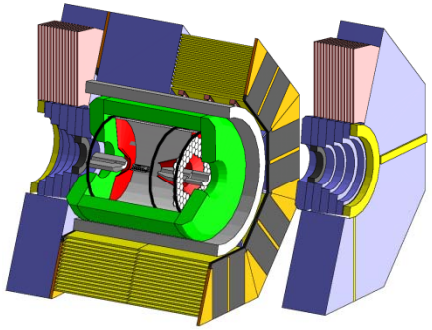


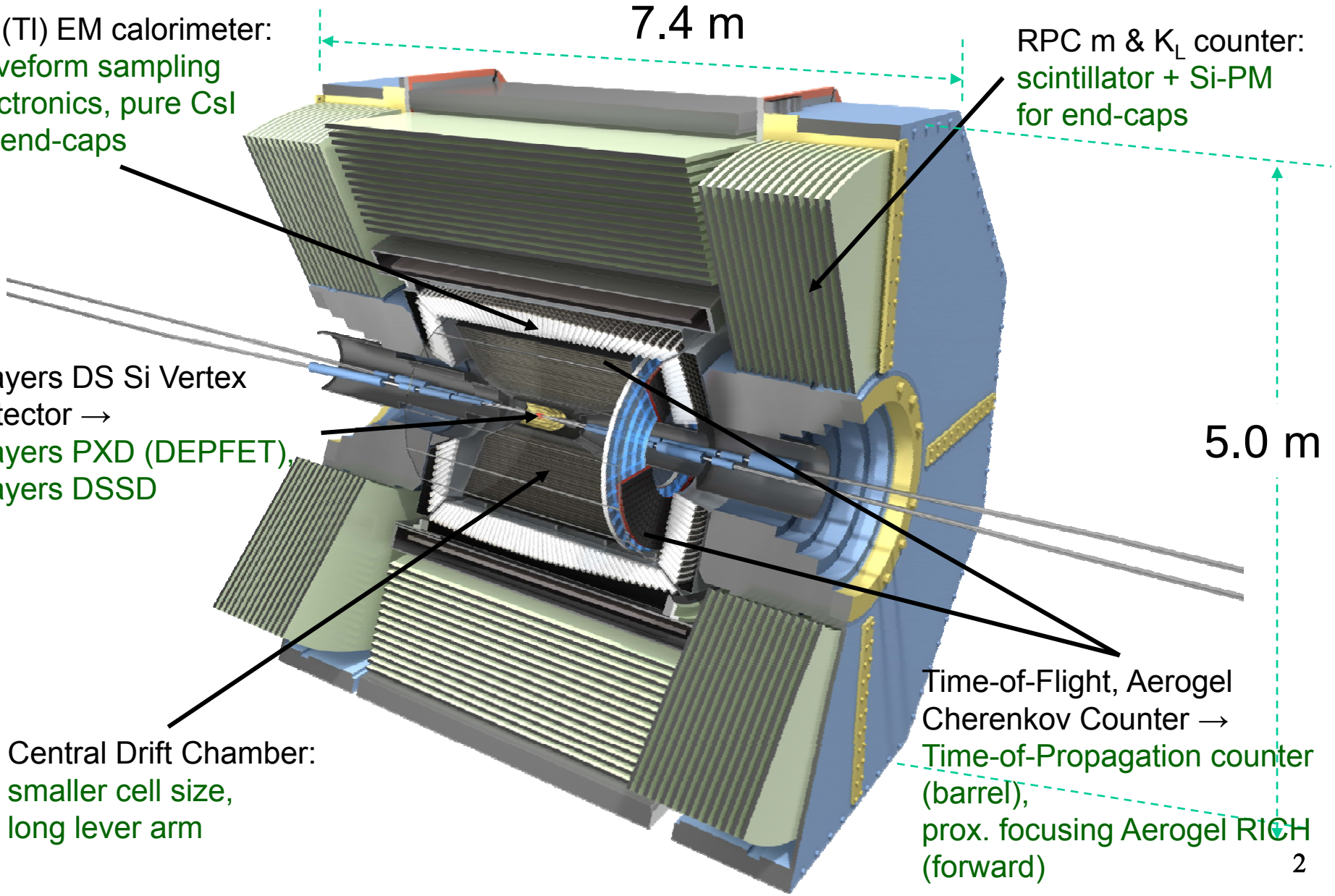
A brief introduction to imaging Time Of Propagation (iTOP) prototype detector test

