Alessandro Dallocchio 27-03-2008

LHC Collimation PHASE II
4th Design Meeting - 14/03/2008

Present: Gonzalo Arnau Izquierdo, Arnaud Pierre Bouzoud, Oliver Aberle, Gilles Favre, Roger Perret, Alessandro Bertarelli (chairman), Alessandro Dallocchio (scientific secretary).

1. Potential problems relative to welding and brazing of Molybdenum

Bertarelli opened the discussion explaining that Molybdenum was proposed as possible material for the “jaw-base” and for the “c-shaped beam” due to its high thermal stability parameter $E \cdot K / \alpha$.
Favre remarked that, at CERN, there is not a good experience on brazing or welding of Molybdenum; also the literature, after a preliminary research, confirms the difficulty of brazing and welding *Mo* especially with components of large dimensions.
Favre explained also that *Mo* is sensible to oxidation, thus attention must be paid to the storage of components ready for the assembling.
It was proposed to use *Mo* only for the c-shaped beam, where no welding or brazing are necessary, and not for the jaw-base. *Favre* also remarked that the machining of large *Mo* components is quite difficult; furthermore, *Mo* is expensive (260 €/kg).
Bertarelli asked to keep on the R&D activity on welding and brazing of Molybdenum also for large components.
Discussion focused on possible materials for the jaw-base: GLIDCOP was proposed due to its high thermal conductivity, weldability and brazability, good mechanical properties also after thermal cycles.
GLICOP has a quite high CTE, this could be a problem if “collimation layers” made up of different materials should be brazed on the jaw-base. *Perret* explained that the difference between CTE of materials that must be brazed could be compensated with a “comb” design solution: the presence of large grooves on one surface helps the compensation of different thermal expansions.

2. Follow up of design solutions (A. Bouzoud)

Bouzoud showed the follow up of design solutions.
Cooling circuit has been split into two parts on the jaw-base. Dimensions of cooling grooves have been changed (6 X 8*mm*); also the circular cooling tubes have been enlarged (inner diameter: 8*mm*). A smaller cooling circuit was also added in order to obtain thermal stabilization of the c-shaped beam; clamping system of this circuit must be studied.
The “weak point” at the middle of the jaw-base must be modified in order to increase the flexibility of the structure. See the following pictures showing some details of the design solutions.

