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CLIC inner detectors cooling and mechanics

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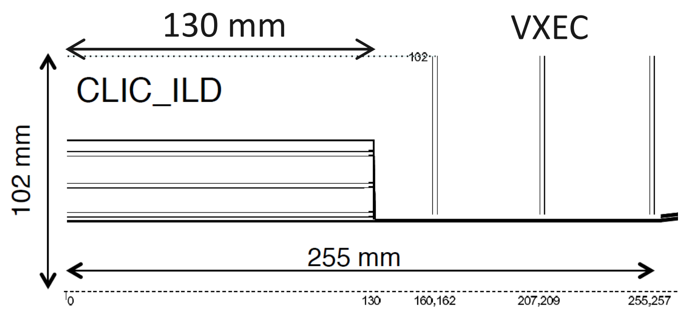
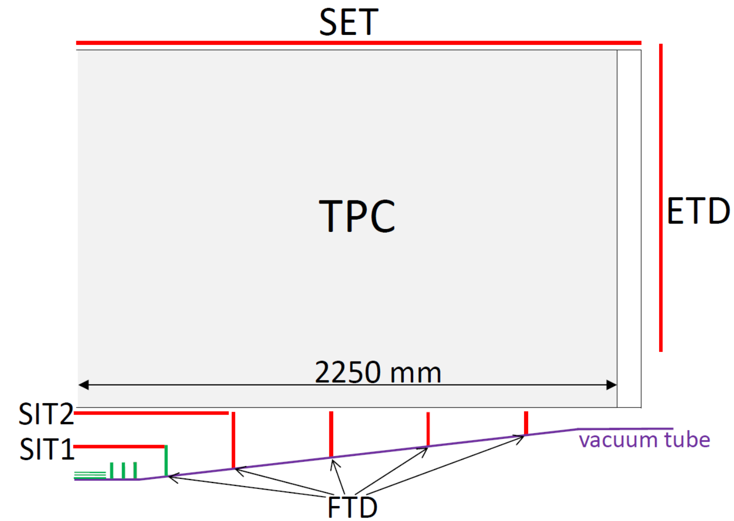
Outline

- CLIC_ILD layout and challenges;
- Air delivery and flow;
- CFD simulations;
- Lightweight mechanical support structures;
- Assembly;
- Cable routing;

CLIC_ILD Layout





- Vertex detector:
  - **Barrel** – 3 double sided silicon pixel layers;
  - **Endcaps** – 3 double sided silicon pixel disks;
- Inner tracker:
  - **Barrel** – 2 silicon micro-strip layers;
  - **FTD** – 1 silicon pixel & 4 silicon micro-strip disks;

Challenges

- Low material budget (<0.2% X/X0 per layer in VXB);
- Proper sensor cooling;
- High dimensional stability;
- Assembly and cabling integration;

- **Integrated design approach:**

Cooling, support and cabling must be treated as one single problem.

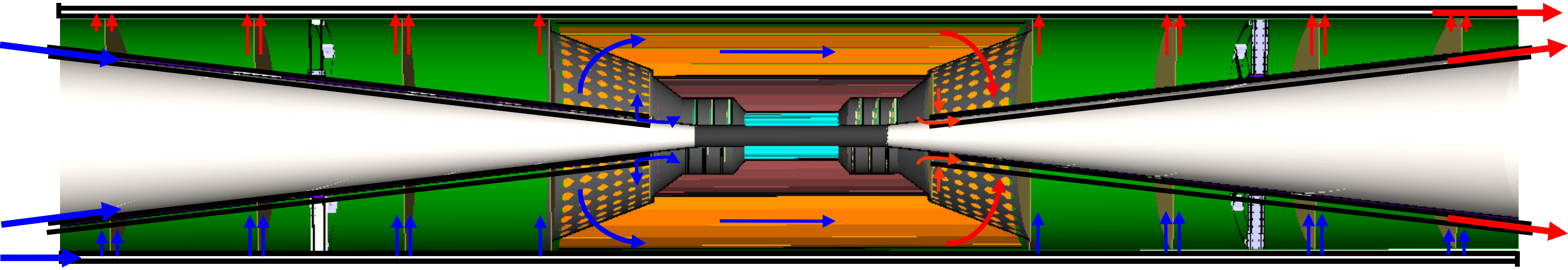
Cooling needs

- Heat dissipated:
  - Silicon pixel layers – 50 mW/cm^2 (averaged)
  - Silicon micro-strip layers – 1 mW/cm^2 (averaged)
- Heat loads:
  - VTX region ≈ 310 W
  - SIT region ≈ 30 W
  - FTD region ≈ 110 W
- Room temperature operation;
- Air cooling is envisaged;

