



European Organization for Nuclear Research

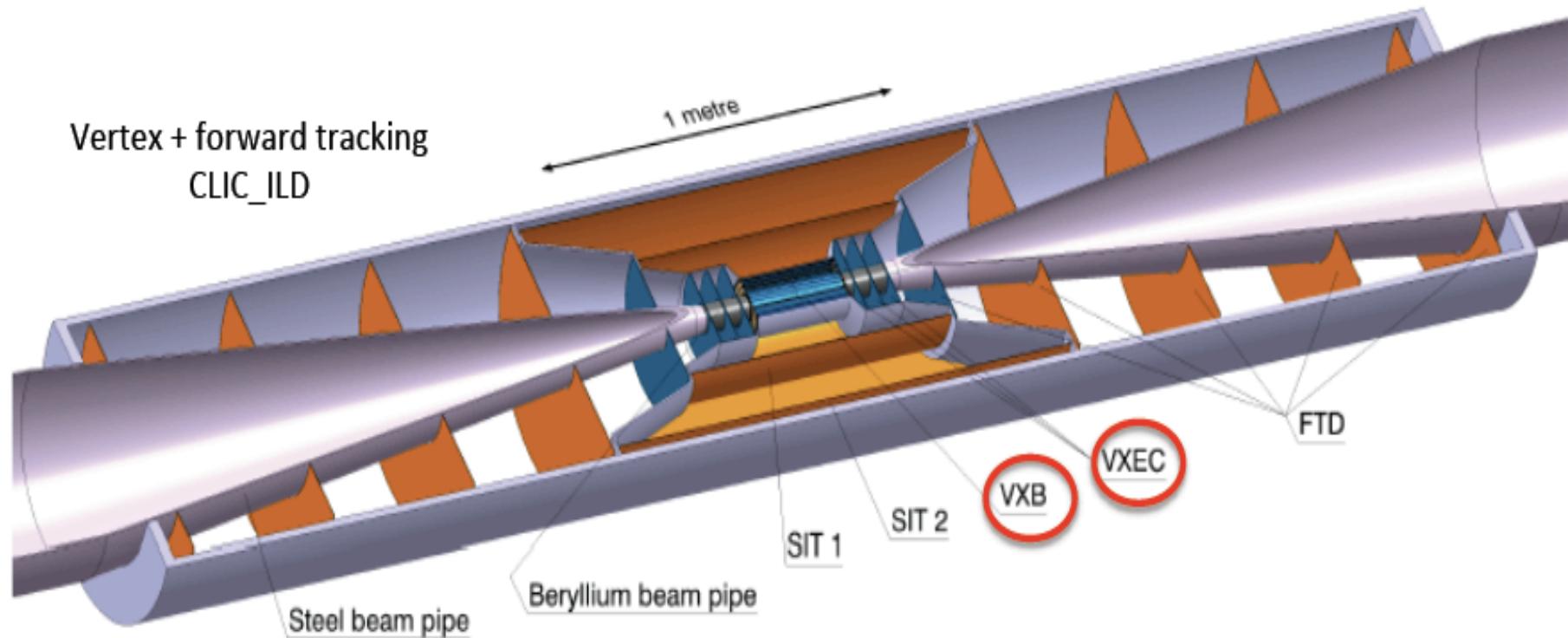


Air cooling and mechanical support of the CLIC_ILD vertex detector

Presented by H. Gerwig
on behalf of F. Duarte Ramos

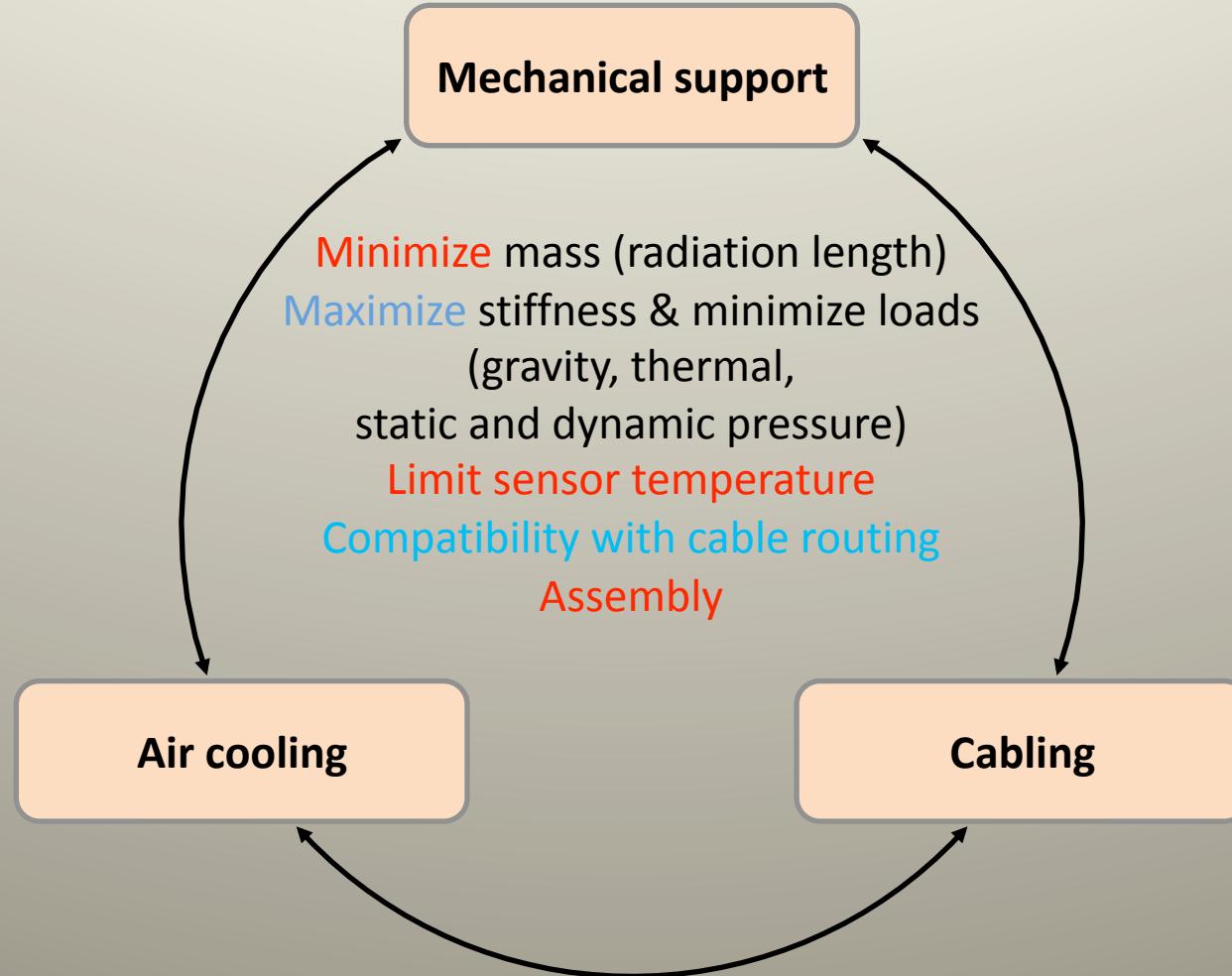
Aircooling?

No way!

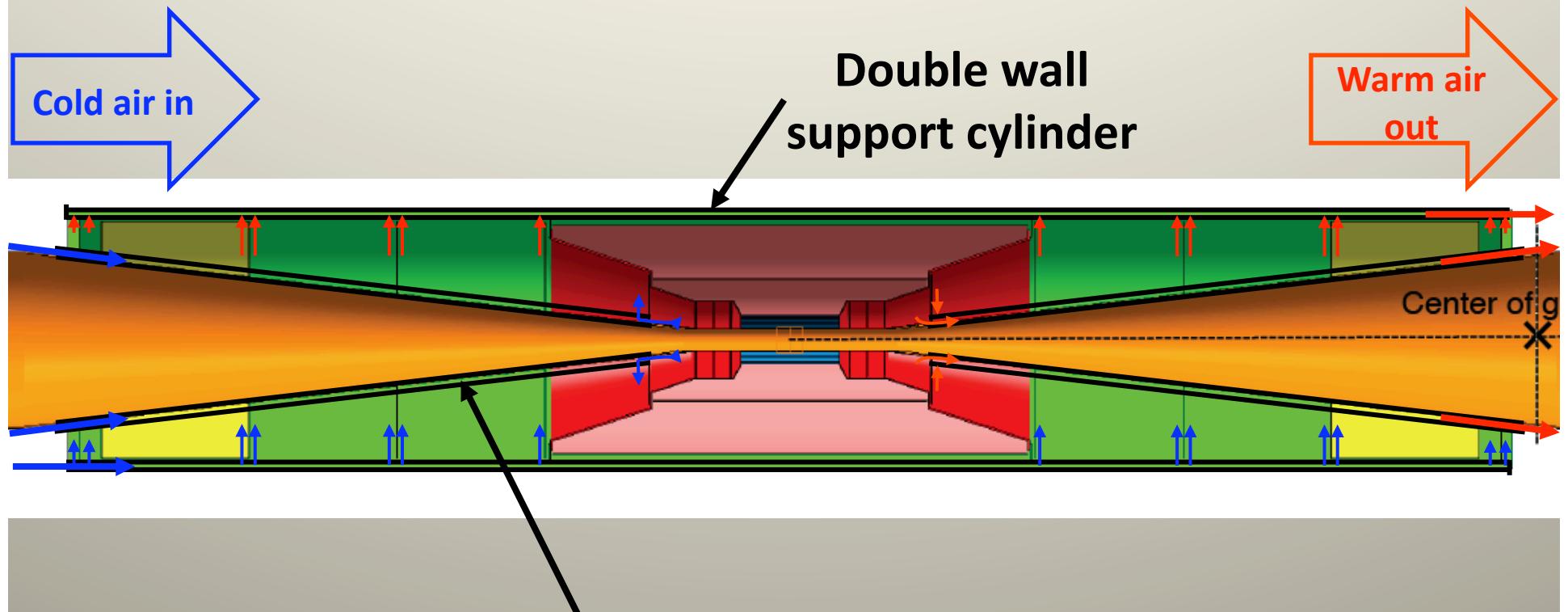


You have to provide air inlets and outlets somewhere!

