

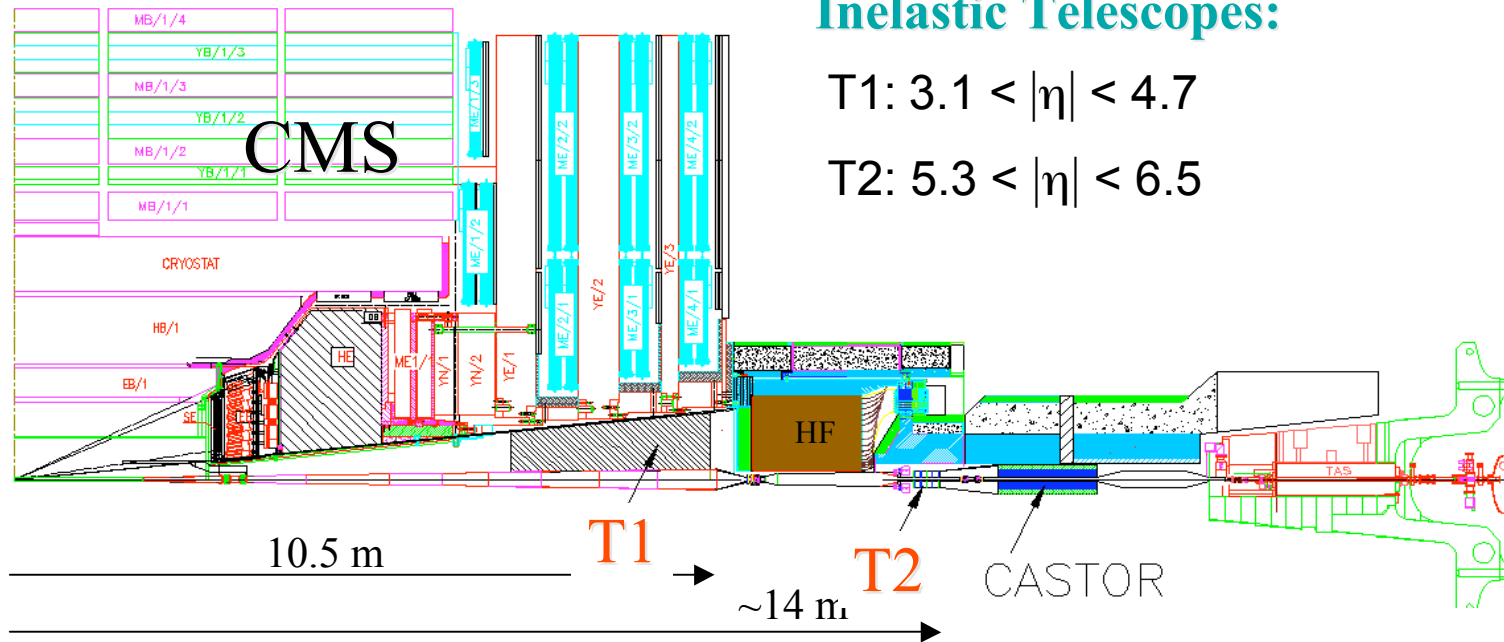


TOTEM Roman Pot controls

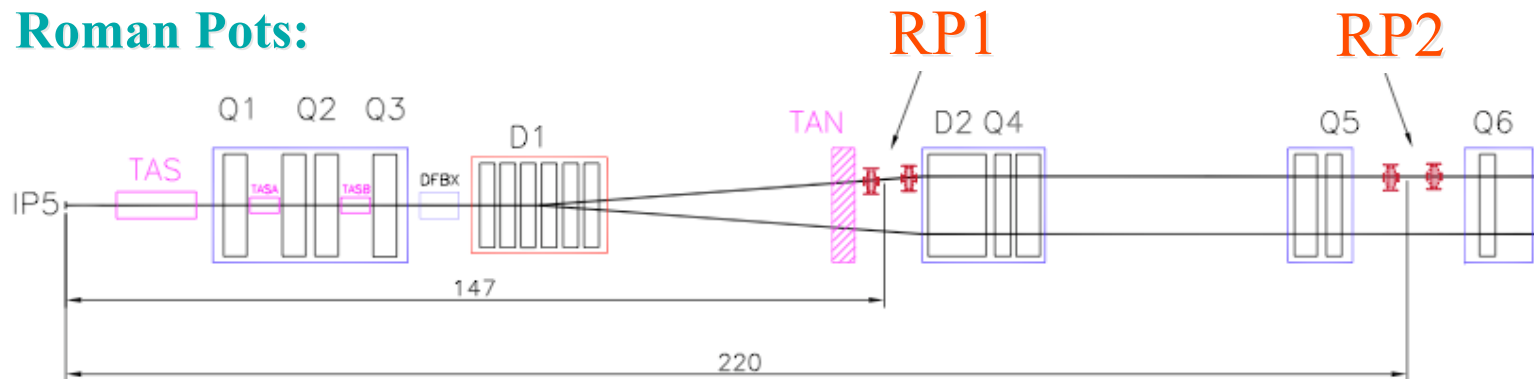
- The TOTEM Roman Pots
- Operation of the Roman Pots and interlocks
- Roman Pot control system
- Use case scenario: a physics run
- Special requirements
- Summary and outlook



