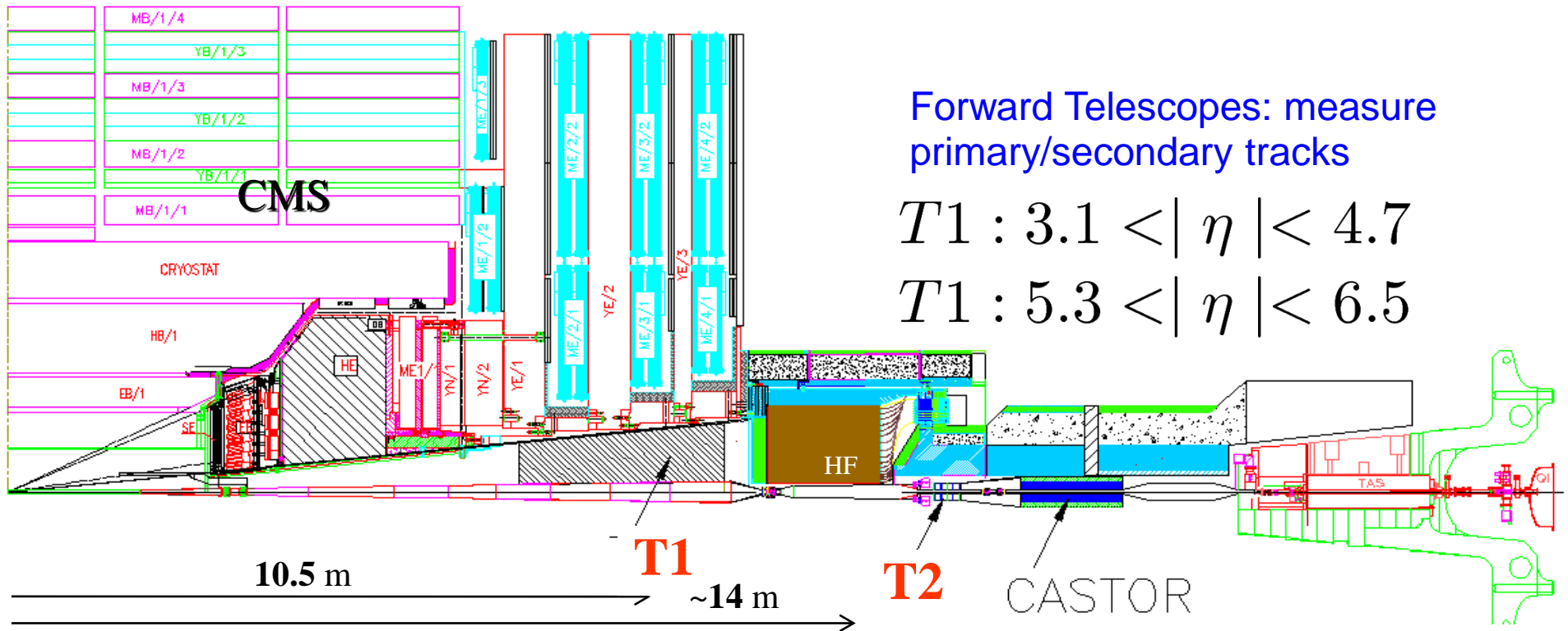


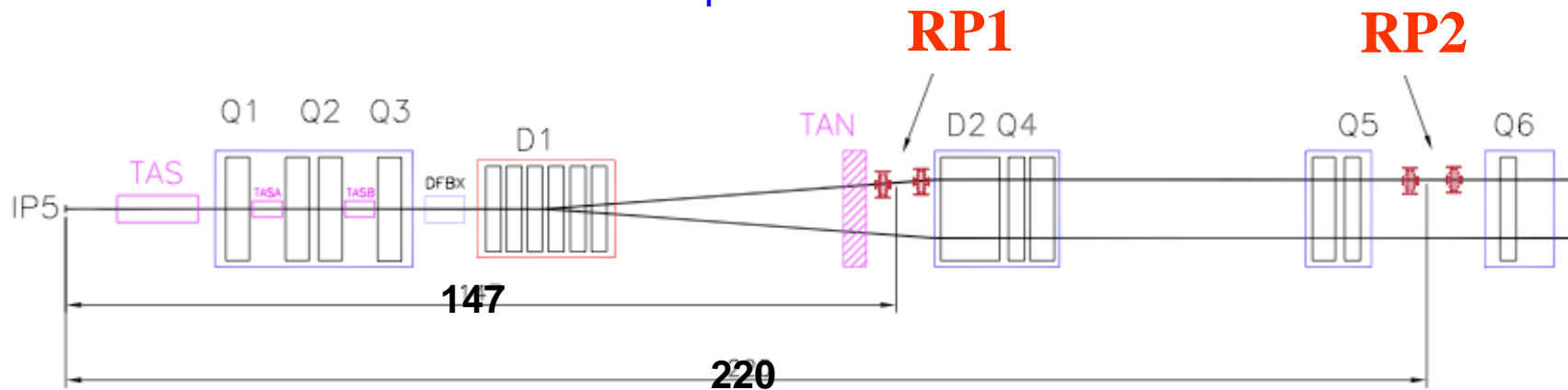
TOTEM: status and prospects

Emilio Radicioni – INFN/CERN

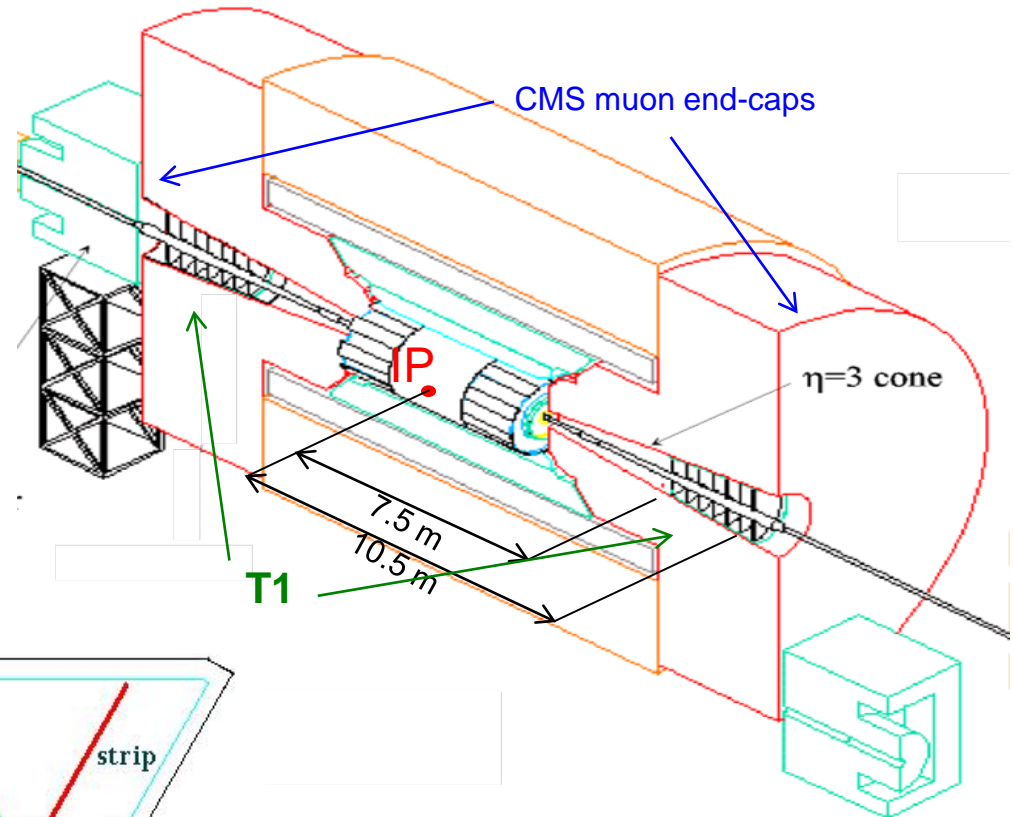
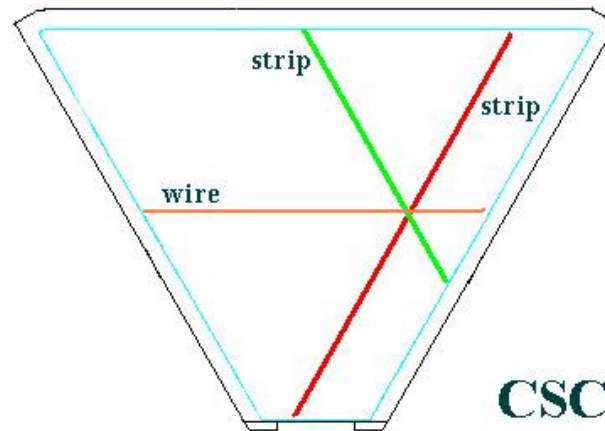
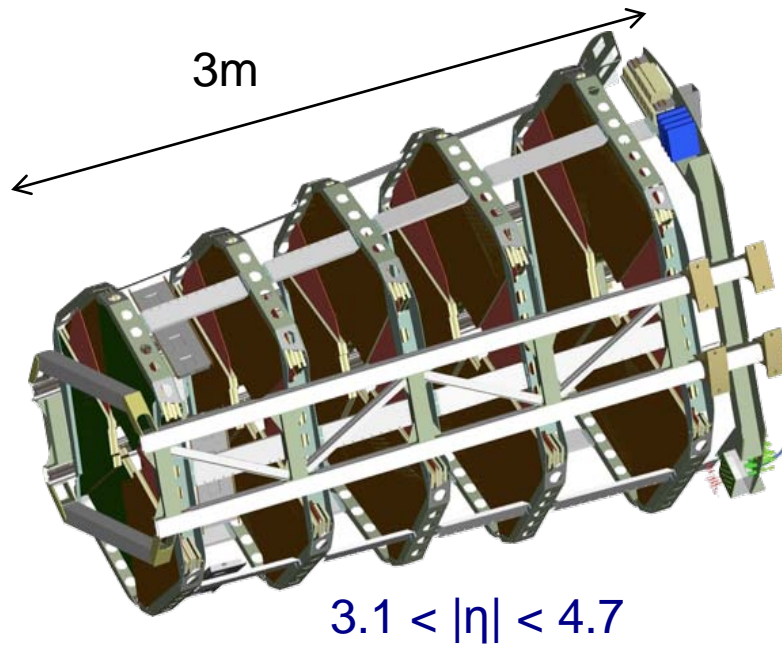
Overall Configuration @IP5



