TOTEM status report

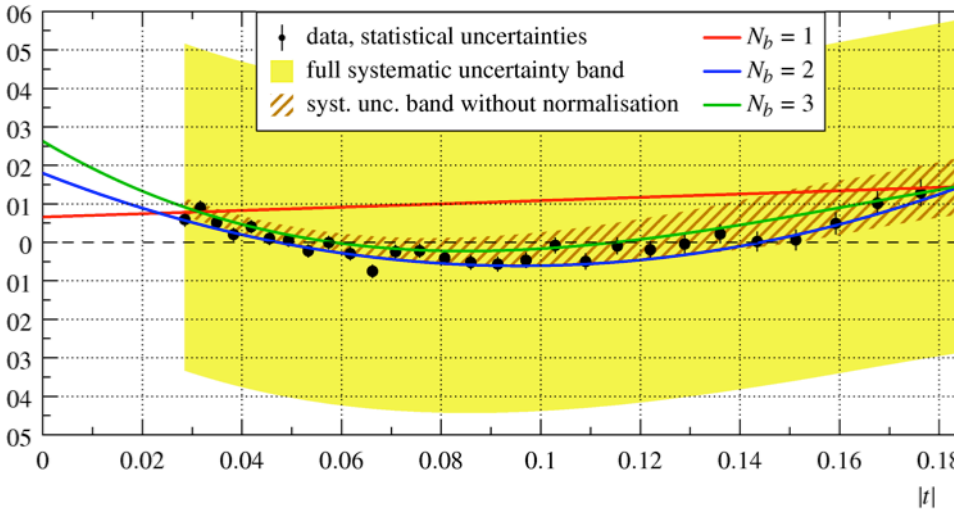
E. Radicioni

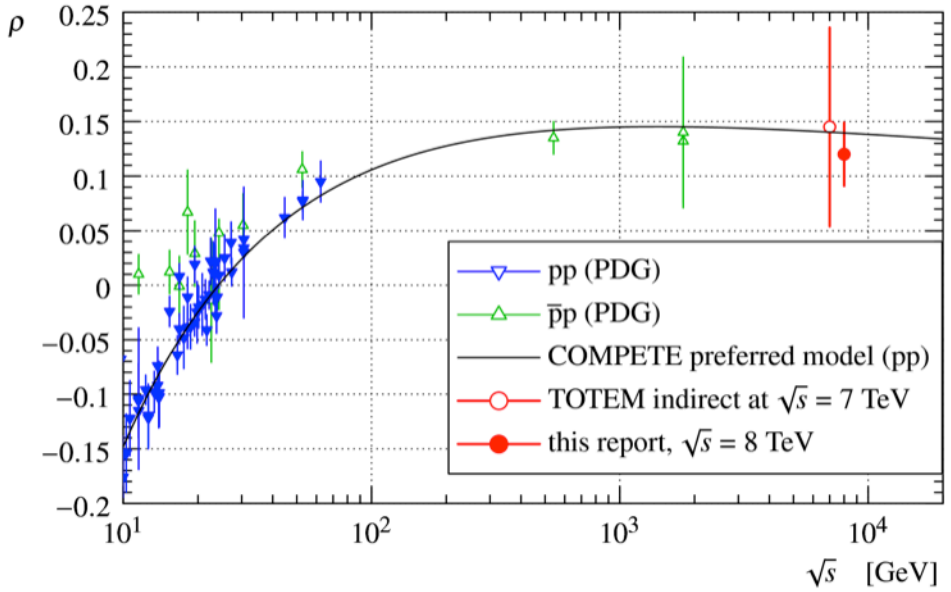
outline

- Running scenarios
- Strategy for special effort on CT-PPS
- Exceptional integration effort
  - RP status and insertion tests
  - DAQ and Trigger integration w/CMS
  - Totem Si-strips readout and reconstruction in CMS DAQ and Offline
  - New diamond detectors
  - Clock distribution system
  - DQM and Offline integration in CMSSW

running scenario: high beta

- β* = 2500m
- Measure elastic scattering in Nuclear-Coulomb interference region at 13TeV
- Check at higher energy what measured at 8 TeV:
  - Non exponential behavior at low |t|
  - ρ values at higher energy.





running scenario: CT-PPS

- Anticipate running operations in 2016
  - γγ candidate at 750 GeV could be produced exclusively and seen in CT-PPS
    - Fichet, von Gersdorff, Royon (arXiv:1601.01712, arXiv: 1512.05751)
    - Csaki, Hubisz, Terning (arXiv:1512.05776, arXiv:1601.00638)
    - Harland-Lang, Khoze, Ryskin (arXiv:1601.07187)
- CT-PPS physics can start one year earlier than foreseen.
  - Exclusive DiJet physics
  - Anomalous quartic couplings measurement.

CT-PPS strategy 2016

2 Tracking horizontal Roman Pots (210 near and far) qualified for Low β and High intensity operation.

Use current Totem Si Strip detectors in 2016 before the new 3D pixel are ready (2017). Estimation of correct working over 10 fb^{-1} per telescope.

2 Telescope groups are available to get up to 20 fb^{-1} of integrated luminosity before loosing tracking efficiency

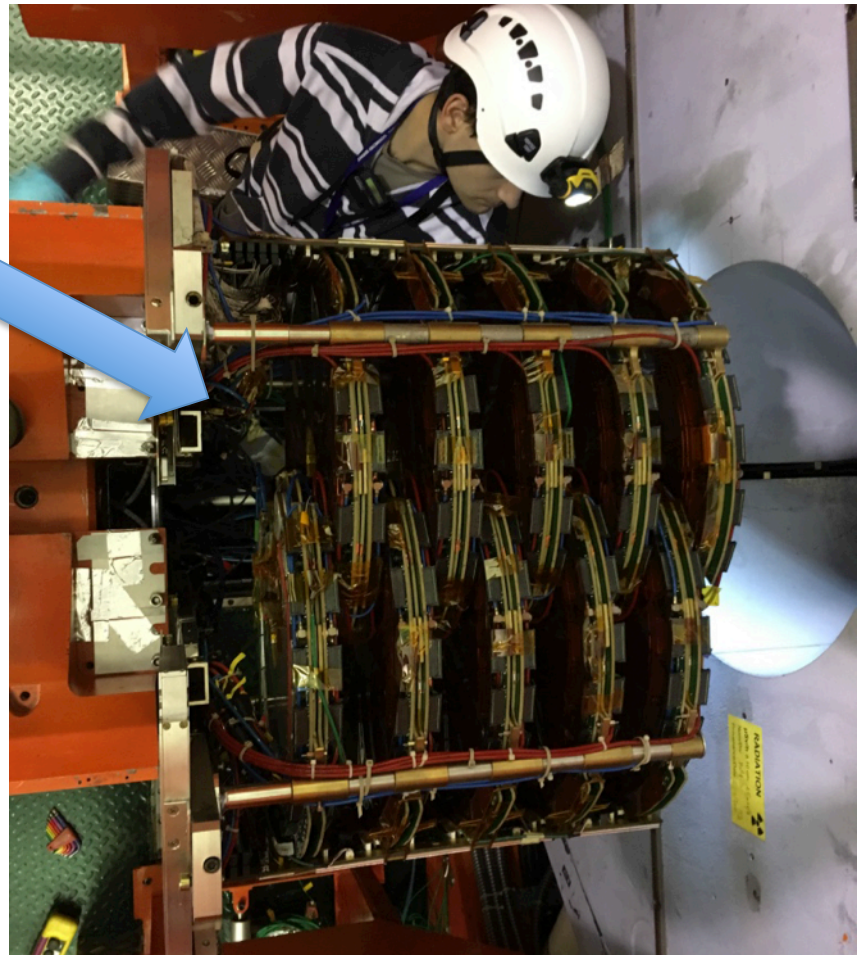
1 Timing cylindrical horizontal Roman Pot qualified for Low β and High intensity operation.

