Self Cooled Lead Lithium blanket and reactor for HiPER

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Conclusions

1. A Self Cooled Lead Lithium blanket is under study and evolving

2. The 3rd laser ring has huge impact in maintenance and availability of the reactor

3. Based on the blanket, we are working in a reactor layout

Conclusions

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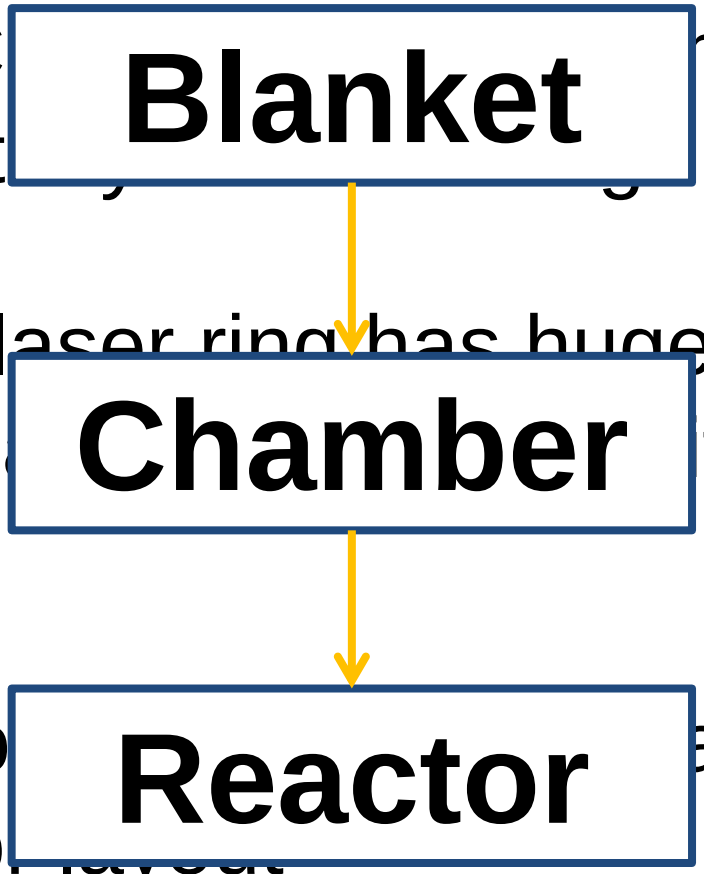
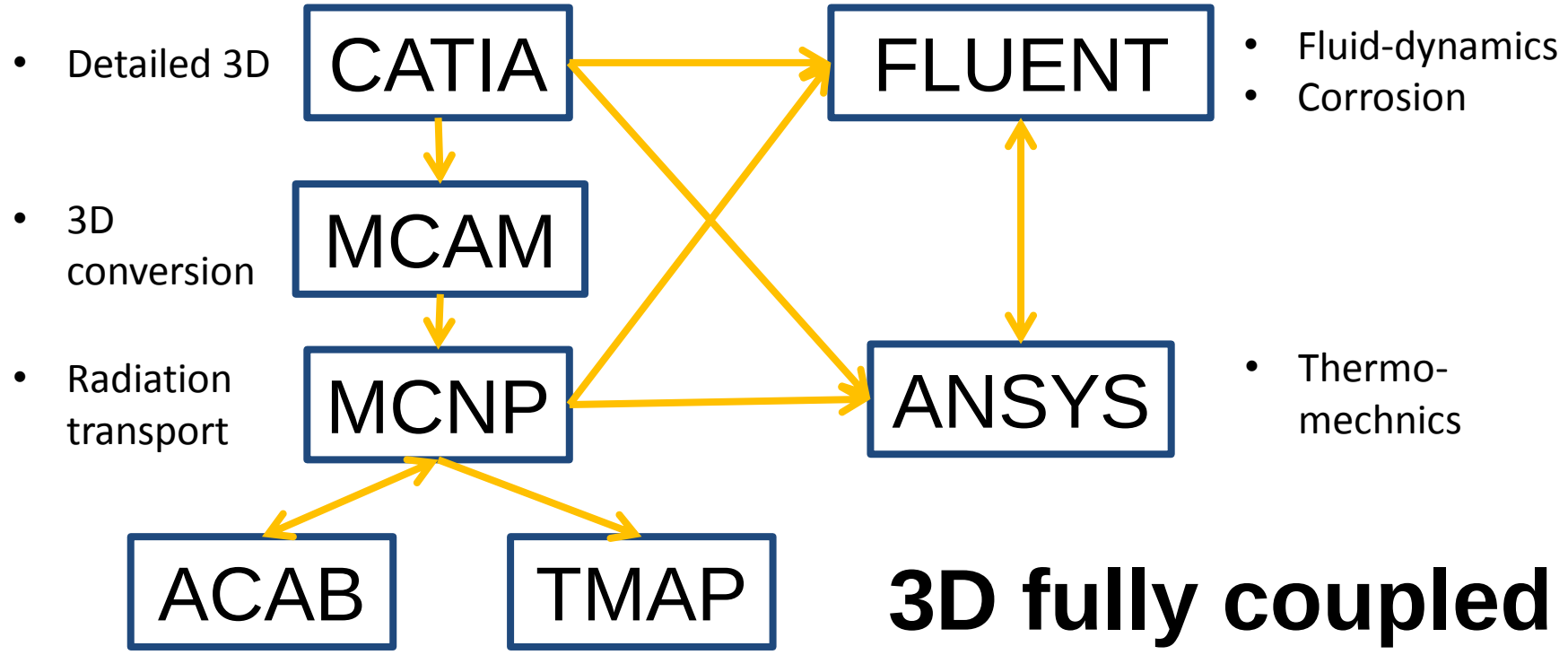