Gary S. Varner

University of Hawai'i at Manoa

19-JUL-2011

Belle II: detector upgrade



CsI(Tl) EM calorimeter:
waveform sampling electronics, pure CsI for end-caps

RPC m & K_L counter:
scintillator + Si-PM for end-caps

4 layers DS Si Vertex Detector →
2 layers PXD (DEPFET),
4 layers DSSD

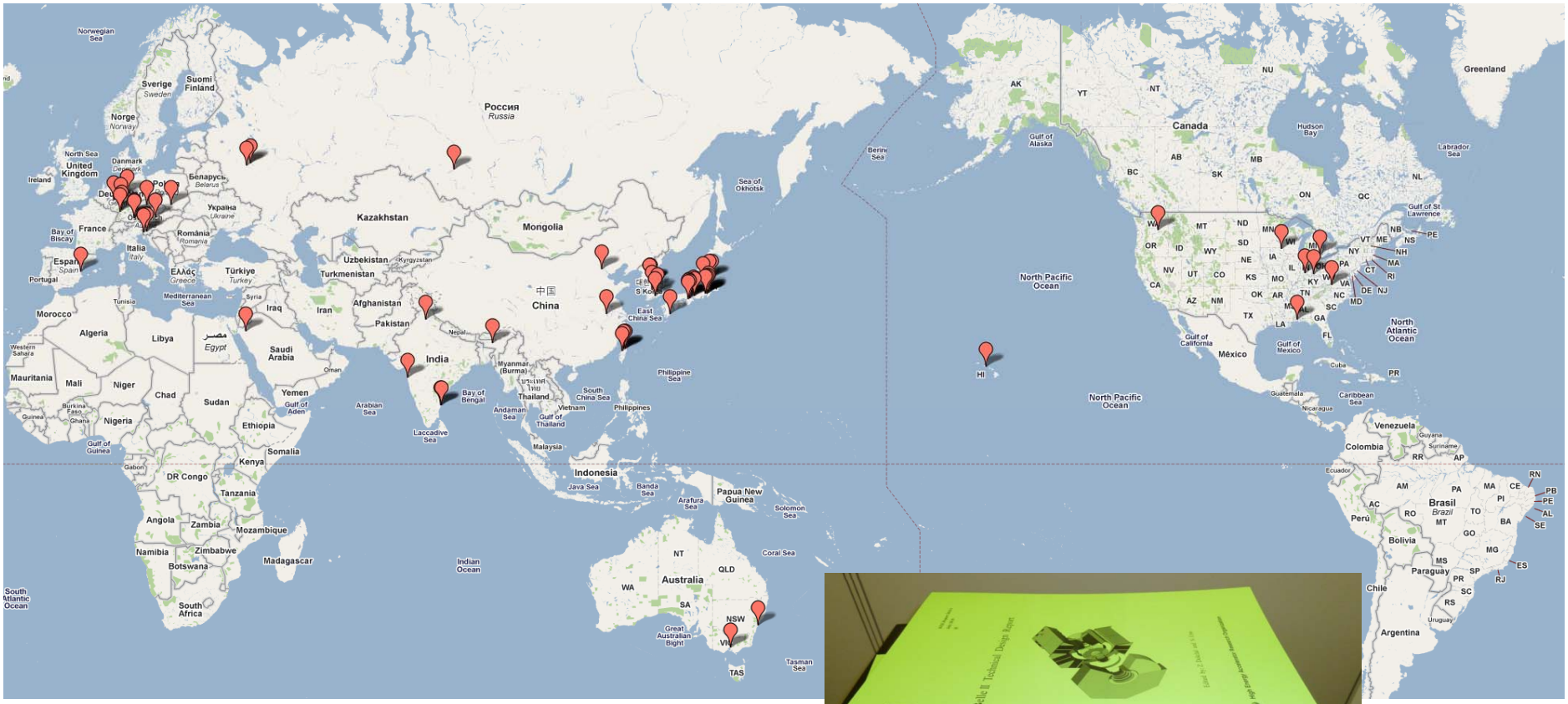
Central Drift Chamber:
smaller cell size,
long lever arm

Time-of-Flight, Aerogel Cherenkov Counter →
Time-of-Propagation counter (barrel),
prox. focusing Aerogel RICH (forward)

