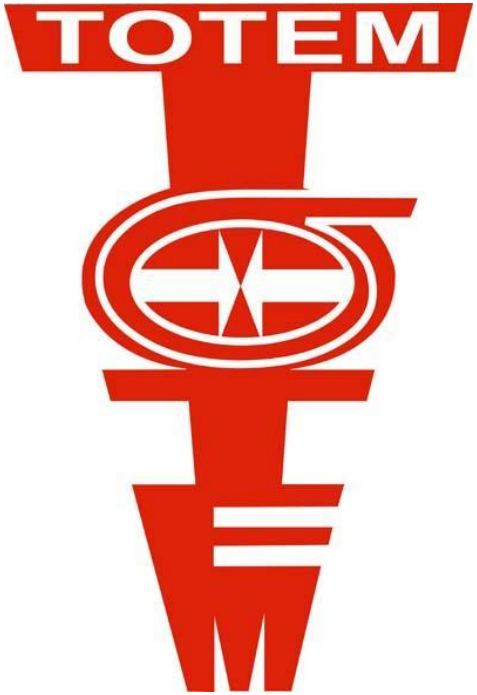
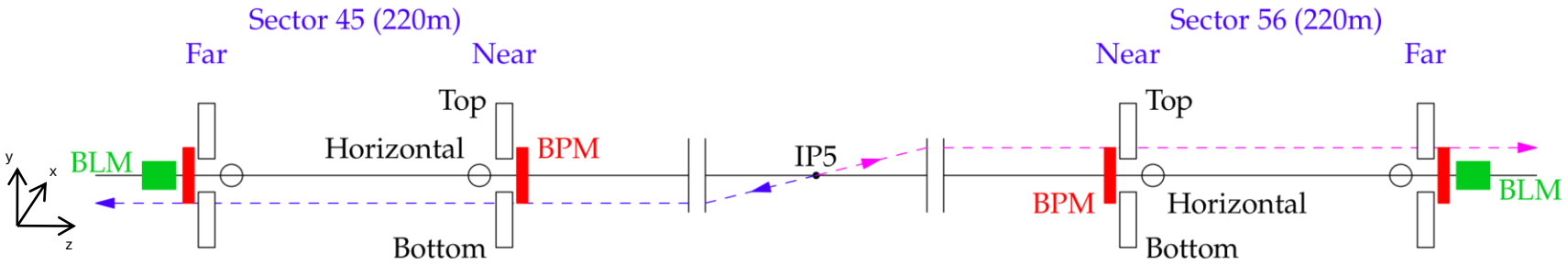
Status 2010

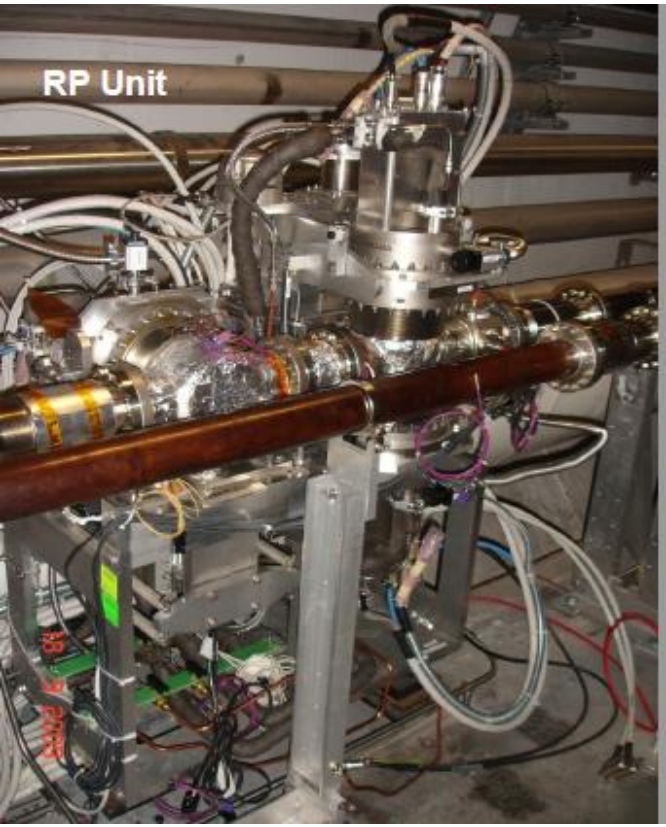


LHCC
18 Nov 2010

Marco Bozzo
on behalf of the TOTEM Collaboration

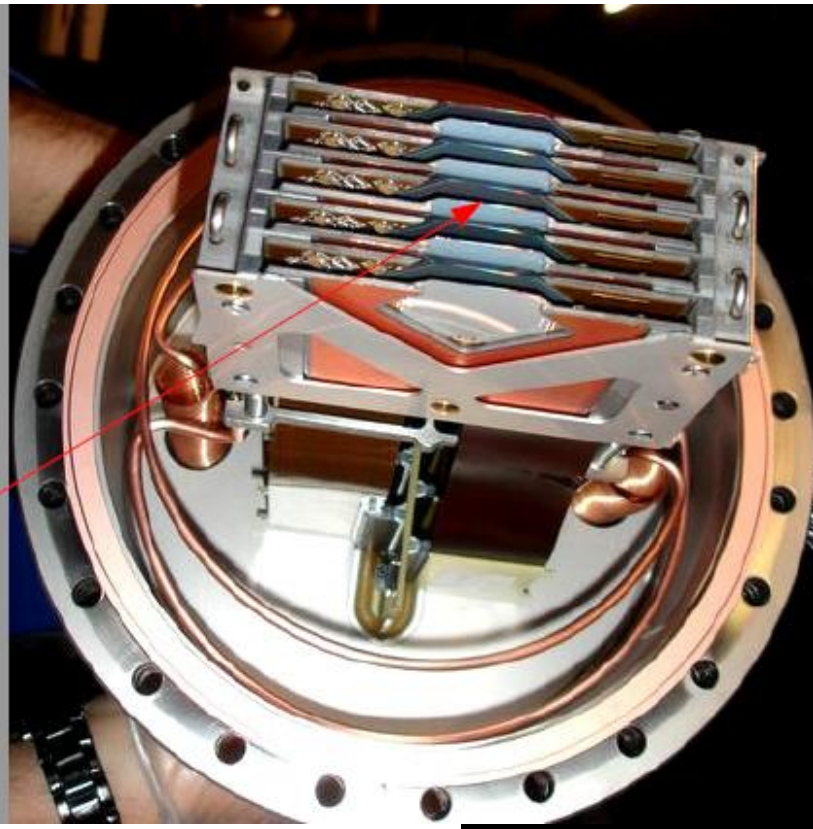
The Roman Pot System



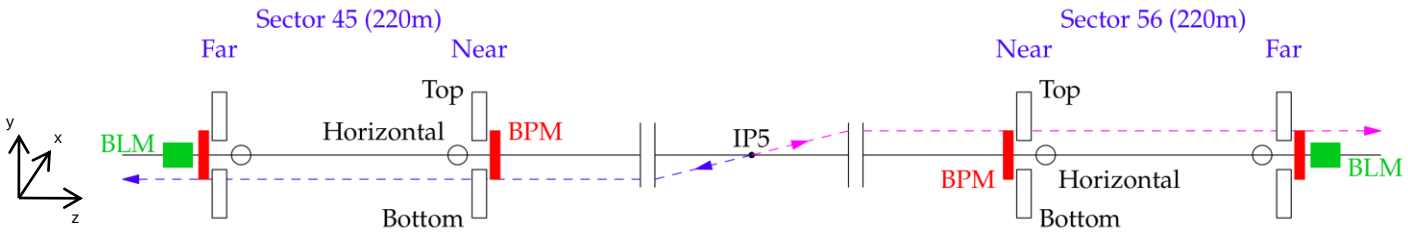


4 Stations
→ 2 Units
→ 3 pots
1 BPM
(Beam Position Monitor)

Edgeless Silicon Detectors



Runs and data taking 2010



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

Special TOTEM Runs:

•21.9.2010

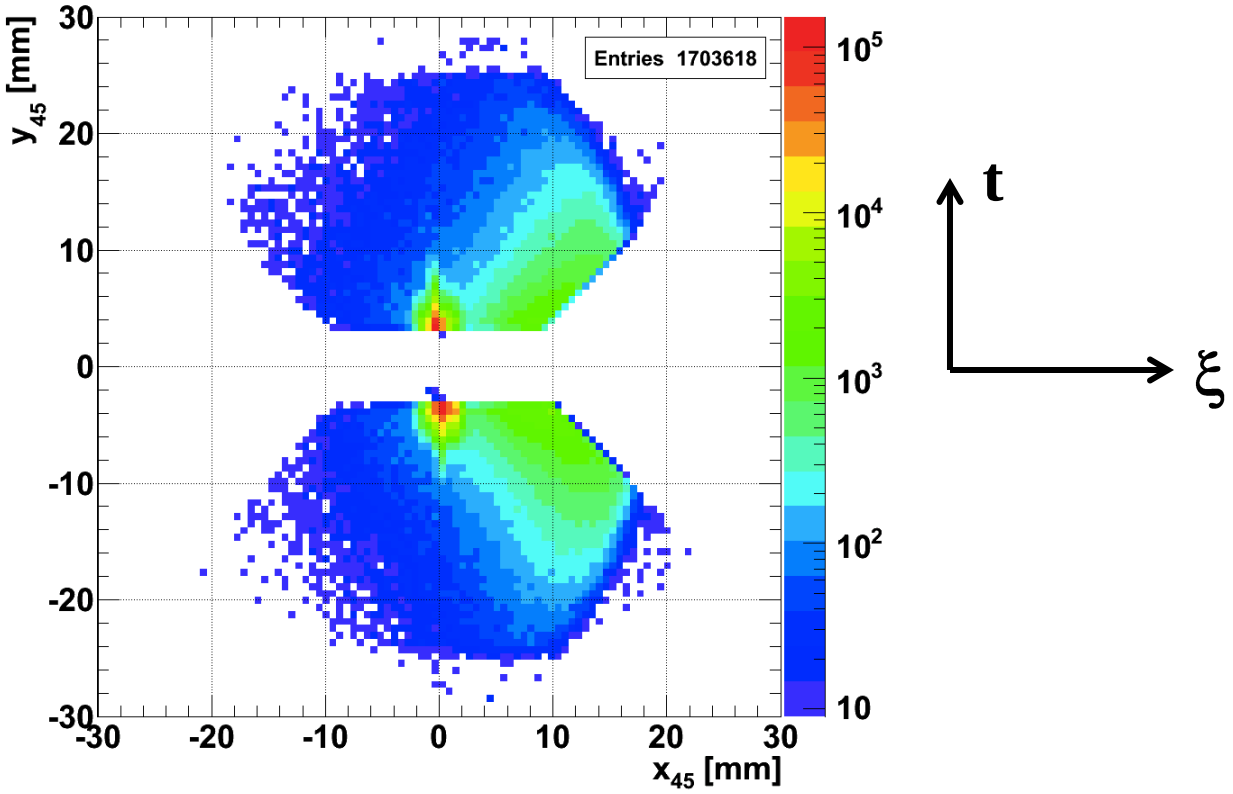
- •RP "alignment" at 3.5 TeV to define a safe running condition with the pots as close as possible to the circulating beams
- •short data taking (one pilot bunch) with RP to 7σ

RP at	*int. L*
20 sigma	**184** *nb*$^{-1}$
18 sigma	**3.5** *pb*$^{-1}$
7 sigma	**9.5** *nb*$^{-1}$

•30.10.2010

- •Special run with
  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})

