ILD: A detector for particle flow

Trying to design a beam tube for ILD

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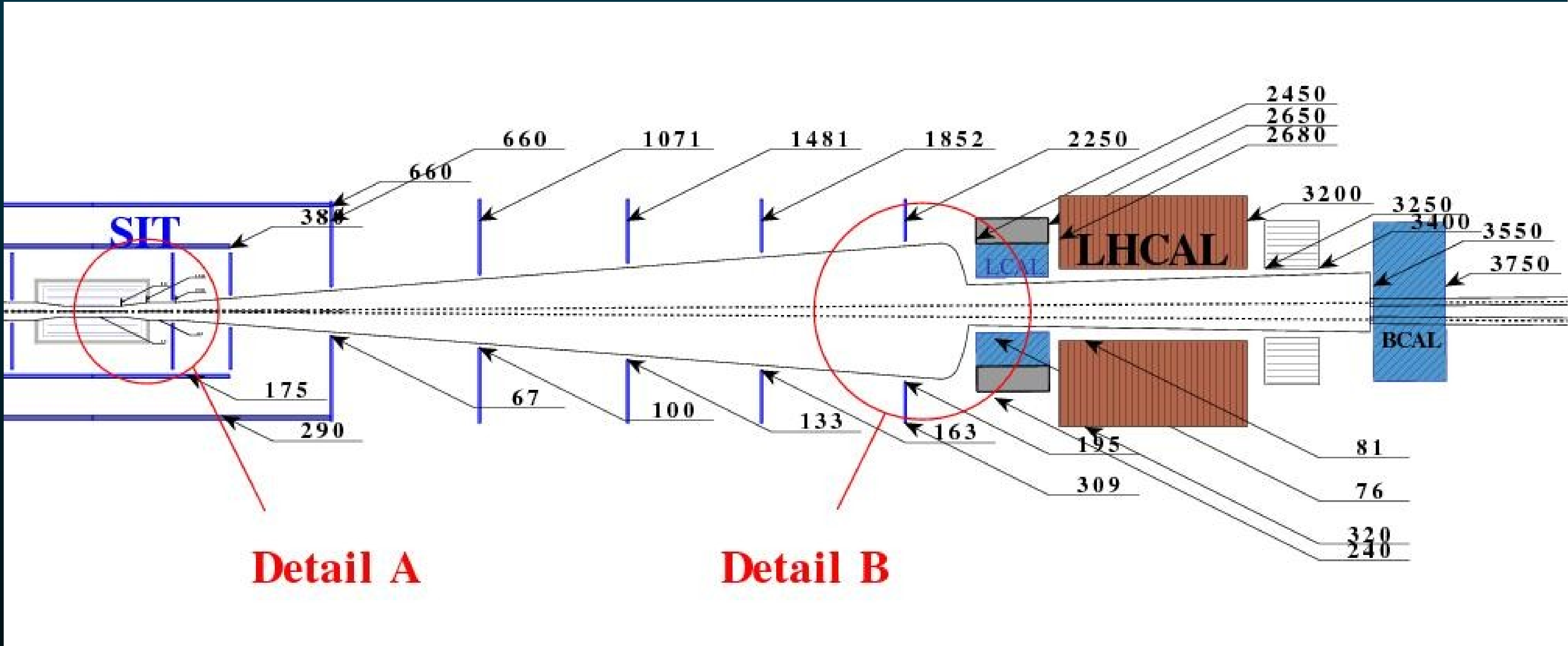
About beam tube

The design of the beam tube obeys few constraints:

- It interferes minimally with the luminosity measurement.
- Its central part is "good" enough to optimise the measurement of the impact parameter and large enough not to interfere with the background.
- It complies with a crossing angle of 7 mrad.
- It is as light as possible to reduce photon conversion and hadron interactions, withstanding nevertheless the atmospheric pressure.
- It has to be held in place and aligned within less than 1mm.
- It has not to induce electromagnetic perturbations generating heat.
- It has to be pumped down to an agreed upon level.

