CMS - Bari: Attività di Upgrade

Lucia Silvestris

March 7, 2013

first collisions "every year"

6 December 2009 at √s=900 GeV

30 March 2010 at √s=7 TeV

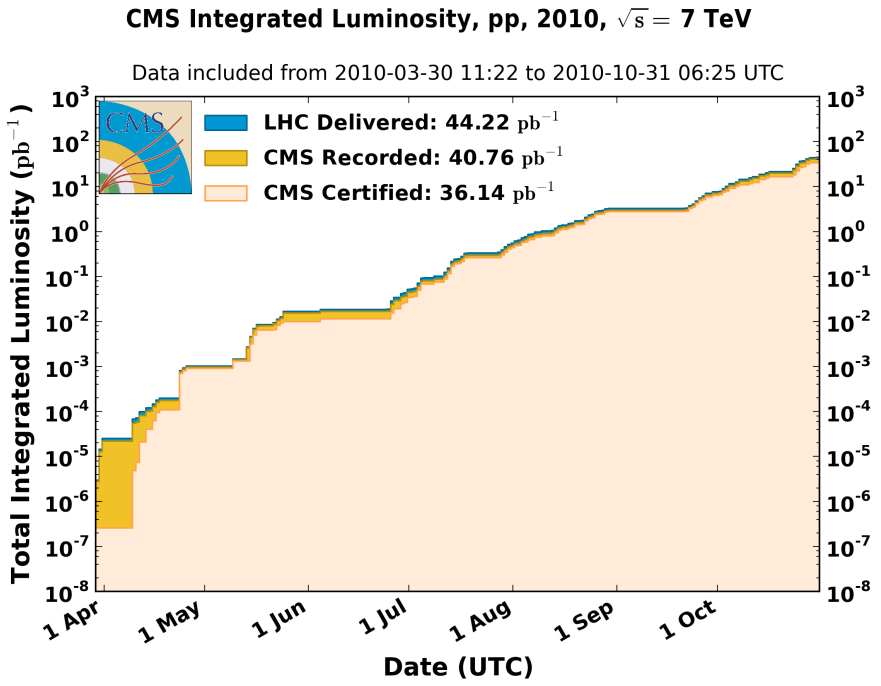
11 March 2011 at √s=7 TeV

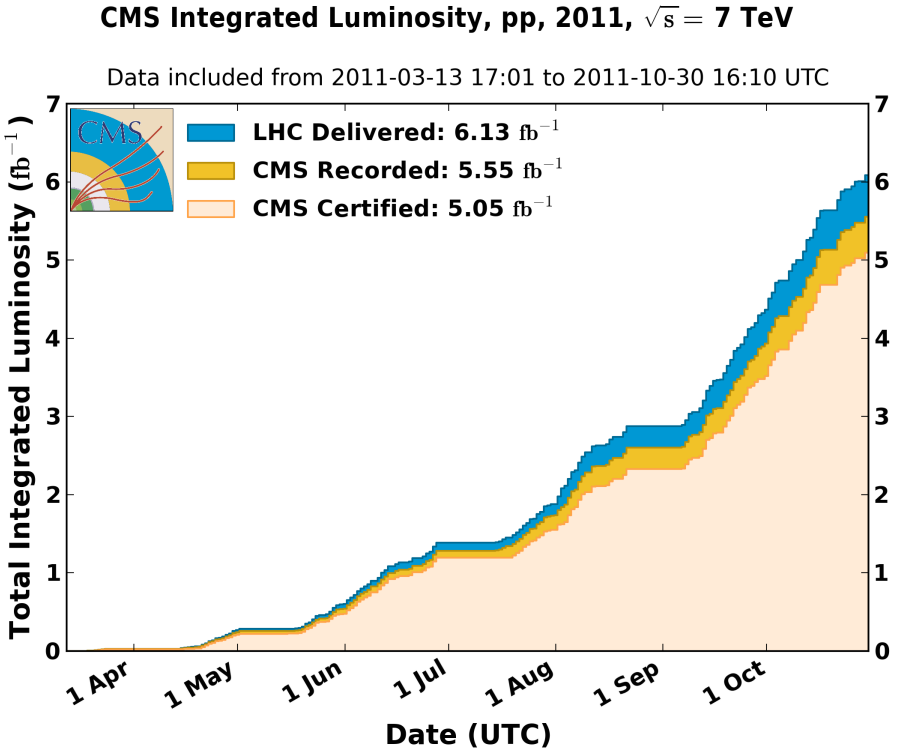
5 April 2012 at √s=8 TeV

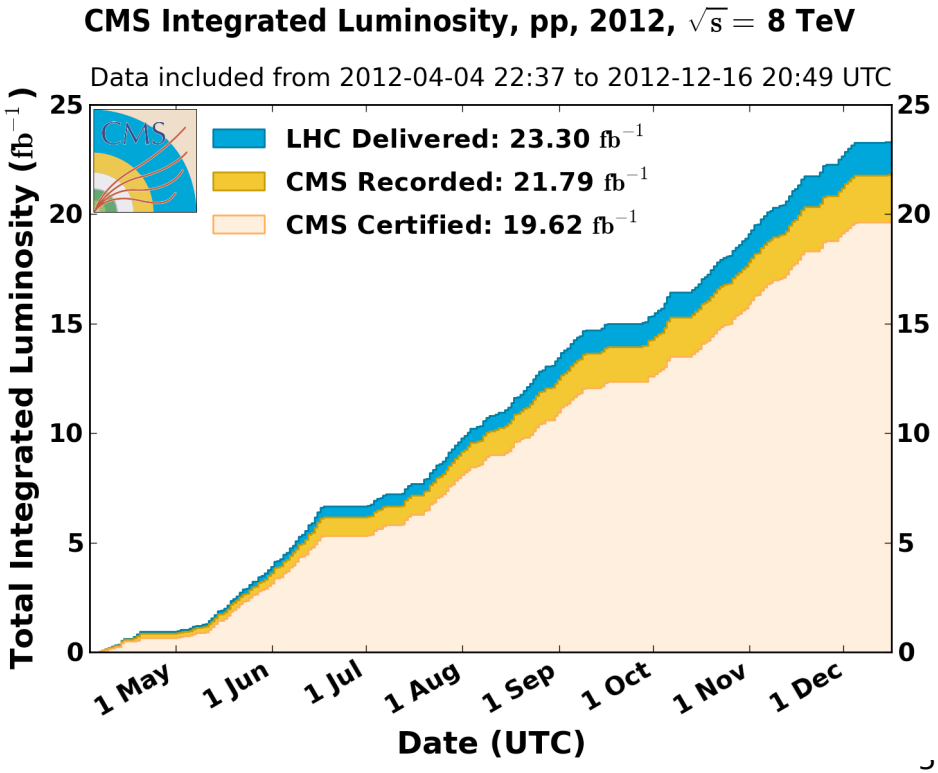
J. Incandela UCSB/CERN

CMS Run I (2009-2013)