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

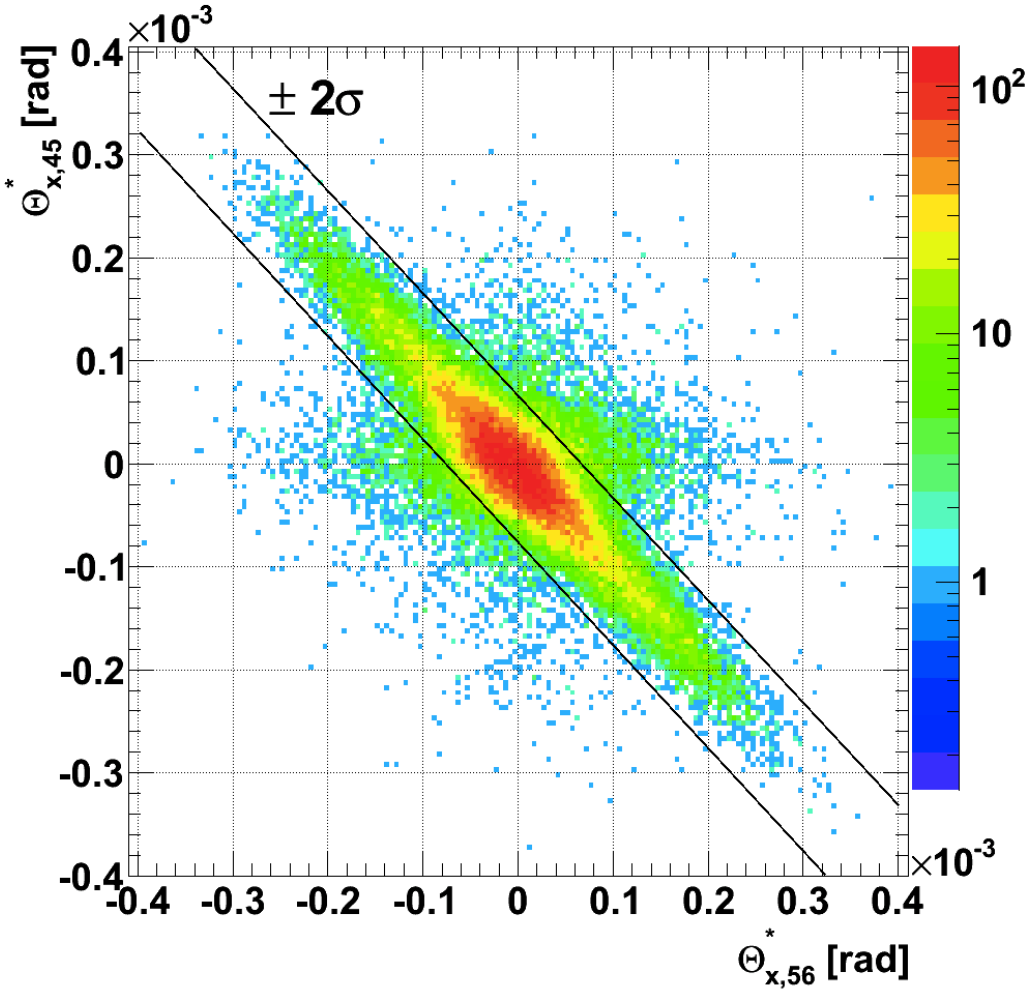


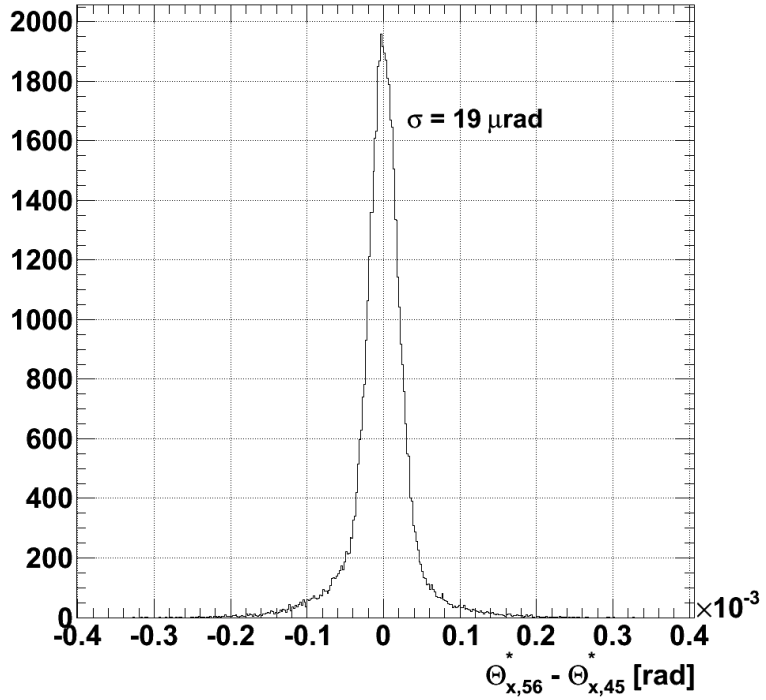
reconstructed tracks in “left AND right”

