SuperB endcap
em calorimeter

Mechanical structure
for Beam test

Mechanical structure for Beam test

WHAT:

- a carbon fibre or glass fibre structure
- holding a 5x5 array of projective LYSO crystals
- surrounded by a crude layer of larger non-projective CsI(Tl) crystals
- in time for a test in November

FOR WHAT:

- crystals performance
- readout system
- effect of material between crystals
- etc.

Mechanical design benefit for Beam test

Q: what would be learnt from the beam test for the mechanical design?

R: tests in which an alveolar filled with crystals-equivalents in order to measure mechanical performance do not require a beam, BUT:

Mechanical spin off

- producing a sub-structure for the BT is teaching for mechanics:
- 1) getting physicists and engineers together
- 2) addressing all possible issues and their evolution for the design
- 3) making a first approach to producers

Structural design start

The structural design can start with parameters adapted from previous similar structures (L3, Babar, CMS)

Design progress will integrate result from BT structure production itself, and from tests to be defined specifically for structural information.

The 5x5 array for BT would be composed of five different sizes of crystals

Discussion of three options

Perugia 2008 05 08 1st new version

rings 6 to 10

back < 26,3mm

front < 23mm

Option 1

The structure is built to fit a 5x5 array with crystal sizes for rings 6-10

- considers the geometry as frozen
- makes the tooling more complex and the deadline tighter
- decisive argument: best for physics

Option 2

The structure is built as per Option 1 but filled with a single size of crystals (no exact match to the compartments)

- tooling as in option 1
- assumes that crystals are of the smaller size and make looser and looser match with following rings

…/…

Option 2 (cont'd)

- mismatch up to 2,5mm (front) and 3mm (back) !!!
- crystal processing to 5 different sizes should not be expensive at all
- We are better back to option 1

Option 3

The structure is built to closely fit 25 projective crystals all of the same size *(is it physically possible?)*

- This is only possible with square bases
- A = B = C   D = E = F
- the extra crack between central xals to match those on the border is negligible at the front, and not more that 10 microns at the xal rear
- this approximation is used in the CMS endcap geometry

.../...

Option 3 (cont'd)

- We may not save on crystal processing
- Tooling for alveolar is simpler but we learn less
- **And** this is not the right model for our endcap geometry
- We are better back to option 1 (again)

Discussion:
a mech. test model

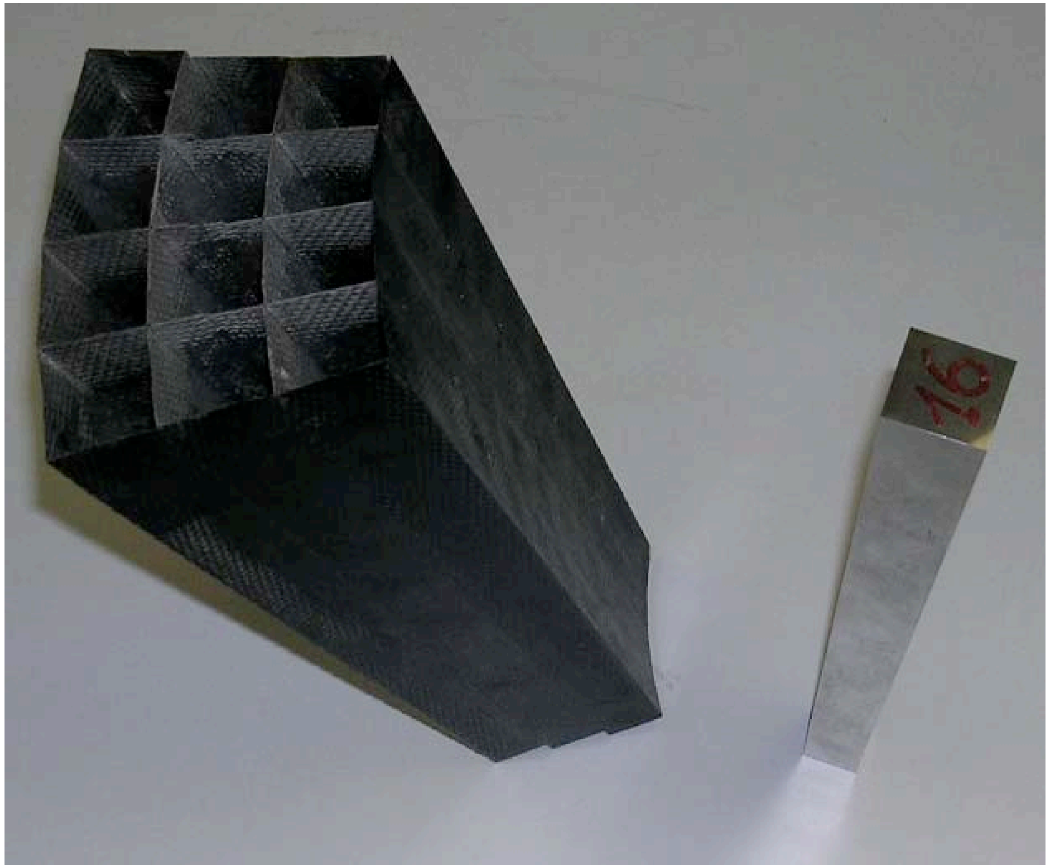
A first approach to the problem is a bending test of the BT alveolar array (5x5) with appropriate boundary.