Roman Pots: measure scattered protons



T1 telescope with Cathode Strip Chambers (CSCs)



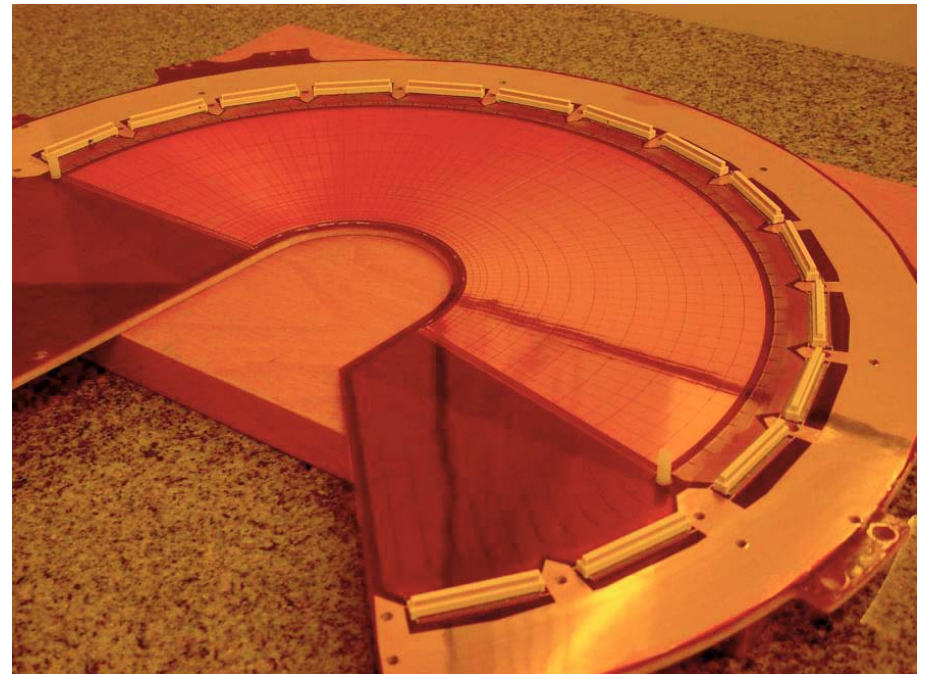
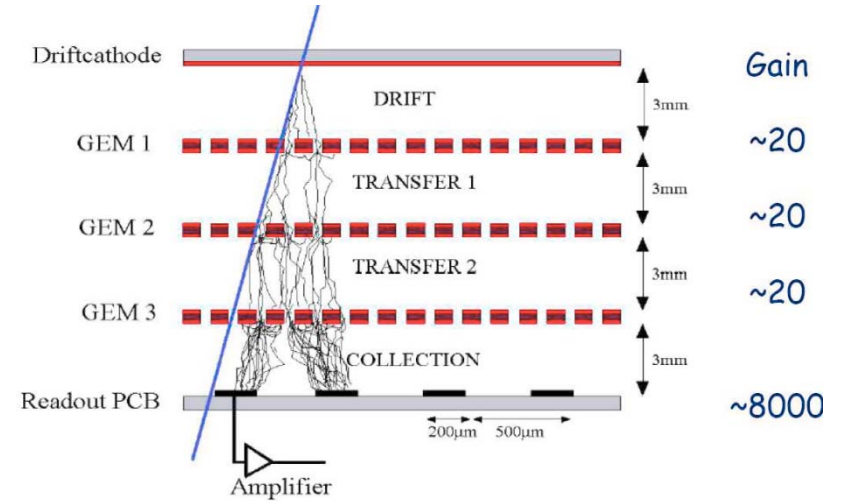
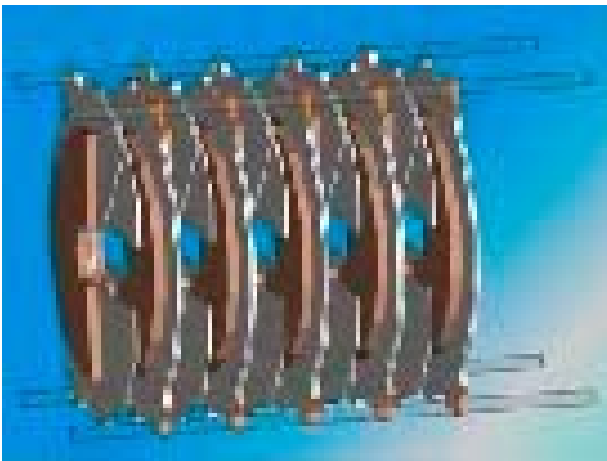
Wire pitch: 3mm
Cathode pitch: 5mm
Gas gap: 10mm

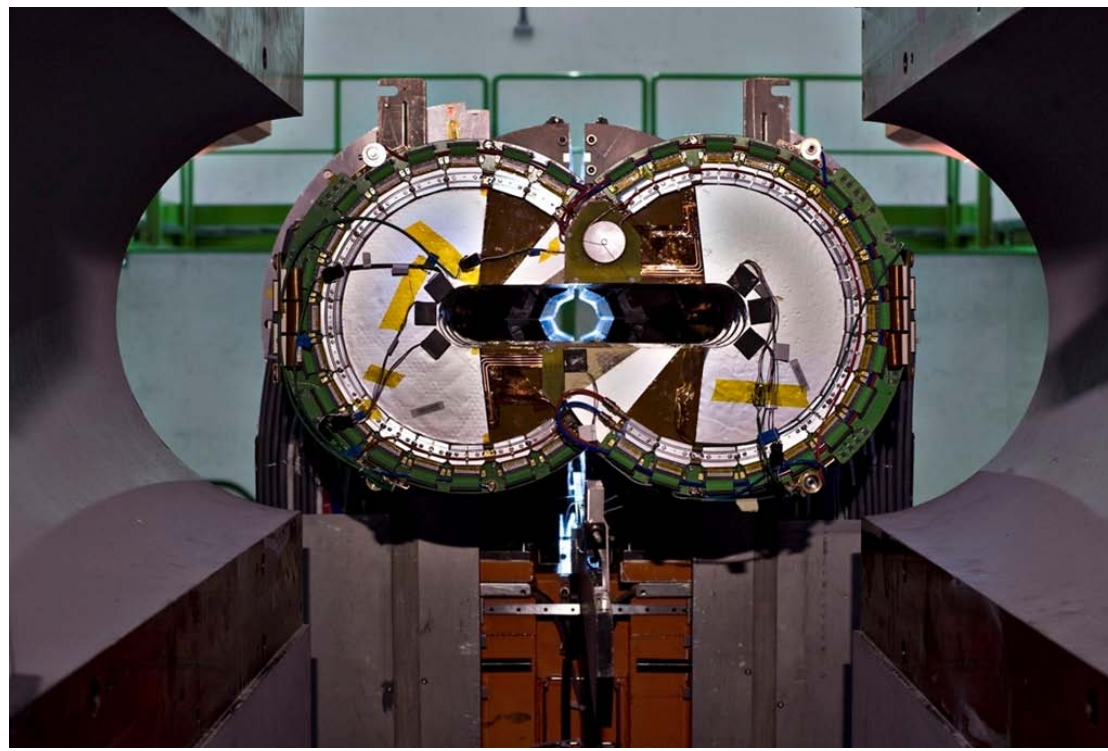
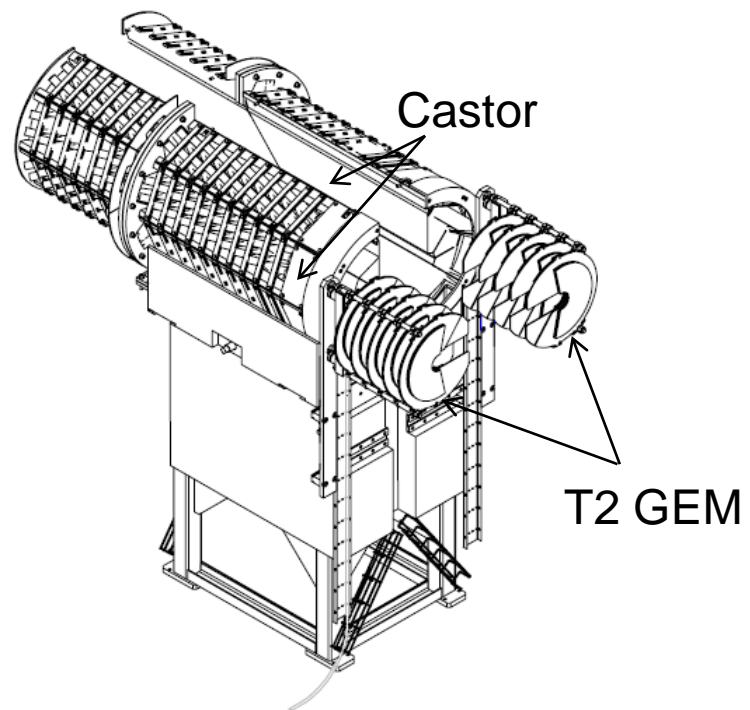
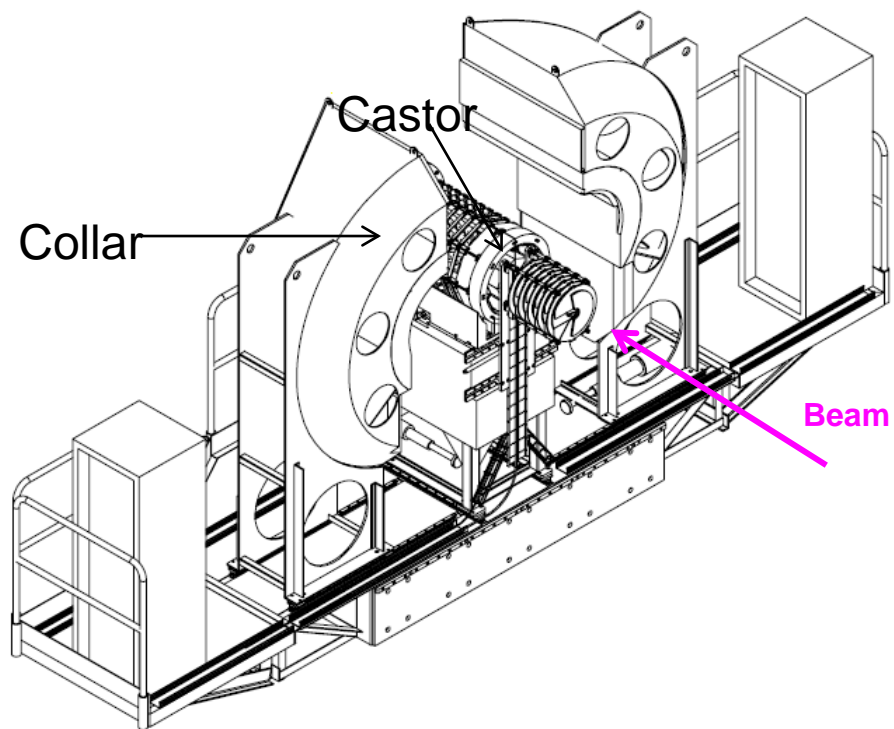
Total anodes: 1124
Total strips: 15936

