PID Summary

Elba SuperB Meeting, June 1rst 2011

Nicolas Arnaud, for the SuperB PID group

- 2 parallel sessions
  - 1 barrel-oriented
  - 1 with misc. topics including forward PID talks
- 1 closed session of the forward task force
  → TF + proponents + PID system managers
  → See report by Hassan this afternoon

PID Parallel Sessions

- Two PID parallel sessions

Sunday, 29 May 2011

[76] **FTOF update including CRT test and background**
by Mr. leonid BURMISTROV (LaL)
(Sala Bonaparte 1: 18:00 - 18:20)

[77] **Test Beam Results on Focusing Aerogel**
by Dr. Evgeniy KRAVCHENKO (Budker INP)
(Sala Bonaparte 1: 18:20 - 18:40)

[78] **Status of the design of the 16-channel WaveCatcher board**
by Mr. Dominique BRETON (LAL ORSAY)
(Sala Bonaparte 1: 18:40 - 18:50)

[79] **PMT Scanning Setup at Maryland**
by Prof. Douglas ROBERTS (University of Maryland)
(Sala Bonaparte 1: 18:50 - 19:05)

[80] **SiPM SPTR in function of the temperature and the wavelength**
by Dr. Véronique PUILL (CNRS IN2P3 LAL)
(Sala Bonaparte 1: 19:05 - 19:20)

[86] **Quick look at irradiated SiPM at low temperatures**
by Dr. Gabriele SIMI (ATTIVITA_DI_RICERCA)
(Sala Bonaparte 1: 19:20 - 19:30)

Tuesday, 31 May 2011

[81] **FDIRC status**
by Dr. Jerry VAVRA (SLAC)
(Sala Bonaparte 1: 16:00 - 16:20)

[82] **Status of Fbox production and Fbox assembly procedure**
by Massimo BENETTONI (PD)
(Sala Bonaparte 1: 16:20 - 16:30)

[83] **Bari activities**
by Mario Nicola MAZZIOTTA (BA)
(Sala Bonaparte 1: 16:30 - 16:45)

[84] **FDIRC Simulation Tools: Preparing for the Prototype**
by Prof. Douglas ROBERTS (University of Maryland)
(Sala Bonaparte 1: 16:45 - 17:00)

[148] **new crt data reconstruction**
by Dr. Gabriele SIMI (ATTIVITA_DI_RICERCA)
(Sala Bonaparte 1: 17:00 - 17:10)

[85] **Barrel electronics status**
by Mr. Christophe BEIGBEDER (LAL)
(Sala Bonaparte 1: 17:10 - 17:25)

[87] **Time for discussion**
(Sala Bonaparte 1: 17:25 - 17:30)

- One forward task force closed session

16:00->*17:30* **Parallel: Forw Task Force Meeting (closed)** (Convener: Abolhassan Jawahery (*University of Maryland*)) (Sala Bonaparte 1))

Contents

- Barrel PID
- Forward PID
- SiPM tests
- Outlook

Barrel PID

- FDIRC status
- Fbox production and assembly status
- Activities related to the FDIRC test @ SLAC Cosmic Ray Telescope (CRT)
- Simulation tools
- Electronics status

- Maryland scanning setup

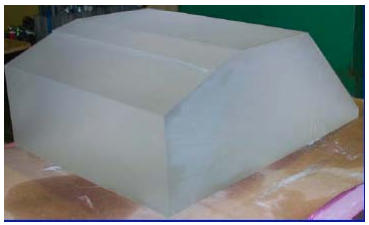
- First discussion about the assignment of tasks among the PID groups
  $\rightarrow$ To be continued

FDIRC status

- Jerry Va'Vra (SLAC)
  http://agenda.infn.it/getFile.py/access?contribId=81&sessionId=39&resId=0&materialId=slides&confId=3352
- Progresses with optics: Fblock & wedge, glue tests, calibration
- Results from SLAC scanning setup
- Start of the FDIRC prototype test @ SLAC CRT in ~3 months
- FDIRC planning updated for 2011
- Preliminary discussion started to assign tasks to institutions on the long-term

CRT test is becoming concrete!

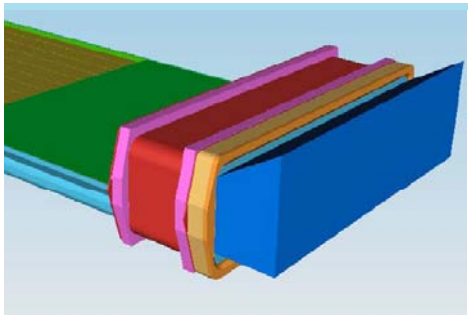
- FBlock and wedge cut
  → Next step is polishing



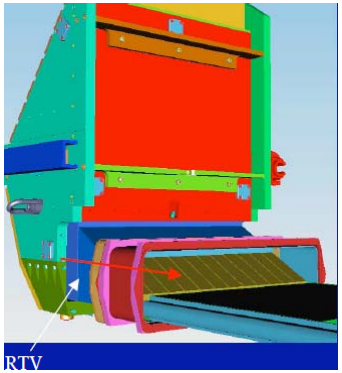
Fblock after a saw raw cut

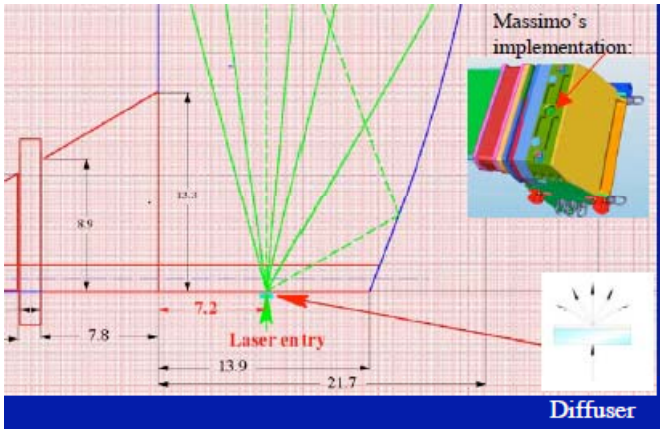
After precise grinding

- Procedure for wedge to barbox gluing defined
  → Epotek 301-2 epoxy in clean room



