Istituto Nazionale di Fisica Nucleare

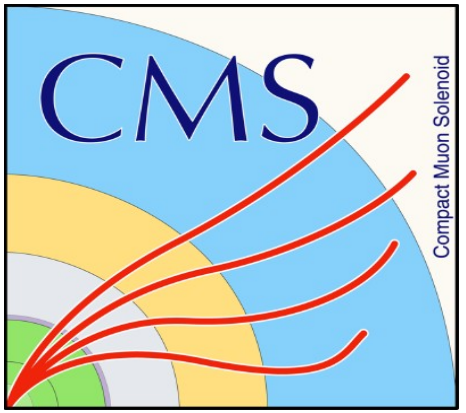
Consuntivi scientifici attività di gruppo 1

Sezione di Pavia: 2017

Andrea.Negri@unipv.it

Attività pavesi

- Frontiera dell'energia
  - **ATLAS** [Responsabile Locale: G. Gaudio]
  - **CMS** [Responsabile Locale: A. Braghieri]
  - **RD Fase 2** [Resp. Locale: C. Riccardi, chiuso 2017]
- Frontiera della precisione
  - **MEG** [Responsabile Locale: P. Cattaneo]
- Frontiera …. delle frontiere
  - **RD_FA**: R&D Future Accelerators



RD_FA

2017

Ricercatori						
	Nome	**Età**	**Contratto**	**Qualifica**	**Aff.**	**%**
1	**Introzzi Gianluca**		Associato	Ricercatore	CSN I	**10**
2	**Polesello Giacomo**		Dipendente	Primo Ricercatore	CSN I	**10**
3	**Salvini Paola**		Dipendente	Ricercatore	CSN I	**10**
				Numero Totale Ricercatori	3	FTE: 0.3

2018

Ricercatori						
	Nome	**Età**	**Contratto**	**Qualifica**	**Aff.**	**%**
1	**Ferrari Roberto**		Dipendente	Dirigente di Ricerca	CSN I	**20**
2	**Gaudio Gabriella**		Dipendente	Ricercatore	CSN I	**10**
3	**Piccinini Fulvio**		Dipendente	Dirigente di Ricerca	CSN IV	**10**
4	**Polesello Giacomo**		Dipendente	Primo Ricercatore	CSN I	**10**
				Numero Totale Ricercatori	4	FTE: 0.5

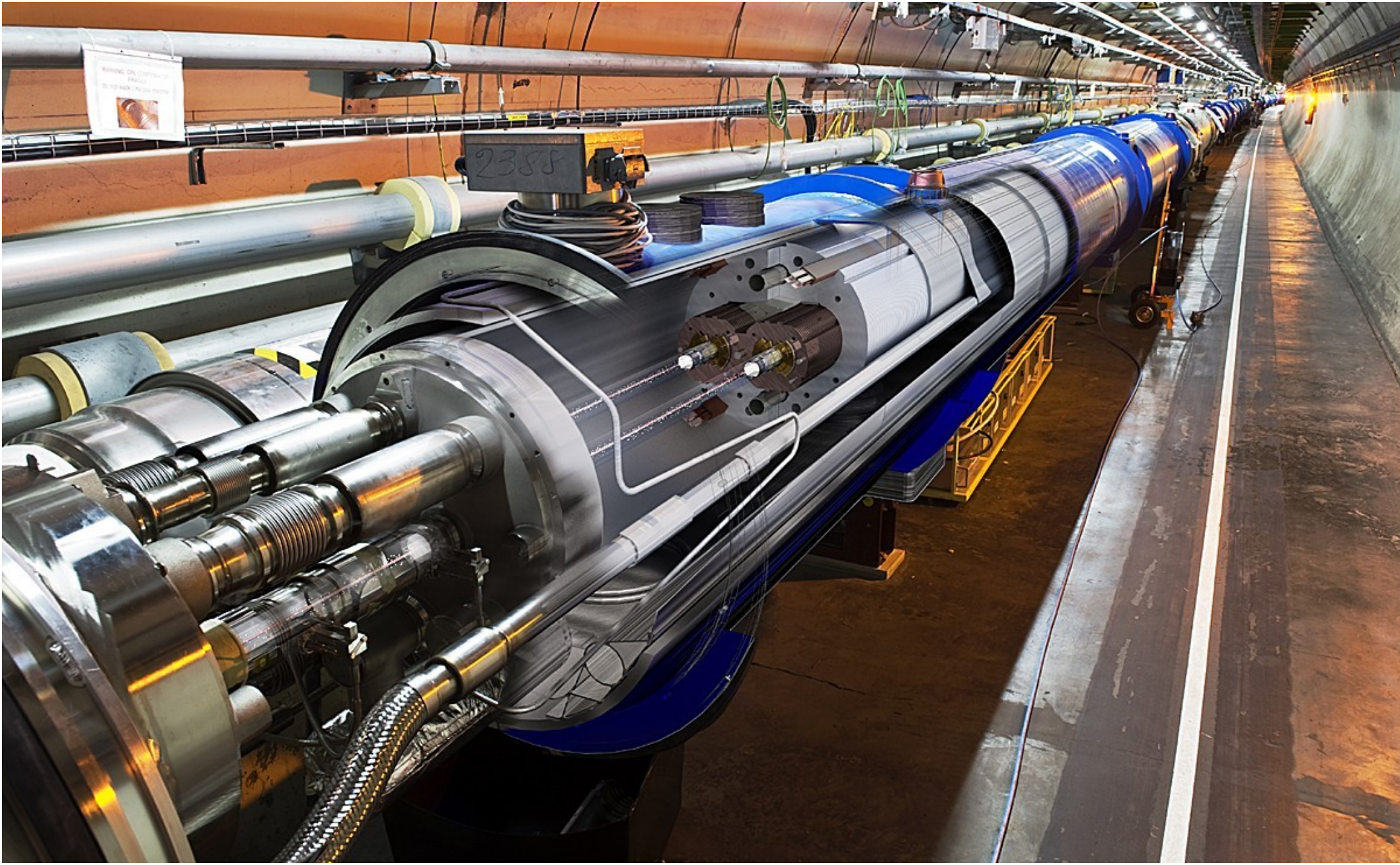
- Incubatore per nuove tecnologie a futuri acceleratori
  - FCC-hh, FCC-ee, CepC, SppC, CLIC, ILC, muon collider, ...
- F. Piccinini coinvolto in WP 1
  - Fisica e simulazione (CDR)

RD_FA: calorimetria

R. Ferrari, G. Gaudio, L. Pezzotti

- Responsabilità del pacchetto dual-readout calorimetry
  - coordinamento generale e simulazioni con Geant4
  - Sviluppo calorimetro a fibre con SiPM (single-fibre) readout
  - Inserita proposta nel CDR rivelatori per CepC e FCCee
  - Diverse presentazioni a workshop (Wuhan, Pechino, CERN) e conferenze (CHEP2017, SIF)
- Testbeam (2017) con un prototipo di ~ 1 cm^2
  - articolo sottomesso
  - Impegnativo programma per il testbeam 2018
- Goal (su 3 anni): costruzione prototipo ~10x10 cm^2
  - con catena di readout: SiPM + ASIC + real-time feature-extraction processor (FPGA/DSP)
  - benchmark principale: $H \rightarrow ZZ^*/WW^*/\gamma\gamma$ ($Z/W \rightarrow 2j/2\tau$)

LHC



LHC 2017 operation

Thanks to all the teams from infrastructure, all equipment groups to operation for their competence, professionalism, creativity and commitment.

2017 goal:

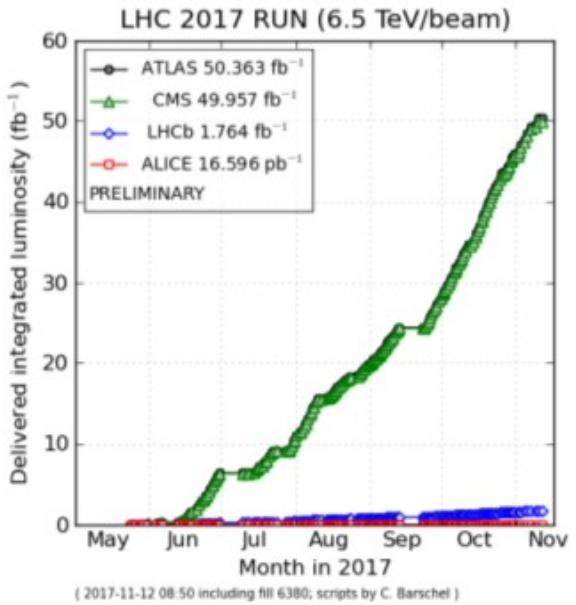
45 fb^{-1}

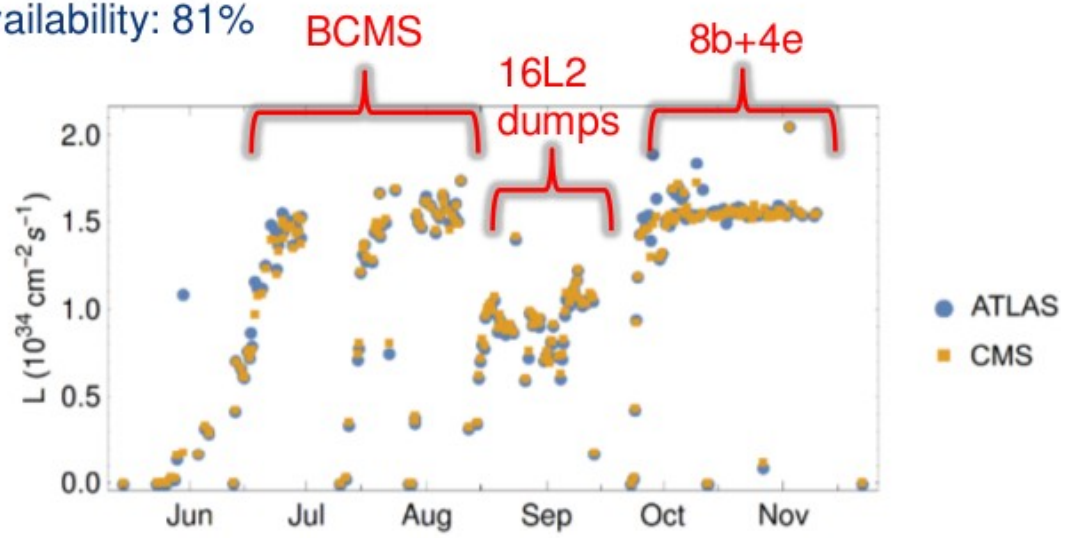
Peak luminosity
2.2 10^{34} cm^{-2} s^{-1}

With luminosity levelling at
1.5 10^{34} cm^{-2} s^{-1}

Lower β^* 30 cm
(new ATS optics)

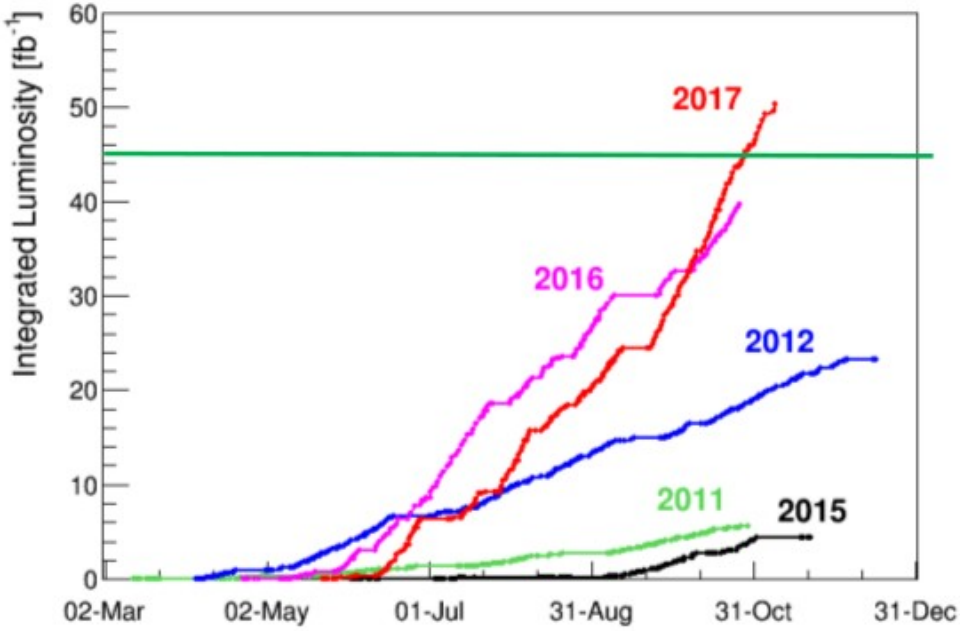
Availability: 81%

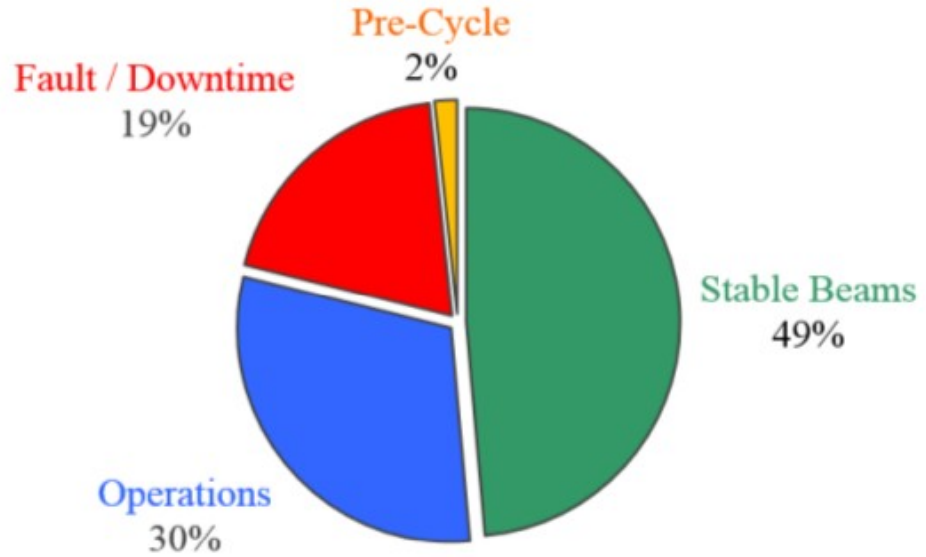




LHC takes <0.03 % of the CERN protons

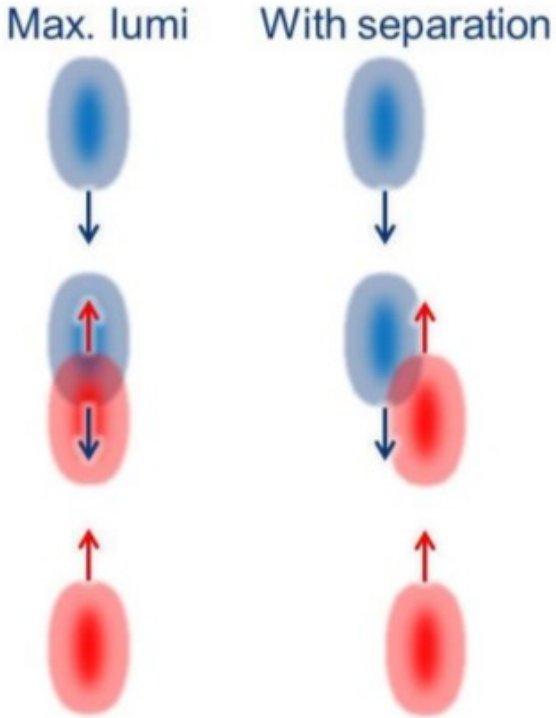
Achieved : 50 fb^{-1}

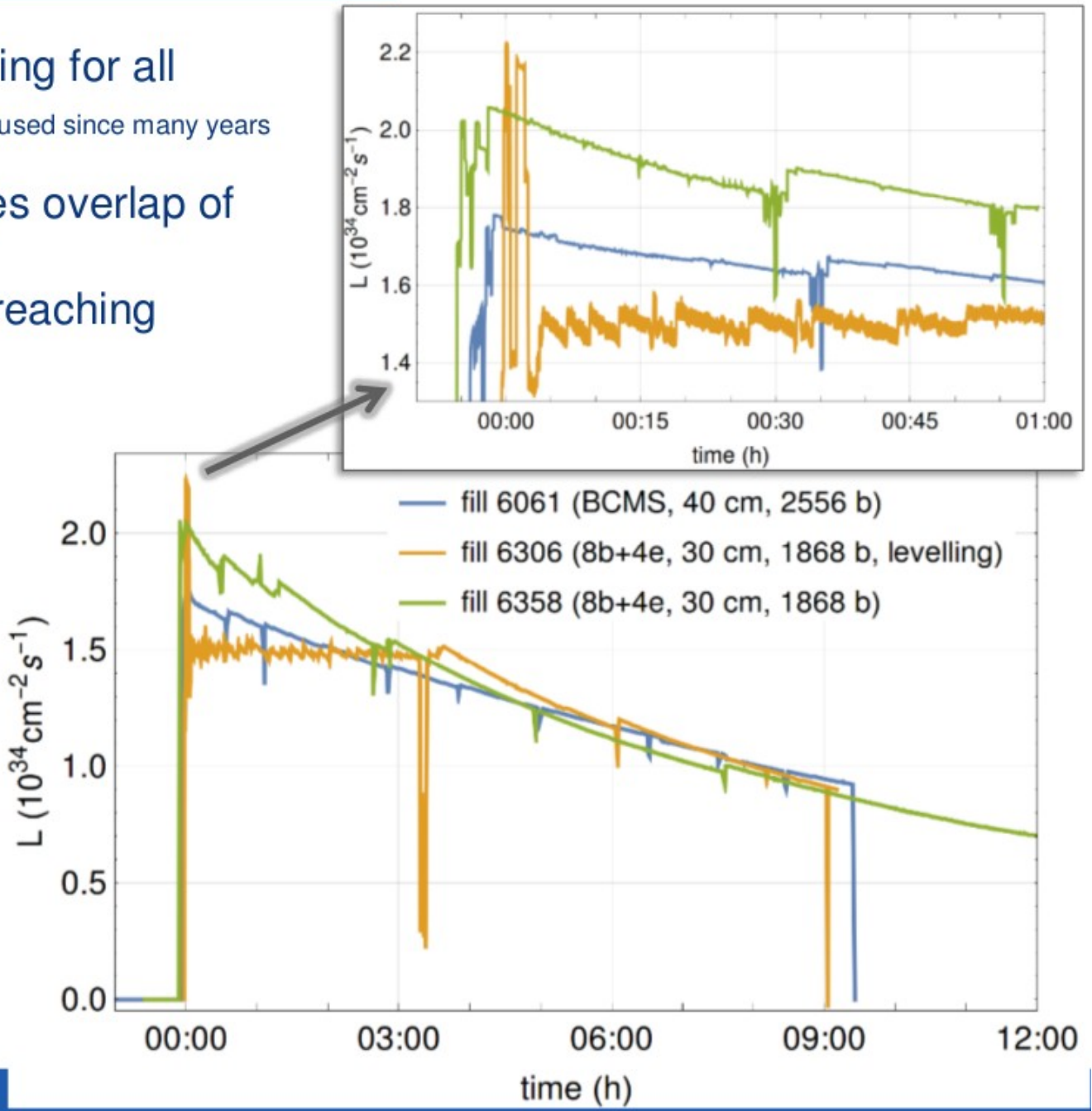




LHC 2017 : separation levelling

- Introduced separation levelling for all experiments (Separation levelling is used since many years for ALICE and LHCb)
- Dynamic orbit bump changes overlap of colliding bunches
- Initial spike before leveling reaching $2.2\times10^{34}\,cm^{-2}s^{-1}$



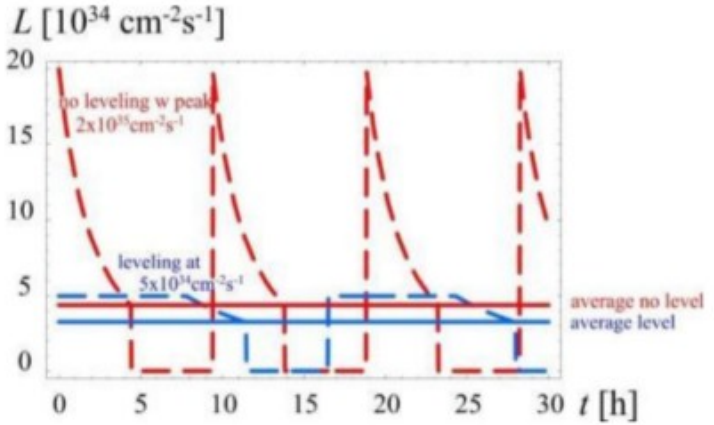


Luminosity Levelling (separation) & Anti-Levelling (crossing angle)

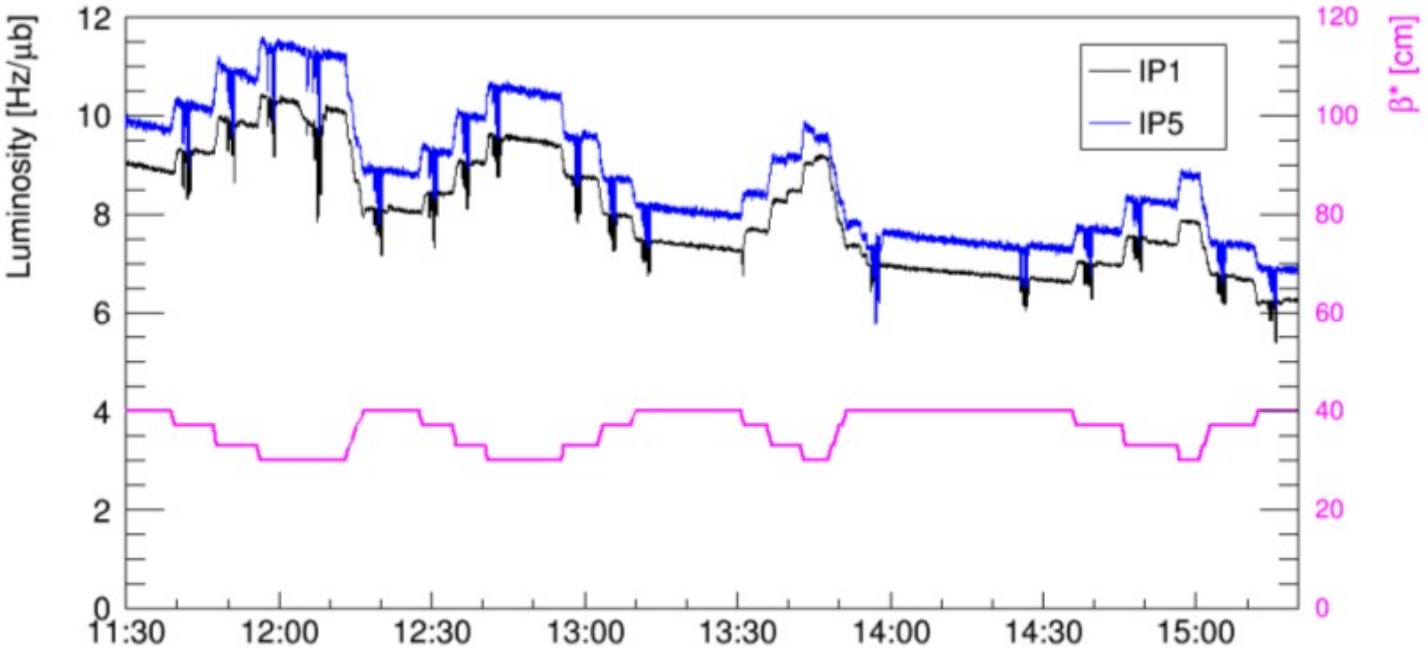
- Initially ATLAS & CMS luminosity levelled at 1.5×10^{34} $cm^{-2}s^{-1}$, using beam separation
- Later anti-levelling by reducing the crossing angle and increase the instantaneous luminosity