- 5 planes with measurement of 3 coordinates per plane
- 3 deg rotation and overlap between adjacent planes
- Primary vertex reconstruction allows background rejection
- Trigger with anode wires

T2 telescope (GEM chambers)

- 65(ϕ) x 24(=1560 pads)
- Pads: $\Delta\eta\Delta\Phi = 0.06 \times 0.015\pi$
- 2x2 mm² \rightarrow 7x7 mm²
- Strips: 256 (width/pitch: 80/400 μ m)
- TOTAL strips: 256x10x2
- TOTAL pads: 1560x10x2

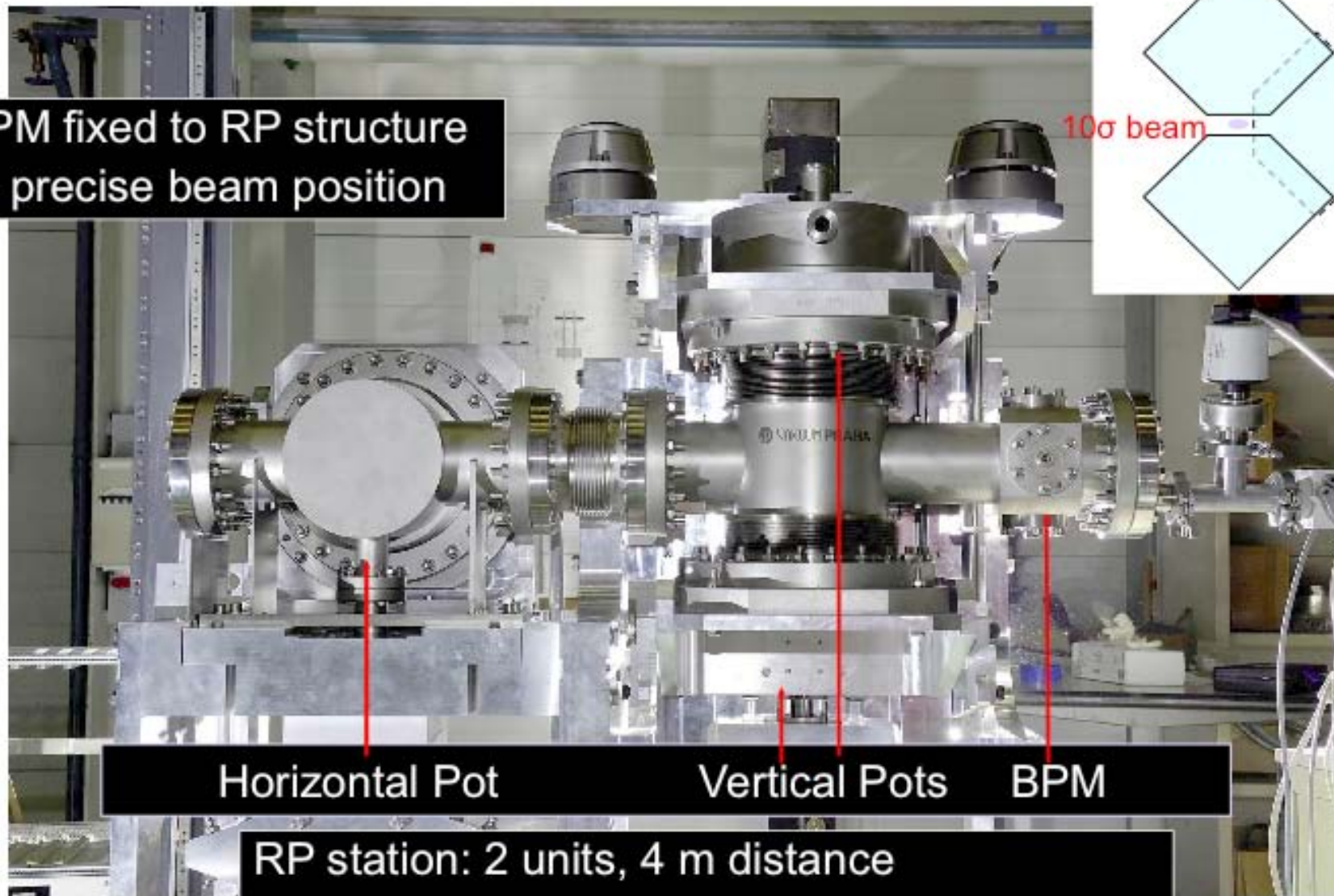
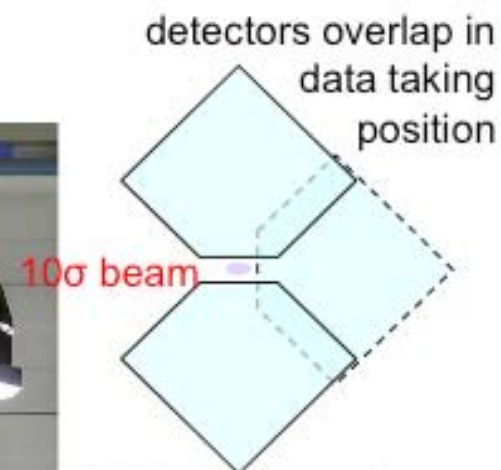






Roman Pot station

BPM fixed to RP structure
→ precise beam position



Horizontal Pot

Vertical Pots

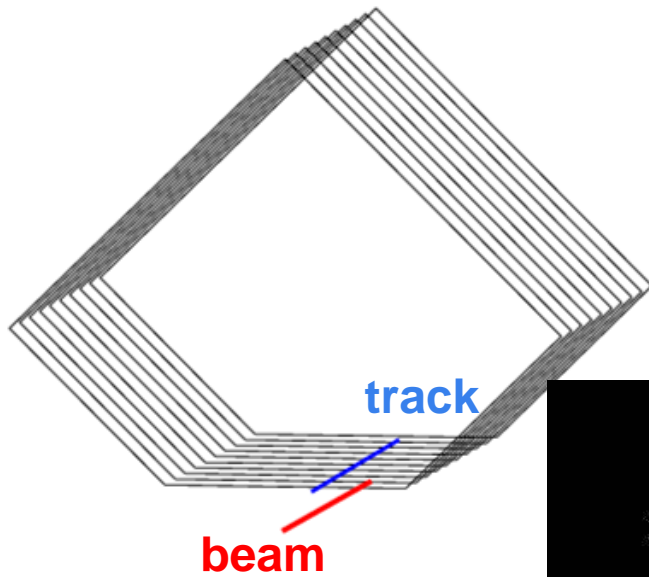
BPM

RP station: 2 units, 4 m distance

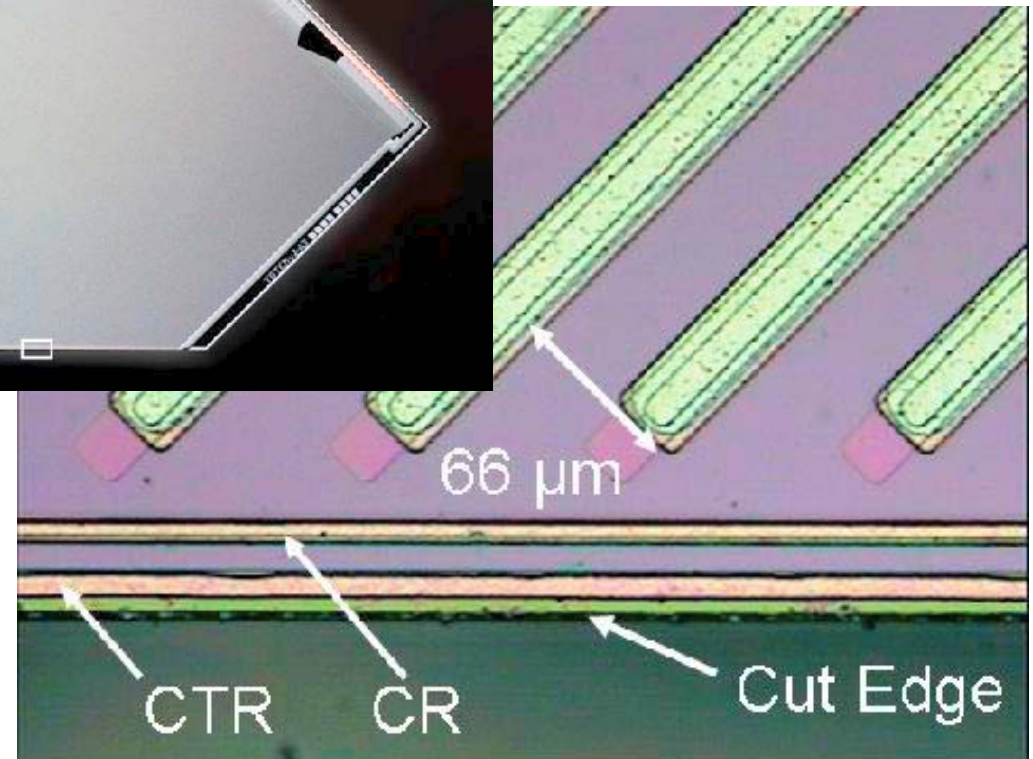
1 unit: 2 vertical / 1 horizontal pot & 1 BPM