Elastic scattering in the vertical plane visible from raw data

Collinearity in θ_x

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

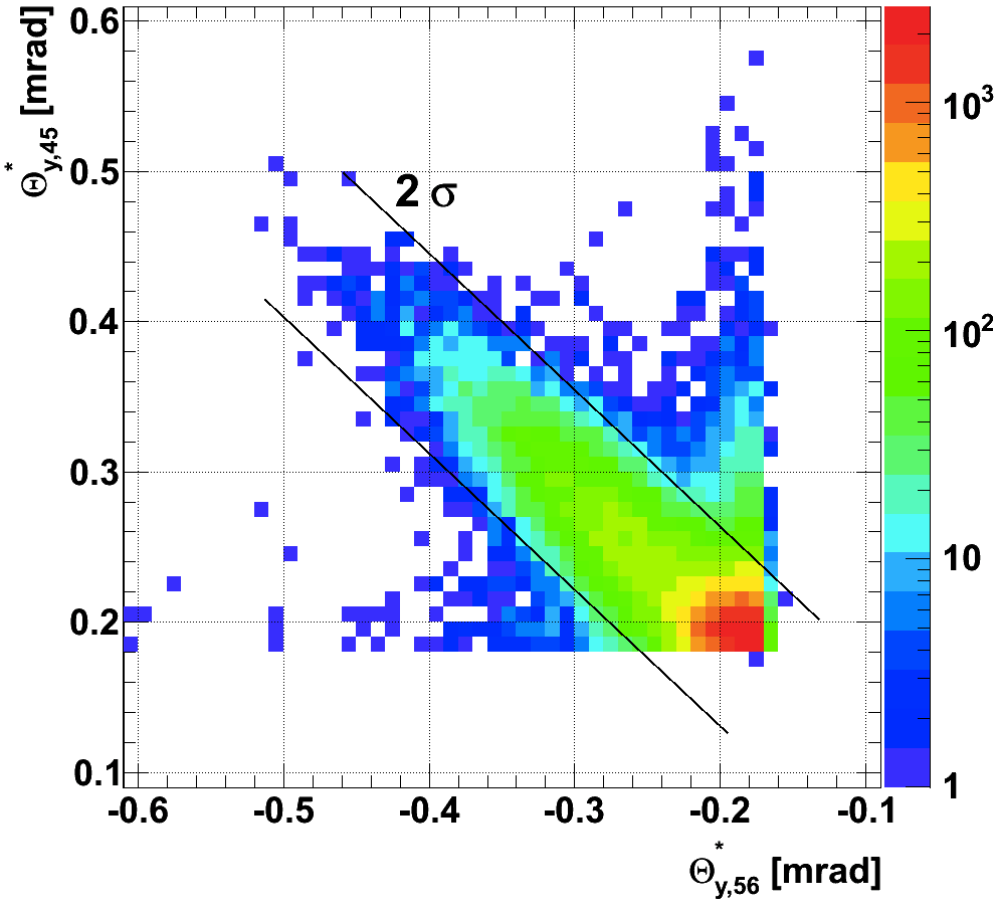


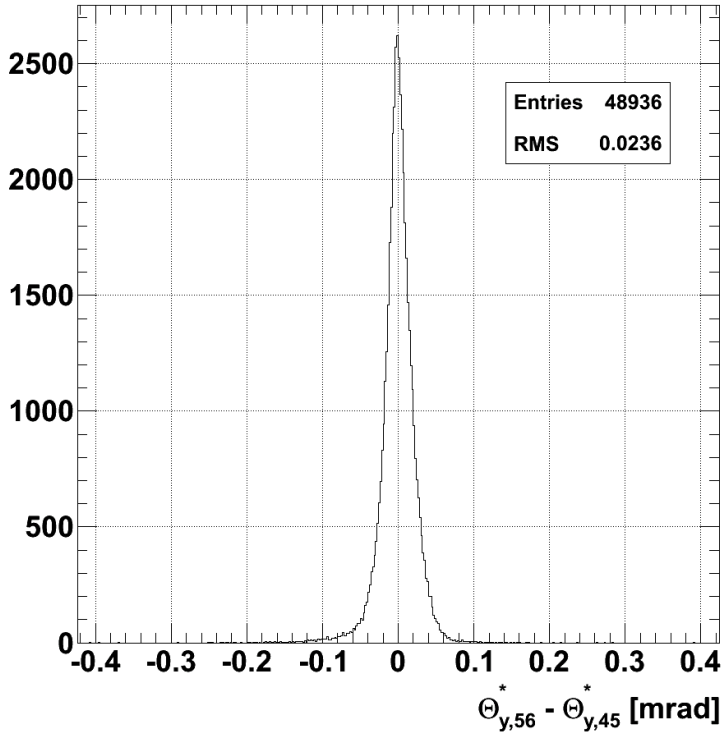


Compatible with the beam divergence

Collinearity in θ_y

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

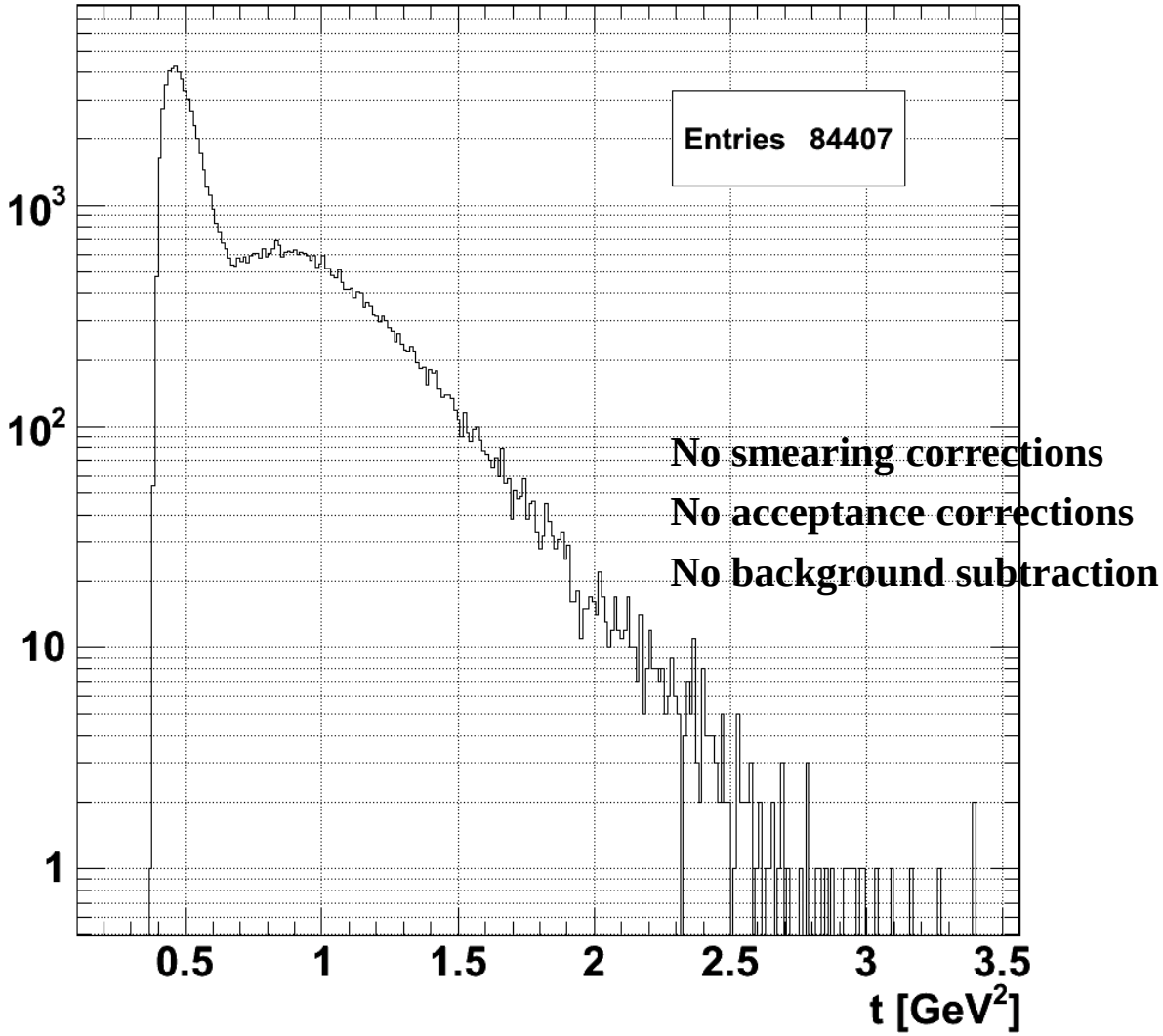




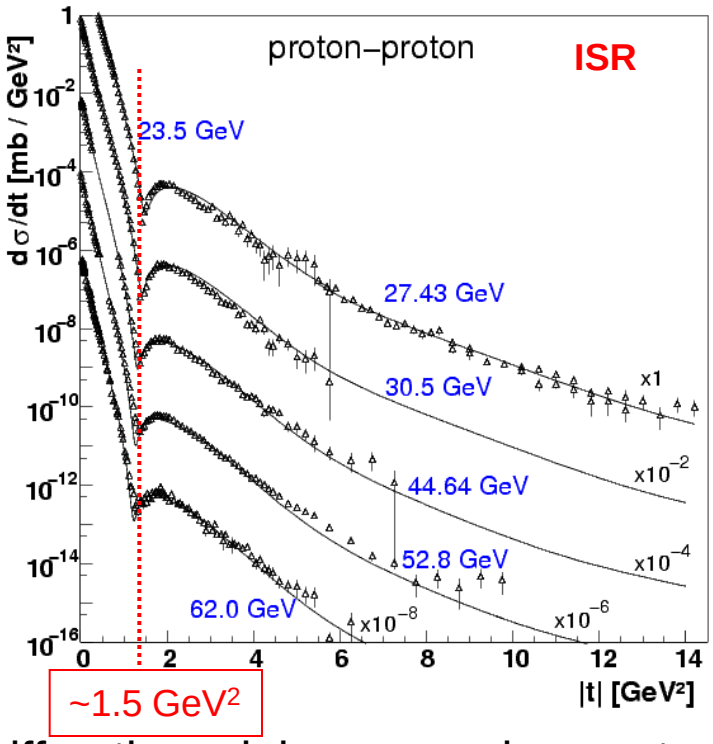
Compatible with the beam divergence

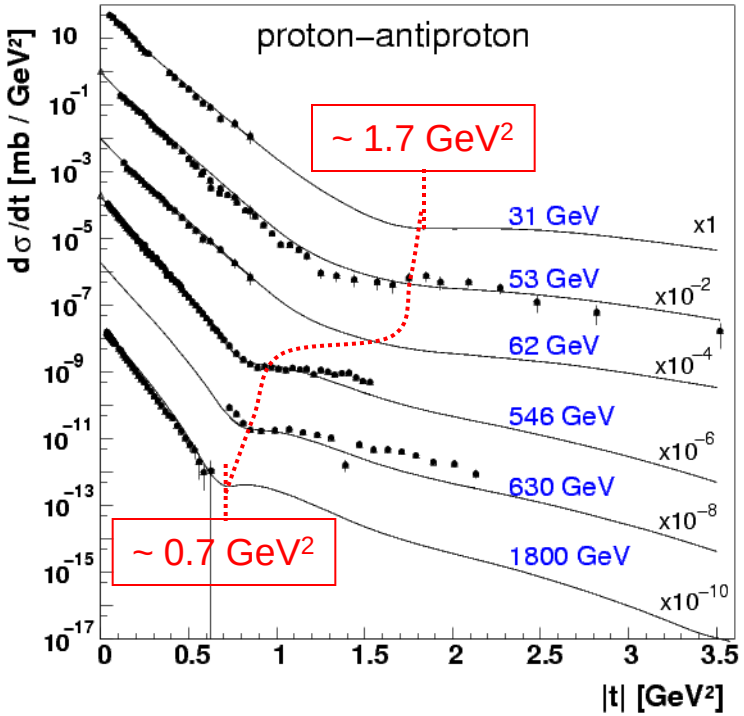
Preliminary t distribution

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

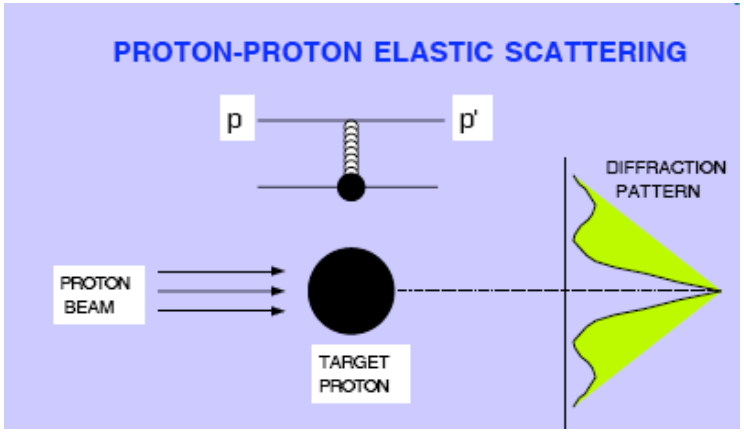


Elastic Scattering - from ISR to Tevatron





Diffractive minimum: analogous to Fraunhofer diffraction: $|t| \sim p^2\,\theta^2$



- exponential slope B at low |t| increases
- minimum moves to lower |t| as $1/\sigma_{tot}$
  → interaction region grows (as also seen from rising σ_{tot})
- depth of minimum changes
  → shape of proton profile changes
- depth of minimum differs between **pp, p^-p**
  → different mix of processes

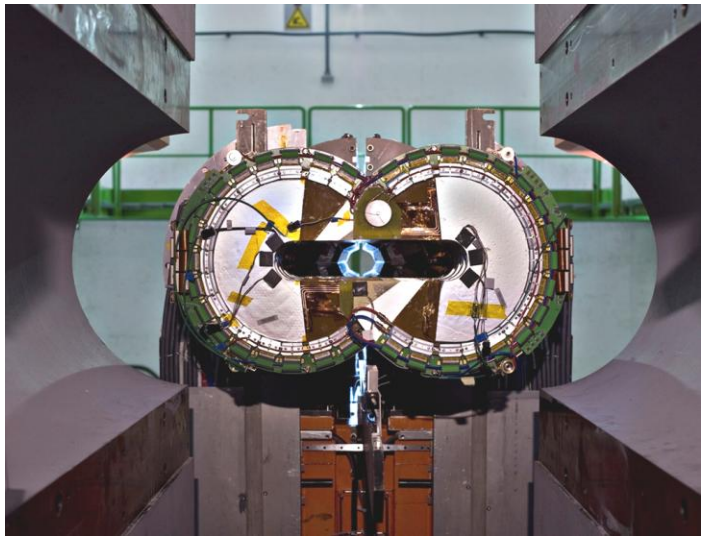
T2 Telescope

GEMs telescopes for tracks and vertex reconstruction

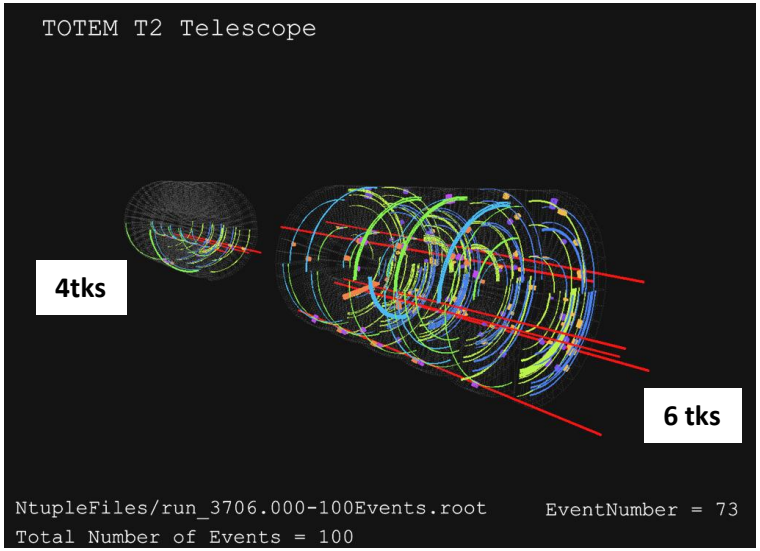
$5.2<|\eta|<6.5 \quad \Delta\phi=2\pi$

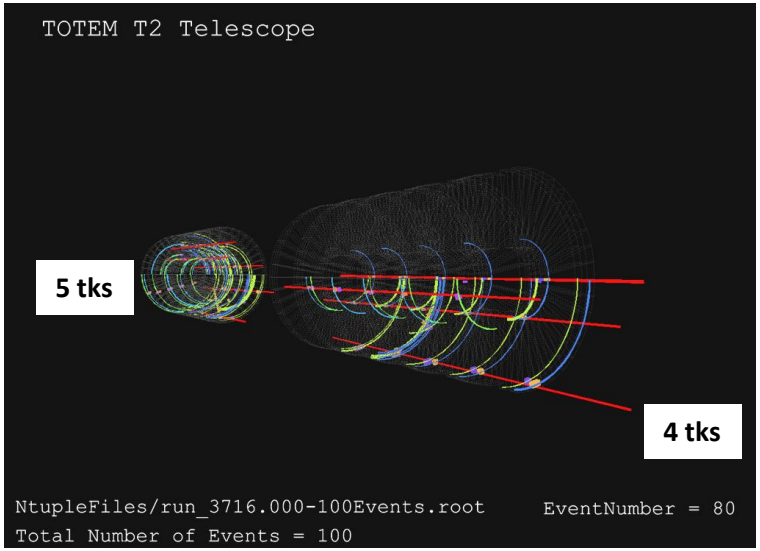
T2 trigger in "special run"

