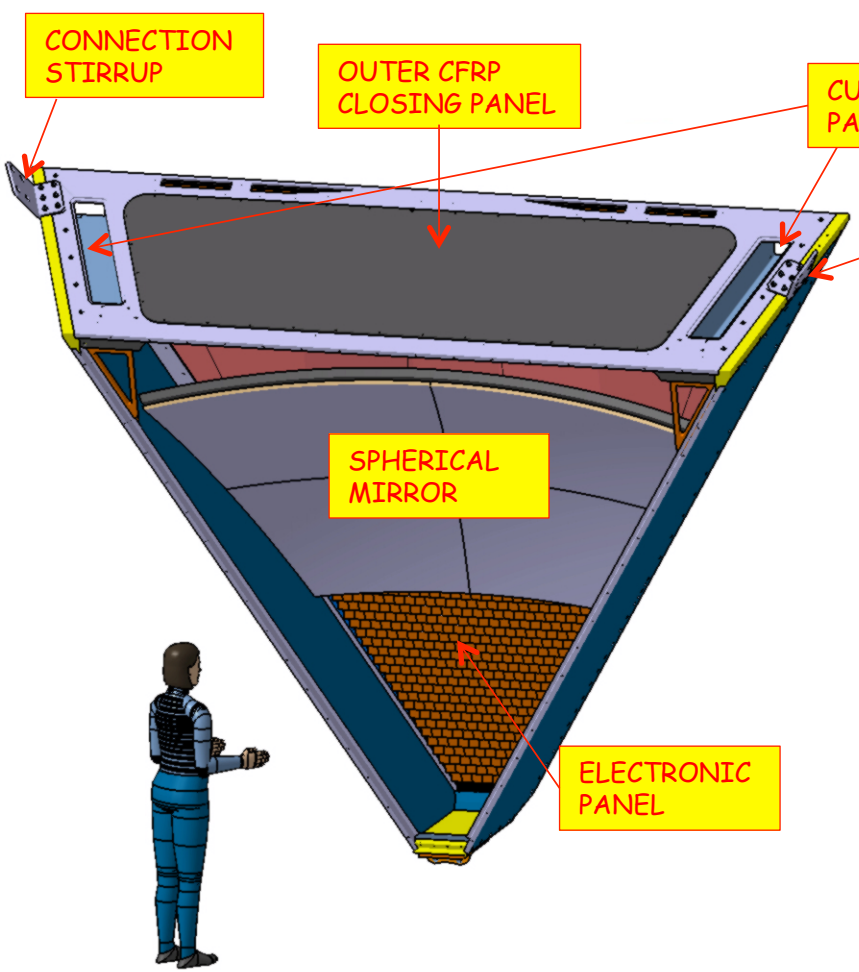
RICH Project Milestones

Activity Name	Date	MS Lvl	Finish Date
RICH Milestone Schedule			
Start of US Scope of RICH Project	9/30/13	1	9/30/13
PMT Contract Awarded	9/30/13	1	9/30/13
Start Aerogel Procurement	12/31/13	1	1/31/14
Start PMT Production	1/1/14	1	1/31/14
FE Interfaces Defined; Preliminary Electronics Design Completed	3/31/14	2	4/30/14
Identification of Mirror Technical Specification	3/31/14	2	4/30/14
Identification of External Frame & Electronic Panel Tech Specs	3/31/14	2	4/30/14
First 20 PMT Delivery	4/30/14	2	5/30/14
Start Mirror Procurement	6/2/14	1	7/1/14
PMT First Delivery Acceptance Testing Completed	6/30/14	2	7/30/14
First 1 m2 Aerogel: Order for Procurement Submitted	6/30/14	2	7/30/14
Start Metallic External Frame Procurement	8/1/14	2	9/3/14
DAQ: FPGA Board Design and Firmware Develop Completed	9/30/14	2	10/30/14
Start Mirror Production	12/31/14	1	3/31/15
DAQ FPGA: Order for Procurement Submitted	1/30/15	2	2/27/15
FE Electronics: Order for Procurement Submitted	2/27/15	2	3/31/15
2 m2 Aerogel Production Completed	3/31/15	2	9/30/15
Start Electronic Panel Procurement	4/1/15	2	5/1/15
Start First Spherical Mirror Characterization	6/30/15	2	8/31/15
FE and DAQ FPGA Boards: Production Completed	7/30/15	1	8/31/15
2 m2 Aerogel Acceptance Tests Completed	9/30/15	2	11/30/15
External Frame & Electronic Panel Completed	10/1/15	2	10/30/15
Mirror Production Completed	12/31/15	1	3/31/16
PMT Production Completed	12/31/15	1	2/1/16
Start Mechanical Assembly Test	12/31/15	2	2/29/16
Start FE and DAQ Electronics Characterization	1/29/16	2	2/29/16
PMT Characterization Completed	3/31/16	2	4/29/16
Mechanical Assembly Survey of Spherical Mirrors Completed	3/31/16	2	4/29/16
3 cm Thickness Aerogel Production Completed	5/31/16	2	10/31/16
Mirrors/Ext Frame/Elect Panel Arrive at JLab	8/31/16	2	9/30/16
Start RICH Assembly	10/3/16	2	11/2/16

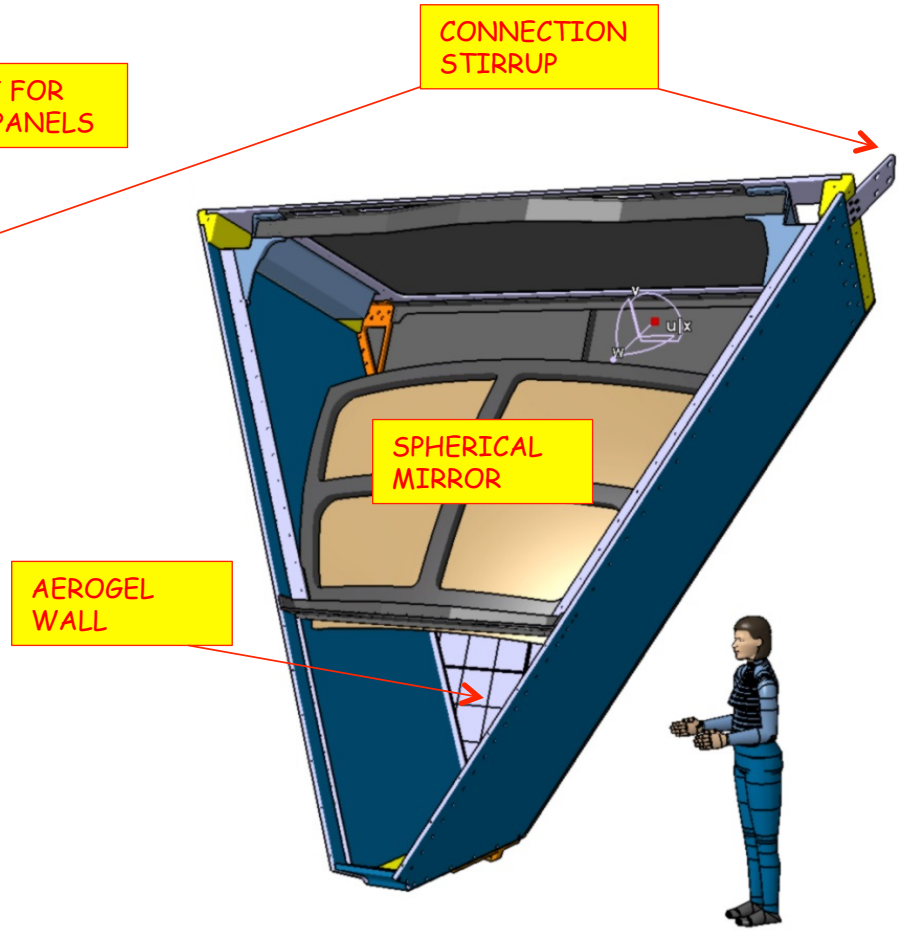


RICH Module General Assembly

RICH module designed to be as much as possible close to the existing LTCC sector layout



