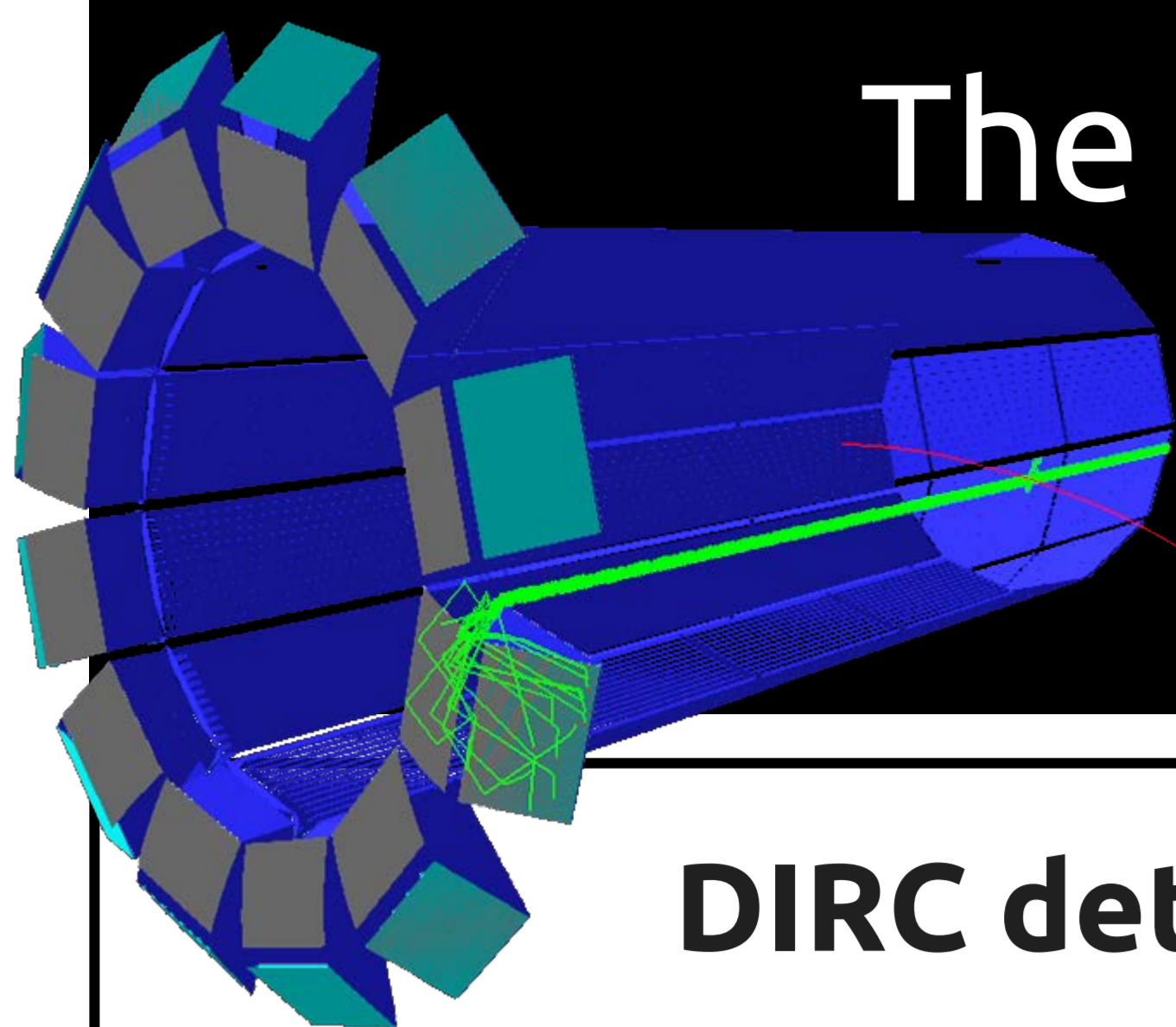


# The Focusing DIRC: an innovative PID detector

R&D program ongoing at SLAC with the participation of

INFN sez. Di Bari; University of Hawaii; University of Maryland;  
L.A.L. Orsay, University of Paris-Sud; INFN sez. di Padova; UC Riverside; SLAC



## DIRC detector concept

Detector for Internally Reflected Cherenkov light

Barrel detector for charged Particle Identification based on Cherenkov angle measurement