Contradictory requirements



Air delivery



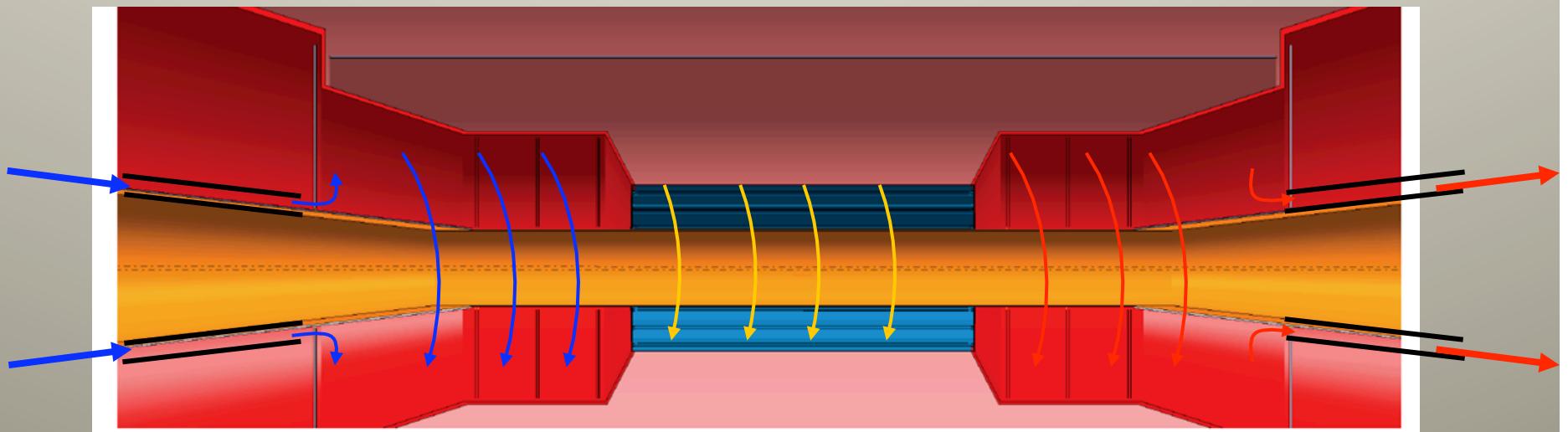
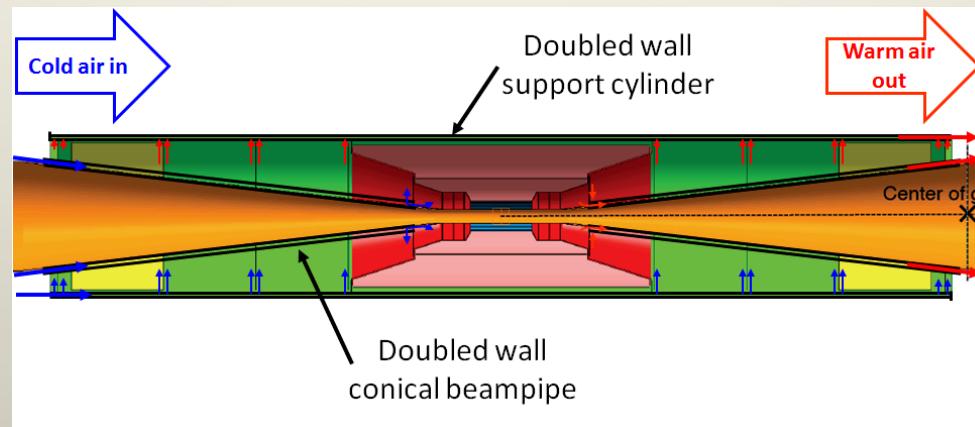
Double wall conical beampipe

CLIC CDR: thickness=4mm Stainless steel

Proposed: thickness=2mm SST + 10mm gap + 2mm SST

*Exact value will depend on beampipe strength calculations

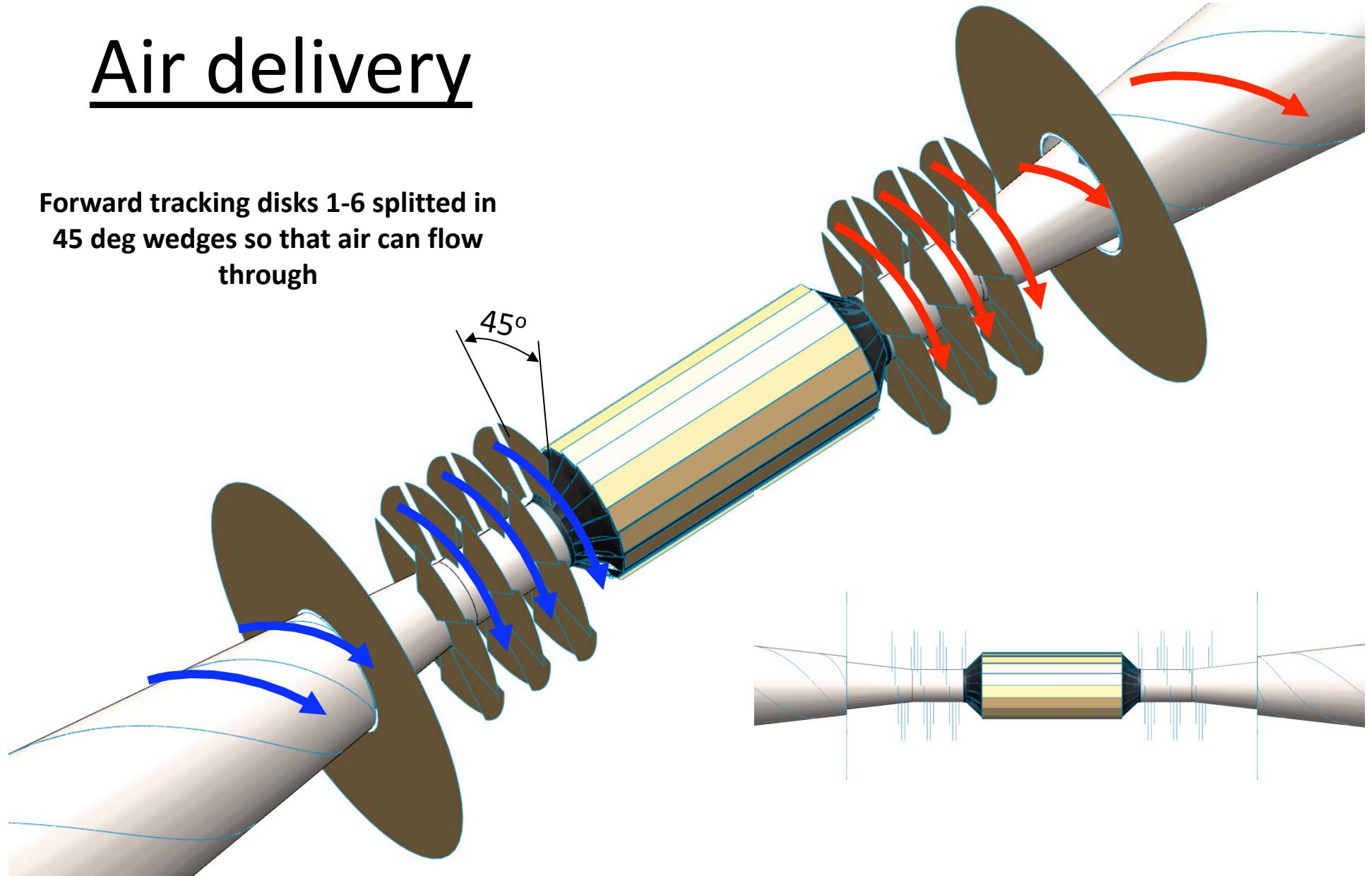
Air delivery



**A rotating flow improves the heat transfer
and allows to go around some obstacles (see next slide).**

Air delivery

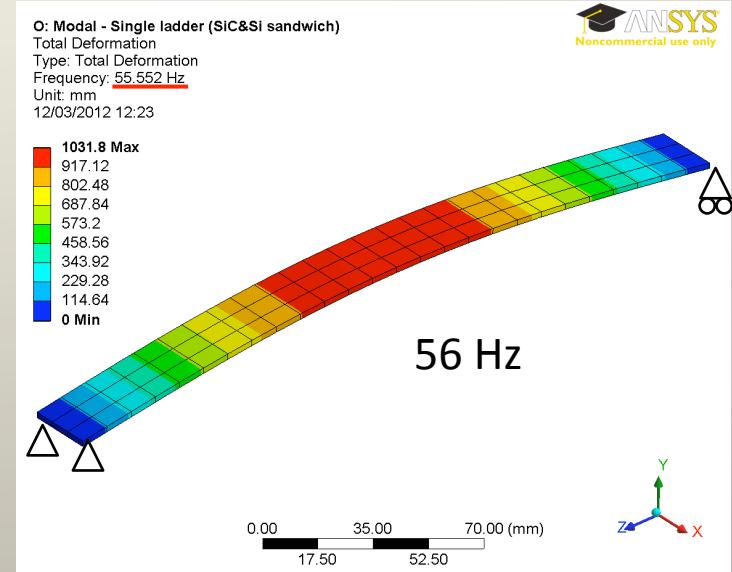
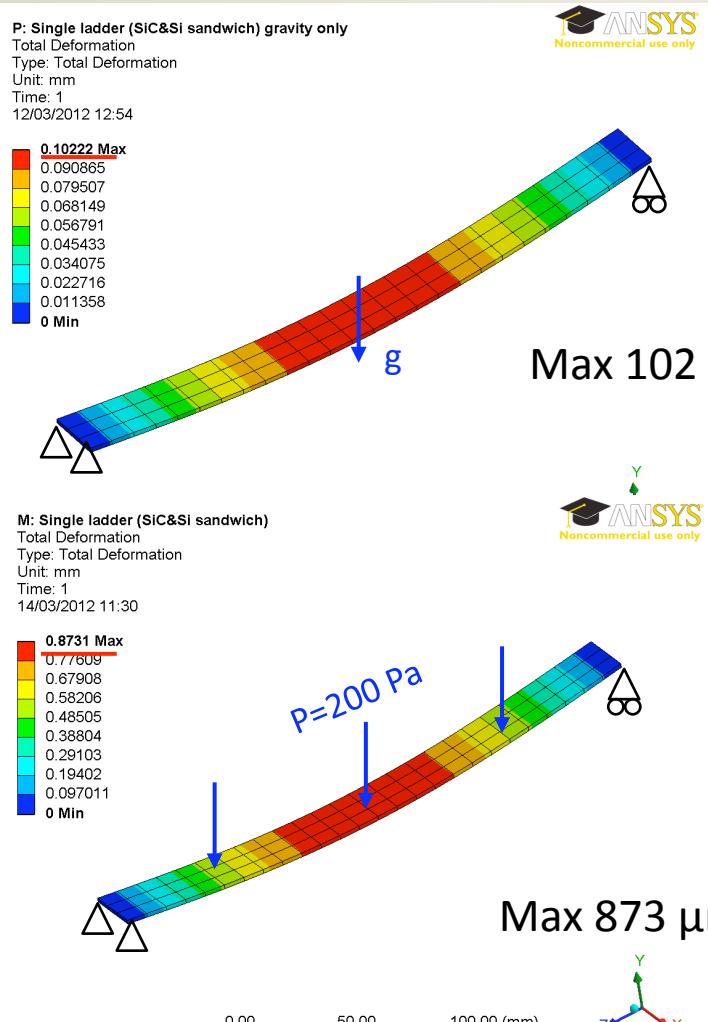
Forward tracking disks 1-6 splitted in 45 deg wedges so that air can flow through



“No” extra material needed for the cooling (ducts, pipes, etc.).

