

TOTEM STATUS REPORT

Nicola Minafra on behalf of the TOTEM Collaboration

133rd LHCC, OPEN SESSION

28 Feb 2018

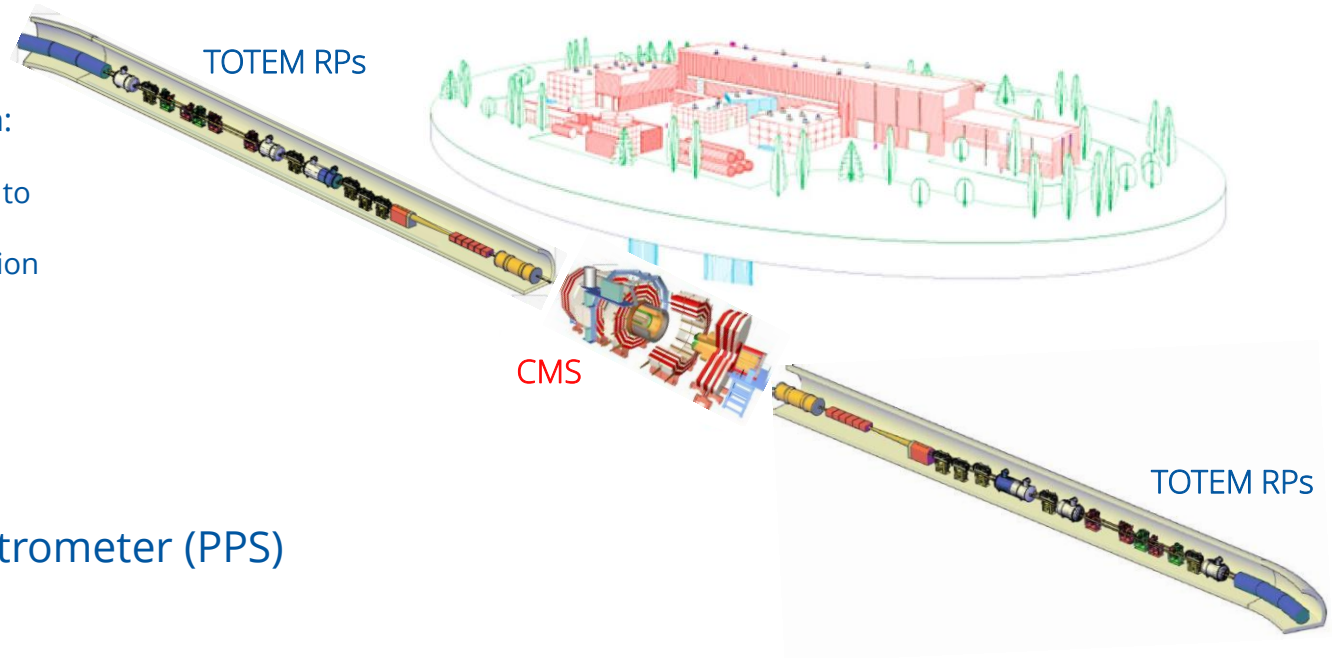


TOTEM

- Preparation for high β^* run:
TOTEM + CMS dedicated to
low mass central diffraction
- YETS activities
- Recent publications

Proton Precision Spectrometer (PPS)

- YETS activities
- Luminosity collected in 2017
- Detectors performance
- Recent publications