- RTV coupling with Fblock

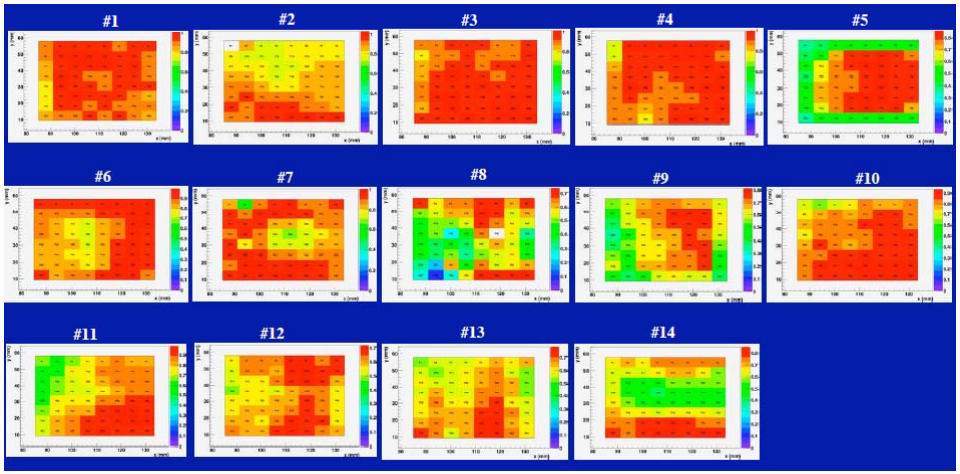


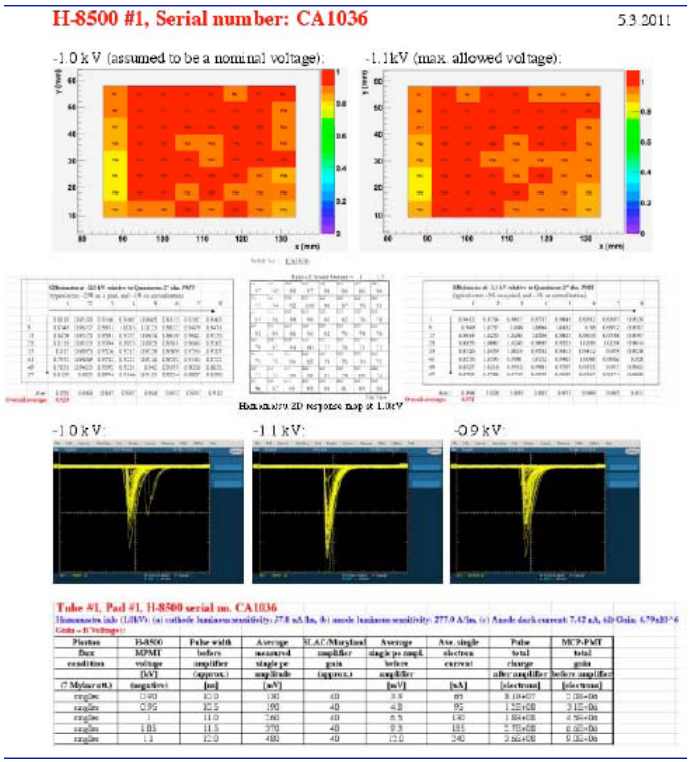


- OPAL diffuser glass to be used for laser calibration at CRT

H-8500 scanning setup

- 14 PMTs scanned

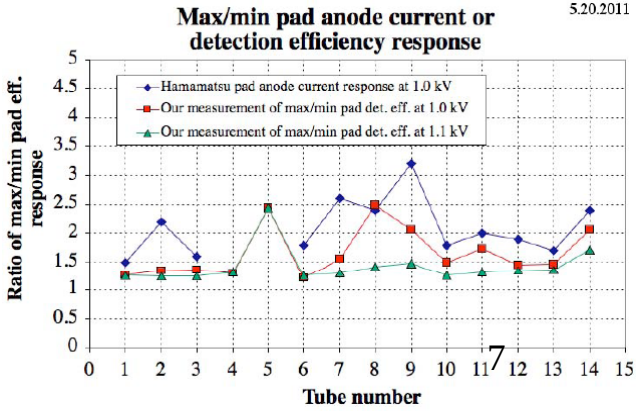




- Various information gathered for each tube
  - Gain
  - 2D efficiency scans at 1.0 et 1.1 kV
  - Scope checks of single photoelectron pulses
  - Hamamatsu data for that particular PMT

- Pixel non-uniformity ~1:1.5

- Efficiencies varying between ~40-50% and 90% w.r.t the reference XP 2020 Quantacon Photonis PMT



FDIRC mechanics (Fbox)

- Massimo Benettoni (Padova)
  http://agenda.infn.it/getFile.py/access?contribId=82&sessionId=39&resId=0&materialId=slides&confId=3352

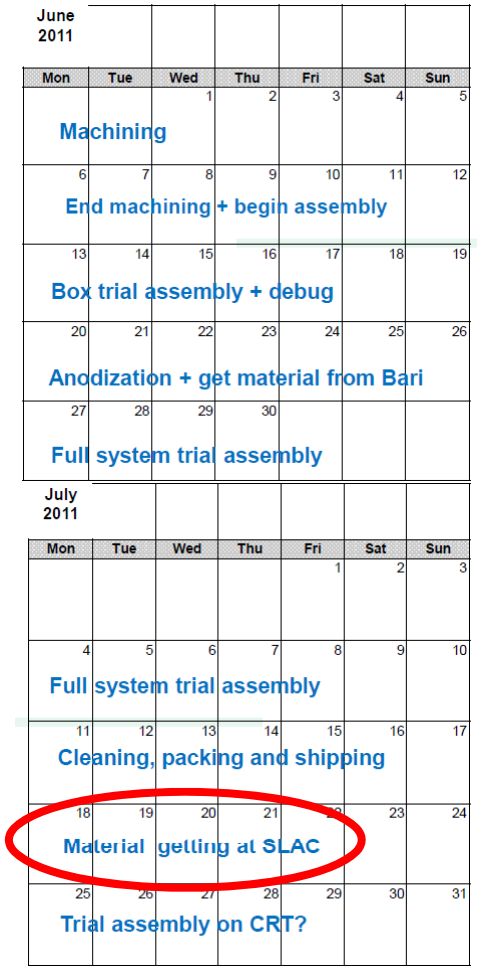
- Parts being produced for the SLAC CRT test
  - Small parts done in Padova: almost finished
  - Large pieces made by workshop

  → Calendar

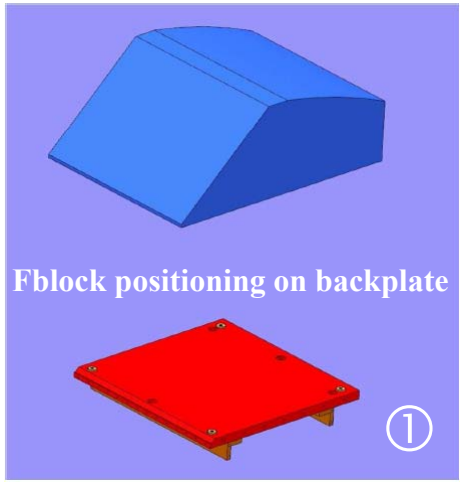
- Fbox assembly procedure being defined

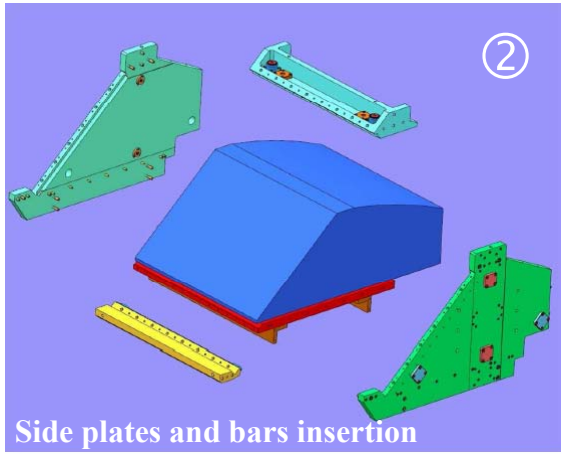
  → See next slide

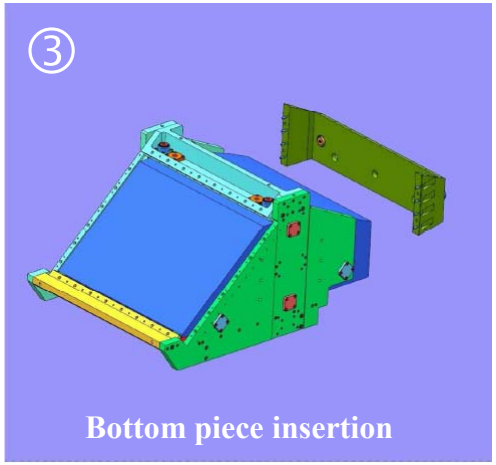
- Some operations are still checked/tested/defined
  - Lifting and handling the Fbox
  - Adjusting and locking position when gluing
  - etc.