Belle II Collaboration

15 countries, ~60 institutions

~400 collaborators

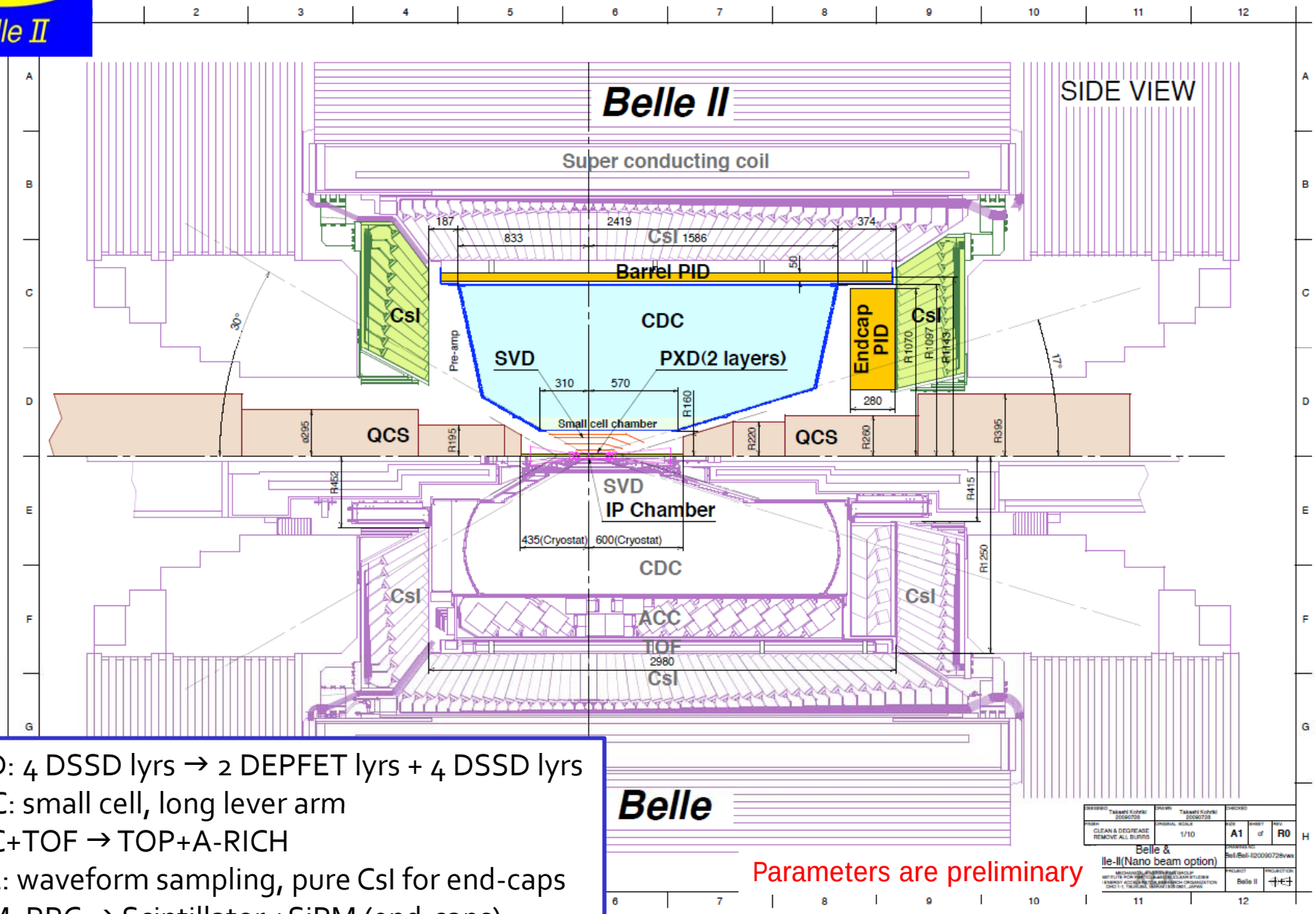


TDR published arXiv:1011.0352v1 [physics.ins-det]

Belle II web page:
http://b2comp.kek.jp/~twiki/pub/Organization/B2TDR/B2TDR.pdf

TDR

Belle II in comparison with Belle

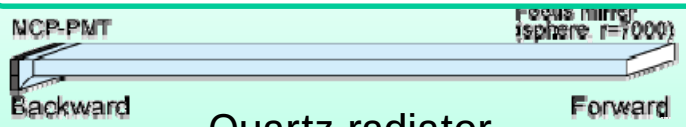


Parameters are preliminary

SVD: 4 DSSD lyrs → 2 DEPFET lyrs + 4 DSSD lyrs
CDC: small cell, long lever arm
ACC+TOF → TOP+A-RICH
ECL: waveform sampling, pure CsI for end-caps
KLM: RPC → Scintillator +SiPM (end-caps)

Particle Identification

Barrel PID: Time of Propagation Counter (TOP)



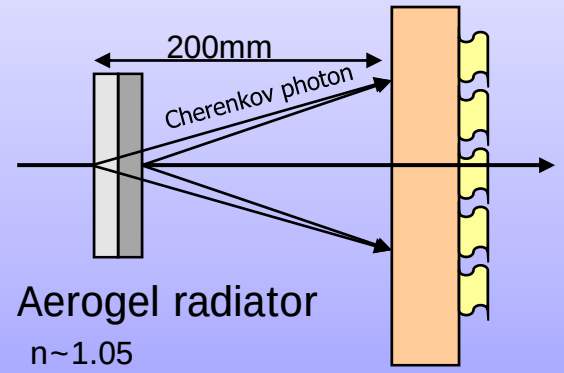
Quartz radiator

Focusing mirror

Small expansion block

Hamamatsu MCP-PMT (measure t, x and y)