By changing the boundary conditions, interesting inputs can be made to refine the structure design.

Mech. test model (cont'd)

- proto cost mainly breaks down into wrapping manpower, mould, mandrel, wall material, curing and finish machining.
- A possibly cheaper second alveolar (same tooling) might help running mech. tests in // with BT.

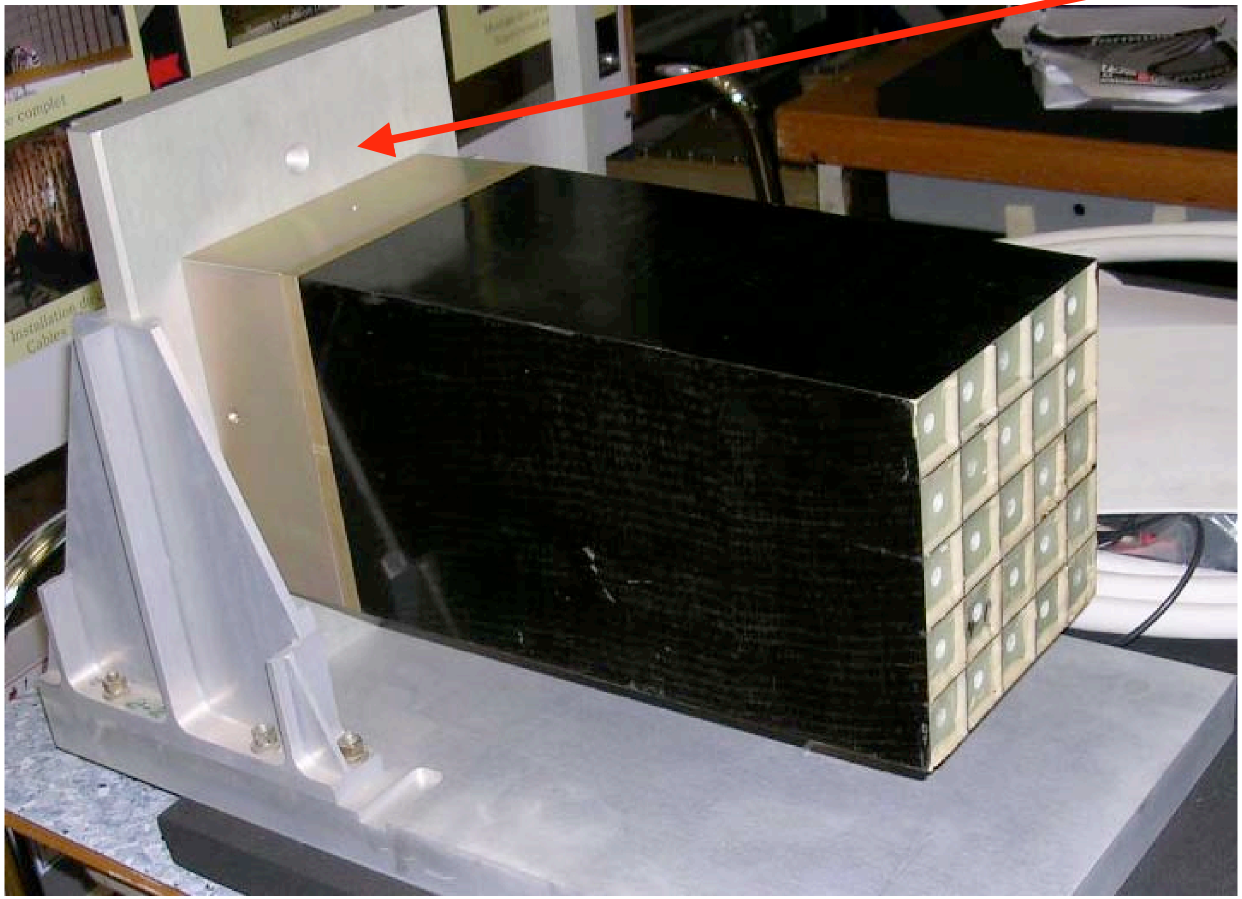
L3 ECAL endcap alveolar



CFRP alveolar
of 12 cells and
inspection mandrel

CMS endcap “supercrystal”

back plate



5x5
cantilevered
CFRP alveolar

CMS endcap “supercrystal”

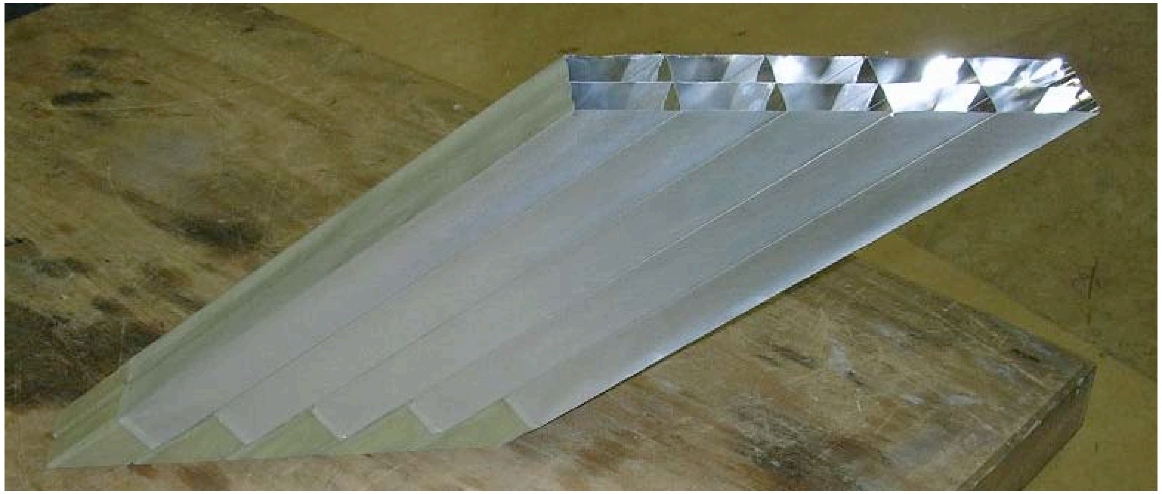
For the record

- Spare 5x5 alveolars are available
- CFRP wall thickness 0,4mm nominal
- Xal size A=B=C=30 taper 0,36° L=220