First part

HiPER

Blanket studies

Methodology

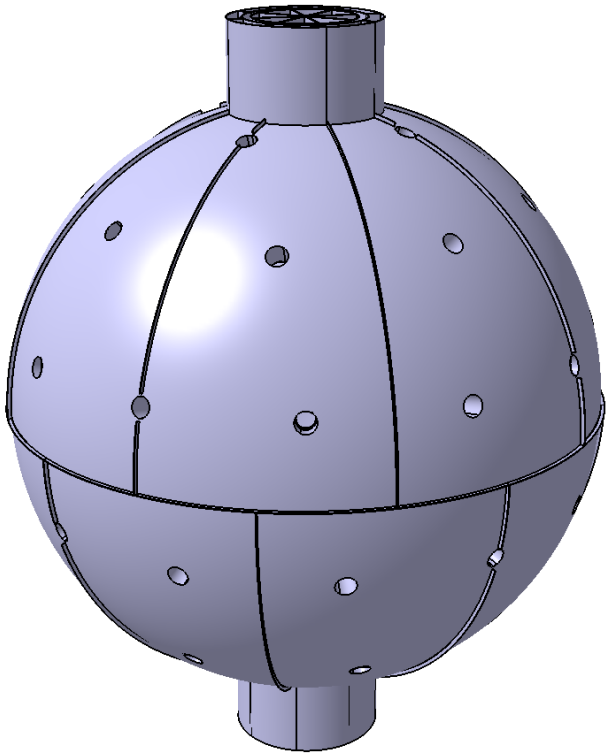


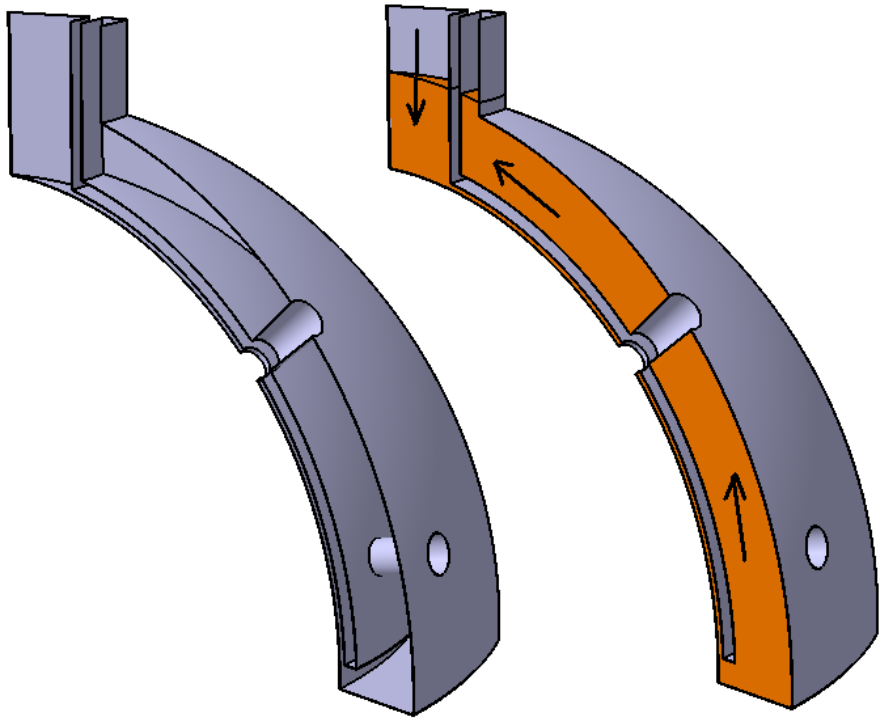
- Detailed 3D
- 3D conversion
- Radiation transport
- Fluid-dynamics
- Corrosion
- Thermo-mechnics
- Rad inventory
- Dose rates
- Waste management
- Tritium spreading & diffusion

3D fully coupled methodology for reactor design

Preliminary blanket

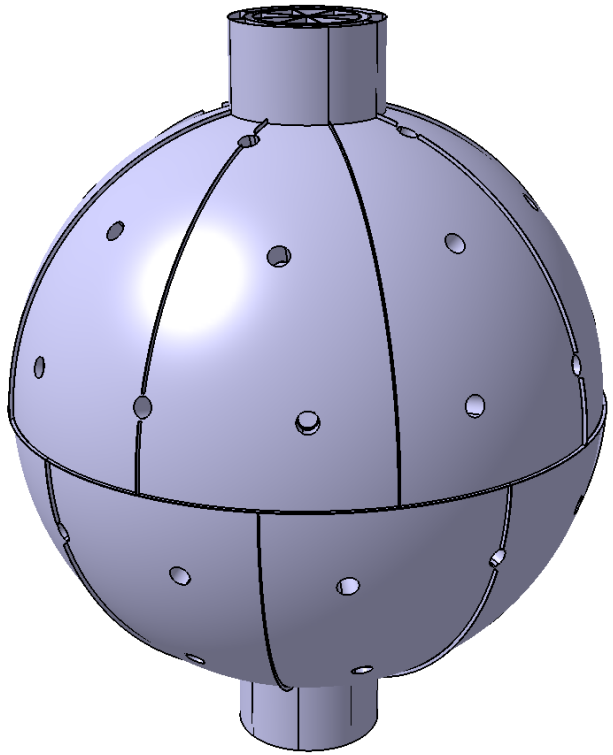
Preliminary Self Cooled Lead Lithium blanket





Preliminary blanket

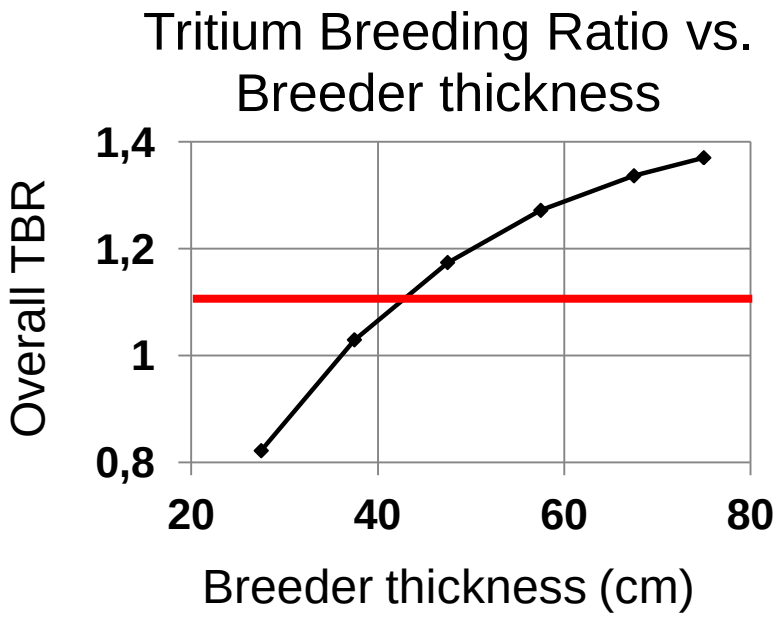
Preliminary Self Cooled Lead Lithium blanket



- Neutronics
- Fluid-dynamics
- Corrosion
- Power cycles
- Safety
- Maintenance
- Interfaces