MDs on β* levelling

Levelling luminosity by β* should be the main levelling technique for HL-LHC



β* levelling in the last LHC MD: a possible tool for 2018 operation

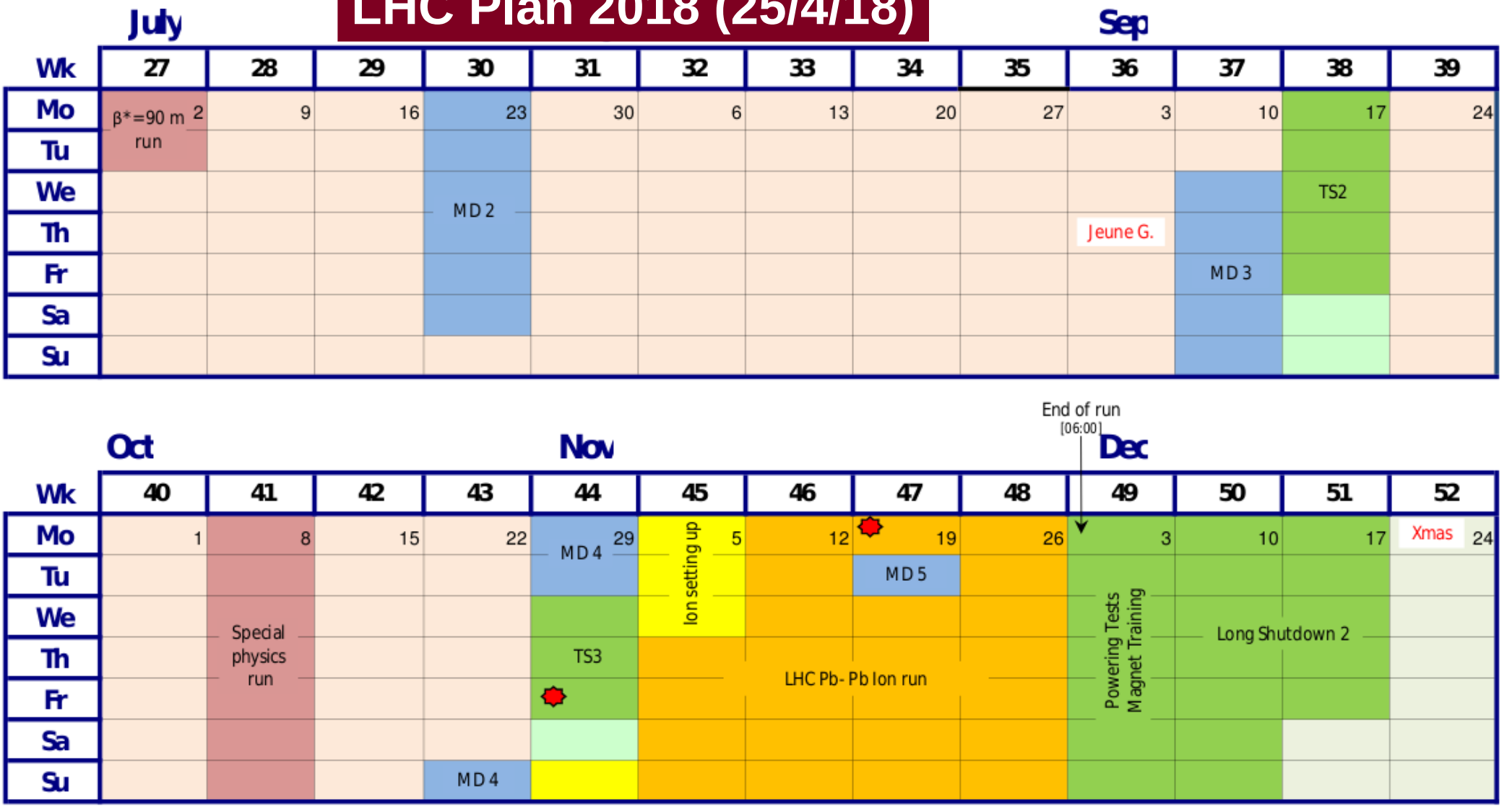


Luminosity evolution during β levelling, moving back and forth between 30 cm and 40 cm. The beams remained head-on* ***within ~ 2 μm*** *!*

LHC Plan 2018 (25/4/18)

- Technical Stop
- Powering tests
- Machine check out
- Recommissoning with beam
- Interleaved commissioning & intensity ramp up
- Proton physics run
- Special physics runs (indicative - schedule to be established)
- Machine development
- Scrubbing (indicative - dates to be established)
- Pb - Pb Ion physics run
- Pb Ion Setting up
- LINAC 3 Pb oven re-fill

LHC Plan 2018 (25/4/18)



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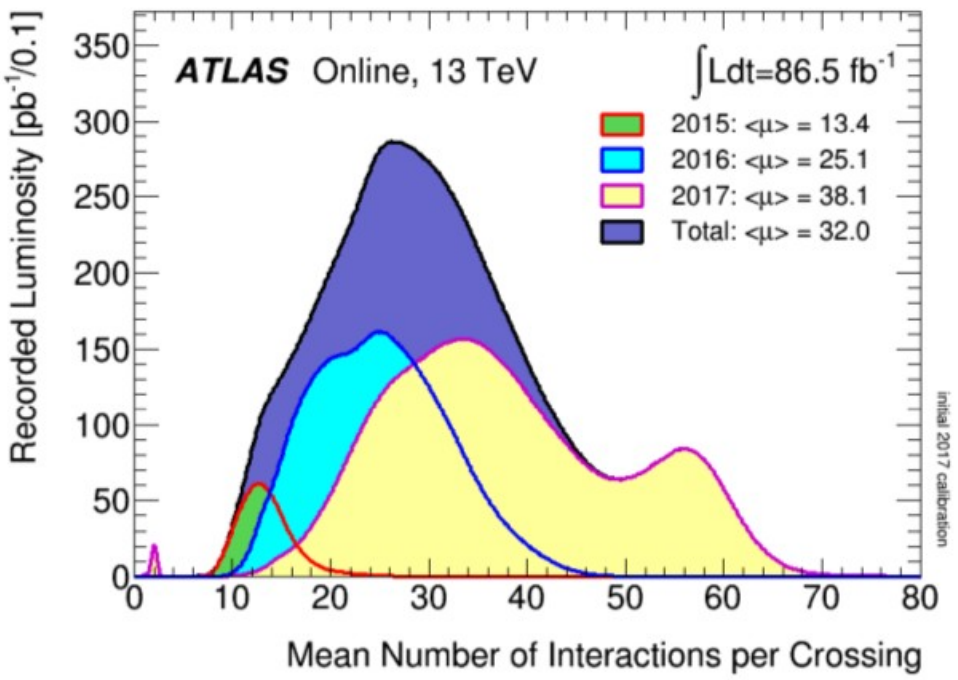
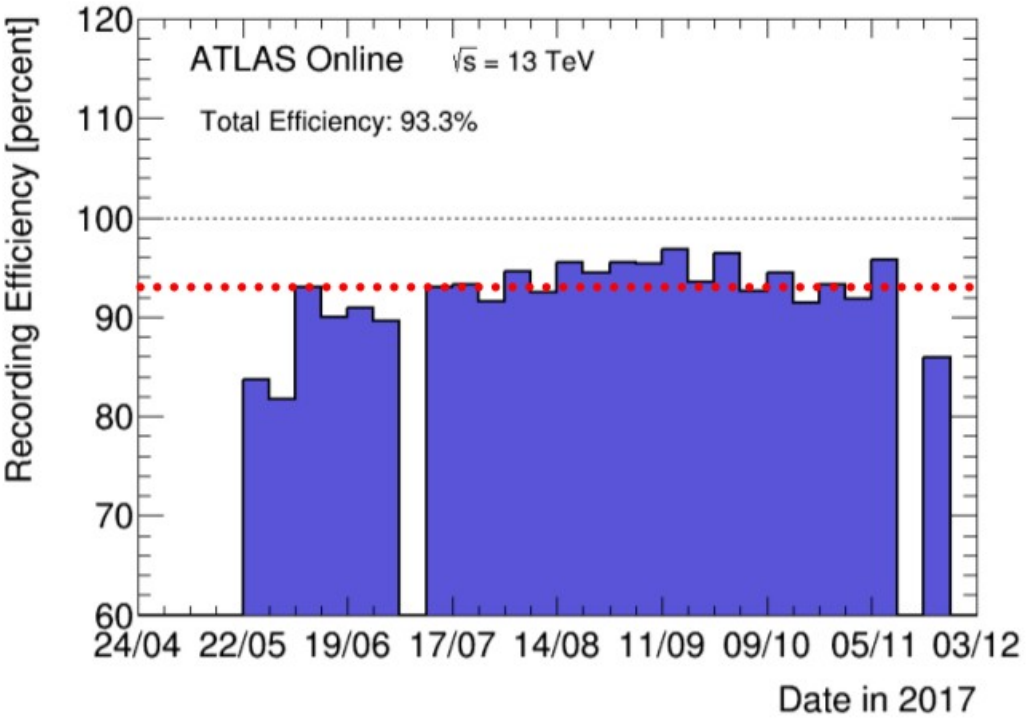
ATLAS

Operations in 2017



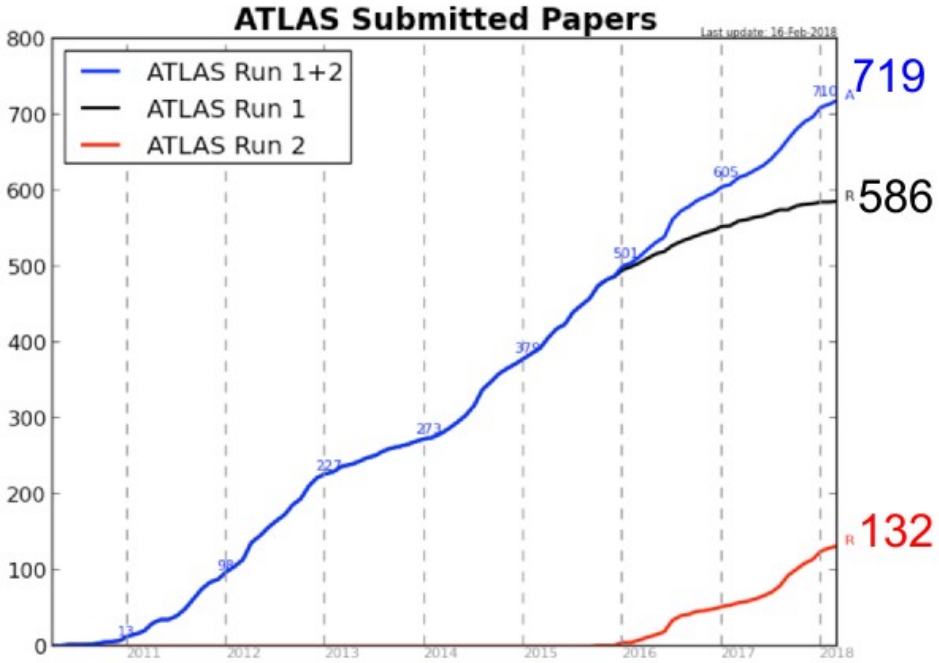


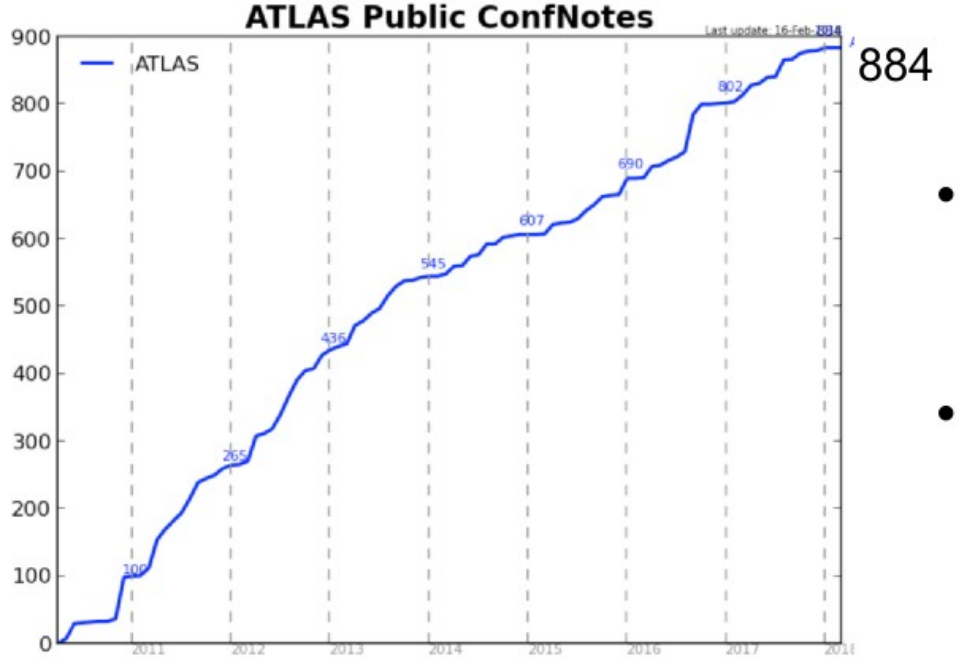
ATLAS pp 25ns run: June 5-November 10 2017										
Inner Tracker			Calorimeters		Muon Spectrometer				Magnets	
Pixel	SCT	TRT	LAr	Tile	MDT	RPC	CSC	TGC	Solenoid	Toroid
100	99.9	99.3	99.5	99.4	99.9	97.8	99.9	100	100	99.2
Good for physics: 93.6% (43.8 fb^{-1})										

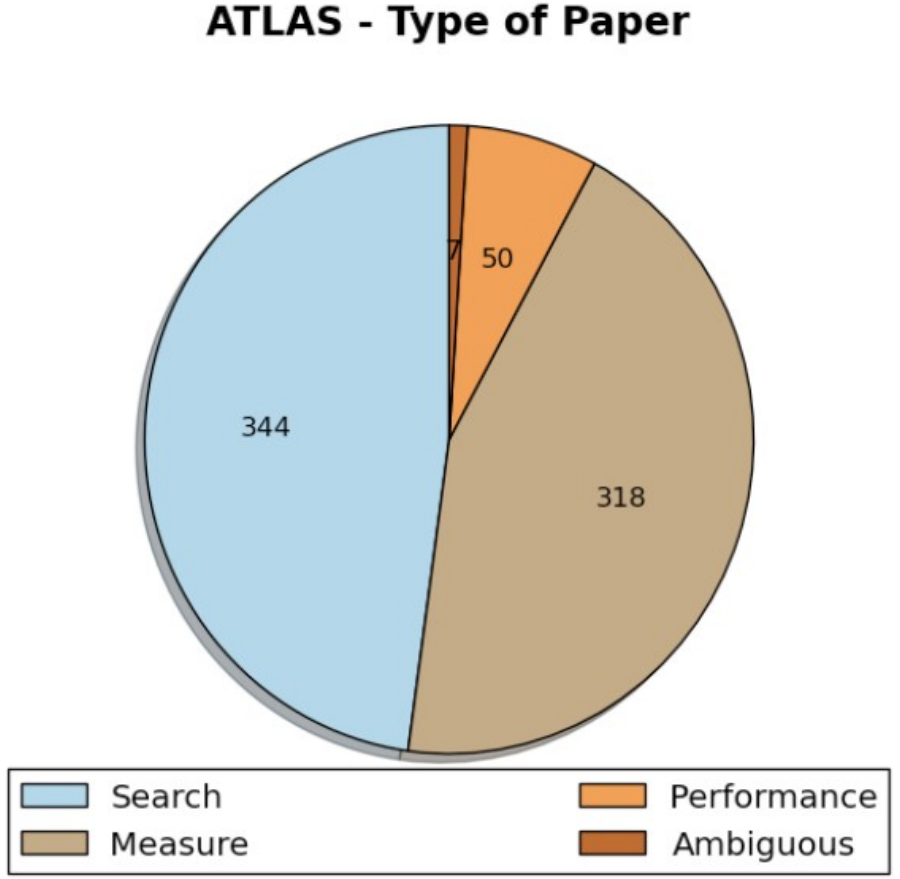
Luminosity weighted relative detector uptime and good data quality efficiencies (in %) during stable beam in pp collisions with 25ns bunch spacing at √s=13 TeV between June 5 – November 10 2017, corresponding to a delivered integrated luminosity of 50.4 fb^{-1} and a recorded integrated luminosity of 46.8 fb^{-1}. The toroid magnet was off for some runs, leading to a loss of 0.5 fb^{-1}. Analyses that don't require the toroid magnet can use these data.

- In 2017, values of <μ> well beyond the design value of 23, partly because of the 8b4e bunch filling scheme.
- High data taking efficiency

Papers







- Rate of papers pretty stable with time, evenly split between measurements and searches
- Since October 1st 2017: **30 new papers** (16 searches, 17 measurements), 8 conferences notes

Atlas Pavia 2017: 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
Pezzotti Lorenzo(*)	Dottorando	100		100
Polesello Giacomo	PR	100		100
Rebuzzi Daniela	PA	100		100
Rovelli Giulia (*)	Dottoranda	100		100
Rimoldi Adele	PA	80		80
Sottocornola Simone	Dottorando	100		100
Vercesi Valerio	DR	70		70
FTE		**13,2**		**13,4**

(*) From October 2017

Tecnologi	Qualifica	ATLAS	RD_Phase2	TOT
Cova Paolo	RU	100		100
De Vecchi Carlo	Tecnologo	30		30
Lanza Agostino	DT	80		80
FTE		**2,1**		**2,1**

ATLAS Pavia 2017: people

Laureati magistrali:

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

Giovanni Stagnitto
"Scale dependence of physical observables and theoretical uncertainties"
20-07-2017

Mariacristina Lo Presti
"Strip Alignment of the MicroMegas RO boards for ATLAS New Small Wheel"
28-09-2017

Giulia Rovelli
"Search for Dark Matter production at accelerators"
27-10-2017

Laureandi magistrali:

Adam Abed Abud

ATLAS Pavia 2017: responsibilities

Responsibilities in ATLAS experiment:

- Ferrari:
  - Phase-2 TDAQ Readout (from April 2017)
  - MDT online monitoring

- Lanza:
  - Responsabile servizi NSW and steering group members
  - Responsabile integrazione FTK VME rack and power supplies
  - Muon Phase-2 L2 coordiator (Power Supply project) and steering group member

- Negri:
  - Responsabile dataflow ATLAS
  - Responsabile integrazione DAQ FTK

- Rebuzzi: Member of the ATLAS Speakers Committee

Responsabilities in ATLAS-Italia:

- Ferrari: Coordinatore Nazionale Upgrade (until Sept. 2017)

ATLAS Pavia Group

- ✦ Physics Activities (Dark Matter Search and Higgs related activities)
- ✦ TDAQ Activity (& MDT online monitoring)
- ✦ Phase I Acivities:

- Fast TracK Trigger (FTK)
- New Small Wheel (NSW)

- ✦ Phase II Activities

- TDAQ and RO
- Hardware Track Trigger (HTT)
- Muon Power Supply
- (Large Eta Tagger)

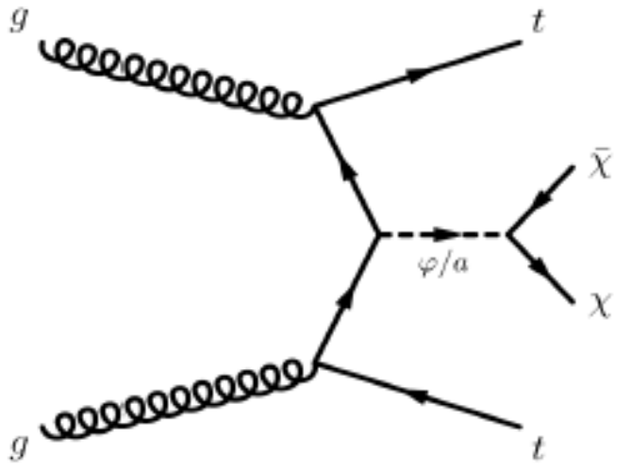
SUSY/Dark Matter Analysis

Personale: Edoardo Farina, Giacomo Polesello, Giulia Rovelli

Attivita': 1) Pubblicazione analisi produzione stop e DM+tt (2 leptons)

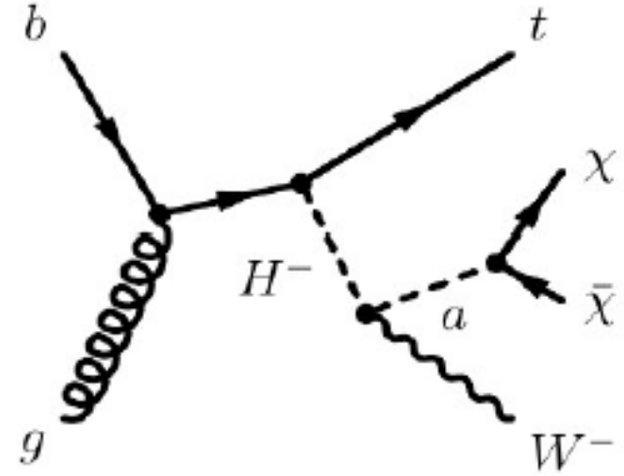
2) Recast del risultato pubblicato per modello DM con due doppietti di Higgs e mediatore pseudoscalare (tesi laurea Rovelli + 'DM Summary paper')