RICH MODULE BACKWARD VIEW *(OPENED)*



RICH MODULE FORWARD VIEW *(OPENED)*

RICH Mechanical Review

JLab, 20 June 2014

Charge of the Review Committee:

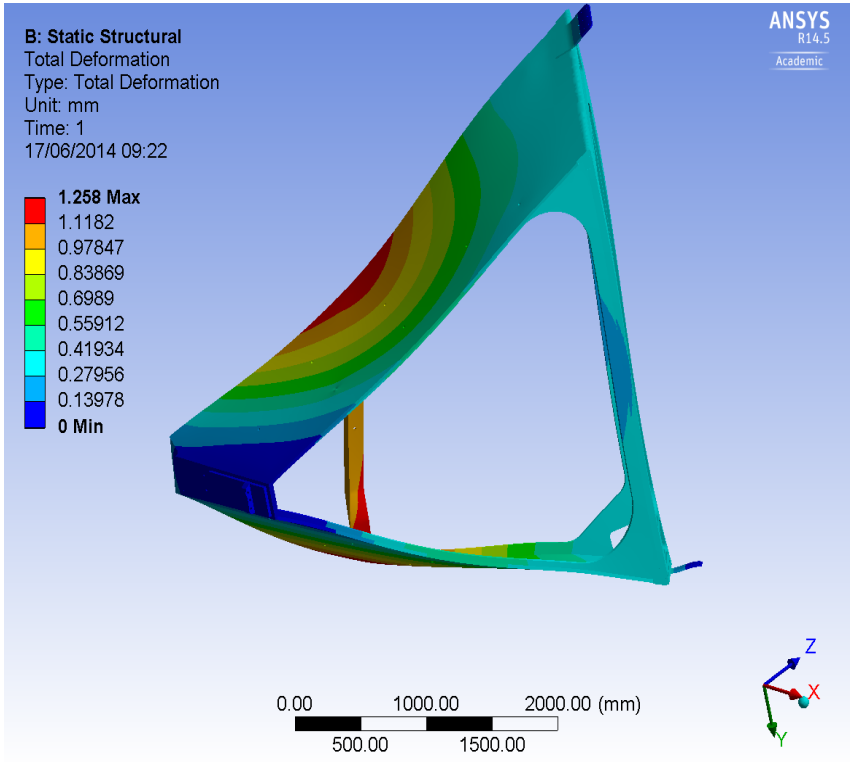
1) Is the proposed RICH mechanical design well integrated into the CLAS12 detector?
I.e. are all the mechanical constraints imposed by the CLAS12 detector be taken into account?

2) Are the external envelop frame and closing panels materials in accordance with the JLab safety rules and regulations?

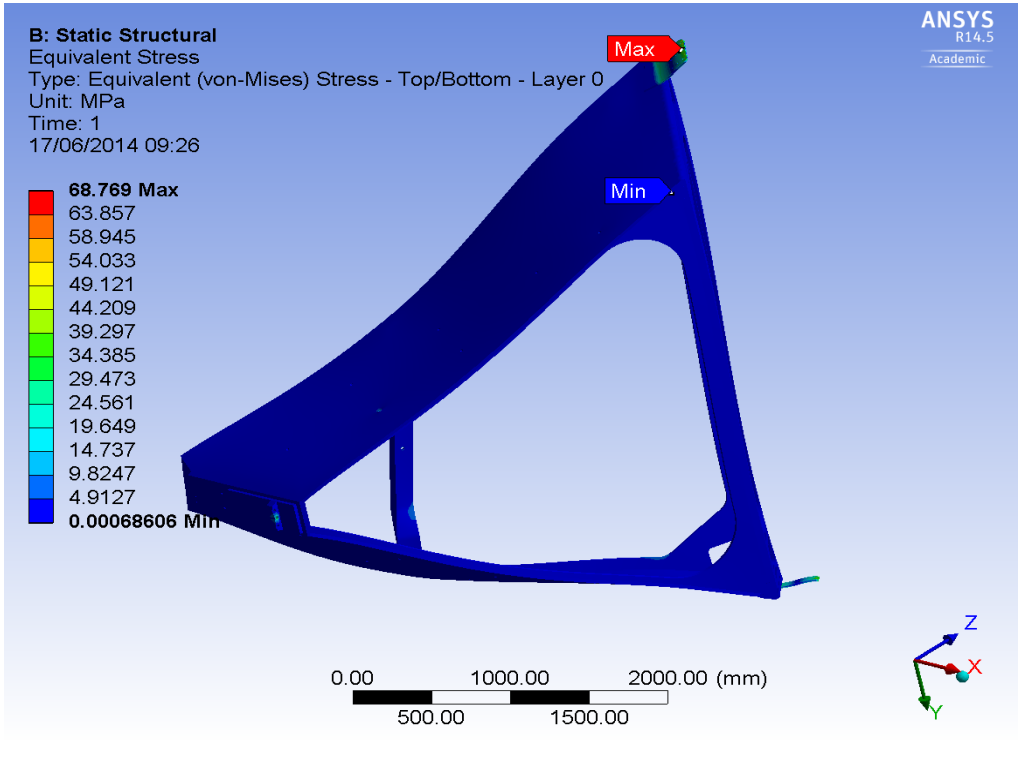
3) Are the gas systems proposed to keep the aerogel dried and the electronics thermal power dissipation system following the JLab safety rules and regulations?

