

# PID Summary

Caltech SuperB Meeting, December 17<sup>th</sup> 2010

**Nicolas Arnaud**, for the SuperB PID group



- 2 **parallel sessions**
  - 1 barrel-oriented
  - 1 with misc. topics (forward PID discussed in task force sessions)
- 2 open sessions of the **forward task force**  
[+1 joint session fwd TF/bwd TF/DGWG + 1 closed session]
  - Status updates of the FARICH, FTOF and pixelated TOF projects
  - Task force report will follow soon – **not discussed here**

# PID Parallel Sessions

- PID parallel sessions

**Tuesday, 14 December 2010**

[59] **FDIRC prototype CRT test and its impact on FDIRC at SuperB**

by Dr. Jerry VAVRA (SLAC)  
(B128 - Baxter Room 128: 11:00 - 11:20)

[60] **FDIRC MC simulation**

by Prof. Douglas ROBERTS (University of Maryland); Dr. Jerry VAVRA (SLAC)  
(B128 - Baxter Room 128: 11:20 - 11:40)

[72] **Mechanics for the CRT test**

by Massimo BENETTONI (PD)  
(B128 - Baxter Room 128: 11:40 - 12:00)

[73] **Barrel electronics**

by Mr. Christophe BEIGBEDER (LAL)  
(B128 - Baxter Room 128: 12:00 - 12:20)

**Wednesday, 15 December 2010**

[127] **LAL test bench for PMTs**

by Mr. Dominique BRETON (LAL ORSAY)  
(B128 - Baxter Room 128: 09:00 - 09:20)

[139] **Quick Report on Radiation Hardness studies on Silicon G-APDs**

by Enrico FELTRESI (PD)  
(B128 - Baxter Room 128: 09:20 - 09:40)

- Forward task force sessions

**Wednesday, 15 December 2010**

[114] **Introductory Remarks**

by Prof. Abolhassan JAWAHERY (University of Maryland)  
(B210 - Baxter Room 210: 11:00 - 11:05)

[115] **Physics Impact of Forward PID**

by Matteo RAMA (LNF)  
(B210 - Baxter Room 210: 11:05 - 11:45)

[116] **Test Beam Study of Impact FPID on F-EMC**

by Stefano GERMANI (PG)  
(B210 - Baxter Room 210: 11:55 - 12:15)

**Wednesday, 15 December 2010**

[117] **Introduction FTOF (+ Cost Estimate)**

by Prof. Achille STOCCHI (LAL - Université Paris Sud and IN2p3/CNRS); Dr. NICOLAS ARNAUD (LAL ORSAY CNRS-IN2P3)  
(B210 - Baxter Room 210: 14:00 - 14:30)

[118] **CRT Experiments: Set-Up/Electronic**

by Mr. Dominique BRETON (LAL ORSAY)  
(B210 - Baxter Room 210: 14:30 - 14:55)

[119] **CRT Experiments: Results of Data Analysis**

by Mr. Leonid BURMISTROV (LaL)  
(B210 - Baxter Room 210: 14:55 - 15:20)

**Wednesday, 15 December 2010**

[121] **FARICH & Responses to TF Questions**

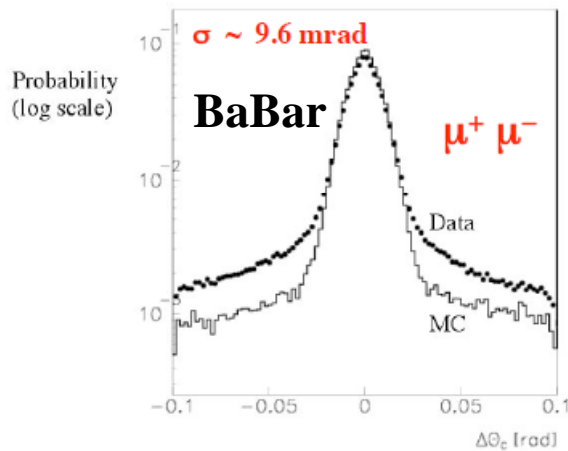
by Dr. Evgeniy KRAVCHENKO (Budker INP)  
(B210 - Baxter Room 210: 16:00 - 16:40)

[122] **Pixelated TOF & Responses to TF Questions**

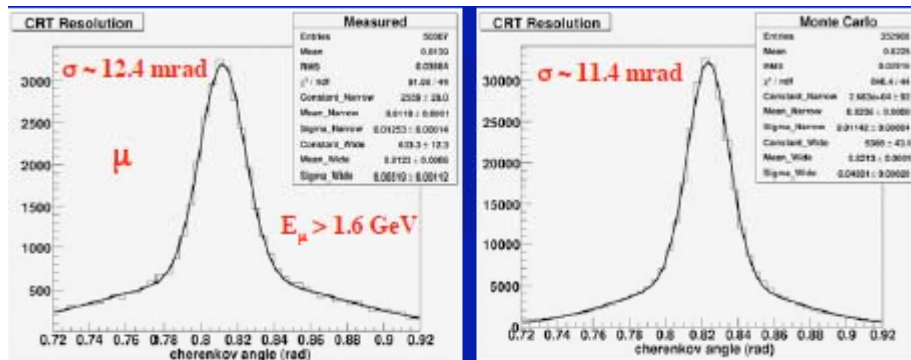
by Dr. Jerry VAVRA (SLAC)  
(B210 - Baxter Room 210: 16:40 - 17:10)

# FDIRC prototype data analysis (J. Va'vra)

- **FDIRC prototype** in SLAC **Cosmic Ray Telescope (CRT)**
- Useful to investigate effects not well-understood  
Ex: tails of  $\theta_C$  distribution (analysis in progress)



