SuperB

EMC

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Nov. 27, 2009

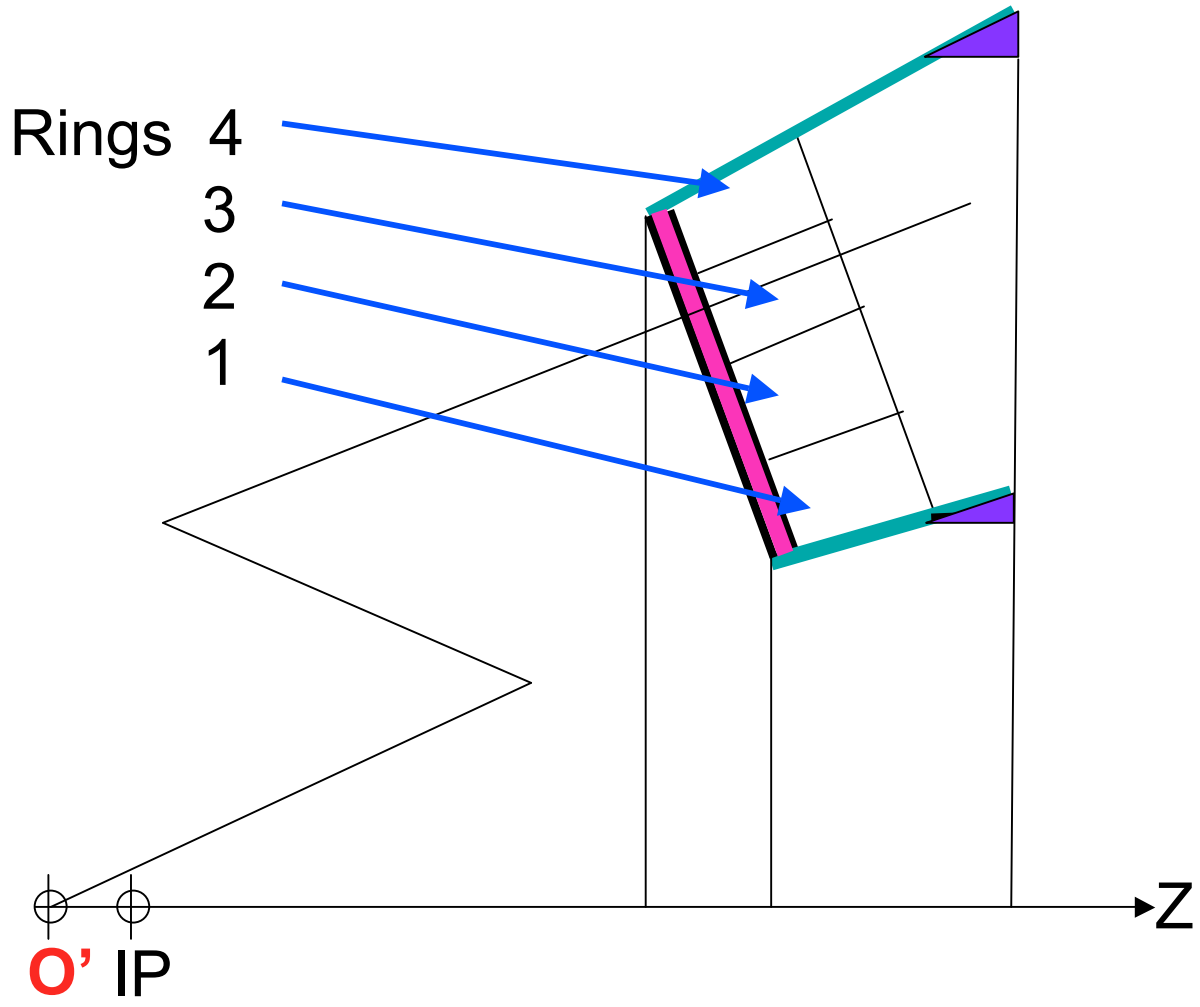
LAL Orsay

Summary

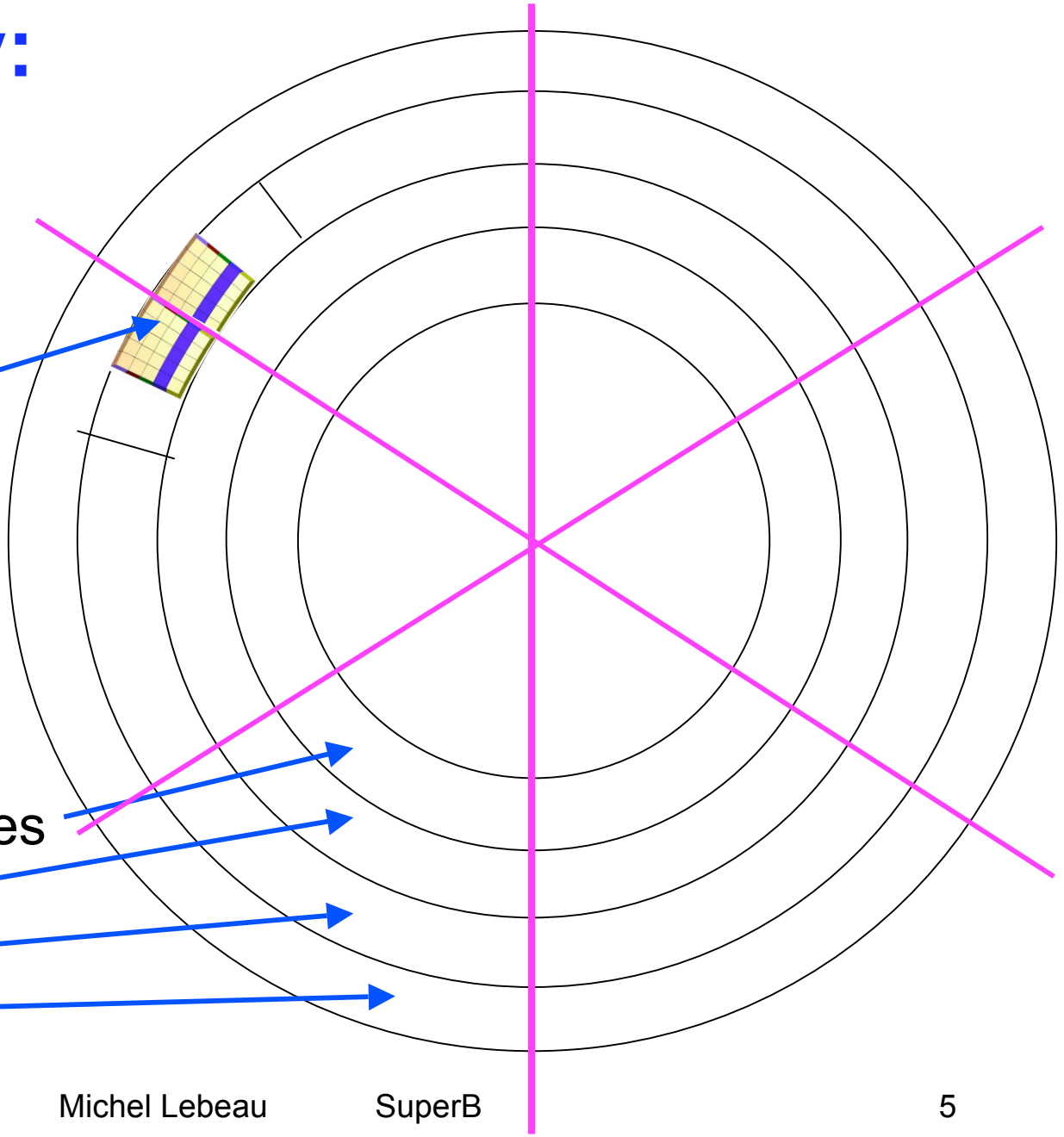
1. EMC crystal array
2. Support structure
3. Alveolar modules
4. Prototype module
5. EMC boundaries
6. Babar barrel-endcap transition
7. Installation tooling (re-use of Babar's)
8. EMC space for services

1- EMC crystal array

ECAL: a crystal array (1/2 side view)



crystal array: front view schematics



Modules of
5x5 crystals

multiples of 6 result in convenient structural symmetry

Ring 1 of 36 modules
2 of 42
3 of 48
4 of 54

crystal array: sizes and quantities

Xtals Dimensions: Back <2.63cm Front < 2.3 cm

Now proposed

for proto module (xals ordered)

Rule: minimum allowed number of crysrtals multiple of 5

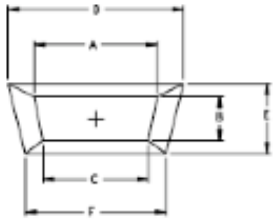
Ring	A	B	C	D	E	F
1	19.48	23.12	18.72	21.37	25.65	20.92
2	20.26	23.12	19.50	22.23	25.65	21.38
3	21.04	23.12	20.28	23.09	25.65	22.25
4	21.82	23.12	21.05	23.96	25.65	23.11
5	22.60	23.12	21.83	24.82	25.65	23.97
6	19.92	23.12	19.27	21.95	25.65	21.22
7	20.59	23.12	19.94	22.68	25.65	21.96
8	21.25	23.12	20.60	23.42	25.65	22.70
9	21.92	23.12	21.27	24.16	25.65	23.43
10	22.58	23.12	21.93	24.89	25.65	24.17
11	20.25	23.12	19.68	22.38	25.65	21.75
12	20.83	23.12	20.26	23.02	25.65	22.39
13	21.41	23.12	20.84	23.66	25.65	23.03
14	21.99	23.12	21.42	24.31	25.65	23.67
15	22.57	23.12	22.00	24.95	25.65	24.32
16	20.51	23.12	20.00	22.71	25.65	22.15
17	21.02	23.12	20.52	23.28	25.65	22.72
18	21.54	23.12	21.03	23.85	25.65	23.29
19	22.05	23.12	21.55	24.42	25.65	23.86
20	22.57	23.12	22.06	24.99	25.65	24.43

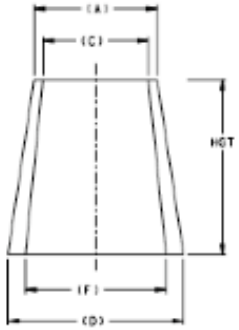
36 — 175 Xtals 35 Modules

42 — 205 Xtals 41 Modules

48 — 235 Xtals 45 Modules

54 — 265 Xtals 53 Modules





2- Support structure

Support structure example:

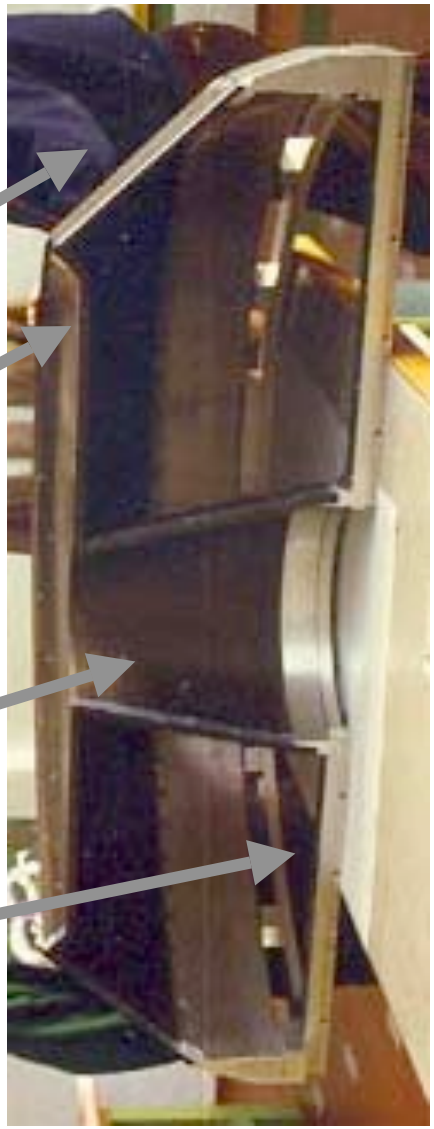
L3 ECAL endcap "Kouglof"

Outer cone
(CFRP)

Flat bottom
(conical in SuperB)
(CFRP)

inner cone
(CFRP)

Back plate
(Al)