Preliminary blanket

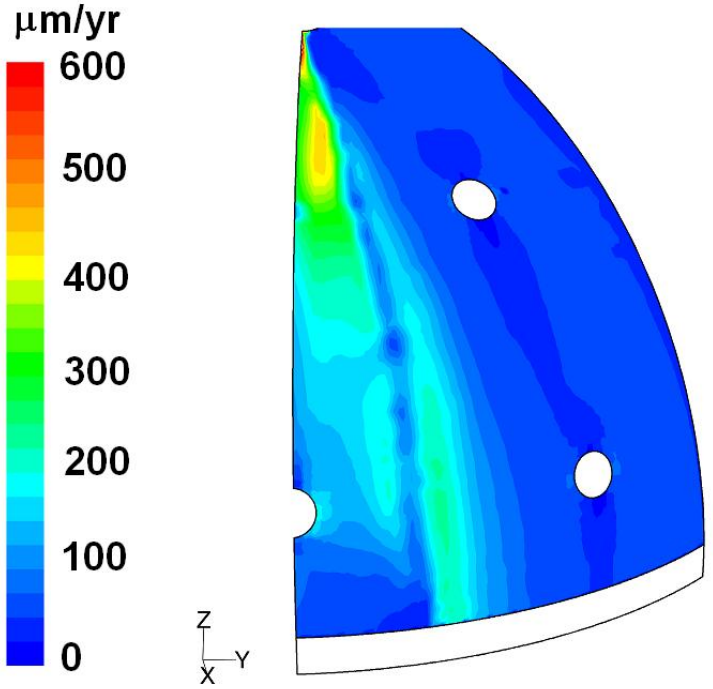
Neutronics



TBR>1.15

CATIA – MCAM - MCNP

Fluid-dynamics & corrosion



CATIA – MCAM - MCNP - FLUENT

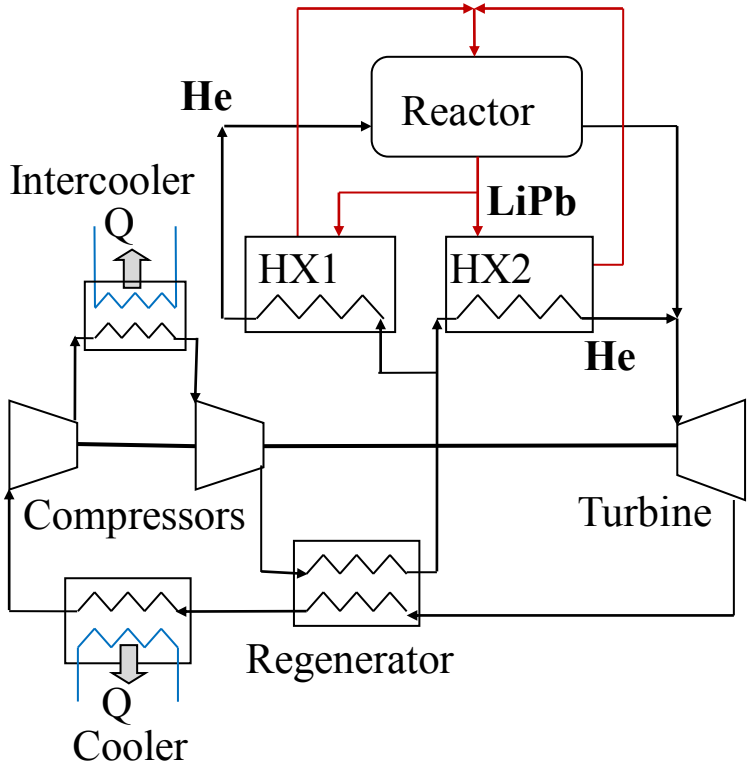
Preliminary blanket

Brayton power cycle

- Helium
- Supercritical CO_2
- Gases mixtures
  (He + Xe, He + Ne)

- Efficiencies
  30 % < η < 40%

Helium



Preliminary blanket

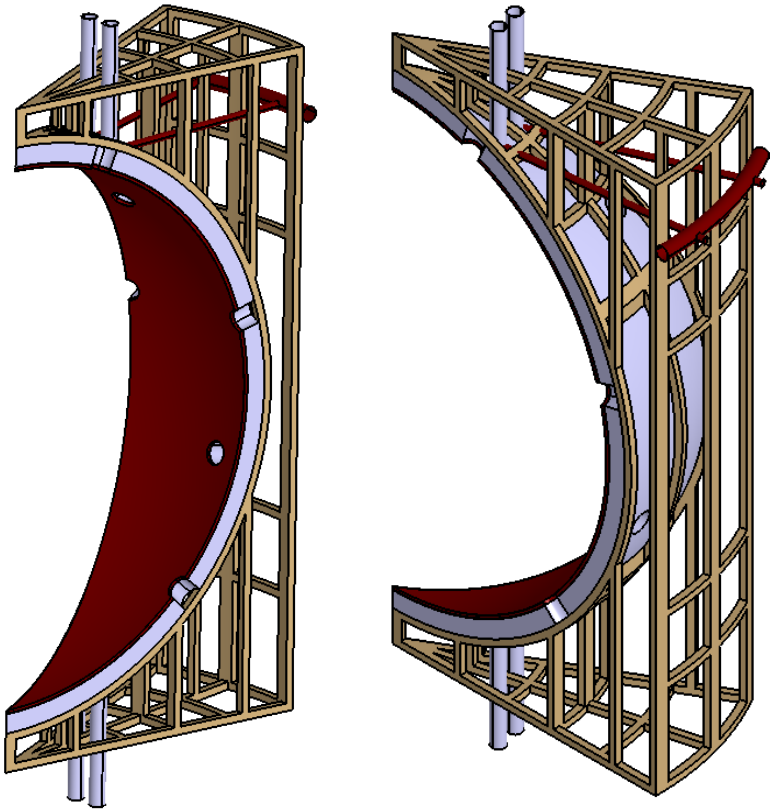
SCLL design evolution demands:

- Reduction of max. corrosion in a factor 10 (**from 400 to 40 μm/yr**)
- Raise 50ºC the LiPb average outlet temperature (**from 400 to 450 ºC**)
- Reduce the weight as much as possible
- Consider logistics & maintenance

Evolution of SCLL

Modifications under study for the future:

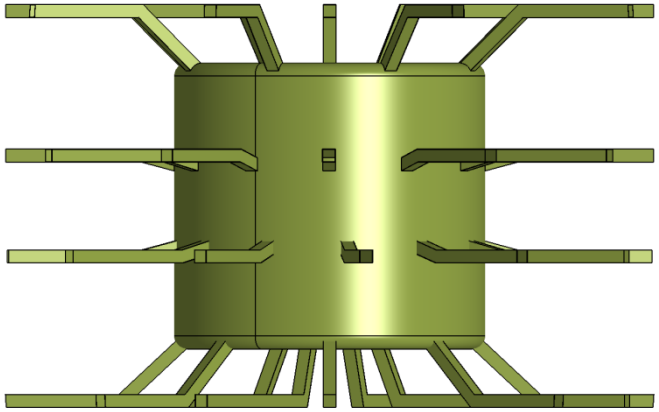
- Single & thick LiPb channel
- 12 sectors, instead of 8
- New piping
- 50% less breeder



Second part

Vacuum chambers

Chamber design



Systems to fit in the chamber:

- Shieldings
- Vacuum pipes
- Laser pipes
- Target injector
- Maintenance docks
- Diagnostics