3) Preparazione analisi monotop+DM su 120 fb-1 di dati



2 b-jets
2 leptons
Etmiss

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



1 b-jet
1/2 leptons
Etmiss

Produzione di DM
In decadimento di H- prodotto in associazione con quark top

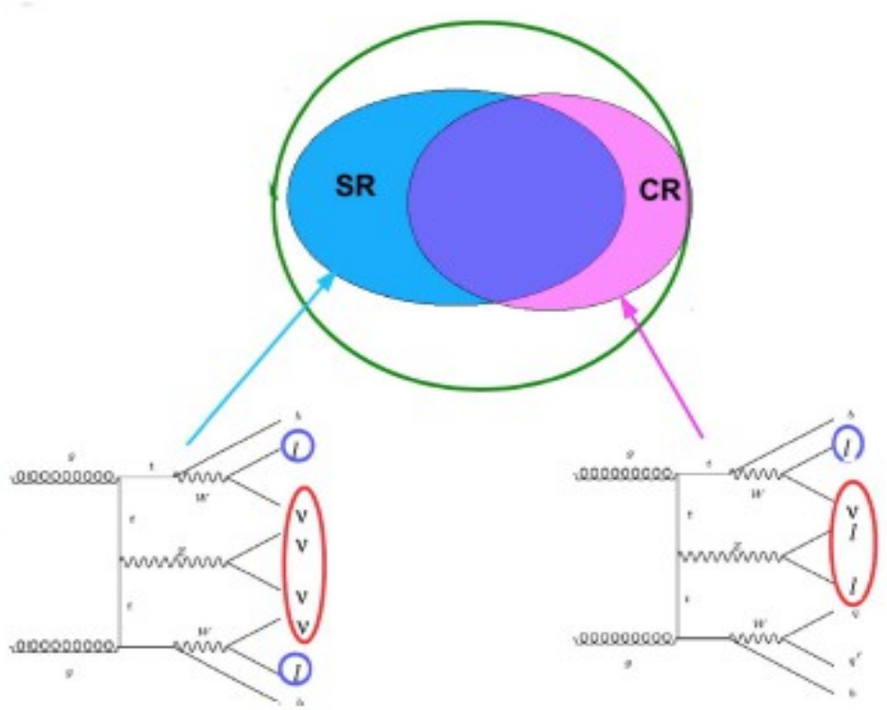
Dark Matter + ttbar analysis

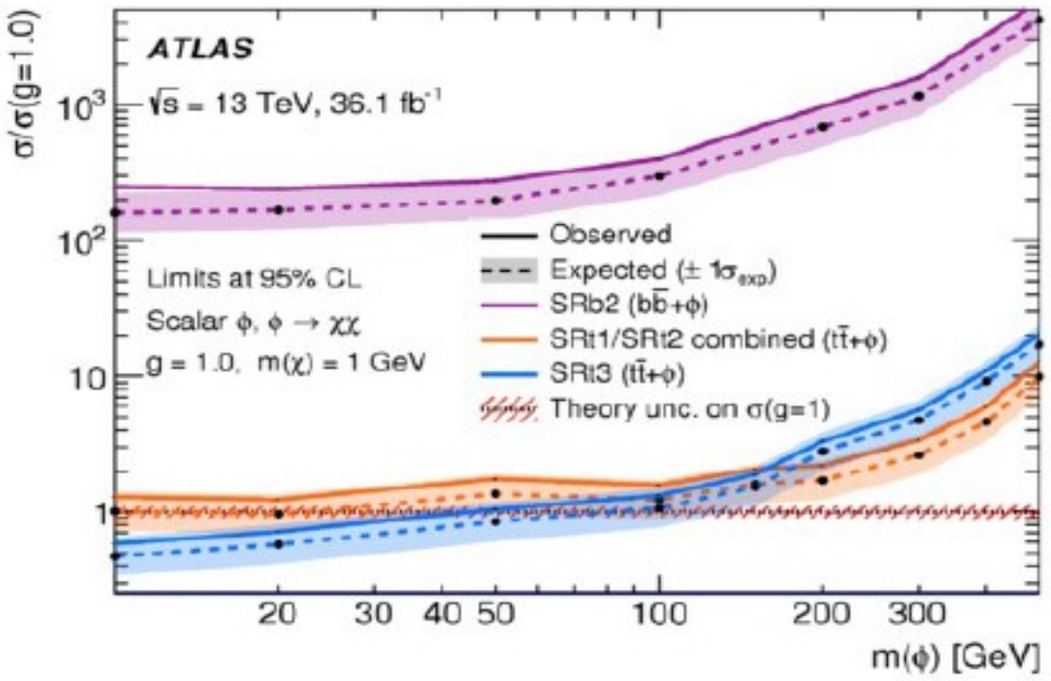
DM+ttbar

Stato: Pubblicato come: EPJ 78 (2018) 18

Contributi:

- Ottimizzazione della regione di segnale per analisi DMtt
- Stima del fondo dominante (ttZ) sulla base di stato finale a 3 leptoni

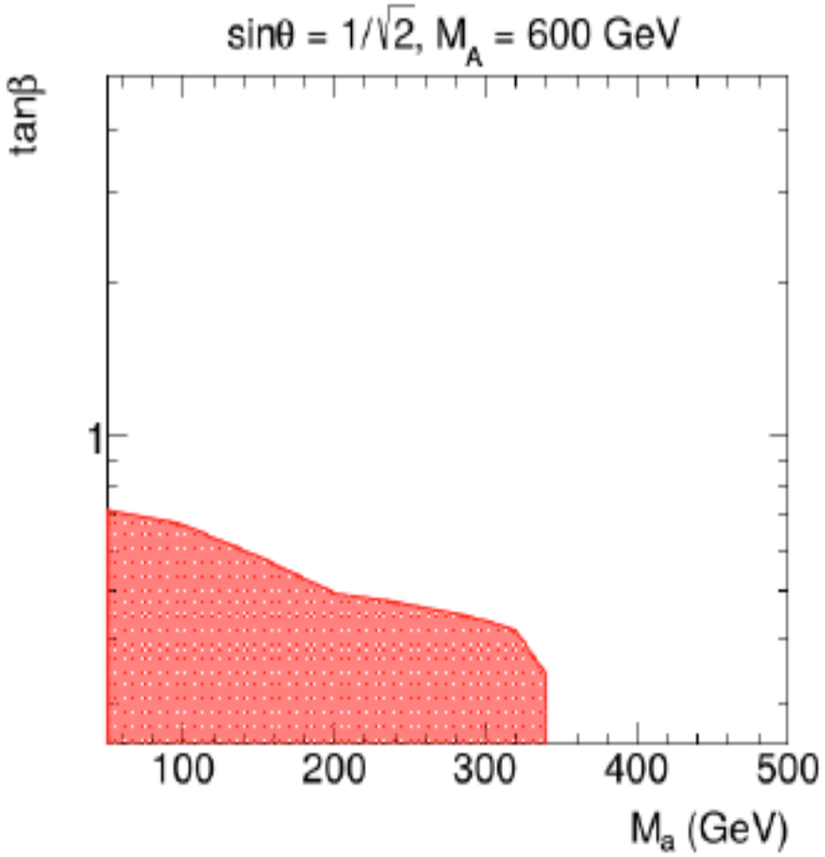




Risultato per mediatore scalare
Analisi a due leptoni ha sensibilita' ottimale per basse masse del mediatore

Recast 2HDM+a result

Estensione dell'analisi DM + tt a modello comprendente 2 doppietti di Higgs e singoletto pseudoscalare suggerito da teorici (ArXiv:1701.07427)



(dalla tesi di laurea di G. Rovelli)

DM summary paper

- Mappamento delle analisi esistenti nello spazio dei parametri del modello

Contributo: Valutazione della copertura Analisi DM+tt,
Sviluppo di tecnica per estrapolare da modello semplificato a 2HDM+a

Farina, Polesello, Rovelli

Higgs Related Activities

- 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 vector-boson fusion production process (until 2014) and for the Higgs Branching Ratios predictions
  - the fourth CERN Yellow Report book ('*Deciphering the nature of the Higgs sector*') published at the end of last year
- 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)
  - This training network concluded in January 2018
- D. Rebuzzi member 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 Thessaloniki next June 20th-22nd

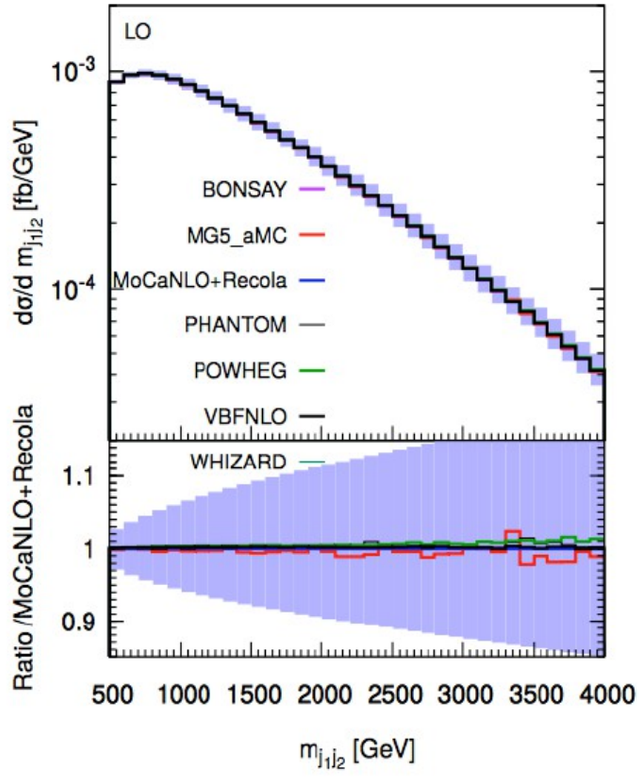
Phenomenology of same sign W scattering

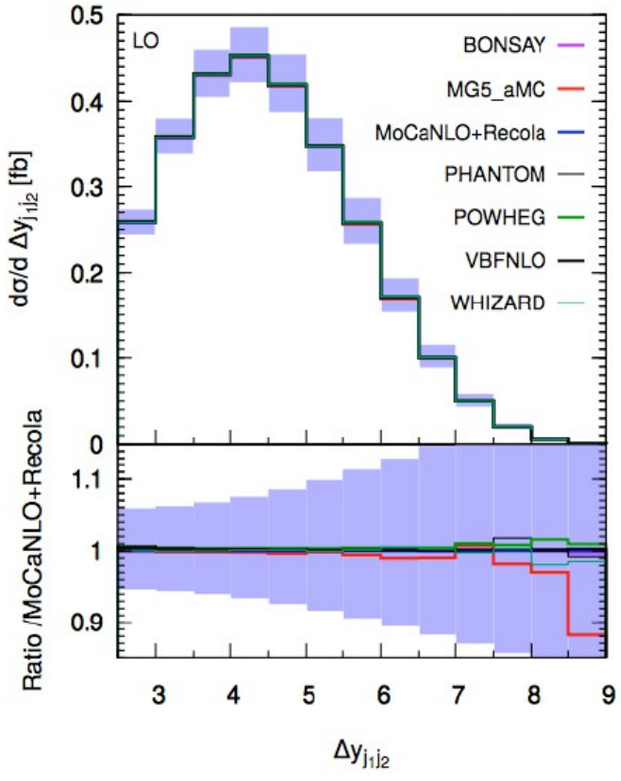
[M. Grossi, G. Polesello, D. Rebuzzi et al., *"VBSCan Split 2017 Workshop Summary"* arXiv:1801.04203v1 [hep-ph], January 2018]

[M. Grossi, D. Rebuzzi et al., *"Precise predictions for same-sign W-boson scattering at the LHC"*, arXiv:1803.07943v1 [hep-ph], to be published, March 201

Code	$\mathcal{O}(\alpha^6)$ s,t,u	$\mathcal{O}(\alpha^6)$ interf.	Non-res.	NLO	NF QCD	EW corr. to order $\mathcal{O}(\alpha_s\alpha^5)$
BONSAY	t,u	No	Yes, virt. No	Yes	No	No
POWHEG	t,u	No	Yes	Yes	No	No
MG5_aMC	s,t,u	Yes	Yes	Yes	virt. No	No
MoCaNLO+Recola	s,t,u	Yes	Yes	Yes	Yes	Yes
PHANTOM	s,t,u	Yes	Yes	No	-	-
VBFNLO	s,t,u	No	Yes	Yes	No	No
WHIZARD	s,t,u	Yes	Yes	No	-	-

Code	σ[fb]
BONSAY	1.43636 ± 0.00002
MG5_aMC	1.4304 ± 0.0007
MoCaNLO+Recola	1.43476 ± 0.00009
PHANTOM	1.4374 ± 0.0006
POWHEG-BOX	1.44092 ± 0.00009
VBFNLO	1.43796 ± 0.00005
WHIZARD	1.4381 ± 0.0002





Data flow & operation

A.Negri, R.Poggi

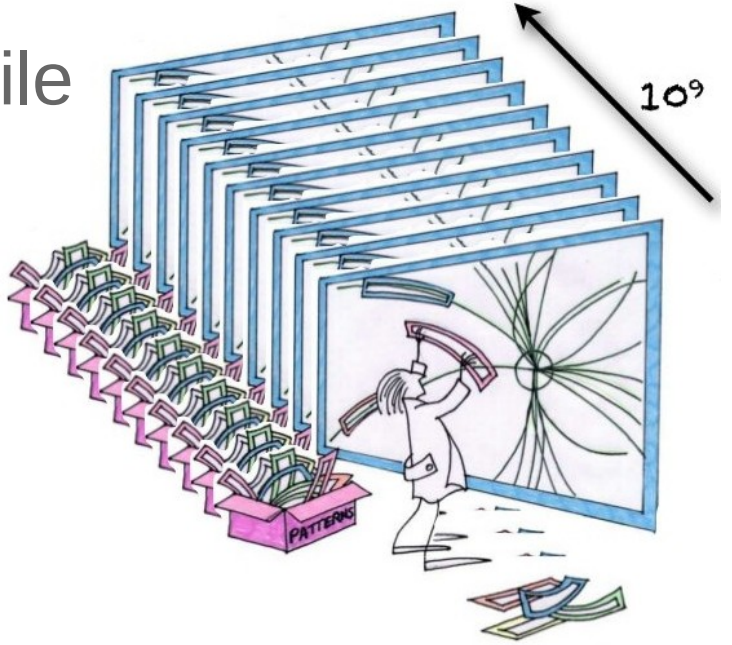
- Operation
  - turni expert on call (~ 1 mese)
  - Trigger/DAQ: efficienza di circa il 93 %
- Data flow: responsabilità pavese
  - Nessun problema significativo nel 2017
  - Aggiornamenti in base alle esigenze di operazione
- Fase I
  - cambiamenti minimali per nuovo framework ricostruzione
- Fase II
  - R&D in fase si avvio (Adam Abed Abud)
  - disaccoppiamento tra farm HLT e DAQ tramite file system distribuito: l'online finisce all'uscita del trigger di livello 1

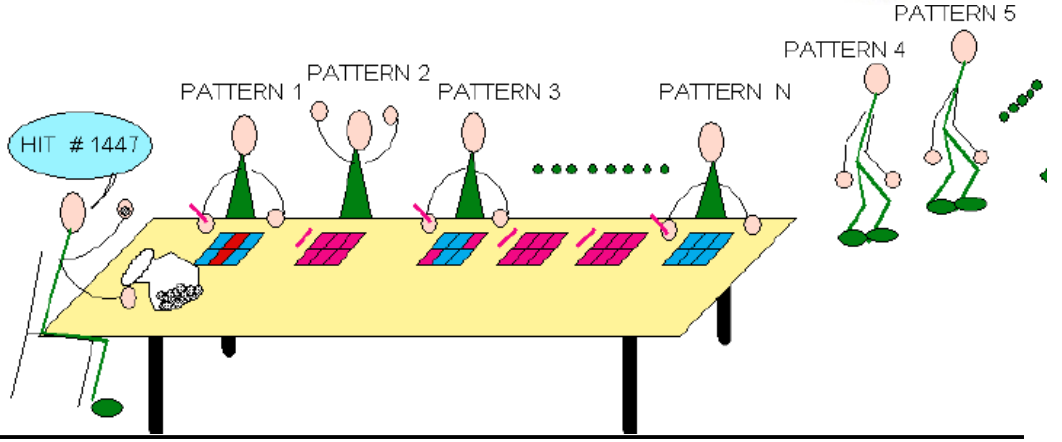
Fase 1

FTK

S.Sottocornola, M.Facchini, A. Lanza, A.Negri

- 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 μs)
- Contributo pavese
  - Integrazione del sistema nell' infrastruttura sw DAQ
  - Integrazione nell'infrastruttura HW
  - Integrazione nell'infrastruttura DCS





FTK: online SW

S.Sottocornola, 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

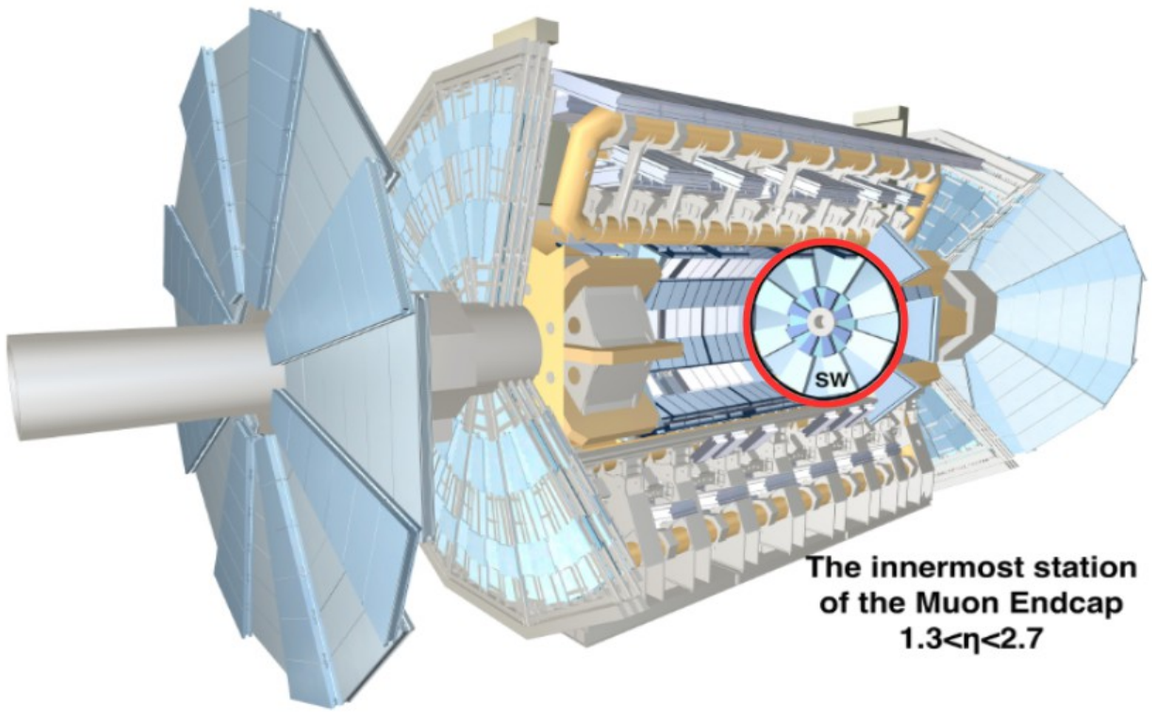
FTK VME Infrastructure

- Production of 20 special fan trays:
  - Concluded in 2017.

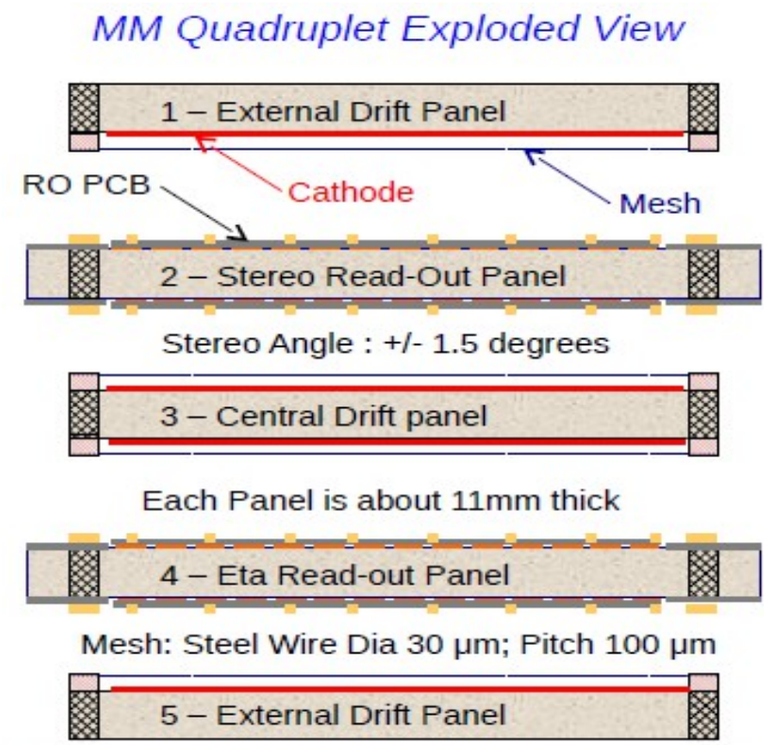
- Installation of Wiener VME crates and Caen power supplies:
  - Installation on three racks was completed at the end of April 2017. The last rack was completed at the beginning of 2018, after some issues with one power supply.