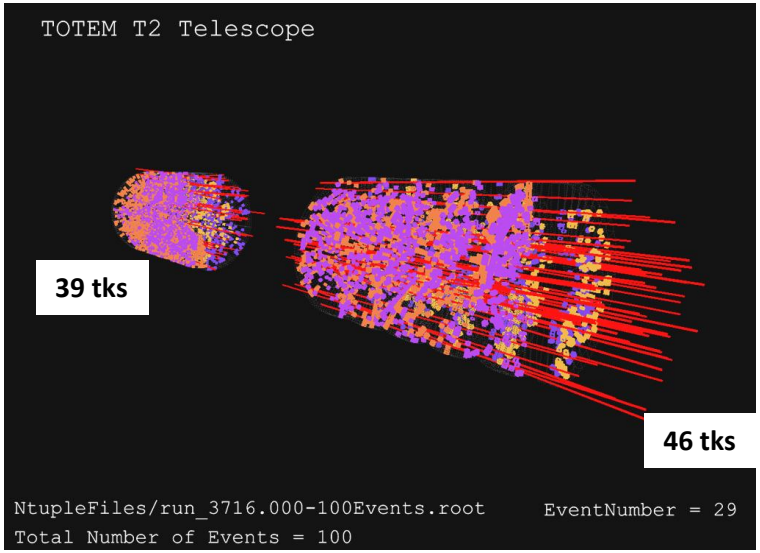
- min-bias only on minibunch

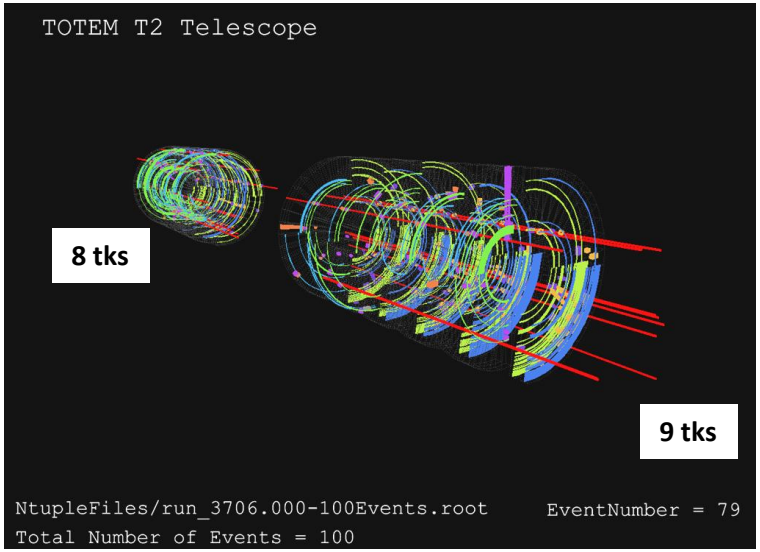


T2 events reconstruction

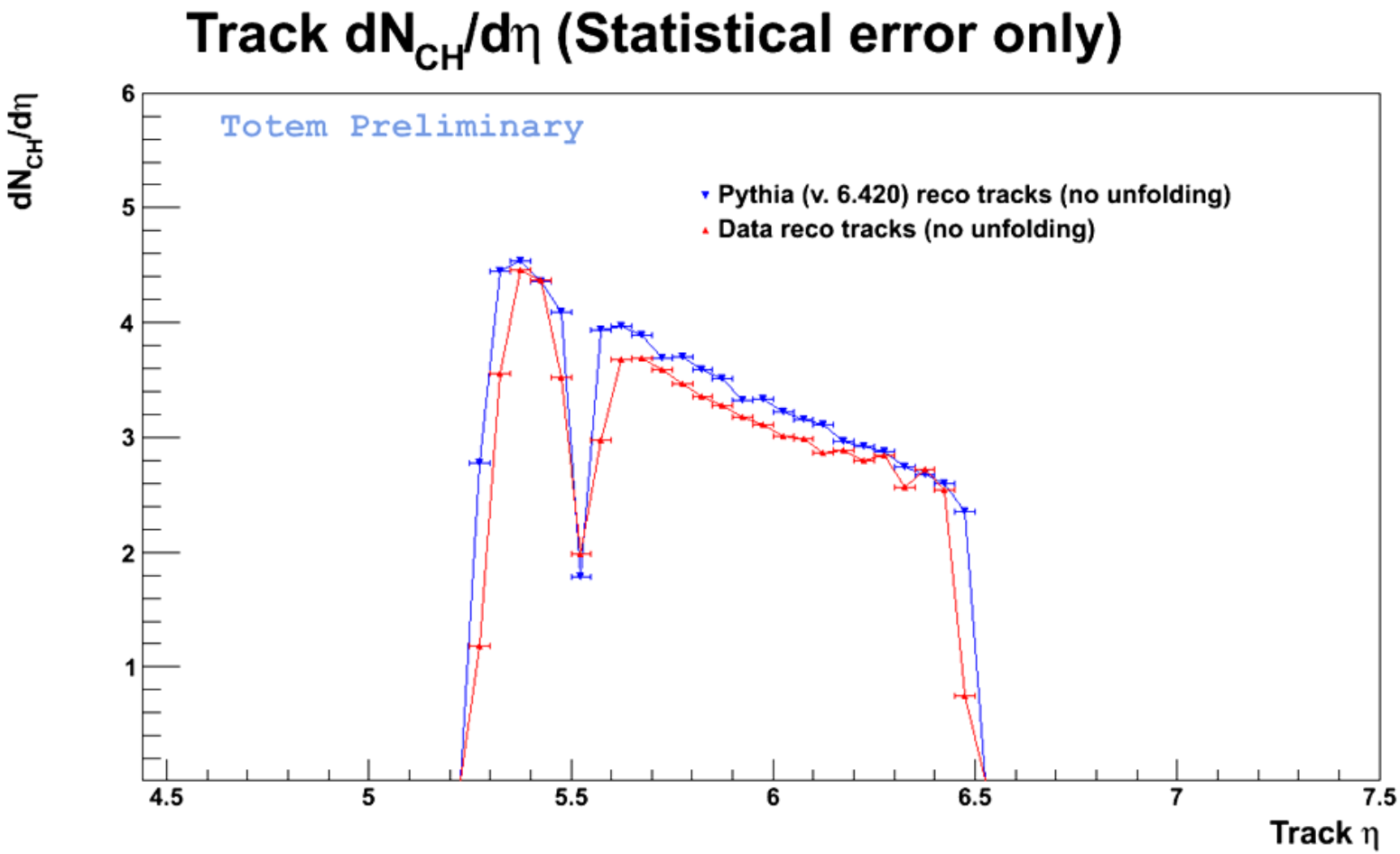








T2 - Preliminary

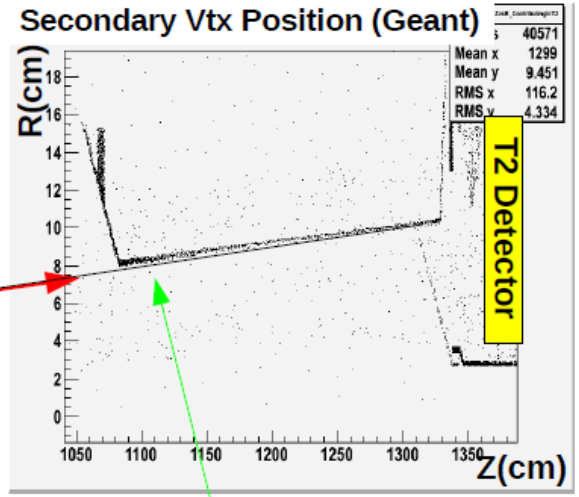


Data from TOTEM special run - trigger: min bias on mini-bunch only

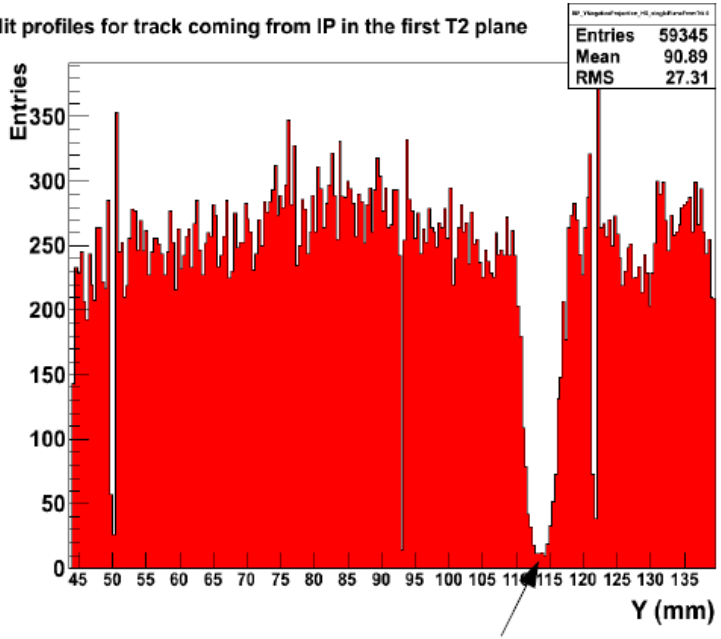
Including secondaries pointing to IP and no efficiency correction

Hit profile in T2:

Beam pipe shadow

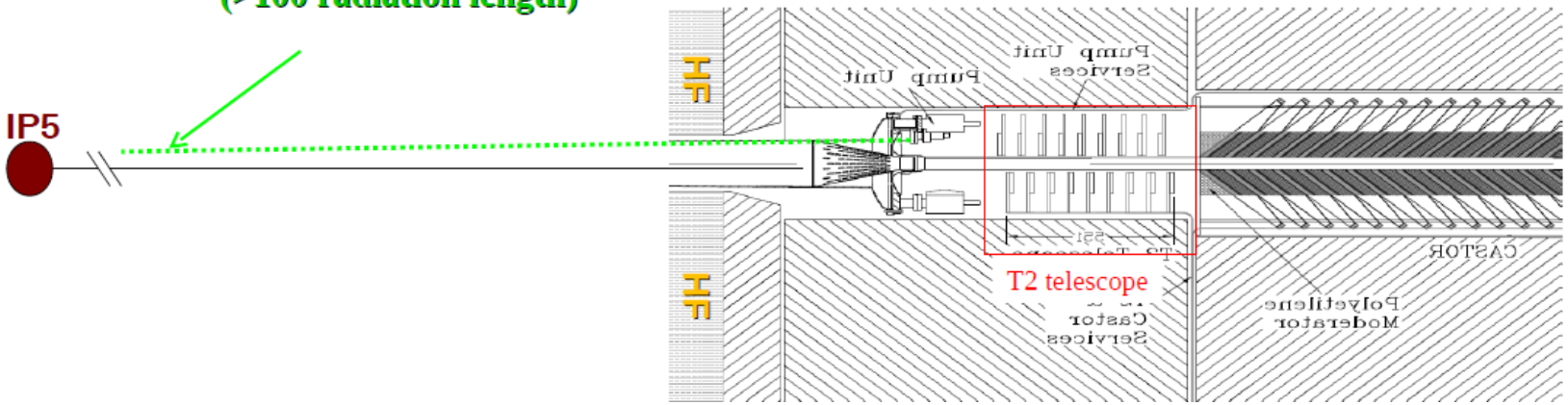


Track From IP

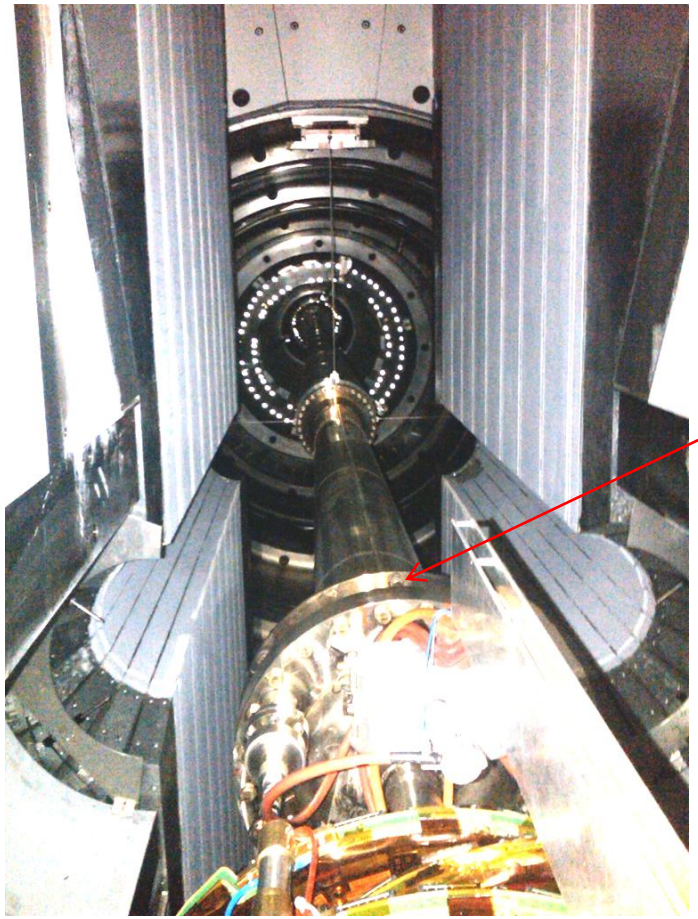


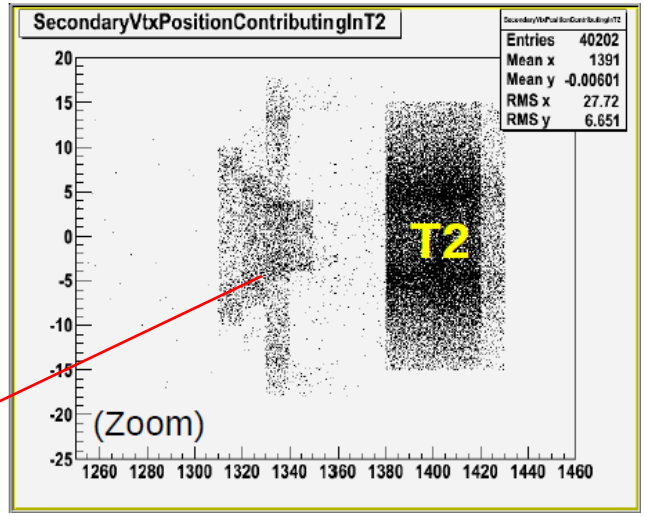
Beam pipe producing missing track hits in an well defined position of each T2 plane. This properties can be used for absolute detector alignment.

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



Beam pipe material and secondary production

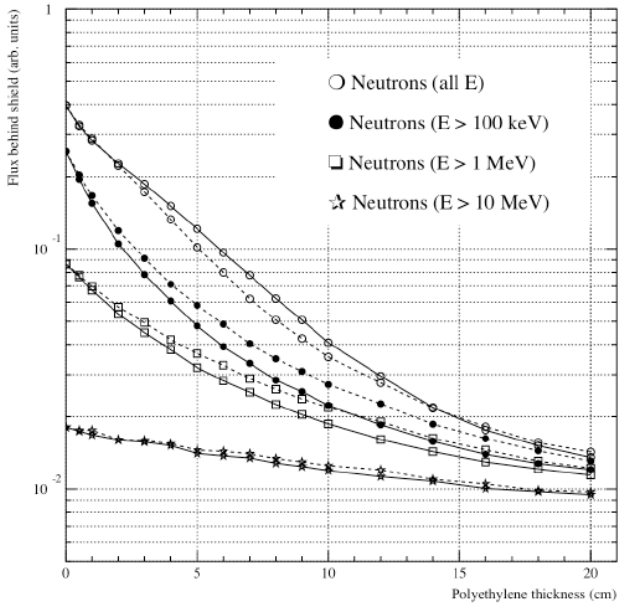


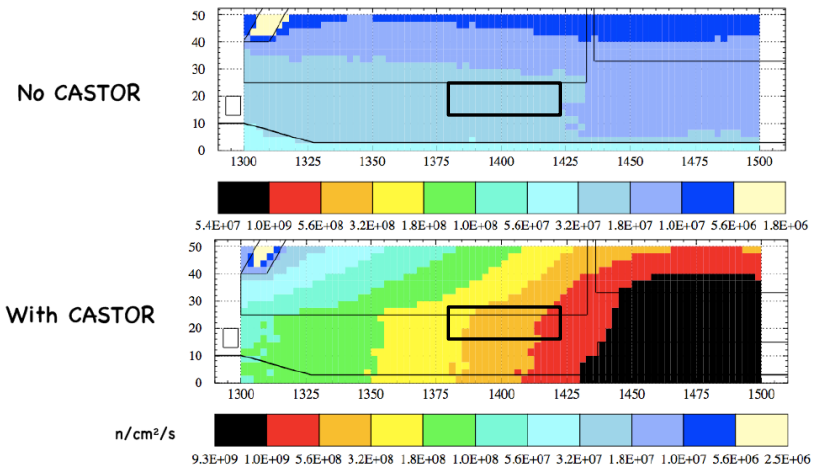


Flange and pumps are responsible for most of the gamma conversion from π_o and scattering of charged π.

Fluence measurement at T2

Simulation

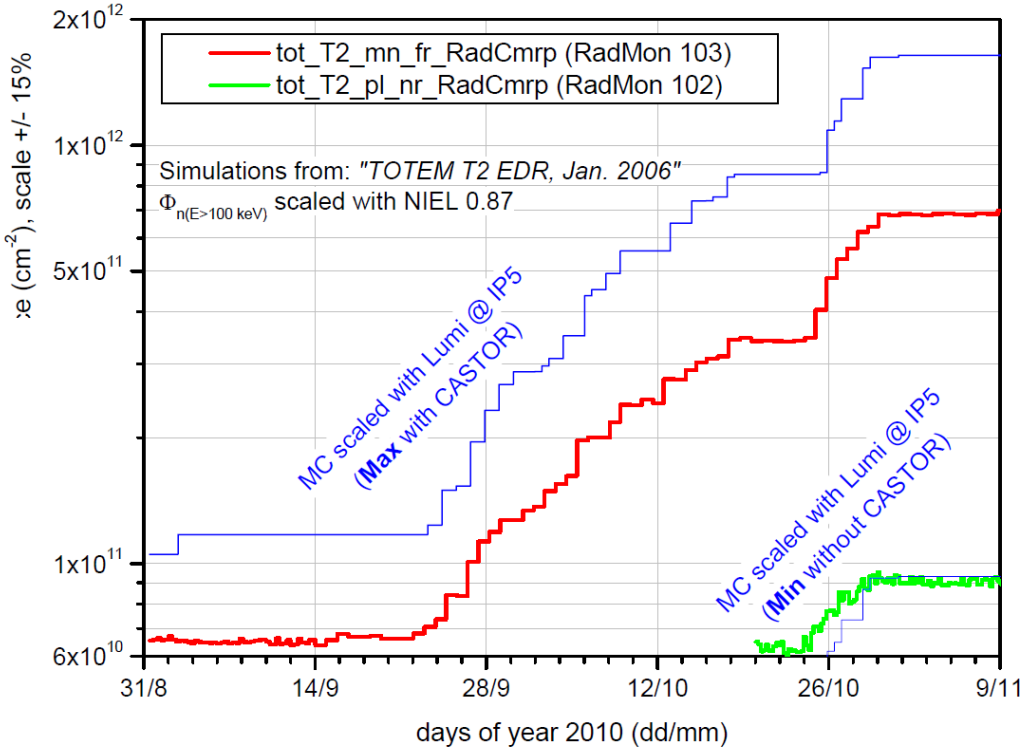




The presence of CASTOR on the minus side is clearly visible in the reconstruction and in the measured fluence.