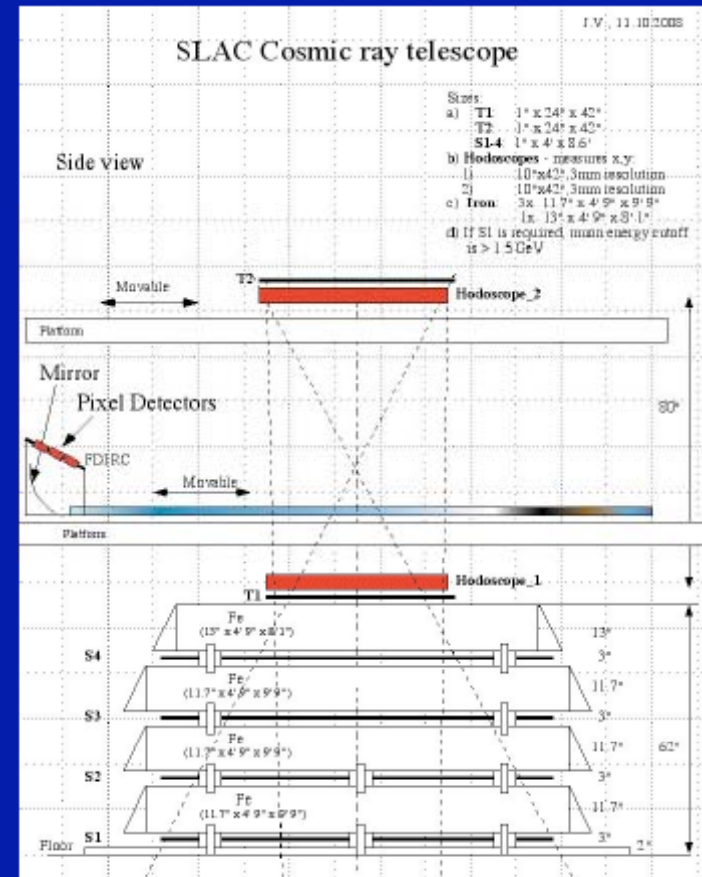
CRT



Data

MC

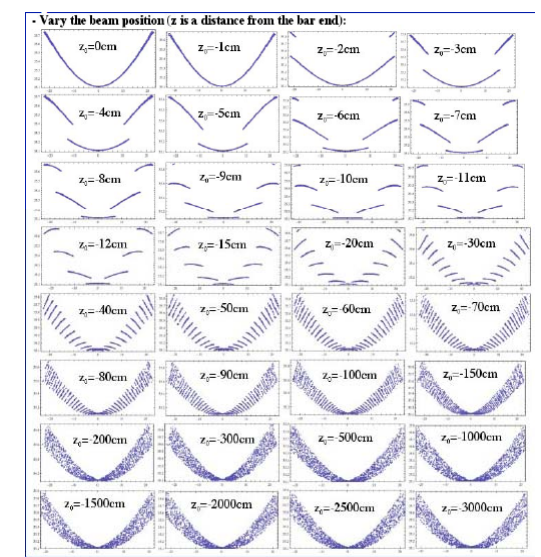
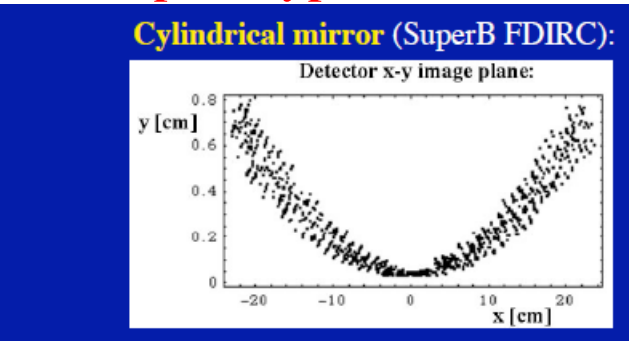
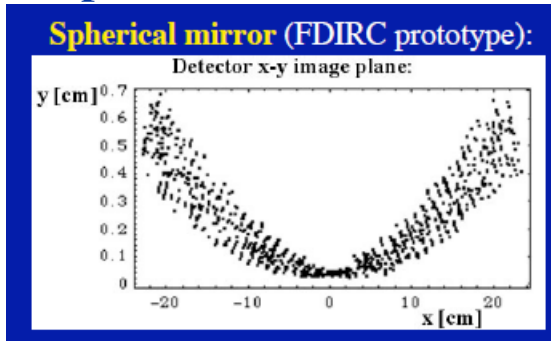
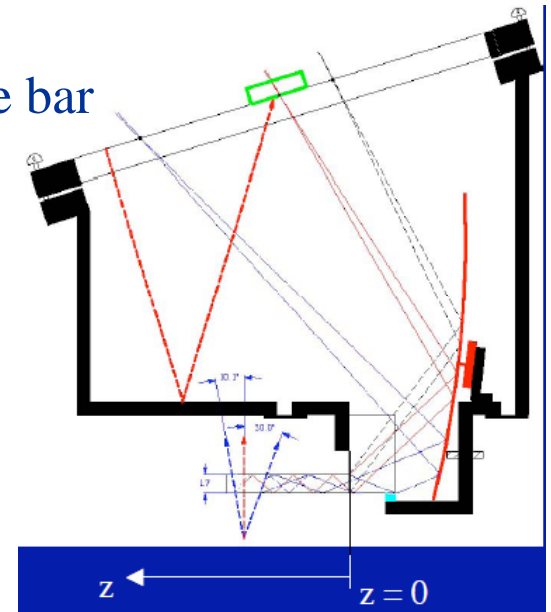
## Cosmic Ray Telescope (CRT): (described in SLAC-PUB-13873 (2010):