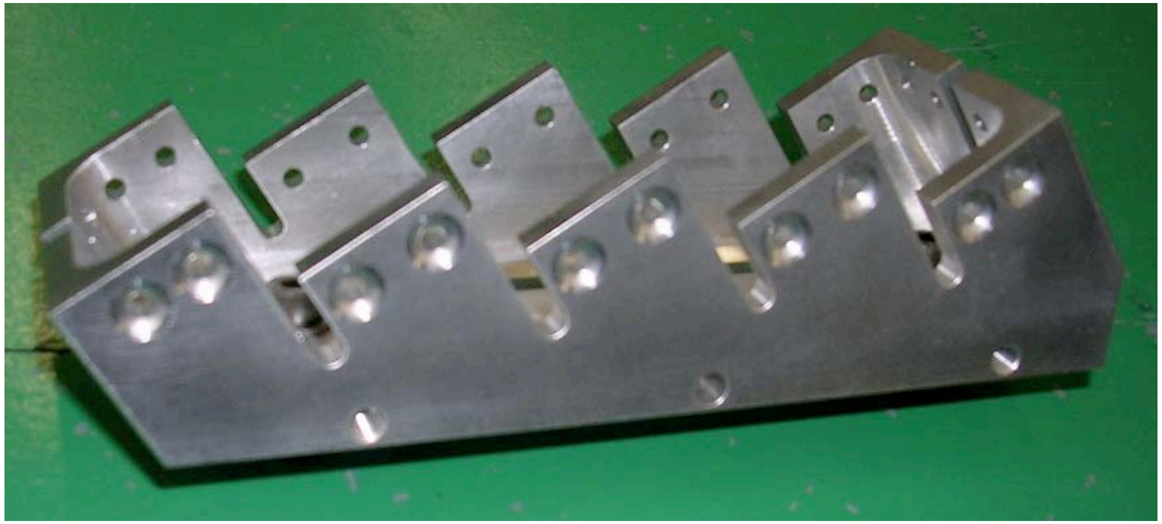
CMS barrel sub-module details

Sub-modules and empty tablets presented on a grid to illustrates the rear fixation (partial cantilever)

CMS barrel sub-module details



Thin-walled Glass FRP alveolar



Rear closure & fixation by complex machined part riveted to alveolar

CMS barrel sub-modules

For the record

- Spare 2x5 alveolars with quasi-normal incidence are available
- GFRP wall thickness 0,2mm nominal
- Xal size A=21,86 B=23,59 C=21,84
- taper 1° L=230