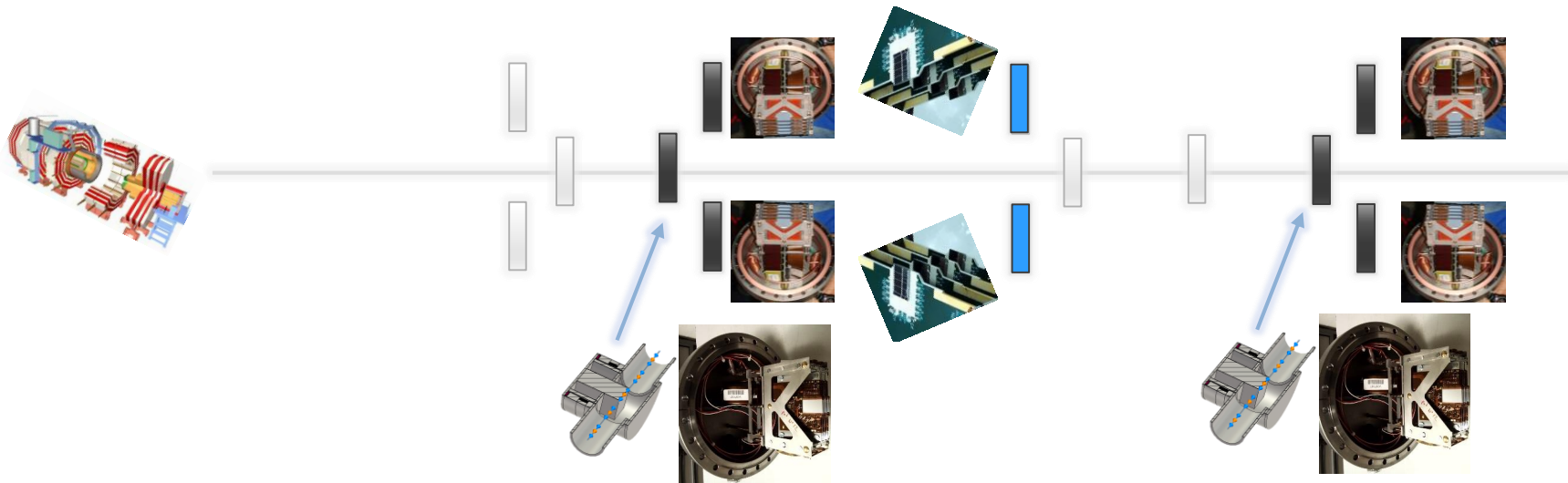
RP configurations: TOTEM

High β^* runs

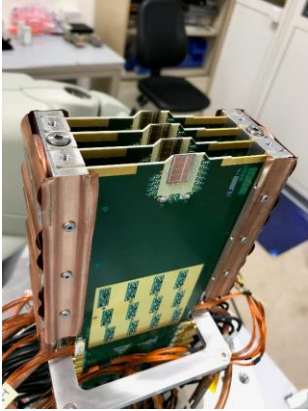
Expected after TS1 (July)

- 6 Vertical RPs
- 2 Horizontal RPs (only alignment)
- 4 Tracking (strip)
- 2 Timing (UFSD)
- Tracking (pixel)

PER ARM



YETS activities: TOTEM Timing



Ultra Fast Silicon Detectors (UFSDs)
Thin (50 μm) silicon detectors with a gain layer

- 12 channels per plane
- 4 planes per package
- 2 packages per arm (top and bottom)
- Time precision better than 50 ps per plane



SAMPIC

- 16 channels/chip
- Up to 64 samples/hit @ 10 GSa/s
- 1.5 GHz bandwidth
- 8-11 bit resolution
- 0.2-1.6 μs channel dead time

Trigger matching and event building
done in the Digitizer Board

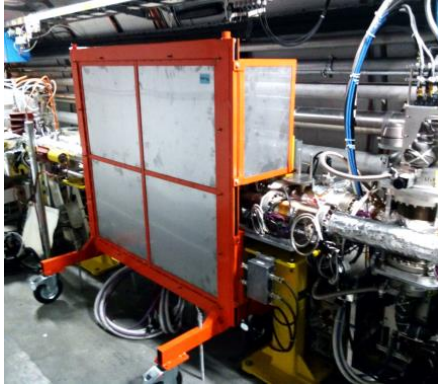
✓ Strip detectors
dismounted from
vertical RPs

✓ UFSD planes prepared and
tested
✓ Detector packages tested for
vacuum, cooling and electrical
functionality

✓ Digitizer Boards (DBs)
V3 produced
✓ Firmware for SAMPIC
ready

✓ Detectors installed
✓ DBs V3 with SAMPIC installed
✓ Final tests on-going...
✓ CMSSW update on-going...

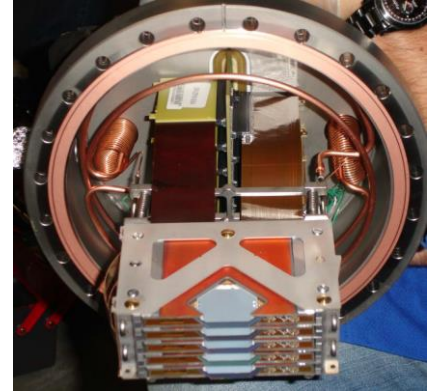
YETS activities: TOTEM Tracking



- ✓ Radiation shield near TCL6 installed

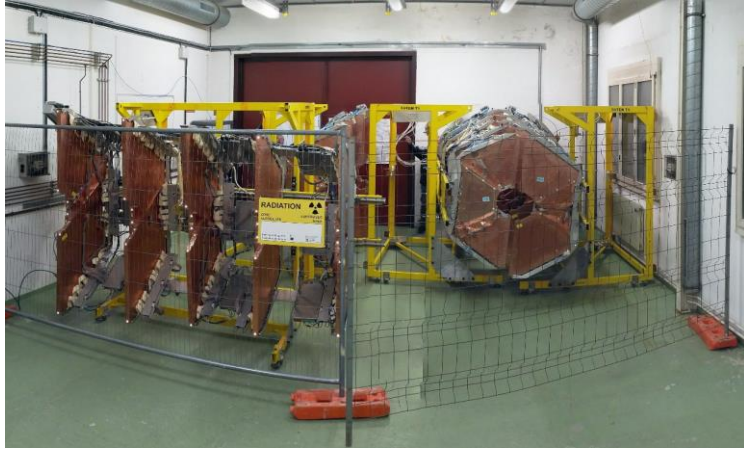


- ✓ Replaced electronics for RP movement
- ✓ Improved handling of movement

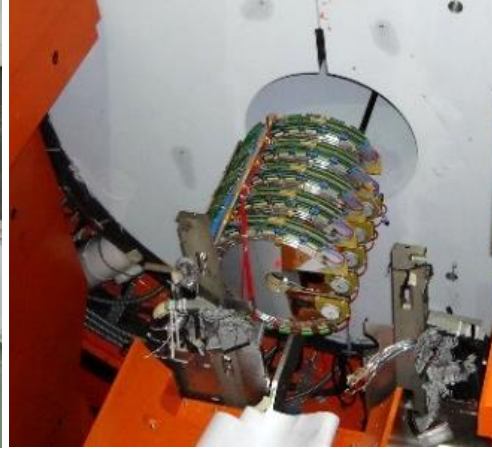


- ✓ Final tests done

YETS activities: gas telescopes



- ✓ T1 storage area prepared (radioactive area)
- ✓ T1 removed from the LHC



- ✓ T2 removed from the LHC
- ✓ T2 stored in special containers that allow storage in standard RP boxes
- ✓ T2 for HL-LHC: R&D started