# FDIRC prototype data analysis (J. Va'vra)

- More findings on the  $\theta_C$  resolution:
  - independent from the number of top/bottom bounces in the bar
  - earliest photons (= shortest TOP) give the best resolution
  - resolution gets worse near ring edges
    - Optical aberration ('kaleidoscopic effect') increases with the distance  $z$  between the track and the bar end
    - Effect amplified by the mirror
- Cylindrical mirror (as in SuperB) twice better than spherical mirror (as in FDIRC prototype)

Using pixels

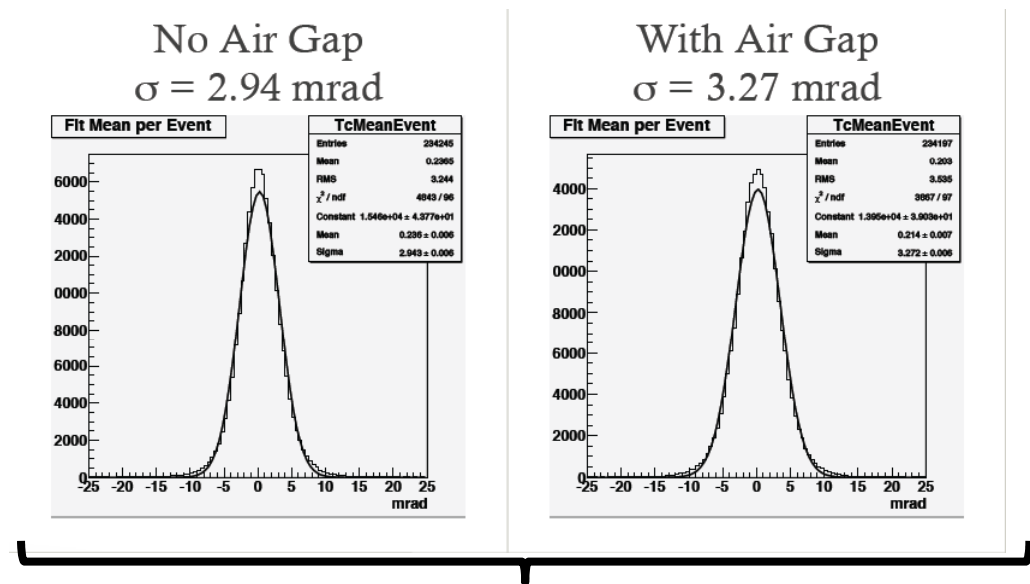
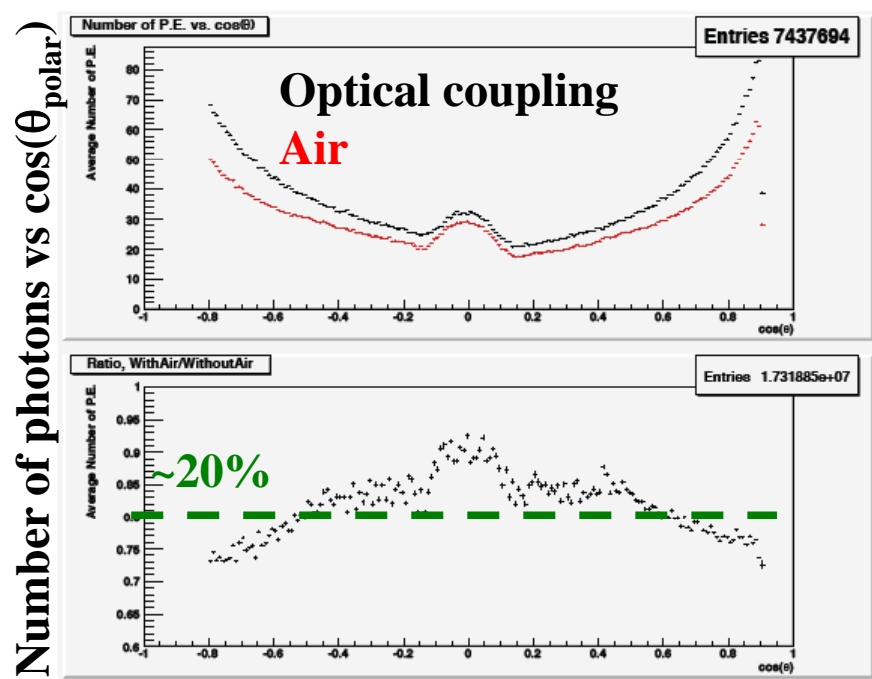


- FDIRC prototype data analysis allow crosschecks with Monte-Carlo simulations (Mathematica ray-tracing)
- Another idea: to use TOP ( $\beta=1$ ) to compute  $\theta_C$  resolution
  - Final analysis will use both pixels and time

# FDIRC MC Simulation (D. Roberts)

- Compare performances with and w/o optical coupling between FBLOCK and PMT
  - No coupling (= air) simplifies the PMT maintenance
  - But photons at large angles are partly lost due to index mismatch