FEA Model Stress Analysis

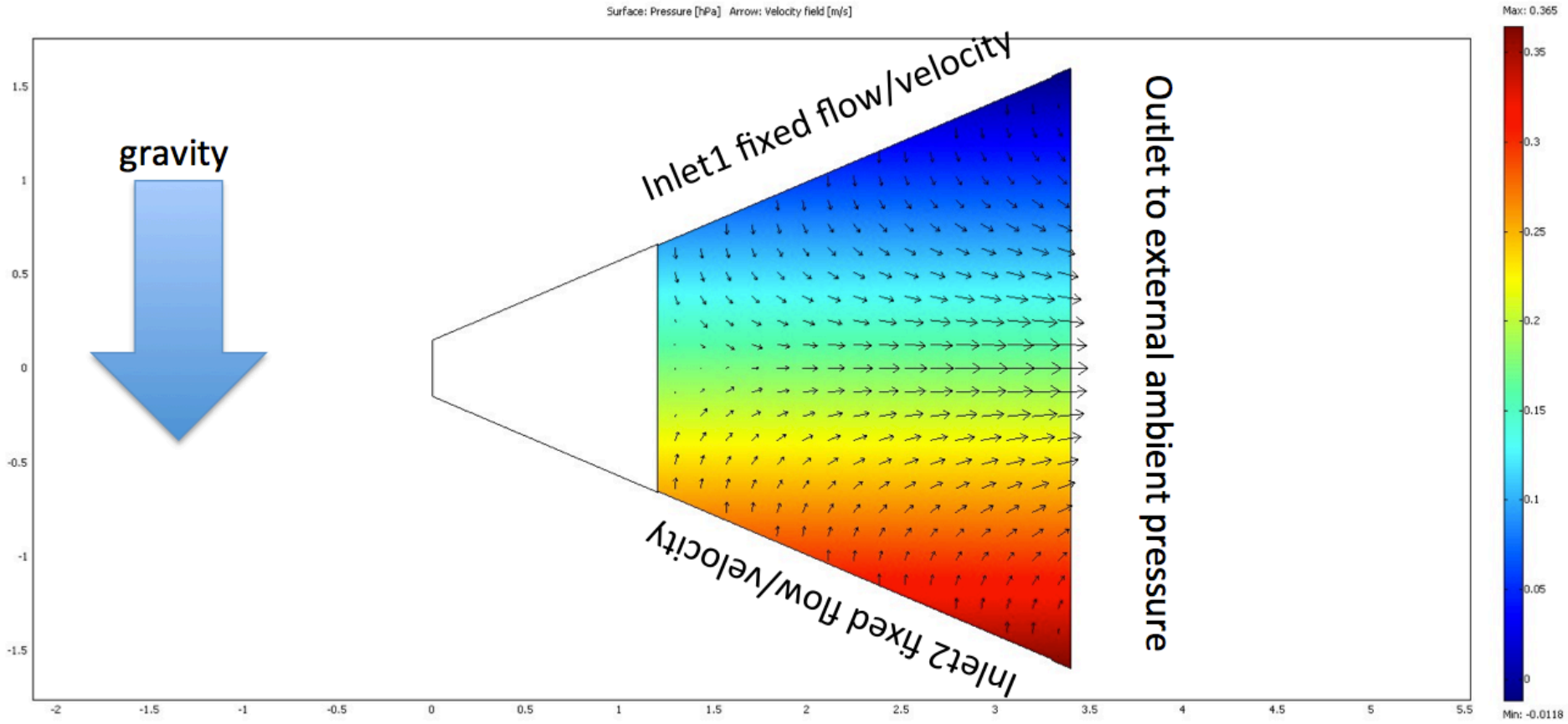
Deformations



Constraint Weight Stress



Gas System Design Parameters



Aerogel

Aerogel is the only known material whose index of refraction is correct for Kaon ID in the desired momentum range. One layer of 2cm thickness and n=1.05 radiator for q<13° and two layers of 3cm thickness and n=1.05 radiator for q>13° will be used.

Milestone: First 1 m^2 Aerogel: Order for Procurement Submitted (6/30/14) **achieved (6/27/14)**

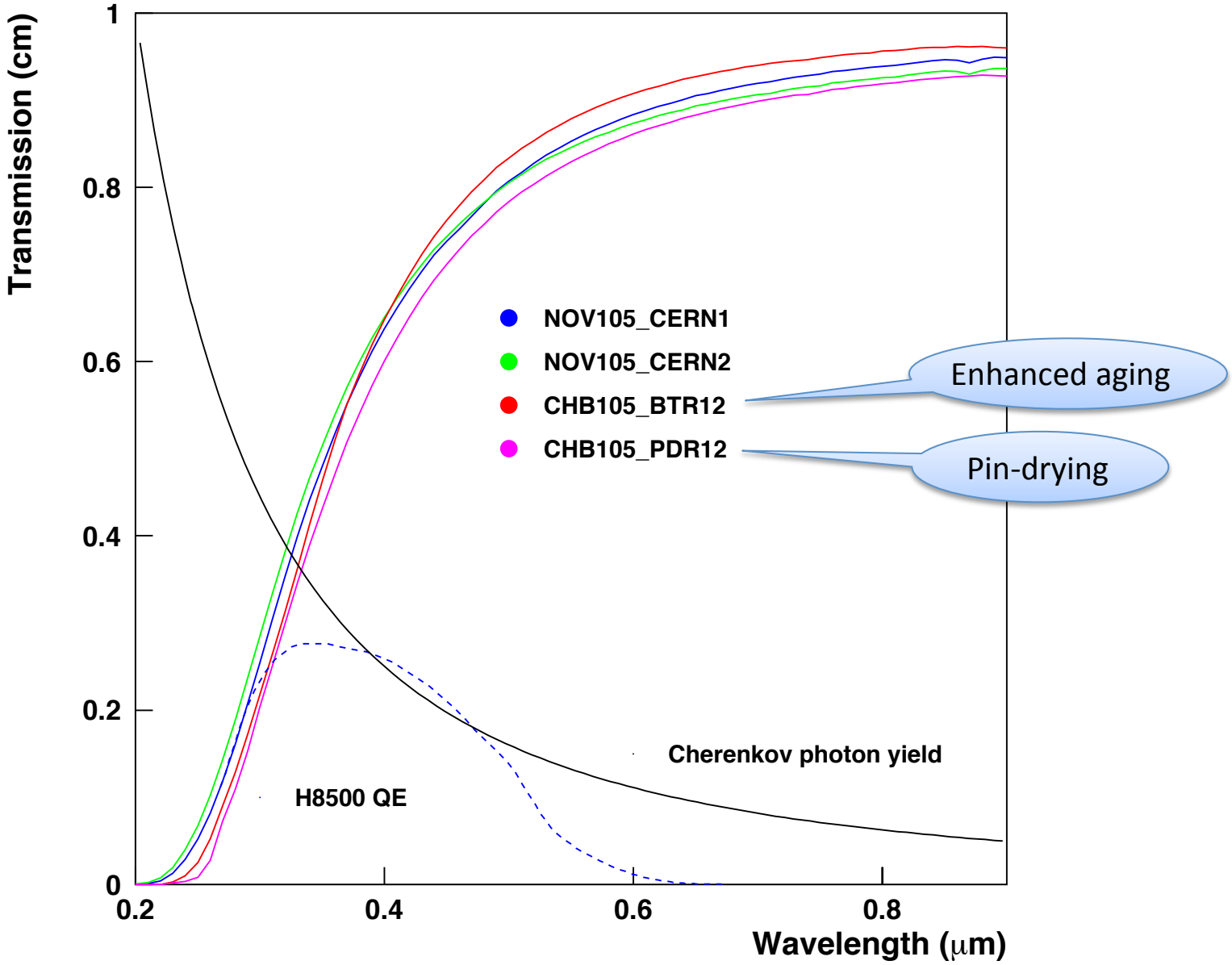
Purchasing order for the first 2 m^2 of large tiles is being processed by INFN Procurement office

- Production completion expected in 1 year
- 10 % will be tested in Ferrara laboratory
- 10 large tiles from test production already delivered at Ferrara for tests