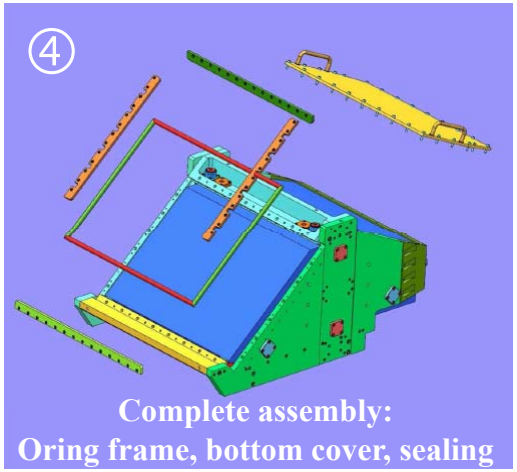


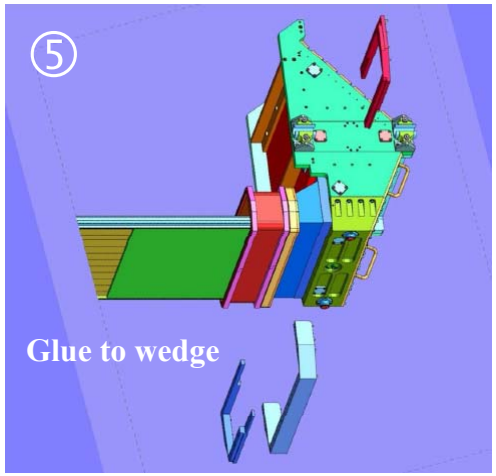
Draft of the Fbox assembly procedure

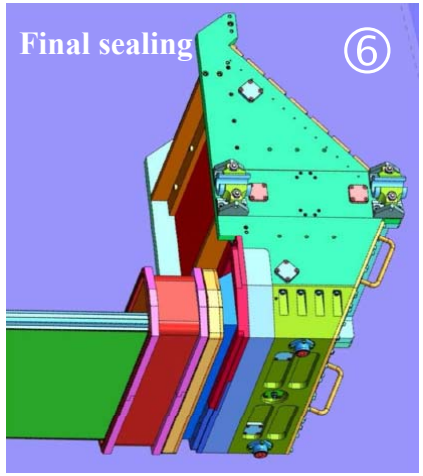








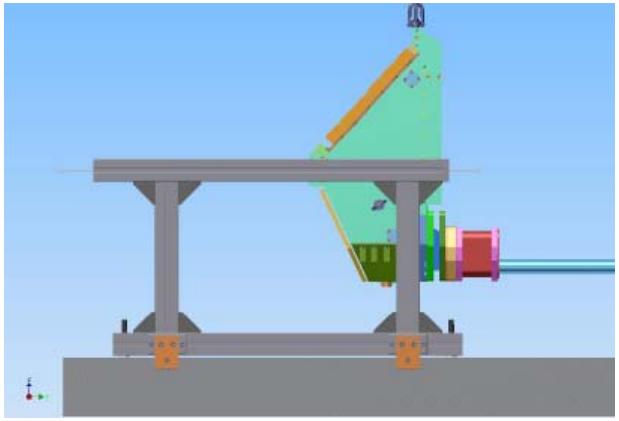




Bari activities

- Nicola Mazziotta (Bari)
  http://agenda.infn.it/getFile.py/access?contribId=83&sessionId=39&resId=0&materialId=slides&confId=3352

- CRT Fbox support
  - Drawings frozen
  - Production ongoing



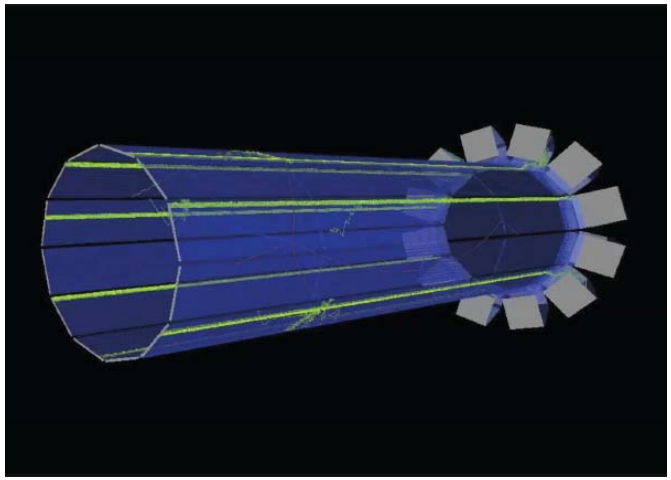
- Dummy Fblock built
  → Dummy wedge being produced

- PMT scanning setup almost ready

- Full simulation activity starting

FDIRC simulation tools

- Doug Roberts (Maryland)
  http://agenda.infn.it/getFile.py/access?contribId=84&sessionId=39&resId=0&materialId=slides&confId=3352
- Summary and status of the current standalone FDIRC Geant4-based simulation
- FDIRC repository in SVN repository
  → fDircG4 package
- Used to produce gdml file for Bruno
- Include creation and tracking of Cerenkov photons through active materials
  → Not possible yet in Bruno; work in progress



- Adaptation to the FDIRC prototype should be very easy
- Multi-step process: simulation → (…) → ROOT-based analysis

Single-photon dictionnary

- Ambiguities in the computation of Cerenkov angle: bar + Fblock reflexions

New CRT data reconstruction

- Gabriele Simi (Padova)
  http://agenda.infn.it/getFile.py/access?contribId=148&sessionId=39&resId=1&materialId=slides&confId=3352

- Starting point: Jerry's fortran code

- Original output (ascii) converted to ROOT

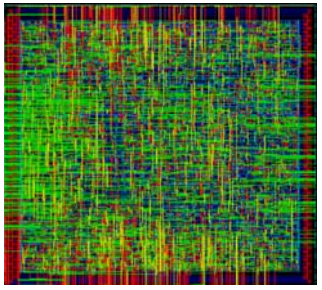
- Plan to rewrite tracking part
  $\rightarrow$ Addition of Kalman filtering

- Add β reconstruction – in addition to Cerenkov angle

Electronics status

- Christophe Beigbeder (LAL)
  http://agenda.infn.it/getFile.py/access?contribId=85&sessionId=39&resId=0&materialId=slides&confId=3352
- Still no news regarding the ANR grant requested (450 k€)
- Two engineers from LPC Caen will become « associate »
  → Work on the SCATS chip design
- Teststand being built for electronics (and PMT) tests
- Design of the mezzanine board started
  → 8 channels CFD-like + amplitude for charge measurement
- Motherboard architecture being studied
  → Mechanical constraints, backplane, cooling and power issues
- Plan is to equip both the LAL bench and the SLAC CRT
- SCATs chip: layout of the 16 channel , simulation post-synthesis and post-layout ongoing
  → Submission still foreseen for July

SCATS digital layout
948 µm × 933 µm

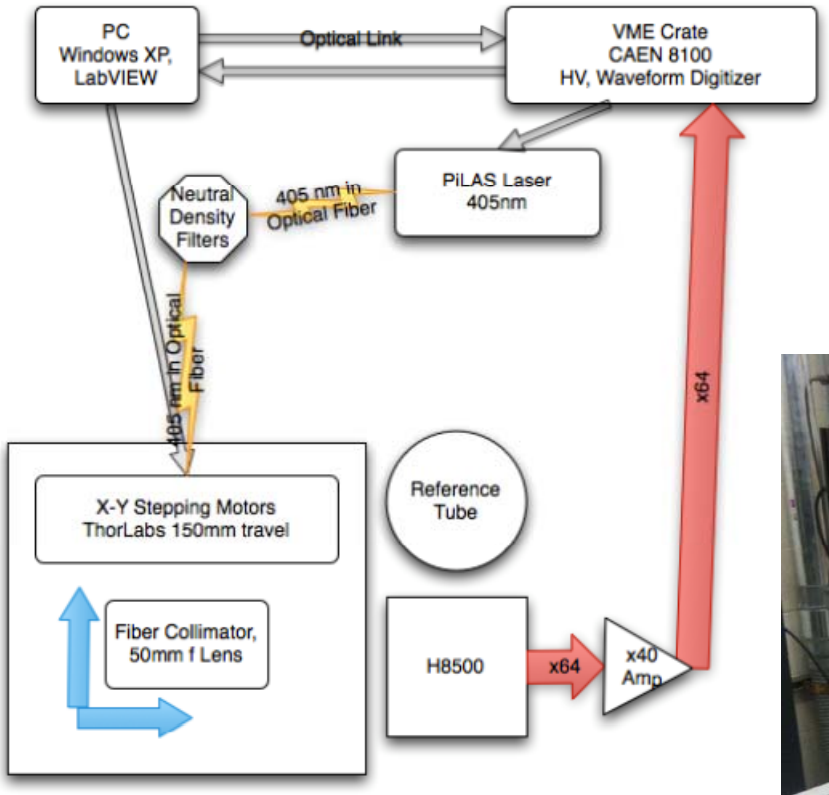


Maryland PM scanning setup

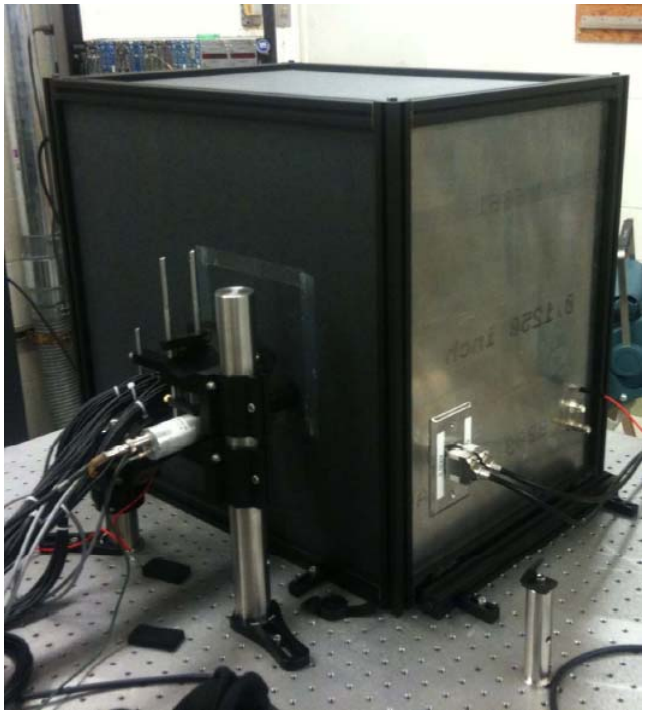
- Doug Roberts (Maryland)
  http://agenda.infn.it/getFile.py/access?contribId=79&sessionId=14&resId=0&materialId=slides&confId=3352
- System to measure and scan phototubes
  → Primarily for H-8500 but flexible
- Readout done by a new & powerful CAEN waveform digitizer board (V1742)
- Steering with Labview
- Teststand still in testing phase but first qualititative measurements presented
- Long todo list:
  - Get more experience with the V1742 board
  - Timing resolution, jitter, noise (from laser!?)
  - Develop the CFD algorithm
  - Speedup scanning cycles
  - Find more accurately the single photoelectron level
- Then define the list of studies and tests

