Layered Collimator jaws

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`/Coll/2003/layer_coll.talk.tex`

Motivation

- If ’Low-Z means C (graphite) or BN $\rightarrow$ A container is mandatory
- News from collective effects : A metallic surface layer is mandatory
  Thickness : $10, 20, 100\mu$m (Cu,Be,Ti) (thick/thin insulator or thick graphite)
  (check, see controversy about older thinner values given to Luca by Luc for TDI)
- Above a few microns, deposited layers are fragile
  (differential thermal expansion,’chemistry’,...)

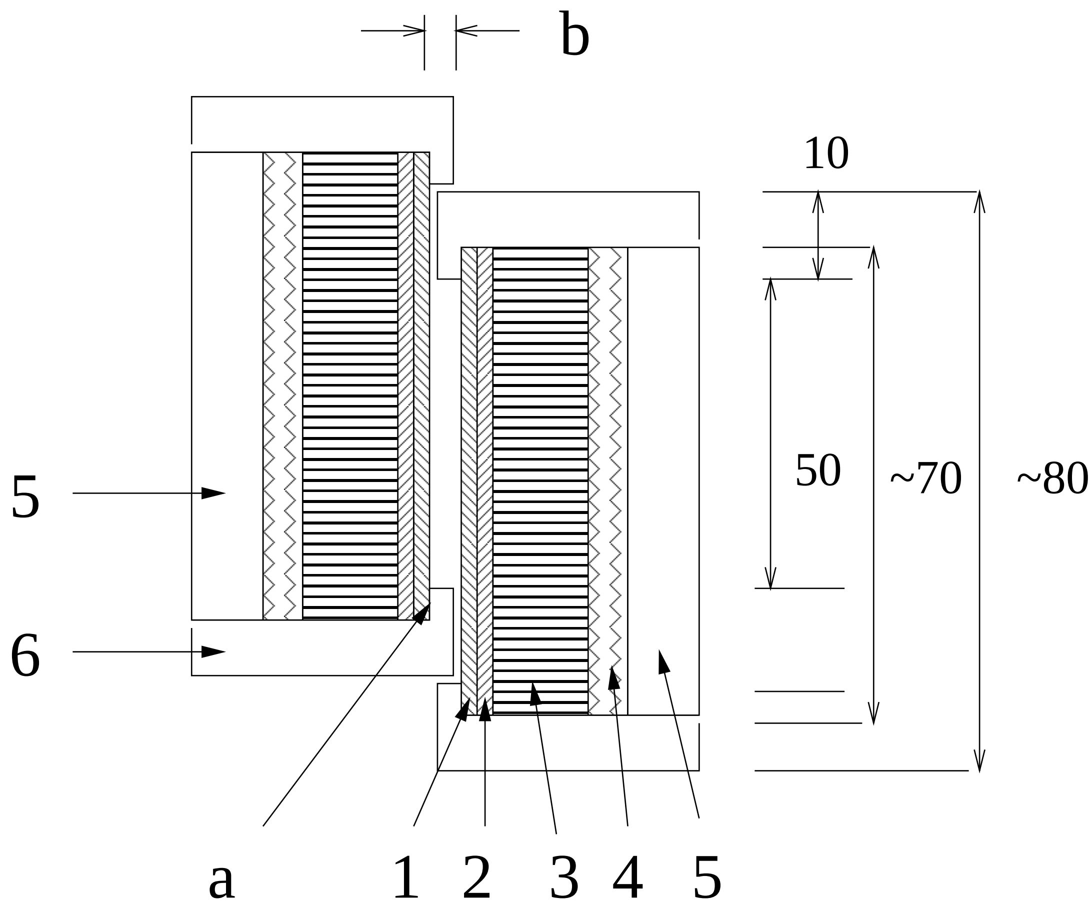
Basic arguments

- An autonomous metallic layer must be thick enough for
  - self-support
  - be rigid enough to ensure the required a face flatness of $\sim 20\mu$m
  - $\Rightarrow$ thickness $\sim$ 1 mm
- At 7 TeV, the r.m.s beam size is 200-300 μm
  $\Rightarrow$ the layer must also have low-Z
- The best low-Z metallic candidate is Be
- But even Be might be close to the critical limit with dump failure

Layered jaws - see figure next slide

1. CVD diamond tiles as a front layer
   an option , needs quick exploratory study
2. Two shifted layers of Be tiles, to ensure electrical continuity
   and reduce thermal stress
3. A thick graphite layer as the main absorber
   use its softness to ensure smooth pressure to align the front layers
4. a cooling element (water flow or heat pipes ?)
5. a rigid back plate (Stainles steel, Titanium ?)
6. a rigid side frame for precise assembly, material identical to 5
   use its softness to ensure smooth pressure to align the front layers

Jaw end view



A few basic formulae

Thermal expansion

$$\frac{\Delta l}{l} = \alpha \Delta T \tag{1}$$

Hooke law

$$\frac{\Delta l}{l} = \frac{\sigma}{Y} \tag{2}$$

Temperature increase with beam loss density

$$\Delta T = \frac{\epsilon^{\mathrm{beam}}}{c_{\mathrm{v}}} \tag{3}$$

Replace $\sigma = \sigma_{\mathrm{uts}}$ to get a crude critical limit

$$\epsilon^{\mathrm{beam}} = \frac{\sigma_{\mathrm{uts}} c_{\mathrm{v}}}{\alpha Y} \tag{4}$$

Material Data

Element	Y	$\sigma_{\rm uts}$	α	$c_{\rm v}$	$\lambda_{\rm abs}$
Unit	[Mpa]	[Mpa]	$[(^\circ K)^{-1}]$	$[Jm^{-3}K^{-1}]$	[cm]
Be	2.6×10^5	800	12.4×10^{-6}	1.94×10^5	41
C	4.9×10^3	400	3×10^{-6}	1.67×10^6	38
Cu	1.2×10^5	300	2×10^{-5}	2.13×10^6	15

Suggested further explorations

- Be $\longrightarrow$ alloy (BeCu?) to reduce Y and λ_{abs}
  but keeping ϵ proportionally lower
  $\Rightarrow$ higher beam loss limit + shorter jaws
- Same considerations for graphite (see Peter's proposal)
- CVD diamond (according to Francesco: allowed naked layer .3mm) ?
- Explore rigid shell, precise assembly method, material