

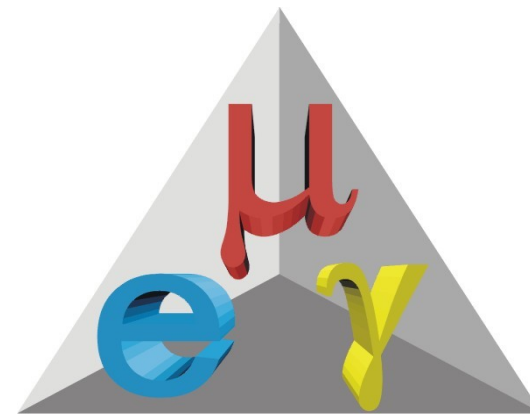
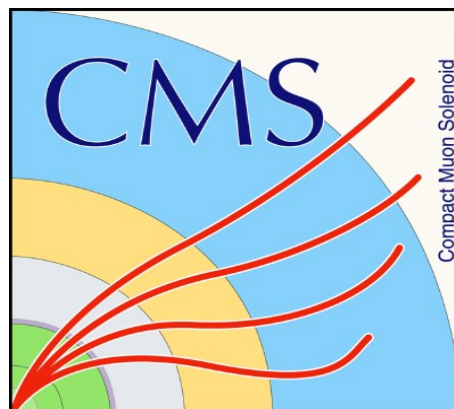


Consuntivi scientifici attività di gruppo 1

Sezione di Pavia: 2016-2017

Attività pavesi

- Frontiera dell'energia
 - **ATLAS** [Responsabile Locale: G. Gaudio]
 - **CMS** [Responsabile Locale: P. Salvini]
 - **RD Fase 2** [Responsabile Locale: C. Riccardi]
- Frontiera della precisione
 - **MEG** [Responsabile Locale: P. Cattaneo]
- Frontiera delle frontiere
 - **RD_FA**: R&D Future Accelerators (dal 2017)



LHC a pieno regime

ATLAS: 38.71 fb⁻¹

ALICE: 13.34 pb⁻¹

CMS: 39.91 fb⁻¹

LHCb: 1.91 fb⁻¹

Integrated Luminosity Evolution

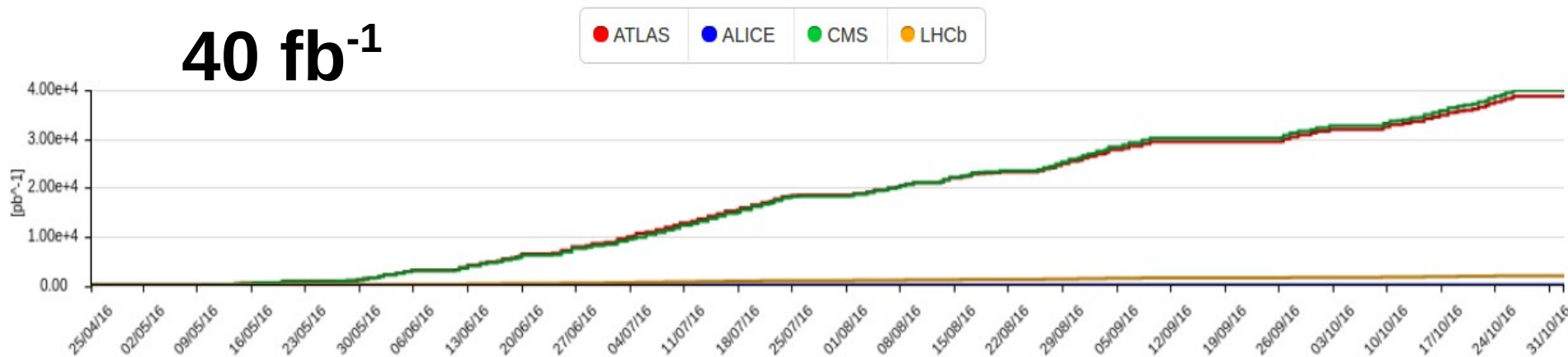
[Export to CSV](#)

[Download](#)

[Undo Zoom](#)

[Hide](#)

40 fb⁻¹



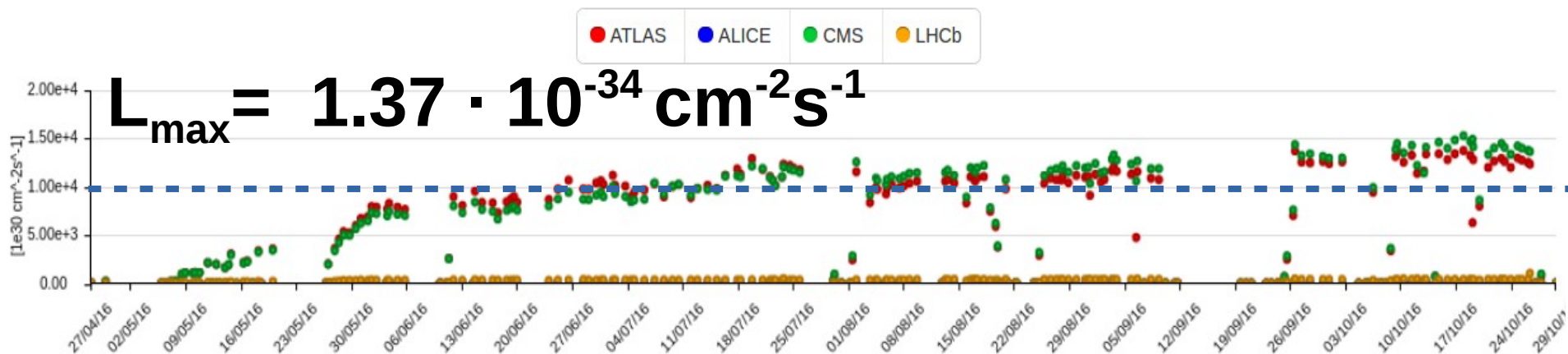
Performance Evolution (Peak Luminosity)

[Export to CSV](#)

[Download](#)

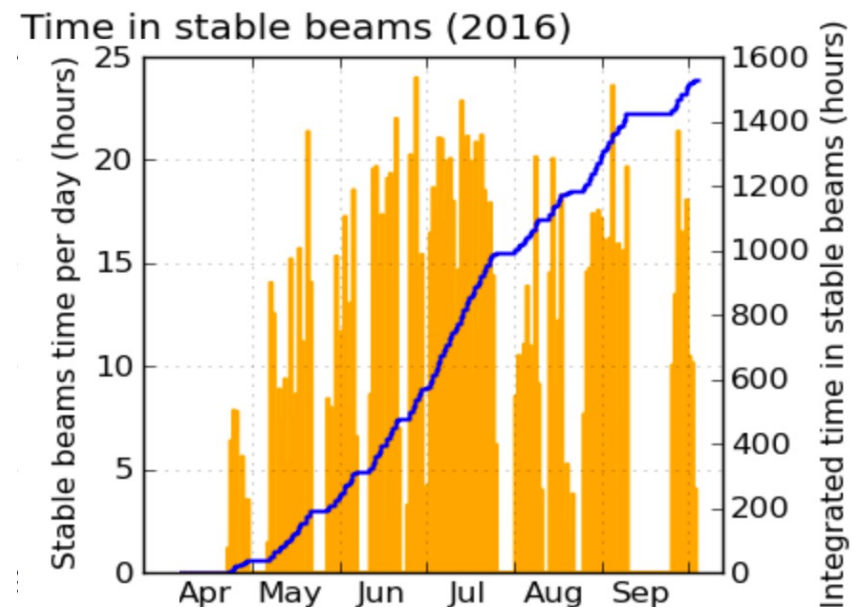
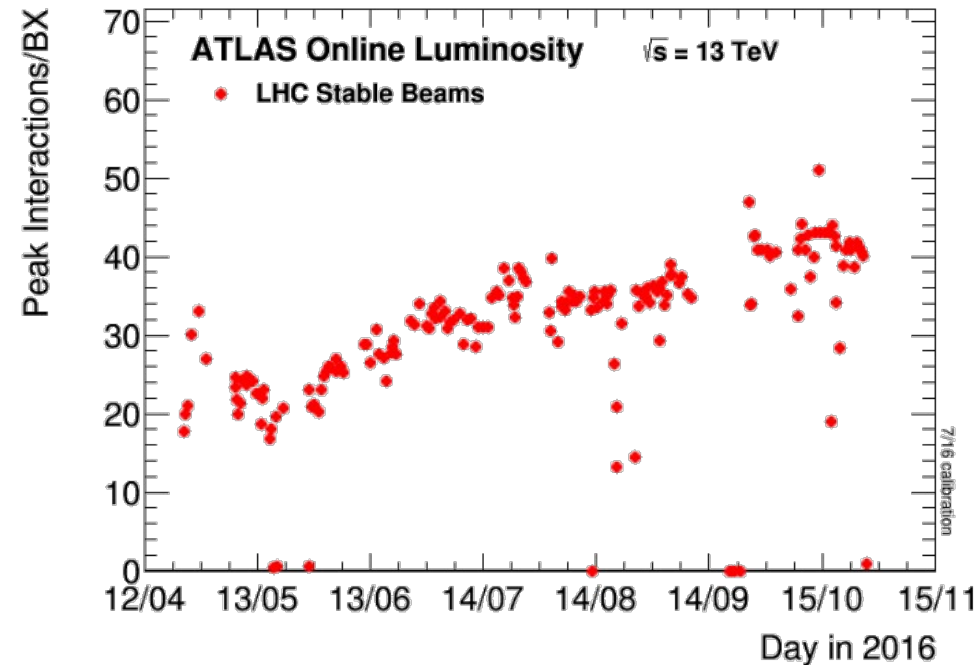
[Undo Zoom](#)

[Hide](#)



LHC

- Luminosità:
 - +40% rispetto al design
- Rispetto al 2015
 - dimezzata β^* (x2)
 - ridotta emittanza (x 1.4)
 - ridotto Xing angle (x 1.15)
 - # bunch limitato SPS (x 0.8)
- Pile up fino a 40
 - Doppio rispetto al design
- Efficienza impressionante
 - 70% del tempo in data taking



LHC 2017

Apr LHC to OP May June													
Wk	14	15	16	17	18	19	20	21	22	23	24	25	26
Mo	3	10	Easter Mon	17	24	1st May	1	8	15	22	29	Whit	26
Tu													
We													
Th													
Fr													
Sa													
Su													

July Aug Sep													
Wk	27	28	29	30	31	32	33	34	35	36	37	38	39
Mo	3	10	17	24	31	7	14	21	28	4	11	18	25
Tu													
We	TS1												
Th													
Fr													
Sa													
Su													

Oct Nov Dec													
Wk	40	41	42	43	44	45	46	47	48	49	50	51	52
Mo	2	9	16	23	30	6	13	20	27	4	11	18	Xmas
Tu													
We													
Th													
Fr													
Sa													
Su													

BEAM SETUP: INJECTION PHYSICS BEAM

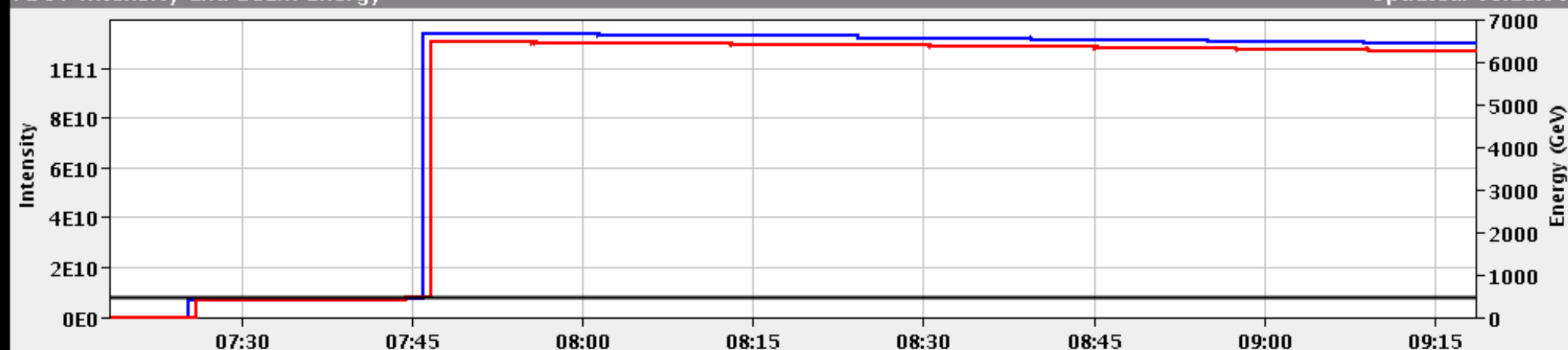
BCT TI2: 0.00e+00 **I(B1):** 1.13e+11 **BCT TI8:** 2.18e+11 **I(B2):** 1.12e+11

TED TI2 position: **BEAM** **TDI P2 gaps/mm** up: 8.44 down: 7.20

TED TI8 position: **BEAM** **TDI P8 gaps/mm** up: 8.84 down: 6.83

FBCT Intensity and Beam Energy

Updated: 09:18:30



BIS status and SMP flags		B1	B2
Comments (16-May-2017 06:47:39) Rampdown NEXT: Collimator BPM commissioning	Link Status of Beam Permits	false	false
	Global Beam Permit	true	true
	Setup Beam	true	true
	Beam Presence	true	true
	Moveable Devices Allowed In	false	false
	Stable Beams	false	false

Consuntivi 2016 ATLAS

Atlas Pavia 2016: people

Ricercatori	Qualifica	ATLAS	RD_Phase2	TOT
Farina Edoardo	Dottorando	100		100
Ferrari Roberto	DR	80	20	100
Gaudio Gabriella	Ric	100		100
Introzzi Gianluca	RU	90		90
Kourkoumeli-Charalampidi Athina	PostDoc	100		100
Livan Michele	PO	100		100
Negri Andrea	PA	100		100
Polesello Giacomo (*)	PR	0		0
Rebuzzi Daniela	PA	100		100
Rimoldi Adele	PA	80		80
Sottocornola Simone	Dottorando	100		100
Vercesi Valerio	DR	70		70
FTE		9,3		9,5

(*) In congedo al
CERN

Tecnologi	Qualifica	ATLAS	RD_Phase2	TOT
Cova Paolo	RU	100		100
De Vecchi Carlo	Tecnologo	30		30
Del Monte Nicola	RU	100		100
Lanza Agostino	DT	80		80
FTE		3,1		3,1

ATLAS Pavia 2016: people

Laureati magistrali:

Matteo Facchini

“The ATLAS Fast Tracker: monitoring, control and configuration”

21-07-2016

Simone Sottocornola

“QA/QC of the MicroMegas Pavia Readout Panels for the Muon Spectrometer Upgrade of the ATLAS Experiment”

28-10-2016

Riccardo Poggi

“Hadronic tau trigger performance study and process management evolution plan for the data acquisition system of the ATLAS experiment at LHC”

28-04-2017

Laureandi magistrali:

Mariacristina Lo Presti - Giulia Rovelli

ATLAS Pavia 2016: responsibilities

Responsibilities in ATLAS experiment:

- ◆ **Lanza:**
 - ◆ Responsabile servizi Muoni
 - ◆ Responsabile servizi NSW steering group members
 - ◆ Responsabile integrazione FTK VME
 - ◆ Muon Phase-2 TDR editor for Power Supply Chapter and steering group member
- ◆ **Negri:**
 - ◆ Responsabile dataflow ATLAS
 - ◆ Responsabile integrazione DAQ FTK
- ◆ **Polesello:** Chair ATLAS Publication Committee (ended March 2017)
- ◆ **Rebuzzi:** Member of the ATLAS Speakers Committee (Oct. 2016)

Responsibilities in ATLAS-Italia:

- ◆ **Ferrari:** Coordinatore Nazionale Upgrade

ATLAS – Muon Services

◆ Power supply maintenance for MDT, RPC and CSC

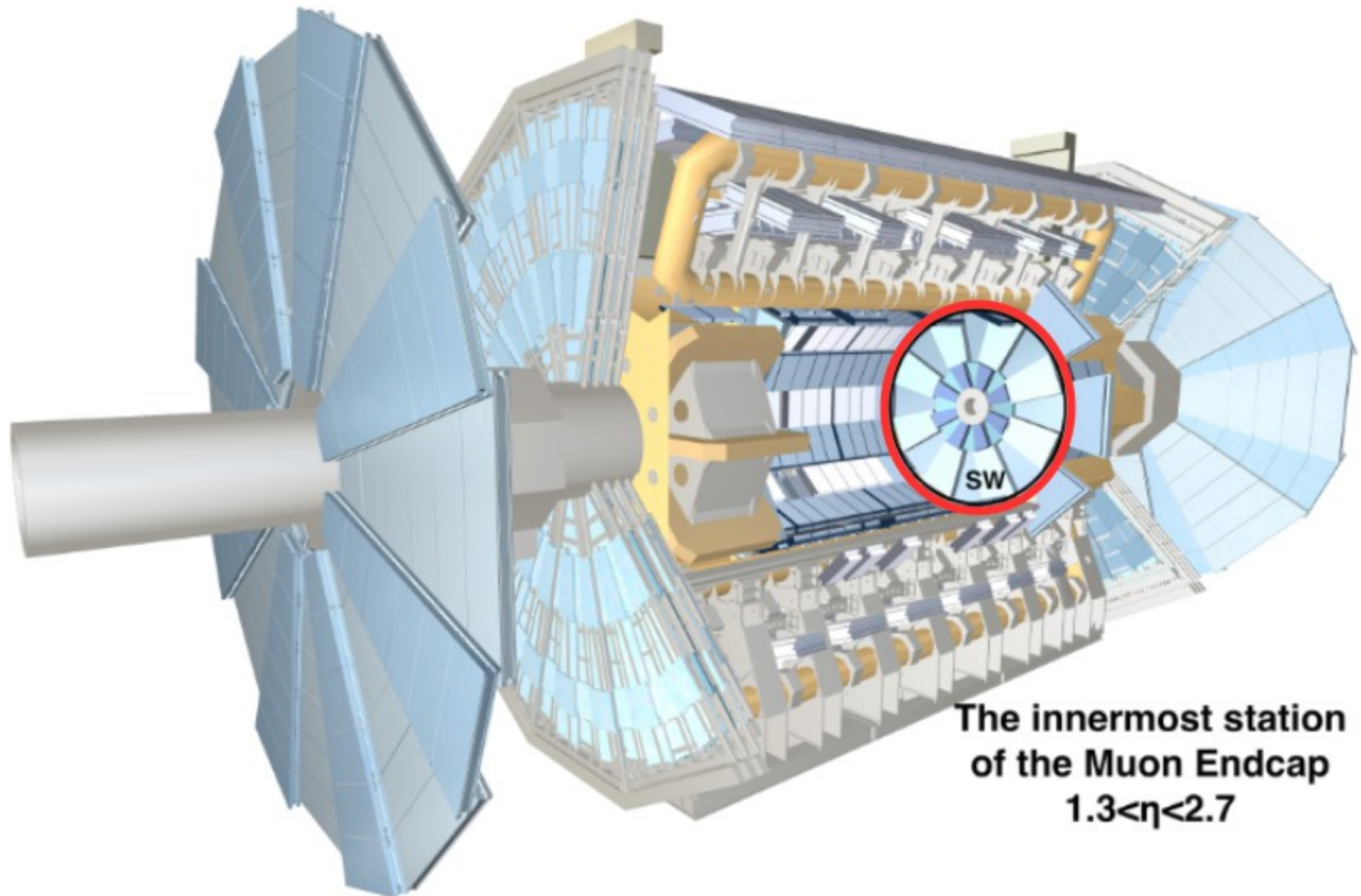
- F No serious issues. MDT HV modules continue having a little more high failure rate than other modules, anyway below 5% of total installed
- F Procured some new RPC modules for BIS78 phase I upgrade project

◆ BMG installation

- ◆ In the 2016 - 2017 winter shutdown 12 new sMDT chambers were installed, covering the Barrel Toroid feet:
 - ◆ procured new HV and LV cables and related labels
 - ◆ installed of HV and LV cables
 - ◆ Installed and connected HV and LV new modules

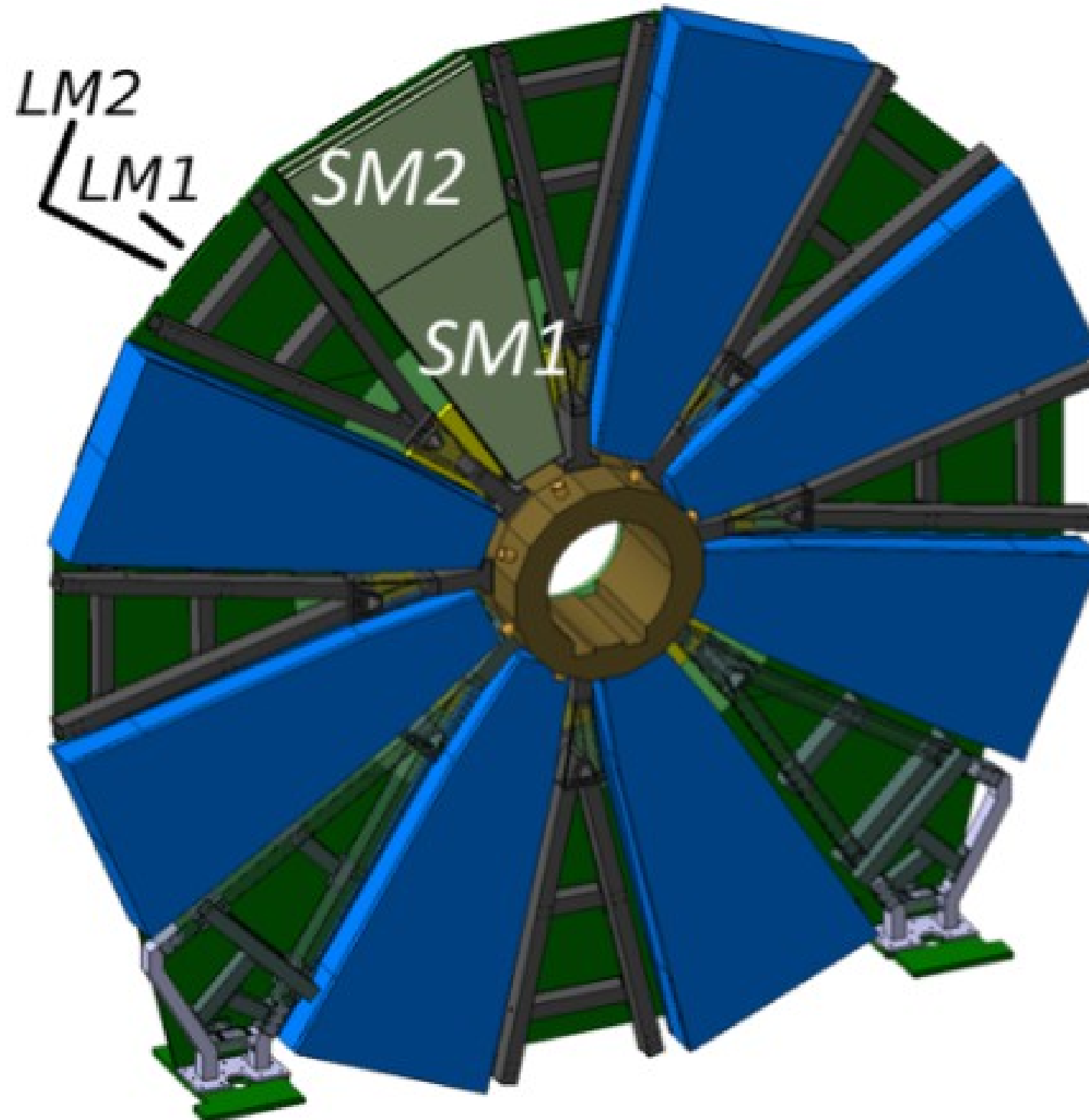


ATLAS New Small Wheels Upgrade



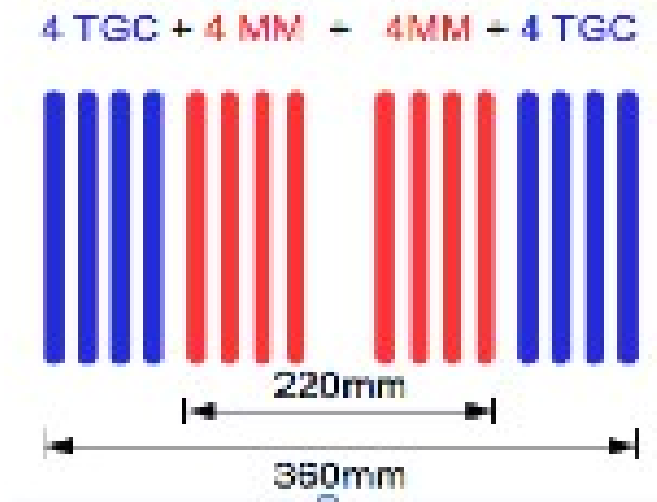
**The innermost station
of the Muon Endcap
 $1.3 < \eta < 2.7$**