Some pictures of the scanning setup

- Schematic



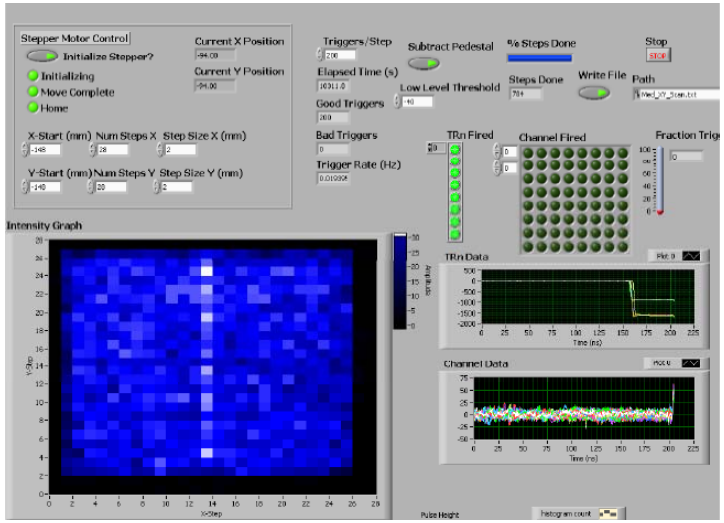
- Black box



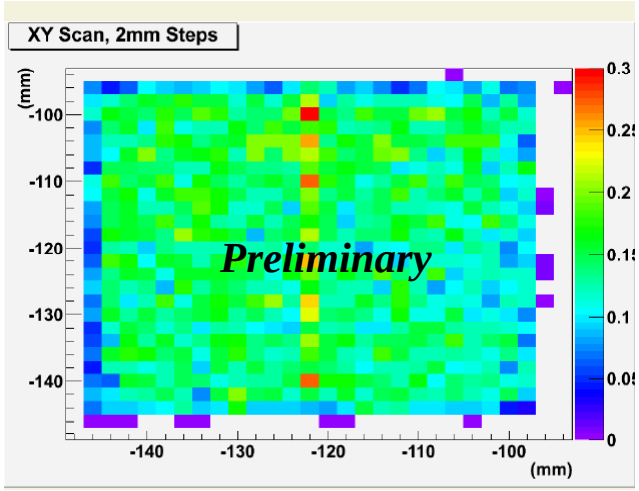
- V1742

Initial results

- Outputs: time (CFD algorithm), integrated charge
- Data files available for offline analysis

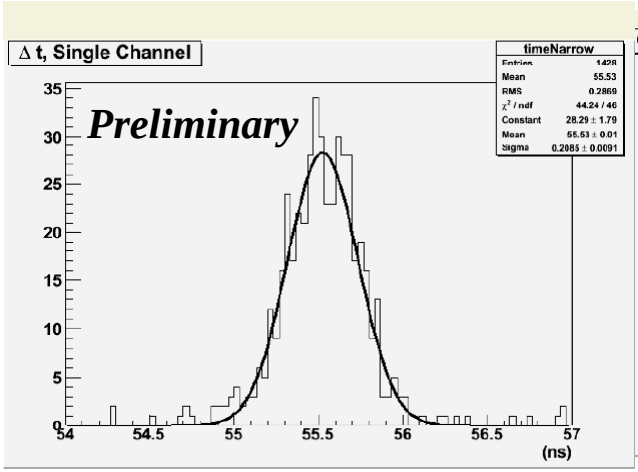


- X-Y scan



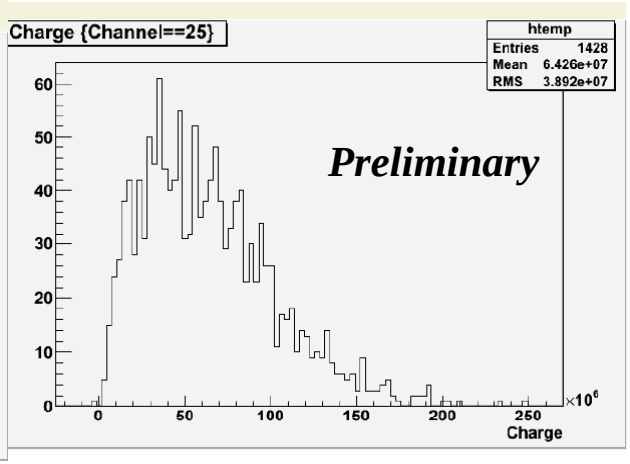
2×2 mm^2 steps

- Timing resolution



σ~210/√2~150 ps

- Integrated charge



Total charge in e$^-$

Forward PID

- FTOF: analysis of the latest radiative Bhabha FullSim production
  - Test @ SLAC CRT ended
    → Hardware problems in the last weeks: latest data of limited interest

- Design of a 16-channel Wavecatcher board

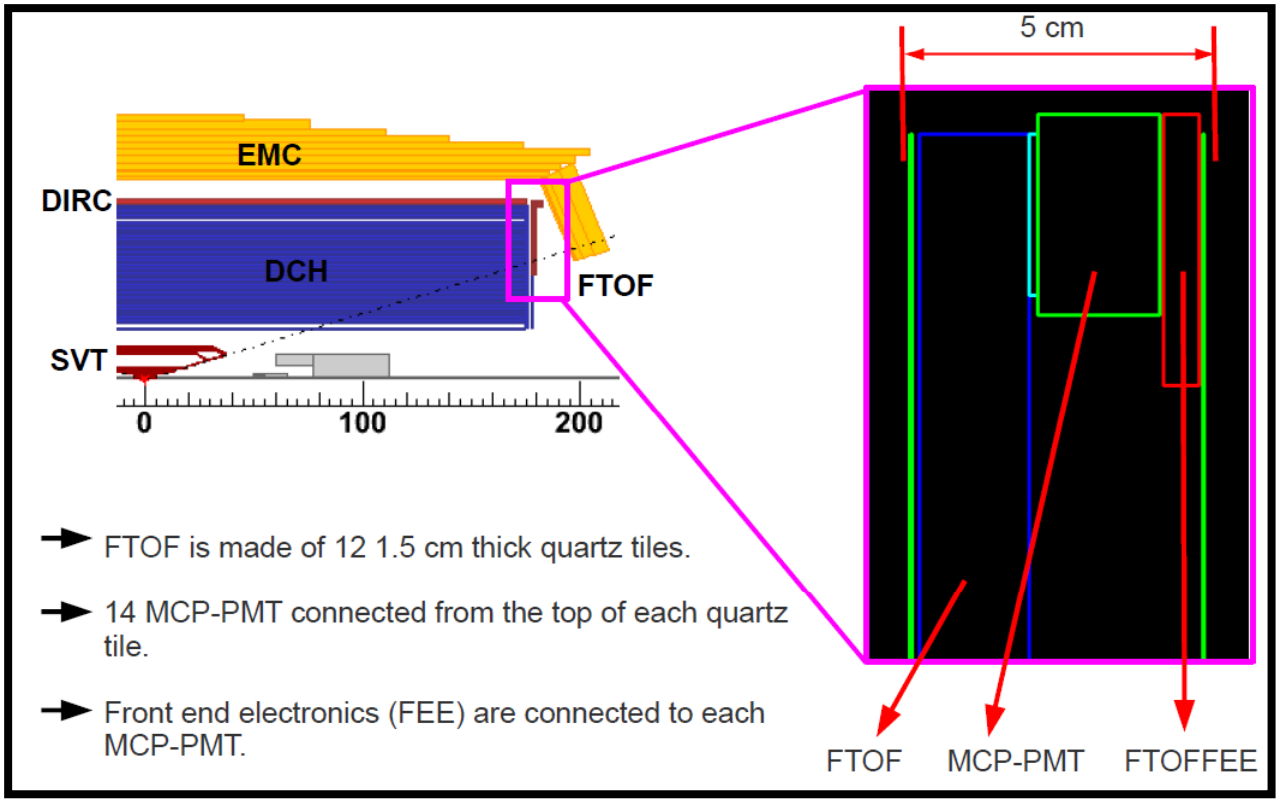
- FARICH: test beam results on focusing aerogel
  → Successful