Data usable for
physics analysis
From Run I







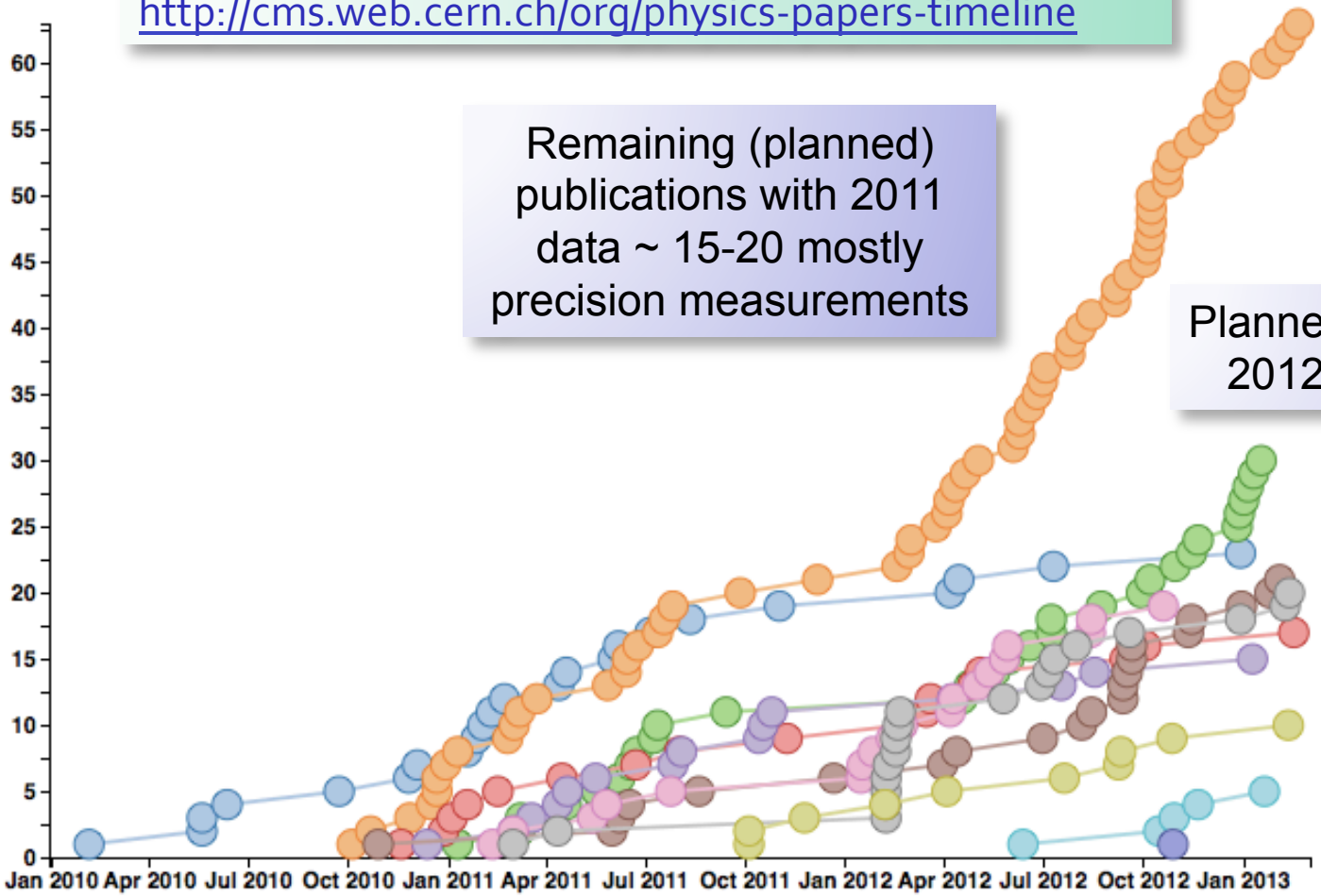
CMS Physics Publications (Run I)

Show all | Total | QCD | Exotica Searches | Supersymmetry | B Physics | Electroweak

Top Physics | Heavy Ion | Higgs | Forward Physics | Standard Model | Beyond the SM: B2G

223 papers published

http://cms.web.cern.ch/org/physics-papers-timeline

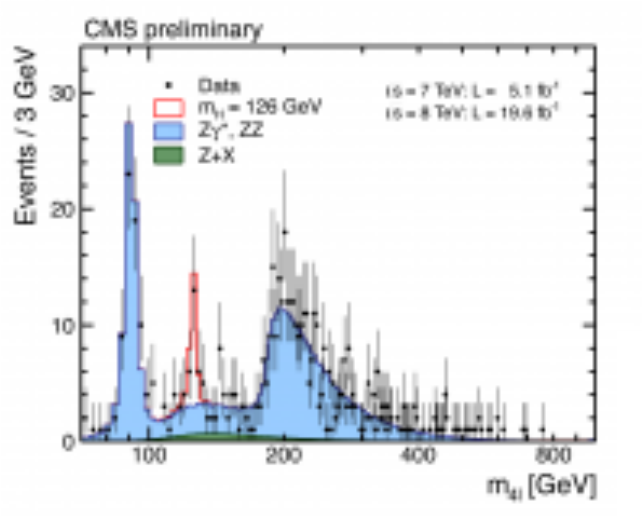


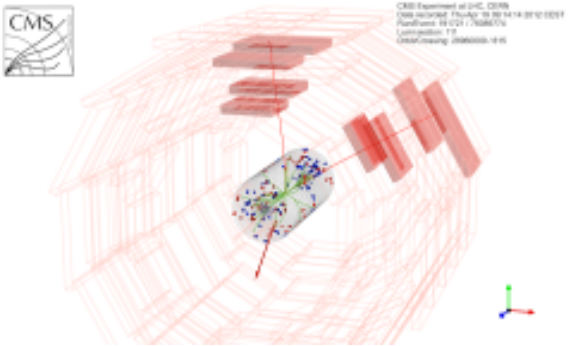
Remaining (planned) publications with 2011 data ~ 15-20 mostly precision measurements

Planned publications with 2012 data ~ 100 -120

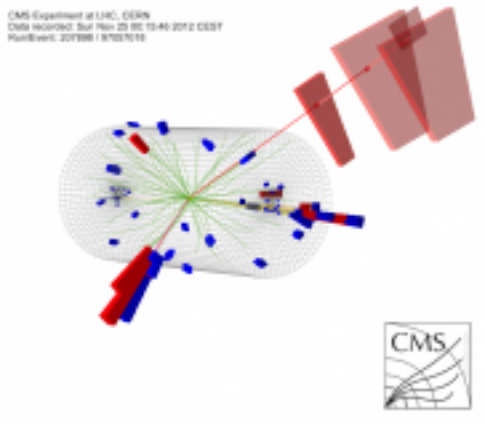
Update di CMS per Moriond

- http://cms.web.cern.ch/news/new-cms-results-moriond-electroweak-2013





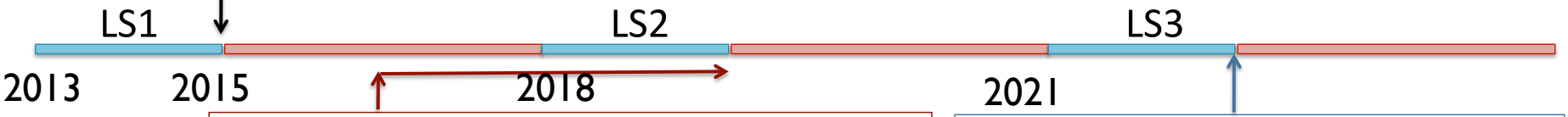
- SM Scalar candidate at $m_H \sim 126$ GeV growing
- So far, all measurements statistically consistent with SM Scalar prediction
- Spin [1], parity, couplings... will profit by increased data sample
- Search for additional scalar particles has just started
- All results are still preliminary, stay tuned
  - $H \to ZZ \to 4\ell$ & $H \to WW \to 2\ell 2\nu$ updated with full dataset
- $H \to ZZ \to 4\ell$ highlights:
  - $m_H = 125.8 \pm 0.5$ (stat.) ± 0.2 (syst.) GeV
  - 6.7 (7.2) s.d. observed (expected) significance
  - $\sigma/\sigma_{SM} = 0.91^{+0.30}_{-0.24}$
    - μ_V (qqH, ZH, WH) $= 1.0^{+2.4}_{-2.3}$
    - μ_F ($gg \to H$, $t\bar{t}H$) $= 0.9^{+0.5}_{-0.4}$
- $H \to WW \to 2\ell 2\nu$ highlights:
  - 4.0 (5.1) s.d. observed (expected) significance
  - $\sigma/\sigma_{SM} = 0.76 \pm 0.21$



CMS Upgrade program

LS1 Projects: in production
- Completion of muon coverage (ME4)
- Improve muon operation (ME1), DT electronics
- Replace HCAL photo-detectors in HF (new PMTs) and HO (HPD→SiPM)

Bari



Phase 1 Upgrades (TDRs)
- Pixel detector replacement
- HCAL electronics upgrade
- L1-Trigger upgrade
- Preparatory work during LS1
  - New beam pipe for pixel upgrade
  - Slices of pixel, HCAL, L1-trigger
  - Install ECAL optical splitters for L1-trigger upgrade // to operations

Bari

Phase 2: scope to be defined
- Tracker Replacement, Track Trigger
- ForwardRegion: Calorimetry and Muons and tracking
- Further Trigger upgrade

