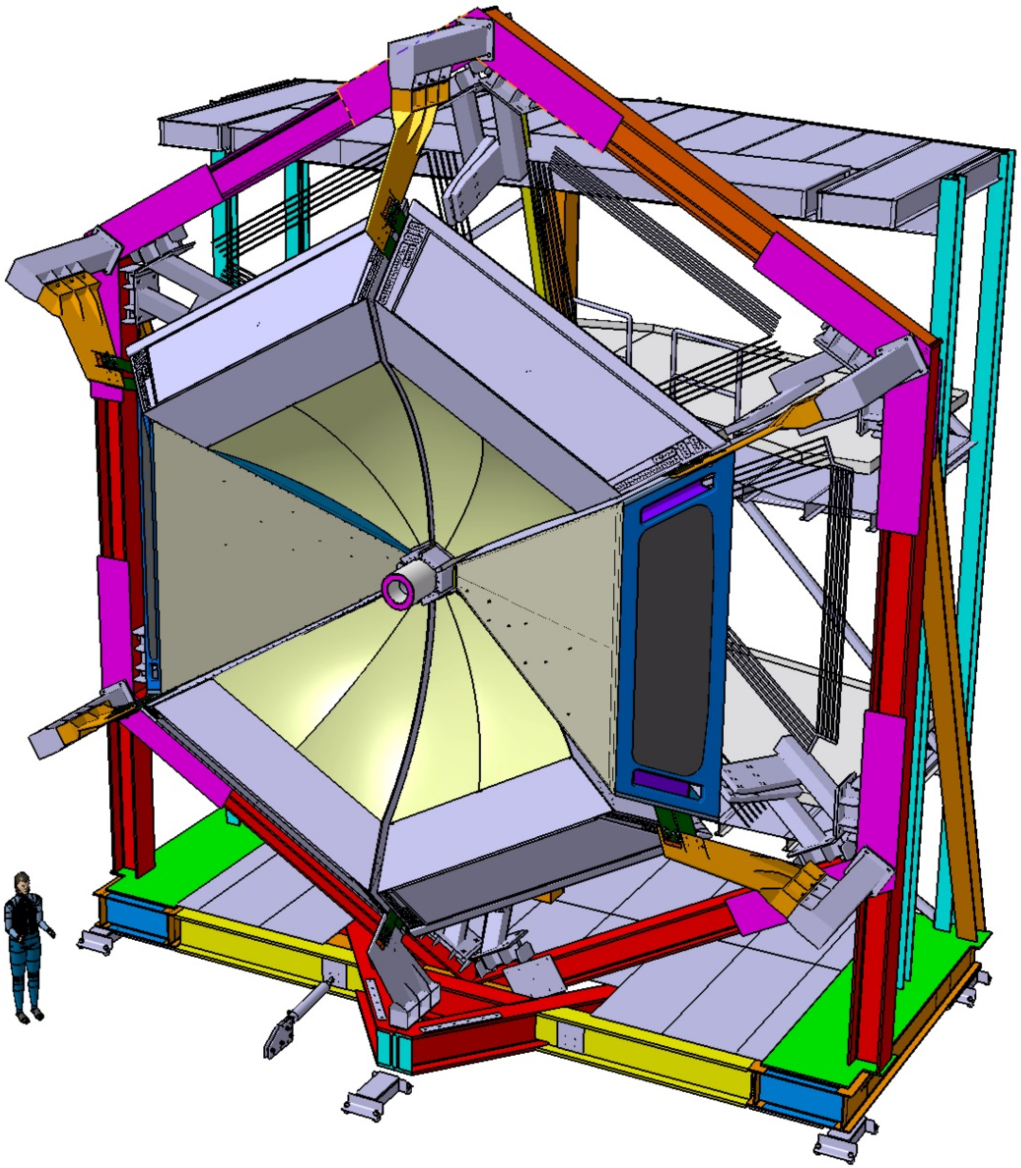


CLAS12-RICH

Project
Scope & Overview

June 13th 2016

Charge 1:

Have the HES&Q considerations been properly included in the design of the detector?

The CLAS12 Spectrometer

Ongoing upgrade of the CLAS detector.
First beam expected in 2017.

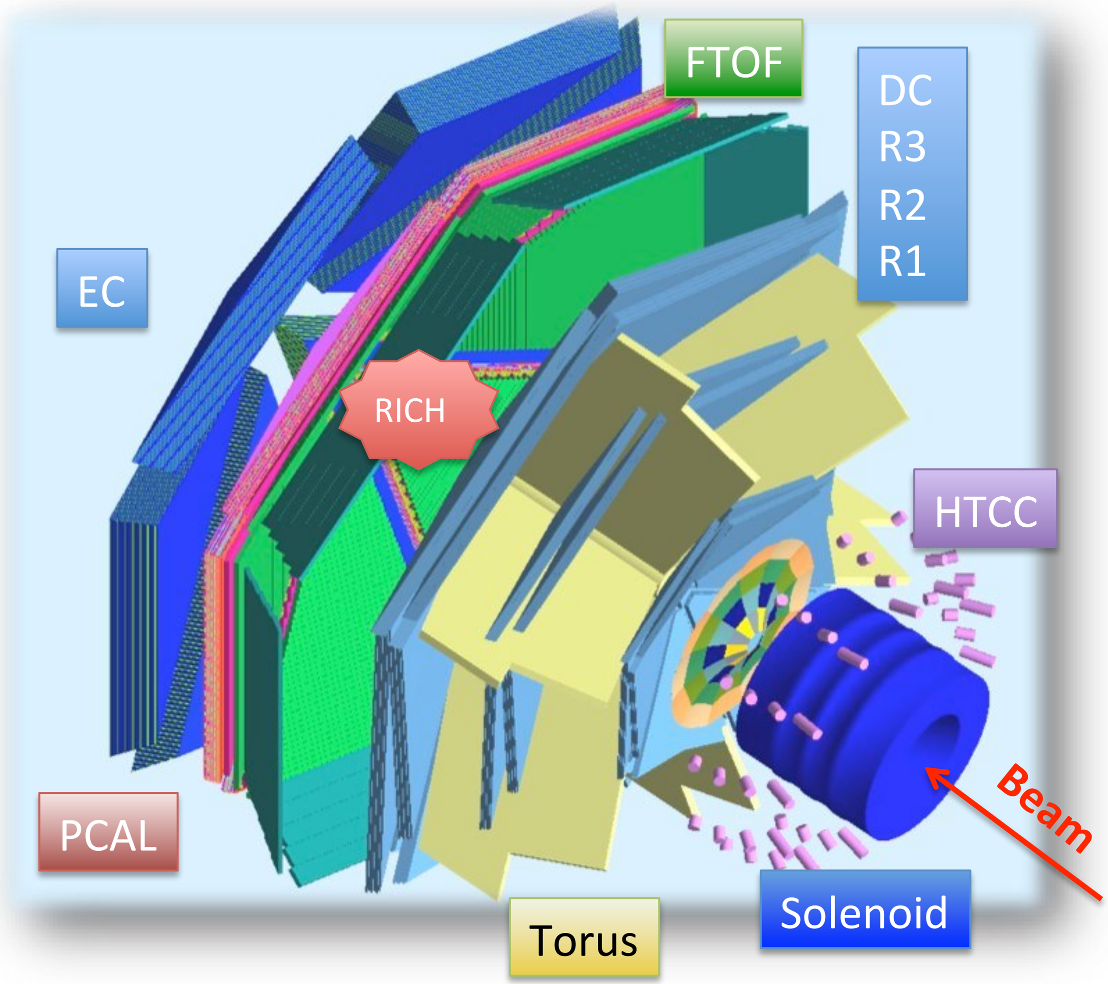
Highly polarized 12 GeV electron beam

Luminosity up to 10^{35} cm^{-2} s^{-1}

H and D polarized targets

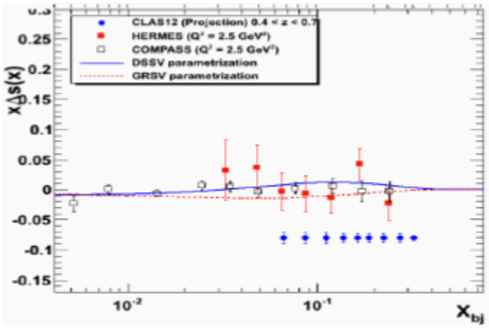
Broad kinematic range coverage
(current to target fragmentation)

RICH: Hadron ID
for flavor separation
(common to >4 SIDIS approved exp.)