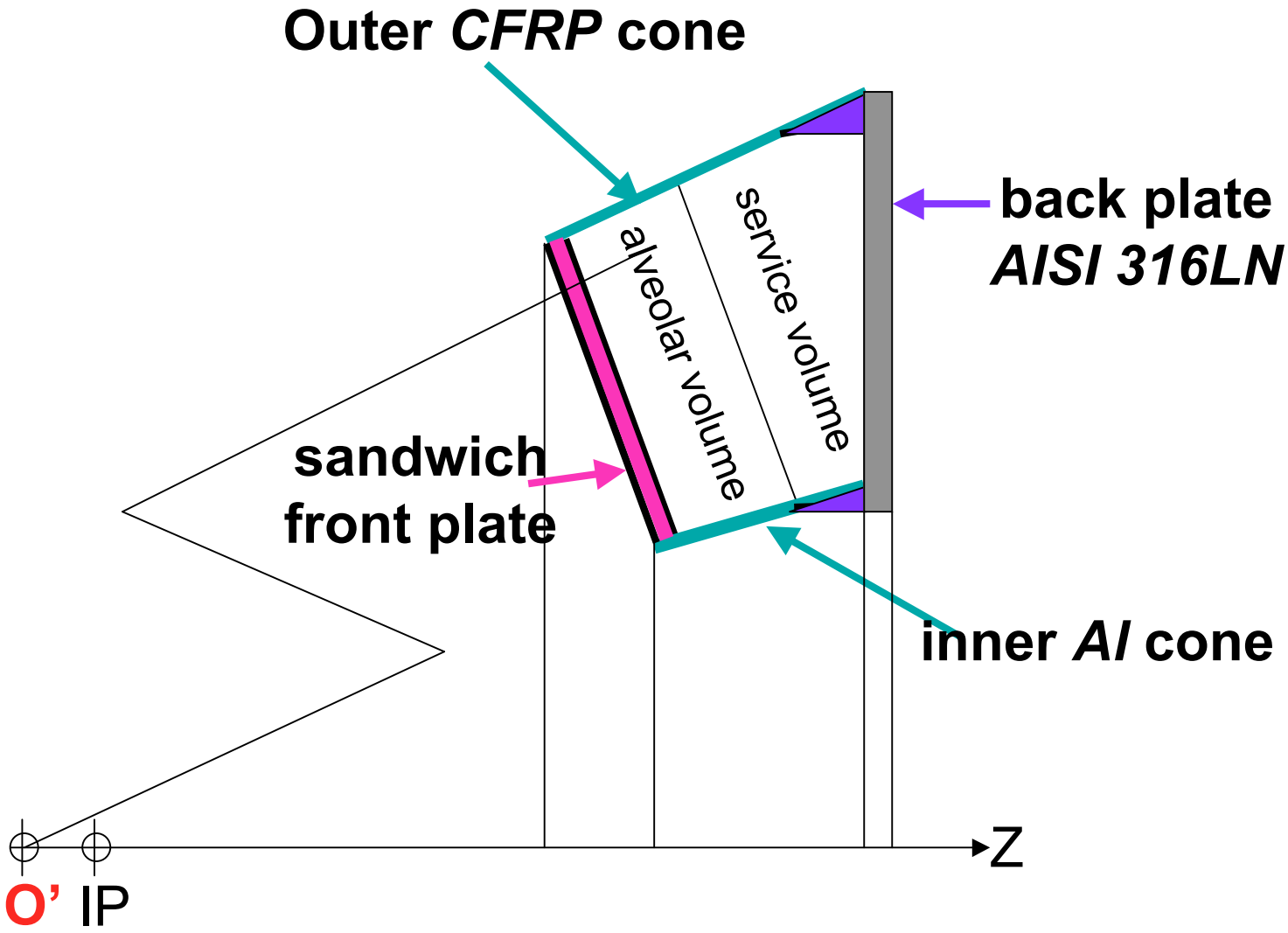


Structure design main lines

- **Conical bottom** sandwich
  - 2 skins to be defined (preferred Al screens)
  - Foam core nesting
    - Calibration circuitry
    - Cooling circuitry
  - Precision holes for alveolar positioning-fixation
  - Total thickness 20 to 30mm
  - calibration circuitry
  - therm. regul. circuitry
  - alveolar positioning
  - alveolar mech. fixation
  - **PID fixation** (to study with LAL)

Structure design main lines

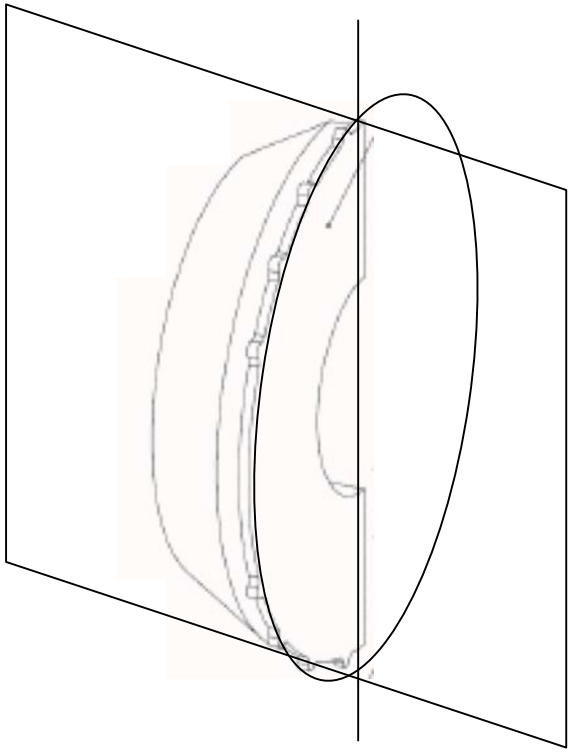
- **Outer cone**
  - –massive CFRP (6 to 10mm)
- **Inner cone**
  - –aluminium (EN AW 7075)
    - thickness 20 to 30mm
    - acts as main supporting shaft
- **Back plate**
  - -frame or plate (open or closed) austen. stainless steel
    - e.g. AISI 316LN
  - –connects inner and outer cone edges
  - **–salvage babar back plate?**



Structure main elements

Solomon's choice:

Solid doughnut or two halves ?



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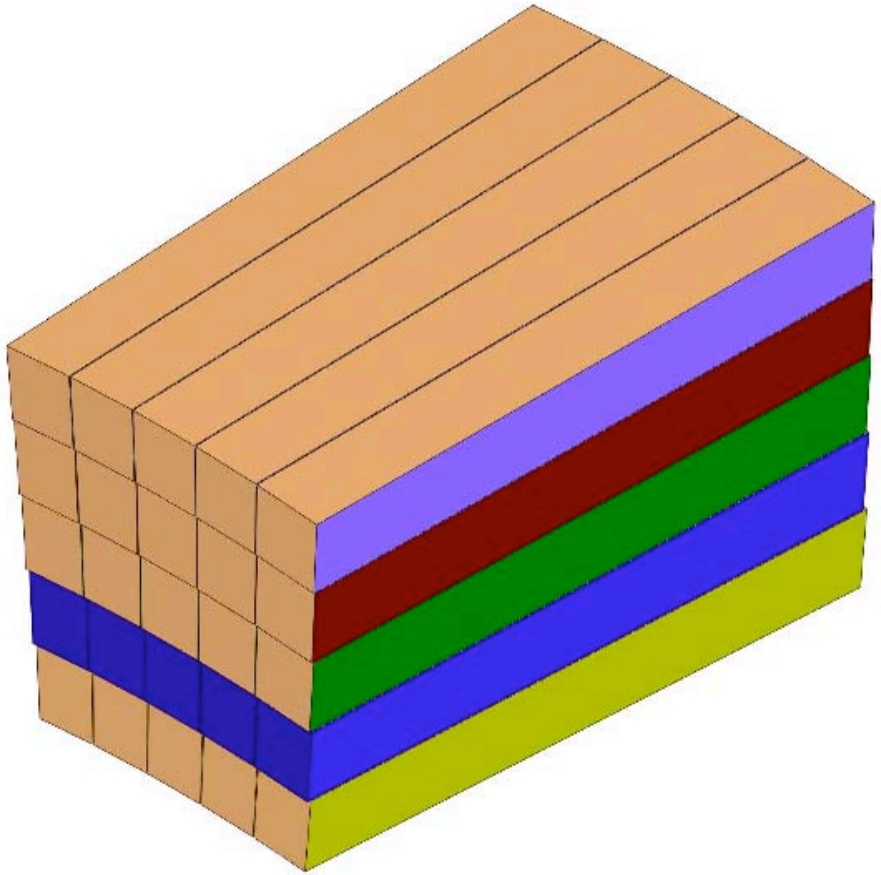
3- Alveolar modules

A module is a 5x5 matrix alveolar

There are only four different types of alveolar modules

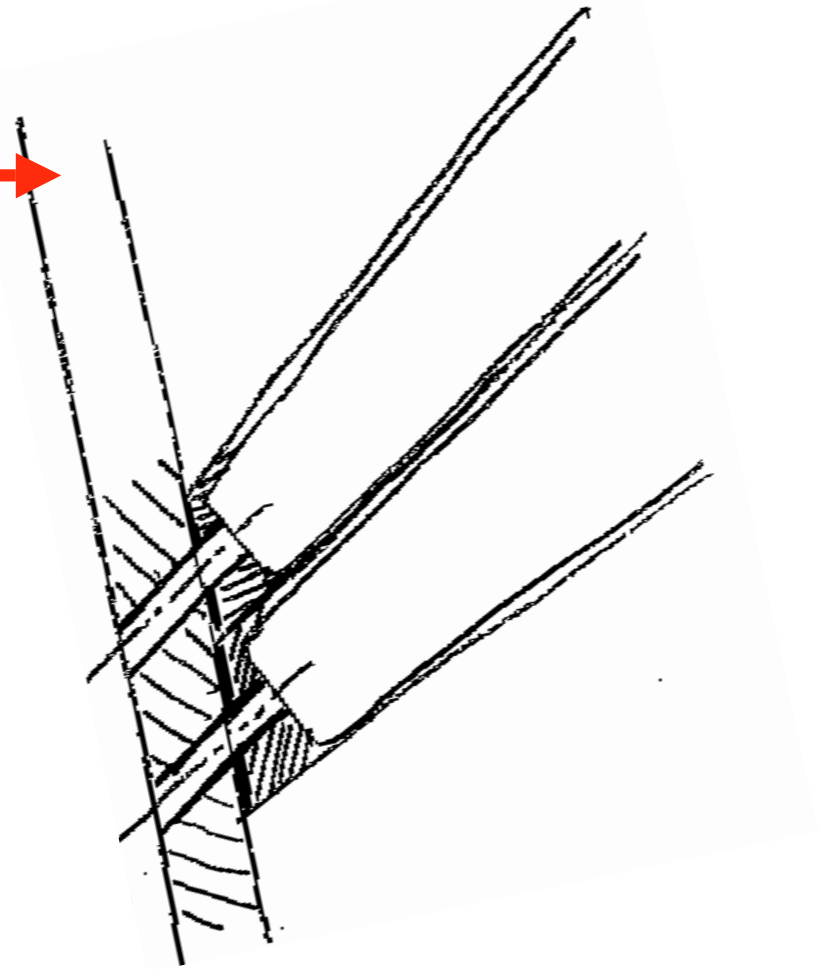
Each type contains five different types of crystals (column) in five identical rows

Isometric view of a module of type 2



Modules front connection

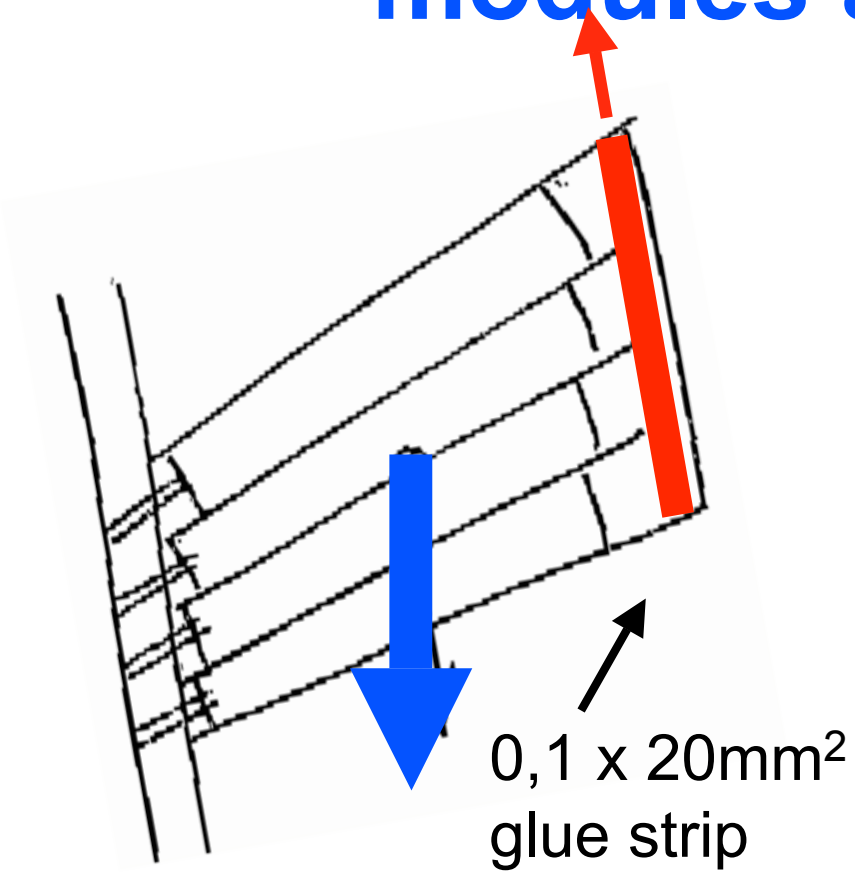
sandwich con. bottom



Module connection to dish conical bottom is by **gluing**

Possible use of CFRP **shear pins** (or dowels)