Bari

Bari

LS1 (2013-2014): RPC Chambers reparation

MOTIVATION

ENDCAP Threshold Problems
- ❖12 Chamber no Th control
- ❖1 Chs with one FEB not working

BARREL Threshold Problems
- ❖12 Chamber no Th control
- ❖ 10 Chs with DT line working
- ❖ 6 Chs with one FEB not working
- ❖ 1 LV problem

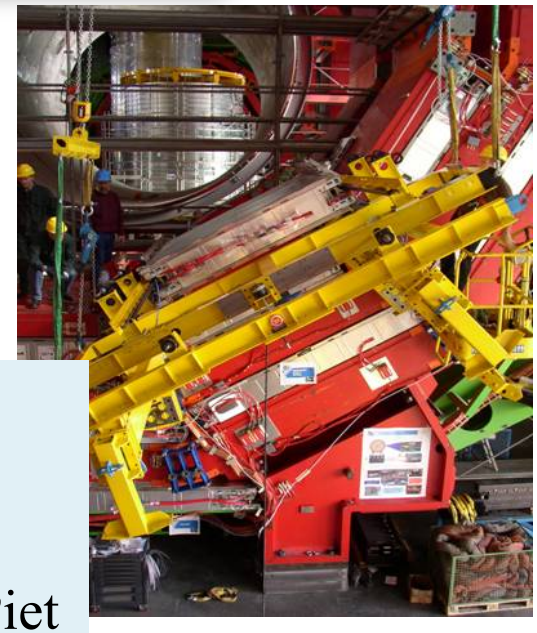
➢ The number of not threshold controlled rolls is increasing in time.

➢ **No Threshold Control → Chamber Noise → Masked strips**

Procedure for the intervention

Gabriella Pugliese

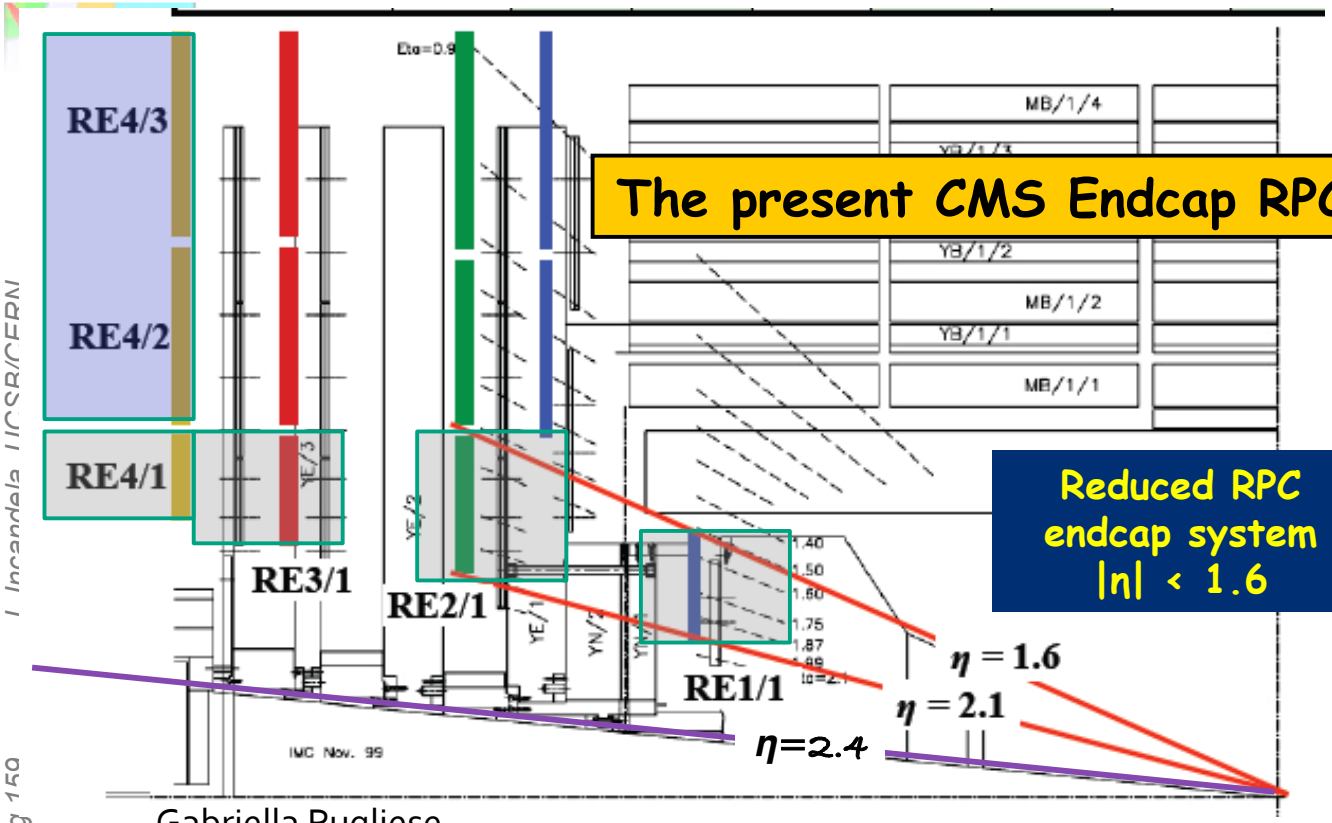
Remove ALL (HV/LV/Signal/DC) **cables**
Extract the chamber of 80 cm (if in the Barrel)
Replaced the DB and Test it
Reinstall the **chamber** & Reconnect Cables
Pre-commissioning: connectivity test & Commissioning



Bari Manpower (from July '13-March '14)

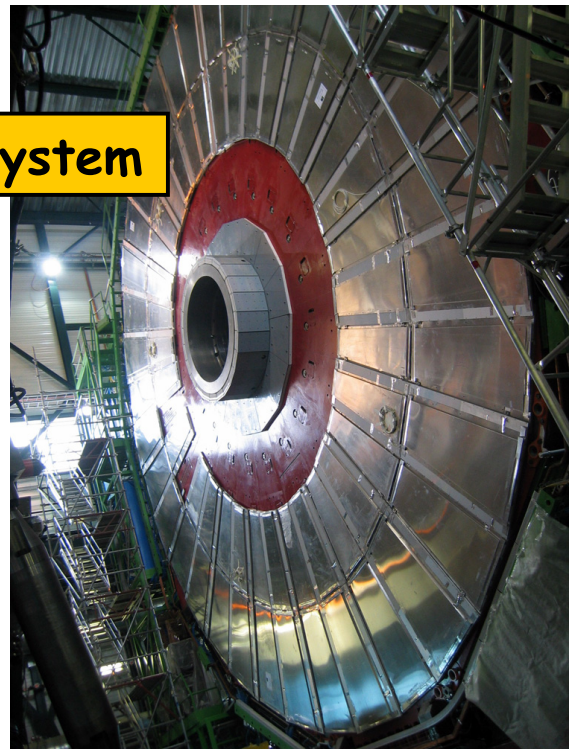
✓ Responsible – Gabriella
✓ **2** Technicians x Installation Team: 6 months
✓ Shift Crew x Commissioning Activities: Marcello M. & Piet

RPC system



The present CMS Endcap RPC system

Reduced RPC endcap system |η| < 1.6



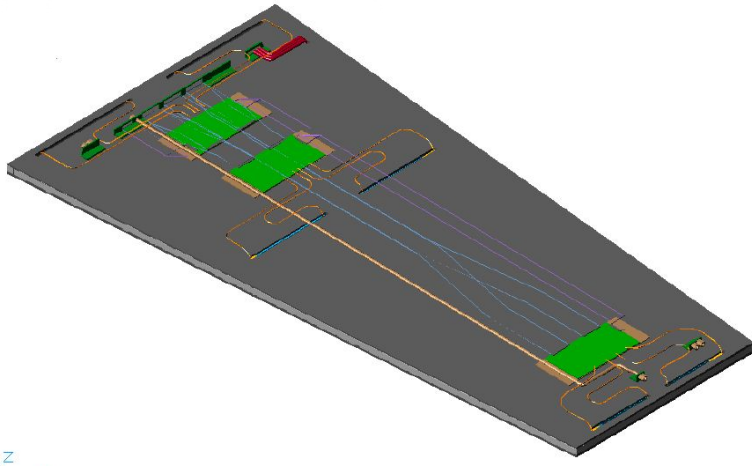
Gabriella Pugliese

The CMS Forward Muon RPC system consists of 3 endcap disks and is equipped with chambers up to |η|=1.6, while the CMS Muon Technical Design Report describes a system with 4 stations and a detector up to |η|=2.1

	RE 1/1	RE 1/2	RE 1/3	RE 2/1	RE 2/2	RE 2/3	RE 3/1	RE 3/2	RE 3/3	RE 4/1	RE 4/2	RE 4/3
STAGED → No. of chambers	36*2	36*2	36*2	18*2	36*2	36*2	18*2	36*2	36*2	18*2	36*2	36*

RPC Endcap Upscope (2013-2014)

Install 4th layer of RPCs during LHC LS1 (2013-2014) with detectors up to $|\eta|=1.6$.