Cold air in

Air delivery

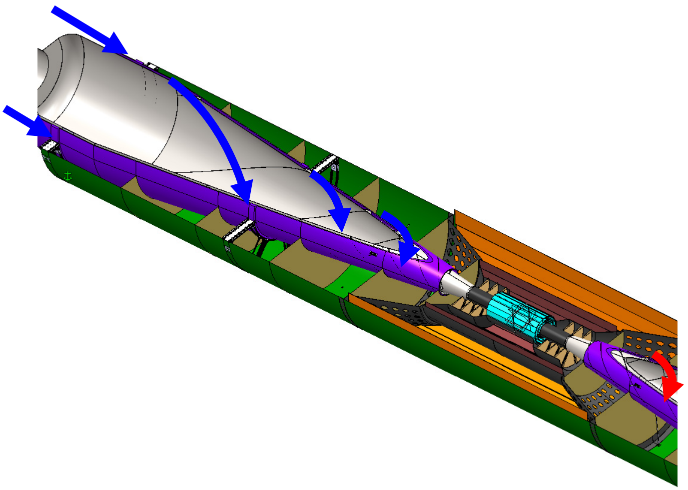
Warm air out

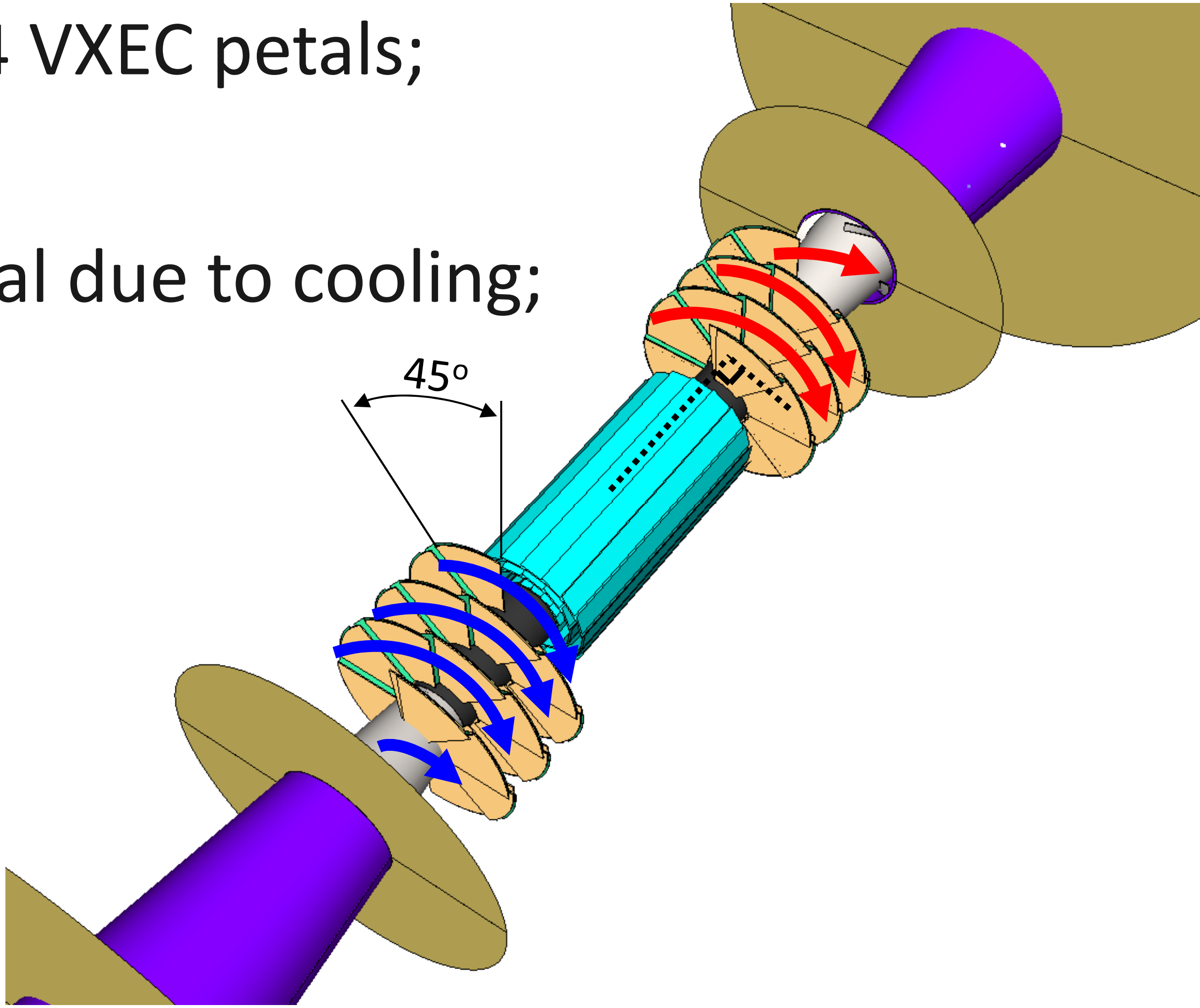


- **Two cooling supplies**
  - FTD:
    - Double wall outer support cylinder;
  - VTX & SIT:
    - **CLIC CDR –** 4mm thick SST conical beampipe portions;
    - **Proposal –** 1mm* SST + 10mm air gap + 3mm SST;

VTX barrel & endcaps

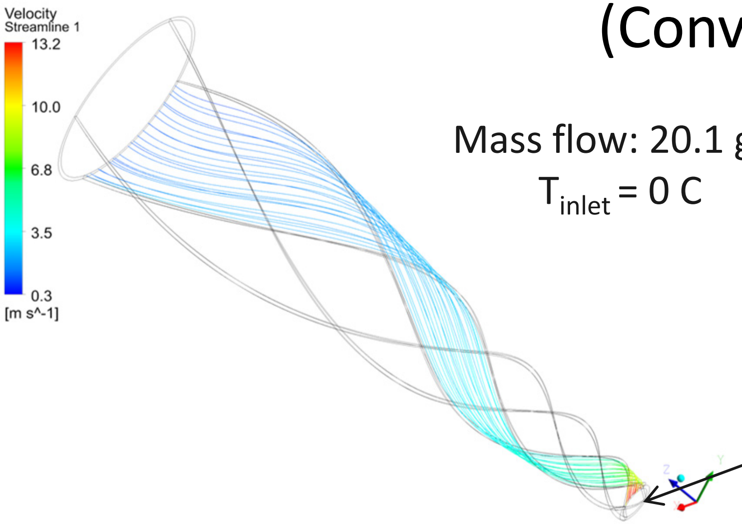
- 3 VXEC disks → 24 VXEC petals;
- Helical air stream;
- “No” extra material due to cooling;





CFD simulations - VTX

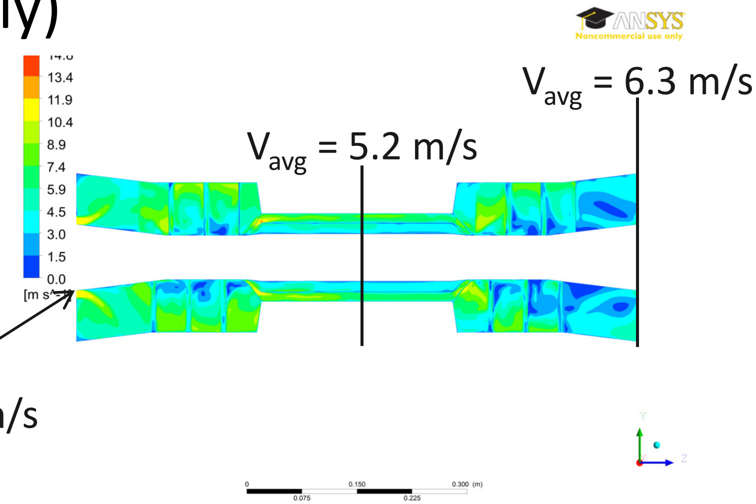
(Convection only)



