AIDA work package 9.5 – Granular calorimeter infrastructure

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CERN LCD

Linear collider detector R&D

CERN contribution to LC R&D has started with test beams for calorimeters

- Linear collider physics aims pose challenges to the calorimetry
  - higher jet energy resolutions → particle flow analysis → highly granular ECAL and HCAL.
  - High energies at CLIC → additional HCAL depth → replace steel by tungsten as the absorber.

9.5 - Granular calorimeter infrastructure for:

➢ Tests of different active HCAL detection techniques in a tungsten HCAL stack

Closely related to WP 8.6 (support for common testbeam for LC)

- Test beam requirements for all Linear Collider sub-detector experiments have been expressed at the East Area Day:
  https://indico.cern.ch/getFile.py/access?contribId=11&sessionId=5&resId=0&materialId=slides&confId=167761

wp 9.5 goals & tasks

Goals - Infrastructure for tests of different HCAL detection techniques, scintillator and gaseous.

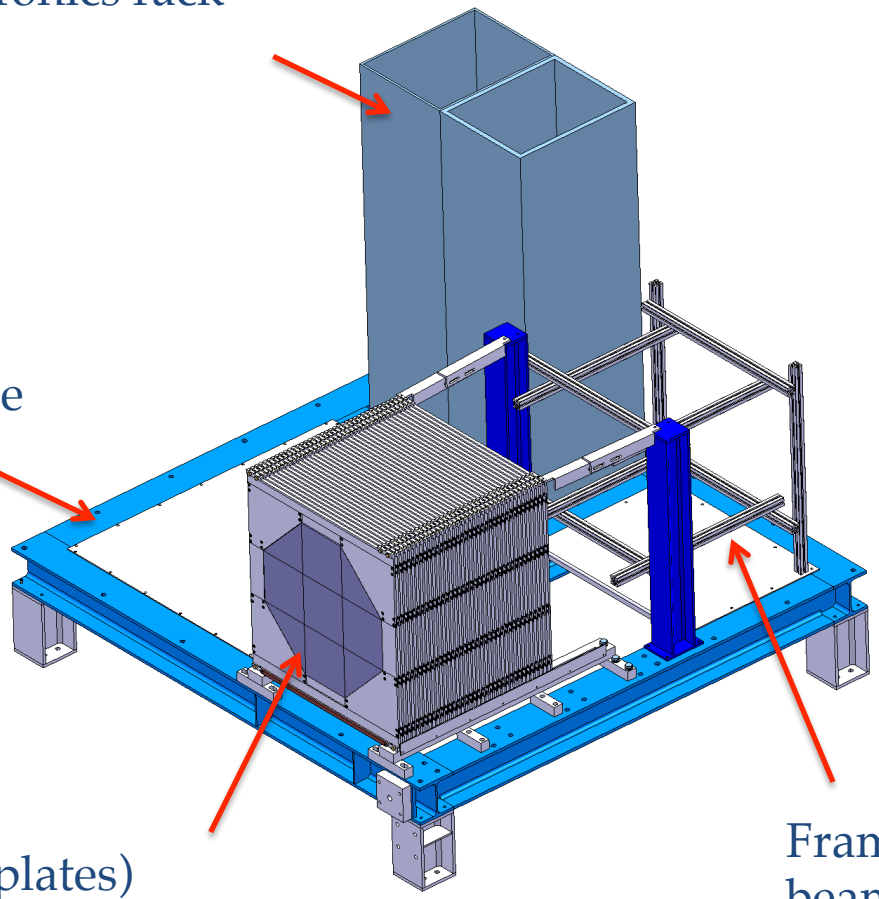
Milestones & deliverables (for CERN):

- Gas system, control & bench structure (month 20, milestone)
- Integrated infrastructure for calorimetry (month 40, del.)
- Report of comparison of GEANT4 sim & testbeam (month 46, del.)

