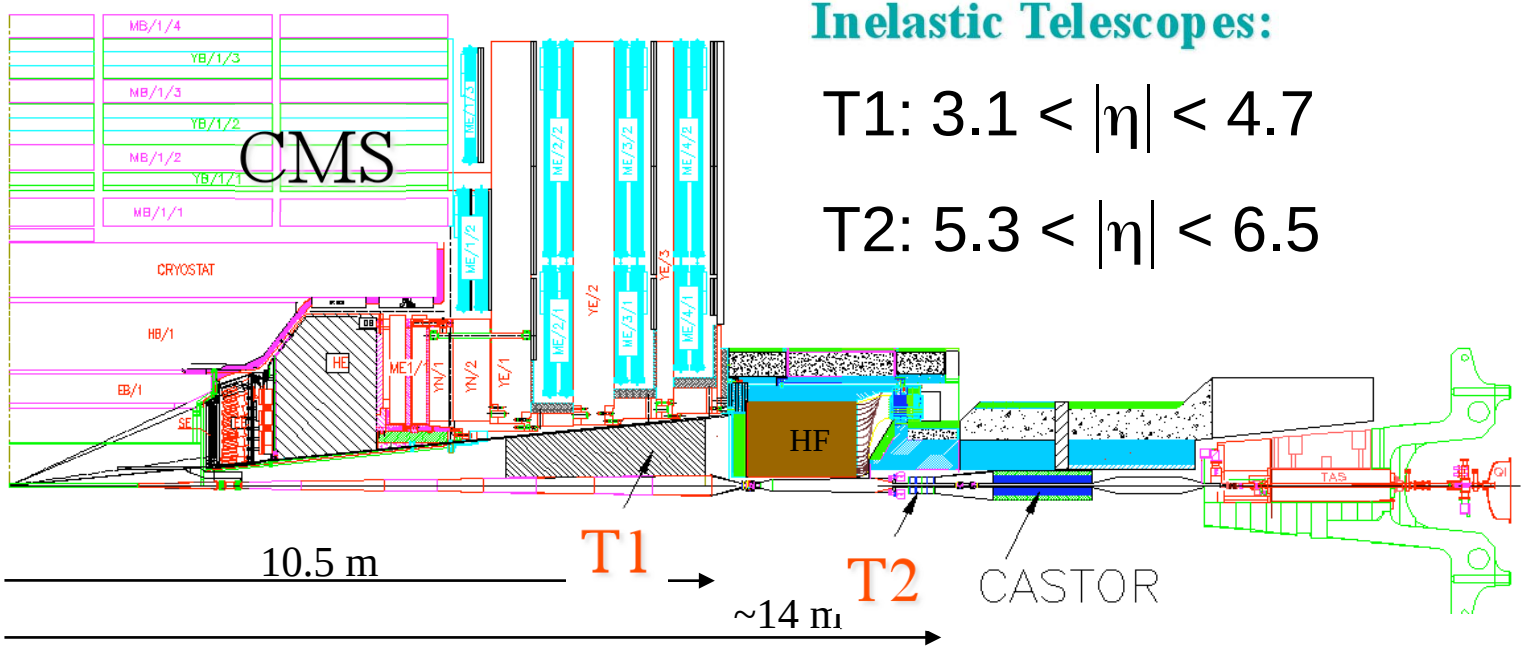
# Roman Pot operation at the LHC

- The Roman Pots
- The position during data taking
- The control and interlocks
- The commissioning
- Summary