Mass flow: 20.1 g/s

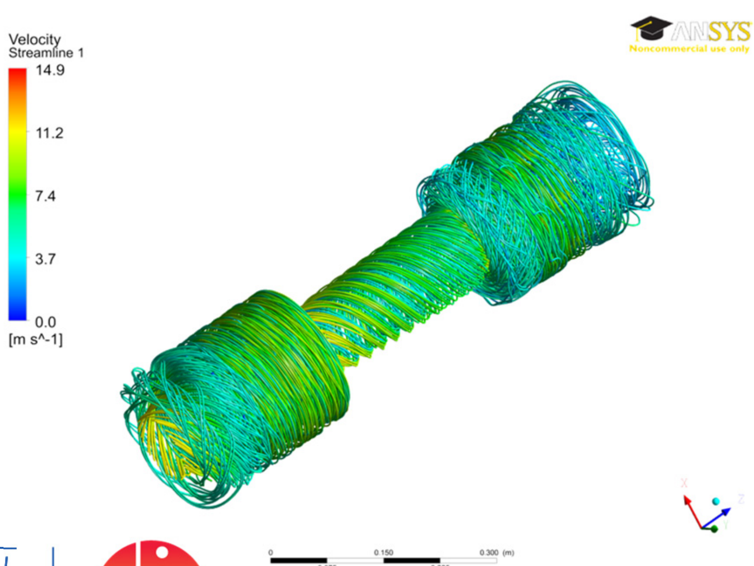
T_{inlet} = 0 C

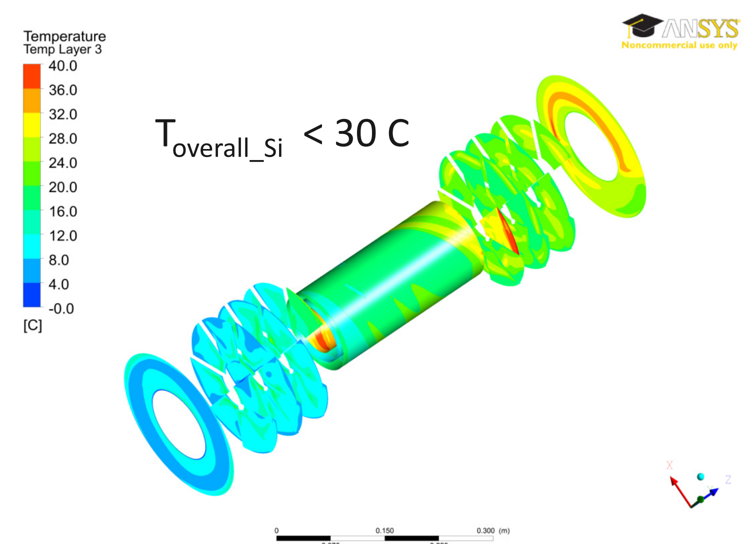
V_{avg} = 11.0 m/s



V_{avg} = 5.2 m/s

V_{avg} = 6.3 m/s

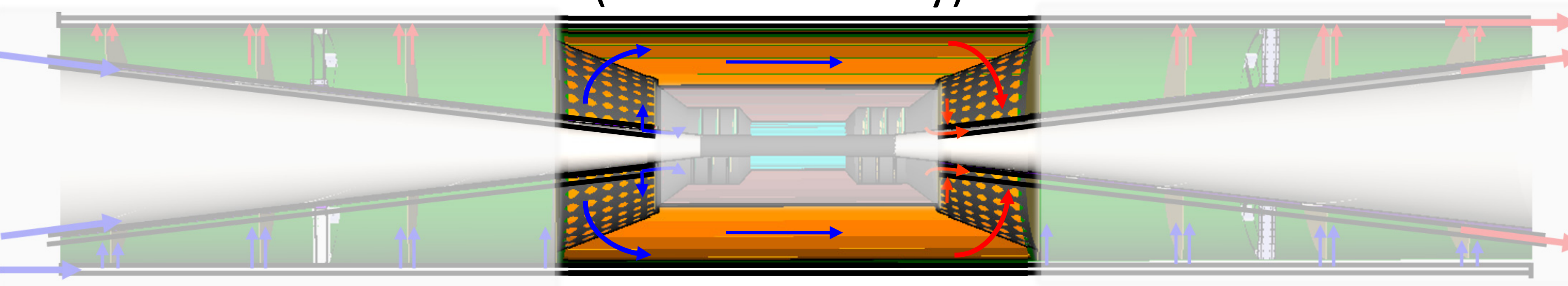


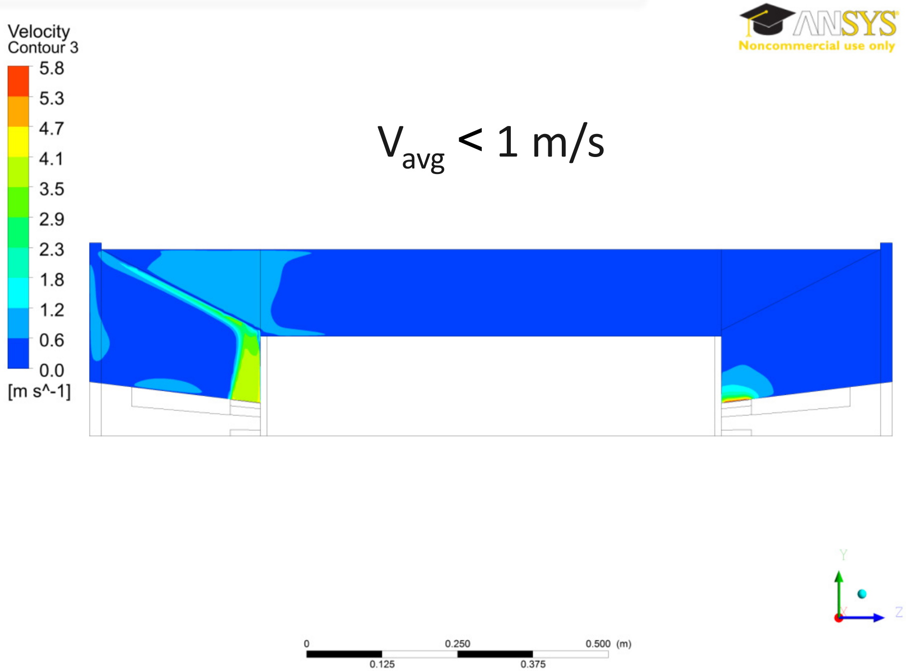


$T_{overall\_Si}$ < 30 C

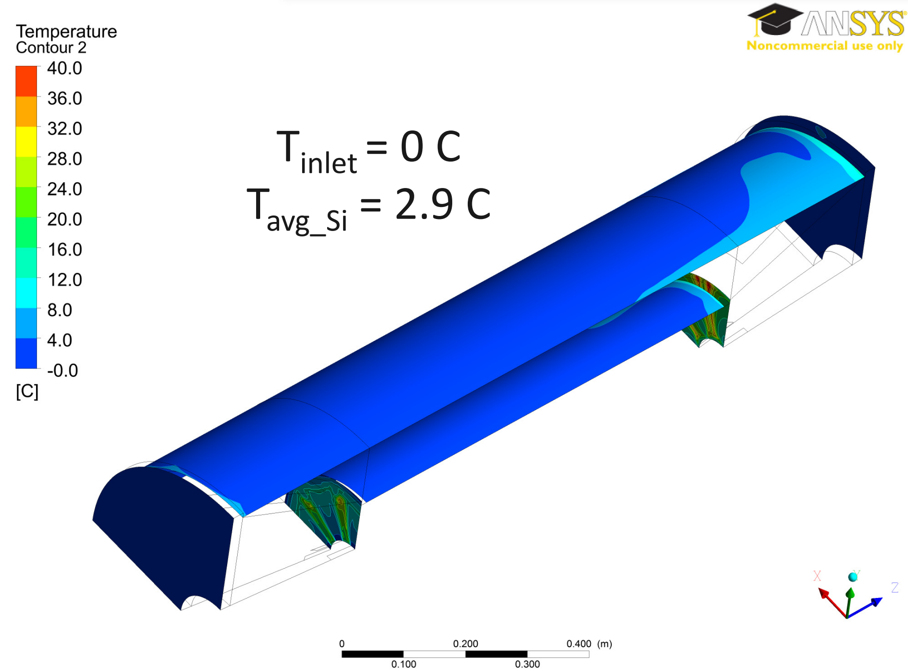
CFD simulations - SIT

(Convection only)





