The CLAS12 Spectrometer

Ongoing upgrade of the CLAS detector.
First beam expected in 2016.

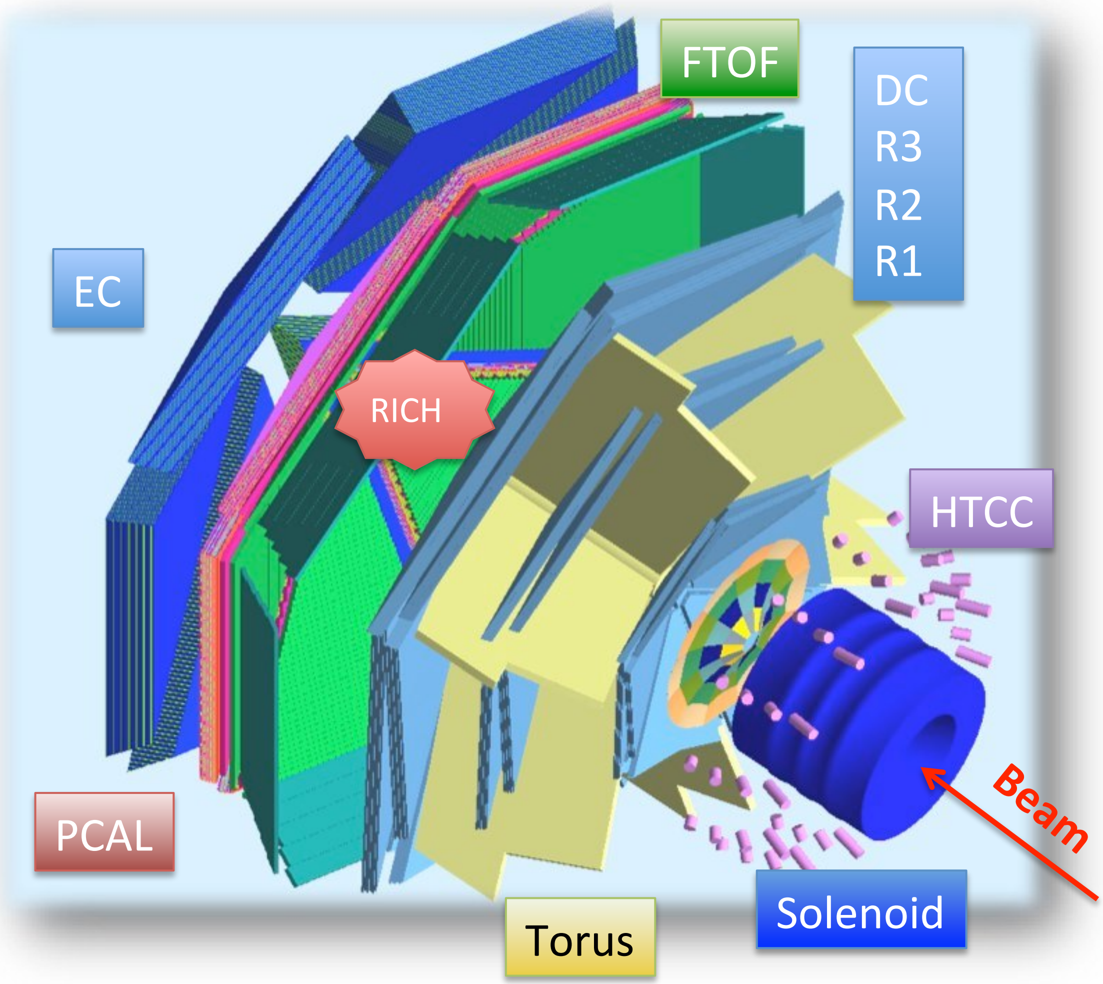
Highly polarized 12 GeV electron beam

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

H and D polarized targets

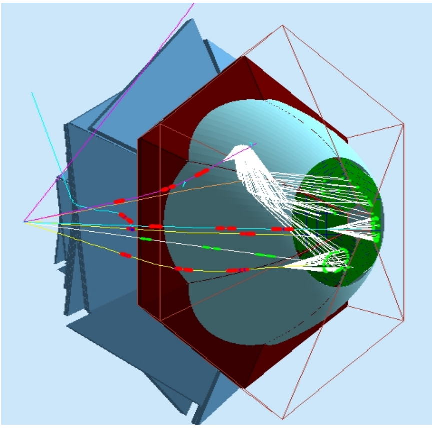
Broad kinematic range coverage
(current to target fragmentation)

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



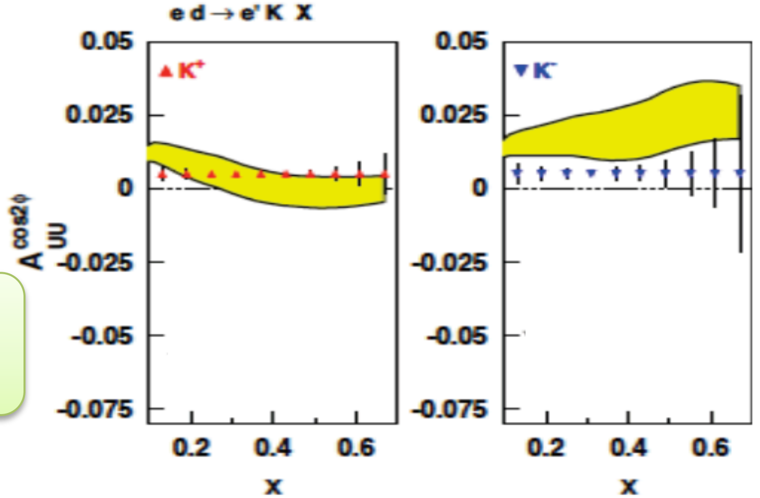
PAC30 report (2006): Measuring the kaon asymmetries is likely to be as important as pions …. The present capabilities of the present CLAS12 design are weak in this respect and should be strengthened.