# The TOTEM experiment

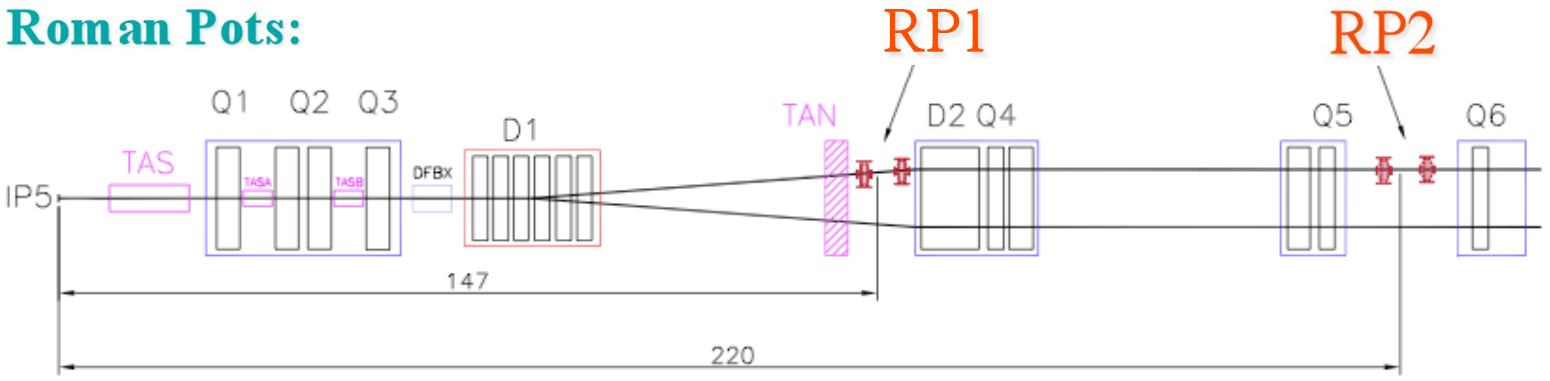



**Inelastic Telescopes:**

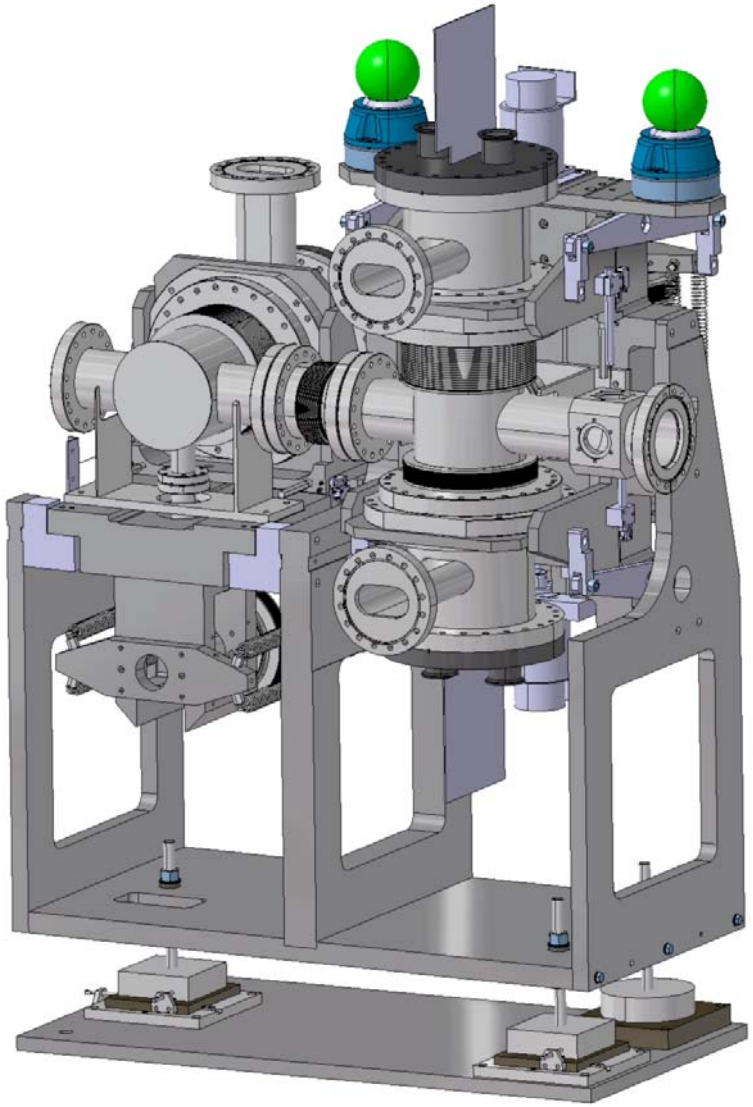
T1: $3.1 < |\eta| < 4.7$

T2: $5.3 < |\eta| < 6.5$

**Roman Pots:**

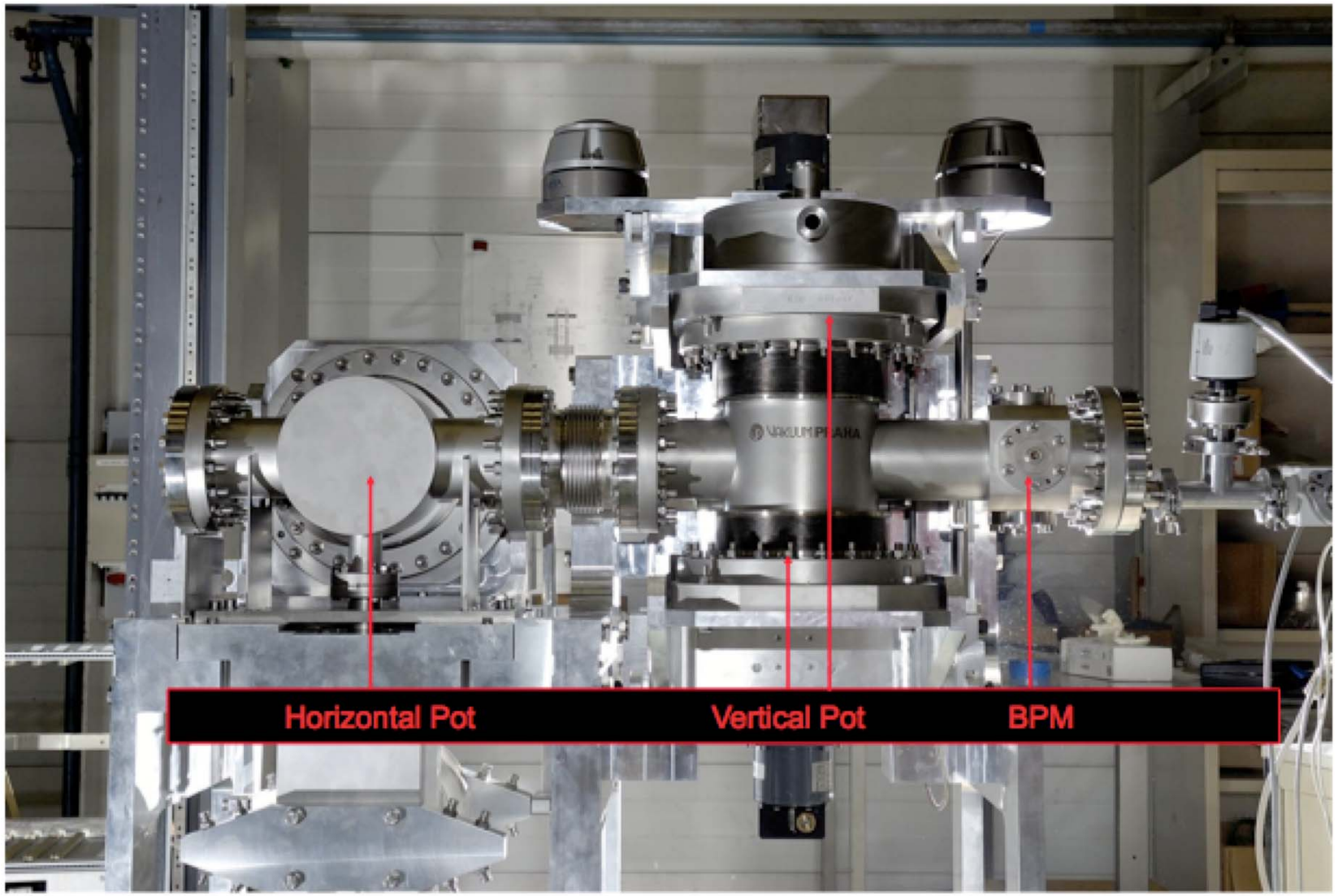


# The Roman Pot Module

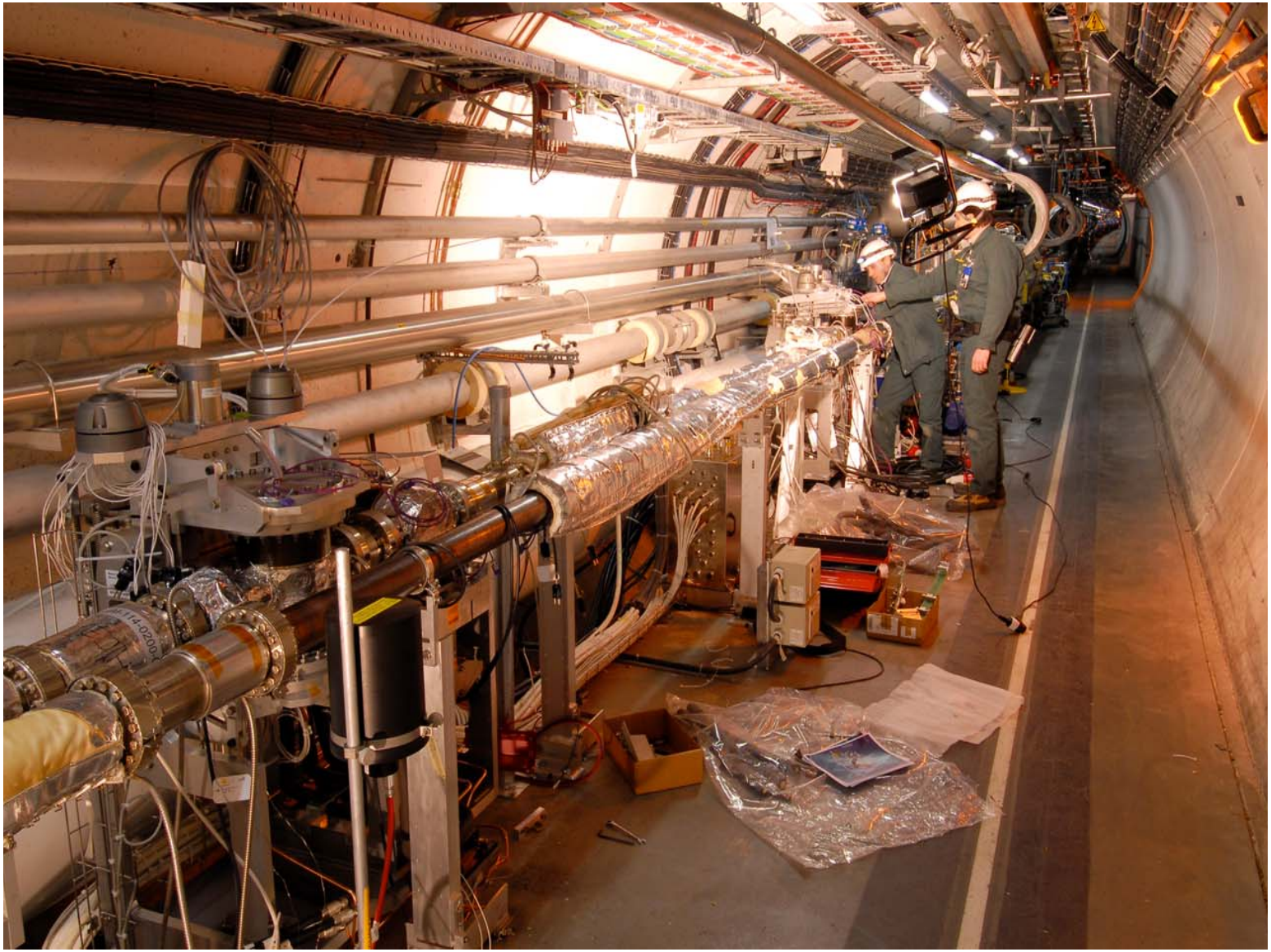


- Three measurement pots : two verticals and one horizontal
- Integrated beam position monitor
- Interconnection bellow between horizontal and vertical pots
- Vacuum compensation system interconnected to the machine vacuum
- Individual stepper motors to drive the pots
- Adjustable jacks to align the RP unit in the tunnel
- Designed by TS/MME