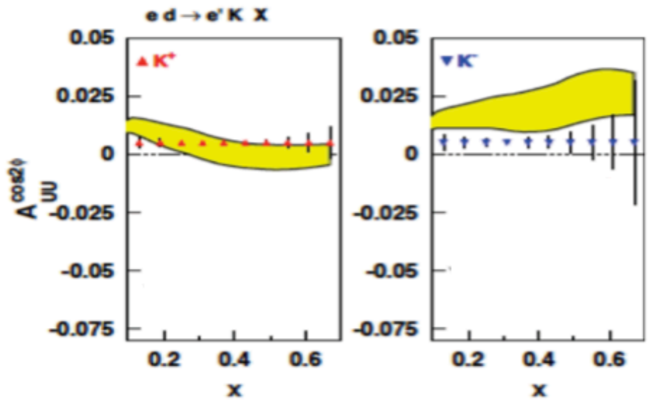


PAC30 report (2006): Measuring the kaon asymmetries is likely to be as important as pions …. The present capabilities of the present CLAS12 design are weak in this respect and should be strengthened.

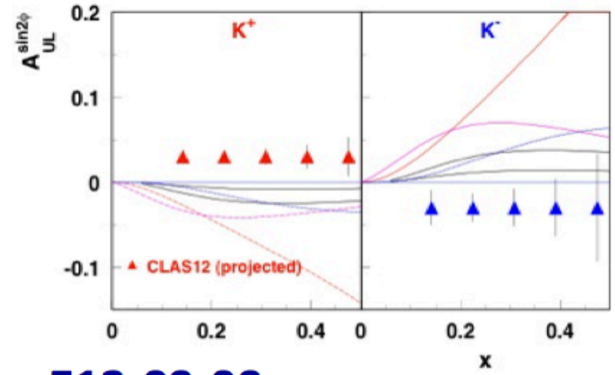
Kaon Program @ CLAS12



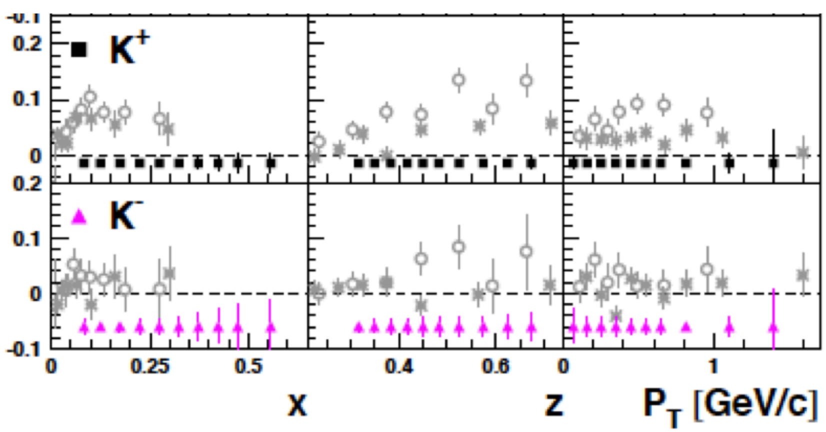
E12-09-07:
Studies of partonic distributions using semi-inclusive production of Kaons



E12-09-08:
Studies of Boer-Mulders Asymmetry in Kaon Electroproduction with H and D Targets



E12-09-09:
Studies of Spin-Orbit Correlations in Kaon Electroproduction in DIS with polarized H and D targets



C12-12-009:
Transverse spin effects in SIDIS at 11 GeV with a transversely polarized target using the CLAS12 detector

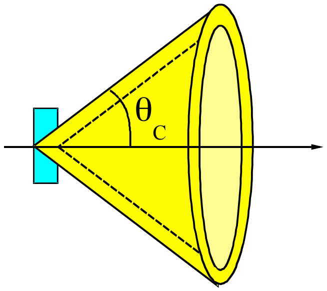
RICH detector for flavor separation of quark spin-orbit correlations in nucleon structure and quark fragmentation. In general, the whole CLAS12 physics program will benefit fro a better PID.

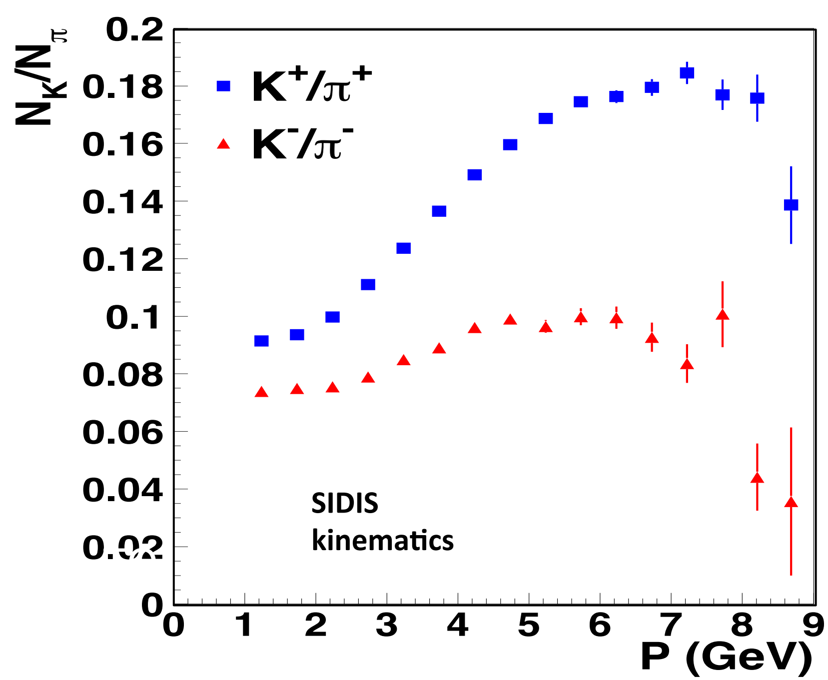
CLAS12 Momentum Range

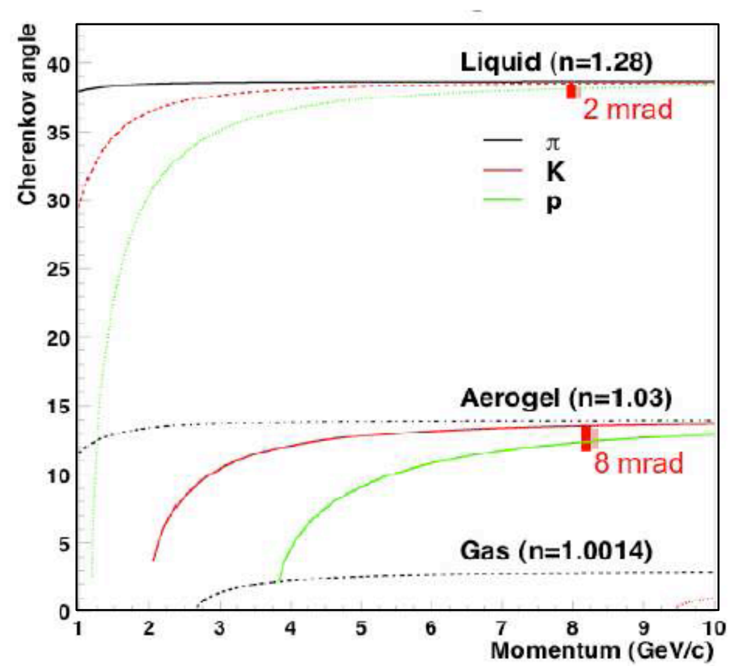
- Kaon flux 1 order of magnitude lower than π → **π rejection 1:500 required**
- **Aerogel** mandatory to separate hadrons in the 3-8 GeV/c momentum range with the required large rejection factors

  → collection of **visible Cherenkov light**

- **Use of PMTs:** challenging project, need to minimize the detector area covered with expensive photo-detectors

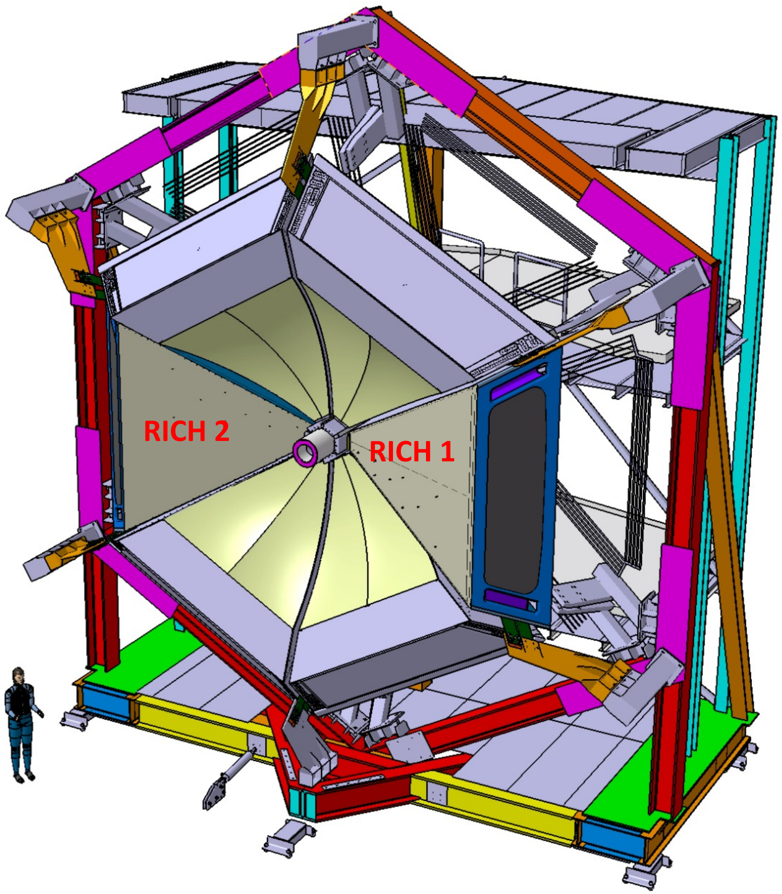






The CLAS12 RICH Project

RICH goal: **π/K/p identification from 3 up to 8 GeV/c and 25 degrees**
~4σ pion-kaon separation for a pion rejection factor ~ 1:500