Tasks -

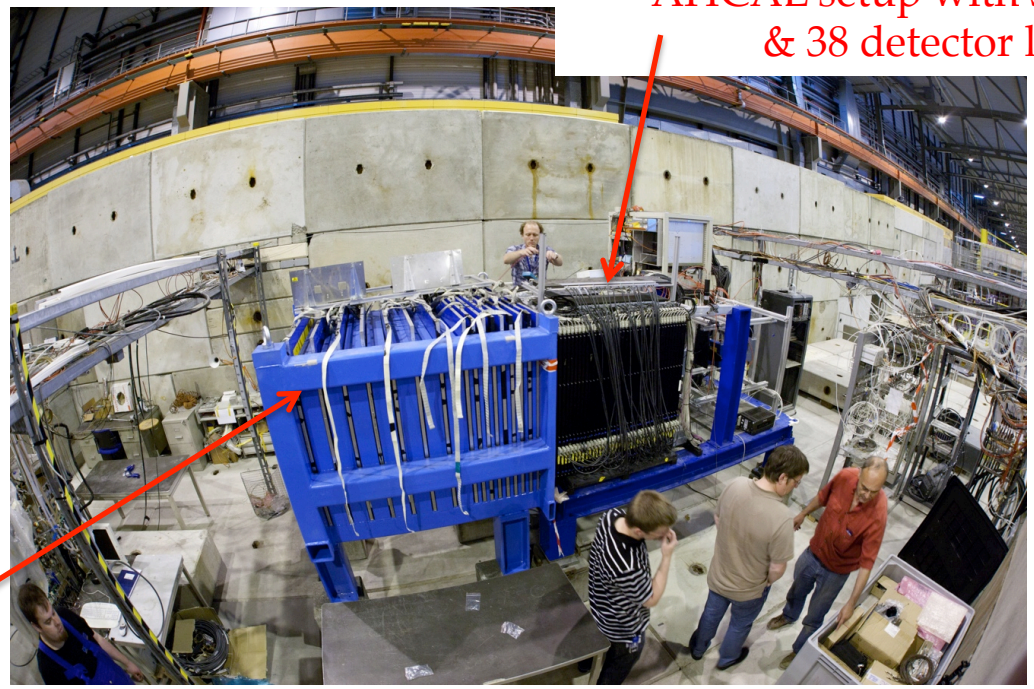
- Readout infrastructure with picoscopes for T3B and glass RPC
- First version of bench structure for HCAL support has been constructed
  - Extended for a tail-catcher, triggering & positioning
  - To be prepared for the next readout system, i.e. gas RPCs.

Calorimeter infrastructure



Tail catcher

AHCAL setup with 38 tungsten & 38 detector layers.



Tail catcher:
Steel/scintillator-strip sandwich calorimeter with 16 layers

- Iron tail catcher absorber structure designed and constructed.
- Compatible with the tungsten absorber structure

- Used in test beams in second half of 2011.

Tungsten analog HCAL test beams

		# events	
π:	10 ≤ E ≤ 300 GeV Including ~100k Kaons at 60 and at 80 GeV.	26 M	2011 @ SPS
e :	10 ≤ E ≤ 40 GeV	2.3 M	
μ :	30x30 triggers, in 9 locations	2.5 M	
	large 80x80 triggers	2.1 M	
Mix :	1 ≤ E ≤ 10 GeV	13 M	2010 @ PS

T3B: The same events in sync with AHCAL, plus standalone events.

- Analysis have been started for the reconstruction and comparison to GEANT4 simulation.

Status & coming plans

- This year the calorimeter test bench will be equipment with glass RPC detector with digital readout.
  - Has been used in a Fe-HCAL prototype at Fermilab, Chicago.
  - Currently still in the USA, to be shipped soon.

- Test beams scheduled so far:
  - 2 weeks in the PS T9, from 14 - 28 May.
  - At the SPS H8 for 2 weeks in June, 1 week in August, 1 week in November.

- A picoscope has been bought by the CERN electronics-pool
  - On loan now for the HCAL. Has been tested with for example the readout of the Cerenkov chambers during test beams.
  - Plan to create RPC with fast readout for gaseous HCAL test beam in 2012 (part of WP 9.5, see Frank Simon)

Preparations for test beam

- US gas mixing rack
  - not EU-ATEX certified (for the 5% isobutane)
    → CERN might provide a new rack

- Cooling: ~5 kW needs to be extracted from HCAL stack
- Discussing with CERN CV
  - Airconditioning units will be provided
  - Company has been contacted to construct tent