Since no β*=90m medium luminosity run is foreseen in 2016, we decided to install 2 diamonds detector packages, developed for the vertical Roman Pots, in the cylindrical one during TS1.

In addition to TOF, they give some proton tagging with enough ξ resolution when Si strip loose efficiency

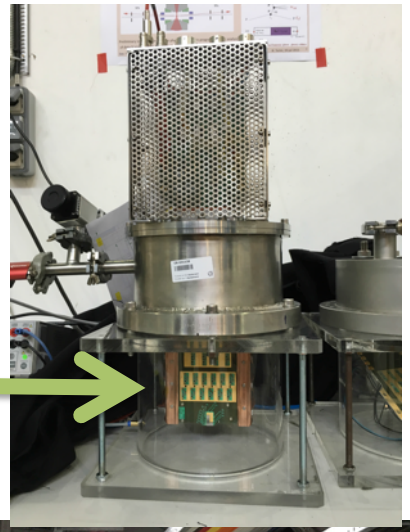
T1, T2 status

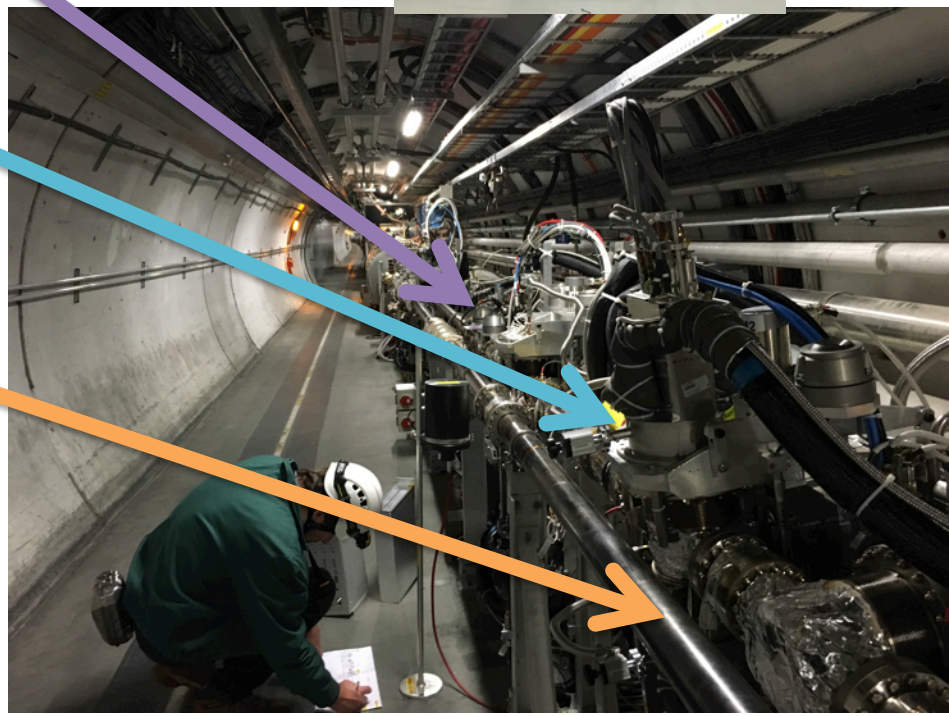
- T2
  - Control loop fixed on the faulty quarter
  - Water leak fixed
  - The detector is fully recovered.
- T1
  - The detector has been removed from
  - CMS and safely stored on surface.
  - Not needed for the 2016 running
  - Scenario: save it from radiation damage



RP status

- Removed 220 Near Vertical detectors to prepare the installation of diamonds later in TS2
- Electrical trigger of the Vertical Pots connected to the new 210 Far (tilted) pots
- Electrical trigger of the 220 Horizontal moved to 210 Horizontal for low β running.
- The two 210 Horizontal are qualified for low β beams insertion together
- Cylindrical RP for timing ready to receive diamond detectors in TS1





RP Insertions 2016

Programme for insertions in intensity ramp-up

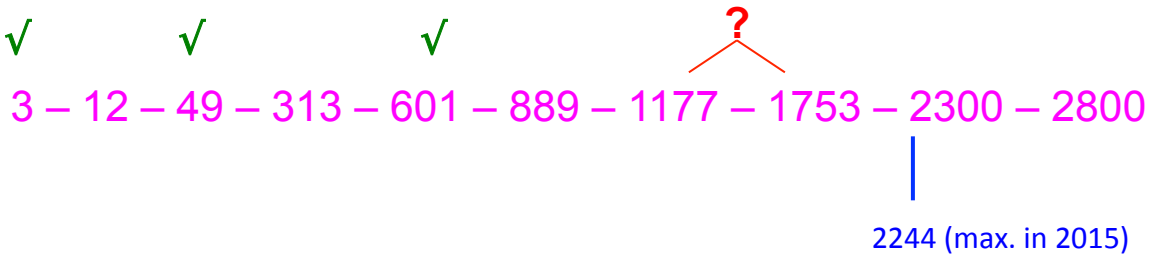
- Agreed settings:
  15 σ + 0.5 mm until TS1, then removal of 0.5 mm margin if demonstrated to be possible

- Insertion in which fills?
  2nd fill of each intensity step, then – if successful – subsequent insertions possible

- Insertion at what time in the fill?
  2 hours after declaration of Stable Beams

→ Insertions with up to 1177 bunches successfully completed ($L \leq 3.2 \times 10^{33}$ cm^{-2} s^{-1})

- Tests of removal of the 0.5 mm margin:
  - in addition to orbit stability observations
  - End-of-fill tests before TS1:

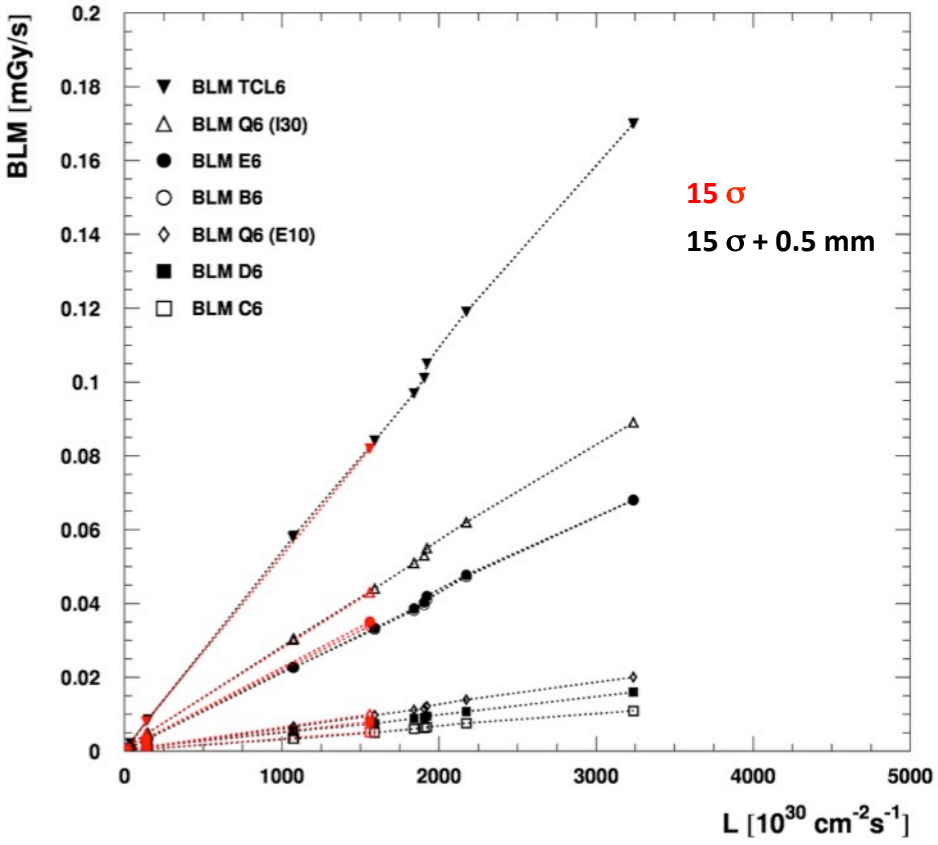


courtesy: Mario Deile

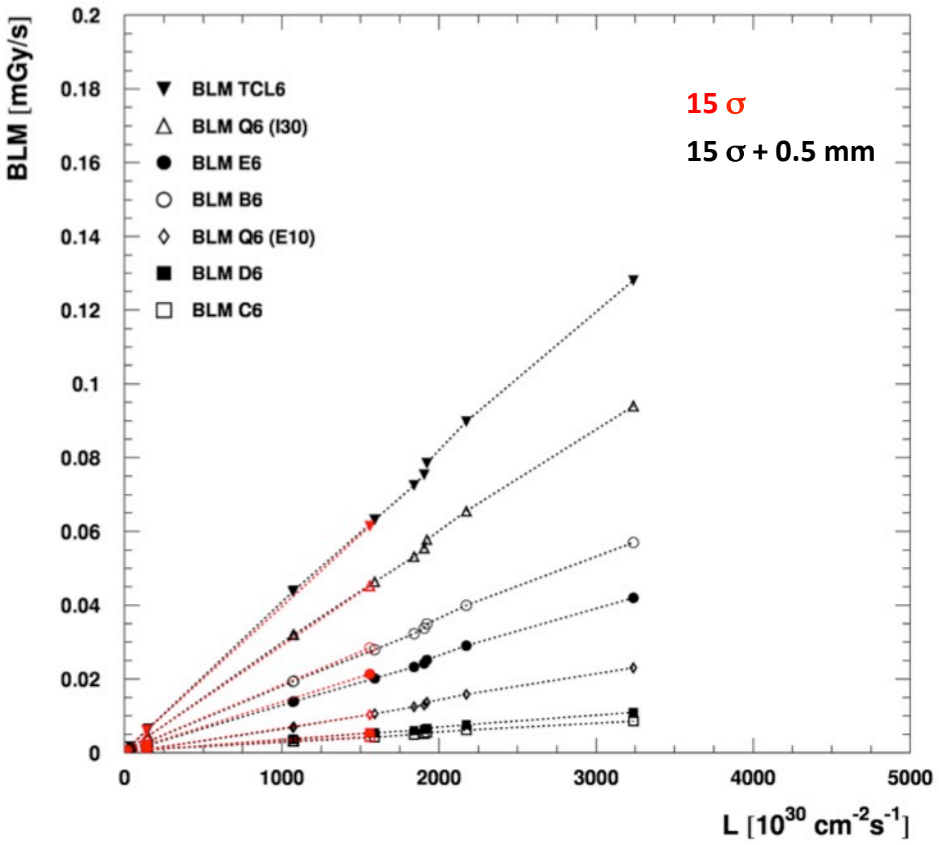
BLM Response 2016 with and without Margin

(15 σ + 0.5 mm and 15 σ)

Sector 5-6



Sector 4-5



So far: very little effect from removing the 0.5 mm margin !

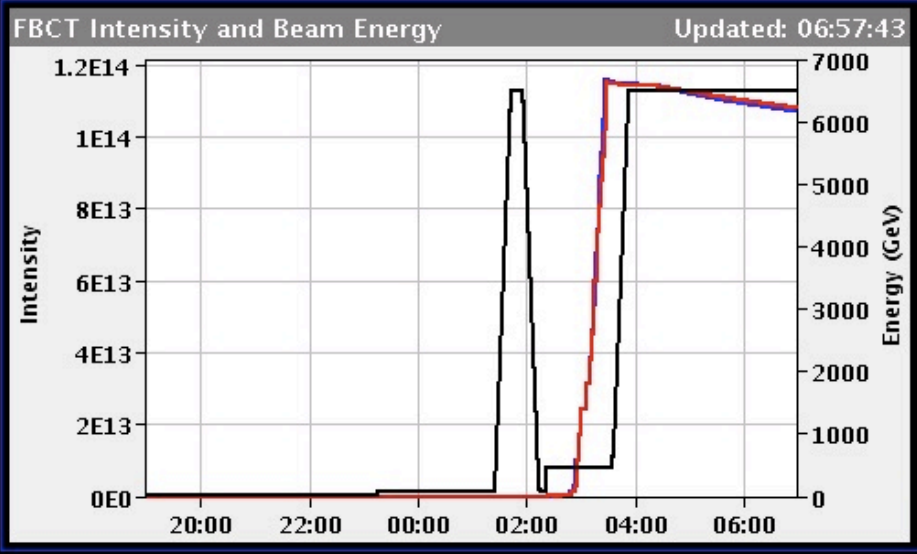
courtesy: Mario Deile

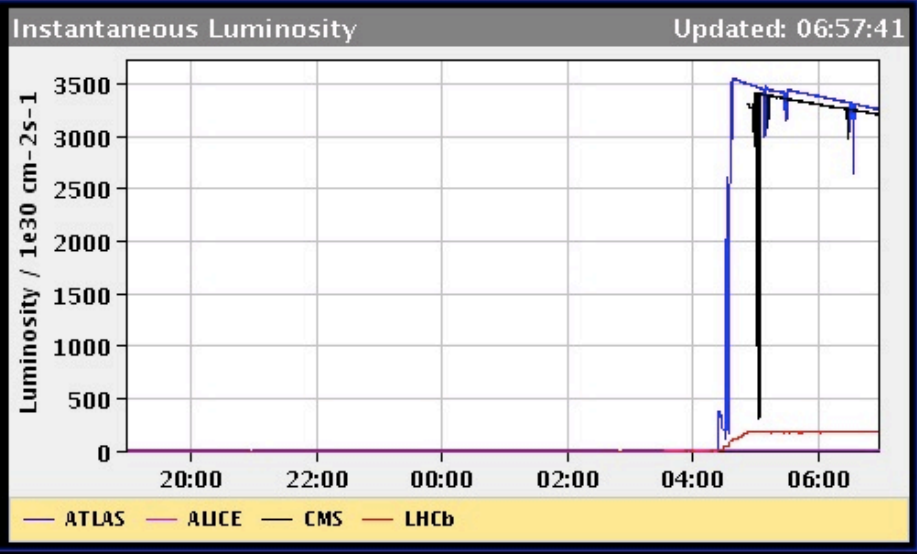
LHC Page1 | Fill: 4947 | E: 6499 GeV | t(SB): 02:21:24 | 20-05-16 06:57:43

PROTON PHYSICS: STABLE BEAMS

Energy:	6499 GeV	I(B1):	1.04e+14	I(B2):	1.06e+14

Inst. Lumi [(ub.s)^-1] IP1: 3256.93 IP2: 1.79 IP5: 3212.21 IP8: 179.67





Comments (20-May-2016 06:43:12)

physics fill with 1200 bunches

TOTEM XRP in

BIS status and SMP flags	B1	B2
Link Status of Beam Permits	true	true
Global Beam Permit	true	true
Setup Beam	false	false
Beam Presence	true	true
Moveable Devices Allowed In	true	true
Stable Beams	true	true