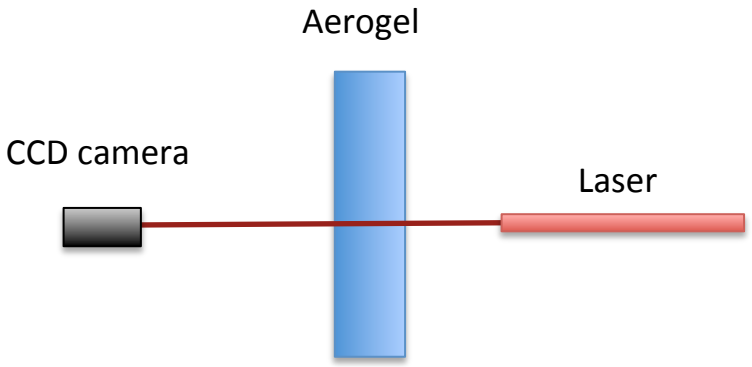
Aerogel Radiator

Rafractive index: 1.05
Area: 20x20 cm^2
Thickness: 3 cm
Scattering Length: greater than 45 mm

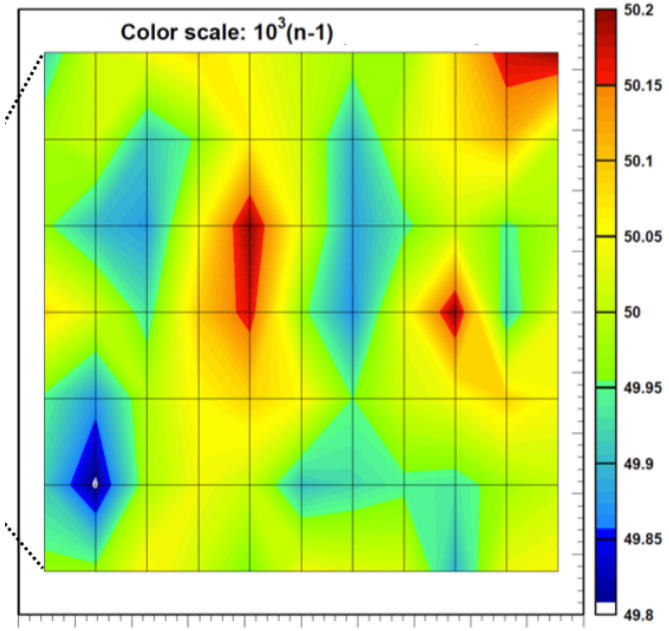
Aerogel Transmittance



Aerogel Uniformity



New automatized system
Studying sensitivity on edge effects, tile bending



$$\delta n \sim 4 \cdot 10^{-4}$$

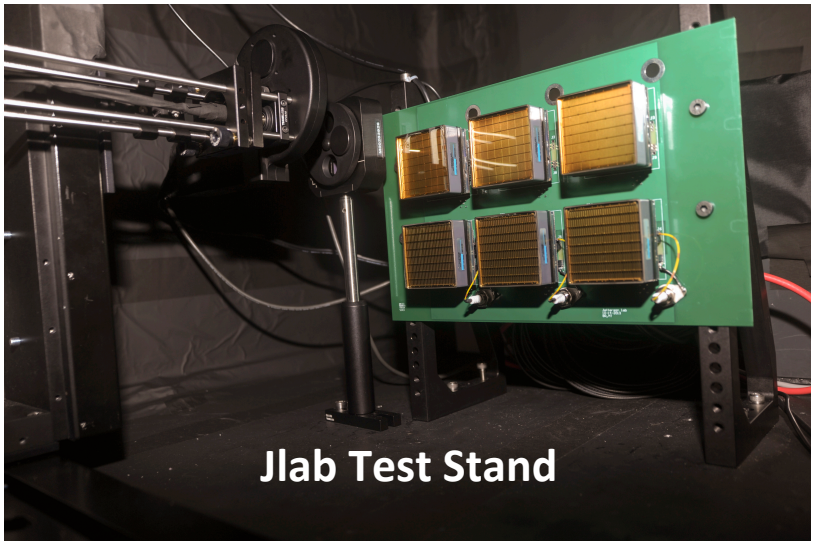
MA-PMTs Acceptance Tests

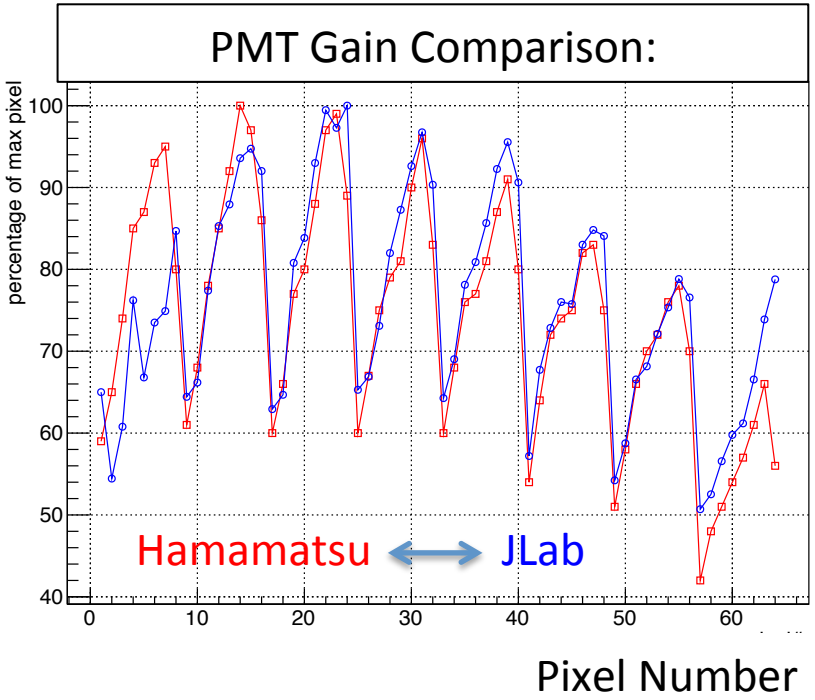
Milestone: First 20 MA-PMT delivery (4/30/14) — **achieved (3/28/14)**

Milestone: PMT First Delivery Acceptance Testing Completed (6/30/14) — **achieved (5/25/14)**