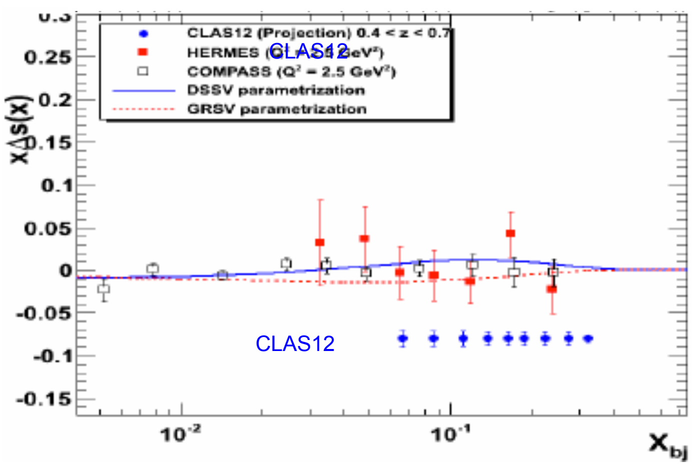
Kaon SIDIS Program @ CLAS12



RICH detector for flavor separation of quark spin-orbit correlations in nucleon structure and quark fragmentation

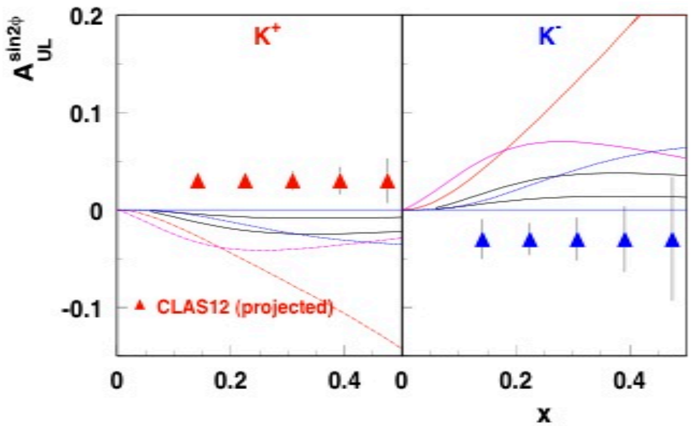
E12-09-08: Studies of Boer-Mulders Asymmetry in Kaon Electroproduction with Hydrogen and Deuterium Targets





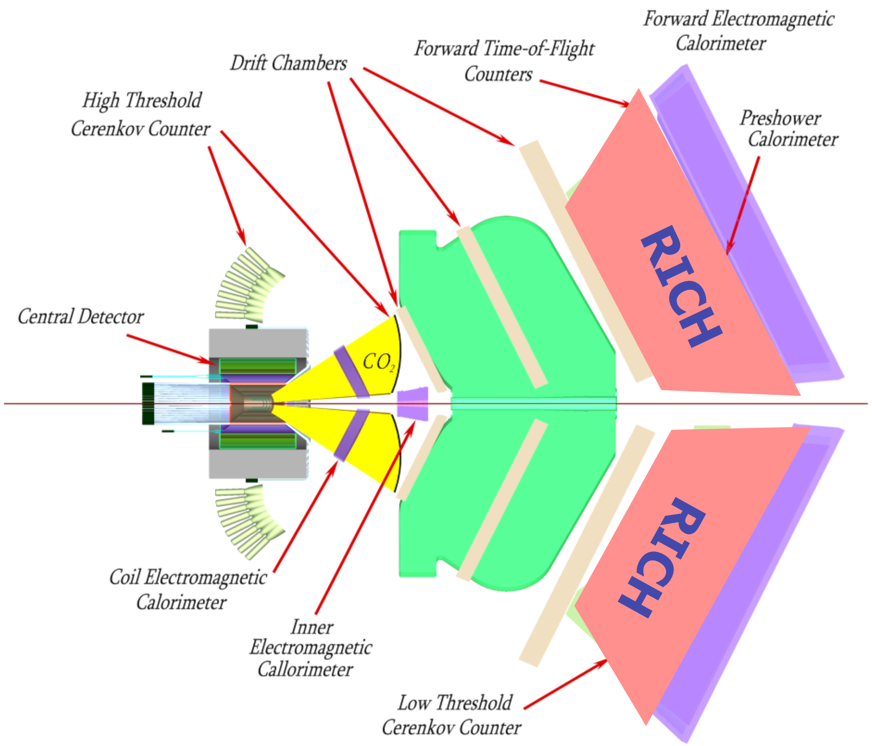
E12-09-07:
Studies of partonic distributions using semi-inclusive production of Kaons

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



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 Base Configuration

1^{st} sector allows:

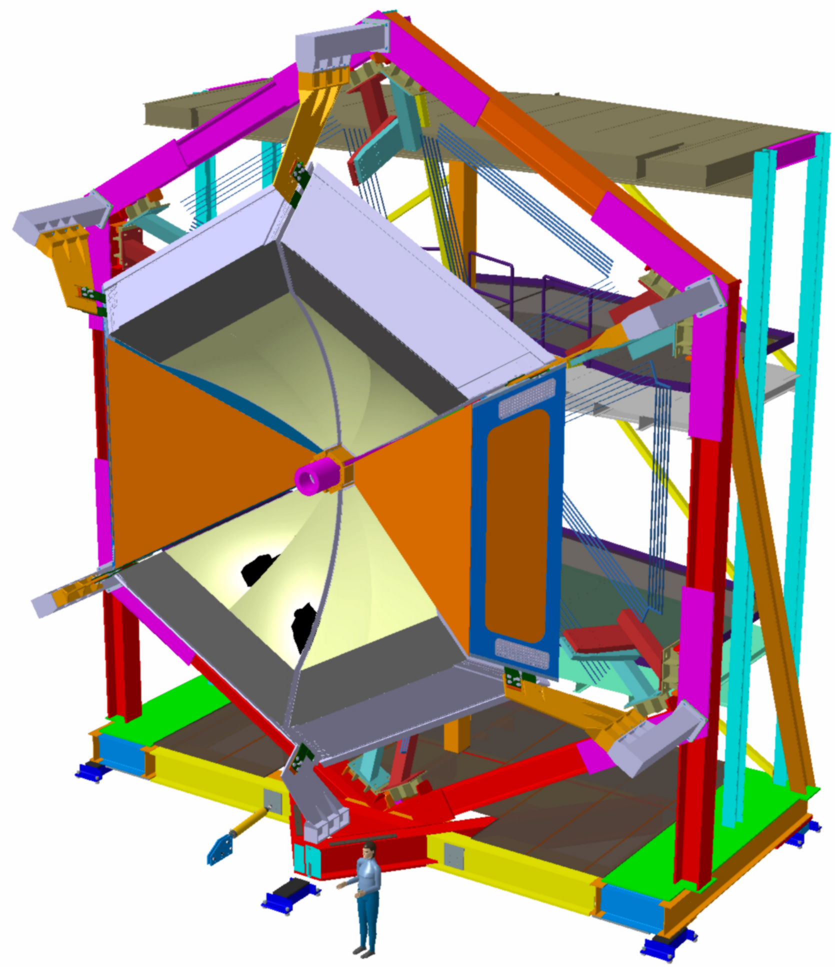
✓ to start physics with un-polarized and longitudinal polarized target

✓ full coverage of the relevant azimuthal angle ϕ (w.r.t virtual photon)

2^{nd} sector allows:

✓ to extend the kinematical coverage into the most interesting regions (high-Q^2 and high-P_T)

✓ the symmetric arrangement needed to control systematic effects in precision measurements with polarized targets (i.e. double ratio method)



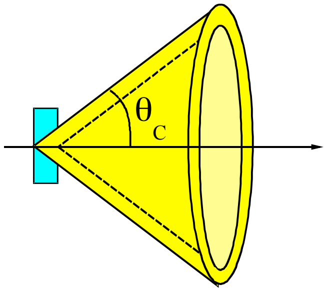
Crucial for the study of parton dynamics related to angular momentum and spin-orbit effects with flavor sensitivity.

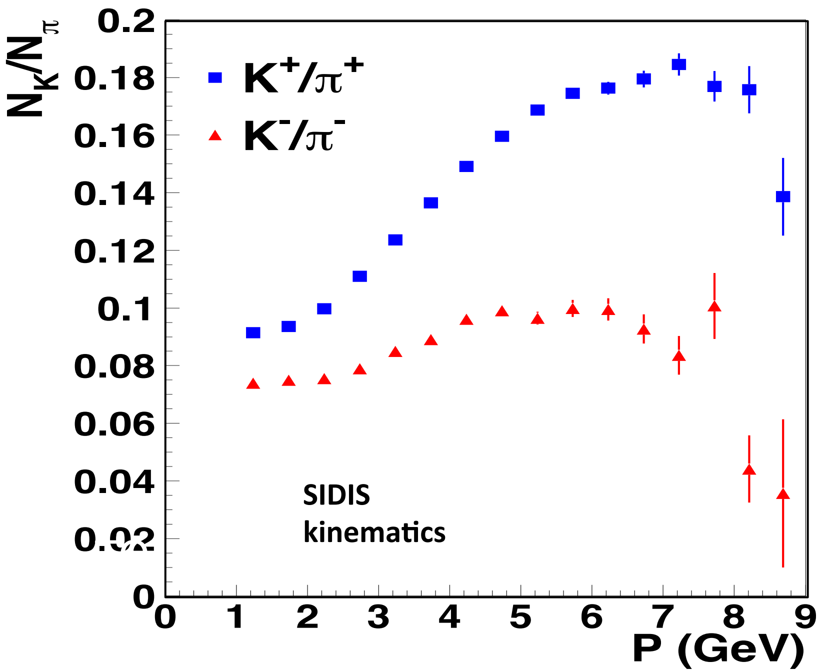
CLAS12 Momentum Range

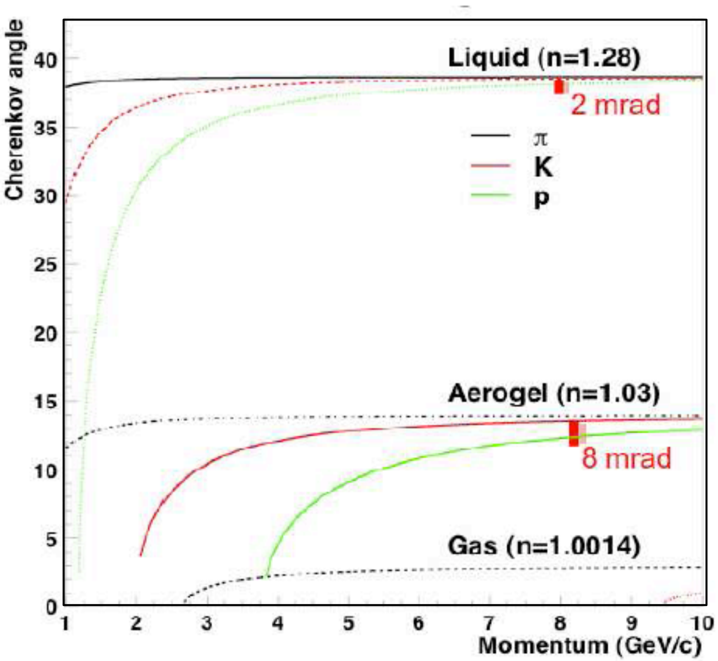
- Kaon flux 1 order of magnitude lower than π → **π rejection 1:500 required**
- **Aerogel** mandatory to separate hadrons in the 3-8 GeV/c momentum range with the required large rejection factors

