

ESS Cryogenic infrastructure – distribution system for the ESS Linac

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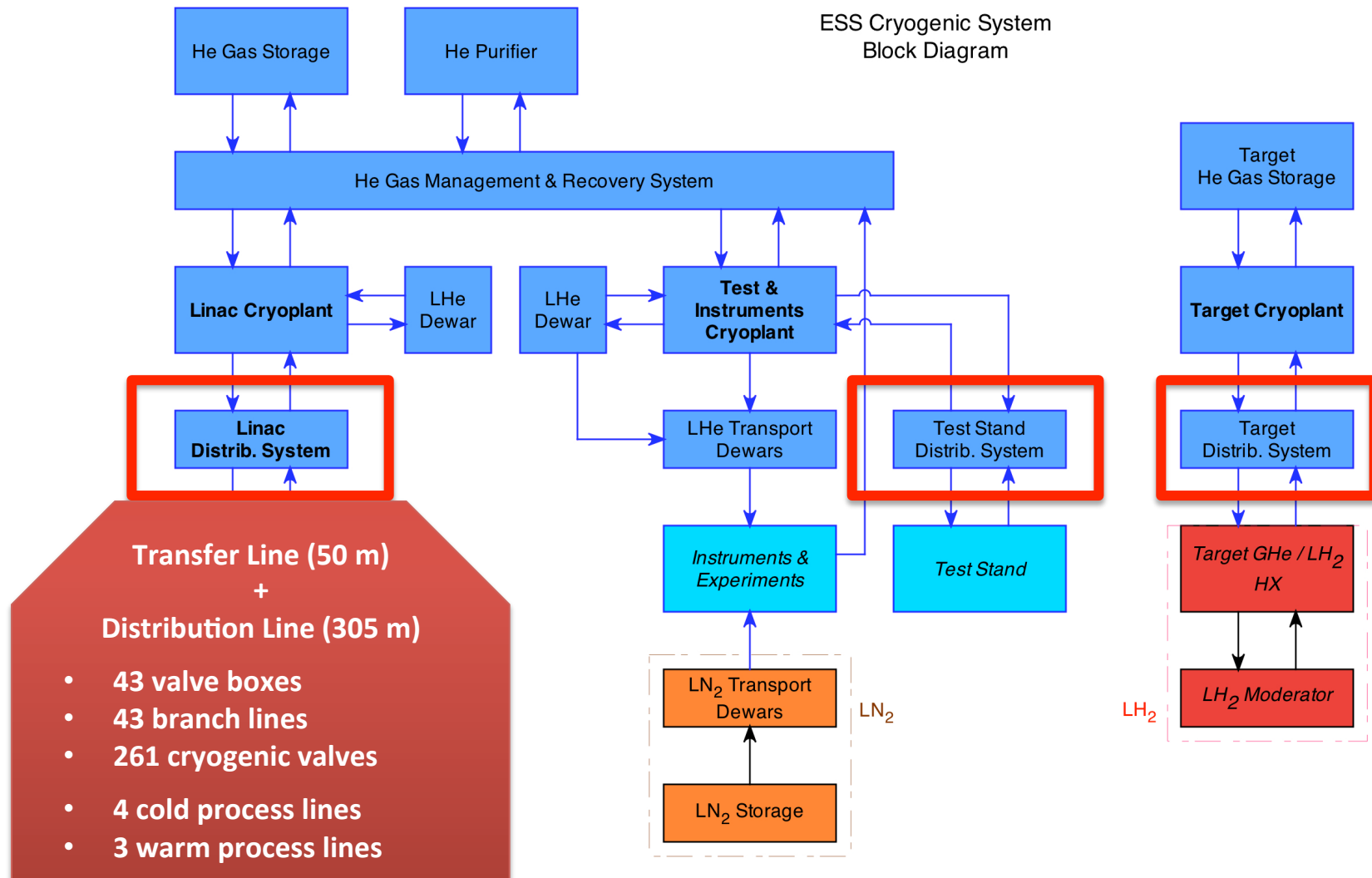
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- ESS Cryogenic system
- Linac Cryogenic Distribution System L-CDS
- L-CDS layouts and flow schemes
- Interfaces
- L-CDS 3D model
- Process and Instrumentation Diagram (PID)
- Prototype valve box design
- Conclusions and open issues