Pixel barrel ladder support

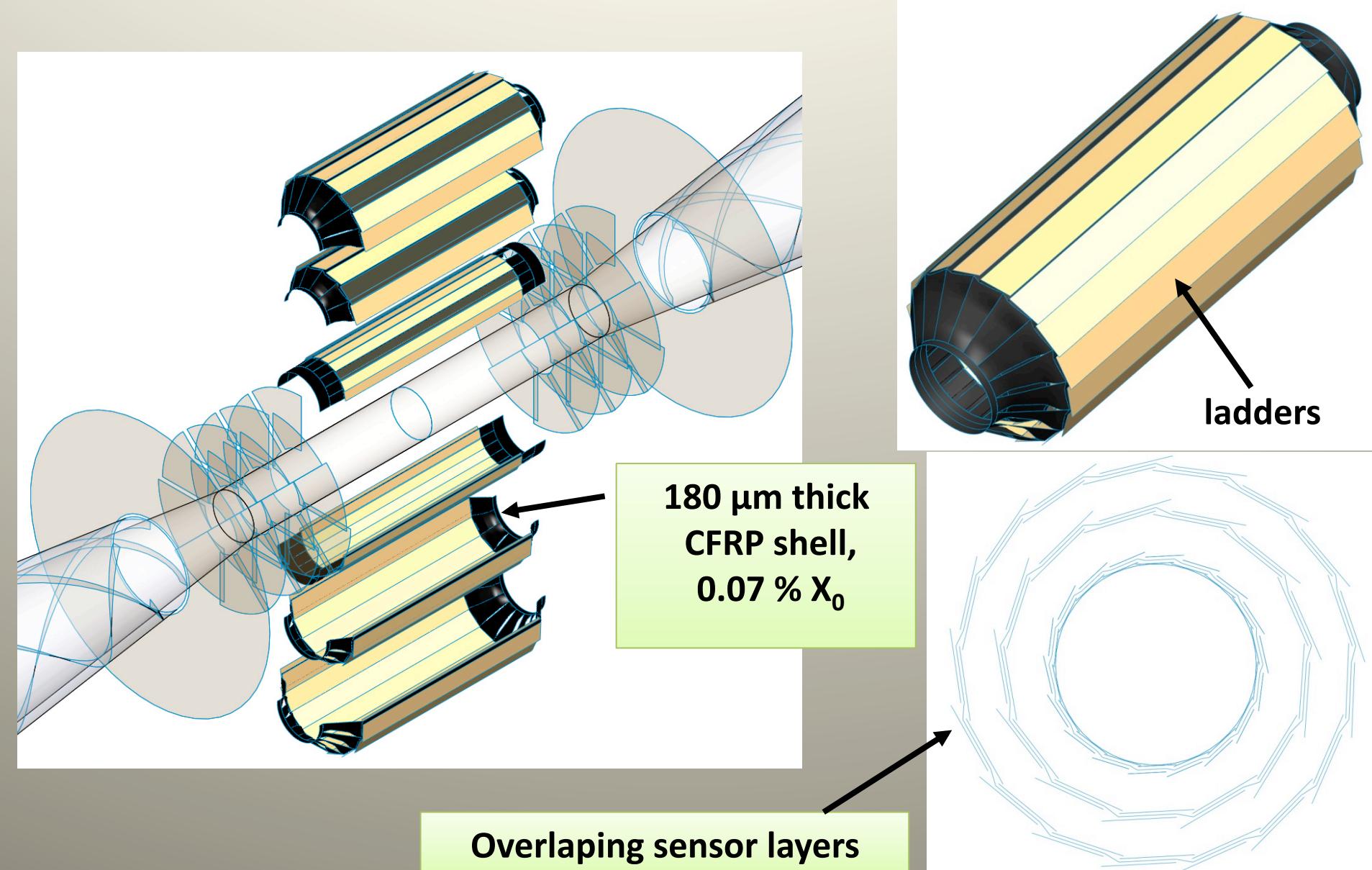
Single ladder example: thickness=2mm SiC foam + 2x50 μ m Si



Vibration induced displacements ?

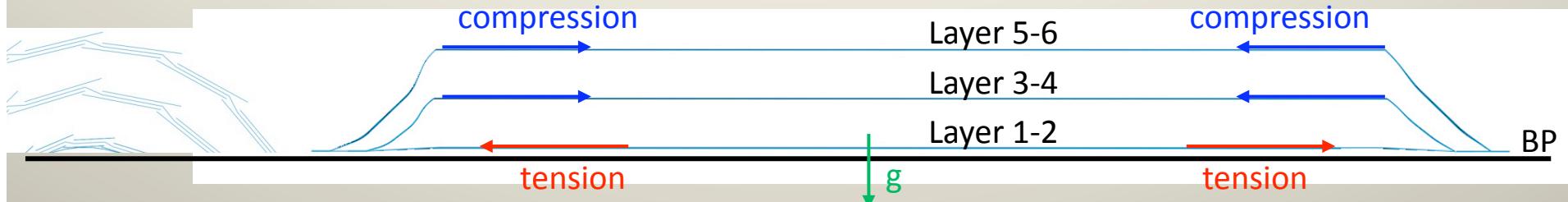
ladder simply supported is considered not stiff enough.

Pixel barrel ladder support cylinders

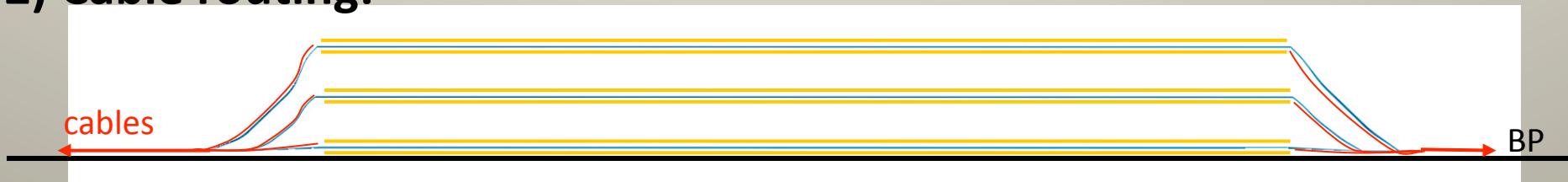


Pixel barrel ladder support – functions

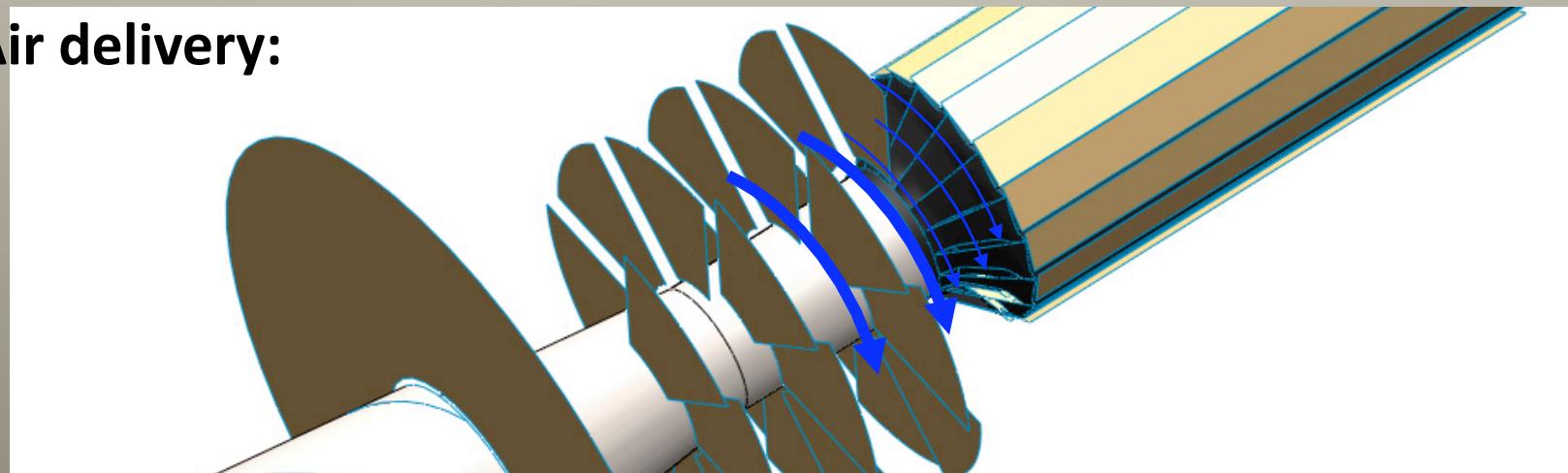
1) Stiffness:



2) Cable routing:



3) Air delivery:



Pixel barrel ladder support

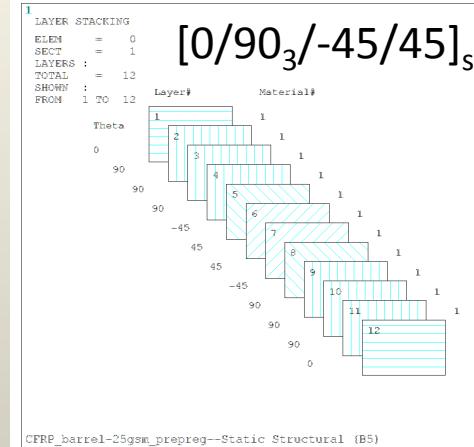
Details

Material: Fibers – Torayca M55J ($E=540$ GPa)
Resin – Cycom 950-1

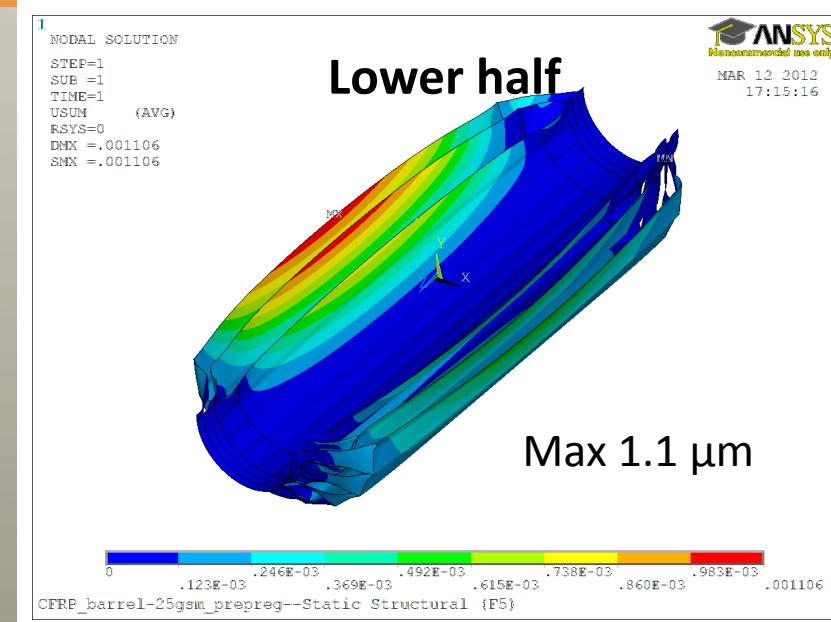
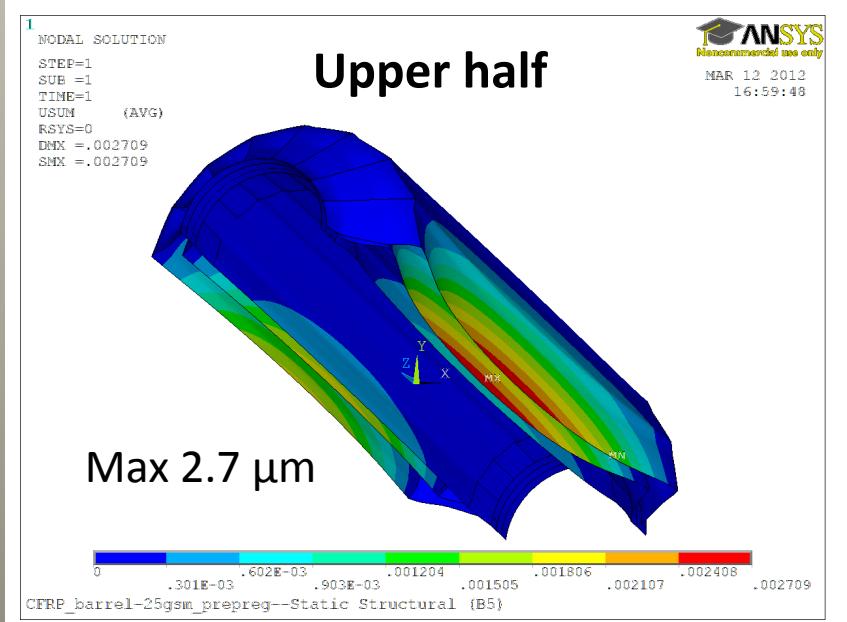
Prepreg: 25 g/m² UD (e.g. North Thin Ply Technology)

Thickness: 180 μm (12 layers)

Total mass: 84 g (upper half 40 g; lower half 44 g)



Deformation under gravity

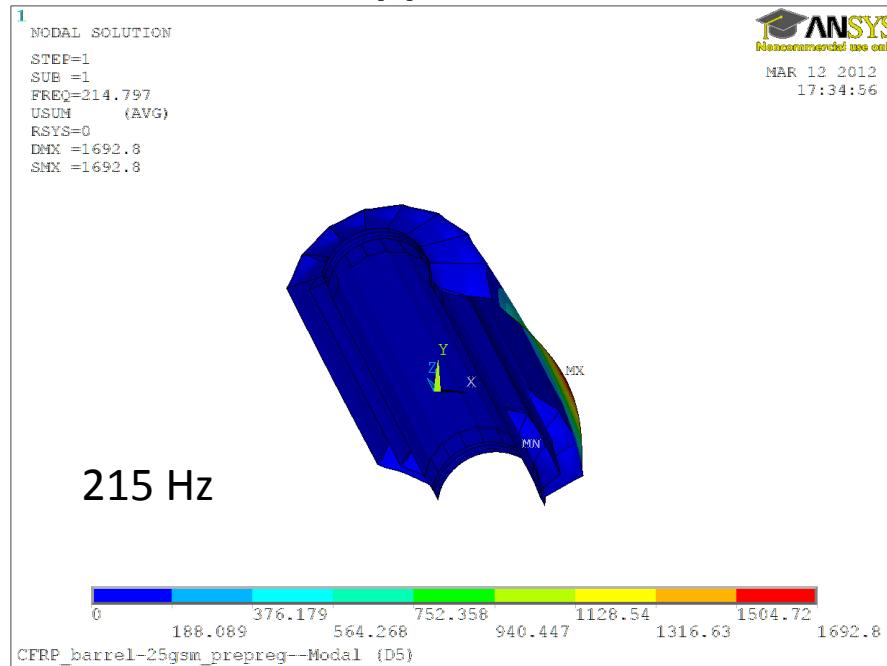


N.B.: Ladders not yet included

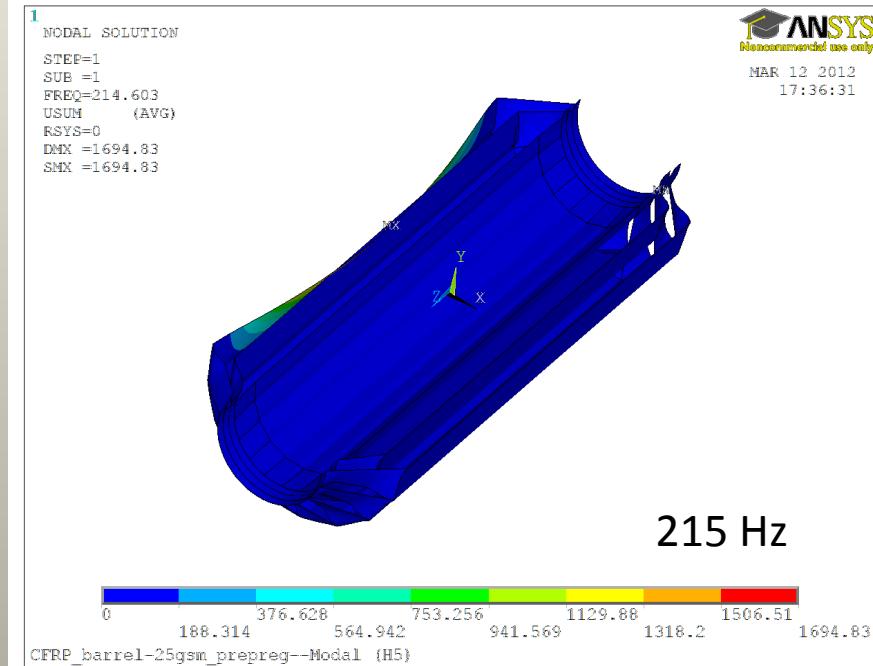
Pixel barrel ladder support

Natural frequencies

Upper half



Lower half



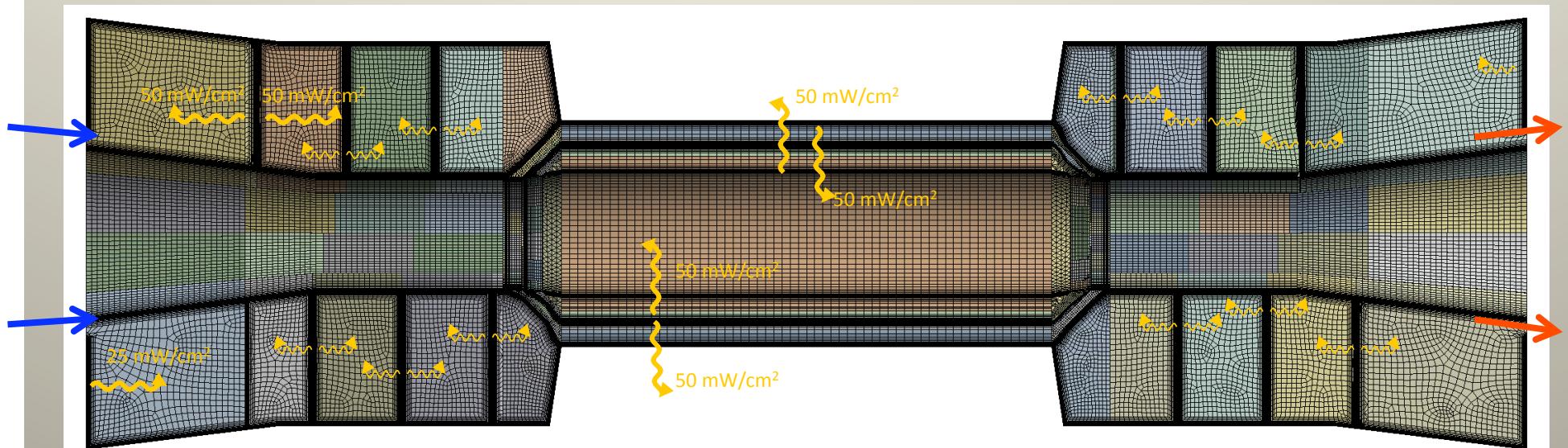
Very stiff design.

