The Beam-Based Aligment of the TOTEM and ALFA Roman Pots

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on behalf of
TOTEM, ATLAS/ALFA and several LHC teams

Global Strategy

In total: 32 pots to be aligned (2 x 12 TOTEM, 8 ALFA)

→ distribute the task in 2 separate exercises:

1. 12 x TOTEM 220 m + 8 x ALFA
   - after the technical stop (13/14/15 May)

2. 12 x TOTEM 147 m
   - to be scheduled (at least 1 week later)

Each alignment exercise is followed by

- Data taking at very small RP distances from the beam
  (major part of TOTEM physics programme!)
- Loss map at nominal physics settings (Vertical: 14 σ, Horizontal: 17 σ)
  → qualify the pots for operation in normal runs with STABLE_BEAMS

Strategy

Method:

Like collimator setup: cut an edge into the beam with the TCPs,
then approach each pot to the beam until BLM detects a loss spike → edge found

Preparation:

Increase monitor factors for the nearest BLMs downstream of RPs:

Discussed with BI, MPP representatives [see Barbara's presentation]

Desired beam conditions:

- E = 3.5 TeV, β^* = 1.5 m, collisions, beam mode = ADJUST
- Bunching:
  1 bunch of (8 – 10) x 10^{10} p [preference for the lower end of the range], $\varepsilon_n = 3 \div 3.5$ μm rad
  9 pilots of 1 x 10^{10} p , $\varepsilon_n = 1 \div 1.5$ μm rad:
  6 colliding in IP1 and 5
  3 colliding in IP2 / IP8

Emittance measurements [F. Roncarolo is notified] :

- BSRTs
- Wire scans before the alignment and after data taking

Simplified Sequence

- TCPs to 5 ÷ 5.5 σ → cut edge, find centre
- put all TOTEM RPs to a safe distance out of garage (V: 20 σ, H: 40 σ)
  to enable last trigger latency check
- start alignment with ALFA RPs and horizontal TOTEM RPs
  (one team on beam 1, the other on beam 2, never two pots on the same beam)
- after each RP pair, refine the beam edge with TCP → beam gets thinner with each pot
- continue with vertical TOTEM RPs (by now the beam might already be cut down to 4 σ)
- prepare data taking:
  vertical TCP ≤ 4 σ
  vertical RP = TCP + 1 σ ≤ 5 σ

  horizontal TCP = 4 σ
  TCSG = TCP + 1 σ = 5 σ (for protection against asynchronous beam dumps)
  horizontal RP = TCP + 2 σ = 6 σ
- data taking
- all collimators and pots to nominal settings (V: 14 σ, H: 17 σ)
- loss map

Total programme: ~ 13 to 15 hours

[For more details see excel sheet (also on indico)]


TOTEM

Backup

Calculation of the Nominal Settings

Agreement for normal runs in Stable Beams:

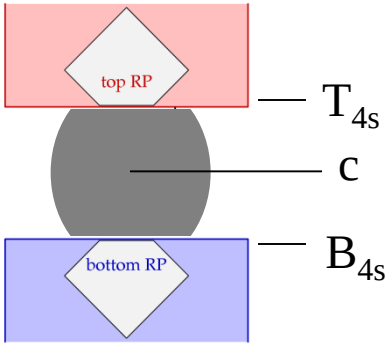
Vertical pots: 14 σ

Horizontal pots: 17 σ

How to define these settings?