INSTITUTIONS
INFN (Italy) Bari, Ferrara, Genova, L.Frascati, Roma/ISS
Jefferson Lab (Newport News, USA)
Argonne National Lab (Argonne, USA)
Duquesne University (Pittsburgh, USA)
Glasgow University (Glasgow, UK)
J. Gutenberg Universitat Mainz (Mainz, Germany)
Kyungpook National University, (Daegu, Korea)
University of Connecticut (Storrs, USA)
UTFSM (Valparaiso, Chile)

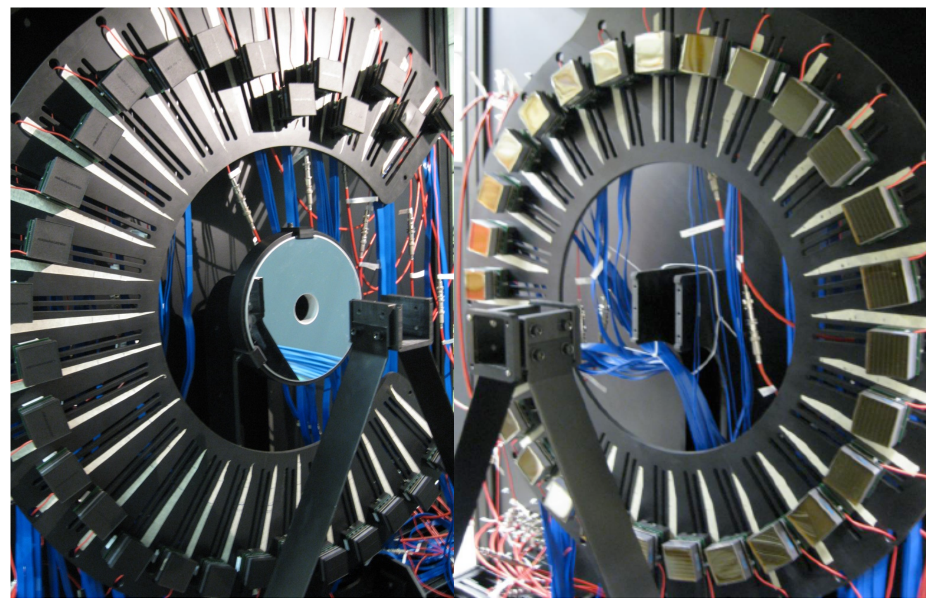
RICH Project Timeline

2010: Concept of Design and Technology

2011: Tests of components and small prototype

2012: Tests of large scale prototype

2013: June: RICH Technical Review
September: Project Review with DOE
Start Construction Phase



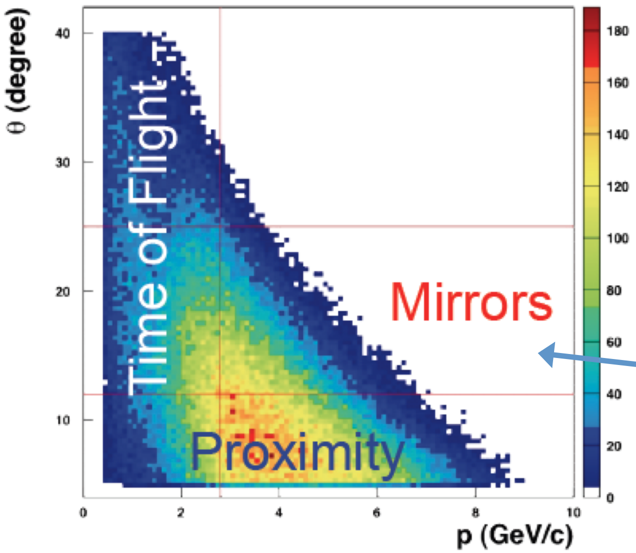
2014: June: RICH Mechanical Review

2015: June: RICH Internal Review
October: Project Mid-term Review
DOE relaxed supervision