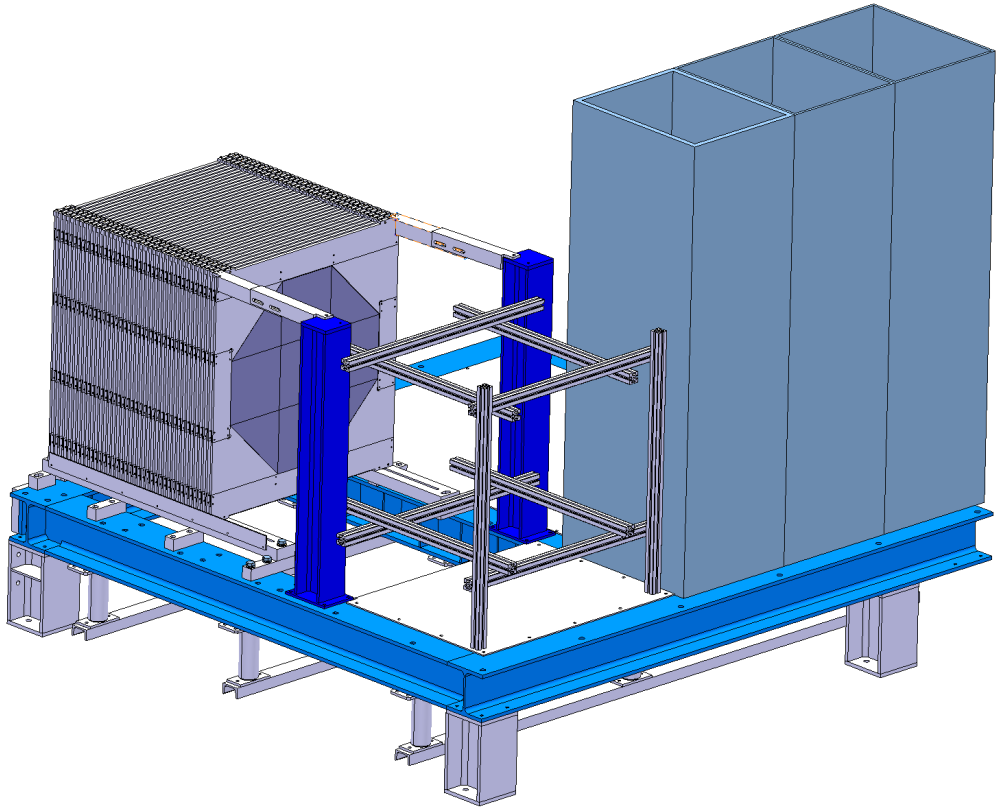
- Transportation from PS to SPS
  - Probably with fully equipped detector

- …

Adjustments to test bench

Covered by WP 8.6 and 9.5:

- Slightly increase gap sizes between tungsten plates.
- Cable basket underneath
- Feet are moved in, to fit on truck
- Extra electronics rack



Money spent WP 9.5

2011, checked with cet.cern.ch:

- 34319 (EU):
  - None.
- 34309 (CERN):
  - Tools for trigger setup, CHF. 1900
  - CHF. 22.495, for two fellows participating (with each 1 person-month).

2012:

34309 (CERN):

- ~ CHF.150 per month on electronics rental
- ~ CHF.1600 for mechanics work

Publications

- Dominik Dannheim, Wolfgang Klempt, Angela Lucaci-Timoce.
  "Temperature studies of the CALICE W-HCAL with CERN 2010 data."
  -- LCD-Note-2011-001

- Dominik Dannheim, Wolfgang Klempt, Erik van der Kraaij.
  "Beam tests with the CALICE tungsten analog hadronic calorimeter prototype"
  -- in preparation

- Wolfgang Klempt, Erik van der Kraaij.
  "ANL visit for exploring possibility of a tungsten RPC DHCAL test setup"
  -- AIDA-REP-2011-004

Summary

- HCAL bench structure successfully used in test beam in 2011.
  - One transportable structure extremely valuable to test the AHCAL in different beam lines under same conditions.
- Trigger & tracking telescope of the bench structure has been extended
  - Wire chambers on loan from CERN and can be used for the coming campaigns.
- CERN electronics-pool has purchased a fast picoscope.
- Project is well on its way for milestone MS42: 'gas system, control and bench structure for an integrated infrastructure for granular calorimetry'.
- Tungsten stack and tail catcher will be equipped in the coming months with the CALICE digital RPC

Backup

Technical plan – (PH-LCD) @ KickOff meeting

Task 8.6 - CERN support for common testbeam:

- Database (à la EDMS) for technical drawings
- Wire chambers, for beam definition
- Special (i.e. big) scintillators for HCAL calibration purposes