ESS Cryogenic System

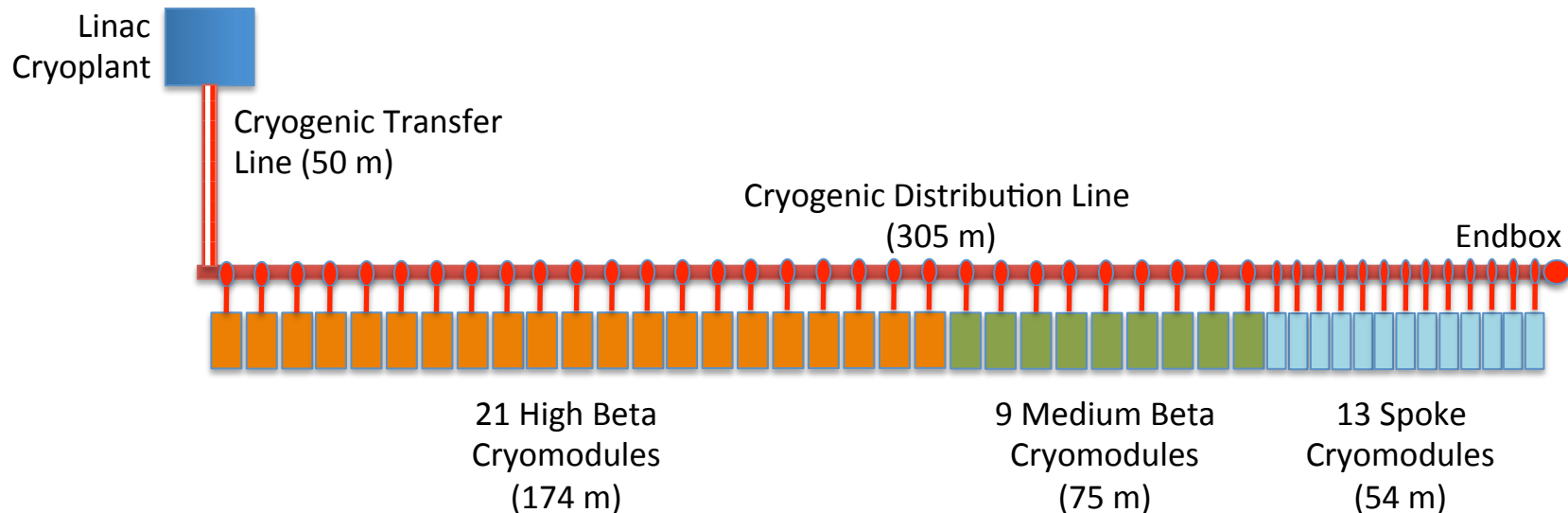
ESS Cryogenic System
Block Diagram



Function and layout of the Linac CDS

Cryogenic Distribution System for the ESS Linear Accelerator is dedicated for delivering the cooling power from the linac cryoplant to the accelerator cryomodules by means of the constant flows of supercritical and cold gaseous helium.