The beam tube in its environment

This is, but for the cupola, the MOKKA design



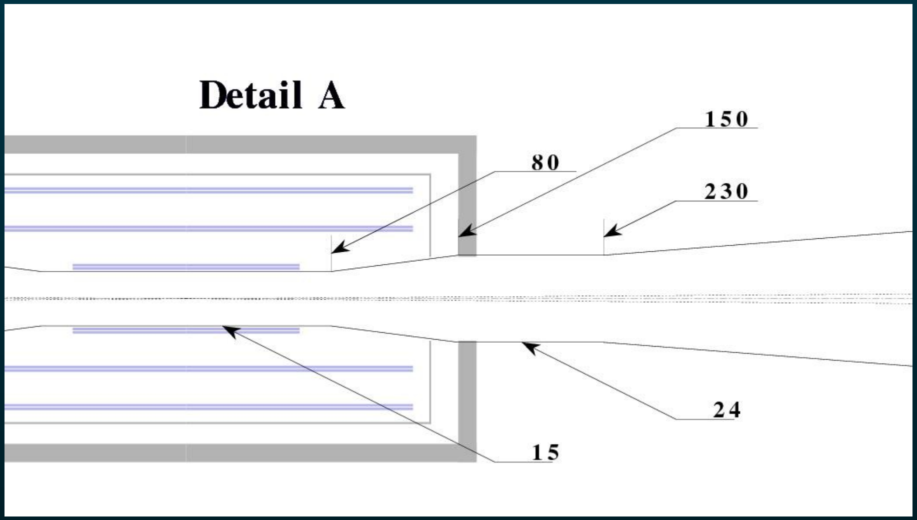
The cone under the luminosity calorimeter is centred on the outgoing beam, it starts at (2430, 17) and has for radius 56. It is in stainless steel in MOKKA could be better in Al?

None of the cones is projective.
The overall structure is not symmetric in φ.

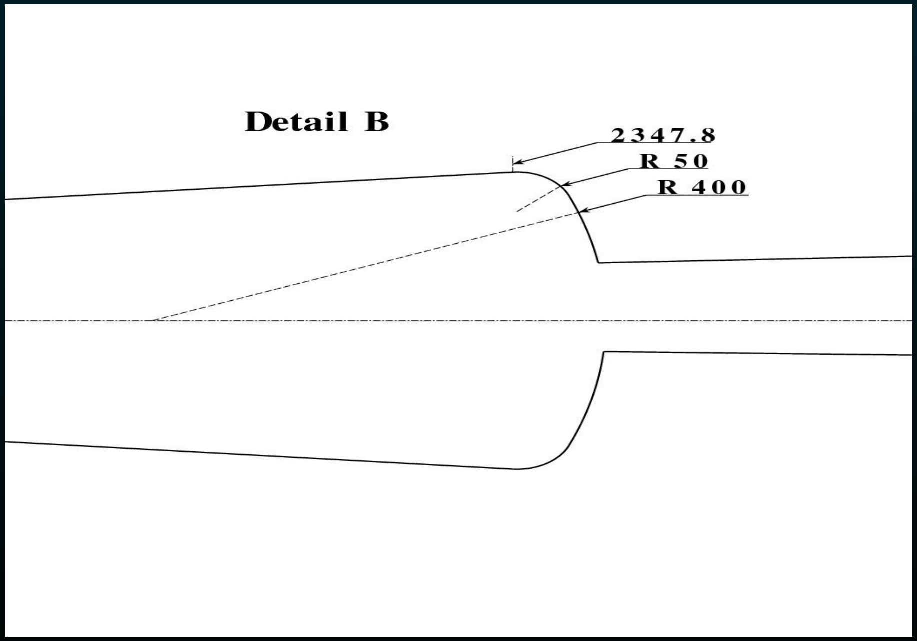
There is a flange at the level of LHCAL

The beam tube in its environment

Central cylinder: R= 15 L= 80
First cone : R= 24 L= 150
Second cylindre: R= 24 L = 230
Large cone: R= 188.55 L = 2348.5
Spherical cupola Centre= (2030, 0) R=400
Fillet R= 50



Details



The beam tube in its environment

Integration of the beam tube

The beam tube under consideration is light, it is not a support structure.