Maintenance has to be fast, reliable and robust

Chamber design

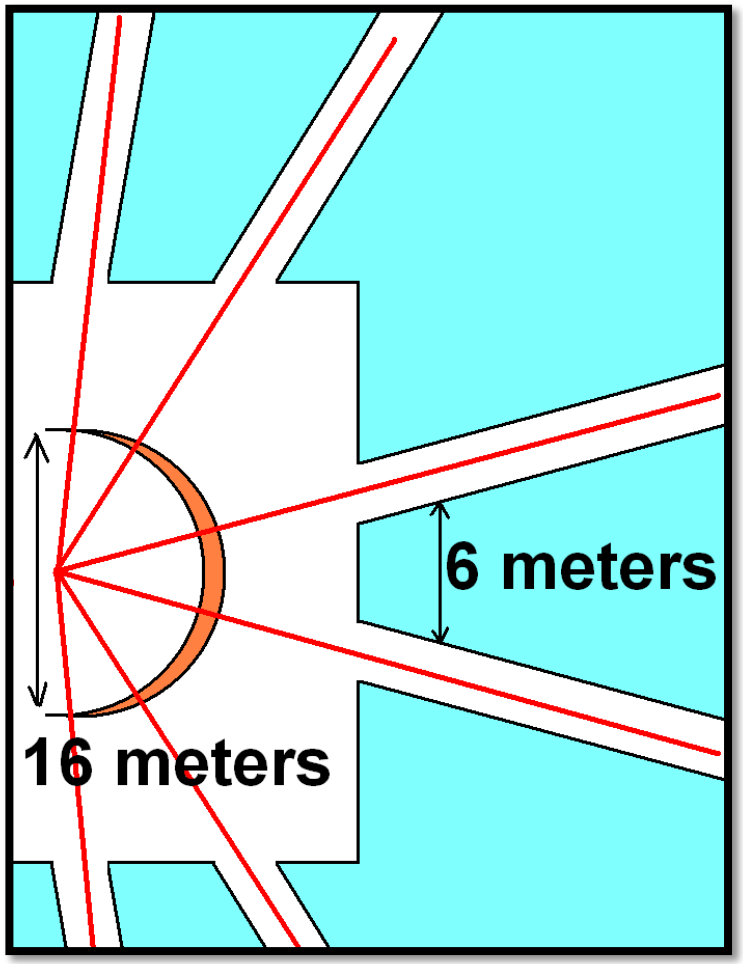
Systems to fit in the chamber:
- Blanket
- Vacuum pipes
- Laser pipes
- Target injector
- Maintenance docks
- Diagnostics

There is no space for the transport of any system, because of 3rd laser ring

In-situ maintenance = expensive electricity

Maintenance has to be fast, reliable and robust

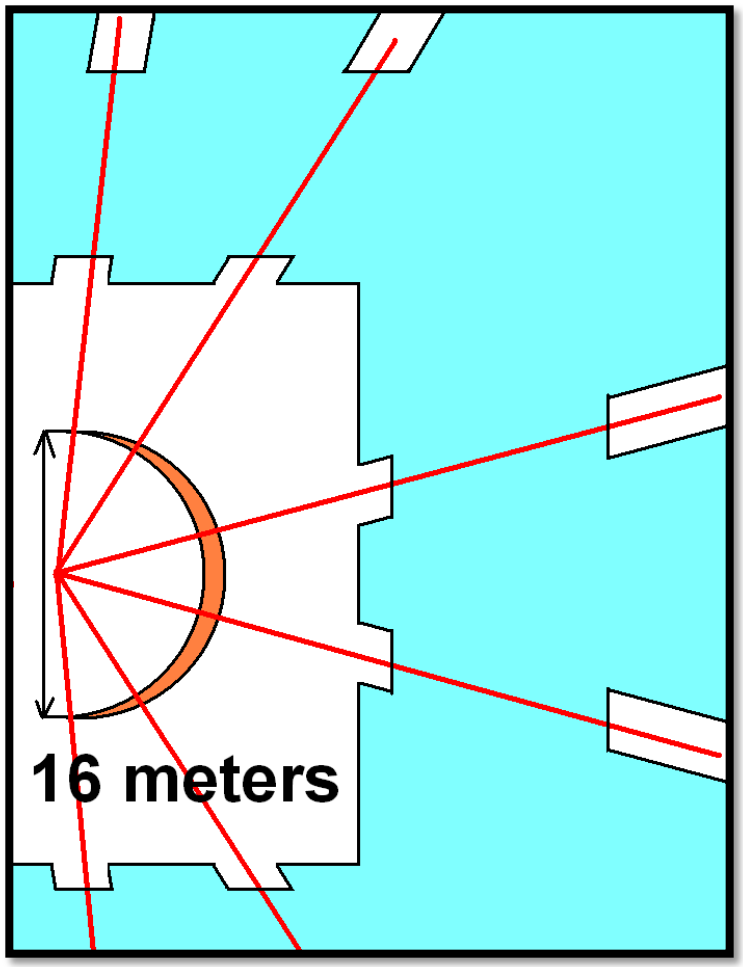
3rd ring manipulation



Alternative 1

- ✖ No available space for system fitting
- ✖ In-situ maintenance required
- ✔ Easy optics assembly

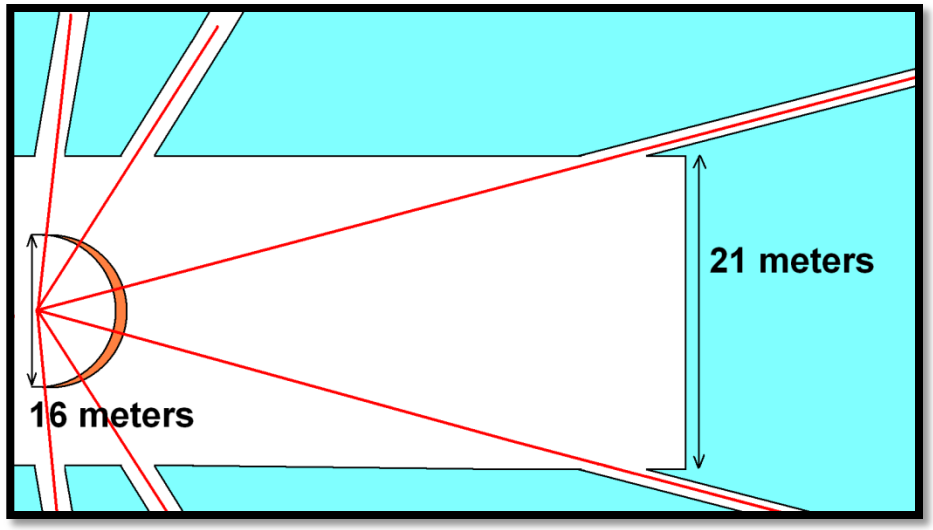
3rd ring manipulation



Alternative 2

- ✖ Final optics as final vacuum barrier
- ✖ Complex door opening
- ✔ Big available space