The TOTEM detectors

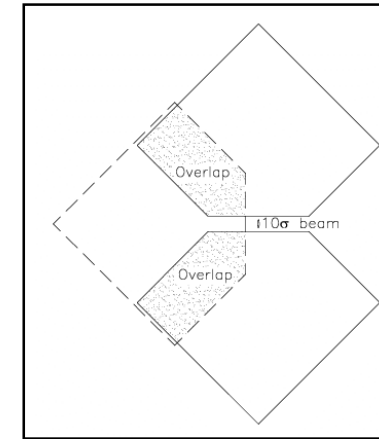
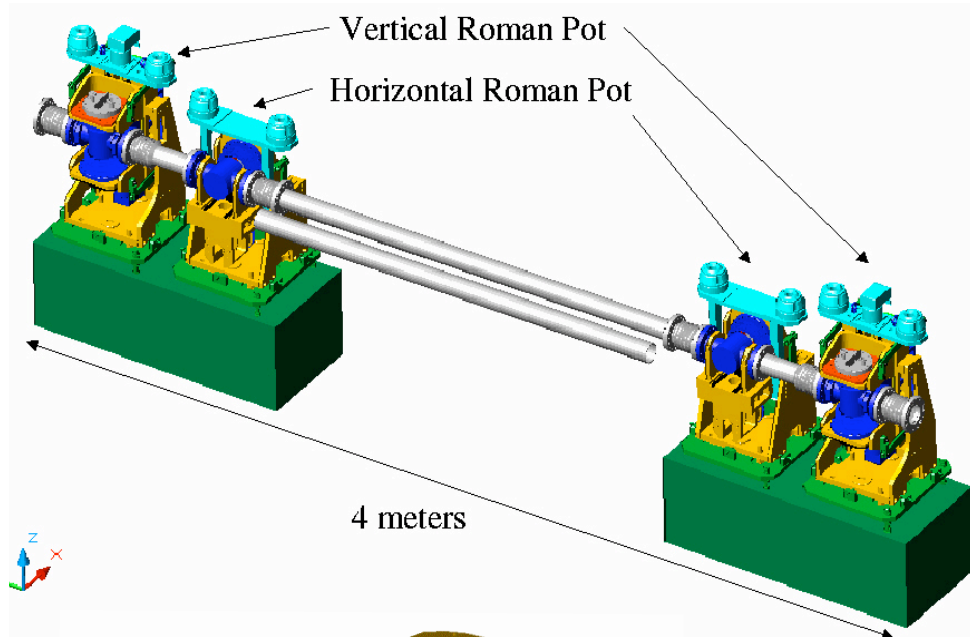


Roman Pots:

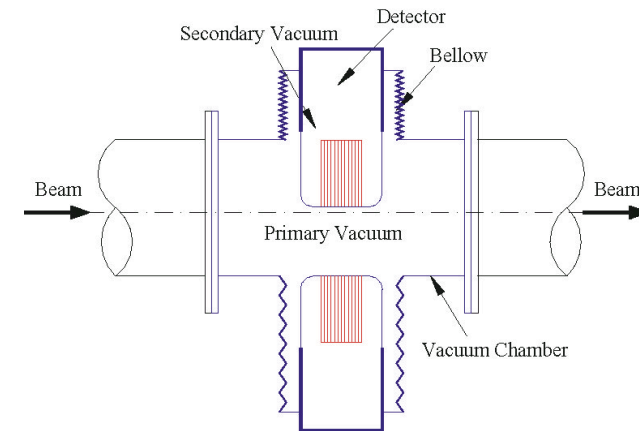
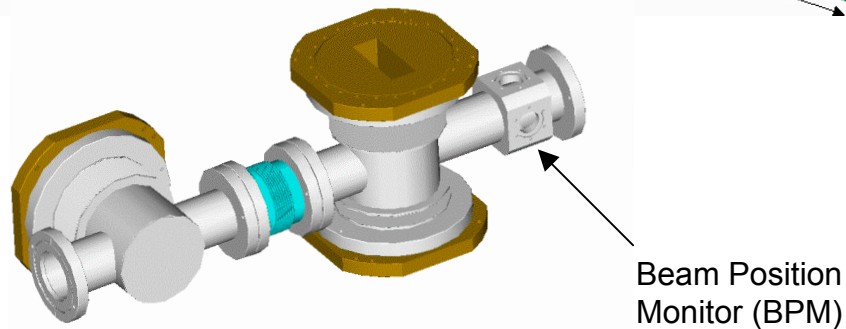