⇒ Dimuon MC study

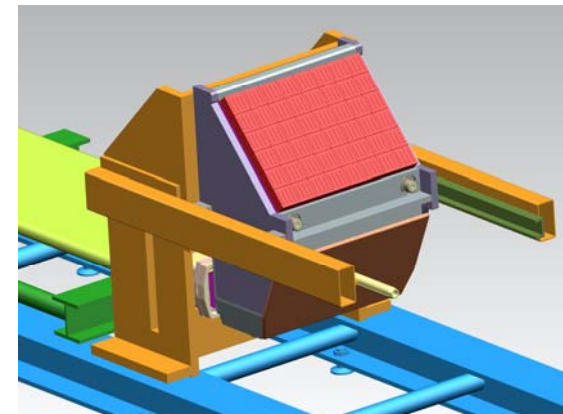
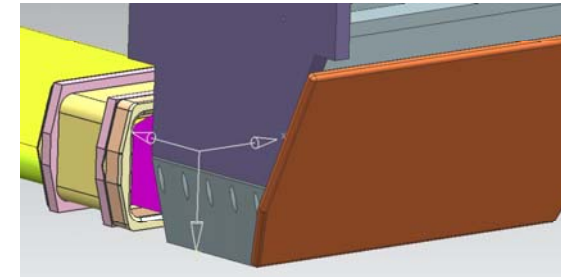
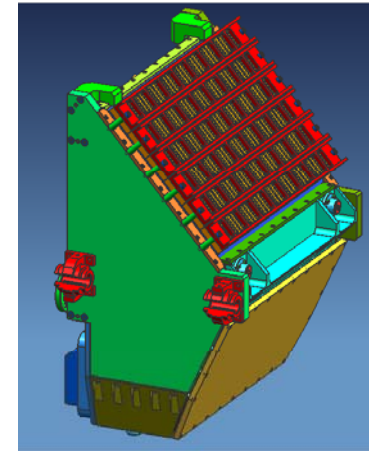


~10% loss in resolution

- Analysis to be refined (timing, chromatic corrections, technique, etc.)

# Mechanics for the CRT test (M. Benettoni)

- **SLAC + Padova + Bari**
- Design of the FBLOCK prototype and of its support structure in the CRT
- Many topics under study: clean room assembly, sealing to the bar box, alignment strategy, etc.
- Preliminary workshop drawings ready
- Current **planning**:
  - Production of parts late January-March  
→ Machining done by external companies
  - Checks and trial assembly in April
  - Shipping to SLAC April-May
  - **Assembly at SLAC in May**
- ⇒ SLAC-Padova-Bari dedicated meeting to review the schedule and make it possible



# Barrel Electronics (C. Beigbeder)

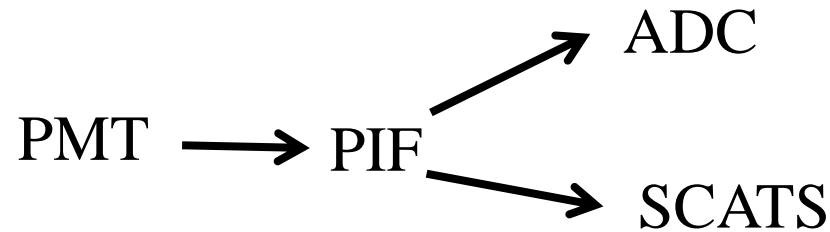
- Development of two chips

- Front-end: **PIF**

- TDC: **SCATS**

16 channels

70 ps resolution



- **SCATS**

- Various progresses: front-end upgrade, readout simulations, RAM design started

- Chip to be submitted in May; 1<sup>st</sup> prototype available ~3 months later

- **PIF**

- No relevant progress since Frascati meeting

- SCATS simulations help defining specifications for the output design architecture and the synchronization of the PIF chip

→ Architecture to be finalized

- Design of the Common Fraction Discriminator (CFD) will start soon

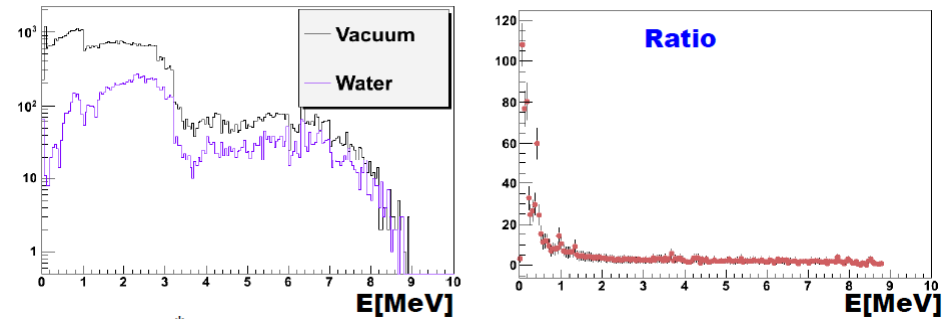
- H-8500 PMT bought to create a test setup in LAL-Orsay

# PM Tests

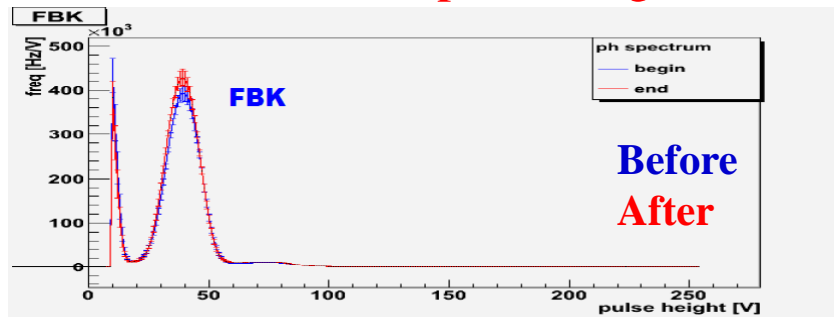


# SiPM n Irradiation Studies (E. Feltresi)

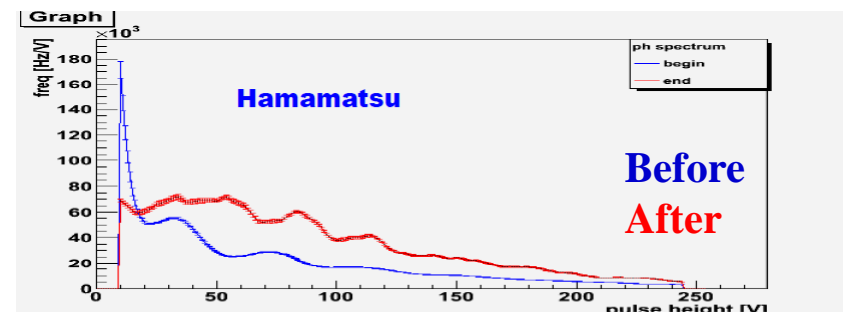
- Irradiation by neutrons of various Si G-APDs at Legnaro
  - **FBK, Hamamatsu**
  - **1 mm<sup>2</sup> to 9 mm<sup>2</sup>**
- **Neutron moderator** (10 cm of water) added in front of Si
  - Less energetic neutrons killed