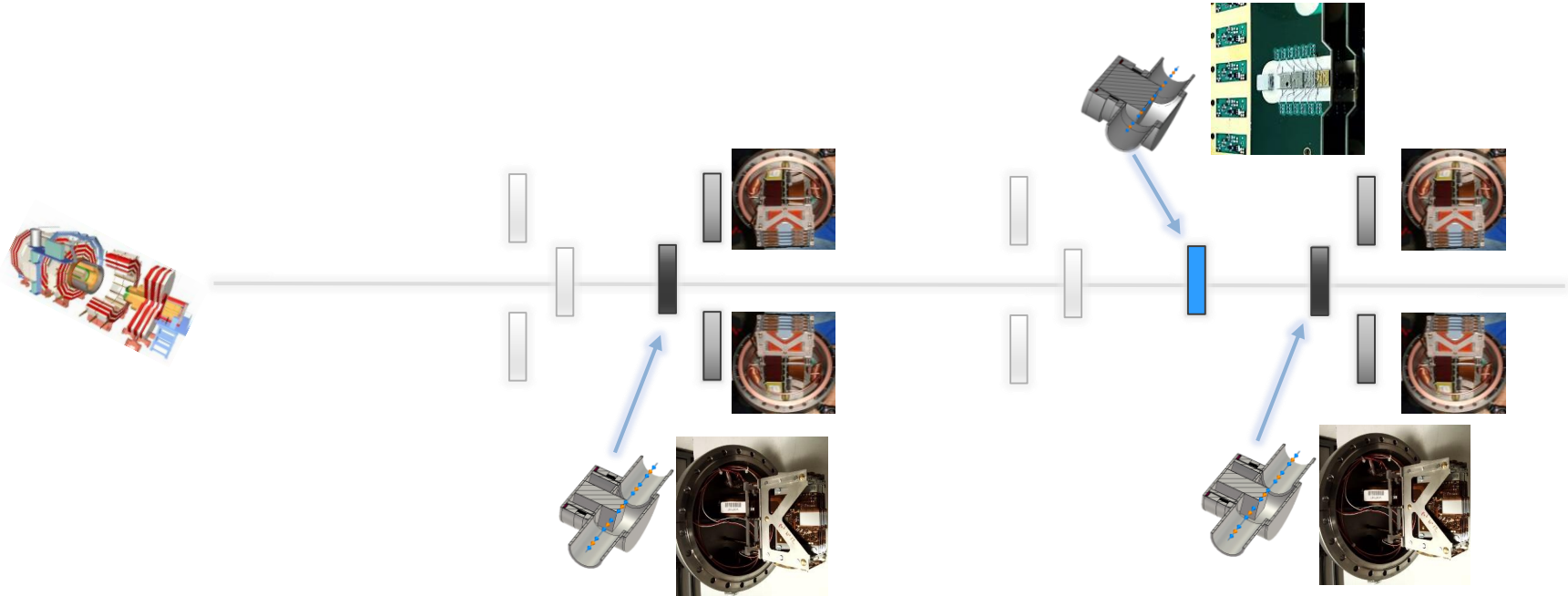
RP configurations: PPS

Normal runs (high intensity)

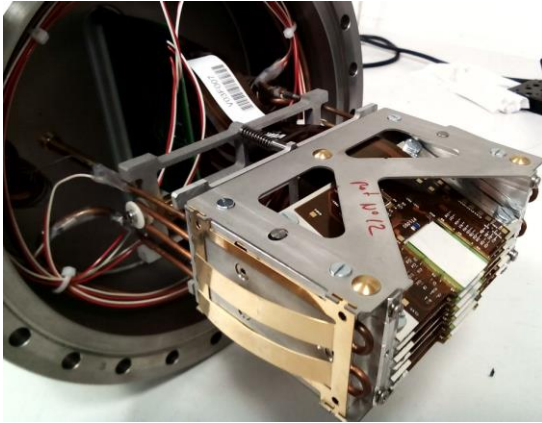
- 4 Vertical RPs (only alignment)
- 2 Horizontal Shielded RPs
- Cylindrical RP

- 4 Tracking (strip)
- 2 Tracking (pixel)
- Timing (Diamond)

PER ARM

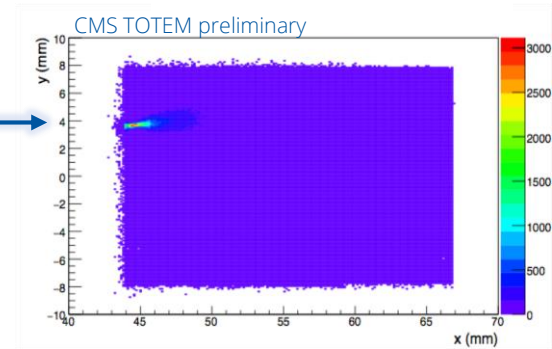


YETS activities: PPS Tracking



Pixel detectors irradiated mostly in a thin region

Exchanging the detector packages between 45 and 56 the beam will be aligned with a non irradiated region



Track impact points reconstructed from the 3D pixel detector package (sector 45).