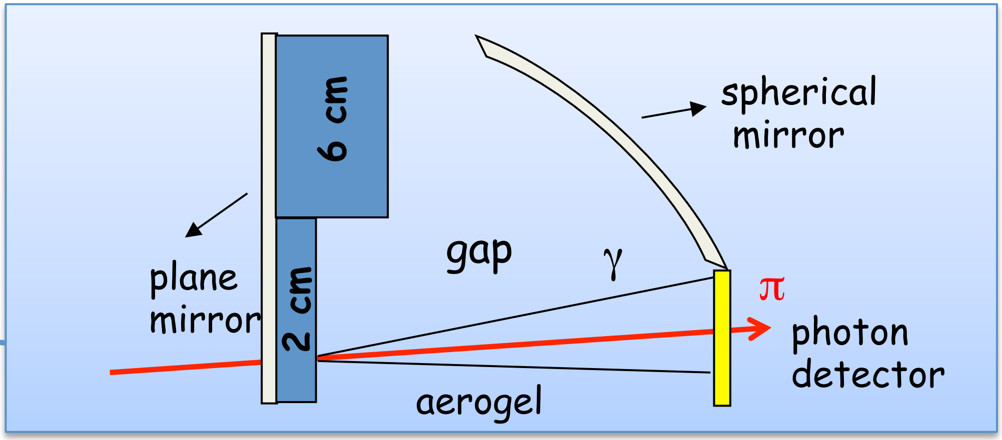
2016: June: RICH Readiness Review

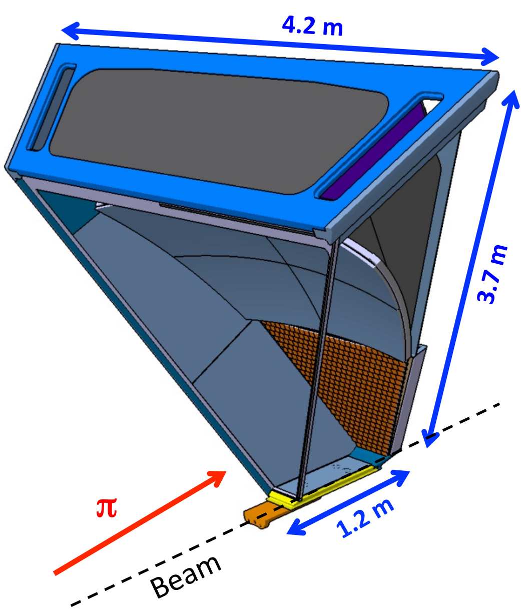
2017: September: Ready for Installation

The Hybrid Optics Design

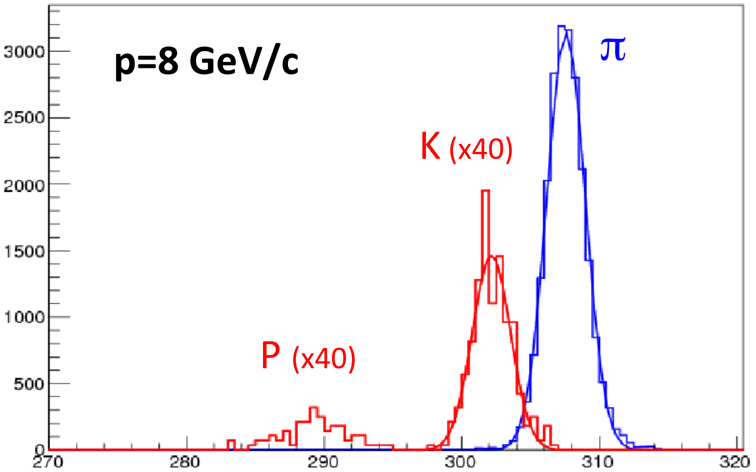


Direct rings and best performance for high momentum particles

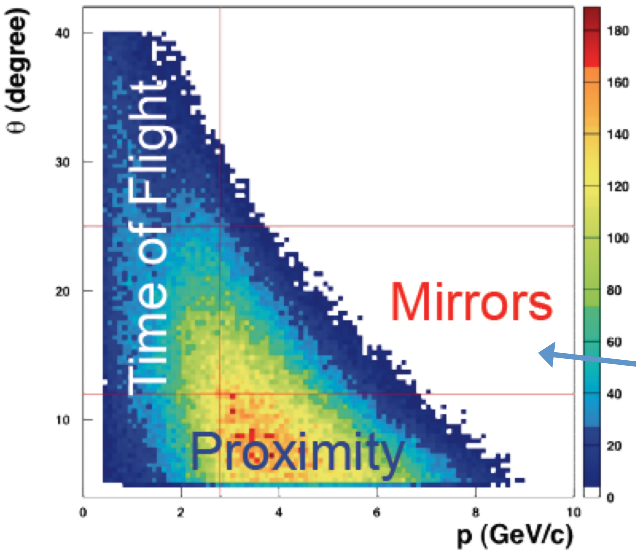




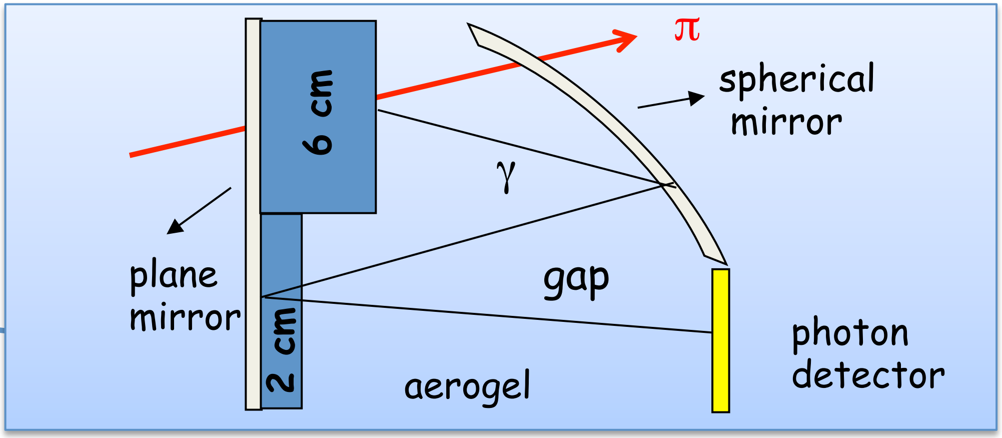
Test beam: clear hadron separation up to the CLAS12 maximum momentum