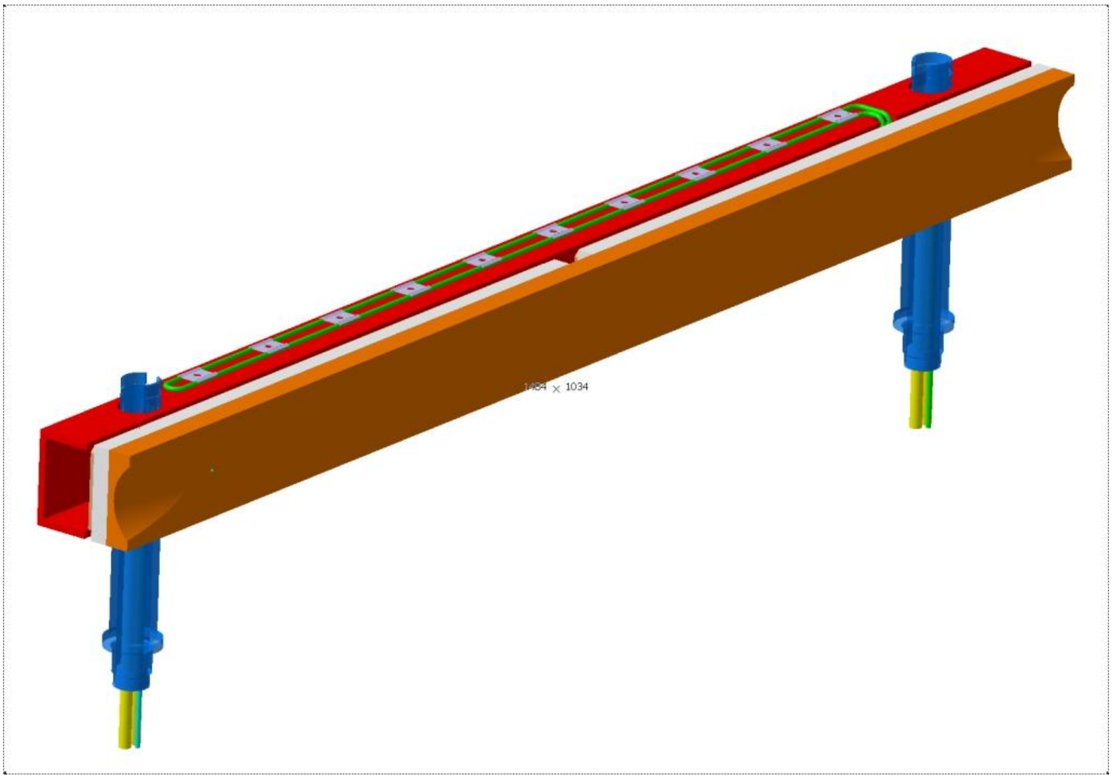

Figure 1: 3D view of the jaw assembly

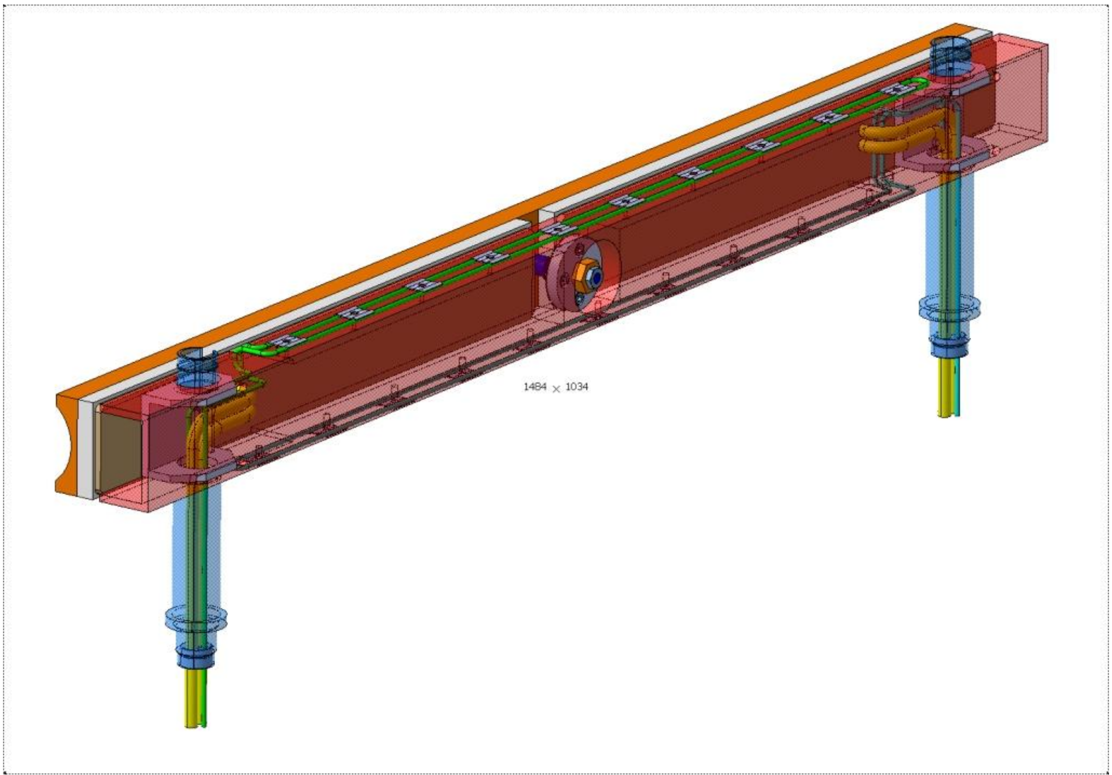

Figure 2: 3D view of the jaw assembly.