radial connection between modules at the back

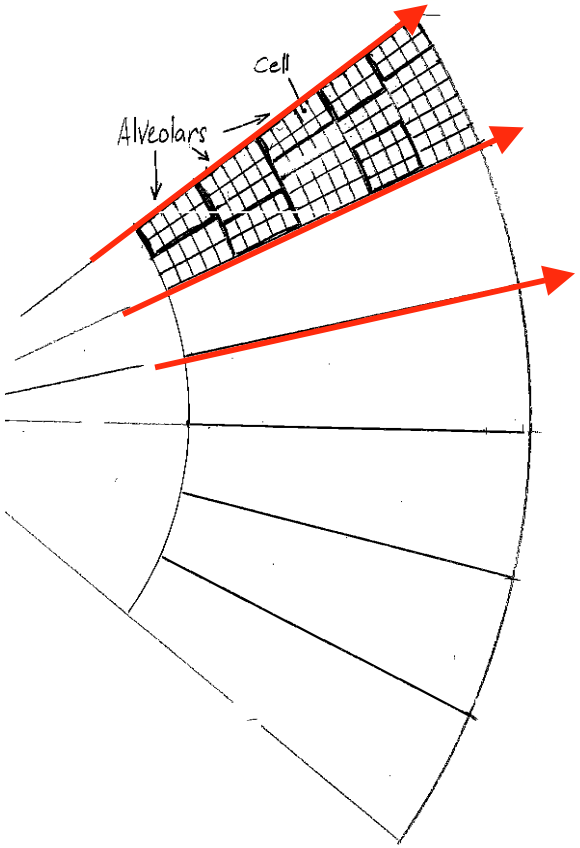


reduces the bending moment of the alveolar

A key feature of the structure

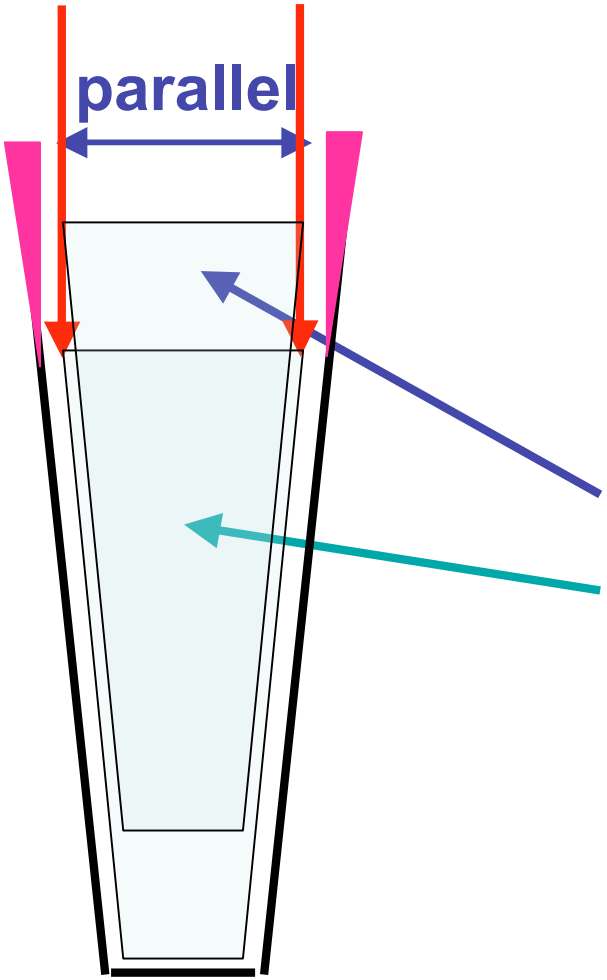
to be assessed by FE Analysis with some test inputs

radial connection between modules at the back



- Rear part of cell walls results after module assembly in a kind of rigid lattice
- Radial (straight) connections can only go through modular splits given by some ϕ **symmetry**
- ϕ symmetry contributes to precision in the construction process by forming assembly steps

radial connection between modules at the back



Cell walls can be thickened by making cell rear **prismatic**

prismatic

tapered

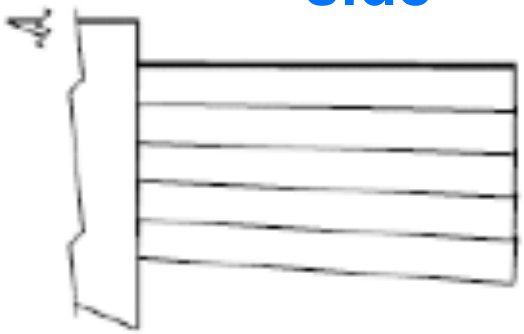
At insertion the crystal rear base generates a prismatic volume

4- Prototype module

A prototype alveolar module of type 2 (crystal types 6 to 10) will be manufactured and used with 25 LYSO crystals in a test beam in spring 2010

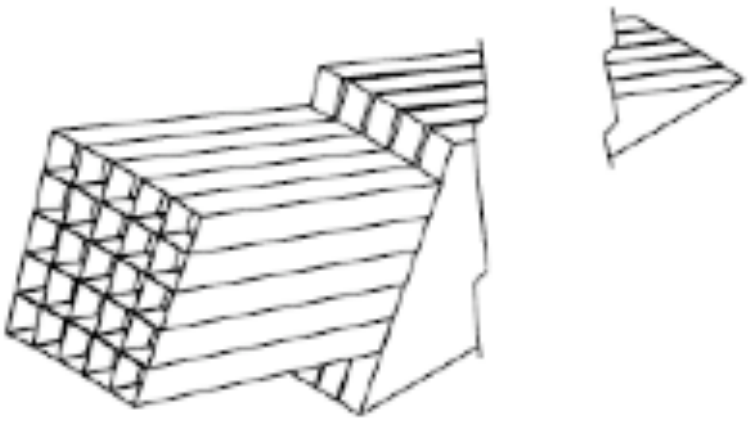
Proto alveolar module production drawings

