Aperture Meter of the Large Hadron Collider

G.J. Müller (CERN, TU Dresden),
K. Fuchsberger, S. Redaelli (CERN)

MOMMU003

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Problem Description

The LHC (Large Hadron Collider) is operated:

- at high momentum (currently 3.5 TeV)
- at high stored beam energies (currently 110 MJ)
- with complex beam configuration
- in a superconducting environment

► beam losses have to be minimized to avoid quenching of the superconducting magnets

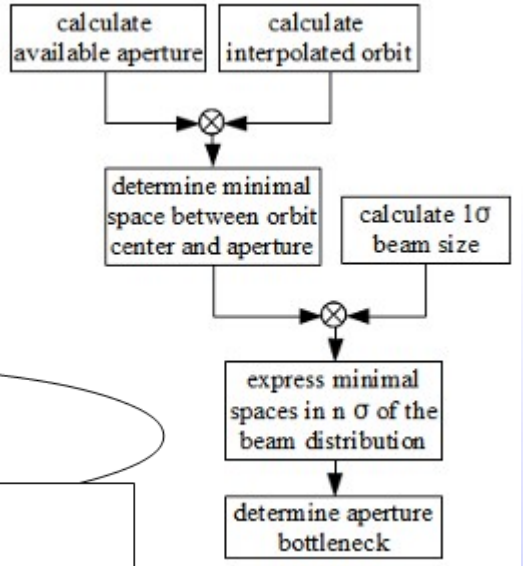
The operation team needs to know:

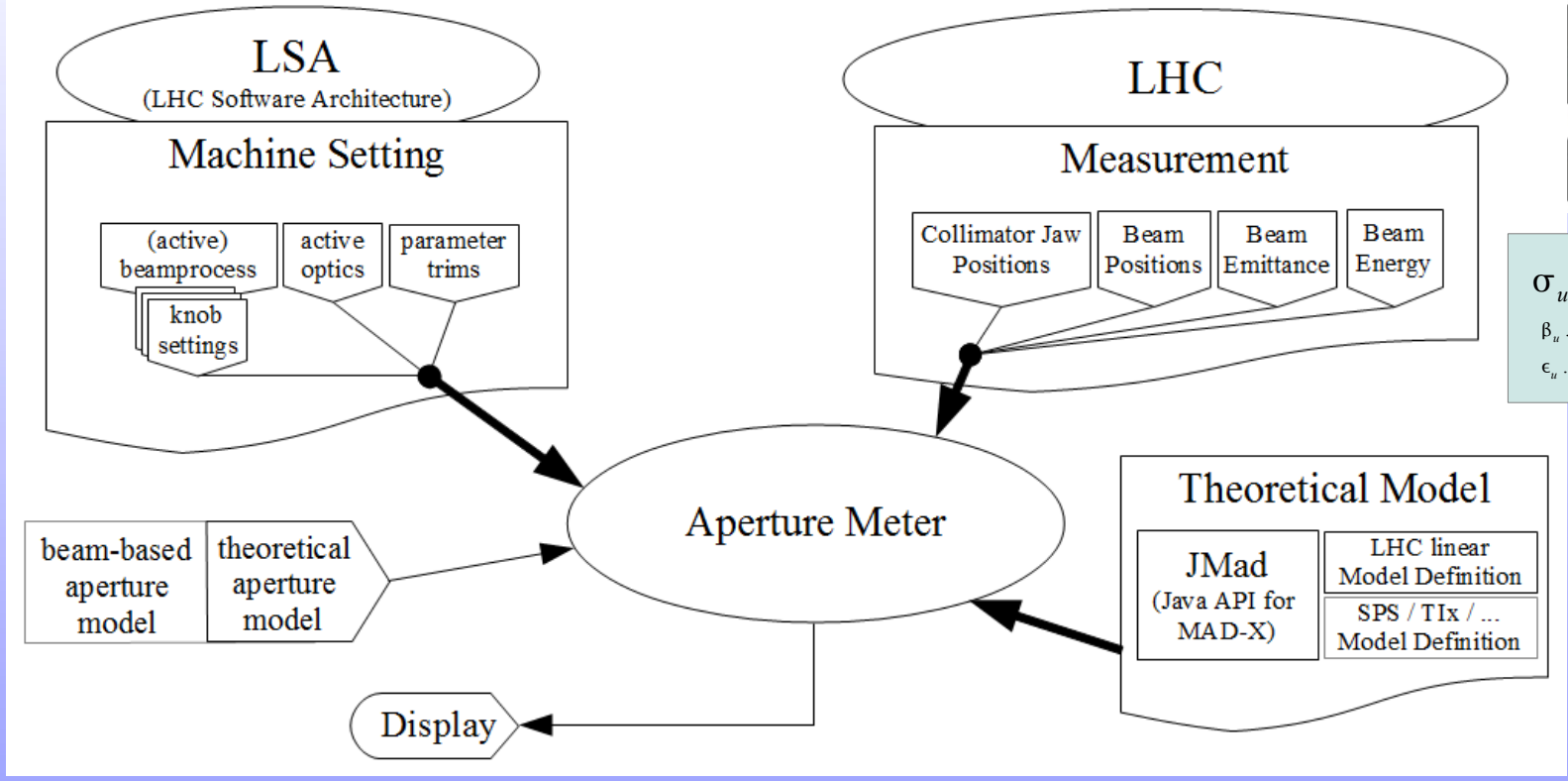
a) Where is the beam?
b) What size has the beam?
c) How much space is left?
d) What changes for a given setting modification?