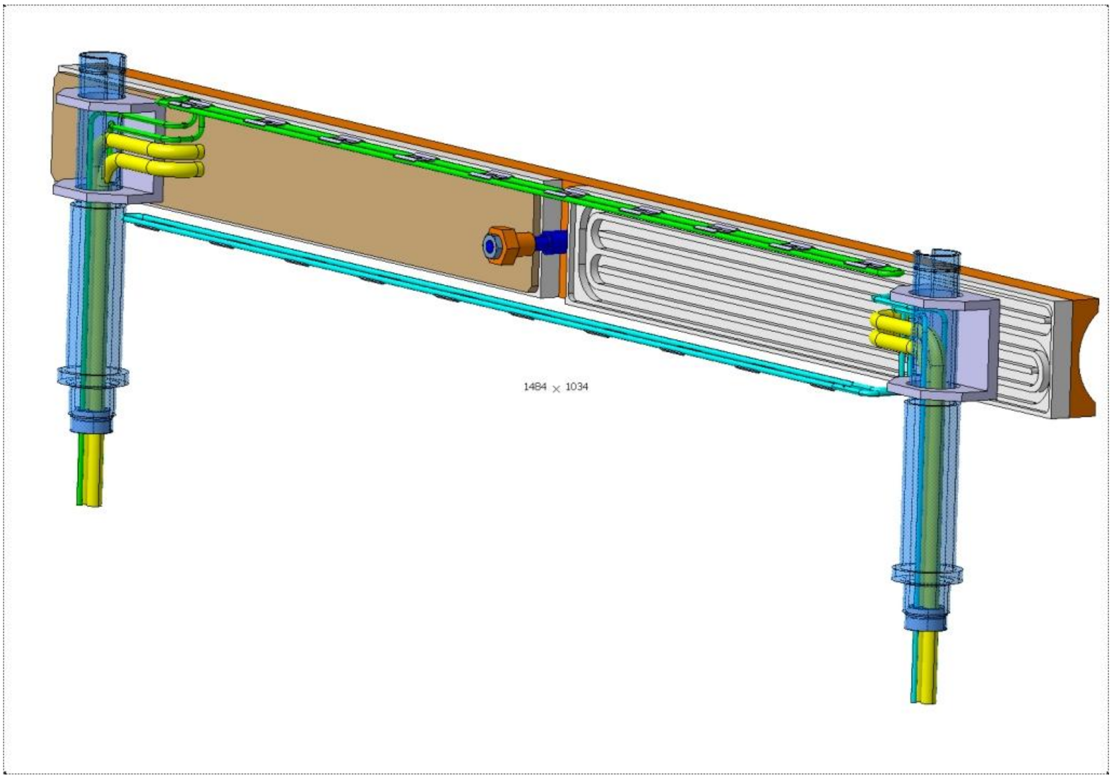

Figure 3: Cooling circuit on the jaw base has been split in two parts.