Gabriella Pugliese

- 144 new chambers (RE4/2-3) needed to install 2 RE4 stations
- RE4/2 and RE4/3 will be pre-assembled in RE4 super modules with a handling frame

Bari Activity:

Pino Iaselli: upscope coordinator

Technicians: 1 week/month (for RE4 super-module assembly and QC test)

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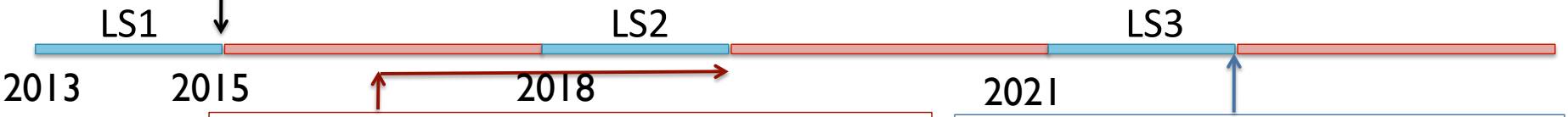

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Bari

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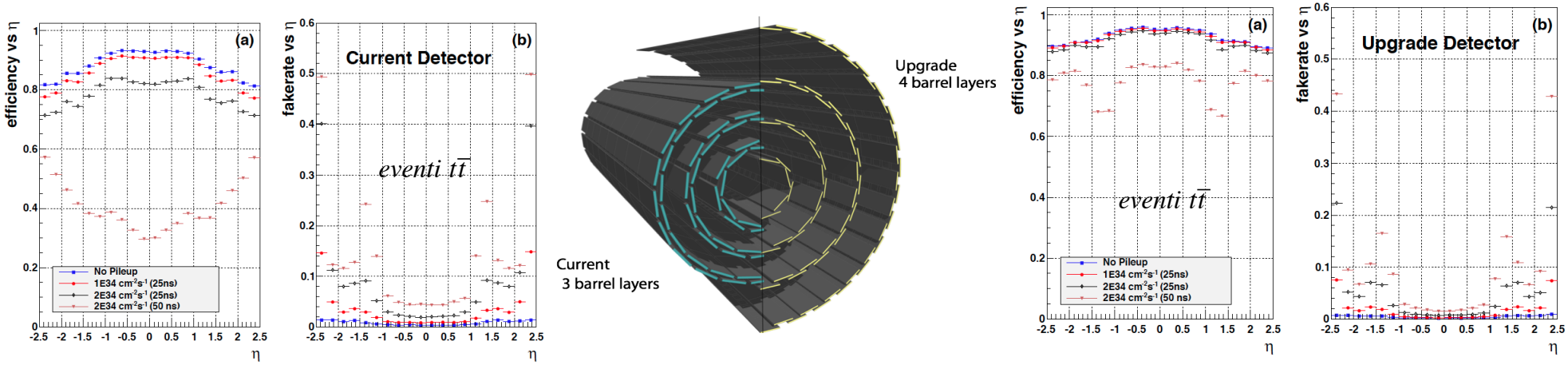
Bari

Bari

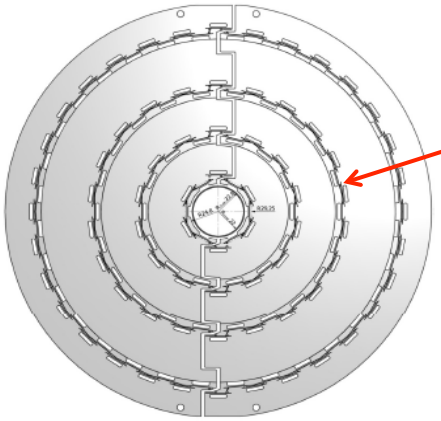
CMS Pixel Upgrade (Fase 1)

- attuale pixel detector progettato per $L \approx 1 \times 10^{34} cm^{-2} s^{-1}$
  - dopo il 2018 $L \approx 2 \times 10^{34} cm^{-2} s^{-1}$



- uno strato in più e un nuovo ROC migliorano l'efficienza e riducono il fake rate

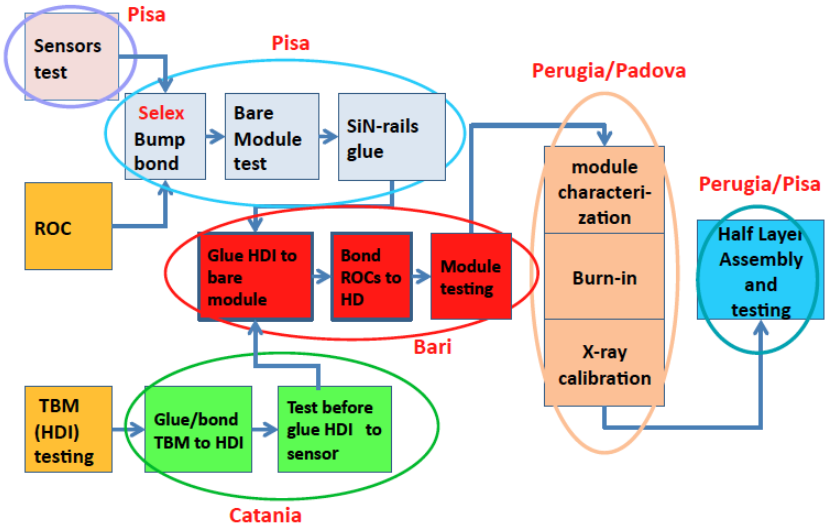
- impegno INFN per il nuovo rivelatore a pixe



metà layer 3: 176 moduli
~ **250 moduli necessari**
tenendo conto di 80% yield
e 15% spares

Salvatore My

Preliminary sharing for Pixel Module Construction



Richieste Servizi CMS Pixel Upgrade

- 2013
  - produzione di 20 moduli prototipo
    - 4 m.u. Camera Pulita
  - disegno e produzione dei jig finali
    - 1 m.u. CAD Meccanico
    - 2 m.u. Officina Meccanica
- 2014
  - inizio produzione moduli finali
    - 6 m.u. Camera Pulita
    - 1 m.u. CAD Meccanico
    - 1 m.u. Officina Meccanica
- 2015
  - fine produzione moduli finali
    - 6 m.u. Camera Pulita
    - 1 m.u. Officina Meccanica
- 2016 + 2017
  - integrazione, commissioning e installazione
    - 3 m.u. Camera Pulita (per eventuali moduli da assemblare)
    - 2 m.u. Officina Meccanica

Salvatore My

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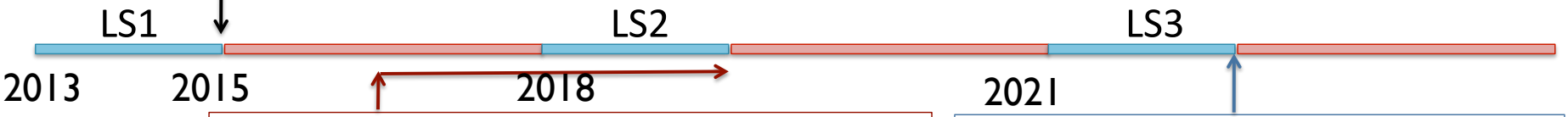

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Bari

Bari

Time-scale for phase II

- First detector design and physics performance on time for ECFA workshop 204 October 2013
- Technical Proposal and Physics TDR by end of 2014