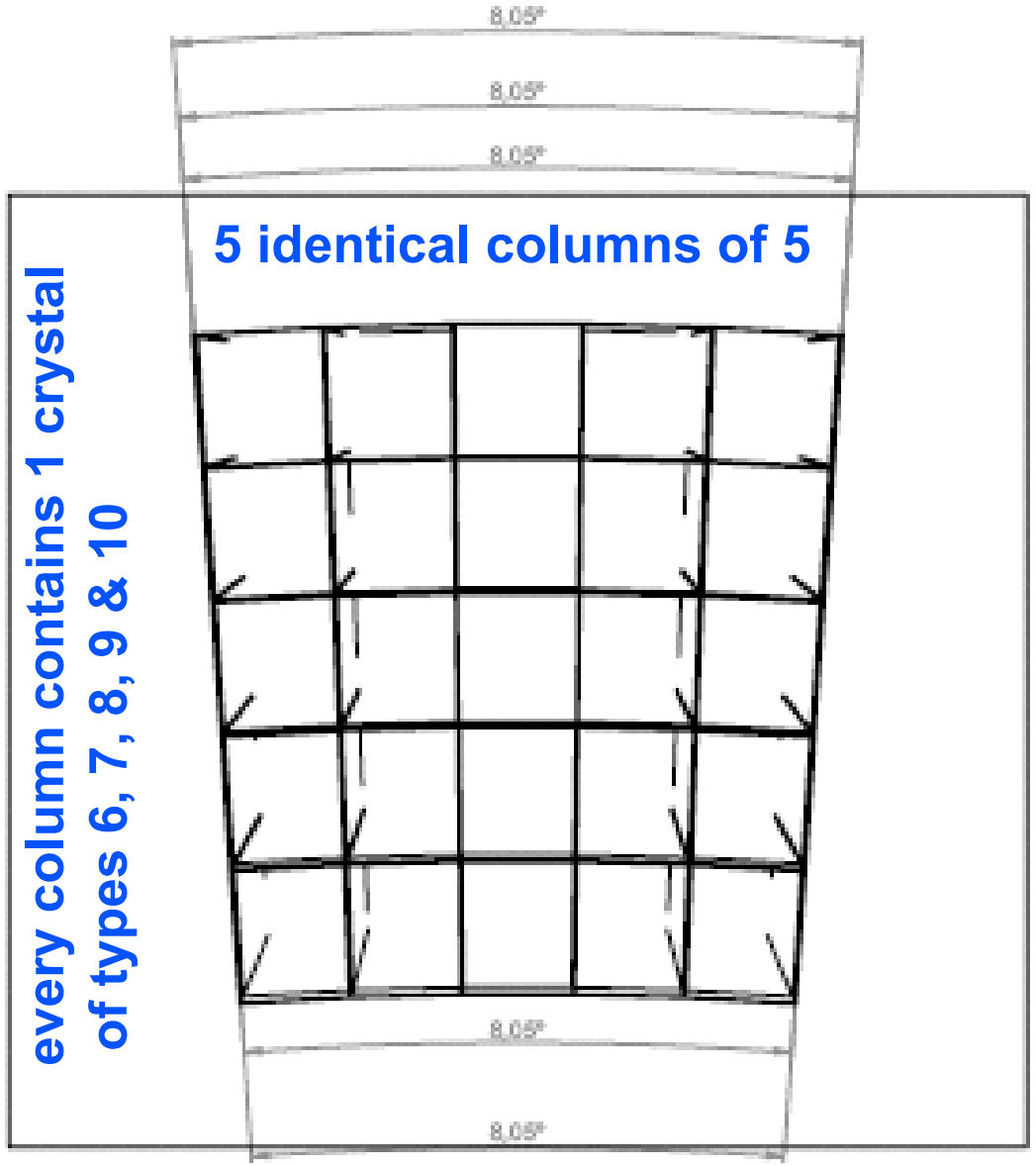
side



top

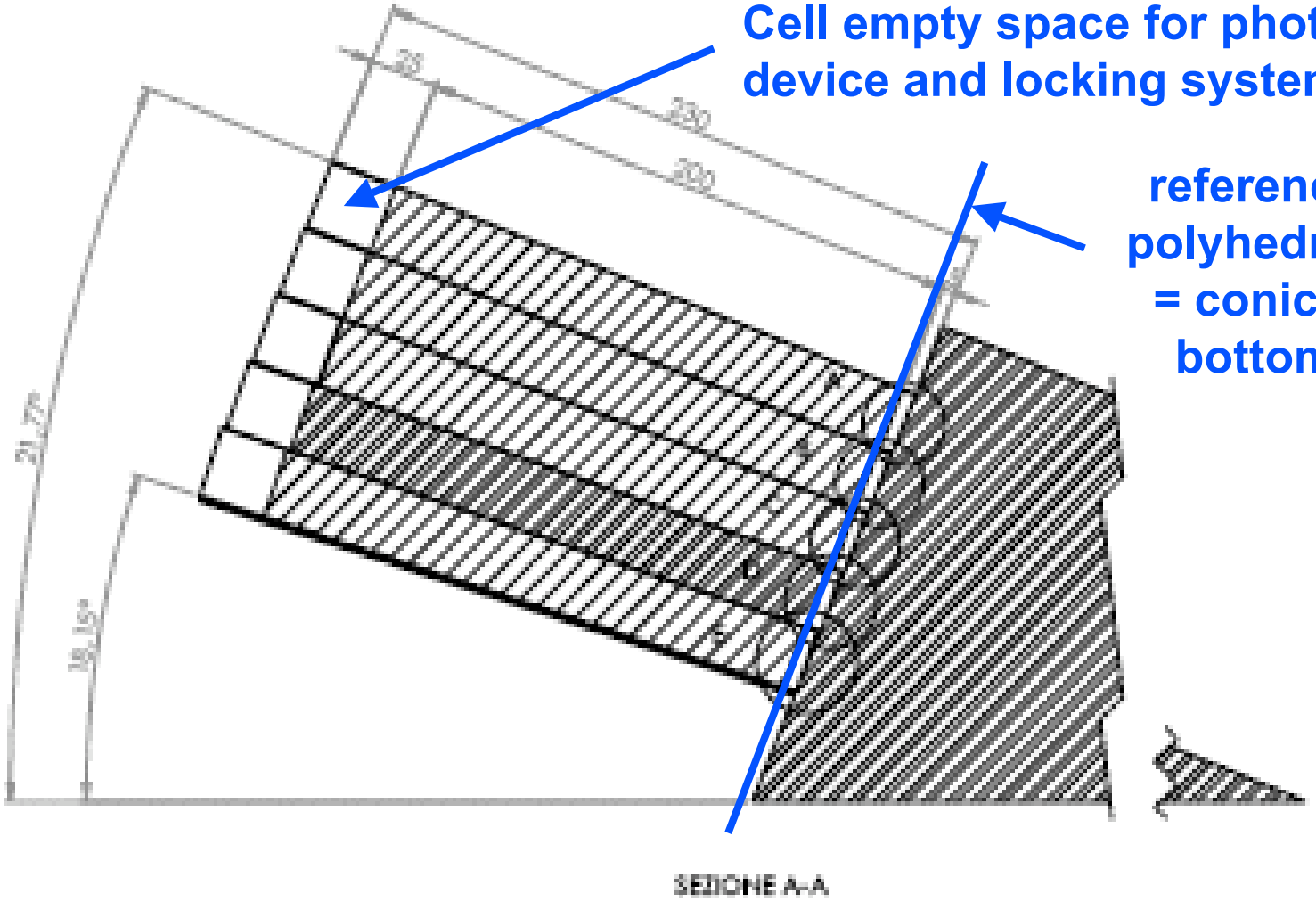
3-D



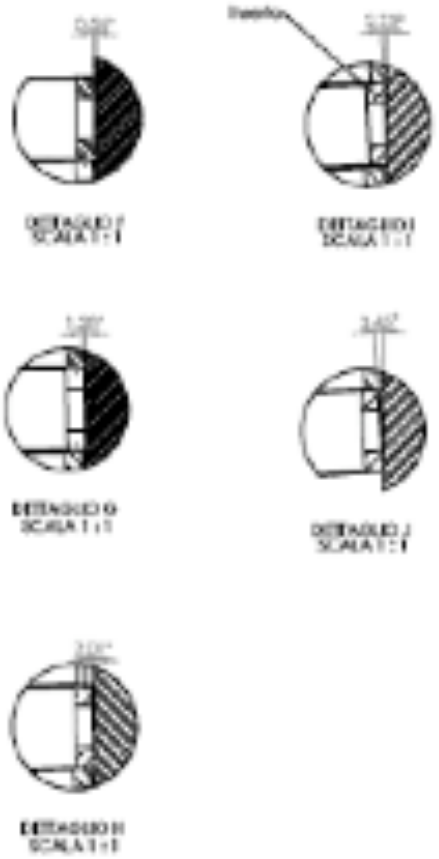


module rear view

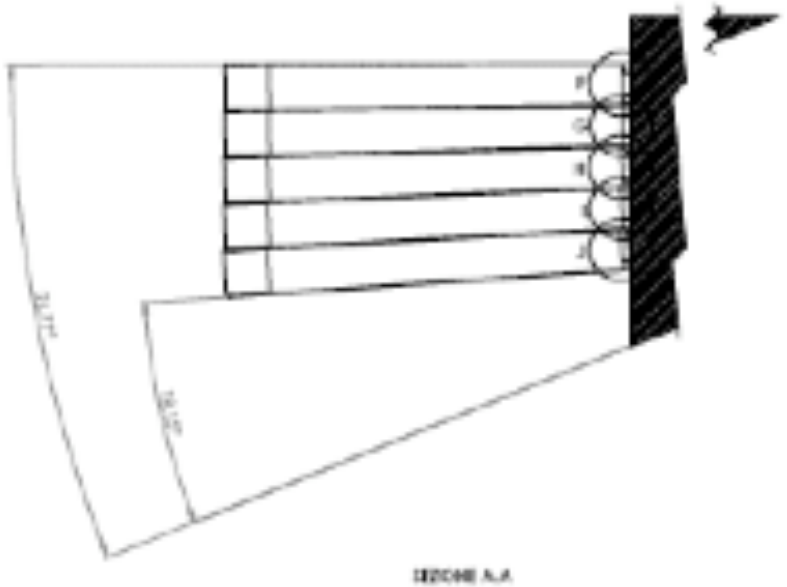
Side section with crystals



detail of alveolar module assembly



detail of inserts

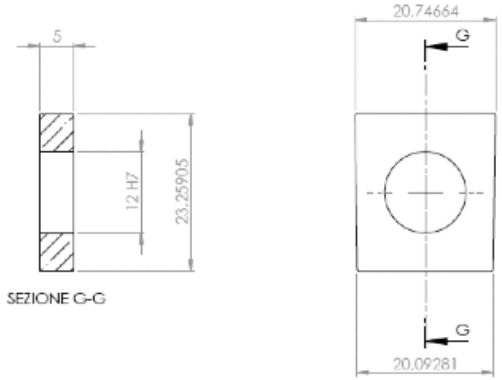


section through 1st row

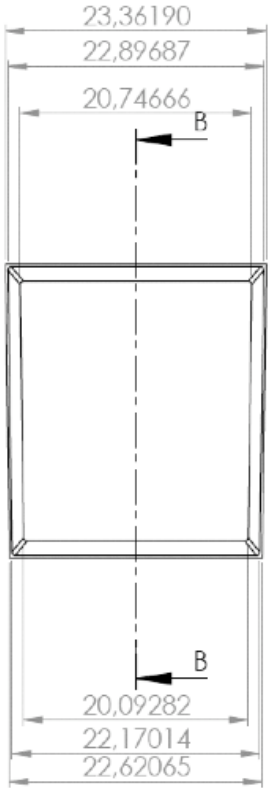
view from rear

Cell

cell longitudinal section

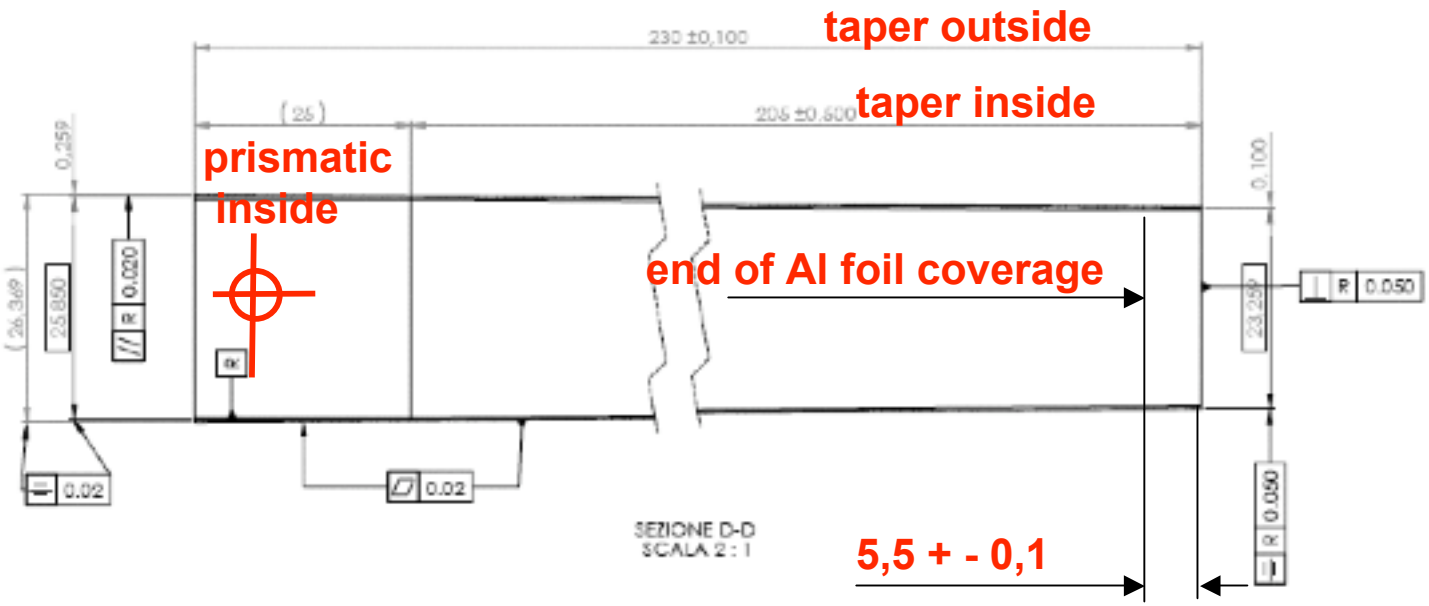


detail of insert

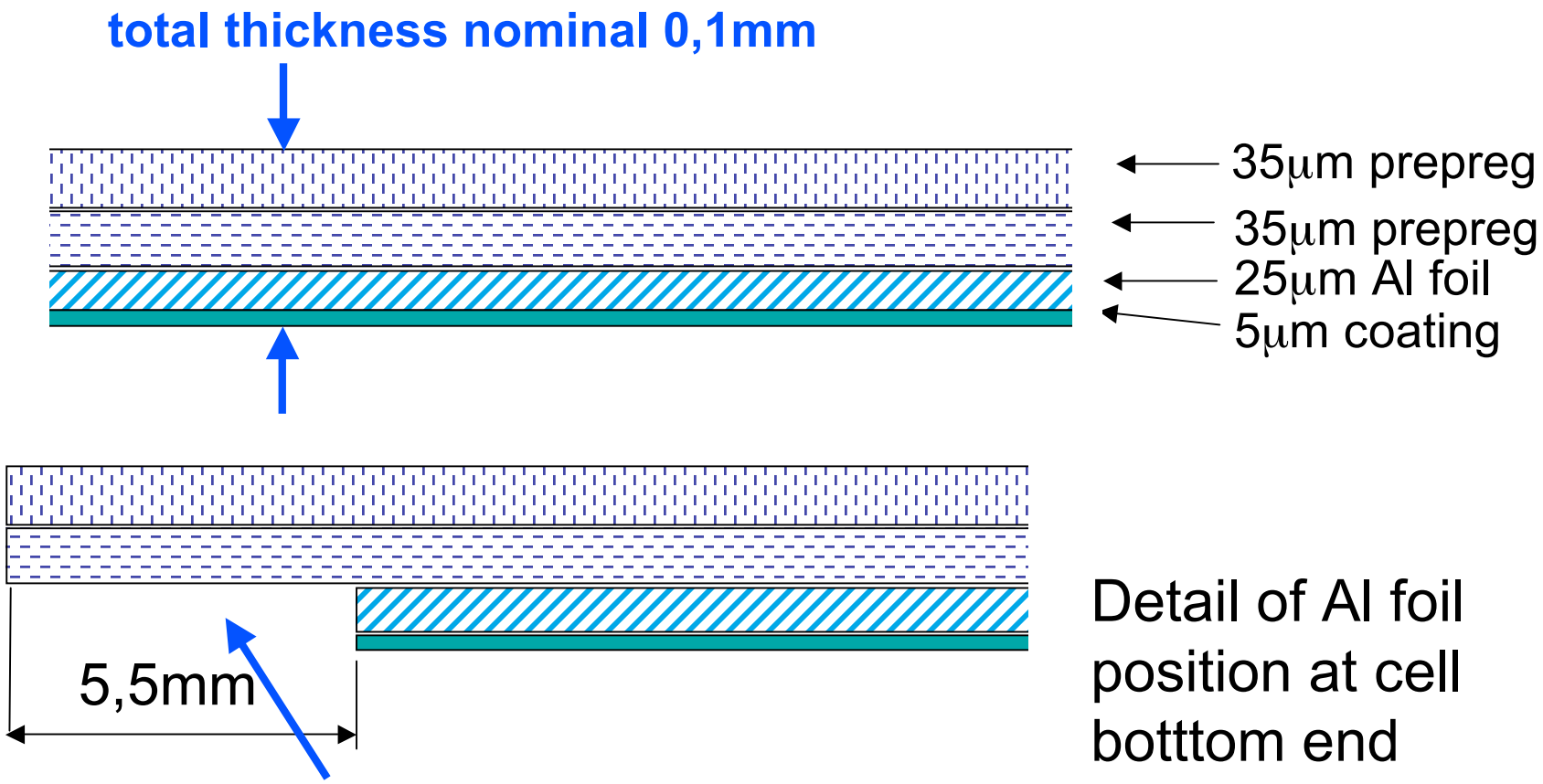


view from rear

Cell longitudinal section and shape details



Cell wall composition

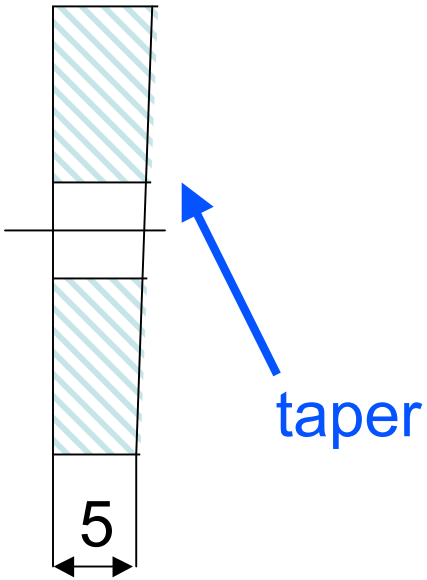


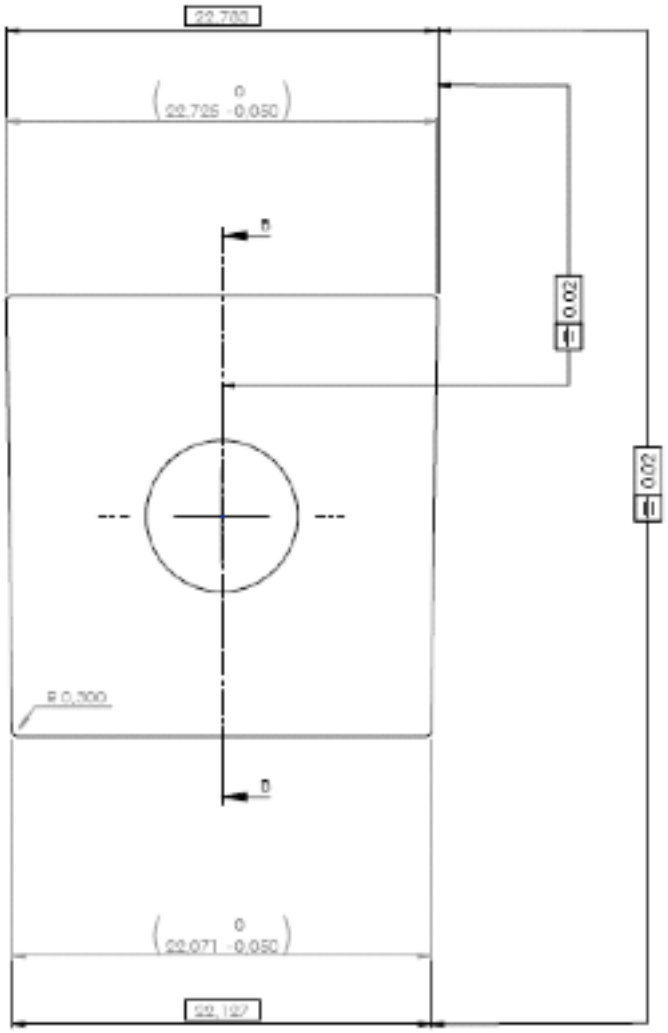
Detail of Al foil position at cell botttom end

the absence of Al foil ensures a good mechanical bond with the insert

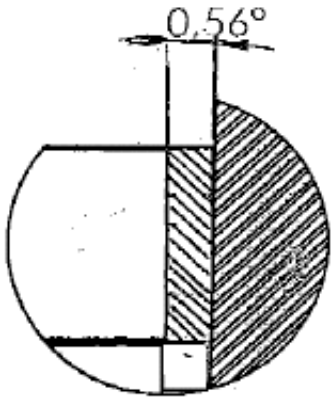
Insert (GFRP)