AFS: 25ns_1177b_1165_990_984_72bpi_19inj

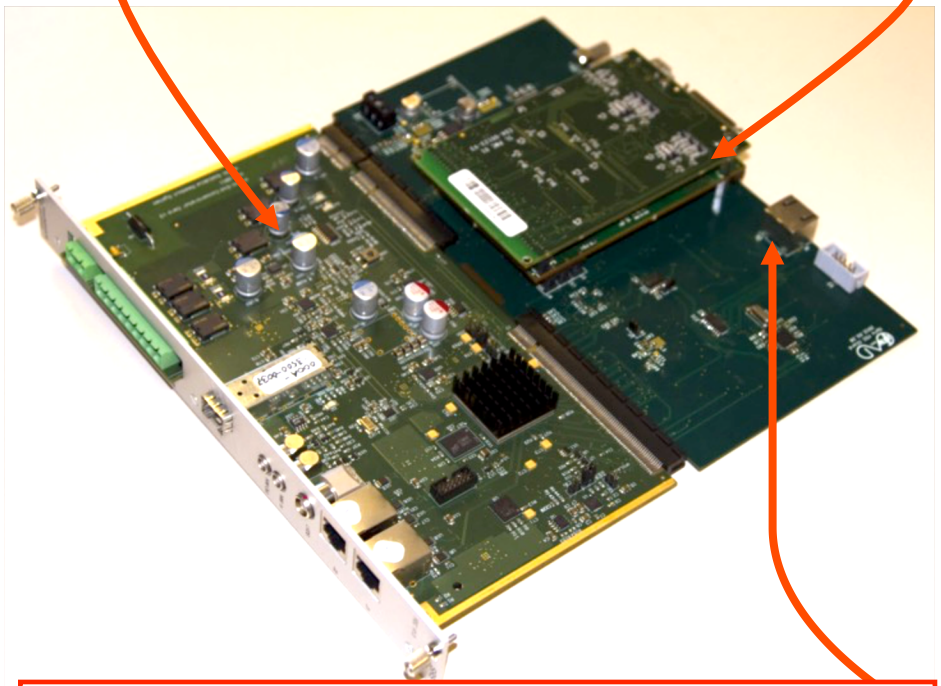
PM Status B1: ENABLED | PM Status B2: ENABLED

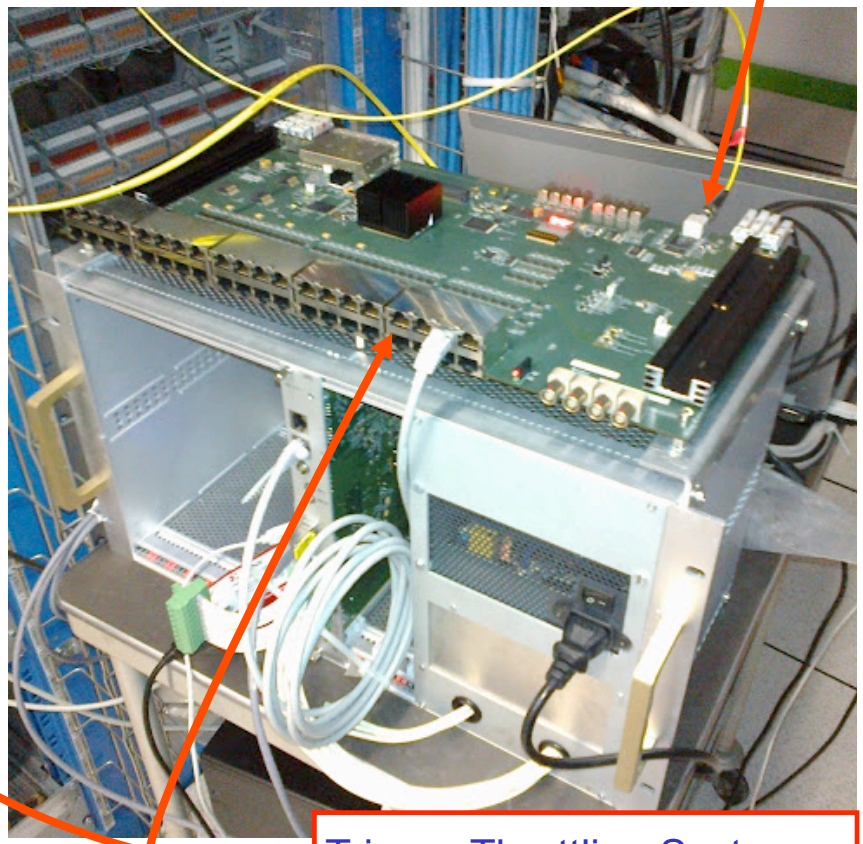
TOTEM readout back-end

SRS-FEC: interface to stand-alone DAQ

OptoRX & S-LINK 64 to CMS DAQ

Data concentrator board with interface to TCDS system (timing trigger and fast-command)





Designed and implemented to be CMS compliant at both HW and FW level

Trigger Throttling System interface to CMS

DAQ and TCDS integration

The TOTEM DAQ has been designed to be compliant with the CMS one. The integration of the two systems required:

- Hardware
  - All OptoRx cards upgraded with larger FPGA flash
  - 5 OptoRx installed and connected to Front-end Readout Links (FRL) and Fast Merging Module (FMM)
  - 2 TCDS (2 iCI + 2 PI) partitions installed with fibers pulled from S1 <-> S2
- Software
  - Level 1 Function Manager implemented
  - Configurator of readout back-end (OptoRx)
  - Configurator of TDCS system
  - MiniDAQ/Global run configuration
- Firmware
  - SLink interface (OptoRX -> FRL)
  - Compatibility to CMS Trigger Throttling System (TTS)
  - Compatibility to TCDS ReSync fast command when Out-Of-Synch

Courtesy: M.Quinto, Integration of TOTEM DAQ in CMS

DAQ integration: project timeline

Feb 9th

- 1st meeting with CMS DAQ
- Documentation opened
- System requirements identified

Apr 6th

- 1st MiniDAQ readout test at 10Hz with emulated data
- Files available to offline/dqm

Apr 27th

- 1st MiniDAQ high rate test ok w. emulated data
- Slink data transfer error identified and fixed
- ReSync fast-command test
- ~90kHz rate limit reached w/o errors

May 2nd

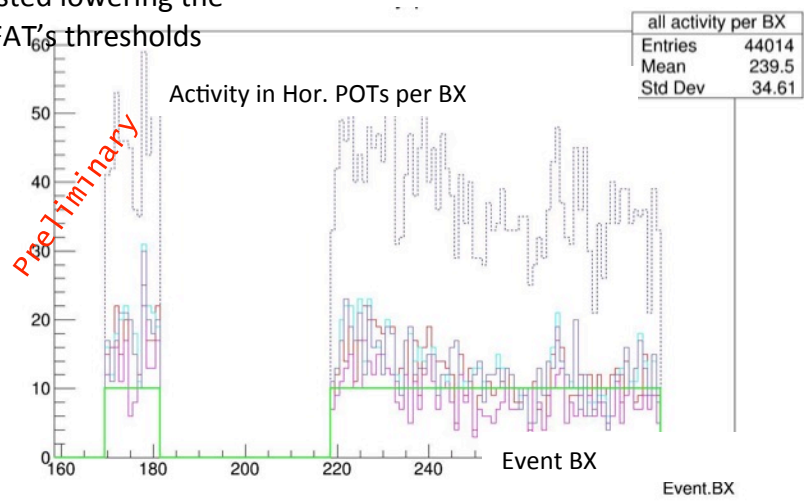
- 1st MiniDAQ test with Si-Strip ON
- ReSynch fast-command test OK
- RAW data mode tested
- Zero-suppr. mode tested lowering the VFAT's thresholds

May 4th

- Si-Strip in global running with CMS
- Stress test 90k rate w. periodic ReSync OK