New Small Wheel Wedge



MM Modules – SM1 by INFN

MM Sharing



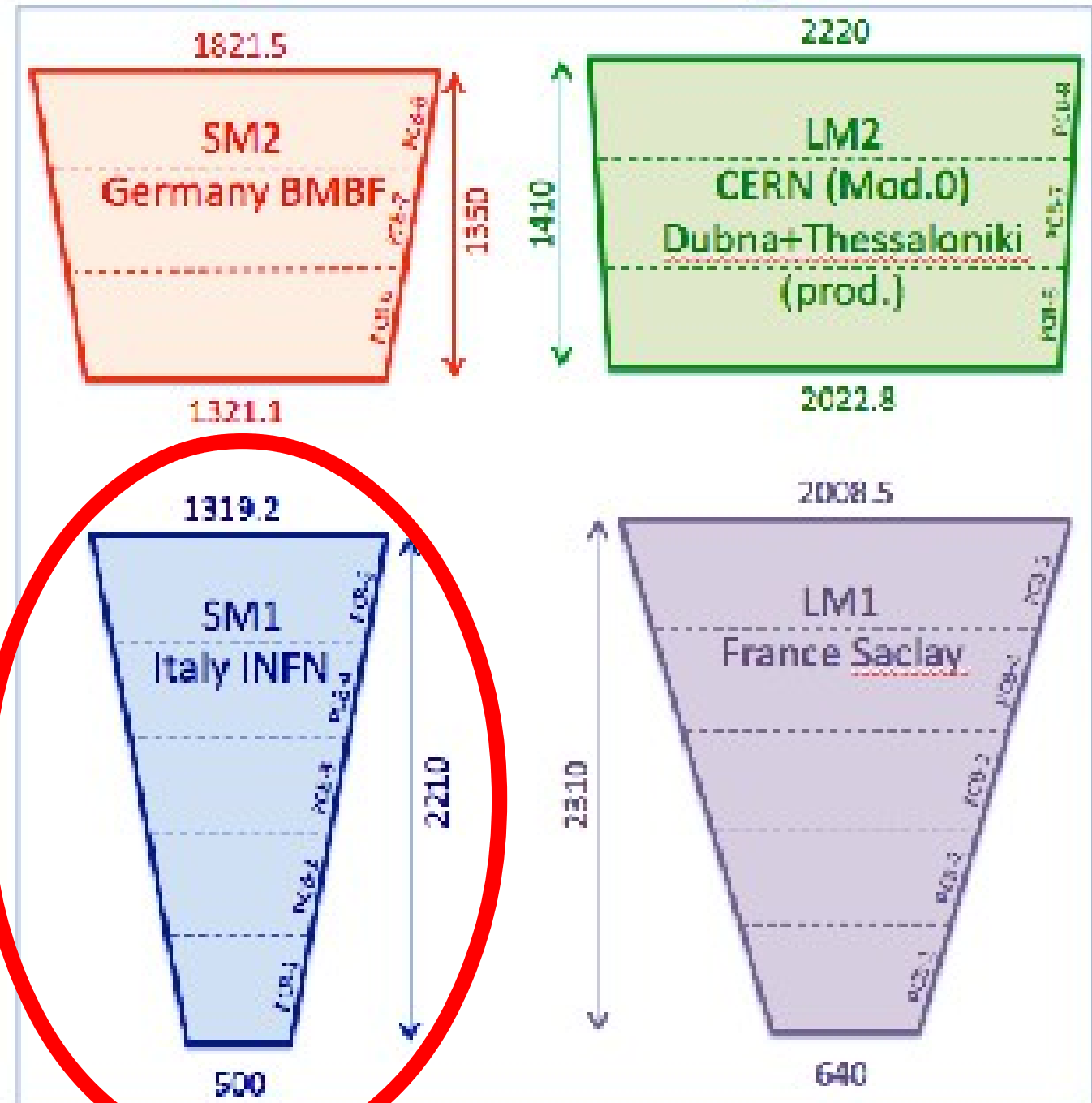
S/L M1 : 5 PCBs

S/L M2 : 3 PCBs

PCB:

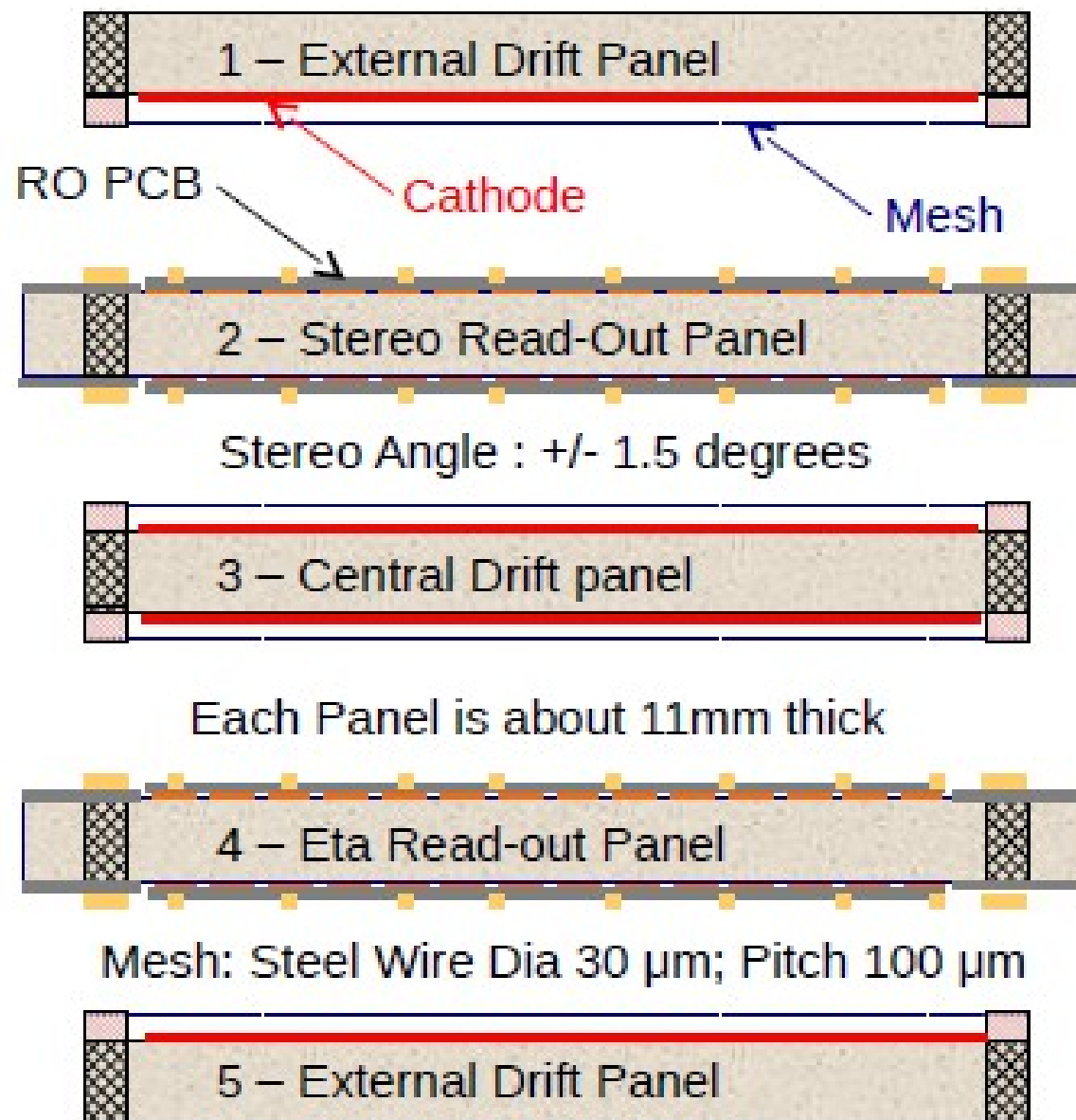
~ 420mm wide
1024 Strips

32 Quadruplet / Site



SM1 Quadruplet Exploded View

MM Quadruplet Exploded View



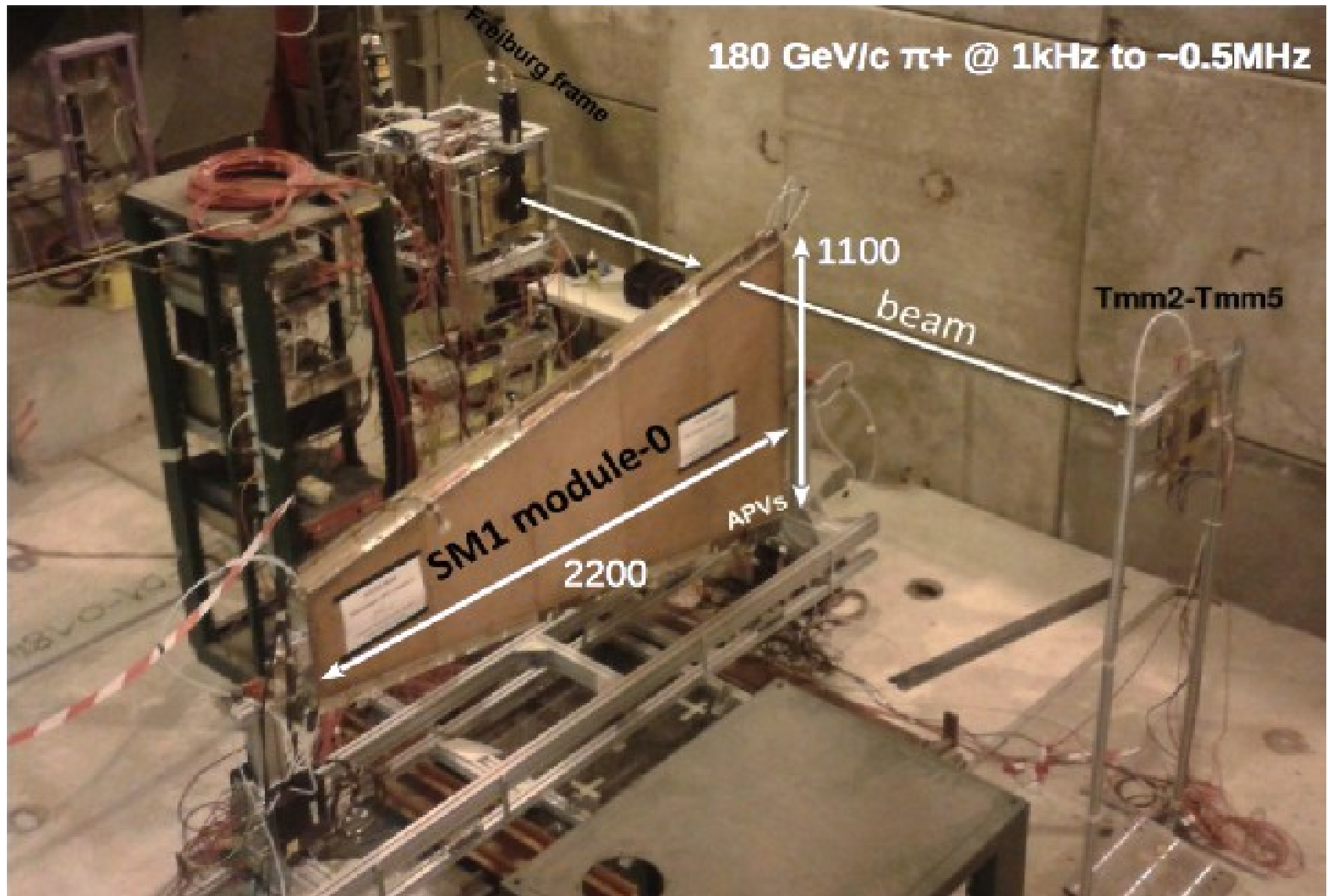
Five panels joined to make a detector unit (Quadruplet) with 4 gas layers.

Pavia
Responsibility

M0 Assembled in Frascati – May 2016



M0 Beam Test at CERN – June 2016



Module 0 Prototype

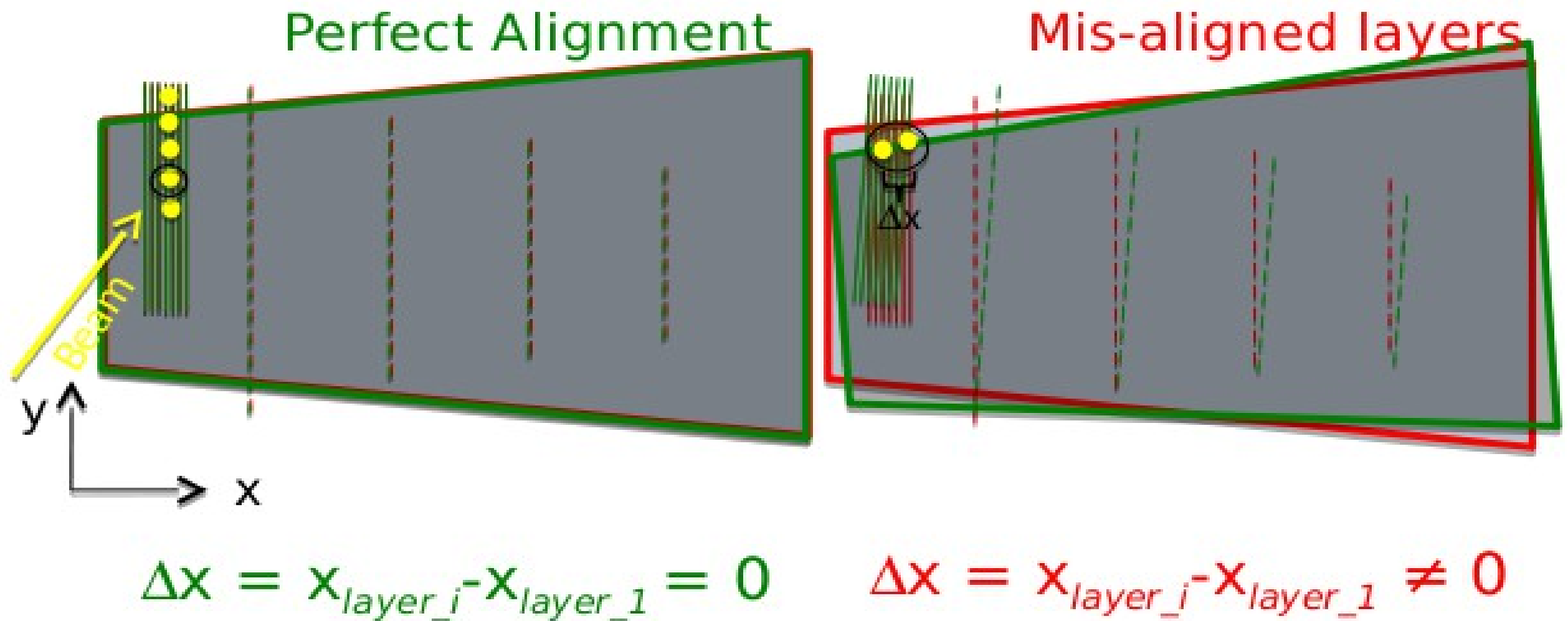
In May 2016 the first full size SM1 prototype (Module 0) was constructed by the INFN consortium, and studied on a dedicated beam test at CERN in June.

The spatial resolution of two SM1 RO layers has been evaluated for the precision coordinate η and for the second coordinate ϕ . An η resolution of $81 \mu\text{m}$ has been determined, while the required resolution is set to be less than $100 \mu\text{m}$.

A measurement of the displacement of strips in the precision coordinate has also been performed. It is an indication of layer-to-layer rotation or strip pattern global deformation. The displacements are less than $\pm 80 \mu\text{m}$, indicating the presence of both shift and rotation within tolerance ($\pm 90 \mu\text{m}$).

RO Layers Misalignment

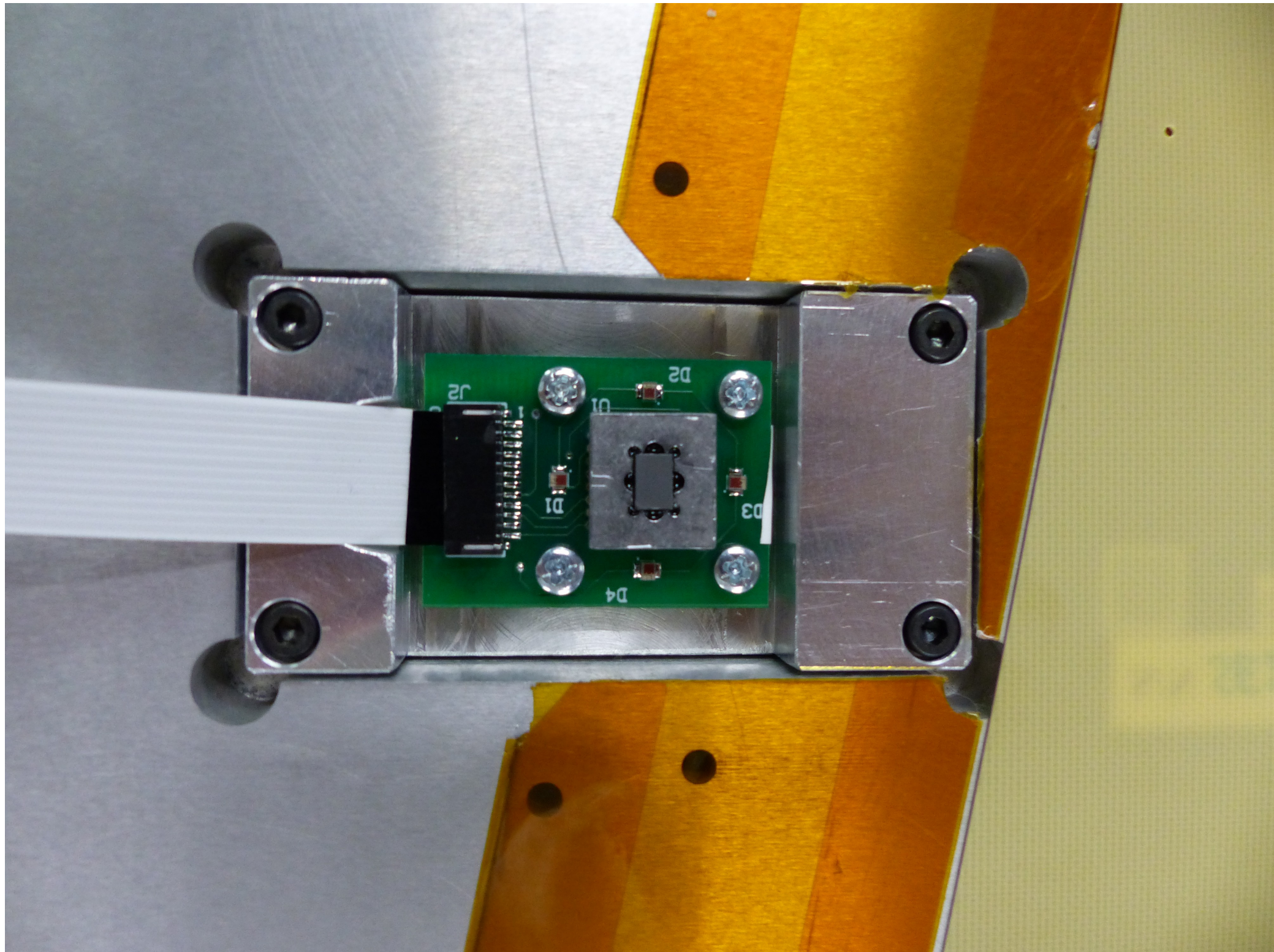
Evaluation of Layers Relative Alignment



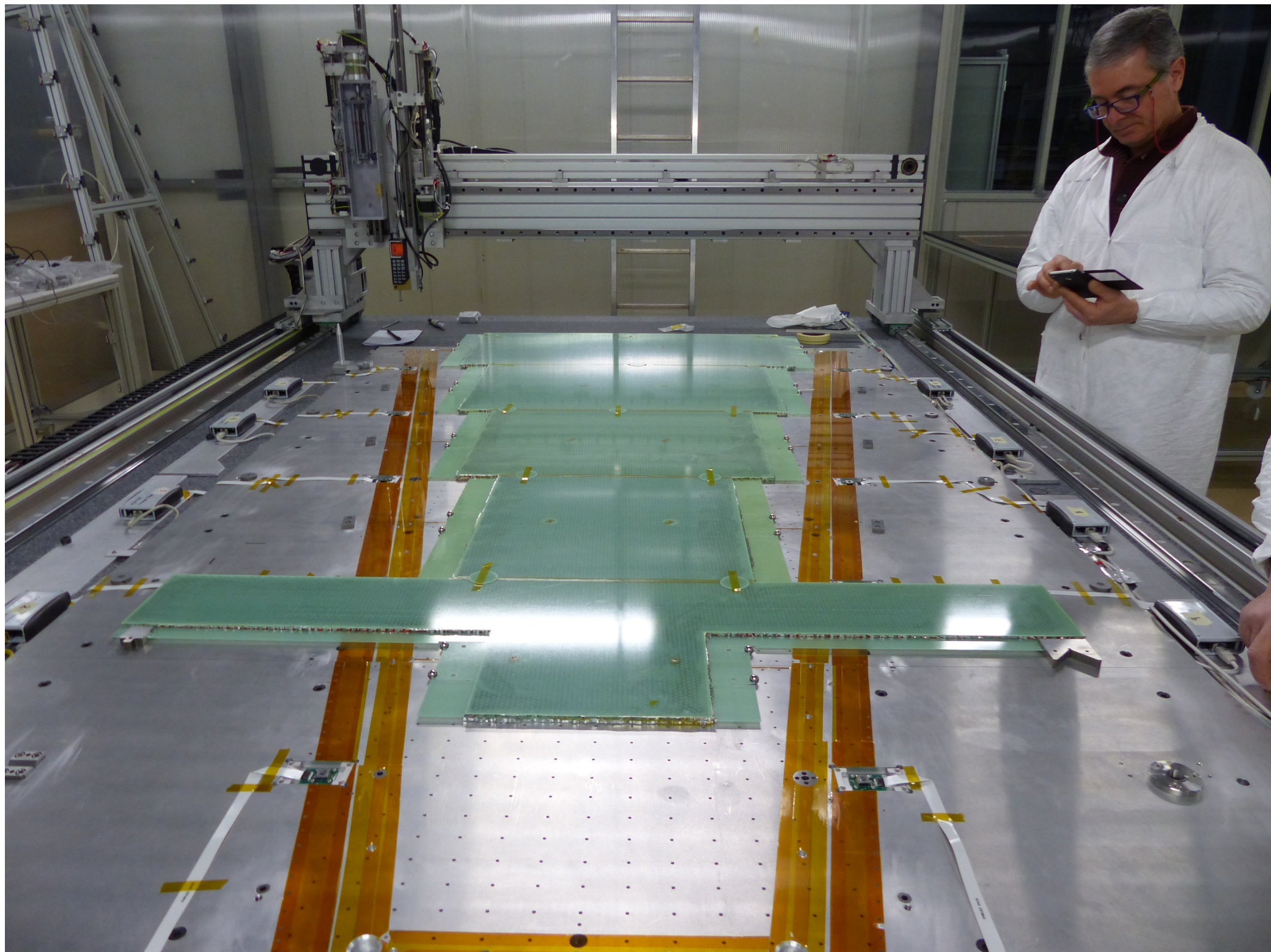
Tools implemented in 2016/17

- ♦ The results of the **June 2016** beam test at **CERN** indicate the importance of an optical system to control **the precise alignment of the RO PCBs**, in addition to the mechanical alignment.
- ♦ An **optical system** composed by **20 contact-CCDs** has been installed in the Al reference plates on the granite table and stiff-back.
- ♦ A **Jig** has been designed and constructed in Pavia (**mechanical workshop**) and calibrated in Freiburg (November 2016) in order to reconstruct the **precise positions of the 20 contact CCDs**. It has been tested in March/April 2017.

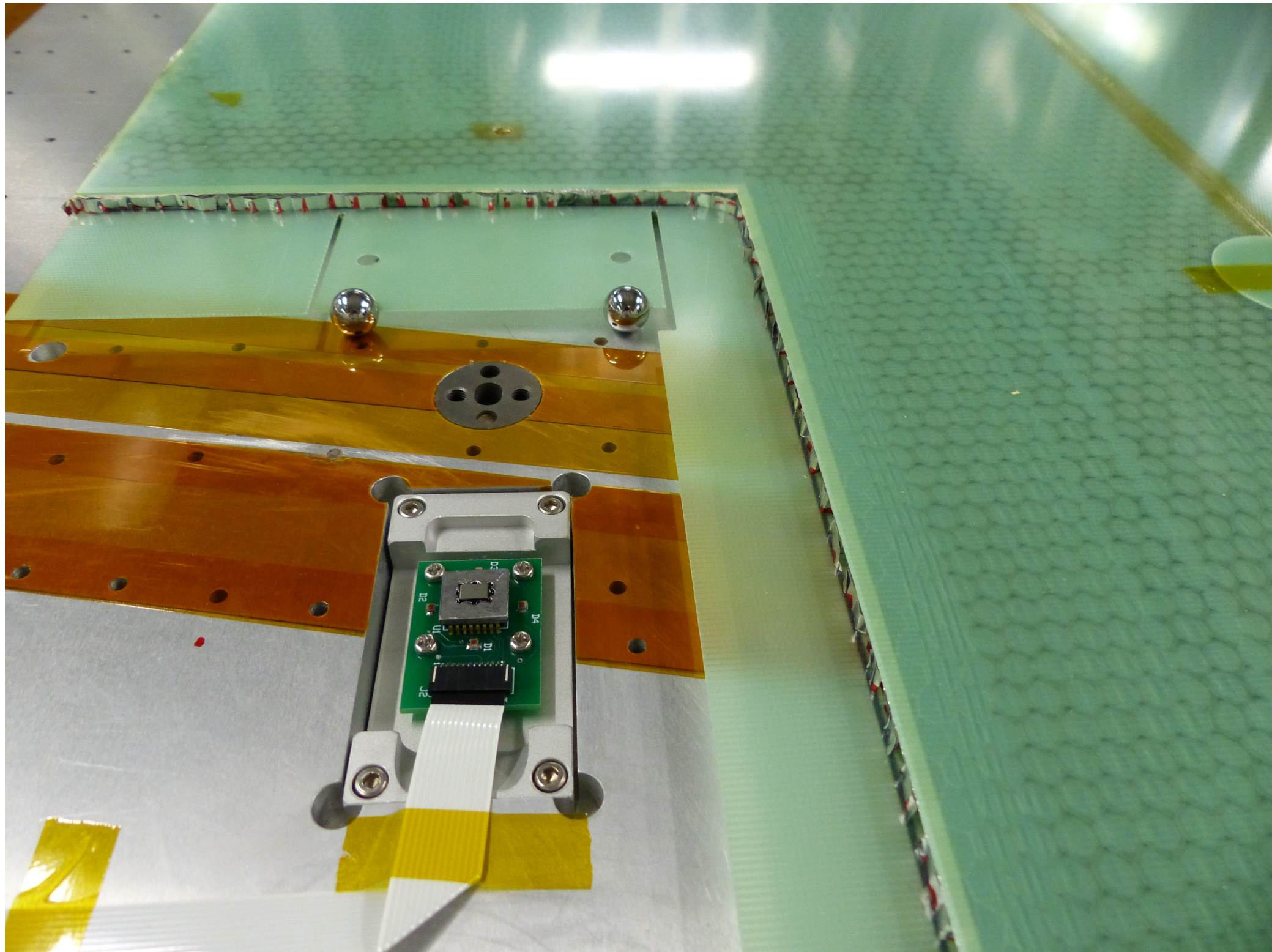
Contact-CCD



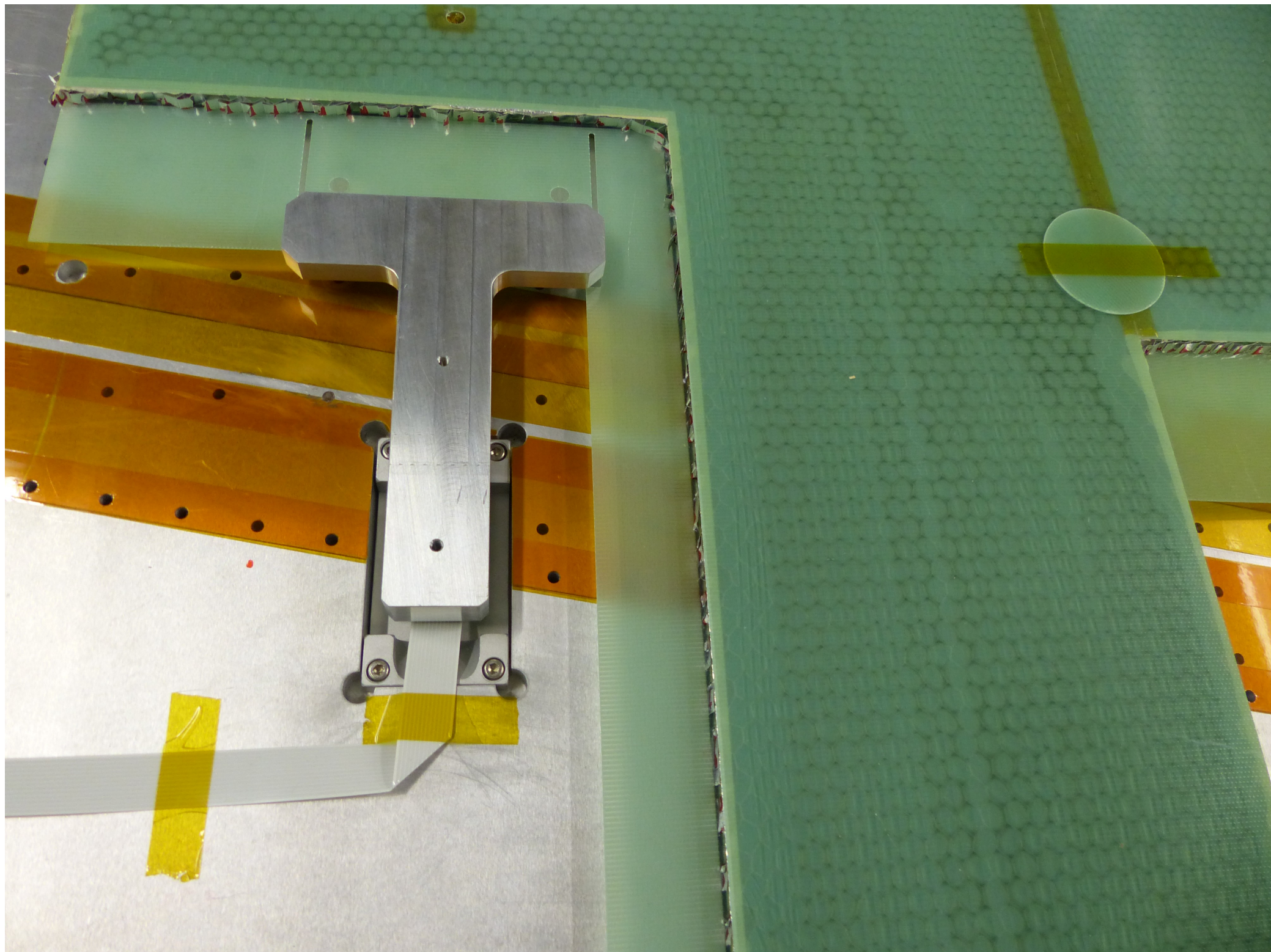
Pavia Calibration Jig



Calibration Spheres & cCCD



Surveyor bridging cCCD & Spheres



Tools implemented in 2016/17

- ◆ Construction steering programs have been written.
- ◆ QA/QC steering programs are being finalized.
- ◆ Procurement & production databases are ready.
- ◆ New tools have been/are under construction for the QA/QC of the components and the final panels.
- ◆ A QA/QC Lab equipped with tools and instruments to check components for the RO panel production is under installation at the INFN shed.