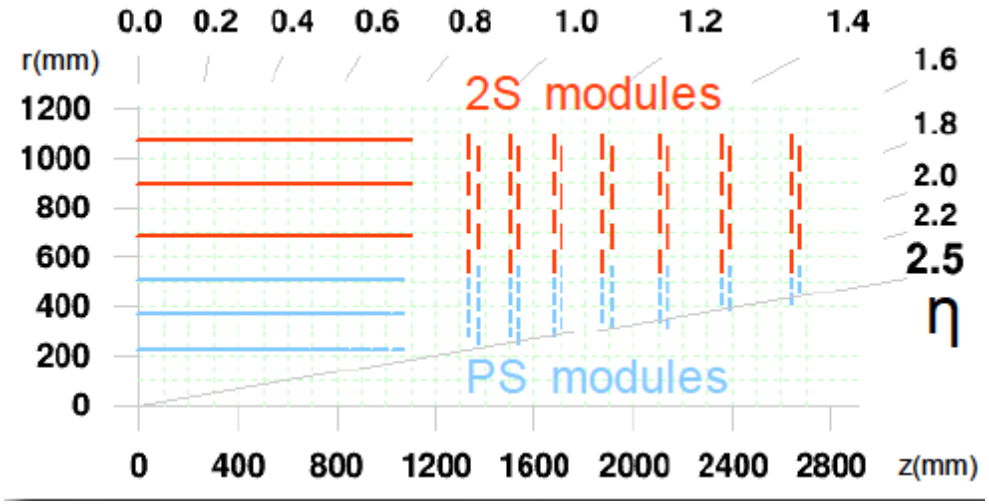
Upgrade Fase II

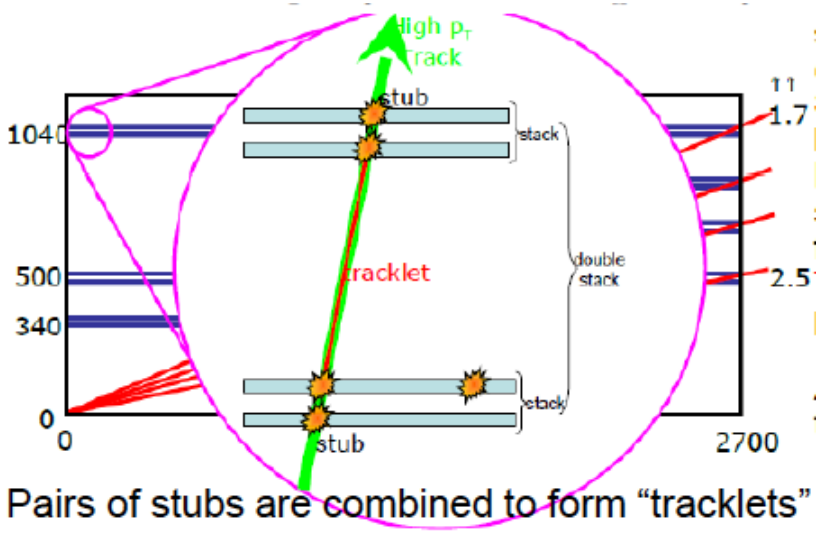
- Upgrade del rivelatore di tracciamento

Full CMS Tracker Upgrade (Fase 2)

- 2022-2023 upgrade di LHC a HL-LHC ($5x10^{34}$ cm^{-2} s^{-1})
  - sarà necessario rimpiazzare l'intero tracciatore con uno interamente ripensato
    - deve avere maggior resistenza al danno da radiazione (3000 fb^{-1} in 10 anni)
    - deve risolvere circa 200 interazioni per bunch crossing (alta granularità)
    - deve intervenire già al Livello 1 del Trigger (rate di μ, e, jet > 100 kHz)
  - Technical Proposal prevista per metà (fine) 2014
  - TDR previsto per metà 2016
  - work in progress sul layout, sui sensori (diamante, silicio 3D, silicio MCZ planare,epitassiale, tipo p, …) e sull'elettronica (65 nm, …)

Salvatore My

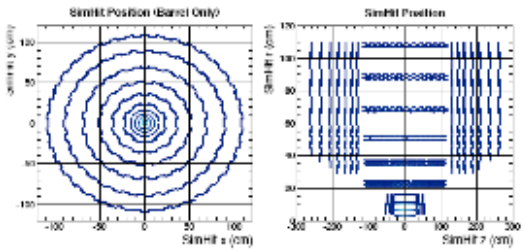




Pairs of stubs are combined to form "tracklets"

Tracker x Phase II (2021..)

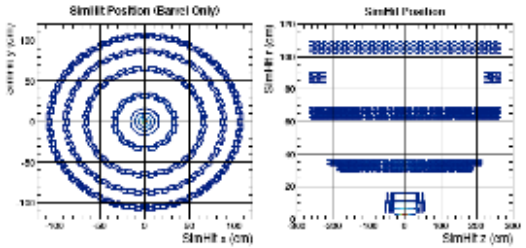
Phase II Tracker Layouts



Barrel EndCap ***('ExtendedPhase2TkBE')***

3 inner layers (rings) composed of Pixel-Strips sensors modules

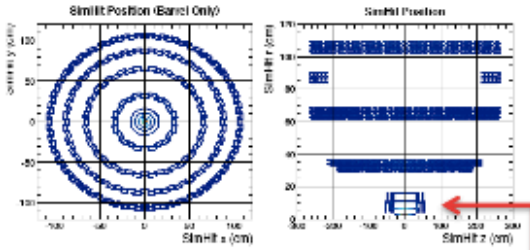
3 outer layers (rings) composed of Strip Sensor modules



LongBarrel version #1 ***('ExtendedPhase2TkLB_4LPS_2L2S')***

4 inner layers composed of Pixel-Strips sensors modules

+ 2 outer layers composed of Strips sensor modules



LongBarrel version #2 ***('ExtendedPhase2TkLB_6PS')***

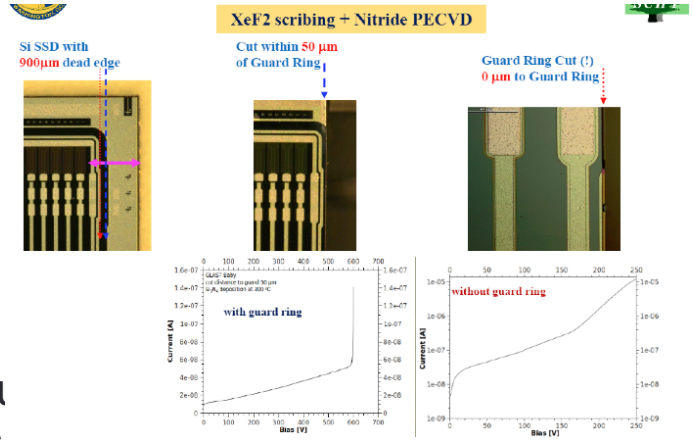
6 layers composed of Strips Sensors modules

Pixel Phase1

4

Impegni di Bari e Richieste Servizi Full Tracker Upgrade

- attività di interesse del gruppo CMS Tracker di Bari — Salvatore My
  - sviluppo di sensori al silicio 3D
    - progetto TRIDEAS dal 2009 al 2012
    - in corso di definizione una attività di R&D nell'ambito della Comunità CMS Tracker Italia
  - sviluppo di sensori edgeless
    - in corso una collaborazione con SCIPP (Santa Cruz) per lo sviluppo di sensori slim edges mediante taglio laser



  - in corso di definizione la partecipazione al progetto congiu CMS+ATLAS per lo sviluppo dell'elettronica di lettura a 65 nm