  → collection of **visible Cherenkov light**

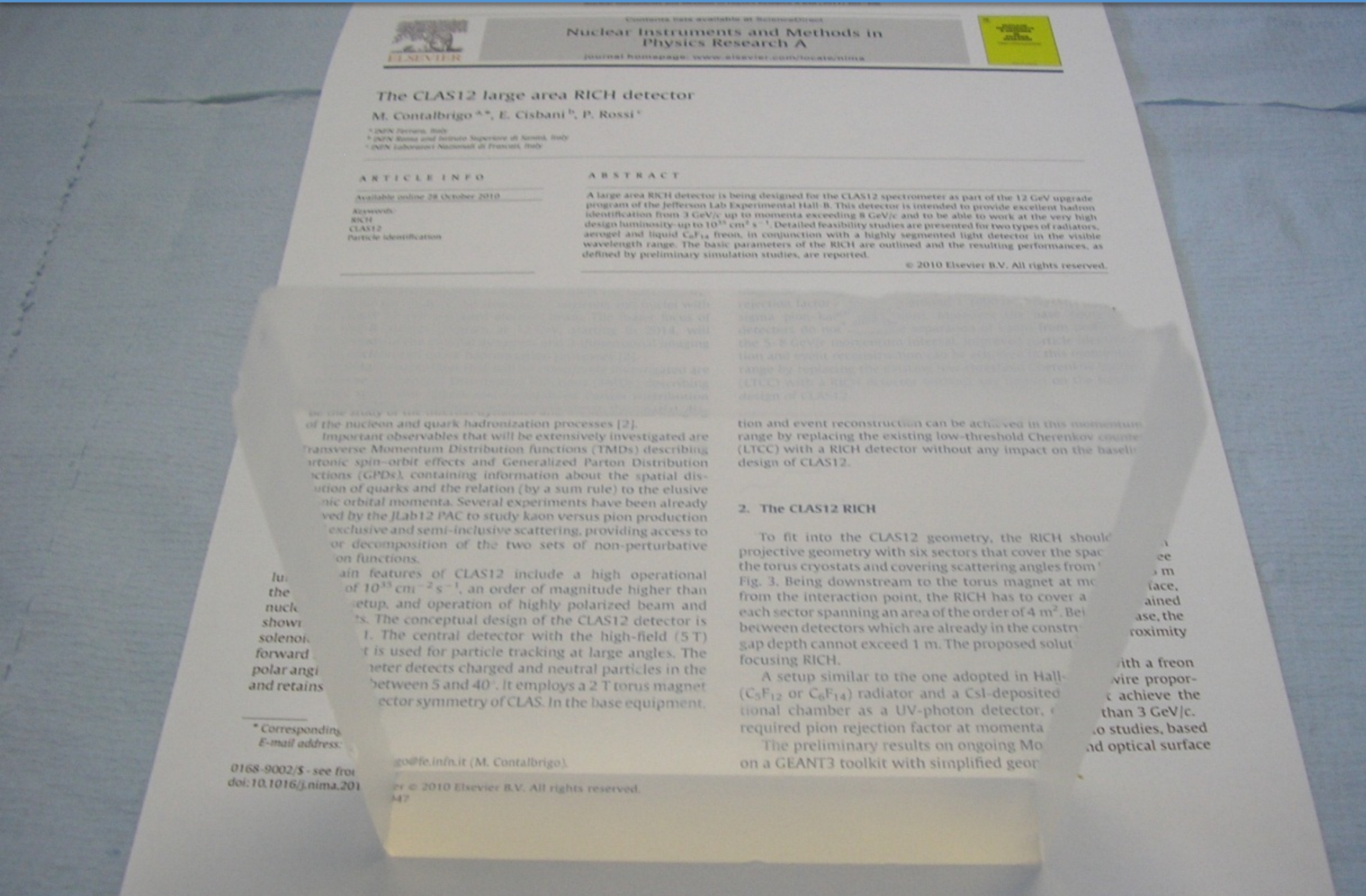
- **Use of PMTs:** challenging project, need to minimize the detector area covered with expensive photo-detectors