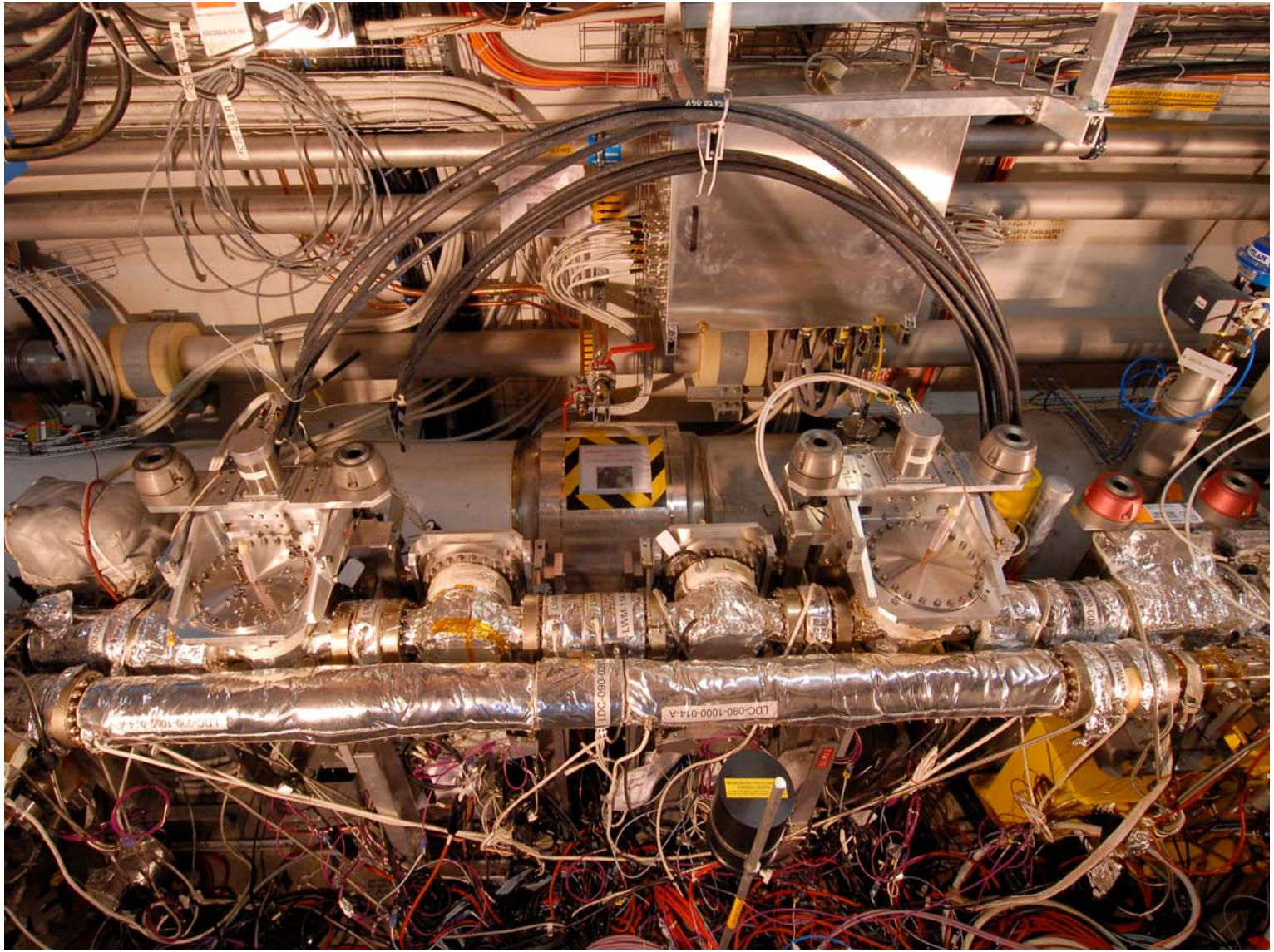
# The Roman Pot Module



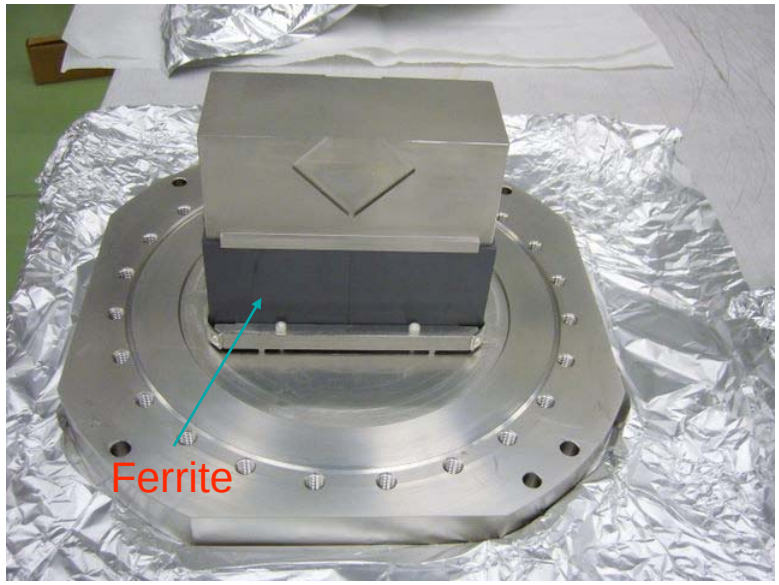
# The Roman Pots at 220 m

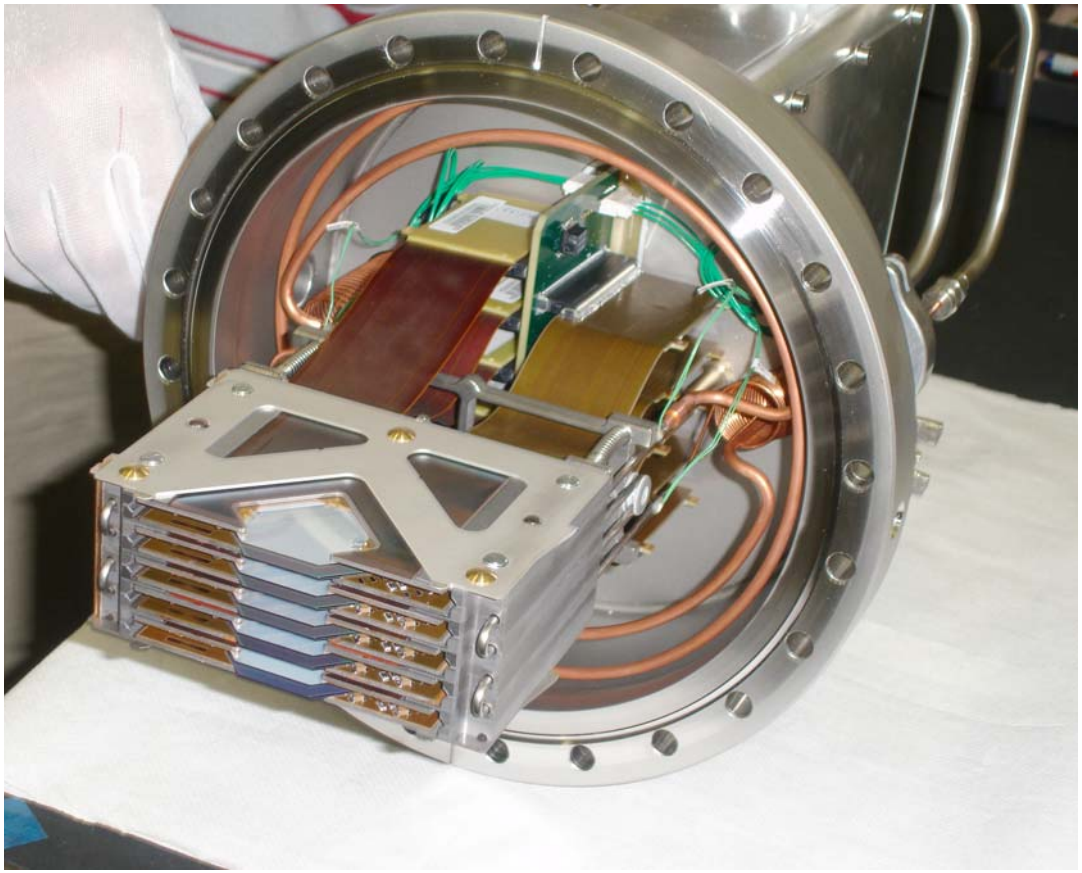


# The Roman Pots at 147 m



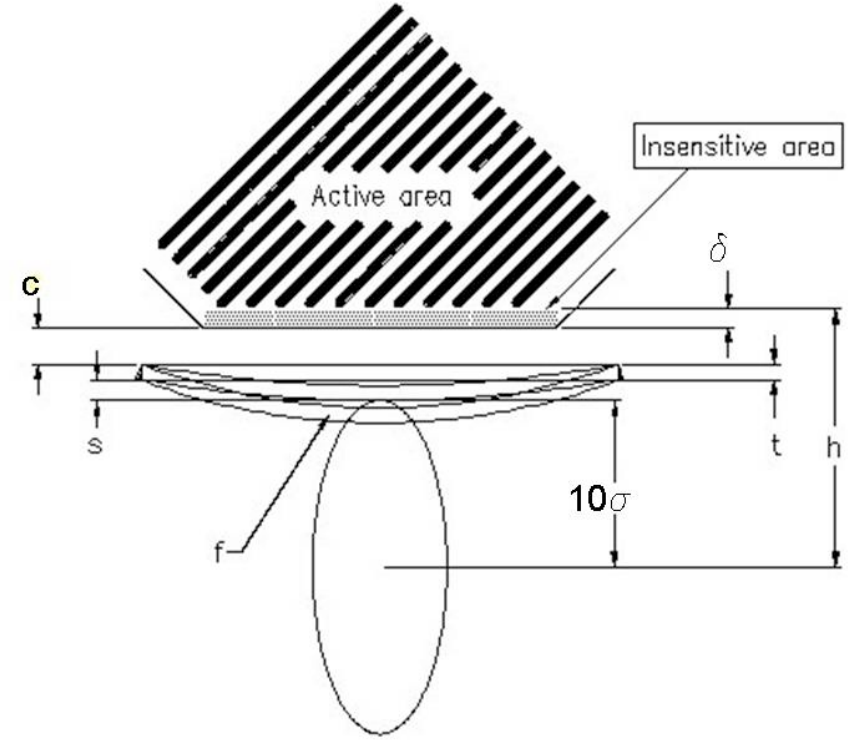
# The window and the detector assembly

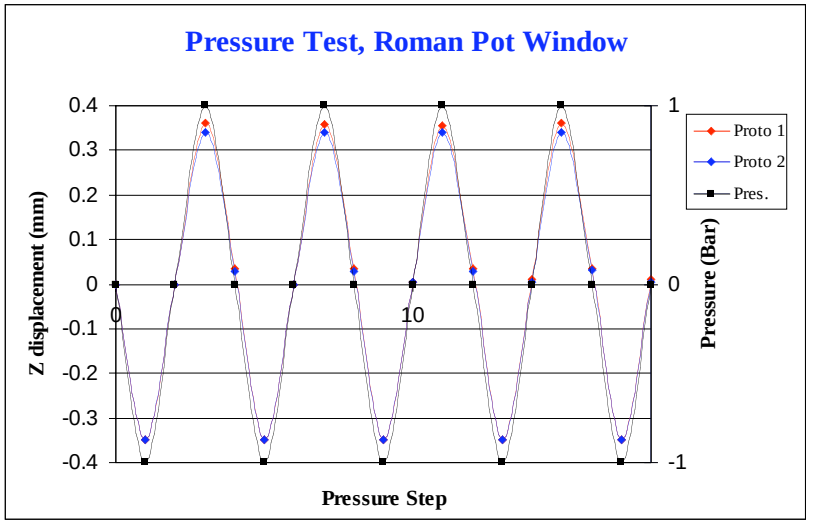


Silicon sensor

# The Roman Pot position during data taking




**Closest approach of