90 Hamamatsu MAPMT out of 400 delivered and tested at Jlab

- 80 H8500 (2 replaced)
- 10 H12700 with enhanced single photoelectron spectrum

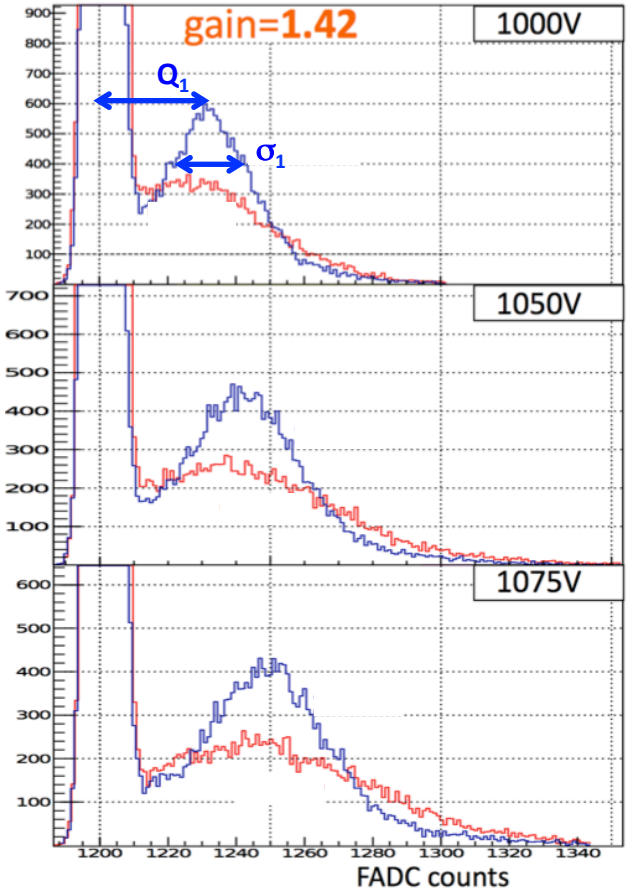


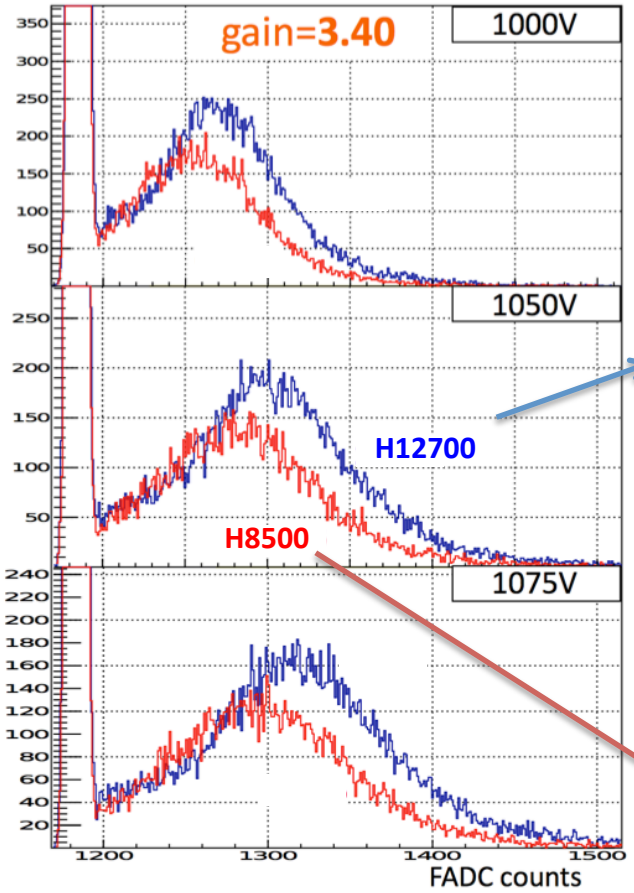


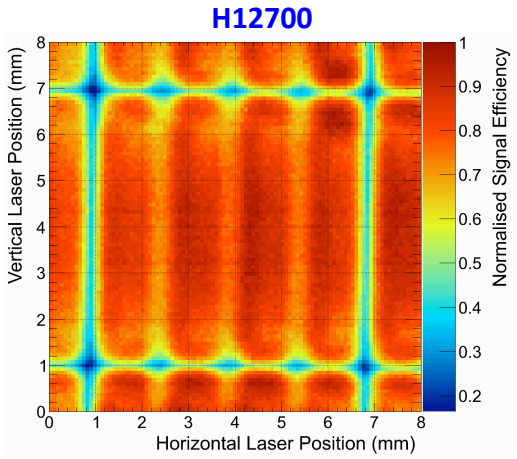
MA-PMT ps Pulsed Laser Test

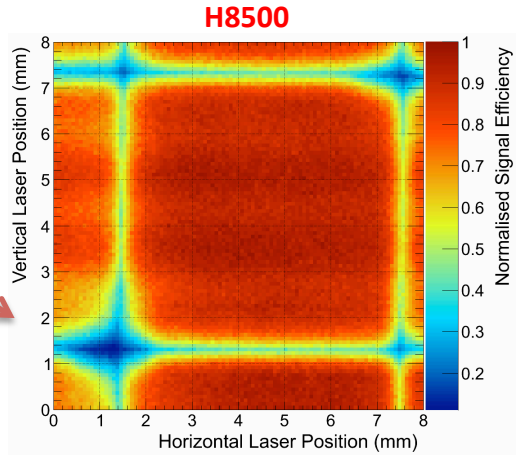
H12700
with optimized dynode structure:

- ✓ higher collection efficiency
- ✓ better SPE resolution
- ✓ enhanced cathode sensitivity
- ✓ slighter lower gain
- ✓ modest increase of dark current









The Novel H12700 MA-PMT

Phase I: 80 H8500 (delivered)

Phase II & III: 300 H12700

- 10 without custom specifications delivered for approval

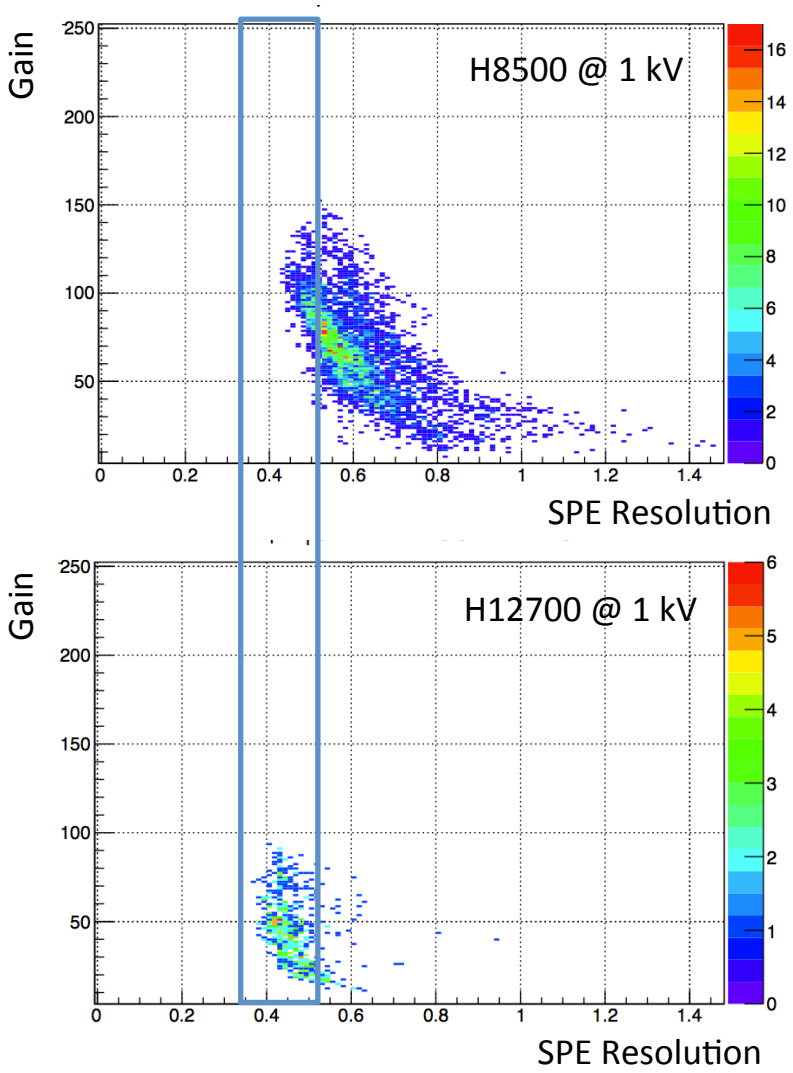
- 20 upcoming for gain specification definition

gain > 8e5 at 1kV no price increase
gain > 1e6 at 1kV 4 % price increase

3 months delay in H12700 delivery schedule

The PMT production will be completed by ~ middle May 2016 instead of December 31, 2015 with 1 month of contingency, i.e. by February 1st, 2016