Task 9.5 - Granular calorimeter infrastructure:

- Readout infrastructure with picoscopes for T3B and gasRPC
- First version of bench structure for HCAL support has been constructed
  - Needs to be extended for a tail-catcher, triggering & positioning
  - At the moment a support frame for the trigger setup is in front: needs to be moved, and ECAL bench needs to be installed
  - Entire frame is to be made movable

Resources – WP 8.6

Implementation plan version: EvdK, 20/03/2012

WP8, PH-LCD

Budget holder: **Erik van der Kraaij**

Budget codes: **EU** **34315**

CERN **34305**

PPA code: **RLC-PRJ**

WP.task	PPA	EU funding to project (CHF)	Budget code for EU funding	CERN funding for project (CHF)	Budget code for CERN funding	Person-Months	Personnel direct costs (EU funds)	Consumable and prototype direct costs (EU funds)	Travel direct costs (EU funds)	Personnel direct costs (CERN funds)	Consumable and prototype direct costs (CERN funds)	Travel direct costs (CERN funds)
WP8.6	RLC-PRJ	95,700	34315	114,700	34305	18	95,700			65,900	42,200	6,600

EU-part of budget allocation (CHF) **Code** **34315**

category / year	2011	2012	2013	2014	total			
staff (PSI)	0	0	0	0	0	Total EU fund.	Plan	
fellow (PFE)	0	30000	20000	20000	70000	70000	95700	Manpower
materials (M)	11800	1600	10700	1600	25700	25700	0	Consumable + travel
total	11800	31600	30700	21600	95700			

CERN-part of budget allocation (CHF) **Code** **34305**

category / year	2011	2012	2013	2014	total			
staff (PSI)	21000	21000	21000	0	63000	Total CERN fund.	Plan	
fellow (PFE)	20000	10000	0	20000	50000	113000	65900	Manpower
materials (M)	0	0	0	0	0	0	48800	Consumable + travel
total	41000	31000	21000	20000	113000			

EU versus CERN post by post

Item	P-M	2011	2012	2013	2014	cost	% EU	% exisitng department resources	% additional CERN resources	EU	existing department resources	additional CERN resources	total CERN
Designer (Erik Richards)	4	2m	2m	0	0	42,000	0%	100%	0%	0	42,000	0	42,000
Designer (to be confirmed)	2			2m		21,000	0%	100%	0%	0	21,000	0	21,000
Erik van der Kraaij (fellow)	3	2m	1m			30,000	0%	100%	0%	0	30,000	0	30,000
New Fellow	2				2m	20,000	0%	100%	0%	0	20,000	0	20,000
Erik van der Kraaij (fellow)	3		3m			30,000	100%	0%	0%	30,000	0	0	0
New Fellow	4			2m	2m	40,000	100%	0%	0%	40,000	0	0	0
Purchase of a tool		10000		9100		19,100	100%	0%	0%	19,100	0	0	0
Travel		1800	1600	1600	1600	6,600	100%	0%	0%	6,600	0	0	0
	18								Totals	95,700	113,000	0	113,000
Planned	18									95,700			114,700

Resources – WP 9.5

Implementation plan version: EvdK, 20/03/2012

WP9, PH-LCD

Budget holder: **Erik van der Kraaij**

Budget codes: **EU** **34319**

CERN **34309**

PPA code: **RLC-PRJ**

WP.task	PPA	EU funding to project (CHF)	Budget code for EU funding	CERN funding for project (CHF)	Budget code for CERN funding	Person-Months	Personnel direct costs (EU funds)	Consumable and prototype direct costs (EU funds)	Travel direct costs (EU funds)	Personnel direct costs (CERN funds)	Consumable and prototype direct costs (CERN funds)	Travel direct costs (CERN funds)
WP9.5	RLC-PRJ	59,800	34319	74,300	34309	12	59,800			47,900	19,800	6,600

EU-part of budget allocation (CHF) **Code** **34319**

category / year	2011	2012	2013	2014	total		
staff (PSI)	0	0	0	0	0	Total EU fund.	Plan
fellow (PFE)	0	30000	20000	10000	60000	60000	59800 Manpower
materials (M)	0	0	0	0	0	0	0 Consumable + travel
total	0	30000	20000	10000	60000		