- DCS
  - It was updated with the speed control of the fan trays

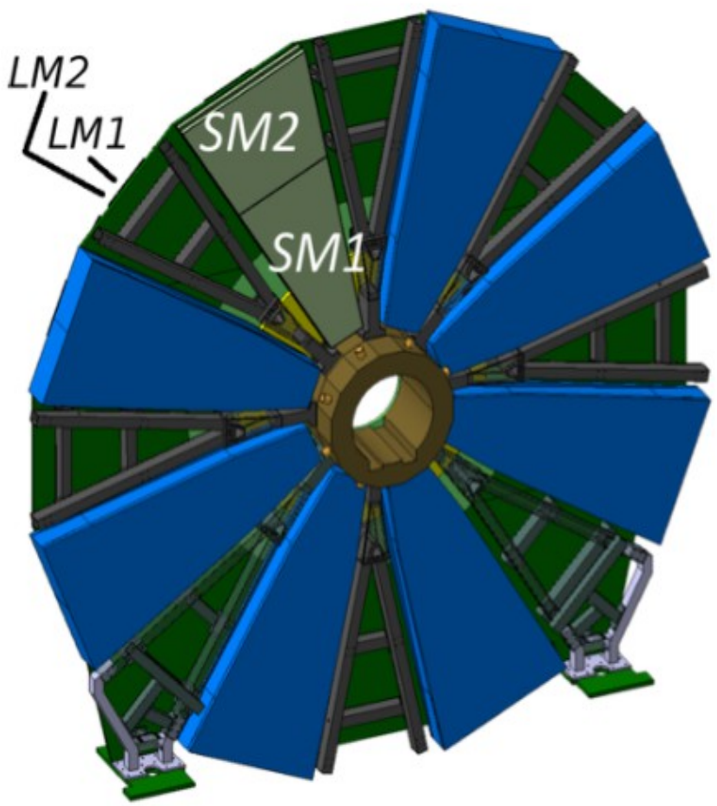
ATLAS New Small Wheels Upgrade



The innermost station of the Muon Endcap
1.3<η<2.7



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



SM1 quadruplets is INFN responsibility
Pavia responsible for Readout Panels construction

Farina, Ferrari, Gaudio, Introzzi, Kourkoumeli, Lanza, Pezzotti, Rovelli

MM – RO Panels

RO panel production strongly limited by PCB availability

- PCB quality improved with time, but it took about one year from preseries (MO/M0.5) to good series production

- First Prod. Module (M1) in December 2017 (all sites)
  - Persistency in HV stability problem observed in M0/M0.5 originally ascribed to bad PCB quality
  - Review in Jan. 2018 and following tests pointed out possible problem with cleanliness of the panels (all type)
  - Dedicated task force and test at cern with experts
  - New clean procedure seems to work, but HV working point too low

- New task force established beg. 2018 with large impact on production
  - Halt on RO panel (and Module) production
  - At present, only panels for 4 quadruplets needed for electronics, integration test, TestBeam/GIF++ test

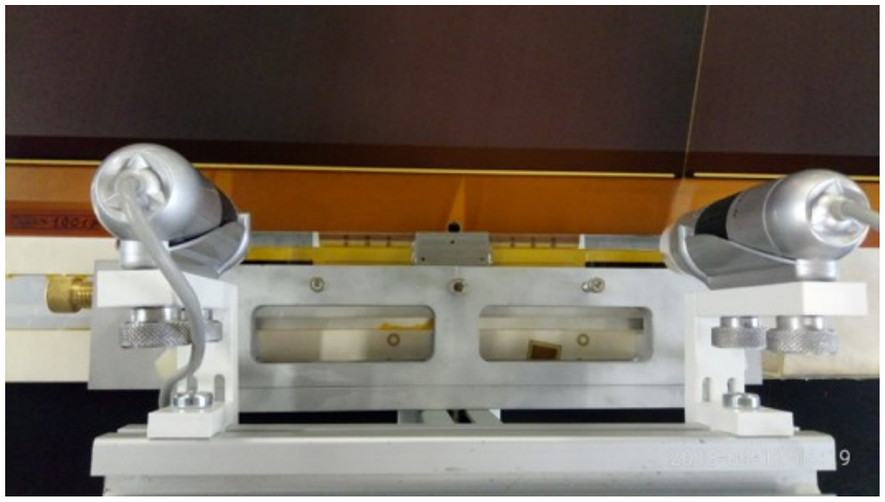
• M0	03/2016
• M0.5	02/2017
• Eta1	08/2017
• Eta2	09/2017
• Stereo1	11/2017
• Stereo2	02/2018
• Stereo3	03/2018
• Eta3	03/2018

Farina, Ferrari, Gaudio, Introzzi, Kourkoumeli, Lanza, Pezzotti, Rovelli

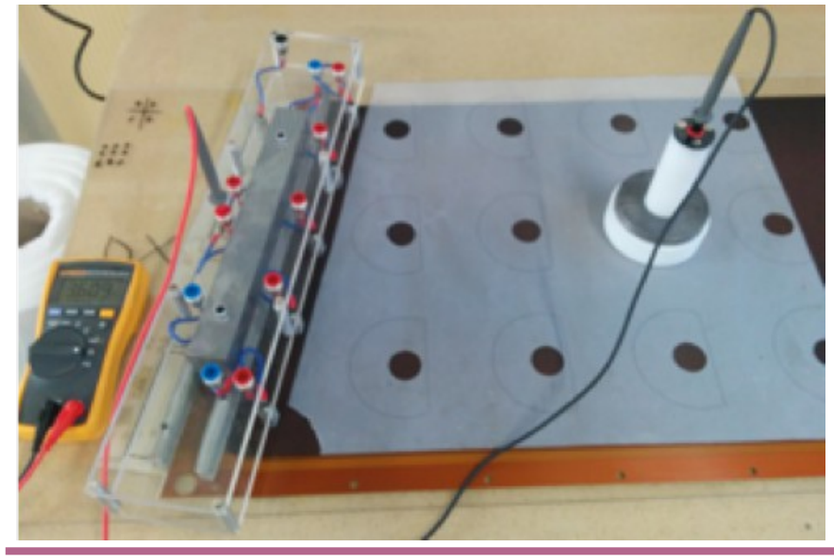
MM – RO Panels

Progress in preparation of the production setup in 2017

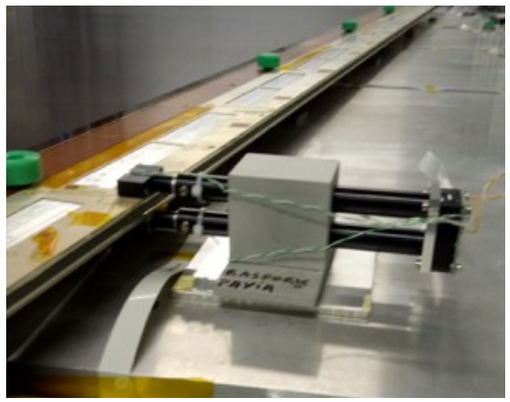
- Optimized procedure and full steering program for panel construction
- QAQC procedure for both PCB and Panel well established
  - QAQC shifts taken by whole ATLAS Pavia Group



FEB Pin Gluing tool(Saclay/Pavia)

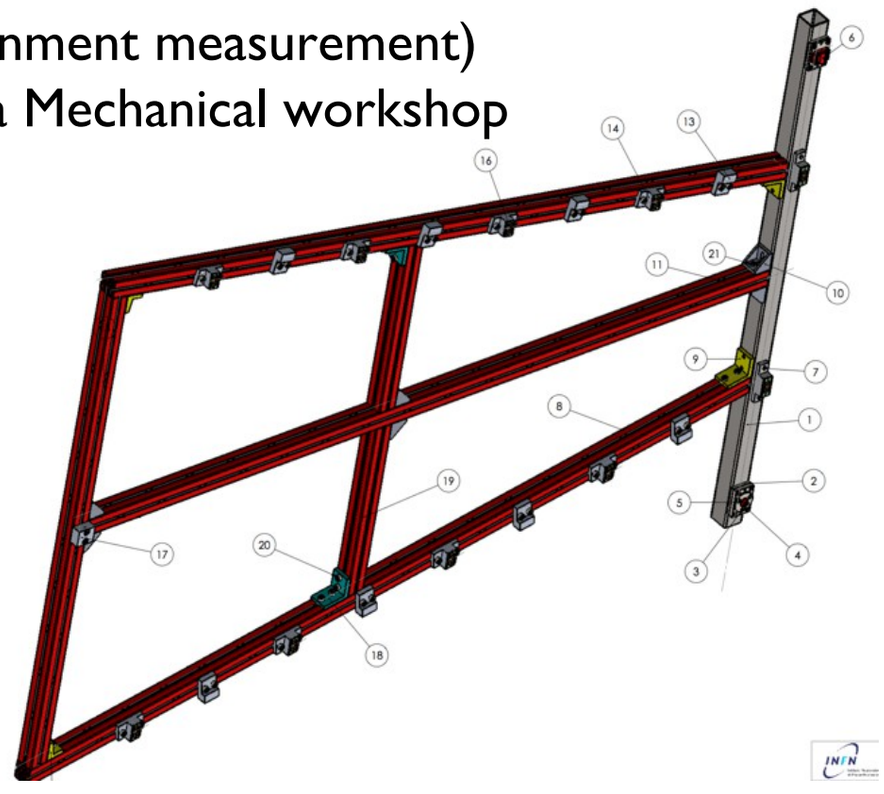


Setup for electrical tests



Side-to-side strip alignment (Saclay)

New jig for CCD calibration
(Strip alignment measurement)
INFN Pavia Mechanical workshop



Farina, Ferrari, Gaudio, Introzzi, Kourkoumeli, Lanza, Pezzotti, Rovelli

NSW - Services

Cables, pipes and fibers on the NJD:

- The routing and box placement design on the NJD rim had to be revised due to the change of envelope. This because the ATLAS Catia model was not completely consistent with the reality, and several checks in the cavern were necessary in order to have it updated;
- Design of the patch-panels in the flexible chains in sectors 1, 9 and 13 had been modified due to the increase of the elx power to more than 100 kW. Because of the lack of space, another patch panel for the sTGC rim elx power was introduced in sector 3;
- Procurement of cables and connectors was almost concluded at the end of 2017. The specifications for the HV bundles were written and their assembly started beginning of 2018;
- A new engineer, Konstantinos Iakovidis, was appointed manager of the services installation on the NJD, and installation started in December 2017.

HV and LV system for MM and sTGC:

- The sTGC HV system was fully delivered;
- The MM HV system was assigned at the end of April 2017 with a price enquiry between CAEN and ISEG. The winner was CAEN. The delivery begun in November 2017 and was completed in March 2018;
- The two LV prototypes were under design in 2017 by the selected companies Caen and Wiener.

NSW - Services

.

MM on-chamber services:

- A large amount of noise was measured on the first MM FE board prototypes, putting a red light on the design of the LV distributor., in charge to Pavia The issue was solved only at the beginning of 2018;
- At the end of 2017 a serious fault was detected by CMS in the Feast DC/DC, used by almost all P-1 and P-2 projects. The issue is still open, and will push the NSW power system to deliver less voltage (9 instead of 12 V) to the FE elx.

The Services Final Design Review (FDR) was passed in July 2017.

NSW – Other contributions from Pavia

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

- Several contributions of INFN Pavia Mechanical Workshop to design finalization of NSW Micromegas detector.

Phase II

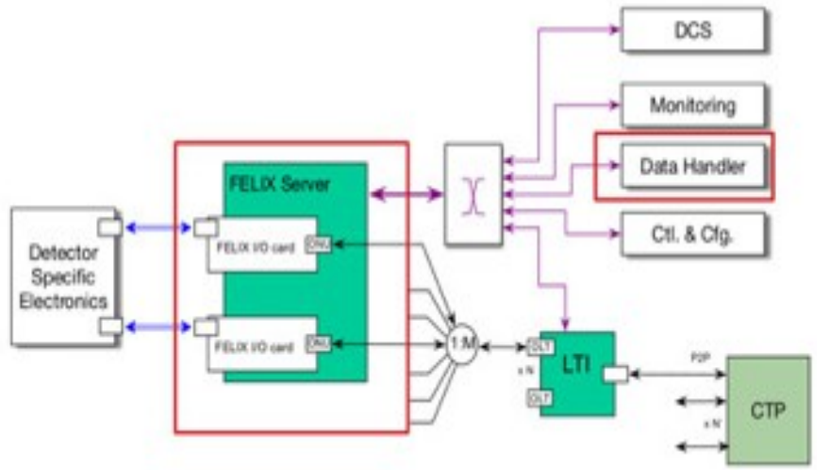
TDAQ Phase-II Upgrade

- Sottomesso TDR (raccomandato per approvazione in aprile)
- G. Lehmann e R. Ferrari coordinatori per la parte di readout

- FELIX Implements the interface to detector-specific electronics via custom, point-to-point, serial links
- Data Handler implements (detector specific) data formatting and monitoring

Phase-II work is progressing on 3 axes

- Requirements collection from detectors and other TDAQ systems
  - ITk DAQ Requirements (ATL-COM-ITK-2018-018)
- Demonstrator programs with ITK pix/strips for early integration experience
- R&D on hw/sw technologies
  - e.g. review of PCIe IV hardware availability, high rate benchmarking (from 100 kHz to 1 MHz and beyond)



ITk-FELIX integration

- Work on providing FELIX based readout for strips and pixel
- Most advanced is readout for the pixel barrel demonstrator in SR1
- 1st integration week Aug 2017 → single chip readout
- 2nd integration week Nov 2017 → dual chip readout on real stave in Wuppertal
- 3rd step ongoing this week → quad chips readout in lab/SR1
- Lively and constructive collaboration between TDAQ and ITK pix experts

Muon Phase-II upgrade project

- The project was approved by the ATLAS EB on July 7th, 2017
- It passed the scrutiny of the LHCC in September, and of the UCG in November
- It was finally approved by the CERN Research Board on December 6th, 2017

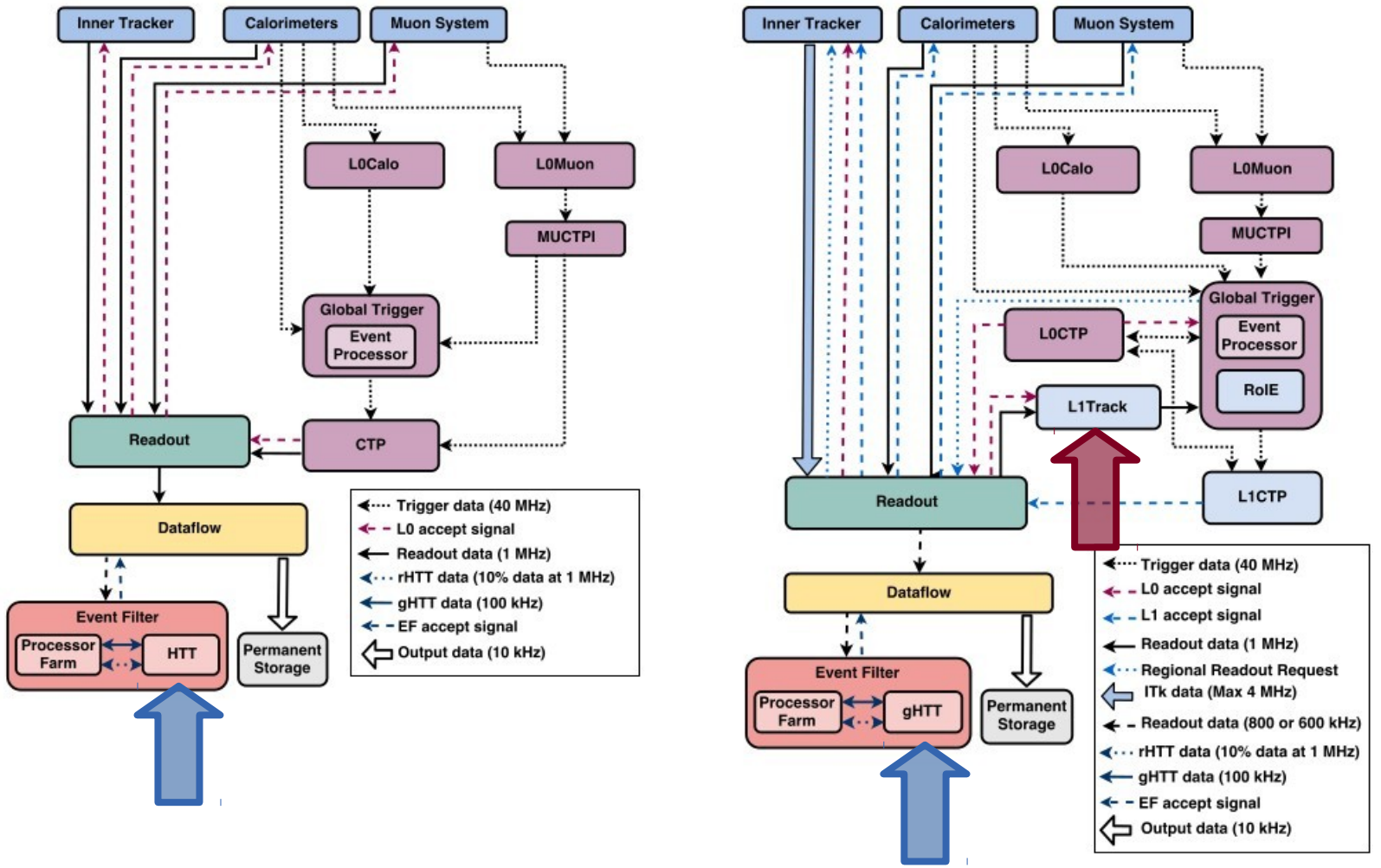
- It does NOT include the **Muon Tagger**, for which Pavia made an expression of interest. The Muon Tagger will be subject of a specific TDR to be edited in 2019

The PS subproject (Coordinator A. Lanza, Deputy M. Beretta)

- It is composed of 7 subtasks:
  - Mainframes and branch controllers (**A. Lanza**);
  - Power generators (**A. Lanza** and M. Beretta);
  - MDT PS (M. Beretta and T. Alexopoulos);
  - RPC PS (G. Aielli);
  - TGC PS (M. Aoki)
  - sTGC HV (??)
  - Installation (**A. Lanza** and M. Beretta)
- Its cost (13 MCHF) was shared between CORE (60%, covering the years 2024 - 2026) and M&O (40%, covering the years 2027 - 2029)
- The total required FTE is 56 from 2018 to 2030

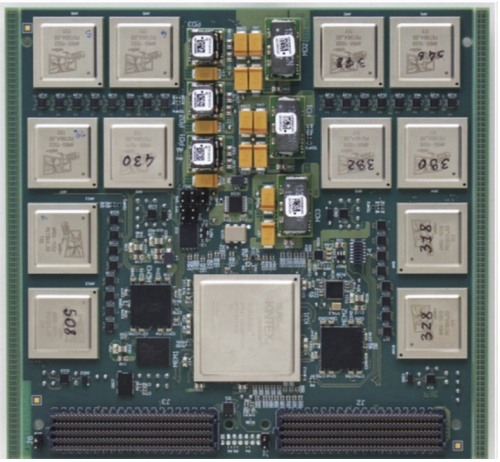
Coprocessore per HLT o L1

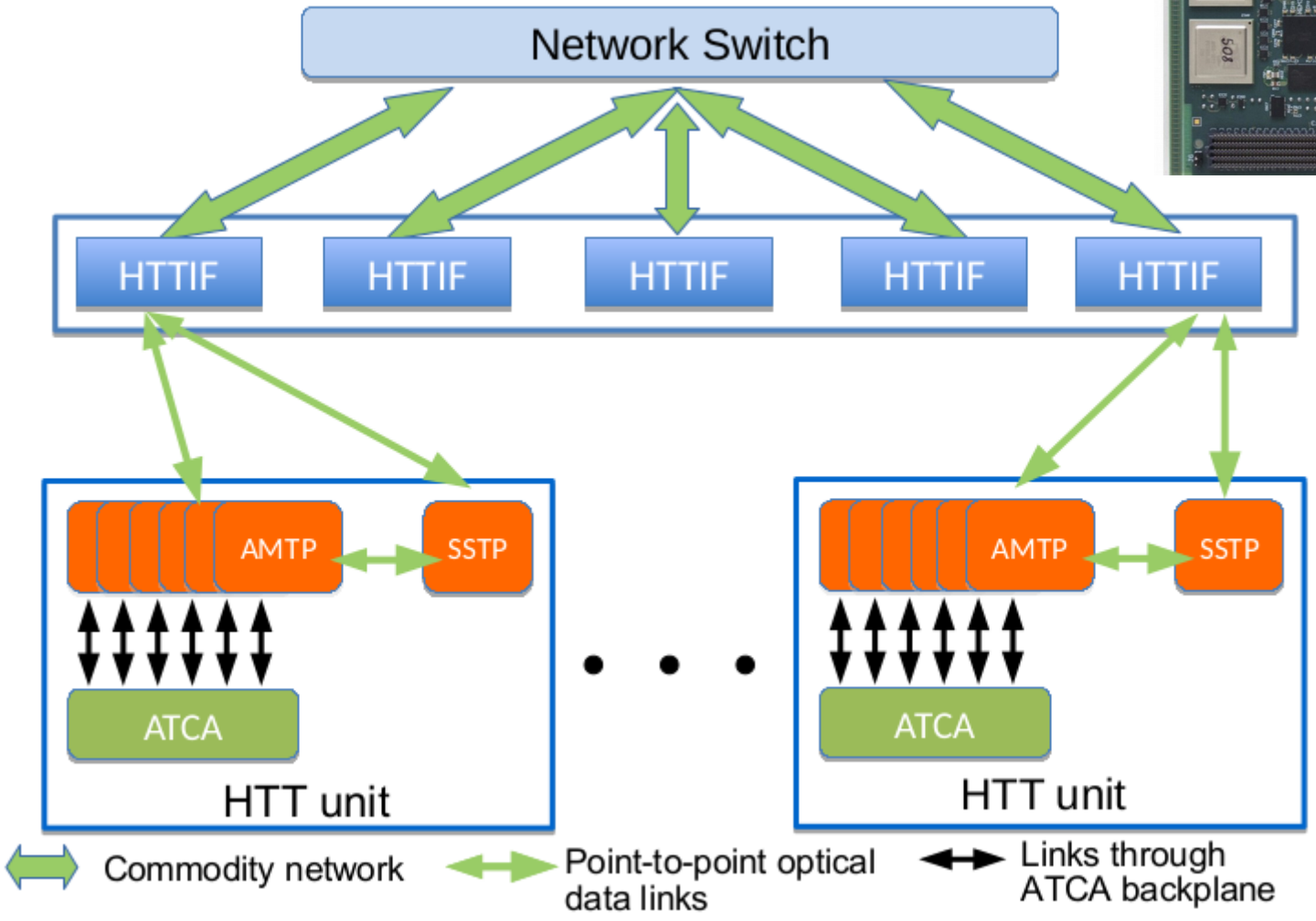
- Baseline: L0-only (left), L0+L1 on the right
  - **EFTrack** (HTT) and **L1Track** using same HW