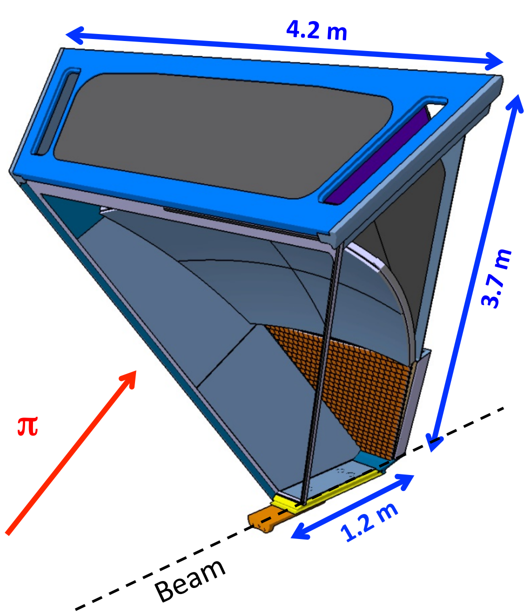


The Hybrid Optics Design

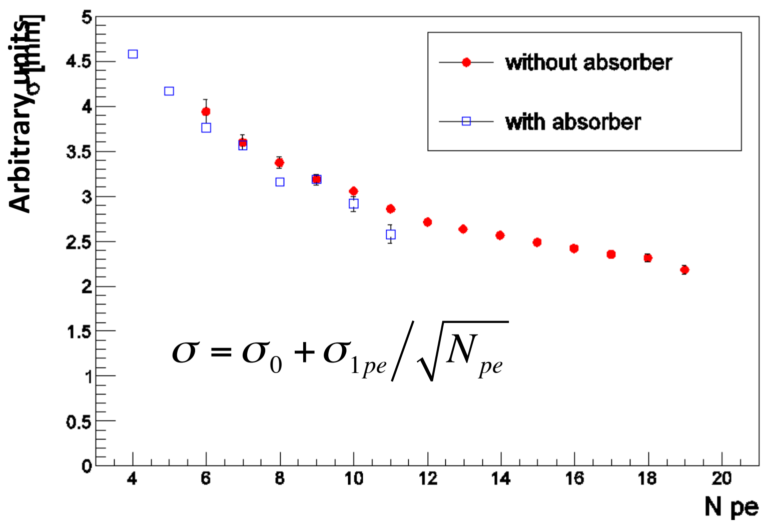


Reflected rings for less demanding low momentum particles

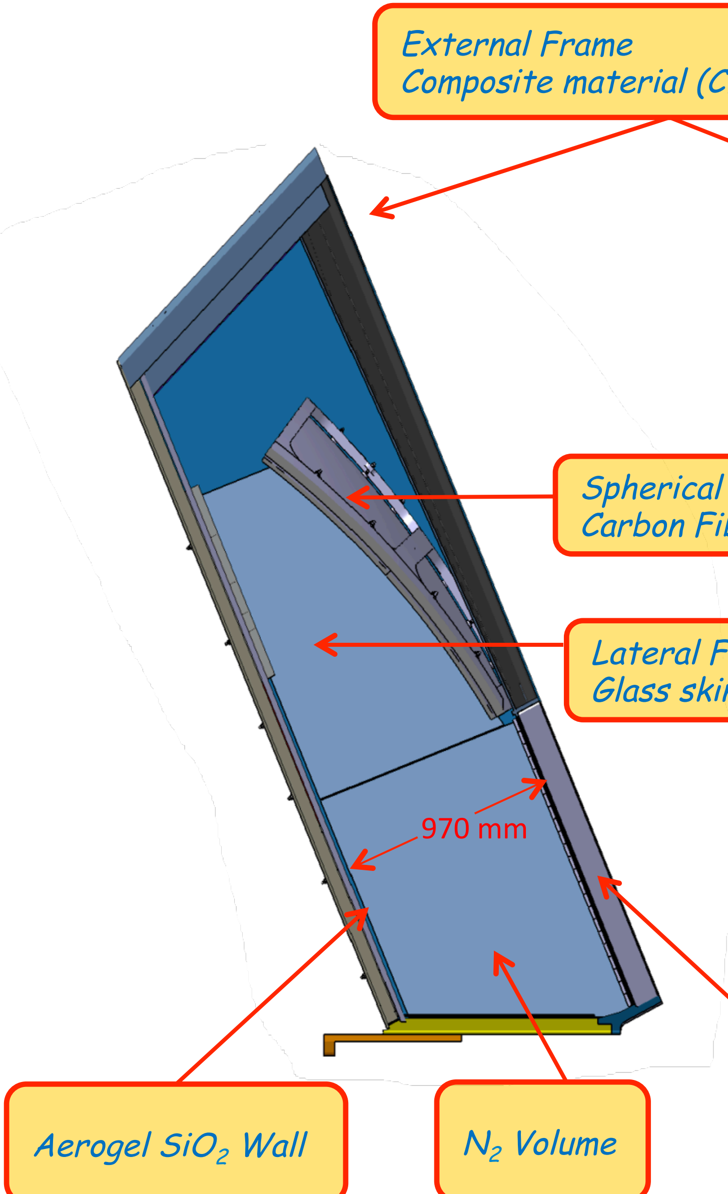


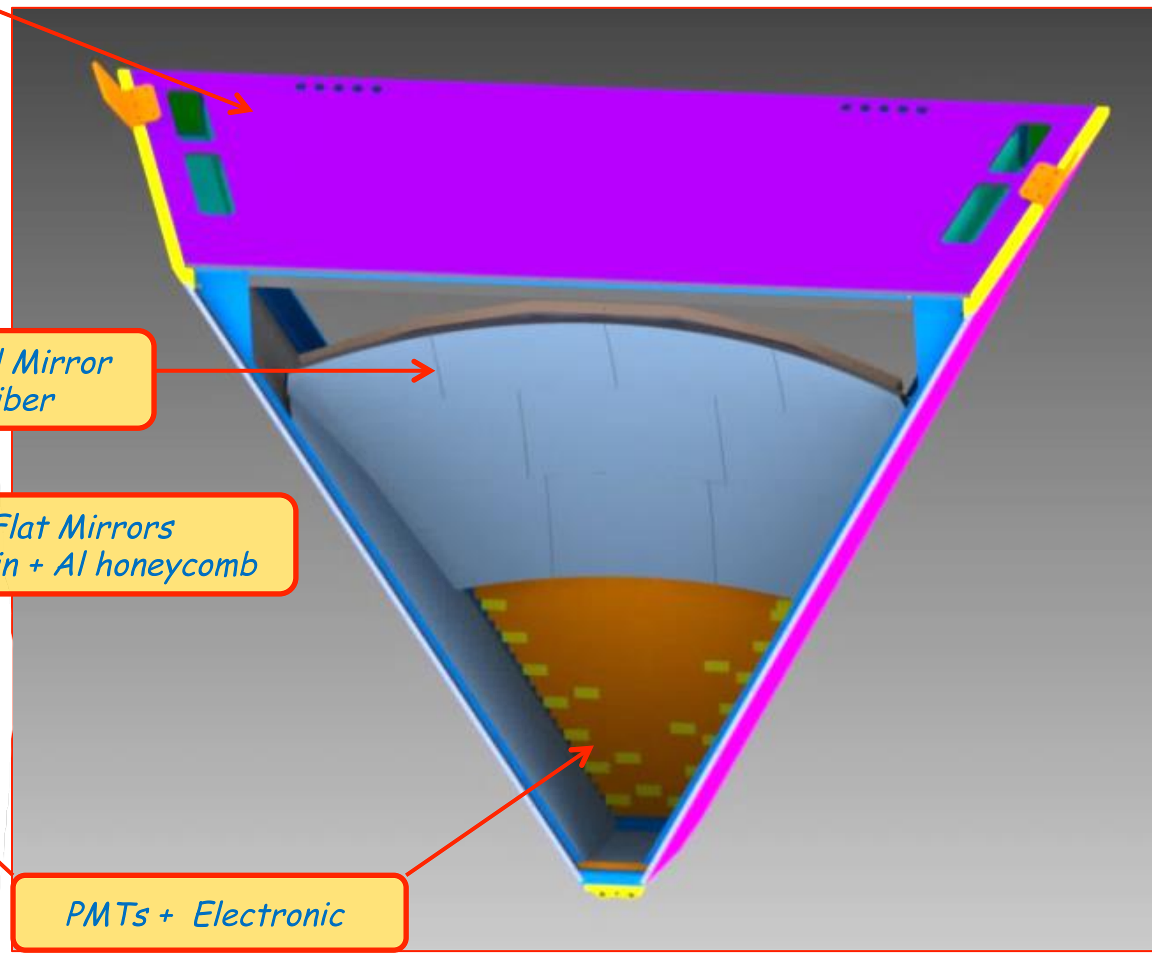


Test beam: resolution is not significantly degraded beyond light yield loss



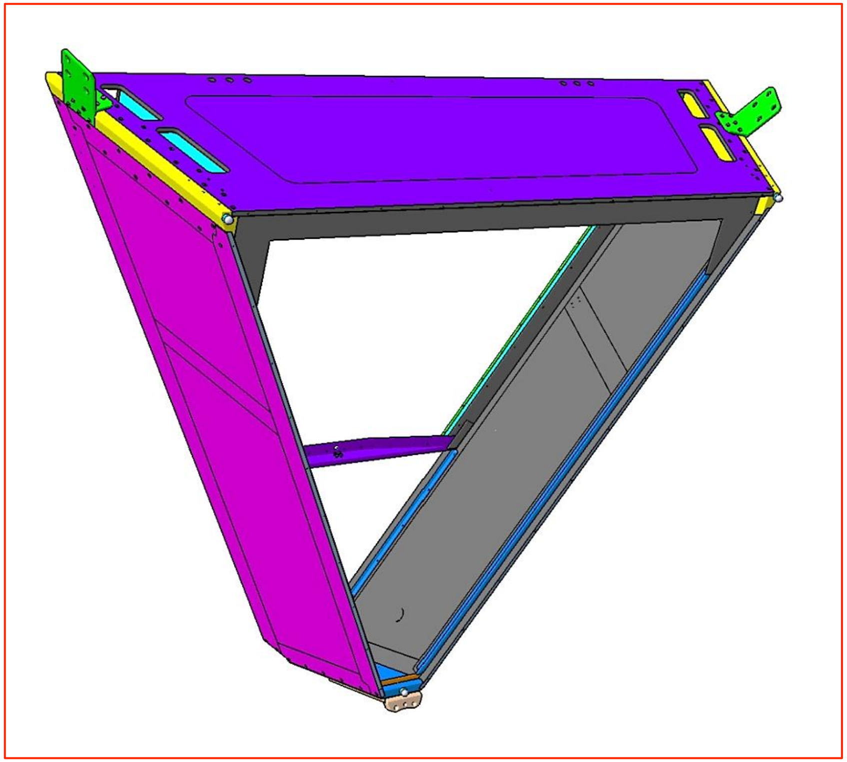
RICH Assembling





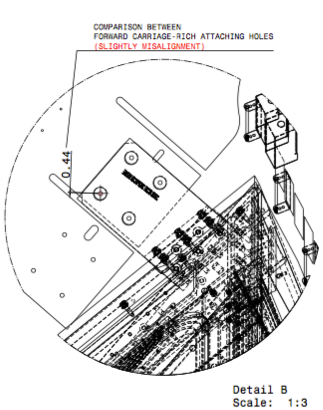
MA-PMTs grouped in 138 tiles
~ 1 m^2 coverage, 25 k channels in total

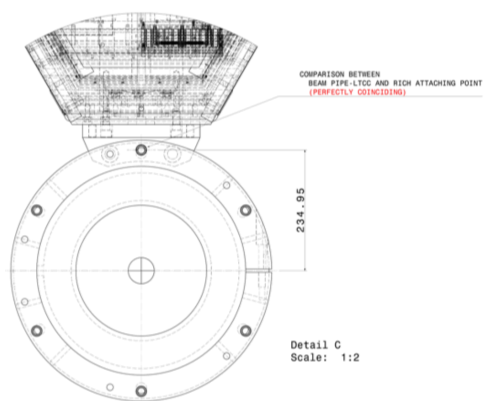
RICH Structure

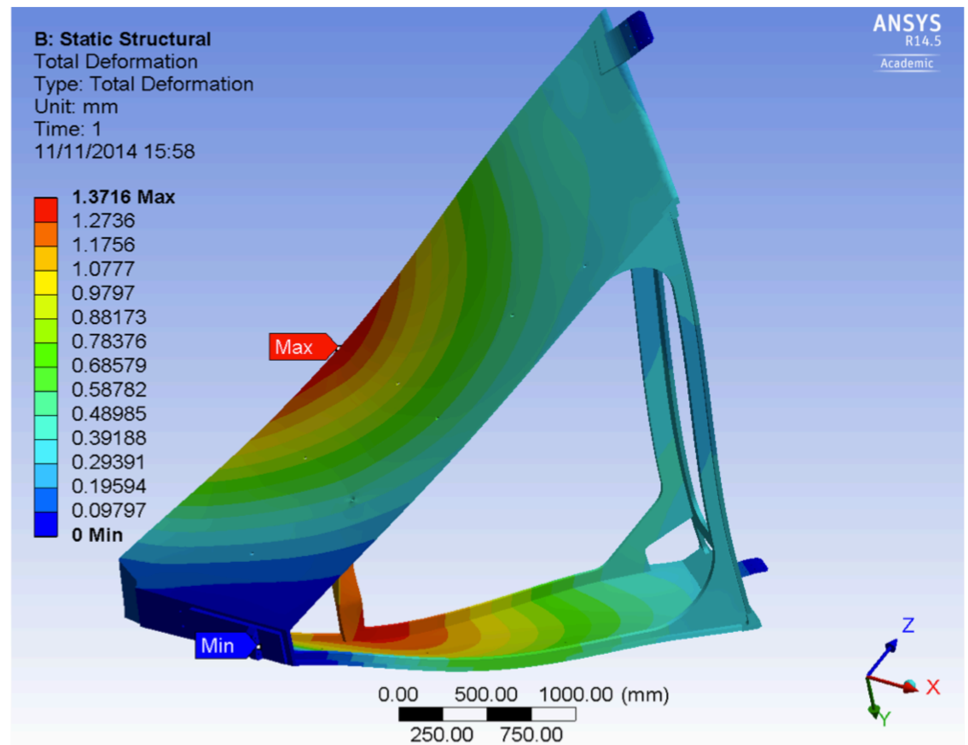


Design to substitute one LTCC sector

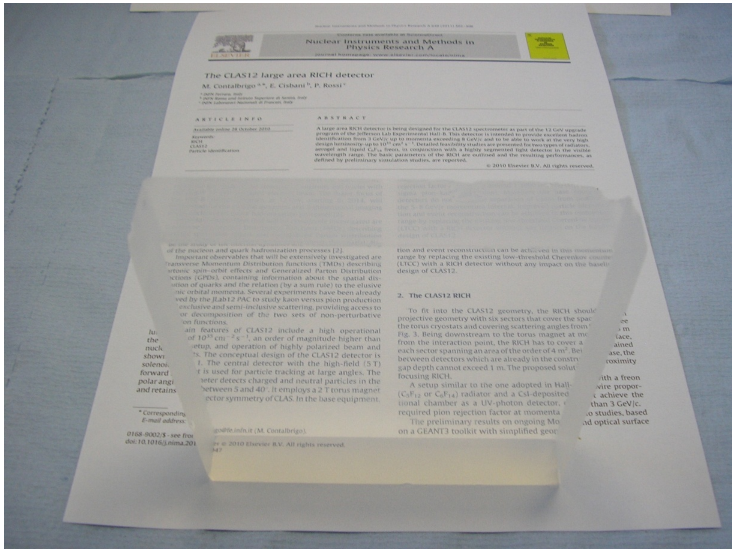
- Use composite Material (CFRP) to increase stiffness and lightness
- Detailed analysis of mounting bracket compatibility







