Results, Status and Perspectives for 2011

János Sziklai

RMKI

On behalf of the TOTEM Collaboration:

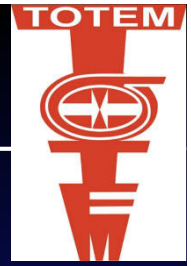
Bari, Budapest, Case Western Reserve, CERN, Genova, Helsinki, Penn State, Pisa/Siena, Prague, Tallin (~ 80 physicists)

Based on talks by

Karsten Eggert at the Resource Review Board Meeting on 12 OCT 2010

Marco Bozzo at the LHCC Meeting on 18 Nov 2010

OUTLINE



- About the TOTEM Experiment at LHC
- TOTEM Detectors and the Experimental Layout
- The Installed Roman Pot system at 220m – Runs and Results in 2010
- The T2 Inelastic Telescope – Runs and Experiences in 2010
- RP and T2 Results – Diffractive processes
- RP installations at 147m
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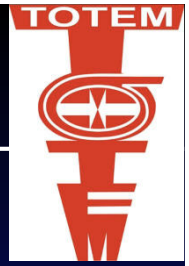
Main TOTEM Physics Goals:



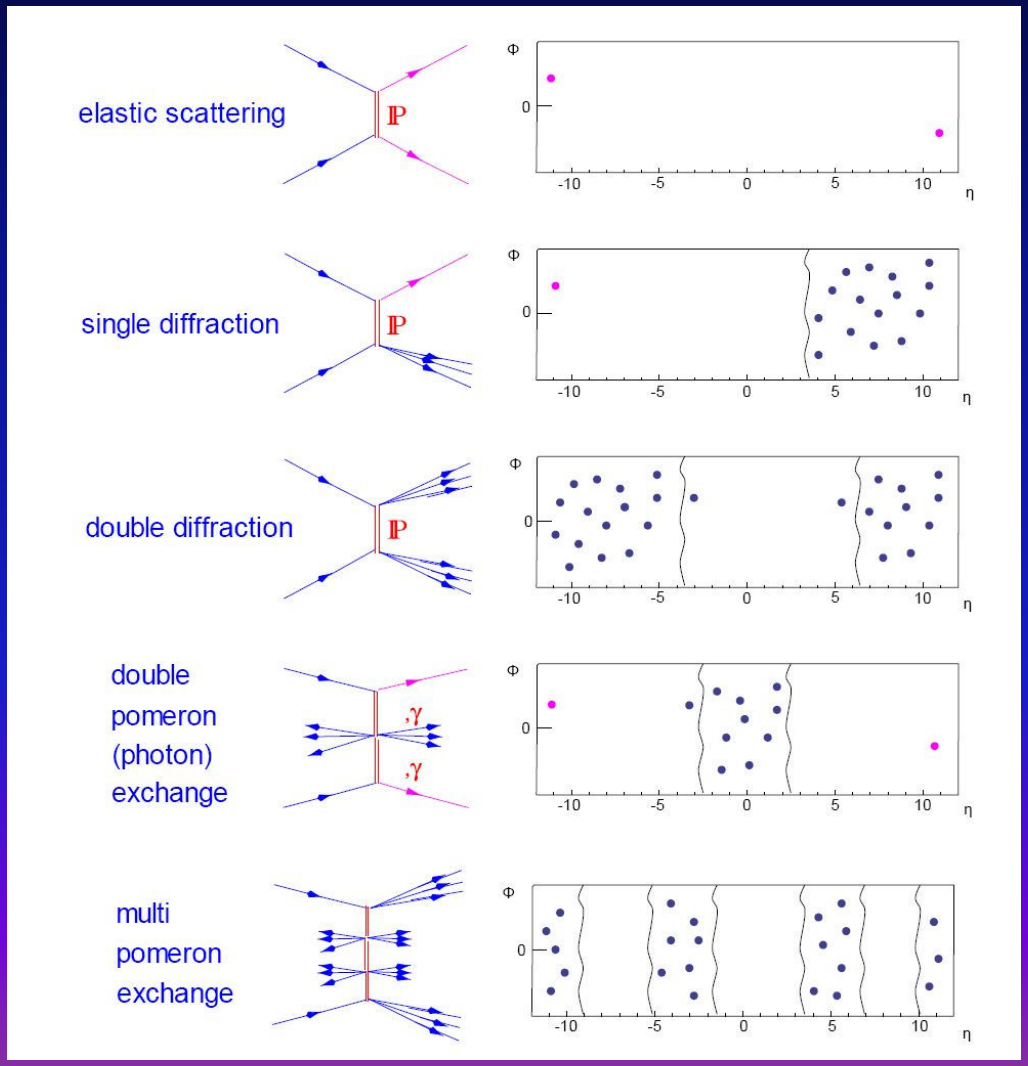
- Measuring the total cross-section with an absolute error of 1 mb by using the luminosity independent method. This requires the simultaneous measurement of the elastic pp scattering down to the four-momentum transfer of $t \approx 10^{-3}$ GeV^2 and of the inelastic pp interaction rate with an adequate acceptance in the forward region

- Measuring elastic proton scattering over a wide range in momentum transfer up to $t \approx 10$ GeV^2

- Measuring diffractive dissociation, including single, double and central diffraction topologies using the forward inelastic detectors in combination with the CMS detector.

Diffractive processes

- **Diffractive process classes and cross sections (Tevatron measured at 1.8 TeV, LHC estimated at 14TeV)**



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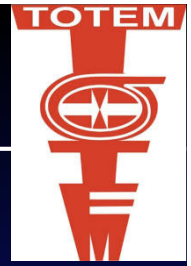

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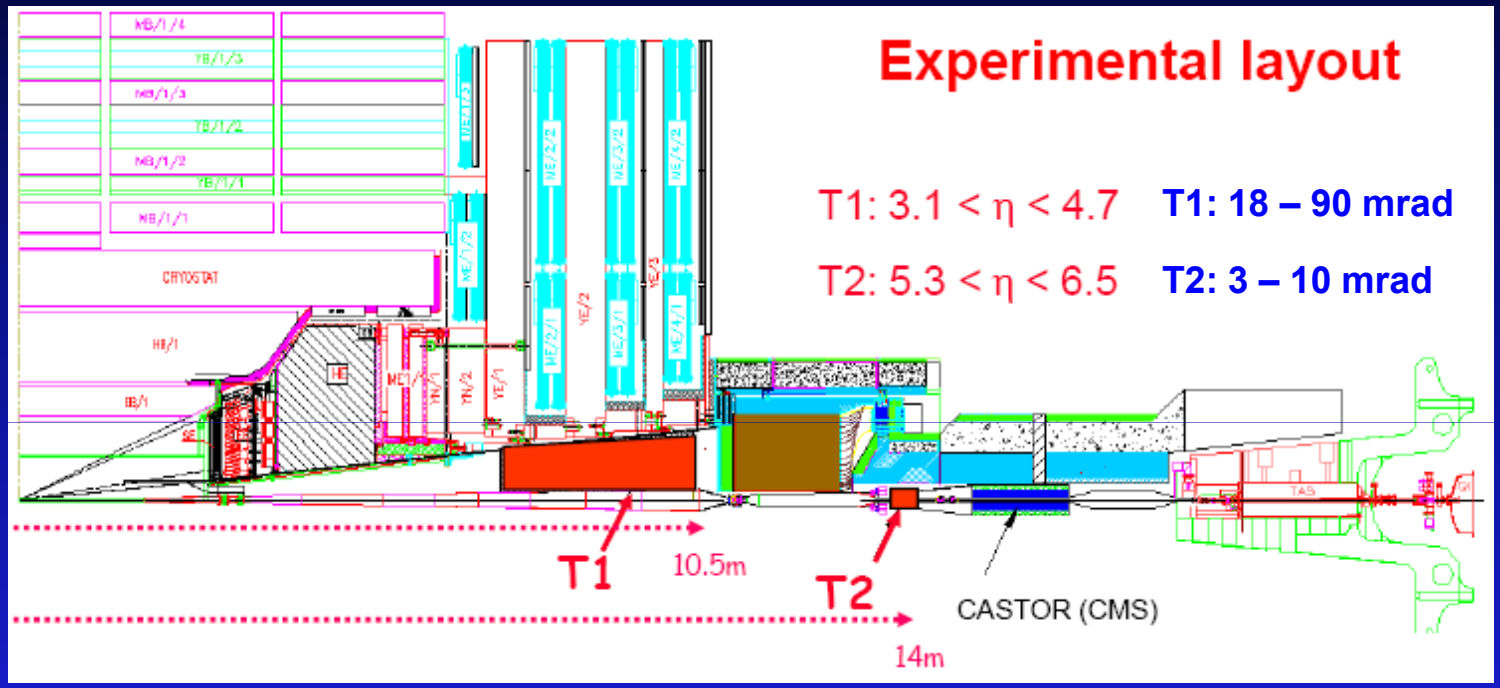
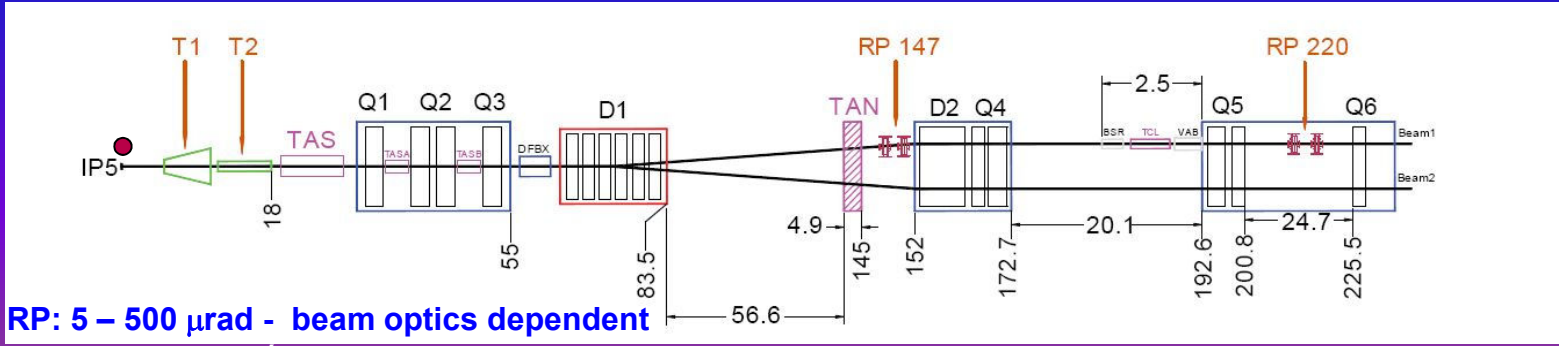
TOTEM Detectors @ IP5

Inelastic detector configurations on both side of IP5: all capable for tracking and triggering

Identifying charged particles in inelastic events & vertex reconstruction

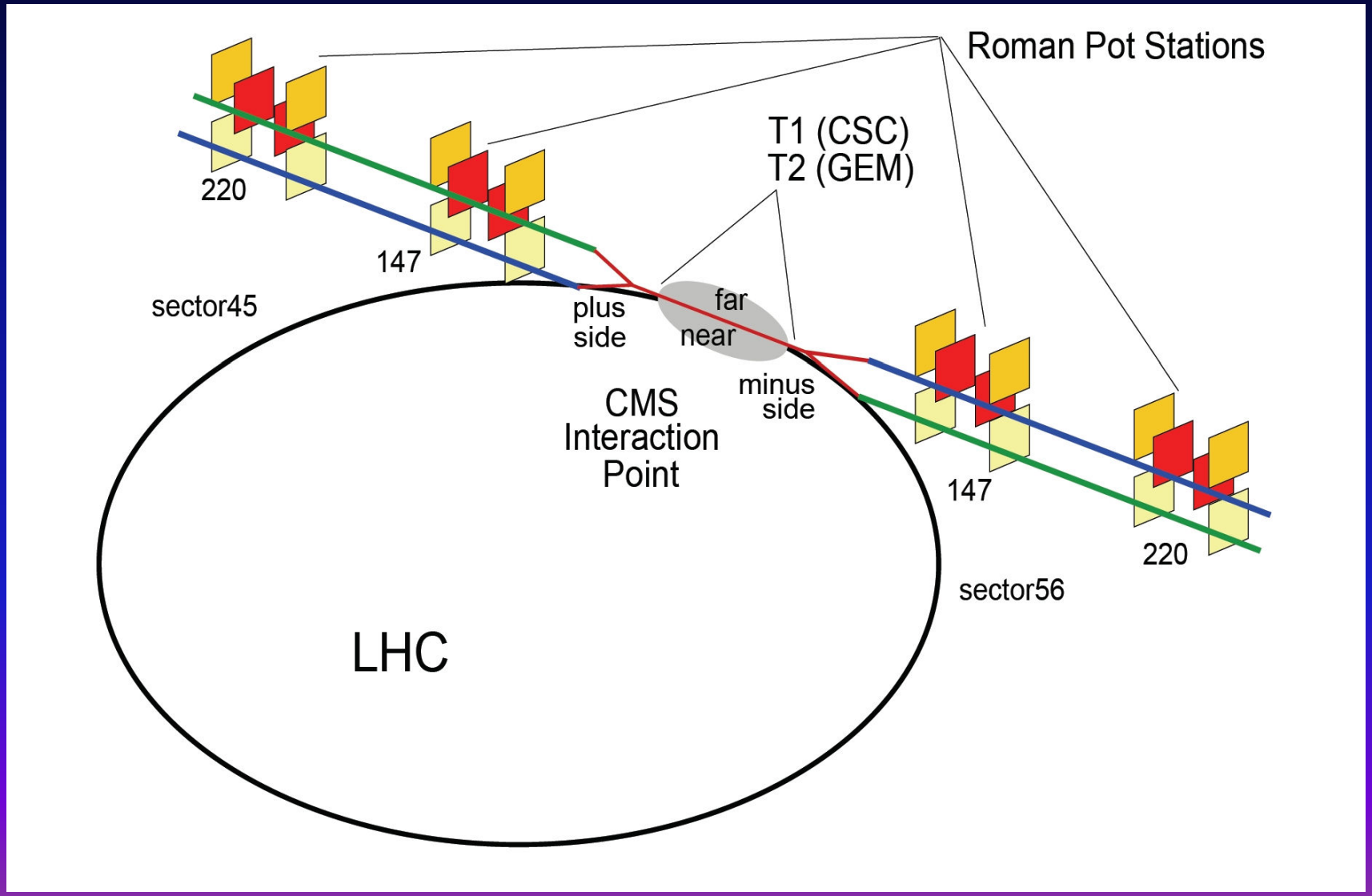


Roman Pots: measuring the elastic & inelastic protons closed to the beam



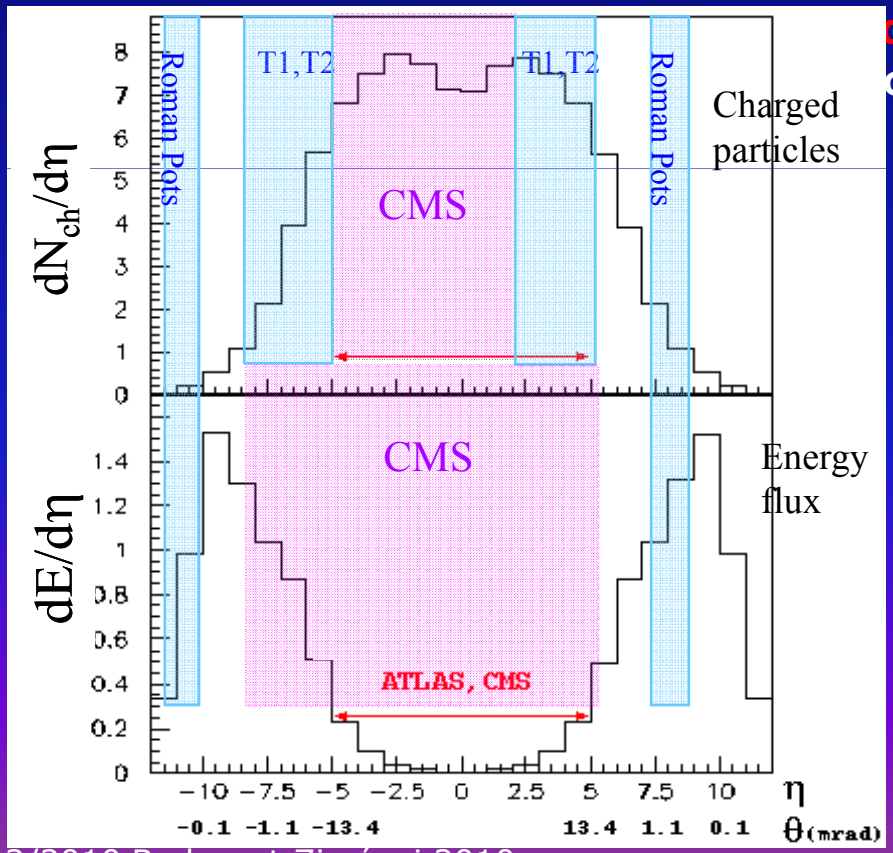
RP: 5 – 500 μrad - beam optics dependent