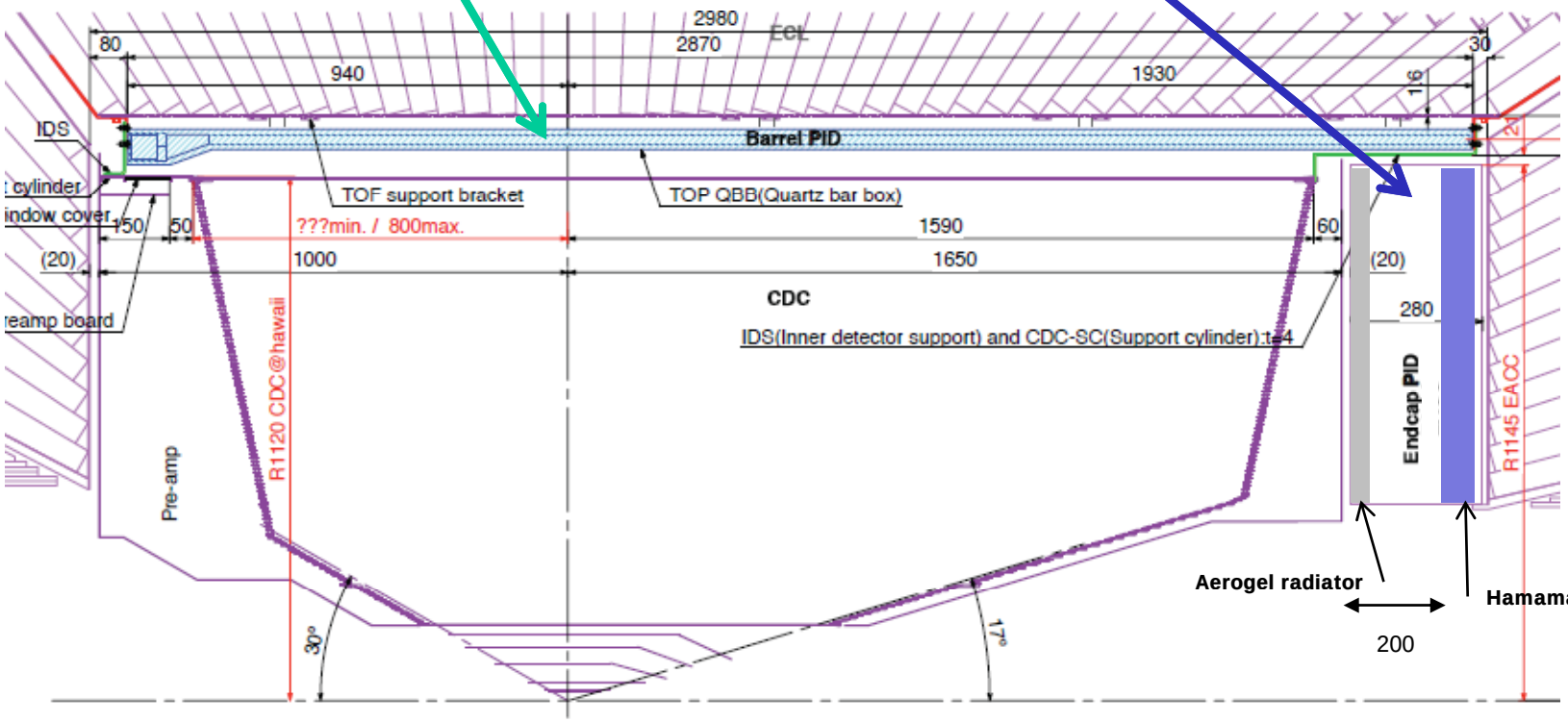
Endcap PID: Aerogel RICH (ARICH)