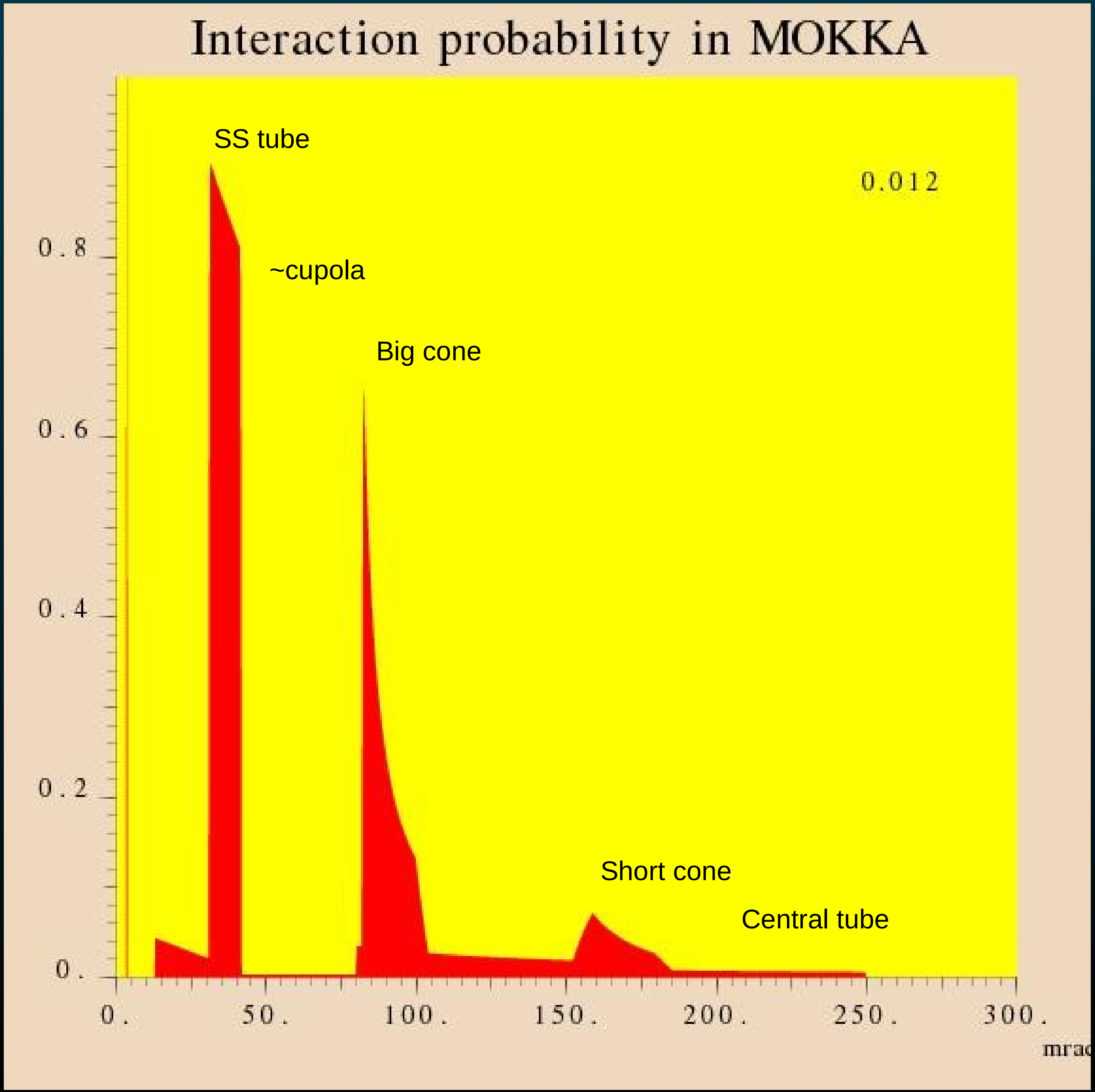
We have considered that the tube itself would be supported
by the same common and rigid frame structure which embeds
the vertex detector,
the SIT,
the forward disks.