BT Alveolar Production

Composition

- 2 or more pre-preg layers
- Inner lining of reflector

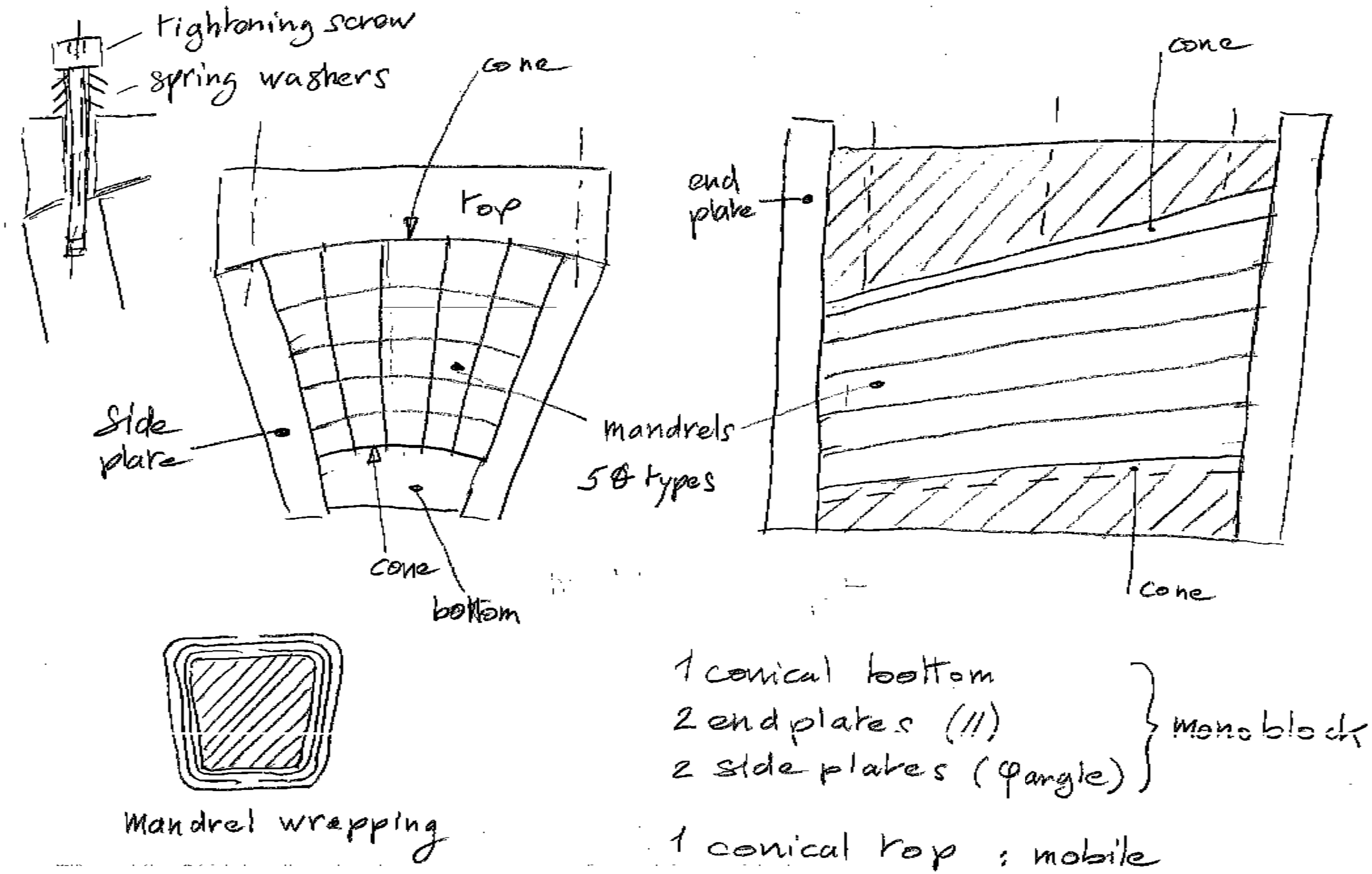
Assembly

- Wrapping (by hand) on mandrel
- layers do not overlap (gap)
- Gaps are covered by next layer
- Constant thickness all around

Process

- Wrapped mandrels piled into a mould with alveolar outer shape
- Press and cure
- Pull when cold
- Machine-finish ends

Alveolar wrapping & moulding



1 conical bottom
2 endplates (//)
2 side plates (φ angle)
} Monoblock

1 conical top : mobile
25 mandrels

MOULD CONCEPT
2009 05 27 ML

Baseline for BT structure

a) 5 crystals of rings 6, 7, 8, 9 and 10

option with back < 26,3mm

crack between nominal 0,4mm

b) crystal tolerances +0 -0,1mm

c) alveolar tolerance -0 + 0,1mm

d) minimum play 0,1mm (between xal max. and alveolar min.) to contain estim. max. deformation

e) resulting aveolar wall thickness 0,3mm

may change with producer's inputs

A possible line of action

1- CAD drawing of the BT structure

(INFN?)

in **June**

2- meeting with a potential producer

(Italy?)