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

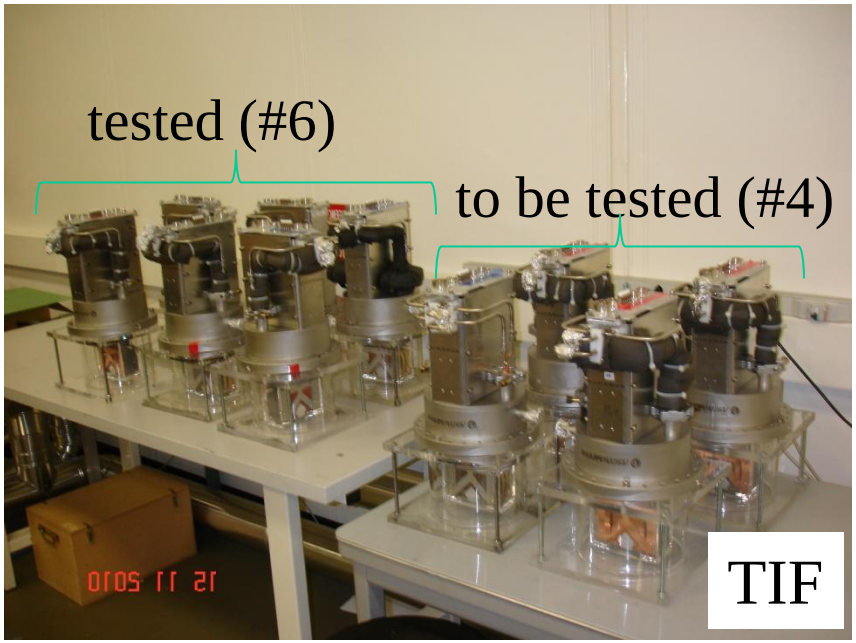
Measured fluence Radmon

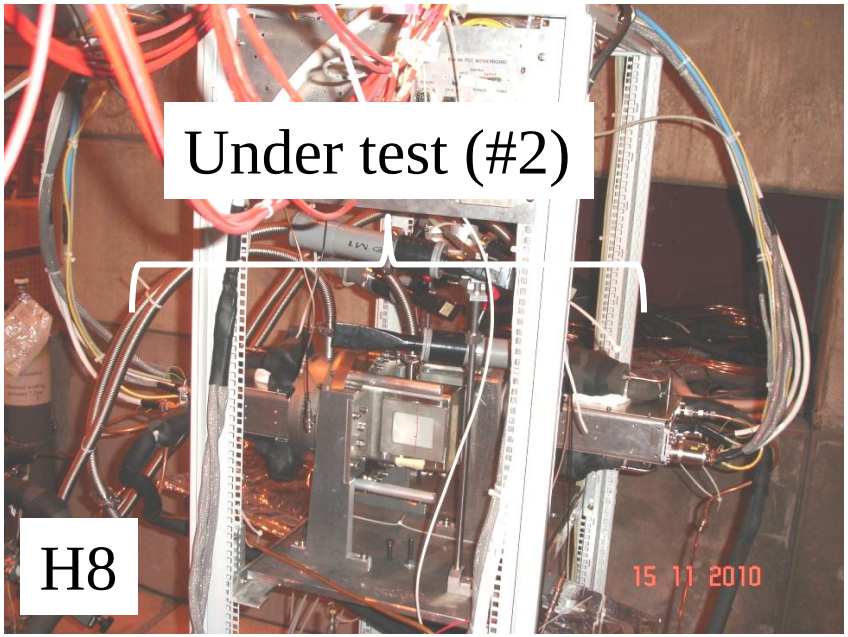


RP installation at 147 m during technical stop

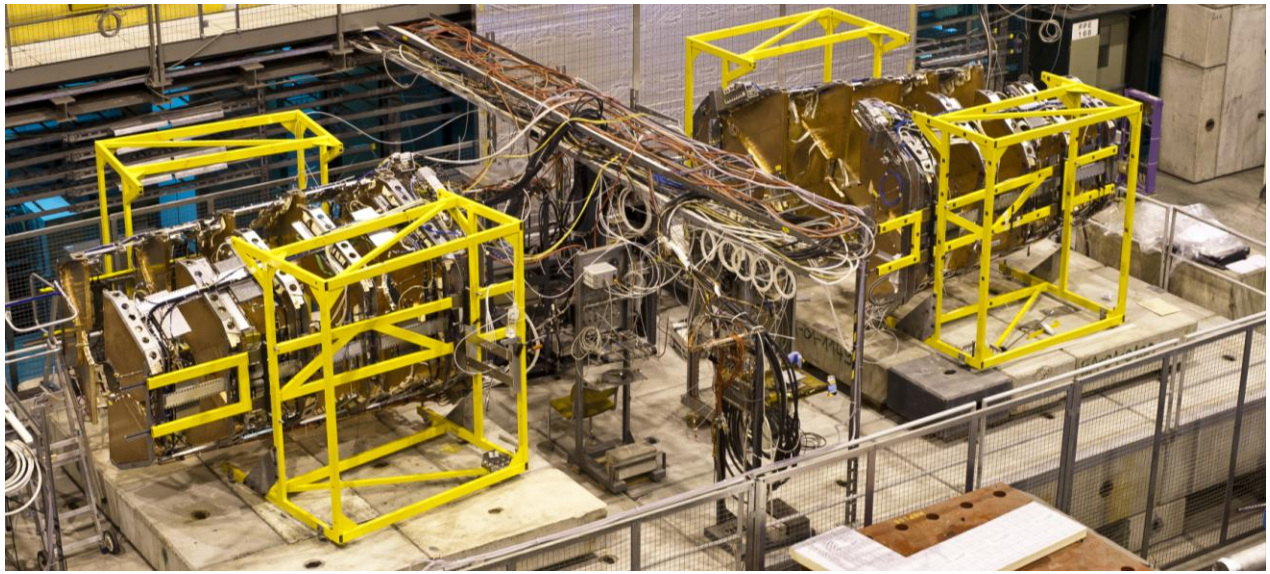
During the Technical stop TOTEM will install the last 12 detectors in the LHC tunnel ("147 m") completing in this way the detectors installation

- 12 detector packages have been produced, completely assembled and are ready for installation; final checks with particles to be completed
- All services for the RPs at 147m are ready for the installation work to start in December 2010.





T1 installation



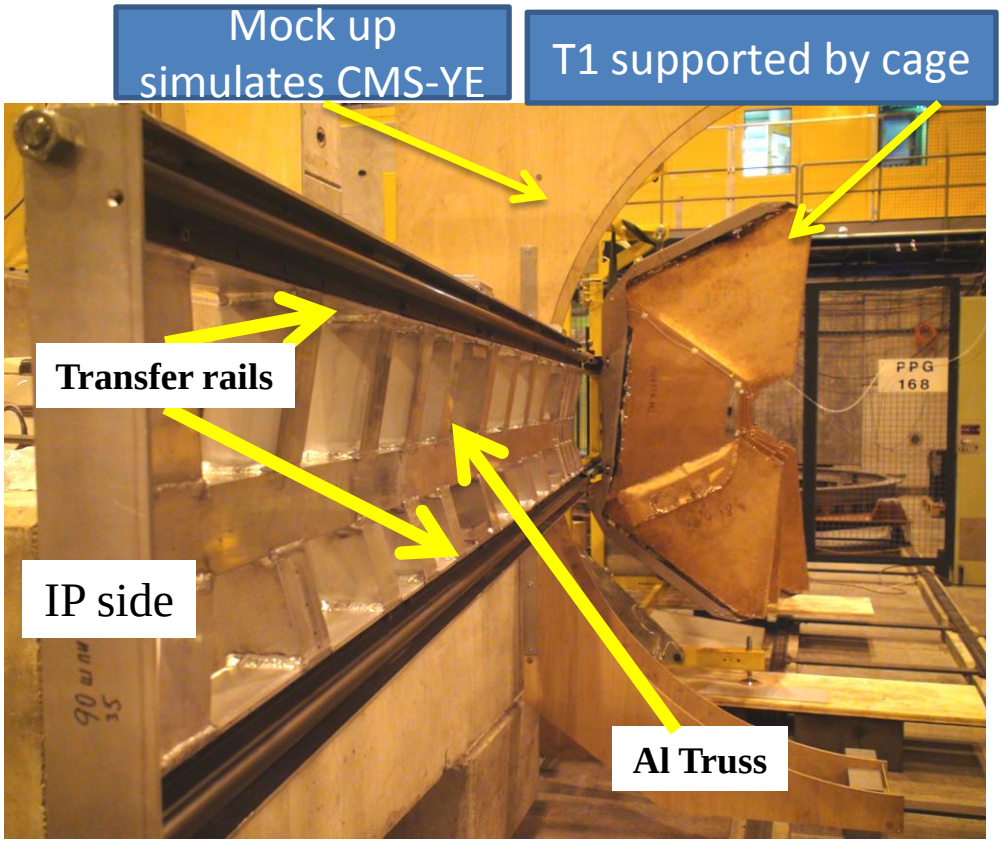
- Update on mechanical components (EDR with CMS held on June 2010)
- Update on electrical components (ESR with CMS held on September 2010)
- Installation at p5

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

- 30 Nov 2010 Final Installation Review with CMS

Update on EDR main issues

- TRUSS installation tool (Cantilever):
  new tool built, stress calculations , certificate (DGS-SEE)
- Transfer of T1 :
  from cage <-> truss
  successful for all 4 telescopes
- Survey :
  measurement of deformation during & after transfer, shimming
- Mock up simulating CMS-YE:
  measurement of clearance during/after transfer



Update on EDR main issues (2)

- Leak test of cooling system :
  leak tested with He, circuits cleaned, filled with deionized-water
- Sensors (B, position) :
  sensors are mounted, cabling completed
- Alignment system of CMS traversing T1:
  checked all cables for possible interference

Checking test for cross laser beams

18 lines

Update on electrical components

Electrical consolidation requested after september ESR (shielding, grounding, low voltage connectors)

- Reinforced grounding of Al structure
- Grounding point on CMS finalized
- All low voltage cable connections/ boxes modified
- Shielding completed
- Fuse boxes built
- DCS/DSS cables checked OK during short technical stops

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 availability of FSU

What remains to do before descending in 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

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 (~15 σ)

Prepare the β^* = 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 programme on Single Diffraction and Double Pomeron exchange

conclusion

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

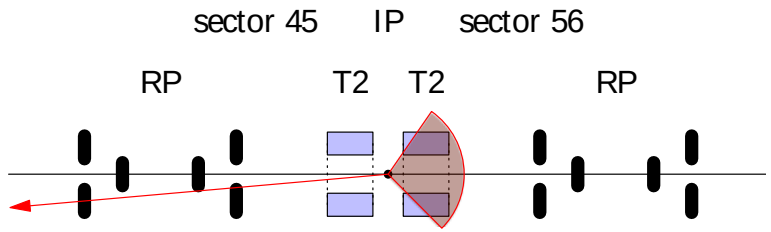
The present understanding of the event topologies (pp, SD, DD, DPE) from T2 and the RP shows already the TOTEM potential in diffractive physics measurements.

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

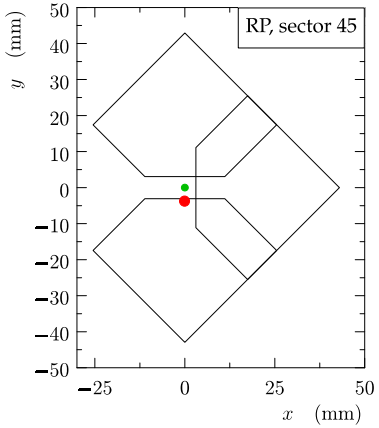
Many thanks to the machine team that has provided the good beam conditions necessary to do the measurement.