This structure (a carbon cylindrical lace)
could hang from the TPC flanges
and be rigid enough
and tunable

The tube would end with bellows to connect smoothly

The services for the inner detectors run around the pipe

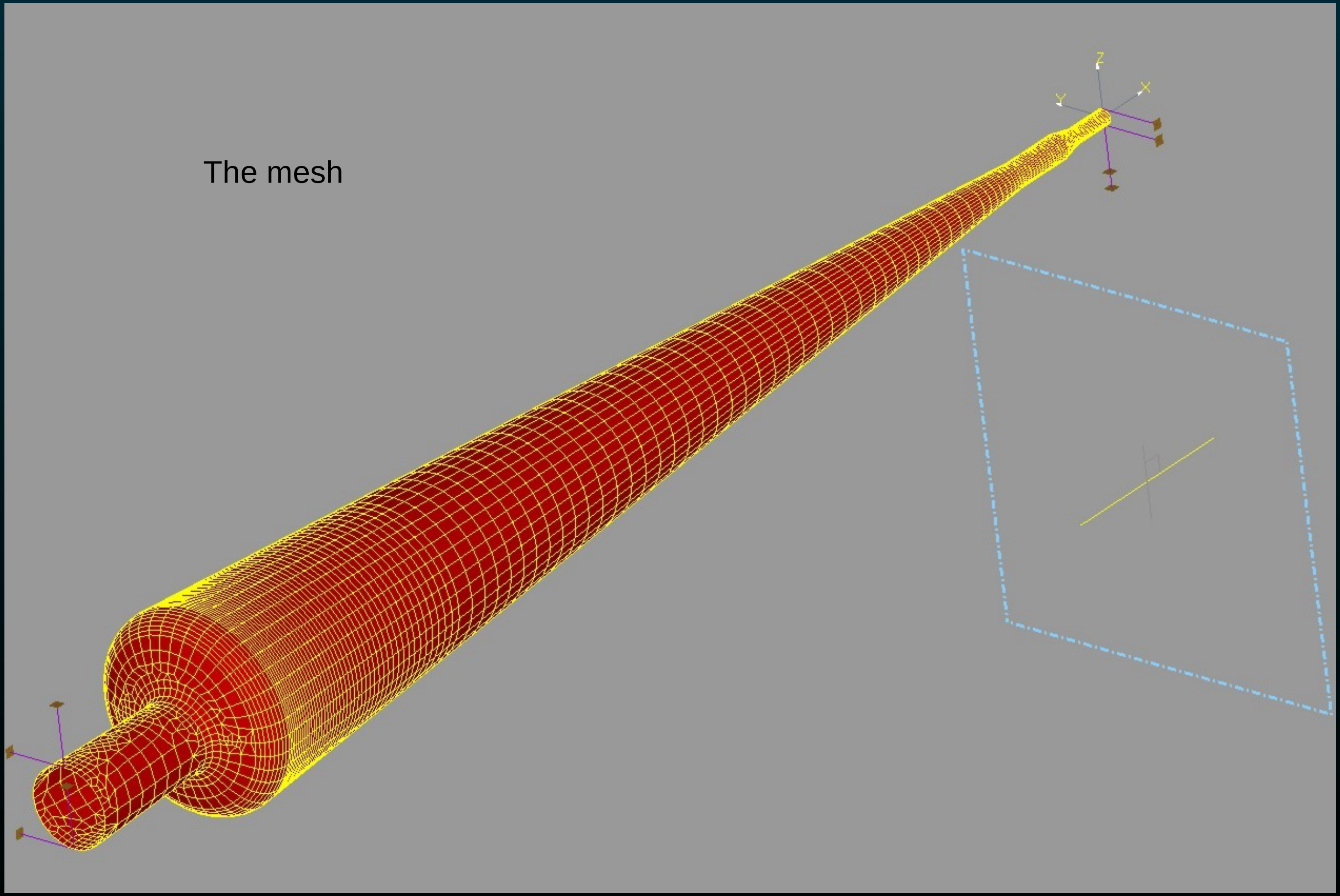
The impact on physics



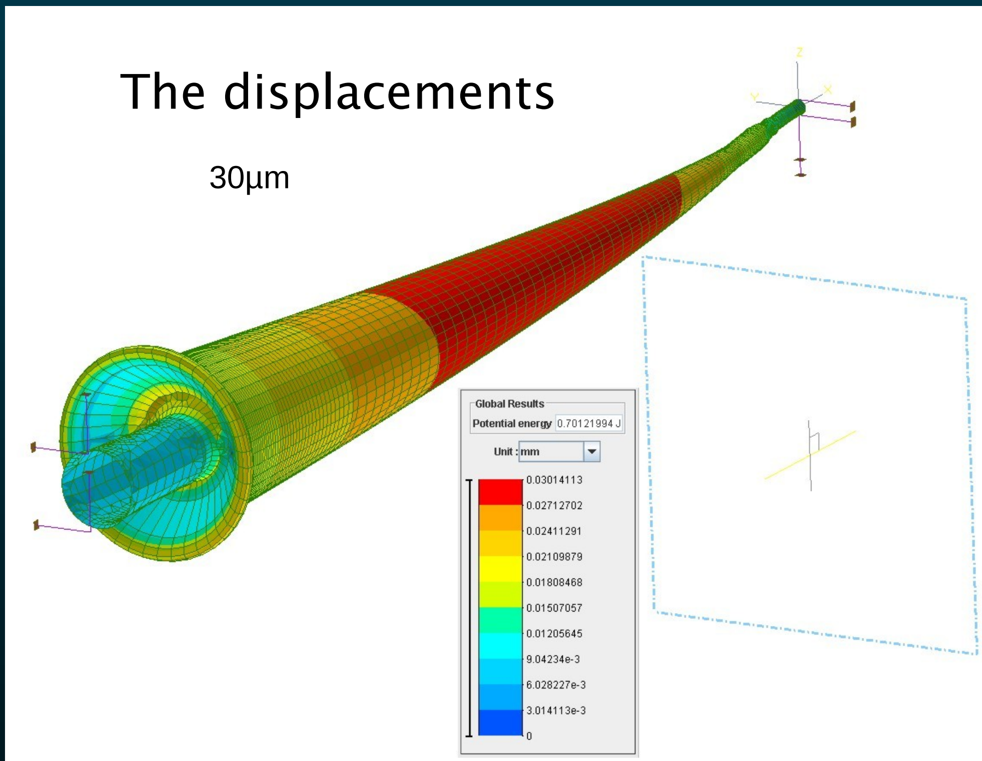