Tools implemented in 2016/17

The **DAQ** system (**Field Point** by National Instruments) was replaced with an **Arduino board** (a micro controller taking inputs from a variety of switches or sensors, and able to control devices as lights, motors, and other actuators).

The **Brown & Sharpe Type 60** indicator used to take data on the granite table is reliable but slow (scan 1 h/panel). It was replaced by a **Blu Laser** with comparable accuracy but much higher speed (scan 15 min/ panel). The **Keyence laser** is on loan from the Department of Electrical Engineering.

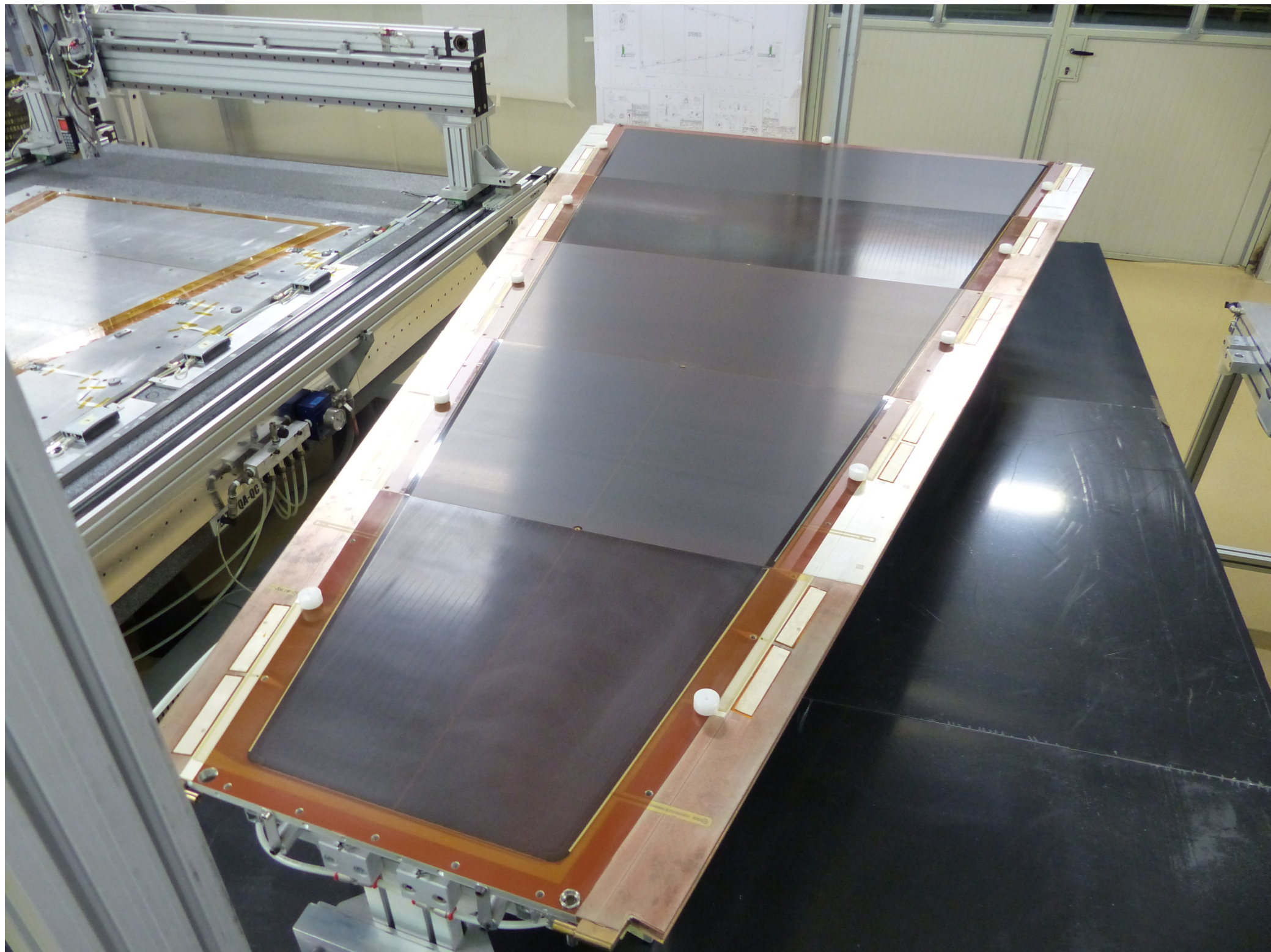
Thanks to mechanical and electronic services

Module 0.5 Prototype

To address issues that arose during M0 construction as well as to test new tooling, a **second full size SM1 prototype (Module 0.5)** are being assembled in Frascati.

Two (**Eta & Stereo**) pre-production RO panels have been produced and tested in Pavia in March 2017. They have been integrated in the **Module 0.5 prototype**.

M05 RO Panel – March 2017



Cables, pipes and fibers on the NJD:

- The design is close to the completion;
- Placement of boxes on the NJD rim is almost completed;
- Design of the patch-panel in the flexible chains in sectors 1, 9 and 13 is well advanced, only the MM LV patch-panel in sector 13 is not yet defined;
- Procurement of parts is starting in these days.

HV and LV system for MM and sTGC:

- After long discussions, an order for developing a demonstrator of the LV converter to place on the NJD rim was issued in February 2017 to both companies CAEN and WIENER. They have one year to deliver their demonstrator;
- The sTGC HV system, based on the Easy3000 module A3535, was purchased end of 2016 via the standard Epool procedure;
- ***The MM HV system was assigned end of April 2017 with a tender between CAEN and ISEG. The winner is CAEN.***

MM on-chamber services:

- HV cable, connectors and filters for the RO panels were completely defined;
- Procurement for the 4 construction sites was completed, end of delivery by next August;
- HV cable, connectors and support pcb for the drift panels were defined at the end of 2016

NSW – Other contributions from Pavia

A. Lanza: NSW Micromegas Steering Group

G. Gaudio: NSW Micromegas Coordination Group member and Module Validation Working group (chair)

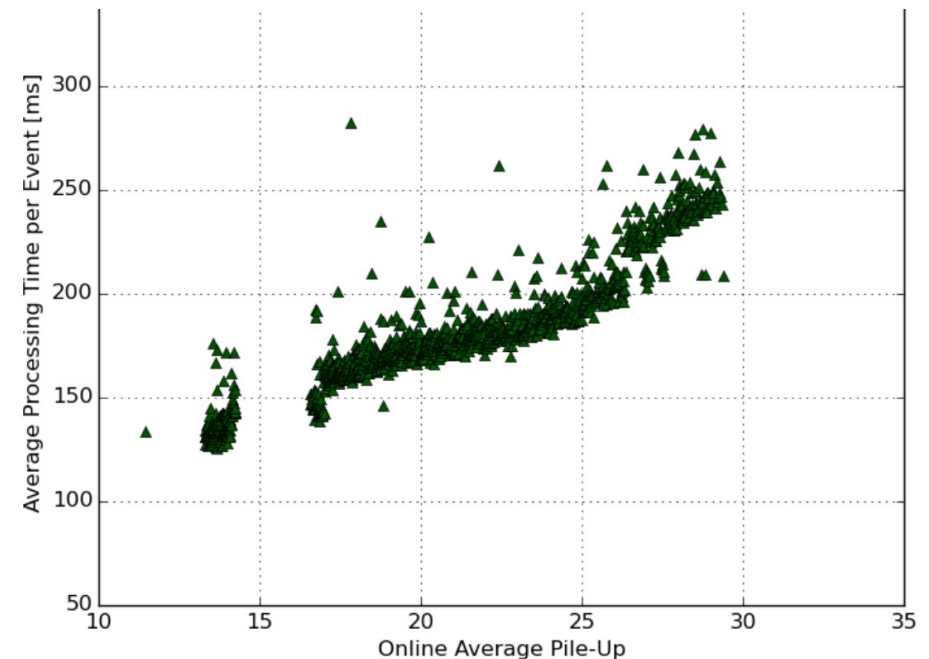
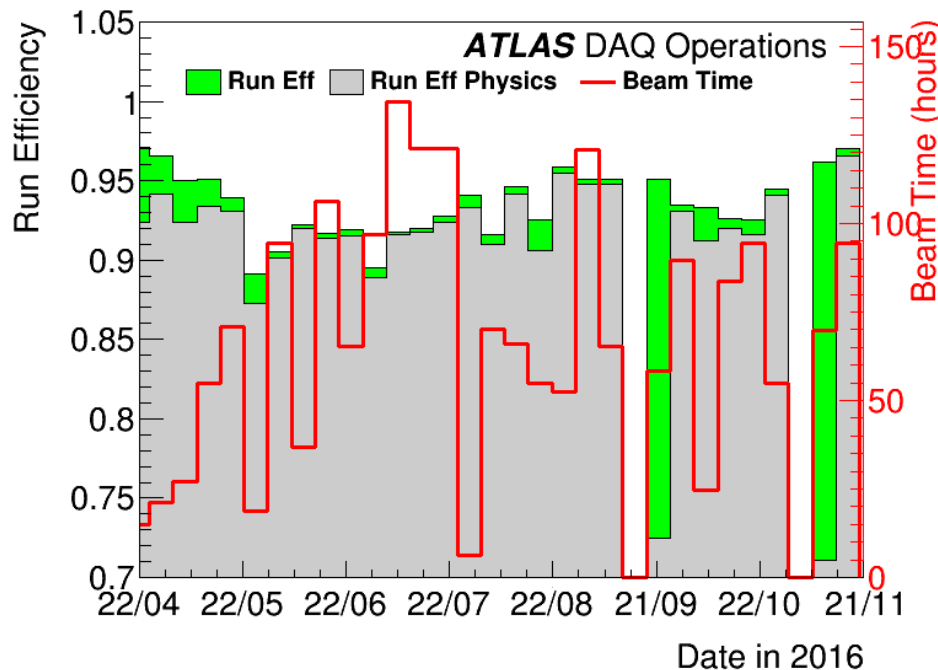
G. Gaudio, G. Introzzi: NSW Micromegas QAQC Working group members

- The Pavia group has performed Certification measurements on preproduction frames for all the collaboration
- Participation of S. Sottocornola on Certification measurements on SMI Module0 at CERN
- Several contributions of INFN Pavia **Mechanical Workshop** to design finalization of NSW Micromegas detector.

T/DAQ operation

A.Negri, R.Poggi

- Trigger/DAQ: efficienza di circa il 93 %
 - In condizioni di alto pileup e basso duty cycle
- Molte componenti operanti oltre i parametri di design
 - Es: scrittura fino a 5GB/s
- Contributo pavese ai turni expert on call



Data Flow

A.Negri, R.Poggi

- Responsabilità pavese “storica”

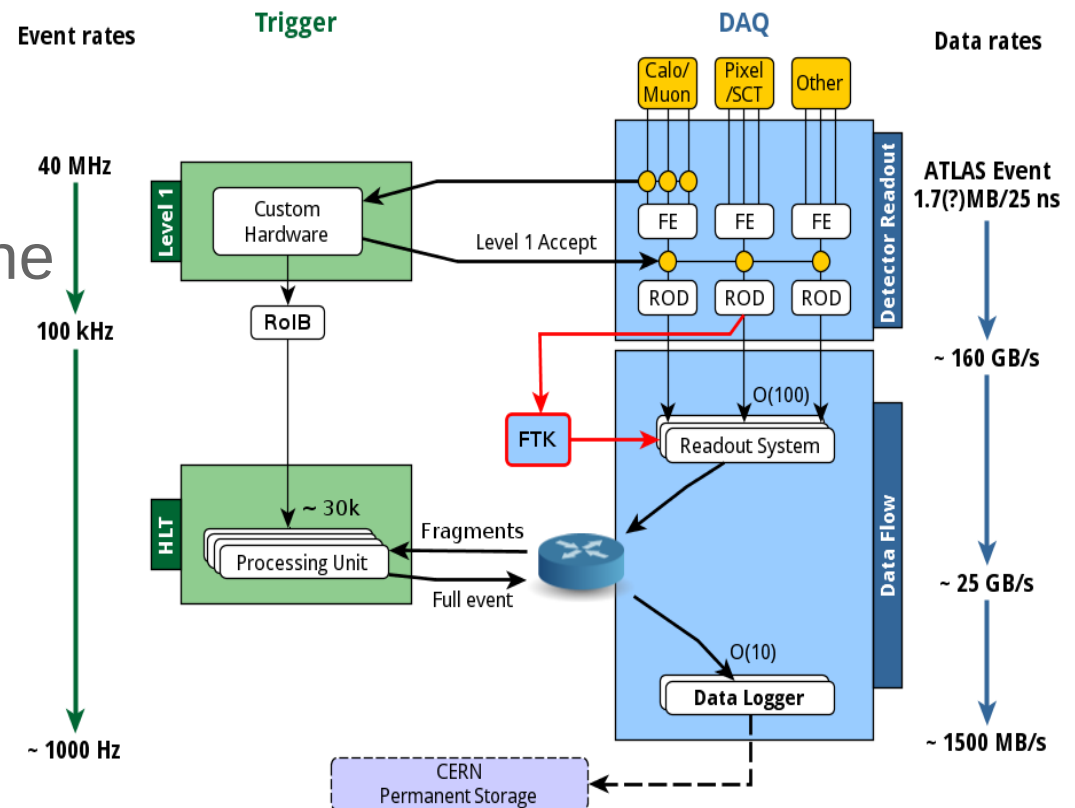
- Nessun problema significativo nel 2016
- Aggiornamenti in base alle esigenze di operazione

- Fase I

- allo studio cambiamenti minimali per ospitare nuovo framework di ricostruzione

- Fase II

- R&D in fase si avvio
- disaccoppiamento tra farm HLT e DAQ tramite file system distribuito: l'online finisce all'uscita del trigger di livello 1



- Run Control

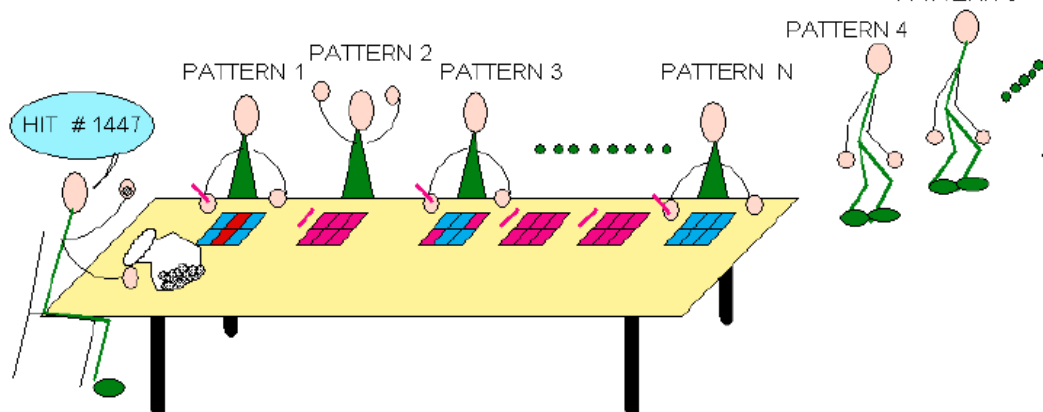
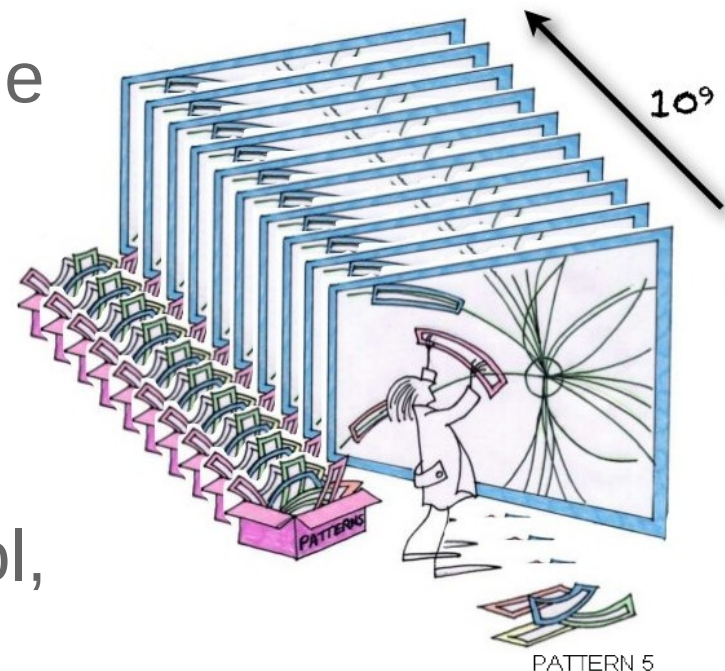
- esplorazione di nuove tecnologie per la gestione dei processi [technical student project]

	Fail Over Policy	Fault Tolerant	Error Recovery	Creation Termin.	Signal	Owner	Hooks	Process Definition	Monitoring
Salt Stack	✓	✓	✗	!	✗	✓	✓	✓	!
Monit	✓	✓	✗	✗	✗	✗	✗	✗	✓
Supervisor	✗	✓	✗	!	✓	✓	✓	✓	✓
Circus	✓	✓	!	✓	✓	✓	✓	✓	✓
Kubernetes	!	✓	✓	✓	!	✓	✓	✓	✓
Docker Swarm	✓	✓	!	✓	✓	✓	✓	✓	✓
Mesos	✓	✓	✓	✓	!	✓	✓	✓	✓

- Processing farm

- sviluppo tool per il commissioning dei nuovi nodi di processamento: lavoro di qualifica come autore ATLAS

- Tracciatore HW basato su memorie associative e successivo fit con FPGA delle road identificate
 - Tracce con risoluzione comparabile con l'offline, disponibili all'inizio degli algoritmi di HLT (pochi μ s)
- Contributo pavese
 - Integrazione del sistema nell'infrastruttura sw DAQ: Run Control, Monitoring, gestione release
 - Integrazione nell'infrastruttura HW
 - Integrazione nell'infrastruttura DCS



FTK: online SW

S.Sottocornola, M.Facchini, A.Negri

- Compilazione e gestione delle release
 - 10 pacchetti, release ~ mensili
- Interfacciamento con il run control
 - Integrazione nell'infrastruttura DAQ
- Procedure di fault tolerance e recovery
 - Rimozione dinamica di componenti dall'acquisizione
- Infrastruttura di monitoring
 - Raccolta e distribuzione dati per il monitoraggio
- Configurazione
 - Tool di generazione della configurazione
- Operation: turni expert on call

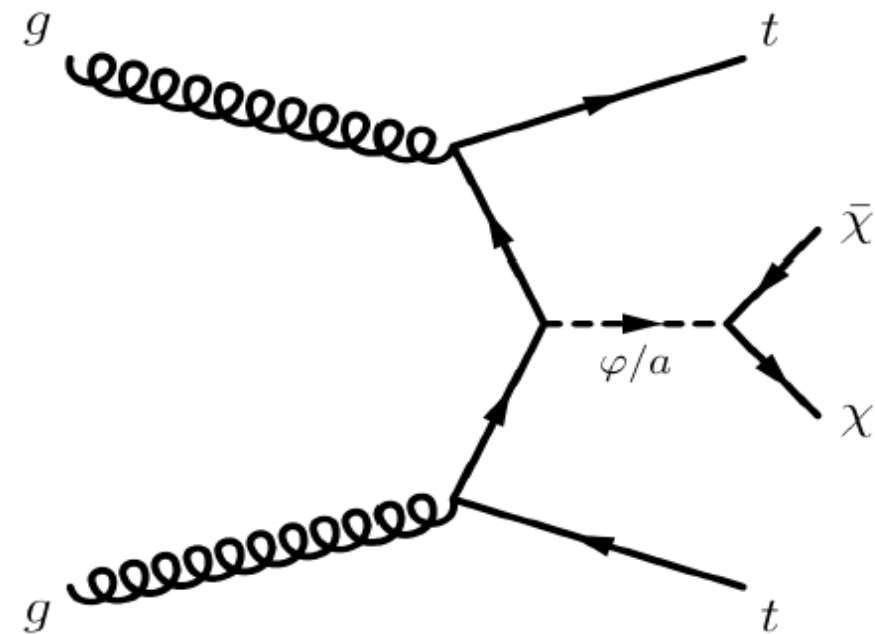
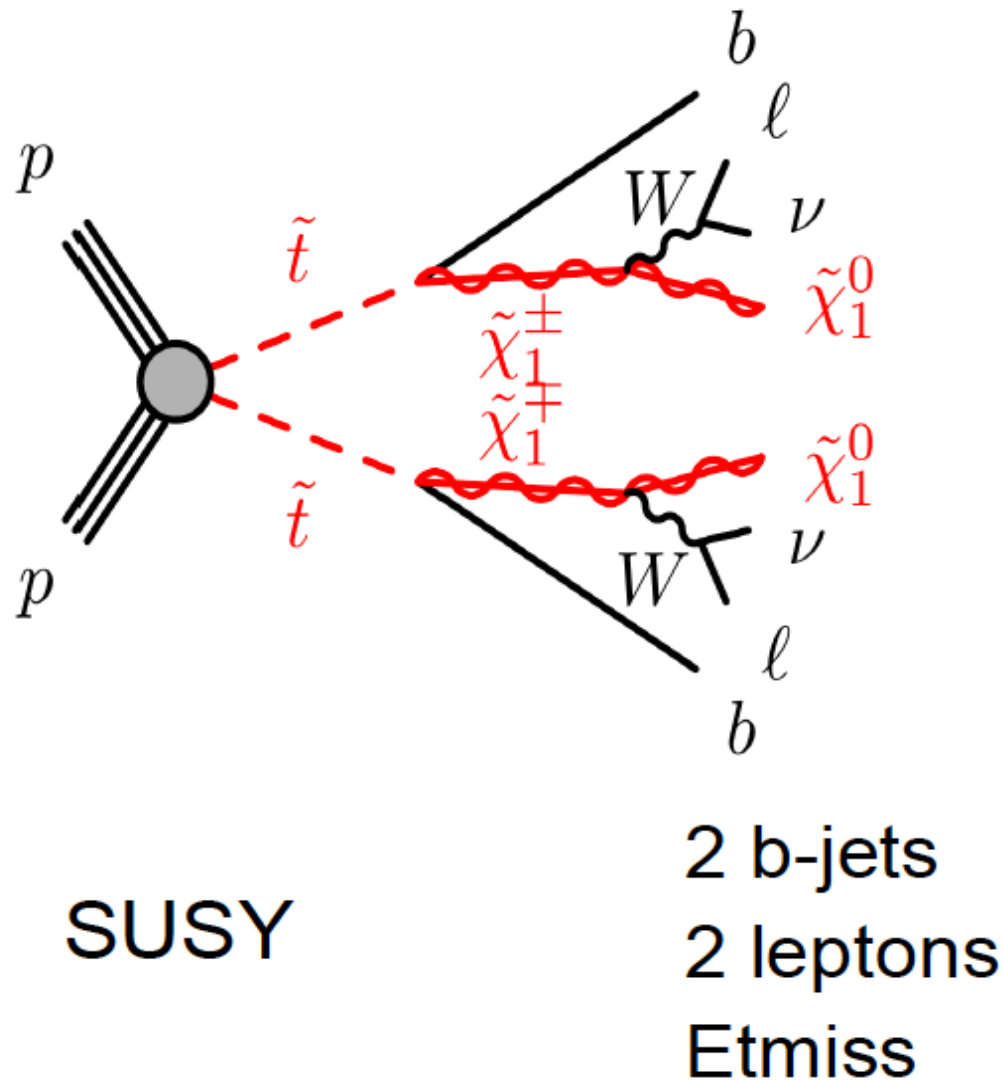
FTK VME Infrastructure