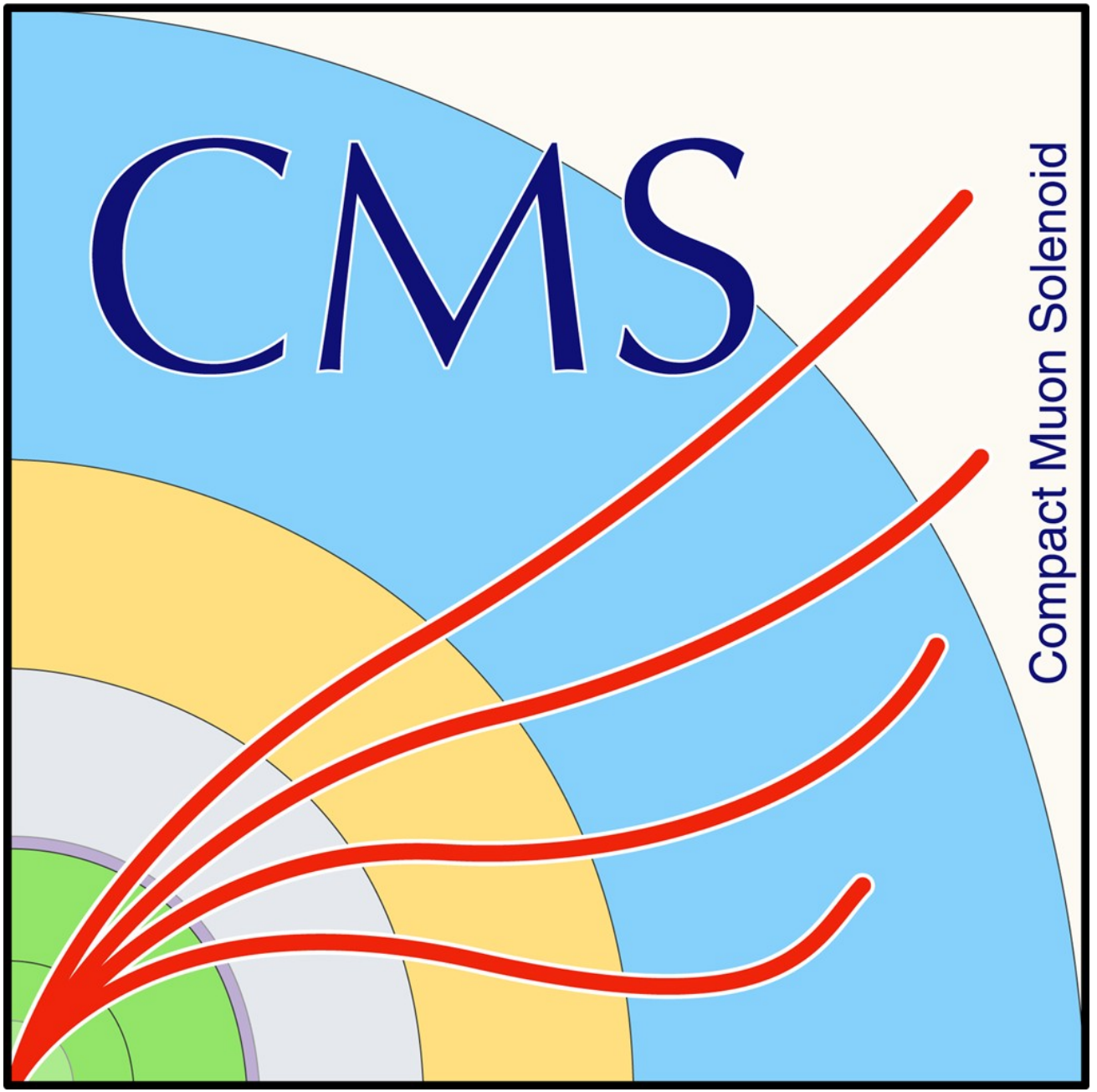
Hardware Track Trigger

- Contributo pavese
  - online SW e possibilmente FW





CMS



CMS PAVIA		FTE	Responsabilità	
Braghieri Alessandro	Ric INFN	0.7		
De Canio Francesco	Assegnista	1.0	RD53A Core Design Team-Coordination of Monitoring	L3
Fallavollita Francesco	Dottorando	1.0	QC GE1/1 & aging tests	
Gaioni Luigi	Assegnista	1.0	RD53A Core Design Team-Coordination of Analog Front End Integration	L3
Galizzi Francesco	Dottorando	1.0		
Magnani Alice	Assegnista	1.0		
Manghisoni Massimo	RU	0.5		
Montagna Paolo	RU	0.7		
Ratti Lodovico	RU	0.2		
Re Valerio	PO	0.6	AIDA2020 WP4 Leader + Analog Working Group Leader	L2
Ressegotti Martina	Dottorando	1.0	TC and Chamber Production Link	
Riccardi Cristina	PA	1.0	Resp. Nazionale GEM & Resource Manager GEM & Muon IB deputy chair	L1
Salvini Paola	Ric INFN	1.0	Responsabile Nazionale RPC	
Traversi Gianluca	RU	0.8		
Vacchi Carla	RU	0.3		
Vai Ilaria	Assegnista	1.0	GE1/1 Slice Test commissioning coordinator	L3
Vitulo Paolo	PA	1.0	R&D fase II Upgrade Coordinator Office	L2
TOTALE FTE		**13.8**		

Il gruppo di Pavia è impegnato in 2 items:

- **TRACKER** detector
- **MUON** system
  - RPC
  - GEM
  - Simulazioni

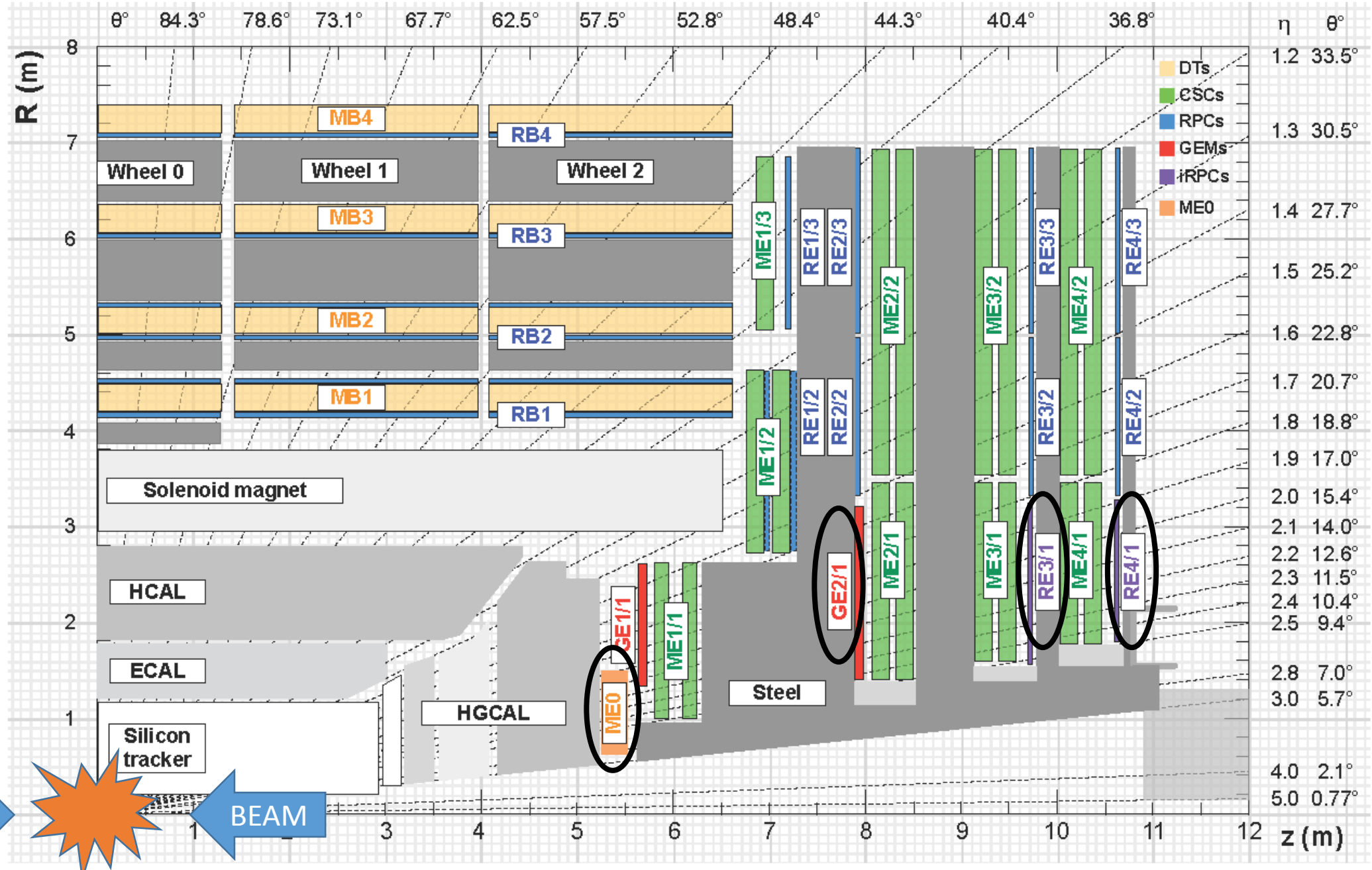
Parte delle attività riguardano l'**upgrade (-> RD_FASE2)**

Upgrade of the Muon Detectors: TDR completato nel 2017 e pubblicato

Sezione longitudinale di un quadrante del rivelatore CMS

nuovi rivelatori previsti nella regione ad «alto» η

RE ⇒ **RPC**
ME/**GE** ⇒ **GEM**



RD_Fase2 di CMS: impegno del gruppo di Pavia

Nel triennio 2015-2017 le attività che riguardano l' «upgrade» sono state finanziate dall'INFN sotto la sigla «RD_Fase2» 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

Dal 2018 l'attività di RD_Fase2 continua nell'ambito dei singoli esperimenti ed i preventivi sono stati presentati separatamente da ATLAS e CMS

Il gruppo CMS di Pavia è attualmente impegnato per circa il 50% in questa attività.

TRACKER

Gaioni Luigi	Assegnista	1
Galizzi Francesco	Dottorando	1
Manghisoni Massimo	RU	0.5
Ratti Lodovico	RU	0.2
Re Valerio	PO	0.2
Traversi Gianluca	RU	0.4
Vacchi Carla	RU	0.3

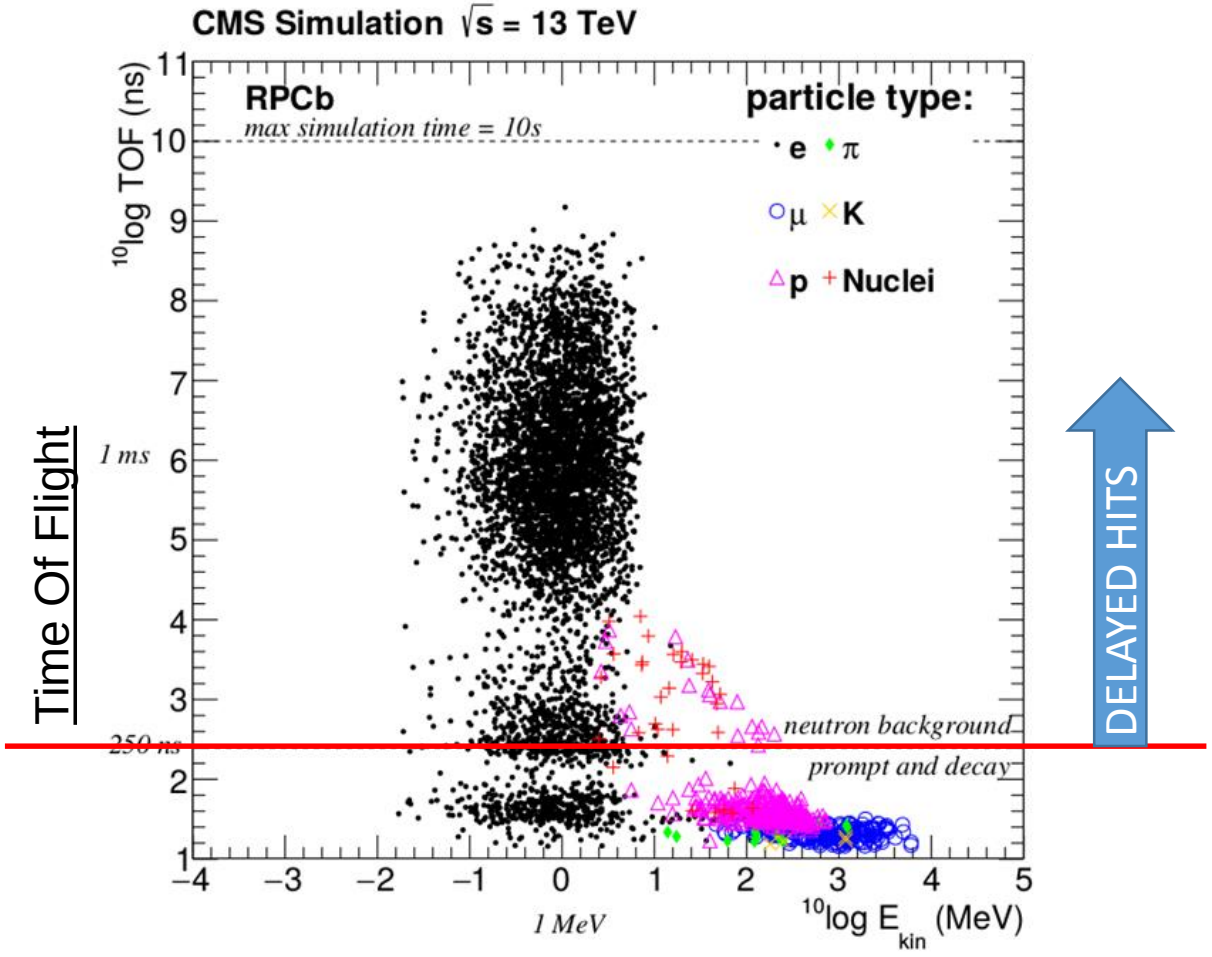
MUON

Braghieri Alessandro	Ric INFN	0.7
Fallavollita Francesco	Dottorando	0.5
Magnani Alice	Assegnista	0.2
Montagna Paolo	RU	0.3
Ressegotti Martina	Dottorando	0.5
Riccardi Cristina	PA	0.5
Salvini Paola	Ric INFN	0.3
Vai Ilaria	Assegnista	0.3
Vitulo Paolo	PA	0.6

SIMULAZIONI MC PER CMS:

Studio del background generato dai neutroni mediante simulazioni MC

Backstory : neutrons are crowling around the detector for milliseconds , so we expect «delayed» hits by respect to particles generated by beam-beam interaction



- Studio della distribuzione in tempo (TOF) dei segnali.
- Assunzione ragionevole: gli hits con TOF> 250 ns sono dovuti a background

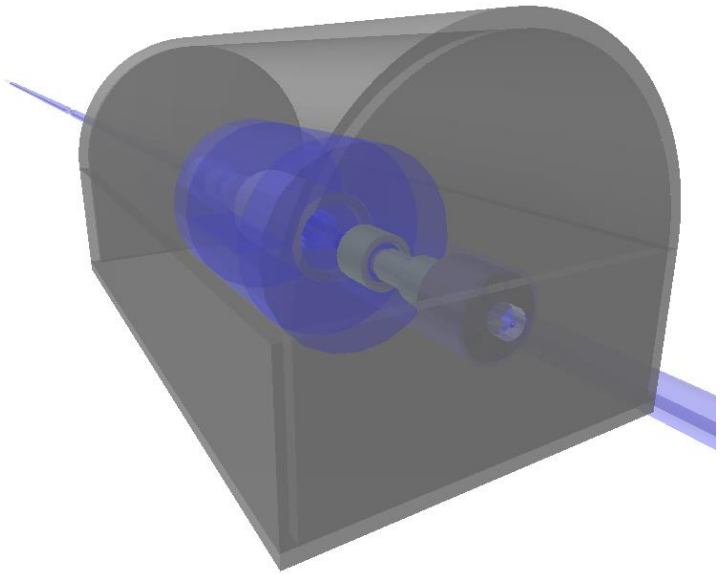
SIMULAZIONI MC PER CMS:

Studio del background generato dai neutroni mediante simulazioni MC

È cruciale un'accurata descrizione delle caratteristiche fisiche e geometriche della caverna che ospita il rivelatore.

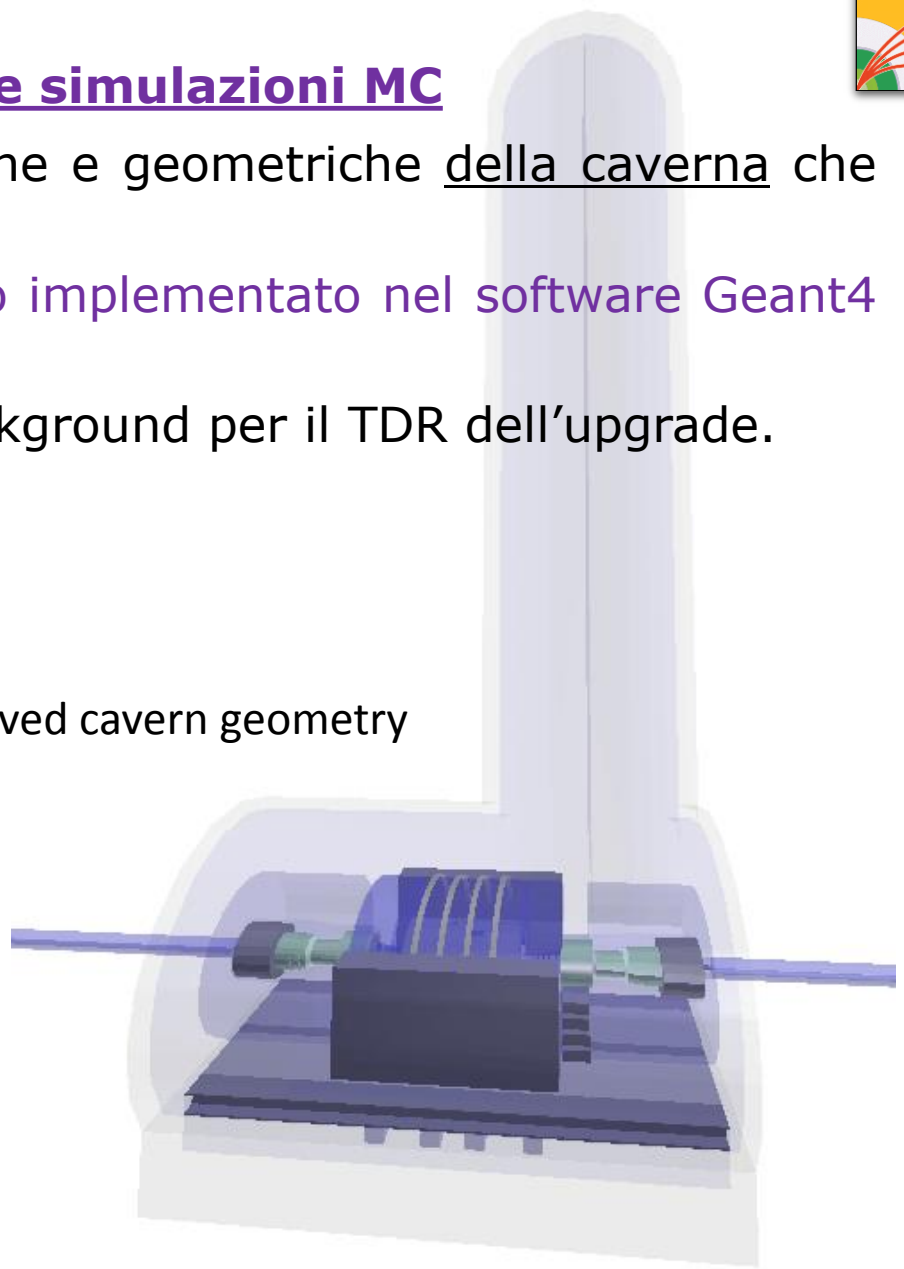
Contributo di Pavia: un nuovo modello più realistico è stato implementato nel software Geant4 che include la forma dei muri, l'elettronica,…

Samples di dati sono stati usati per produrre le stime di background per il TDR dell'upgrade.



Cavern geometry - standard scenario

Improved cavern geometry



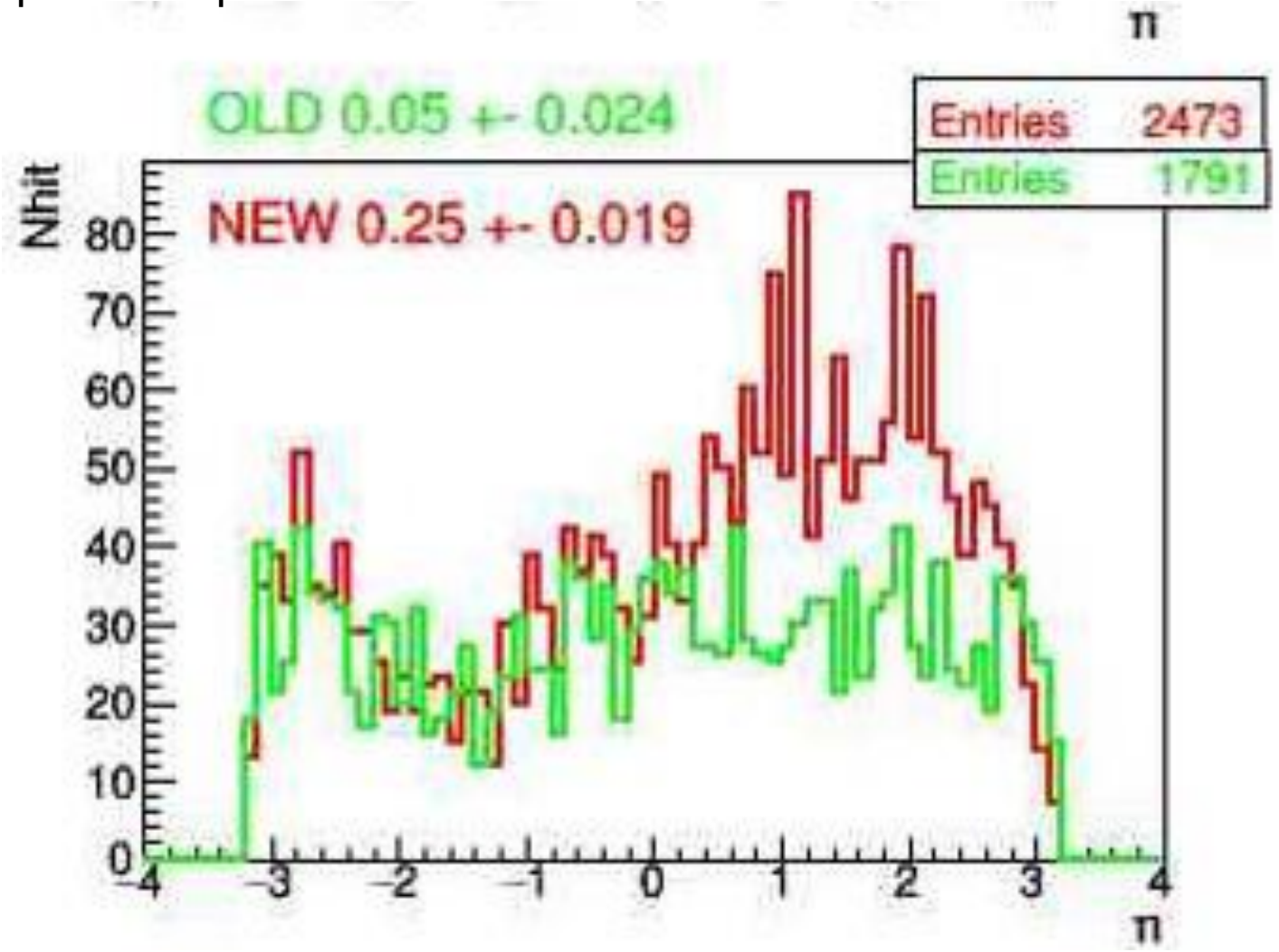
SIMULAZIONI MC PER CMS:

Studio del background generato dai neutroni mediante simulazioni MC

Esempio di simulazione: distribuzione in pseudorapidità di eventi Minimum Bias e neutron background.

NEW: risultati con una descrizione più realistica della geometria della caverna.