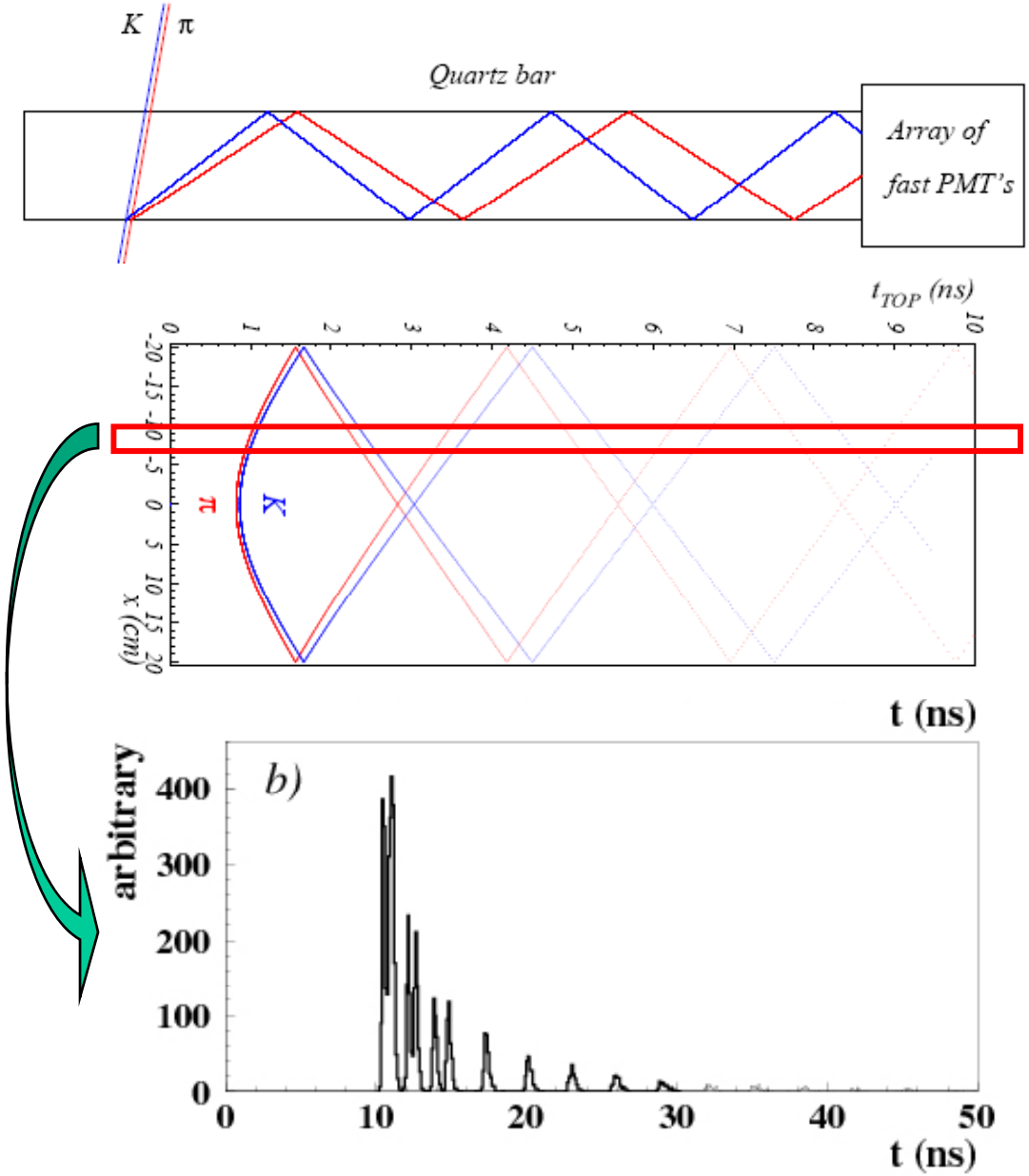
Aerogel radiator

n~1.05

Hamamatsu HAPD + new ASIC



Barrel PID: imaging
Time of propagation (iTOP) counter

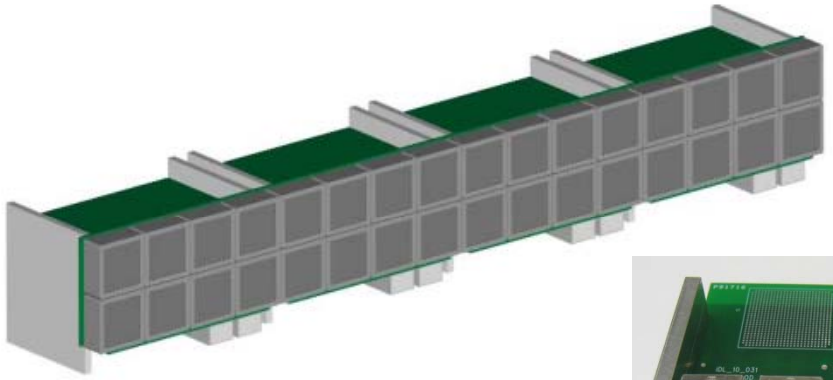


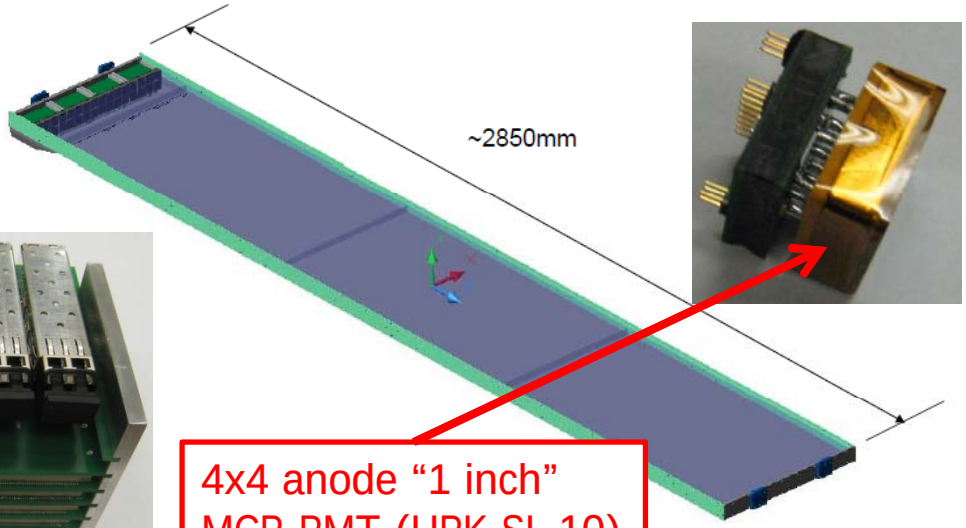
- Cherenkov ring imaging with precise time measurement.
- Reconstruct angle from two coordinates and the time of propagation of the photon
  - Quartz radiator (~2cm)

Use space-time correlation of detected photons to estimate Particle ID

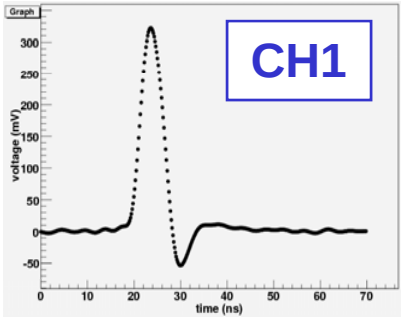
Time distribution of signals recorded by one of the PMT channels: different for π and K