- ◆ **Design, procurement and production of 16 special fan trays:**
 - ◆ Design was finished before the end of 2016;
 - ◆ Procurement was done in November - December 2016, delivery was completed in April 2017. Four prototypes were prepared and installed in January 2017;
 - ◆ Production is in progress and expected to finish by June 2017.
 - ◆ Installation is going in parallel with the production. 4 out of 16 fan trays were installed in ATLAS last April.
- ◆ **Installation of Wiener crates and Caen power supplies:**
 - ◆ Power supplies were all delivered by end of February 2017;
 - ◆ 9U VME crates were all delivered at the beginning of April 2017;
 - ◆ Installation was completed at the end of April 2017
- ◆ **Design, procurement and assembly of 20 9U VME load boards:**
 - ◆ Boards necessary to test the cooling performance of the VME racks;
 - ◆ Design completed in November 2016;
 - ◆ Procurement done in November – December 2016. Delivery of the two major component was delayed up to end of April 2017 by Farnell without a clear explanation;
 - ◆ Production is starting now and should be completed by end of June. Test will follow in parallel;
 - ◆ Cooling tests will be probably scheduled in one of the technical stops in July or August

SUSY/Dark Matter Analysis

Personale: Edoardo Farina, Giacomo Polesello, Giulia Rovelli

Attività': 2 analisi con stesso stato finale; Stop 2l, DM+tt (2l)



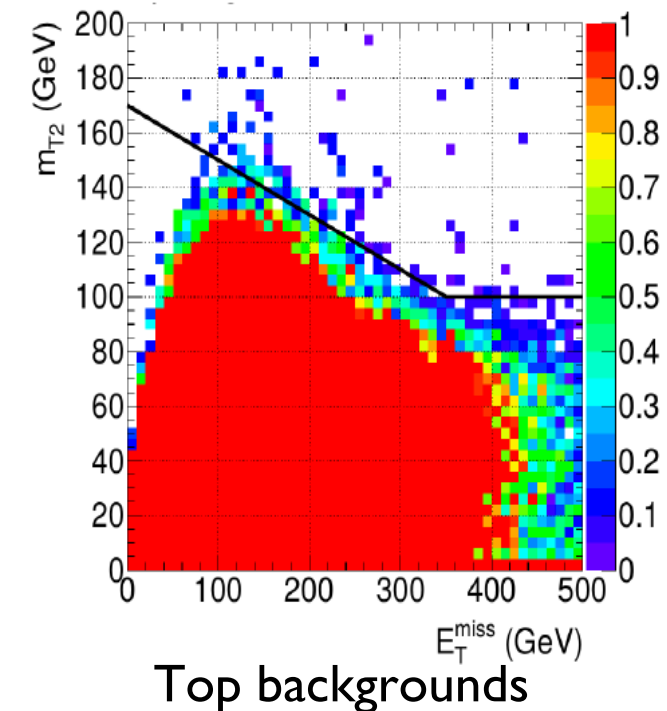
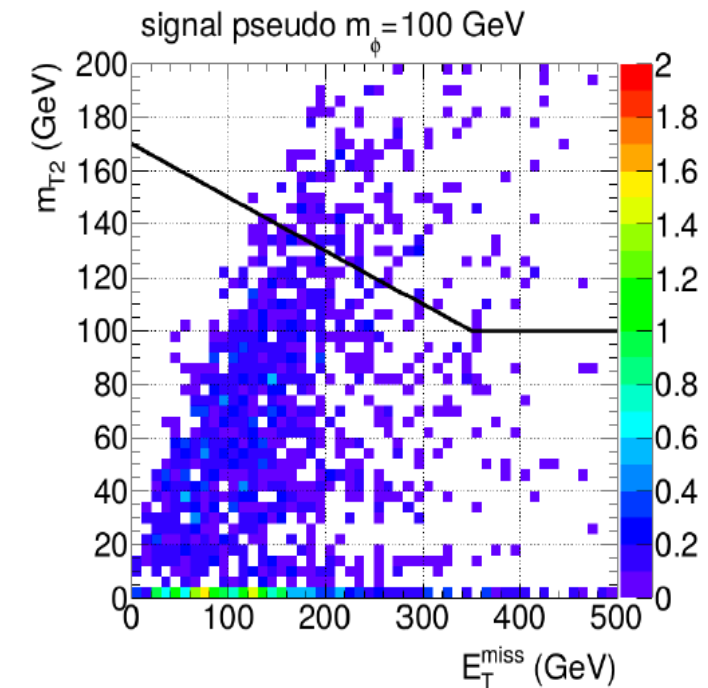
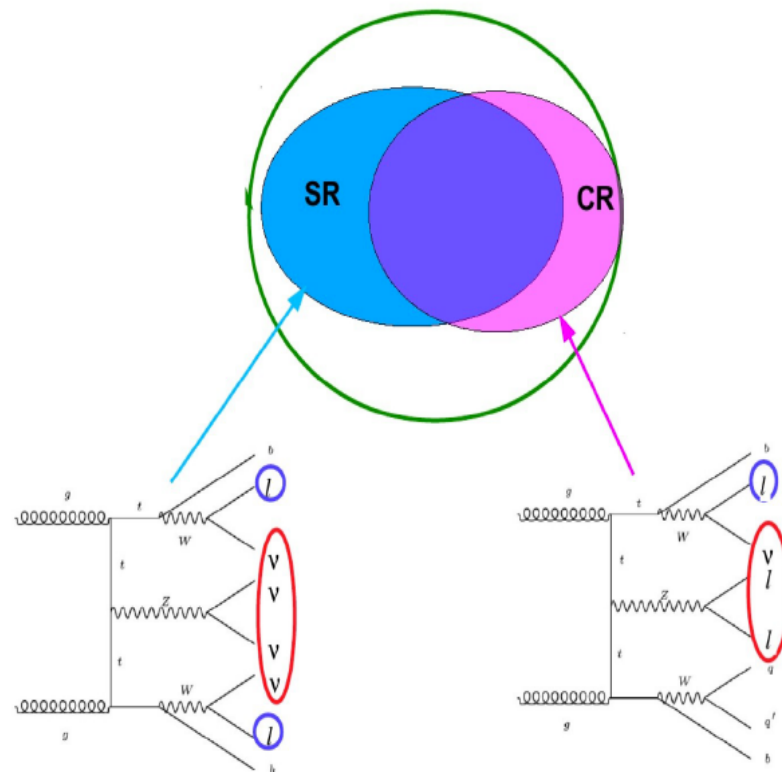
Modello semplificato con
 produzione di Dark Matter
 mediata da nuova particella
 scalare/pseudoscalare

Finalization of 2015/2016 Data Analysis

Stato: Analisi su dati 2015-2016, con obiettivo conferenze estive

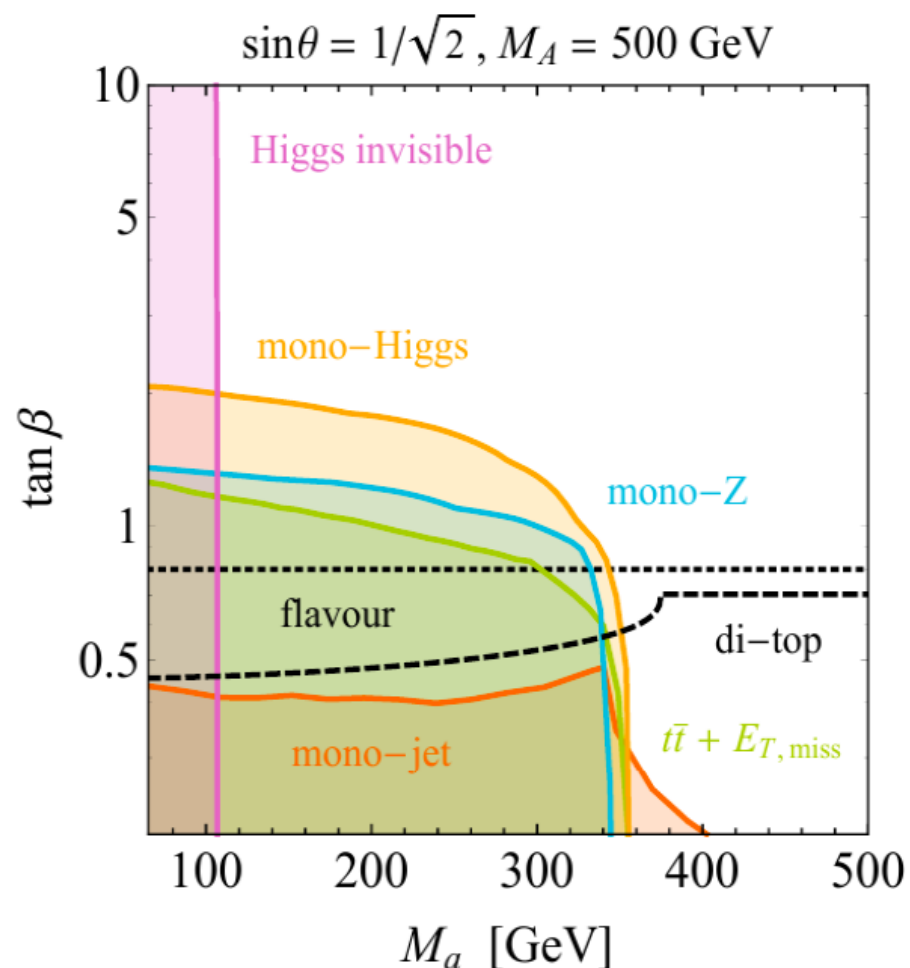
Contributi:

- Ottimizzazione della regione di segnale per analisi DMtt
- Stima del fondo dominante (ttZ) sulla base di stato finale a 3 leptoni per le due analisi
- Valutazione dell'efficienza di analisi su MC truth



Ongoing Physics Studies

Estensione dell'analisi DM + tt a modello comprendente 2 doppietti di Higgs e singoletto pseudoscalare suggerito da teorici



- Mappamento delle analisi esistenti nello spazio dei parametri del modello
- Definizione di nuove segnature
- Combinazione copertura differenti analisi

Contributo: Valutazione della copertura Analisi DM+tt, presentata al workshop di ATLAS in corso a Bucarest

ArXiv:1701.07427

Higgs Related Activities

- D. Rebuzzi among the proposers of the COST Action (supported by the EU Framework Programme Horizon 2020) named **Vector Boson Scattering Coordination and Action Network (VBSCan)**
 - Approved by the EU with the highest score: the study of the Vector Boson Scattering has been appointed as one of the crucial areas where to investigate the intimate structure of EWSB in LHC phase 2 era
 - International research consortium with Italy as main proposer and several European and extra-European countries http://www.cost.eu/COST/_Actions/ca/CA16108?parties
 - DR representative for Italy in the Management Committee and involved in two working group activities
 - First kick-off meeting in Bruxelles last April 30th - next meeting in Split next June 28th-30th
- D. Rebuzzi member of the “Marie Curie Initial Training Network (FP7-PEOPLE-2012- ITN)” titled **HiggsTools** - Co-chair of the Recruitment Team (with Nigel Glover)
- DR member of the “Marie Curie Initial Training Network titled **HiggsTrain**, currently under evaluation by the EU - Chair of the Recruitment Team
- Since March 2010, D. Rebuzzi is **member of the LHC Higgs Cross Sections WG**
 - Work for the combination of ATLAS and CMS results together with theory predictions
 - ATLAS contact for the Higgs Branching Ratios predictions
 - fourth Yellow Report book just formally approved by the CERN editorial board, now in



Muon Phase-2 Upgrade

- ◆ The Muon phase-II upgrades passed the IDR in October 2016.
- ◆ One of the approved project was the replacement of the full Muon power system, HV and LV. The cost of this project is estimated to be 10,467 kCHF, and the time schedule will span from 2024 to 2030
- ◆ The Muon phase-II upgrade kick-off meeting took place the day after the IDR
- ◆ The TDR is under writing, and must be ready by end of May 2017 for an ATLAS EB approval in the June 2017 ATLAS week. The RRB in April 2018 should approve the money matrix and give the green light for spending rump-up

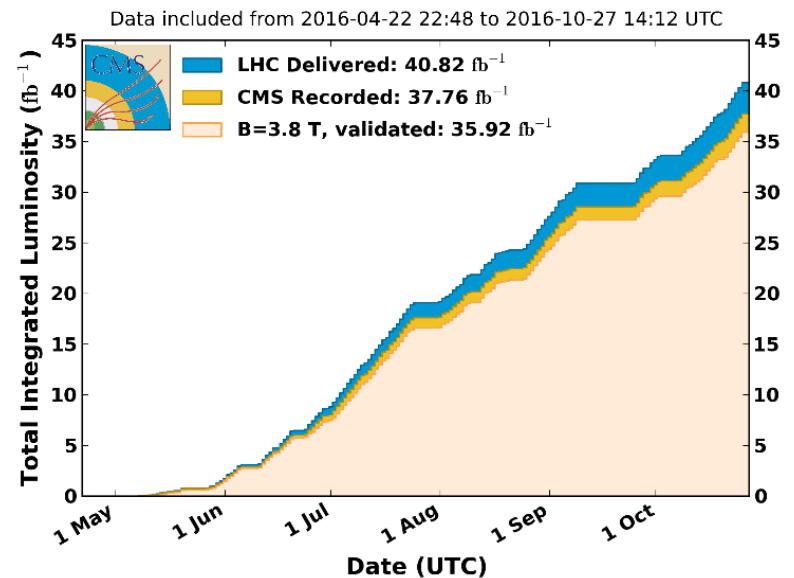
THANKS



CMS in 2016

Luminosità registrata durante Run II
basata in CMS su 4 diversi sottorivelatori
e basata su nuovi algoritmi

CMS Integrated Luminosity, pp, 2016, $\sqrt{s} = 13$ TeV



CMS preliminary results: April 22nd - October 27th 2016

Tracker		Calorimeters			Muon Spectrometer			Operational Issue
Pixel	SST	ECAL	ES	HCAL	CSC	DT	RPC	Tracker HV ramp
99.9	99.1	99.3	99.7	99.6	99.9	99.9	99.6	99.5
All good for physics: 96%								
Luminosity weighted fraction (in %) of data certified as good for physics analysis relative to 37.76 / fb of data recorded by the CMS experiment during 2016 proton-proton collisions at 13 TeV with magnet at 3.8T.								

Alta % di data «certificati» per
ciascun sottorivelatore durante i run
2016

CMS PAVIA



		CMS	FaseII	CHPIX	
Alessandro Braghieri	Ric. INFN	0.2	0.5		MUON
Daniele Comotti	Dottorando	0.3			TRACKER
Francesco De Canio	Assegnista	0.7		0.3	TRACKER
Lorenzo Fabris	Dottorando	0.4		0.2	TRACKER
Francesco Fallavollita	Dottorando		1.0		MUON
Luigi Gaioni	Assegnista	1.0			TRACKER
Alice Magnani	Dottoranda	0.8	0.2		MUON
Massimo Manghisoni	RU	0.5		0.2	TRACKER
Paolo Montagna	RU	0.5	0.2		MUON
Benedetta Nodari	Dottorando	0.8		0.2	TRACKER
Lodovico Ratti	RU	0.2			TRACKER
Valerio Re	PO	0.7			TRACKER
Martina Ressegotti	Dottoranda		1.0		MUON
Cristina Riccardi	PA	0.6	0.3		MUON
Elisa Riceputi	Dottorando	1.0			TRACKER
Paola Salvini	Ric. INFN	0.8	0.2		MUON
Gianluca Traversi	RU	0.6		0.2	TRACKER
Carla Vacchi	RU	0.4		0.2	TRACKER
Ilaria Vai	Dottoranda	0.7	0.3		MUON
Paolo Vitulo	PA	0.5	0.4		MUON

totale FTE = 10.7(cms)+4.1(faseII) +1.3(chipix)

CMS Pavia

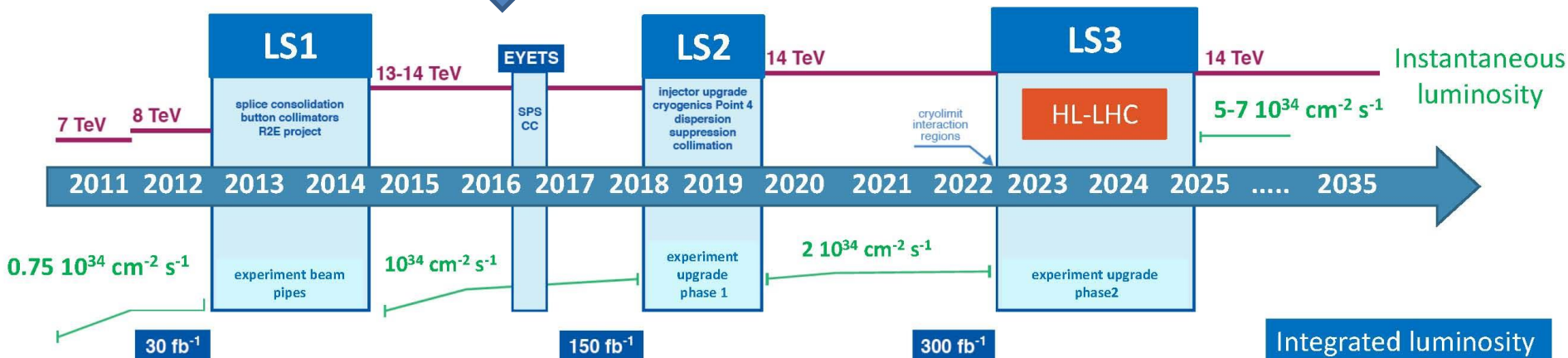
DATA ANALYSIS
& simulation

CMS outreach

TRACKER

MUON

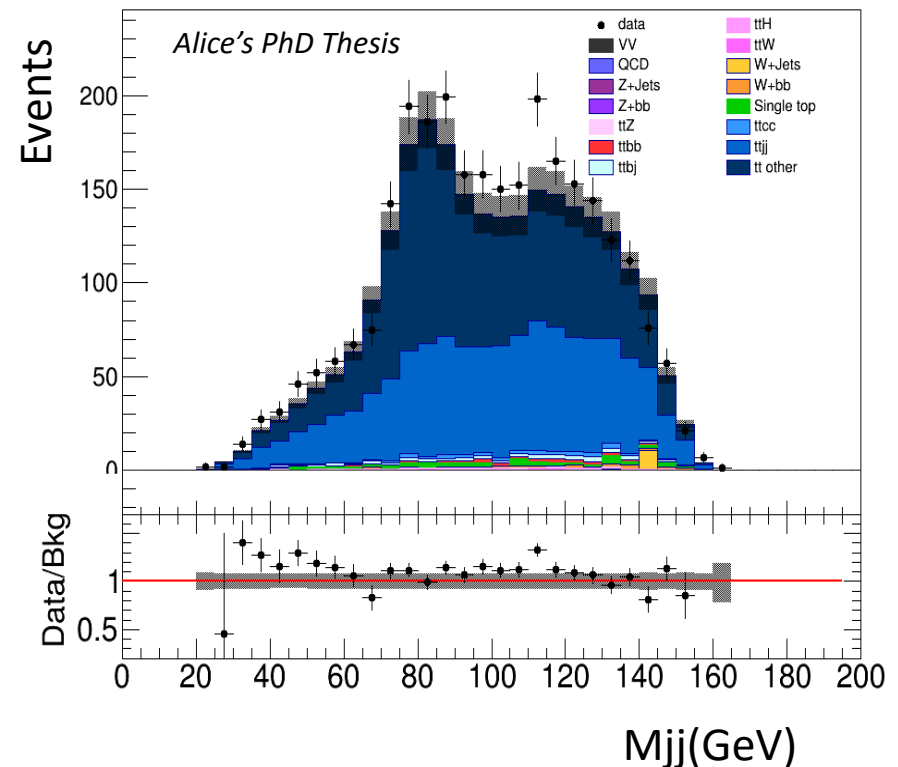
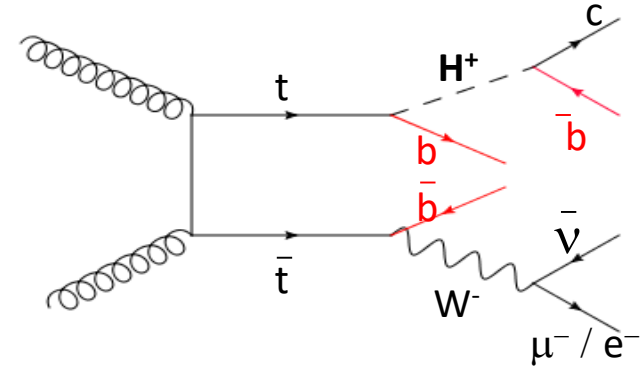
Run2 Upgr.Fase I Upgr.Fase II



Light charged Higgs $H^+ \rightarrow cb$

Search for a charged Higgs with $m_W < m_{H^+} < m_{\text{top}}$ produced in top quark decays and going to cb .

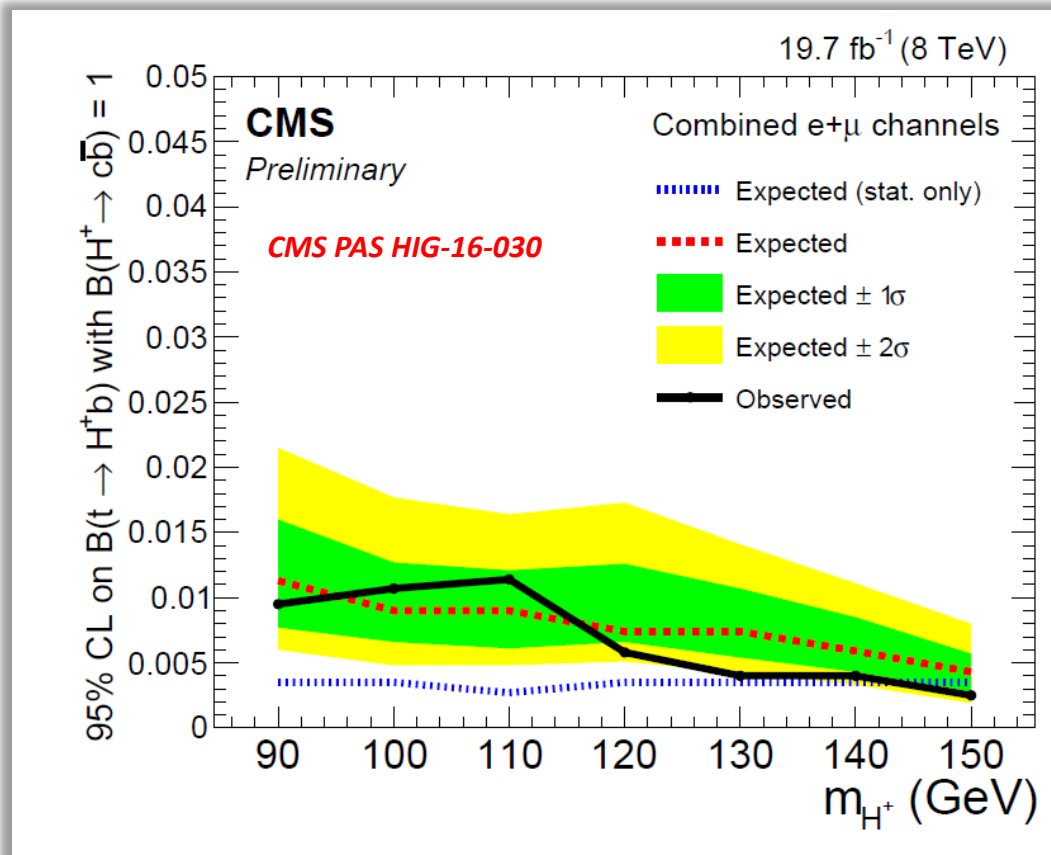
- The final state is sensitive to low $\tan\beta$ region in the **MSSM**, and it can be dominant in the **Flipped 2HDM**
arXiv:1304.1787v2, arXiv:1002.4916v2
- Similar searches performed by CMS & ATLAS in the $H^+ \rightarrow cs$ final state (*Eur. Phys. J. C (2013) 73:2465, CMS-PAS-HIG-13-035*) **The third b jet allows a better rejection of the tt background.**
- The H^+ can be looked for reconstructing the M_{JetJet} with a **kinematic fit** technique and looking for a secondary peak, which should appear if the H^+ signal is present, in addition to the peak due to the main background source ($t\text{-}\bar{t}$)



Light charged Higgs $H^+ \rightarrow cb$

19.7 inv fb of data collected in 2012 at centre-of-mass energy of 8 TeV was analyzed. No excess found. A model independent upper limit on $BR(t \rightarrow H^+ b)$ was set assuming $BR(H^+ \rightarrow cb) = 1$

The analysis was made public for ICHEP 2016 - A paper is in preparation



Muoni

Responsabilità :

- C.Riccardi → responsabile nazionale progetto GEM-Muoni di CMS;
GEM Conference Committee & Editorial Board member; MUON IB Deputy Chair
- I.Vai → Co-convener of the ME0 detector R&D working group; responsible for CMS GEM DCS Gas Panel
- P.Vitulo → coordinator GEM R&D Phase II Upgrade Office

Attività :

RPC & GE1/1

Attività pavese sul rivelatore RPC

- **Lavori di manutenzione:**

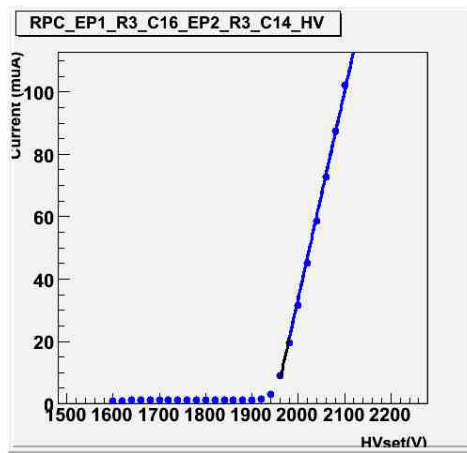
controlli su bakelite, riparazioni e controlli sistema gas (barrel gaps), controllo performance del rivelatore.

Importante contributo di **Samuel Gigli**

- **Misure di ageing :**

su gap RPC del Barrel e EndCap di CMS a P5. Studiata la curva caratteristica I-V con Ar per valutare la resistività degli elettrodi e confrontarla con misure di anni precedenti.