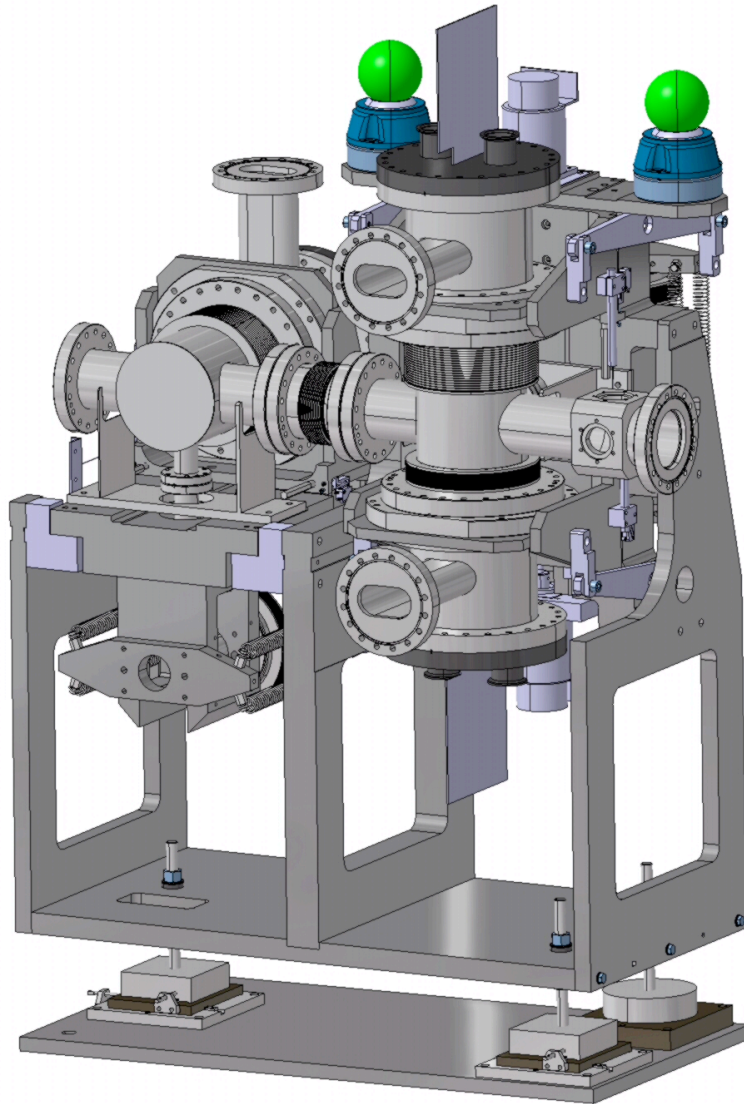
The TOTEM Roman Pots: Concept



Si detector arrangement

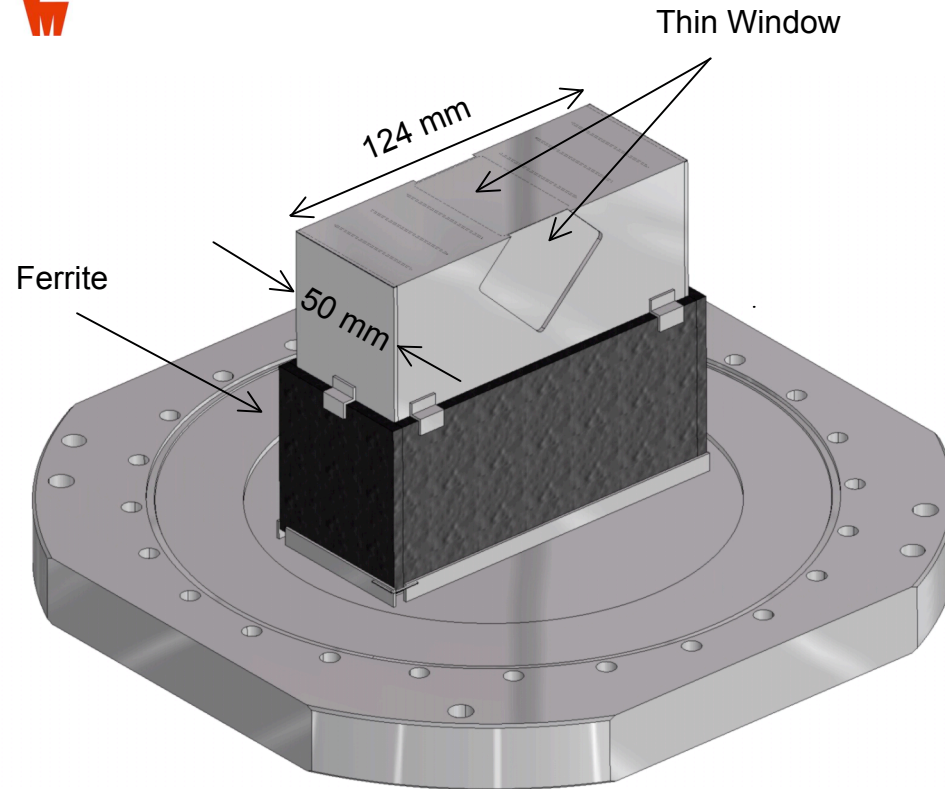


The Roman Pot unit



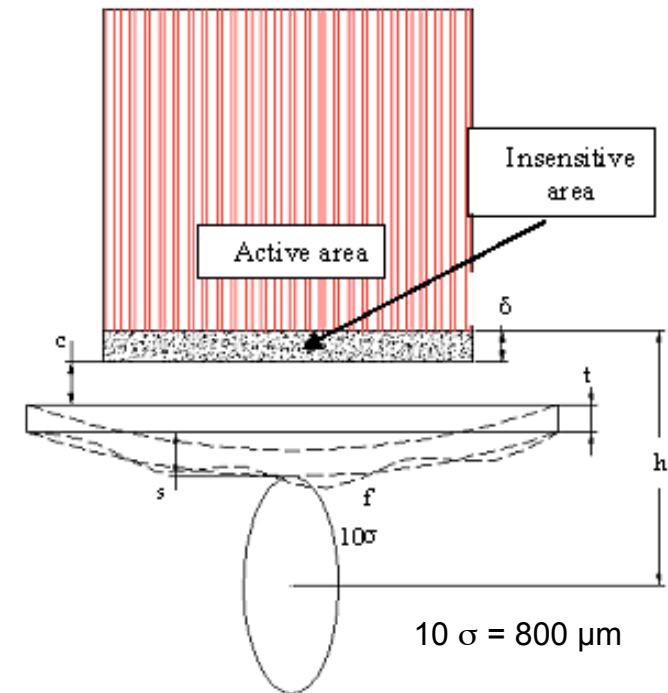
- Three measurement pots : two verticals and one horizontal
- Integrated beam position monitor
- Interconnection bellow between horizontal and vertical pots
- Vacuum compensation system interconnected to the machine vacuum
- Individual stepper motors to drive the pots
- Adjustable jacks to align the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

The pot and the thin window



Ferrites surround the window box in order to reduce the RF influence of the box on the beam and of the beam on the electronics (gain of a factor 5).

First prototypes stand pressure of more than 30 bar.