By Paulo Mora de Freitas

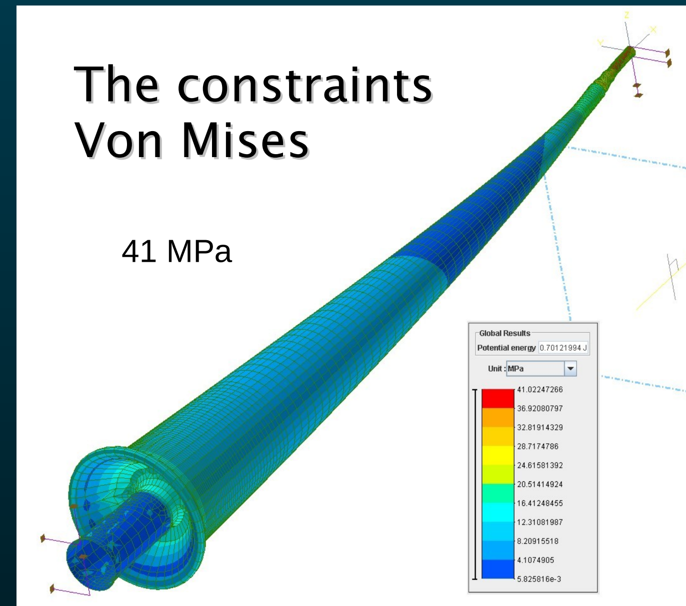
Mechanical studies

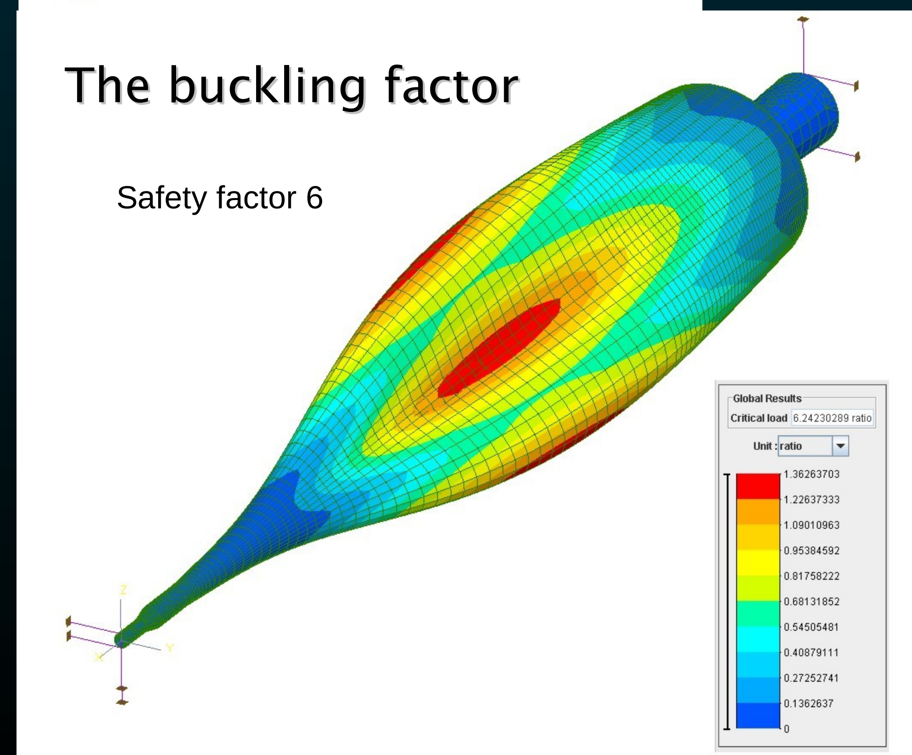
The first model, à la MOKKA.
0.5mm central tube
0.75 small cone and second cylinder
2mm large cone and cupola
weight : 2x6 Kg



Mechanical studies







Should work!