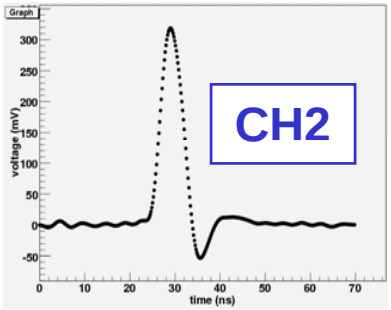
Highly integrated readout

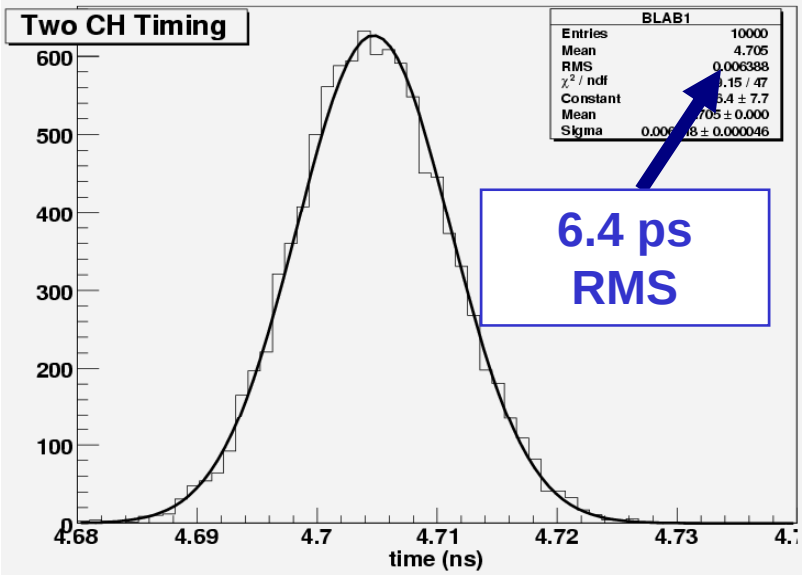


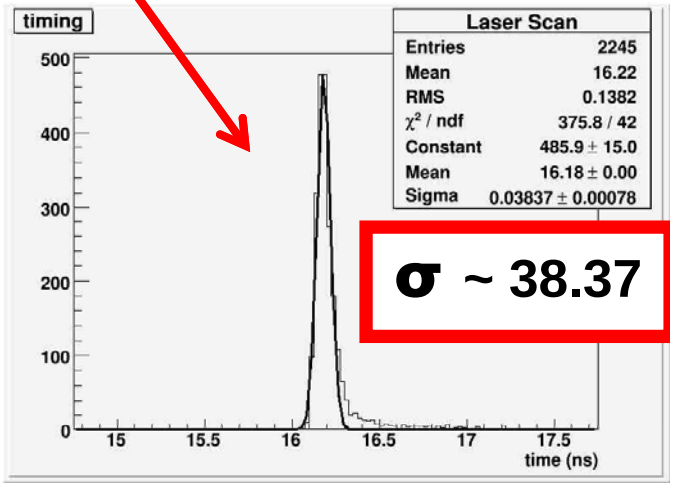


4x4 anode "1 inch"
MCP-PMT (HPK SL-10)