$$\cos \theta_C = \frac{1}{n\beta}$$

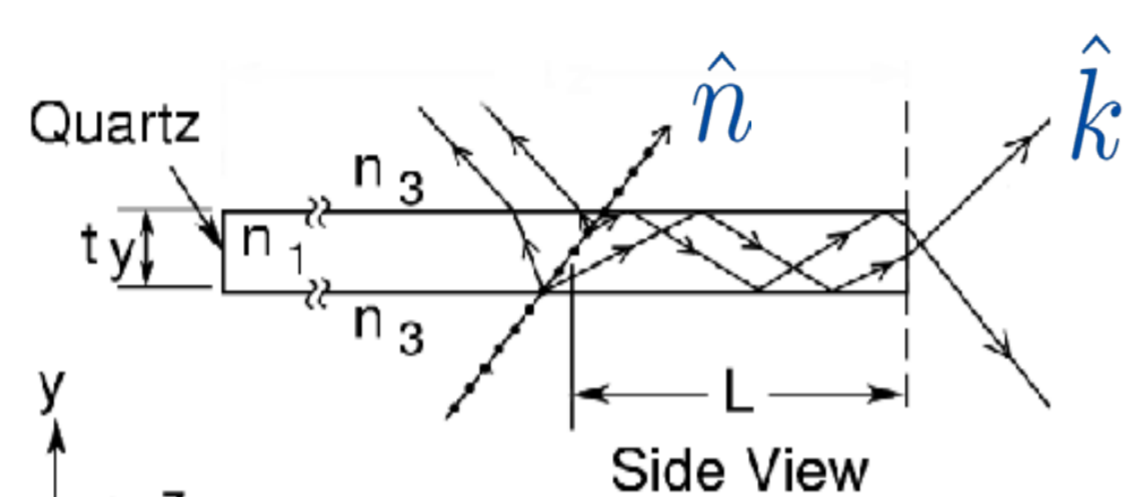
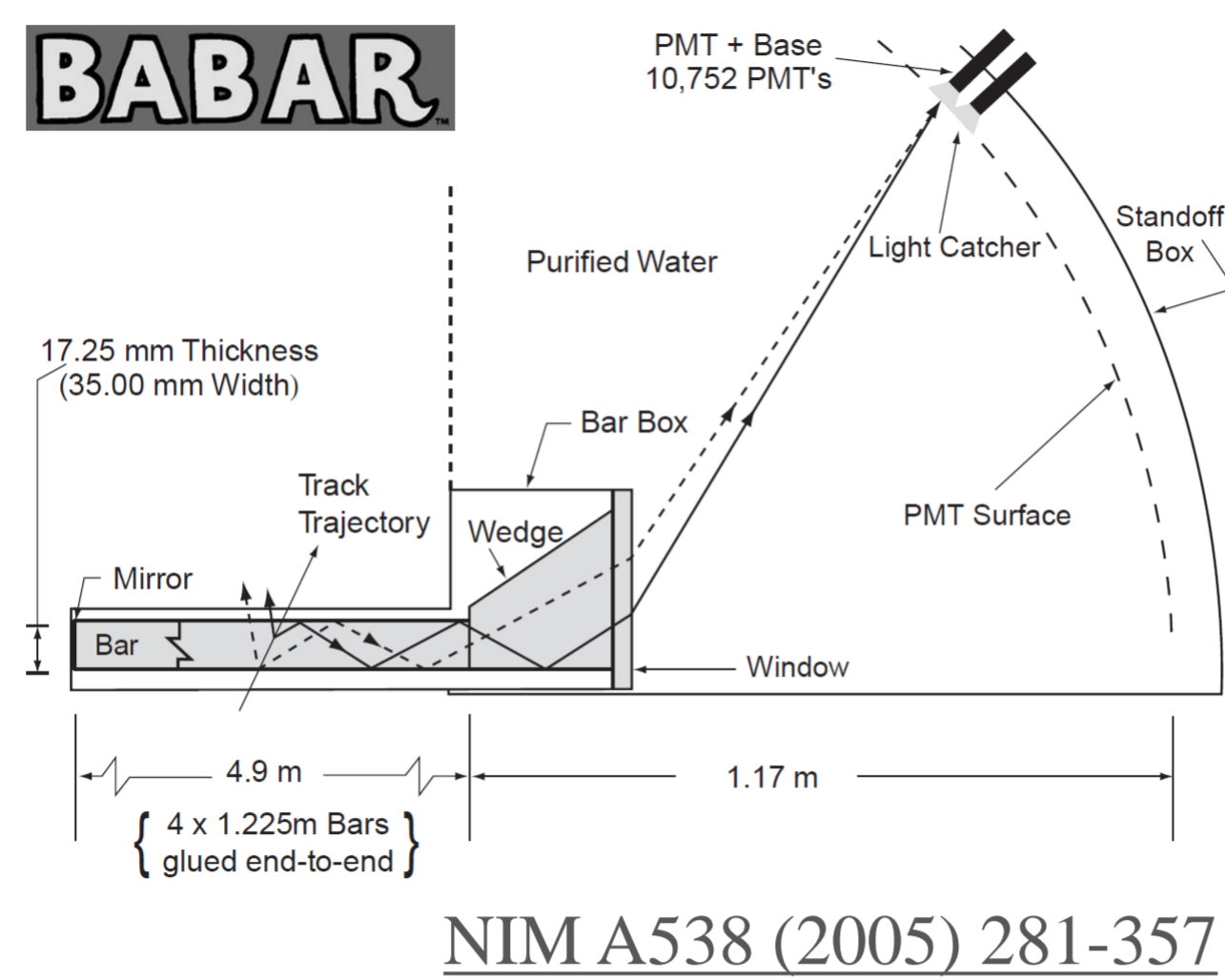
Performance:

$\pi/K$  separation above  $2.5 \sigma$  up to a momentum of 4.2 GeV thanks to:

- Single photon  $\theta_C$  resolution of 9.6 mrad
- Measured time resolution of 1.7 ns
- Performed reliably for ~10 years

Main elements:

- 144 fused silica bars, each 4.9 m long
- Water-filled camera equipped with 10,752 PMTs



Principle:  $\cos \theta_C = \hat{k} \cdot \hat{n}$   
 $\hat{n}$ : given by tracking  
 $\hat{k}$ : the main DIRC challenge

## Challenge for future experiments

- Deal with ~100x luminosity ( $\sim 10^{36} \text{ cm}^{-2}\text{s}^{-1}$ )
- Retain or improve BaBar DIRC performances

## The FDIRC concept

### New Optical Camera

- 25x smaller
- Radiation resistant fused silica
- Focusing design using cylindrical mirror
- Modular cameras (with mirrors on the sides)

### BaBar quartz bars reused

- Reduce the overall detector cost but lead to a more complex device

### New H8500 MaPMT

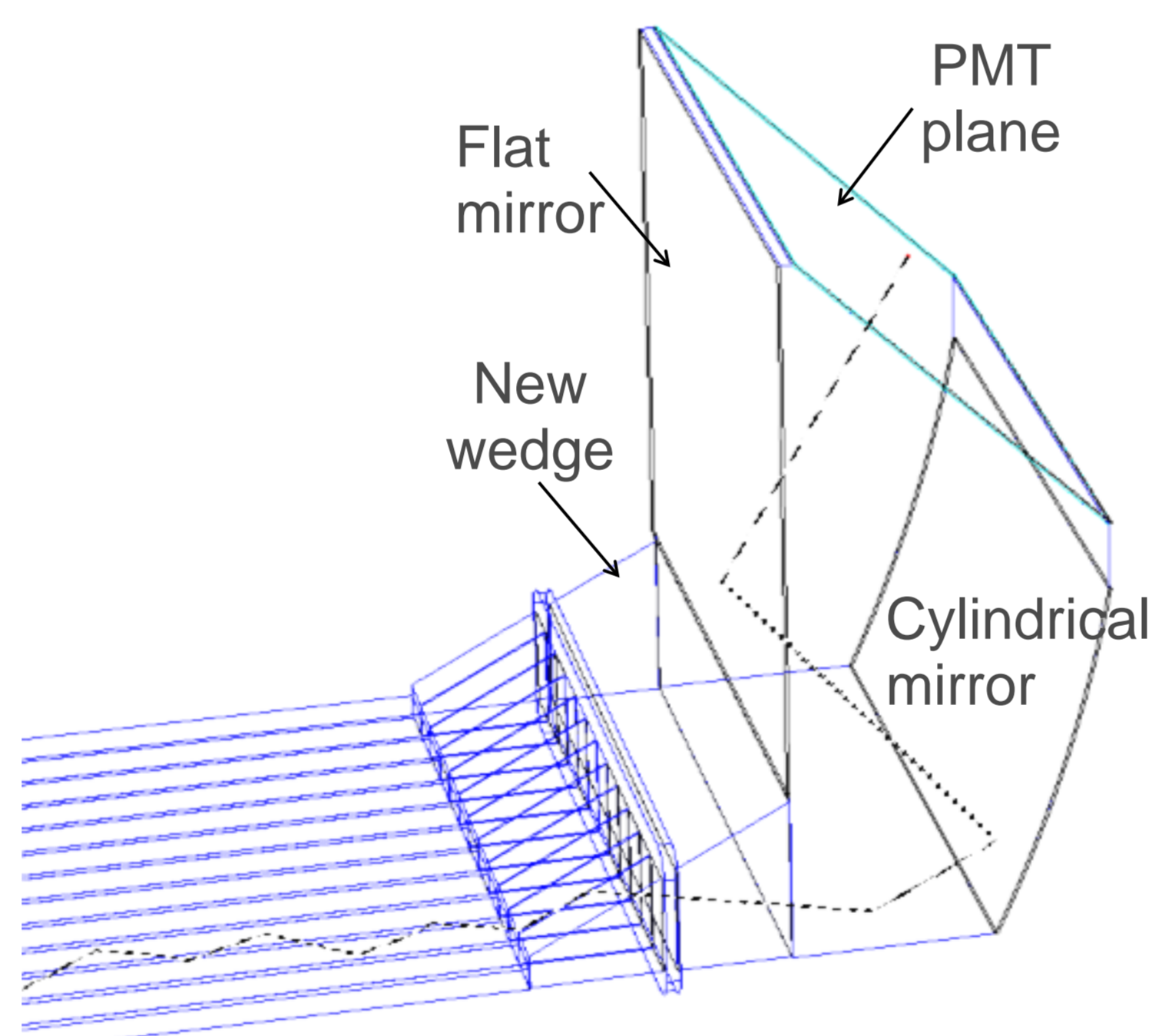
- 10x faster ( $\sigma \sim 200$  ps)
- Highly pixelated
- Coupled to new fast digitizing electronics