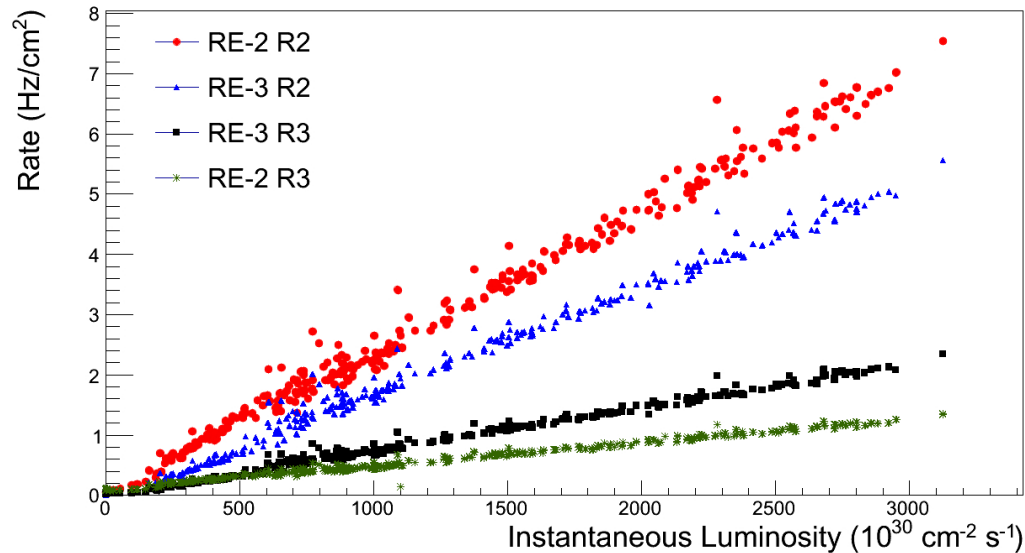
C.Riccardi,P.Vitulo



$$\rho = R * \text{GapArea} / 2d$$

RPC monitoring @ P5

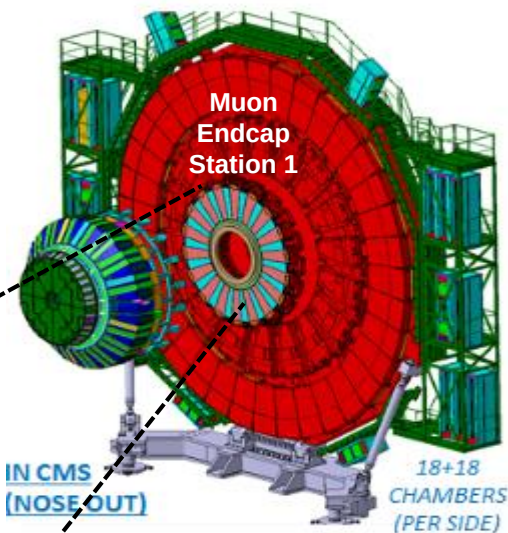
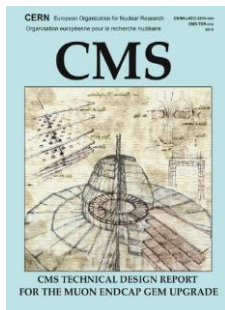
- **RPC current monitor** current vs. luminosity plots is now part of RPC monitoring in WBM (Web Base Monitoring)



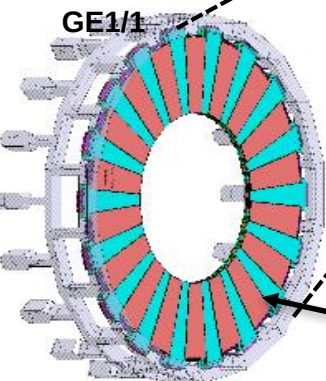
P.Montagna, P.Salvini

Approvato 10/2015

GE1/1 : STATION

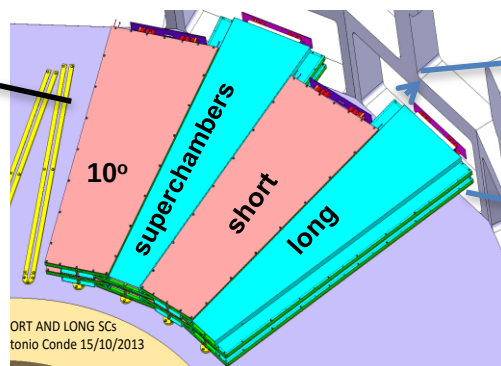


- GE1/1 : 10° in Φ **triple-GEM**
- 2 GEM chambers form a “**super chamber (SC)**”;
- 144 total chambers (36 super chambers in one station per endcap)



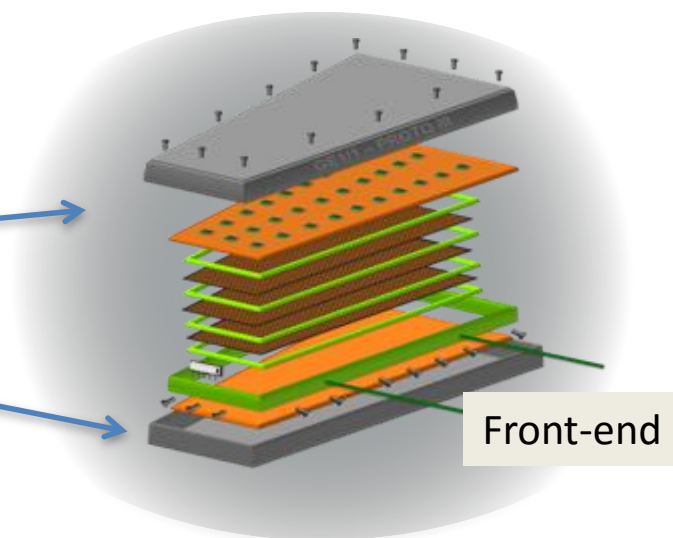
Short SC
eta=1,61-2.18

Long SC
eta=1.55-2.18



40° Slice in 2016-17 YETS

Chamber

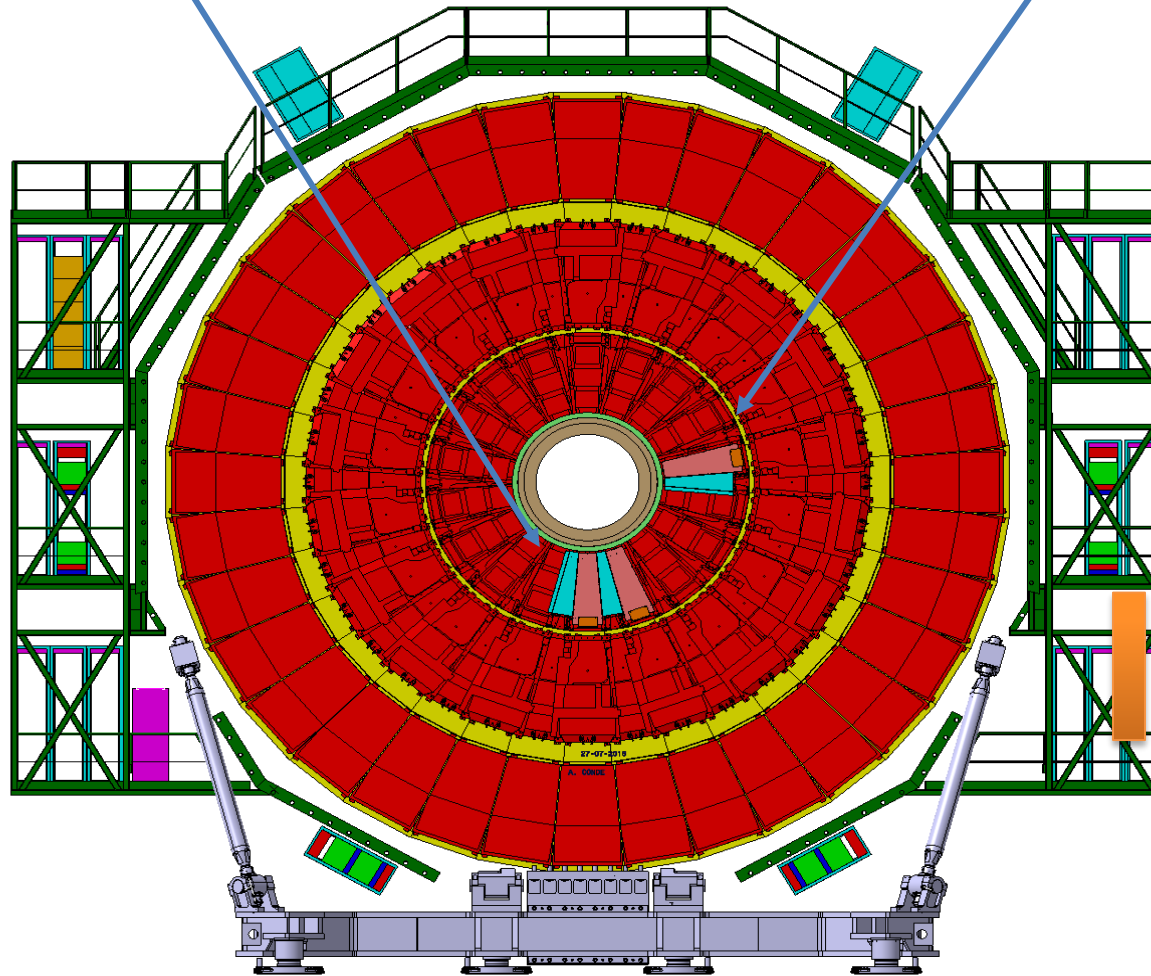


GE1/1 Slice Operational at P5!

YE-1

Far

Near



GE1/1 DCS integration @ P5

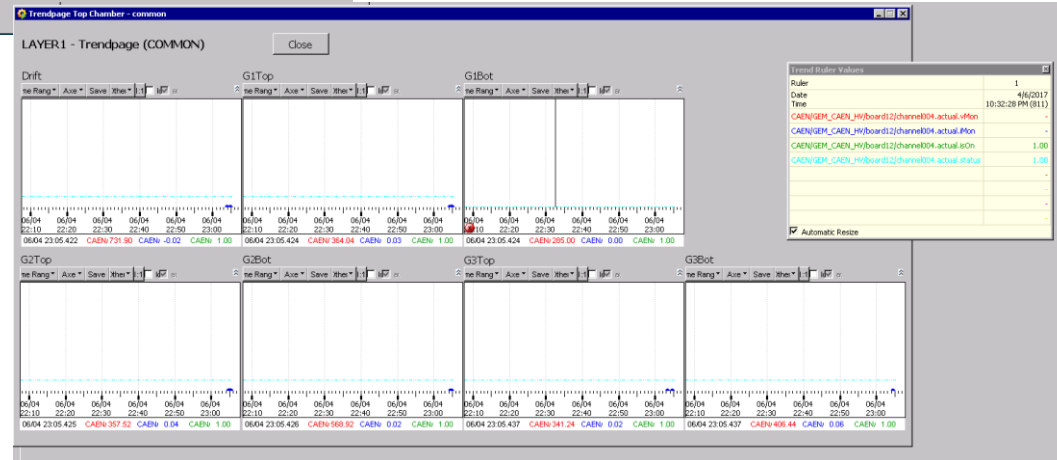
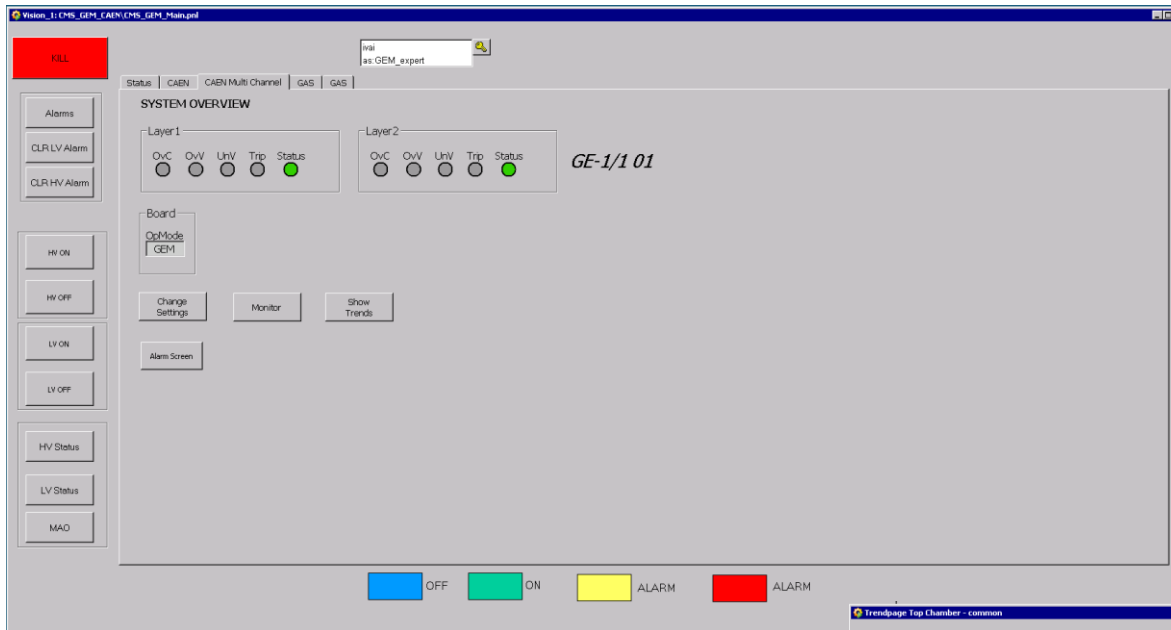
GE1/1 Slice Test DCS - 1

Control and monitoring of the multichannel HV board CAEN A1515TG:

- Settings of all the interesting parameters of the board, which actually supplies two Triple-GEM chambers installed in CMS
- Constant monitoring of the parameters
- Plots for the trending in time of the parameters
- Alarm notification

- Implemented in the GEM DCS project
- Accessible from the GEM Terminal Server
- Actually used during the GE1/1 Slice Test

Martina Ressegotti



GE1/1 DCS integration @ P5

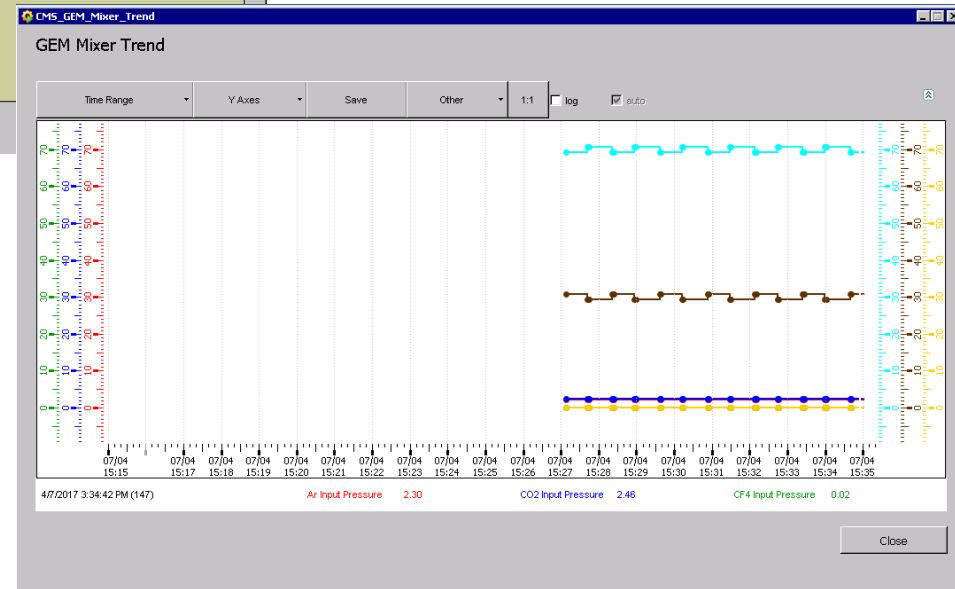
GE1/1 Slice Test DCS - 2

Monitoring of the full gas system and environmental parameters:

- Constant monitoring of the gas system parameters (flows, pressures, mixture) and environmental data
- Plots for the trending in time of the parameters
- Alarm settings and notification

- Implemented in the GEM DCS project
- Accessible from the GEM Terminal Server
- Actually used during the GE1/1 Slice Test

Ilaria Vai

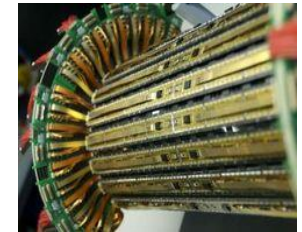
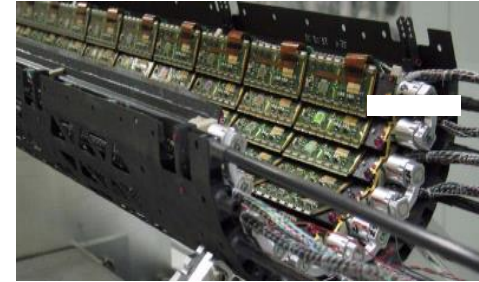


Phase II Tracker Activities of the Pavia Group

Inner tracker:

L'attività sui layer interni è svolta insieme alla collaborazione RD53 e prevede:

- lo sviluppo di circuiti di front-end per elaborare i segnali provenienti da rivelatori a pixel (rispettando le specifiche per i layer interni di fase 2);
- è in corso anche un lavoro in collaborazione con il gruppo di microelettronica del Fermilab finalizzato al progetto di un canale analogico di front-end con la tecnologia scelta dalla collaborazione;
- la caratterizzazione della tecnologia scelta dalla collaborazione per la realizzazione dei circuiti dal punto di vista della resistenza alle radiazioni;
- il progetto di alcuni circuiti ausiliari che si troveranno nella periferia del chip di readout.



Atlas & Cms Phase 2 Pixel Challenges :

- Very high particle rates: $500\text{MHz}/\text{cm}^2$
 - Hit rates: $1\text{--}2\text{GHz}/\text{cm}^2$ (factor 16 higher than current pixel detectors)
- Smaller pixels: $\frac{1}{4} - \frac{1}{2}$ ($25 - 50\text{um} \times 100\text{um}$)
 - Increased resolution
 - Improved two track separation (jets)
- Participation in first/second level trigger ?
 - A. 40MHz extracted clusters (outer layers) ?
 - B. Region of interest readout for second level trigger ?
- Increased readout rates: $100\text{kHz} \rightarrow 1\text{MHz}$
- Unprecedented hostile radiation: 1Grad , $10^{16}\text{Neu}/\text{cm}^2$

Phase 2 Pixel Project

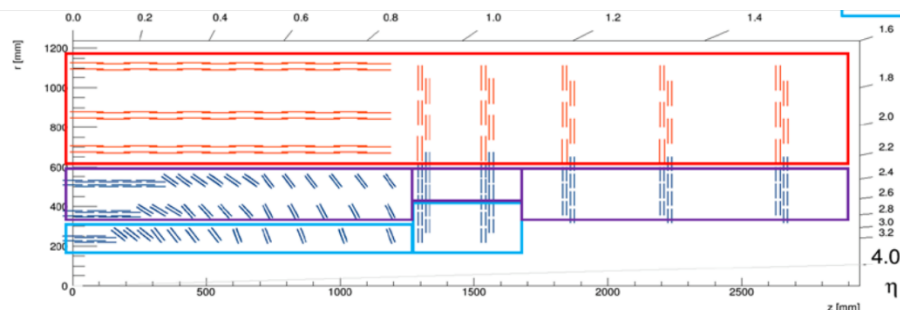
- Hybrid pixel detector with separate readout chip and sensor.
- Pixel sensor(s) not yet determined
- Planar, 3D, Diamond, HV CMOS, , ,
 - Possibility of using different sensors in different layers
 - Final sensor decision may come relatively late.
- Very complex, high rate and radiation hard pixel readout chips required

Phase II Tracker Activities of the Pavia Group

Outer tracker:

stiamo lavorando insieme al gruppo di microelettronica (PH/ESE-ME department) del CERN al Pixel-Strip (PS) module.

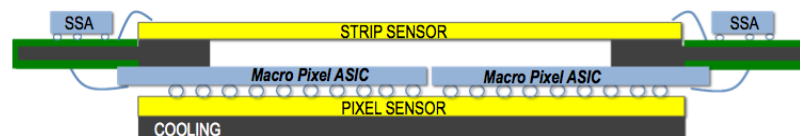
Il PS module è composto da un layer di pixel e da uno di strip.



CMS outer tracker geometry used for simulation. Blue lines are the PS modules, while red lines are Strip-Strip modules

SPECIFICHE :

- Provides high pT information to the Level-1 Trigger
- Stores Events for the L1 latency duration and provides it when requested.
- Provides accurate Z information



Descrizione :

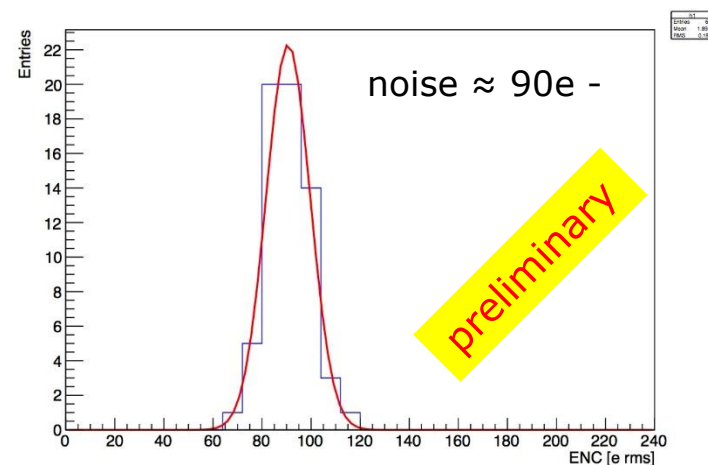
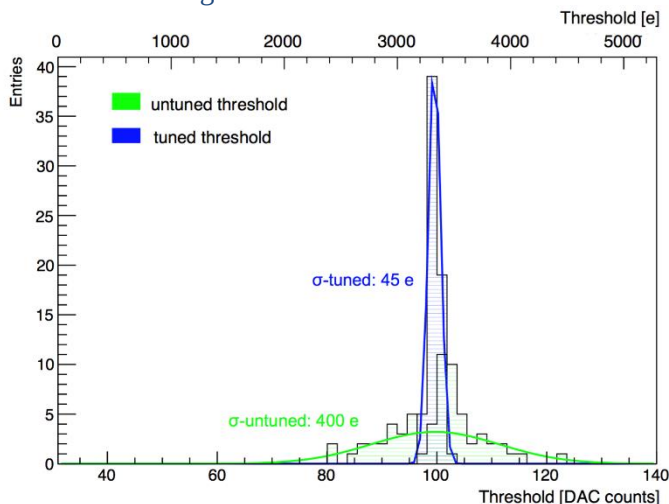
- Strips are readout from 16 Short Strip ASICs, while Pixels are readout from 16 Macro Pixel ASICs
- The SSA (Strip Sensor ASIC) processes the sensor signals, and immediately sends strip data to the corresponding MPA (Macro Pixel ASIC) chip, at Bunch Crossing frequency.
- The MPA processes signals from each pixel. It correlates the bottom sensor hits with the data received from the SSA strips and builds stubs. A stub is a particle with a momentum $> 2 \text{ GeV}/c$ which crosses the two sensor layers.
- The MPA sends out stubs at each BX (25 ns) while it stores the full event for the duration of L1 Latency.

Asynchronous front-end for the RD53A chip

risultati preliminari front-end sviluppato per l'inner tracker.