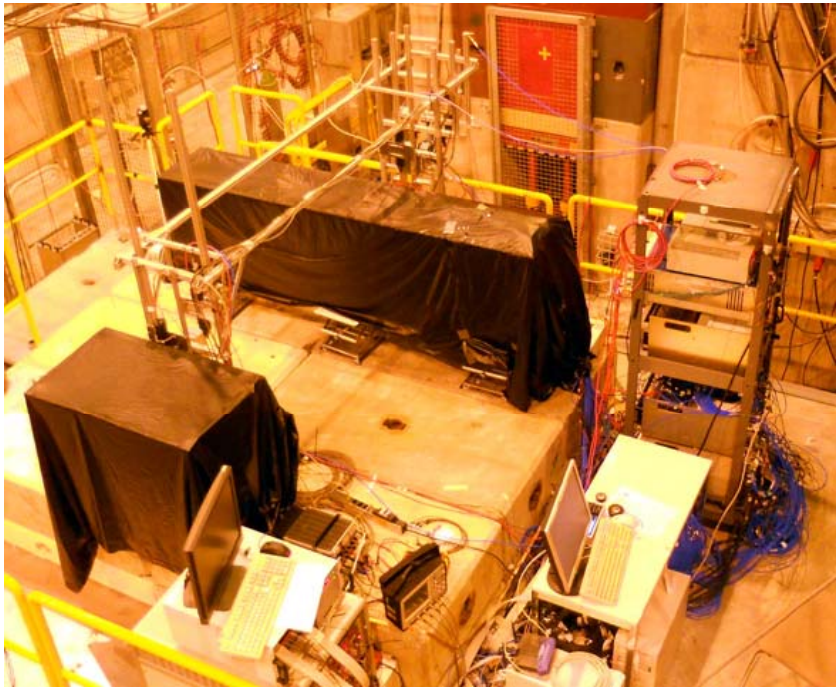


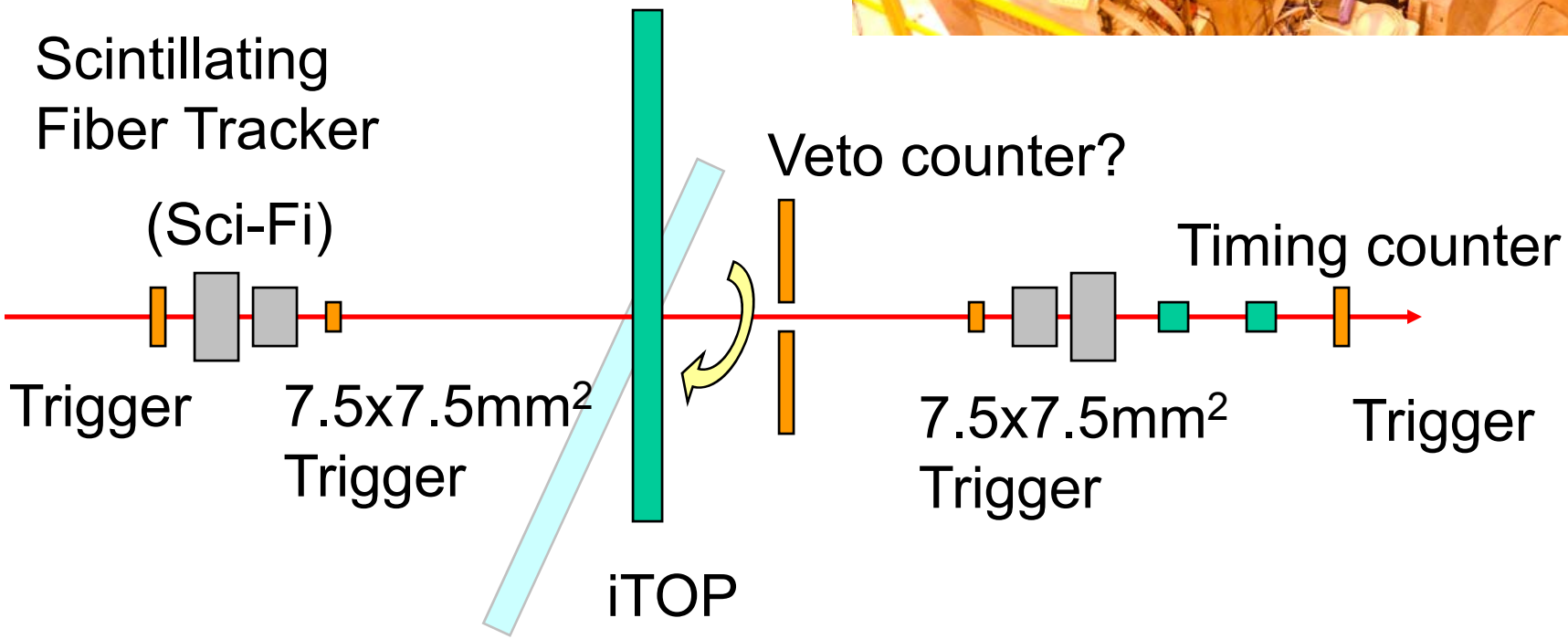
Single p.e. resolution

NIM **A602** (2009) 438

Autumn 2011 beam test

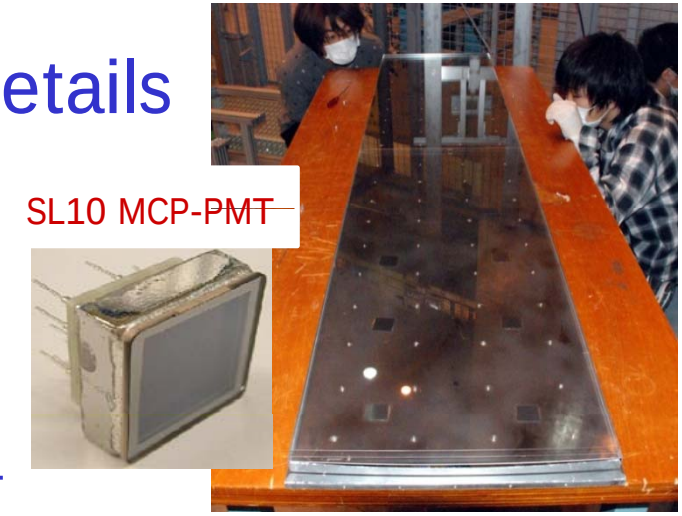
- CERN SPS T4-H6B or FTBF
  - 120GeV hadrons/p
  - DAQ rate: ~100Hz?
    - 25MB/s (PCI bus limited)
    - ~250kB/event (non Zero-Supr.)