May 18th

- Si-Strip timed w/ LHC beam and CMS global trigger



Courtesy: M.Quinto, Integration of TOTEM DAQ in CMS

First global run of SiStrips in CMS DAQ

Mozilla Firefox

CMS RunSummary Run ... | https://cm...mmary.html

https://cmswbm.web.cern.ch/cmswbm/cmsdb/runSummary/RunSummary.html

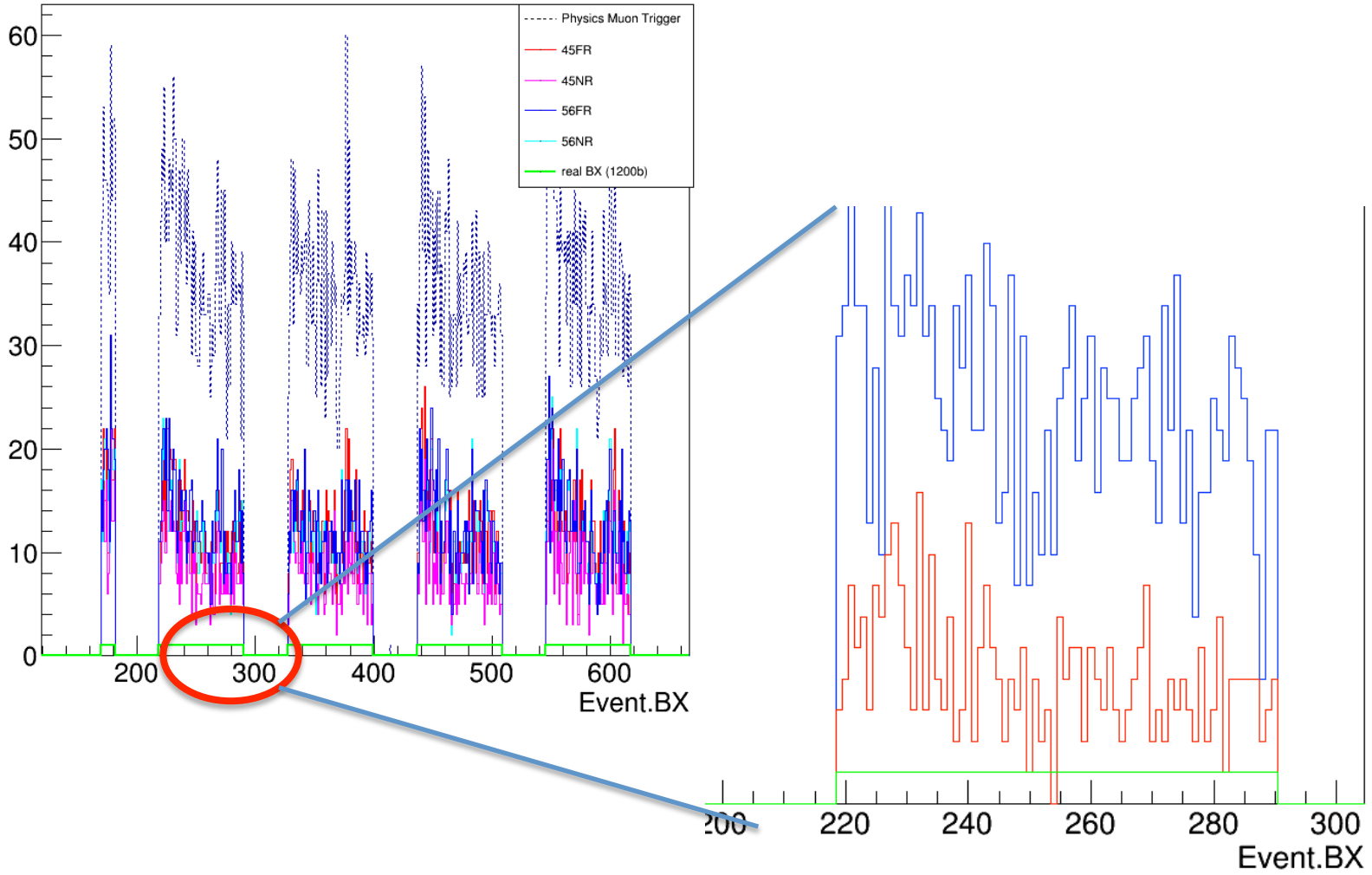
Run Summary

All times are in UTC.
TRIGGERS and L1 triggers numbers are the total pre-deadtime triggers, including Calibration and Random ones.