Layout of the cryodistribution system for the Optimus linac

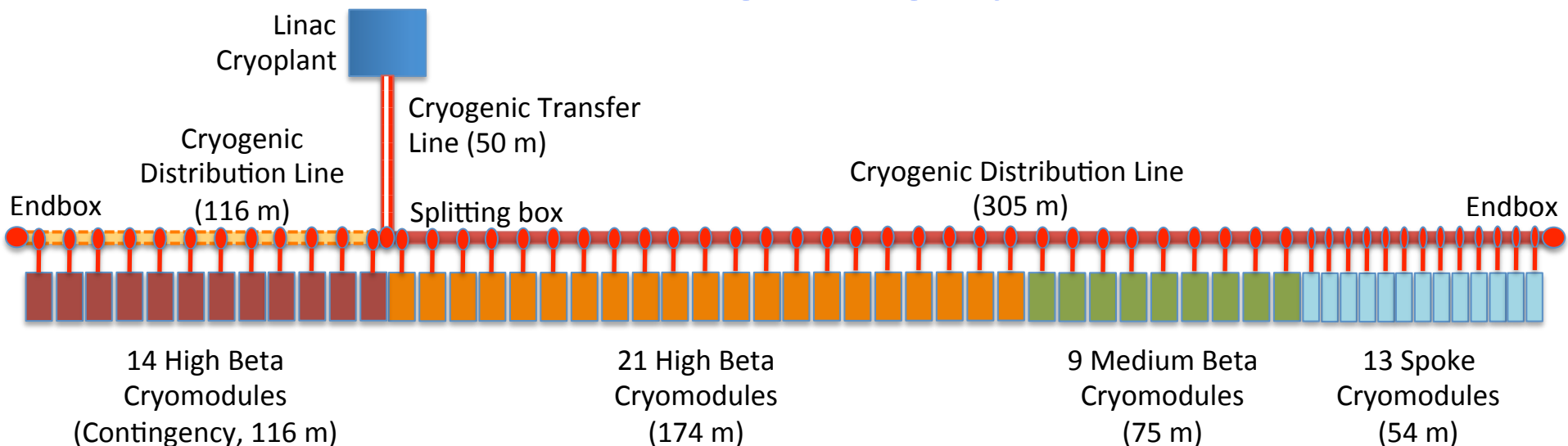


Function and layout of the Linac CDS

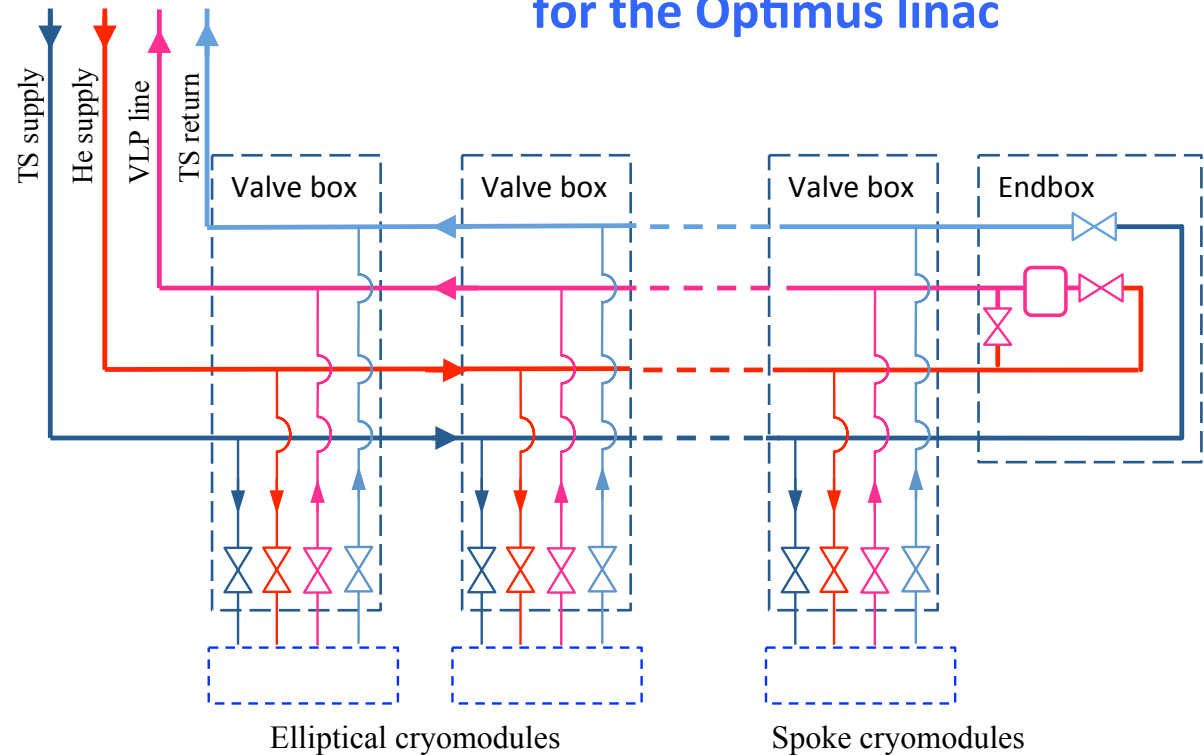
Cryogenic Distribution System for the ESS Linear Accelerator is dedicated for delivering the cooling power from the linac cryoplant to the accelerator cryomodules by means of the constant flows of supercritical and cold gaseous helium.

