LHC collimators
Mechanical point of view

1 Collimator number and types.
2 Parameters for technical specification.
3 Collimators in LHC tunnel.
4 Present status of collimator studies
Collimator number and types.

A total of 66 collimators, 1 or 2 moveable jaws, are repertoriated for:

- **Momentum cleaning in IR3:**
  1 primary (TCP: H plane) 200mm Al, Ti, or other light material jaws
  Associated with
  6 secondaries (TCS: H, S(kew), V plane) 500mm Cu jaws per beam.

- **Betatron cleaning in IR7:**
  4 primaries (TCP, H, S, V plane) 200mm Al, Ti, or other light material jaws
  Associated with
  16 secondaries (TCS, 4xH, 4xS, 4xV plane) 500mm Cu jaws for per beam.

- **Injection single pass cleaning:**
  2 tertiaries (TCL, V plane) 1000mm Cu jaw(s) in IR2R for beam1 and
  in IR8L for beam2.

- **High luminosity region protection:**
  2 tertiaries (TCL, H plane) 1000mm Cu jaw(s) per beam in IR1 and in IR5
2 Parameters for technical specification.

_ Aperture limits:
  - 1- Maximum: $\phi 48\text{mm}$ to be confirmed.
    _ It defines the transition pieces length (~ 100mm), to avoid impedance perturbations, on both ends of the jaws.
  - 2- Operating aperture at 7 TeV:
    _ Hence the primary collimator jaws are closed at $\pm 6\sigma$ ($\sigma_{col} \sim 150 \mu\text{m}$) total aperture is ~ $1.8\text{mm}$ (fig. 1).

_ Jaw positioning precision and quality:
  - 1- Jaw positioning:
    _ No absolute positions are required: only position wrt local beam position and size.
    _ Precision required in relative position: $\pm \delta x, \delta x \leq 0.3 \sigma_{col}$ (~ $50\mu\text{m}$).
    _ Stepping increment: $2.5 \mu\text{m}$ expected, $5 \mu\text{m}$ in LEP.
    _ Position repeatability: $< \frac{1}{2} \text{ step}$ ($< 2 \mu\text{m}$ achieved in lab).
  - 2- Jaw quality:
    _ Flatness: $20 - 50 \mu\text{m}$ (120 $\mu\text{m}$ achieved in LEP with composite jaw: fig. 2).
    _ Surface roughness: $1.6 \mu\text{m}$ high quality machining.
    _ Tolerances in angle: $\pm 0.1 \text{ mrad}$. 
fig. 1
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fig. 2

5 G. Burtin 20-11-2001
-3- Error contribution (δx):
  _ Jaws positioning precision wrt external reference sockets fixed on the tank.
  _ Jaw motion (motor unit + mechanical driving) & control.
  _ Thermal expansion effects.
3 Collimator in LHC tunnel.

- LHC environment (from integration layout):
  - 1- Comfortable situation in general: fig. 3
  - 2- Critical situation at some secondary collimators (located inside Quad section): fig. 4
fig. 3
fig. 4
Alignment parameters and precisions:

- Z precision positioning is not critical (precision may be defined as ±1mm).
- Precision on X & Y positioning (of each Taylor ball) guarantees relative jaws position wrt local references (surrounding Quad or Dip).
- Longitudinal tilt depends on precision on X or Y or both.
- Collimators stability inside LHC tunnel must also be considered (ground motion...).
4 Present status of collimator studies

-1- A collimator model is being built to investigate:
  _ Integration components.
  _ Transition pieces and impedance measurements.
  _ A “scale 1” collimator for integration studies in LHC (fig. 5 & Picture 1).

-2- Due to high radiation level around collimators (>10^5 Gy/y):
  _ Special components have to be selected.
  _ Quick, precise and stable alignment mechanical system has to be provided.
  _ A “plug and play” tank fixation will be studied (collimator failure).

-3- Good vacuum properties are expected, but must be still specified by LHC/VAC.

-4- Shielding and BLM configuration around collimators has to be compatible.
fig. 5