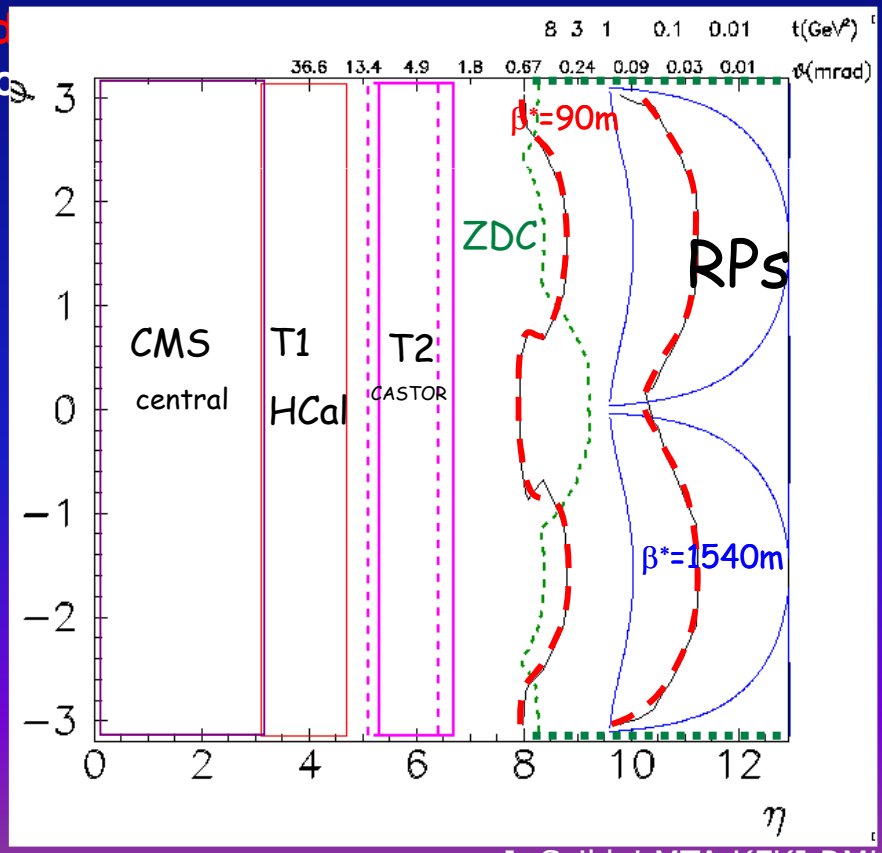
Experimental layout of the TOTEM Detectors



TOTEM capabilities

- Unique possibility of detecting charged particles with high pseudorapidity
- Ideal tool for studying forward phenomena (elastic & diffractive scattering)
- In case of inelastic events the energy flow and the multiplicity increases in forward angles





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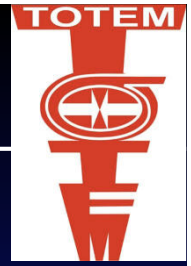

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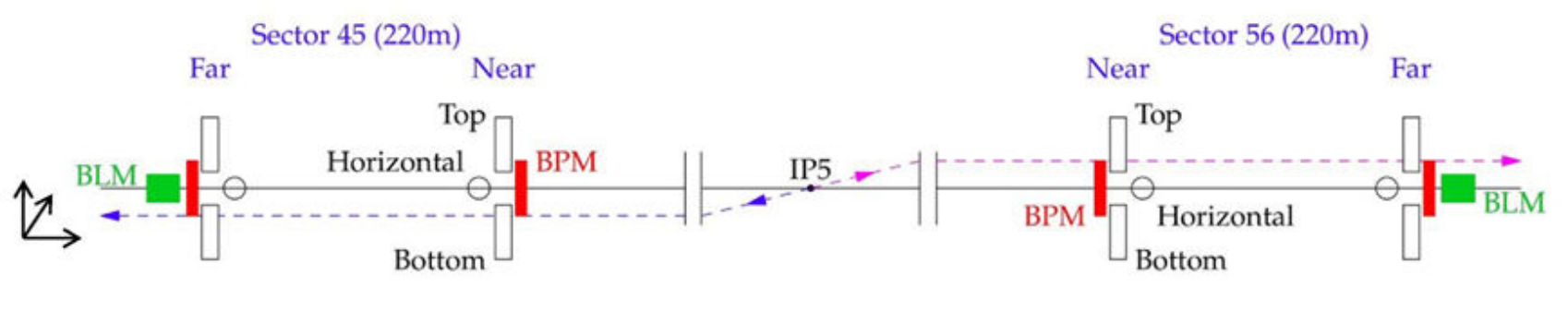
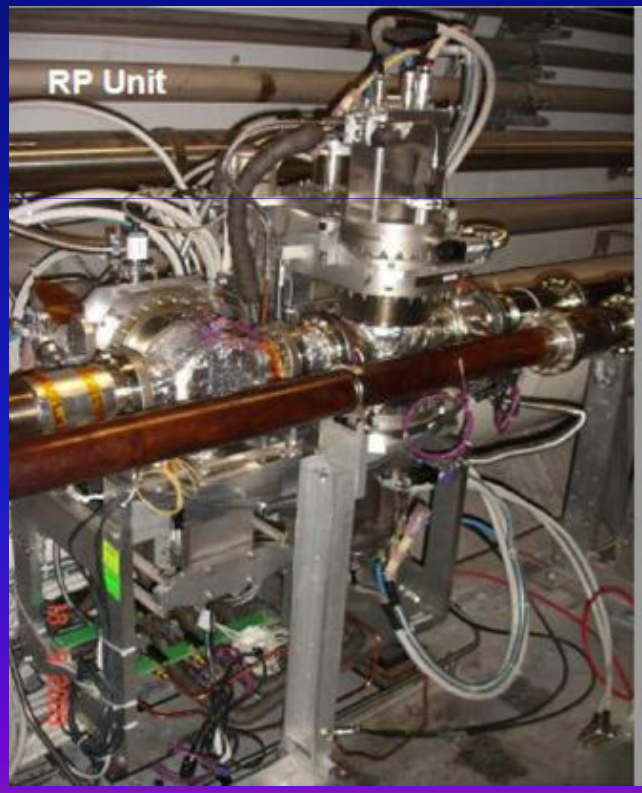
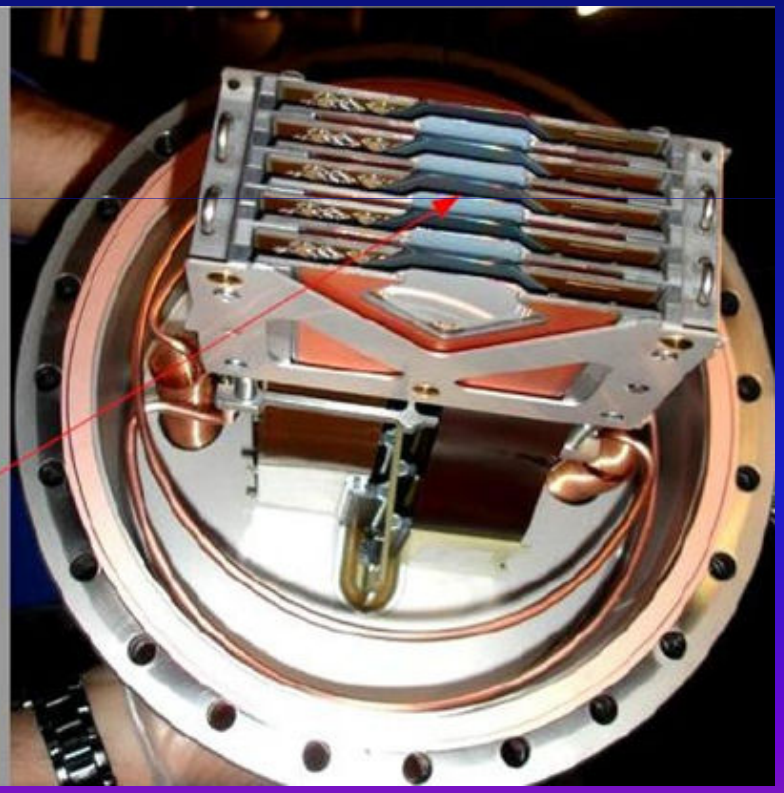
The Roman Pot System





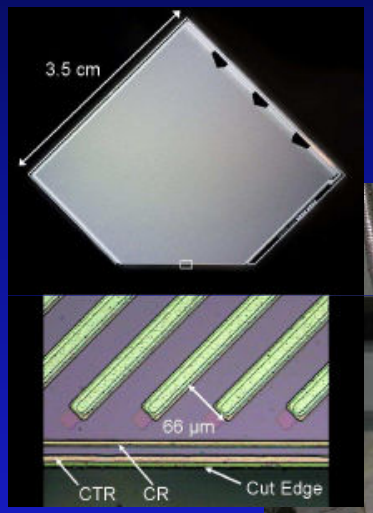
4 Stations
→ 2 Units
→ 3 pots
1 BPM
(Beam Position Monitor)

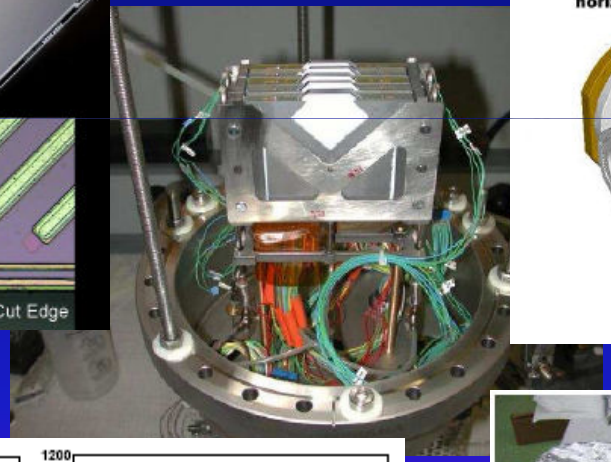
Edgeless Silicon Detectors

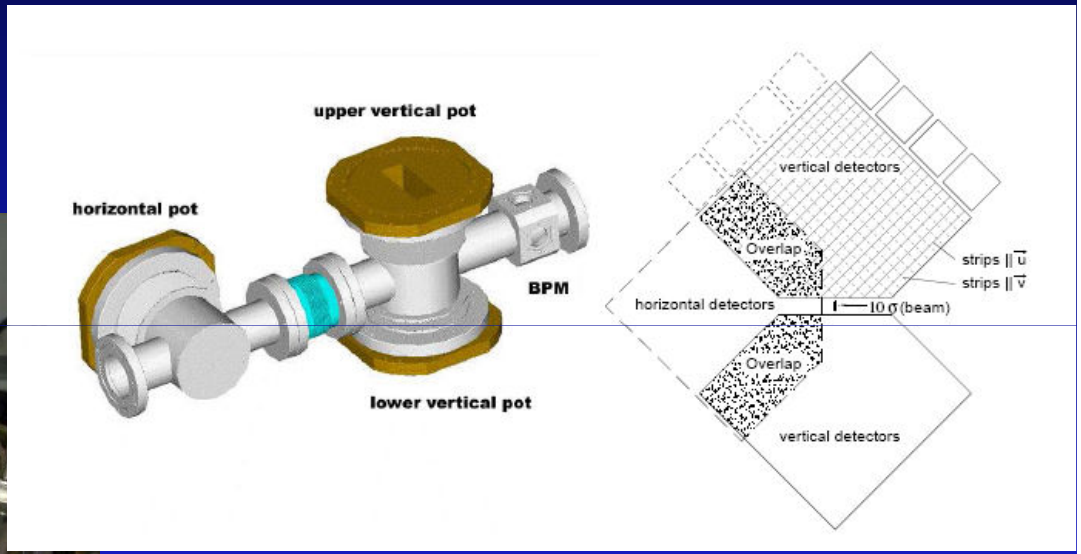


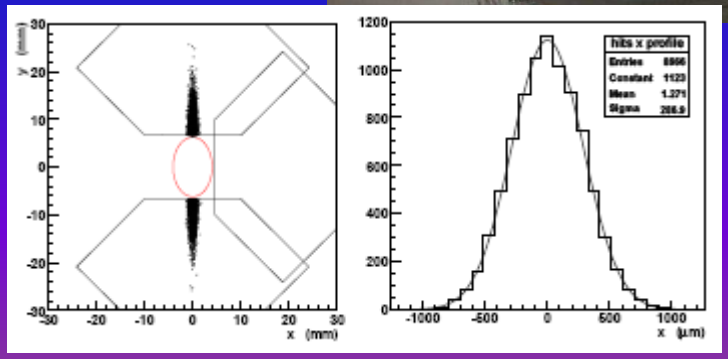
The Roman Pot System

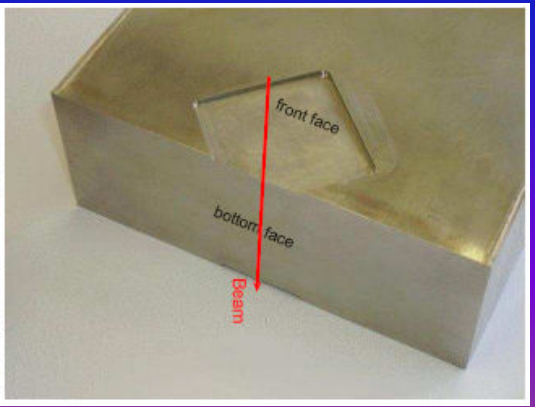
- Special movable detector assembly in a separate vacuum space
- Roman Pot pairs at a distance of 4 meters at 147 és 220 m from IP



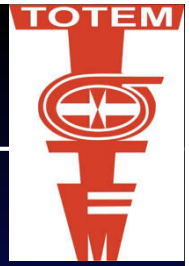








Runs and data taking 2010



- Regular running with RP approaching the beams to ~18σ to increase statistics at large *t*-values t ~3.5 GeV^2

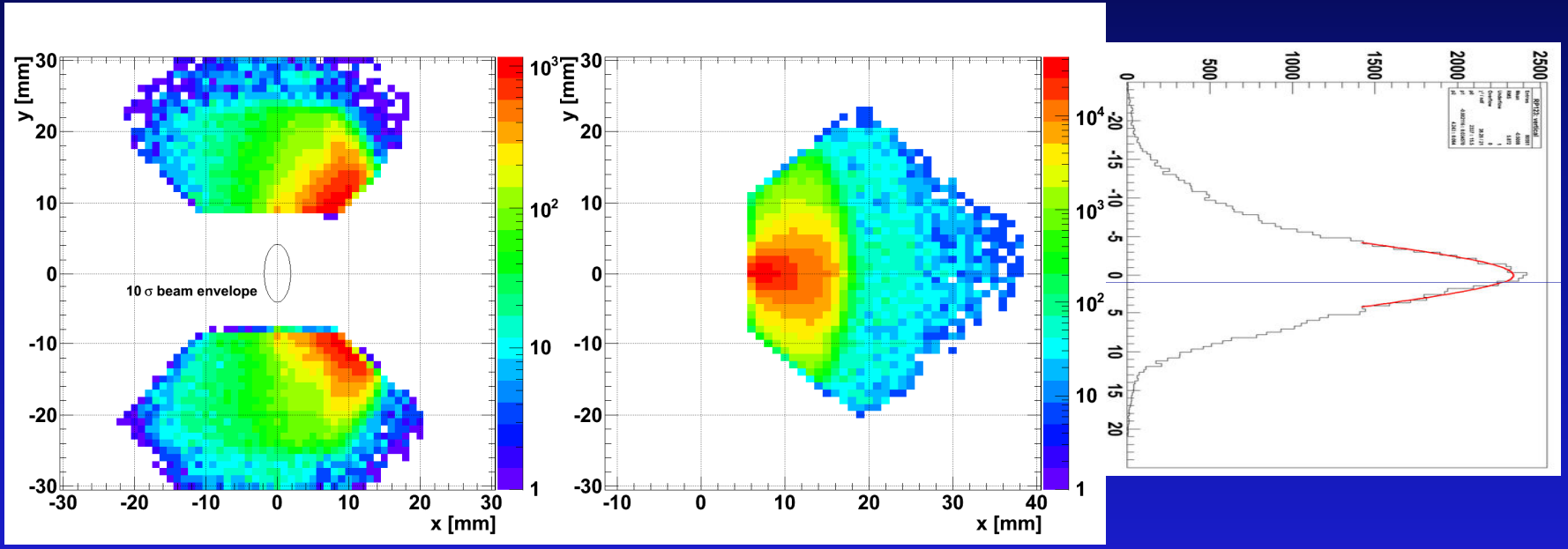
Special TOTEM Runs:

RP at	*integ. Luminosity*
20 sigma	*184 nb-1*
18 sigma	*3.5 pb-1*
7 sigma	*9.5 nb-1*

- 21.9.2010
  - RP "alignment" at 3.5 TeV to define a safe running condition with the pots as close as possible to the circulating beams
  - short data taking (one pilot bunch) with RP to 7σ
- 30.10.2010
  - Special run with low proton densities/bunch:
    1 bunch (1e10 p/b) + 4 bunches x 7e10 p/b.
  - 5 hours data taking for TOTEM
  - data with T2 at reduced pile-up on mini-bunch crossing (~ 10^{-2})

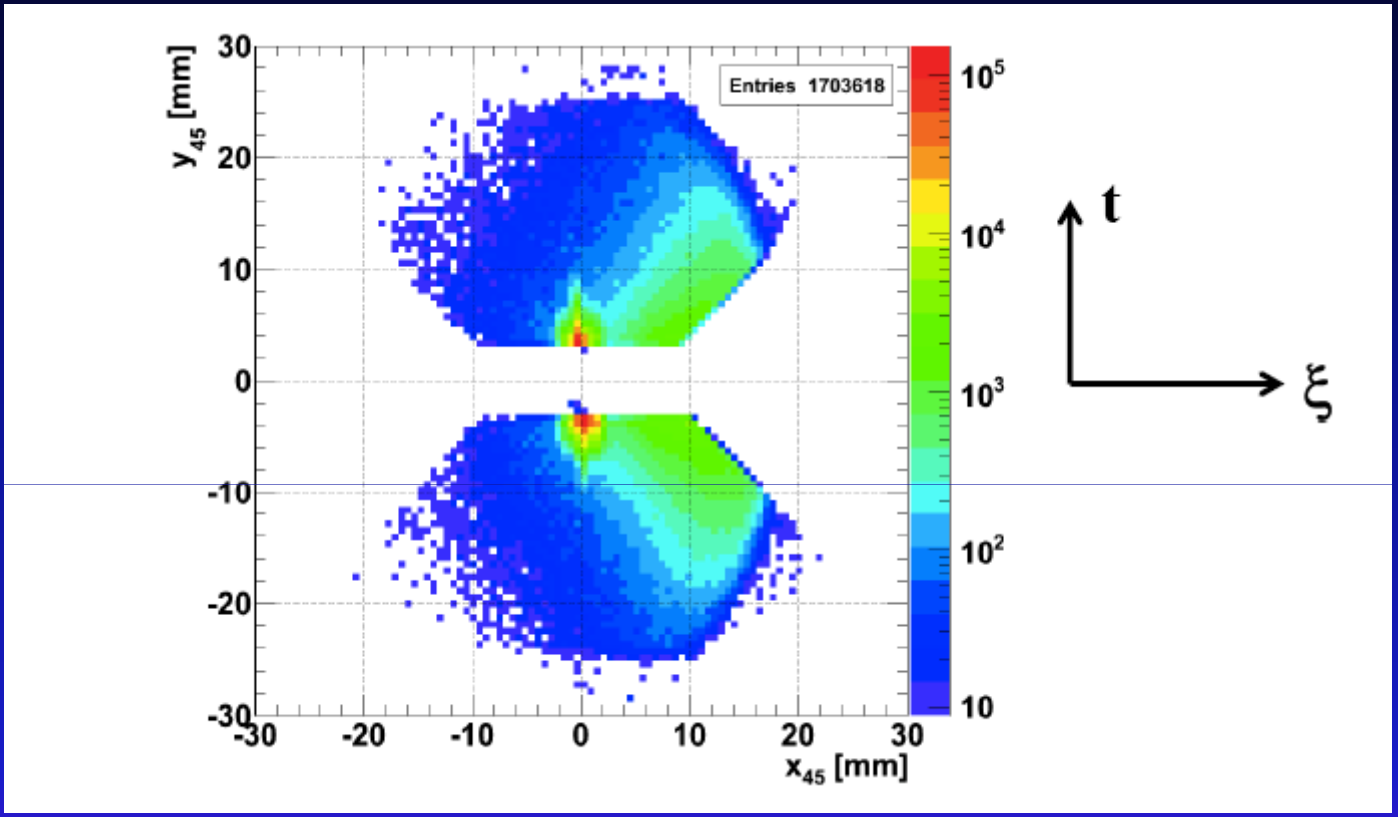
Tracks in vertical and horizontal RP detectors: Raw distribution: protons and background

Tracks distribution in the vertical RPs (left) and horizontal RP (right).



The colour scale for the panel on the right is rescaled to cope with the 10 times higher rate measured on the horizontal RP detectors.

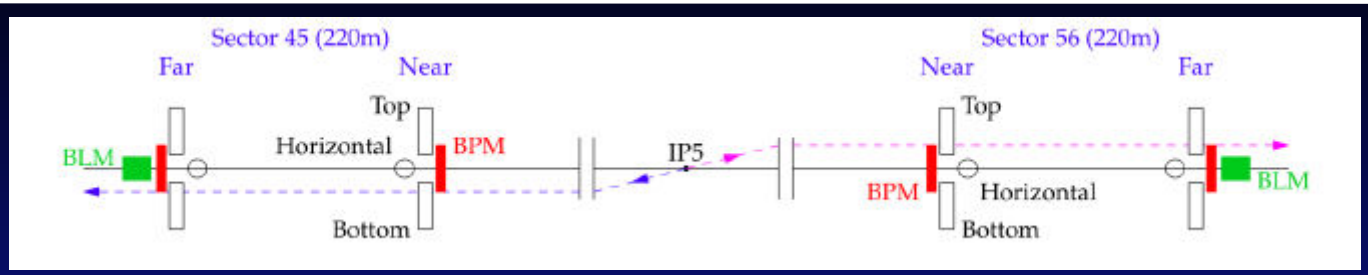
Raw distribution: reconstructed tracks
Hit map (side 4,5) for left right coincidences

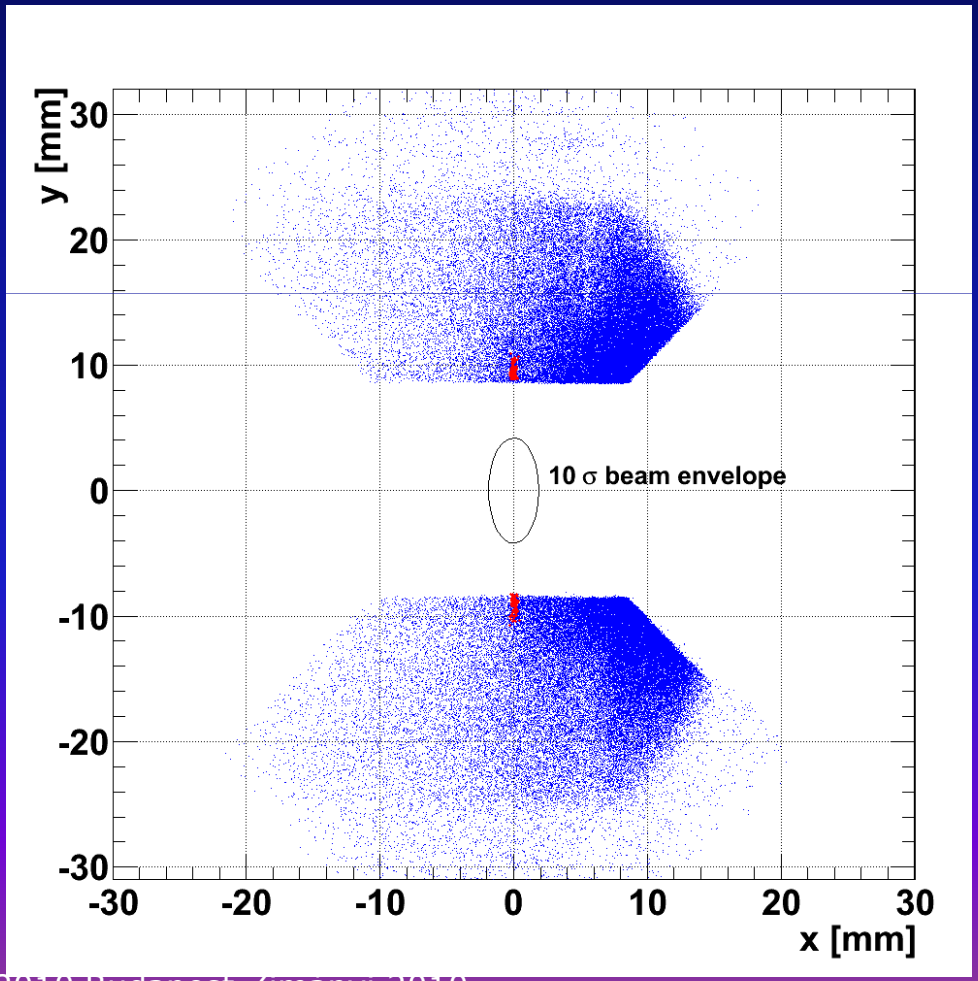


reconstructed tracks in “left AND right”

Elastic scattering in the vertical plane visible from raw data

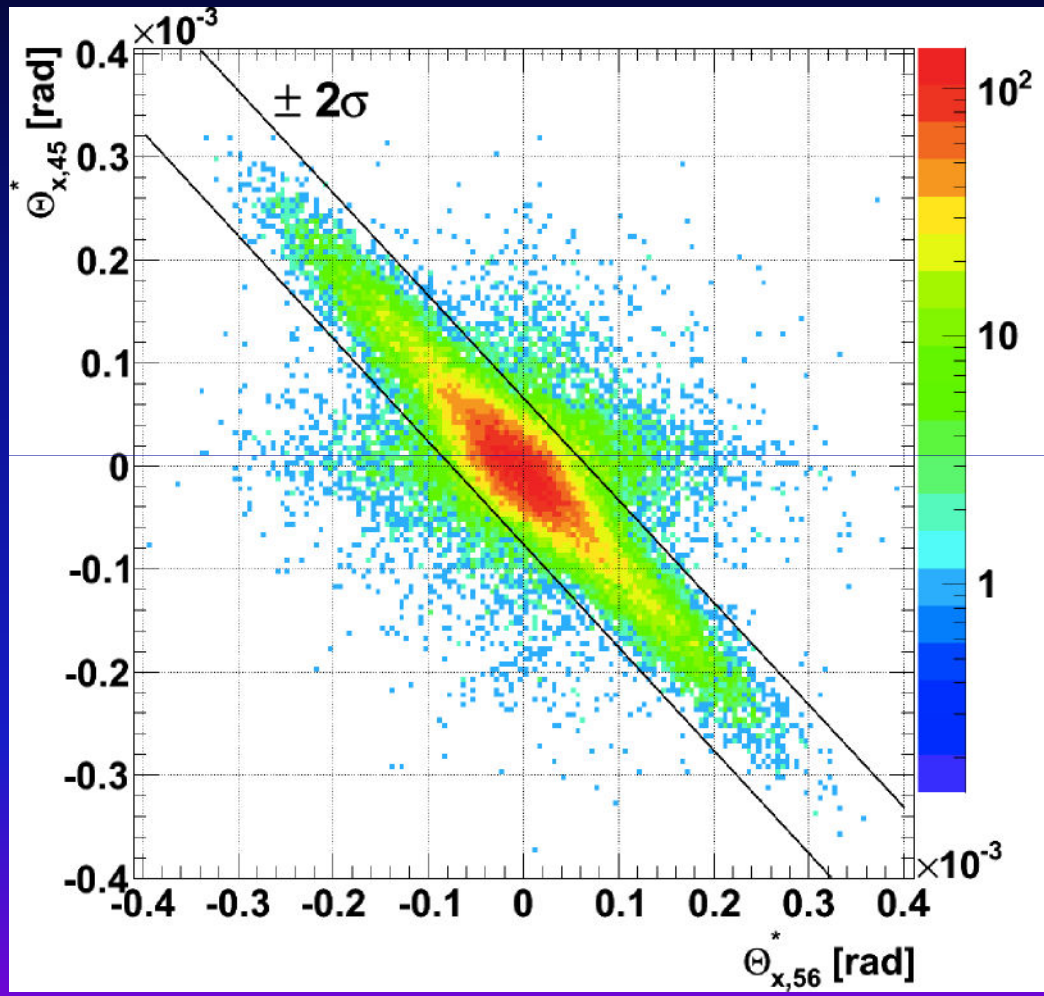
Elastic Scattering Analysis

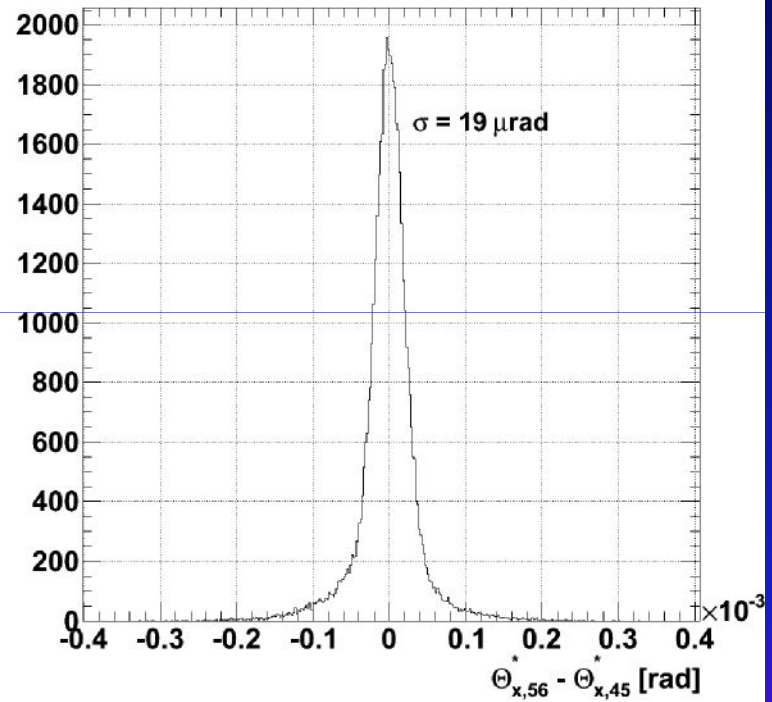




Integrated luminosity	80 nb^{-1}
Number of events:	1.9 M
Coincidences: bot 45 top 56	
single proton near .and. far	59 k
low x	180
final elastic selection	101