Sect. BB



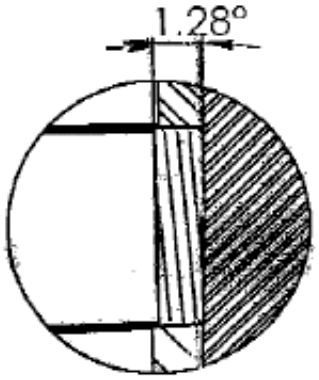


Inserts

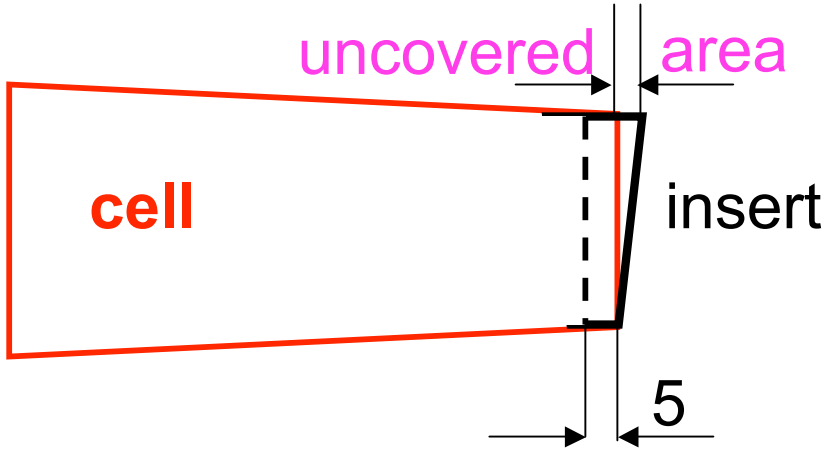


Type 10

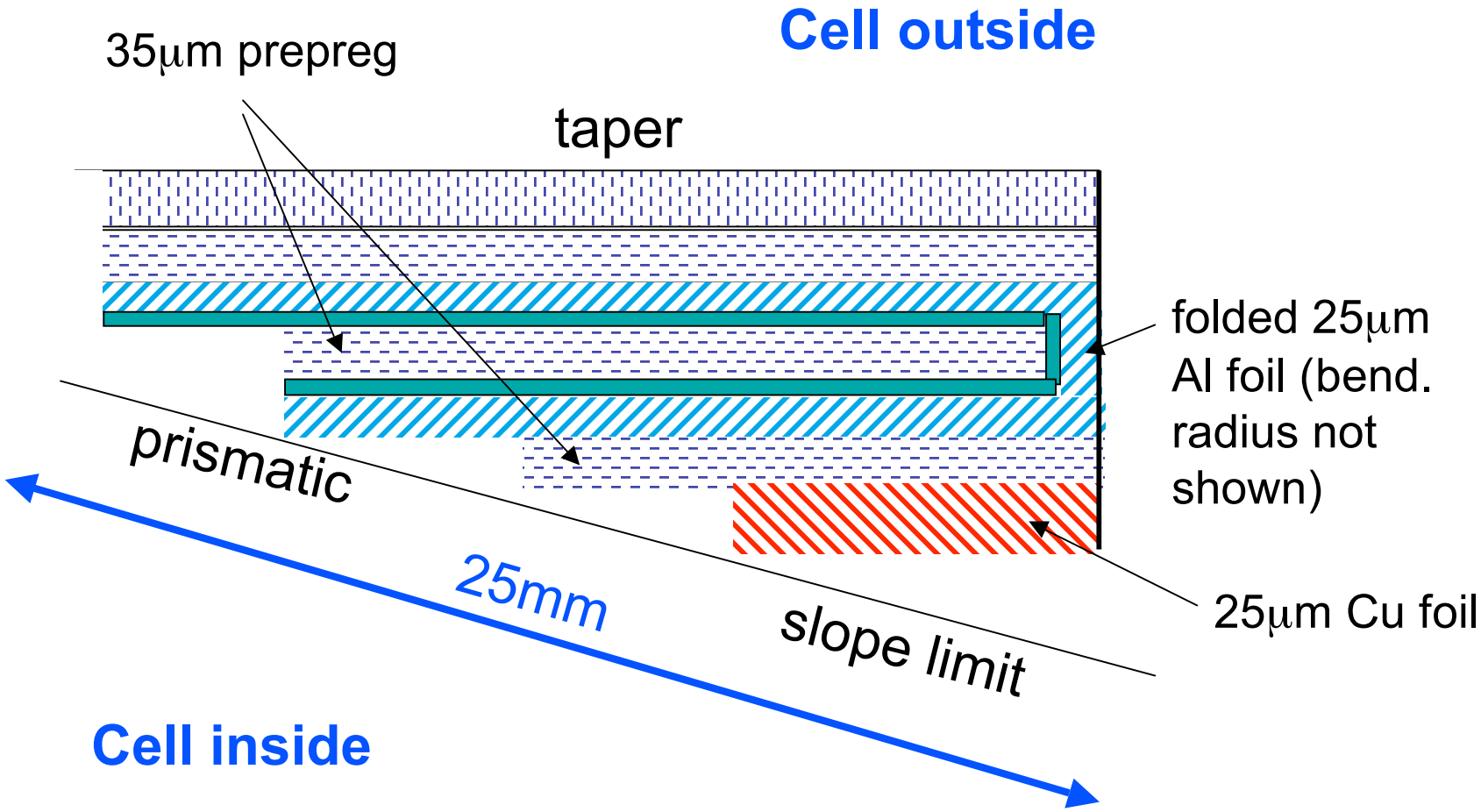
For production simplicity the cell end is straight and leaves an uncovered area on the tapered insert



Type 9



Cell rear taper detail *(false scale)*



5- EMC boundaries

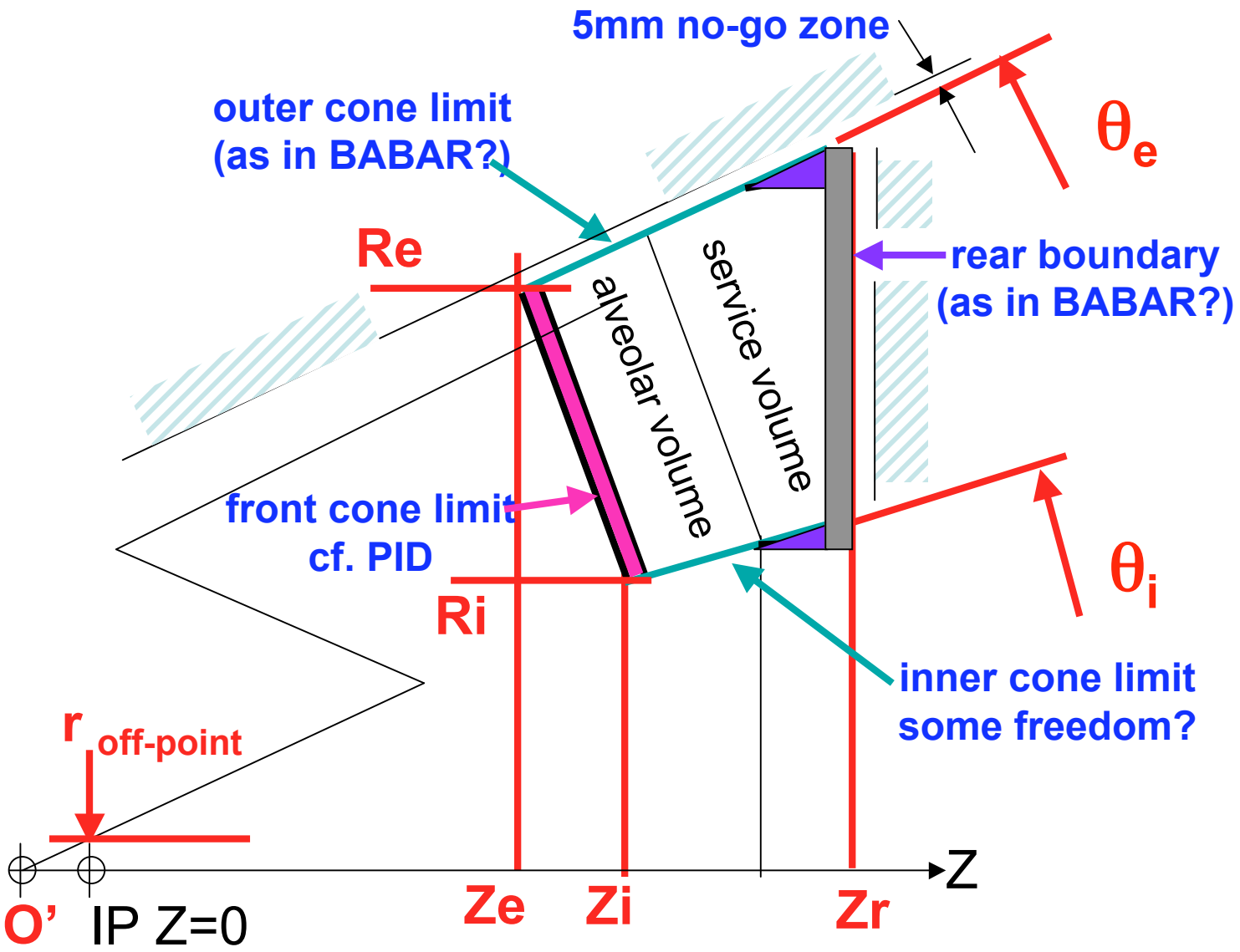
to be agreed upon with
other sub-detectors

Boundaries

- Babar barrel end cone + 5mm no-go zone
- Front cone incl. 5mm no-go zone

  this meeting for PID interface
- Inner cone (some more freedom?)
- Rear limit (incl. 5mm no-go zone)

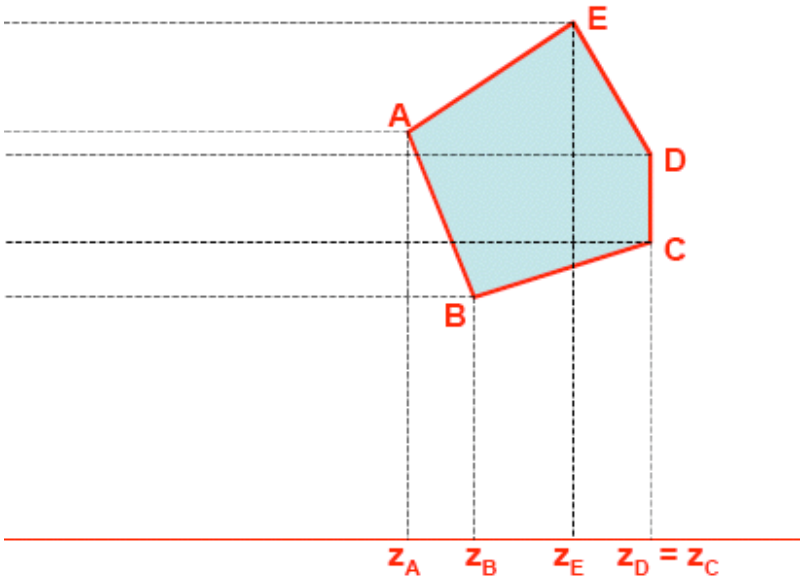
Boundaries and coordinates



Basic parameters

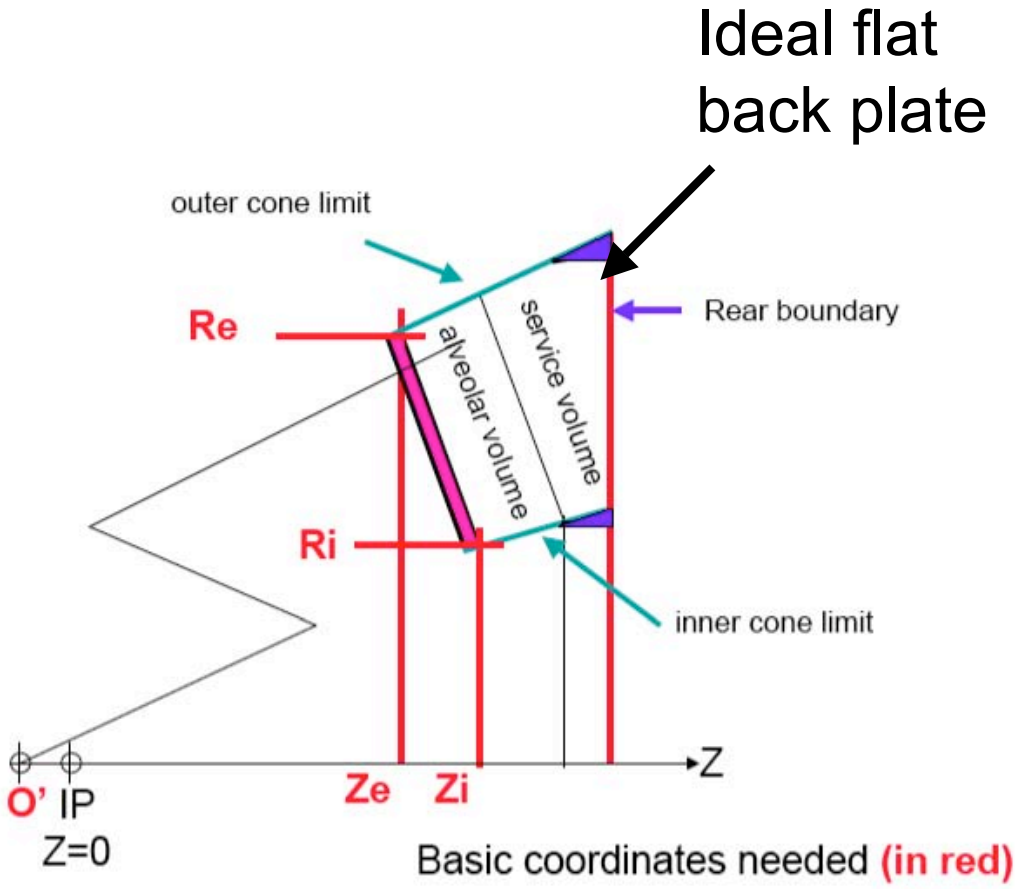
Babar

r_A="915.254079110629"	z_A="1808.9490179276"
r_B="505.747713468808"	z_B="1979.86389412623"
r_C="597.965158490213"	z_C="2318.78072095699"
r_D="758.762982134662"	z_D="2318.78072095699"
r_E="1123.3793002059"	z_E="2177.88847145028"