1st week of **July**

I could participate

3- to adapt BT struct. design and launch production would need a few weeks

---> go through **Summer vacations**

possible delivery (reception-inspection at producer’s) in **October**

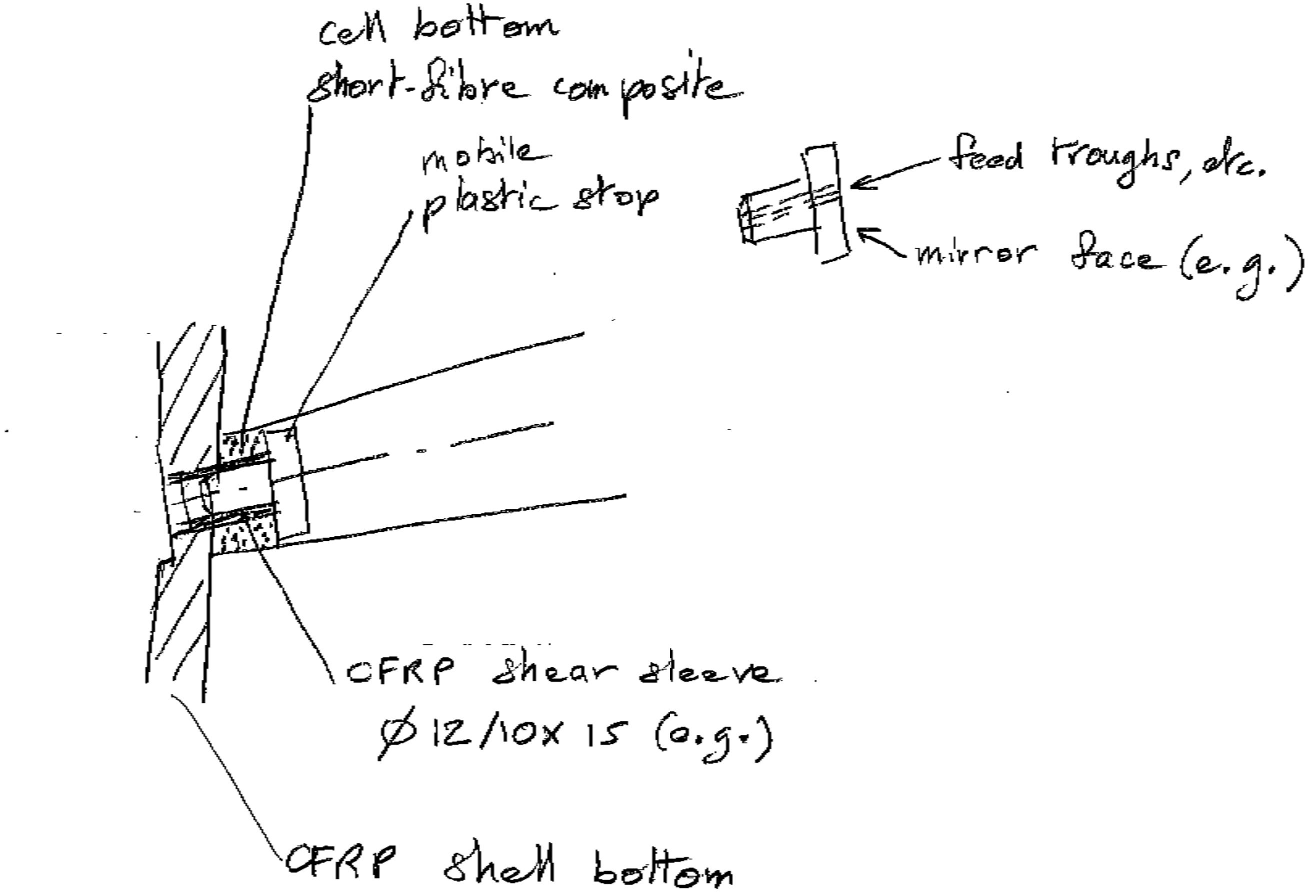
Question 1: structural details

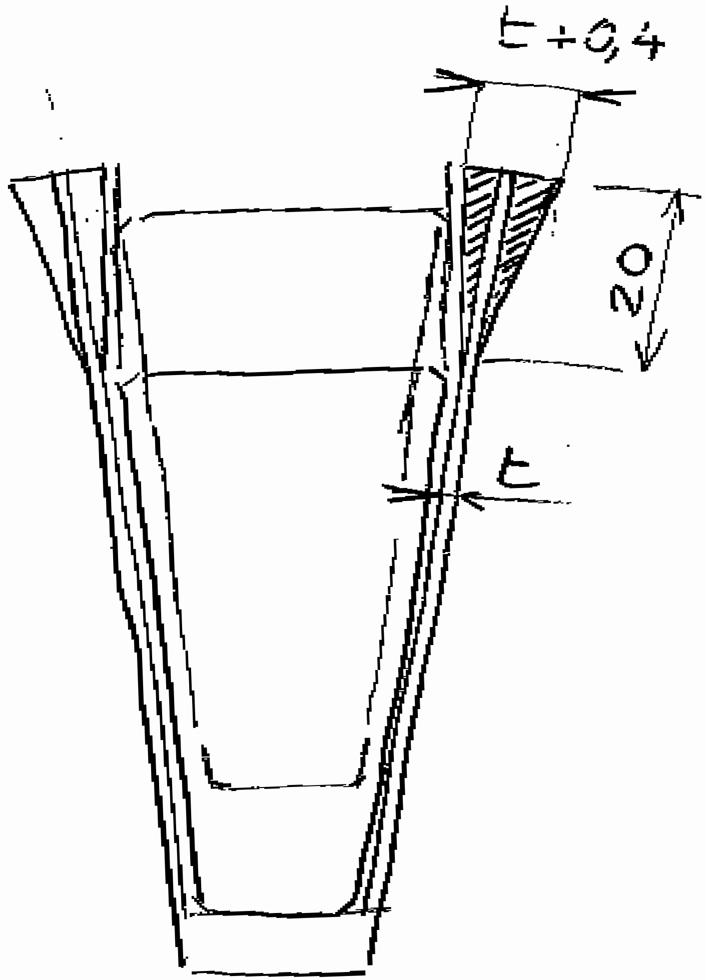
Even simple, the BT alveolar must integrate some features of the final detector