RP system: total 122880 channels in 4 stations (+/- 220m). 4 additional stations to be installed (+/-147m)

- Planar *edge-less* (50 μm) silicon sensor



- Specific guard ring configuration to minimize dead edge



Status

T2 very forward GEM chambers

- Present status: commissioning and alignment
- Track reconstruction in an hostile environment, large particle density
- Severe backgrounds in the very forward cone
- Beam gas and halo interactions
- Photon and hadron interactions producing showers

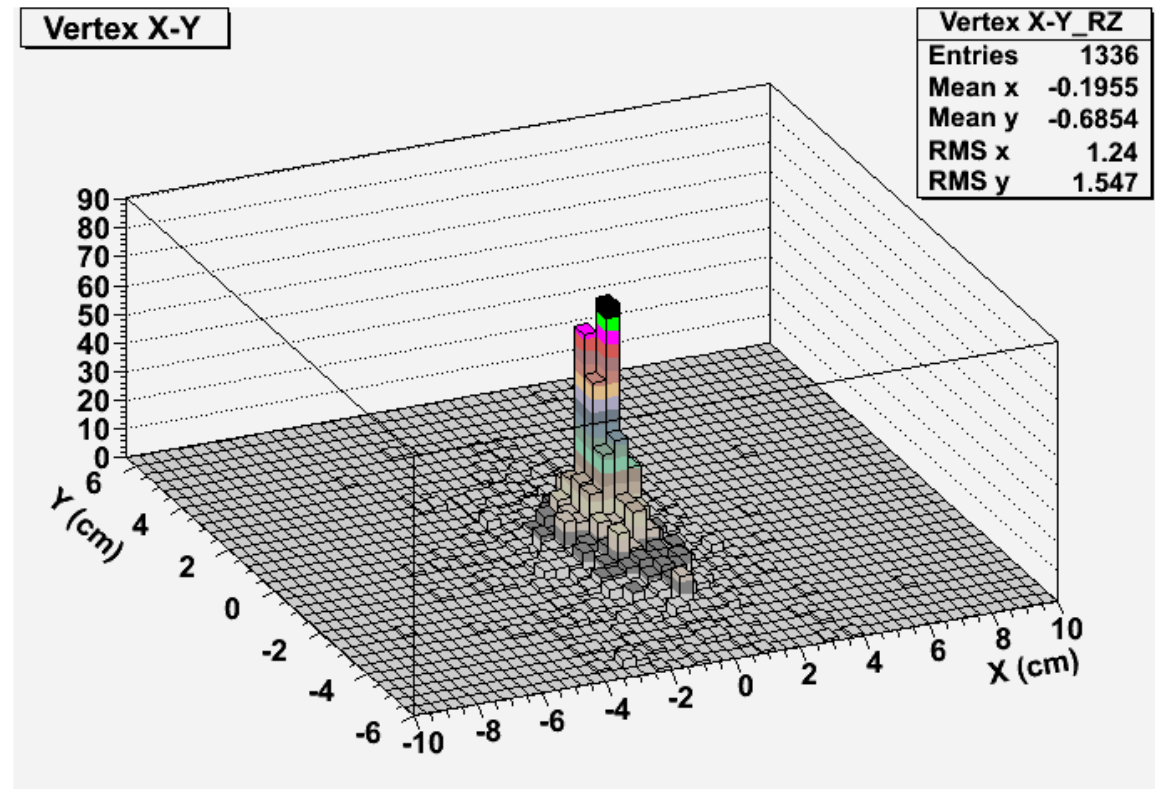
• Vertex pointing / impact parameter calculation important to reject re-interactions

all 4 quarters installed & operational.

trigger: min bias track,
 ≥ 5 out of 10 planes in road-coincidence.

Vertex reconstruction

Precision: $\sigma \sim 2$ cm



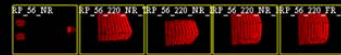
#Run 1 #Event 78 (77/429)
No TimeScales

Press F1 for Help
222 FPS

T2_PLUS



T2 event at \sqrt{s}
= 7 TeV



#Run 1 #Event 78 (77/429)
No TimeScales
T2_MINUS

Press F1 for Help
222 FPS



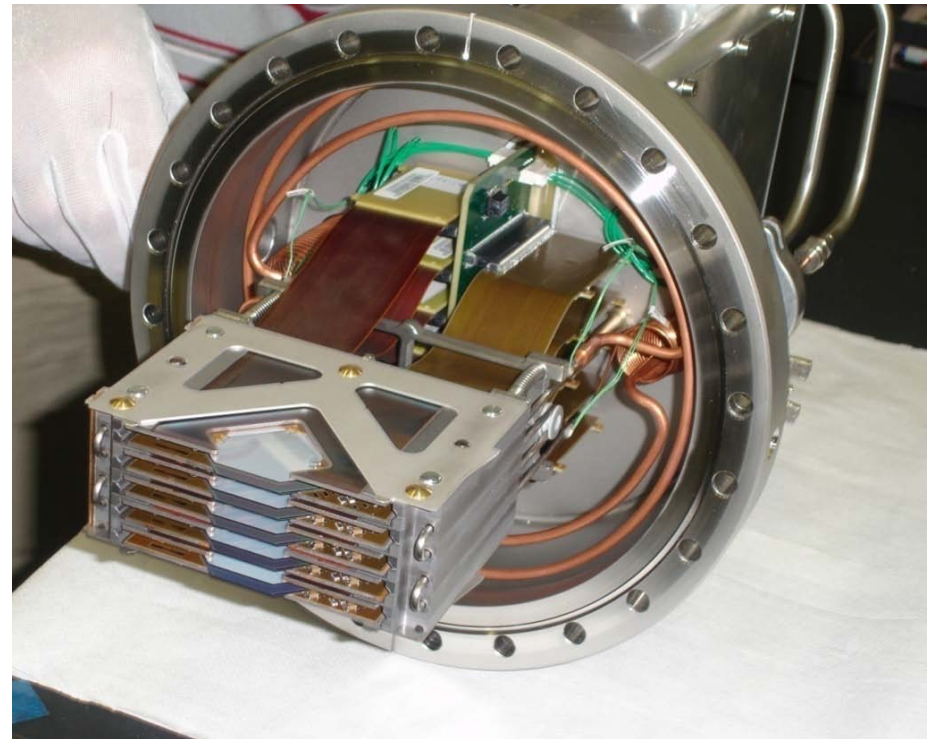
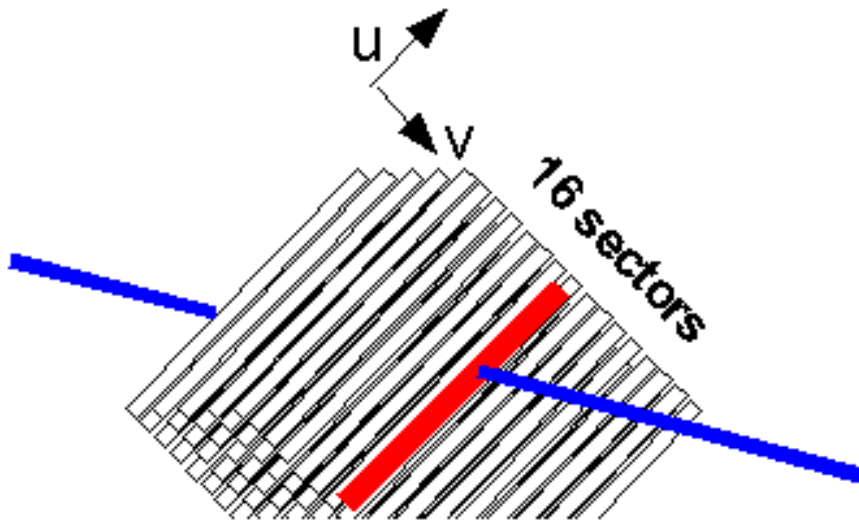
Roman Pots with edgeless Silicon detectors

Measure elastic & diffractive protons close to the outgoing beams

all 12 pots at 220 m

equipped & operational

Track trigger: 3 out of 5 planes
in u & v projection road-coincidence



#Run 2 #Event 16 (226/270)

No TimeStamp

RP_56_NR

RP in retracted position
Only background



RP tracking in retracted position

TotemDQM - TestBeamDQM_cfg.py <@pctotem31.cern.ch>

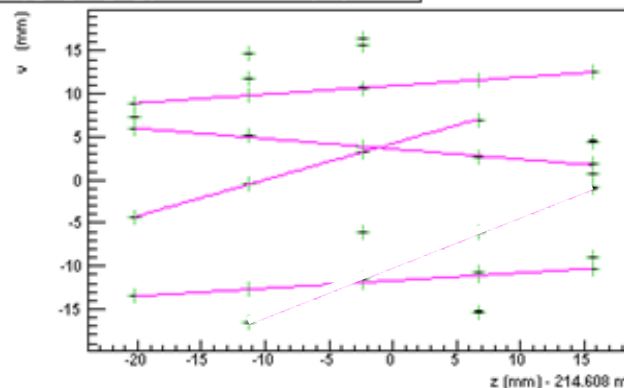
File Window Application Layout

Untitled

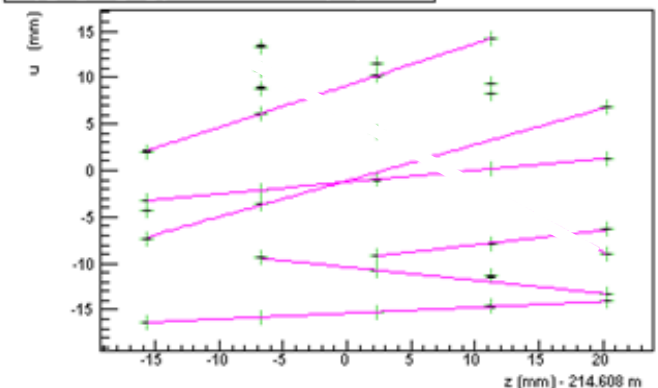
Top

Too many combinations
(shower)

rp_56_220_nr_tp : actual track - v projection



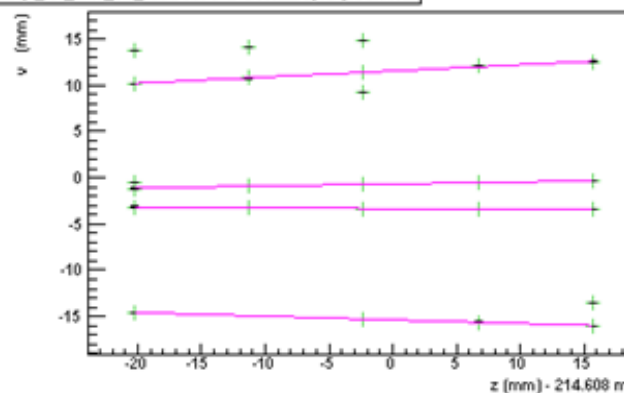
rp_56_220_nr_tp : actual track - u projection