N.B.: Ladders not yet included

FEM boundary conditions

$V_{z\text{ in}}=5.4 \text{ m/s}$
 $V_{\theta\text{ in}}=9.7 \text{ m/s}$
 $m_{\text{flow}}=20.1 \text{ g/s (16.2 l/s)}$
 $T_{\text{in}}=0 \text{ }^{\circ}\text{C}$

$P_{\text{out}}=0 \text{ Pa}$



Heat loads:

FTDs 1-6	179 W
FTD 7	16 W
Barrel layers 2-5	+ 152 W

346 W

Model info:

- Steady-state analysis
- 2.55M cells
- SST k- ω turbulence model

N.B.: Barrel layers 1 & 6 not yet included

Air velocity

Velocity
Streamline 1

14.9

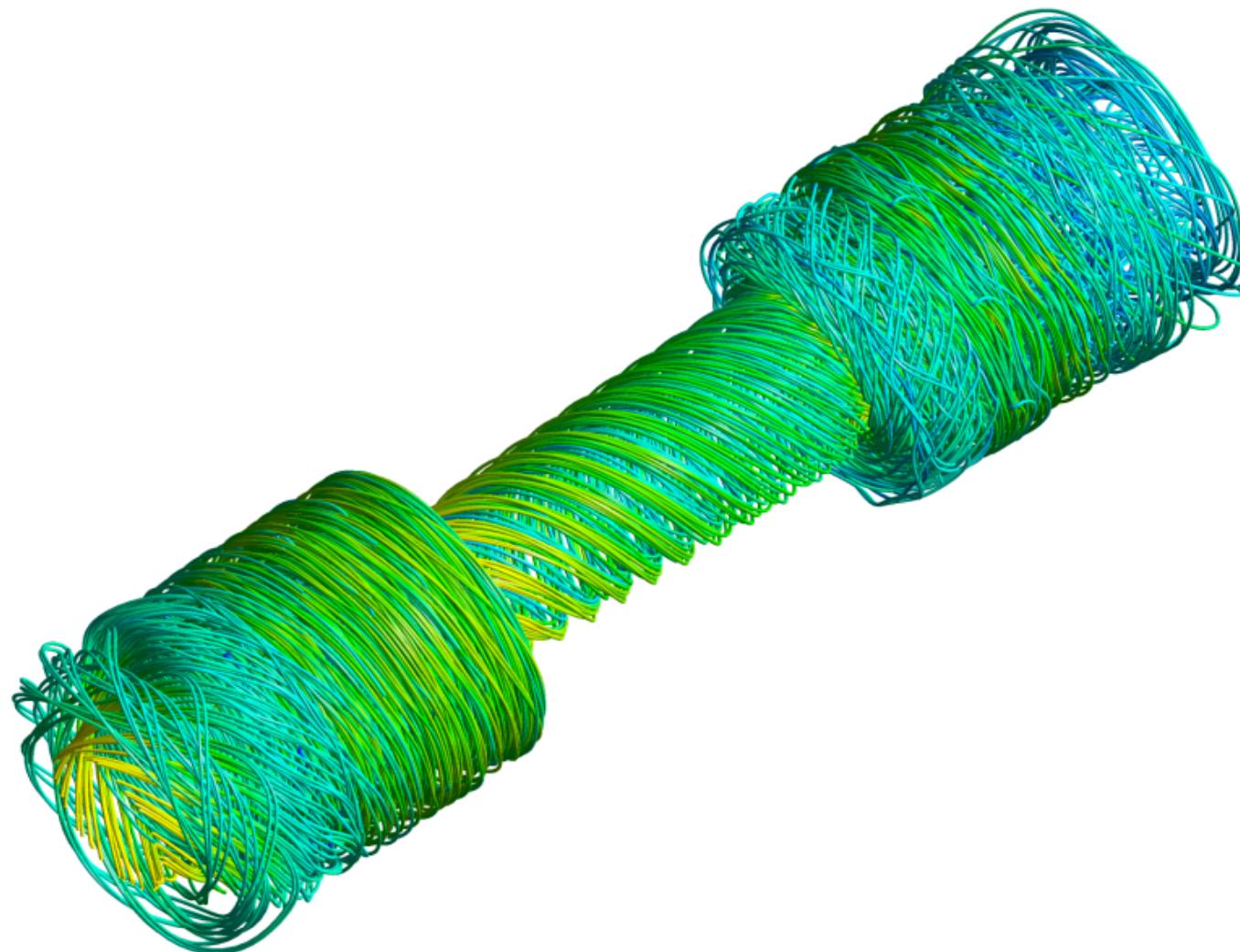
11.2

7.4

3.7

0.0

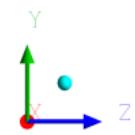
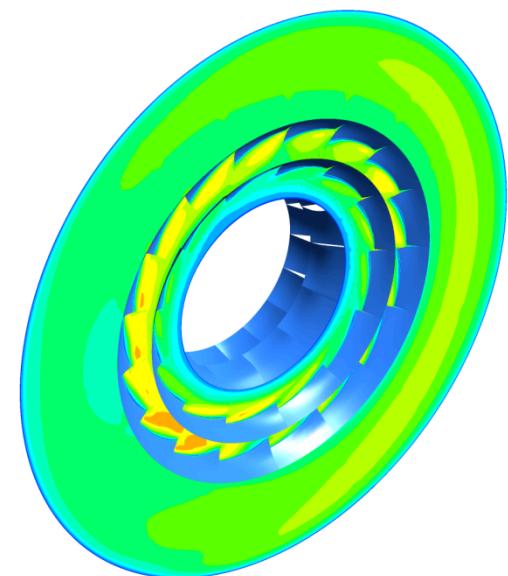
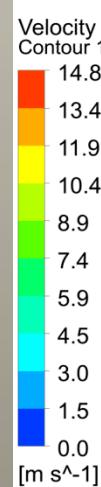
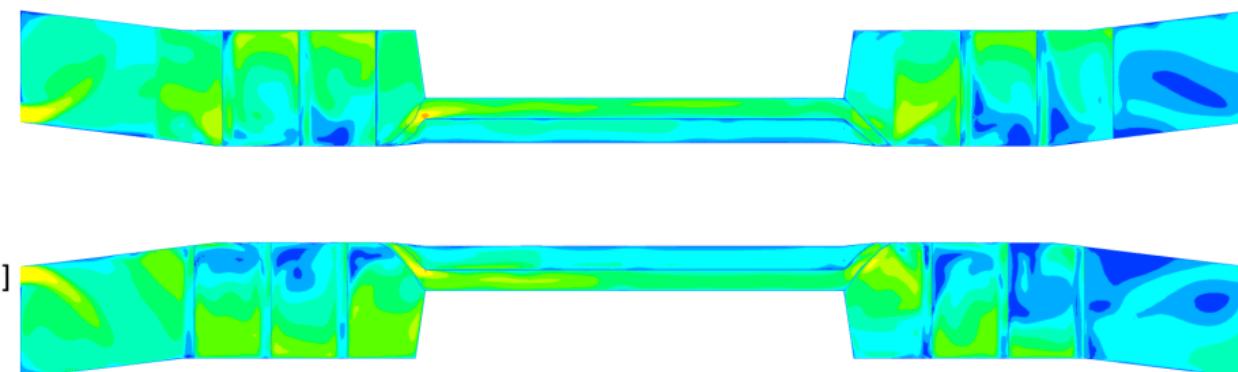
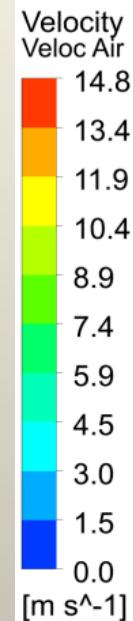
[m s⁻¹]



0 0.150 0.300 (m)
0.075 0.225

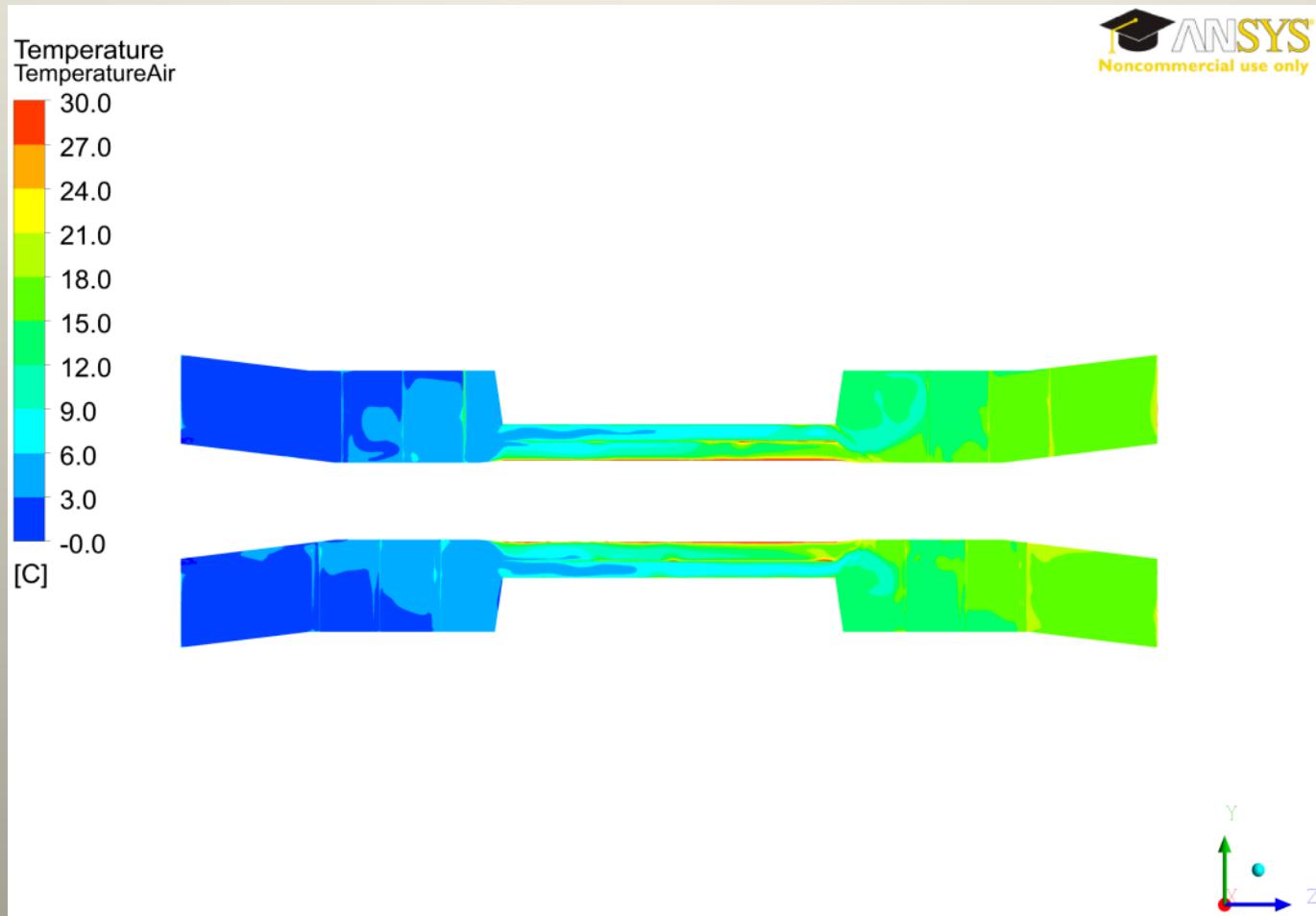


Air velocity in areas



Mass flow: 20.1 g/s
Avg. velocity @ inlet: 11.0 m/s
Avg. velocity @ Z=0: 5.2 m/s
Avg. velocity @ outlet: 6.3 m/s