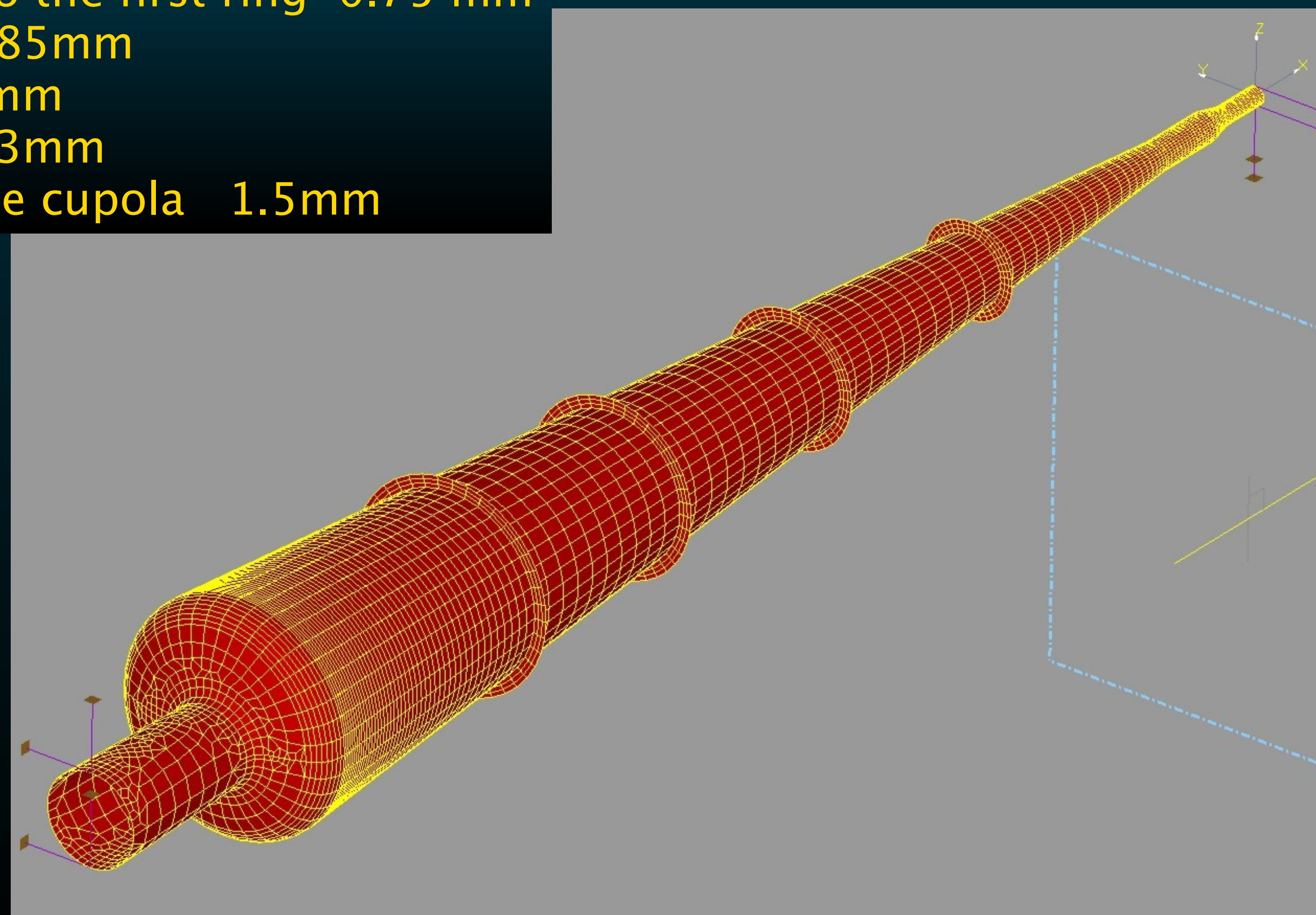
Mechanical studies

The second model: adding ring reinforcements (1mmx10mm) at the place of the disks 3, 4, 5, 6

Inner cylinder 0.5 mm
first cone and region up to the first ring 0.75 mm