### Optical design optimized

- Designed by ray-tracing
- Verified by Geant4 simulation

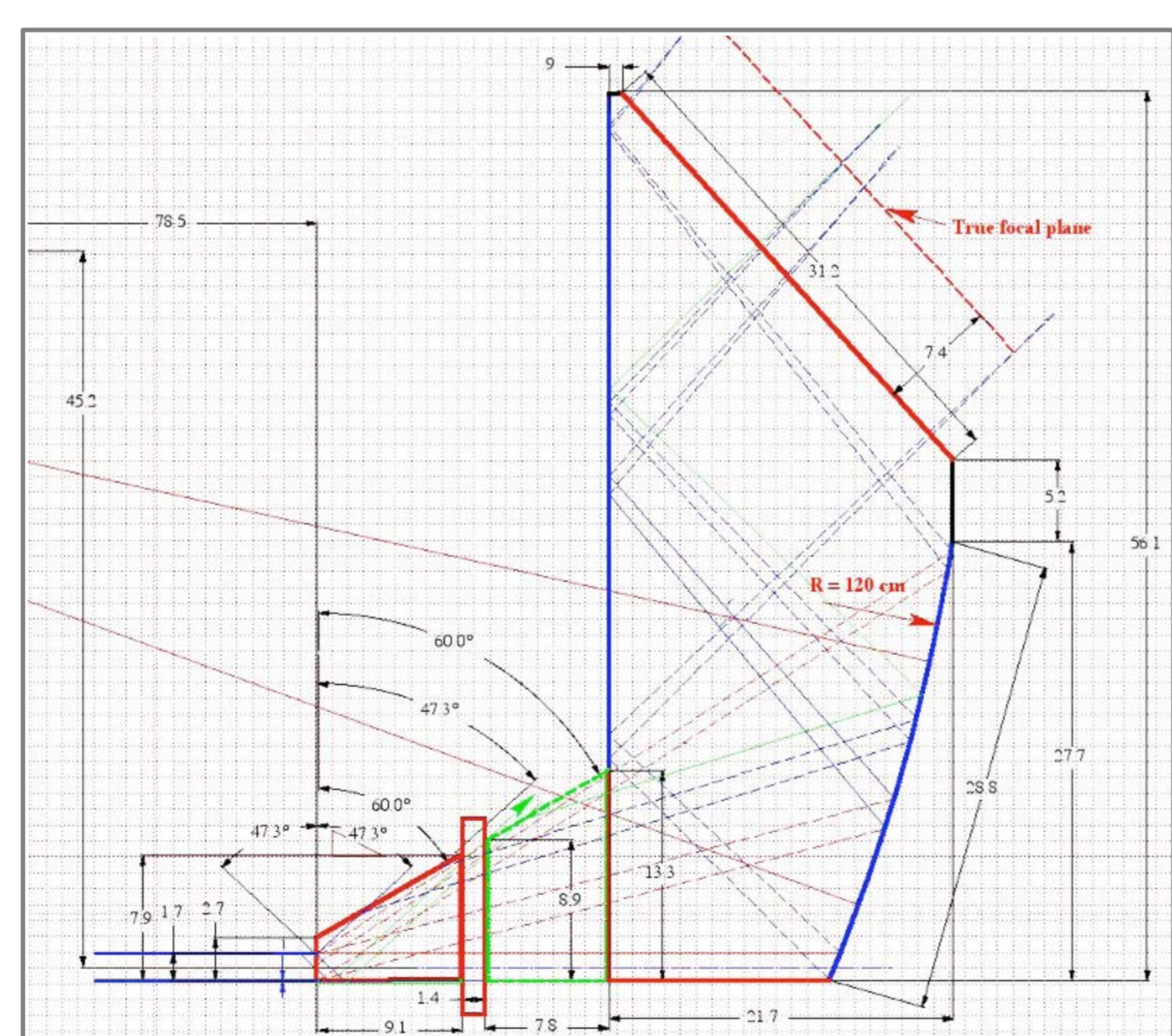
### Chromatic correction

- Correct chromatic error by timing



NIM A639 (2011) 282-286

NIM A dx.doi.org/10.1016/j.nima.2012.11.112



The FDIRC would have been the main PID detector in the barrel region of the SuperB experiment, a project which has been stopped in December 2012