Air temperature

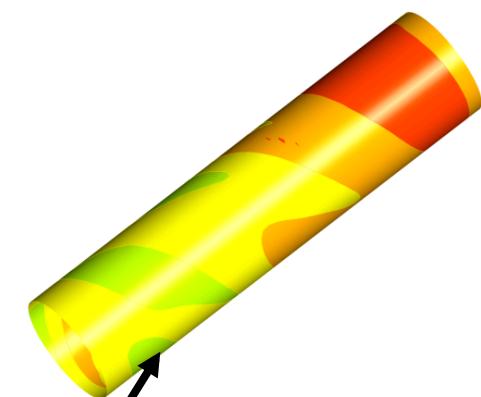
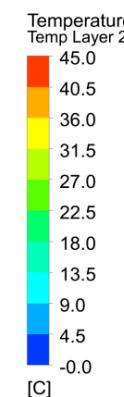
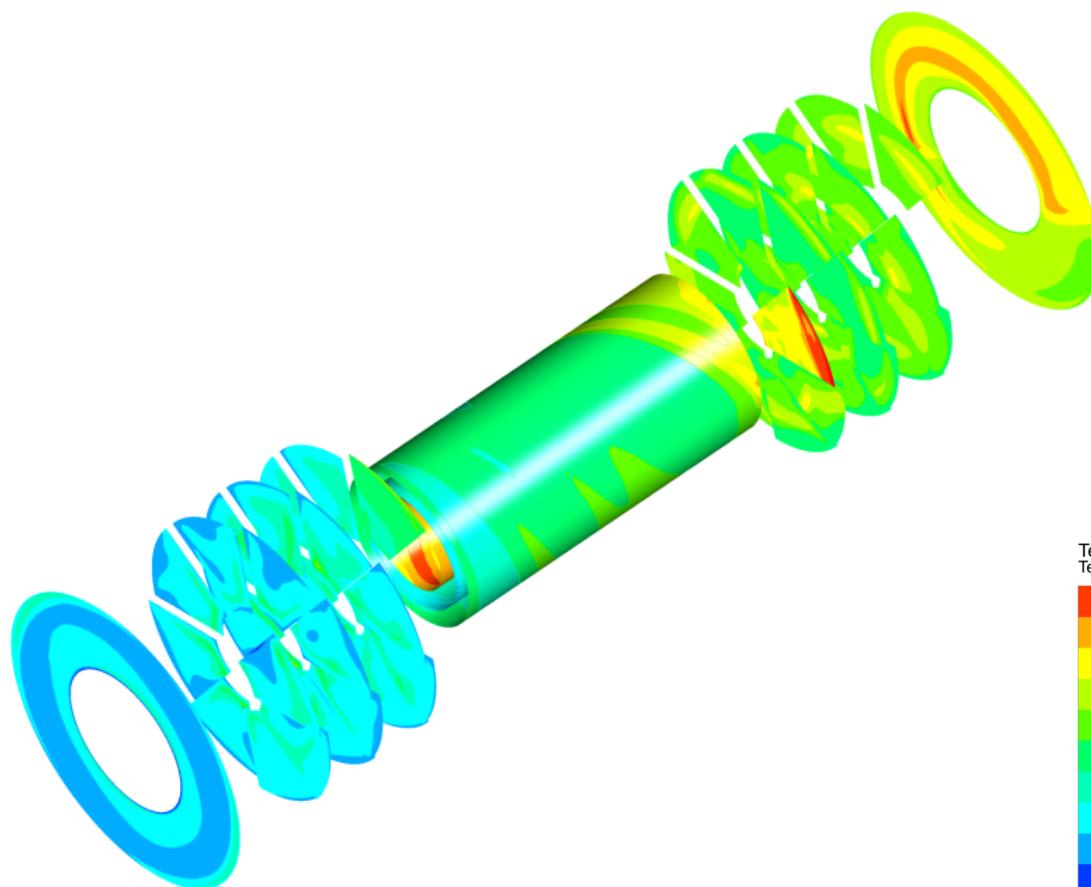