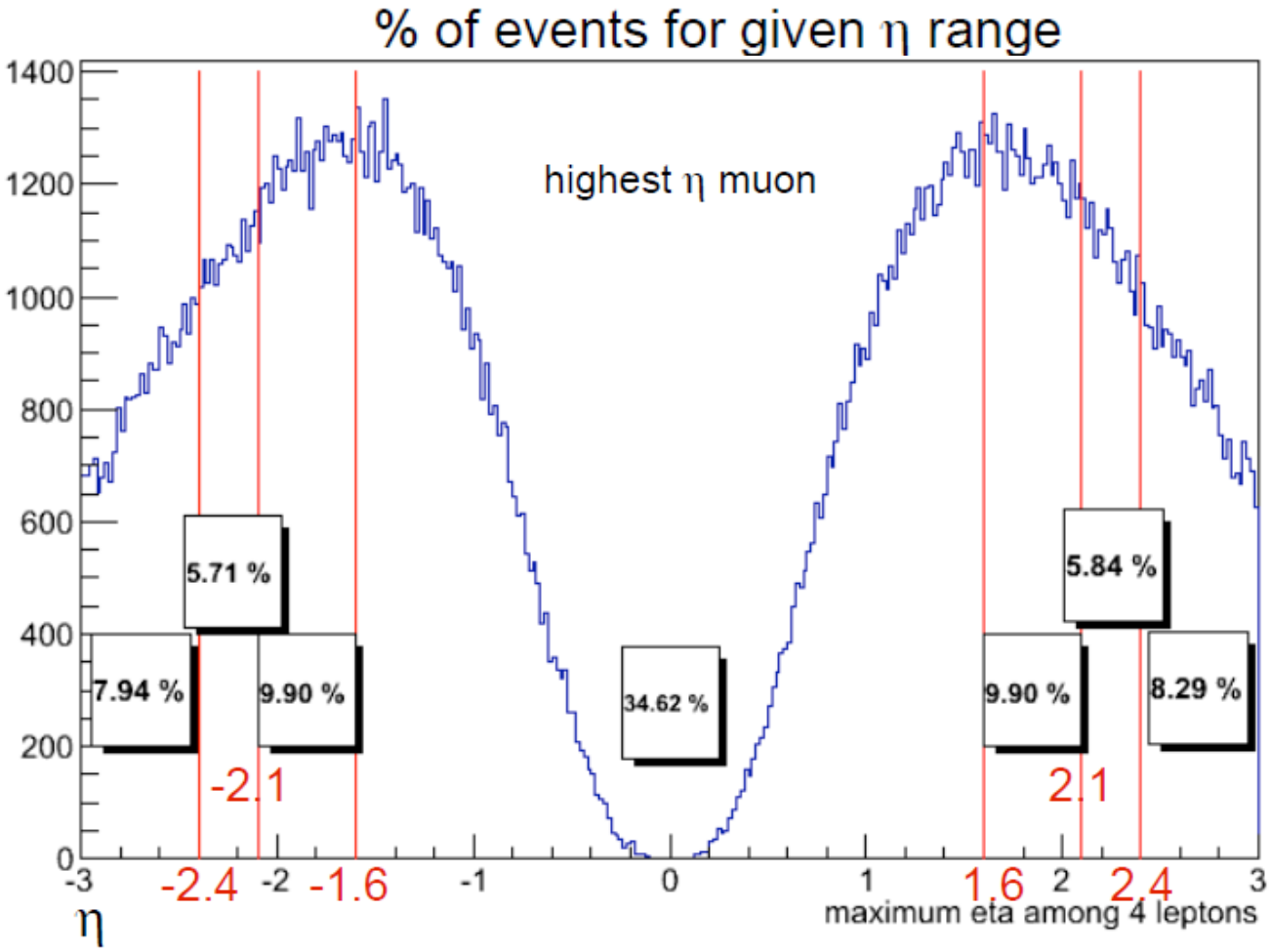
- dal 2013 al 2018
  - richieste per ora indicative e varieranno a seconda degli impegni che si definiranno meglio nei prossimi mesi
  - 4/5 m.u./anno Camera Pulita per test su sensori 3D ed Edgeless e assemblaggio prototipi
  - 2 m.u./anno Officina Meccanica per prototipi per test beam
  - 4 m.u./anno Servizio Elettronico

Upgrade Fase II

- Upgrade del sistema dei Muoni (GEM e GRPC)