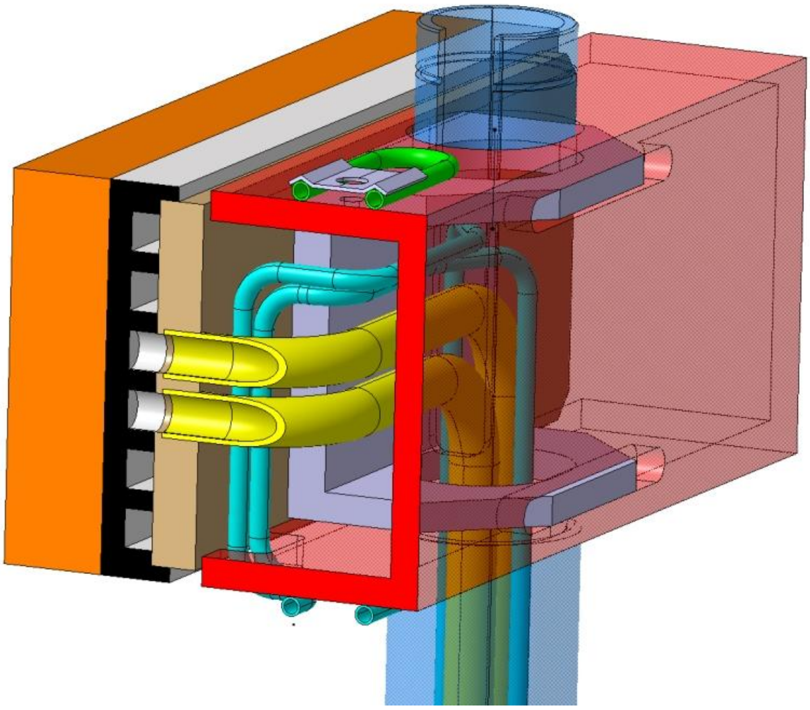

Figure 4: Cutaway of the jaw assembly. Two independent cooling circuits for jaw-bas and c-shaped beam.