1. Open alveolar bottom for services (monitoring fibre, themal sensor, etc.)
2. Rear part of walls featured for mechanical connections

following sketches are examples (possible solutions) proposed for discussion in next meetings

cell front part detail





thickening of wall rear part

Thickening of wall rear part

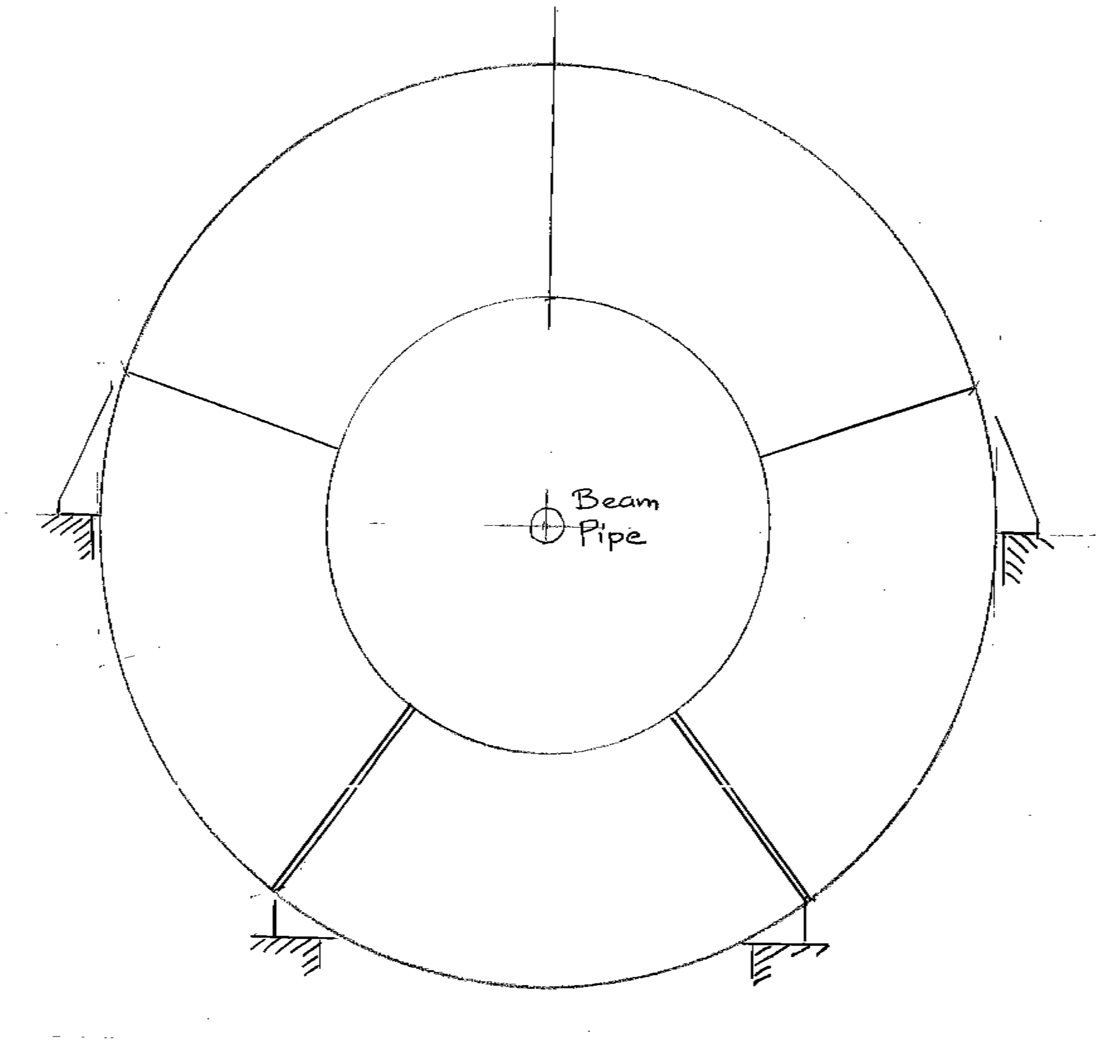
Question 2: symmetry

- The two new geometries in Perugia document 2008 05 08 have only one ϕ symmetry of 5, which is used for the modular cell array (ϕxθ = 5x5 and 5x3)
- After division by 5, the ϕ numbers (i.e. how many modules in one ring) have no common multiples
  – case 1: 35 - **41** - 45 - 53 **41 chosen for BT**
  – case 2: 33 - 36 - 40 - 45 - 53 - 50 - 54
- This poses a problem concerning the modularity of the full endcap