Temperature
Temp Layer 3



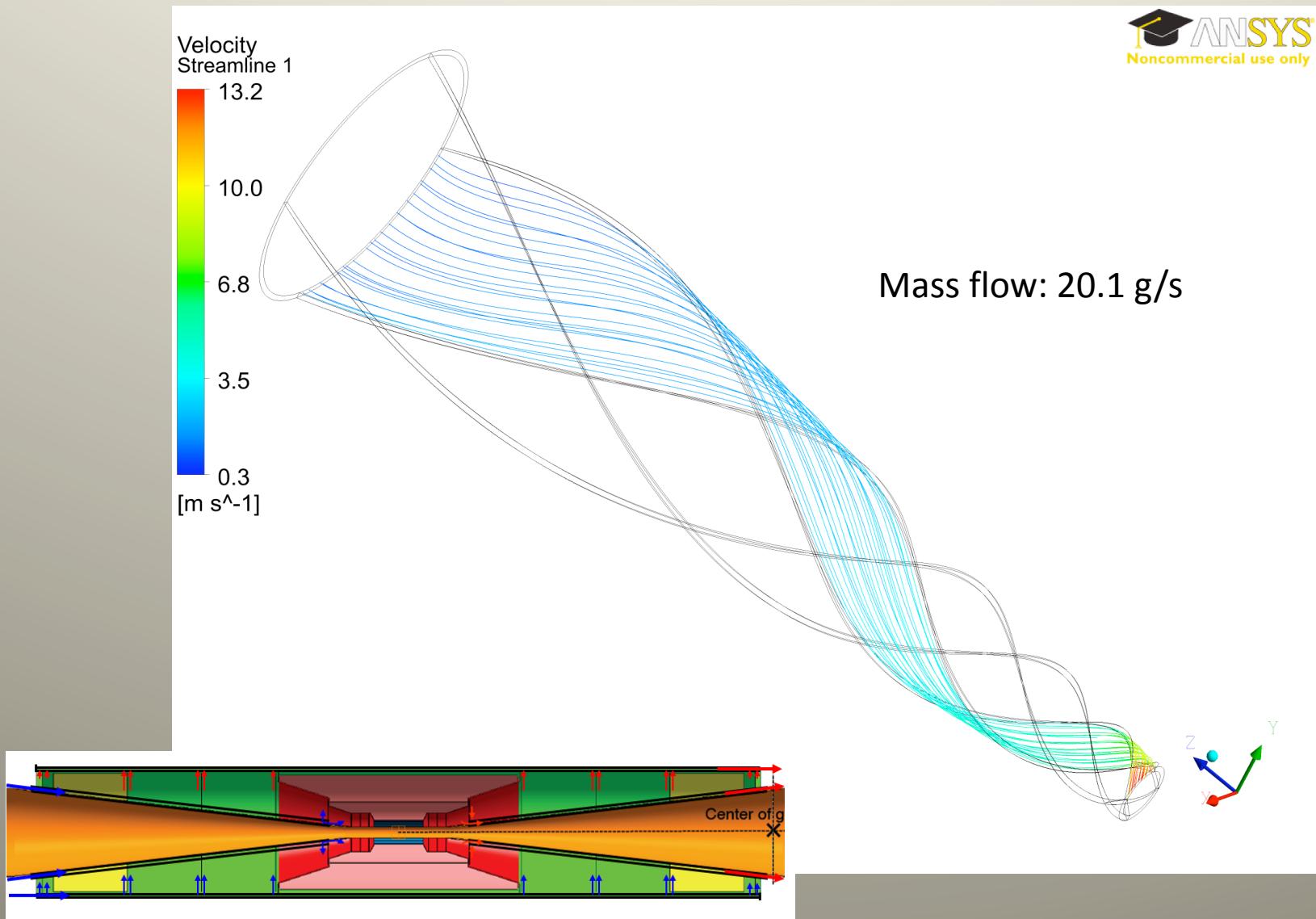
Silicon sensor temperature

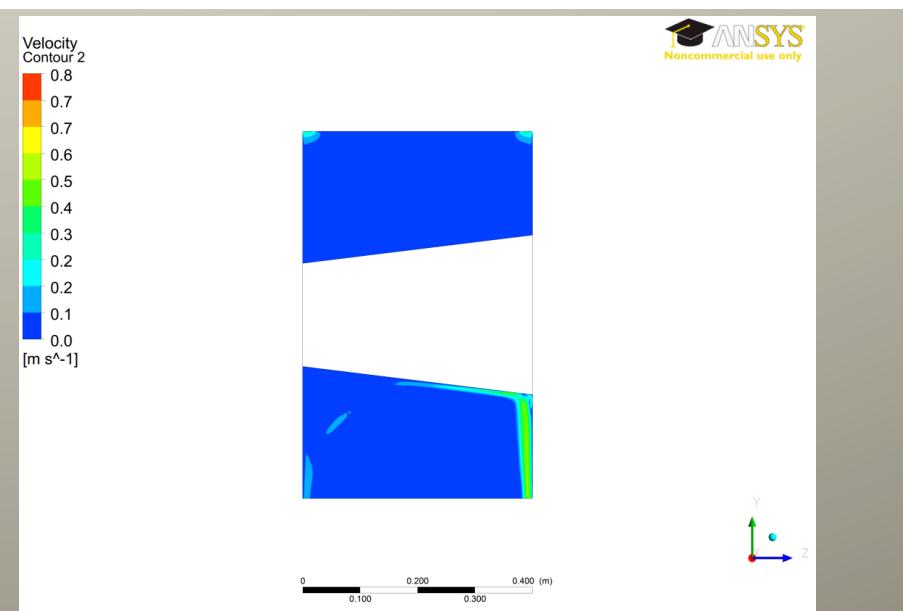
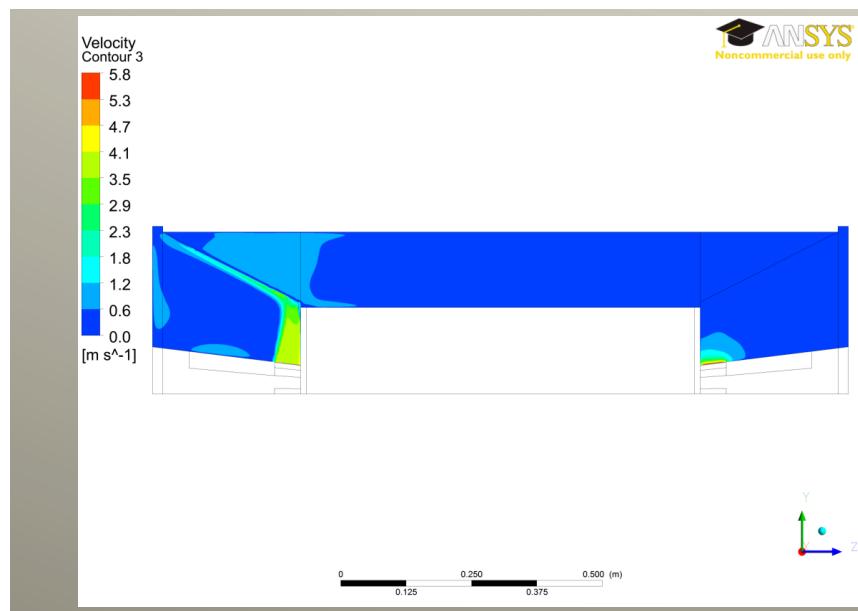
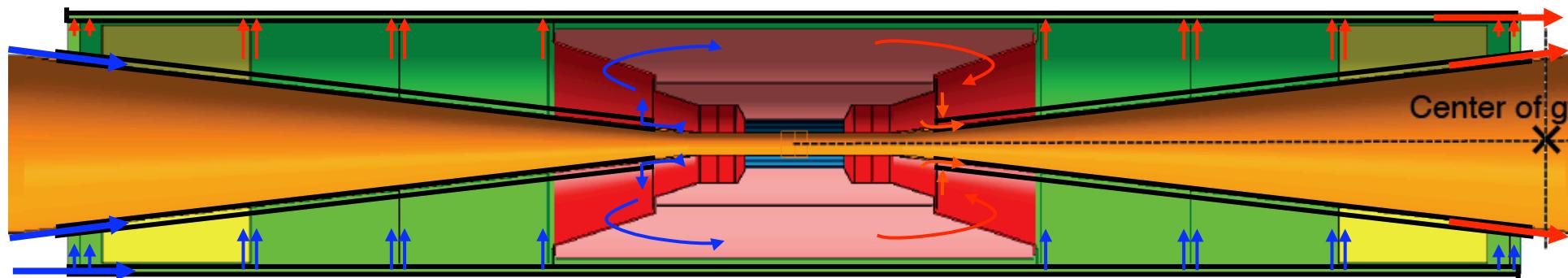
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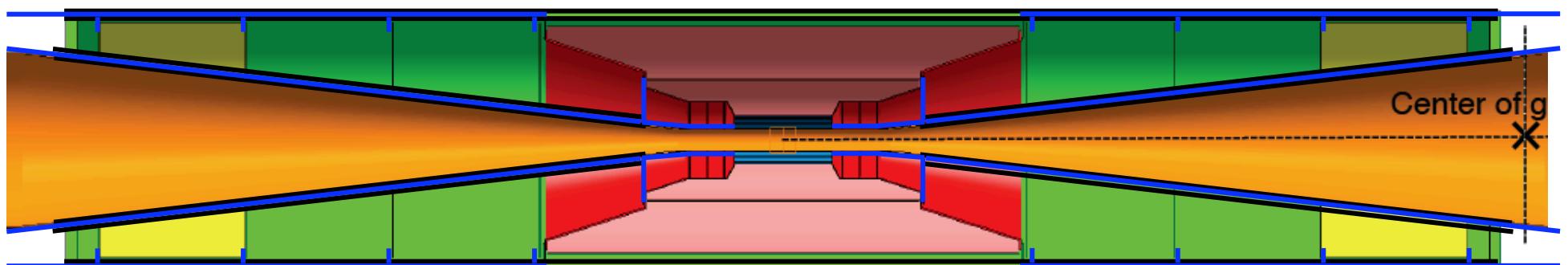
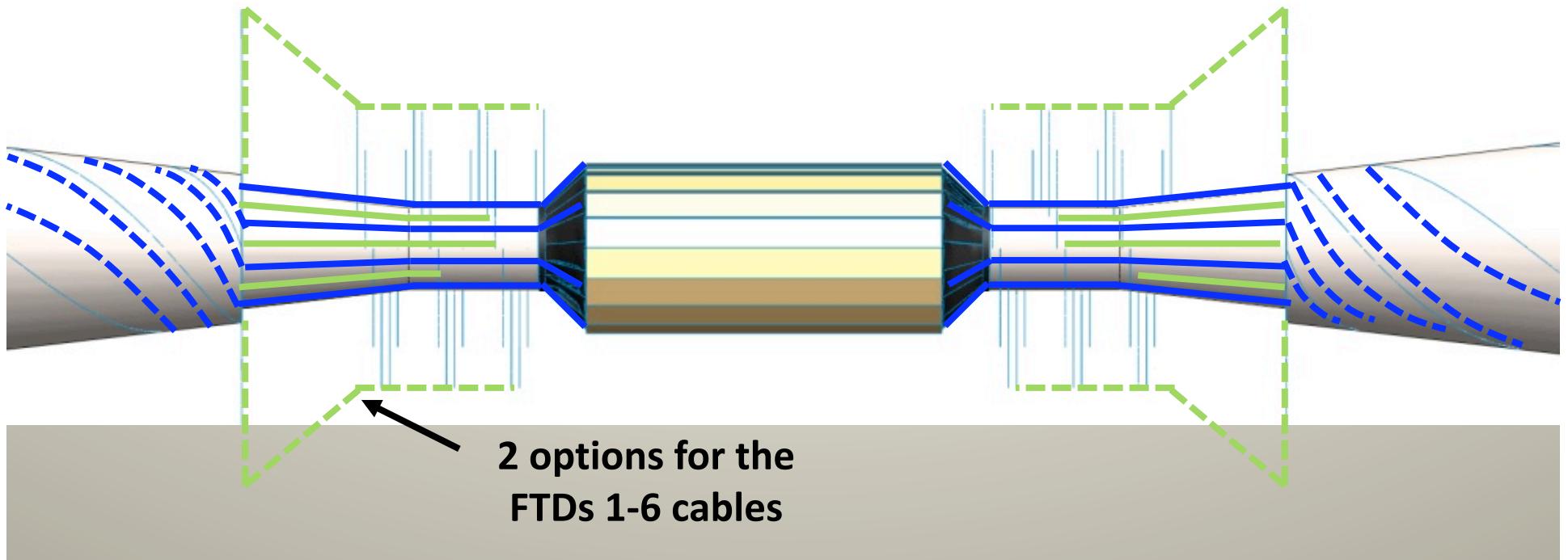
Barrel support geometry will need further optimization
(temperature at barrel layer 2 above 40 C)
Otherwise temperature is kept below 30 C

Air supply through double-wall conical beampipe





Cabling – possible routings

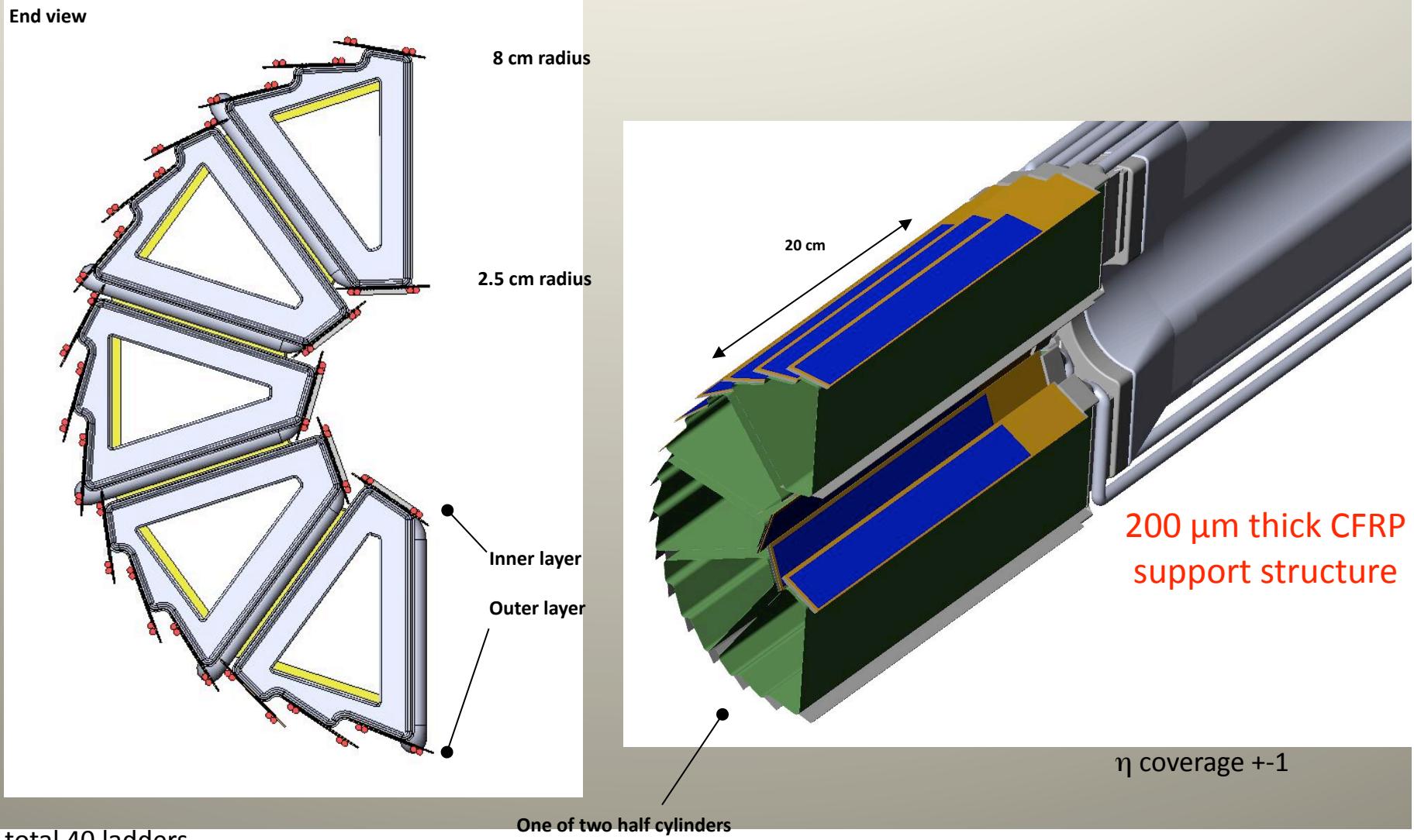


Summary

- VTX detector design must cleverly solve support, cooling and cabling issues in an integrated way
 - Current design proposal has taken these issues into account
 - This air cooling study shows encouraging first results
 - vibration is still an unknown variable, to be checked
 - At the best with a thermo-mechanical prototype