Aerogel Radiator

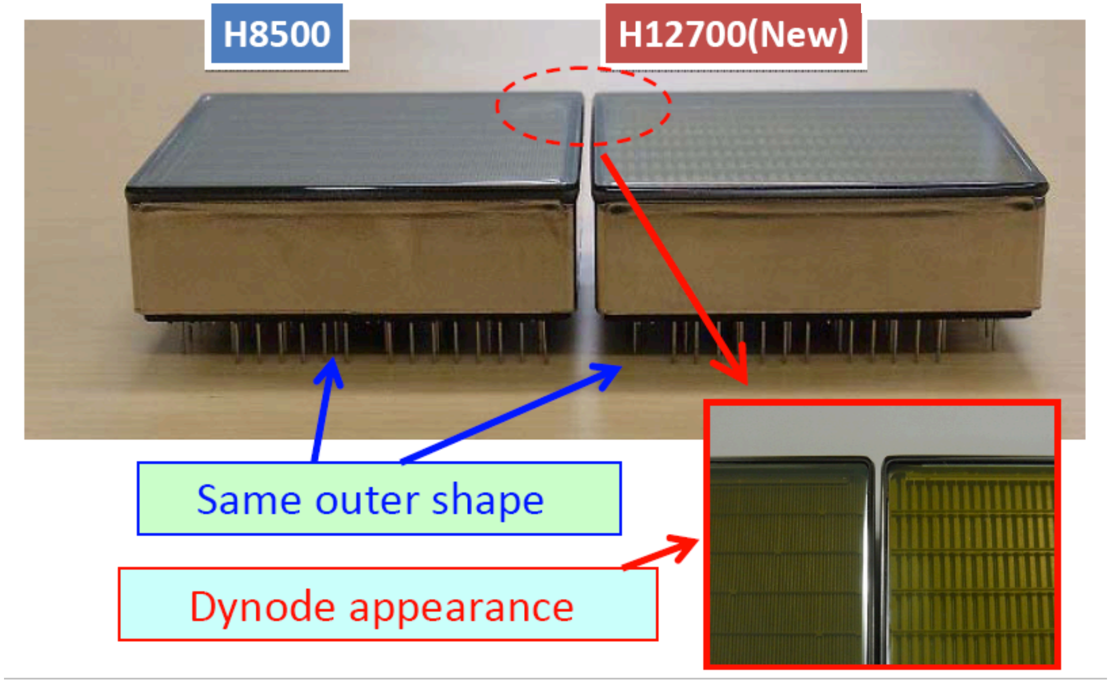


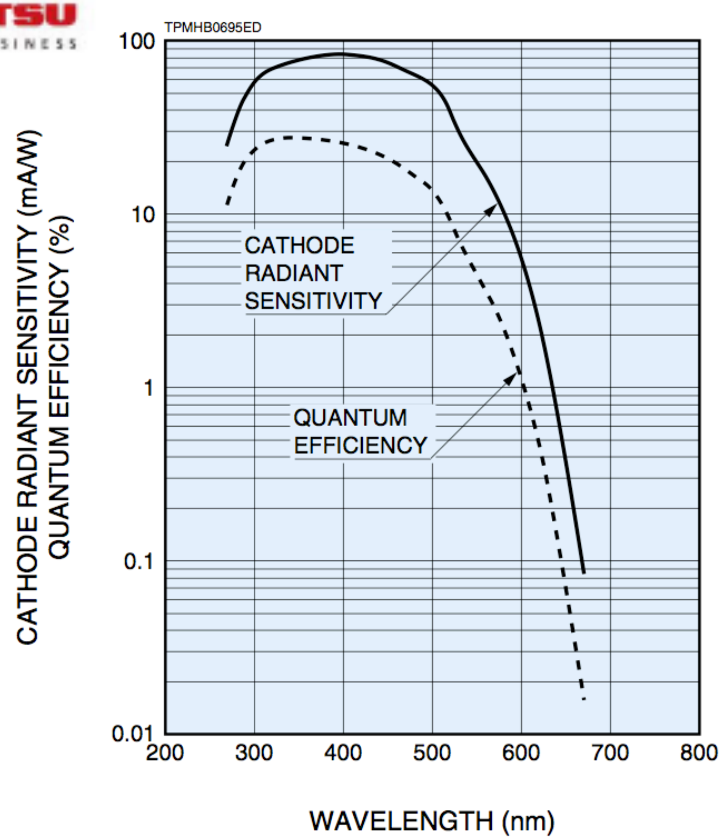
Photon Detectors: MA-PMT

The only option to keep the schedule is the use of multi-anode photomultipliers (we consider the promising SiPM technology as the alternative)

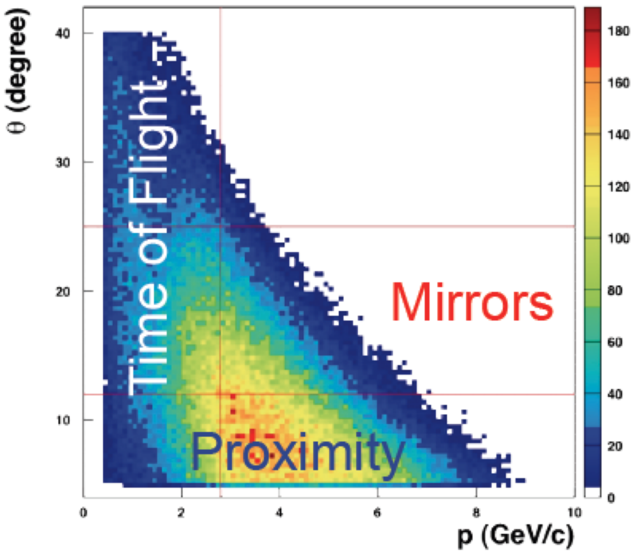
- ✓ Mature and reliable technology
- ✓ Large Area (5x5 cm^2)
- ✓ High packing density (89 %)
- ✓ 64 6x6 mm^2 pixels cost effective device
- ✓ High sensitivity on visible towards UV light
- ✓ Fast response