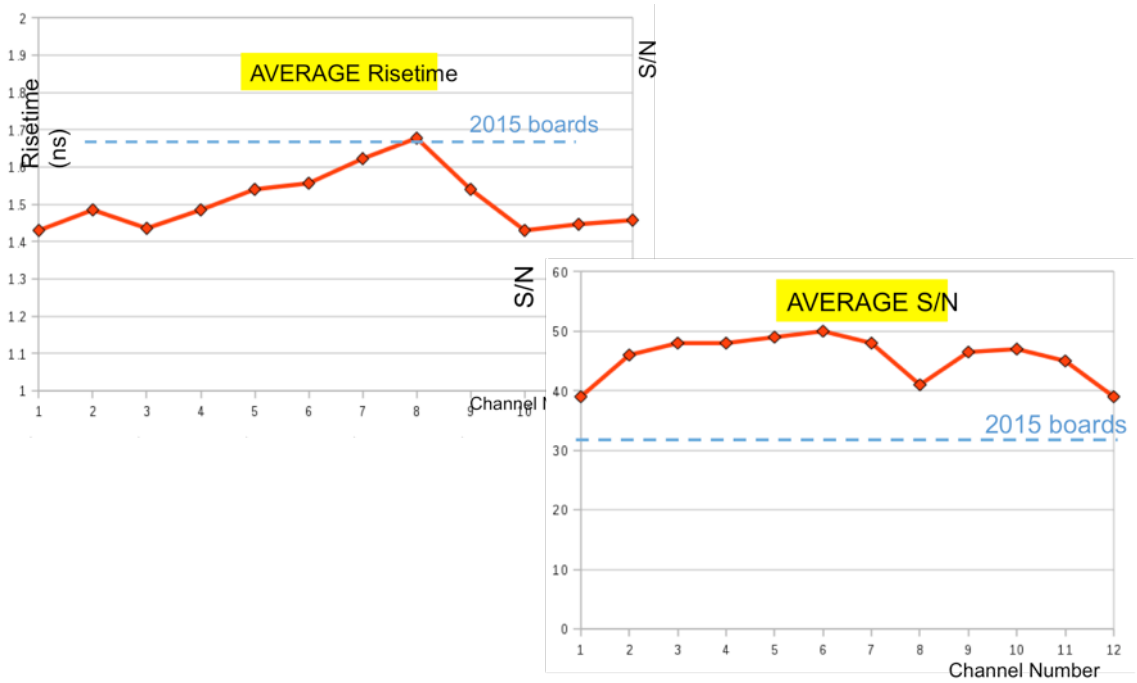
RUN	LUMI_NB_LIVE_DELIV	SEQUENCE	TRIGGER_MODE	L1_KEY	HLT_KEY	STARTTIME	STOPTIME	TRIGGERS	BFIELD	TIER0	COMPONENTS
272524	0.000000 0.000000	GLOBAL-RUN toppro	l1_hlt_cosmics2016/v98	cosmics2016_TSC/v56	/cdaq/cosmic/commissioning2016/firstCollisions/v2.1/HLT/V8	2016.05.04 17:11:15	null	802418	3.799	1	CSC DAQ DCS DQM ECAL ES PIXEL RPC SCAL TCDS TRG
272514	0.000000 0.000000	PRIVATE-GLOBAL-CALO ecalpro	MANUAL	null	/minidaq/EcalCalibration/v7.0/EcalCalibration_MiniDAQ/V3	2016.05.04 16:21:46	2016.05.04 16:22:30	null	3.799	1	DAQ ES TCDS
272512	0.000000 0.000000	GLOBAL-RUN toppro	l1_hlt_cosmics2016/v98	cosmics2016_TSC/v56	/cdaq/cosmic/commissioning2016/firstCollisions/v2.1/HLT/V8	2016.05.04 16:06:42	2016.05.04 16:37:22	100949818	3.799	0	DAQ DCS DQM RPC SCAL TCDS TOTEM TRG
272511	0.000000 0.000000	GLOBAL-RUN toppro	l1_hlt_cosmics2016/v98	cosmics2016_TSC/v56	/cdaq/cosmic/commissioning2016/firstCollisions/v2.1/HLT/V8	2016.05.04 15:45:27	2016.05.04 15:55:54	412543	3.799	1	DAQ DCS DQM ECAL PIXEL RPC SCAL TCDS TOTEM TRACKER TRG
272507	0.000000 0.000000	GLOBAL-RUN toppro	l1_hlt_cosmics2016/v98	cosmics2016_TSC/v56	/cdaq/cosmic/commissioning2016/firstCollisions/v2.1/HLT/V8	2016.05.04 15:22:16	2016.05.04 15:25:54	33837	3.799	1	DAQ DCS DQM ECAL PIXEL SCAL TCDS TOTEM TRACKER TRG
272506	0.000000 0.000000	PRIVATE-GLOBAL-TOTEMCTPPS totempro	MANUAL	null	/minidaq/2016/Basic/HLT/V3	2016.05.04 15:17:02	2016.05.04 15:17:26	null	3.799	1	DAQ TCDS TOTEM
272505	0.000000 0.000000	GLOBAL-RUN toppro	l1_hlt_cosmics2016/v98	cosmics2016_TSC/v56	/cdaq/cosmic/commissioning2016/firstCollisions/v2.1/HLT/V8	2016.05.04 15:11:27	2016.05.04 15:16:07	179438	3.799	1	DAQ DCS DQM ECAL PIXEL SCAL TCDS TRACKER TRG
272499	0.000000 0.000000	PRIVATE-GLOBAL-MUTRG triggerdev	MANUAL	null	/minidaq/2016/Basic/HLT/V3	2016.05.04 14:57:07	2016.05.04 15:08:59	null	3.799	0	DAQ TCDS
272496	0.000000 0.000000	GLOBAL-RUN toppro	l1_hlt_cosmics2016/v98	cosmics2016_TSC/v56	/cdaq/cosmic/commissioning2016/firstCollisions/v2.1/HLT/V8	2016.05.04 14:52:43	2016.05.04 15:01:42	359077	3.799	1	DAQ DCS DQM PIXEL SCAL TCDS TRACKER TRG
272495	0.000000 0.000000	PRIVATE-GLOBAL-MUTRG triggerdev	MANUAL	null	/minidaq/2016/Basic/HLT/V3	2016.05.04 14:50:03	2016.05.04 14:55:51	null	3.799	0	DAQ TCDS
272494	0.000000 0.000000	PRIVATE-GLOBAL-MUTRG triggerdev	MANUAL	null	/minidaq/2016/Basic/HLT/V3	2016.05.04 14:41:23	2016.05.04 14:46:35	null	3.799	0	DAQ TCDS
272493	0.000000 0.000000	PRIVATE-GLOBAL-TOTEMCTPPS totempro	MANUAL	null	/minidaq/2016/Basic/HLT/V3	2016.05.04 14:21:56	2016.05.04 14:43:49	null	3.799	1	DAQ TCDS TOTEM
272492	0.000000 0.000000	PRIVATE-GLOBAL-TOTEMCTPPS totempro	MANUAL	null	/minidaq/2016/Basic/HLT/V3	2016.05.04 14:16:12	2016.05.04 14:21:14	null	3.799	1	DAQ TCDS TOTEM
272491	0.000000 0.000000	PRIVATE-GLOBAL-TOTEMCTPPS totempro	MANUAL	null	/minidaq/2016/Basic/HLT/V3	2016.05.04 13:58:16	2016.05.04 14:15:54	null	3.799	1	DAQ TCDS TOTEM
272490	0.000000 0.000000	PRIVATE-GLOBAL-TOTEMCTPPS totempro	MANUAL	null	/minidaq/2016/Basic/HLT/V3	2016.05.04 13:55:23	2016.05.04 13:56:20	null	3.799	1	DAQ TCDS TOTEM
272489	0.000000 0.000000	PRIVATE-GLOBAL-TOTEMCTPPS totempro	MANUAL	null	/minidaq/2016/Basic/HLT/V3	2016.05.04 13:43:36	2016.05.04 13:51:33	null	3.799	1	DAQ TCDS TOTEM
272488	0.000000 0.000000	GLOBAL-RUN toppro	l1_hlt_test2016/v6	cosmics2016_TSC/v53	/cdaq/special/VirginRaw/Apr2016/HLT/V2	2016.05.04 13:41:46	2016.05.04 14:42:21	6462014	3.799	1	DAQ DCS DQM SCAL TCDS TRACKER TRG
272487	0.000000 0.000000	PRIVATE-GLOBAL-HCAL hcalpro	MANUAL	null	/minidaq/2016/HCAL/HLT/V3	2016.05.04 13:42:35	2016.05.04 13:44:15	null	3.799	0	DAQ HCAL HF TCDS

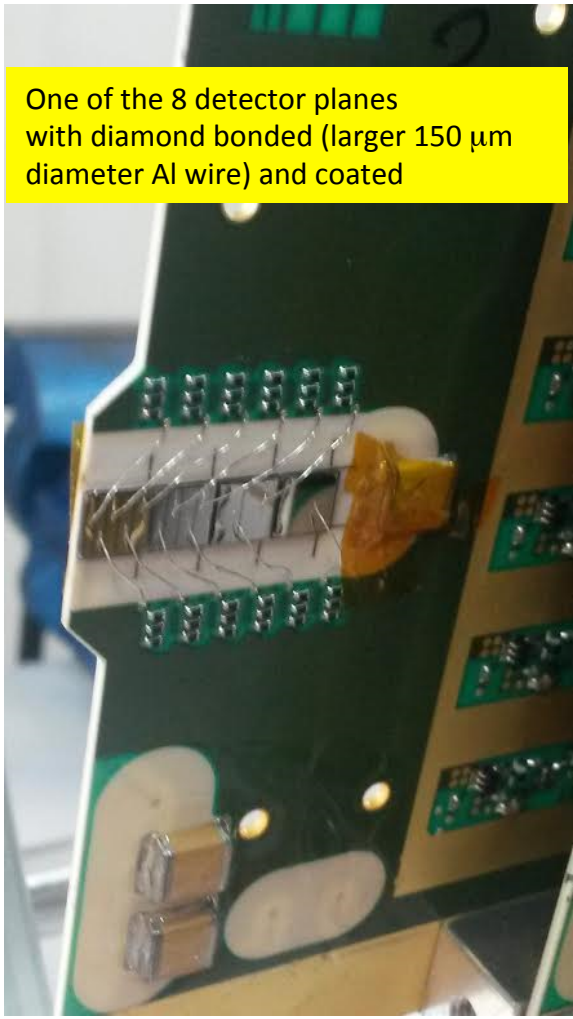
- Diamond detectors will follow the same path front-end → TOTEM Opto-RX → CMS FRL