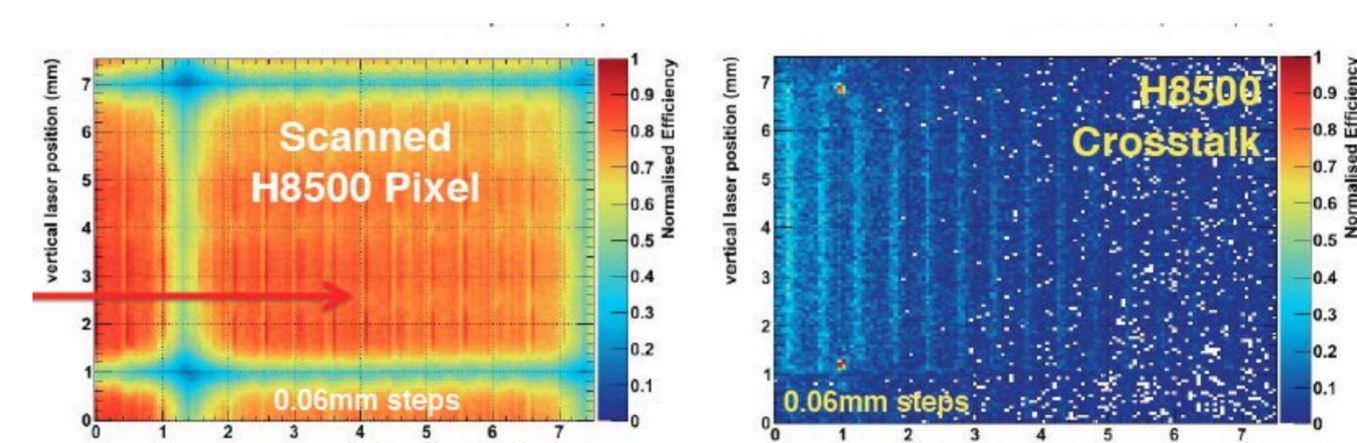
## FDIRC: the R&D program

First FDIRC prototype with oil-filled camera and fast timing; demonstrated for the first