$V_{avg} < 1$ m/s

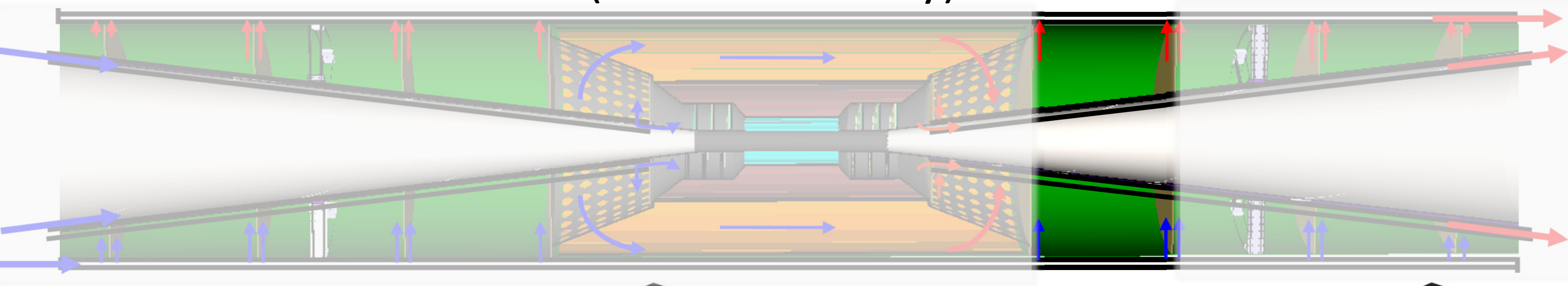


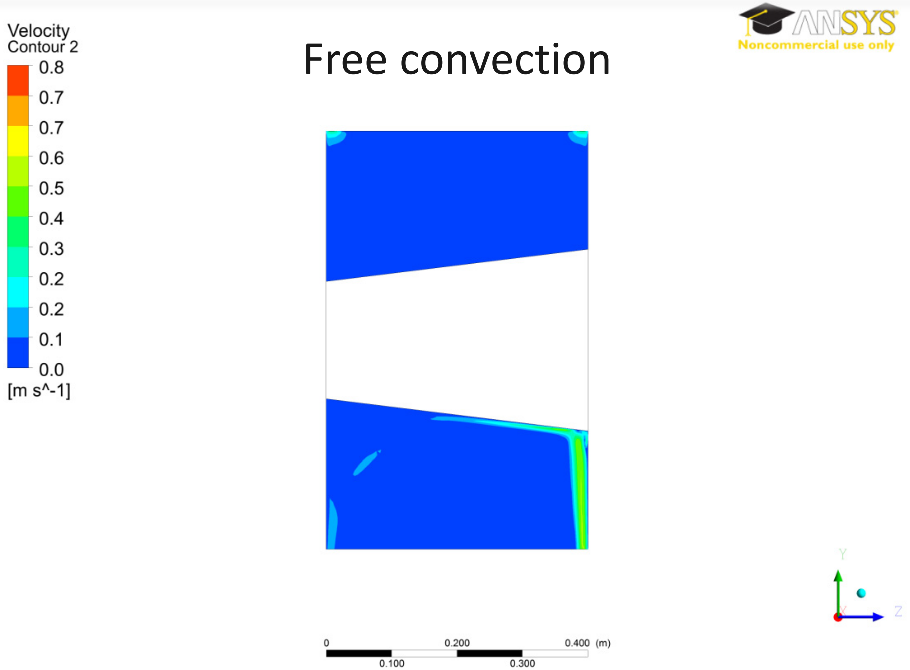
$T_{inlet} = 0$ C

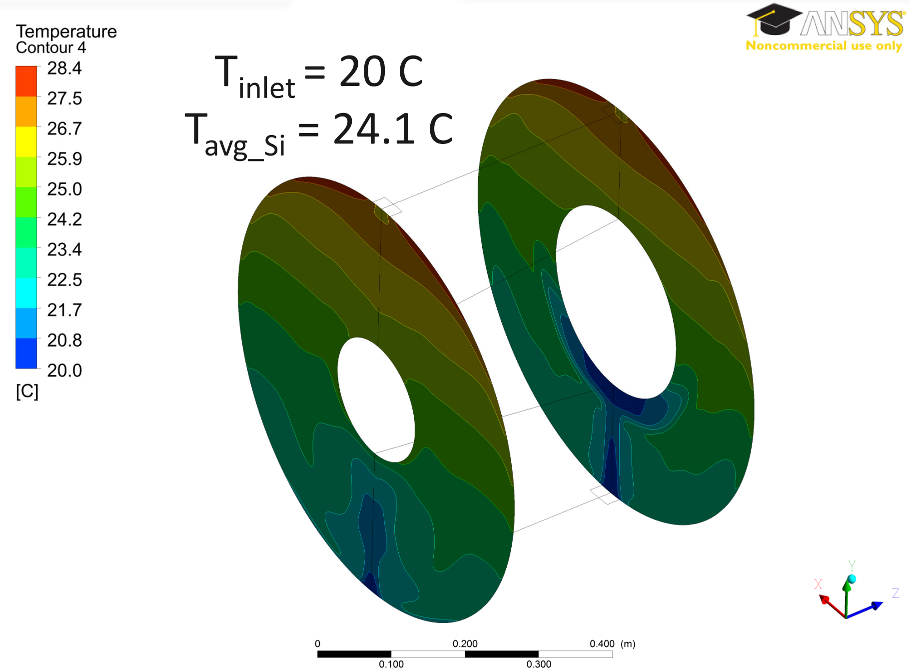
$T_{avg\_Si} = 2.9$ C

CFD simulations - FTD

(Convection only)