- **FBK device looks promising**

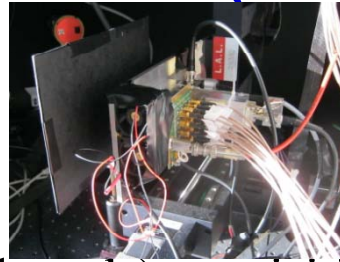


- **Hamamatsu's one doesn't**

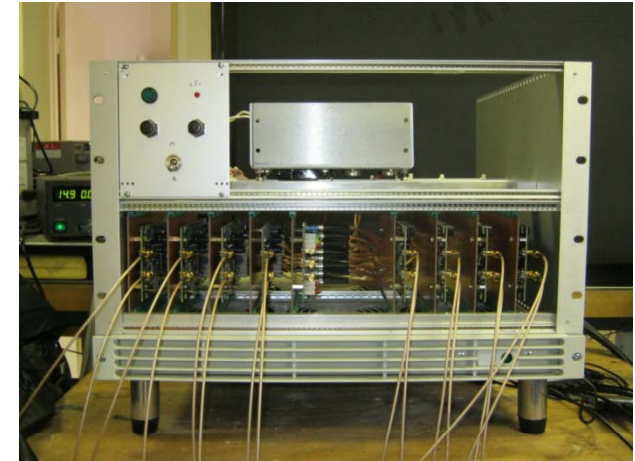


- More work on simulation needed to understand these results
- Plan to test other moderators (paraffin, graphite) in the near future

# LAL Test Bench (D. Breton)



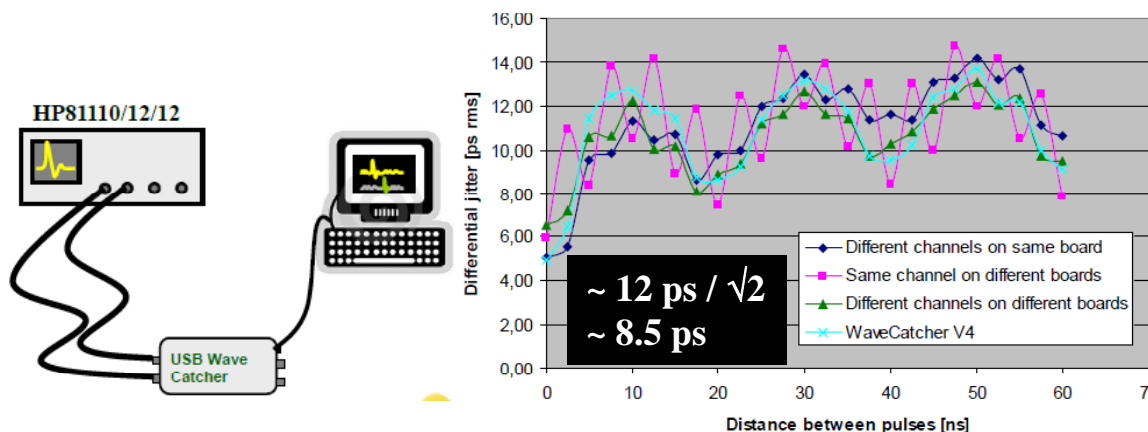
- Test of a Burle MCP-PMT (25  $\mu\text{m}$ )
- Electronics: 16-channel (8 **USBWC** boards) acquisition crate identical to the one used at SLAC for CRT tests
- Preliminary map produced
  - Test bench optimizations needed
- Important results for the electronics already achieved



- **Time performance of the multiboard system**

- **Find and fix an USB buffer problem inside the DAQ PC which was a source of synchro losses between boards**

