About an ancient study on beam-tube
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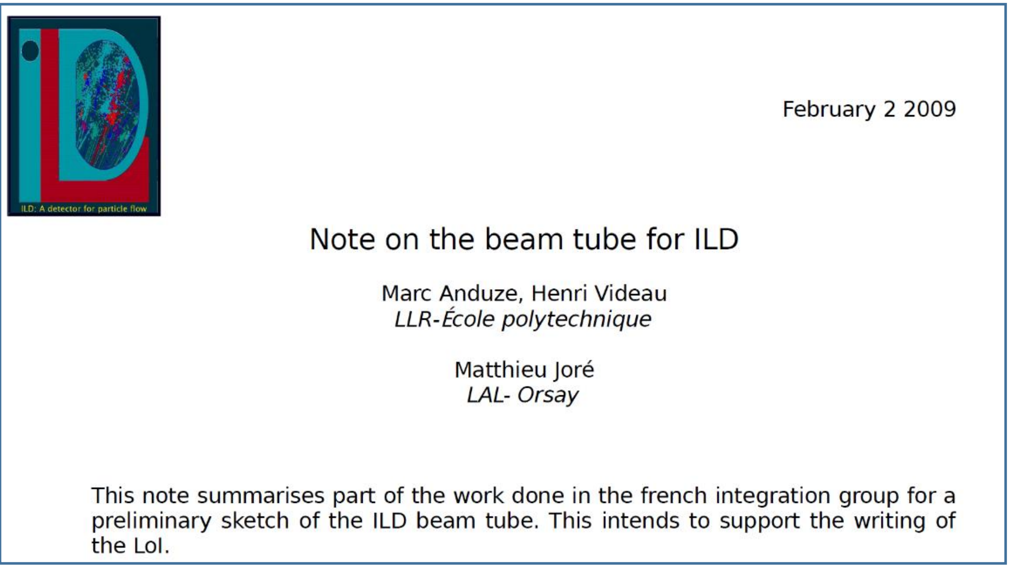

February 2 2009

Note on the beam tube for ILD

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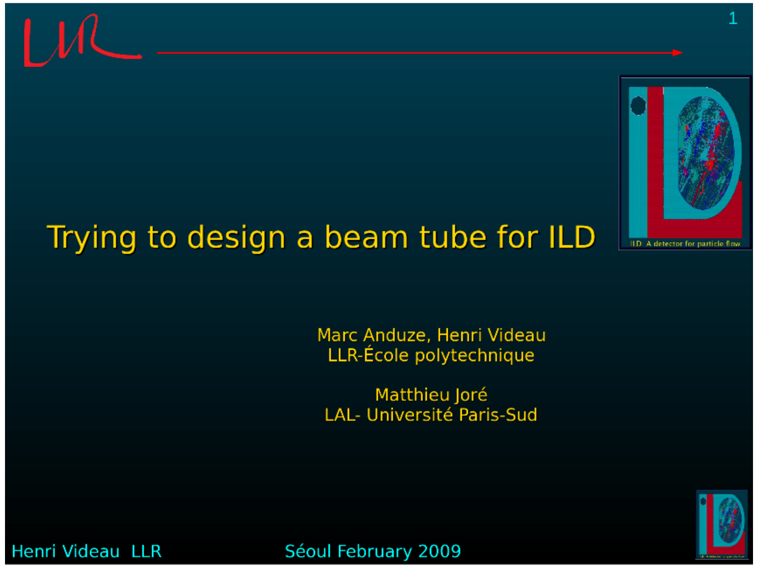
This note summarises part of the work done in the french integration group for a preliminary sketch of the ILD beam tube. This intends to support the writing of the LoI.

This was for the LoI
to have a probably viable scheme
and a first view on a cost



The design of the beam tube obeys few constraints:

1. It interferes minimally with the luminosity measurement.
2. Its central part is “good” enough to optimise the measurement of the impact parameter and large enough not to interfere with the background.
3. It complies with a beam angle of 7 mrad. That will induce breaking the φ symmetry of the tube
4. It is as light as possible to reduce photon conversion and hadron interactions, withstanding nevertheless the atmospheric pressure.
5. It has to be held in place and aligned within less than 1mm.
6. It has not to induce electromagnetic perturbations generating heat. Looked at in another reference
7. It has to be pumped down to an agreed upon level. Looked at in another reference

Constraint 1: Luminosiy

the tube is made conical in such a way that no electron used for luminosity (θ < 75 mrad) crosses the tube.
the cone is closed in front of the luminosity calorimeter by a thin cupola.