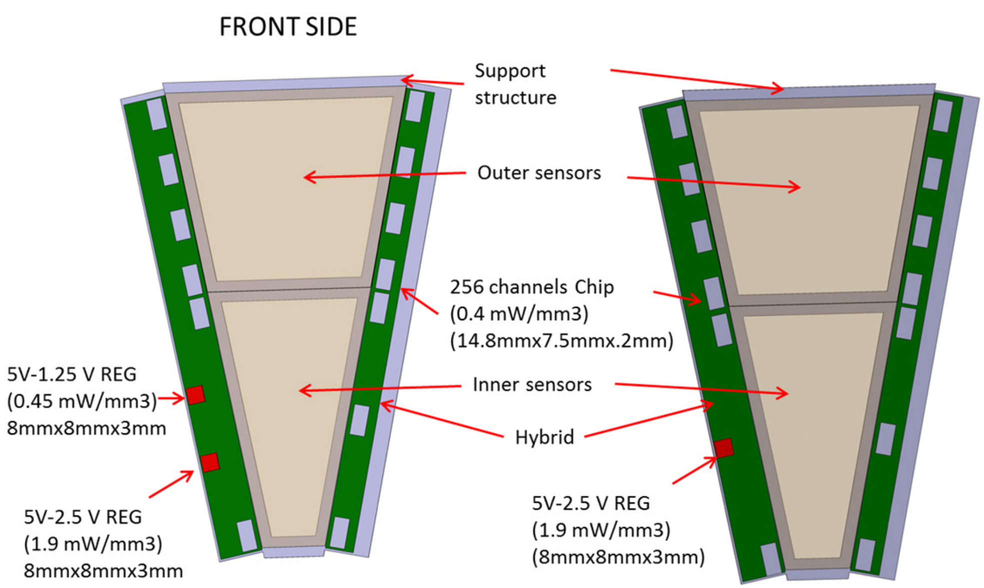


T_{inlet} = 20 C

T_{avg_Si} = 24.1 C

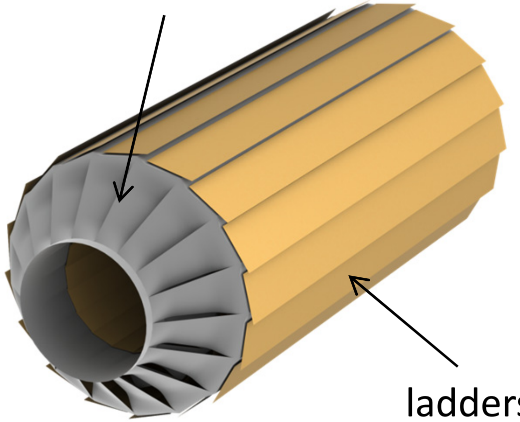
ILD FTD collaboration

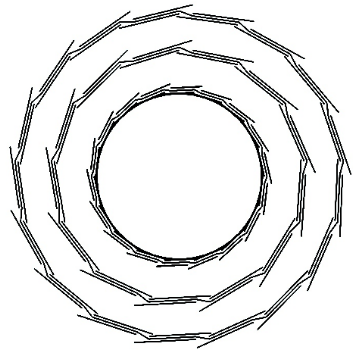
- IFCA-Santander / CERN;
- Goal: mutually profit from knowledge of FTD design and CFD simulation to evaluate air cooling performance on a realistic FTD design;



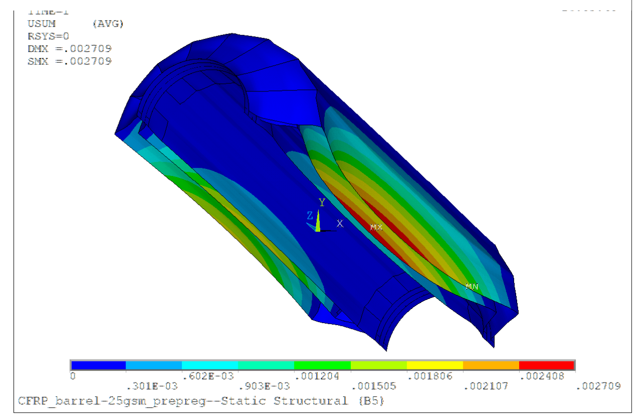
ILD FTD Petal
Courtesy: D. Moya (IFCA)

VTX barrel support

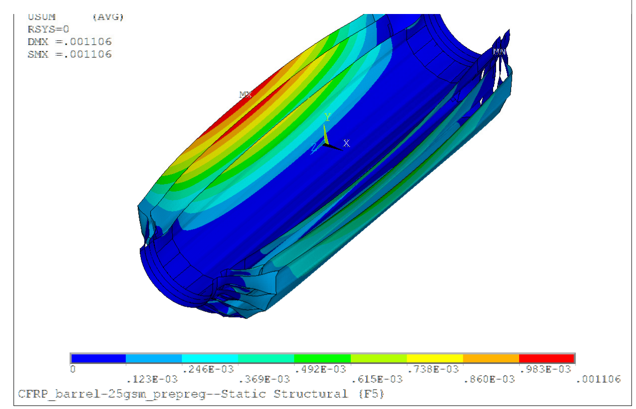




Upper half deformation

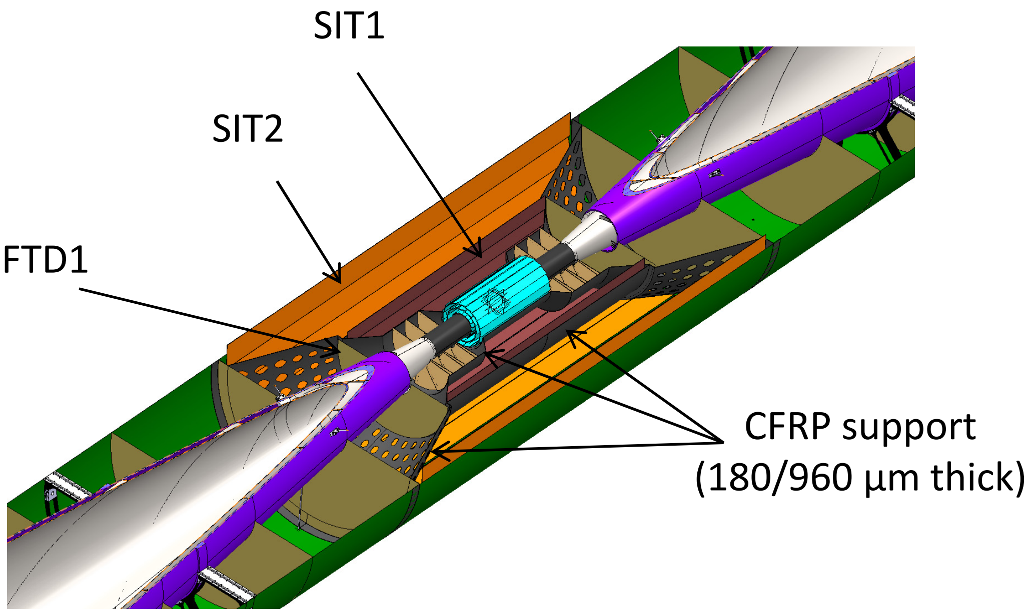


Lower half deformation

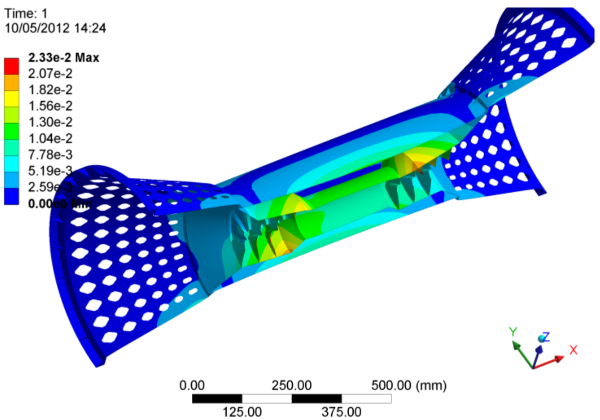


FEM simulations	Upper half	Lower half
Maximum displacement [µm]	2.7	1.1
1st eigenfrequency [Hz]	215	215