Closest approach to beam center:

$$h(t) = \delta + c + t + f + s(t) + 10\sigma$$

$$\delta = 47 \mu\text{m} \text{ insensitive area}$$

$$c = 50 \mu\text{m} \text{ distance to window}$$

$$t = 150 \mu\text{m} \text{ window thickness}$$

$$s(t) = < 50 \mu\text{m} \text{ flatness}$$

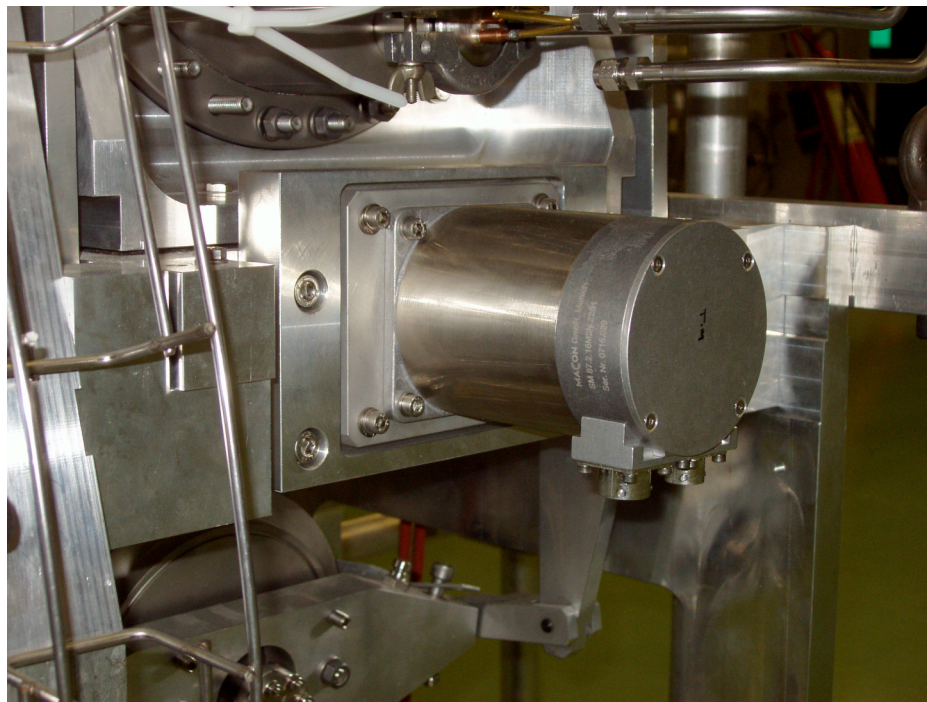
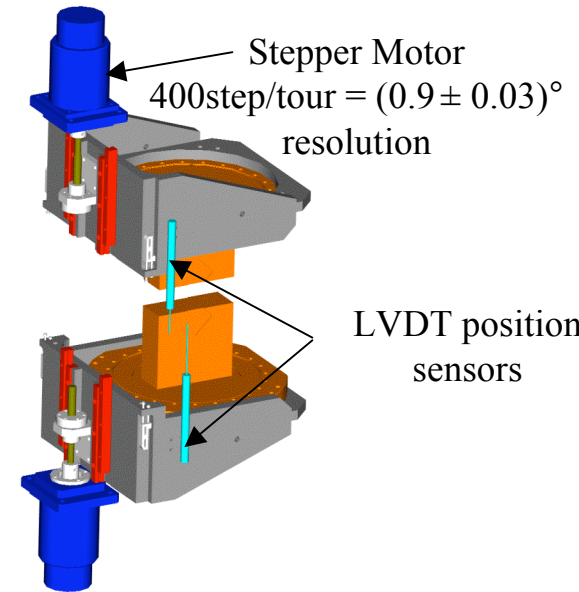
$$h(t) = 10 \sigma + \leq 300 \mu\text{m} = \leq 1.1 \text{ mm}$$

f = window displacement in case of vacuum loss.



Motor and LVDT

Micro-stepping motors with 400 steps/360° and controls as for the LHC collimators.
 Movement resolution: 2 mm/400 steps = 5 μm.
 Precision relies on the screws quality.
 Relative positioning resolution 0.1% (50 μm over 50 mm stroke) from inductive LVDT.
 Radiation hard up to 1 Mrad.





Roman Pots in LHC



One Roman Pot unit in the LHC



First Roman Pot station in the LHC

- All Roman Pot stations installed in the LHC
- Before installation final bake out and vacuum test done by LHV vacuum group.



Operation of the Roman pots

EDMS document 863466

TOTEM creates USER_PERMIT and delivers it to the BIC via the 2 CIBUs.

At injection:

- RPs are out and motor power off \Rightarrow Both CIBUs receive USER_PERMIT=TRUE.

Stable beams:

- RPs move 35 mm \Rightarrow verify BLMs, Rad. Monitors and trigger rates.
- Move RPs up to 10-15 σ from beam such that trigger rates are equal in both vertical RPs.