Constraint 2: Impact parameter

The first layer of the vertex detector has to be as close as possible to the interaction point, but it has not to be spoiled totally by the background.
The background spreads from the axis with z approximately like a square root, this provides a minimum radius and maximum length of the central cylinder.

Constraint 3: Crossing angle

The axis of the detector is along the bisector of the incoming and outgoing beams. The cone is centred on this axis being large enough to accommodate the crossing angle.
The luminosity calorimeter, the beam calorimeter and the LHCAL are centred on the outgoing beam.
Therefore from the cupola to the front of the beam calorimeter the tube is centred around the outgoing beam.
This means that the downstream part of the tube makes a 7 mrad angle with the cone, breaking the ϕ symmetry.

Constraint 4: Transparency

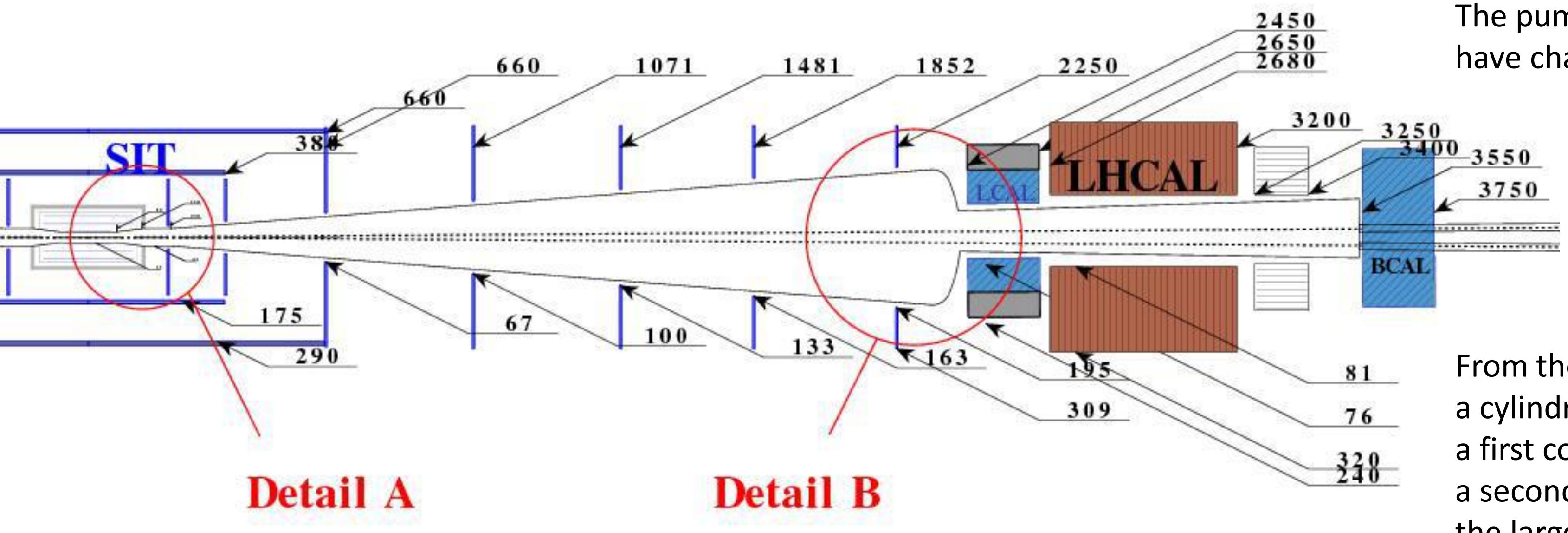
This constraint applies differently in the different sections of the tube. It is specially strong in the central part.

The main trouble does not come from photon conversion but from multiple scattering and hadron interaction.

Beryllium optimises radiation length and interaction length and is a mechanically sound material but suffers from the toxic character of the beryllium oxide
a design for the beam pipe can not be considered without working with manufacturers.
The amount of material has to be reduced to a minimum and most of the mechanical study will just try to minimise the mass keeping the stability.

A specific discussion has to consider the opportunity to have cones pointing to the interaction or not.