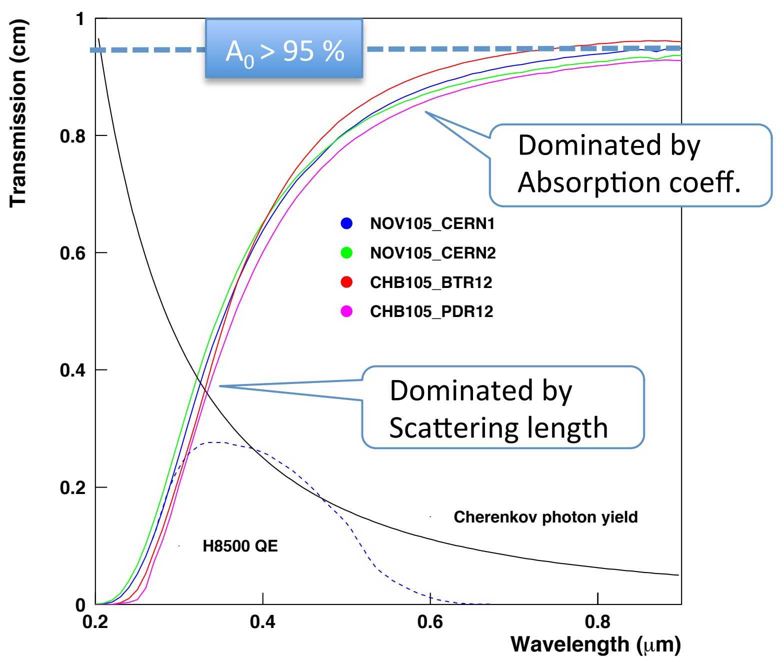
Aerogel Radiator

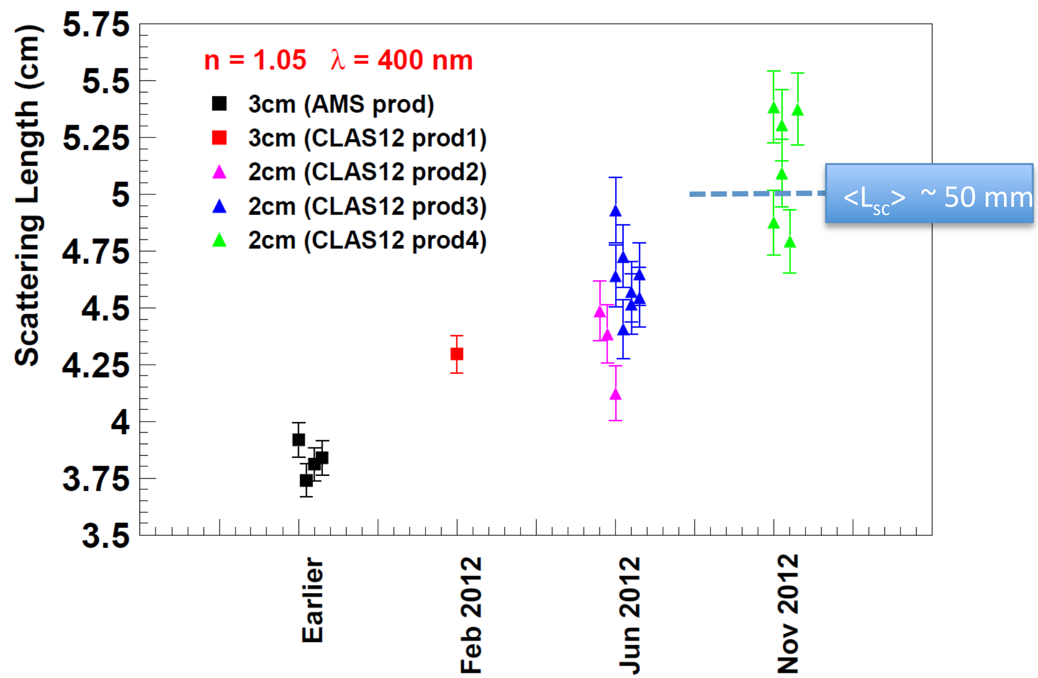


Aerogel with n=1.05 in collaboration with Budker and Boreskov Institutes of Novosibirsk

Flexible geometry, mass production capability

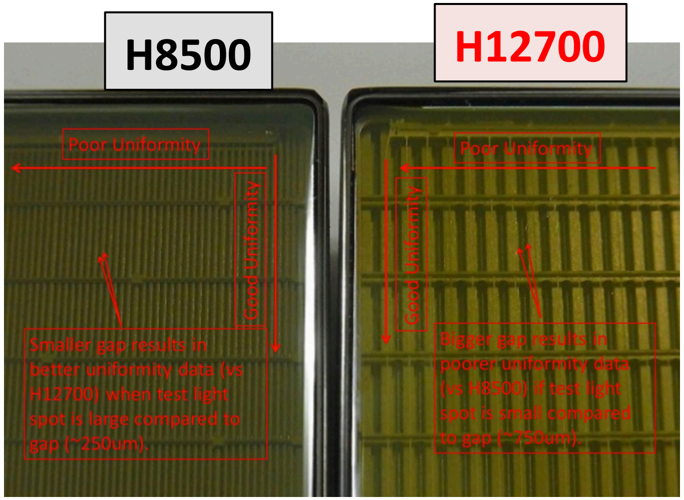
Achieved ~ 0.00050 $\mu m^4\ cm^{-1}$ clarity for large tiles (LHCB has 0.0064 $\mu m^4\ cm^{-1}$ for n=1.03)

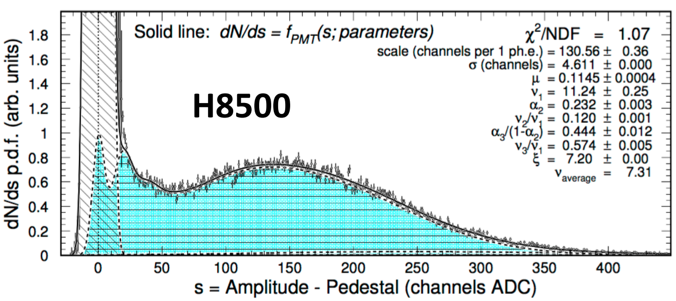




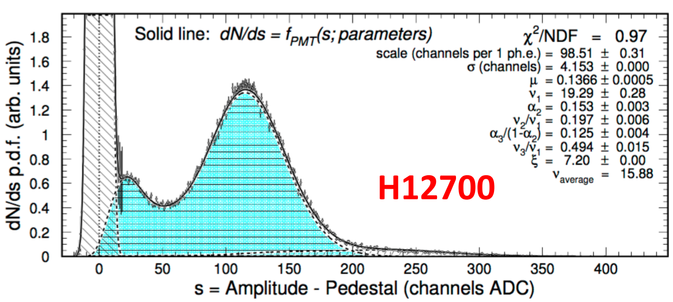
Hydrophillic aerogel requires dry N_2 atmosphere