between rings 1 and 2 0.85mm
between rings 2 and 3 1mm
between rings 3 and 4 1.3mm
between the ring 4 and the cupola 1.5mm

Weight : 2x4Kg

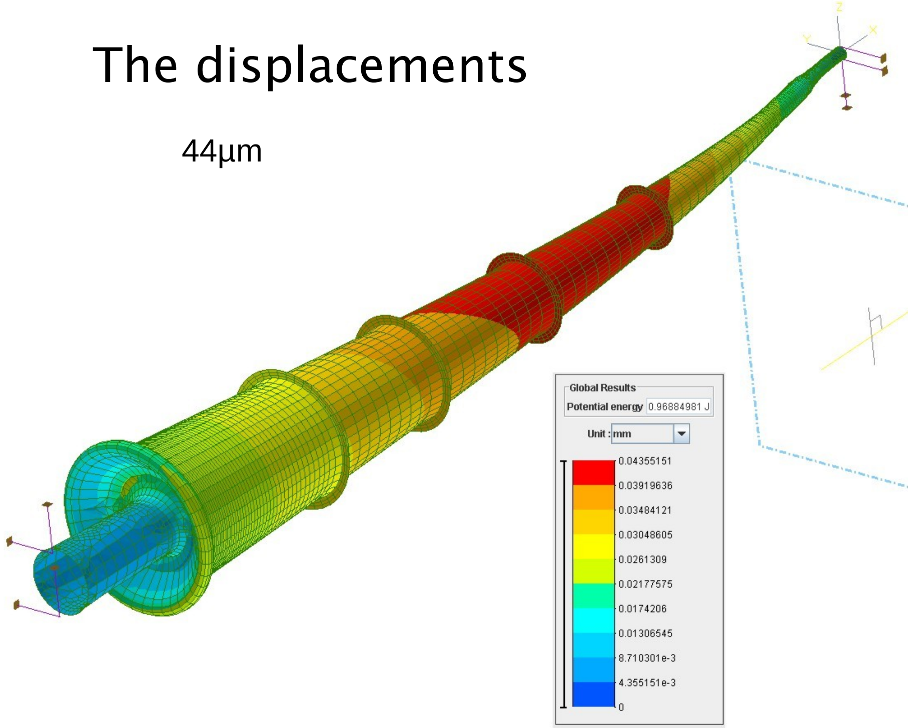
The interaction probability is reduced by a factor 1.5