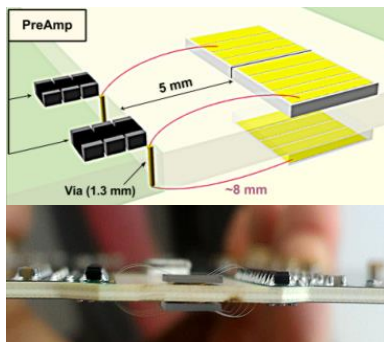
- ✓ 2 strip detectors removed
- ✓ 4 pixel detectors ready

- ✓ Pixel detectors removed to be exchanged 45 with 56
- ✓ R&D to introduce a remotely controlled vertical micro-movement for larger radiation tolerance

- ✓ 4 Detectors installed: all PPS trackers
- ✓ CMSSW updated
- ✓ Final tests on-going...

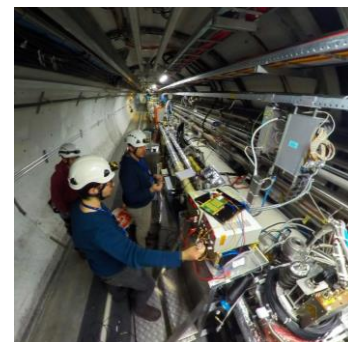


YETS activities: PPS Timing



Double Diamond detectors
Two sCVD diamond sensors read out in parallel with the same amplifier

- 12 channels per plane
- 2 planes per package (plus 2 single diamond)
- Time precision better than 50 ps per plane



- ✓ Timing detectors dismantled
- ✓ Digitizer Boards (DBs) V3 produced

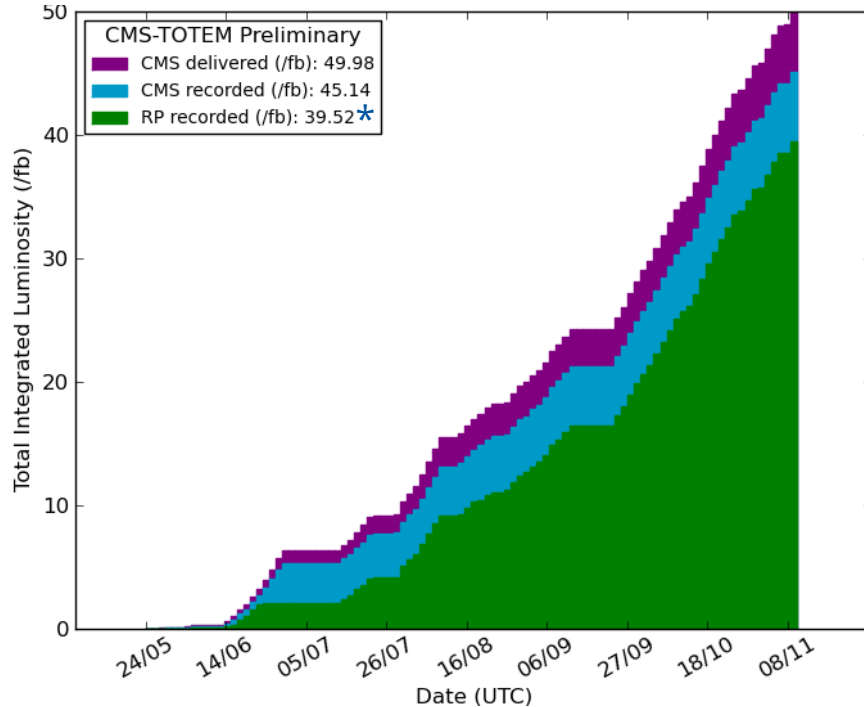
- ✓ 2 UFSD planes removed
- ✓ 2 diamond planes reused
- ✓ 2 diamond planes prepared
- ✓ 4 "double diamond" planes prepared

- ✓ Detector packages tested for vacuum, cooling and electrical functionality
- ✓ DBs V3 tested

- ✓ Detectors installed
- ✓ DBs V3 installed
- ✓ CMSSW updated
- ✓ Final tests on-going...