From the point of view of the production of background by conversions or interactions this is a second order effect.
It is better to have 3 X0 in an angle α than 1 X0 in 3α? Do we prefer to concentrate the difficulties or to spread them.
At the end the solution may be dictated by the beamstrahlung background and its constraints on the shape.



This is, but for the cupola, the MOKKA design
The pump has disappeared now and the dimensions have changed somewhat due to the L* change.

From the centre
a cylindrical part with a small radius,
a first cone opens the tube to avoid the pair background,
a second cylinder joins to the large cone,
the large cone points slightly beyond the interaction point not to be projective,
a thin cupola closes the tube in front of the luminosity monitor,
a conical tube passes through the monitor centred on the outgoing beam,
a flange connects to the rest of the beam tube.

The cone through the luminosity calorimeter is centred on the outgoing beam
None of the cones is projective.
The overall structure is not symmetric in ϕ.

The beam tube under consideration is light, **it is not a support structure**, except maybe for the inner vertex detector .

We have considered that the tube itself would be supported
by the same common and rigid frame structure (ISS) 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 tuneable

The tube would end with bellows to connect smoothly

Beware The services for the inner detectors (may) run around the pipe!

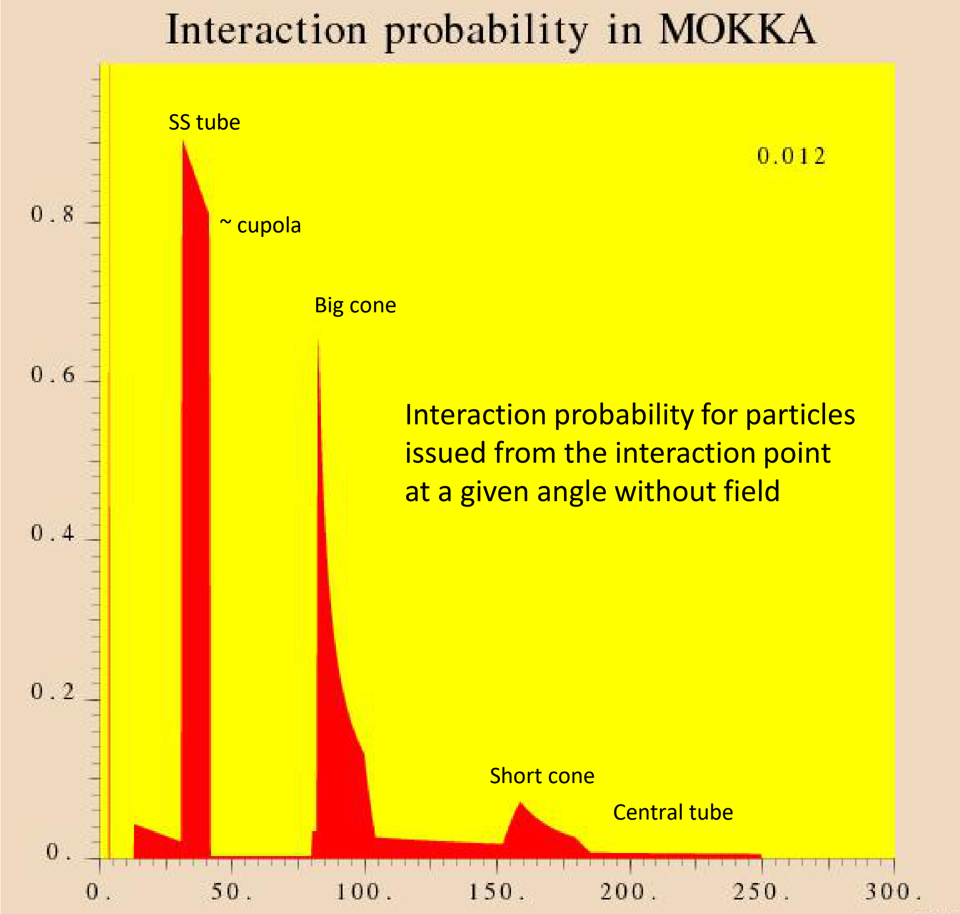
Like for the rest of the inner components,
the interaction length has to be minimised
rather than the radiation length:
A converted photon can be well recovered, not a hadron interaction!

Minimise the weight, not the Z.

Carbon fibre may not be always the solution.