→ See forward PID slides

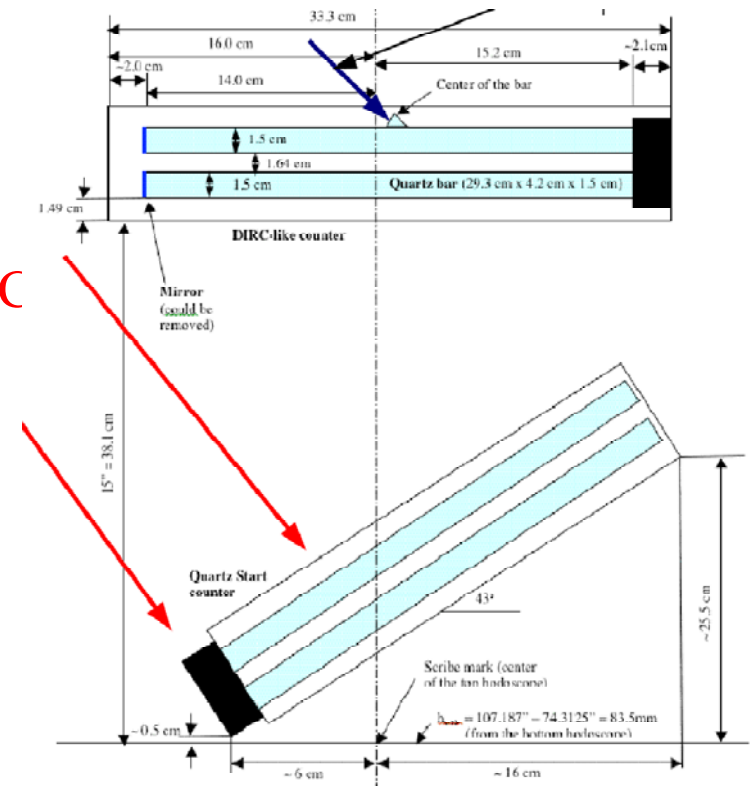
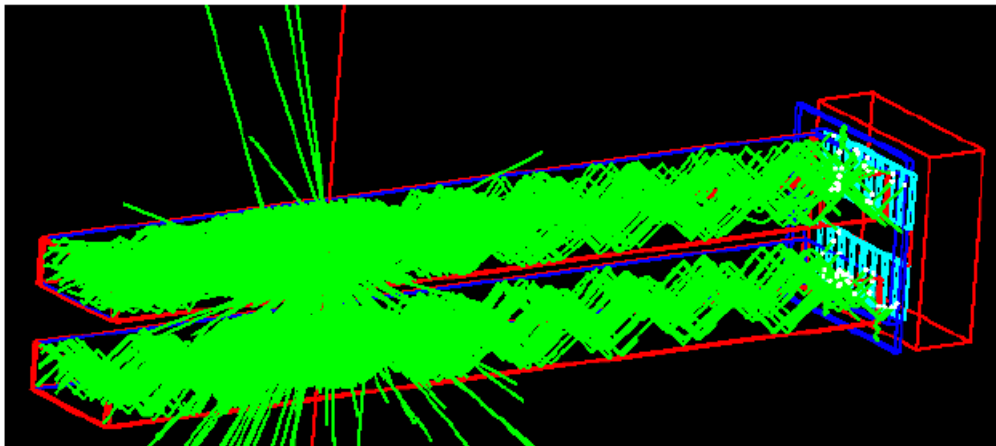


→ Design of a 16-channel board in progress

# Forward PID

# FTOF Update (LAL, SLAC)

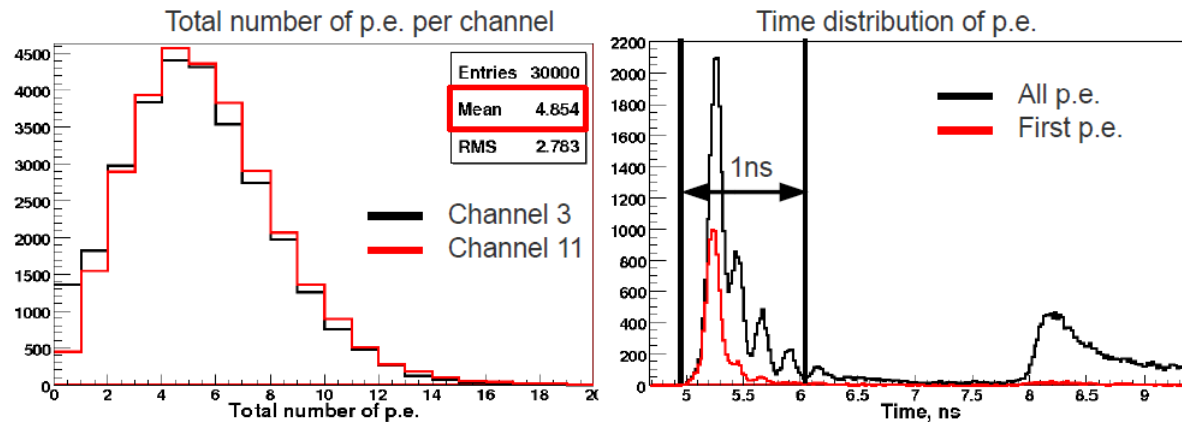
- New iteration on **the cost: ~ 2 M€**  
→ PMT cost alone is ~1.2 M€
- **Recent activities centered on the CRT test @ SLAC**  
→ **Leonid's work**



- CRT and USBWC DAQ systems are separated for technical reasons  
→ **Timing coincidences used to match events and hence select energetic muons**
- **Simulation developed to help understanding the data**  
→ **Key features of the setup discovered**

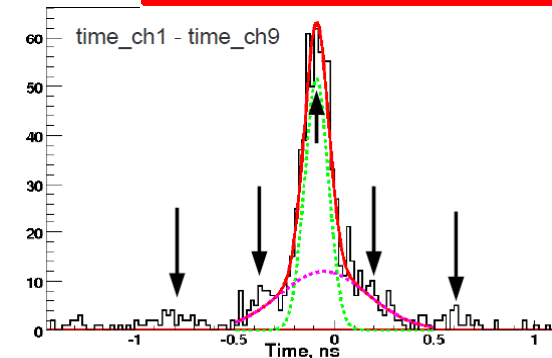
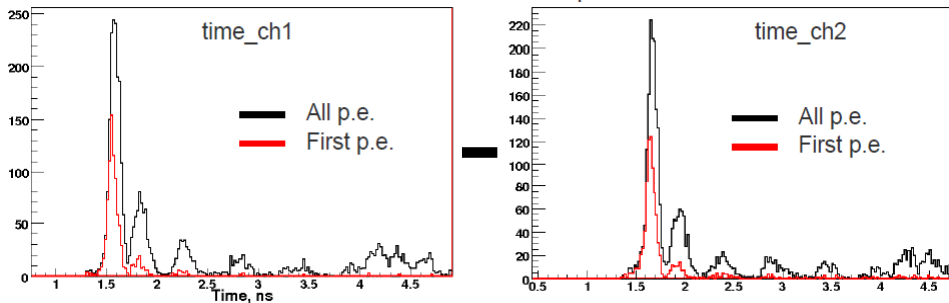
# FTOF Update (LAL, SLAC)