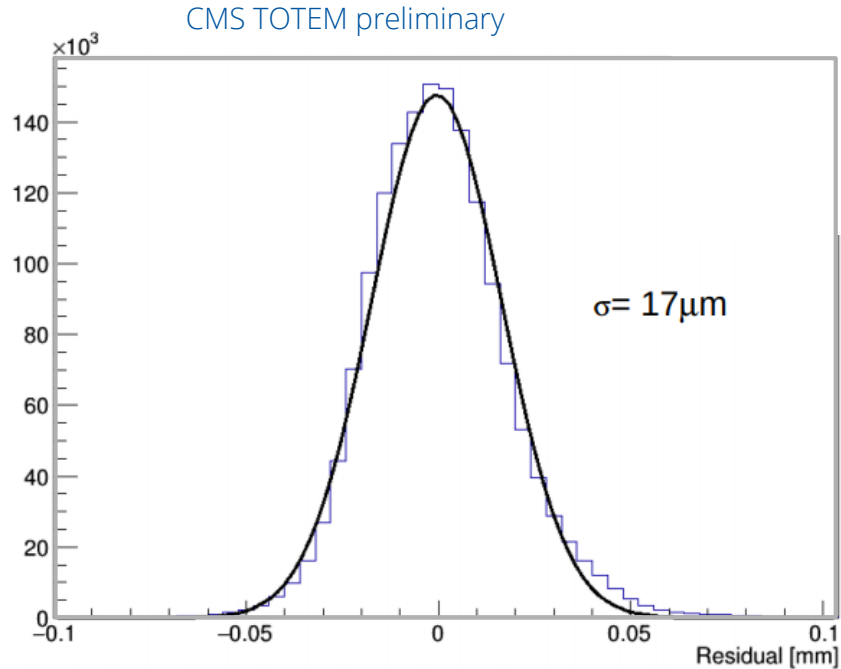
Online Luminosity 2017

Starting from **CMS-online Luminosity** measurements, it is possible to measure the fraction collected with RPs inserted



*: Luminosity collected by CMS with RPs inserted in the beam

Performance of the pixel detectors



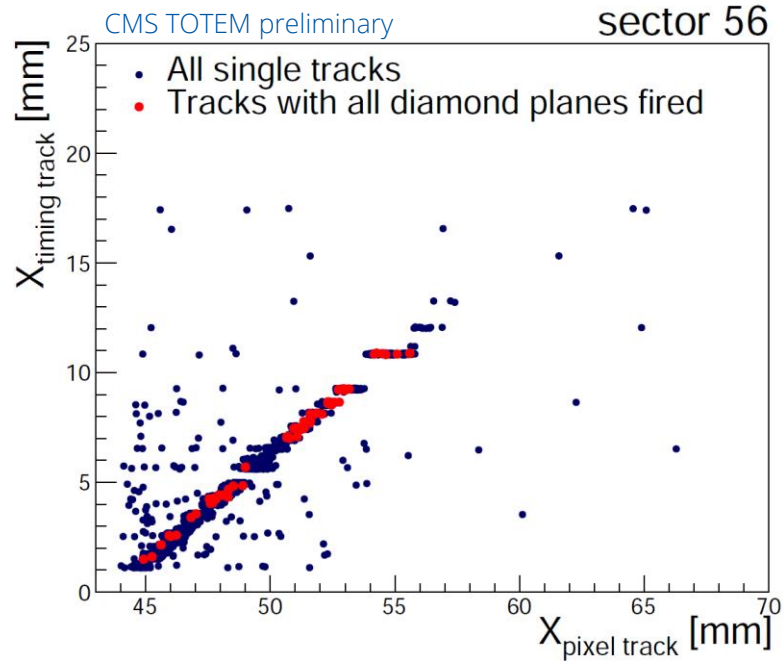
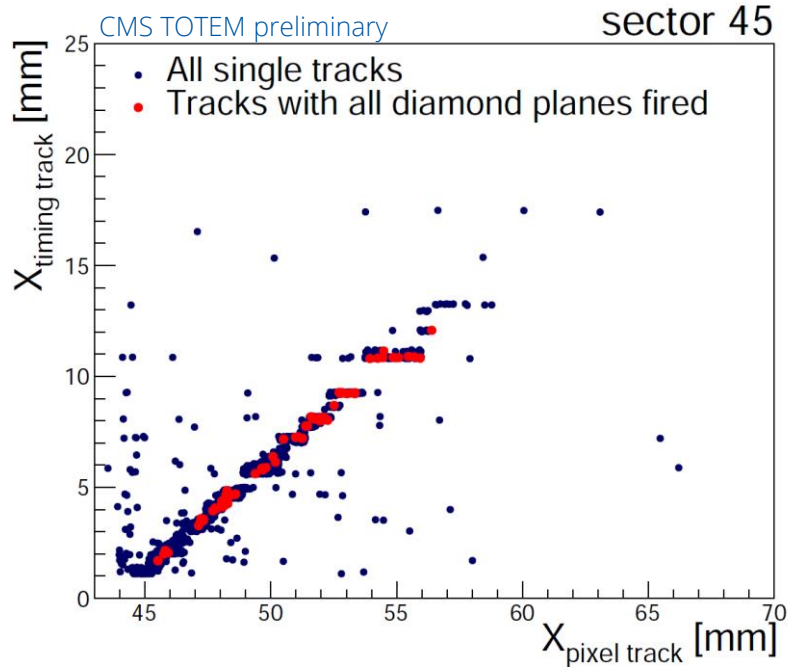
Hit residuals for single planes are evaluated with respect to the local track reconstructed in the pixel RP.

Residuals are consistent with those obtained at the beam tests.

The pixel tracker works as expected.