Calculation of the Nominal Settings

Alignment exercise:



Method 1: via calculated beam centre

$$T_{14\sigma} = c + 14\sigma = \frac{T_{4\sigma} + B_{4\sigma}}{2} + 14\sigma$$

$$B_{14\sigma} = c - 14\sigma = \frac{T_{4\sigma} + B_{4\sigma}}{2} - 14\sigma$$

Method 2: from the 2 individual beam edges

$$T_{14\sigma} = T_{4\sigma} + 10\sigma$$

$$B_{14\sigma} = B_{4\sigma} - 10\sigma$$

- Both methods use σ at the RP as input from the optics
- Method 1 assumes that T and B have a common scale zero point,

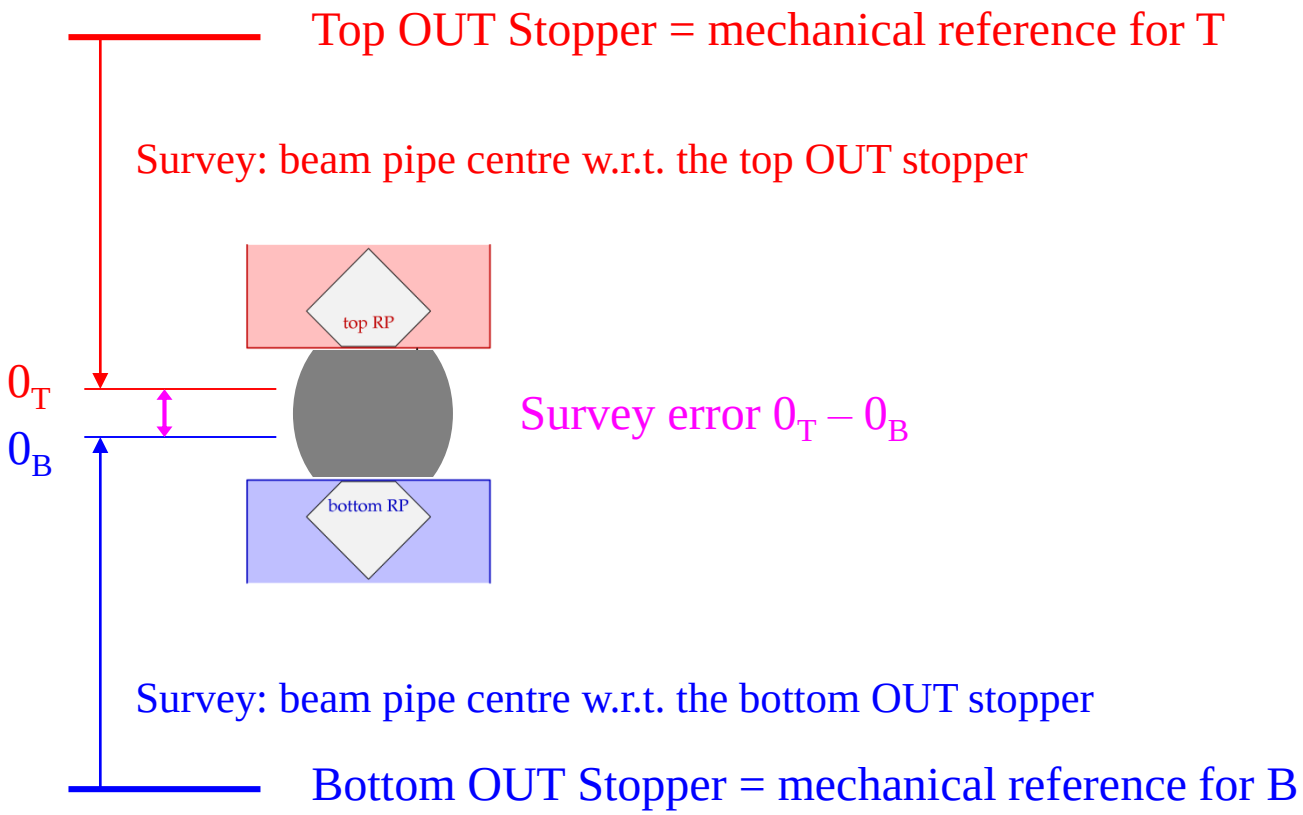
i.e. they are calibrated w.r.t. the same reference point

→ sensitive to survey errors

- Method 2 suffers from errors due to betatron beating

Calculation of the Nominal Settings

Potential problem of method 1:



If survey is perfect ($0_T = 0_B$), method 1 = method 2