Will not affect the RICH installation



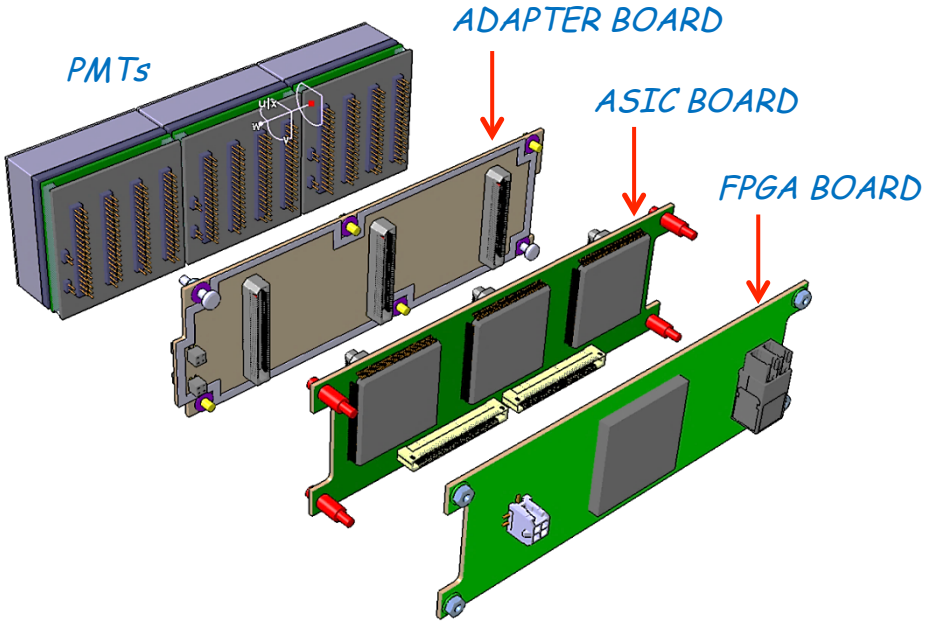
Read-Out Electronics

Work done in parallel to finalize executive design of

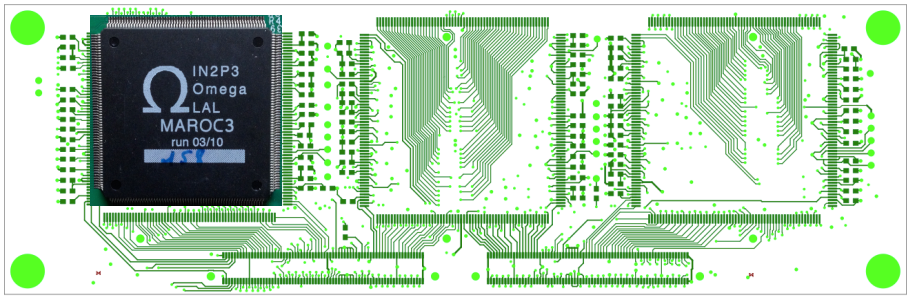
- Adapter board (Genova)
- ASICs boards (Ferrara)
- DAQ boards (JLab)

Design completed, board prototype production ongoing

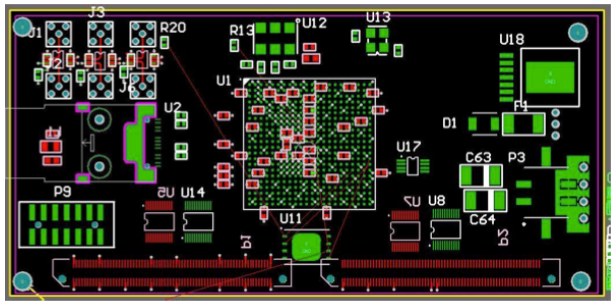
Goal: two complete readout systems (1 in Italy, 1 at JLab)



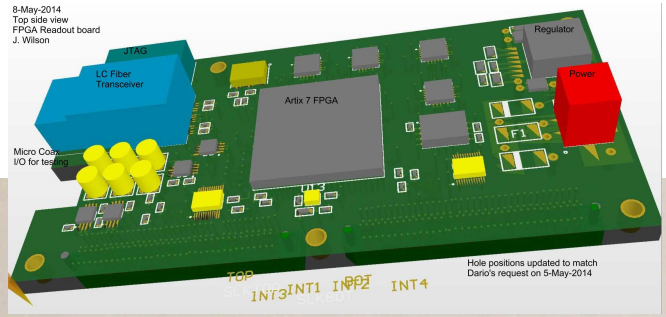
ASIC BOARD routing (INFN)



Universal FPGA BOARD 2D layout (JLab)



FPGA Boards



Sample Boards to check components conflicts and cabling issues

ASIC board
2 MaPMT

ASIC board
2 MaPMT

ASIC board
3 MaPMT

FPGA board #1
*Modified
Fiber Transceiver

FPGA board #2

FPGA board #3
*Modified
Fiber Transceiver

Two sample FPGA boards shown with modified orientation of the fiber transceiver.
LC Fiber cable omitted on FPGA board #3 (see photo) above.
No issues with DC input connector, but no cabling is shown at this point.

Mirrors

The RICH detector exploits two large mirrors (several squared meters), one planar just before the aerogel tiles and a spherical one placed above the MA-PMT array, to contain the Cherenkov photons within the module and direct them toward the PMTs.

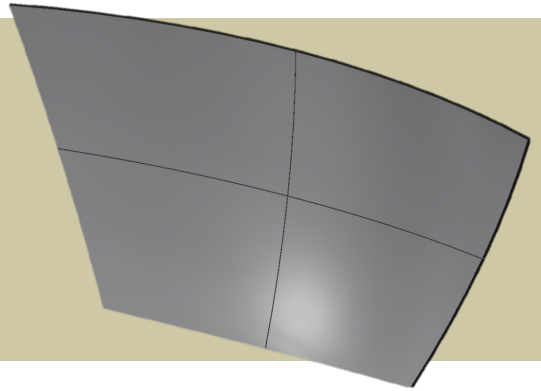
Milestone: Start Mirror Procurement (6/2/14) **achieved 75 %**