Tracks with the timing detectors

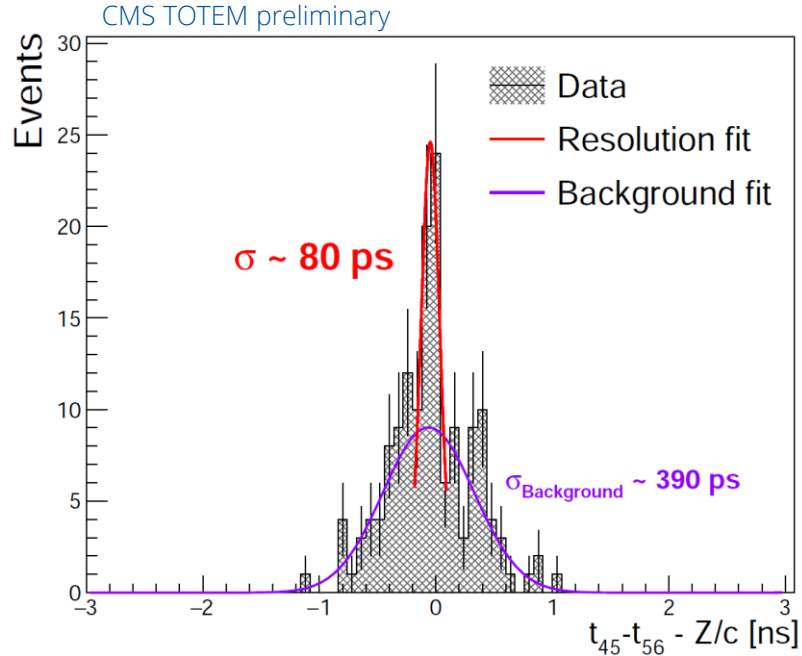
The horizontal position of the reconstructed tracks in the timing detectors can be correlated with the tracks reconstructed in the pixel detectors



Low pileup data ($\langle \text{PU} \rangle \sim 0.8$) requiring:

- 1 vertex in CMS,
- 1 track (per arm) in Pixel Detector,
- 1 track (per arm) in Timing Detector,
- single hit per plane in the Timing Detectors

Performance of the timing (diamond) detectors



Selections:

- Pile up ~ 0.8
- RF precision clock
- single vertex reconstructed in CMS
- single track reconstructed in PPS pixel detector
- all PPS diamond planes with a single hit
- total mass of CMS particle flow objects reconstructed in each event greater than 320 and less than 1500 GeV (double arm acceptance region of PPS)

Precision per arm: $\sigma_{\text{arm}} \sim \frac{80 \text{ ps}}{\sqrt{2}} \sim 56 \text{ ps} \quad \rightarrow \quad \sigma_z \sim 17 \text{ mm}$

Precision per plane: $\sigma_{\text{plane}} \sim \sigma_{\text{arm}} \sqrt{3} \sim 100 \text{ ps}$

More statistics collected...

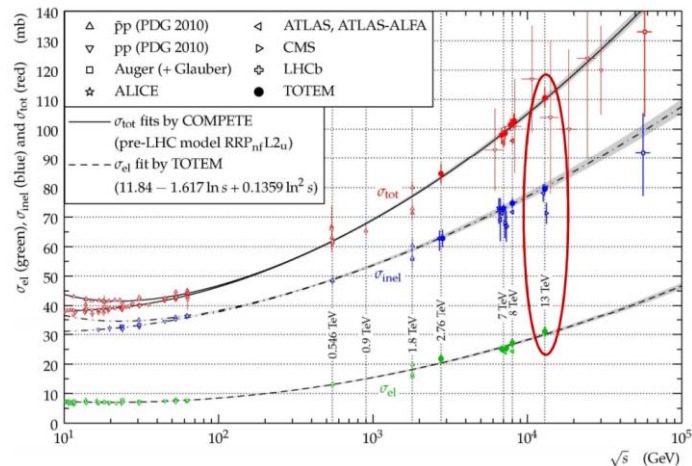
Poster (Diego Figueiredo):

Operation and performance of new detectors in the CMS-TOTEM Precision Proton Spectrometer

Highlights on Papers

First measurement of elastic, inelastic and total cross-section at $\sqrt{s} = 13$ TeV by TOTEM and overview of cross-section data at LHC energies

CERN-EP-2017-321



$$\sigma_{el} = 31.0 \pm 1.7 \text{ mb}$$

$$\sigma_{inel} = 79.5 \pm 1.8 \text{ mb}$$

$$\sigma_{tot} = 110.6 \pm 3.4 \text{ mb}$$

EUROPEAN ORGANIZATION FOR NUCLEAR RESEARCH

TOTEM 2017-401

CERN-PH-EP-2017-231
December 15, 2017

First measurement of elastic, inelastic and total cross-section at $\sqrt{s} = 13$ TeV by TOTEM and overview of cross-section data at LHC energies