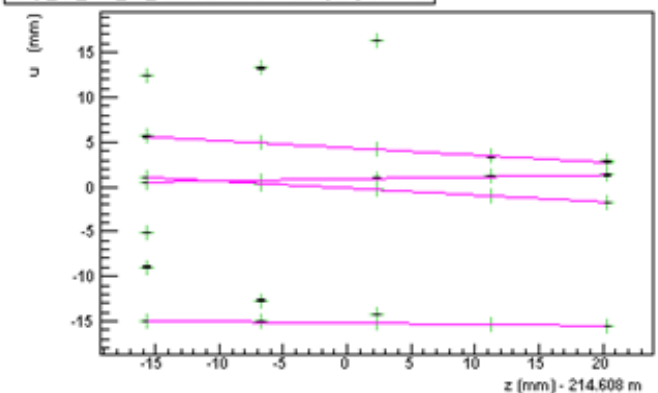
Bottom

Too many combinations
(shower)

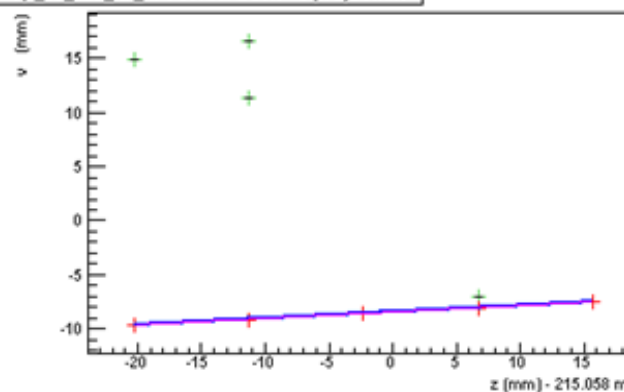
rp_56_220_nr_bt : actual track - v projection



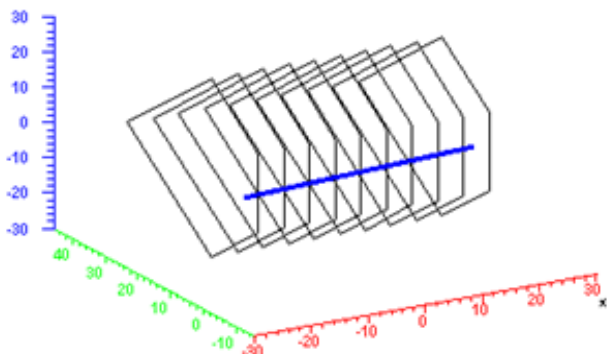
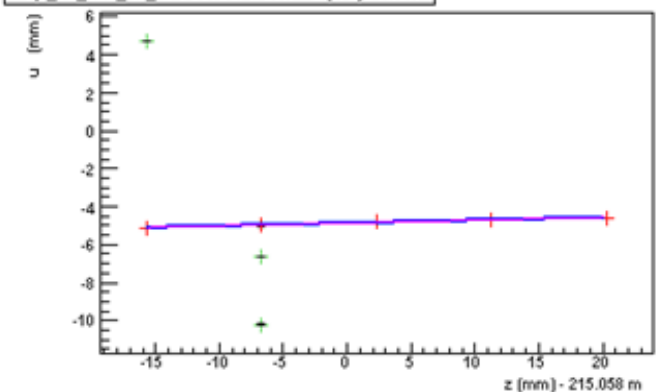
rp_56_220_nr_bt : actual track - u projection