from S.Germani

SuperB

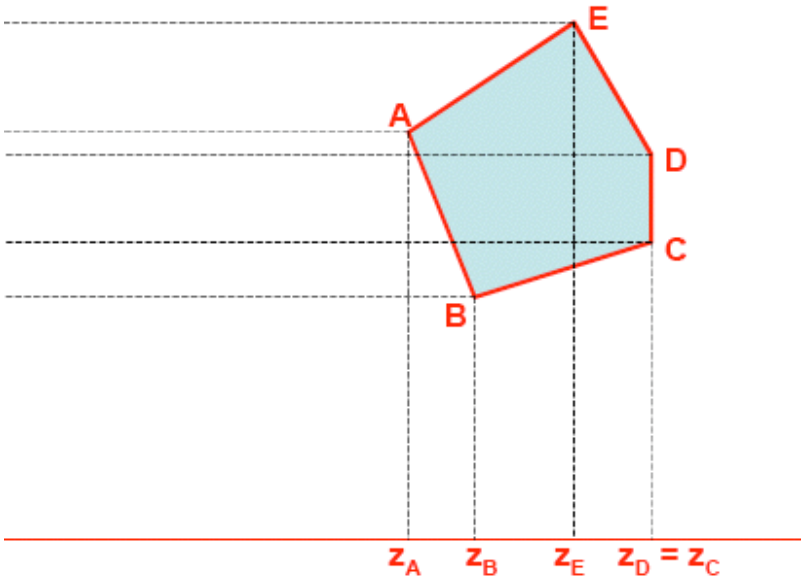


Basic coordinates needed **(in red)**

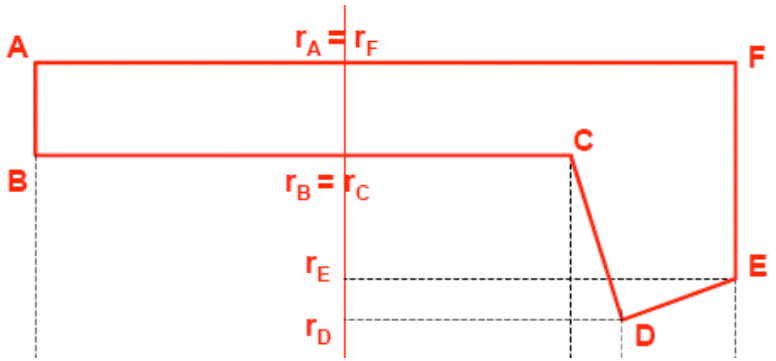
Basic parameters

Babar endcap

r_A="915.254079110629"	z_A="1808.9490179276"
r_B="505.747713468808"	z_B="1979.86389412623"
r_C="597.965158490213"	z_C="2318.78072095699"
r_D="758.762982134662"	z_D="2318.78072095699"
r_E="1123.3793002059"	z_E="2177.88847145028"



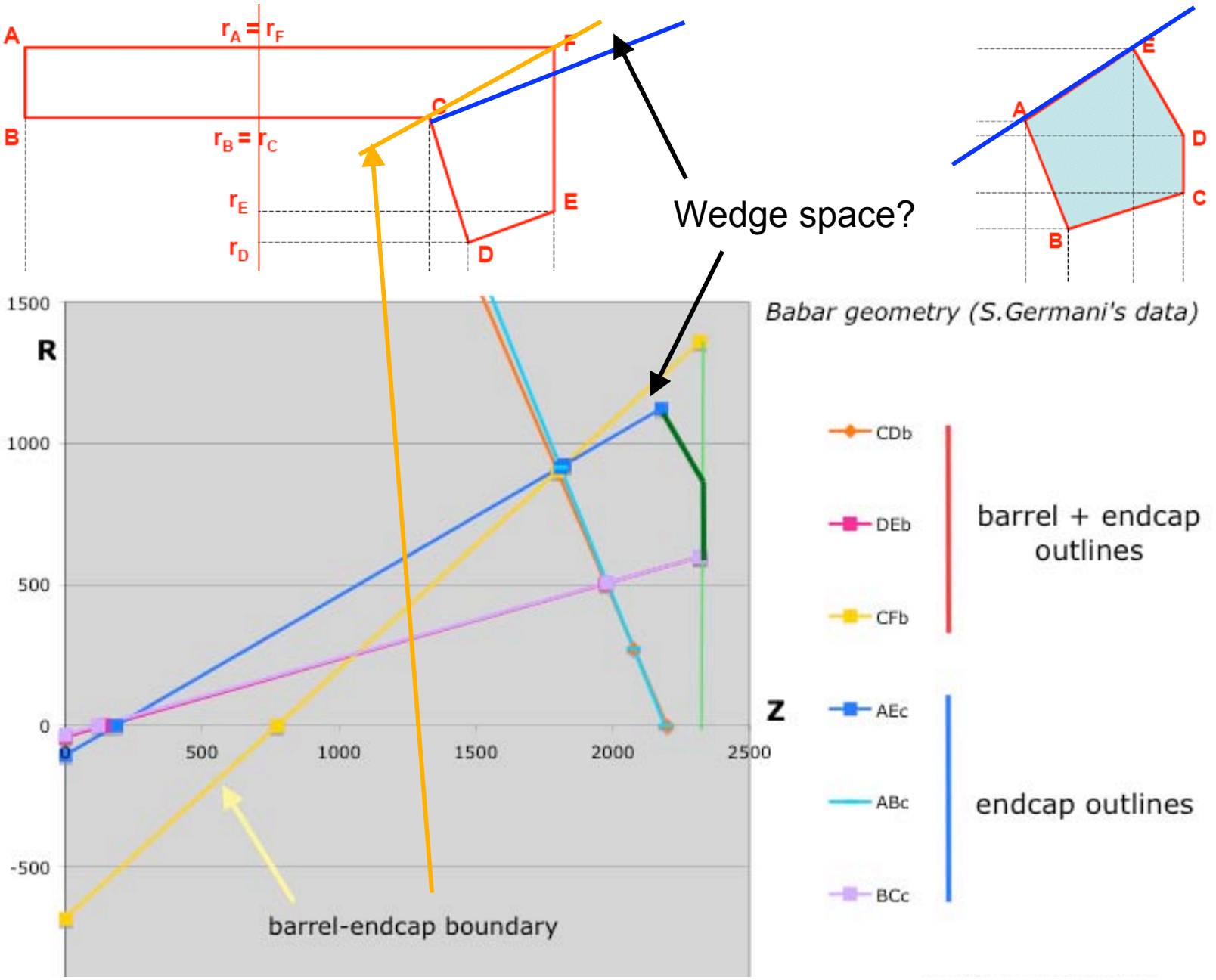
Babar barrel + endcap

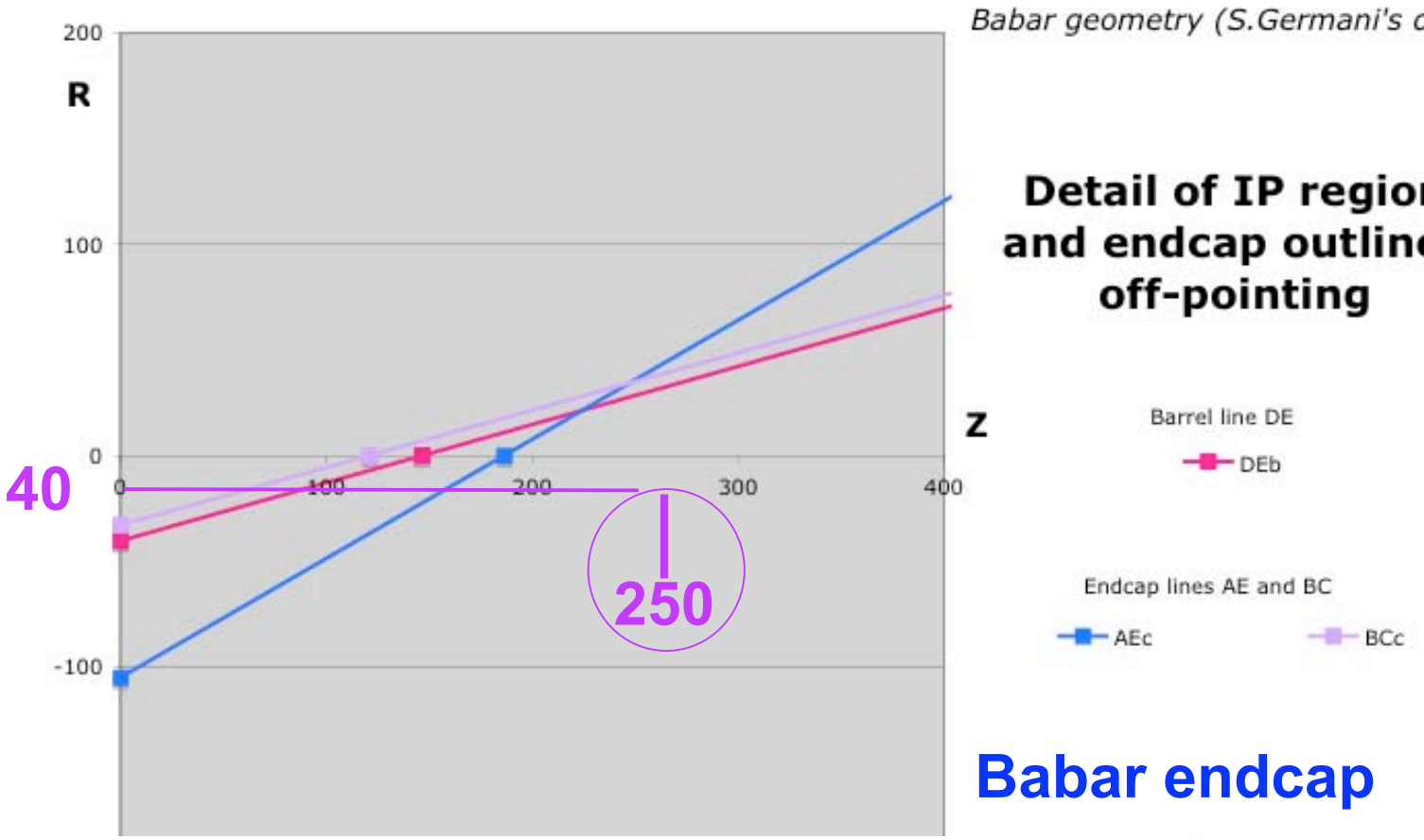


from S.Germani

6- Babar barrel-endcap transition

Babar outline parameters indicate an empty wedge between barrel and endcap


A
$r_A = r_F$
F
B
C
$r_B = r_C$
r_E
E
r_D
D
Wedge space?
E
A
D
C
B
Babar geometry (S.Germani's data)
1500
R
1000
500
0
-500
0
500
1000
1500
2000
2500
Z
barrel-endcap boundary
CDb
DEb
CFb
AEc
ABc
BCc
barrel + endcap outlines
endcap outlines