Nella regione $\eta>0$ del rivelatore le pareti della caverna sono più vicine e sono responsabili di un maggiore background.



CMS MUON SYSTEM: RPC detectors

Lavori di «manutenzione» e test periodici

- Controlli della bakelite, riparazione del sistema di distribuzione del gas (=> importante contributo dei tecnici)
- Verifica performance dei rivelatori.
- Misure di aging sui rivelatori del Barrel e degli Endcap. Studio della curva caratteristica Tensione-Corrente per valutare la resistività degli elettrodi e confrontarla con le misure degli anni precedenti
- Realizzazione di un «current monitor» on-line (misura della corrente in funzione della luminosità)

Queste attività periodiche rientrano nelle competenze di Pavia e sono state documentate anche negli anni precedenti.

CMS MUON SYSTEM: RPC detectors (RD_Fase2)

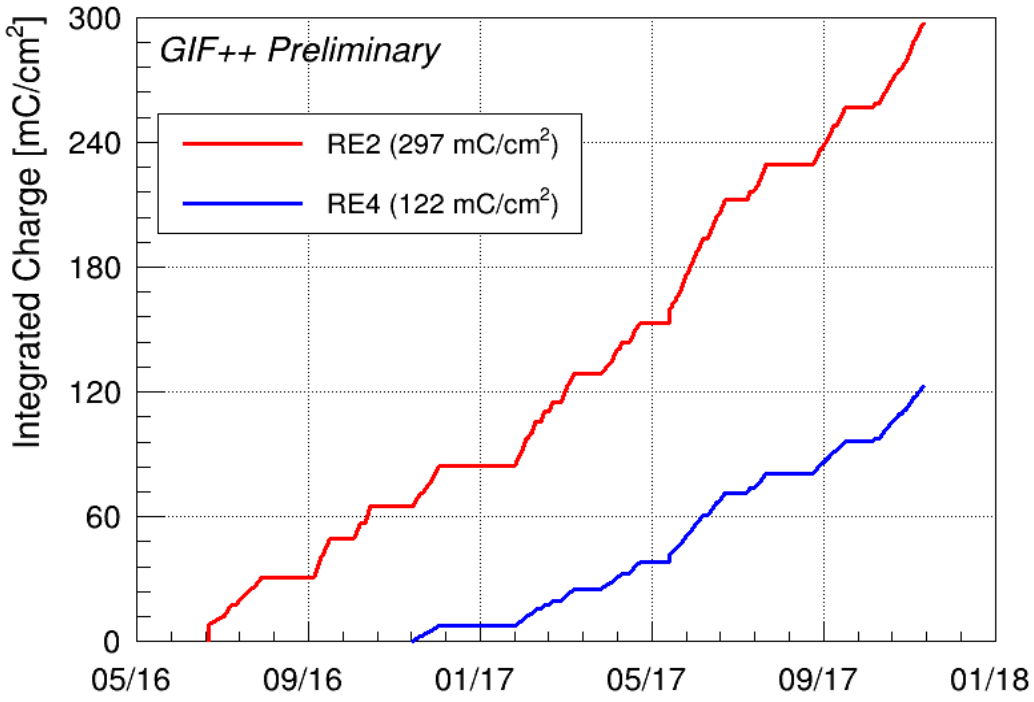
Longevity studies @ GIF++ facility

La GIF++ Facility (North Area) dispone di sorgente di ^{137}Cs da circa 14 TBq. È stata allestita una stazione in cui è possibile irraggiare diversi set di rivelatori RPC con intenso flusso γ (e anche muoni prodotti dal fascio primario di SPS) e di studiarne il funzionamento nel tempo.

Performance dei rivelatori in funzione della carica assorbita. Importante item, perché…

Expected integrated charge @ HL-LHC "safety" value

840 mC/cm²

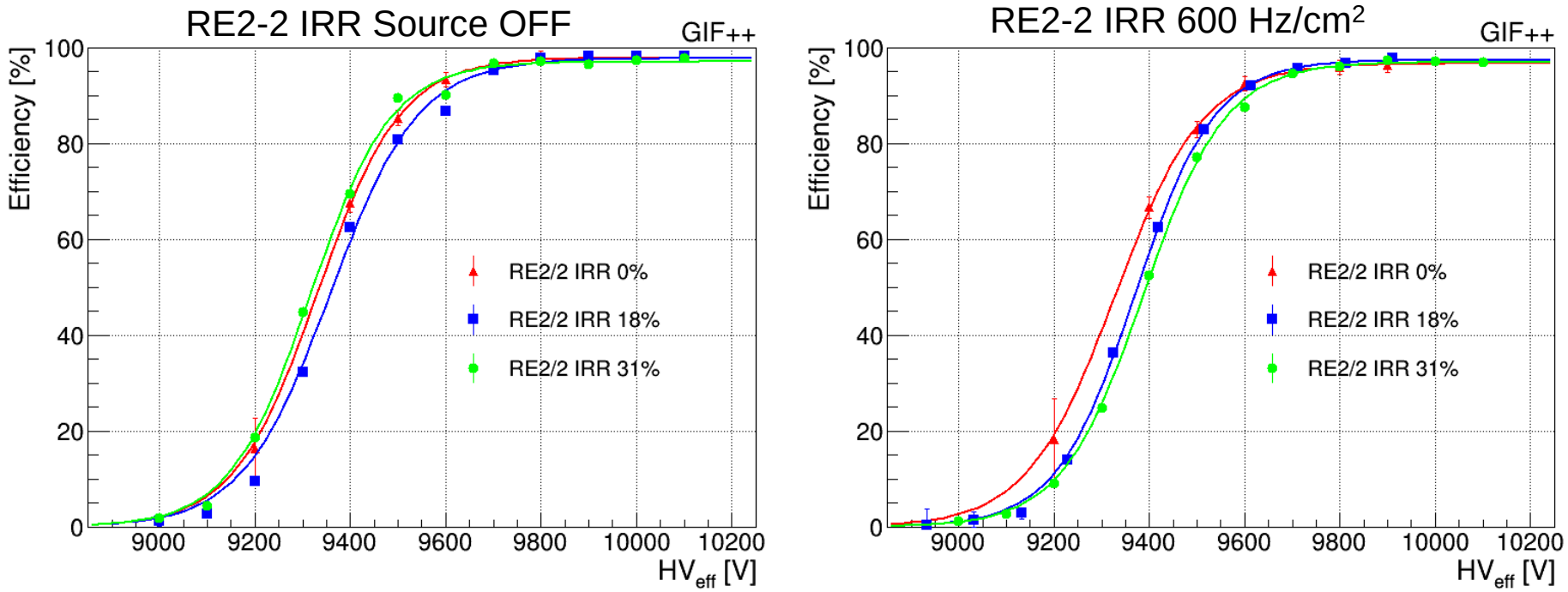


Ad oggi la carica massima assorbita da alcuni rivelatori è dell'ordine di 300 mC/cm²

CMS MUON SYSTEM: RPC detectors (RD_Fase2)

Longevity studies @ GIF++ facility: Alcuni risultati

Efficiency *vs* HV_{eff} *at different integrated charge stages.*



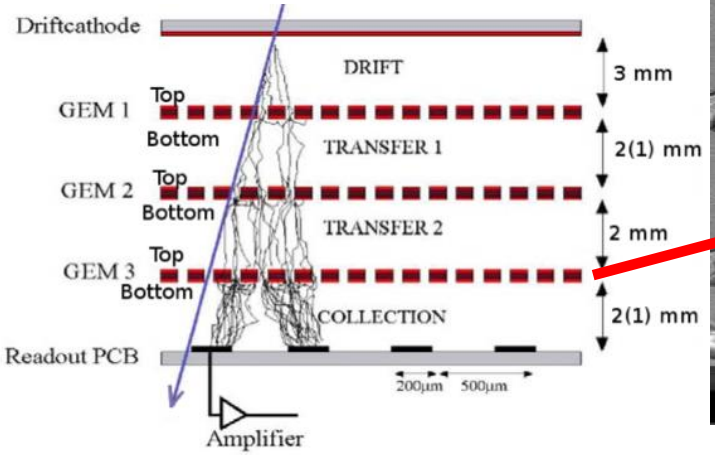
$$\varepsilon(HV_{eff}) = \frac{\varepsilon_{max}}{1 + e^{-\Lambda(HV_{eff} - HV_{50})}}$$

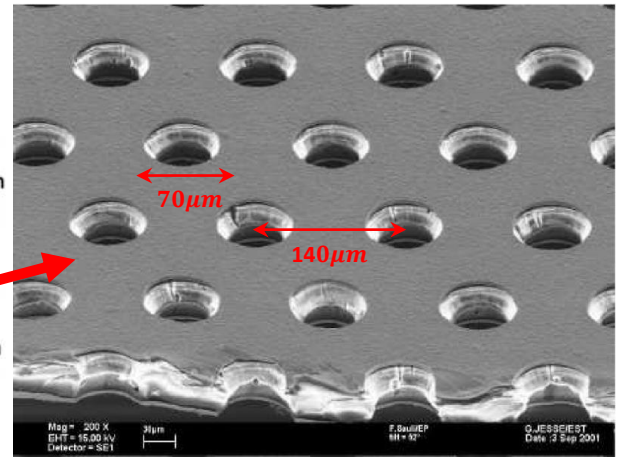
- ***Performance stable*** *up to 31 % of the expected HL-LHC integrated charge*
- ***No shift in he working point*** *(WP). (defined as the voltage value at which 95% of the maximum efficiency is reached +120 V)*

CMS MUON SYSTEM: GEM detectors

Sono previsti tre diversi tipi di rivelatori:

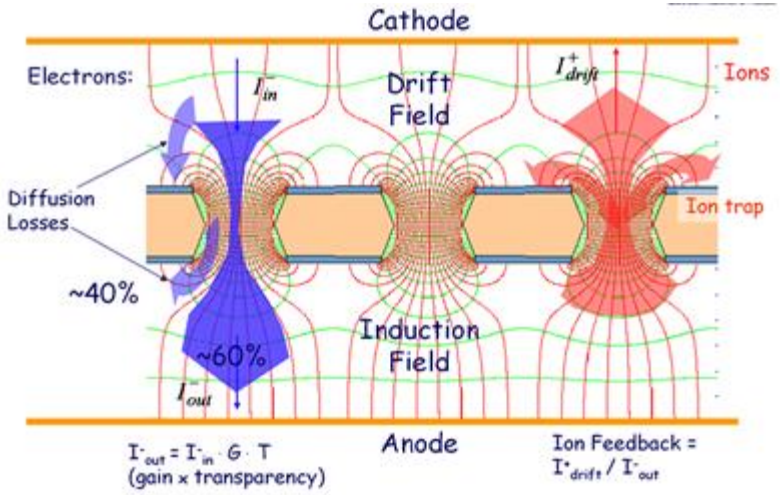
- GE1/1 (2019-2020)
- GE2/1 (RD_FASE2, 2022)
- ME0 (RD_FASE2, 2024)





L'impegno di Pavia è stato due fronti:

- GE1/1. Partecipazione allo «Slice test». Un gruppo di 5 camere sono state installate in fascio e testate nel corso del 2017.
  - DCS
  - Commissioning and online operation
  - Integration@P5
  - Misure di aging GIF++



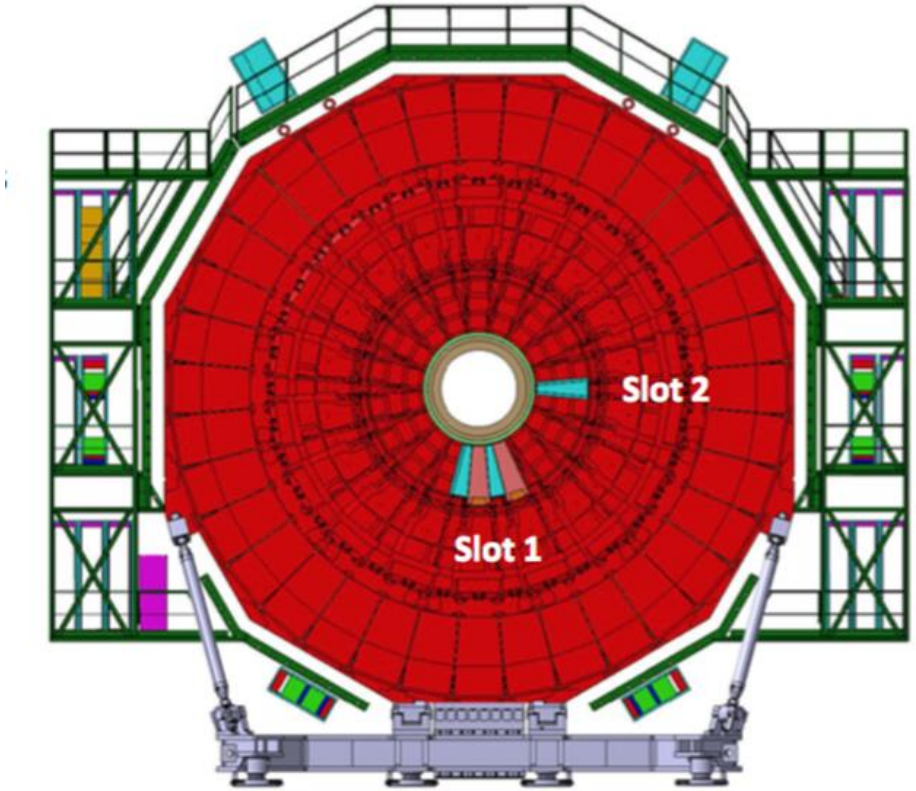
- ME0. Studio del rivelatore
  - Caratterizzazione e funzionamento del rivelatore @GIF++
  - Beam test @ CHARM Facility
  - Studio del background
  - Trigger capabilities

CMS MUON SYSTEM: GEM detectors

GE1/1 Slice Test (P5). 5 super-camere, ognuna formata da 2 rivelatori Triple-GEM sono state montate nel rivelatore CMS ed hanno funzionato nel corso del 2017. Fondamentale per

- Testare le procedura di installazione (camere, eletronica, gas system, cavi)
- Testare il funzionamento del rivelatore in fascio.

L'installazione di tutte le camere avverrà tra il 2019 e 2020.

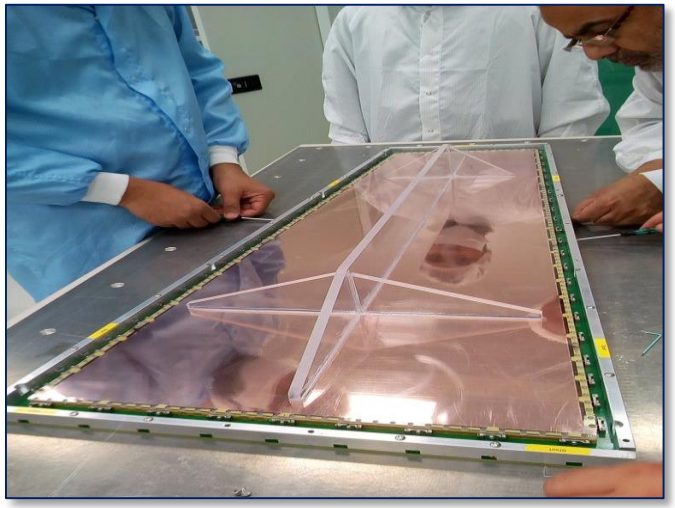


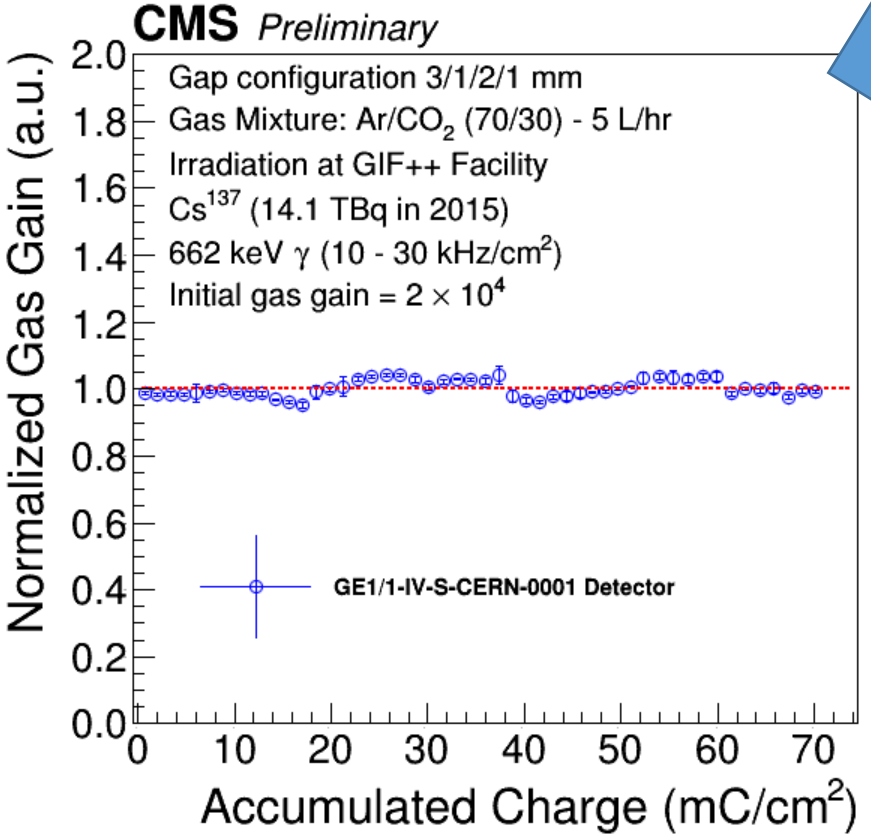
Contributions from Pavia:

- Partecipation to the installation and stability tests
- DCS development:
  - System development (gas monitoring, HV control, ..)
  - FSM and detector protection development
  - DCS operation and integration into CMS
  - On-call support
- DSS tests
- DOC shifters training and supervision

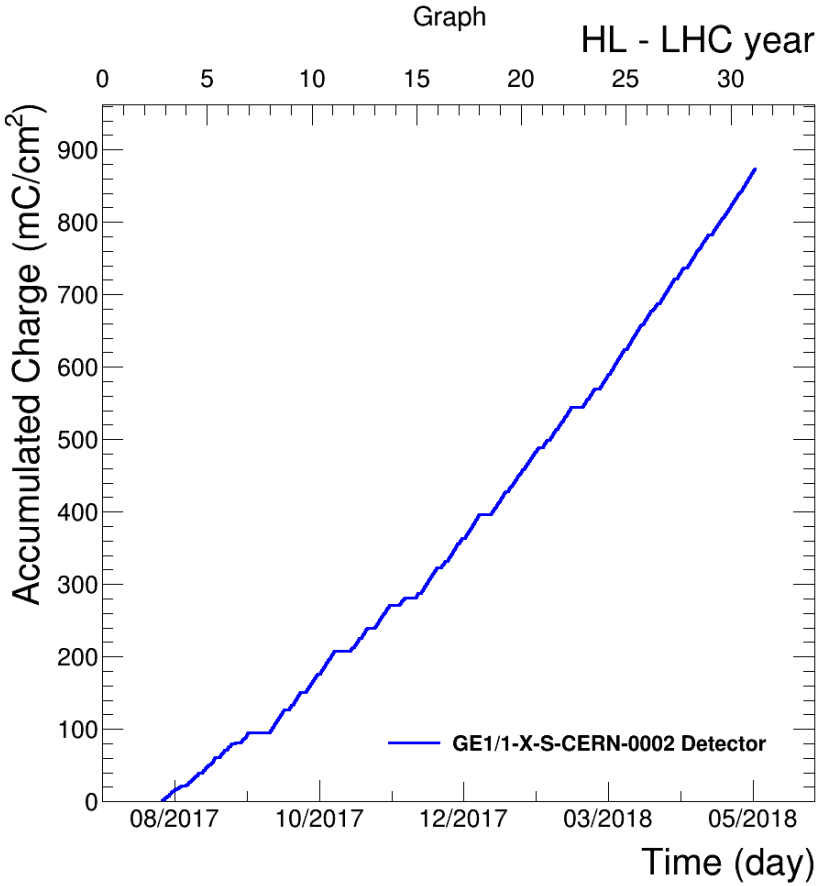
CMS MUON SYSTEM: GEM detectors. Tests @GIF++

- **Misure di aging per GE1/1**
- **Misure per validare tecnologia triple-GEM per ME0** (RD_FASE2). Sono necessari circa 900 mC/cm^2 di carica integrata (30 anni di HL)





Raggiunti oggi 4/05/2018!!!

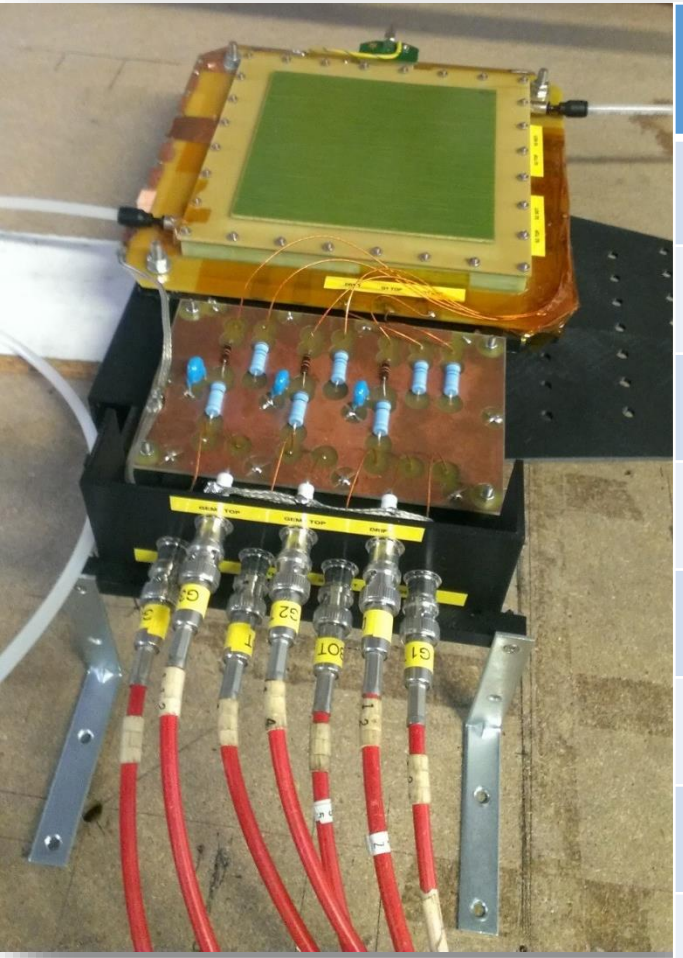


NO aging observed up to $\sim 135\ mC/cm^2$

$\sim 48\%$ of ME0 operation at the HL-LHC

CMS MUON SYSTEM: GEM detectors (RD_Fase2)

Tests @ CHARM Facility (East Area). Single Mask triple GEM irradiated by mixed field (p, n,…) generated by the PS proton beam to study dischange probability.