However, it is considered to install additionally 14 contingent cryomodules. Then these additional modules will be served by another cryogenic distribution line.

Layout of the cryodistribution system for the Optimus linac with the design contingency



Flow scheme of the cryodistribution system for the Optimus linac

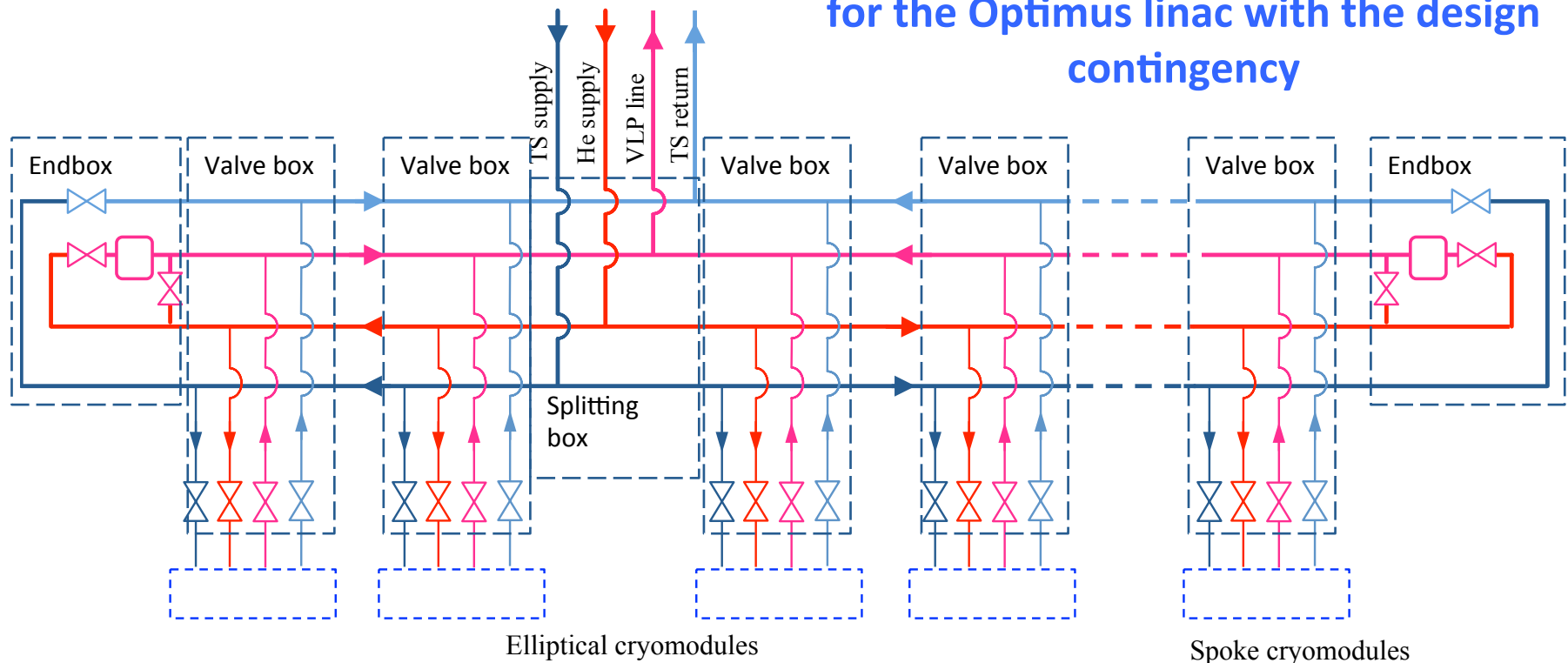


Two main circuits:

- thermal shield circuit (TS supply and TS return lines)
- cold helium circuit (Helium supply and VLP lines)

Linac CDS flow scheme