rp_56_220_nr_hr : actual track - v projection

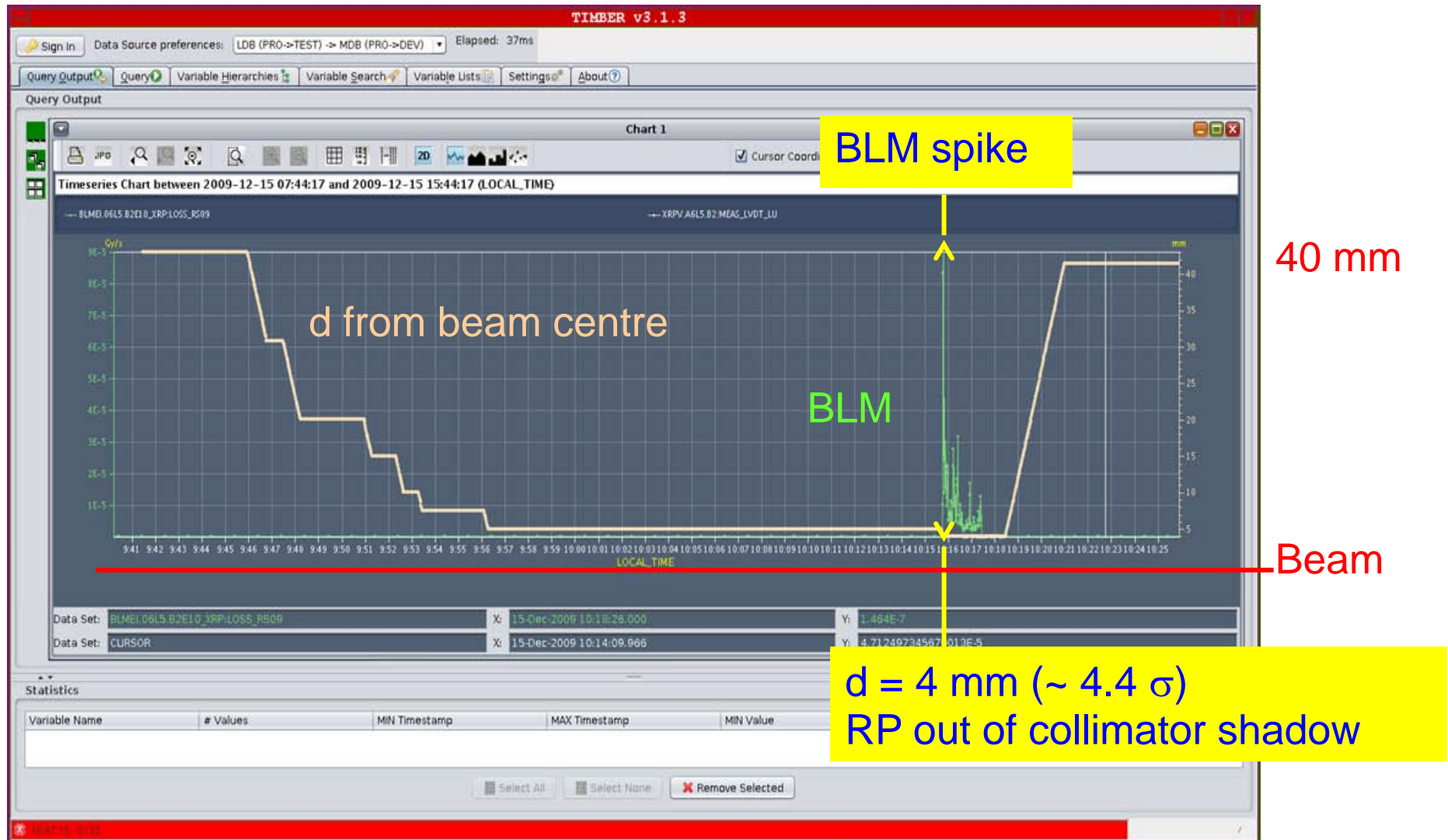


rp_56_220_nr_hr : actual track - u projection



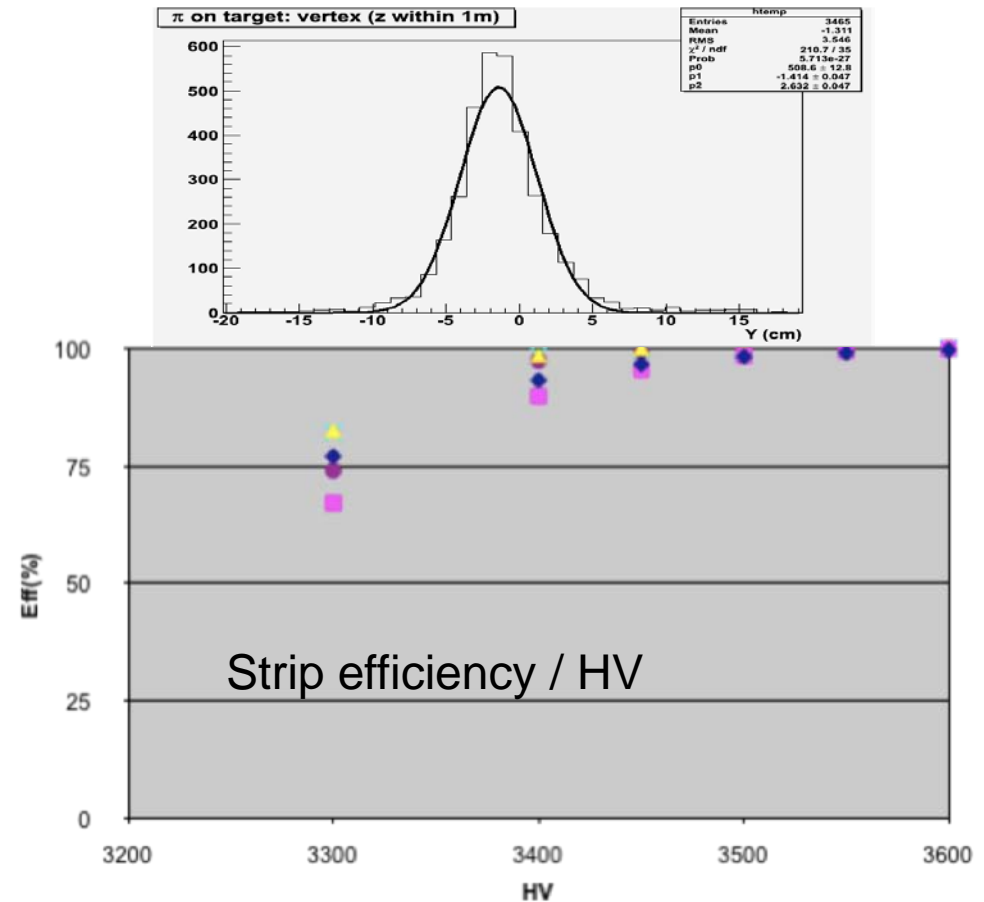
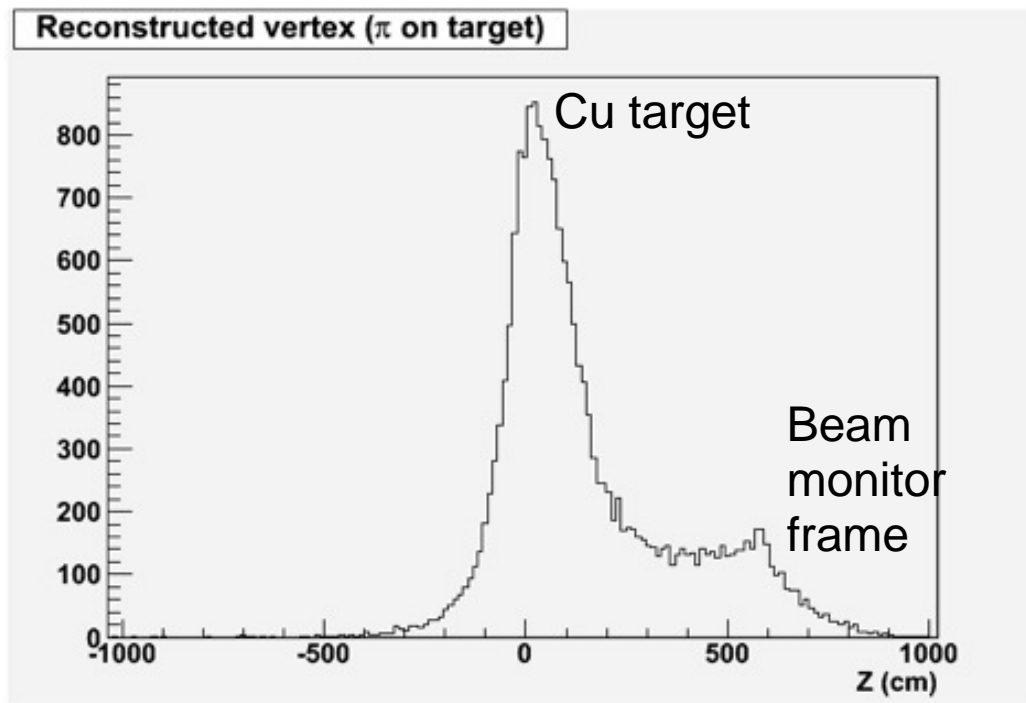
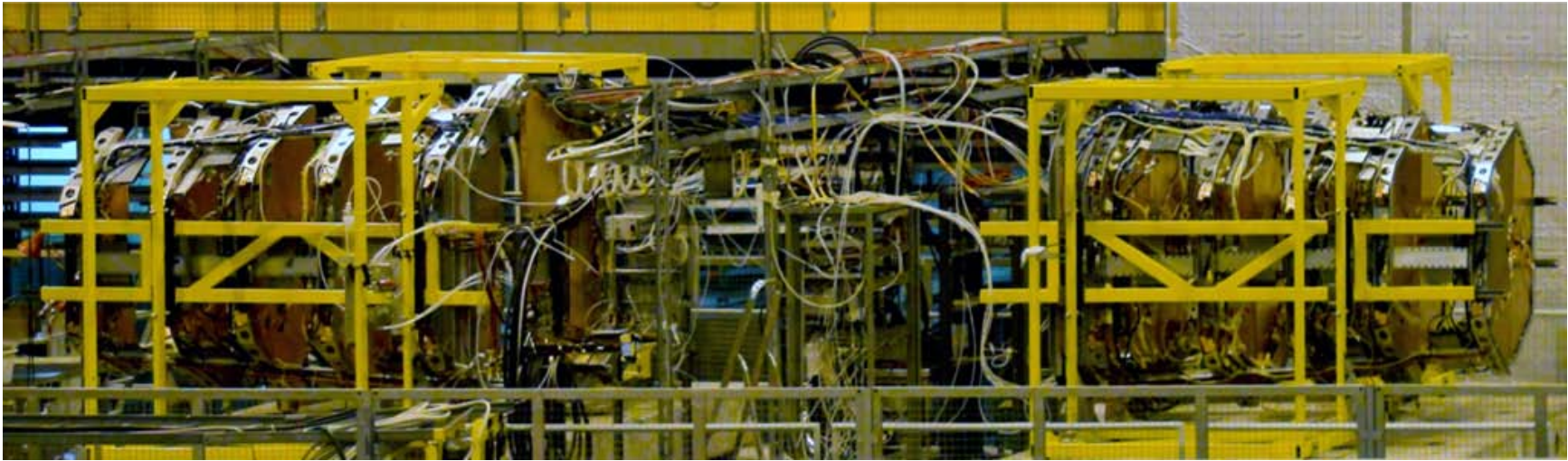
Moving RPs w.r.t. Collimators

1 RP @ 4.4σ (12/2009)



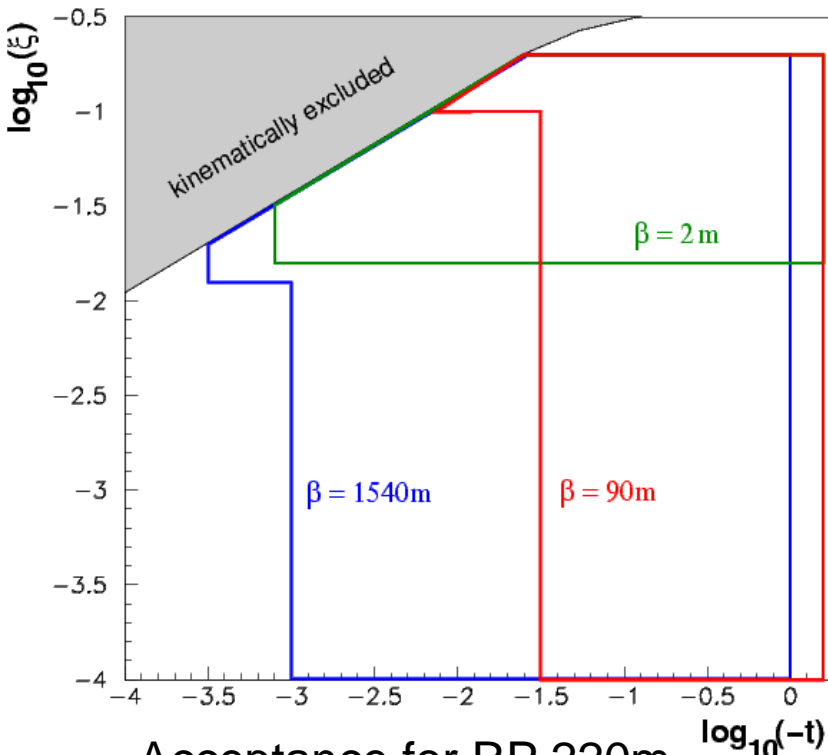
Screenshot from the LHC Control Center

Fully operational T1 in commissioning area



Plans for measurements

RP system acceptance



Acceptance for RP 220m

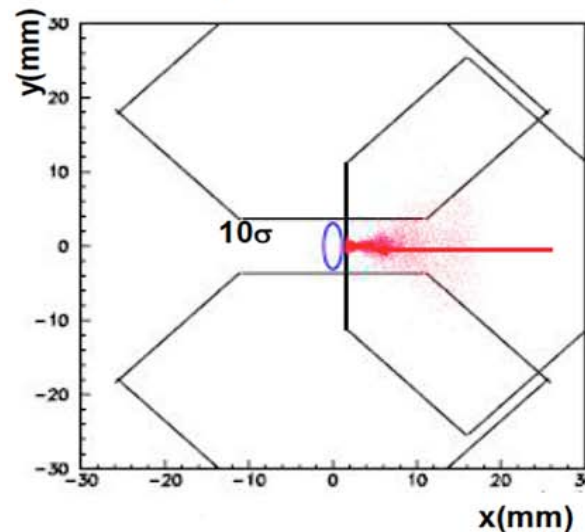
ξ/t plane

x/y plane

- Machine optics determines acceptance
- Likely running scenarios in 2010/2011:
 - $\beta^* = 2\text{m}$
 - $\beta^* = 90\text{m}$
- Acceptance for diffractive protons and capabilities to extrapolate towards $t=0$ change dramatically