$H \rightarrow ZZ \rightarrow 4\mu$

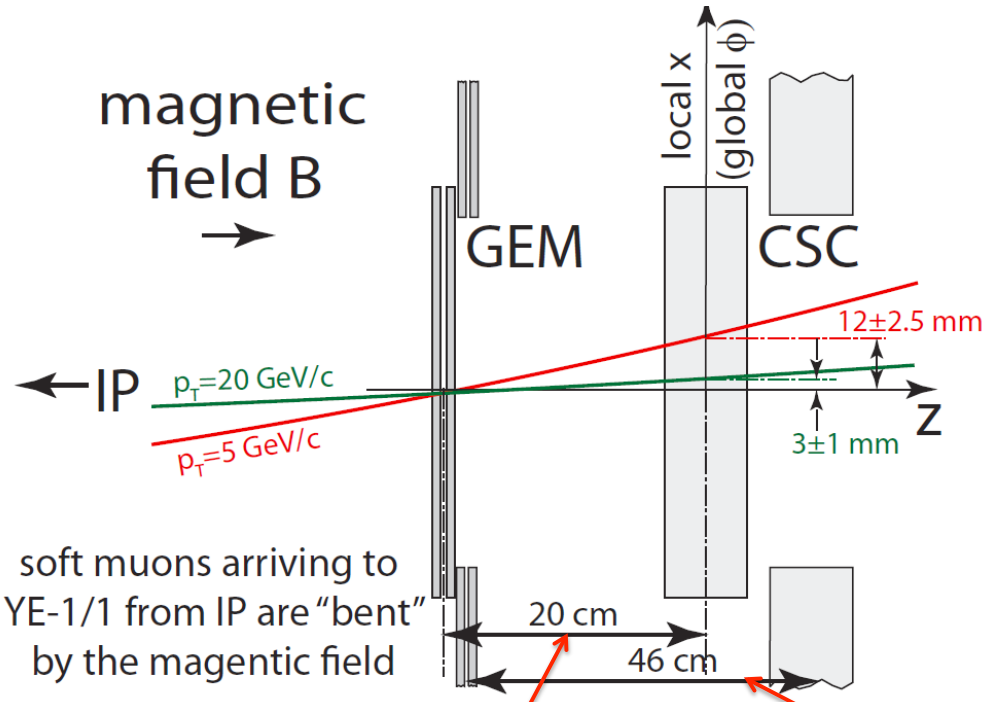
Increasing tracking and muon η coverage



Very forward region $|\eta|>1.6$ has the highest trigger rate

- A third of the CMS muon acceptance!
- No "good" handles at high PU

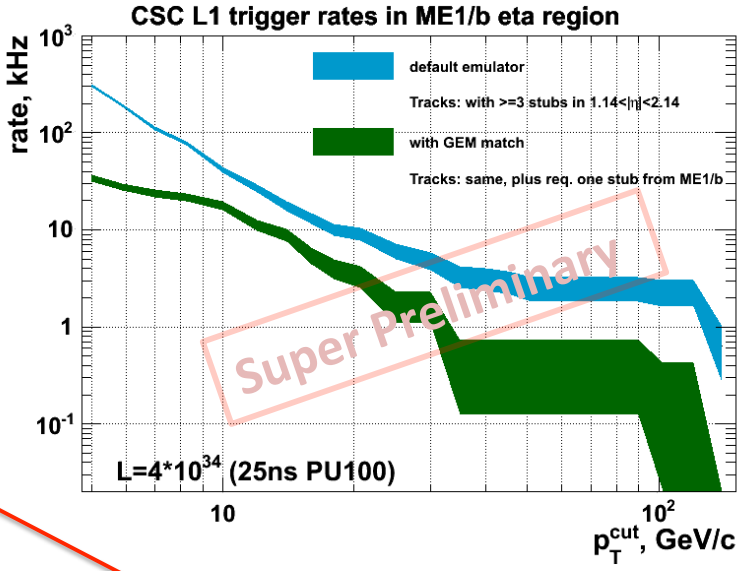
Marcello Abbrescia

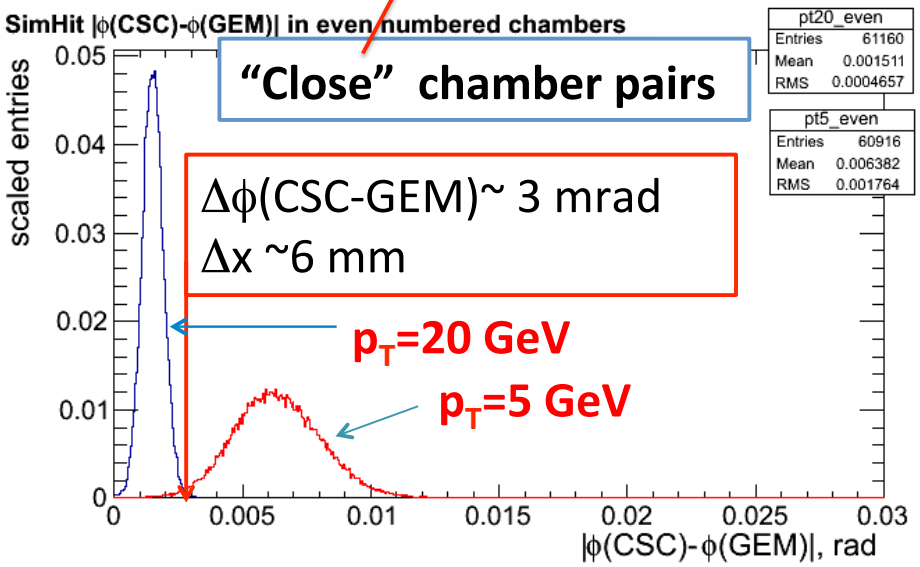


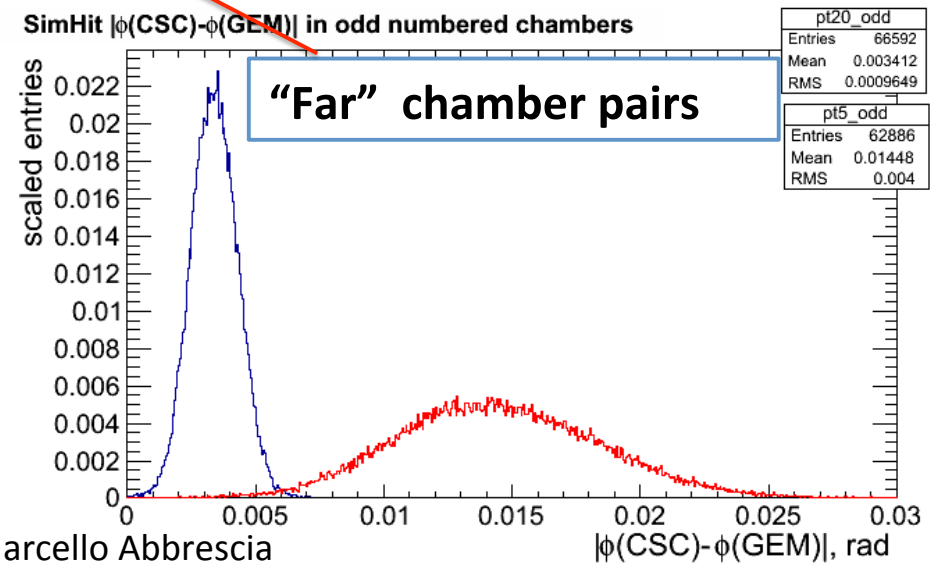
Can a second muon system improve momentum resolution?

The new detector needs around 2-3 mm of spatial resolution to effectively discriminate 5-10 GeV muons from 20+ GeV ones

YE-1/1	p_T=5 GeV	p_T=20 GeV
$\Delta x_{\Delta z=30\ cm}$	12±3mm	3±1mm







R&D on GEM x Phase II (2013-2021..)

People involved: M. Abbrescia, C. Calabria, A. Colaleo, G. De Robertis, F. Loddo, M. Maggi, S. Nuzzo, A. Ranieri, R. Radogna, R. Venditti

Activity foreseen:

2013 - 2014

- R&D on gas mixtures for time resolution optimization (continuing the activity on GEM R&D)
- Learning phase on new GEM stretching procedure and detector assembly
- Study and prototyping of the new electronics based on VFAT3

2 months (per year) of technicians – 2 months in the 10.000 clean room

2015-2016

About 25% of the (40/160) chamber production to be done in Italy, equally distributed among
LNF and Bari

- Detector assembly in the clean room
- Detector tests (gain uniformity) in a dedicated workshop
- Final design of the VFAT electronics and production

4 months (per year) of technicians + clean room (both to be defined in details)

2017-2018

- Detector tests @CERN with cosmics
- Installation and commissioning during LS2

R&D on GRPC x Phase II (2013-2021..)

Motivation:

- The current RPC technology (based on HPL electrodes) and the related FE electronics limits *the high rates performance* and justify the absence of RPC detectors in the high η region where the expected particle rate is ≈ 10 kHz/cm².
- RPC rate capability depends on a number of parameters, such as the electrode resistivity, the gas gap size, the front end electronics sensitivity

Goals:

develop ad innovative High Rate RPC detector (based on doped glass electrodes) with high spatial and timing resolutions.

Benefit:

1. no linseed oil used
2. detector compatible with the mechanics, the gas mixture, the electronics off-detector of the present CMS RPC system.
3. take profit of the expertise on RPC construction and operation

R&D on GRPC x Phase II (2013-2014)

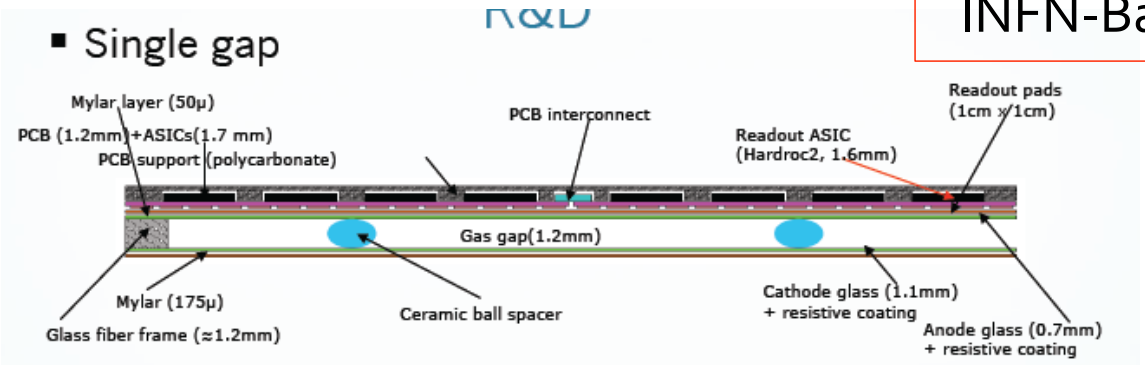
Prototype construction and test: Single/double small RPC prototype (30 x 30 cm^2) construction using doped glass electrodes (r ≈10^{10}Ωcm) with 1.2 mm gas gap and 0.7 mm electrode thickness. Micro strip plane of about 2-4 mm in pitch to achieve sub-millimetre spatial resolution. Extensive tests to certified the prototype. The tests will be performed tougher with the GEM activities.

1. Cosmic test @ Bari laboratory to study the performance. Comparison between Bakelite and glass RPC

Sinergia con R&D GEM

2. Beam tests @ LNF to study the detector rate capability
3. long term ageing test @ GIF/GIF++ to study possible degradation of material, electronics and chamber performance at doses equivalent to those expected in the CMS high η region

Manpower:
INFN-Bari technicians: 1 month/year.