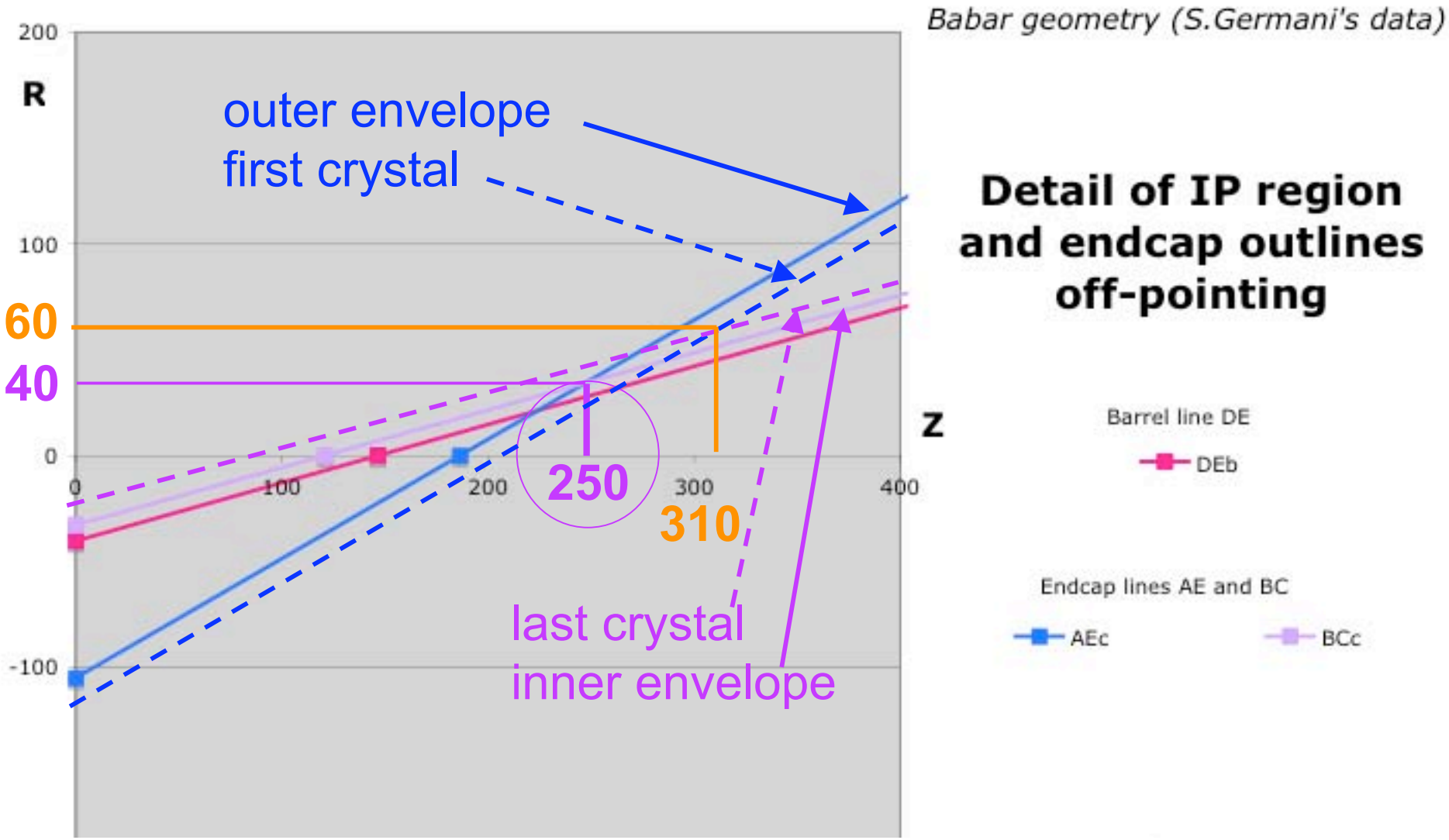
Babar endcap
outer and inner cone
envelopes intersect at
Z = + 250mm
R = 40mm

Assuming a 10mm dead space between envelope and crystal limit gives a an off-point circle at

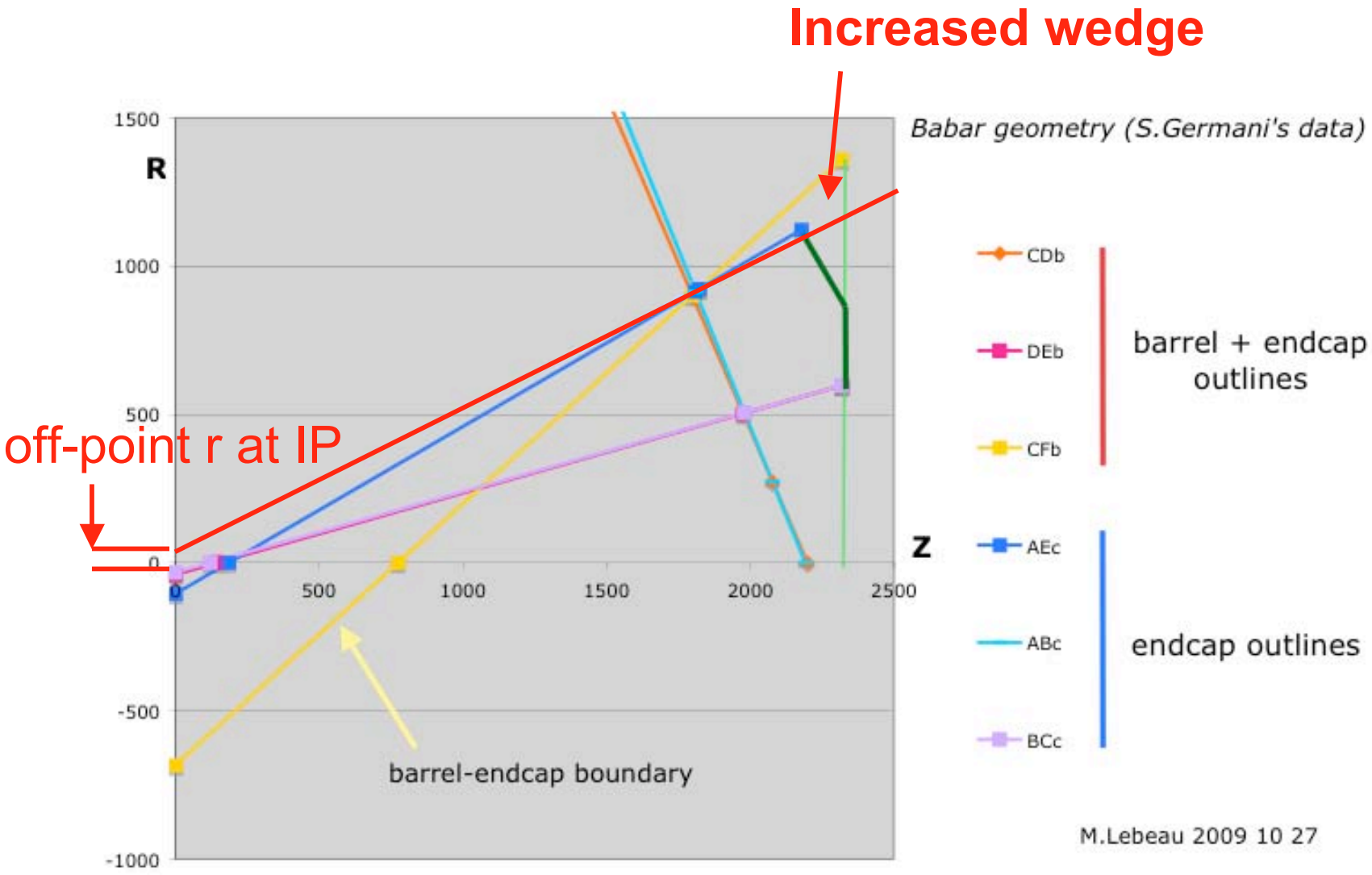
R = 60mm

But this circle is not at IP:

Z = + 310mm


Babar geometry (S.Germani's data)
Detail of IP region and endcap outlines off-pointing
outer envelope
first crystal
last crystal
inner envelope
60
40
250
310
R
Z
200
100
0
-100
0
100
200
300
400
Barrel line DE
DEb
Endcap lines AE and BC
AEc
BCc

Placing the off-point circle at IP implies reducing outer cone envelope angle, thus increasing the wedge between barrel and endcap.


Increased wedge
Babar geometry (S.Germani's data)
off-point r at IP
R
Z
1500
1000
500
0
-500
-1000
0
500
1000
1500
2000
2500
barrel-endcap boundary
CDb
DEb
CFb
AEc
ABc
BCc
barrel + endcap outlines
endcap outlines
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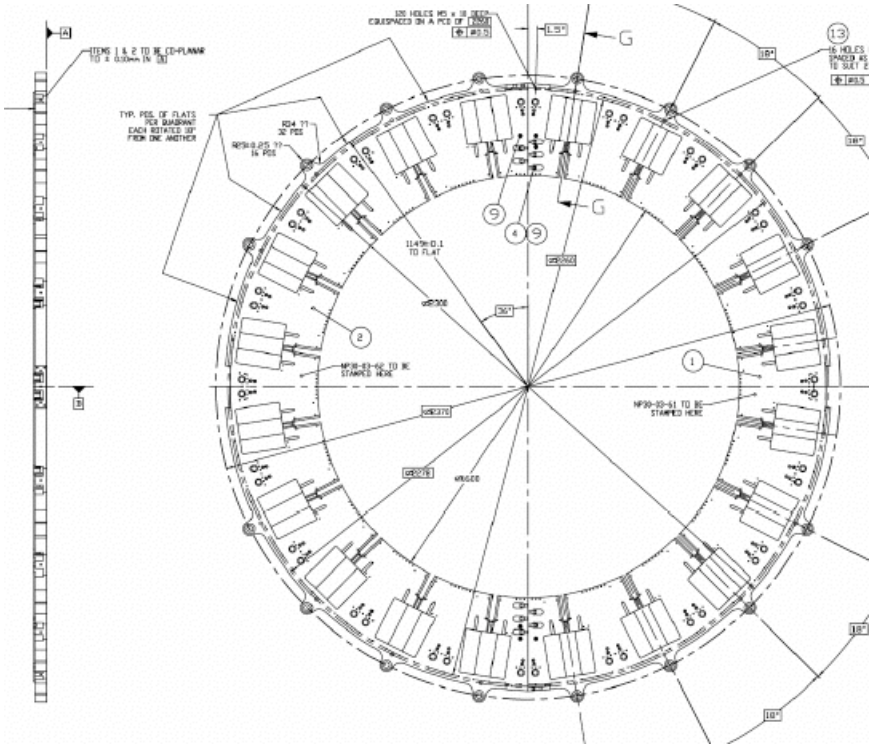
7- Installation tooling (re-use of Babar's)

According to Babar technical database

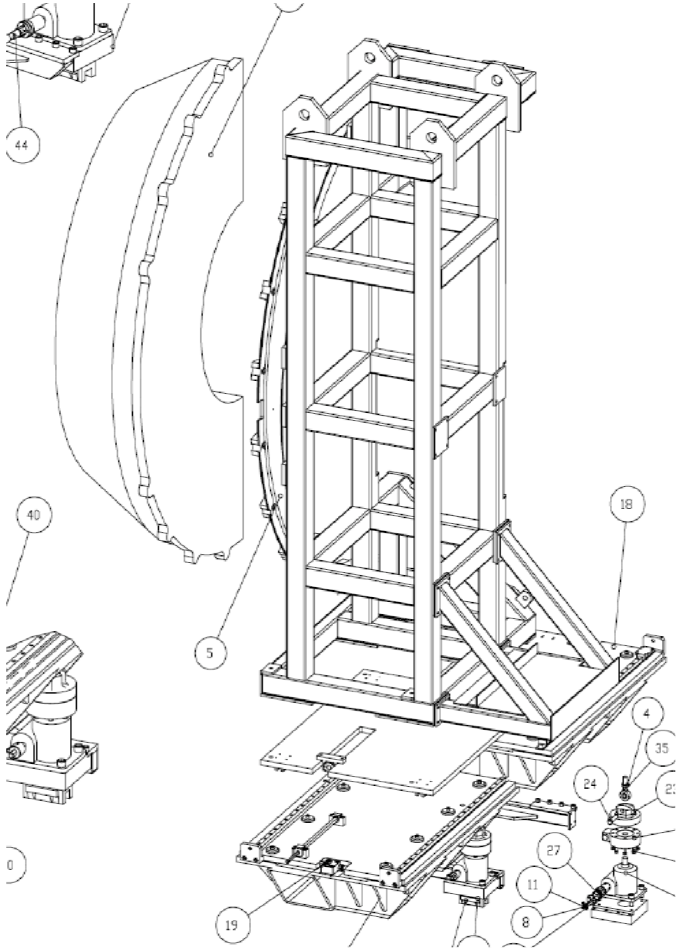
back plate as rear support



is Babar endcap back plate re-usable?