HAMAMATSU
PHOTON IS OUR BUSINESS

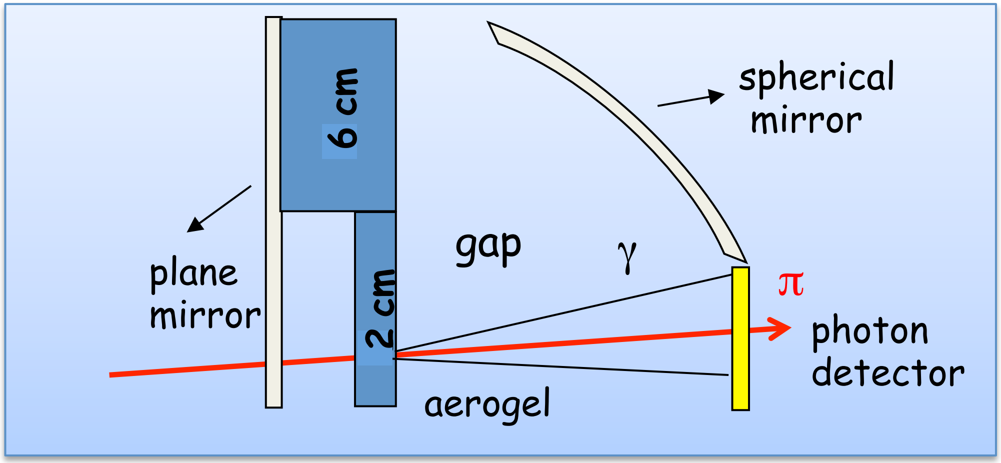


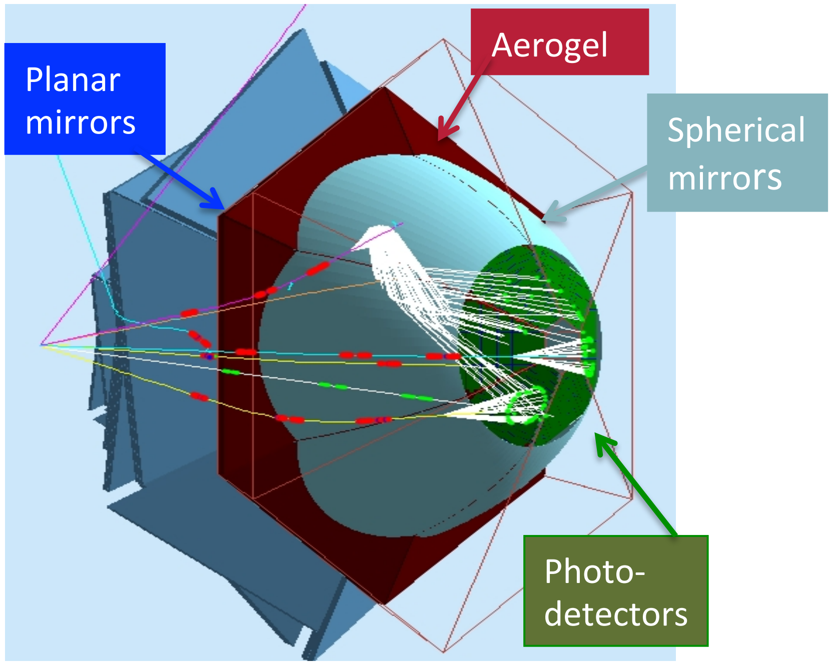


The Hybrid Optics Design

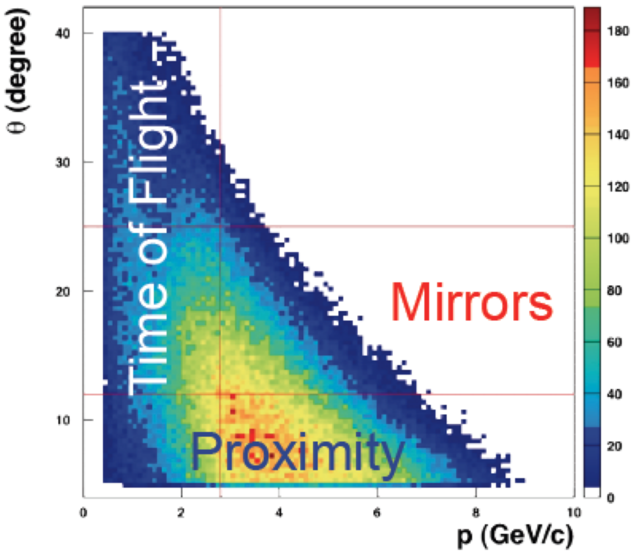


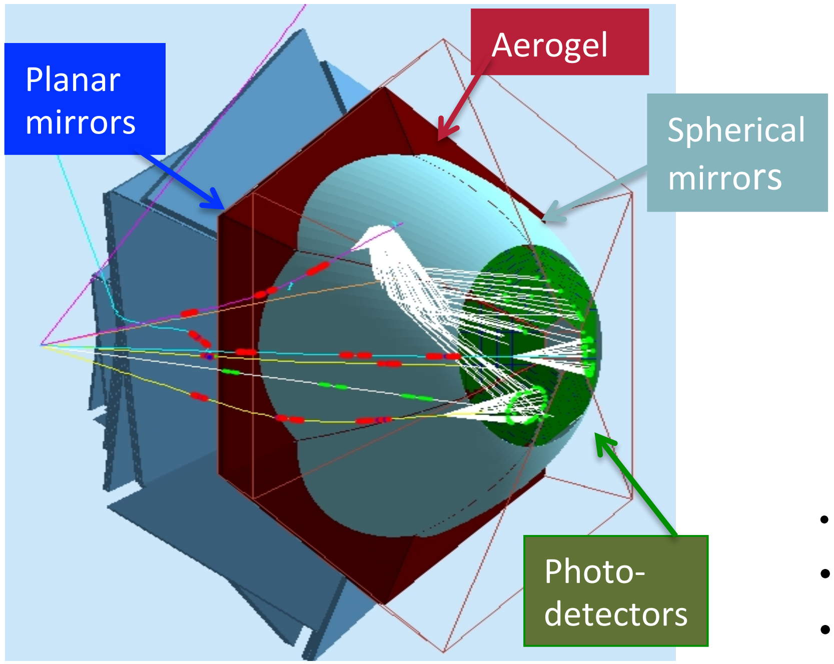
Direct rings/best performance for high momentum particles