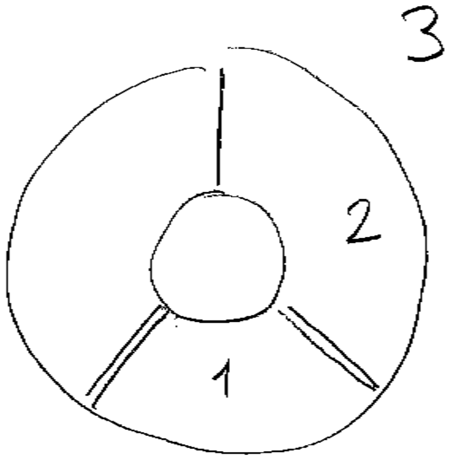
Question 2 cont'd: how shall we split the endcap?

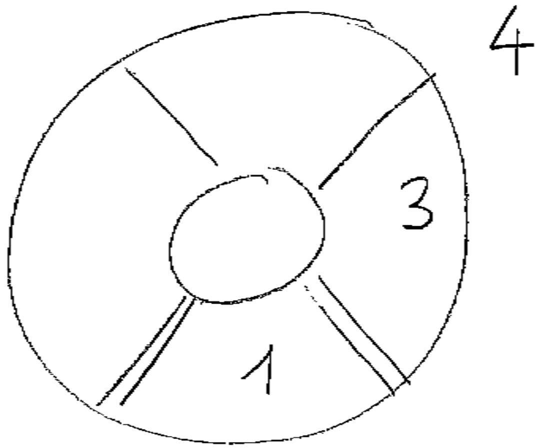
- Horse collar (Babar) concept assumes
  n_1 = 1 (or 2) super-module below and
  $n_2 >> n_1$ modules above
- Classical (L3, CMS) vertical split assumes a ϕ symmetry of 2
- horizontal split = ϕ symmetry of 2 too
- In all these cases the split is by radial planes useful for structural rigidity

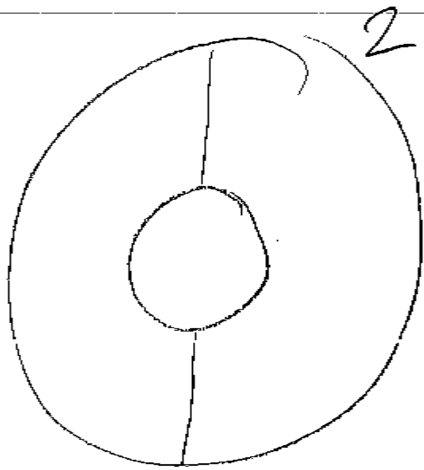
Horse collar and wedge

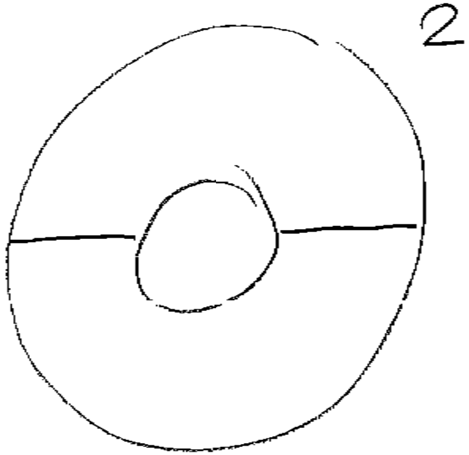


ϕ symmetry of 5









etc.

Question 2 cont'd: endcap split

- Prime ϕ numbers (absolute or relative) result in unrealistic jagged splits

unless…

- The endcap is a solid ring

 a thorny situation wrt beam pipe