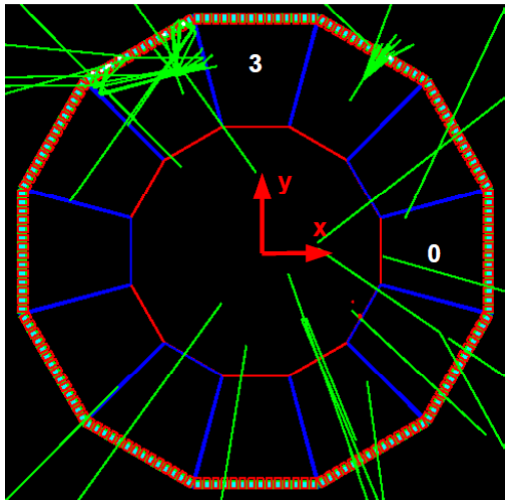
FTOF background analysis

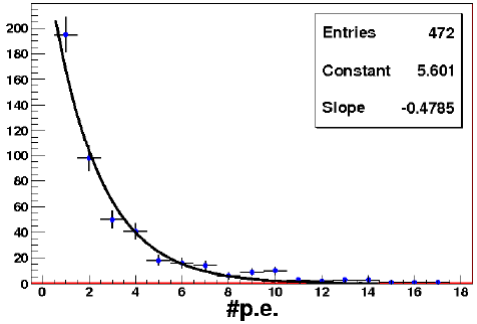
- Leonid Burmistrov (LAL)
  http://agenda.infn.it/getFile.py/access?contribId=76&sessionId=14&resId=0&materialId=slides&confId=3352
- Based on the Elba FullSim production
  → Bug fix w.r.t. the Frascati production (not all tracks processed on forward side)
- Main source of background: ~1 GeV/c e^+ hitting the beam pipe around z=1 meter
  → EM showers which final neutral descendants (γ, n) end up in the FTOF
  → Production of pairs which then emit Cerenkov light
- Main issue: PM total integrated charge after 5 years running at 10^{36}
- Photoelectron (p.e.) rate computed using two methods in agreement
  - Tracks entering the FTOF volume provided by Bruno
    + standalone Geant4 simulation of the FTOF for Cherenkov light production
  - DIRC-based formula from Jerry
- Current background level too high: no safety margin, need to reduce gain
  → Should be mitigated: shielding? Magnetic field change?
  → Excess seen by all systems on the forward side!

Background in FTOF

- FTOF geometry





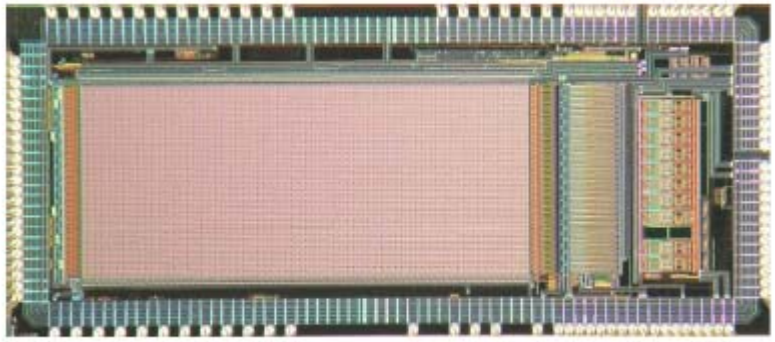


- Bruno + standalone G4: 1.8 p.e. / bunch crossing in the whole FTOF
  → Rate at the PM level: 460 kHz/cm^2
  - DIRC-based estimation gives 3.2 p.e.: in agreement – although less accurate
- A given sector is only hit in a few percents of events

Design of a 16-channel Wavecatcher board

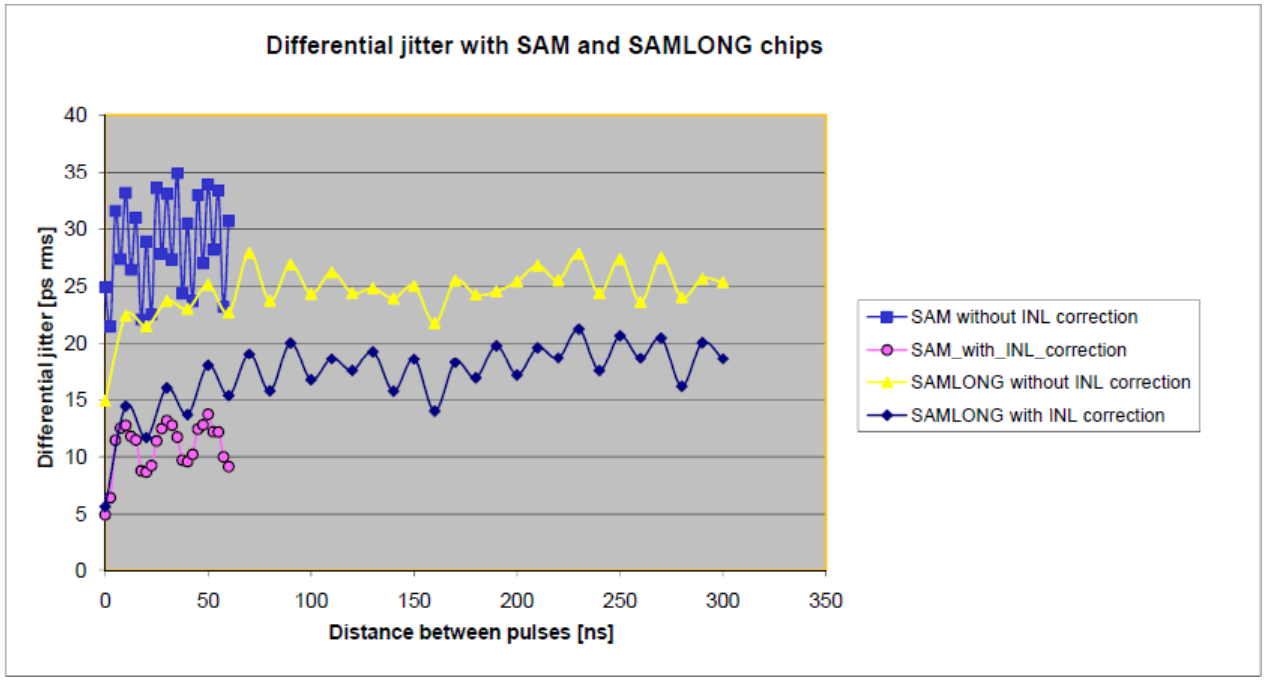
- Dominique Breton (LAL)
  http://agenda.infn.it/materialDisplay.py?contribId=78&sessionId=14&materialId=slides&confId=3352
- Successful tests with a 16-channel crate (8 2-channel USBWC boards)
  - Lab time precision per pulse: ~8.5 ps RMS
  - Confirmed by FTOF test in the SLAC CRT
- Next step towards the final design of FTOF electronics: a 16-channel board
  → 20 boards in a crate: 320 channels!
- Goal is to keep the same timing precision on a much bigger scale
- First 16-channel board prototype to be available in September
- In parallel: design of a new SAM chip: the SAMLONG chip
  - 4 times longer analog memory depth
  - Reduced power
  - Additional new features
  → Future boards will be able to use either SAM(LONG) chip
- First look at the design of a TDC targeting the ps level

SAMLONG chip



- Picture of the chip
  → First prototype received last September

- Timing performances
  - SAMLONG better than SAM w/o correction
  - Fine calibration more difficult due to the memory depth