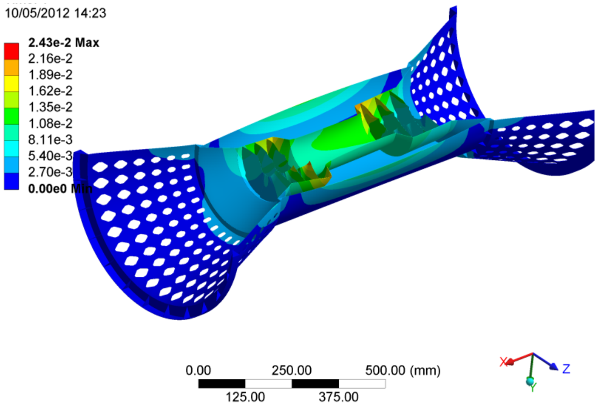
VTX endcaps & SIT1 support



Upper half deformation

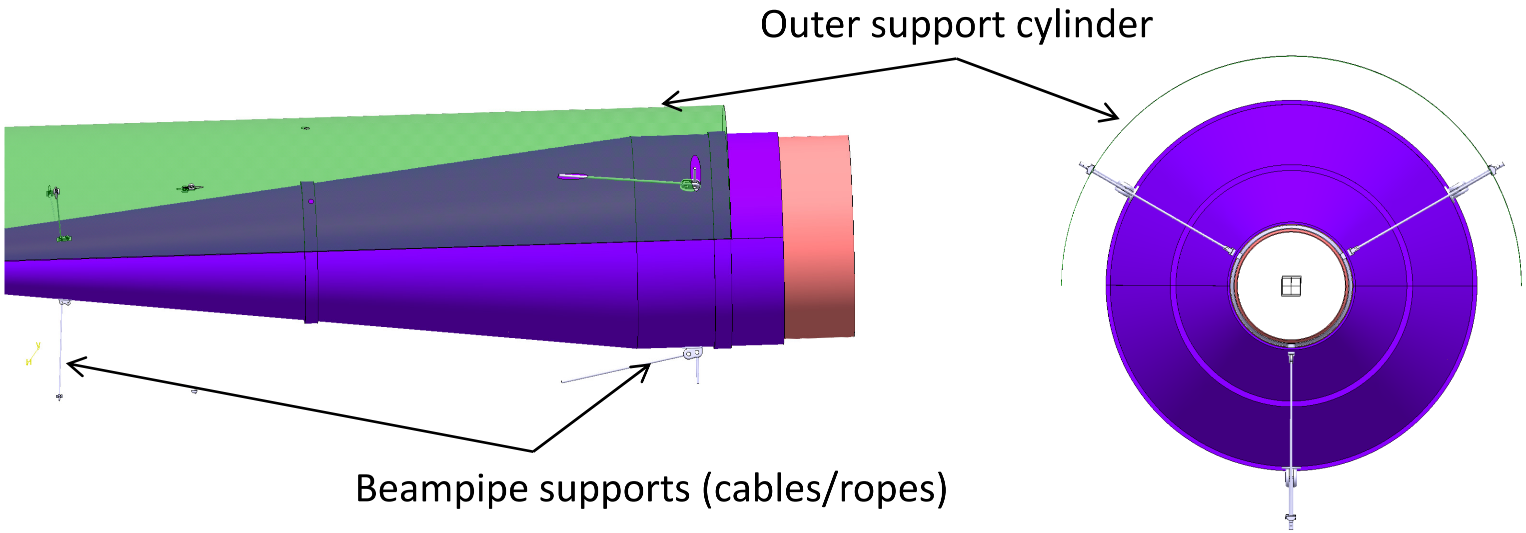


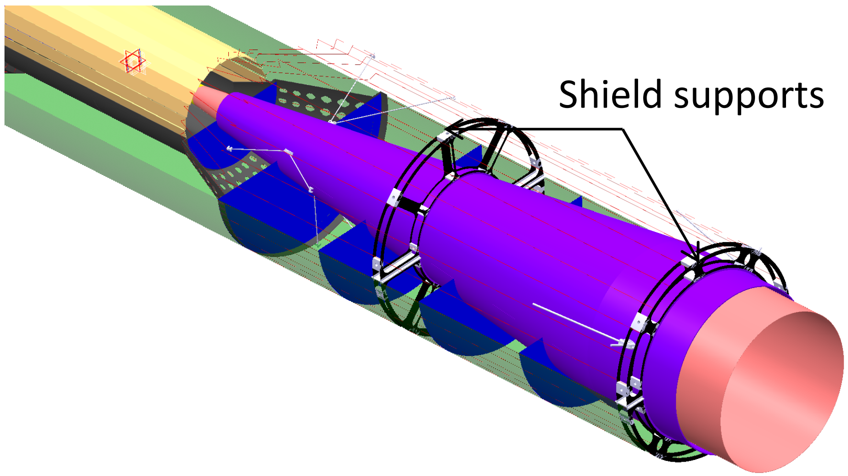
Lower half deformation



FEM simulations	**Upper half**	**Lower half**
Maximum displacement [µm]	23	24
1st eigenfrequency [Hz]	89	90