Photon Detector

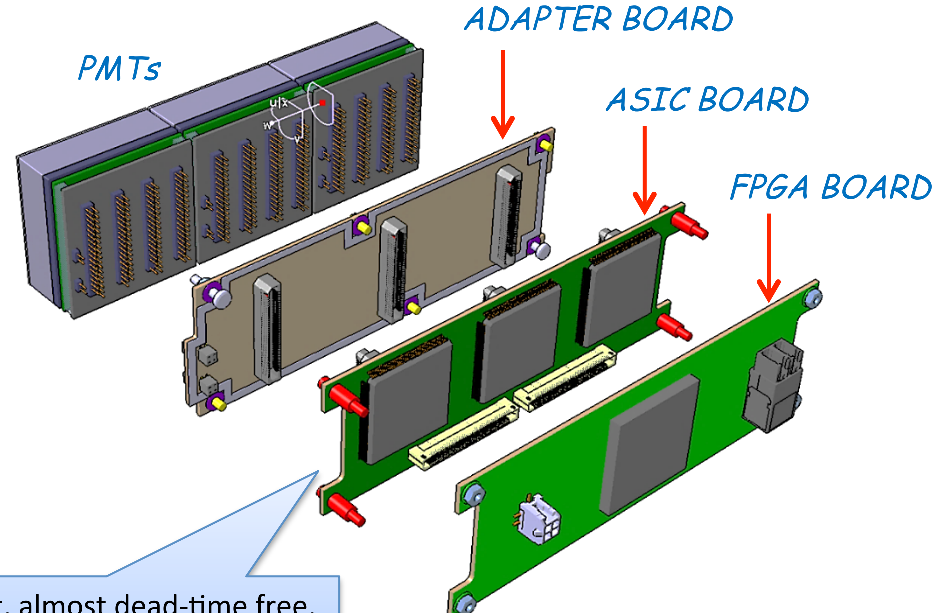




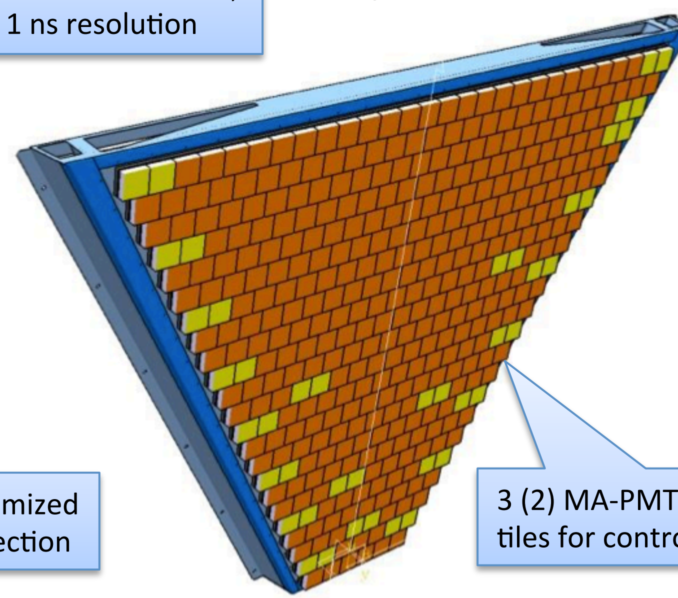
(h) Hamamatsu H8500 PSPMT CA7782, HV = 1100 V



(g) Hamamatsu H12700 PSPMT GA0133, HV = 1100 V



Digital readout, almost dead-time free, 20 kHz, 8 μs latency, 1 ns resolution

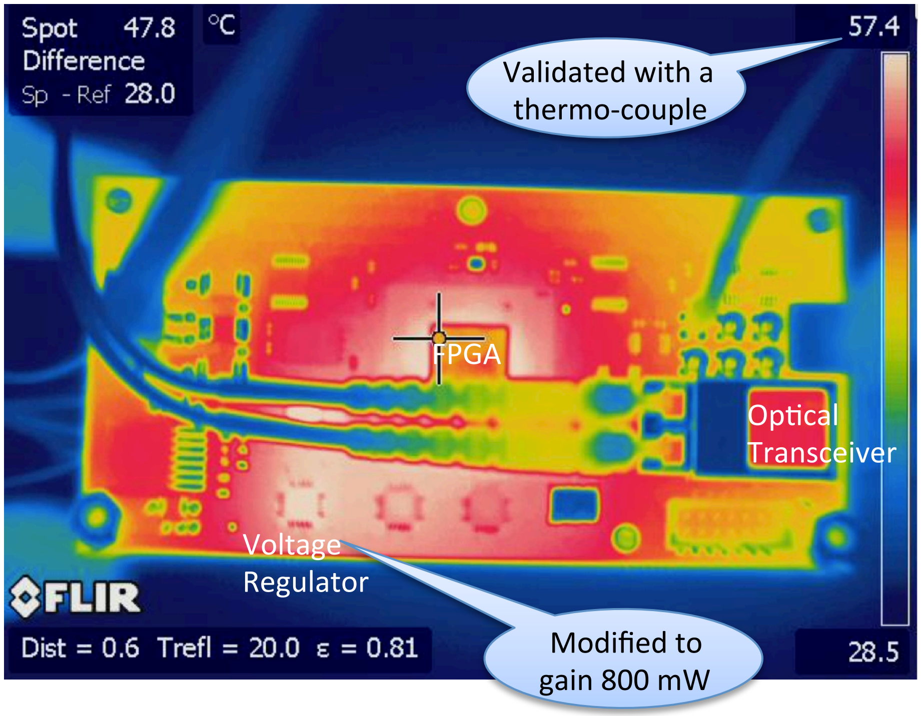


Dynode structure optimized for single-photon detection

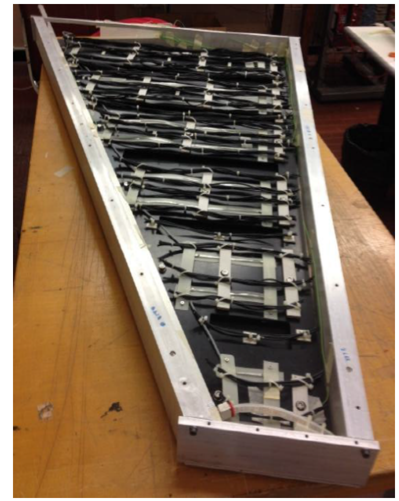
3 (2) MA-PMT grouped into tiles for control and services

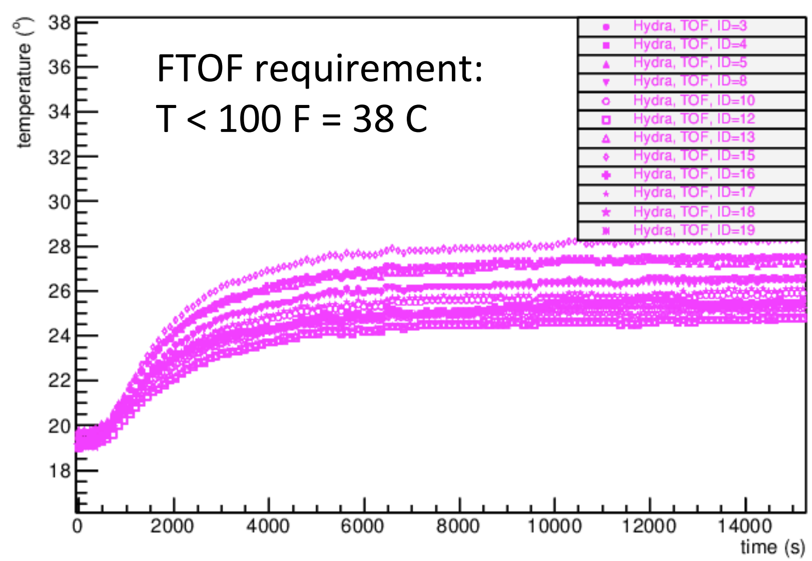
Electronics Cooling

Tile power dissipation ~ 3.5 W



Half-Module Air Cooling Tests with ~ 100 slm

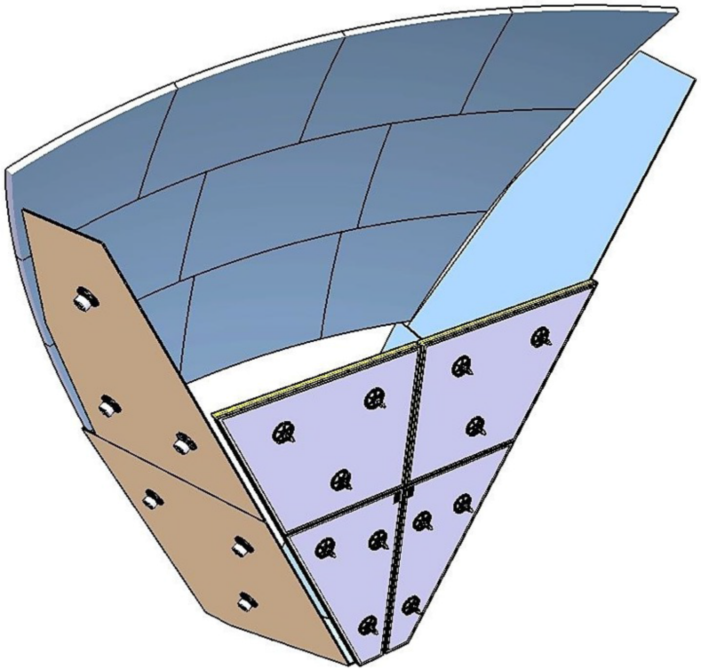




Air Cooling required

- compressor for clean ~ 200 (+50%) slm air flow
- interlock system to prevent over-temperature
- temperature monitor (FPGA + dedicated sensors)