Solution / Design

The Aperture Meter as a fixed display in the Control Room

Calculate the available free space for the beam by merging measurements and online simulation data





$$\sigma_u = \sqrt{\beta_u \, \epsilon_u} \qquad u = x, y$$

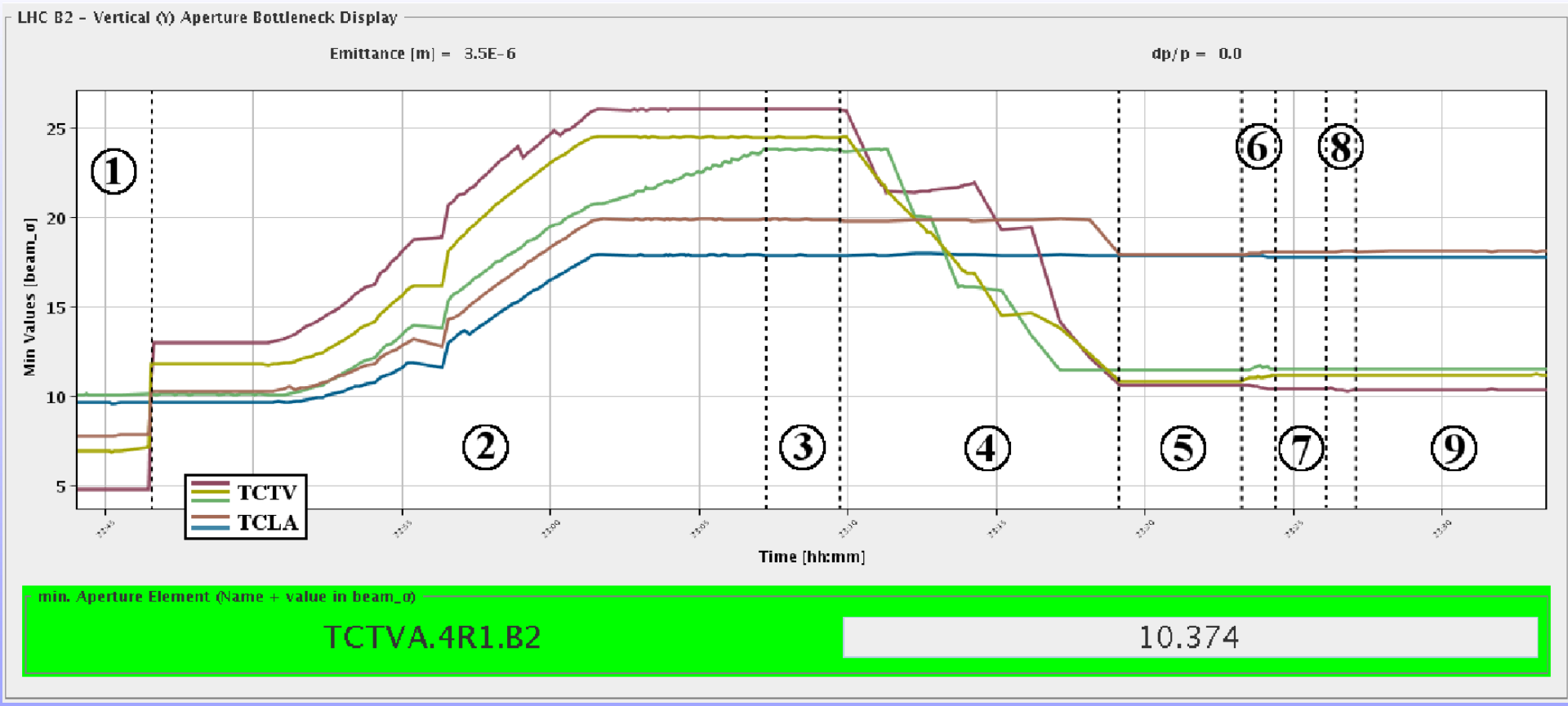
β_u ... *beta function*

ϵ_u ... *normalized emittance*

Do What?! – Results

minimal aperture evolution (beam 2 vertical) over operational cycle (primary/secondary collimator excluded)

1) Injection
2) Ramp
3) Flattop
4) Squeeze
5) Beta Target
6) Collision
7) Physics
8) Luminosity Scan
9) Physics



Do What?! – Results

minimal aperture evolution (beam 1 horizontal) during triplet aperture scan in IP5 (CMS) to determine the maximal available aperture before the decision was take to further reduce the β* to 1.0m