CERN-part of budget allocation (CHF) **Code** **34309**

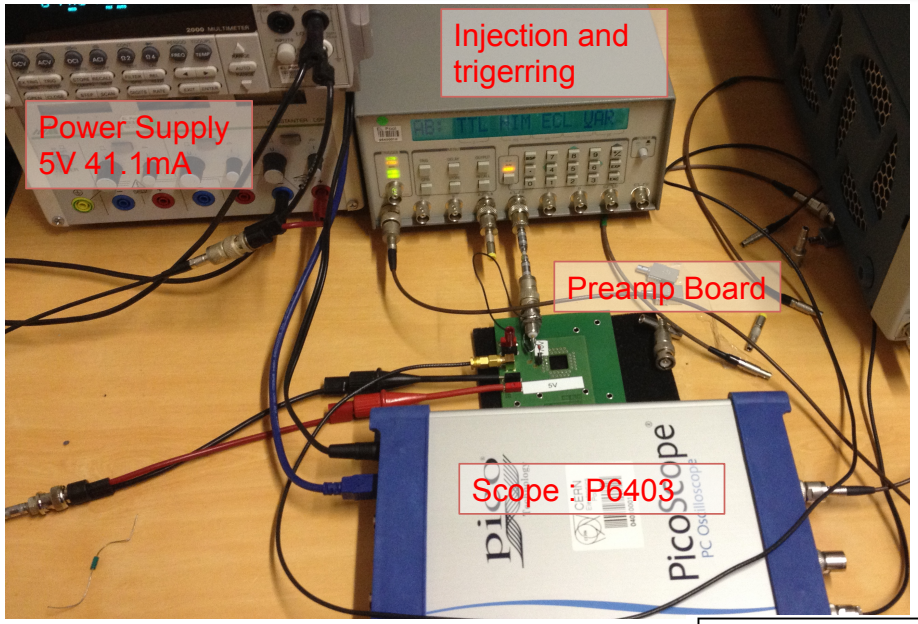
category / year	2011	2012	2013	2014	total		
staff (PSI)	0	0	15600	15600	31200	Total CERN fund.	Plan
fellow (PFE)	20000	20000	0	0	40000	71200	47900 Manpower
materials (M)	5500	5500	500	500	12000	12000	26400 Consumable + travel
total	25500	25500	16100	16100	83200		

EU versus CERN post by post

Item	P-M	2011	2012	2013	2014	cost	% EU	% exisitng department resources	% additional CERN resources	EU	existing department resources	additional CERN resources	total CERN
Dominik Dannheim	2			1m	1m	31,200	0%	100%	0%	0	31,200	0	31,200
Nardulli, replaced by Lucaci in 2012	2	1m	1m			20,000	0%	100%	0%	0	20,000	0	20,000
Erik van der Kraaij (fellow)	2	1m	1m			20,000	0%	100%	0%	0	20,000	0	20,000
Erik van der Kraaij (fellow)	3		3m			30,000	100%	0%	0%	30,000	0	0	0
New Fellows	3			2m	1m	30,000	100%	0%	0%	30,000	0	0	0
Purchase of a tool		5000	5000	0	0	10,000	0%	100%	0%	0	10,000	0	10,000
Travel		500	500	500	500	2,000	0%	100%	0%	0	2,000	0	2,000
	12								Totals	60,000	83,200	0	83,200
Planned	12									59,800			74,300