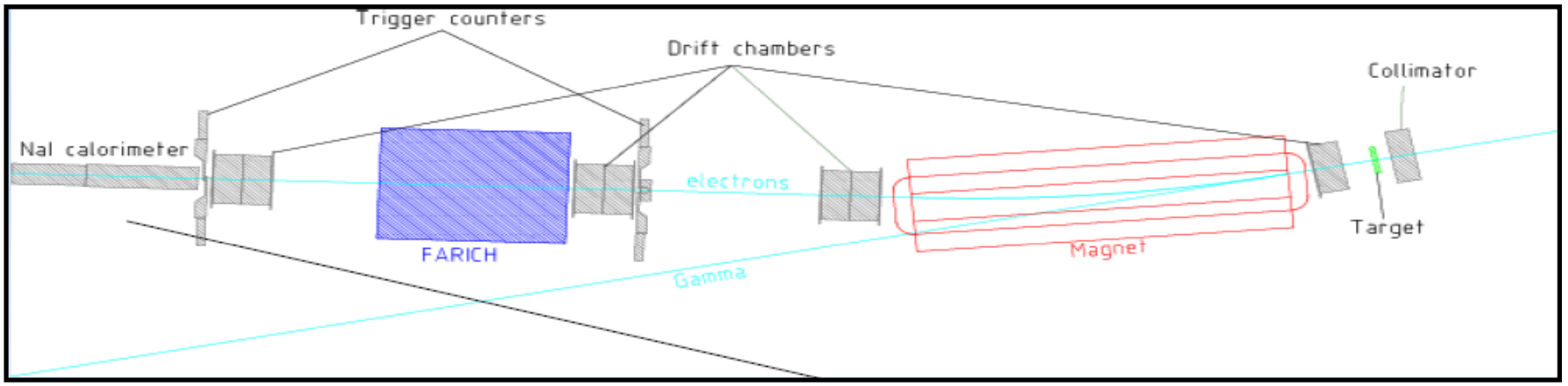
Focusing aerogel test beam

- Evgeniy Kravchenko (Budker INP)
  http://agenda.infn.it/getFile.py/access?contribId=77&sessionId=14&resId=0&materialId=slides&confId=3352

- Successful beam test of 4-layer aerogel

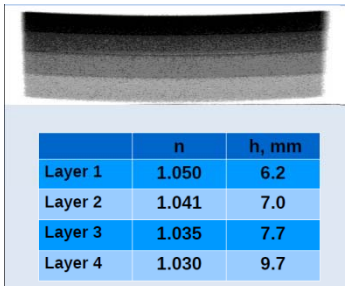
- Results in agreement with MC simulation

- Experimental setup
  - 1.3 GeV secondary electrons



Results

- 4-layer aerogel
  → n function of the density ρ

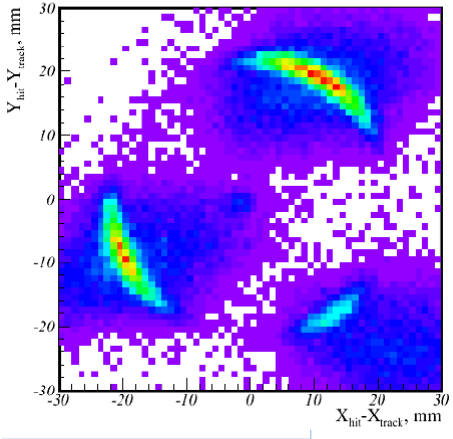


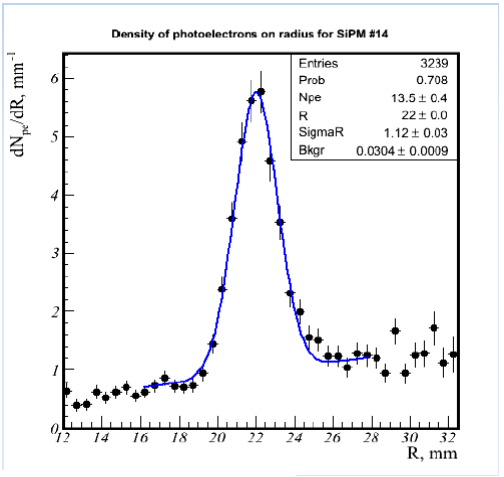
	n	h, mm
Layer 1	1.050	6.2
Layer 2	1.041	7.0
Layer 3	1.035	7.7
Layer 4	1.030	9.7

$100 \times 100 \times 31\ mm^3$

- SiPM for these initial tests

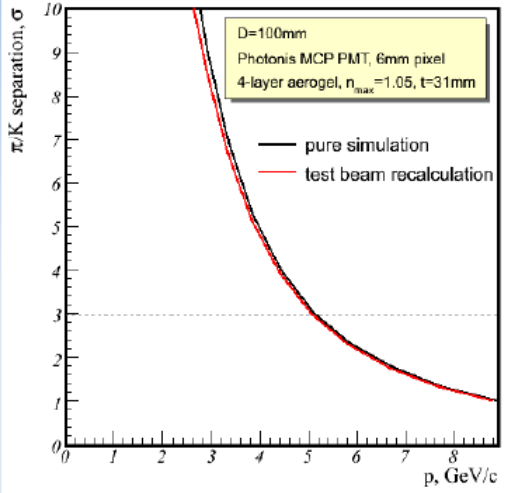
- Nice rings seen
  → Radius measurement





- Agreement with simulation

- Next plans
  - Analyze data from various samples
  - Try different setups
  - Use Planacon PMTs
  - Work on electronics & mechanics



SiPM

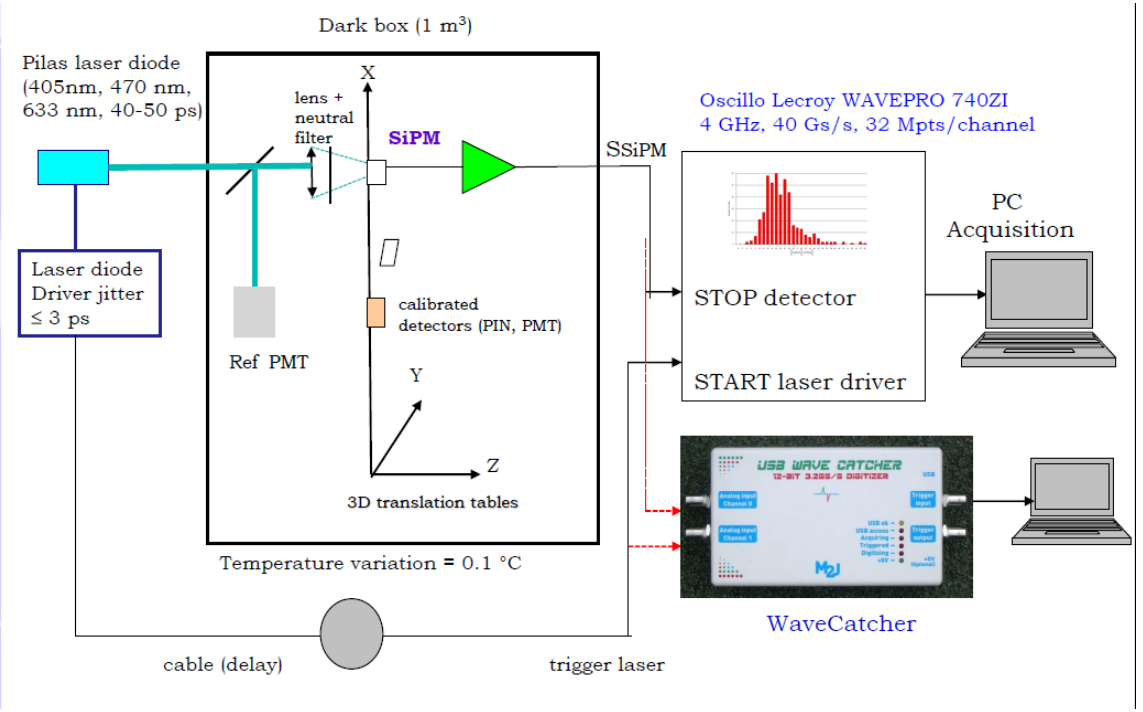
- Single photoelectron timing resolution studies
- Study of irradiated SiPM behaviour at low temperature

Single photoelectron timing studies

- Véronique Puill (LAL)
  http://agenda.infn.it/getFile.py/access?contribId=80&sessionId=14&resId=0&materialId=slides&confId=3352

- Basic characterization of SiPMs

- Timing measurement test bench



- Single photoelectron timing resolution (SPTR, a.k.a. TTS) studied as a function of
  - Bias voltage
  - Wavelength
  - Temperature