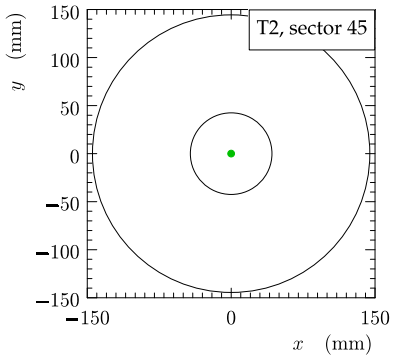

TOTEM

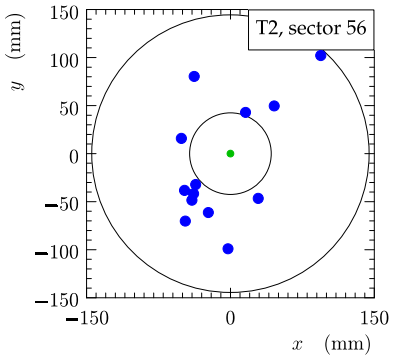
Single diffraction low ξ

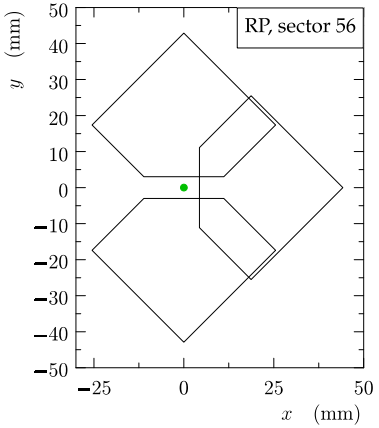


run: 37280003, event: 3000









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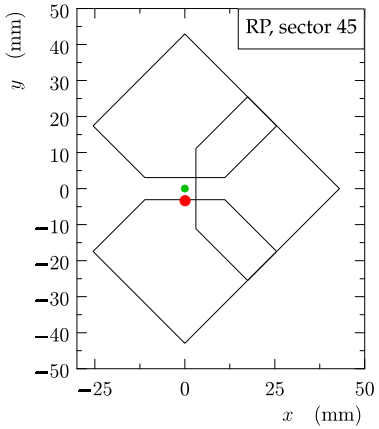
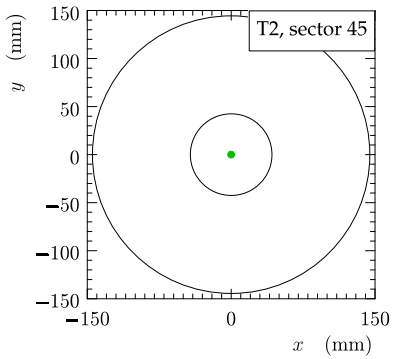
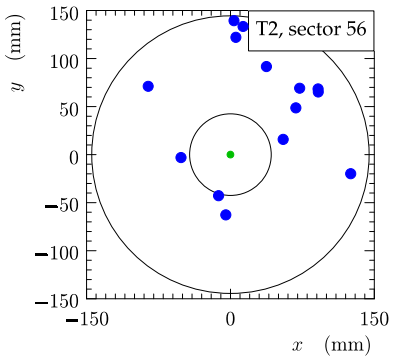
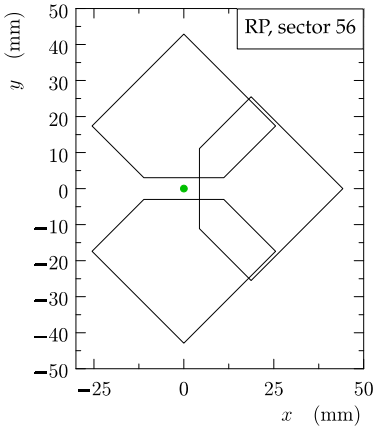
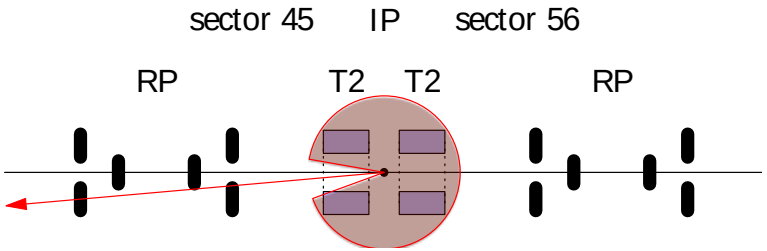








Single diffraction large ξ



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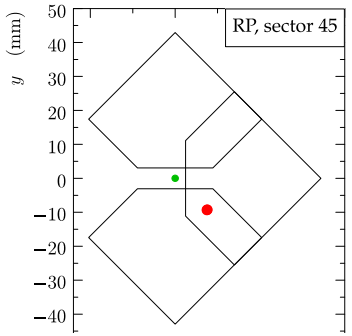

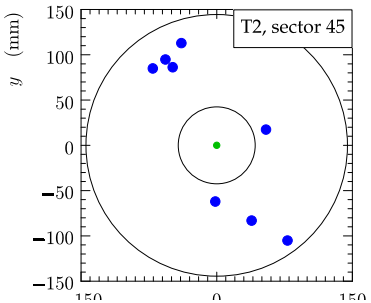

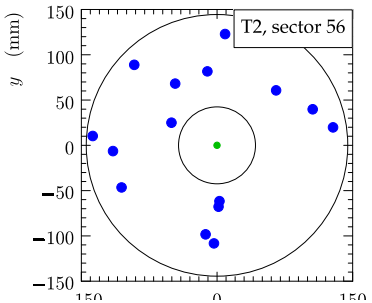

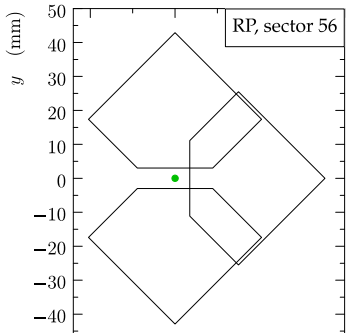

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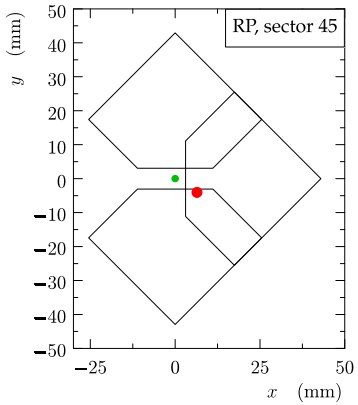
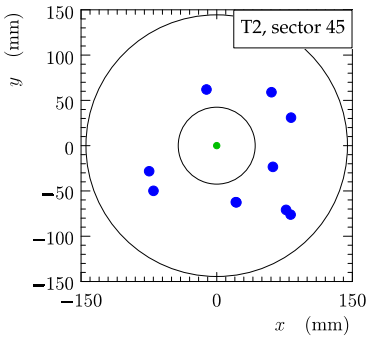
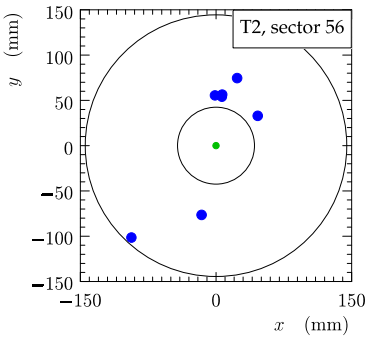
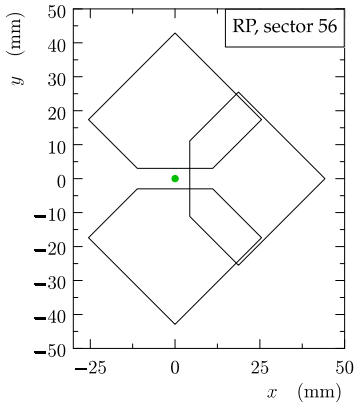
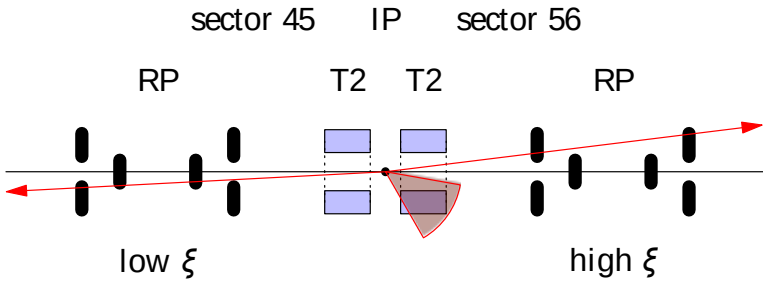