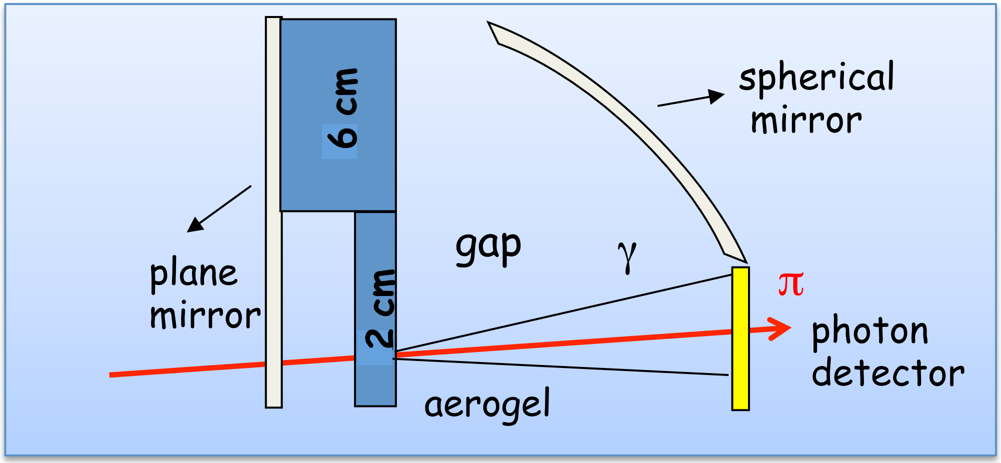


The Hybrid Optics Design

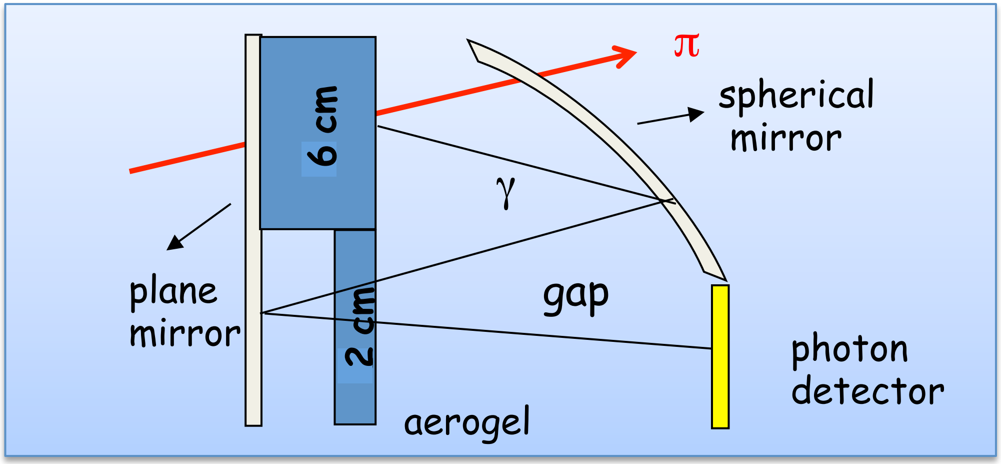




Direct rings/best performance for high momentum particles



Reflected rings for less demanding low momentum particles



- Minimize active area (cost) to about 1 m^2
- Material budget concentrated where TOF is less effective
- Focalizing mirrors allow thick radiator for good light yield

Mirror Technology

Metalized Carbon Fiber substrate
for spherical mirror

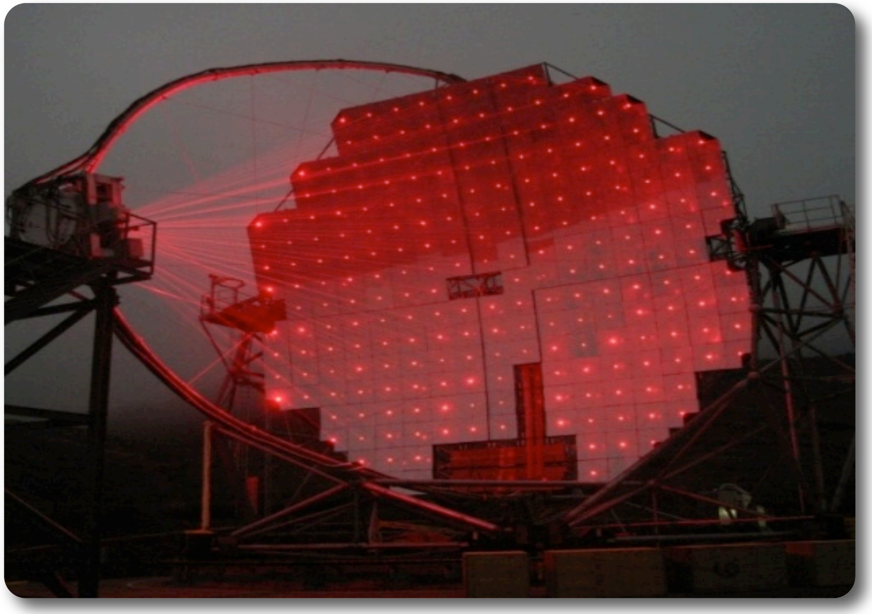
Self-supporting structure with
minimal material budget
(applications in physics experiments)

Thin glass skin on a flat support
for planar mirrors

Cost-effective technology for precise
large area mirrors
(applications in terrestrial telescopes)