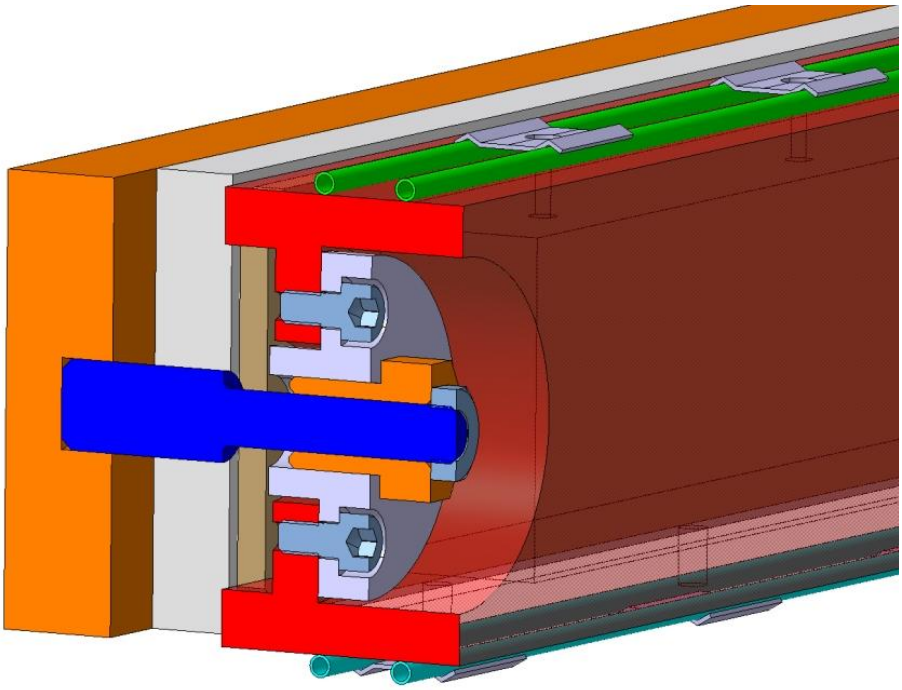

Figure 5: Control system at the middle of the jaw assembly

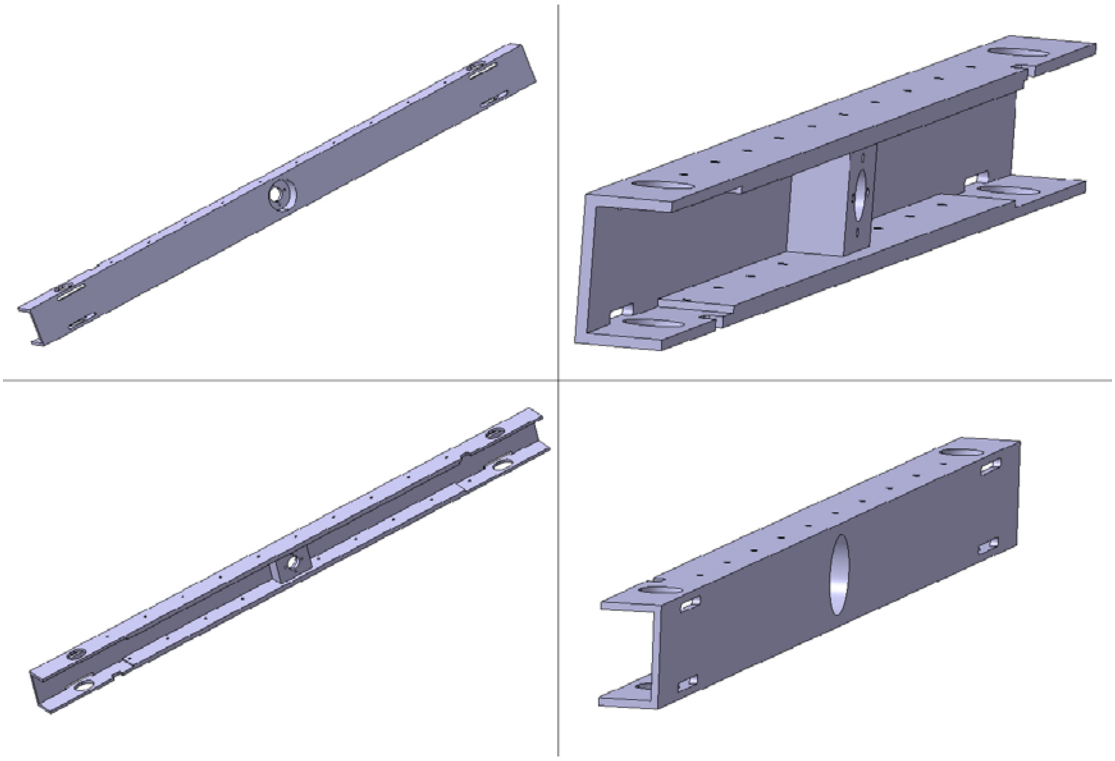

Figure 6: c-shaped beam

3. Outcomes from material R&D brainstorming discussion – 19/03/2008

Presents: A. Dallocchio, A. Bertarelli, G. A. Izquierdo, Ludger Weber (EPFL), W. Vollenberg, A. Bouzoud, I. Wevers.

Bertarelli illustrated a list of requirements for metal-diamond composites (more details can be found on the presentation).
The first important question concerns the maximum dimension of a monolithic component made up of metal-diamond composite that could be achieved (ideal dimensions required: 80 x 22 x 1000*mm*).
Weber explained that presently, the production of metal-diamond components is limited to small pieces (*Plansee* produces plates 200 x 200*mm* with a thickness of few millimeters). The production of component with large dimensions may require a long R&D activity (1 year); furthermore, good results cannot be ensured. An industrial partner is strictly necessary.
Bertarelli asked about the effect of repeated heating cycles on metal-diamond composites. *Weber* explained that a test was performed (20 heating cycles up to 650°C) on Cu-diamond: no changes in properties was observed. A specific test is required to verify material behaviour when submitted to high temperature cycles up to 900°C.
Concerning the specifications required for flatness and roughness, *Weber* remarked that a surface coating (e.g. copper) is necessary.
Vollenberg proposed an assembling procedure that can be used for the jaw-base, covers of cooling circuit and collimation layers:

1. Brazing of cu-diamond components
2. Cu surface coating
3. Surface machining
4. Bake out

Weber confirmed that this procedure should give good results (to be confirmed by experimental tests).
Arnau Izquierdo proposed a different solution: Molybdenum cooling circuit could be directly embedded in a Cu-diamond component during the production process of the composite. *Weber* explained that this is possible but a Cu surface coating on Molybdenum is necessary to avoid the creation of Mo carbide during the heating process.
Weber confirmed that can provide Metal-diamond samples. Several test must be performed in order to validate the use of these materials (out-gassing, SEY, radiation hardness…). *Ivo Wevers* asked for cylindrical samples *Φ4 x 10mm*. Larger samples are also useful to perform machining and surface coating tests.

4. Action list

- Supply of metal-diamond composite samples.
  (L. Weber)

- Validation of the material to UHV requirements.
  (I. Wevers; W. Vollenberg)

Next Phase II Design meeting will be on March 27th, 2008.
Room 376-1-016

Next brainstorming discussion on materials will be on April 3rd, 2008.
Room 376-1-016