Summary of results

Area (mm^2)	Producer	Pixel size (µm)	Best SPTR (FWHM -± 5 %) @ 467 nm & Vbias max	SPTR Variation 405 nm → 635 nm	SPTR variation 0 °C → 20 °C
1	HAMAMATSU	50	150 ps	≈ 0 %	≤ 5 %
1	HAMAMATSU	100	160 ps	≈ 10 %	≤ 5 %
1	Sensl	20	160 ps	≈ 0 %	≤ 10 %
1	Sensl	35	200 ps	≈ 15 %	≤ 15 %
1	ASD (FBK)	50	140 ps	≈ 30 %	≈ 0 %
9	HAMAMATSU	25	250 ps	≈ 10 %	≈ 0 %
9	HAMAMATSU	100	170 ps	≈ 20 %	≈ 0 %
9	Sensl	35	measurement impossible at single p.e level		
9	ASD (FBK)	50	300 ps ± 10 %	measurement impossible	

Low temperature behaviour of irradiated SiPMs

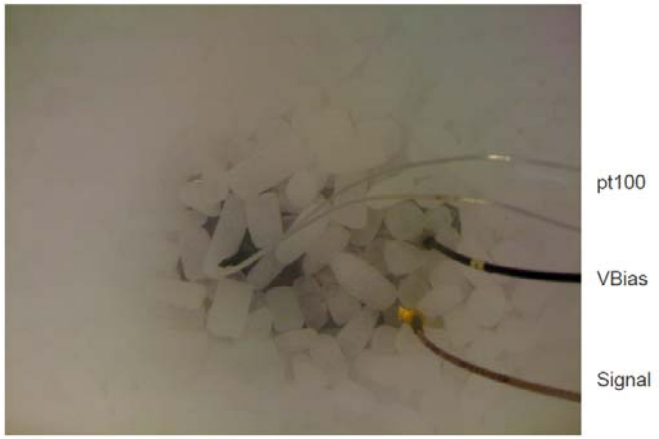
- Gabriele Simi (Padova)
  http://agenda.infn.it/getFile.py/access?contribId=86&sessionId=14&resId=1&materialId=slides&confId=3352

- Dark rate is an issue for SiPMs looking for single photoelectrons
  → Can be reduced by decreasing the temperature

- Does this variation depend on the irradiation level?
- And what about the after pulses?

- Comparison of 2 FBK SiPMs from the same batch – 40 μm pixel size, 1 mm^2
  → One non-irradiated, the other irradiated with 2.1×10^{10} 1 MeV n/cm^2

- PMTs in dry ice (-78.5°C)
  - Measured temperature stable after ~1 hour
  - Question about the actual SiPM temperature
    → Test to be repeated with better thermal contact



Conclusions

Outlook

- A lot of progresses in the preparation of the FDIRC prototype CRT test
  - Optics
  - Mechanics
  - Scanning setup
  - Preparation of data taking and analysis

  → Test should have started by the time of the September meeting!

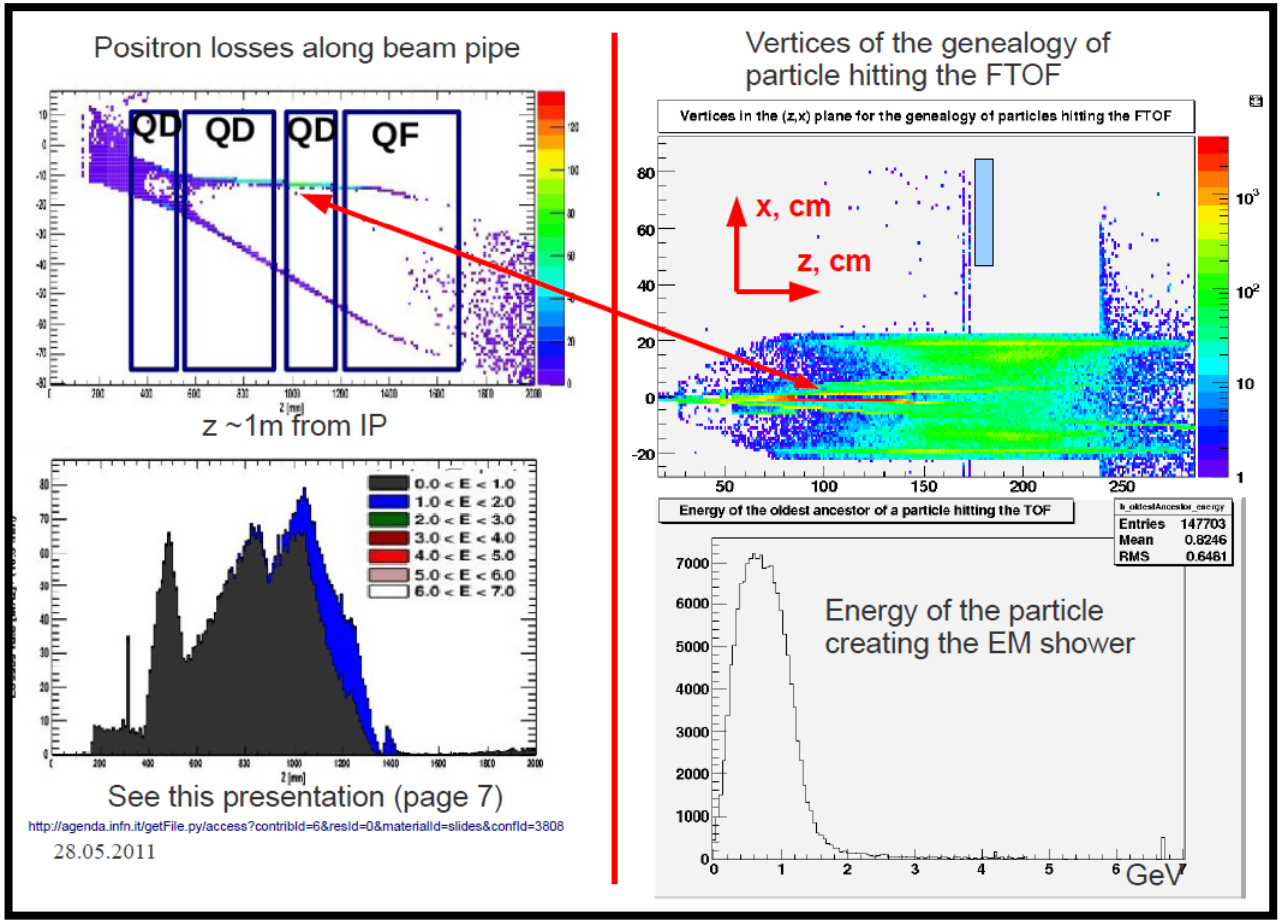
- Many activities ongoing in the different institutions
  - PM characterization
  - Electronics
  - Simulation, data analysis

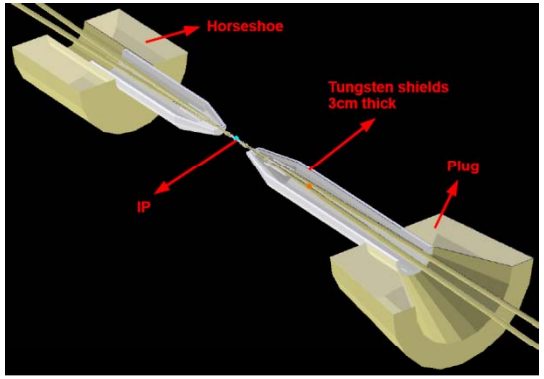
- Developments for forward PID
  - FTOF: high background in the latest Rad. Bhabha Fullsim production
  - FARICH: aerogel beam test