detector to beam center (f=0):**

**$h(t) = \delta + c + t + f + s(t) + 10\sigma = 10\sigma + \leq 450$ µm**

$\delta$ = 47 µm insensitive area

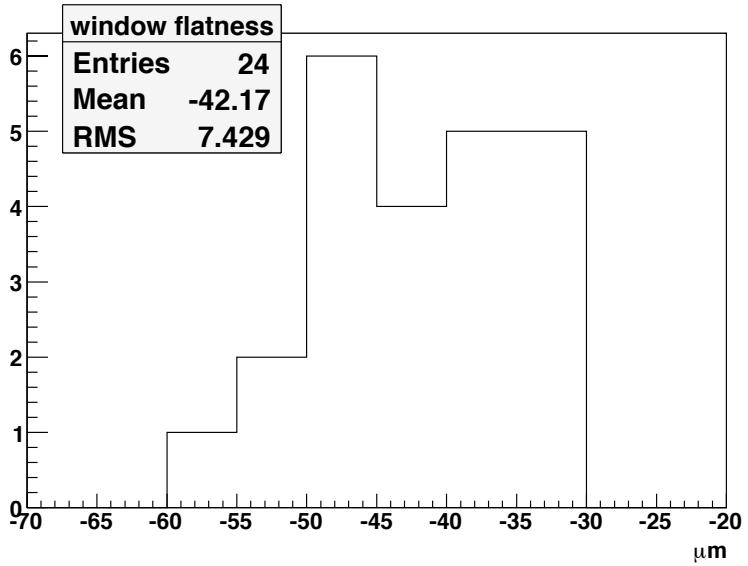
c = 200 µm distance to window

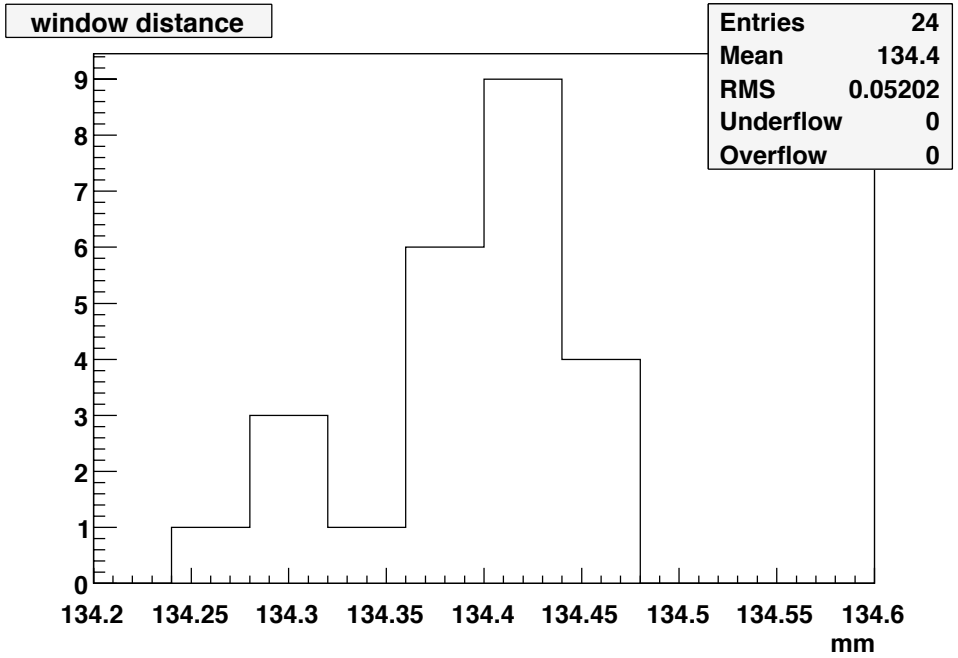
t = 150 µm window thickness

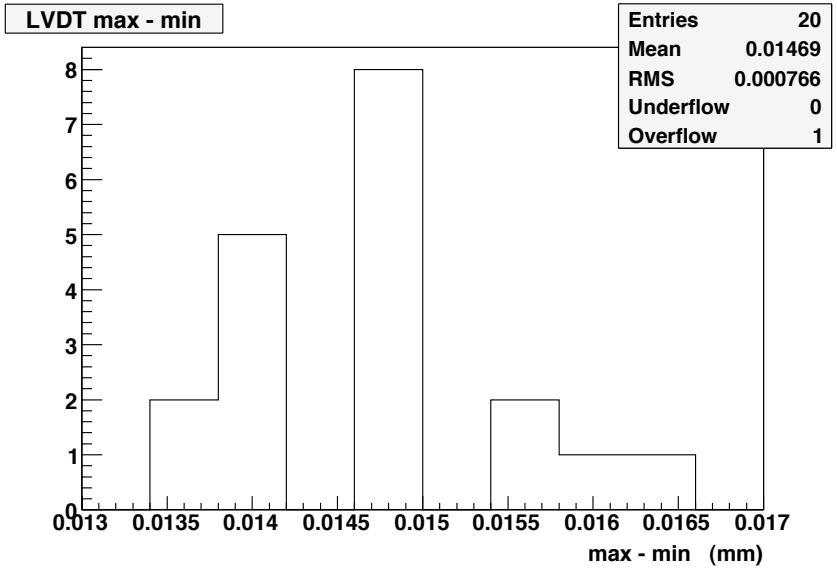
s(t) = < 50 µm flatness

f = window displacement in case of vacuum loss (= 50 µm at 100 mbar).