time the feasibility of chromatic correction

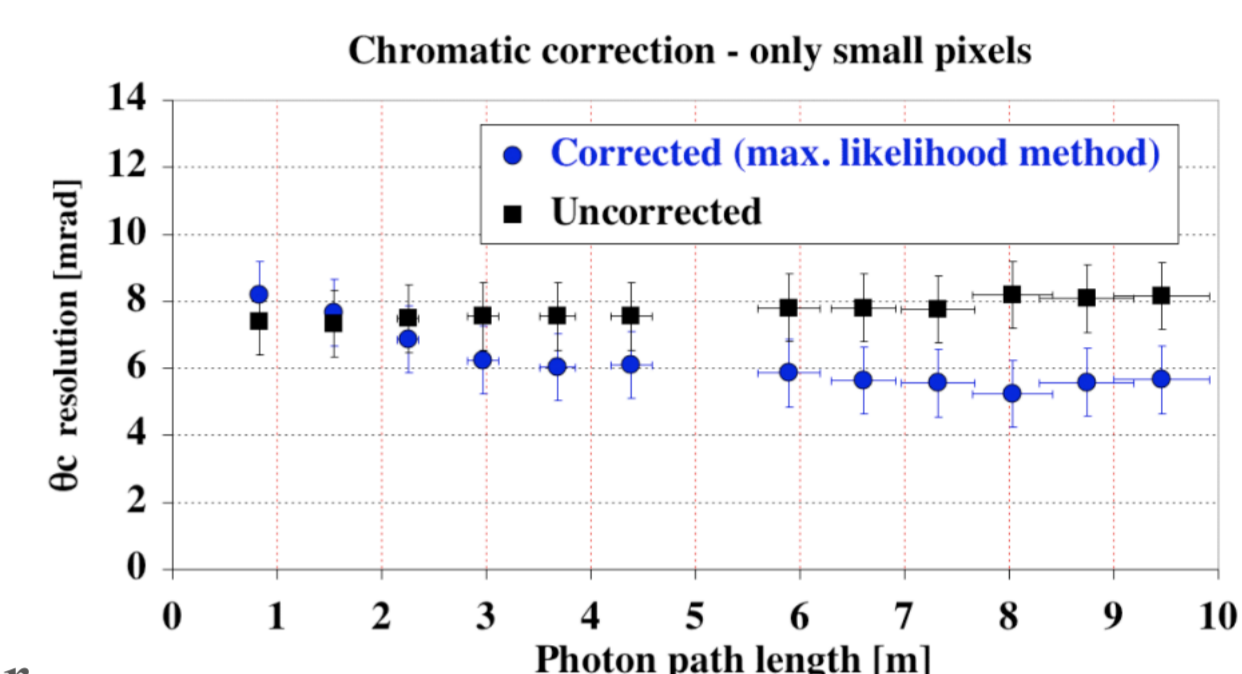
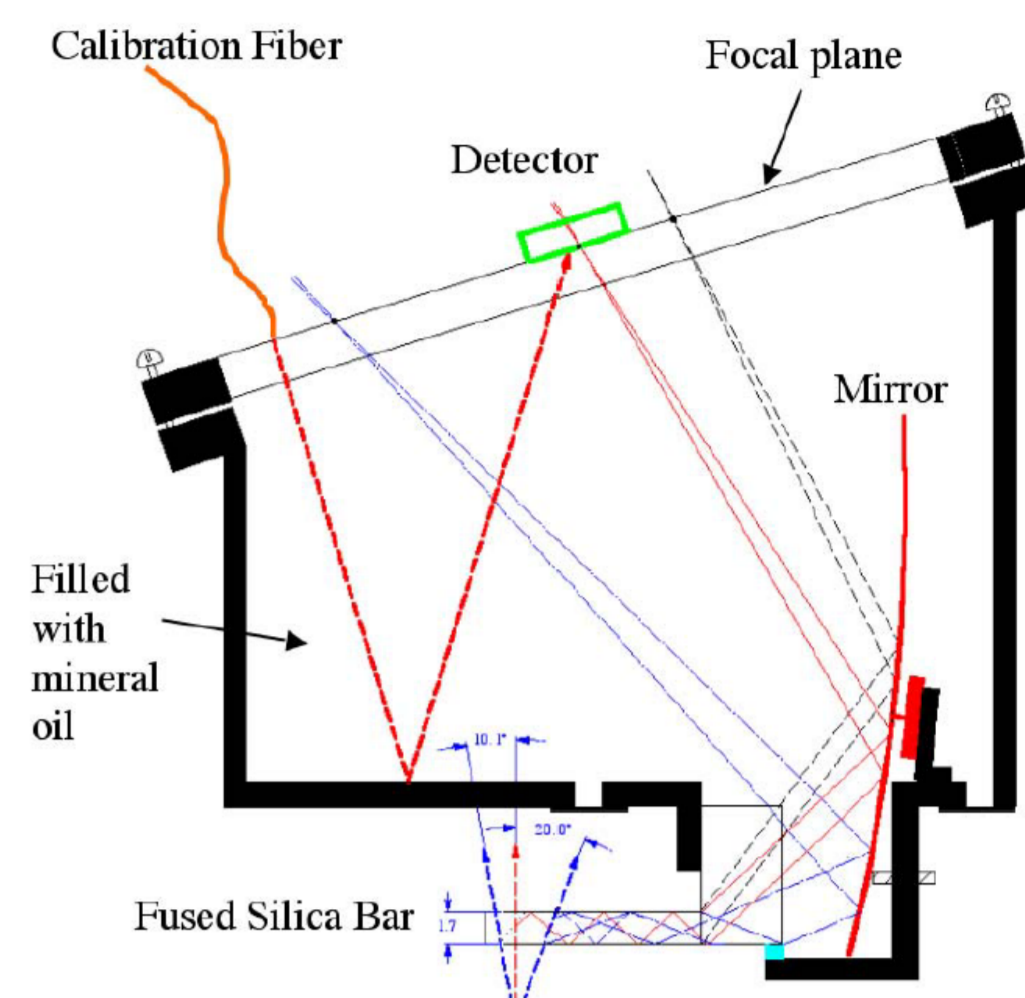
NIM A595 (2008) 104-107