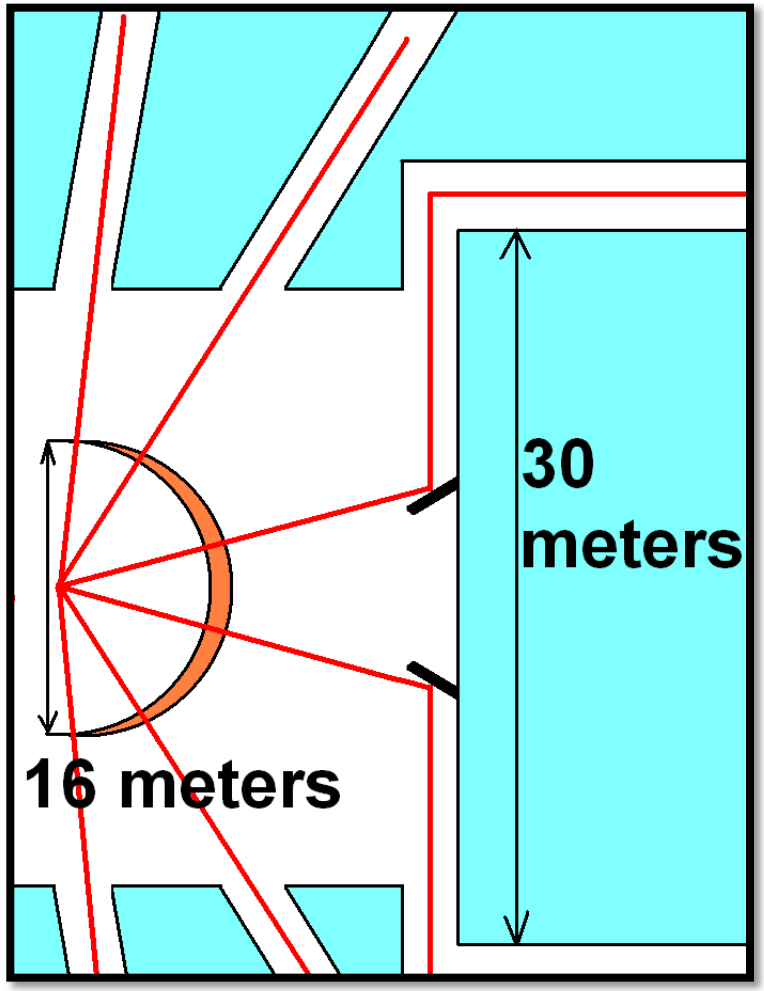
3rd ring manipulation



Alternative 3

- ✖ Huge chamber
- ✖ Doubtful optical viability
- ✔ Big available space

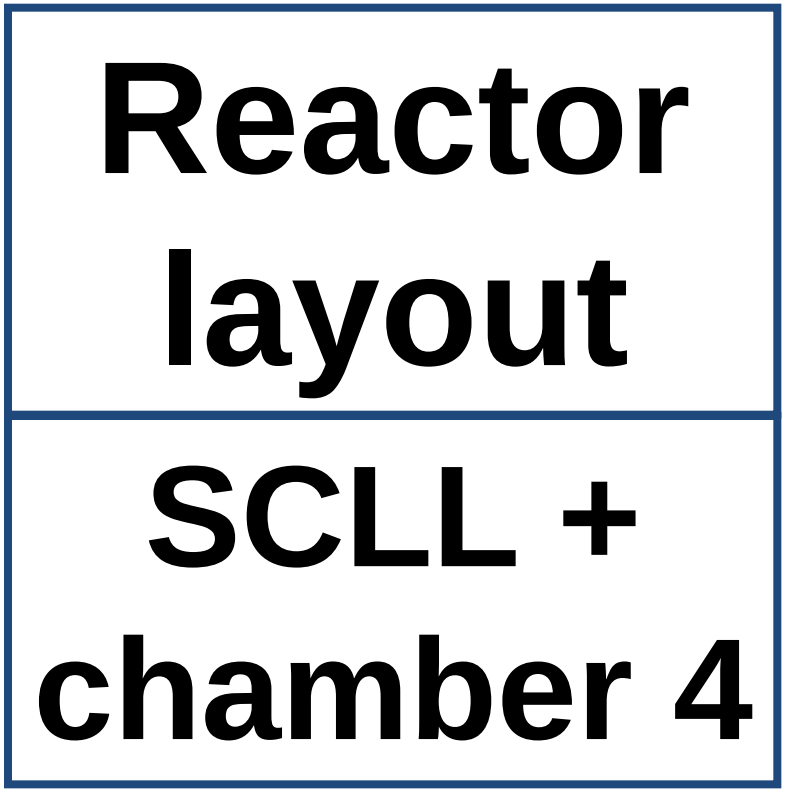
3rd ring manipulation



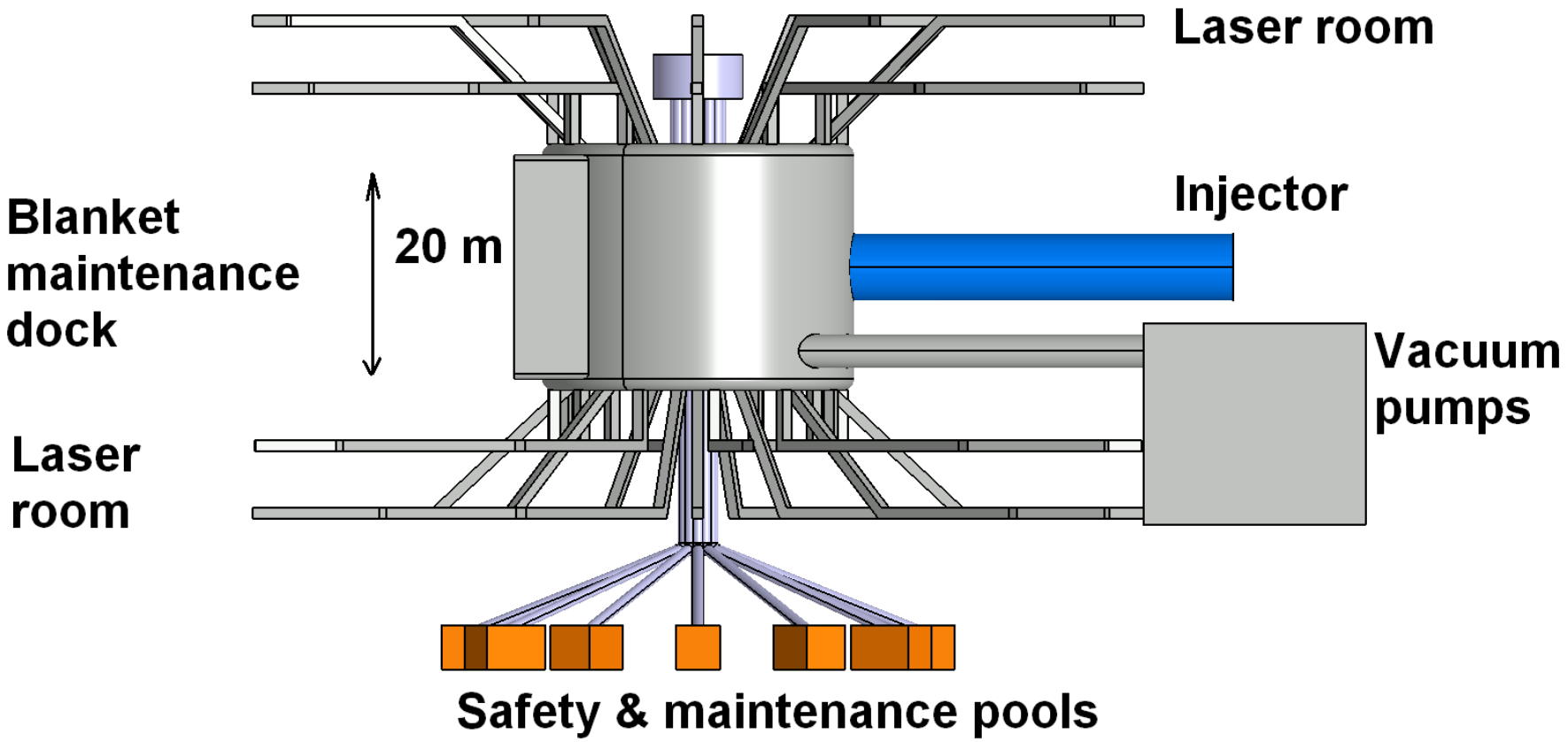
Alternative 4

- ✓ Huge available space
- ✓ System grouping
- ✓ Easy door opening
- ✓ Reasonable chamber size
- ✓ … many others
- **Optical viability??**