Protection of RP:

- RP has to be out except for “stable beam” or “unstable beam”:
ensured by interlock system via “user_permit” (first CIBU)
- Injection permit via CIBF.
- Wish: RP movement controlled by collimator supervisor system
ensures that RP stay always in the shadow of collimators.
- rate too high \Rightarrow retract RP: **threshold still undefined;**
beam dump due to high detector rate not foreseen in the beginning.
Option for beam dump via “user_permit” (second CIBU) reserved for later.



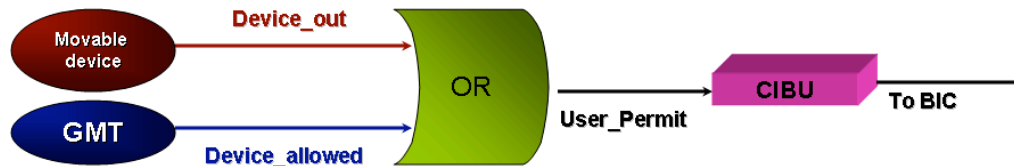
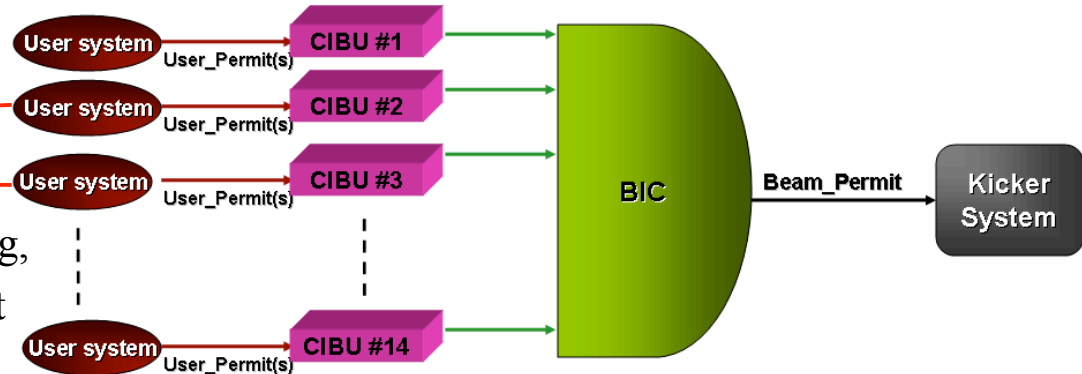
Interlock actions

TOTEM has 2 CIBUs:

RP position

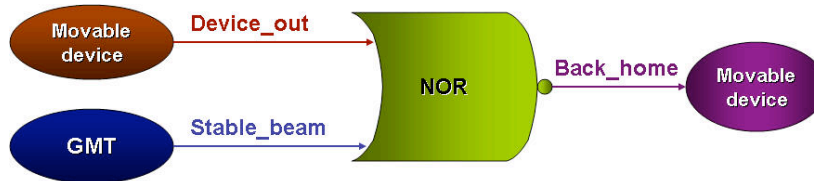
Detector information

(e.g. rate), unused in the beginning, corresponding “user_permit” kept permanently “high” (UPS)



Dumps the beam and inhibits Injection if RP is IN and the mode forbids it.

Device_out = TRUE only if device is in home position
 Device_allowed = TRUE only if mode= stable or mode = unstable



Drives the RP out if it is IN and the beam is not stable.

Device_out = TRUE only if device is in home position
 Stable_beam = TRUE only if mode = stable