Global run of SiStrips, latency adjusted



diamond detectors





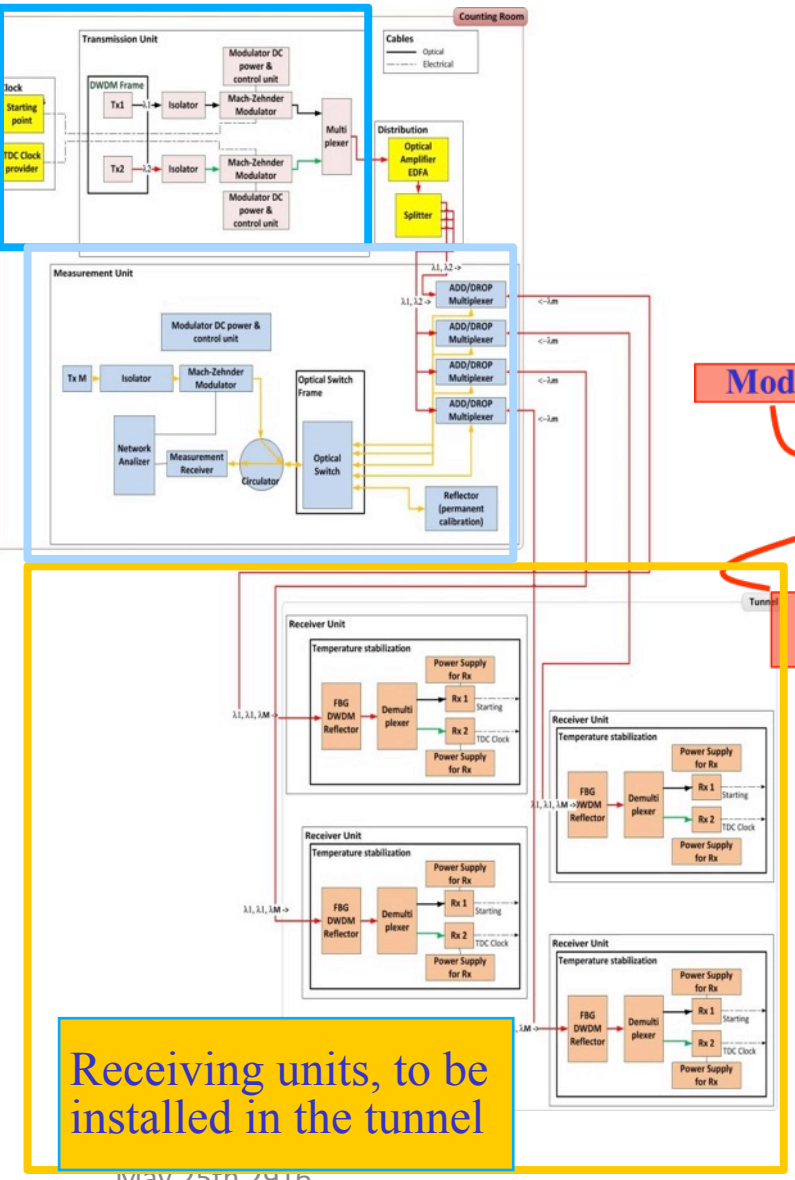
One of the 8 detector planes with diamond bonded (larger 150 μm diameter Al wire) and coated

- Specs equivalent or better than R&D samples
- Compatible with resolution <= 100ps per plane
- T/P stability verified OK for the first detector package (including overpressure test and T_{min} down to -25 C). Second package to follow
- Detector package integration is OK, initial noise hiccups solved
- Final test with front/end electronics next week

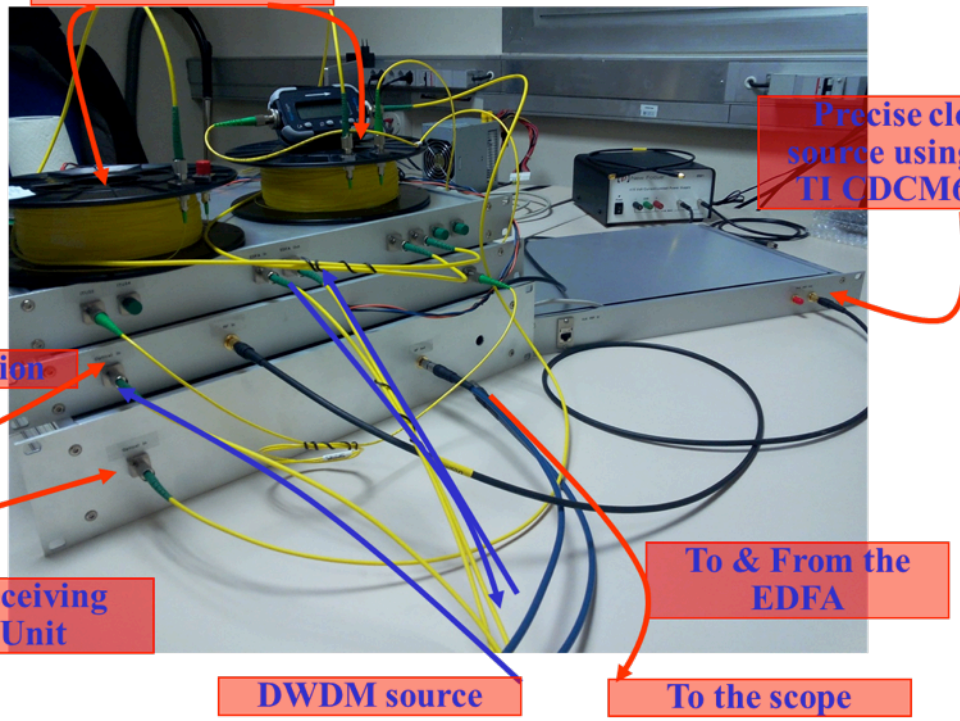
Goal: ready for installation during TS1

Clock distribution system ready for installation in TS1

Transmission & Measurement units



Receiving units, to be installed in the tunnel

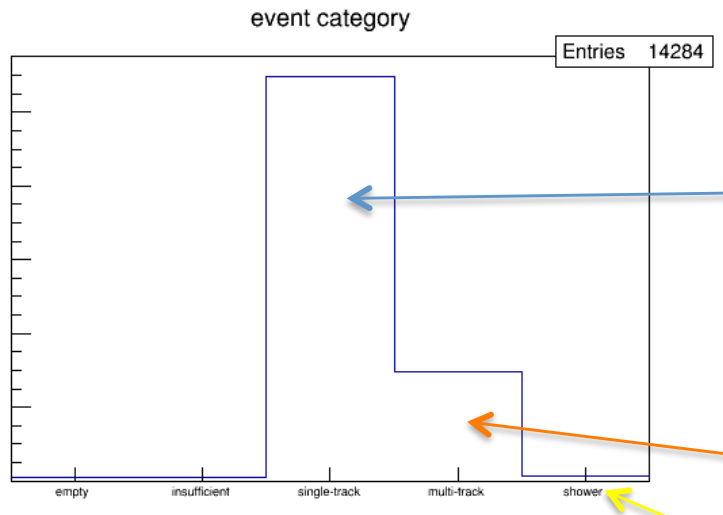


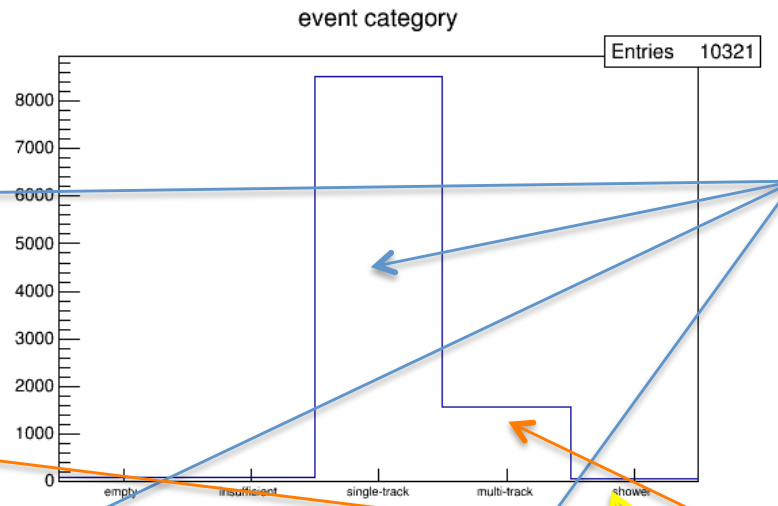
- All components set up in the laboratory for characterization and stability checks. Working and ready to be installed
- Installation of the receiving units close to the RPs in the tunnel during TS1.