The TOTEM Collaboration

G. Antchev⁹¹, P. Aspell⁹¹, I. Atanassov⁹¹, V. Avati^{7,91}, J. Baechler⁹¹, C. B. Barrera¹⁰⁹, V. Berardi^{14,91}, M. Beretti⁹¹, E. Bossini⁹¹, U. Bottigli⁹¹, M. Bozzo^{91,101}, H. Burkhardt⁹¹, F. S. Cafagna⁹¹, M. G. Cacciari⁹¹, M. Cacciari^{91,101}, T. Côté^{91,101}, M. Delle⁹¹, F. De Lorenzis^{6,91}, A. D'Orazio^{6,91}, M. Douček⁹¹, D. Drouot⁹¹, K. Eggert⁹¹, V. Eremin⁹¹, F. Ferro⁹¹, A. Fiegobski⁹¹, F. Garcia²⁰, V. Georgiev⁹¹, S. Gianini⁹¹, L. Grzanek⁹¹, J. Hammerbauer⁹¹, J. Heine⁹¹, P. Helander^{26,29}, T. Hildner⁹¹, V. Ivanchenko¹¹, M. Janku⁹¹, A. Kuro⁹¹, J. Kalyan^{6,91}, J. Koppen⁹¹, V. Kramida⁹¹, S. Lami⁹¹, G. Lattio⁹¹, R. Laubakanga⁹¹, E. Lohari⁹¹, C. Lindos¹⁰⁹, M. V. Lokajický⁹¹, L. Losurdo⁹¹, M. Lo Vetere^{6,91}, F. Lucas Rodriguez⁹¹, M. Macri⁹¹, M. Malawaś^{7,91}, N. Minafra¹⁰⁹, S. Mmolo⁹¹, T. Naaranja⁹¹, F. Nemes⁹¹, H. Niewiadomski⁹¹, T. Nowak⁹¹, E. Oliveri⁹¹, F. Ojman^{91,101}, M. Orsini⁹¹, K. Osterberg^{91,101}, P. Palazzi⁹¹, V. Passarelli⁹¹, Z. Peroutka⁹¹, J. Procházka⁹¹, M. Quins^{6,91}, E. Rademacher⁹¹, E. Radicioni⁹¹, F. Ravotti⁹¹, E. Robutti⁹¹, C. Royon⁹¹, G. Roggiani⁹¹, H. Saarikko^{91,101}, A. Scribano⁹¹, J. Sinyk⁹¹, J. Smajek⁹¹, W. Swojski⁹¹, R. Stefanowicz⁹¹, J. Sukić⁹¹, C. Taylor⁹¹, E. Tcherniaev⁹¹, N. Tantar⁹¹, V. Vaček⁹¹, J. Weizsäcker⁹¹, J. Williams¹⁰⁹, P. Wysłowski⁷, J. Zich⁹¹, K. Zieliński⁷

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Submitted to Phys. Rev. D

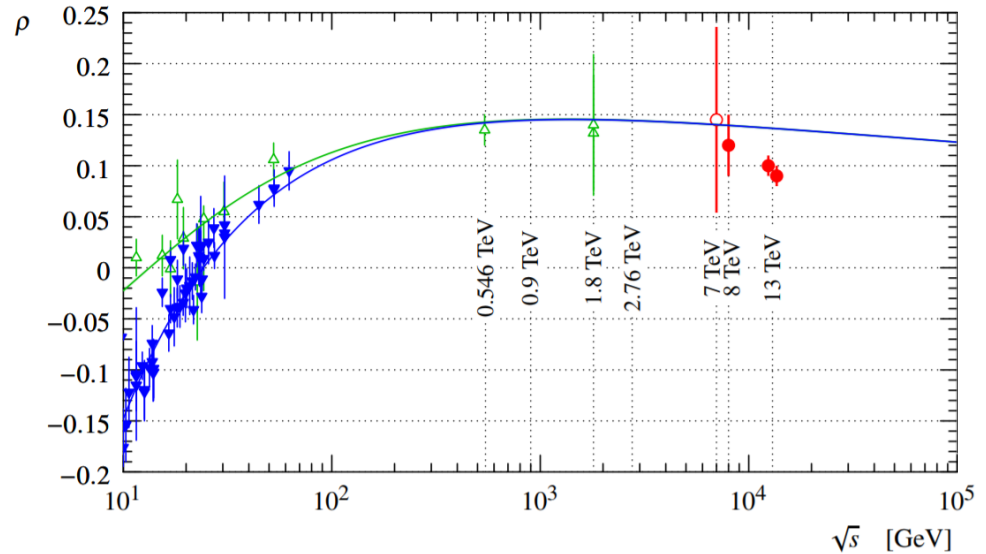
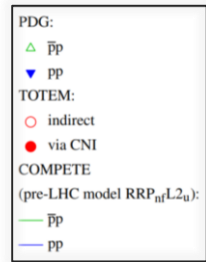


Highlights on Papers



First determination of the ρ parameter at $\sqrt{s} = 13$ TeV – probing the existence of a colourless three-gluon bound state

CERN-EP-2017-335



Submitted to Phys. Rev. D



Highlights on Papers



CMS PAPER PPS-17-001
TOTEM-NOTE-2017-003

DRAFT
CMS Paper

The content of this note is intended for CMS internal use and distribution only

2018/02/20
Head Id: 447011
Archive Id: 447037P
Archive Date: 2018/02/20
Archive Tag: trunk

Observation of proton-tagged, central (semi)exclusive production of high-mass lepton pairs in pp collisions at 13 TeV with the CMS-TOTEM Precision Proton Spectrometer