Diffractive protons : hit distribution @ RP220m

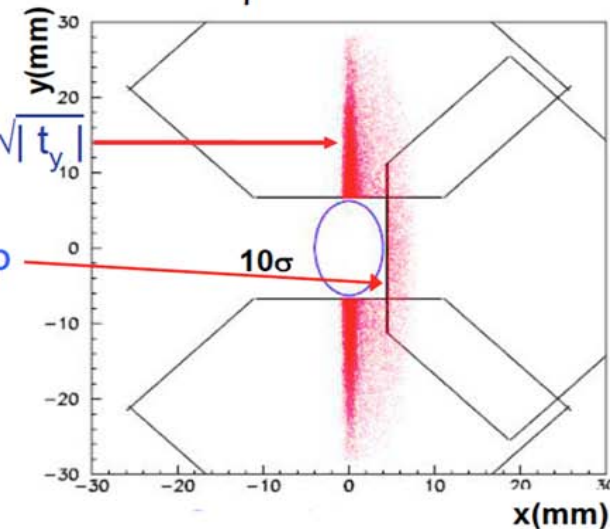
low β^* : 0.5 – 11 m



$$y \sim \Theta_y^{\text{scatt}} \sim \sqrt{|t_{y10}|}$$

$$x \sim \xi = \Delta p/p$$

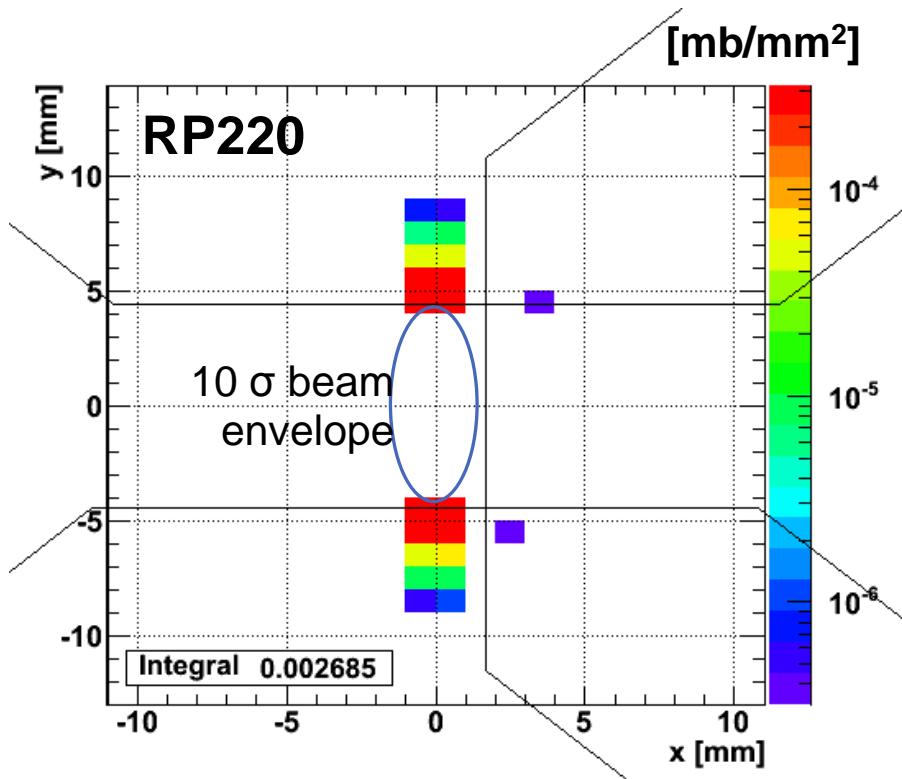
$\beta^* = 90\text{ m}$



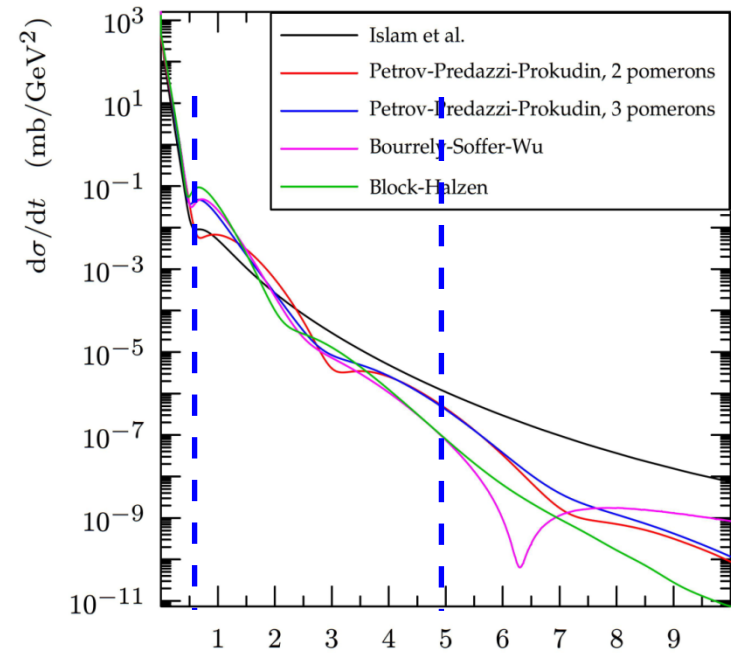
Elastic Scattering $\sqrt{s} = 7 \text{ TeV}$, $\beta^* = 2\text{m}$

trigger: $\text{RP}_{\text{vert},45}$.and. $\text{RP}_{\text{vert},56}$

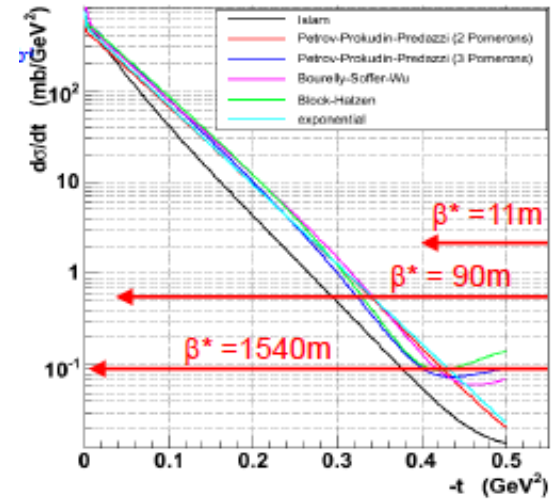
Elastically scattered proton flux



rate few 10 Hz (RP @ $10 \sigma_{\text{beam}}$
 $\beta^* = 2\text{m}$, $N = 43$ & $N/bx = 5 \cdot 10^{10}$)

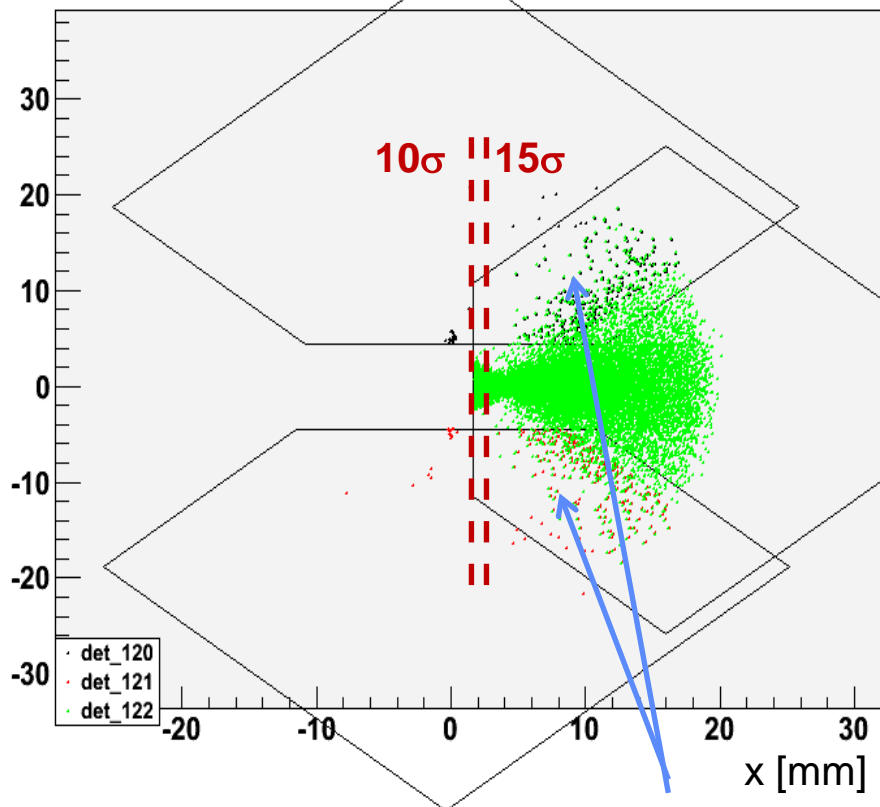


At larger $|t|$, σ is
 several orders of
 magnitude
 smaller ($\approx \text{mHz}$)
 → dedicated long
 runs with vertical
 pots at largest
 possible
 luminosity



Diffractive p @ $\beta^*=2m$

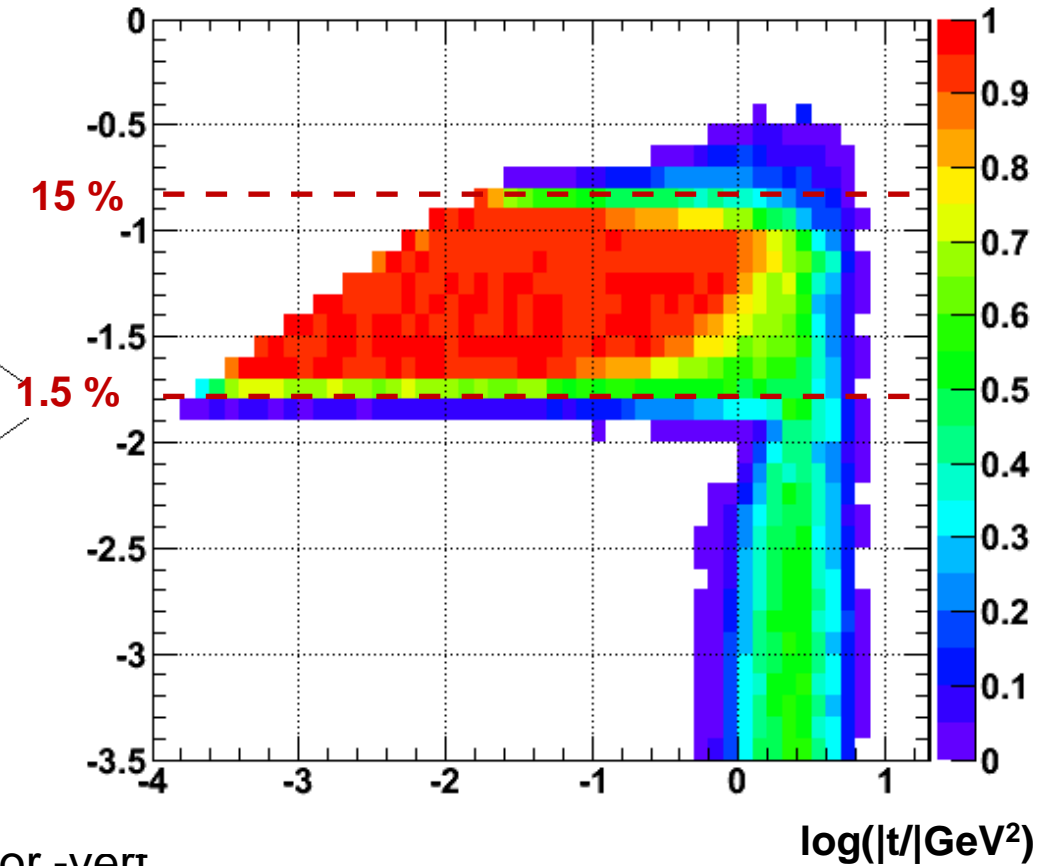
SD protons @ RP 220



0.02 mb of tracks both in hor.-vert.