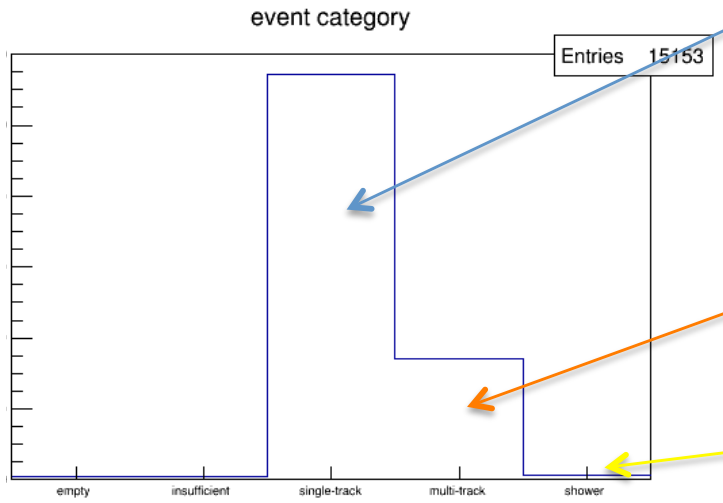
Offline and DQM

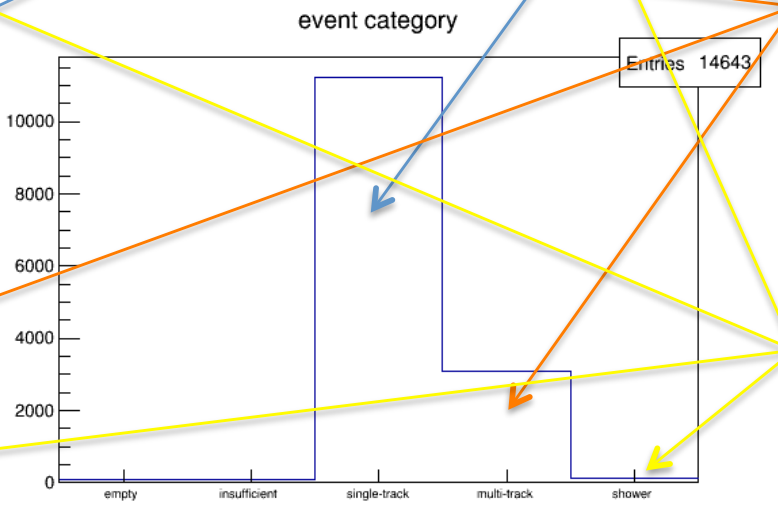
- All code (unpacking, clustering, reco, …) migrated to CMSSW8X
- Code refactory to comply to CMS SW standards
- Integration/backporting in CMSSW81X
- Already working SiStrip DQM
  - Diamond detectors to follow
- Integration of SiStrips
  - reconstruction OK
  - working on simulation
- In parallel, working on simulation and Database for all detectors, including:
  - Diamonds
  - Quartic
  - pixels

Offline and DQM: first data plots from global runs







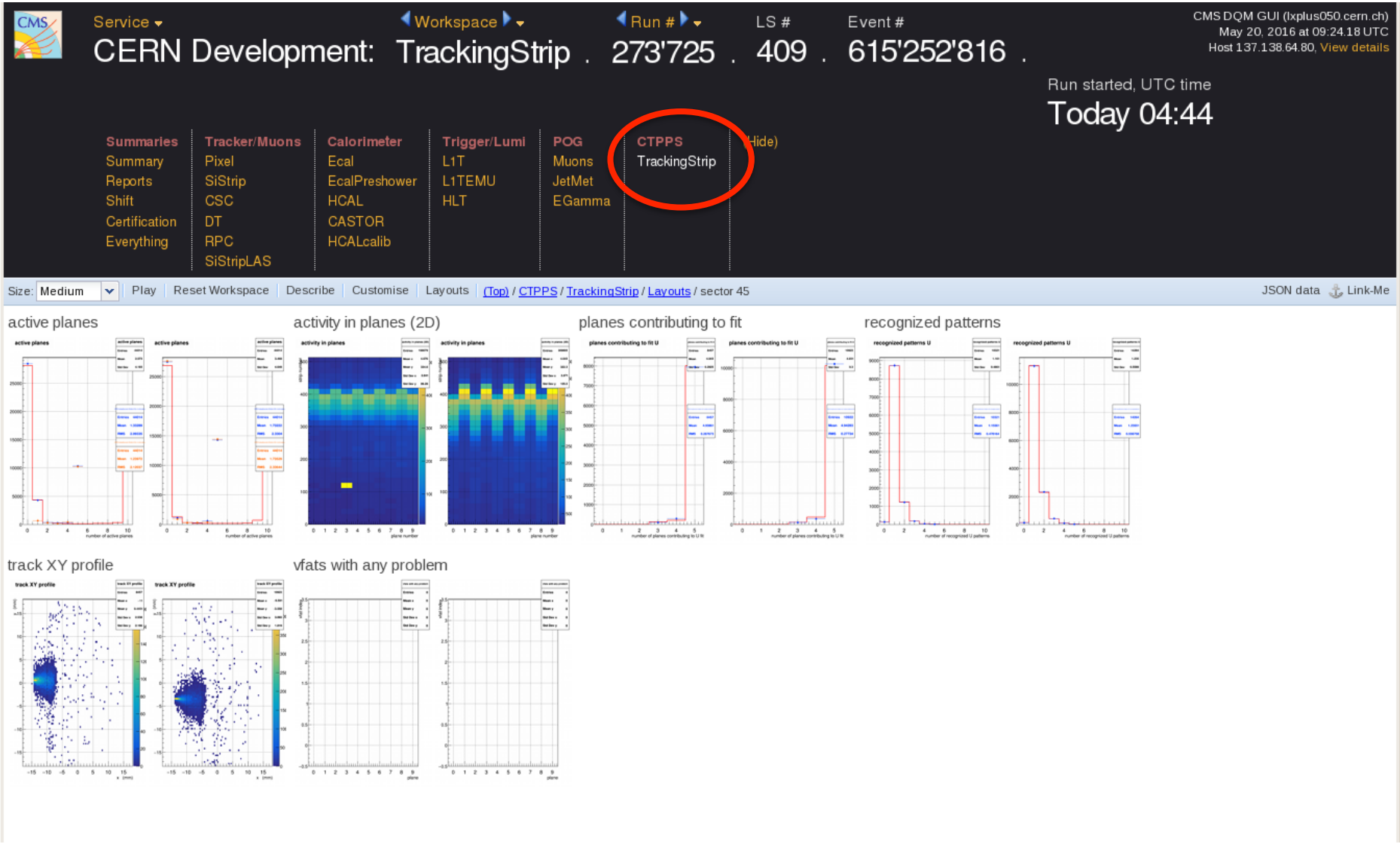


Single track

Multiple trac

Showers.

DQM in CMS system



conclusions

- Inter-operation of TOTEM systems with CMS has been demonstrated
- Silicon Strips detectors are now routinely included in the CMS global runs
- Tight schedule on several fronts for “accelerated” CT-PPS
  - up to now all deadlines have been met
  - next: TS1 installations
- The achievements of the last few months would not have been possible without help from
  - CMS DAQ group and Offline Coordinators
  - for the operations in IP5, the CMS Run Coordinators