Collinearity in Θ_x

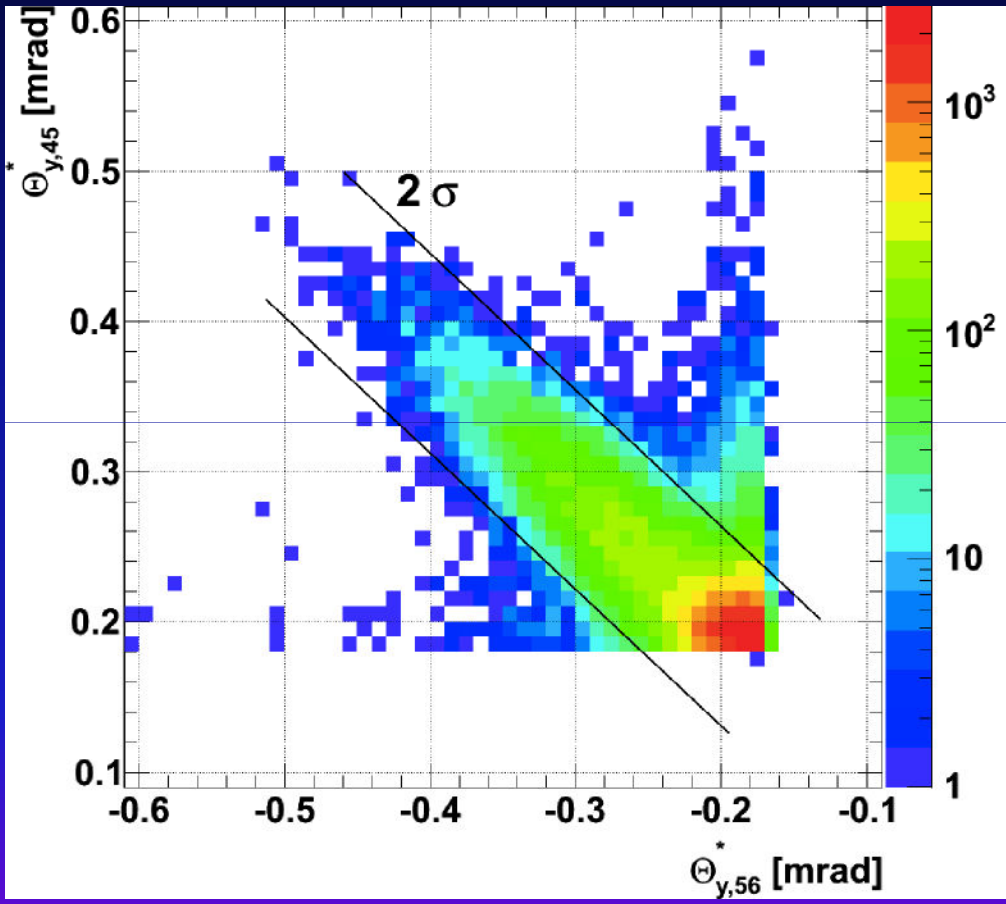


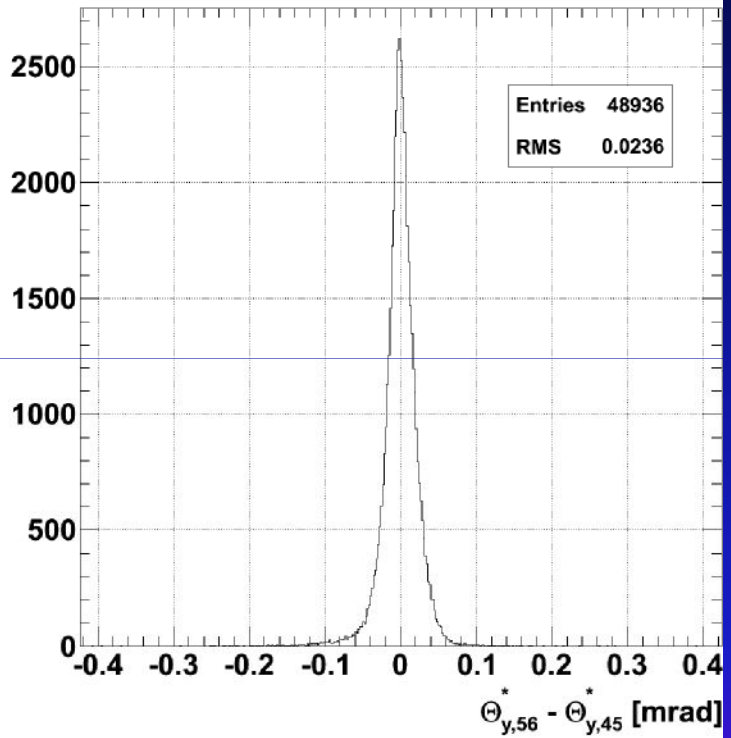


Compatible with the beam divergence

Collinearity in Θ_y

Low ξ, i.e. $|x| < 0.4$ mm and 2σ cut in $\Delta\theta_x^*$

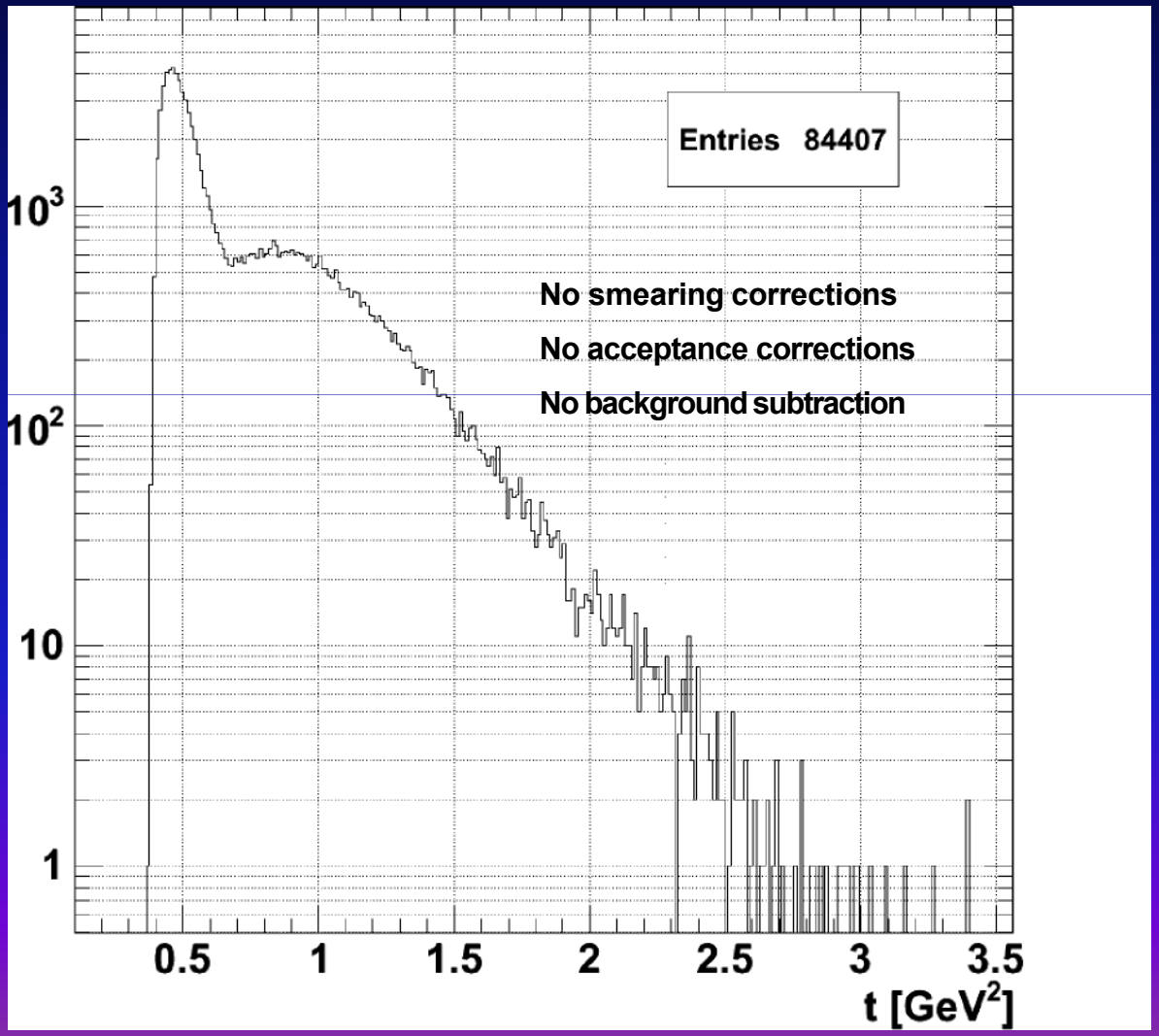




Compatible with the beam divergence

Preliminary t distribution

~80,000 elastic scattering events in ~9 nbarn $^{-1}$



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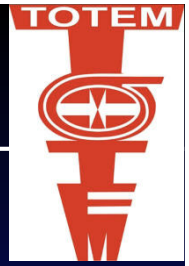

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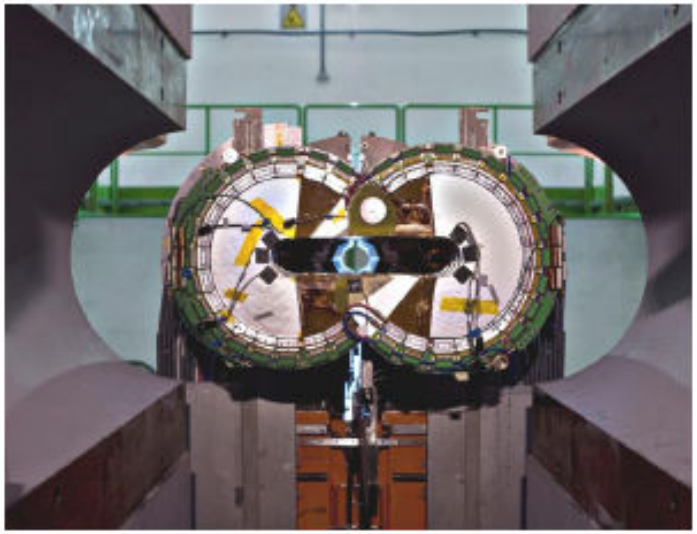
T2 Telescope

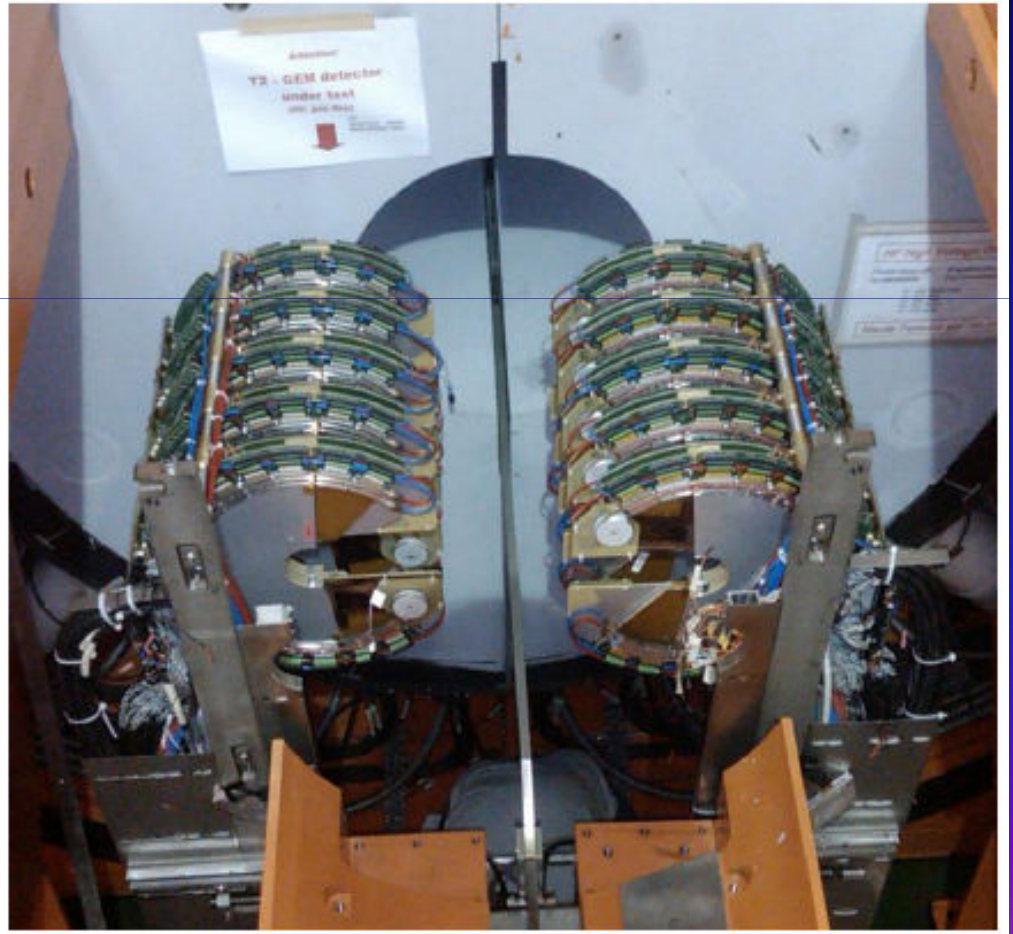
GEM (Gas Electron Multiplier) telescopes for tracks and vertex reconstruction

$5.2 < |\eta| < 6.5 \quad \Delta\phi = 2\pi$

T2 trigger in "special run"

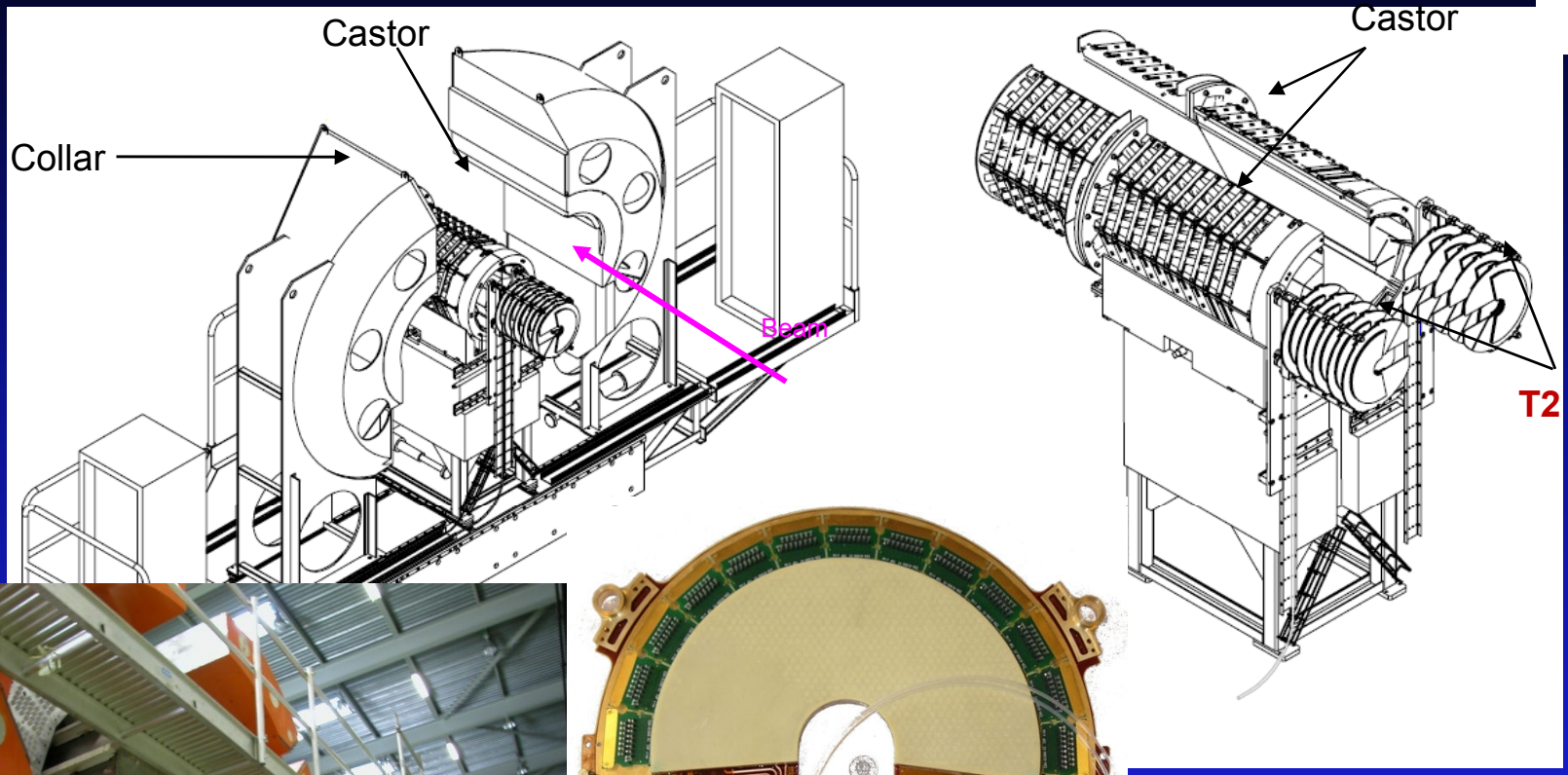
- min-bias only on minibunch

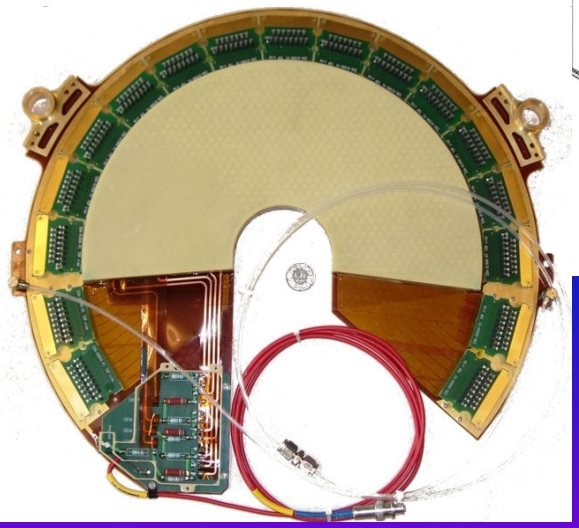




T2 Telescope GEM (Gas Elecron Multiplier)