Backup

More about the source of FTOF background

- Well-identified source not coming directly from the IP

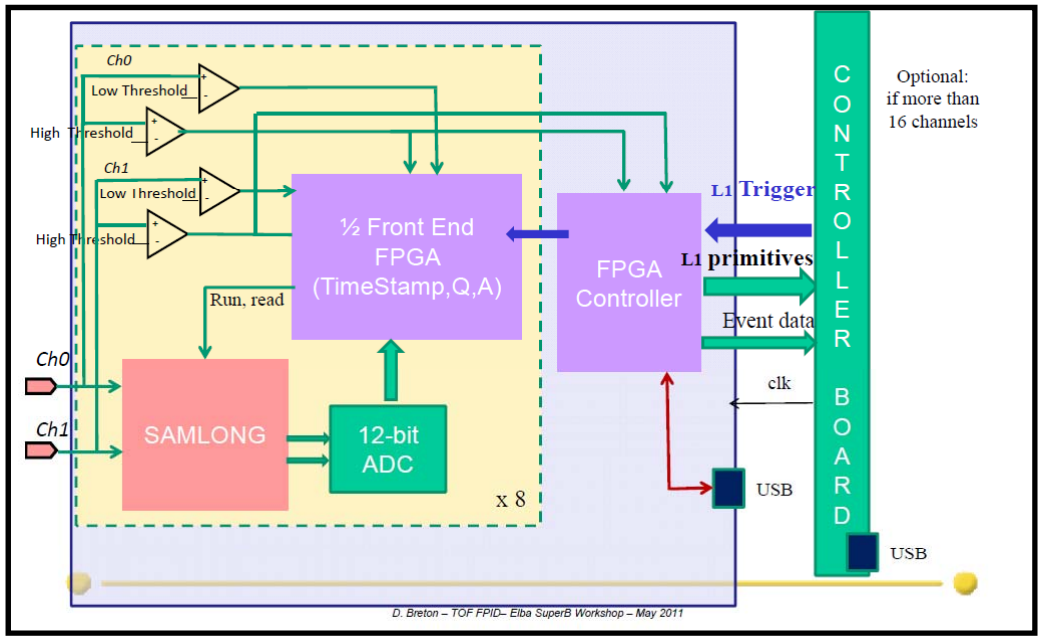




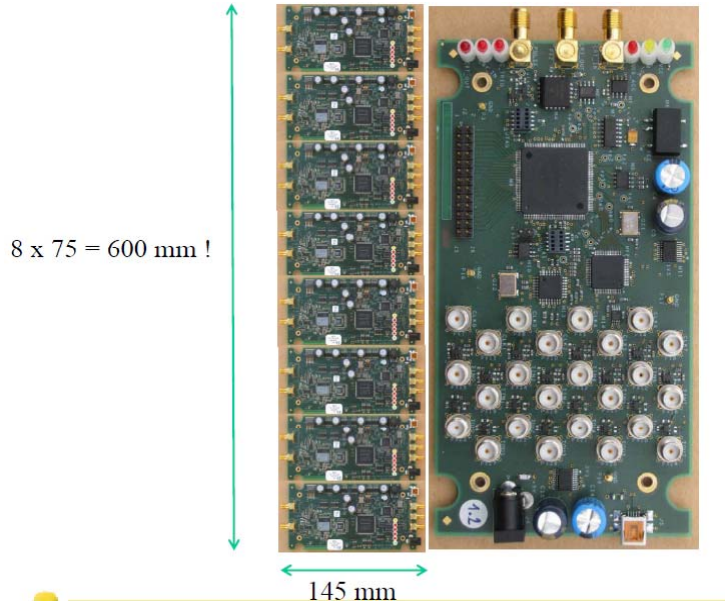
- Mitigation: shielding and/or preventing this bkg from being generated
- Main topic to be working on in the coming weeks

The 16-channel board

- Schematic

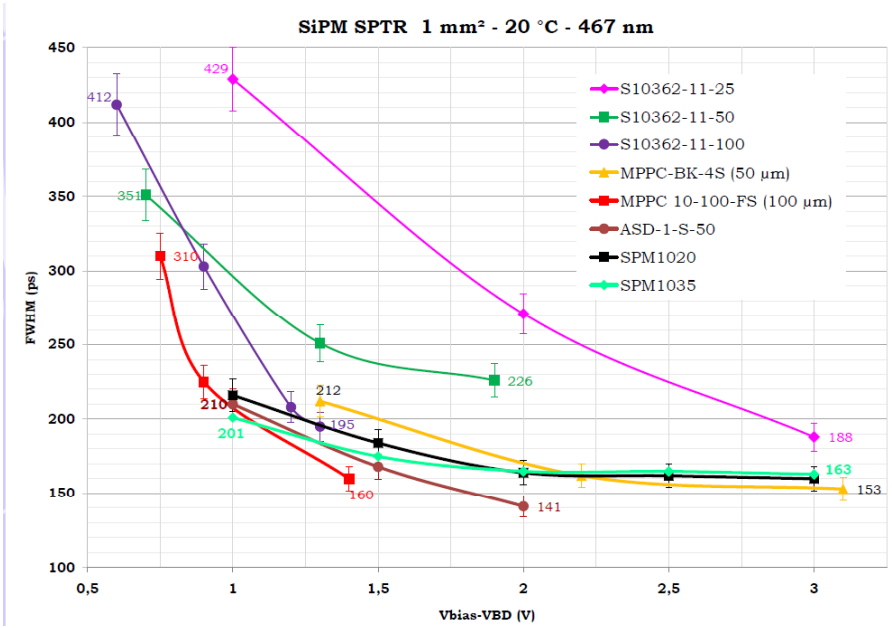


- Integration of 16 channels on a single board

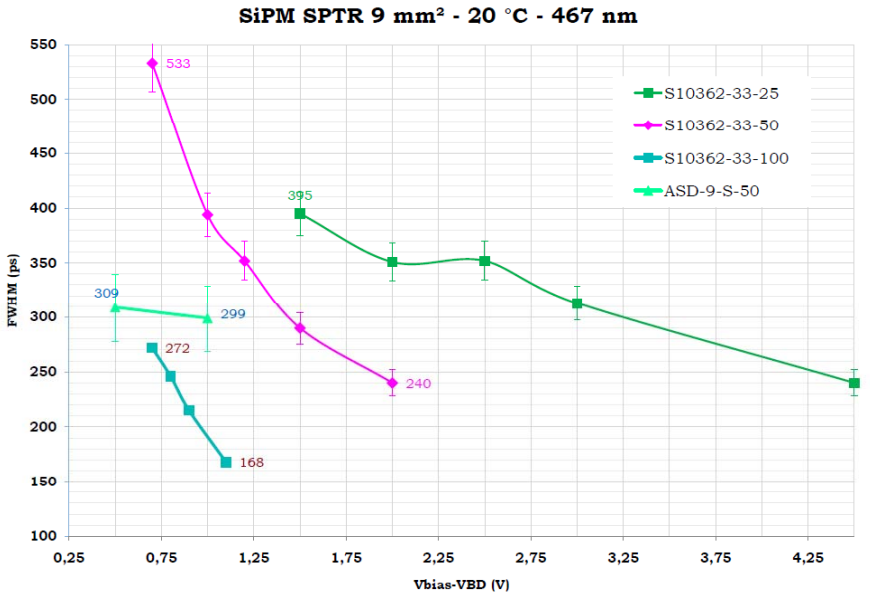


Examples of results: SPTR vs. applied voltage

- 1 mm^2 SiPM

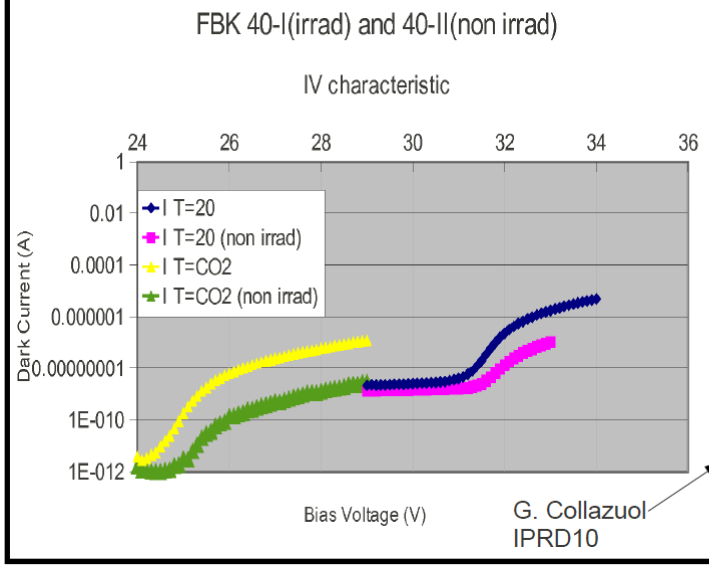


- 9 mm^2 SiPM



Test results

- I-V curve and breakdown voltage



V_{bd}(Volts) from linear fit of dI/dV

T	non irr.	irr
20C	31.5V	31.6V
CO_2	27.3V	26.2V

$dV_{bd}/dT/V_{bd}$~0.15%/C

Measured on other FBK SiPM=0.25%/C
→ expect V_{bd}~24V

- Dark rate
- Both PMTs have similar behaviours
- Decreases with temperature smaller than expected.
  → Temperature issue!?

- Dark rate at ½ photon threshold
  - Fit spectrum to determine ½ photon level

	T=20	$T=CO_2$	ratio
Non Irradiated	8.5MHz	350KHz	$2^{4.6}$
Irradiated	1.4MHz	55KHz	$2^{4.7}$
Ratio	6.1	6	

- Rad damage : dark rate increase x6
  - Independent of temperature
- Temperature: dark rate decrease x25
  - However expected a decrease of $x2^{10}$~x1000