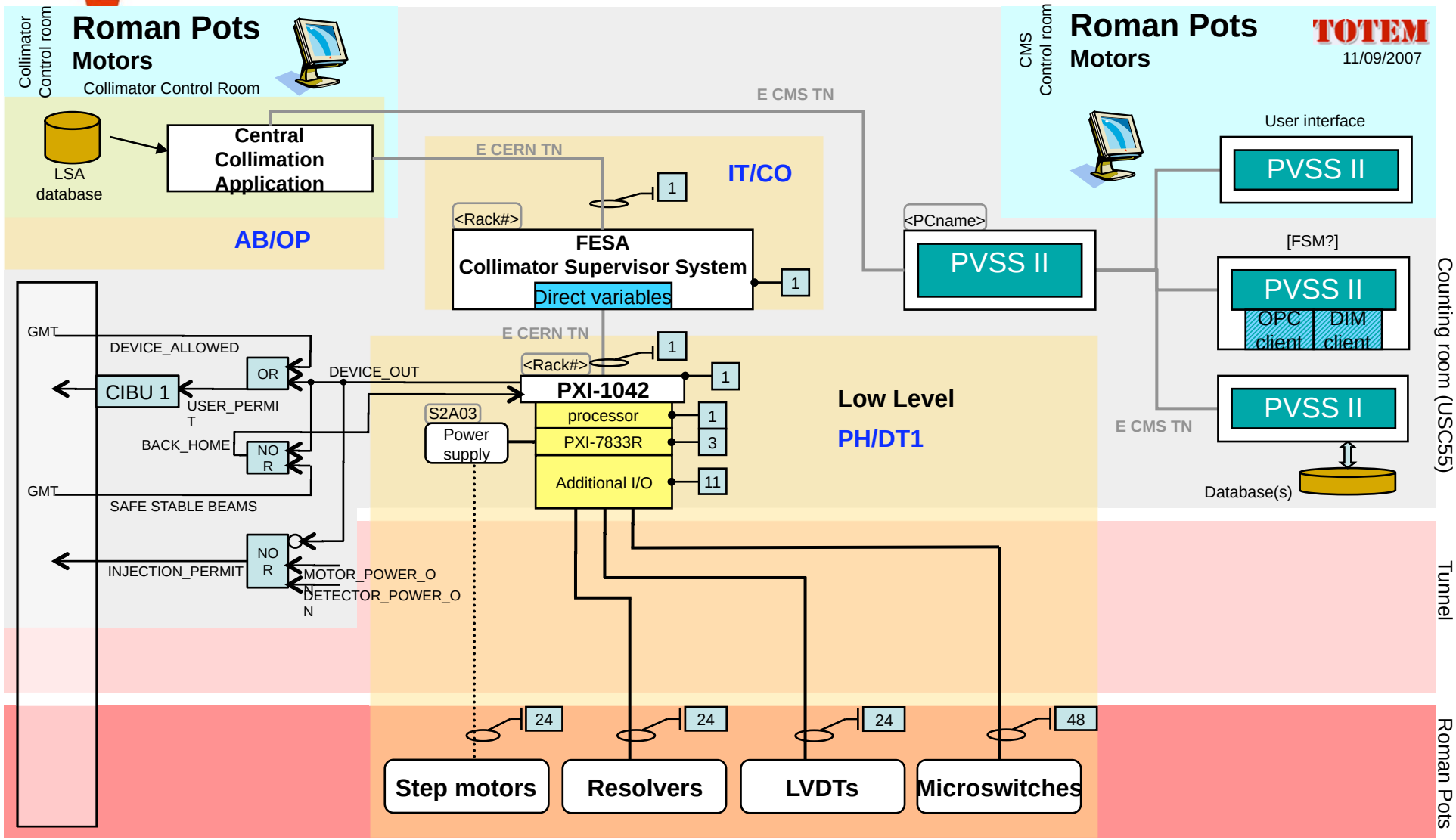
# Some parameter measurements



# The Roman Pots Motor Control



# The Roman Pots Motor Control

CCA:
- Central Collimation Application in CCC,
- Controls fully the Roman pot settings,
- When STABLE_BEAM is reached Roman pots can move to a new limit agreed between TOTEM and the LHC,
- All settings and modifications of the Roman Pot position are done from the CCC through the CCA on request of TOTEM.

CSS:
- Collimator Supervisory System,
- Is the interface between CCA and the Low Level Control,
- Is the standard version used for the collimation with some adaptation,
- The PC gateway is located in USC55,
- A new position request by TOTEM is transmitted through the CSS to the Low Level Control.

Low Level Control:
- Moves the Roman Pots to the requested position,
- Reads the LVDTs with 100 Hz,
- Sends a signal in case the Roman Pots exceed the position limit (→ CIBU 1).

# How do we control the position?

Rules:
- Safety first,
- Copy as much as possible the Collimator Control.

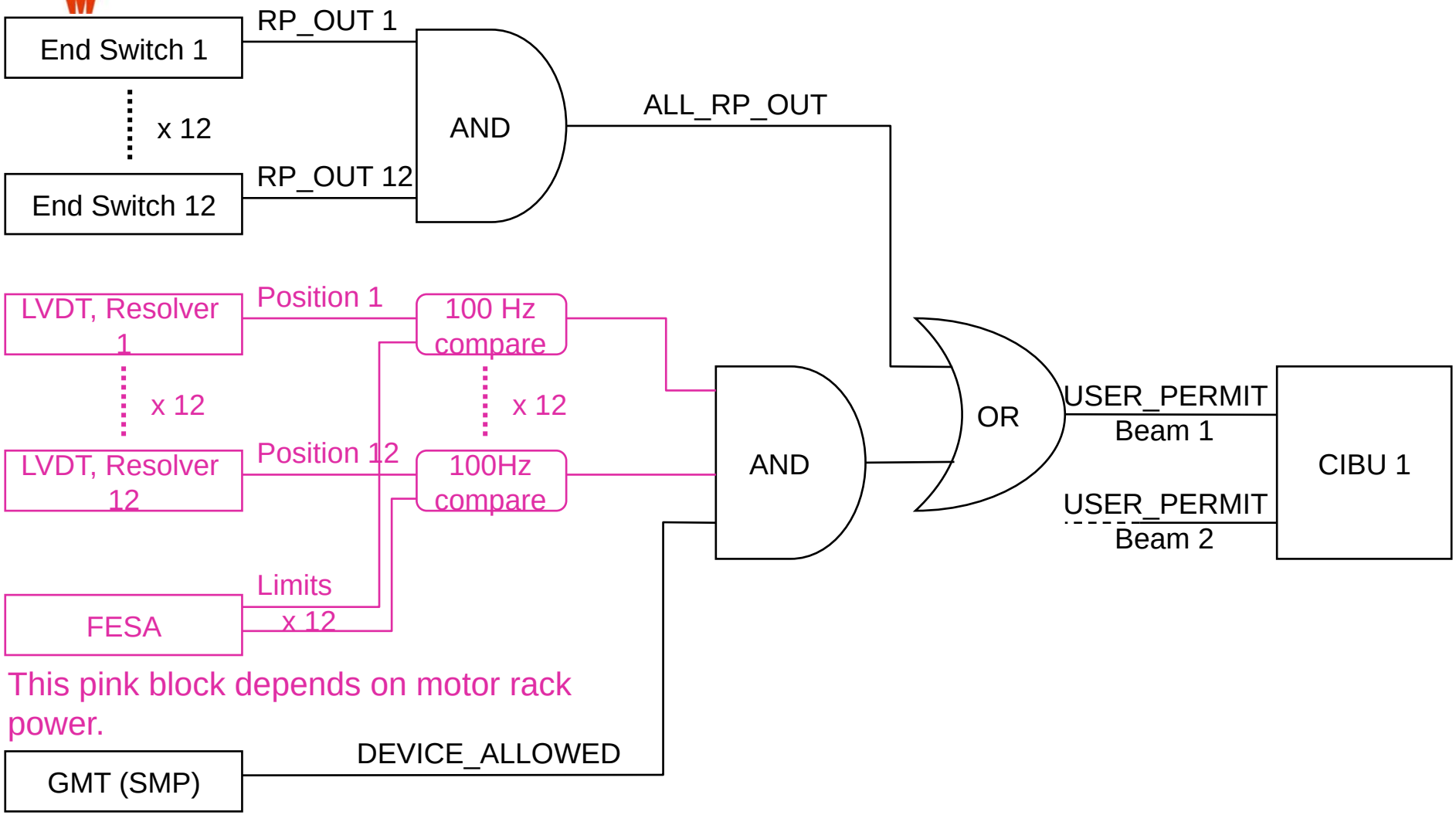
Procedures:
- Agree on the ultimate limit and store it in the data base in the CCA,
- Once the beam is stable correct this limit with the BPM values,
- Control the LVDT and resolver values,
- Compare the LVDT values with the limit,
- In case the limit is exceeded → beam dump

# Two running scenarios

Before injection:
- Roman Pots in the retracted position, i. e. at the end switch,
- LVDT value zero (for instance)