Several PMT scanning setups to study Hamamatsu H-8500 MaPMTs

- Gain uniformity better than 1:2.5
- Pixel-to-pixel cross-talk ~3%
- TTS down to ~140 ps (~200 ps averaging over pixel area)



Montgomery, R et al. (2011) NDIP poster

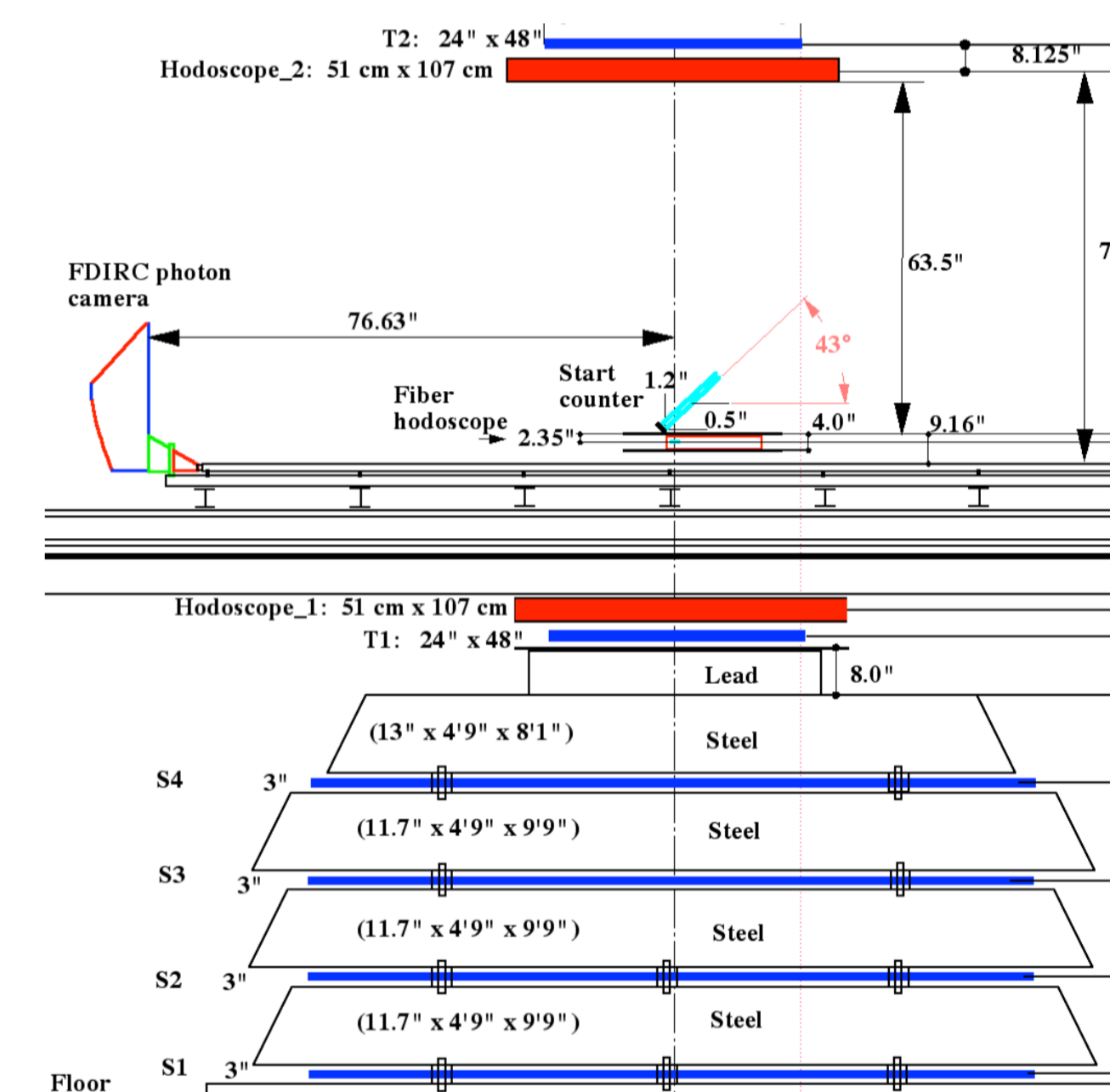


## First full-size FDIRC sector at SLAC CRT

A proof-of-principle of the technology

### Test facility: SLAC Cosmic Ray Telescope

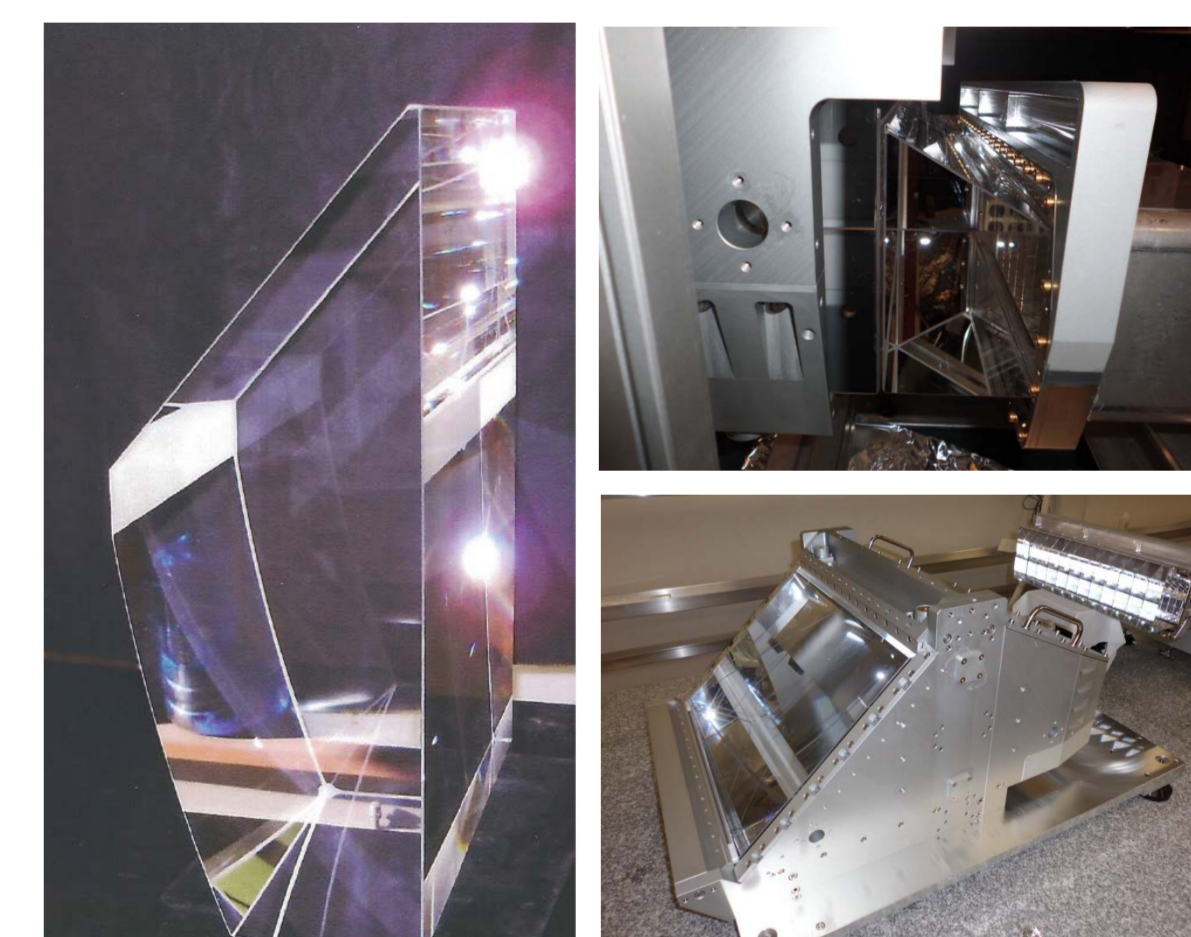
- Selects muons with  $p > 2$  GeV so that  $\theta_C = 47.2^\circ$
- Good tracking resolution of ~1.5 mrad
- 3D muon tracks (needed to fully characterize the device)
- Precise timing given by a small Cherenkov start-counter