T3B preamp for use with RPC

- Very preliminary -

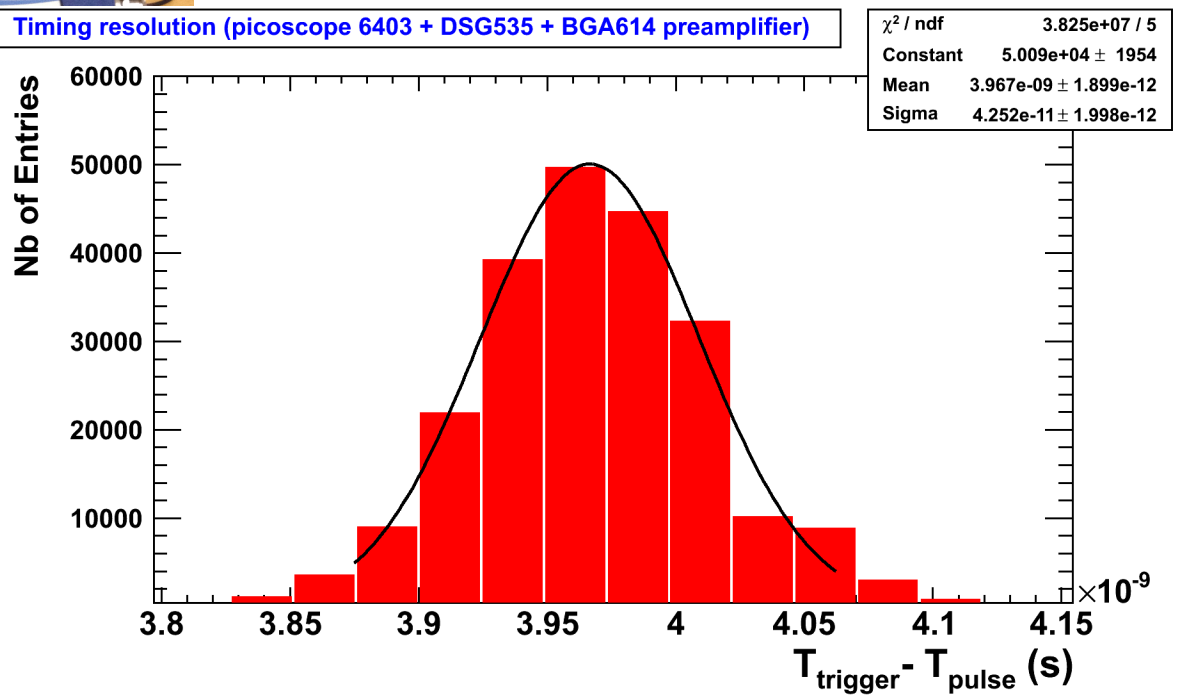


Obtained BGA614 preamplifier board from Frank Simon.

- Studied the preamp in setup with pulse generator
- Created simulation

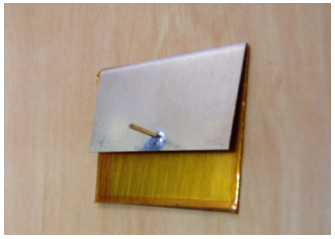
by Mathieu Benoit

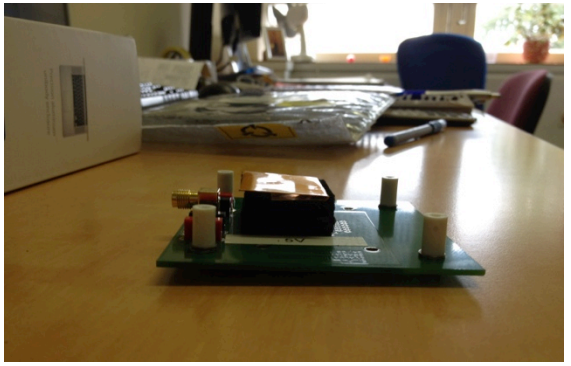
With generated pulse, obtain:

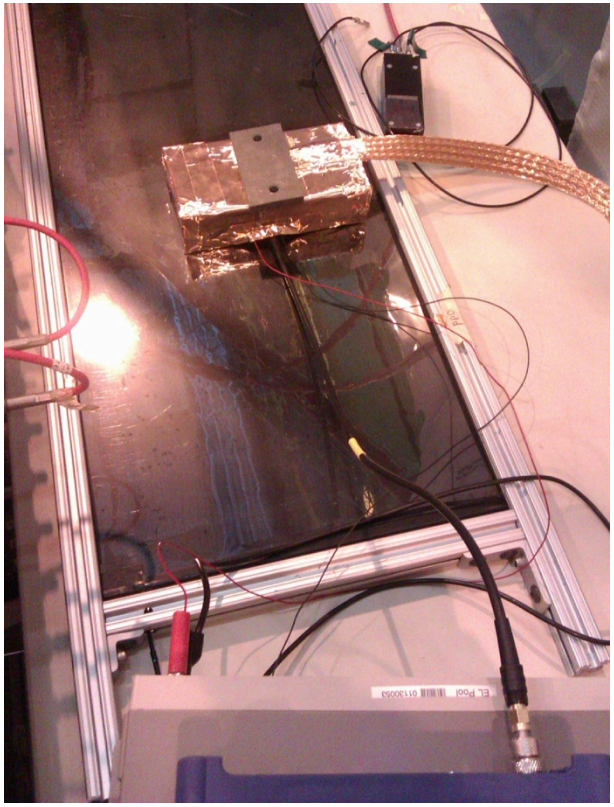


Test on glass RPC at CERN - Very preliminary -

'pick-up' pad: Copper electrode (3.1 x 2.6 cm^2), covered with 0.07mm thick kapton tape