Design & installation together with CMS

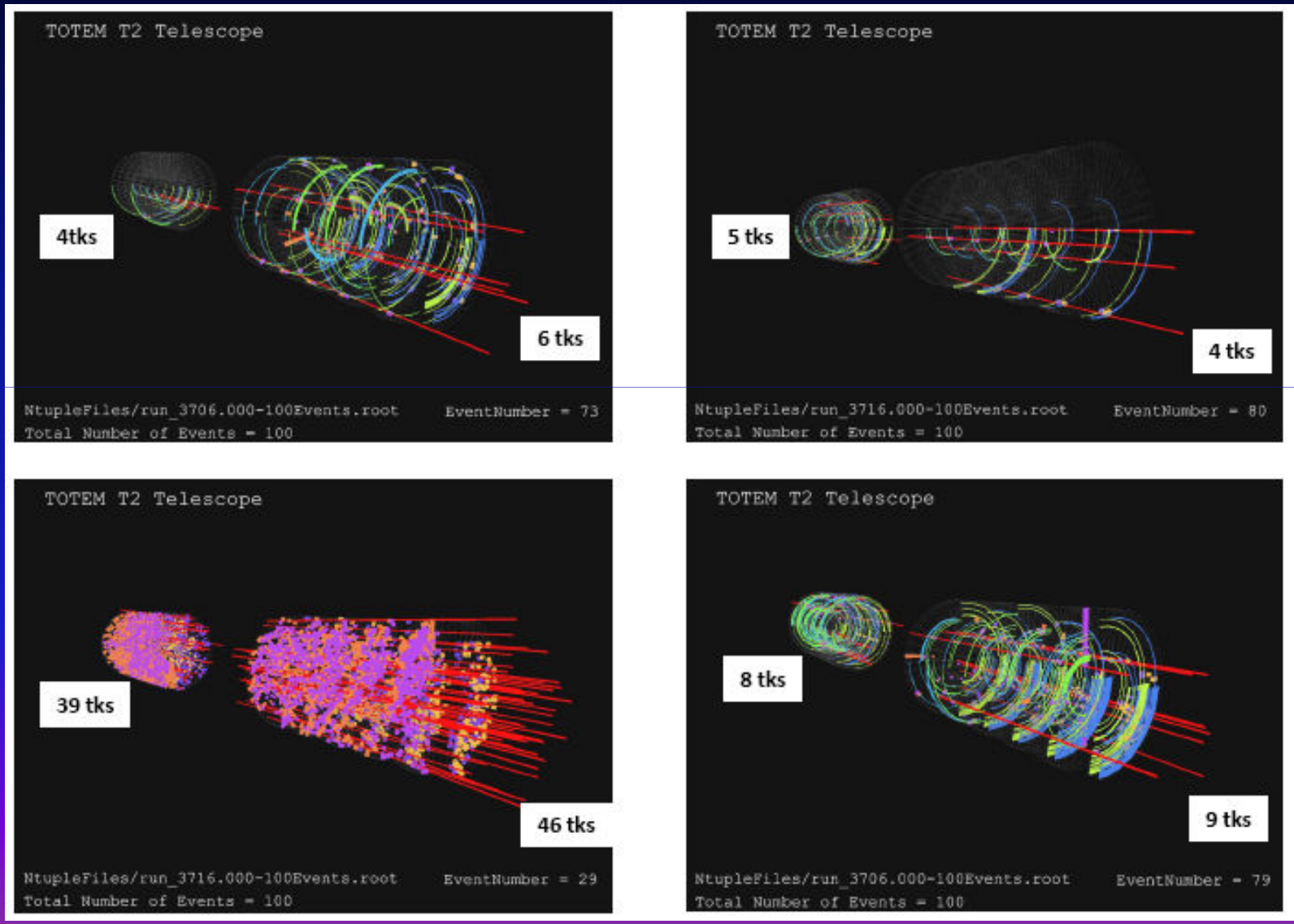




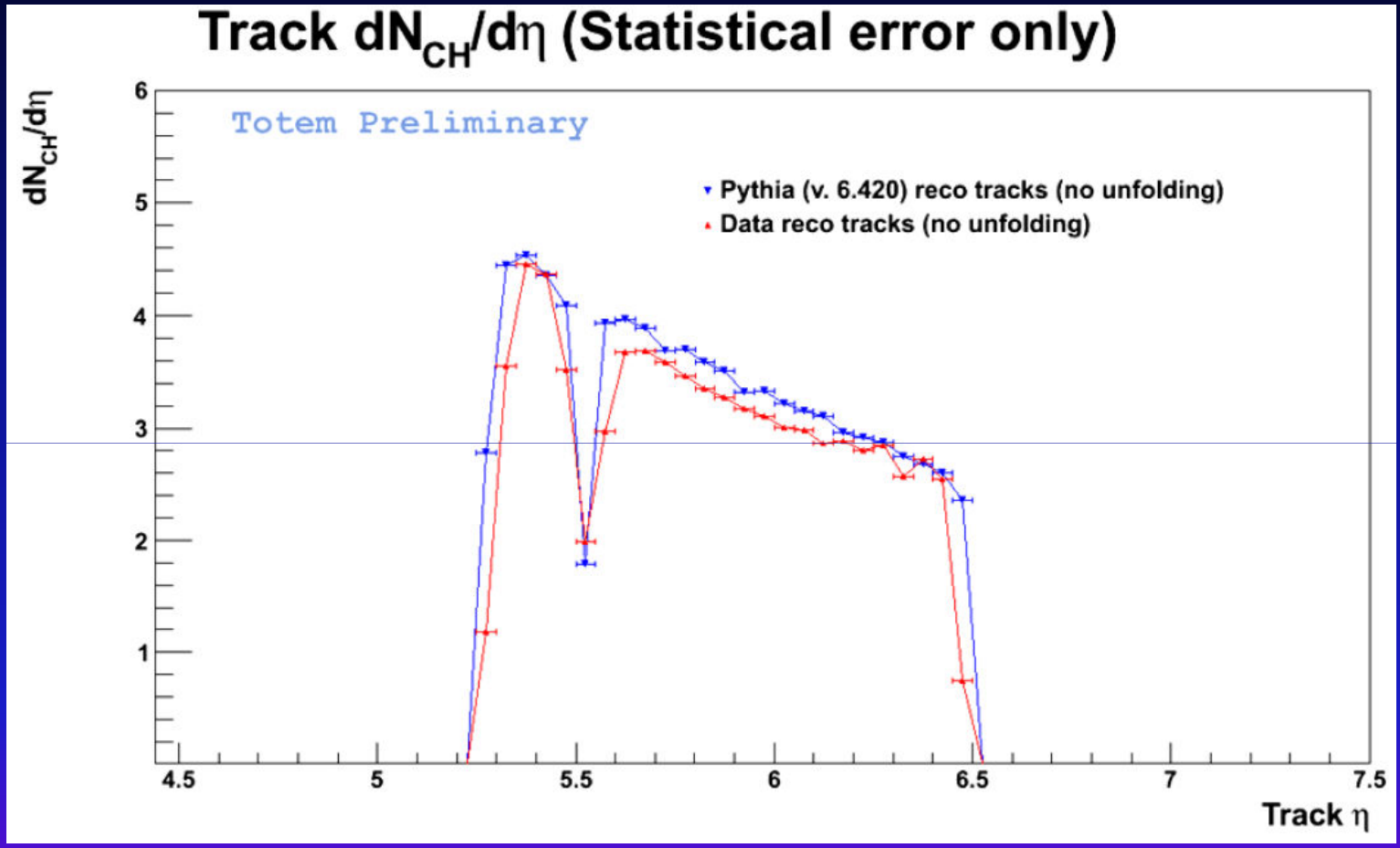
Final GEM chamber

10 tripple GEM layers on both sides of the IP to tolerate high particle fluxes in $5.3 < |\eta| < 6.6$ pseudorapidity range

T2 events reconstruction



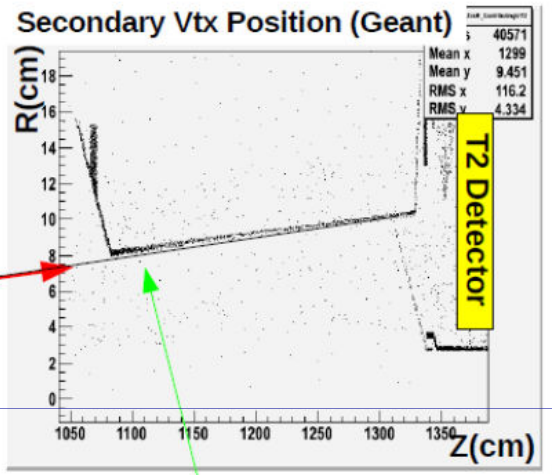
T2 - Preliminary



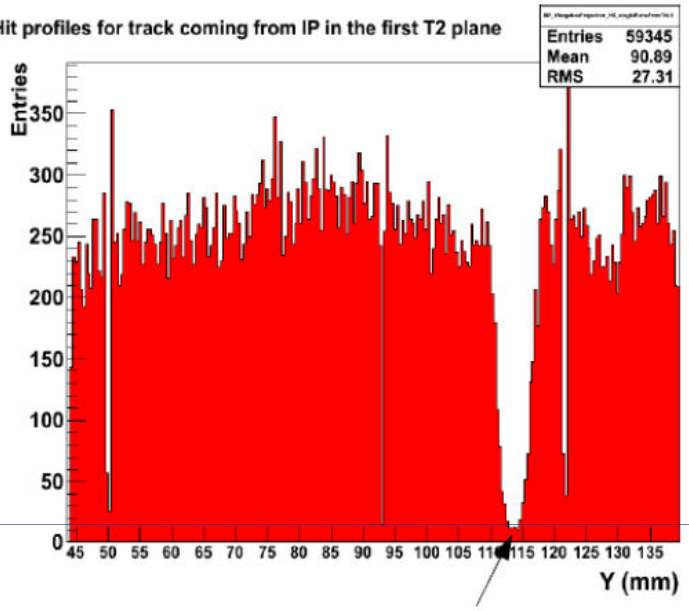
Data from TOTEM special run-trigger: min bias on mini-bunch only
Including secondaries pointing to IP and no efficiency correction

Hit profile in T2:

Beam pipe shadow

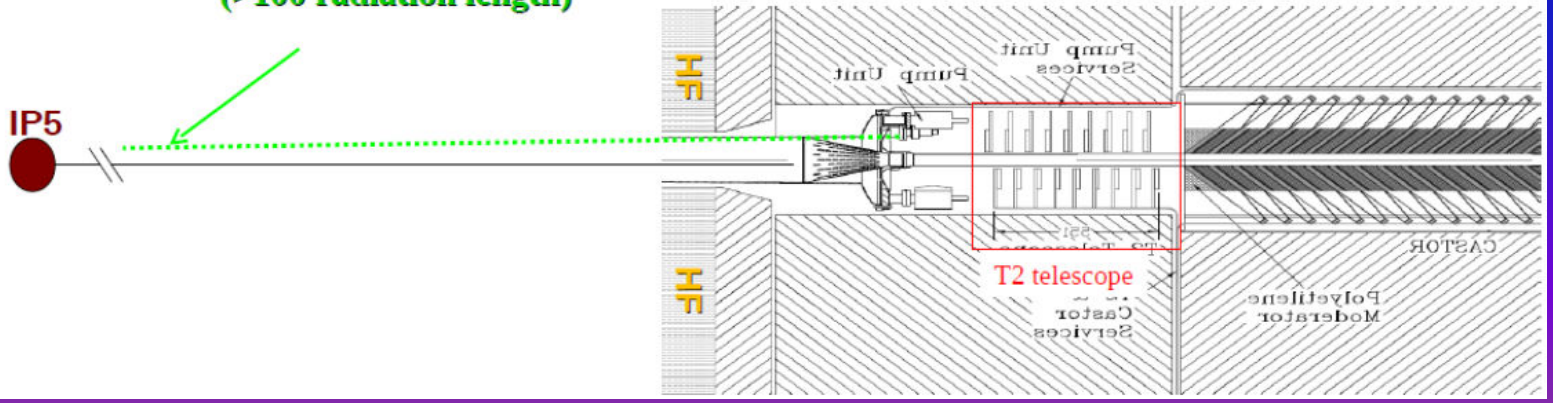


Track From IP

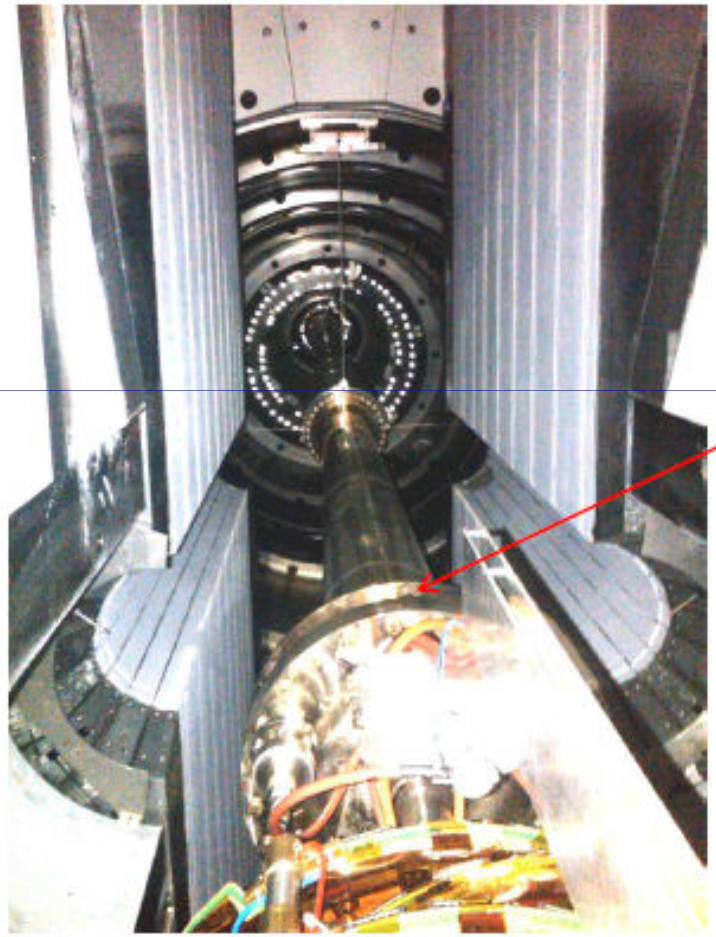


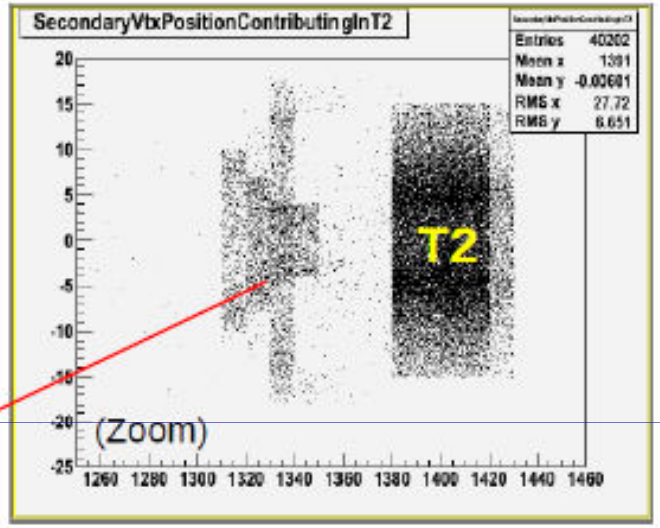
Beam pipe producing missing track hits in an well defined position of each T2 plane. This properties can be used for absolute detector alignment.