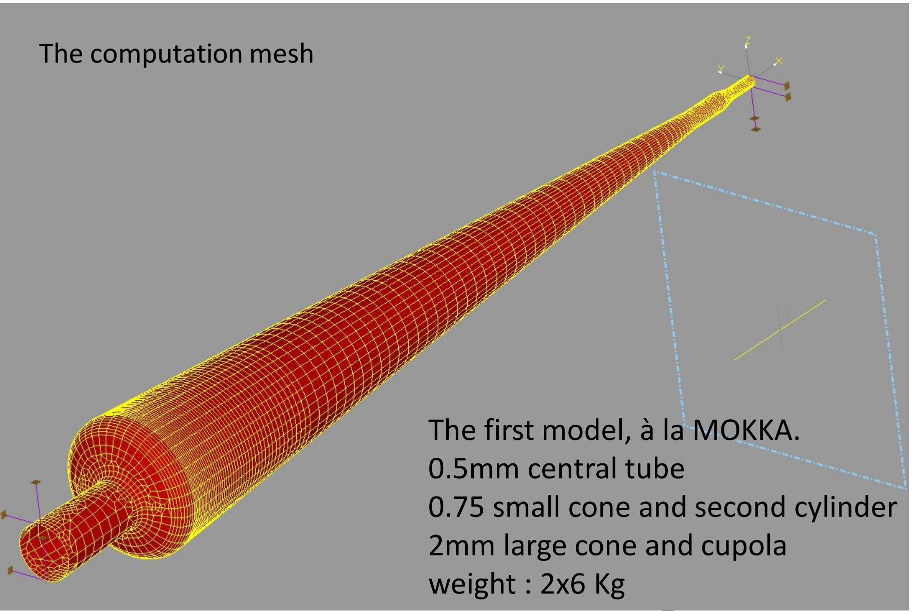
The interaction probability of particles forced to cross the cone due to the field is not considered in the adjacent plot.

Only the cupola is in front of the Lcal
It could be better to be more projective



By Paulo Mora de Freitas

First model à la Mokka in Be

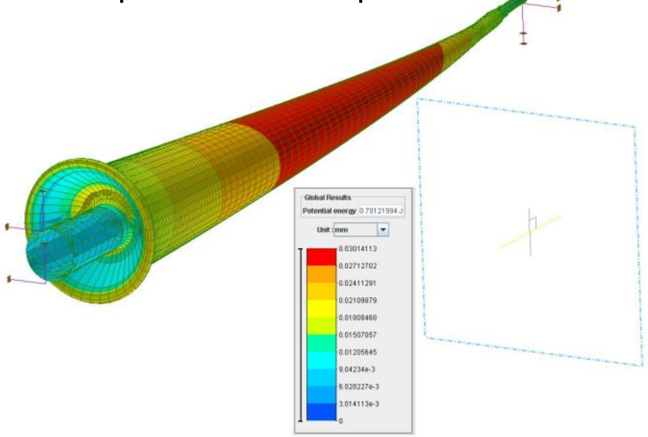


Conditions of the simulation

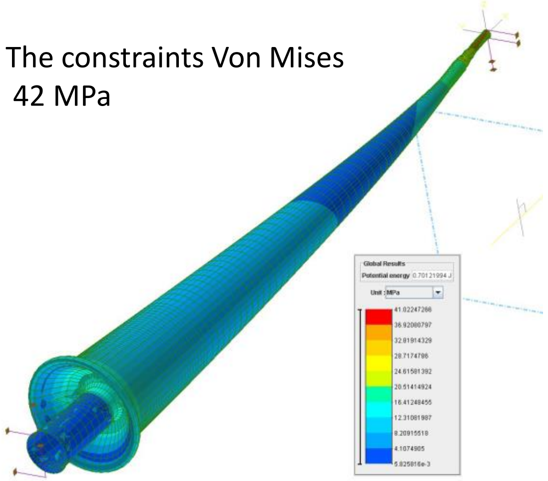
- the weight of the tube has not been taken into account,
- the beryllium mass is 6.01 kg for half of the tube,
- half of the tube has been simulated making use of the z symmetry.
- The tube is clamped in position in z at the interaction point level.
- At the level of the terminal flange the tube can slide in z but not in x-y.