- frame or **plate** (open or closed) aluminium or st.steel
- connects inner and outer cone edges
- integrates supporting points
- matches Babar original fixation points

Re-use maximum of Babar End Cap installation tooling



Inspection of existing tooling

Re-condition if required

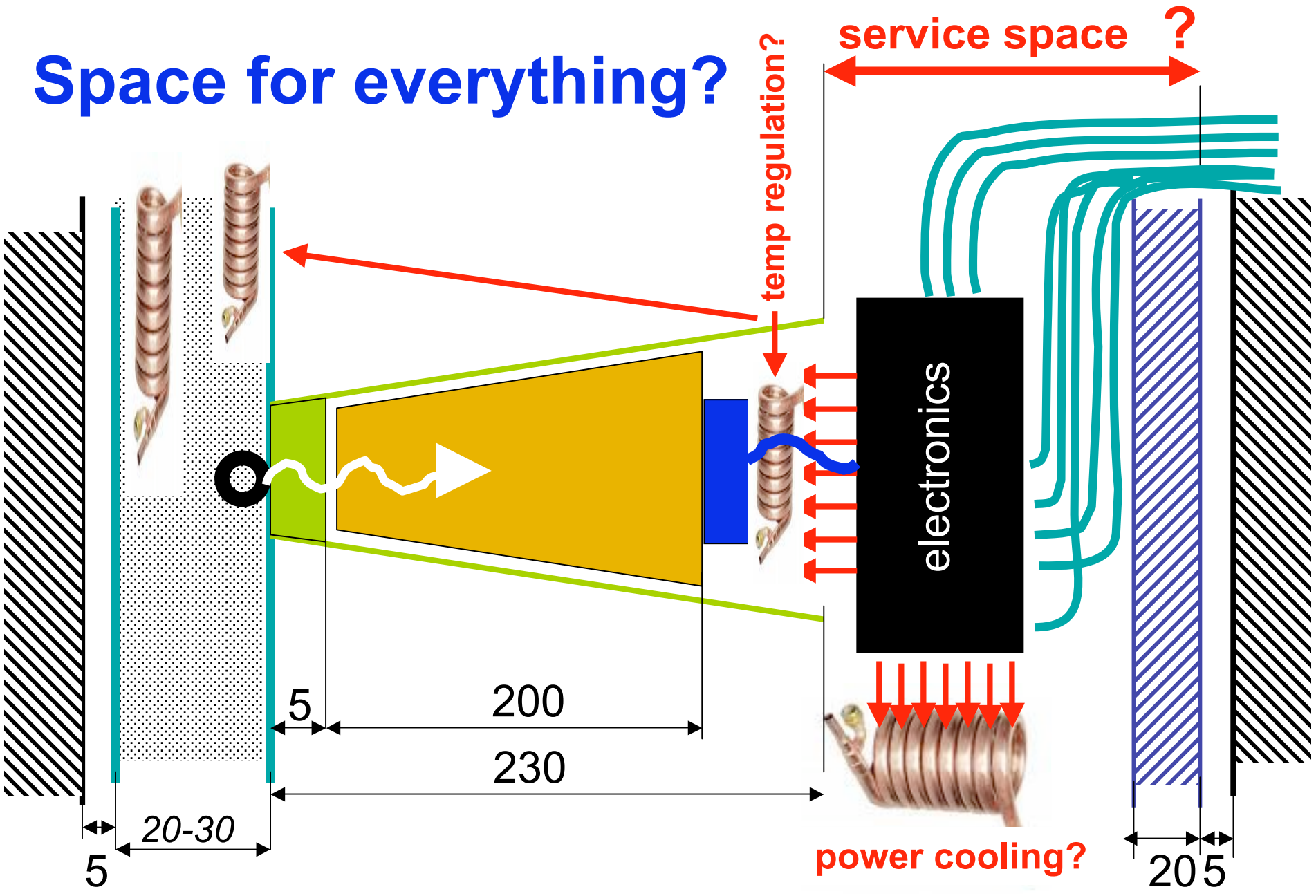
Create ad hoc interface for new design

8- EMC space for services

Service space behind crystals

- photodetectors
- VF readout
- monitoring (?)
- cooling for electronics
- xals & PD thermal regulation
- temp. sensing
- fluid (dew, leak) detect.
- radiation monitoring
- survey references

Space for everything?



Cooling & thermal regulation

- **Cooling**
  - **Catch heat at source**
  - Stop heat leaks to crystals
- **Thermal regulation**
  - Enclose crystals and photodetectors
  - Front and rear **thermal screens**

Cooling & thermal regulation

- Electronics cooling
  - Power dissipation?
  - Cooling to temp. order of ±2°C
- Thermal regulation
  - If regulation to temp order of |0,5°C|
  - LYSO crystals light output - 0,4%
  - Photo-detector (if APD -1,2%)

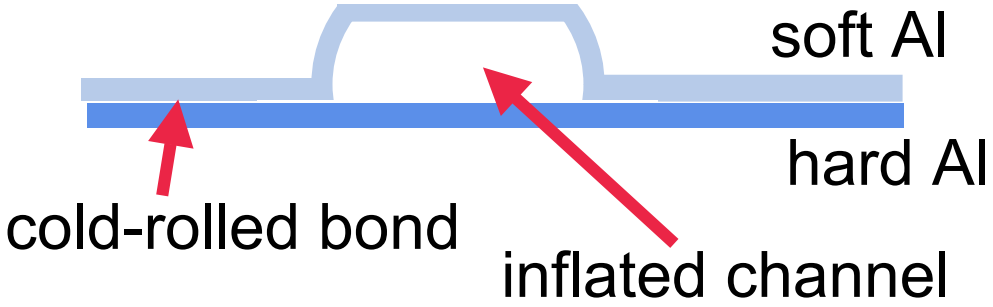
Thermal regulation

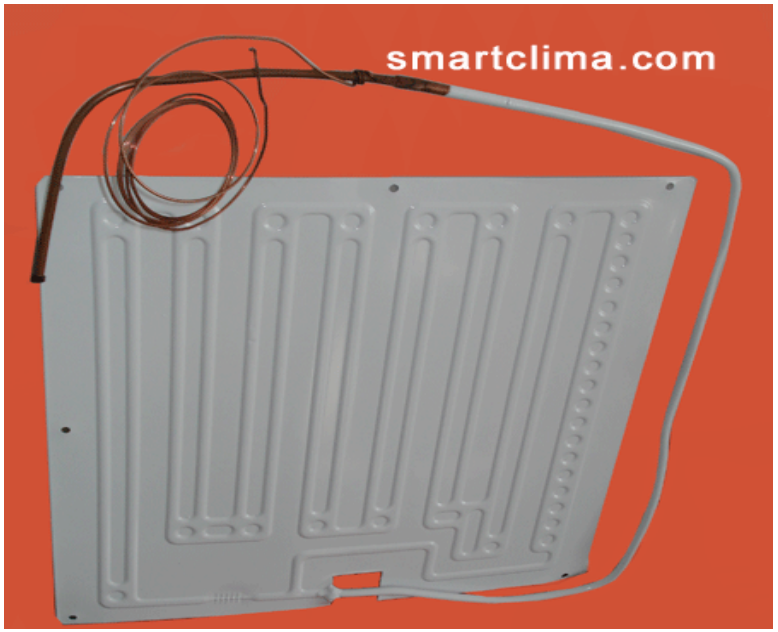
- If regulation to temp order of |**0,5°C**|
- LYSO crystals light output - 0,1%

  [RYZ,IEEE Trans.Vol.55 N°4 Aug.2008 pp2425-31]

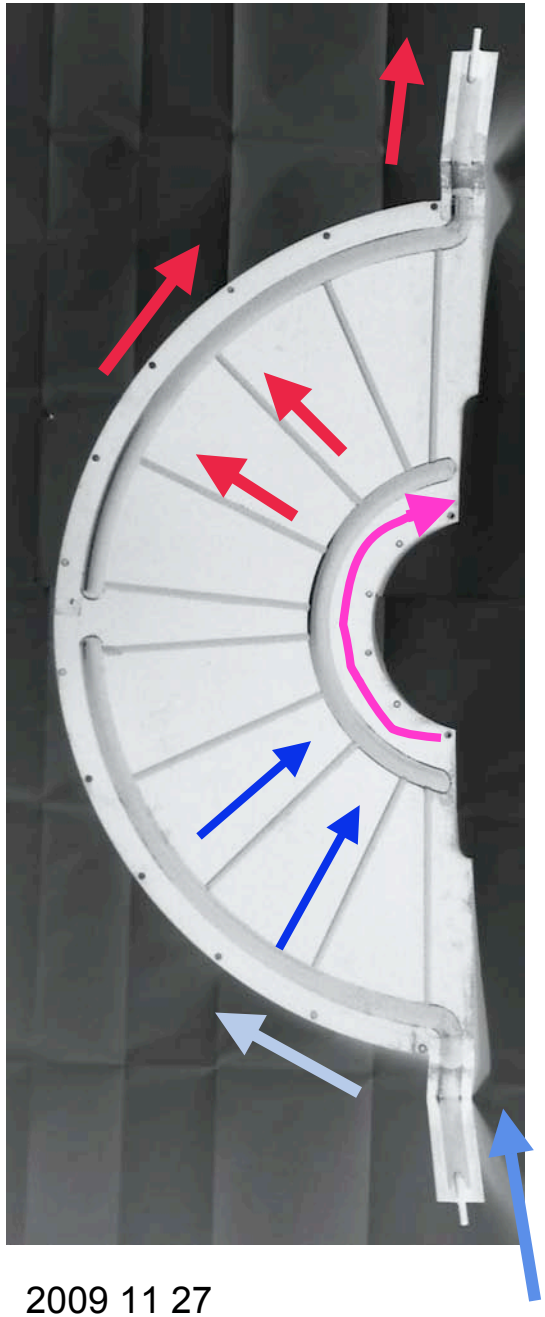
▲ Photo-detector (if APD **-1,2%**)

ROLLBOND screens could be used as skins for sandwich front plate





Example of a
Rollbond
fridge thermal screen
- All aluminium
- Typical thickness
  1,3mm on flat
  4 to 5mm on channels



Rollbond model of cooling screen

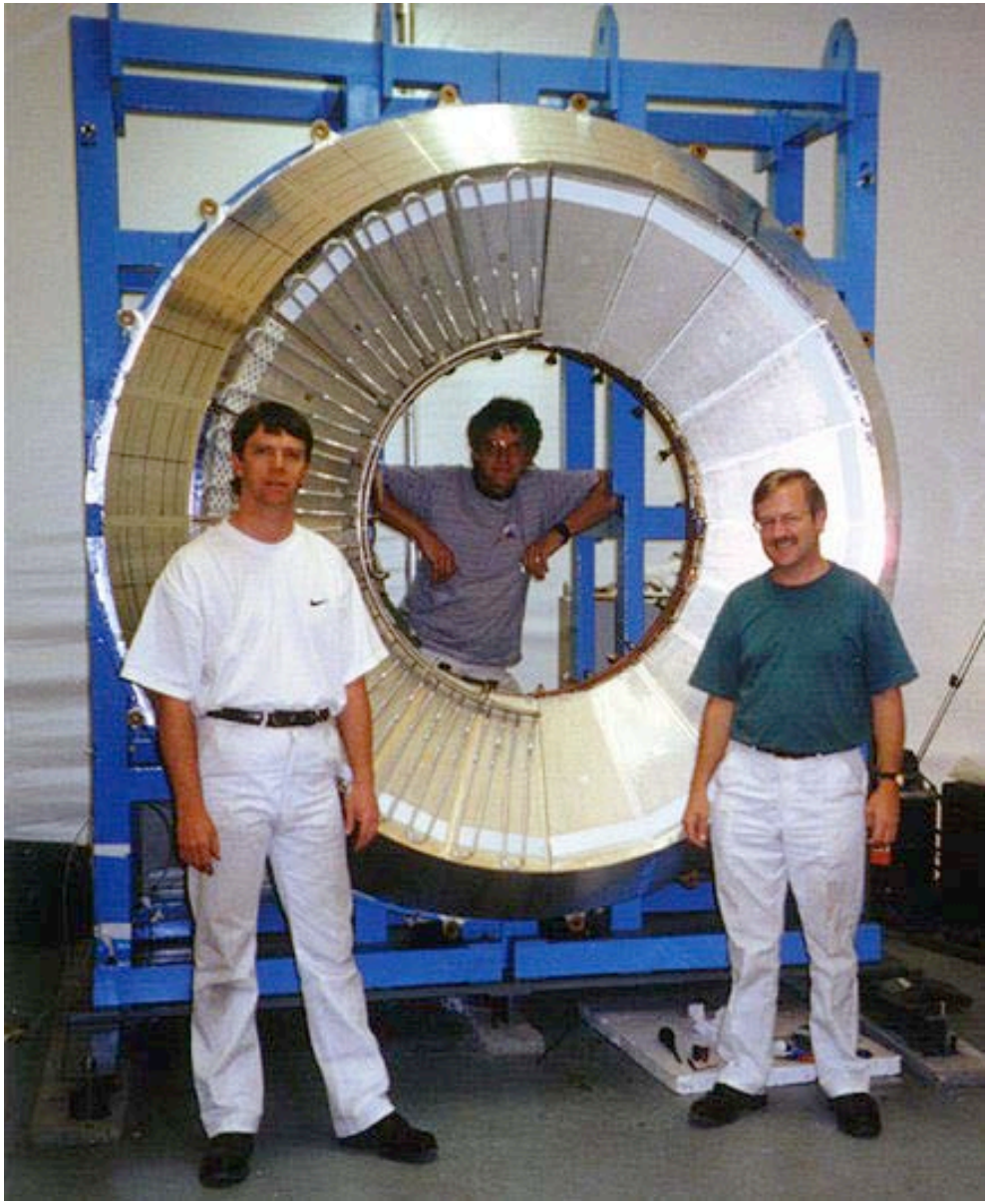
- evolution from a polymer screen for L3 ECAL endcaps
- The real screen would have
  - 40 radial branches inst. of 10
  - increased feeding channel sections
- estimated 8kg spread Al mass per screen
- *Rollbond not fit for unit parts*
- *Looking for variations*

Cooling & thermal regulation

- Coolant
  - **Babar Fluorinert (FC77)**
    - Derivation from existing barrel system
    - Saving on system
  - Or demin. water
    - heat capacity x 4
    - viscosity -30%
    - Spending on system

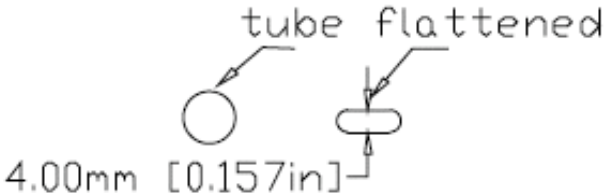
Calibration - Monitoring

- Use as much as possible from Babar monitoring design features,
- Coolant in particular
  - **Babar Fluorinert (FC77) with FDG tracer**
- but…
  - Al welding very delicate (was Babar lucky?)
  - Integrate pipe work into support front plate sandwich
- Other solutions
  - ***Rollbond*** screen (or equivalent) as sandwich inner skin



Babar endcap monitoring pipe work

- 40 radial loops
- aluminium alloy
- OD 9,5mm ID 8,5mm
- Flattened to 4mm



- Total pipe mass ≈10kg
- Fluid coverage 1,3 litre
- Line spacing ≈ 70mm

Thanks