- Significantly **more than 1 ph.e. per channel**
- **Most of the late ph.e. arrive less than 1 ns (PMT rise time) after the first ph.e.**  
 $\Rightarrow$  CFD algorithm (used to measure timing) performances are degraded



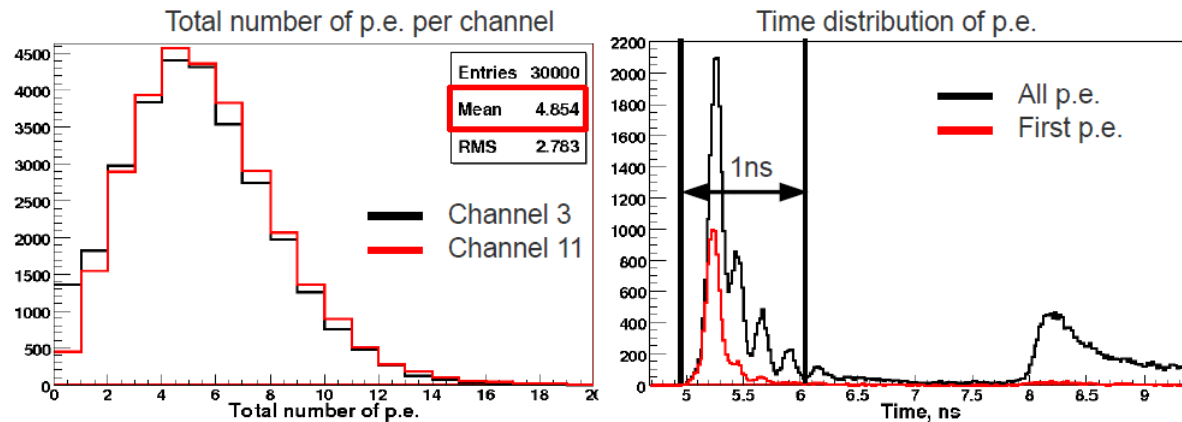
- No absolute time  $\Rightarrow$  **Compute differences between 2 channels**
- **Simulation results do depend on the track parameters**

	$\sigma$ , ps	fraction, %
wide	221.5	45.5
narrow	59.5	50.5



# FTOF Update (LAL, SLAC)

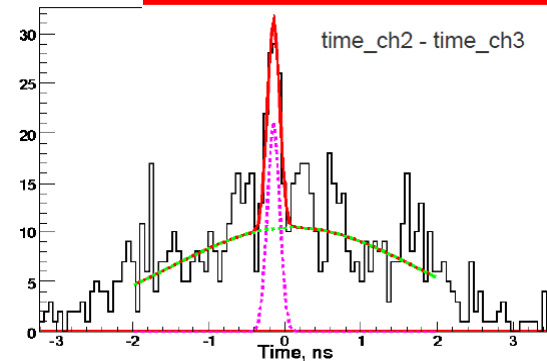
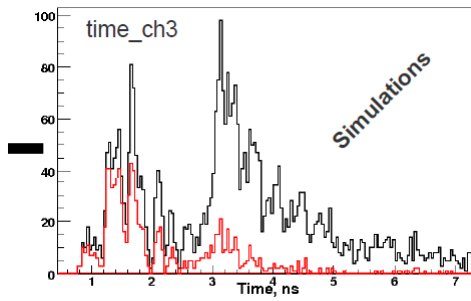
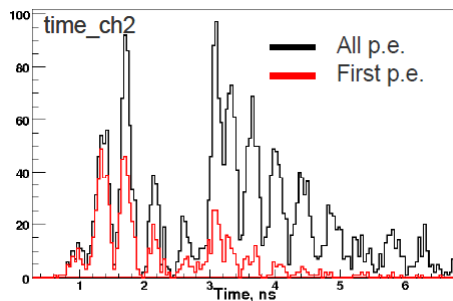
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 $\Rightarrow$  CFD algorithm (used to measure timing) performances are degraded



- No absolute time  $\Rightarrow$  **Compute differences between 2 channels**
- **Simulation results do depend on the track parameters**

	$\sigma$ , ps	fraction, %
Wide	1644	88.7
Narrow	80	11.3

11

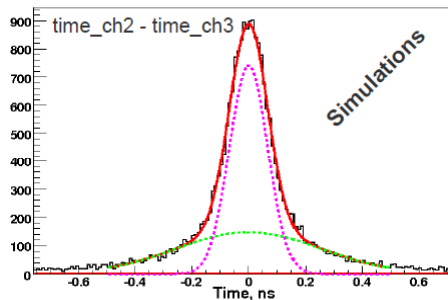


# FTOF Update (LAL, SLAC)

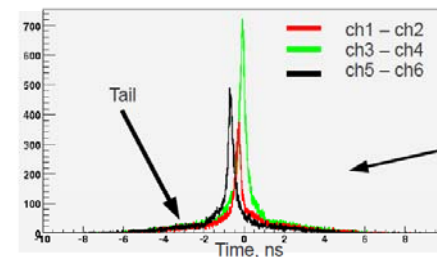
- **Problem** discovered at LAL on 12/06 about **USBWC board synchronization**
  - Some USBWC buffers may not be emptied properly: then, the waveforms recorded at a given time in the 16 channels would come from different events!
  - **Impossible to match CRT and USBWC events** ☹
  - **Fixed software running at CRT since 12/08**; first results expected soon (low rate)
- Only possibility for now: **integrate all events (muons) together and make time differences between channels of the same board (no desynchronization)**
  - Keep **'clean' waveforms** (remove crosstalks and multipеaks) only