Third part

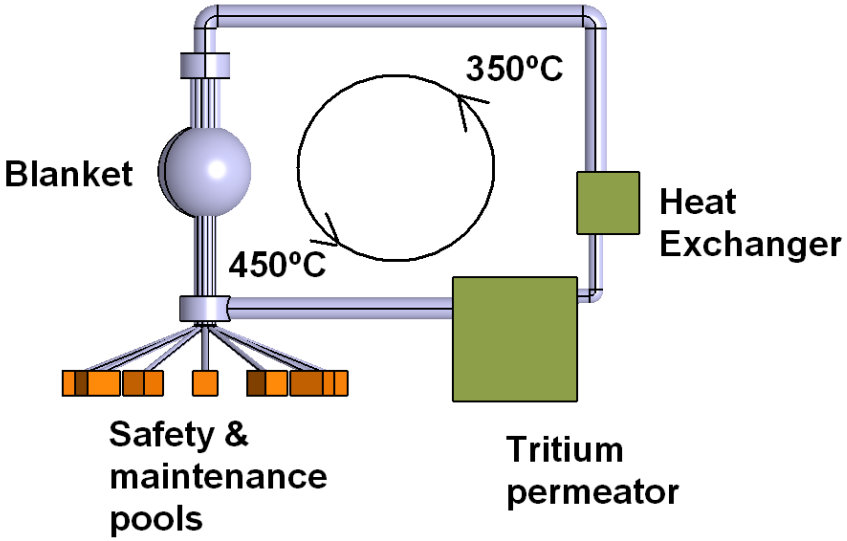


Systems integration

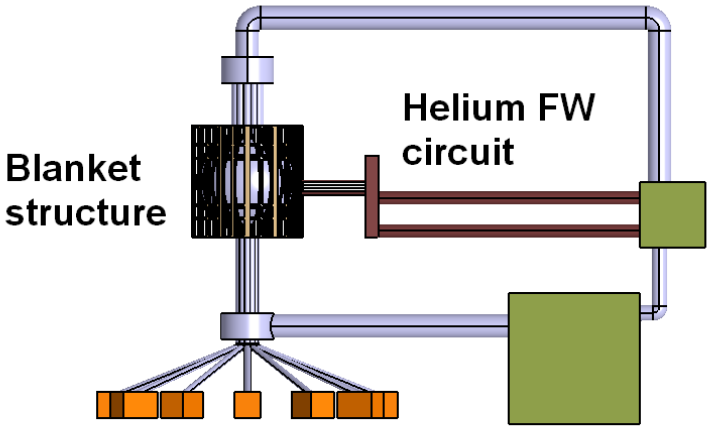


Cooling circuits

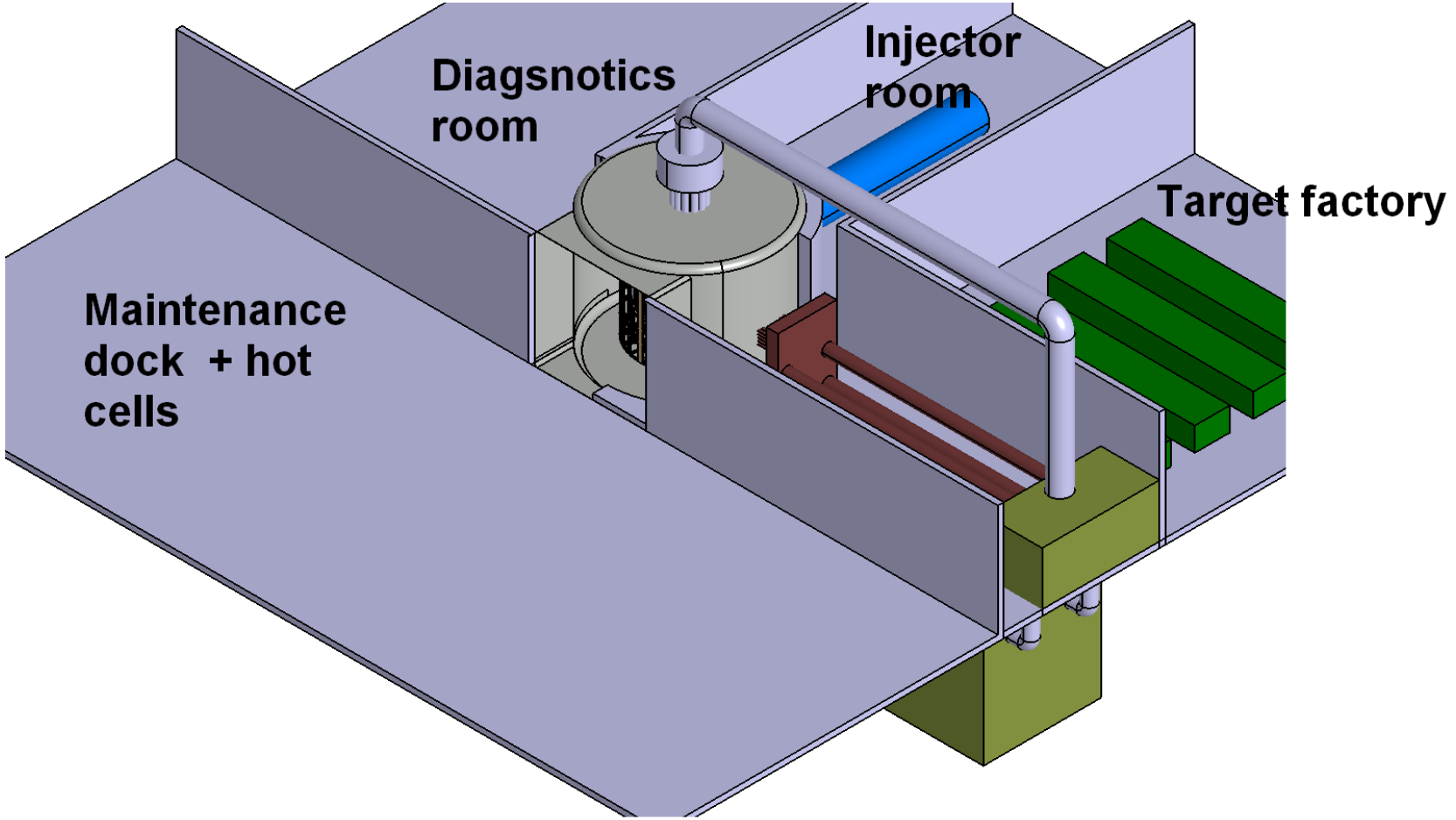