E' stato integrato nel chip prototipo di CHIPIX65 (gruppo V) la cui caratterizzazione è ora in corso. Una versione modificata di questo canale verrà integrato nel chip RD53A la cui caratterizzazione il prossimo anno verrà fatta in ambito CMS.

dispersione di soglia del canale prima e dopo la correzione che avviene con un DAC a 4 bit integrato nel front-end.



istogramma, ricavato solo su 64 pixel dei 2048 a disposizione per le misure, che mostra un noise di circa 90 elettroni. Le misure per ricavare il noise da tutti i pixel sono in corso

RD53A Chip

➤ Demonstrator chip:

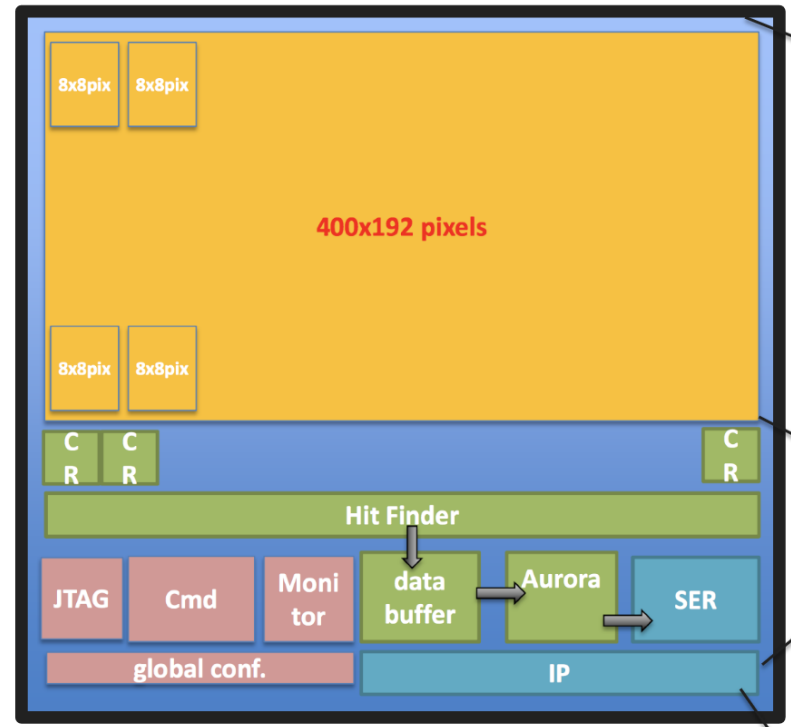
- Full size chip ($\sim 2\text{cm} \times 2(1)\text{cm}$), small pixels ($50 \times 50 \mu\text{m}^2$), Large pixels, Very high hit and trigger rates, Radiation and SEU tolerance, Effective in-time threshold: 1000e, Low power, Serial powering, Functional in test beams, etc.
- Specification document agreed with CMS and ATLAS phase 2 pixel communities.
- Engineering run $\sim 1\text{M}\$$
 - Shared run with other project(s) (CMS MPA)

➤ Schedule:

- Chip submission: end of May 2017

➤ Core design team and responsibilities

- Valerio Re (INFN-PV): Analog Working Group
- Luigi Gaioni (INFN-PV): Analog Matrix and Analog EOC
- Francesco De Canio (INFN-PV): Analog EOC

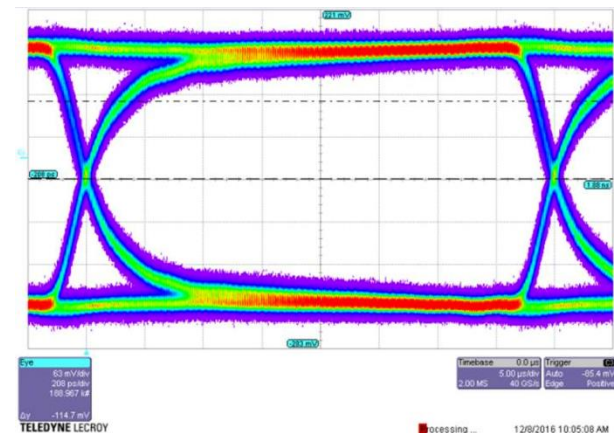
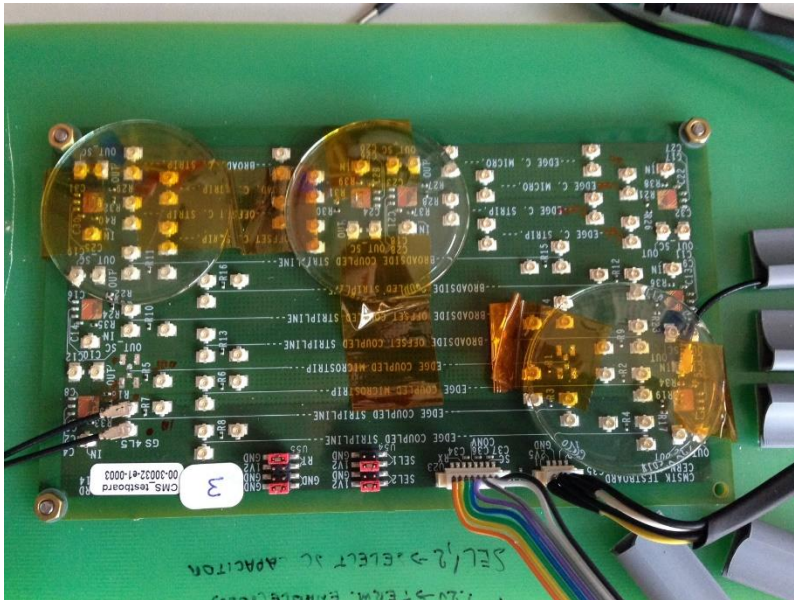


Outer Tracker Activity

Si sono caratterizzati i driver e receiver SLVS (Scalable Low Voltage Signaling) , ovvero dei circuiti in fase di integrazione nei chip MPA e SSA che sono i chip sviluppati per leggere i pixel e le strip del PS module dell'outer tracker

⑩ SLVS IO pad evaluation test chip

- ⌘ Area 2mm x 1mm
- ⌘ Submitter in May 2016 and characterized in fall 2016

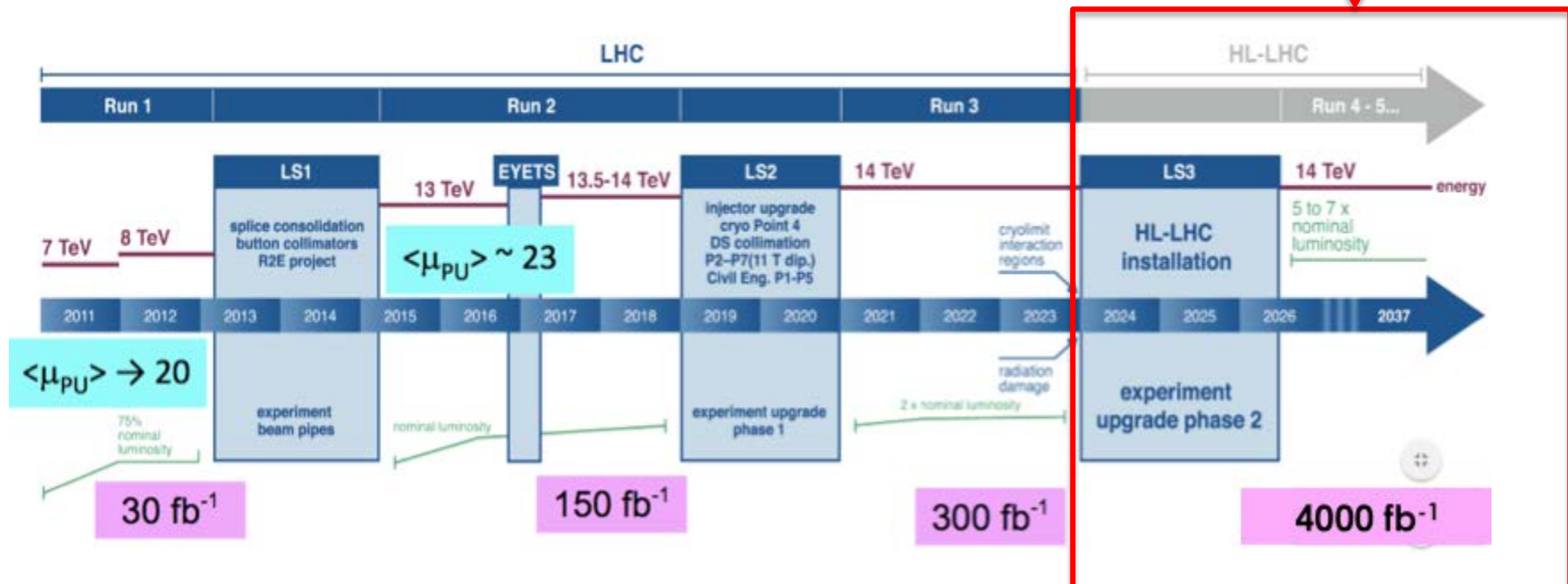


Measurements with high speed oscilloscope (SDA 13000 serial data analyser) and wide bandwidth active probe (D13000PS differential probes) (courtesy of M. Kovacs)

Consuntivi 2016 di RD_Fase2

Sezione INFN - Pavia

- Sigla RD_Fase2 è stata aperta per il triennio 2015-2017 con lo scopo di:
 - organizzare e supportare le iniziative di R&D finalizzate alla stesura dei TDR (Technical Design Report) dei progetti di upgrade degli esperimenti ATLAS e CMS per la fase HL-LHC
 - favorire sinergie tra gli esperimenti ATLAS e CMS



RD_fase 2 @ PV

- A Pavia le attività di fase 2 finanziate sotto questa sigla sono quelle del progetto **MUONI** e **TRACKER**^(*) di **CMS**.
- La sigla si esaurirà con le richieste finanziarie per il 2017 e dal 2018 l'attività di fase2 continuerà nell'ambito dei singoli esperimenti. I preventivi 2018 saranno presentati separatamente da ATLAS e CMS.

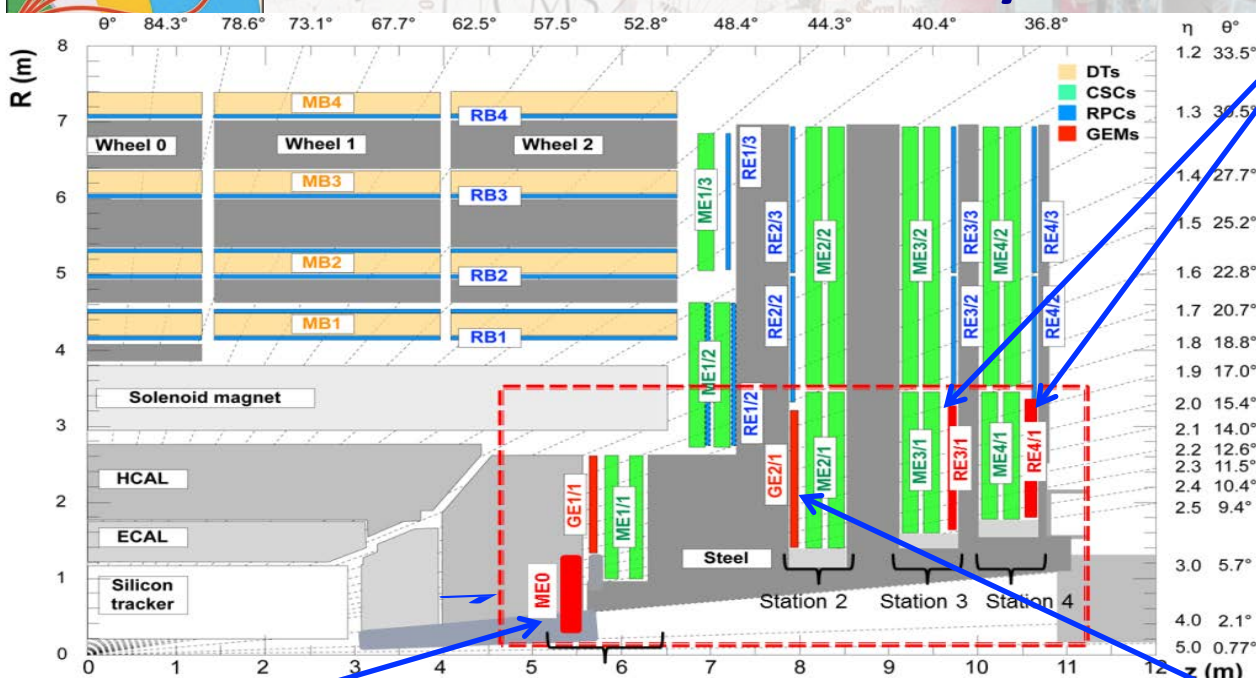
Anagrafica 2016- Responsabili locali: C.Riccardi, G.Polesello

Ricercatori					
Nome	Età	Contratto	Qualifica	Aff.	%
1 Braghieri Alessandro		Dipendente	Ricercatore	CSN III	50
2 Ferrari Roberto		Dipendente	Dirigente di Ricerca	CSN I	20
3 Magnani Alice		Associato	Dottorando	CSN I	20
4 Montagna Paolo Maria		Associato	Ricercatore	CSN I	20
5 Riccardi Cristina		Associato	Prof. Associato	CSN I	30
6 Salvini Paola		Dipendente	Ricercatore	CSN I	20
7 Vai Ilaria		Associato	Dottorando	CSN I	30
8 Vitulo Paolo		Associato	Prof. Associato	CSN I	40
Numero Totale Ricercatori				8	FTE: 2.3

(*) solo per il 2017



CMS Phase 2 Upgrade for the Forward muon system



NEW STATIONS RE3/1 and RE4/1

($1.6 < |\eta| < 2.4$)

- 144 RPC chambers (about 1.5-2.0 m² area) for the inner (ring n.1) region of disks 3 and 4

GE21 L1 trigger rate reduction, enhance via redundancy, reconstruction
ME0 detector extends coverage and performance of muon Id and trigger beyond $\eta=2.4$ e $\eta<2.8$

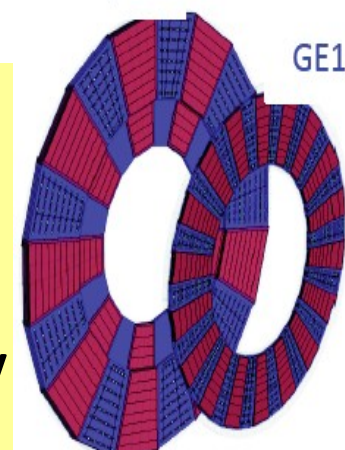
ME0:

GEM Phase 2 : Trigger and reconstruction

GE2/1:

GE2/1

GE1/1



- Muon tagger** at highest η ($\eta < 2.8$)
- 36 20° super-module wedge each consist 6 layers of 3-GEM chambers.
- Numb. of chambers: 216
- Installation: July 2024

- $1.6 < |\eta| < 2.5$
- 36 20° super-chambers
- Total number of 3-GEM chambers: 72
- Option: uRwell technology
- Installation: YETS 2022



CMS Pavia Muon phase 2 R&D



Responsabilities :

- **C.Riccardi** → responsabile nazionale progetto GEM-Muoni di CMS;
GEM Conference Committee & Editorial Board member; MUON IB Deputy Chair
- **I.Vai** → Co-convener of the ME0 detector R&D working group; responsible for CMS GEM DCS Gas Panel
- **P.Vitulo** → coordinator GEM R&D Phase II Upgrade Office

Activities:

- **GEM Forward Muon system**
 - Tests on GEM prototype for ME0 detector : Background simulations, performance measurements and neutron test. (A. Braghieri, F.Fallavollita, A.Ferraro, A.Magnani, P.Montagna, R.Nardò, M.Ressegotti, C.Riccardi, P.Salvini, I.Vai, P.Vitulo & Samuel Gigli, Emanuele Romano)
- **RPC Irradiation tests**
 - Aging test on detectors and materials at GIF++ (A. Braghieri)



CMS RPC Phase 2



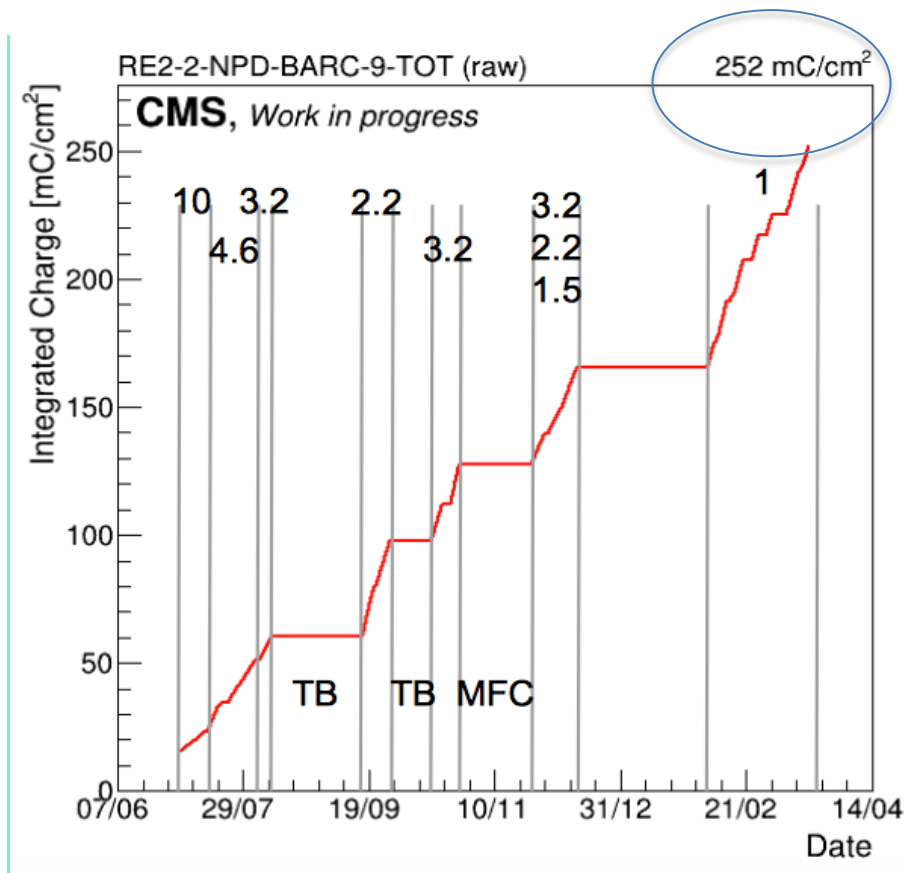
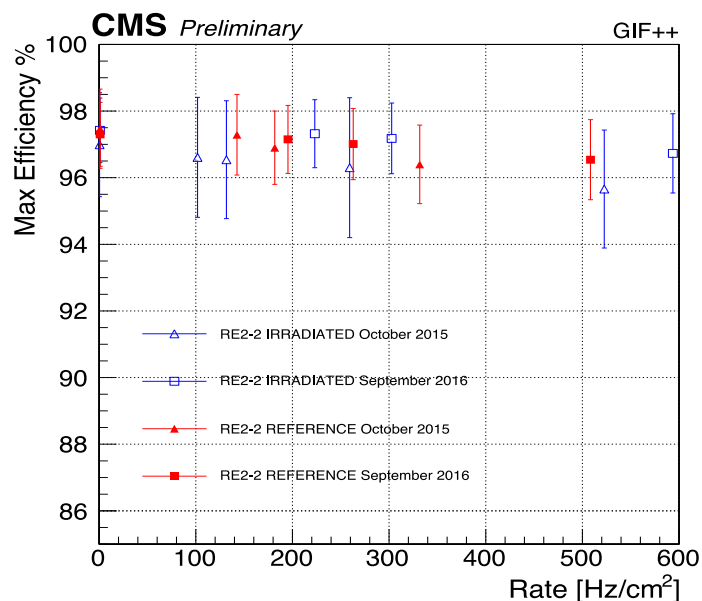
aging of present system at GIF++

Expected maximum background rate

$$\phi_{\max} = 600 \text{ Hz/cm}^2 \text{ (factor 3 included)}$$

Expected integrated charge:

after 3000 fb⁻¹ → 1 C/cm² (factor 3 included)



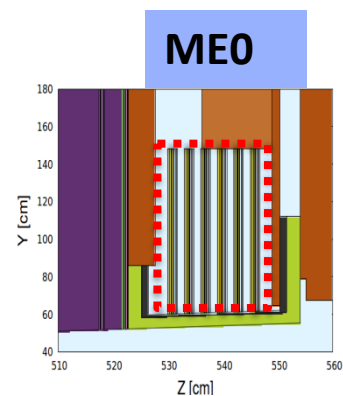
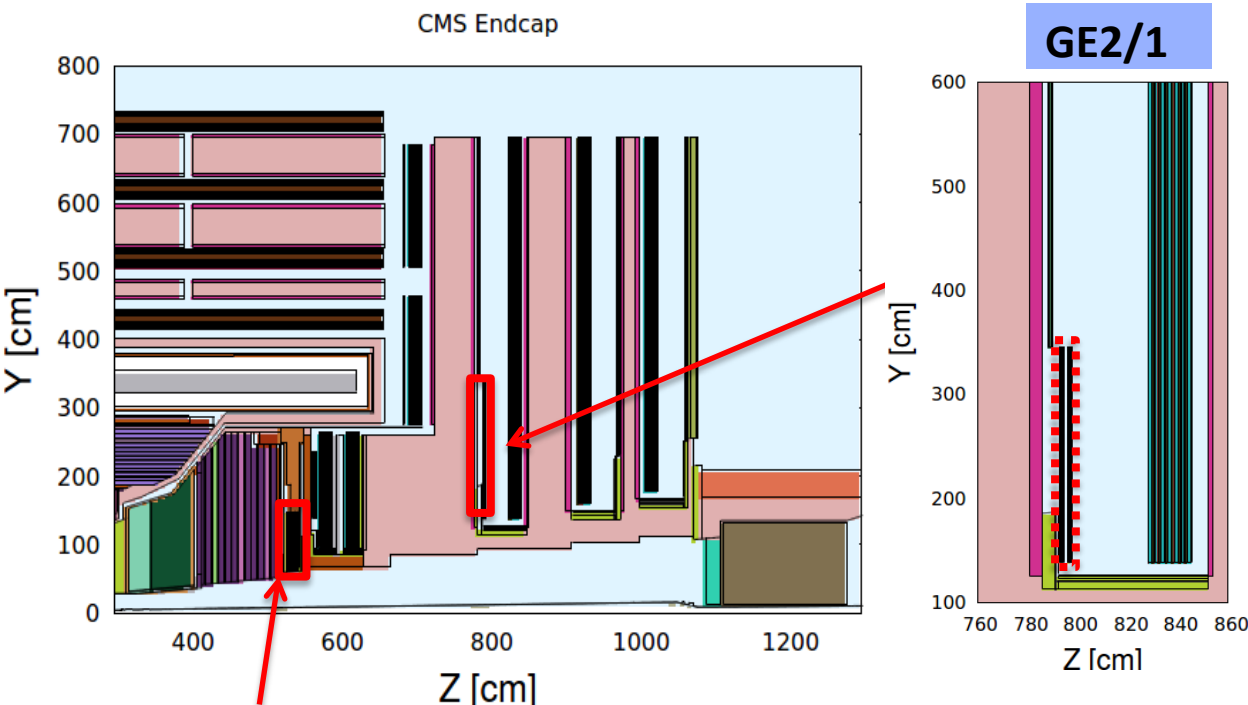


Background simulation studies

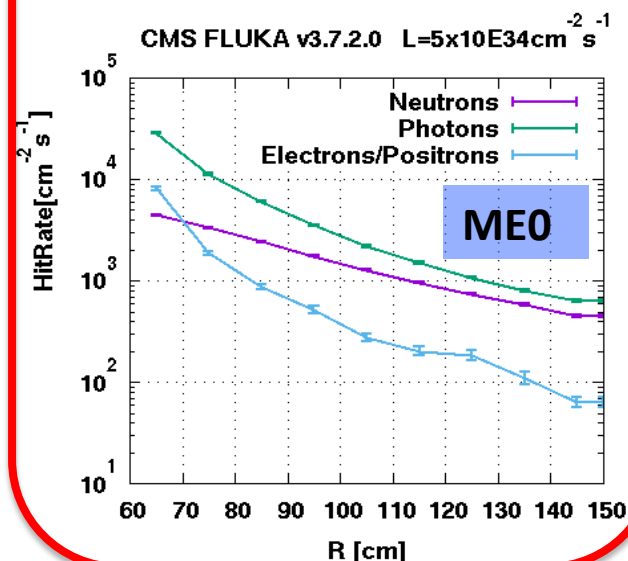
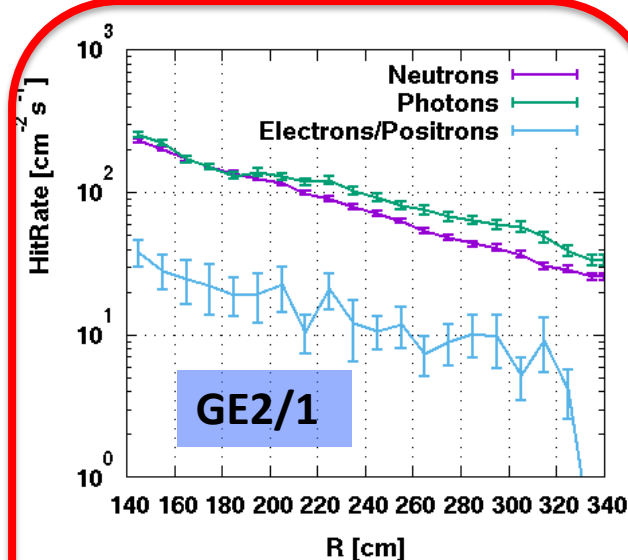


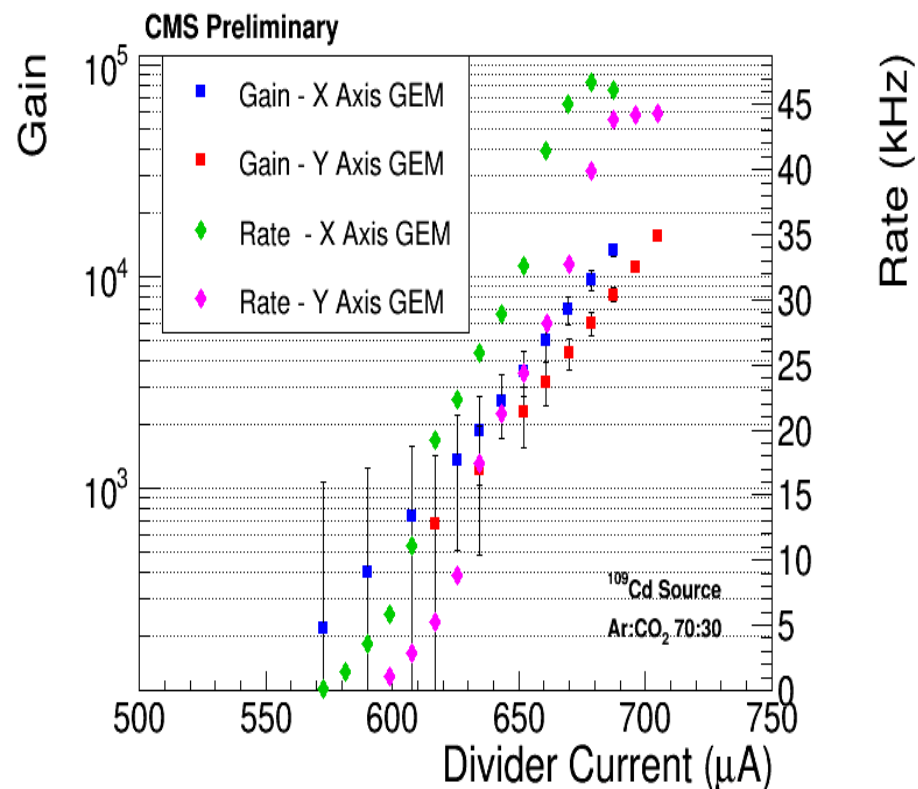
Backgrounds – 6x total doses with respect to LHC

- TP geometry (v.3.7.2.0)
- Detailed description of HGC
- Detailed description ME0+shielding



New simulations with an updated geometry are under study in 2017





Readout of
triple GEM
1

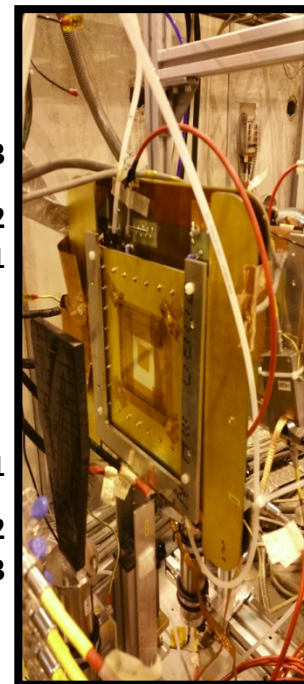
1 mm
2 mm
1 mm
3 mm

GEM3
GEM2
GEM1

Readout of
triple GEM
2

3 mm
1 mm
2 mm
1 mm

GEM1
GEM2
GEM3



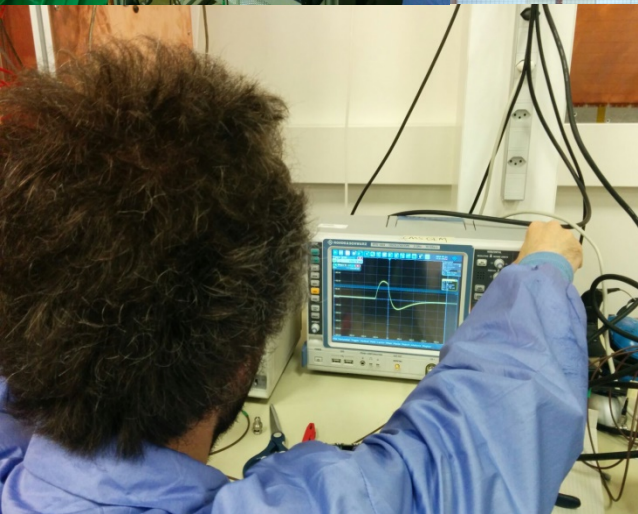
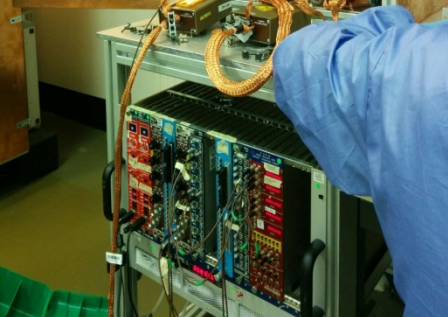
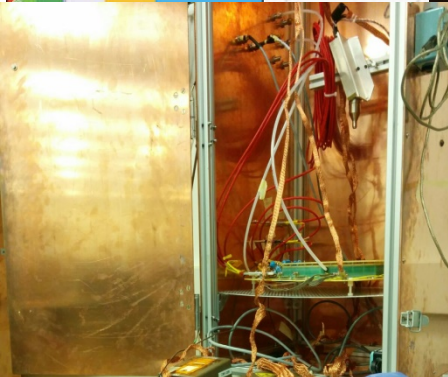
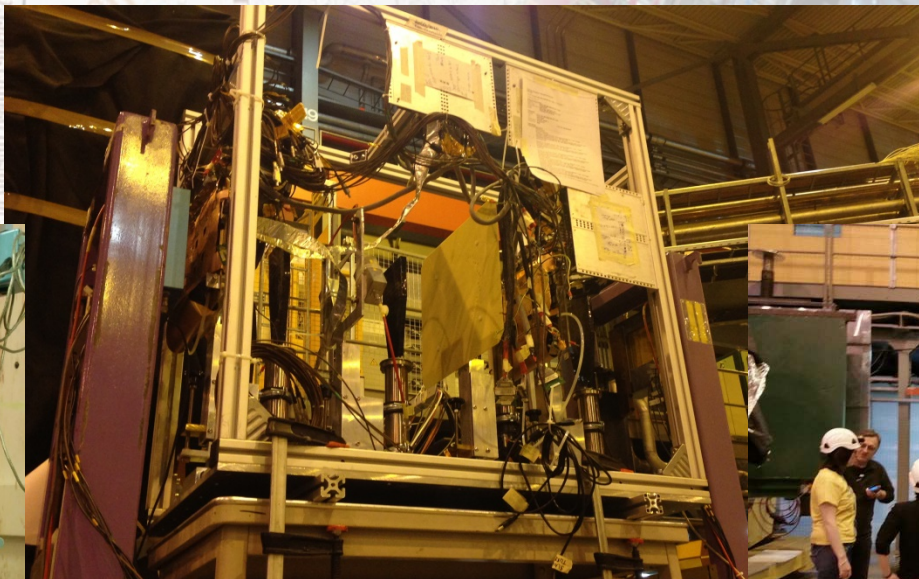
A ^{109}Cd source is used to measure detector's gain.