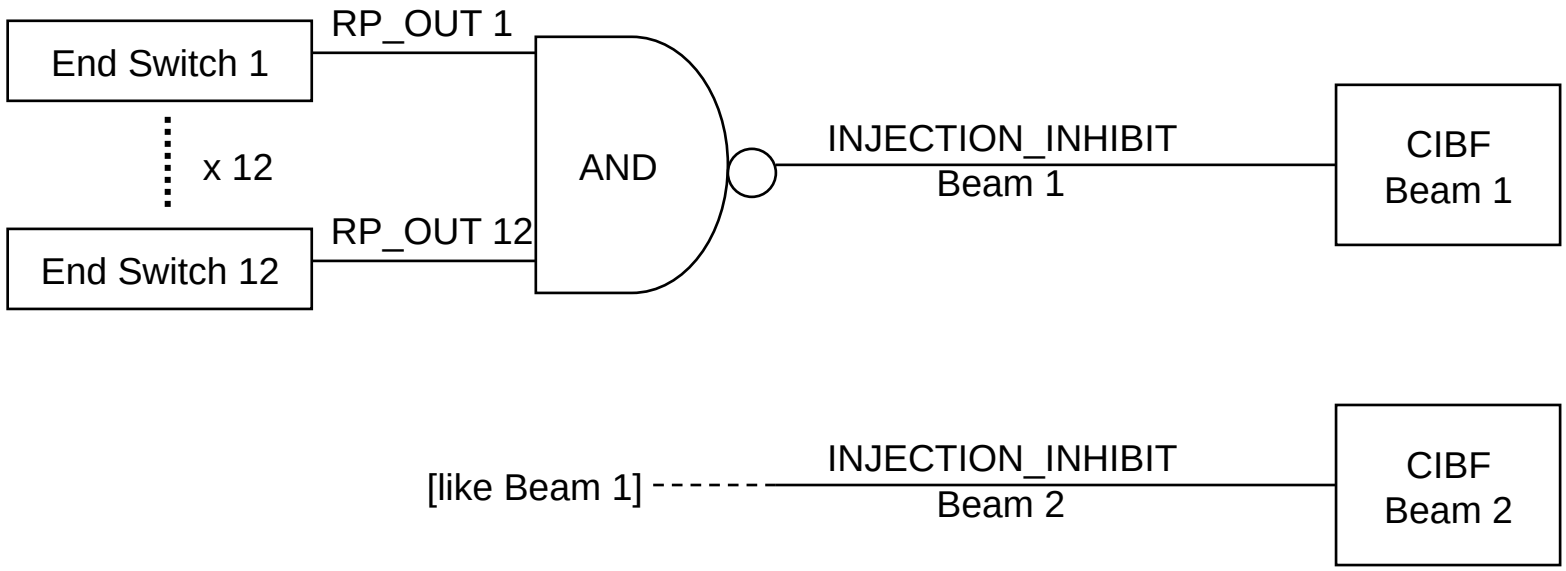
After injection:
- Wait for stable beams,
- Approach the Roman Pots to the agreed position (more refined movement see later),
- In case of UNSTABLE_BEAM retract Roman Pots,
- In case LVDT value exceeds limit → beam dump,
- In case of detector failures (CIBU 2) take necessary actions, either by retracting the Roman Pot(s) or by switching the detector power off.
- At IMMINENT_BEAM_ABORT retract Roman Pots.

# Position Interlock (CIBU 1)

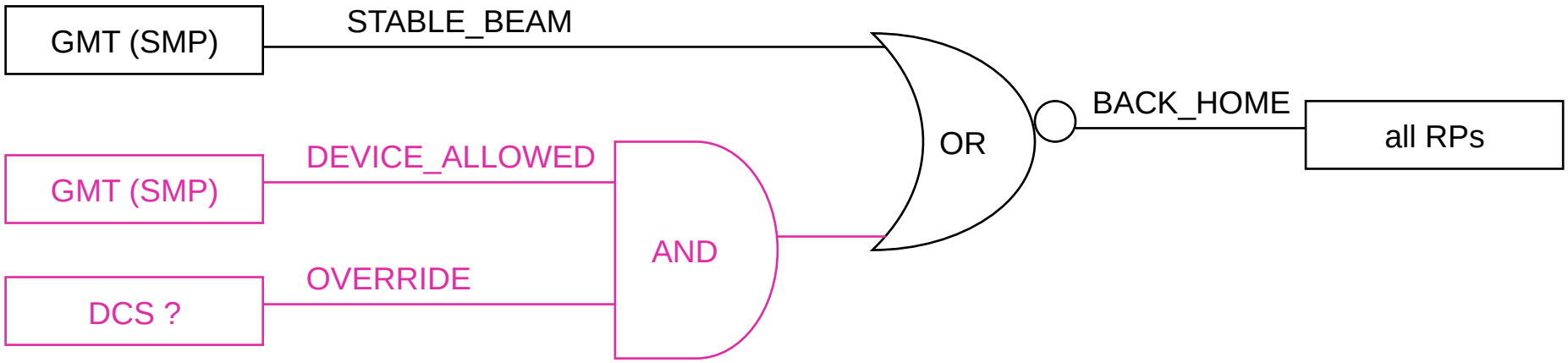



**Note: DEVICE_ALLOWED = STABLE_BEAM or UNSTABLE_BEAM**

# Injection Inhibit (CIBF)



# RP Retraction in UNSTABLE _BEAM Mode




This pink block allows RP operation in UNSTABLE_BEAM mode via a manual override,
to allow common collimator + RP calibrations.
**(Note: DEVICE_ALLOWED = STABLE_BEAM or UNSTABLE_BEAM)**

Could we use the SAFE_BEAM flag instead of the manual OVERRIDE ?
(I.e. is SAFE_BEAM intensity enough for Ralph's tests ?)

# Commissioning of the Roman Pots

## Before the LHC start:

- Finish cabling and piping with priority to the 220 m stations;
- Commission the motors and calibrate the LVDTs and the resolvers in sector 4-5 and 5-6;
- Install one assembly of 10 Si detectors in a horizontal pot in sector 4-5 end of June;
- Commission the $C_3F_8$ cooling;
- Install one assembly in a horizontal pot at 220 m in 5-6 in July;
- Install two assemblies in vertical pots at 220 m in 4-5 and 5-6 during a technical stop.

- Test the Interlocks.

# A typical TOTEM run

## After the LHC start:

- At stable beam start moving the pots (together with CCC):

  - Read the BPMs and verify with CCC the beam position;
  - Correct limit with BPM values;
  - Approach the pots by 35 mm (= safe position)
  - Move the horizontal pots nearer to the beam up to the agreed limit to see the diffractive peak – verify the rates;
  - Move the vertical pots nearer to the beam such that the rates are equal in both pots (if they exist). Go to 10-15 $\sigma$ from the beam center.
  - Compare RP rates with BLMs during these processes;
  - Compare beam position from rate information with BPMs;
  - If situation good for data taking set MOVEMENT_INHIBIT.

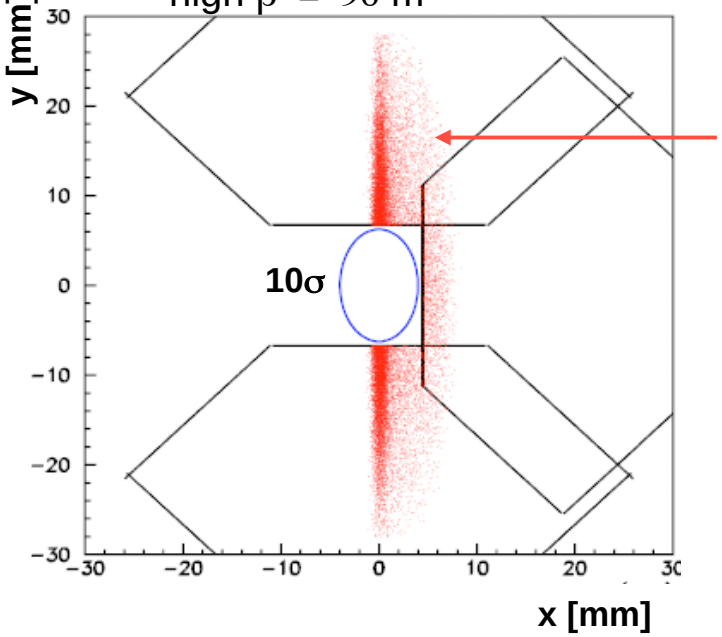
- Verify detector efficiency and trigger, DAQ, DCS etc.;
- If satisfactory take data.