Manufacture Engineering Phase ongoing with companies in Italy and USA

Setting up characterization and acceptance procedures

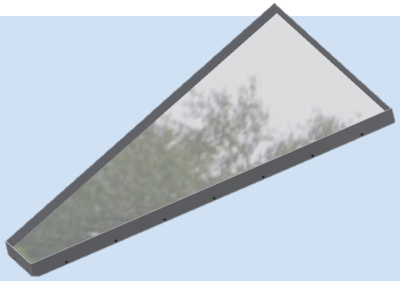
CFRP SPHERICAL Mirror

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%

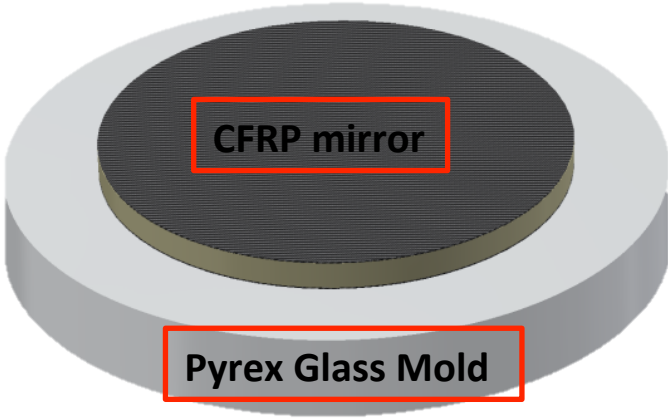


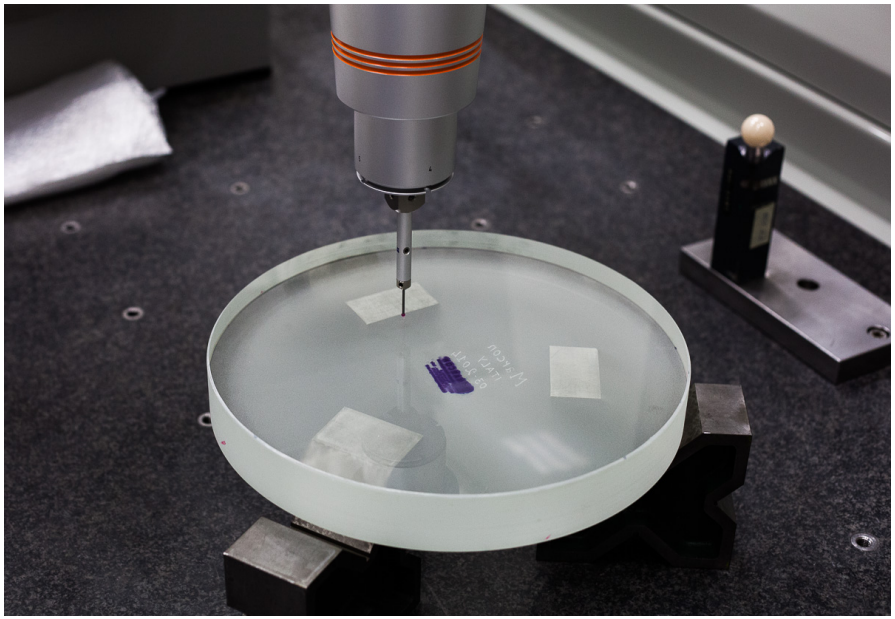
CFRP Spherical Mirror: Mandrel Demo

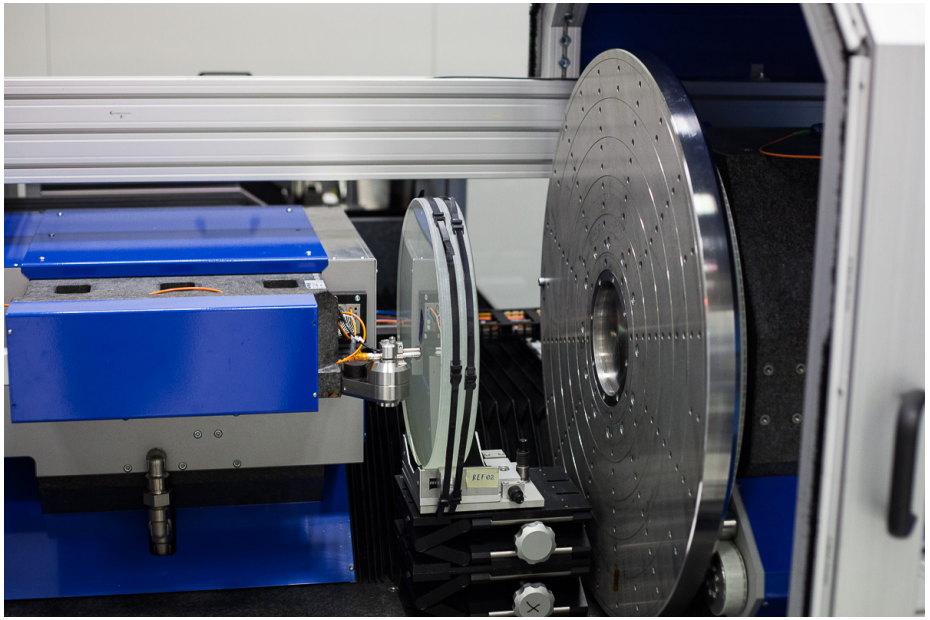
Mandrel demo delibered by Marcon (Italy) :

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

Mechanics is fulfilling specs







Supremax Mandrel

Shape Accuracy

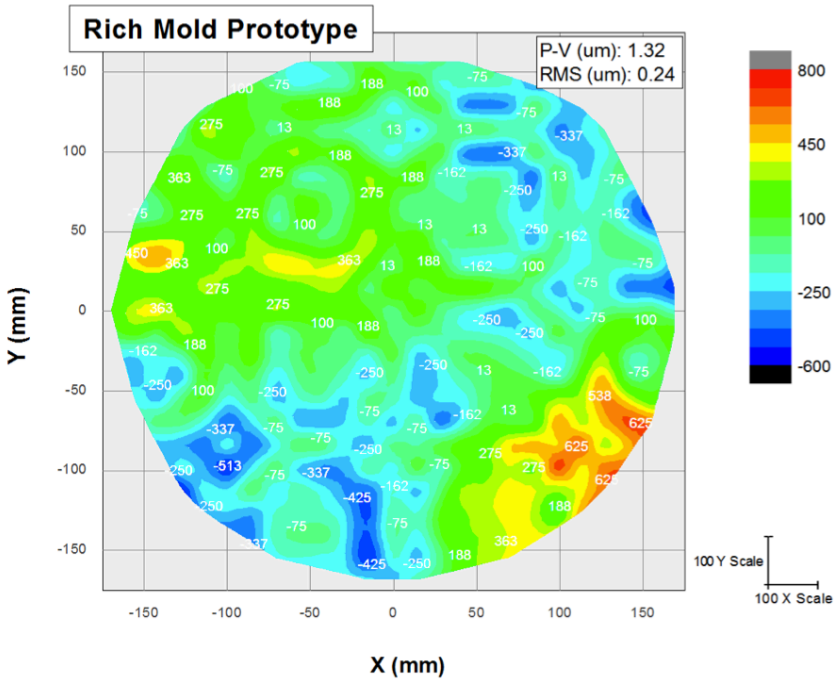
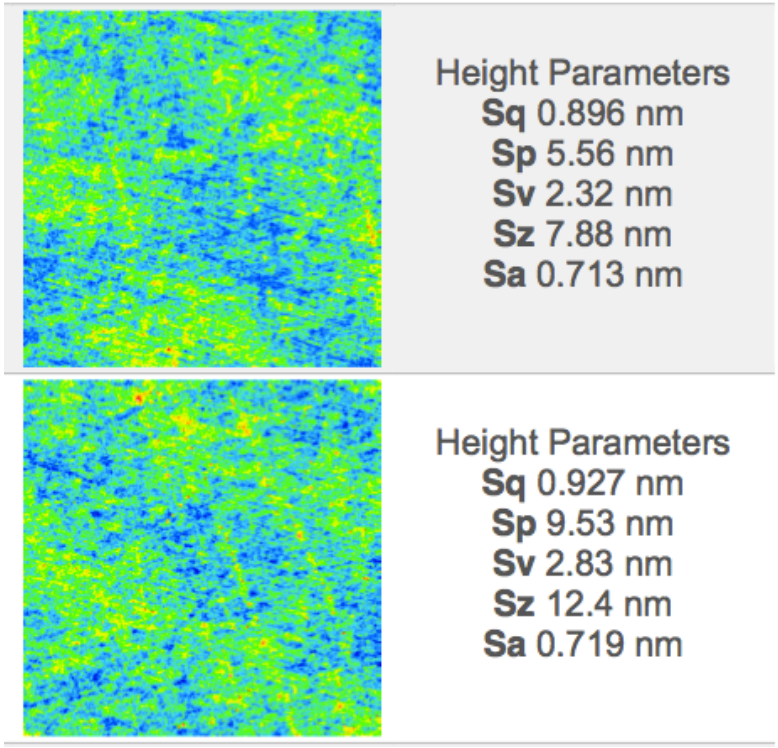