The gain is calculated as

$$G = I_{net} / (N_p q_0 R_{plateau})$$

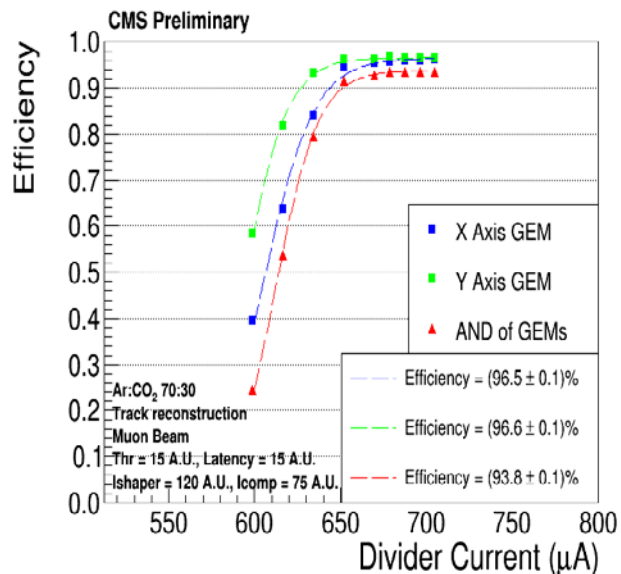
Gain up to
 $\sim 10^4$
(Ar:CO₂ 70:30)

Assuming that the ionizing radiation is due to the luminescence of the copper inside the detector.



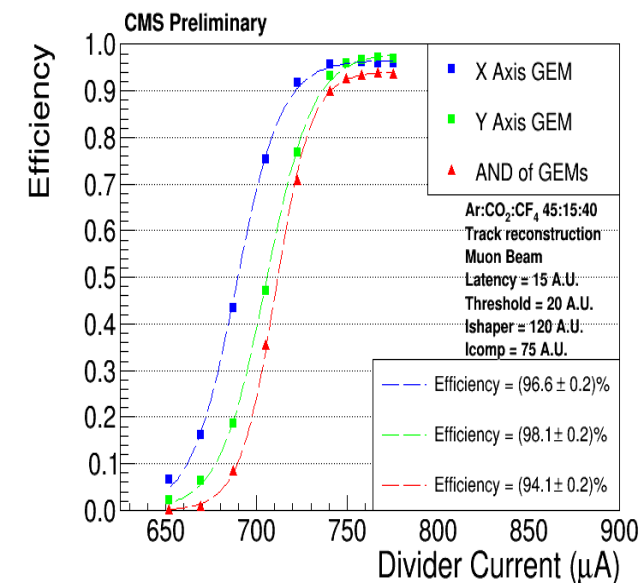


ME0 prototype @ Test Beam (SPS H8)



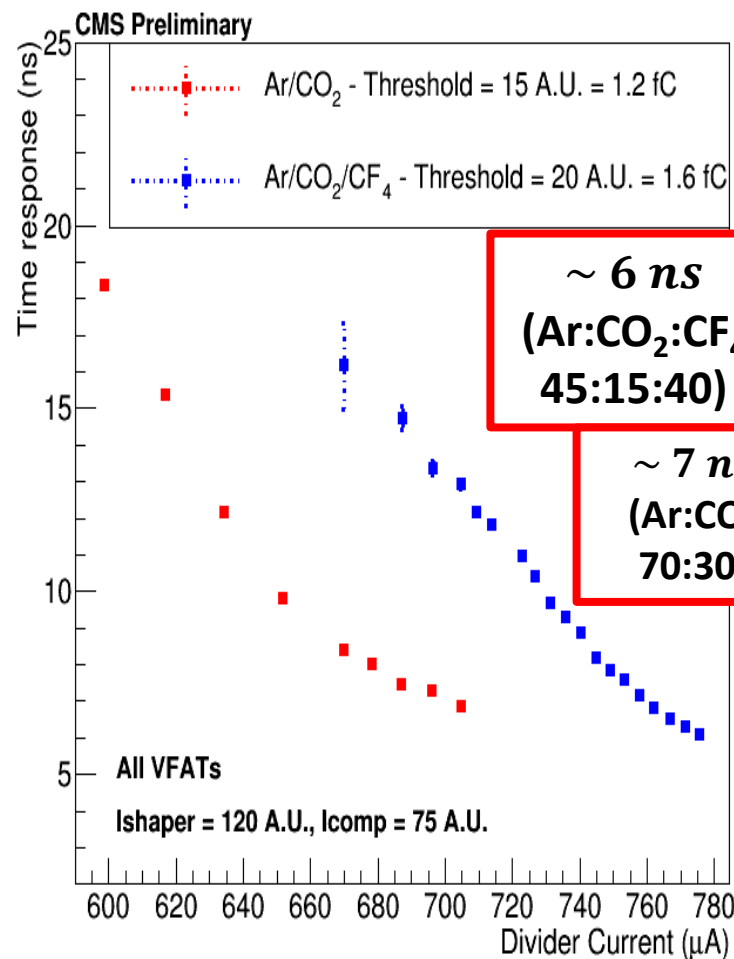
Ar:CO₂

**X axis GEM:
96.5%**
**Y axis GEM:
96.6%**
**from 675 µA per
divider**



Ar:CO₂:CF₄

**X axis GEM:
96,6%**
**Y axis GEM:
98.1%**
**from 750 µA per
divider**

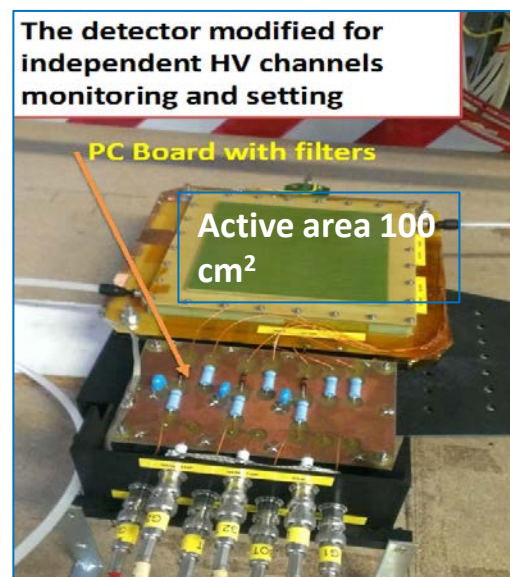
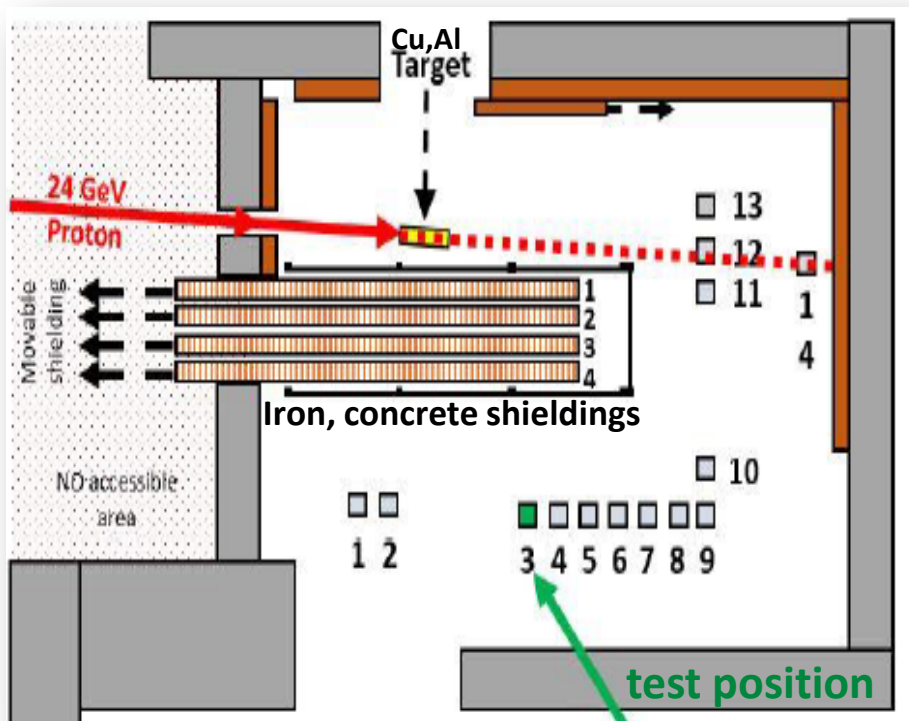




ME0 sparks probability test @ CHARM



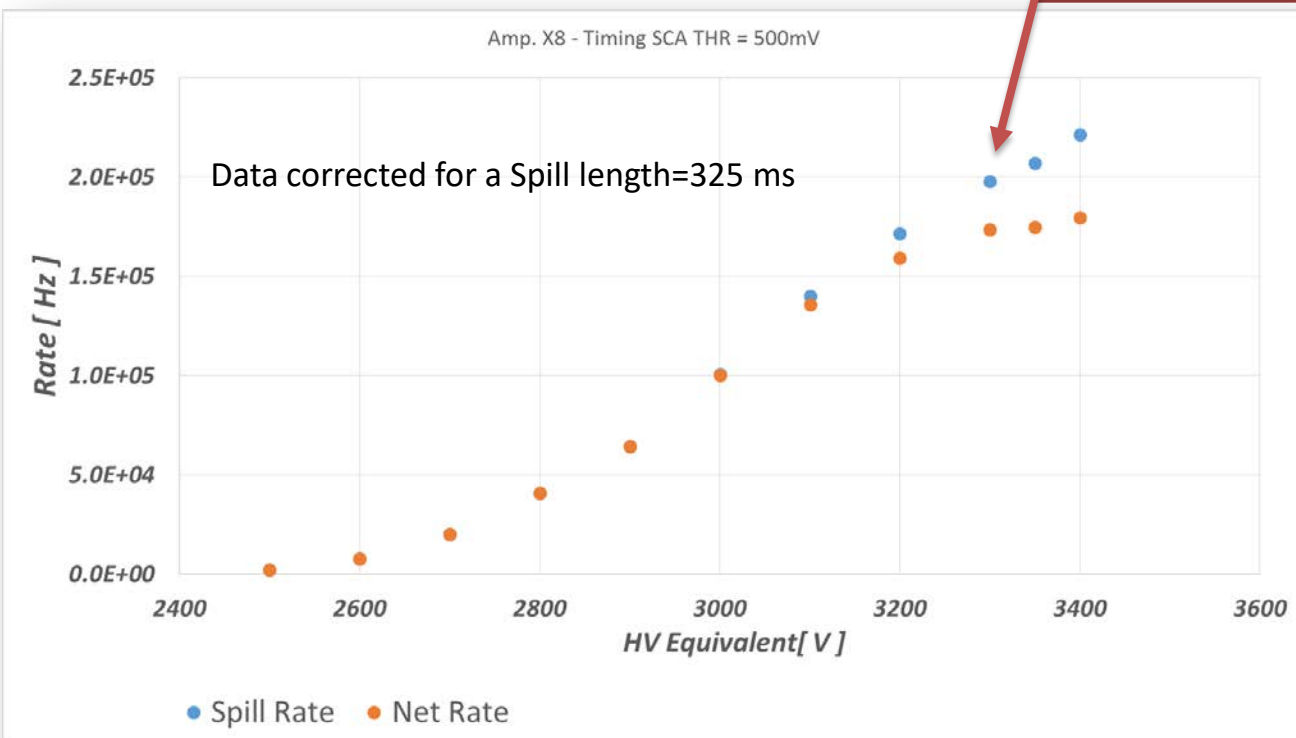
- A survey of the literature shows quite large uncertainties on the available data that come from different GEM configurations and beam configurations.
- New measurements are on-going in CMS @ CHARM facility. The **goal is to set an upper limit on the discharges probability below 10^{-11}**





Neutron test of GEM @ CHARM

We Run at this
setting
(3300 HV_eq - X8)
in stable conditions



- ❑ Rate (Thr=500 mV) corrected for a 325 ms spill length . At plateau about 175 kHz.
- ❑ Good spills (@ GEM running in stable condition) : 18524
- ❑ No TRIP observed during this time.
- ❑ With NULL observation Upper Limit (@ 95% CL) is 3.

Preliminary UPPER LIMIT for Discharge Probability :
 $3 / (1.75 \cdot 10^5 \text{ Hz} \cdot 0.325 \text{ s} \cdot 18524) = \mathbf{2.85 \times 10^{-9}}$



Results on Neutron test @ CHARM



Nov 2016 TB

GEM @ stable condition (3.3 kV_{eq} ; GAIN : 2.5×10^4) T_{eff}= 1.7 h

Integrated Dose : 9.36 Gy

POT total : 8.07×10^{15}

1MeV-n equivalent fluence: $2.47 \times 10^{11} \text{ cm}^{-2}$

Neutron Discharge Prob. Upper limit $< 2.85 \times 10^{-9}$

(no observation of any HV TRIP)

June 2017 TB

New test beam is in preparation to extend and improve the measurements in mixed field.

The number of discharging event created by neutron will be evaluated. Rate of the signal and current will be measured and monitored.

Two week of beam have been requested ~ 15h of continuous run with a neutron fluence of $> 10^7 \text{ cm}^{-2}/\text{spill}$ (Energy range 1eV / 5 GeV)

Report on MEG experiment

Search for Lepton Flavor Violation in $\mu \rightarrow e^+ \gamma$ decay



Paolo Walter Cattaneo
Consiglio di Sezione
16 Maggio 2017

Papers in 2016/2017

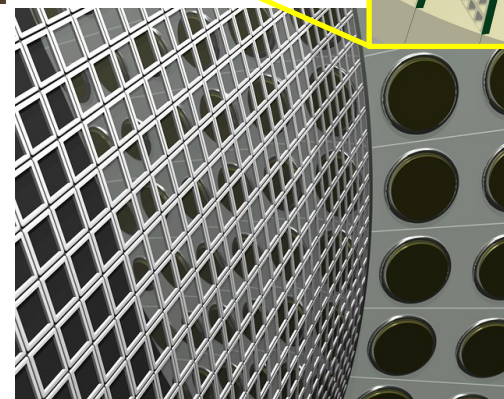
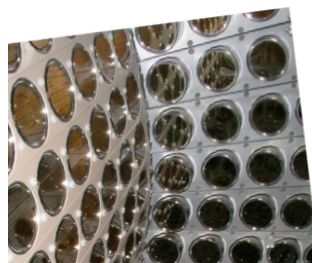
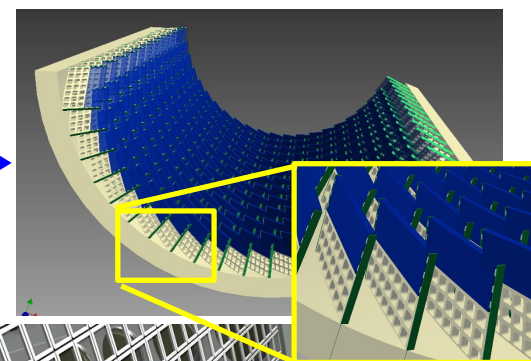
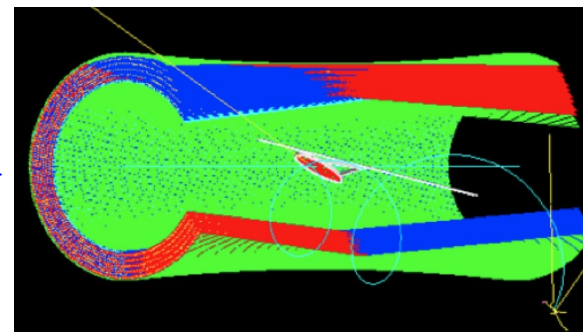
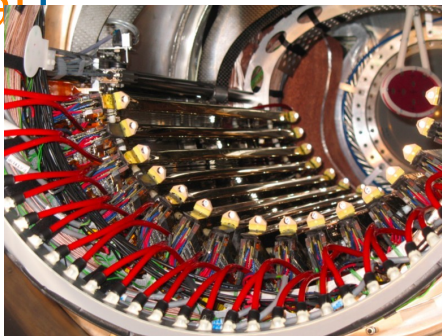
- 1) Measurement of the radiative decay of polarized muons in the MEG experiment, EPJC 76(3) (2016) 108.
- 2) Muon polarization in the MEG experiment: predictions and measurements, EPJC 76(2) (2016) 223.
- 3) Time resolution of time-of-flight detector based on multiple scintillation counters readout by SiPMs, NIMA 828 (2016) 92
- 4) Pixelated position timing counter with SiPM-readout scintillator for MEGII experiment, POS Photodet2015 (2016) 011
- 5) Test and characterization of SiPMs for MEGII high resolution timing counter, NIMA 824 (2016) 145
- 6) A high resolution TC for the MEGII experiment, NIMA 824 (2016) 92
- 7) A dedicated calibration tool for the MEG and MEGII positron spectrometer, NIMA 824 (2016) 575
- 8) Search for the lepton flavour violating decay $\mu \rightarrow e \gamma$ with the full dataset of the MEG experiment, EPJC 76(8) (2016) 434
- 9) 30-ps time resolution with segmented scintillation counter for MEGII, NIMA A845 (2017) 507

MEG Upgrade

✓ MEG upgrade approved at PSI in Jan. 2013

✓ Upgraded items

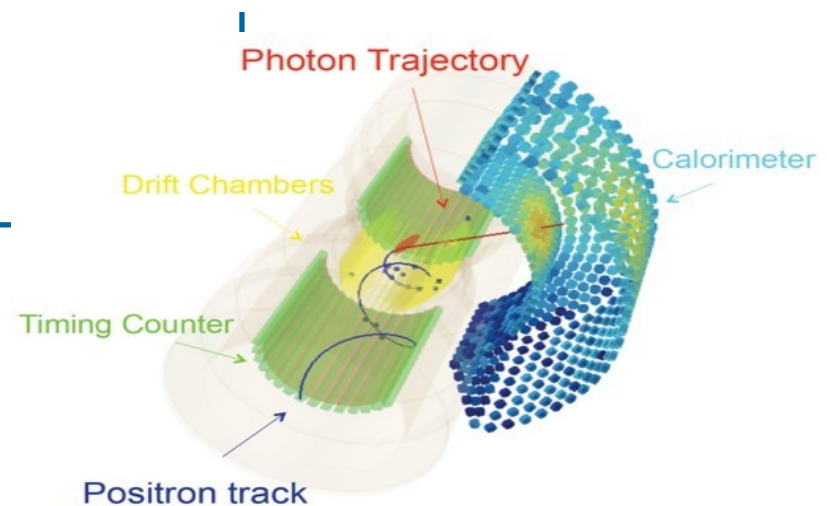
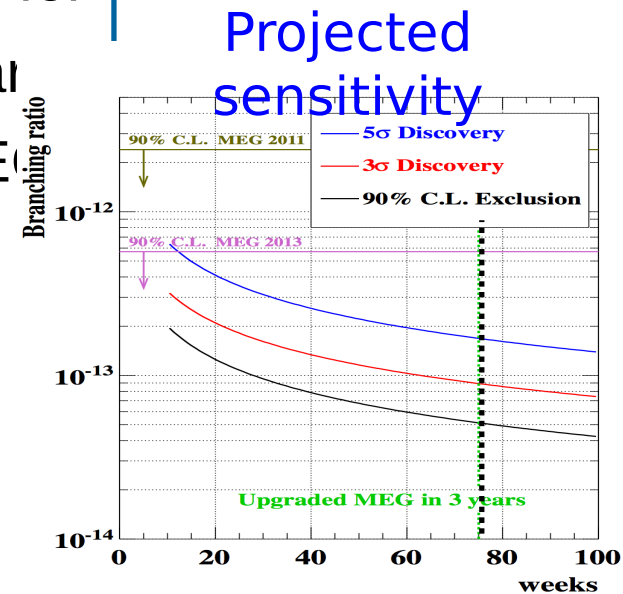
- ✓ Higher μ intensity
- ✓ Single volume drift chamber with stereo angle configuration
- ✓ Pixelated timing counter with SiPM readout
- ✓ LXe detector with SiPM readout
- ✓ Thinner target



MEG Upgrade

- ✓ Upgraded MEG is expected to search for $\mu \rightarrow e\gamma$ down to $B \sim 5 \times 10^{-14}$ in three year
- ✓ $\times 10$ improvement w.r.t. current MEG
- ✓ More details in arXiv:1301.7225

PDF parameters	Present MEG	Upgrade scenario
e^+ energy (keV)	306 (core)	130
e^+ θ (mrad)	9.4	5.3
e^+ ϕ (mrad)	8.7	3.7
e^+ vertex (mm) Z/Y(core)	2.4 / 1.2	1.6 / 0.7
γ energy (%) ($w < 2$ cm)/($w > 2$ cm)	2.4 / 1.7	1.1 / 1.0
γ position (mm) $u/v/w$	5 / 5 / 6	2.6 / 2.2 / 5
γ - e^+ timing (ps)	122	84
Efficiency (%)		
trigger	≈ 99	≈ 99
γ	63	69
e^+	40	88



Upgrade Pavia

Pavia/Genova/Tokyo has been working on an upgrade of the TC for MEG2 (2017-2019)

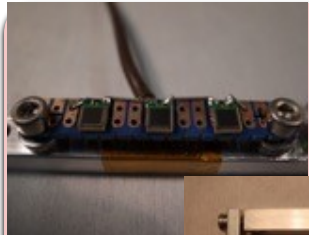
Choice of SiPM for reading scintillator pixels,
production and systematic test in Pavia and PSI:
Single device, 6-in series boards, pixel equipped with
SiPM boards.

Tests under beam in single particle mode (BTF) and
in high rate (PSI) (pre-pre-engineering run).

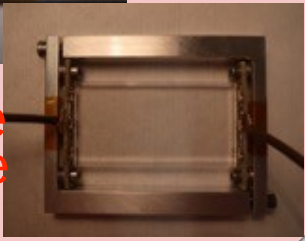
A 3 years long R&D...

Single pixel R&D

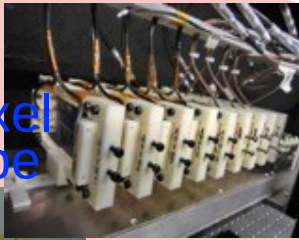
1st pixel prototype



probe single pixel



1st multi-pixel prototype



test @BTF, SiPMs choice



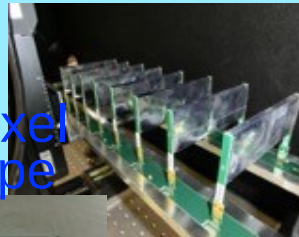
2nd pixel prototype



comparison tests



2nd multi-pixel prototype



test @BTF backplanes readout

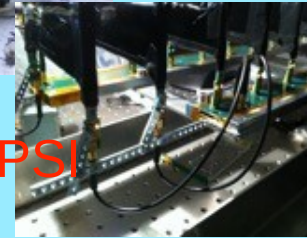


Multipixel prototypes and solution for final detector

high rate test



test @PSI



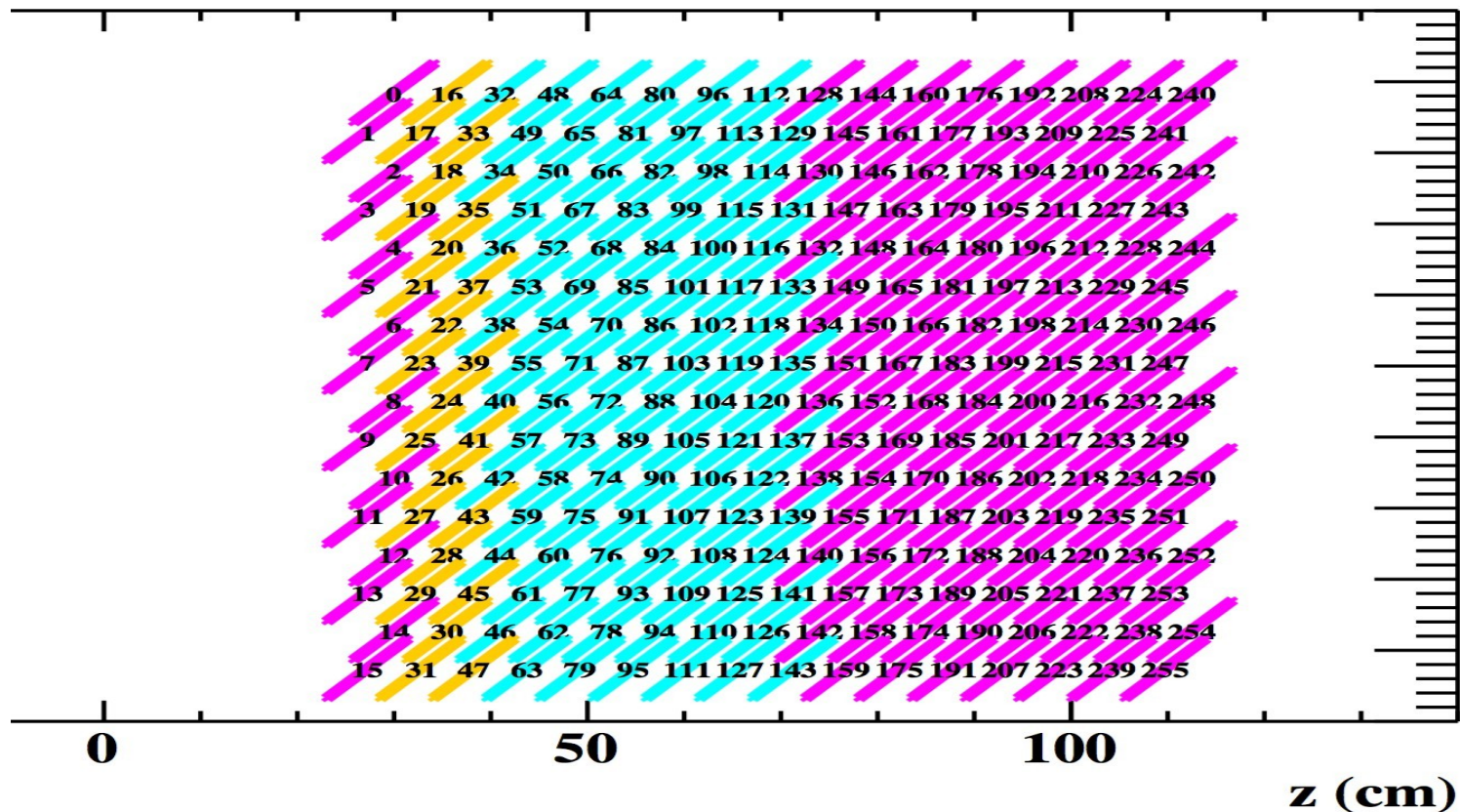
final TC construction

NOW!