With a lot of help from Liang Guan (ATLAS):

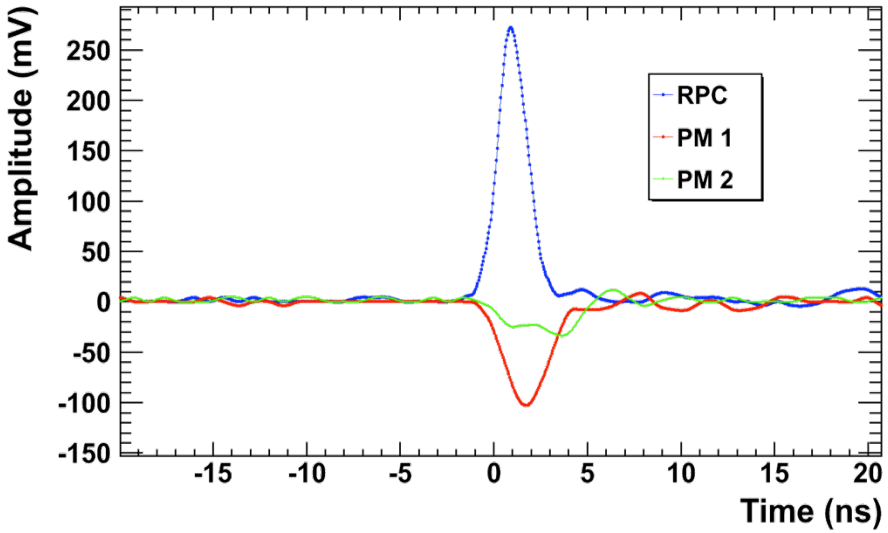
Cosmic tests with:

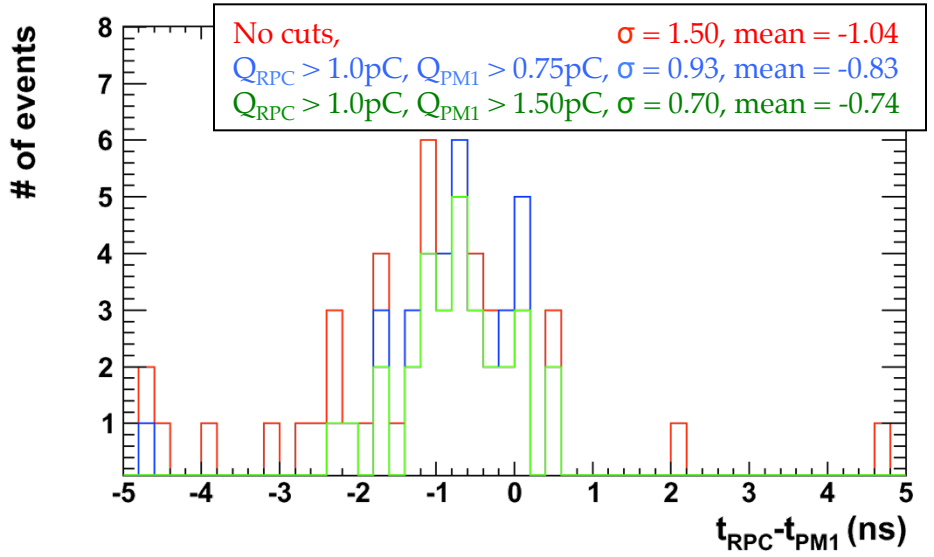
- RPC from Argonne
  - Gas : ATLAS standard mix, 5% isobutane, 0.3% SF6 , 94.7% tetrafluoroethane
  - 7kV bias, leakage current of 80uA
- 2x2cm^2 scintillator

Timing measurement

- Very preliminary -

- With cosmics, measure Δt between thresholds: +50 mV for RPC
  -10 mV for PM





- Within statistical limit, show a good timing resolution, ≈O(1ns)
  For comparison: SiPM T3B has σ ~ 0.8 ns.
- RPC works well with BGA614 based amplifier
- Constructing a T3B-like board for RPC

Fast RPC readout for timing measurements

- Design for readout board is ready and now being ordered and assembeled