EDMS document 863466

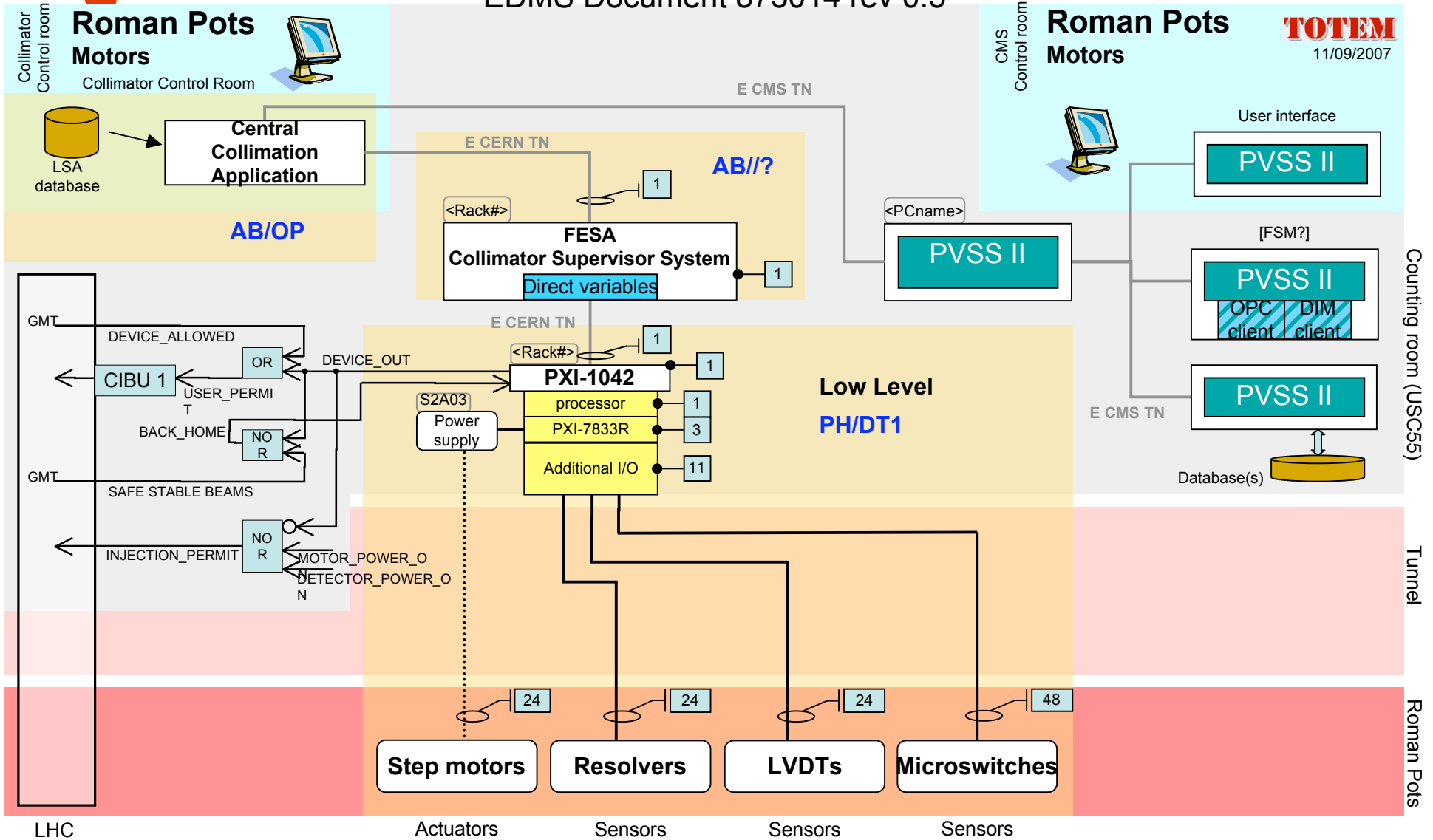
Back_home = TRUE only if device NOT in garage and mode ≠ stable

[graphs © D. Macina]



Roman Pot control system

EDMS Document 873014 rev 0.3



Counting room (USC55)
Tunnel
Roman Pots

LHC

Actuators

Sensors

Sensors

Sensors



Architecture

EDMS Document 873014 rev 0.3

General idea: copy and clone as much as possible from collimator control.

- **Low level control:**
 - Same PXI hardware as collimator control.
 - Resolver readout at 100Hz, LVDT read out at 2 Hz.
 - Responsibility of PH/DT1.
- **Specific TOTEM requirements:**
 - Motor power failure \Rightarrow RP out by compensation system.
 - Non-concordance between resolver and LVDT \Rightarrow RP moves out.
 - Adapt low level control to accept machine protection limits.
 - Machine mode available to low level electronics by CSS.
- **CSS (collimator supervisory system):**
 - CSS runs on PC gateway running also the low level FESA server.
 - Responsibility of collimator control (?).
 - PC gateway location to be agreed.
- **CCA (central collimation application):**
 - CCA controls RP settings.
 - Only for STABLE_BEAMS RP limits will be set compatible with Coll.
 - Then the RPs can be moved towards beam to a new limit.
 - When good position is found \Rightarrow save it into LSA database.



Use case scenario: prepare a TOTEM physics run

Initial condition:

- Roman Pots are in the retracted position.
- LHC is preparing for physics (`Adjust` or `UnstableBeams`).

Start condition:

- The operator changes the LHC machine mode to `StableBeams`.