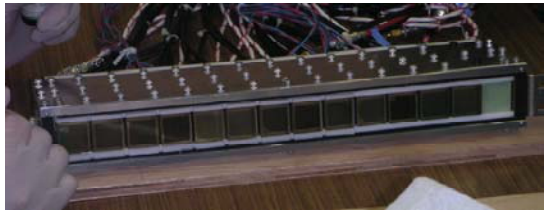


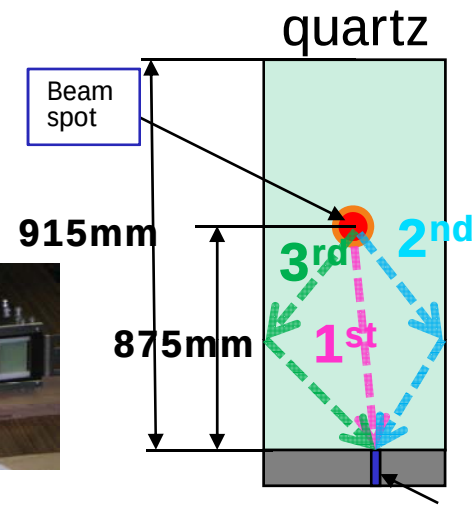


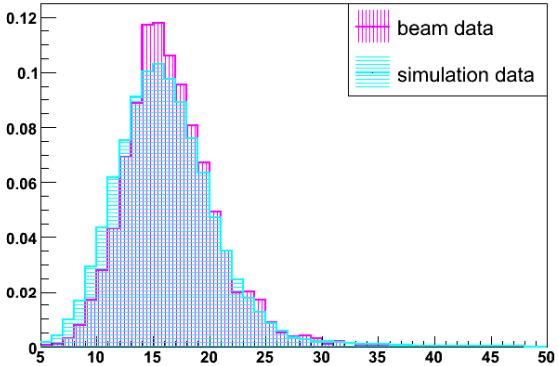
Earlier Test Details

- Quartz radiator
  - 2.6m^{L} x 45cm^{W} x 2cm^{T}
  - Excellent surface accuracy
- MCP-PMT
  - Hamamatsu 16ch MCP-PMT
    - Good TTS (<35ps) & lifetime
    - Multialkali photo-cathode → SBA
- Beam test in 2009
  - # of photons consistent
  - Good time resolution

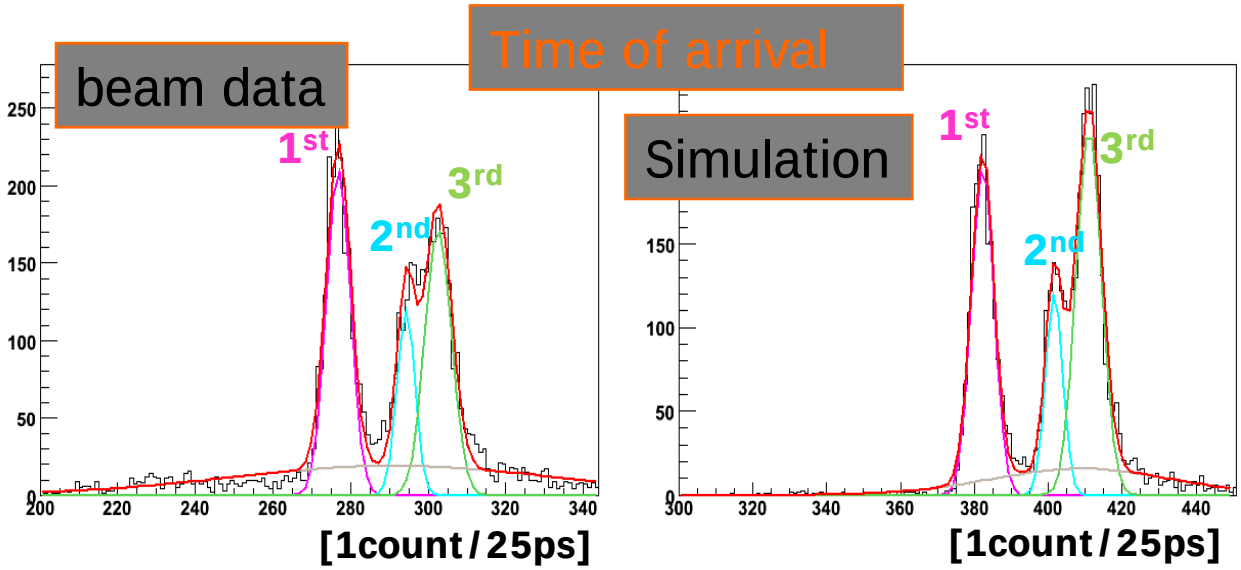








# of photons



Summary

- While earlier tests have demonstrated the basic concept, a number of key elements needs to be studied carefully in a definitive beam test
  ➔ in preparation for DOE "CD-1" review in Feb. 2012
- Specific study items:
  - Final 16-anode MCP-PMTs
  - Highly integrated electronics
  - Study forward mirror, expansion wedge and scattered photon optics
  - Close loop between GEANT4 and beam test data
  - PDF-driven likelihood analysis → realistic reconstruction
  - Multi-track hits, coherent backgrounds (event overlay)
- FTBF capabilities a good match (though CERN if ready in October)