Mechanical studies

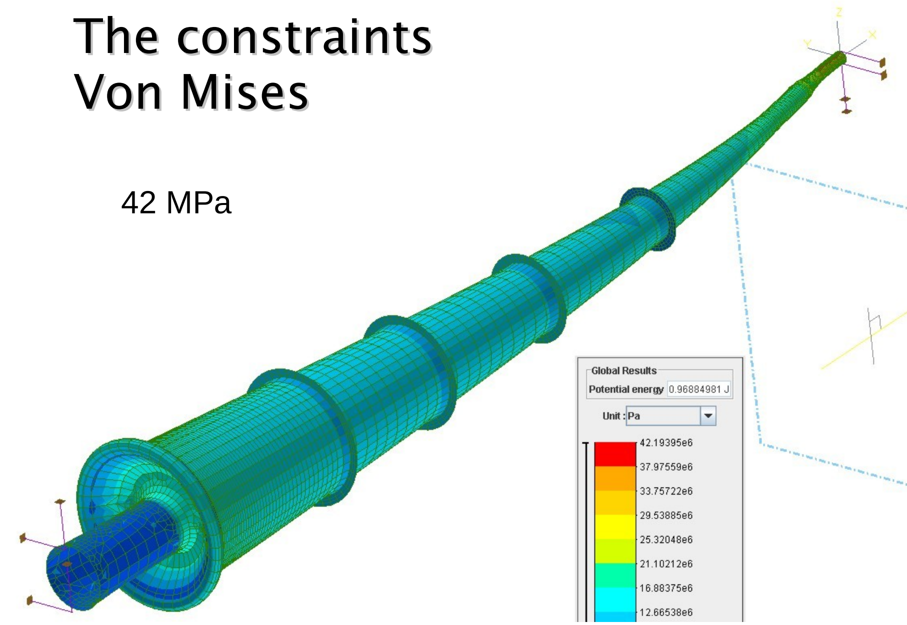
The displacements

44µm



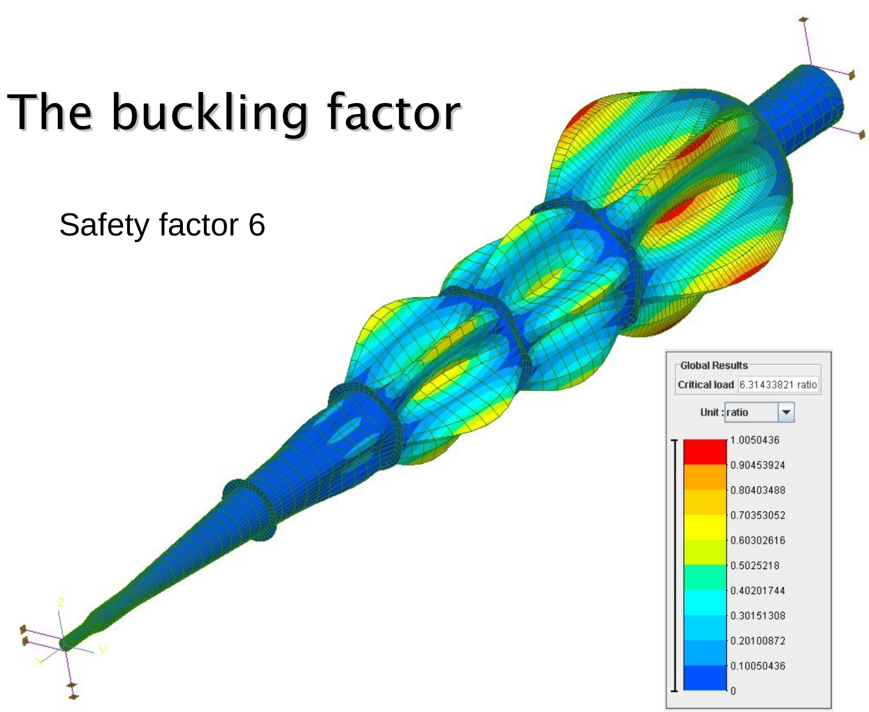
The constraints Von Mises

42 MPa



The buckling factor

Safety factor 6



The limit comes from the buckling, we fixed its safety factor at 6.

And ultimately

The price

By looking at the Be beam tube built for LHCb
(Gloria Corti private communication)
the price as of today could be in the range 1-1.5 M€.

Conclusion

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To go beyond this first approach, with Beryllium
would need to work with manufacturers
because the technology becomes very important.

The example of LHCb tube shows that such a tube
results from a strong R&D by the manufacturer
on the way to realise cones and to perform the weldings.

Therefore at the level of the LoI
we could simply show this design keeping in MOKKA the actual,
much more conservative design.

Other solutions are under consideration.

What about a skin, a sail between rings?
A problem of longitudinal forces.
A delicate solution to model.

What about a carbon fibre structure with an aluminium coating?