Figure 1 – Residual plot from CMM measurements

Ruoghness



Conclusions

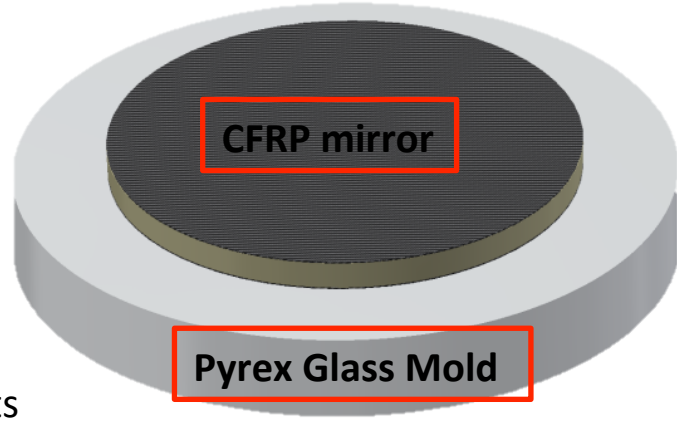
The glass prototype mold has been measured to assess shape errors and roughness.

- 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

CMA (USA, AZ):

Two mirrors demo delivered:
- CFRP skin and rohacell core
- spherical shape, 3.5 m radius , 30 cm diameter
- 1st demo: coating not fulfilling specifications
- 2nd demo: to be coated in Europe



Several small samples delivered for coating optimization and tests

A third demo in preparation:
- 4 m radius, CLAS12 finish, from the Marcon mandrel

RIBA (Italy):

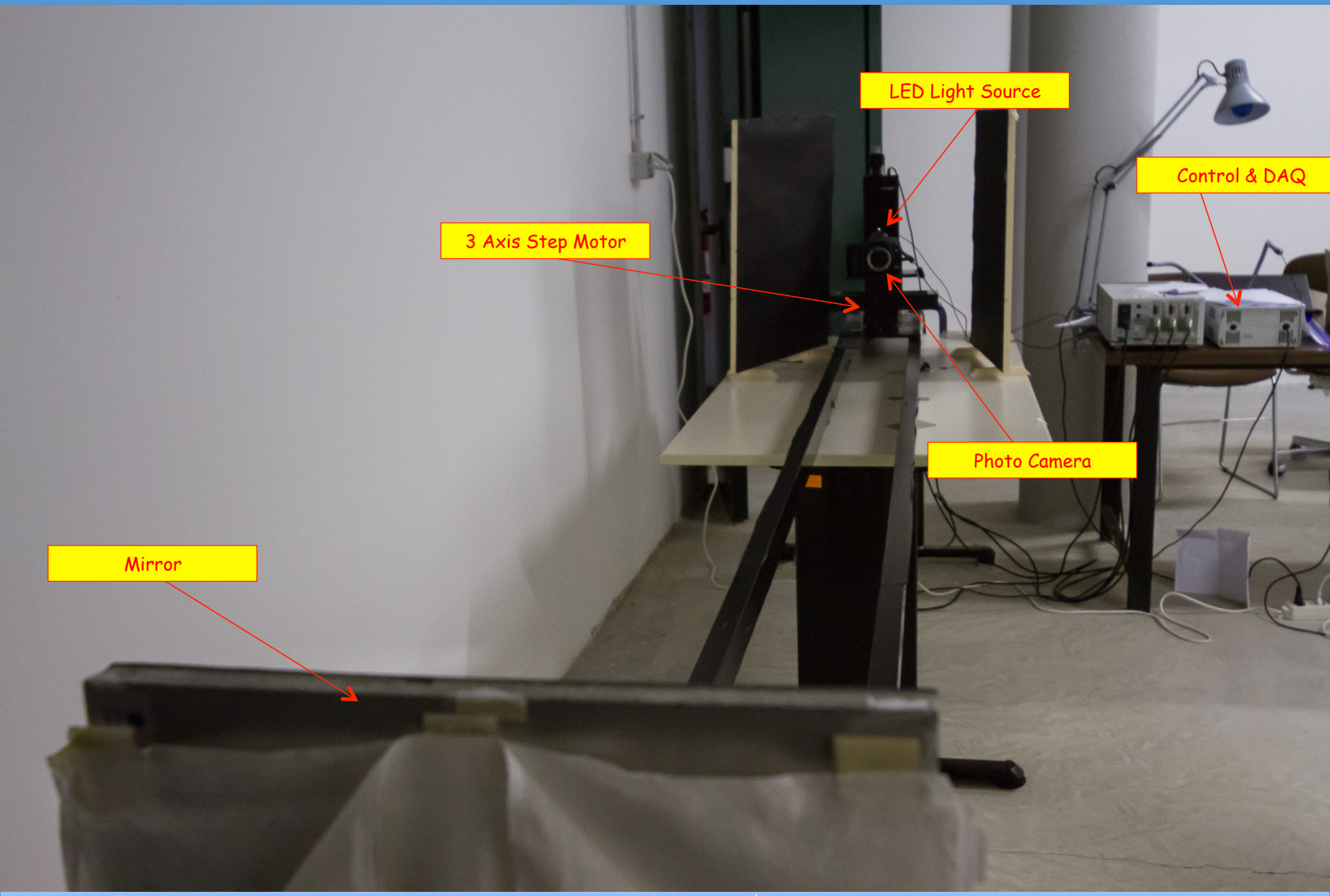
Three mirrors demo delivered:
- CFRP skin and rohacell core
- spherical shape, 4 m radius , 30 cm diameter
- to be coated in Europe

Several small samples delivered for coating optimization and tests

Additional demos planned in the fall:
- 4 m radius, CLAS12 finish, from the Marcon mandrel

Characterization and acceptance procedures under development

Frascati D0 Measurement Set-up



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 delivered : 1.6 mm (standard) thick glass skin

Do not meet but is close to specifications
Should undergo mechanical tests (as aerogel holder)

2nd demo planned in the fall : <1 mm (goal) thick glass skin