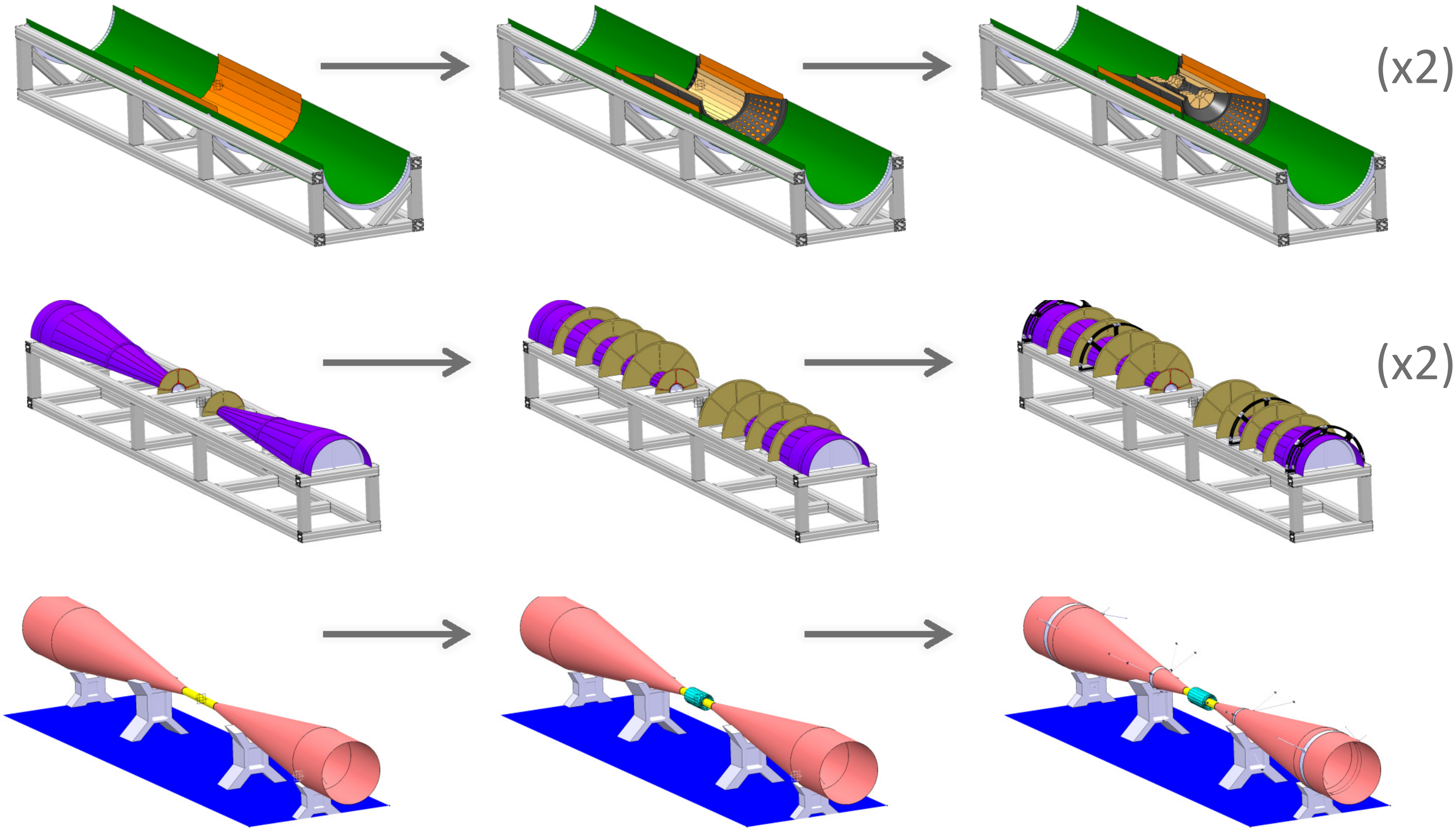
Heavy objects support



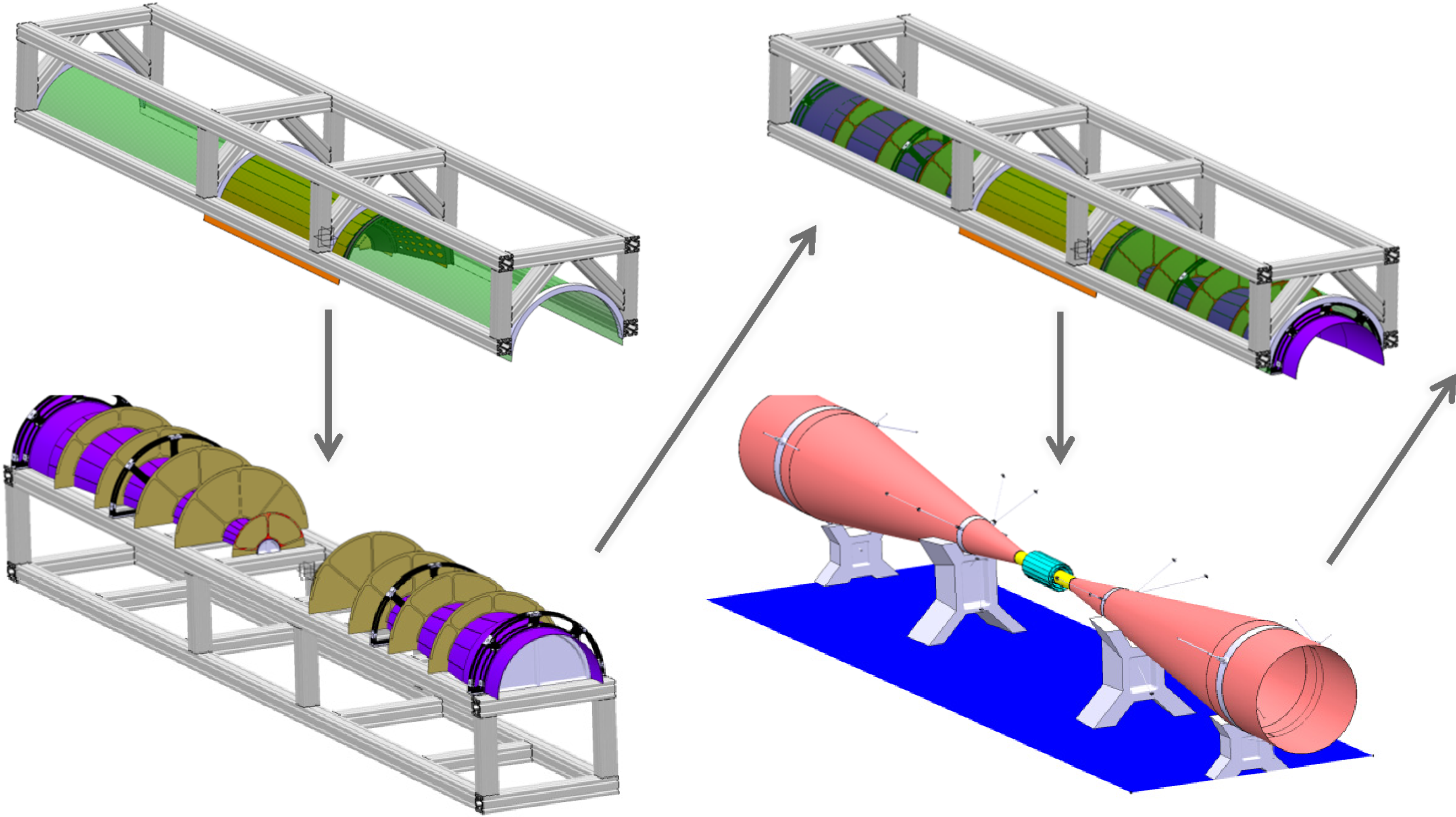


- **Given:**
  - $M_{shield} \approx 270$ kg
  - $M_{beampipe} \approx 45$ kg
- **Goal:**
  - Decouple the supports of both objects