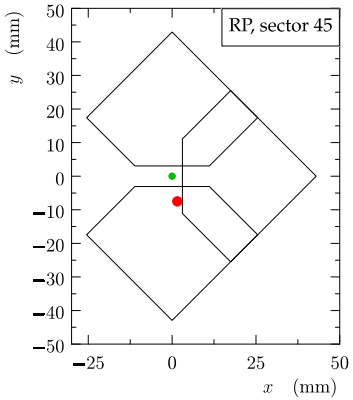


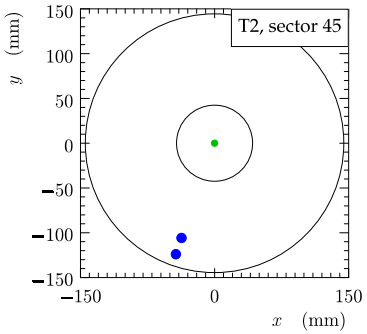


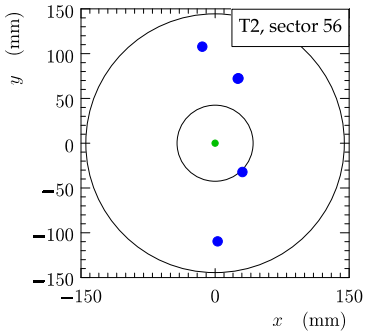
Double Pomeron Exchange

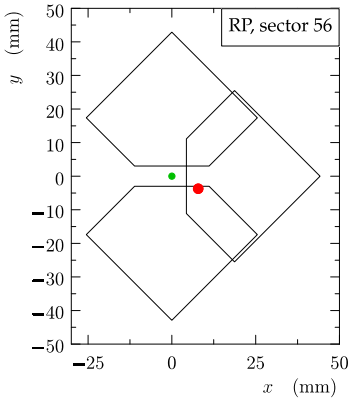


run: 37250009, event: 14125

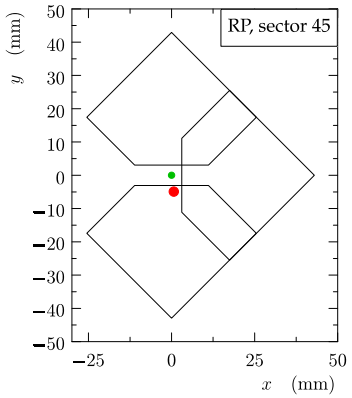


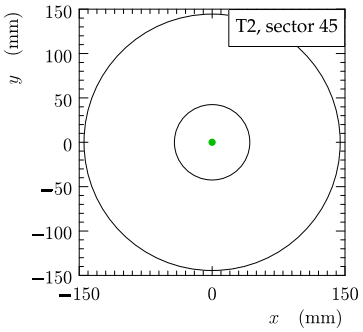


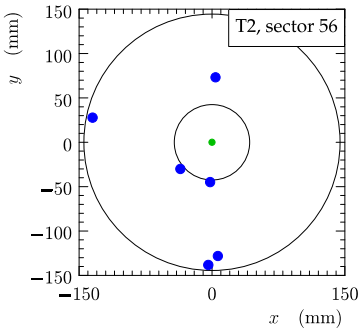


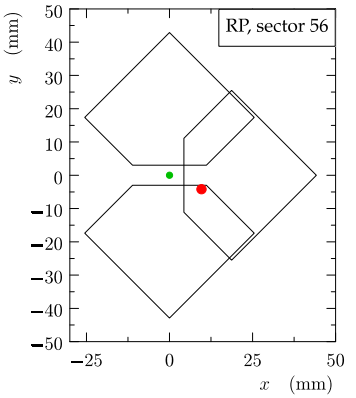


run: 37220007, event: 9904

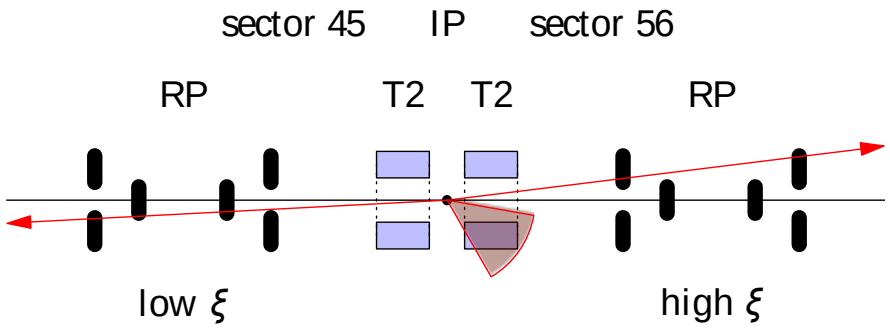


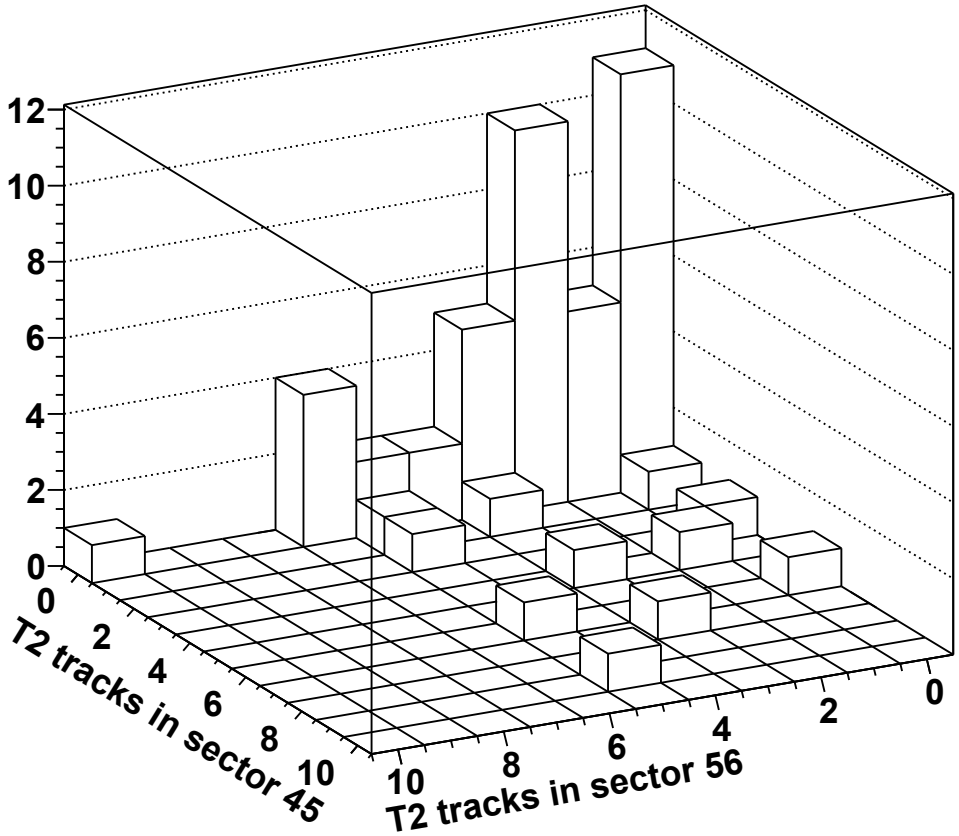






Double Pomeron exchange



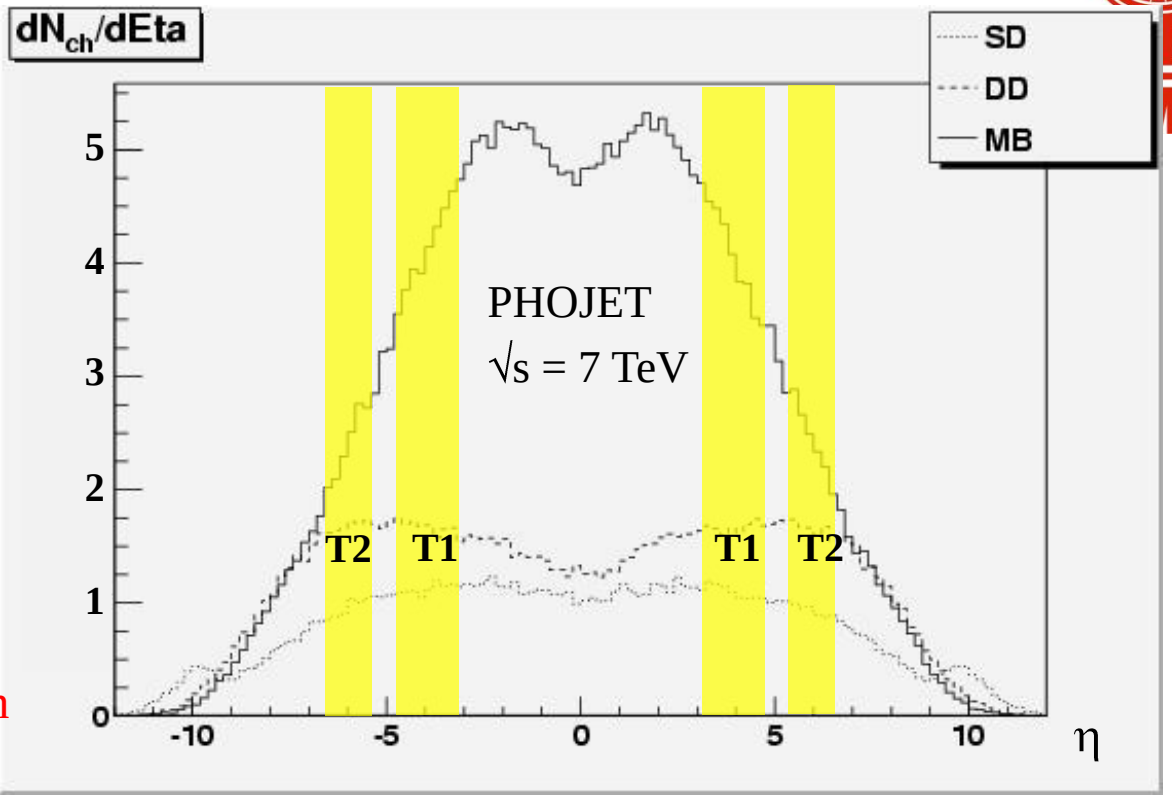


Acceptance for Inelastic Events (1)

Uncertainties in inelastic cross sections large:

- non-diffractive minimum bias (MB) 40 – 60 mb
- single diffraction (SD) 10 – 15 mb
- double diffraction (DD) 4 – 11 mb

Low multiplicities in diffraction



Accepted event fraction:

	MB			DD			SD		
Min. number of tracks	T1+T2	1/2 T1 + T2	T2 only	T1+T2	1/2 T1 + T2	T2 only	T1+T2	1/2 T1 + T2	T2 only
≥1(L + R)	100,0%	100,0%	98,2%	94,1%	92,9%	89,8%	77,6%	75,4%	71,3%
≥2(L + R)	100,0%	99,5%	95,1%	88,9%	83,4%	73,8%	68,6%	61,9%	51,3%
≥3(L + R)	99,9%	98,1%	89,0%	83,9%	75,3%	57,5%	61,4%	49,9%	32,3%
≥4(L + R)	99,1%	95,9%	82,2%	78,2%	66,3%	45,5%	55,0%	40,0%	19,0%
≥5(L + R)	98,3%	93,2%	71,7%	73,3%	59,5%	33,3%	48,4%	31,4%	11,5%

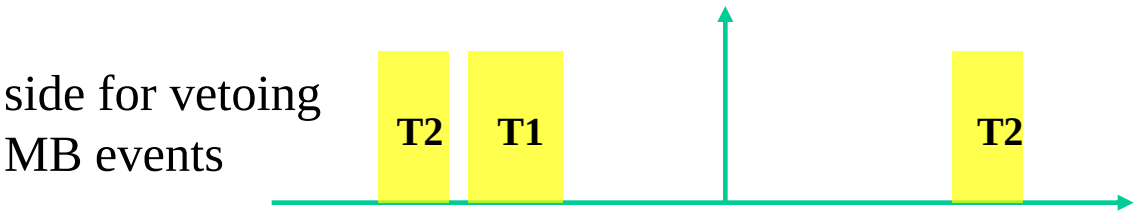
Efficiency increases

Acceptance for Inelastic Events (2)

Very low-mass diffractive event rate (**2.9 mb ?**) with all particles at $|\eta|$-values beyond T2 acceptance needs to be estimated

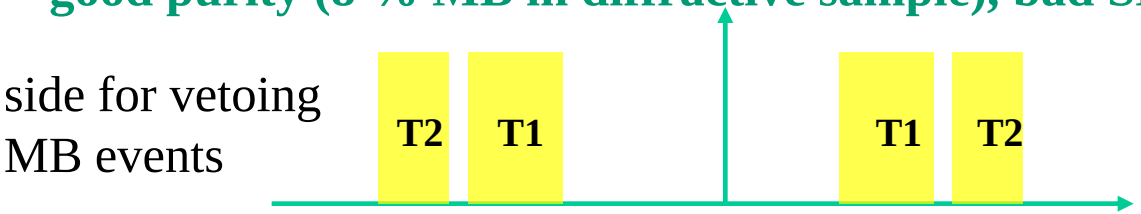
$\Rightarrow$

Extrapolation in diffractive mass using a **very pure low-mass SD** event sample with a **good diffractive mass determination** :



~~**bad purity (44 % MB in diffractive sample), bad SD mass determination**~~

good purity (8 % MB in diffractive sample), bad SD mass determination

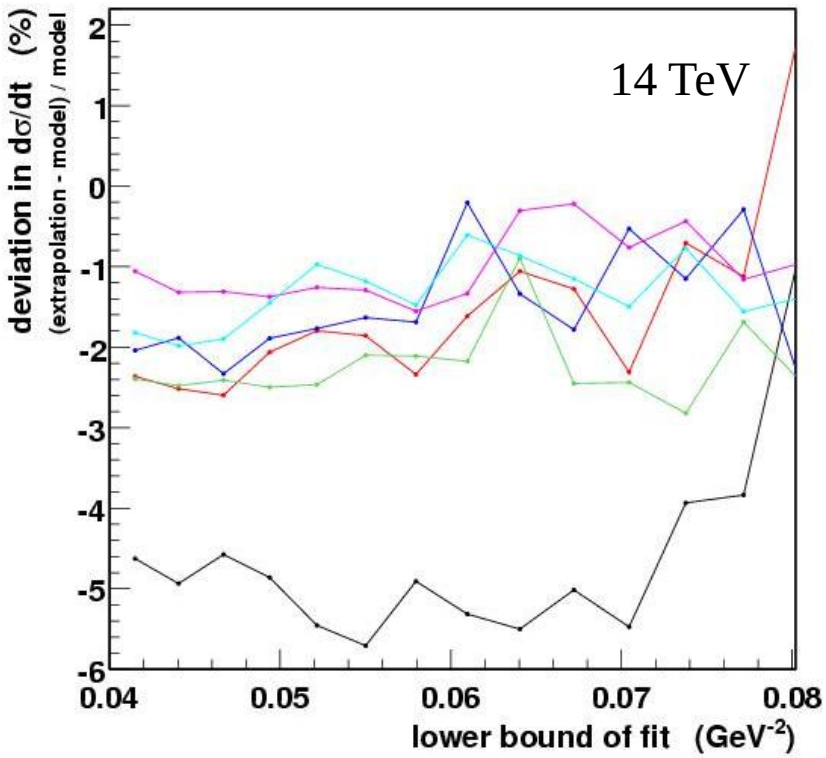


~~**bad purity (44 % MB in diffractive sample), good SD mass determination**~~

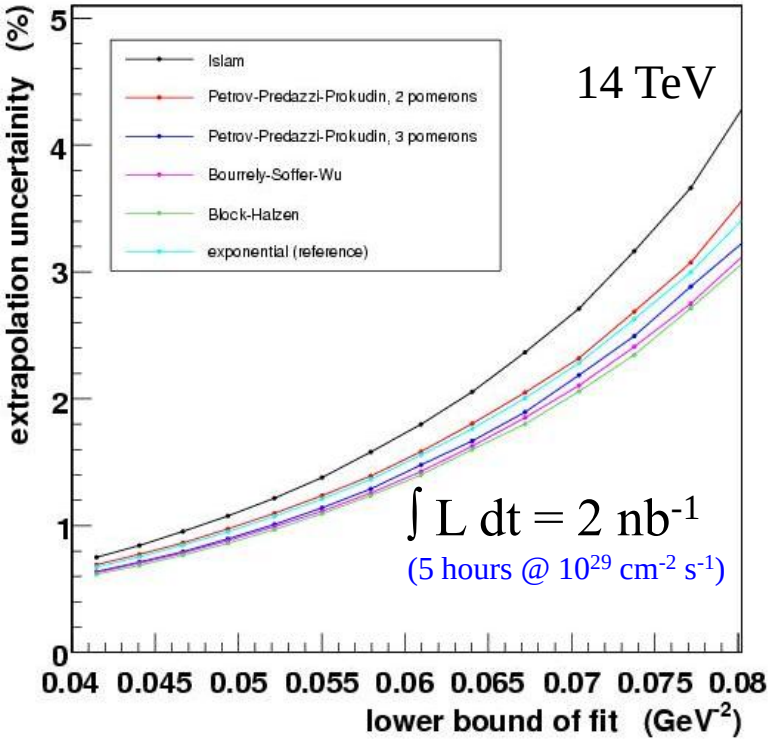
good purity (5 % MB in diffractive sample), good SD mass determination

Extrapolation to the Optical Point (t = 0) at $\beta^* = 90$ m

(extrapol. - model) / model in $d\sigma/dt|_{t=0}$



Statistical extrapolation uncertainty



Common bias due to beam divergence (angular spread flattens dN/dt distribution):

–2% (@14 TeV) → –3% (@7 TeV), **can be corrected for**

Key advantage of 7 TeV w.r.t. 14 TeV: $|t_{min}|$ reduced : 0.024 GeV^2 → 0.012 GeV^2 : **shorter extrapolation**