NIM A701 (2013) 115-126  
SLAC-PUB-13873

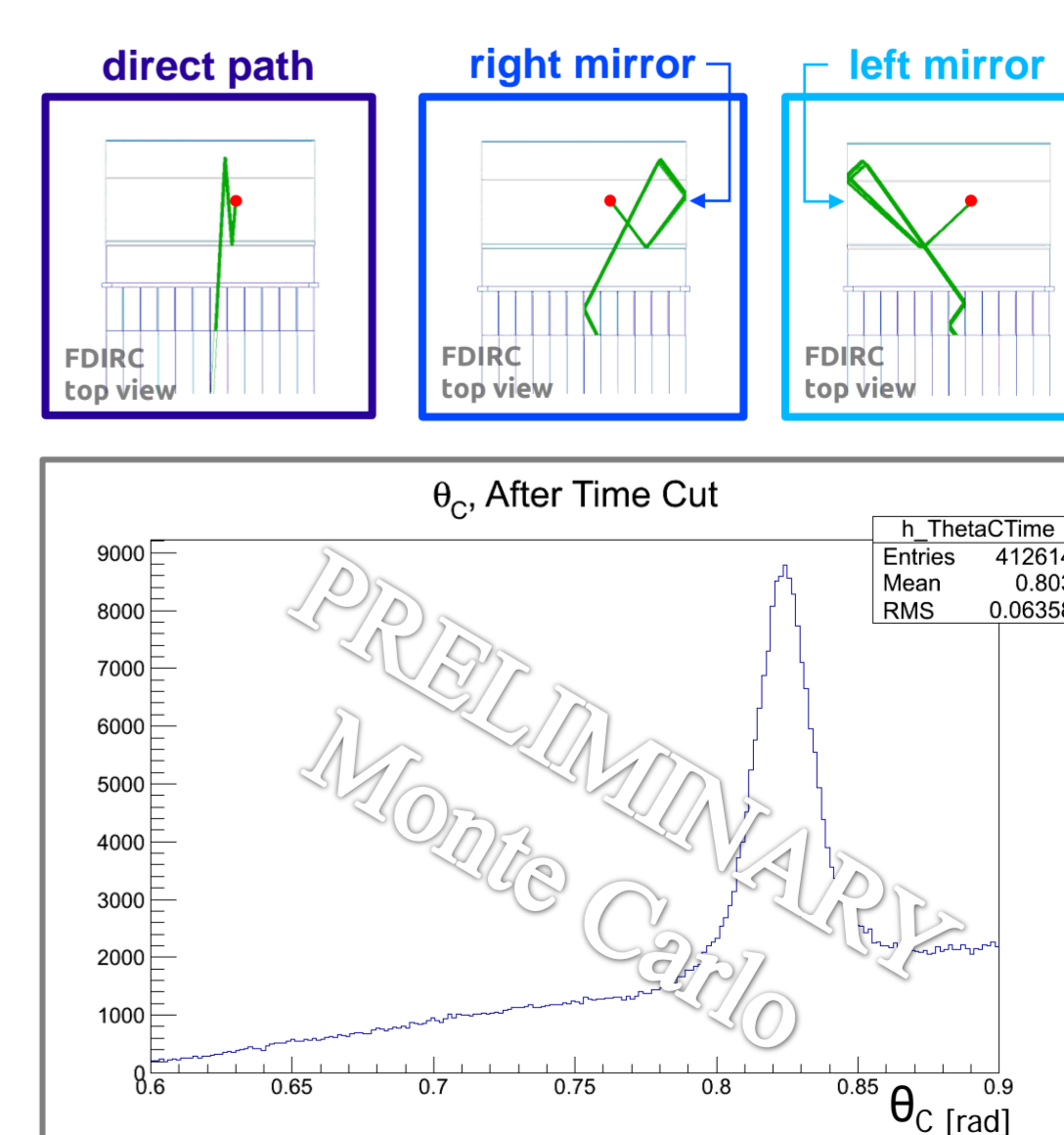
### First FDIRC sector built and instrumented

- First fused silica optical block manufactured
- Plating of the surfaces
- Optical coupling
- Mechanical enclosure (Fbox)
- 12 H-8500 MaPMTs (768 channels)
- Fast digitizing electronics (SLAC, Hawaii, LAL)



### Data analysis

- Full Geant4 simulation is needed to map pixel hits to photon directions (lookup table)
- Ambiguities due to the multiple possible photon paths:
  - Complex problem (>10 ambiguities per hit)
  - Use hit time to remove some of the ambiguities
  - Various reconstruction algorithms being studied



Data are being collected right now  
Results are expected soon

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