Gabriella Pugliese

Back-up slides

RPC upgrade activities 2013-2021

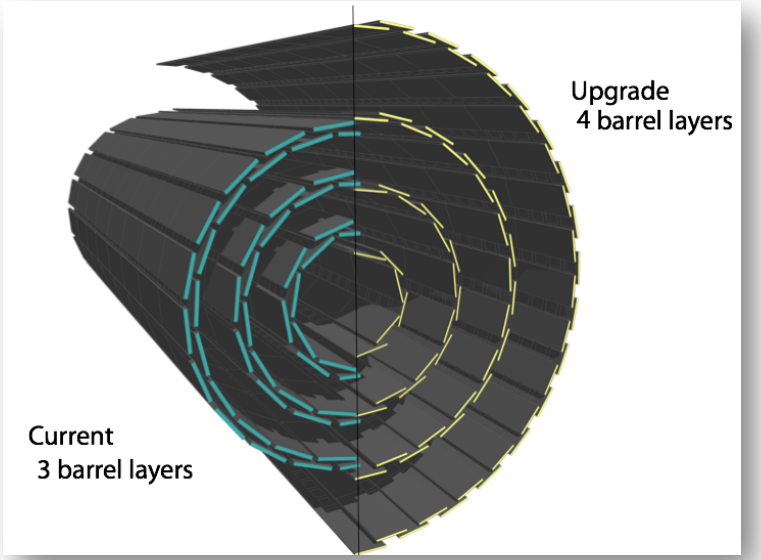
1. The addition of a 4^{th} layer of RPCs to extend coverage to $|\eta| = 1.6$ to preserve a low P_T threshold for the Level 1 Muon Trigger at high instantaneous luminosity (during LS1: 2013-14)

2. R&D to develop detectors that can extend coverage to the region $1.6 < |\eta| < 2.1$ or even higher. Possible technologies include GEM or GRPCs

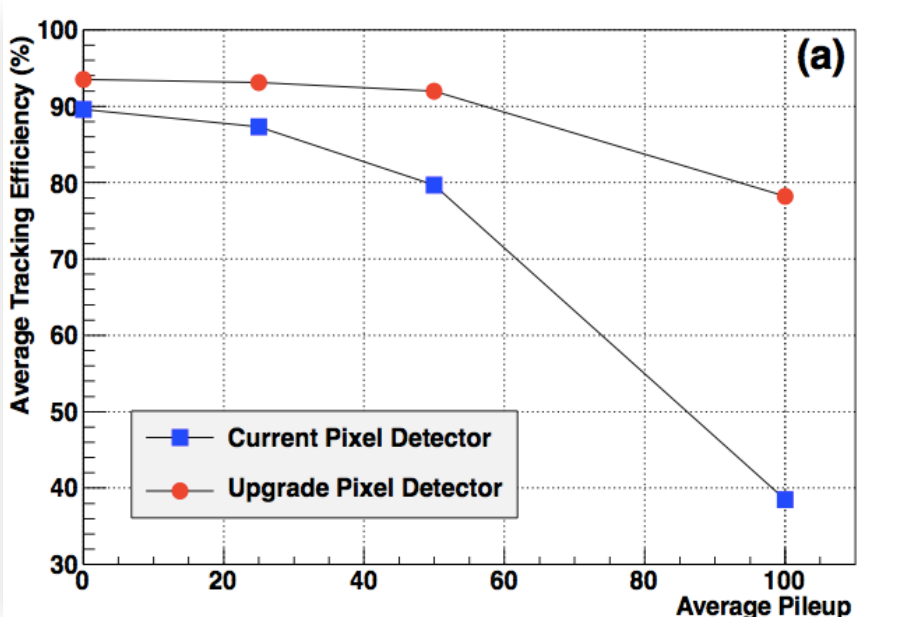
Gabriella Pugliese

Pixel Upgrade (2013-2017-18)

- Upgraded Pixel Detector
  - Less material, better radial distribution
    - New readout chip & extra layer recovers tracking efficiency, reduces fakes



- CMS Full simulation tt comparisons vs PU
  - Tracking performance
  - Efficiency
- Very powerful even without optimization!
  - B tagging, tracking efficiency at 65-70 PU equal to current detector at 25 PU
    - Fakes not quite as big improvement but usually requires careful optimization



Upgrades: Impact on Higgs Physics

$H \rightarrow ZZ \rightarrow 4l$

- *Sensitive to lepton efficiency*
  - *50% improved*

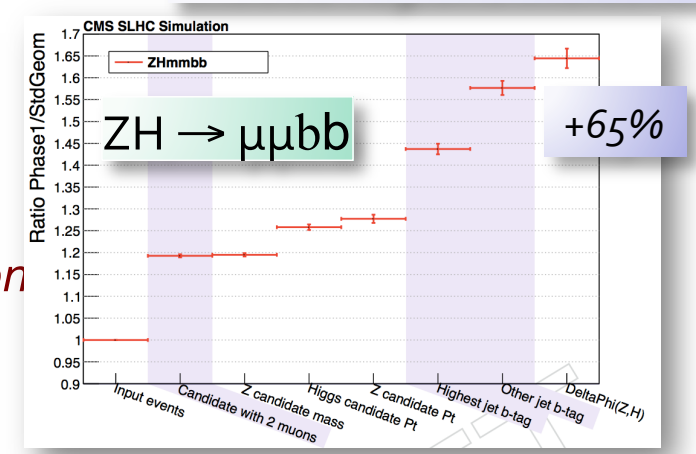
$ZH \rightarrow \mu\mu bb$

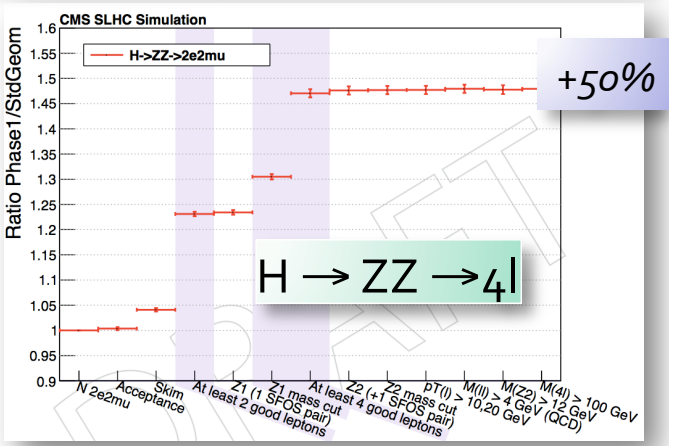
- *Associated production*
  - *High muon ID efficiency*
  - *High b-tagging efficiency*
  - *Good dijet mass resolution*
  - *65% improved*

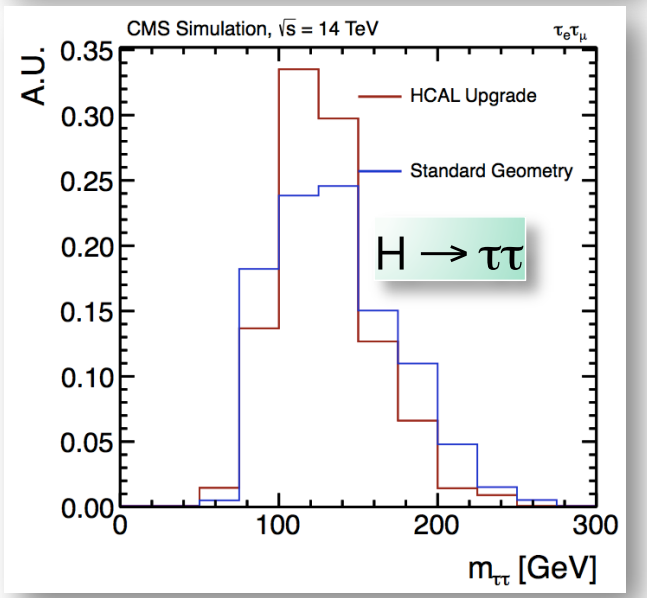
$H \rightarrow \tau\tau$ (VBF)

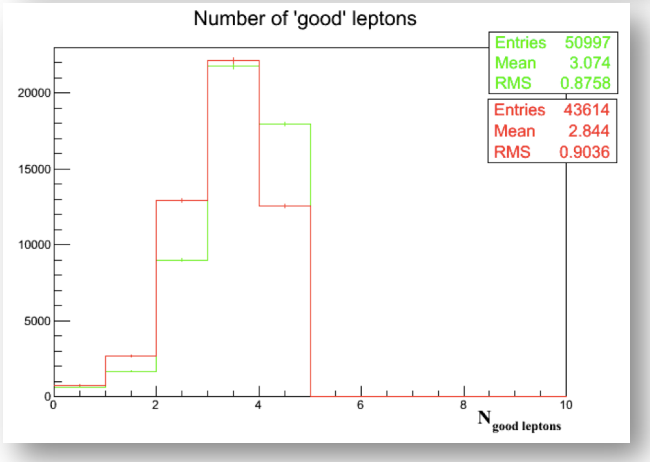
- *Improved*
  - *MET resolution*
  - *Forward jet tagging capability*
  - *Identification*

Improved signal yield (relative to current detector):
shaded regions indicate cuts with biggest gains expected









- Improved $m_{\tau\tau}$ resolution
- More good leptons
  better tracking & isolation