BeamPipe cone at η~5.54 (>100 radiation length)



Beam pipe material and secondary production

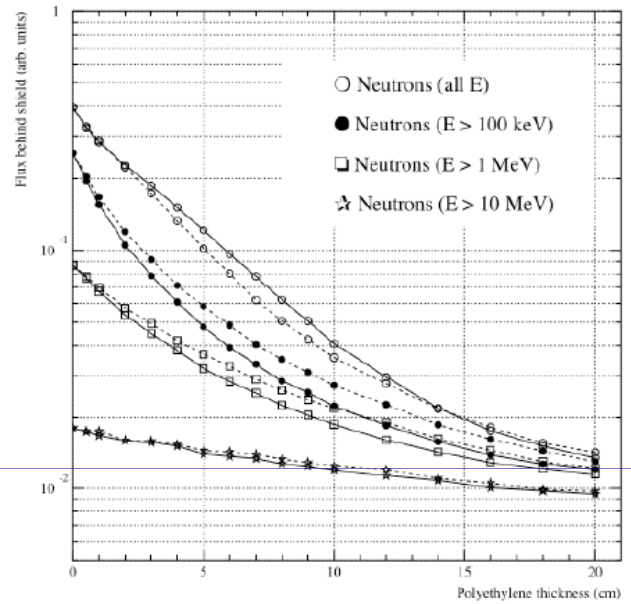


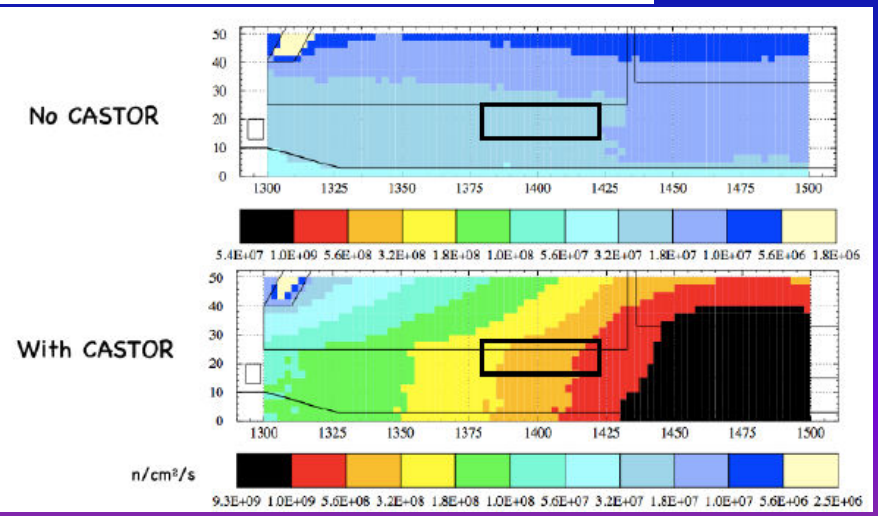


Flange and pumps are responsible for most of the gamma conversion from π_o and scattering of charged π.

Fluence measurement at T2

Simulation

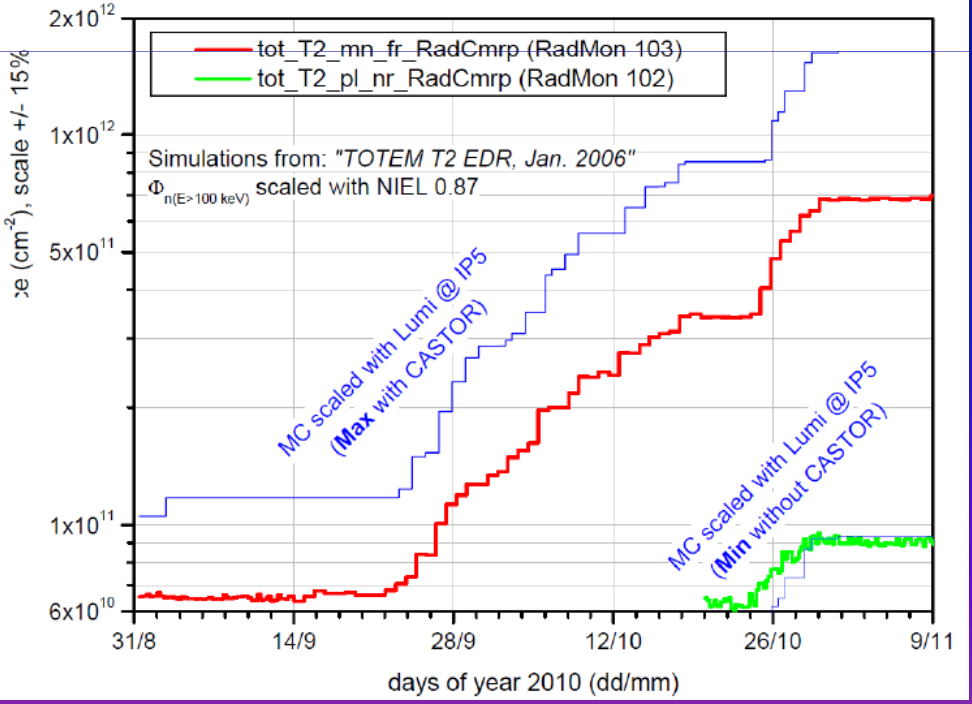




The presence of CASTOR on the minus side is clearly visible in the reconstruction and in the measured fluence (radiative flux integrated over time).

To moderate the flux a borated PE plug will be installed during the technical stop

Measured fluence Radmon



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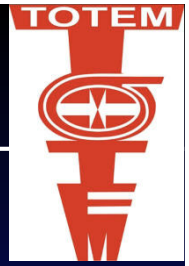

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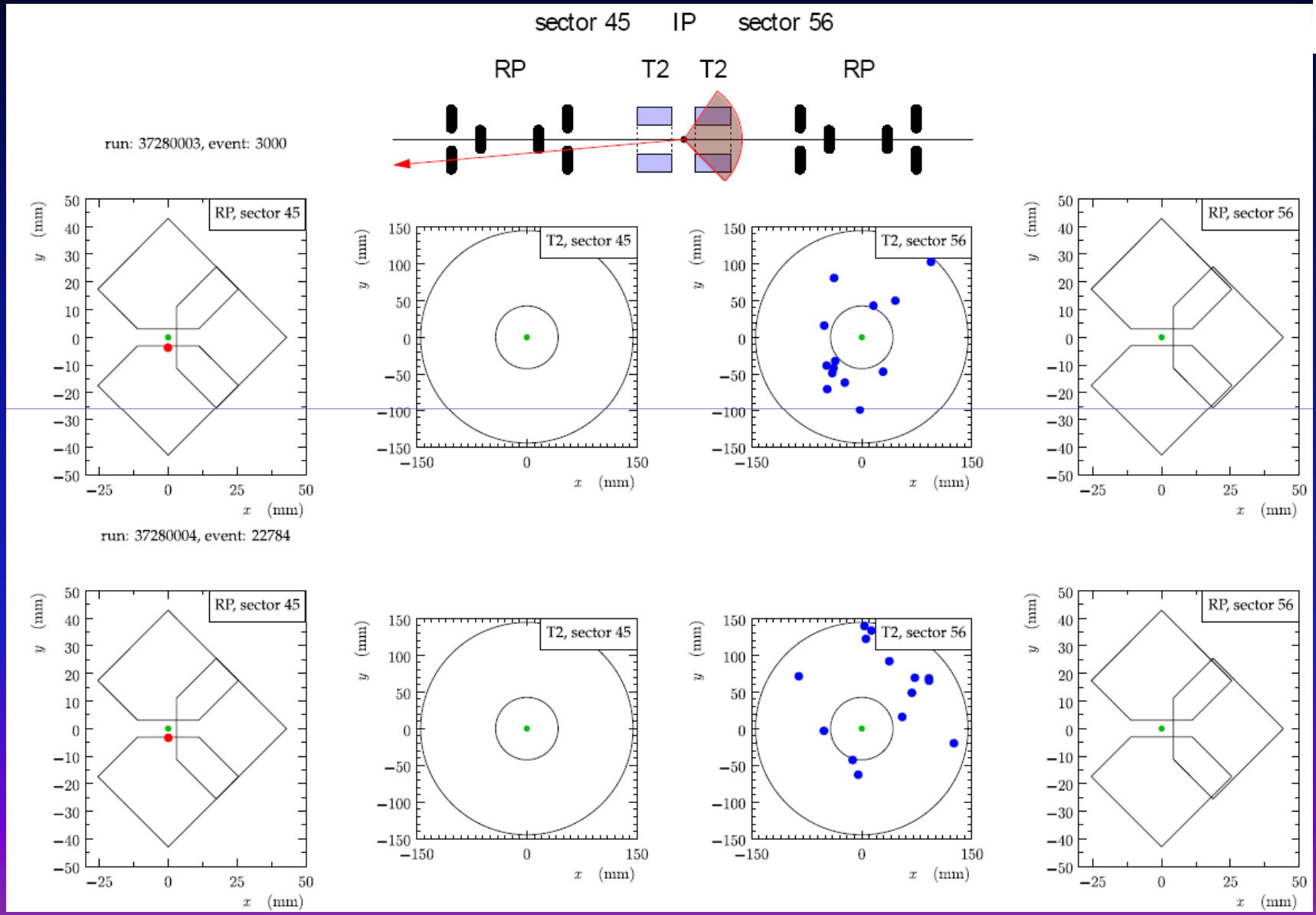
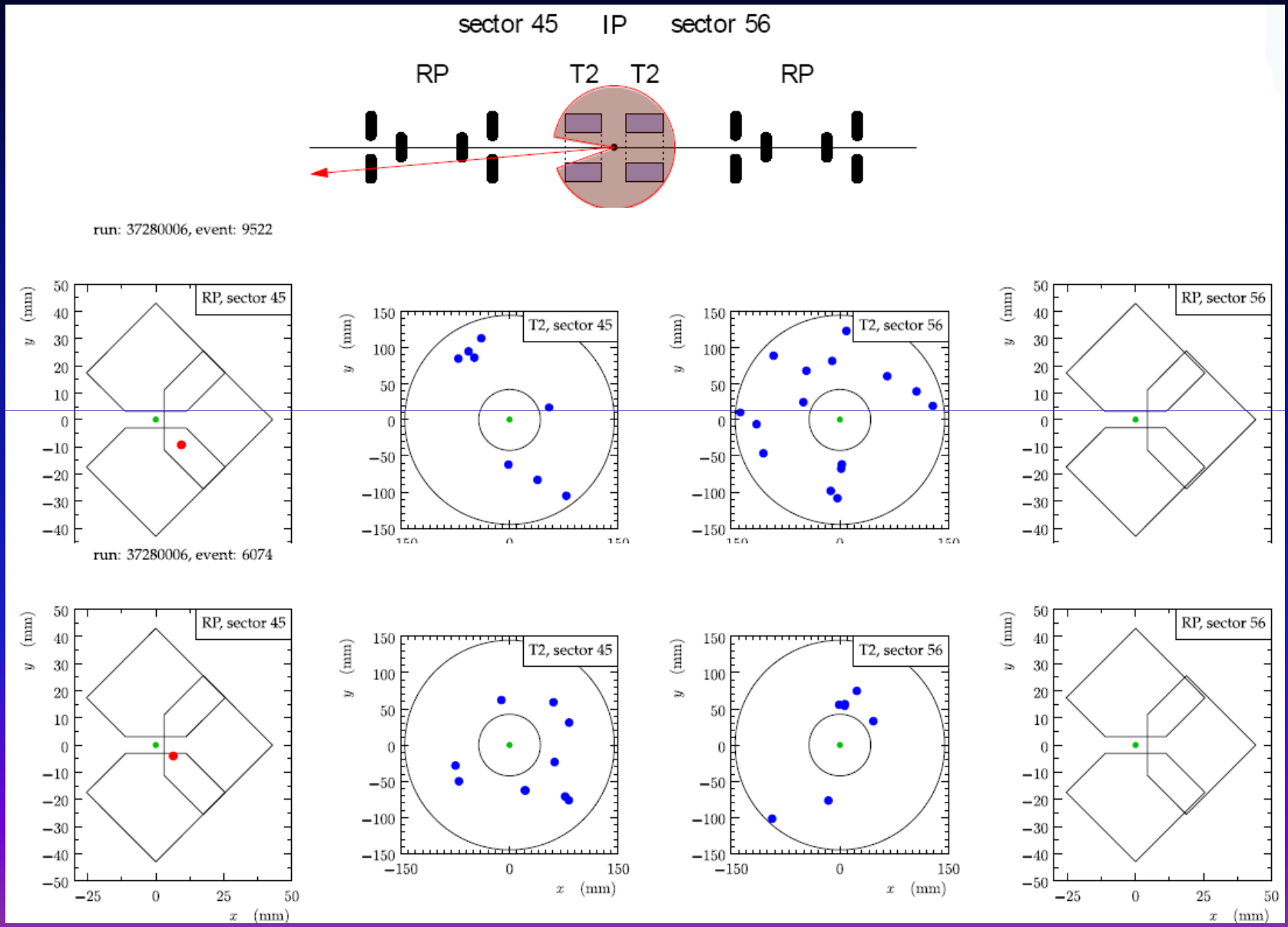
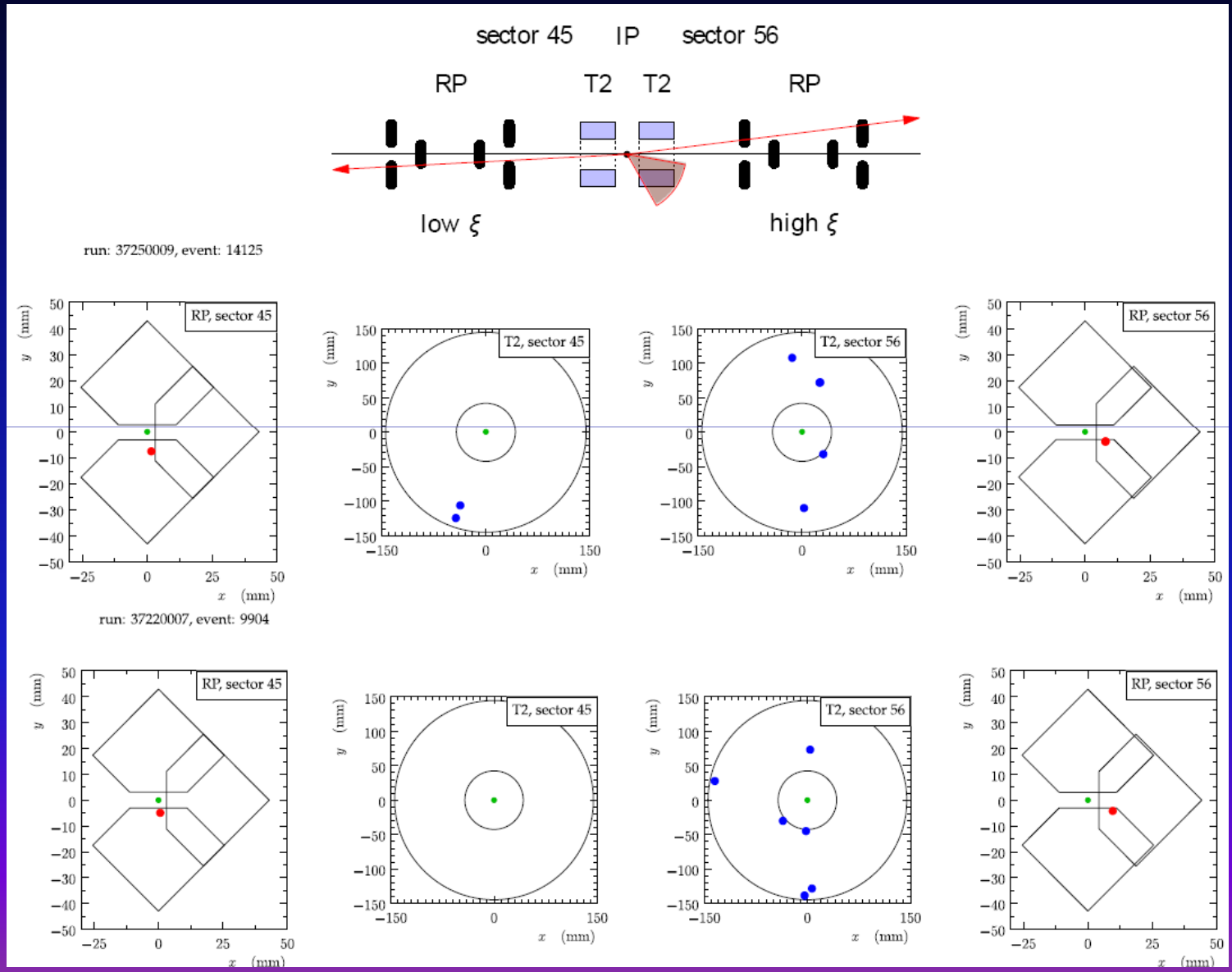
Single diffraction low $\xi = \Delta p/p$