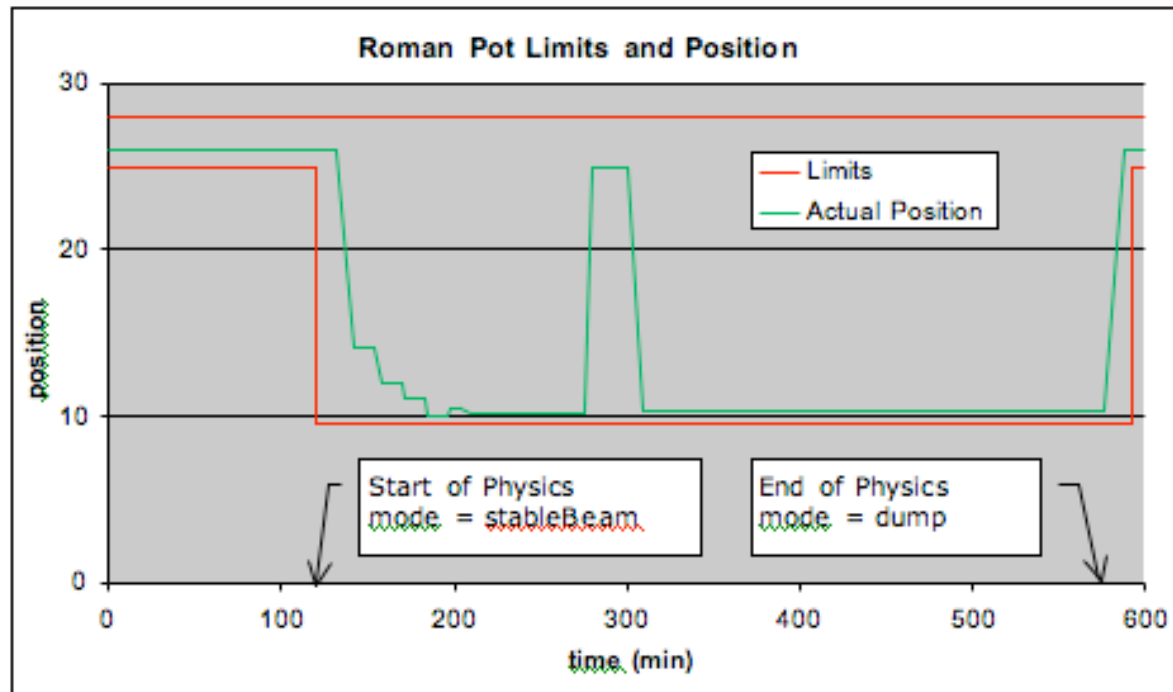
Evolution:

1. The system broadcasts the new machine mode. It will be a HW signal to the CCA, CSS, PXI crate and CIBU, coming directly from the GMT. For the DCS it will be a SW signal transmitted via DIP.
2. The low level system changes the limits according to the new machine mode.
3. TOTEM contacts the CCC to move the Roman Pots to a specified position.
4. The LHC operator enters the request in the Collimator Control application.
5. The CCC checks that limits obey the currently imposed limits of the RP position.
6. The position request is transmitted through the CSS to the low level system
7. The low level system moves the Roman Pots to the new position.

Point 3 to 7 can be repeated many times, depending on the need of the TOTEM experiment.



Special requirements



- Motor power off when RPs in retracted position and not STABLE_BEAMS.
- Position limits based on machine mode (communicated to low level).
- Fast automatic retraction when counting rates too high, to be verified and calibrated together with BLMs and radiation monitors.
- Movement inhibit during data taking.
- Access to movements by TOTEM shift crew at a later stage.



Summary and outlook

- Good progress has been made in the understanding and schematics of the overall Roman Pot control with the help of AB/CO.
- Low level control and motorization already advanced with the help of PH/DT1.
- **Open points (operational procedure):**
 - Procurement and hardware maintenance of PC-gateway, timing receiver and other equipment through AB/CO?
 - Can TOTEM use spares?
 - Operating system (LINUX) from AB/CO.
 - Location of PC-gateway to be agreed.
 - Clarify connectivity and agree.
 - Help needed for FESA configuration adapted to TOTEM requirements.
 - Help needed for commissioning (0.3 - 0.5 FTE for both items).

With some good will from all people involved, TOTEM, AB/CO and PH/DT1 it should be possible to move a few Roman Pots during the initial phase of LHC.