# Early Physics (1)

## Measurement of elastic and diffractive protons

Hit distributions @ RP220

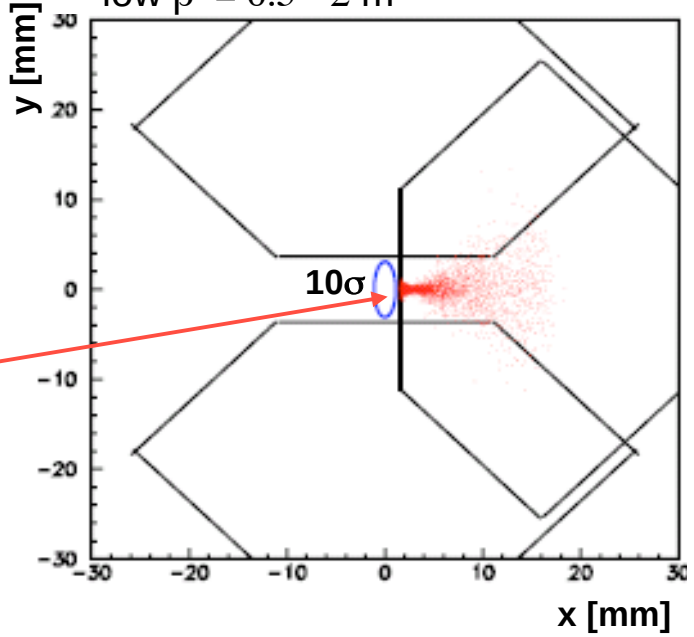
high $\beta^* = 90$ m




$y \sim \Theta_y^{scatt} \sim |t_y|^{1/2}$

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

low $\beta^* = 0.5$ - 2 m



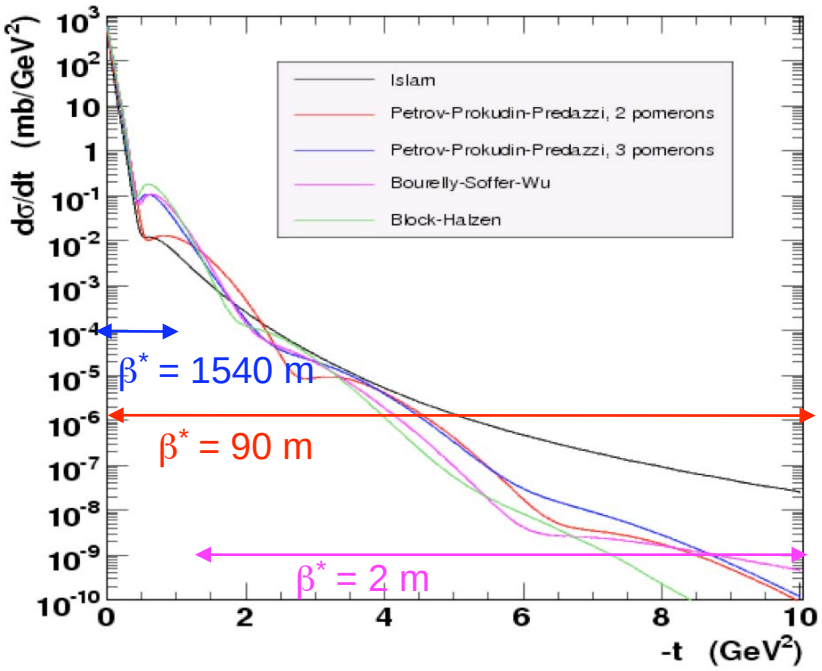

**Detect the proton via:**

**its transverse momentum $t_y$ (high $\beta^*$)**

**its momentum loss $\xi$ (low $\beta^*$)**

# Early Physics (2)

## Elastic Scattering

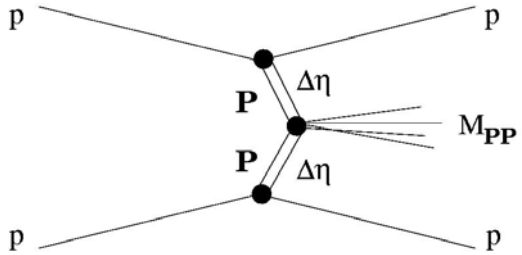



Statistics for 3 hours of running with $\beta^* = 2$ m at $L = 10^{32}$ cm$^{-2}$ s$^{-1}$ ($\int Ldt = 10$ pb$^{-1}$):

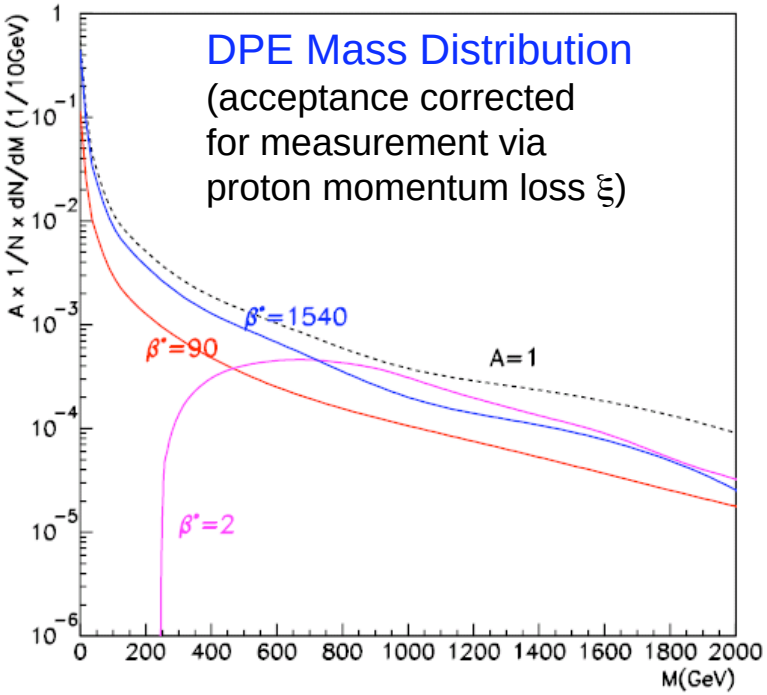
- $10^6$ Events
- $60 \times 10^6$ DPE events

within acceptance

## Central Diffraction (DPE)




$$M_{PP}^2 = \xi_1 \xi_2 s$$



# Summary

- TOTEM will install 2 Roman Pots in the horizontal position before LHC closure, 2 more in the vertical position during a technical stop.
- TOTEM will copy as much as possible the control of the collimators. This needs a close collaboration between TOTEM and the LHC.
- During 2008 TOTEM intends to take data for diffractive physics. With a common effort from LHC and TOTEM we will manage to get the Roman Pots to a safe position for the best physics.