LiPb circuit



First Wall Helium circuit

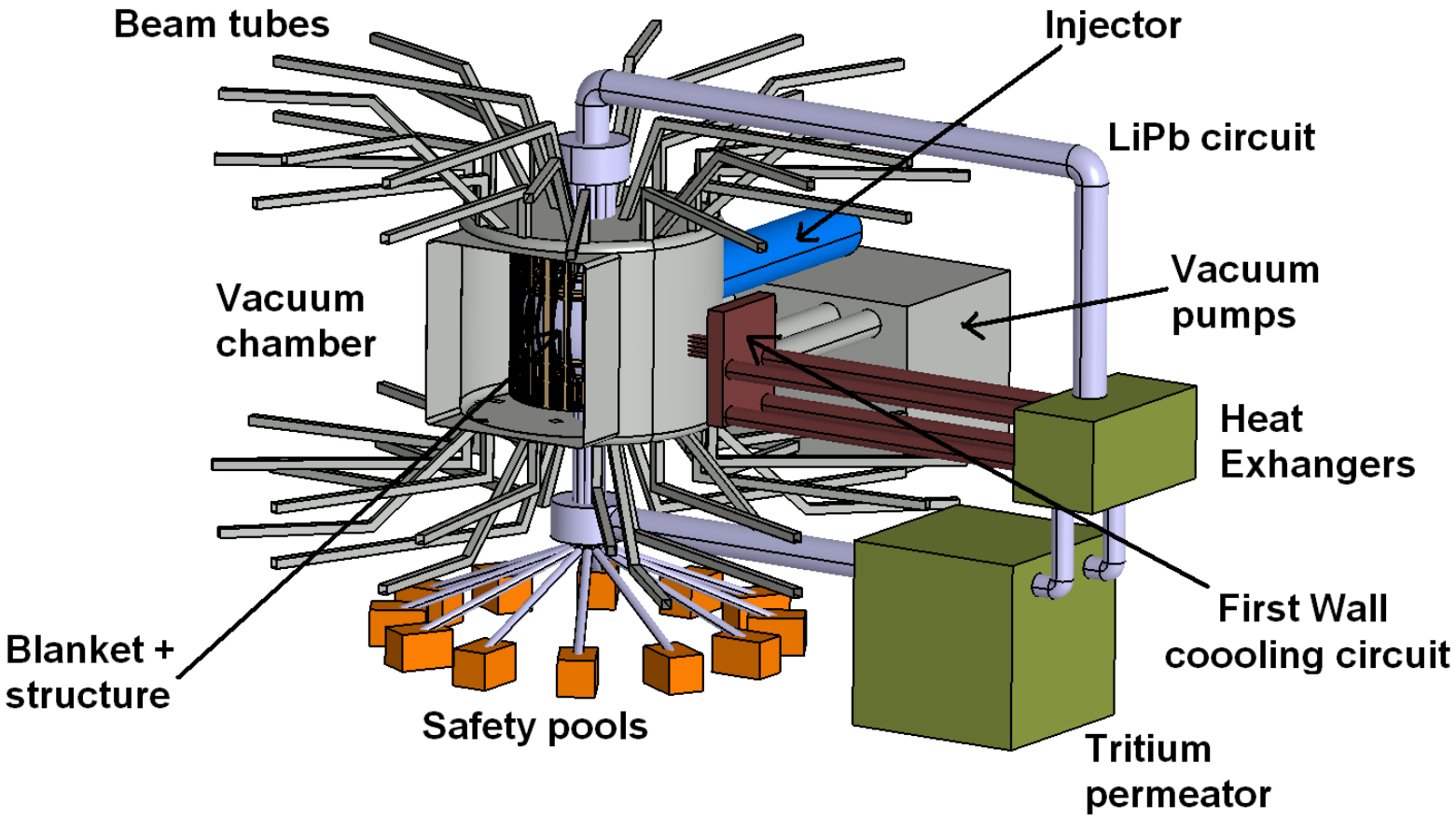


Big central space

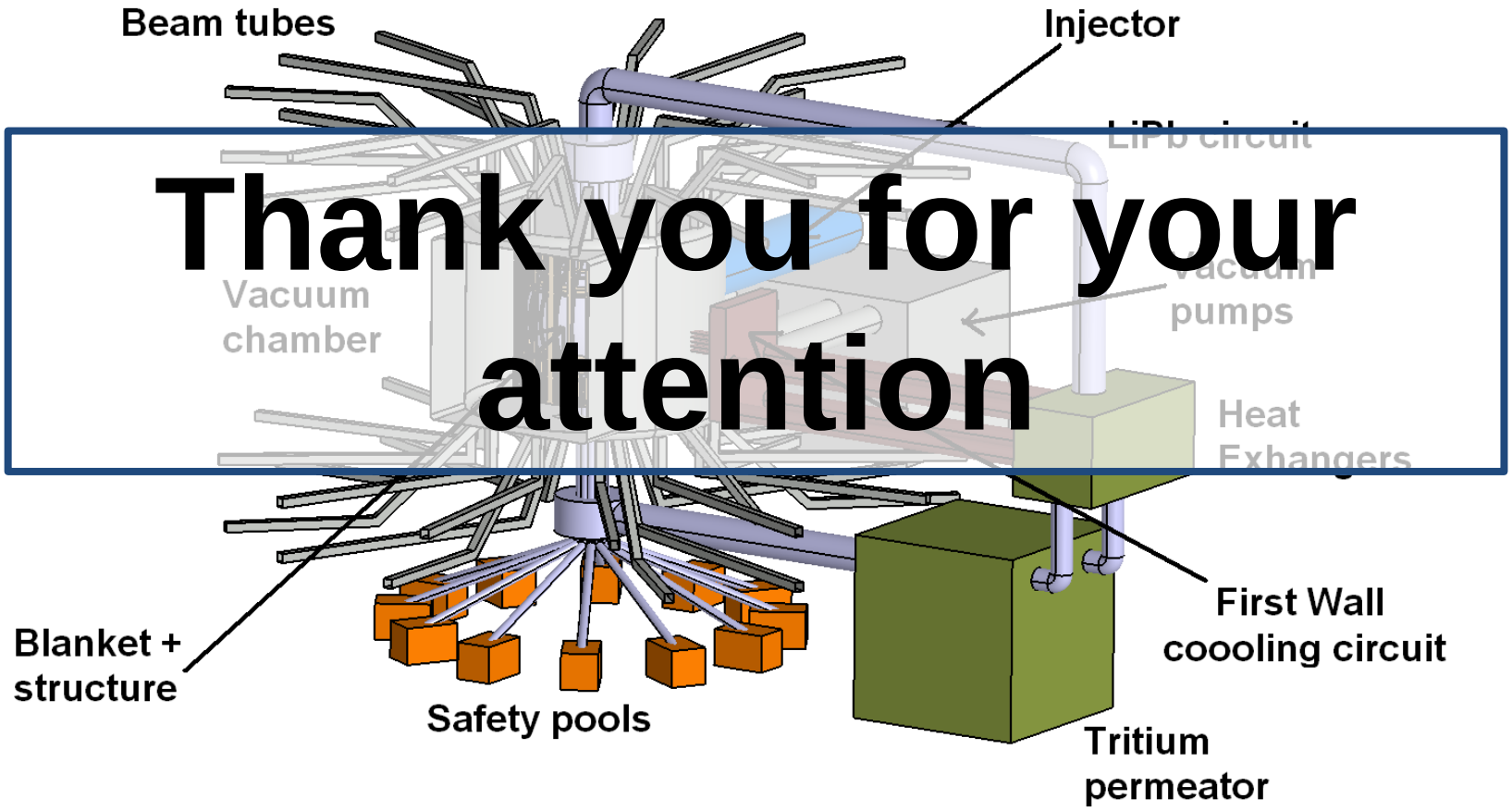


Single purpose room for every system!