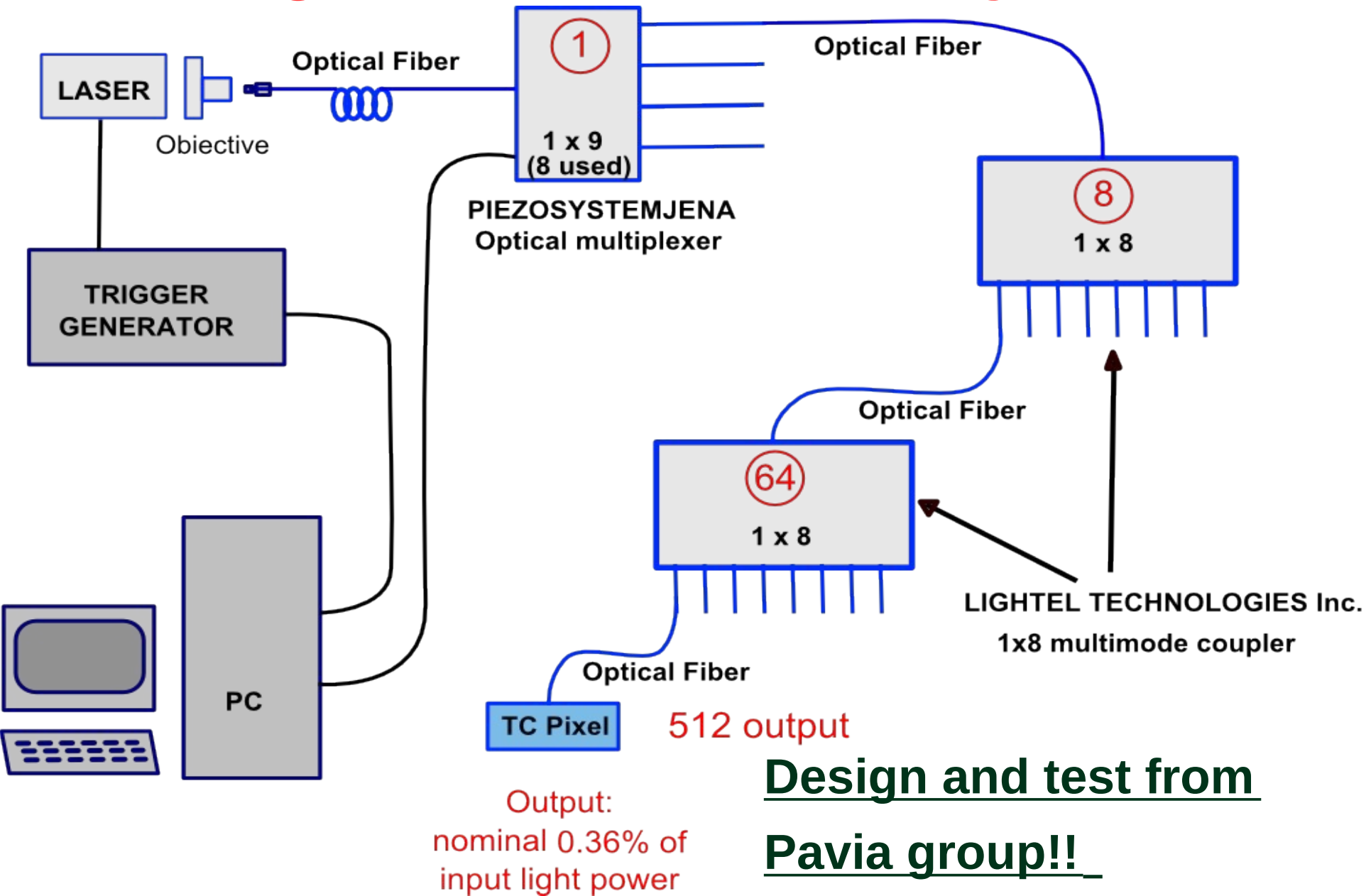


Beam test 2016@PSI: results

We tested 256 (sector) at middle of 2016.
TC behaviour good. Readout electronics fine.



Design of the calibration system



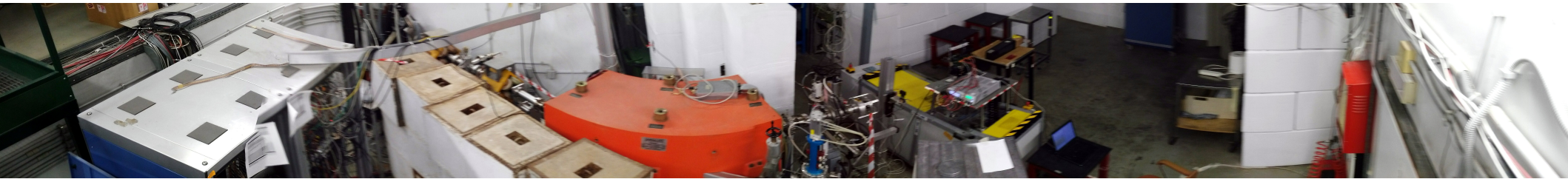
Installation ongoing with Pavia's contribution

Irradiation test of SiPMs of pTC at BTF

Test organized and run only by Pavia.

The goal was to irradiate with e^+ of ~ 100 MeV simulating Michel positrons in MEGII

SiPMs of the same model (AdvanSiD) used for pTC in operational condition ($V_{ov}=3V$).



BTF provides the appropriate location

SiPM available

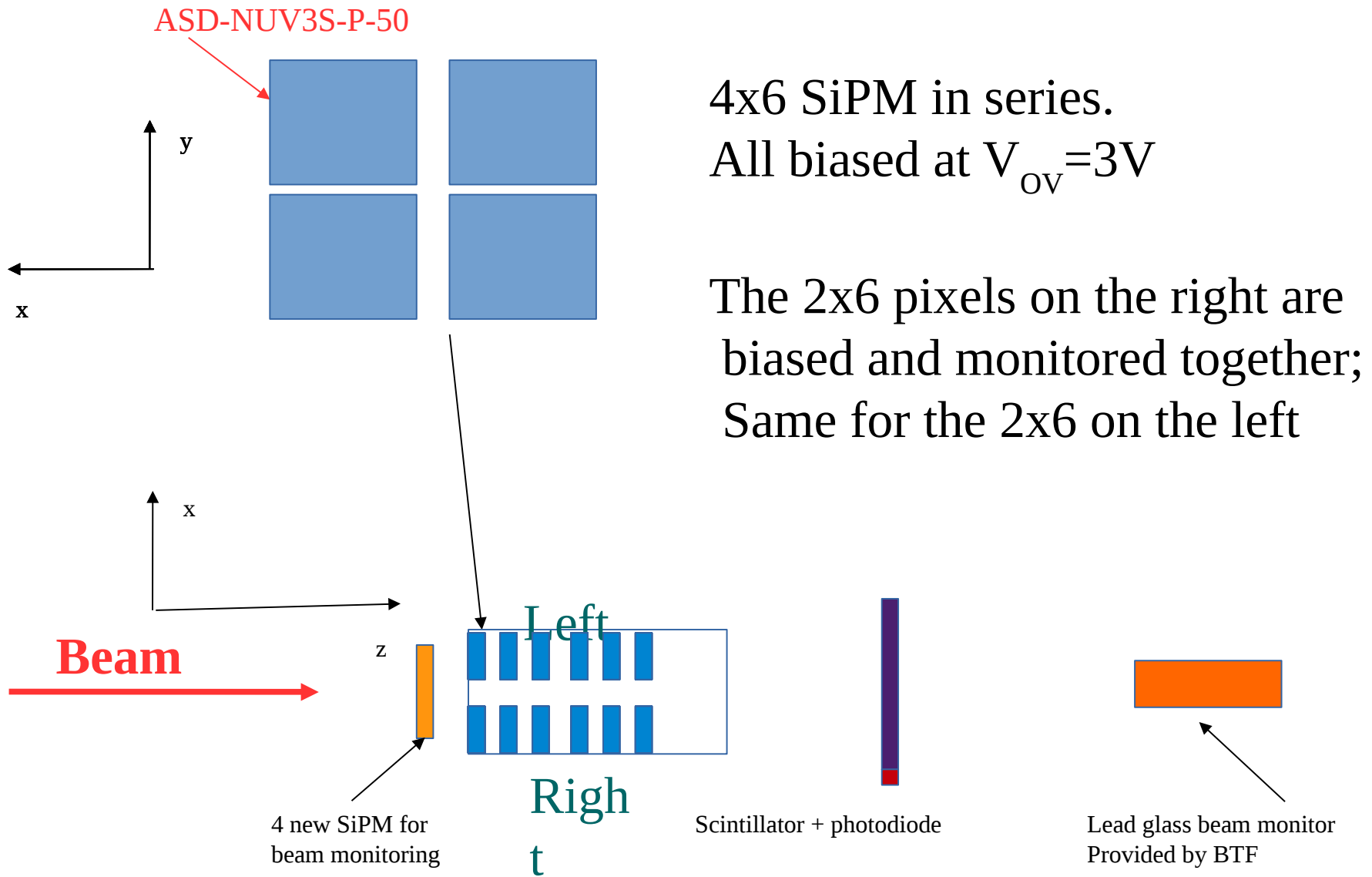
We bought for the test 25 SiPMs ASD-NUV3S-P-50
latest version delivered for MEGII

In addition 16 SiPM with cell $40 \times 40 \mu\text{m}^2$
ASD-NUV3S-P-40

We irradiated 24 SiPM ASD-NUV3S-P-50
For monitoring we used 4 ASD-NUV3S-P-40

In addition we used a photodiode glued to a
scintillator for monitoring and beam
centring purpose

The irradiation set up



The beam set up

The beam energy was set to 150 MeV to guarantee higher flux.
Compromise to energy close to MEGII (50 MeV) and flux.
We expect $\sim 10^5$ e/bunch, 25 Hz.

The smallest beam spot size was <2 mm but we asked a larger value to have almost uniform irradiation of the devices.
Through defocusing the BTF staff achieved $\sigma_{xy} \sim 5$ mm sufficient

Beam spot position and 2D size throughout the run measured by BTF staff (using pixel device readout by medipix) and are available offline

The integrated particle flux is integrated by the Lead Glass and is available offline.

Measurements

During data taking we monitor the current of the two arrays of 12 (6x2) SiPM in series.

It kept steadily increasing significantly.

IV curve during the data taking would have required too much time and the shift crew was limited (most on the time 1 person).

The last two pairs of SiPM were removed after $\sim 1/3$ and $2/3$ of the total irradiation time to measure the effects with three different doses.

After irradiations IV curves and current at $V_{ov}=3V$ are being measured in Pavia. Current continuously, IV curves periodically.

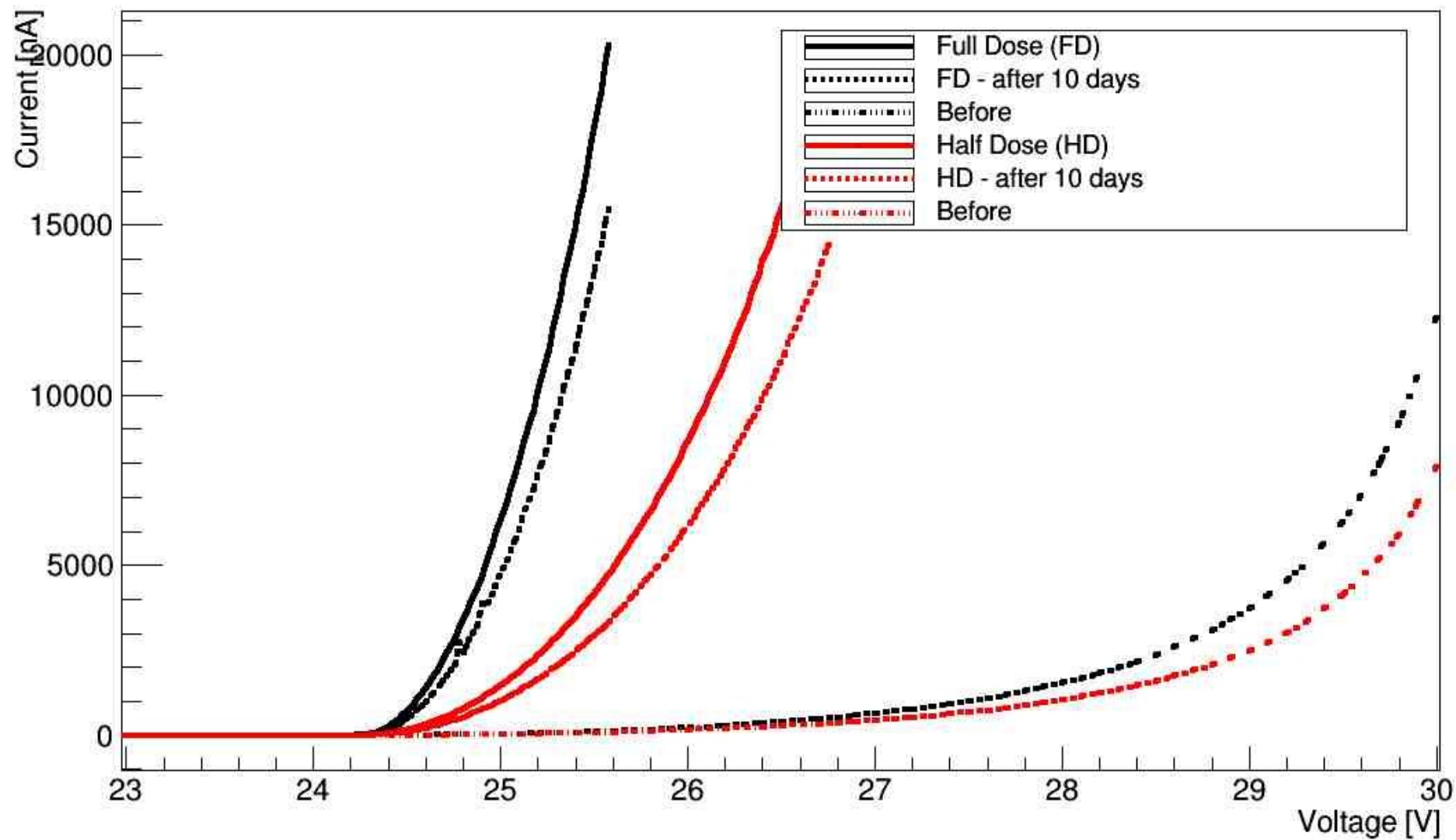
Analysis

Analysis of the data collected by BTF staff and with our devices required to establish the particle flux through the SiPMs.

BTF staff produced a preliminary analysis gave the following numbers:

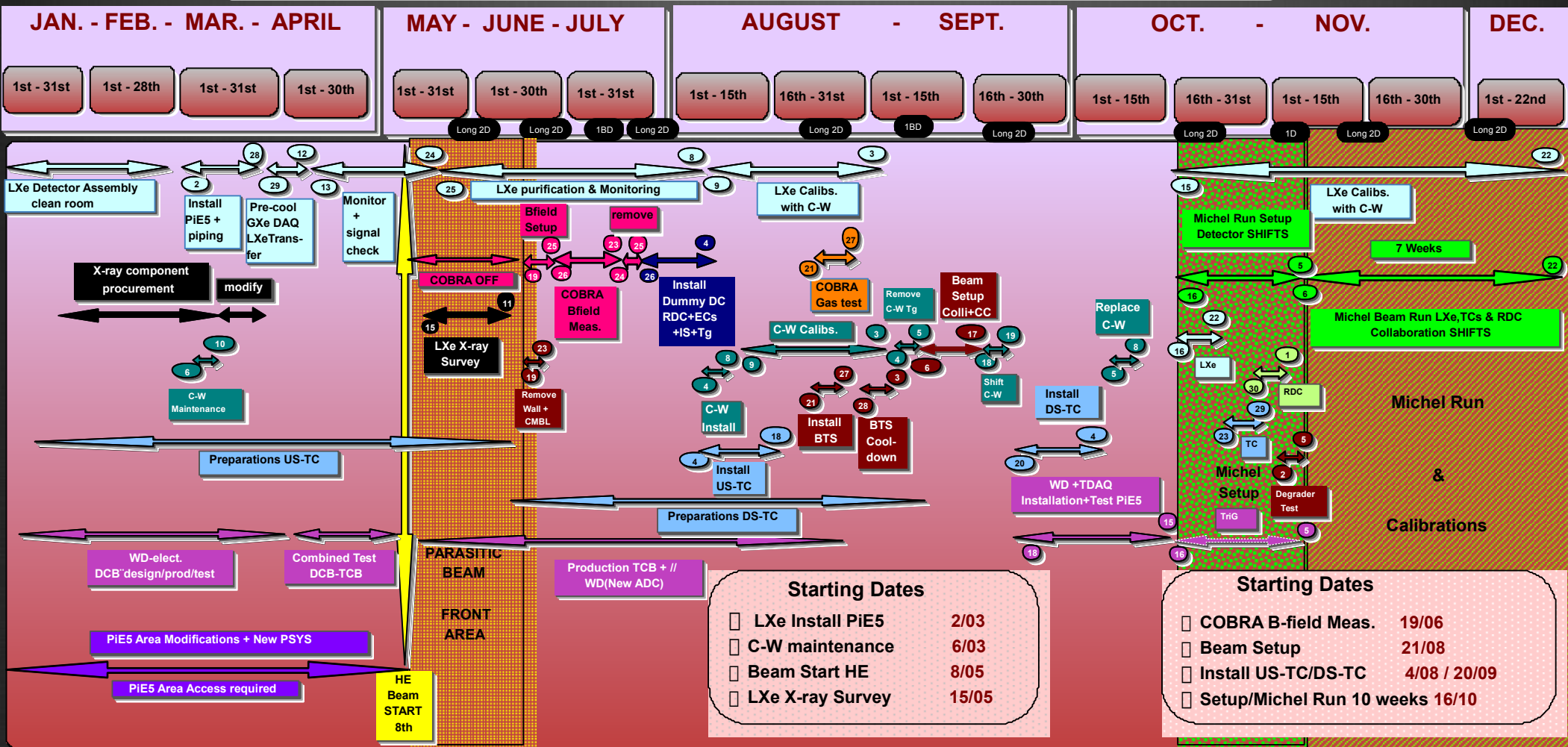
- Total particles on lead glass: 5.56×10^{11}
- Total particles with correction factors: 7.78×10^{11}
- Average number of bunches: 1.30×10^7
- Active time 259388 s ~ 72h
- Uptime DAQ 122 h

More analysis will follow



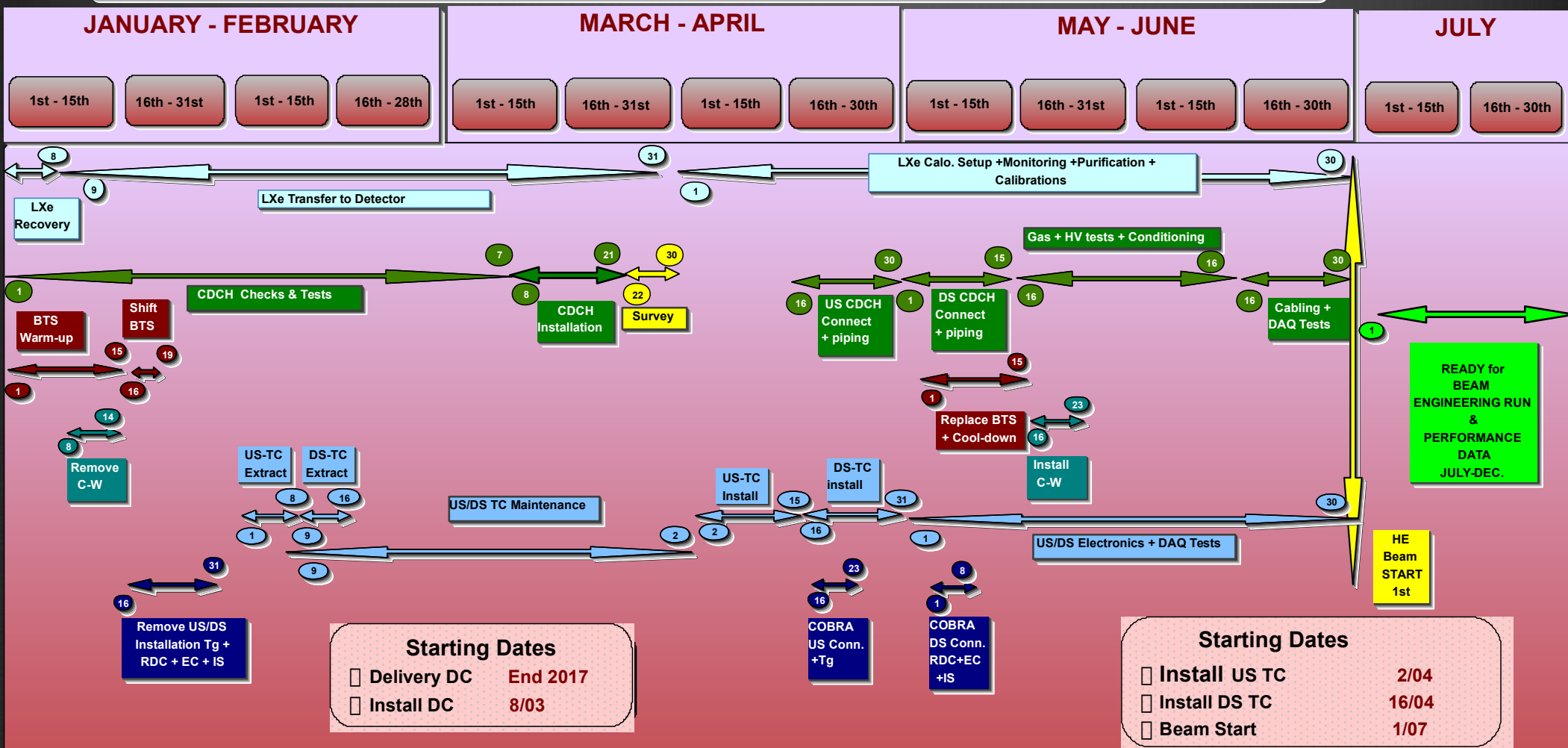
2017 Setup & Pre-engineering Run

Jan 2017
V1
P-RK



- LXe X-ray Survey in // with front area available for Mu3e CMBL & HyperMu beam times
- Front area removal CMBL followed by COBRA magnetic field measurements
- C-W calibration & monitoring LXe detector // detector installation
- Beam setup followed by installation & detector Michel Run preparations (DETECTOR SHIFTS)
- Approx. 7 weeks of combined detector DAQ testing & engineering Data (COLLABORATION SHIFTS)

Installation Engineering Run 2018

 Feb. 2017
V1
PRK


Shows MEG II will be ready for a Full Engineering Run + 6 Months of Performance DataTaking in 2018

MEG Pavia: Attivita' 2016

- Meeting collaborazione
- MEGII pre-engineering run
- Commissioning TC al PSI
- Commissioning sistema calibrazione laser del TC
- Sviluppo software MEG2 per nuovo TC
- Articolo su design di MEGII
- Conferenza CKM2016

MEG Persone 2016

Paolo W. Cattaneo	1 Ric INFN	50%
Gianluigi Boca	Ric. Uni.	50%
Antonio De Bari	Ric. Uni.	20%
Massimo Rossella	Tec. INFN	30%
Marcello Simonetta	Ass. Ricerca	100%
Lab. Elettronica		6 m.u.
Lab. Meccanica		3 m.u.
Totale	FTE	2.5

MEG Pavia: Preventivo di spesa 2016

	Assegnati	Impegnati
Missioni	13.0ke	13.0ke
Incontri coll.		
Run		
Montaggio TC/Laser al PSI		
Consumo	5.0ke	4.8ke
Metabolismo		
Consumo PSI per costruzione TC		
Inventariabile	9.0ke	9.0ke
Impulsatore ottico		
Power energy meter		
Alimentatore		
Controller fibre ottiche		
Totale	27.0ke	26.8ke

Nuova sigla 2017: RD_FA

- Incubatore per nuove tecnologie a futuri acceleratori
 - FCC-hh, FCC-ee, CepC, SppC, CLIC, ILC, muon collider, ...
- Work Packages
 - **WP 1: Fisica e simulazione** [Piccinini]
 - WP 2: Machine Detector Interface
 - WP 3: Pixel detectors
 - WP 4: RICH e TPC con MPGD (principalmente a EIC)
 - WP 5: Ultralight Drift Chamber
 - WP 6: Silicon Microstrip Tracking
 - **WP 7: MPGD per Muon systems**
 - WP 8: Muon Collider R&D
 - **WP 9: Dual Readout calorimetry (dal 2018)** [Ferrari, Gaudio, Rebuzzi, L. Pezzotti]