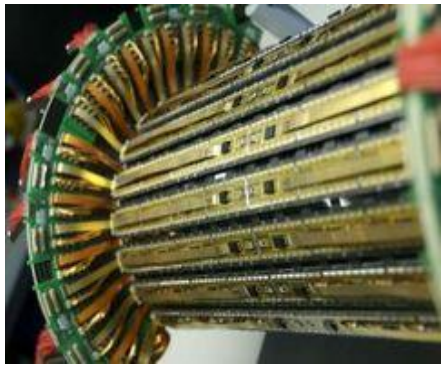


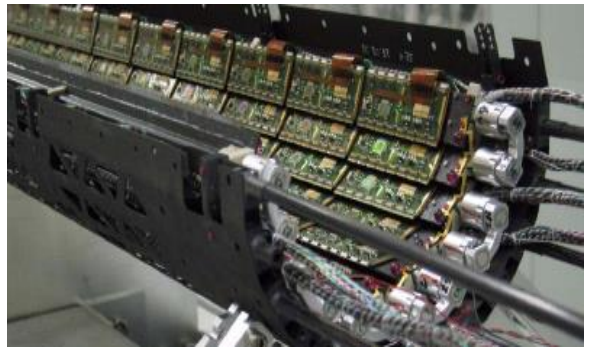
Particle Type	*Particles on GEM/spill*
neutron	9.57×10^9
gamma	5.48×10^9
HEH	1.51×10^8
e- / e+	4.47×10^7
k	1.73×10^5
muons	2.64×10^6
pions	4.58×10^6
protons	5.54×10^6

- Correction for dead time(1.2 us) → average counts /spill = 2.85×10^6
- No correction for activation (ie counts from activated materials included)
- Gain → 4×10^4
- «good» spills → 30758
- No HV TRIP observed → upper limit is 3
- Discharge probability/Hit (Upper limit)= $\frac{3}{2.85 \times 10^6 \times 30758} = 3.42 \times 10^{-11}$

CMS TRACKER SYSTEM: principalmente RD_FASE2

Inner tracker: Front-end readout chip for hybrid pixels and IP blocks (RD53).
RD53 is an ATLAS-CMS-LCD collaboration



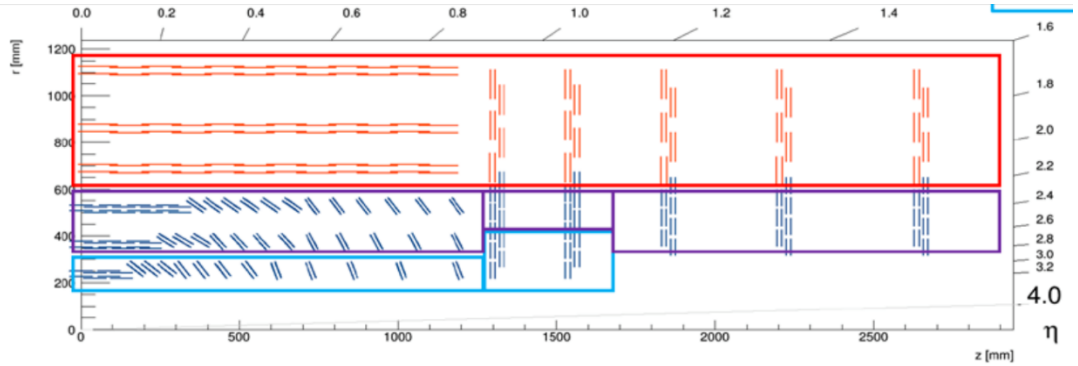


Challenges

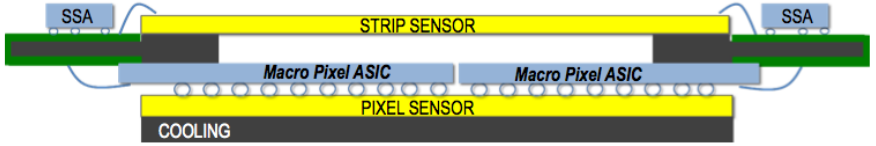
- Very high particle rates: 500MHz/cm^2
- Smaller pixels: (25 – 50 um x 100um)
- Participation in first/second level trigger ?
- Increased readout rates: 100kHz -> 1MHz
- Low mass -> Low power
- Unprecedented hostile radiation: 1Grad, 10^{16} Neu/cm^2

(pixel will get in 1 year what we now get in 10 years

Outer tracker: MPA chip for the Pixel-Strip module



- 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



- Strips are readout from 16 Short Strip ASICs, while Pixels are readout from 16 Macro Pixel ASICs
- The sensor signals, and immediately sends strip data to the corresponding MPA chip.
- The MPA processes signals from each pixel and builds stubs. A stub is a particle with a momentum > 2 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.

CMS TRACKER SYSTEM: attività nel corso del 2017

Inner Tracker

- RD53A chip
  - Finalization of the asynchronous front-end design
  - Finalization of the driver and receiver designs
  - Finalization of the two bandgap reference circuits
  - Integration of the asynchronous front-end within the RD53A chip together with other two analogue front-end
  - Integration of the two bandgap reference circuits in the chip periphery

Outer Tracker

- Finalization of the differential drivers and receiver for the Pixel-Strip (PS) Module in collaboration with the Micro Electronics group of CERN

AM08 chip

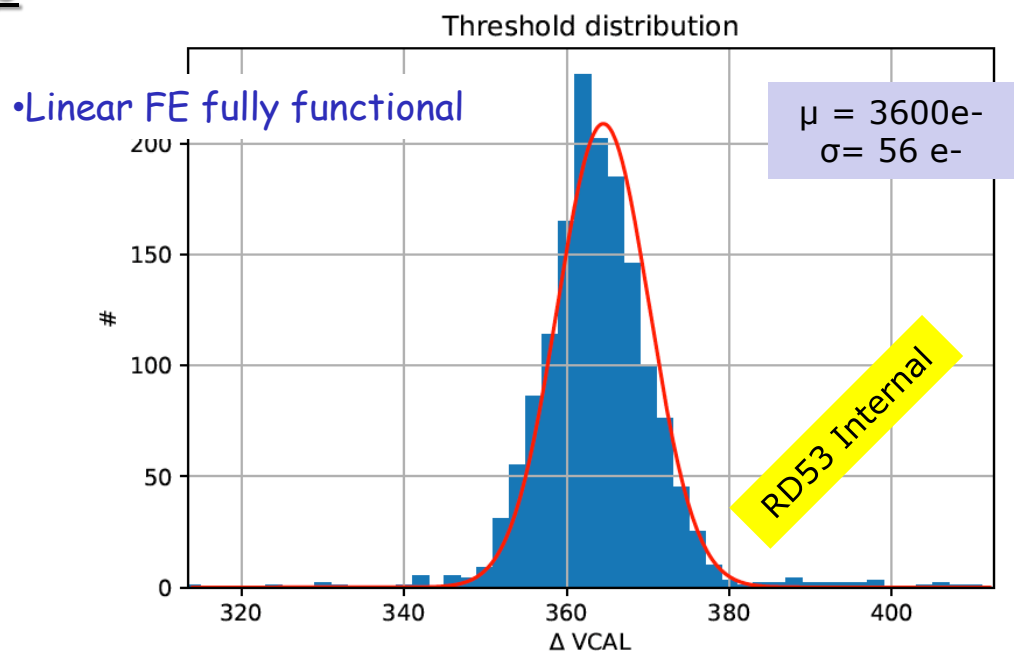
- Design of 1Gbps LVDS driver and receiver for the AM07 chip

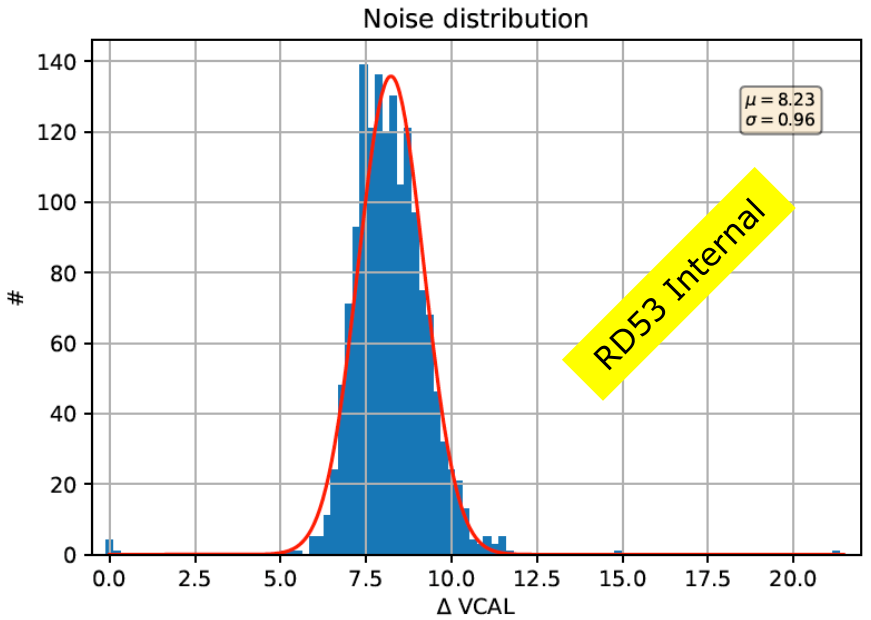
CMS TRACKER SYSTEM: RD53A chip

- Demonstrator RD53A chip:
  - Full size chip (~2cm x 2(1)cm), small pixels (50x50um^2),
    Large chips, 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.

- **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**

- Submitted on 31st August 2017
- First diced chips received in Bonn 06.12.2017
- -> 50 chips loaded on PCBs and under test



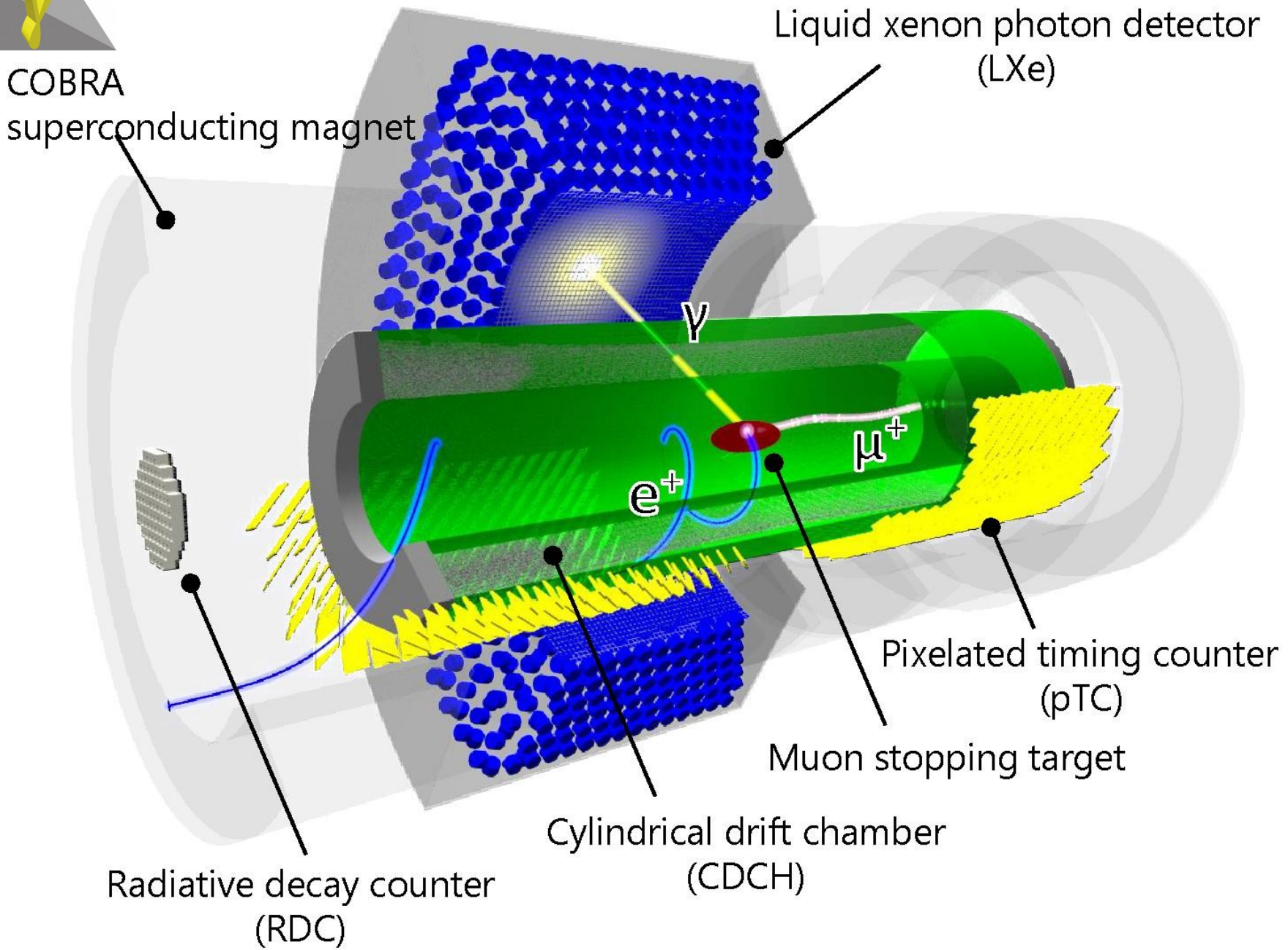


During 2017…

- Published 121 physics papers, about half of these articles were based on the integrated luminosity collected in 2015 and 2016 during the 13 TeV run, while the others were reporting results from data collected at lower centre-of-mass energy in previous years.
- In 2017 LHC reached an instantaneous luminosity of about 1.5 10^{34} $cm^{-2}s^{-1}$ that allowed additional 51 fb^{-1} to be collected by CMS at center-of-mass energy of 13 TeV.
- Highlights of 2017 physics results includes the observation of the Higgs boson coupling to third-generation fermions, at the 5 sigma level for tau leptons and at the 3 sigma level for b-quarks. The scrutiny of the standard model predictions continued with many new results, examples are the first observation of same-sign W boson pairs and a precise measurement of the electroweak mixing angle using Drell-Yan events. Top quark production in proton-lead collisions was observed and evidence for single-top plus Z boson associated production in pp collisions was reported. Many searches for physics beyond the standard model explored new territory, as an example mass limits on neutralino (gluino) production as high as 650 GeV (1.3 TeV) were set, together with limits on various kind of new resonances at the TeV scale.

  By the end of 2017, the total number of papers published by CMS in peer-reviewd journals amounted to about 720.

MEG


Liquid xenon photon detector
(LXe)
COBRA
superconducting magnet
γ
μ+
e+
Pixelated timing counter
(pTC)
Muon stopping target
Cylindrical drift chamber
(CDCH)
Radiative decay counter
(RDC)

MEG Pavia: Attivita' 2017

- MEGII pre-engineering run: Ottobre-Dicembre
- Commissioning sistema calibrazione laser del pTC con Tokyo
- Sviluppo sotfware MEG2 pTC
- Articolo su design di MEGII (accettato Maggio 2018)
- Conferenza INSTR17 Novosibirsk

MEG Persone 2017

Paolo W. Cattaneo	1 Ric INFN	50%
Gianluigi Boca	Prof. acc.	30%
Antonio De Bari	Ric. Uni.	20%
Massimo Rossella	Tec. INFN	30%
Roberto Nardò	Tec. EP Università	30%
Lab. Elettronica		4 m.u.
Lab. Meccanica		2 m.u.
Totale FTE		1.5

1. **The MEGII detector**
   MEG II Collaboration (P.W. Cattaneo (INFN, Pavia) for the collaboration). May 29, 2017. 12 pp.
   Published in **JINST 12 (2017) no.06, C06022**
   DOI: 10.1088/1748-0221/12/06/C06022
   Conference: C17-02-27 Proceedings
   e-Print: **arXiv:1705.10224** **[physics.ins-det]** | **PDF**
   References | BibTeX | LaTeX(US) | LaTeX(EU) | Harvmac | EndNote
   ADS Abstract Service
   Detailed record - Cited by 3 records

2. **Radiation Hardness tests with neutron flux on different Silicon photomultiplier devices**
   P.W. Cattaneo, T. Cervi, A. Menegolli, M. Oddone, M. Prata, M.C. Prata, M. Rossella. May 24, 2017. 9 pp.
   Published in **JINST 12 (2017) no.07, C07012**
   DOI: 10.1088/1748-0221/12/07/C07012
   Conference: C17-02-27 Proceedings
   e-Print: **arXiv:1705.08786** **[physics.ins-det]** | **PDF**
   References | BibTeX | LaTeX(US) | LaTeX(EU) | Harvmac | EndNote
   ADS Abstract Service
   Detailed record

3. **30-ps time resolution with segmented scintillation counter for MEG II**
   Y. Uchiyama (Tokyo U., ICEPP) *et al.*. 2017. 4 pp.
   Published in **Nucl.Instrum.Meth. A845 (2017) 507-510**
   DOI: 10.1016/j.nima.2016.06.072
   Conference: C16-02-15 Proceedings
   References | BibTeX | LaTeX(US) | LaTeX(EU) | Harvmac | EndNote
   Detailed record - Cited by 1 record

4. **Mass test of AdvanSiD model ASD-NUV3S-P SiliconPMs for the Pixel Timing Counter of the MEG II experiment**
   Massimo Rossella (INFN, Pavia) *et al.*. 2017.
   Published in **JINST 12 (2017) no.02, C02024**
   DOI: 10.1088/1748-0221/12/02/C02024
   Conference: C16-10-03 Proceedings
   References | BibTeX | LaTeX(US) | LaTeX(EU) | Harvmac | EndNote
   Detailed record

5. **Experimental status of muon lepton flavour violation**
   Paolo Walter Cattaneo (INFN, Pavia). 2017. 5 pp.
   Published in **PoS CKM2016 (2017) 068**
   DOI: 10.22323/1.291.0068
   Conference: C16-11-28 Proceedings
   References | BibTeX | LaTeX(US) | LaTeX(EU) | Harvmac | EndNote
   Link to PoS server; Link to Fulltext
   Detailed record

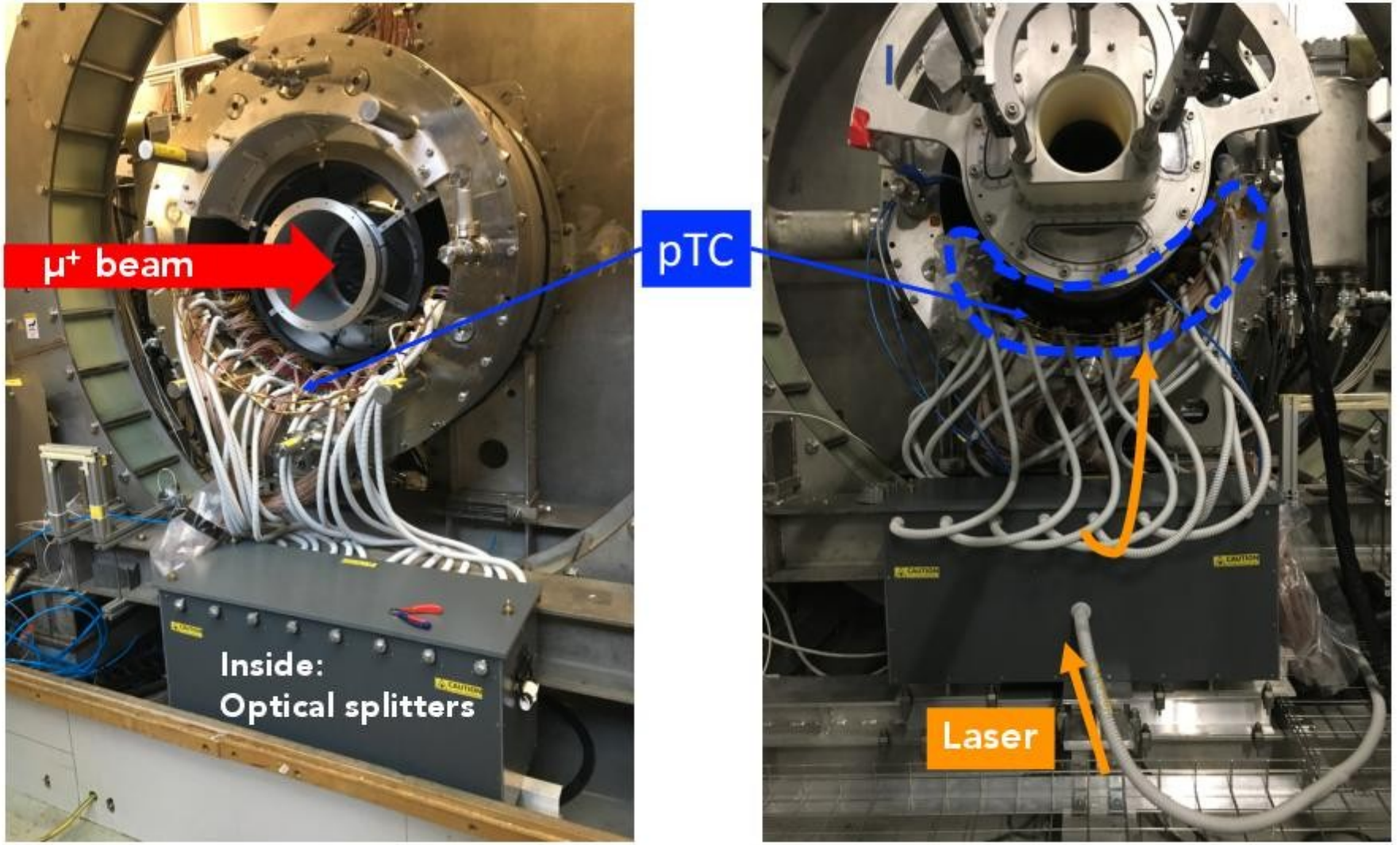
MEG pre engineering run
Oct-Dic/2017

Reminder

US/DS installation

Upstream (5th Sep., 2017)

Downstream (25th Oct., 2017)



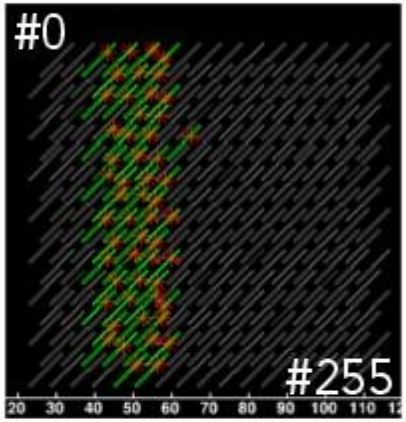
Reminder

First full operation (Oct. 2017)

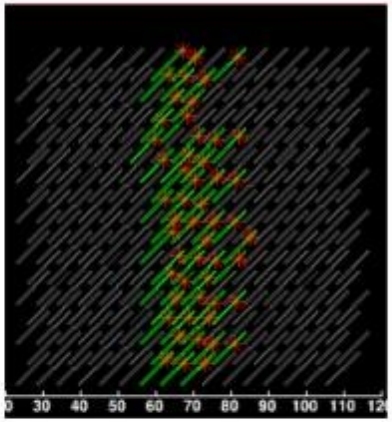
*different configuration of US/DS because of easier assembly work.