## Simulation results

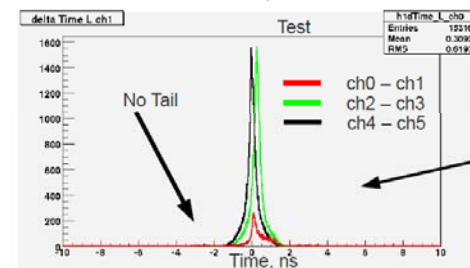
	$\sigma$ , ps	fraction, %
wide	254.5	42
narrow	67.3	58



## Evidence of desynchronization in data



**Comparison of channels from different boards**



**Comparison of channels from the same board**

# FTOF Update (LAL, SLAC)

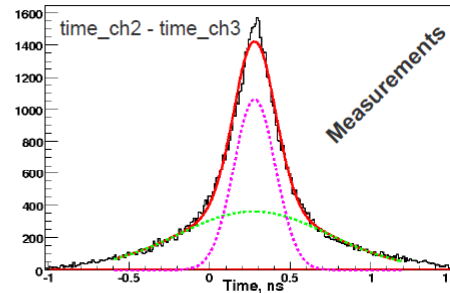
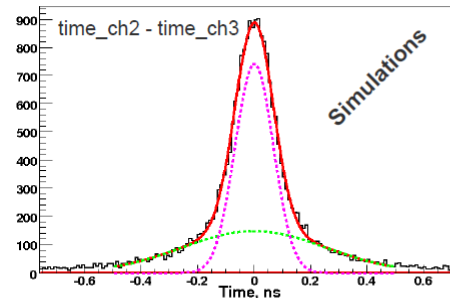
- Limited agreement between data and simulation so far

	$\sigma$ ,ps	fraction, %
wide	254.5	42
Narrow	67.3	58

Time resolution/channel:  
 $67.3/\text{sqrt}(2) \sim 50\text{ps}$

	$\sigma$ ,ps	fraction, %
wide	470.5	54
Narrow	129.0	46

Time resolution/channel:  
 $129.3/\text{sqrt}(2) \sim 90\text{ps}$



⇒ **Simulation needs to be improved** to account for the main setup features.  
In particular, the PMT will be simulated

- **Future plans**

- Try to **reduce the # of ph.e.**

- Rotate the counter a bit [in DIRC, minimum yield @  $\cos(\theta) \sim 0.15$ ]

- Put absorber in front of PMT

- **Switch to SL 10:** rise time twice faster and twice more channels



# FARICH (E. Kravchenko)

- Concluding slide from Evgeniy's talk

- FARICH with an excellent performance is proposed.
- Background rate is under control.
- Aging of MCP PMTs is minor.
- 25% of X0 of additional material in the endcap
- Degradation of momentum resolution for forward tracks
- Absence of experimental results from the prototype from our group

The gain in efficiency for selected physics channels is about 5%.

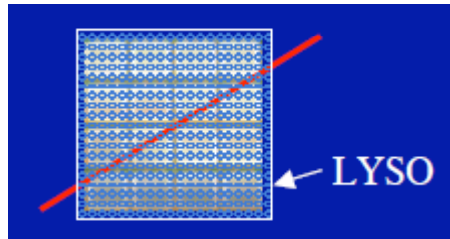
The cost of the system is around 3.5 Millions Euros

- Prototype status

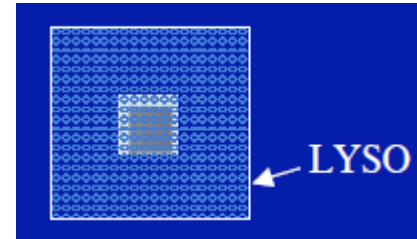
- 2+2 focusing aerogel tiles ready to be tested
- SiPMTs used as photon detectors
- Beam tests scheduled in January-February 2011

# Pixilated TOF (J. Va'vra)

- Hamamatsu G-APDs in front of a long LYSO crystal (forward EMC)



4×4 array



Single 9 mm<sup>2</sup>

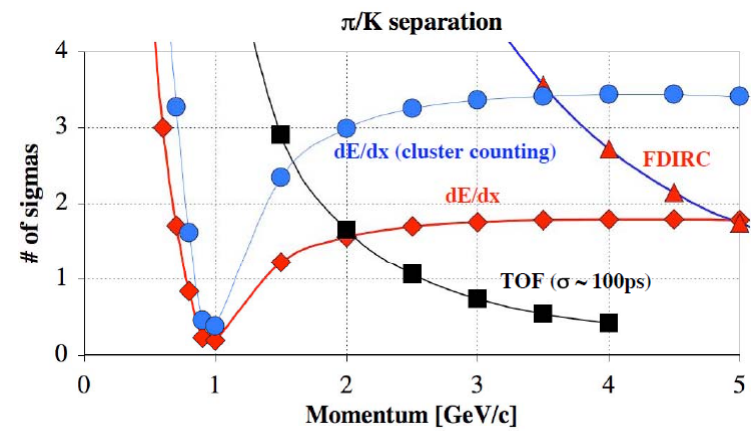
- Left setup being currently tested in CRT at SLAC  
→ Results expected beginning of January (low DAQ rate)

- Right setup to be tested early next year

- $\sigma \sim 136$  ps for a short LYSO crystal  
→ Promising performances

- Main points to be studied:

cost, electronics (link from detector, location, specs, etc.), signal yield



# Conclusions

# Outlook

- **Progress in Barrel and Forward areas**
  - Despite lack of manpower (hard to focus on various topics in parallel) and lack of approval... until today
- **The SLAC CRT is definitely the device where to make PID tests**
  - This setup needs some support to be maintained
  - ... and manpower to be operated and to analyze its data
- Efforts are TDR-oriented
- Hope that approval brings us part of the missing manpower soon...