SCLL reactor layout

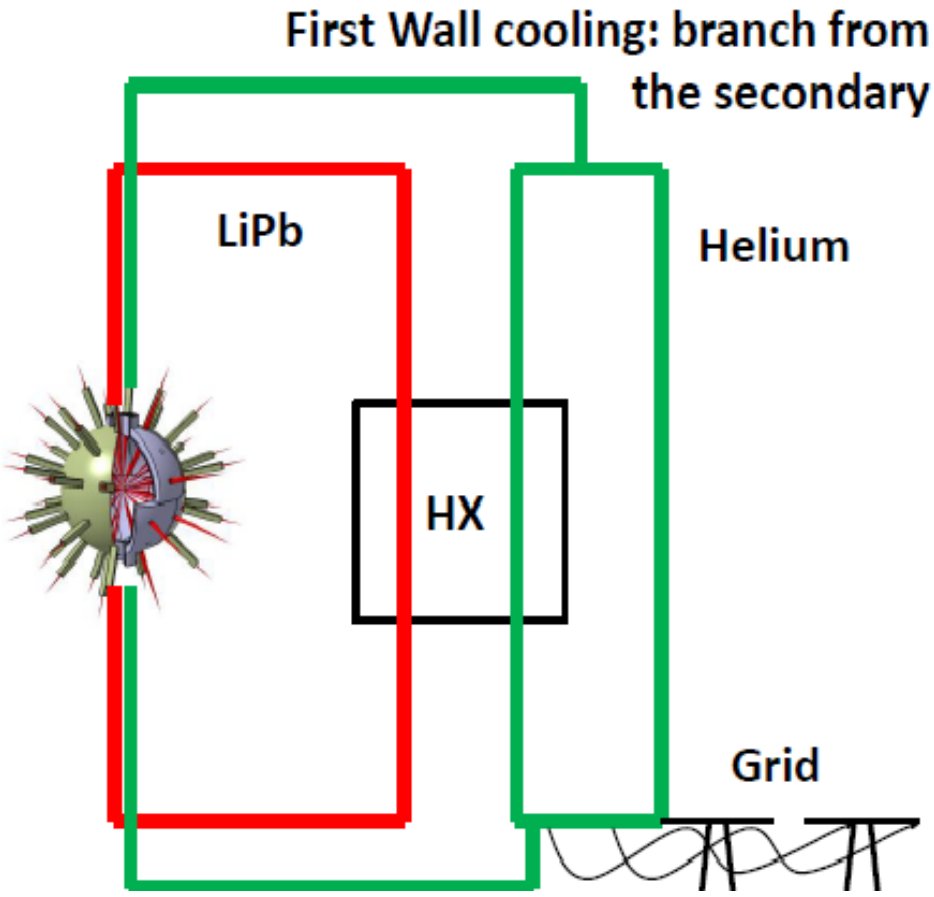


SCLL reactor layout

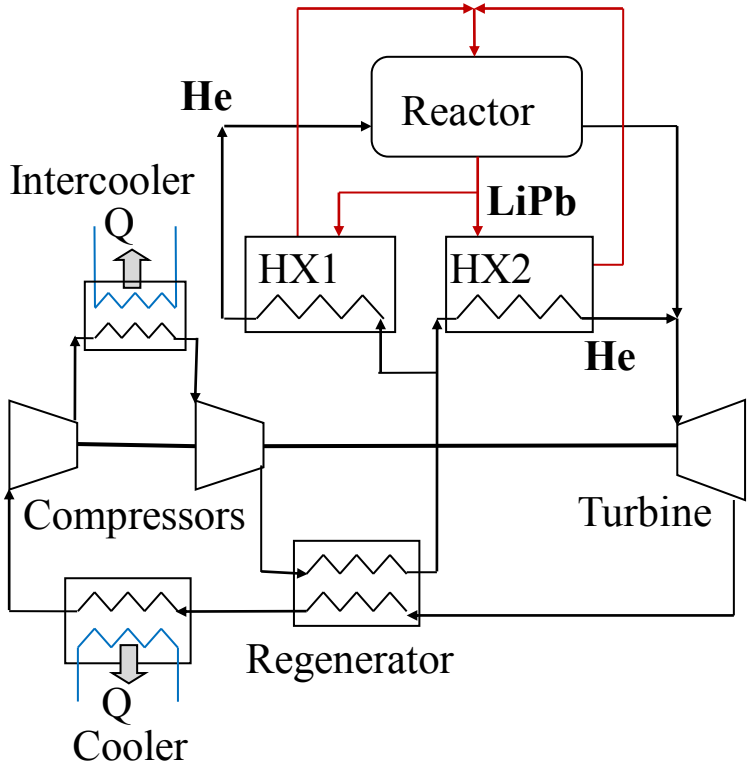


Thank you for your attention

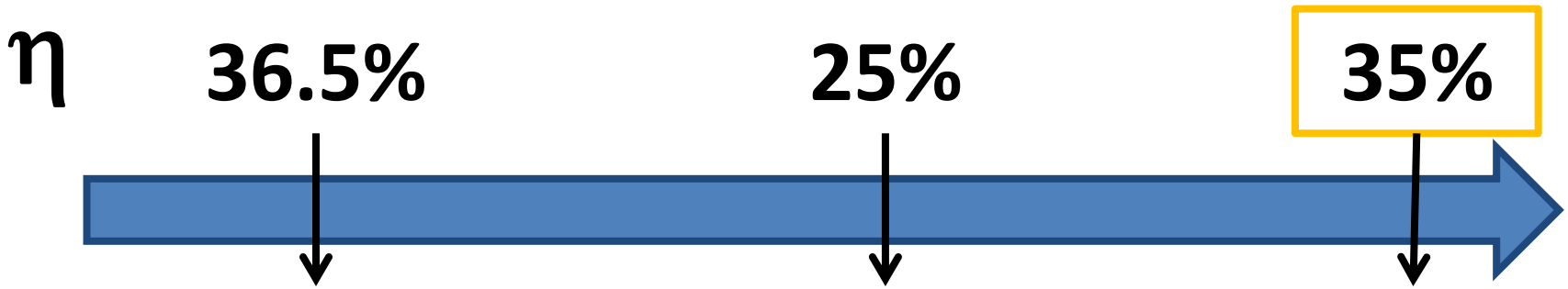
Helium Brayton PC



Helium



Helium Brayton PC



Preliminary:

- He FW inlet 350ºC
- Ideal components

Intermmidiate:

- He FW inlet 350ºC
- **Realistic components**

Advanced:

- **He FW inlet 400ºC**
- **Realistic components**

Blanket for HiPER reactor

Self Cooled Lead Lithium Blanket

Advantages:

- Simplicity & reliability
- Low Chemical reactivity
- High TBR
- Online TBR adjustment
- Easy tritium recovery
- Benefit from R&D programs in MFE

Disadvantages:

- Corrosion with EUROFER
- Heavy blanket
- Tritium spreading