DS

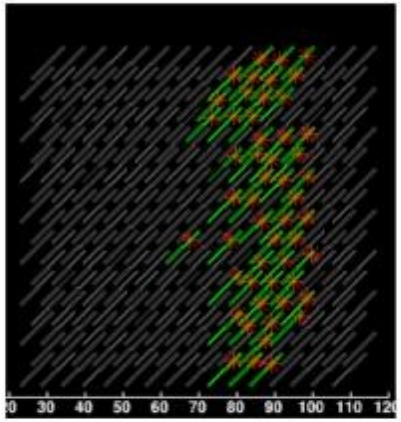
Fiber 1



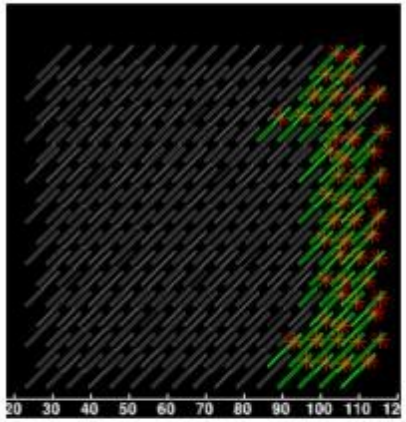
Fiber 2



Fiber 3

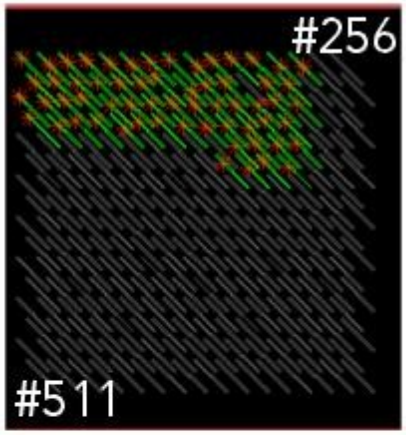


Fiber 5

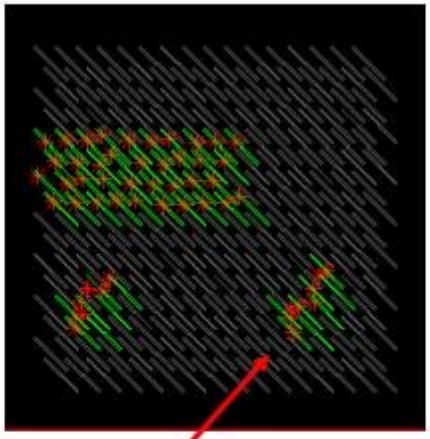


US

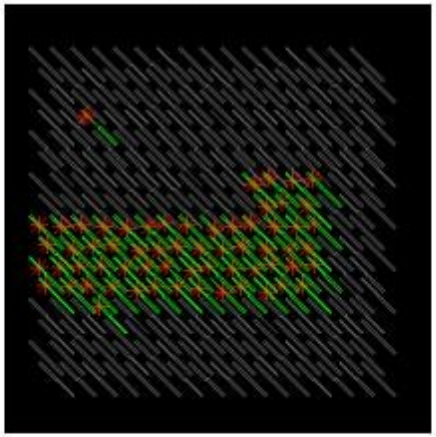
Fiber 9



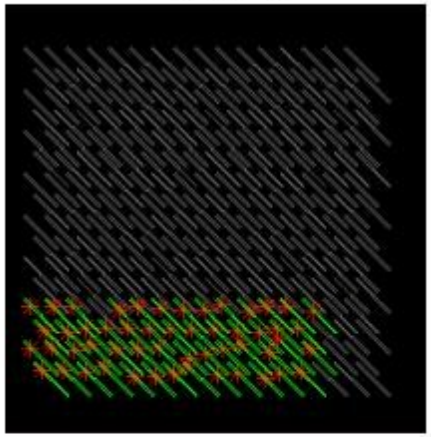
Fiber 6



Fiber 8

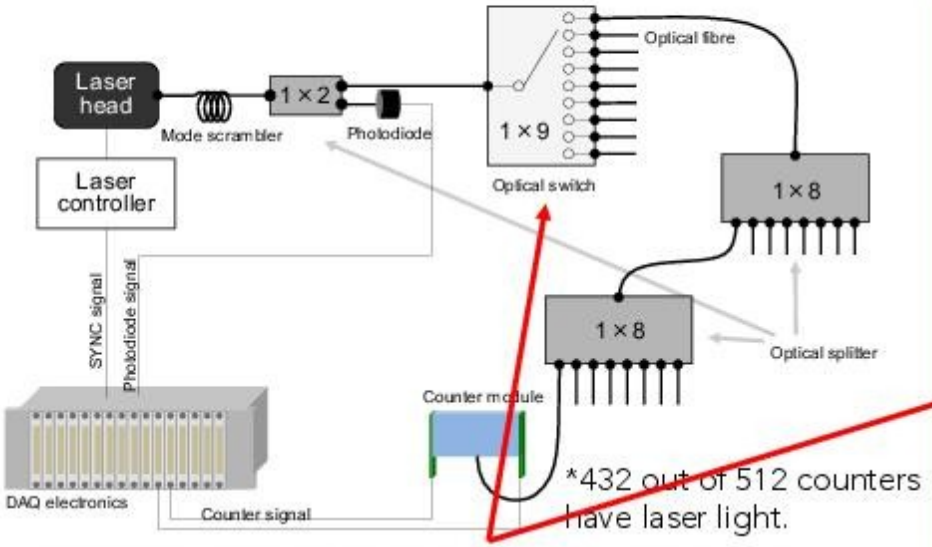


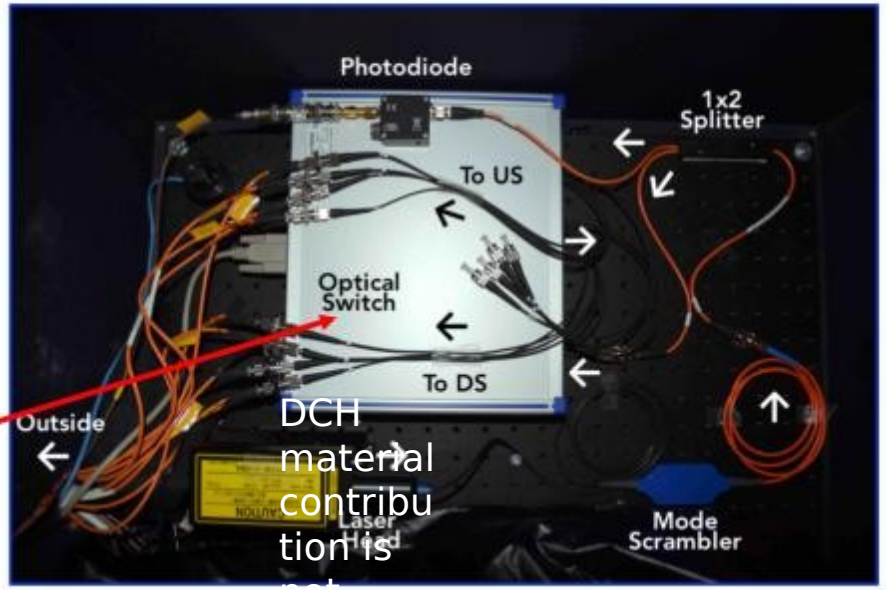
Fiber 7



positron track

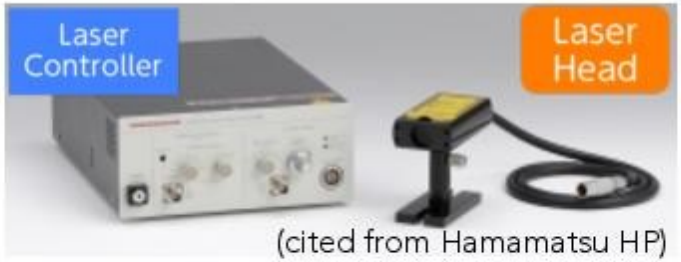
Laser-based method: concept





New!! Optical switch will be available from this year!!

- PLP-10 (Hamamatsu) is used as a light source.



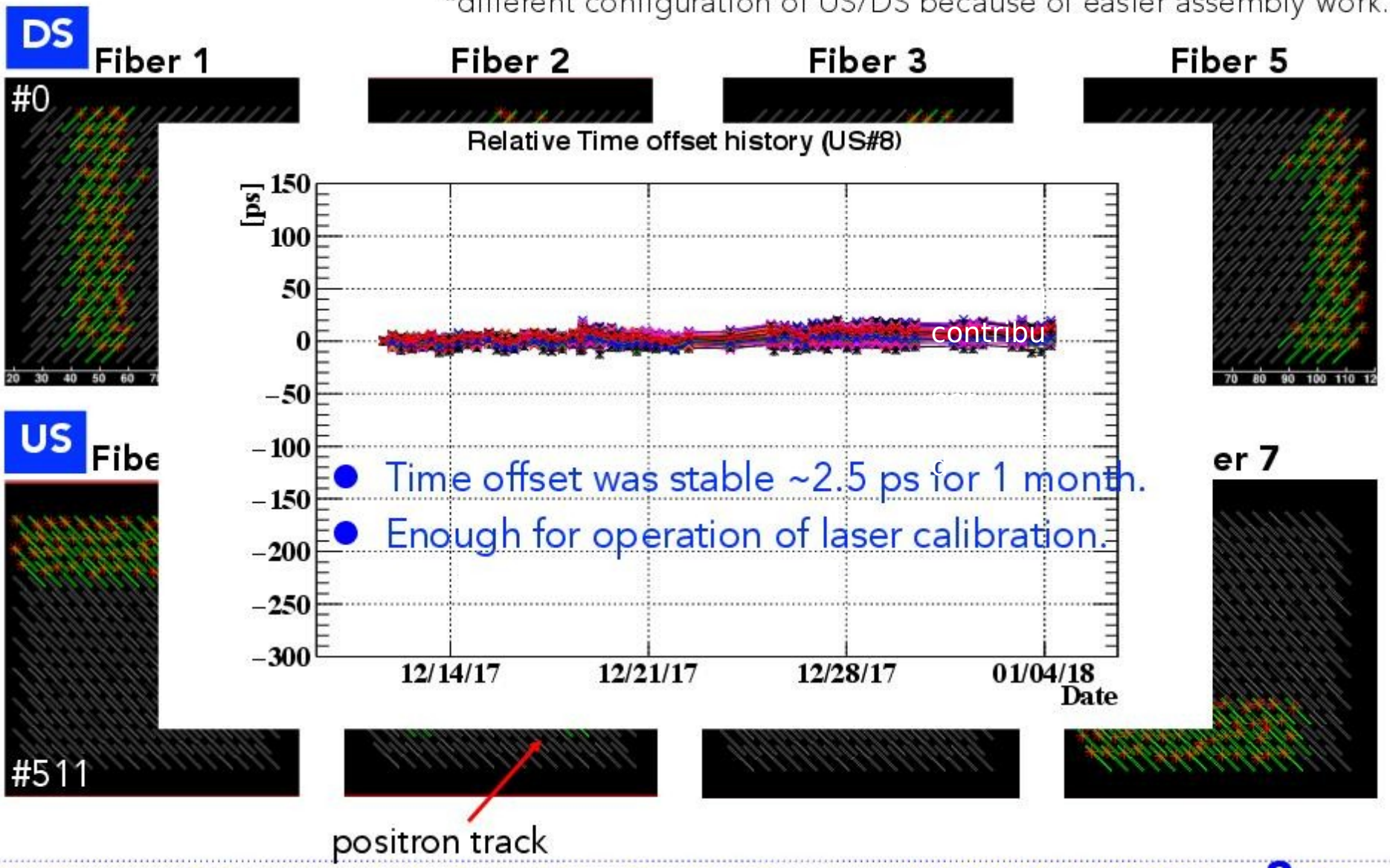
-Wavelength 405 nm
-Wavelength FWHM < 10 nm
-Pulse duration typ. (max) 60 (100) ps

- Pulse laser is divided into each counter simultaneously.
- Time offset of each counter is measured relative to laser-synchronized pulse.
- Calibration uncertainty is estimated as 24 ps by testing all parts of laser calibration system.

Reminder

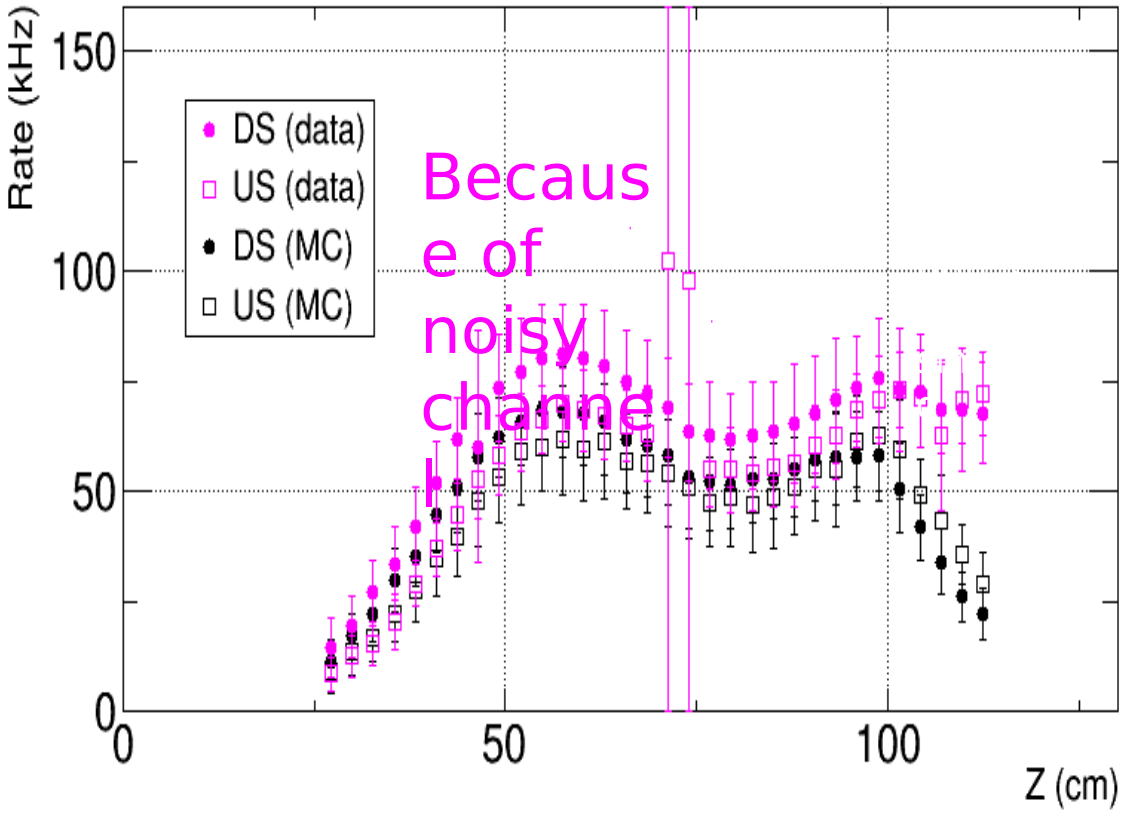
First full operation (Oct. 2017)

*different configuration of US/DS because of easier assembly work.



Hit Rate

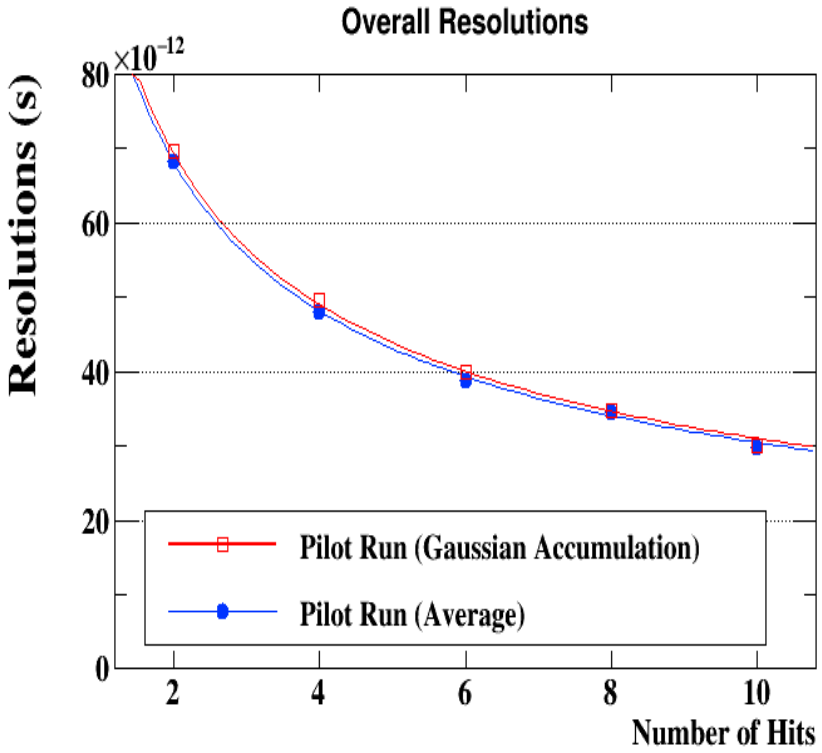
DS background > US background



No large unexpected background.

Resolutions with Number of Hits

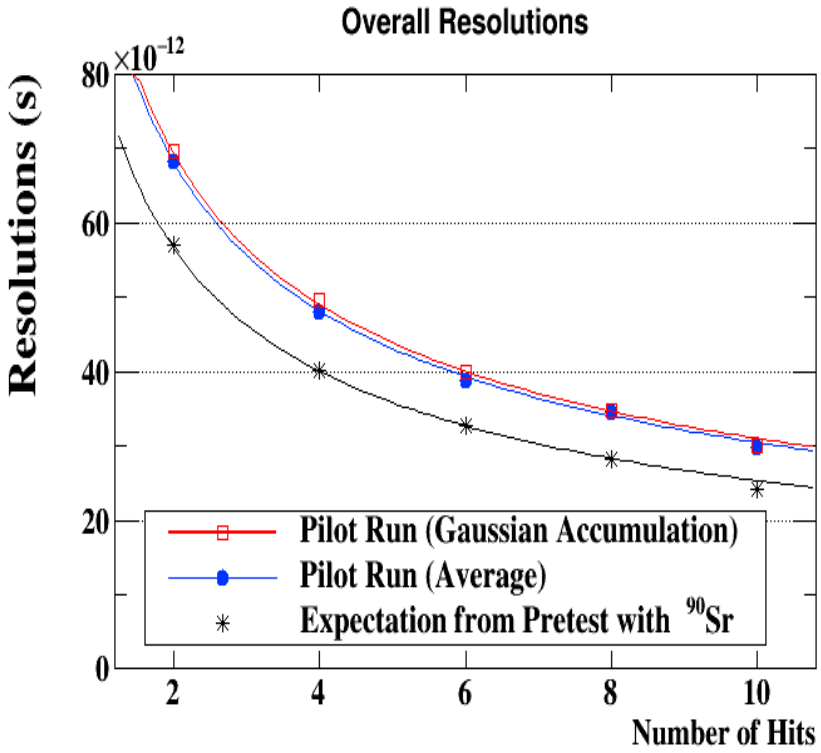
Overall resolution;



The time calibration b/w counters works well.

Comparing with Expectation

Overall resolution;



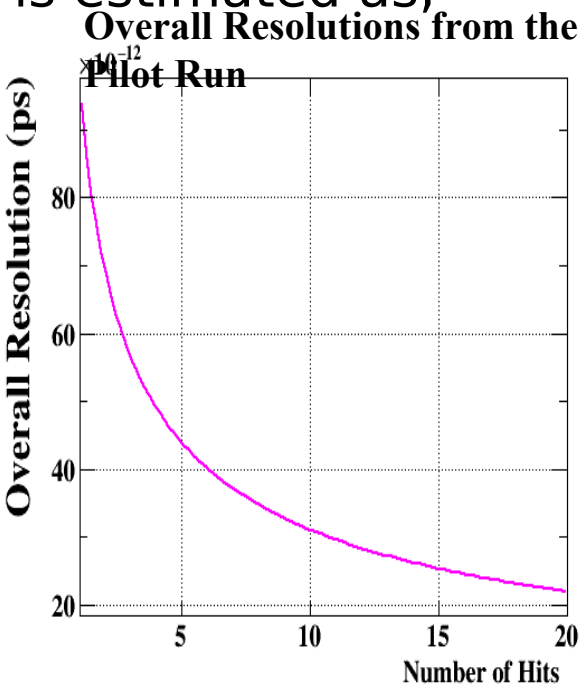
We tested with Sr source for all single counters.

The difference is 53.6 ps.

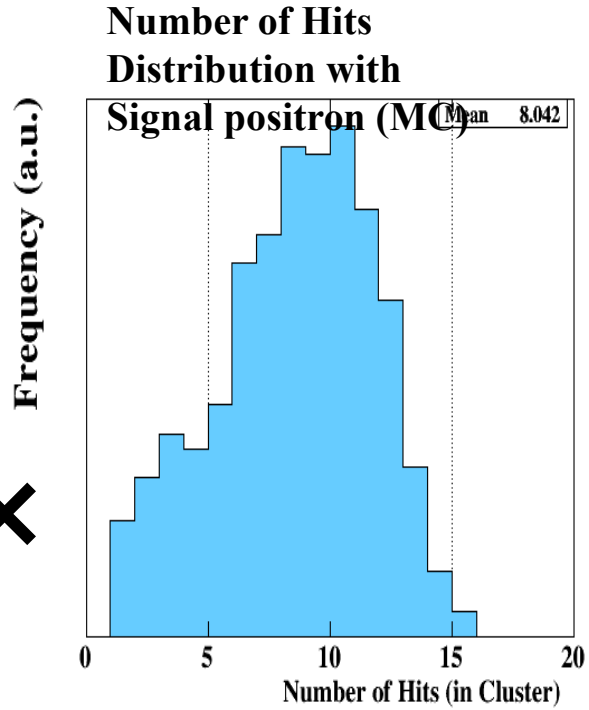
The contribution of electronics jitter and/or noise effect is large.

Final Performance for Signal Positron

By multiplying the obtained function in pilot run by the ratio of the number of hits from signal positron (MC), the overall TC resolution is estimated as,



×



= **38.5 ps**

Large improvement from MEG(76 ps)

3ª missione@GR1

- Notte dei ricercatori
  - E suoi “spinoff”
- Masterclasses ATLAS e CMS
  - Contributo a stage di dipartimento
- Talk vari
  - Scuole, collegi ed eventi di divulgazione