The displacement is due to the φ symmetry being broken

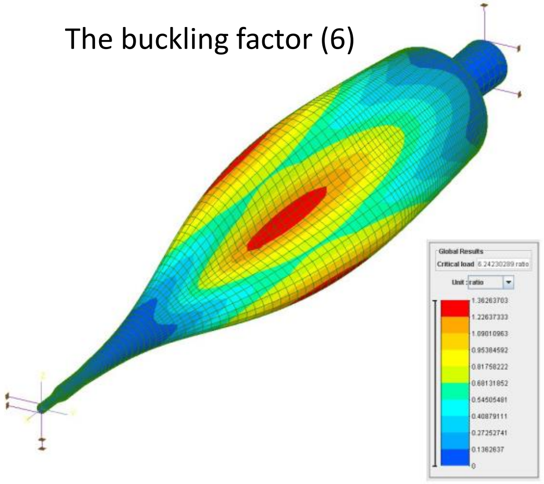
Displacements 30 µ



The constraints Von Mises
42 MPa



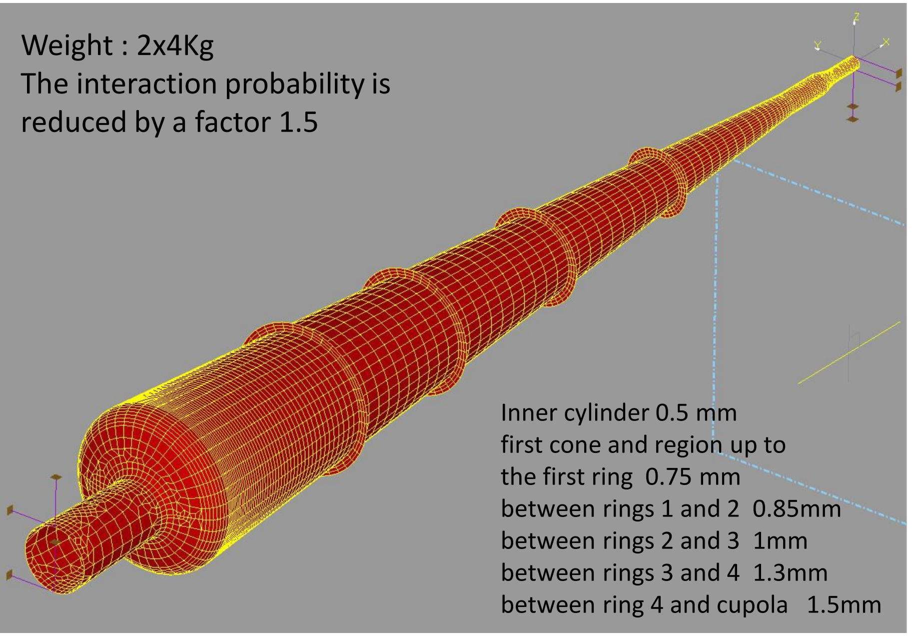
The buckling factor (6)



OK

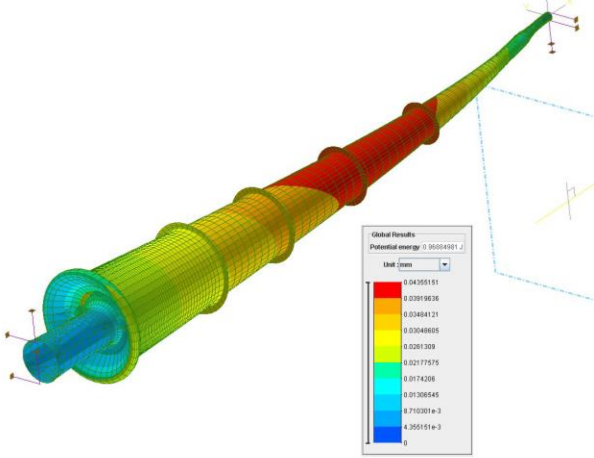
Second model

Adding ring reinforcements at the disks 3, 4, 5, 6
They may be used to held the tube.
1mm thick, 10mm wide welded to the cone.