Standard technologies already in use and commercially available

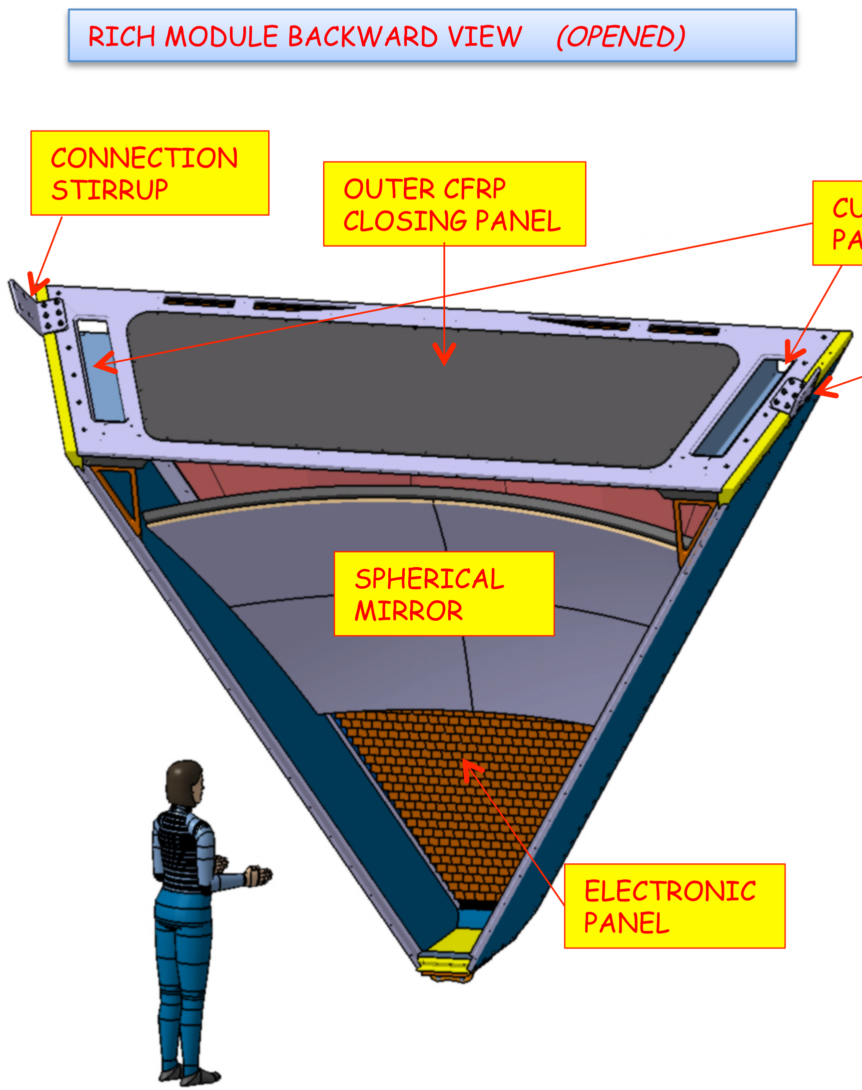
LHCB mirror

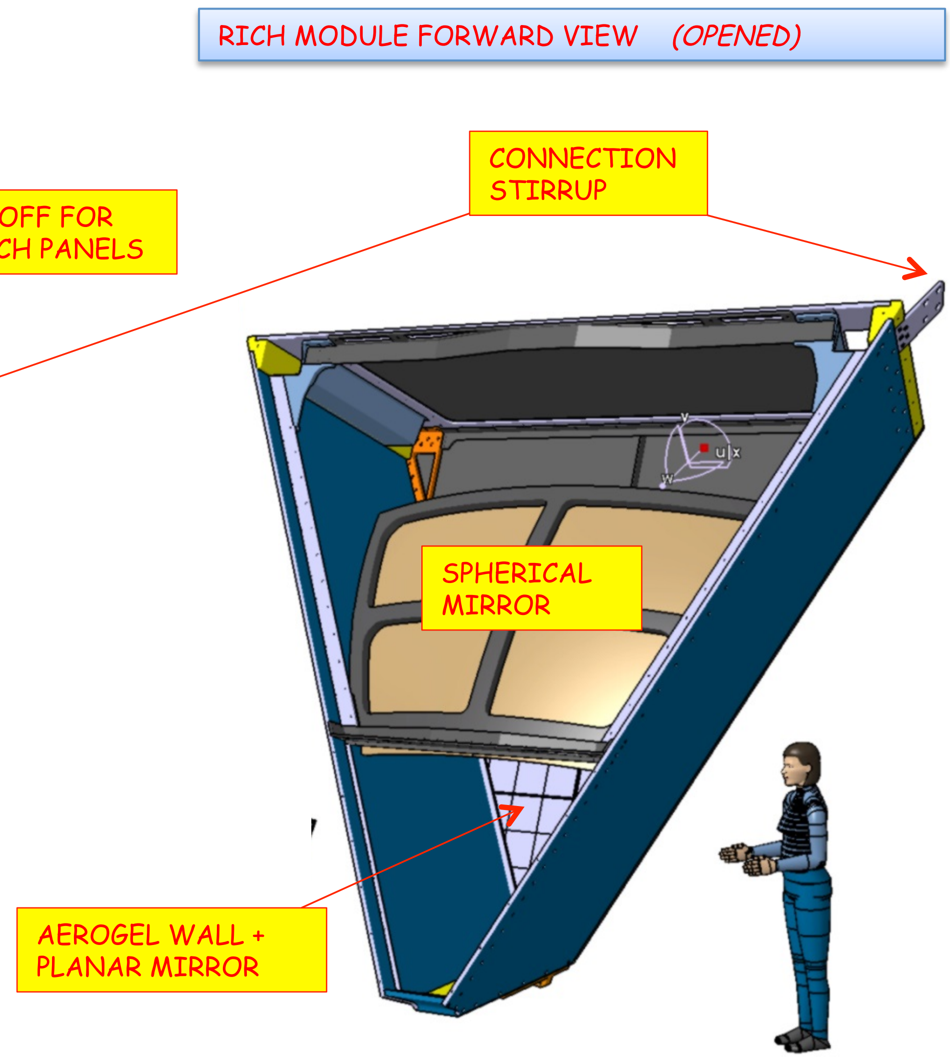


MAGIC-II telescope

RICH Module General Assembly

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





RICH Construction Schedule

Milestone	Date
Concept of Design and Technology	2010
Tests of components and small prototype	2011
Test-beam with electrons (Frascati) and hadrons (CERN)	2012-2013
Start Engineering Phase	Feb. 2013
Hall-B review	June 2013
TDR	Aug. 2013
Physics Division review with DOE observers	Sep. 2013
Hamamatsu contract awarded	30 Sep. 2013
Electronics boards completed	July 2015
MA-PMT production completed	Dec. 2015
Mirror production completed	Sep. 2015
Start RICH assembly	Oct. 2016
Aerogel production completed	Dec. 2016
RICH project completed	**June 2017**

Conclusions

RICH construction phase started in September 2013

Goal: 1st sector ready by the June 2017

RICH module external layout modeled as LTCC → D. Orecchini talk

Structure lighter than LTCC validate by stress FEA model analysis → S. Tomassini talk

Waiting validation before starting procurement and optimizing internal elements

Gas system Design Parameters have been identified → R. Perrino talk

N_2 flux to preserve aerogel performances

Air cooling for electronic box

Waiting Hall-B constraints before starting technical design and prototyping