The CMS and TOTEM Collaborations

Abstract

The process $pp \rightarrow p(\ell^+\ell^-p')$, with $\ell^+\ell^-$ a muon or an electron pair produced at midrapidity with mass larger than 110 GeV, has been observed for the first time at the LHC in pp collisions at $\sqrt{s} = 13$ TeV. One of the two scattered protons is measured in the CMS-TOTEM Precision Proton Spectrometer (CT-PPS), which operated for the first time in 2016. The second proton either remains intact or is excited and then dissociates into a low-mass state p' , which is undetected. The measurement is based on an integrated luminosity of 9.4 fb^{-1} collected during standard, high-luminosity LHC operation. A total of $12 \mu^+\mu^-$ and $9 e^+e^-$ pairs with $m(\ell^+\ell^-) > 110$ GeV, and matching forward proton kinematics, are observed, with expected backgrounds of 1.49 ± 0.07 (stat) ± 0.53 (syst) and 2.36 ± 0.09 (stat) ± 0.47 (syst), respectively. This corresponds to an excess of more than five standard deviations over the expected background. The present result constitutes the first observation of proton-tagged $\gamma\gamma$ collisions at the electroweak scale. This measurement also demonstrates that CT-PPS performs according to the design specifications.

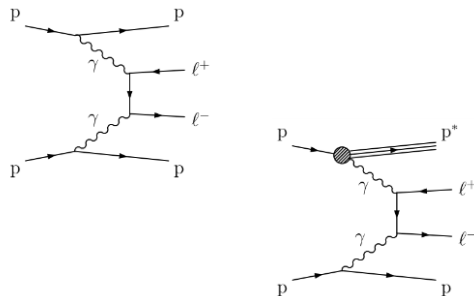
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PDFAuthor:	George Alverson, Lucas Taylor, A. Cern Person
PDFTitle:	Observation of proton-tagged, central semexclusive production of high-mass lepton pairs at 13 TeV with the CMS-TOTEM Precision Proton Spectrometer
PDFSubject:	CMS
PDFKeywords:	CMS, physics, software, computing

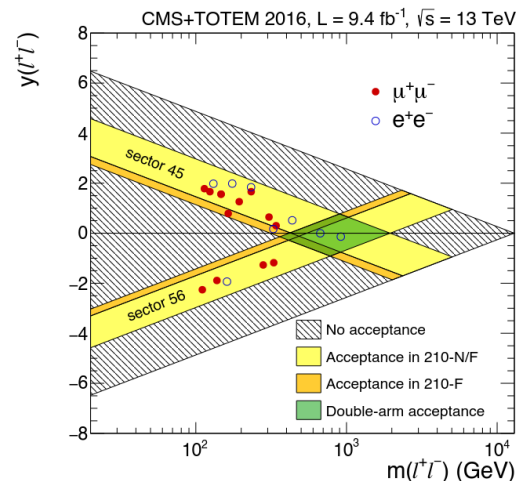
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Observation of proton-tagged, central (semi)exclusive production of high-mass lepton pairs in pp collisions at 13 TeV with the CMS-TOTEM Precision Proton Spectrometer

CMS PAPER PPS-17-001
TOTEM-2018-001



12 matching $\mu^+\mu^-$ events
BG: 1.49 ± 0.07 (stat) ± 0.53 (syst)



8 matching e^+e^- events
BG: 2.36 ± 0.09 (stat) ± 0.47 (syst)

Combined significance $> 5.1 \sigma$

Ready for submission

Poster (Ksenia Shchelina):

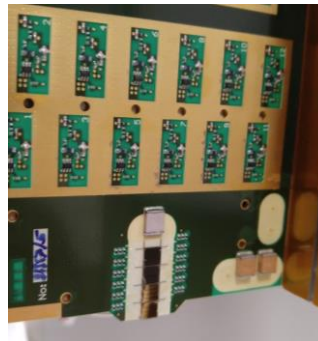
Observation of semiexclusive dilepton production with proton tag in CMS-TOTEM Precision Proton Spectrometer



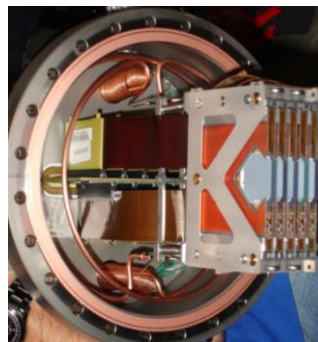
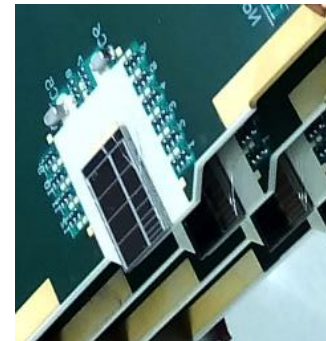
Conclusions

- detector packages (4 technologies) installed and tested during YETS
- TOTEM
 - successful installation of the detectors
 - preparation for dedicated run ($\beta^* = 90\text{m}$)
 - 2 papers submitted for publication
- PPS
 - >39 /fb collected in 2017
 - successful commissioning of the detectors
 - 1 CMS and TOTEM paper ready for submission
 - 1 paper under preparation: $\gamma\gamma \rightarrow \gamma\gamma$

Diamonds



UFSDs



Silicon strips



Silicon pixels



totem.web.cern.ch