The displacement is due to the φ symmetry being broken

Displacements 44 µ



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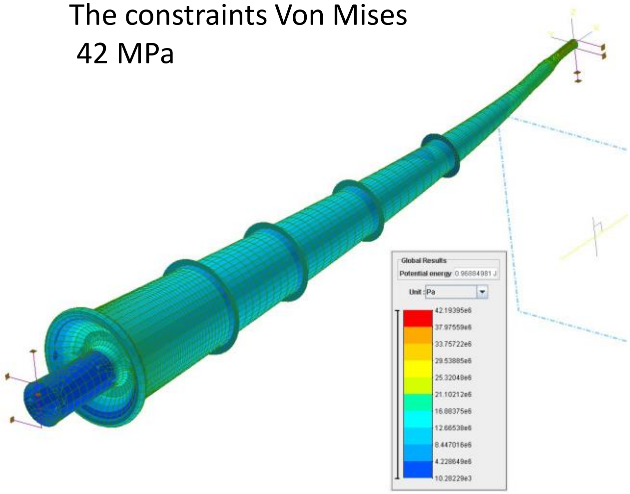
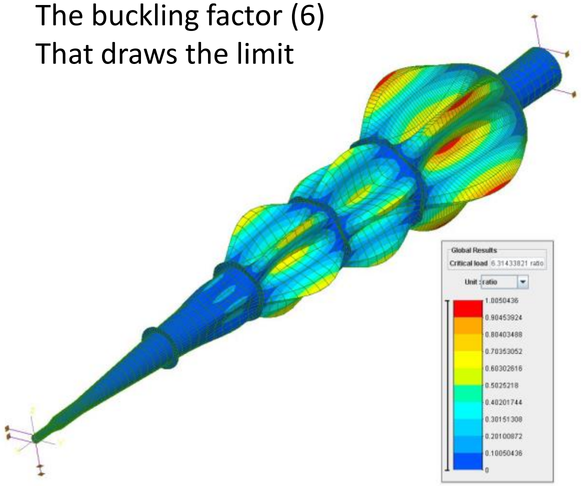
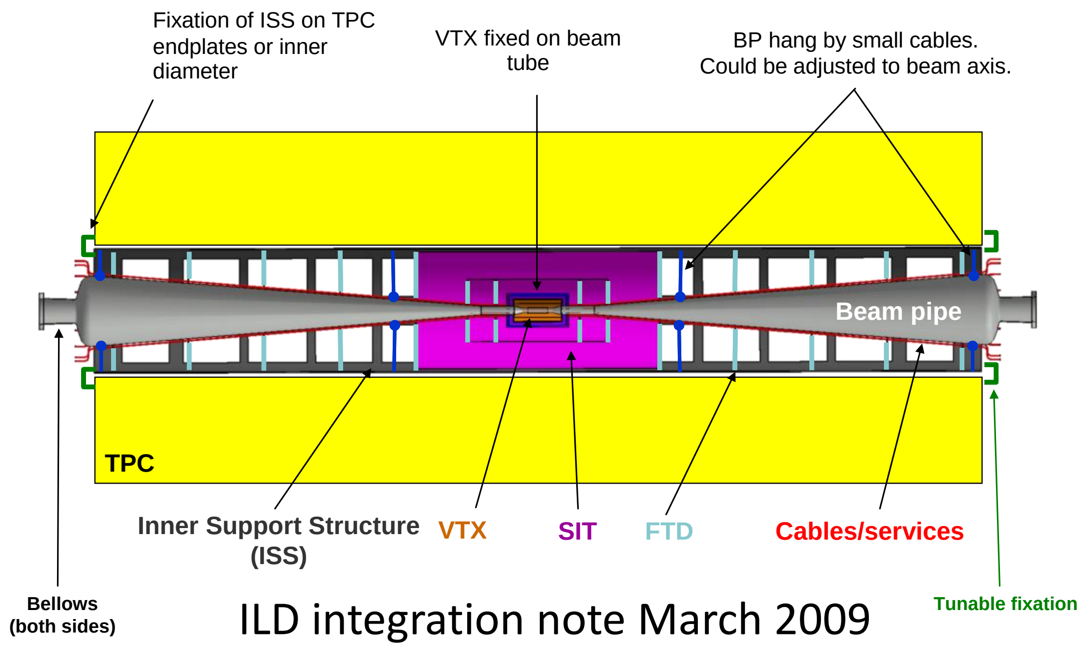


The buckling factor (6)
That draws the limit





ILD integration note March 2009

ISS structure

But beam tube is not an autonomous question
It has to be integrated into the ISS
And what is important is the overall transparency
- Support
- Cables and services running or not along the pipe
Beryllium may well be needed only in the central part and not in the big cone.

Before to redesign the beam tube,
advance well the design of
the vertex detector, the forward disks, the SIT
and their services , the ISS.

The end