$\log(\xi)$

RP 220 acceptance



Pythia SD: $\sigma_{\text{acc,sd}} \approx 1.2 \text{ mb (x2)}$ / $\sigma_{\text{sd}} \approx 13.7 \text{ mb}$

Phojet CD: $\sigma_{\text{acc,cd}} \approx 0.05 \text{ mb}$ / $\sigma_{\text{cd}} \approx 1.33 \text{ mb}$

Diffractive p @ $\beta^* = 2\text{m}$

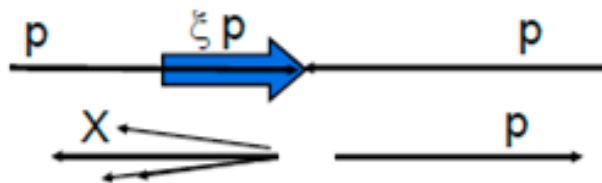
Courtesy K. Osterberg

diffractive p in horizontal RP's + diffractive system in T2

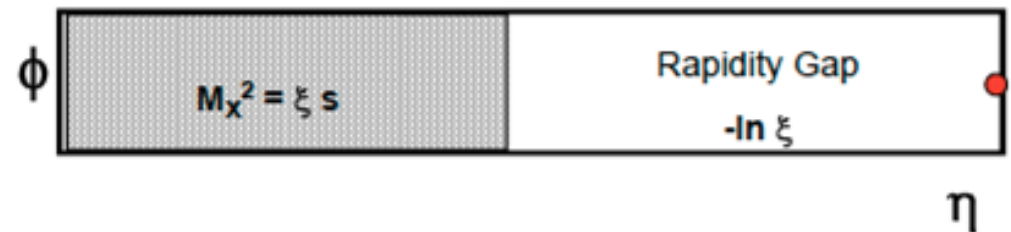
trigger: $\text{RP}_{\text{hori},+(-)}$ & $\text{T2}_{-(+)}$ (SD), $\text{RP}_{\text{hori},+}$ & $\text{RP}_{\text{hori},-}$ (CD)
 rates large (SD \sim tens kHz, CD \sim 200 Hz for
 $\beta^* = 2\text{ m}$, $N_b = 43$ & $N_p/b = 5 \times 10^{10}$)

■ $d\sigma^{\text{SD}}/dM$

• $0.015 < \xi < 0.15 \Rightarrow 850 < M < 2500\text{ GeV}$ $\sigma(M) \approx 25\text{ GeV}$



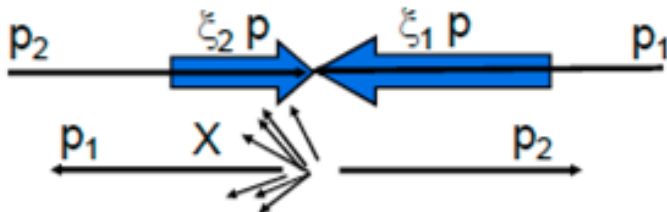
SD



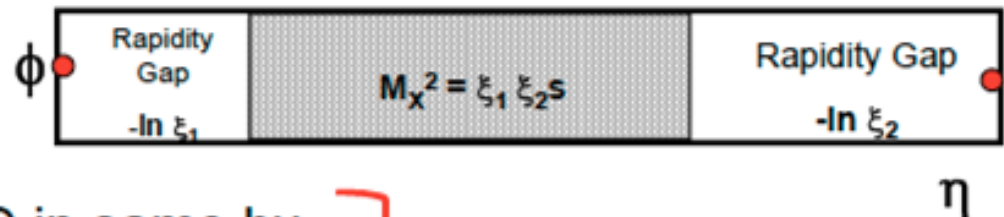
■ $d\sigma^{\text{CD}}/dM$

• $125 < M < 800\text{ GeV}$

$\sigma(M) \approx 10\text{ GeV}$, $\sigma(\phi) \approx 6^\circ/\sqrt{|t|}$



CD



CD backgrounds: 2 separate SD in same bx
 & SD + DPE (only 1 p seen) in same bx
 (~ 100 & $\sim 30\text{ Hz}$ for $\beta^* = 2\text{ m}$, $N_b = 43$ & $N_p/b = 5 \times 10^{10}$)

$S/B \propto 1/L_{bx} \Rightarrow$
 $\downarrow^2 N_{p/\text{bunch}}$ & $\uparrow \beta^*$

Summary measurements @ $\beta^* = 2\text{m}$

RP @ $10 \sigma_{\text{beam}} + 0.5 \text{ mm}$

β^* [m]	Process	RP accepted σ [mb]	Accepted rate @ $L = 5$ $\cdot 10^{30} / \text{s} \cdot \text{cm}^2$ [Hz]**	$\langle \text{Events/bx} \rangle$ @ $L_{\text{bx}} = 10^{25}$ $/\text{s} \cdot \text{cm}^2$ ***	Acceptance range in t [GeV ²] or ξ [%]
2	Elastic scattering (PPP3*)	0.004	20	0.00004	$\sim 0.6 < t < \sim 5$
2	SD, Pythia	2.4	12k	0.024	$0.02 \leq \xi \leq 0.2$
2	CD, Phojet	0.05	250	0.0005	$0.02 \leq \xi \leq 0.2$
2	Min bias, Pythia	60	300k	0.6	$N_{\text{track}, T2} \geq 1$

* PPP3: Petrov-Predazzi-Prokudin model, 3 pomeron

** $N_{\text{bunch}} = 43$, $N_{\text{p/bunch}} = 5 \cdot 10^{10}$ & $\beta^* = 2 \text{ m} \Rightarrow L_{\text{bx}} = 10^{25} \text{ cm}^{-2}$

Studies @ $\beta^*=90\text{m}$

- Access to a much larger $|t|$ and ξ range

-->

- Elastic scattering in a wider $|t|$ range
- Total cross section at 5% ÷ 6% accuracy
 - T1 to complete η coverage
- Soft diffraction in a large M range (65% of diffractive protons are detectable)
- Systematic study the event classification of interest for HECR: SD, inelasticity, rates and multiplicity

T2-only studies ($5.3 < \eta < 6.5$)

- May be performed at any β^*
- $dN_{\text{charged}}/d\eta$
- Search for high charged multiplicity events
- Rate very high at $\beta^*=2m$
- Conditions
 - Trigger: $T2_{\text{plus}}(\geq n \text{ track})$.or. $T2_{\text{minus}}(\geq n \text{ track})$
 - Require ≤ 1 interaction/bx, i.e. $\leq 0.35/\text{bx}$
 - At standard bunch intensity, take data at end of fill?
 - Require good understanding of tracking, vertexing and primary/secondary track discrimination

Summary

- Early measurements at all β^*
 - Large $|t|$ elastic ($0.65 < |t| < 5 \text{ GeV}^2$)
 - Large mass SD and CD
 - Forward charged multiplicity (T2-only)
 - (+ training for better optics)
- Later measurements with special optics, $\beta^*=90\text{m}$
 - Early measurements of σ_{tot} with precision 5%÷6%
 - Elastic scattering in a lower range ($0.15 < |t| < 2.5 \text{ GeV}^2$)
 - SD and CD in a large M range
 - Classification of inelastic events

LHC Page1

Fill: 1180

E: 450 GeV

25-06-2010 22:23:10

BEAM SETUP: INJECTION PROBE BEAM

BCT TI2: 0.00e+00

I(B1): 0.00e+00

BCT TI8: 0.00e+00

I(B2): 0.00e+00

TED TI2 position:

BEAM

TDI P2 gaps/mm

up: 9.88

down: 9.81

TED TI8 position:

BEAM

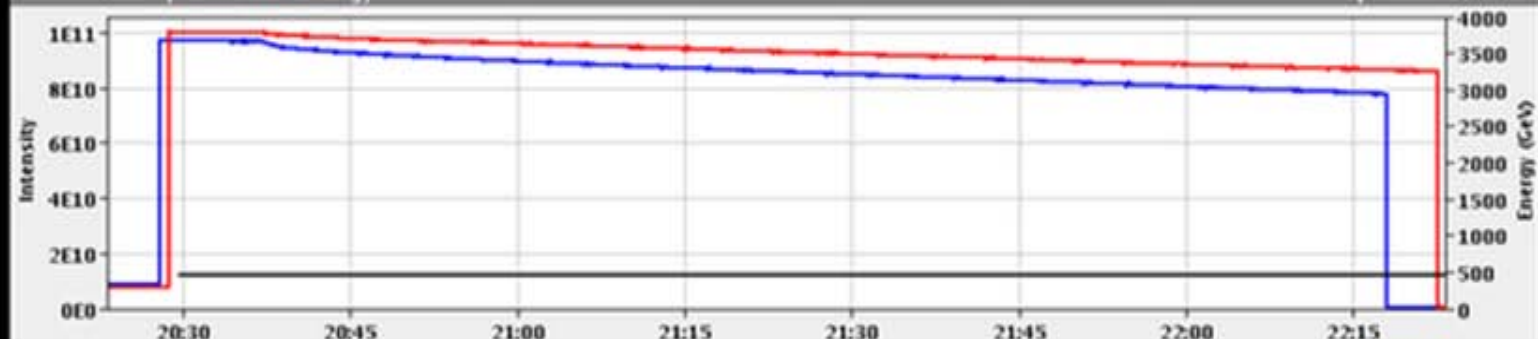
TDI P8 gaps/mm

up: 8.77

down: 8.78

FBCT Intensity and Beam Energy

Updated: 22:23:10



Comments 25-06-2010 22:12:41 :

TOTEM setup completed with success
TOTEM crew owes a good bottle
to the LHC crew

BIS status and SMP flags

B1

B2

Link Status of Beam Permits

false

false

Global Beam Permit

false

false

Setup Beam

true

true

Beam Presence

false

false

Moveable Devices Allowed In

false

false

Stable Beams

false

false

LHC Operation in CCC : 77600, 70480

PM Status B1

ENABLED

PM Status B2

ENABLED