Spare slides

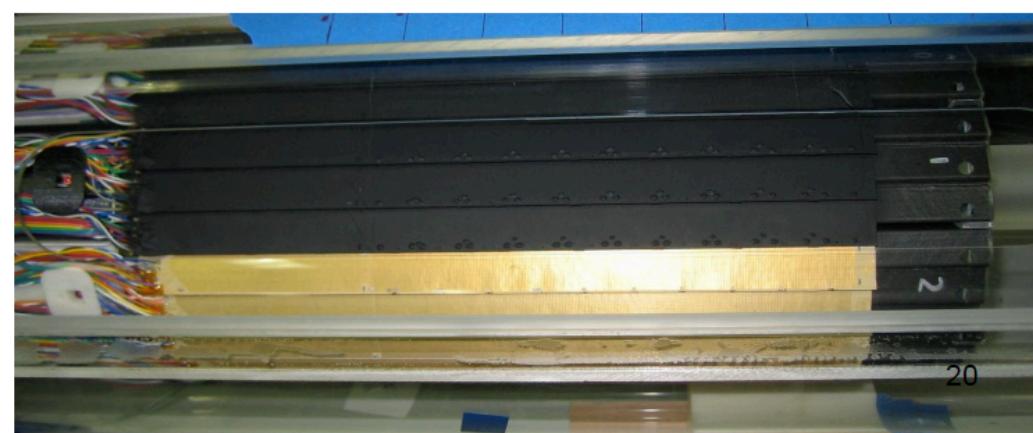
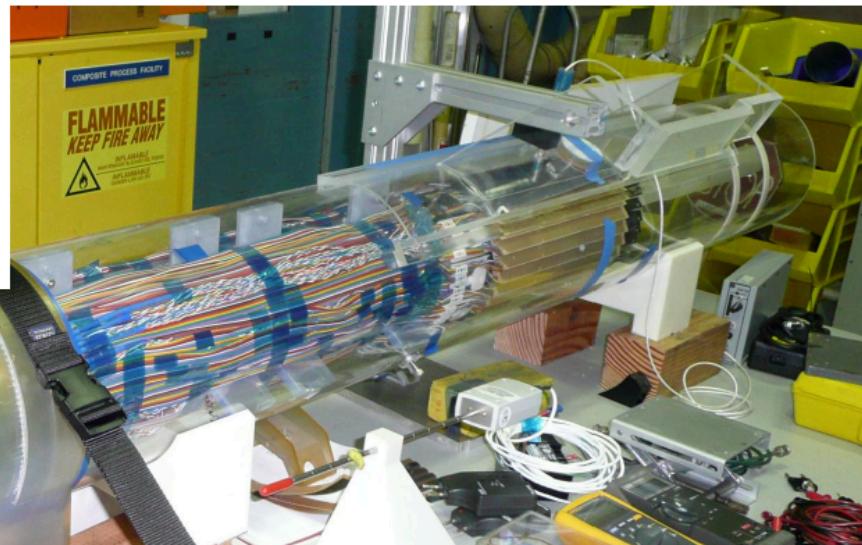
STAR Pixel Detector, Howard Wieman, LBNL



Source: H. Wieman, "HFT Pixel Detector WBS 1.2", STAR HFT CD1 Review, Nov. 2009

Spare slides

STAR Pixel Detector, Howard Wieman, LBNL Setup

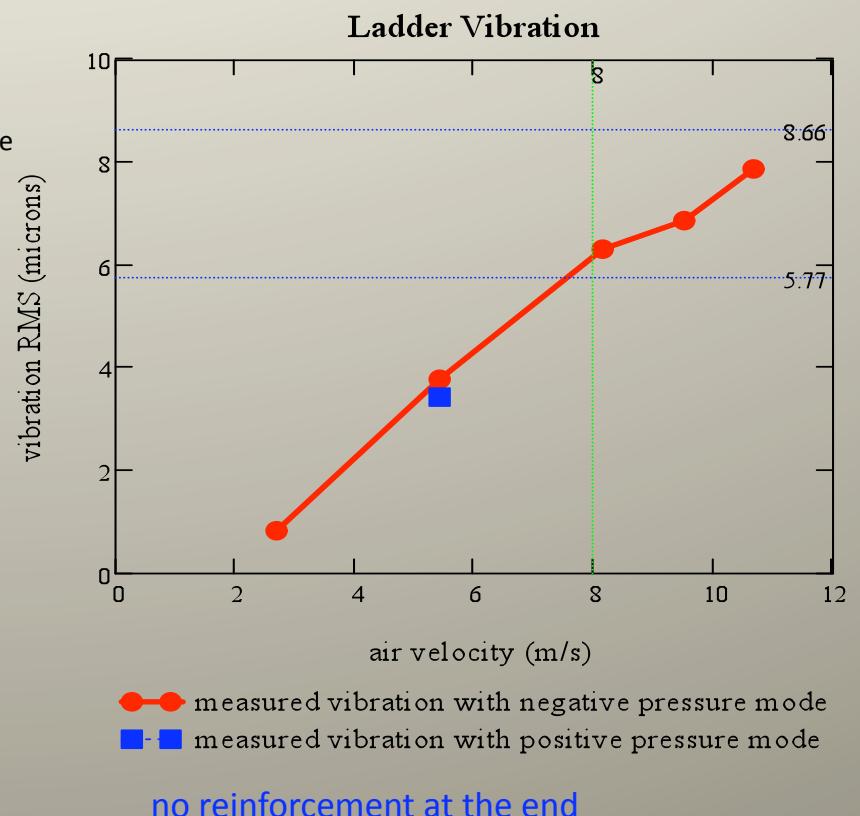
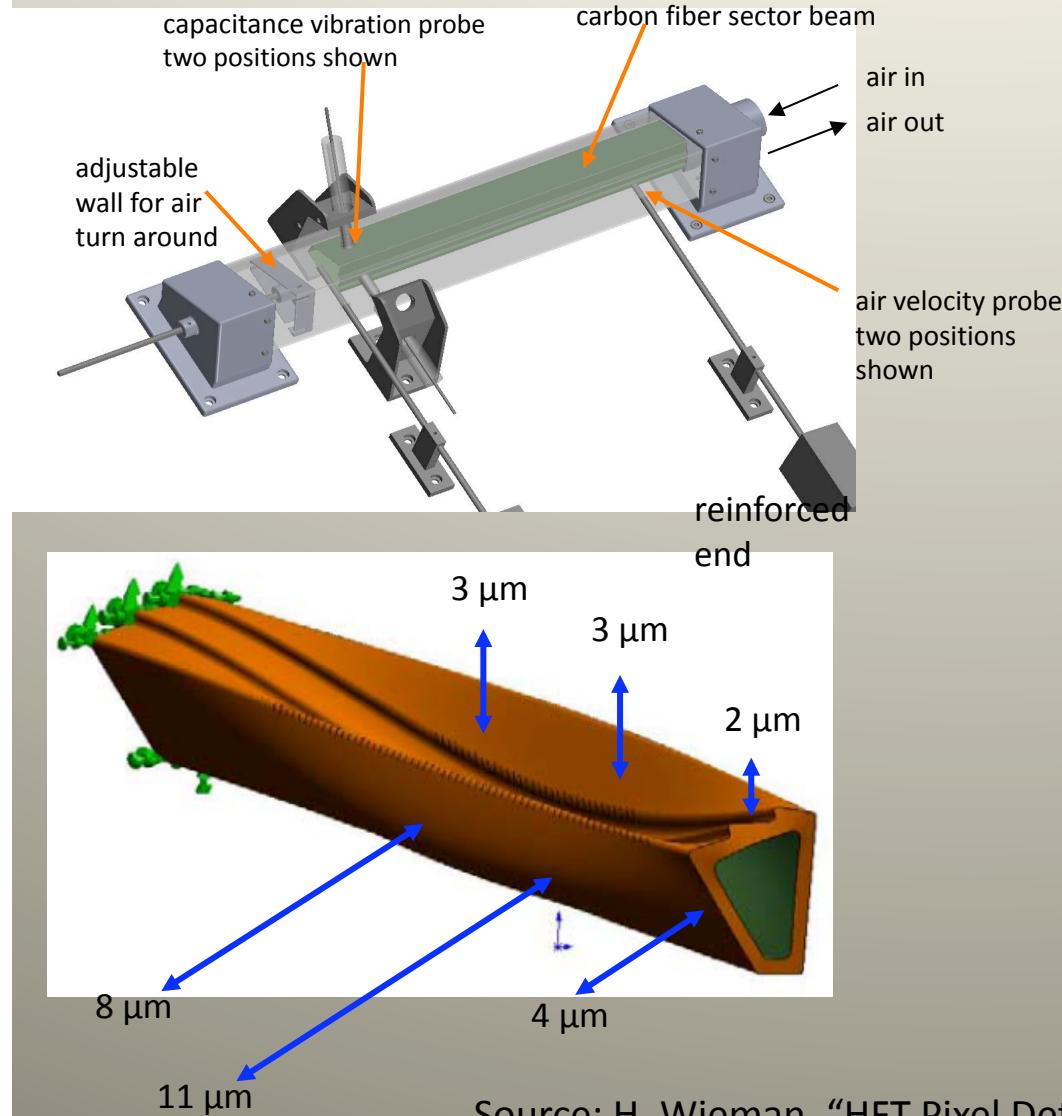


9/7/2011

Source: H. Wieman, "STAR-PXL Mechanical Integration and Cooling", St. Odile Ultra-Thin Vertex Detector Workshop, Sep. 2011

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Source: H. Wieman, "HFT Pixel Detector WBS 1.2", STAR HFT CD1 Review, Nov. 2009