Single diffraction large ξ



Double POMERON exchange



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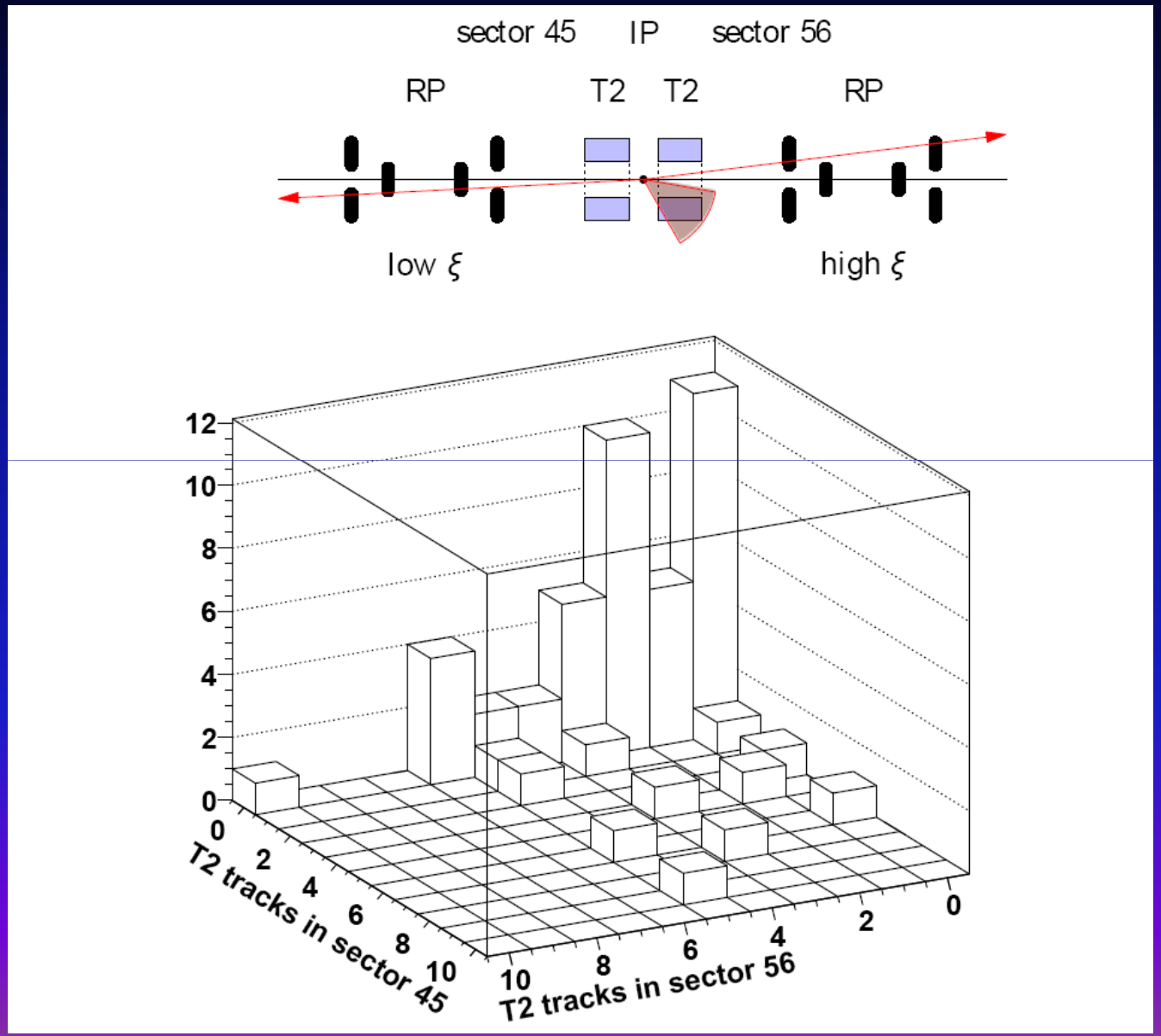

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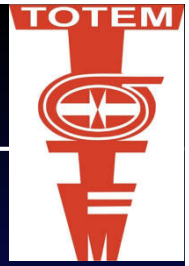

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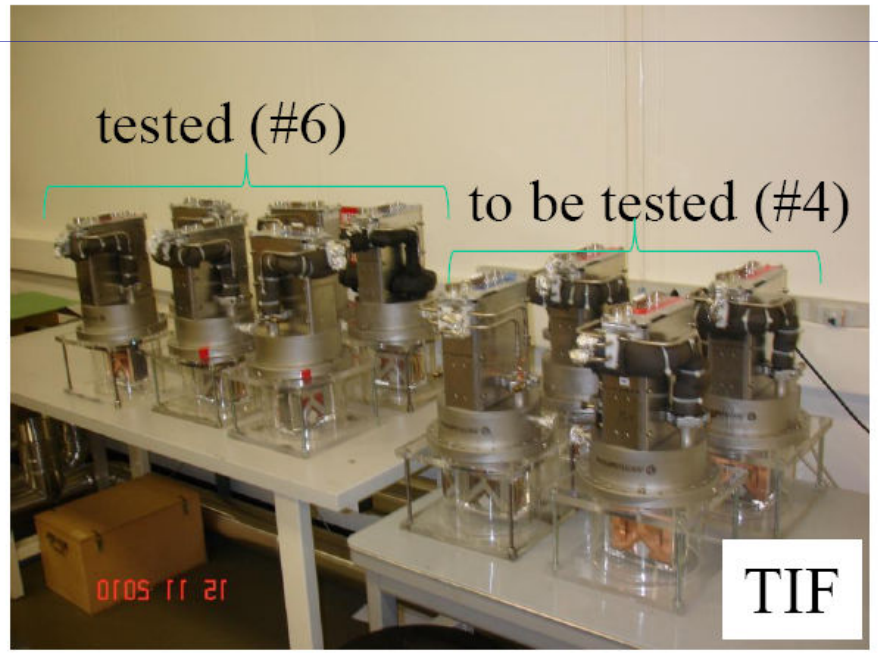
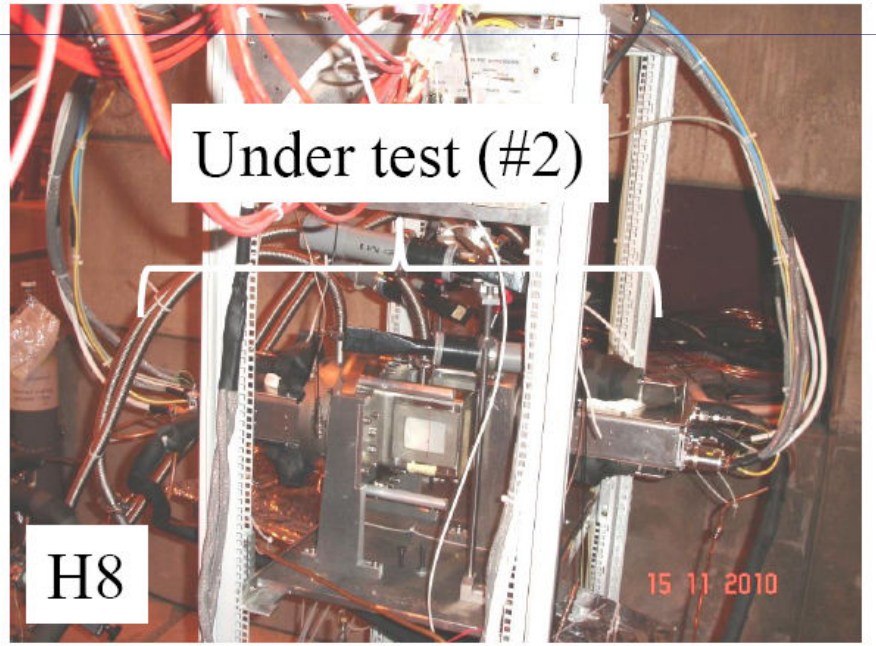
RP installation at 147 m during technical stop

During the Technical stop TOTEM will install the last 12 detectors in the LHC tunnel (“147 m”) completing in this way the installation of RP detectors.

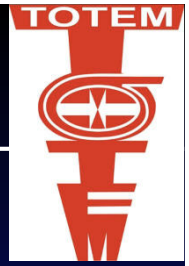
12 detector packages have been produced, completely assembled and are ready for installation; final checks with particles are completed by now.

All services for the RPs at 147m are ready for the installation work to start in December 2010.





OUTLINE



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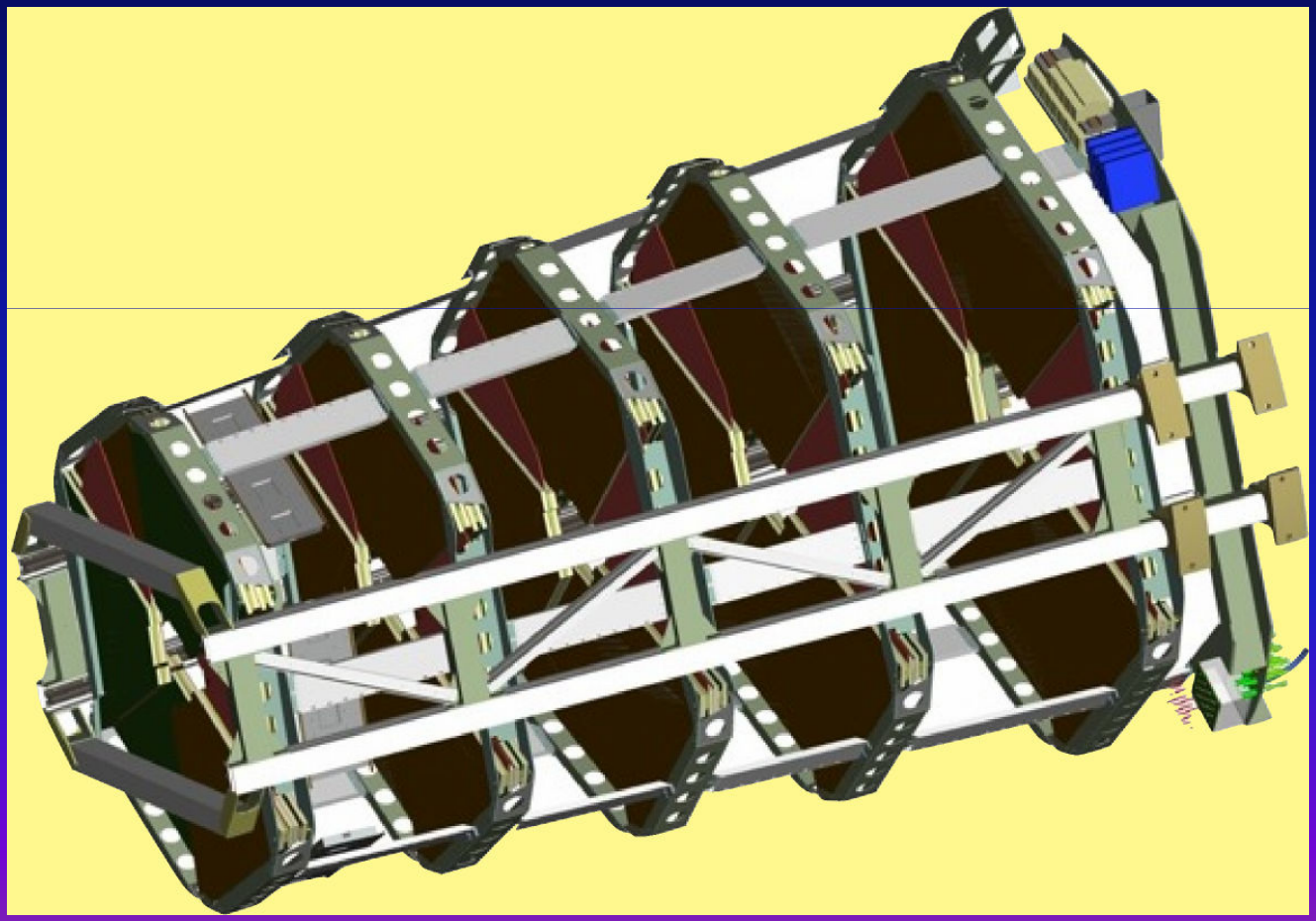
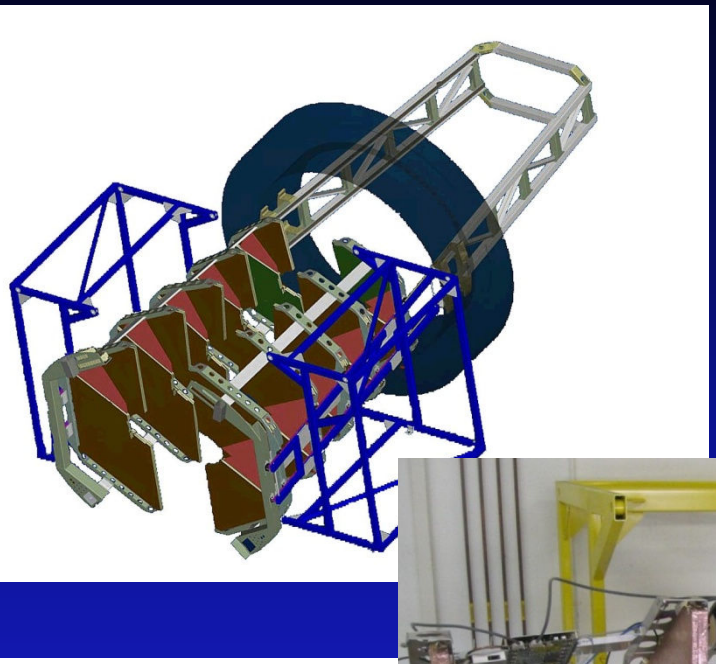
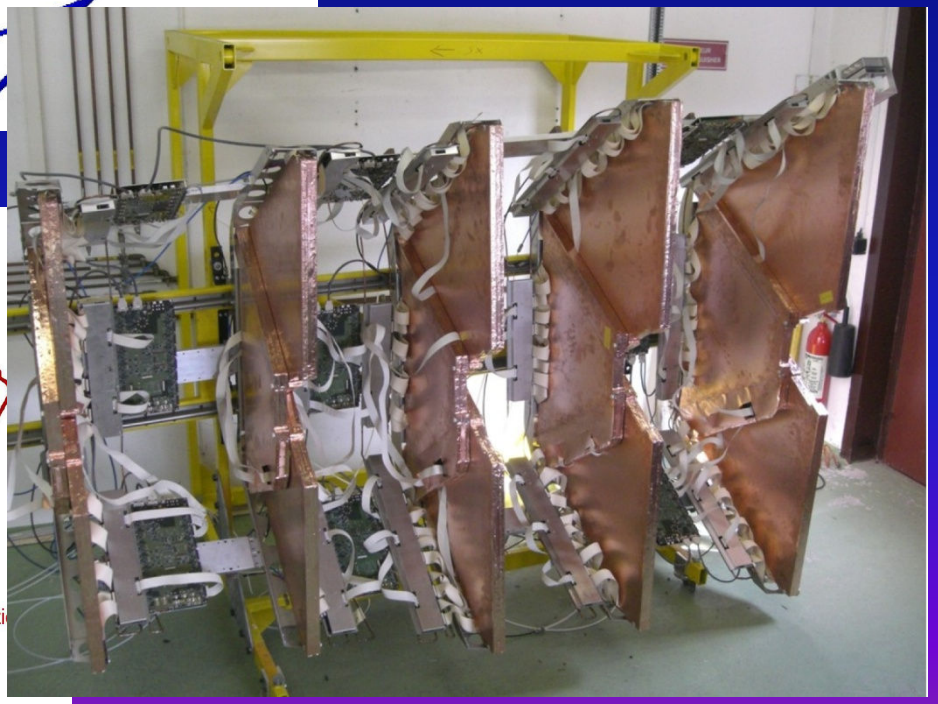
T1 telescope CSC (Chatode Strip Chambers)

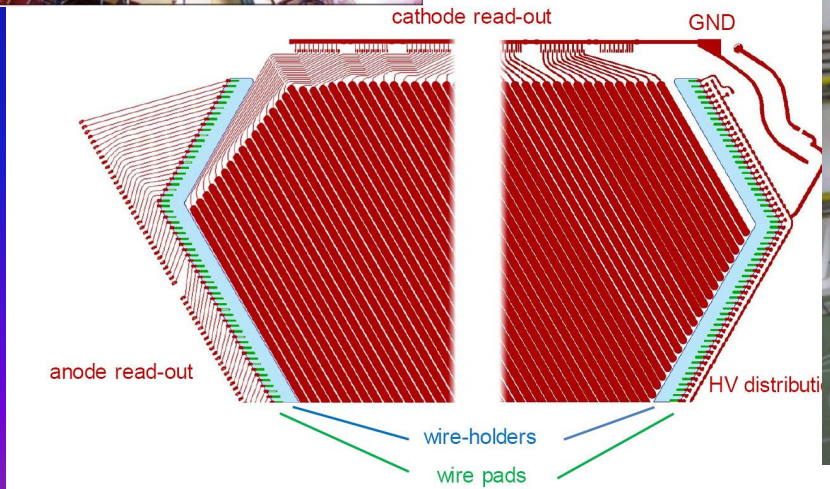
- 5 layers of CSC chambers with decreasing diameters
  - 2 x 3 trapezoid shaped CSC (Chatode Strip Chambers) detector elements