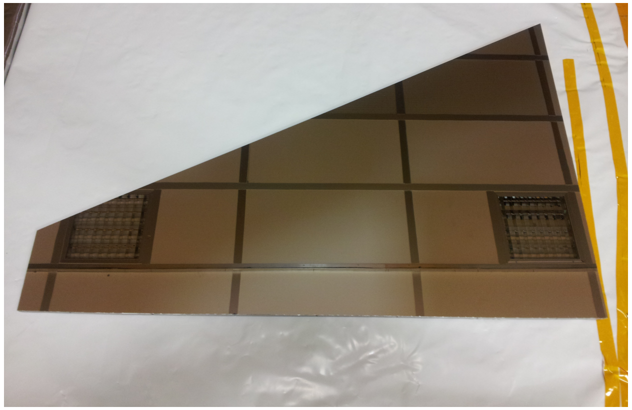
Glass-skin Planar Mirror

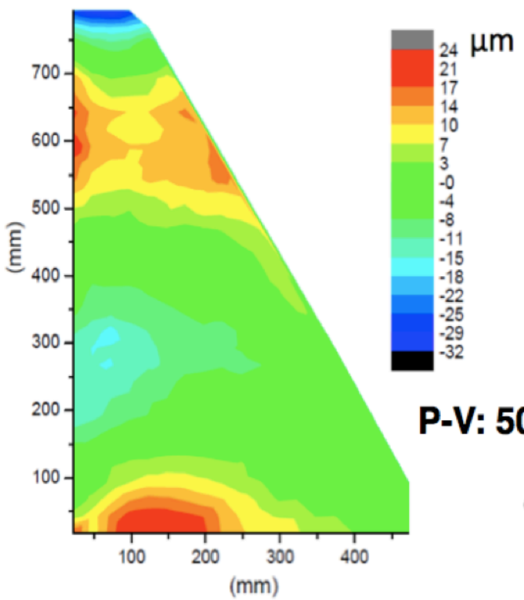


Cost-effective technology derived from terrestrial telescopes:

- Glass-skin of 0.7 mm thickness
- Al Honeycomb core
- Areal density comparable with CFRP
- Not available for curved mirrors

Demonstrator passed optical and mechanical tests

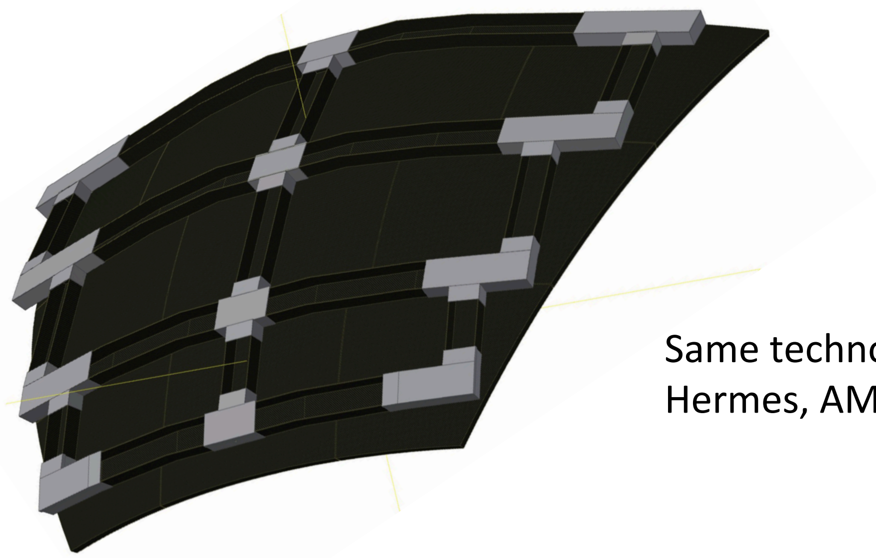




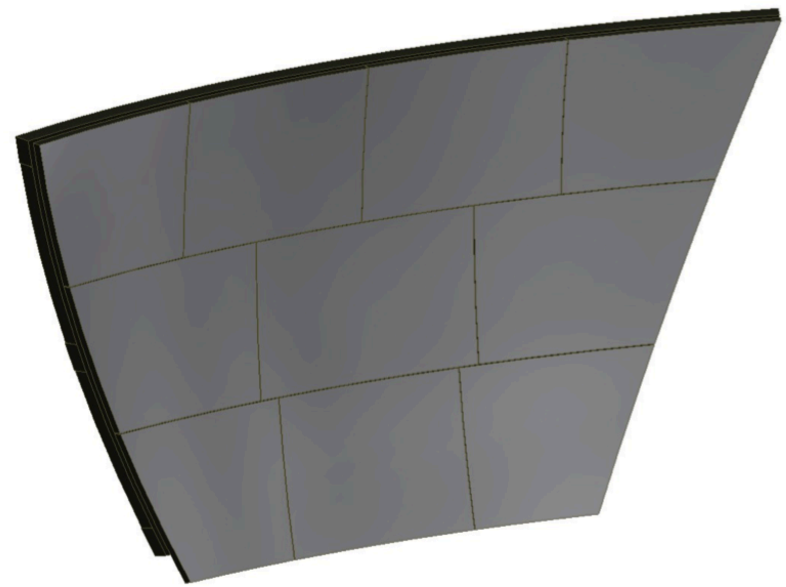
P-V: 50 µm

σ_θ **= 0.1 mrad**

CFRP Spherical Mirror



Same technology of Hermes, AMS, LHCb



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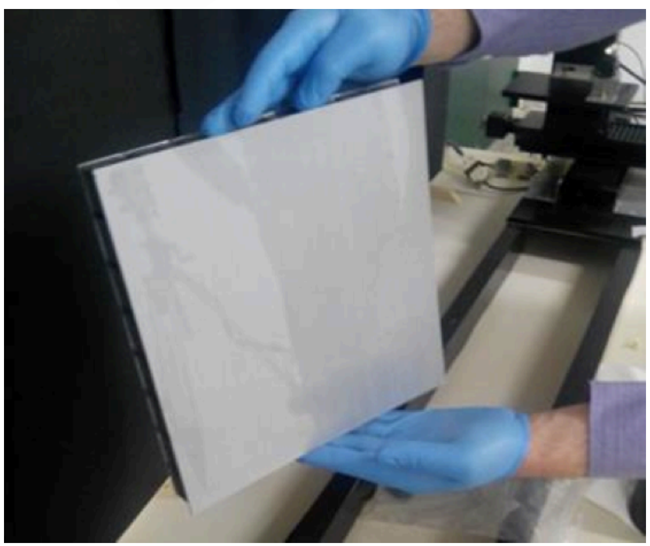

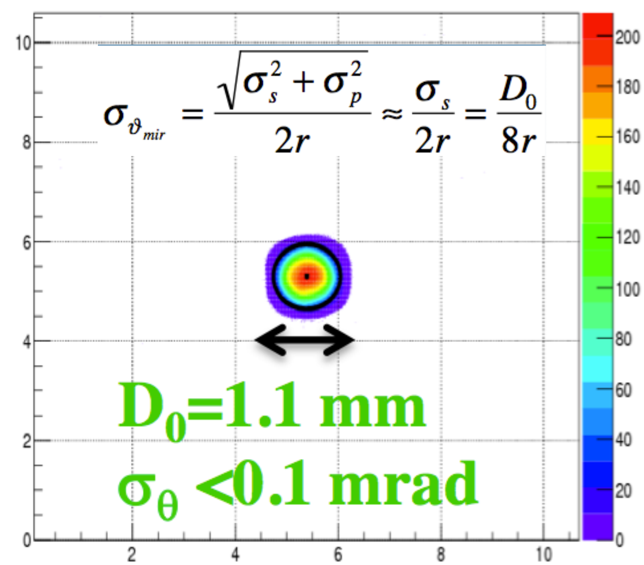

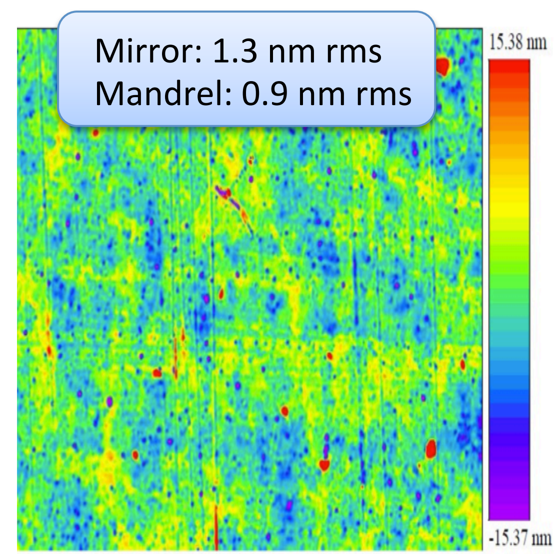

CLAS12 RICH Project

✔ Scope

Extend CLAS12 hadron (kaon, proton) identification in the full phase-space

✔ Overview

Design to substitute one LTCC sector
Performance proven with large-scale prototype
Quality assurance verified on demonstrators

✔ Safety Considerations

- No hazardous material
- Standard HES&Q as Hall-B, i.e. HV
- Electronics cooling requires interlock
- Aerogel preservation requires N_2