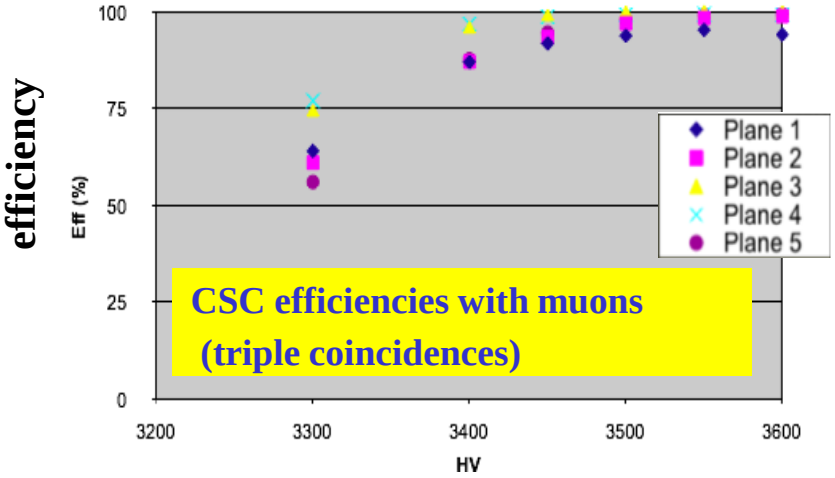
→ **Total cross-section measurement with the Optical Theorem**

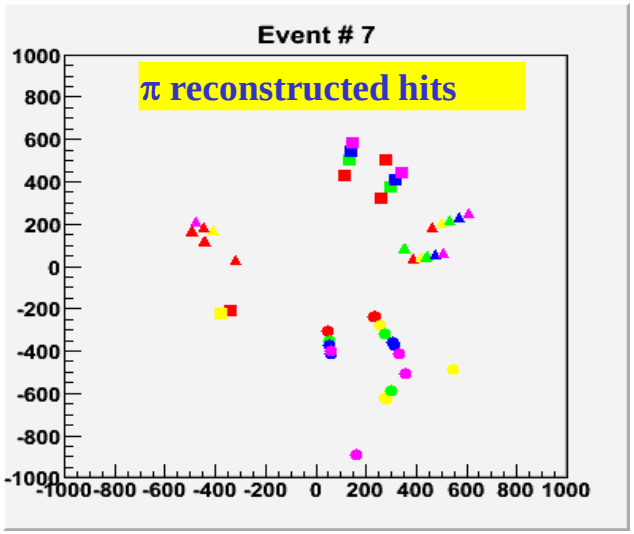
$$\sigma_{tot} = \frac{16\pi}{1+\rho^2} \frac{dN_{el}/dt\big|_{t=0}}{N_{el}+N_{inel}}$$

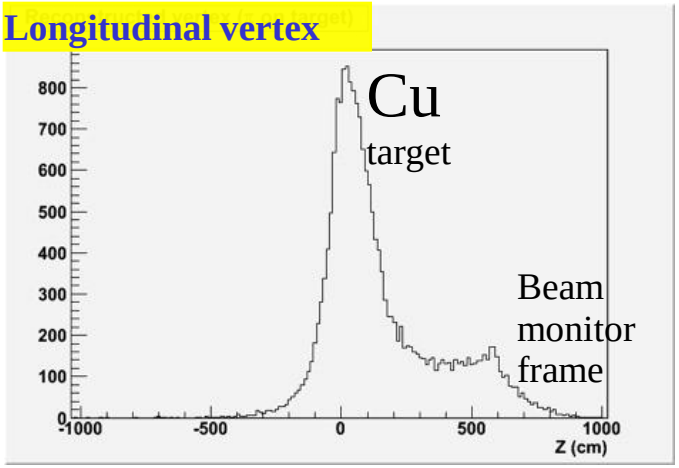
T1 Telescope Performance

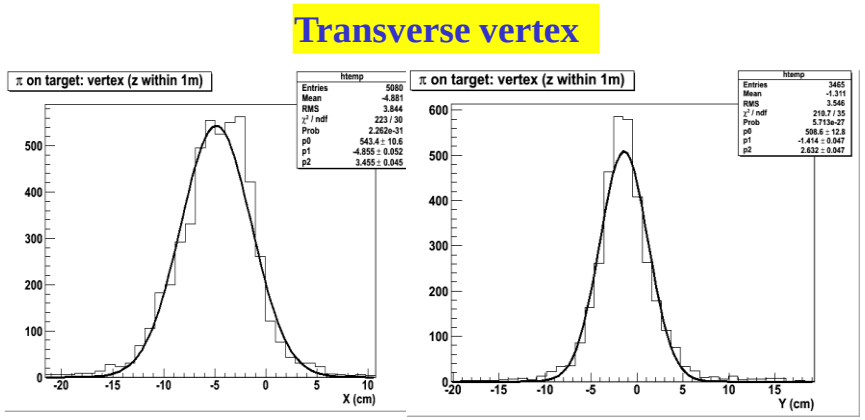
Both arms successfully tested with pion and muon beams

Pions on copper target to get many-tracks events

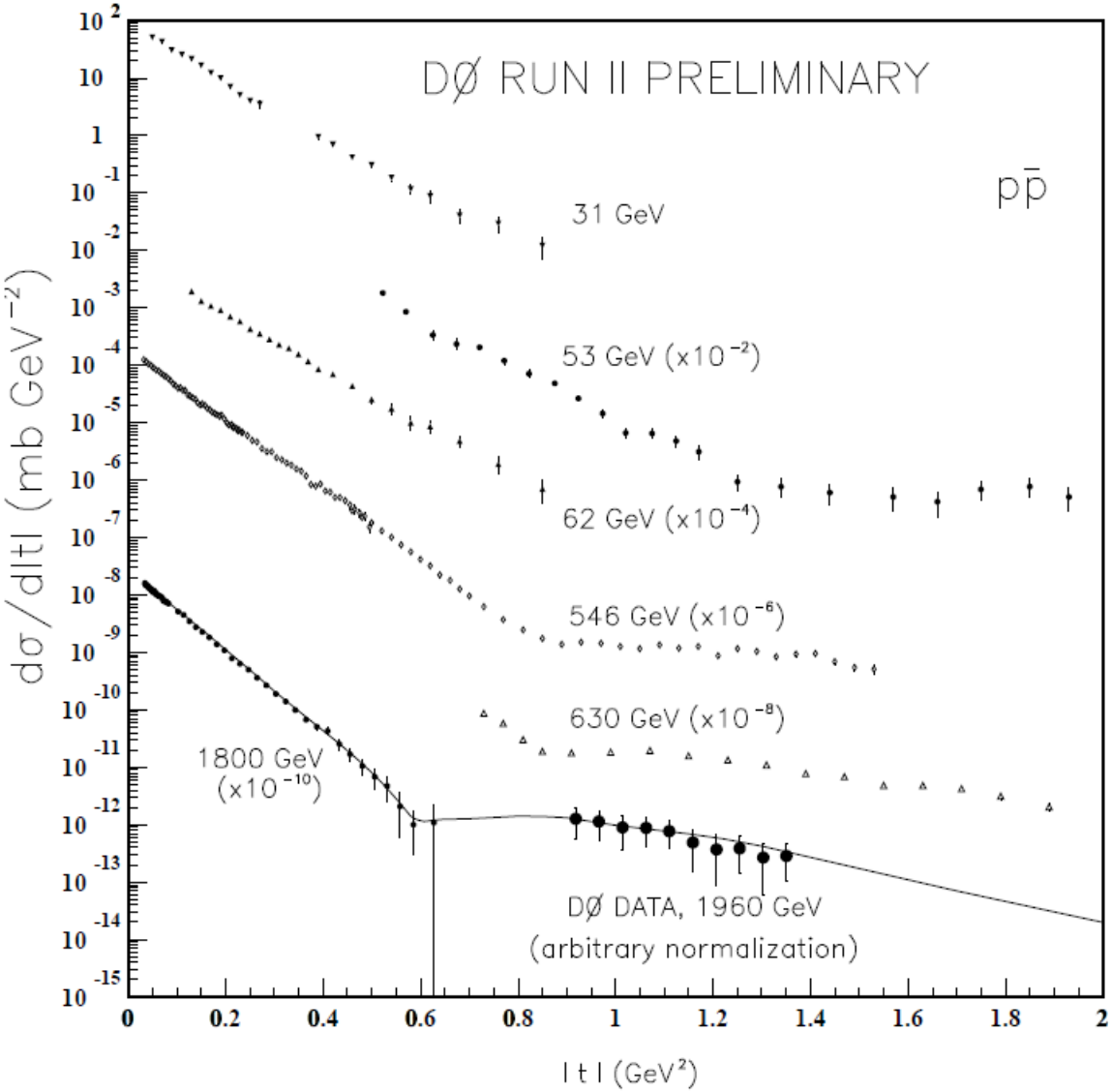




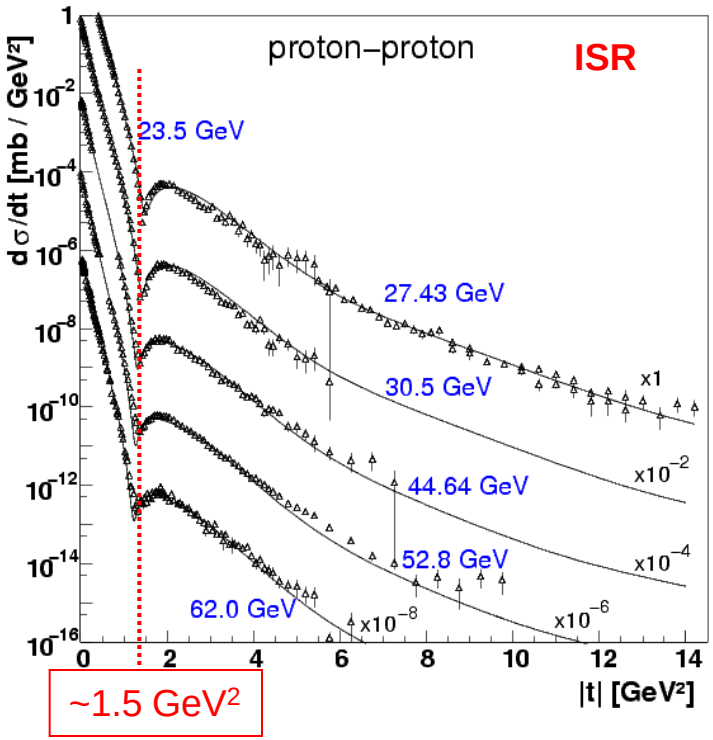


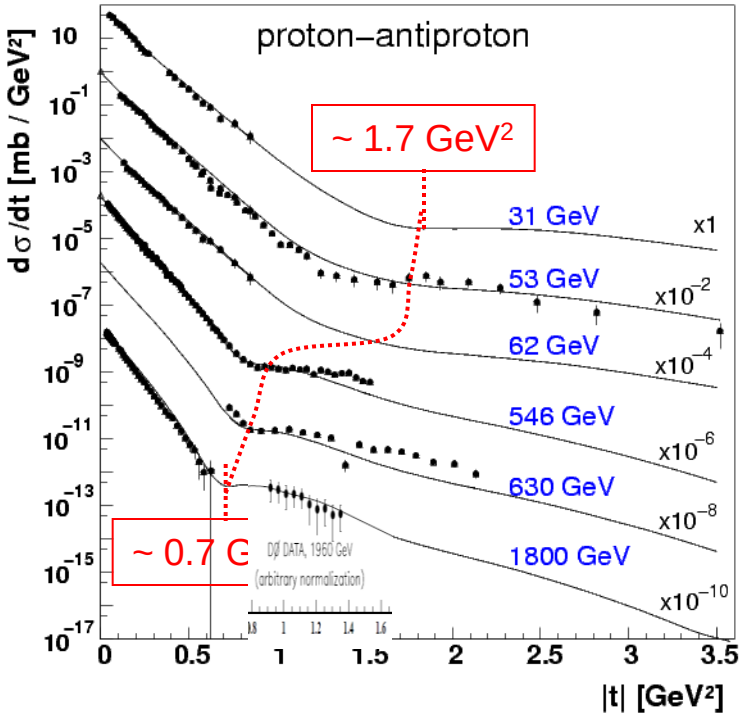


D0 (unpublished – 2004)

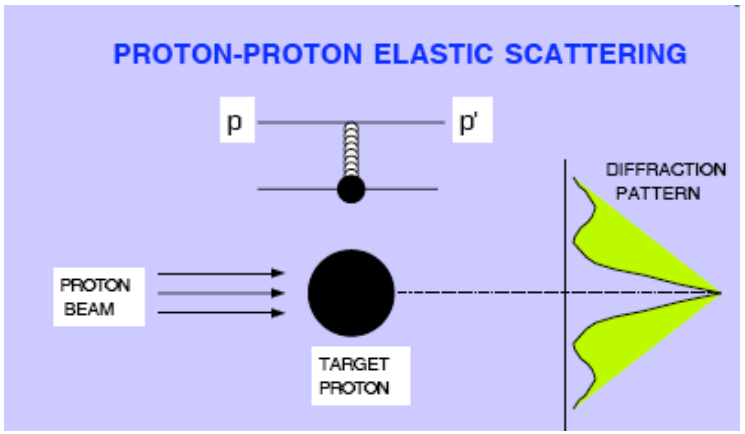


Elastic Scattering - from ISR to Tevatron





Diffractive minimum: analogous to Fraunhofer diffraction: $|t| \sim p^2 \theta^2$



- exponential slope B at low |t| increases
- minimum moves to lower |t| as $1/\sigma_{tot}$
  → interaction region grows (as also seen from rising σ_{tot})
- depth of minimum changes
  → shape of proton profile changes
- depth of minimum differs between **pp, p^-p**
  → different mix of processes