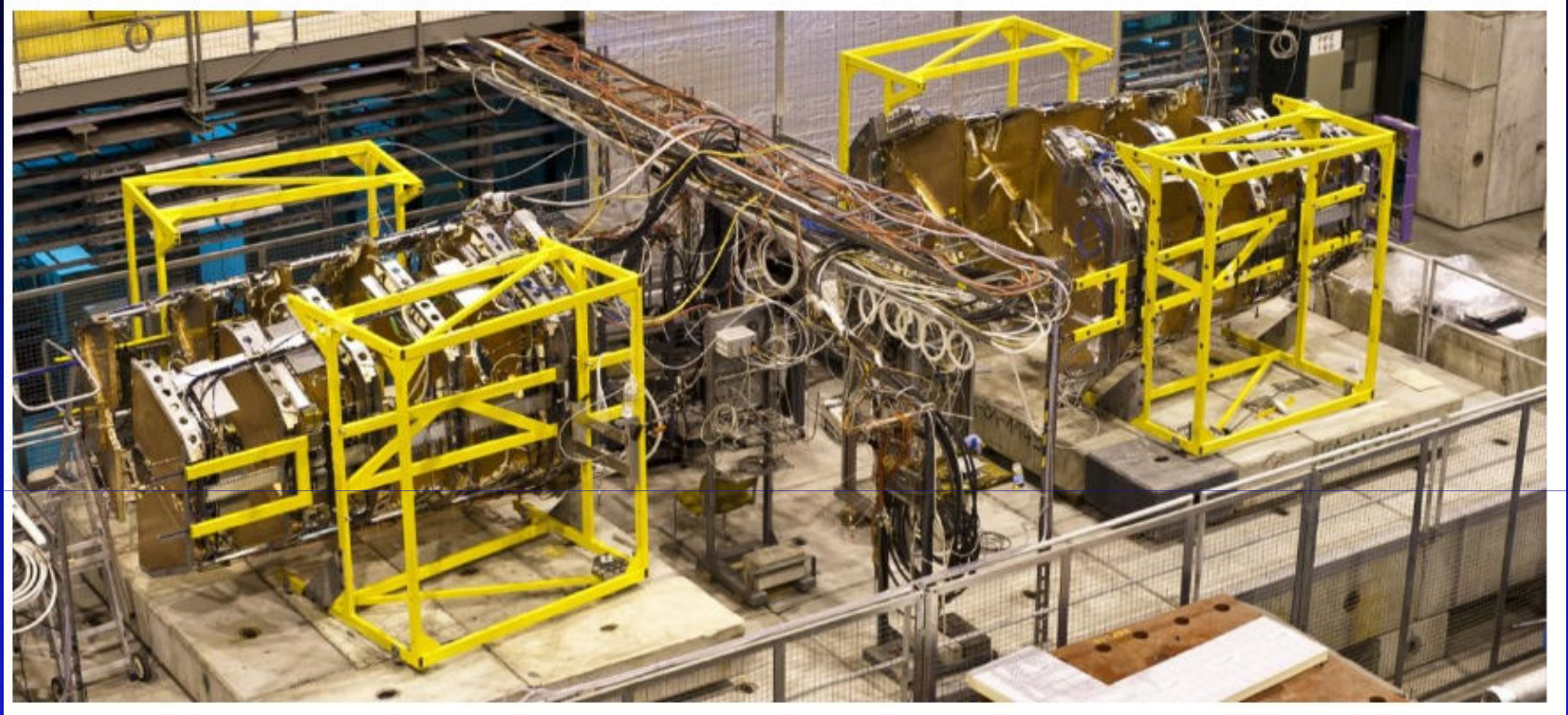
T1 telescope - details







T1 Testing at H8



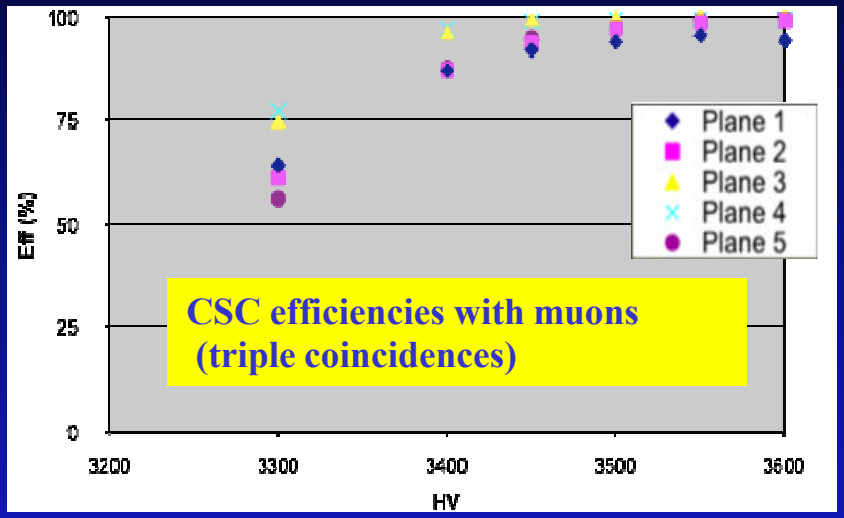
- Update on mechanical components (EDR with CMS held on June 2010)
- Update on electrical components (ESR with CMS held on September 2010)
- Installation at IP5

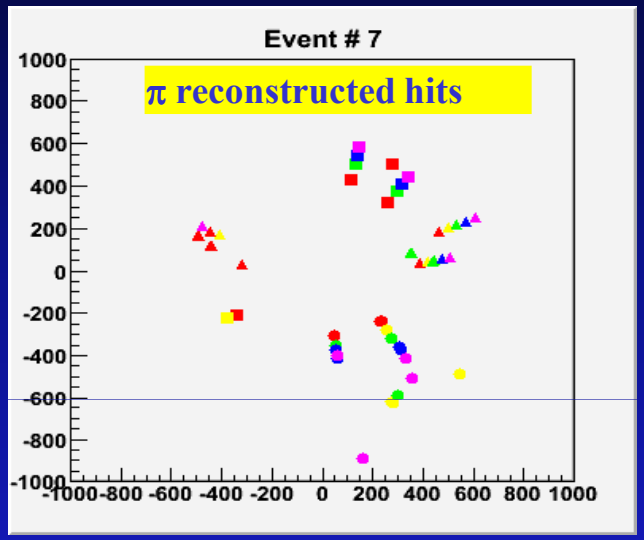
All issues are monitored by TOTEM and CMS and followed up in close collaboration

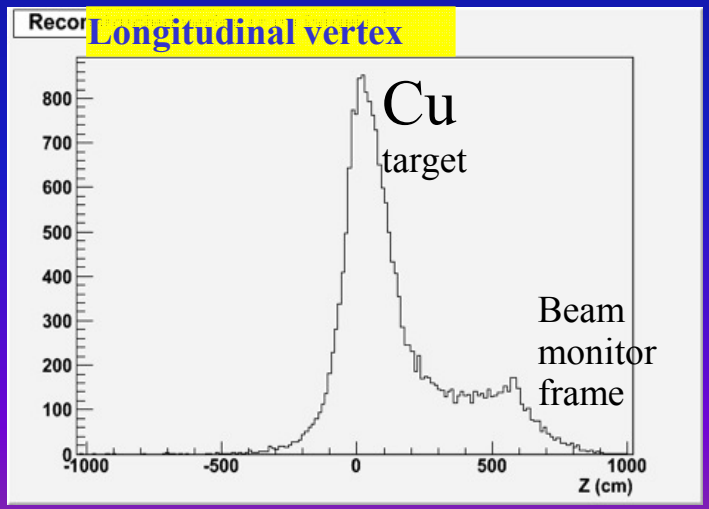
- 30 Nov 2010 Final Installation Review with CMS

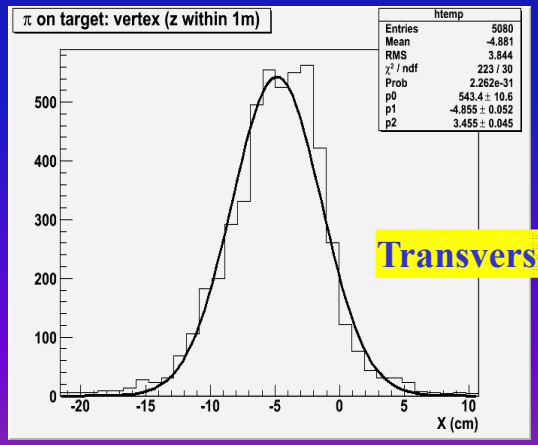
T1 Telescope Performance

Both arms successfully tested with pion and muon beams
Pions on copper target to get many-tracks events

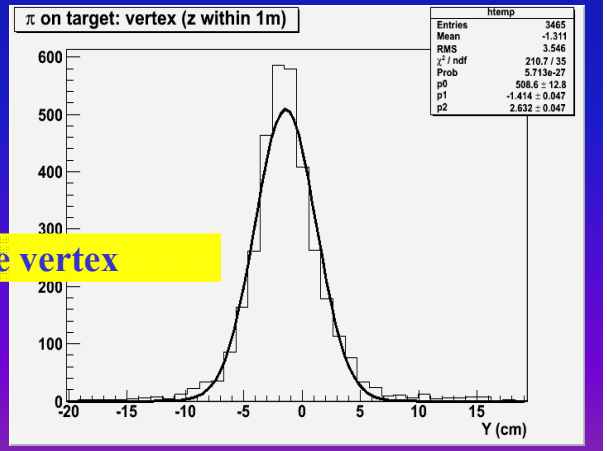








Transverse vertex



T1 Installation in CMS: both sides (+/-)

Detailed installation planning up to date

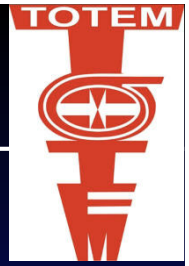
Organization work in constant contact with CMS at all levels

- The installation of both arms requires the presence of the T1/CMS team during Christmas break
- Schedule with associated manpower finalized
- Availability of manpower confirmed: CERN, INFN, and the Field Support Units (FSU)

What was done before descending into the pit:

- Final system check with particles (18-22 Nov in H8)
- Final remeasuring of the envelope by the Geometers
- 30 Nov 2010 Final Installation Review with CMS

OUTLINE



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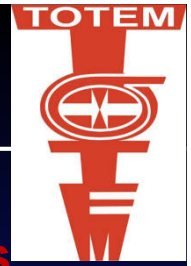
TOTEM Running Strategy for 2011



Understand the new optics and improve statistics at large t-values

Repeat RP alignment at nominal conditions: approach the RP detectors to the sharp beam edges produced by the LHC collimators

For regular running at closer approaches to the beams (~15σ)

Prepare the $\beta^* = 90$ m optics

Measure the total cross-section and luminosity at 3.5 TeV

Low proton density bunches (~1 10^{10}p/b)

Special runs with several such bunches plus one normal bunch:

Approach RP to ~ 5 σ to reach a minimum t of ~0.2 GeV^2

Addition of one small bunch during normal low β runs (if possible):

Take data with T1, T2 at reduced pile-up (< 10^{-2})

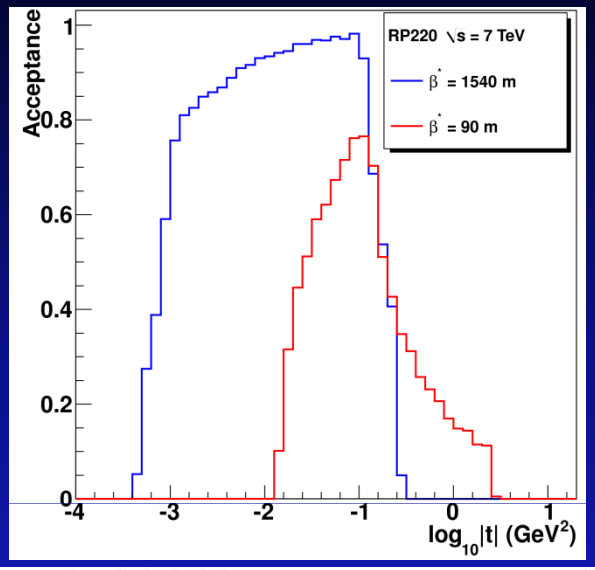
Targets:

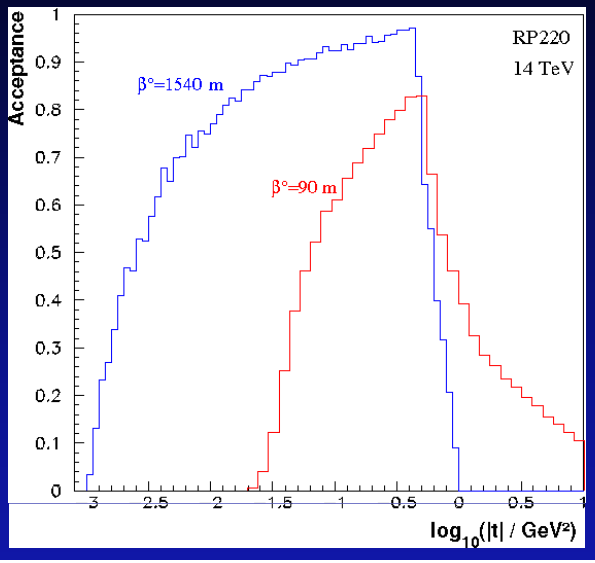
- **With β^*=90m optics and RP close to the beams measure σ_{tot} and σ_{el}**
- **Correlations between the forward proton and topologies in T1 and T2 with a rich program on Single Diffraction and Double POMERON exchange**

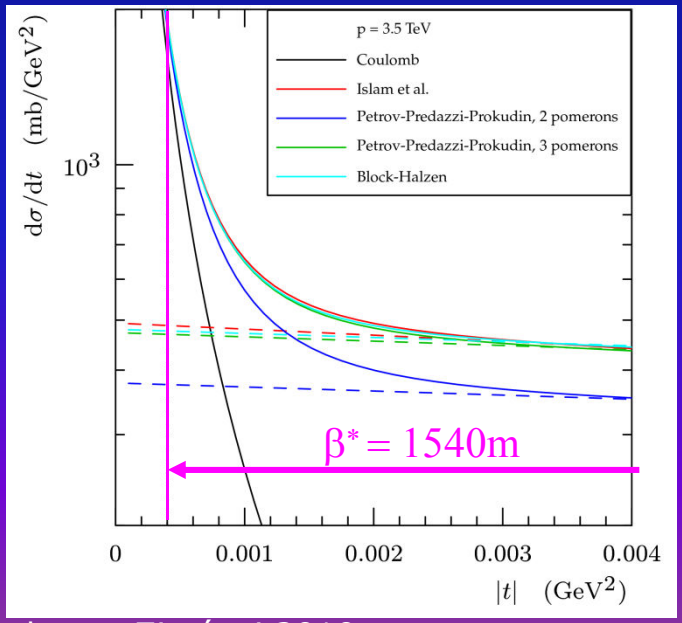
Programme for 2011

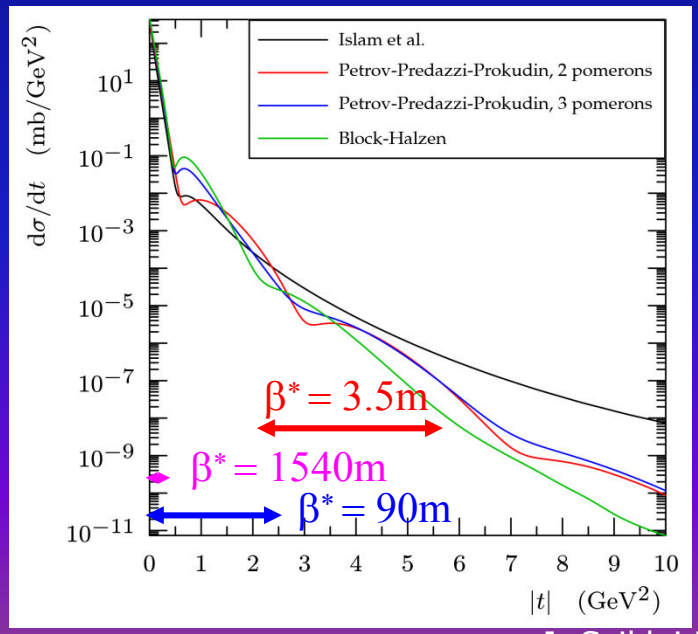
Elastic Scattering Acceptance at √s = 7 TeV

RP220









Conclusions

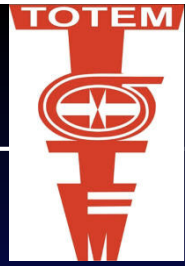
TOTEM has already collected interesting data on elastic scattering at medium t !

The present understanding of the event topologies (pp, SD, DD, DPE) from T2 and the RP shows already the TOTEM potential in diffractive physics measurements.

These will be fully exploited next year with the doubled η range provided by the newly installed T1 and with the larger β^*=90m optics .

Many thanks to the machine team that has provided the good beam conditions necessary to do the measurement!

Questions ?



Thank you!