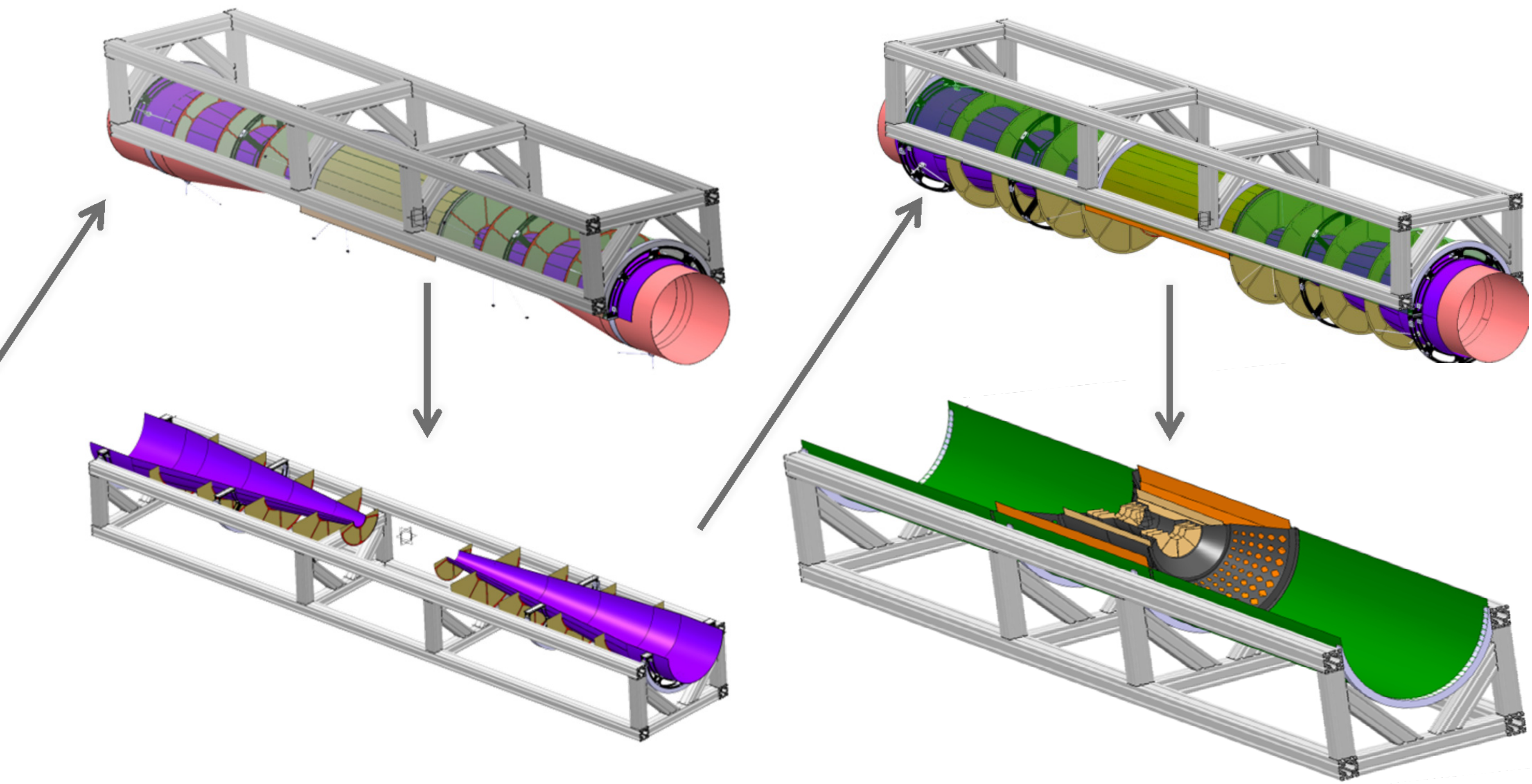
Assembly



Assembly

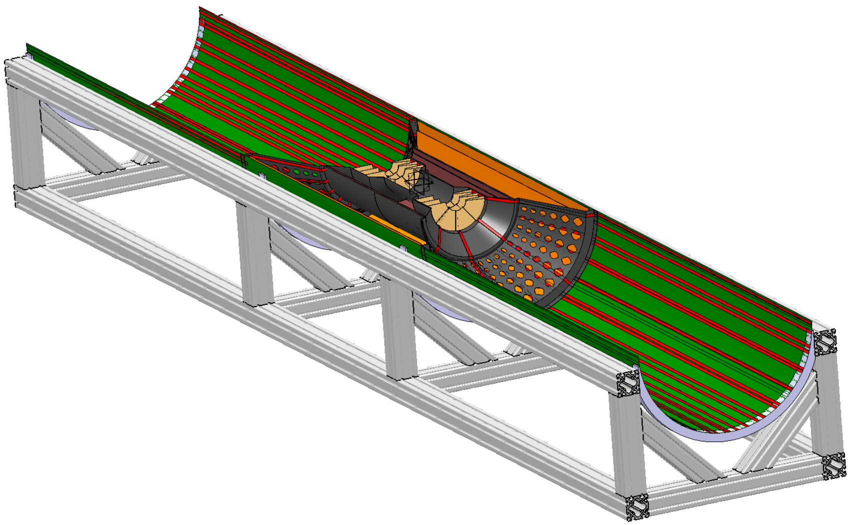


Assembly

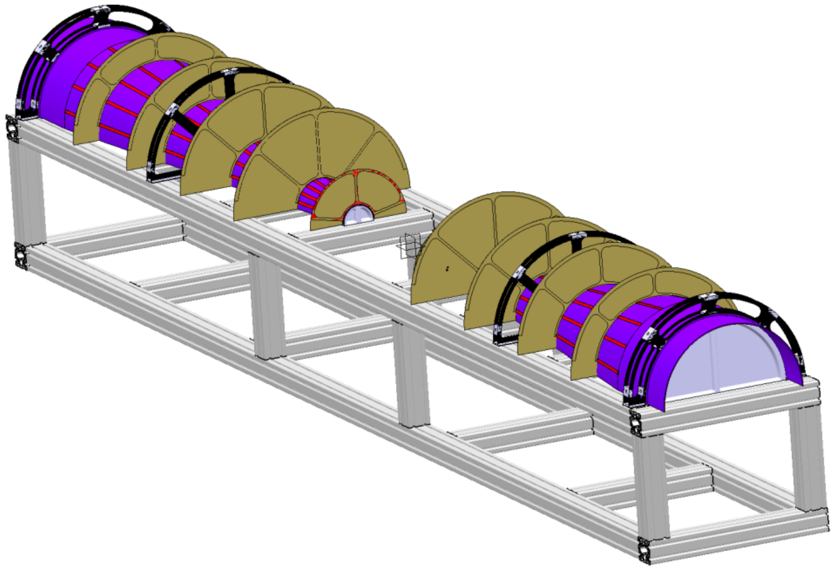


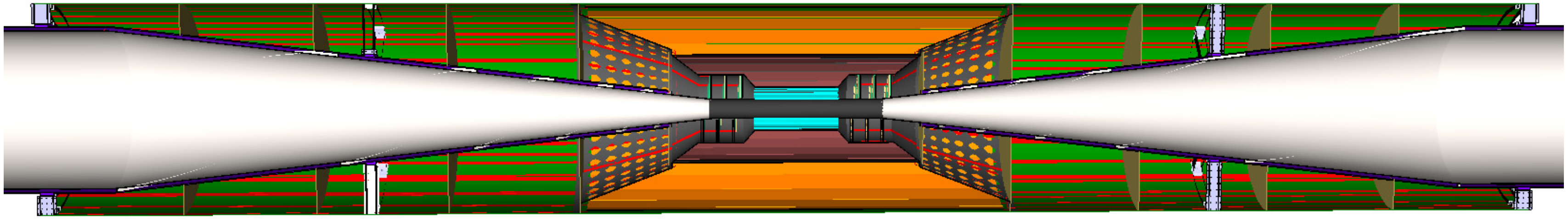
Cabling

VXEC / SIT



FTD





Summary

- CLIC inner detectors design must cleverly solve support, cooling and cabling issues in an integrated way;
- Current design proposal has taken into account some of those issues (ongoing work);
- Air cooling seems feasible but vibration is still an unknown variable (to be checked experimentally);
- Proposed solutions need to be checked against their impact on physics.

Thank You.