Flow scheme of the cryodistribution system for the Optimus linac with the design contingency



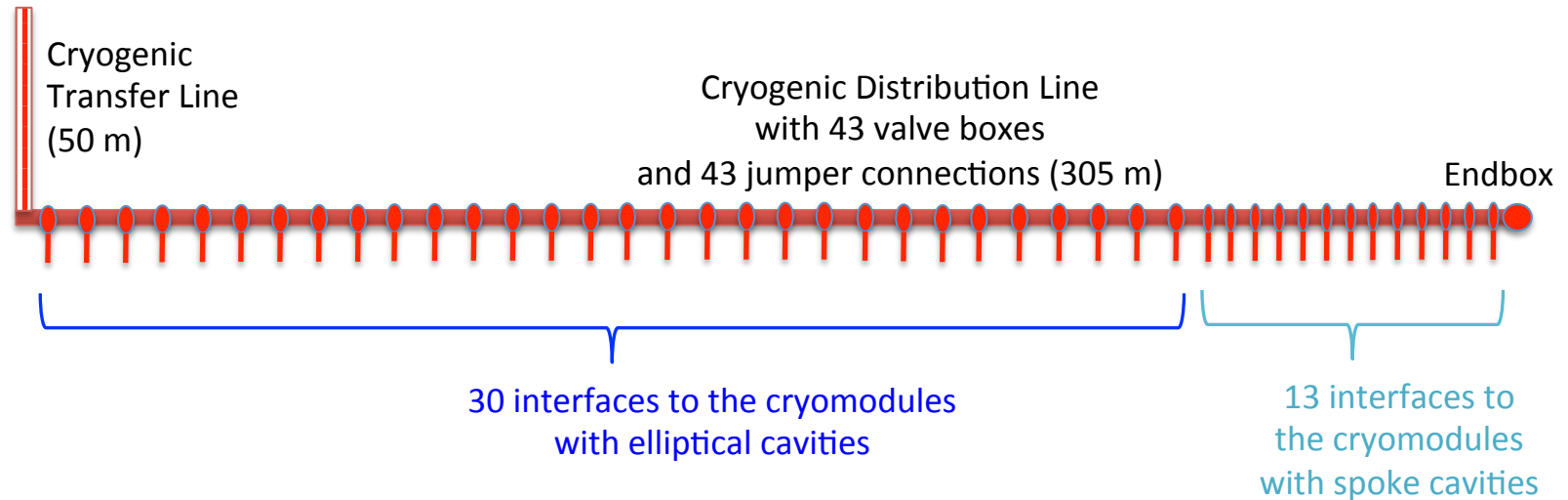
Two main circuits:

- thermal shield circuit (TS supply and TS return lines)
- cold helium circuit (Helium supply and VLP lines)

Linac CDS boundaries and interfaces

Interface to
the cryoplant

Layout of the cryodistribution system for the Optimus linac



Main interfaces with the ESS work packages and systems

WP4 Spoke cavities and cryomodules

WP5 Elliptical SFR inc. cryomodules

WP9 Installation

WP11.2 Accelerator cryoplant

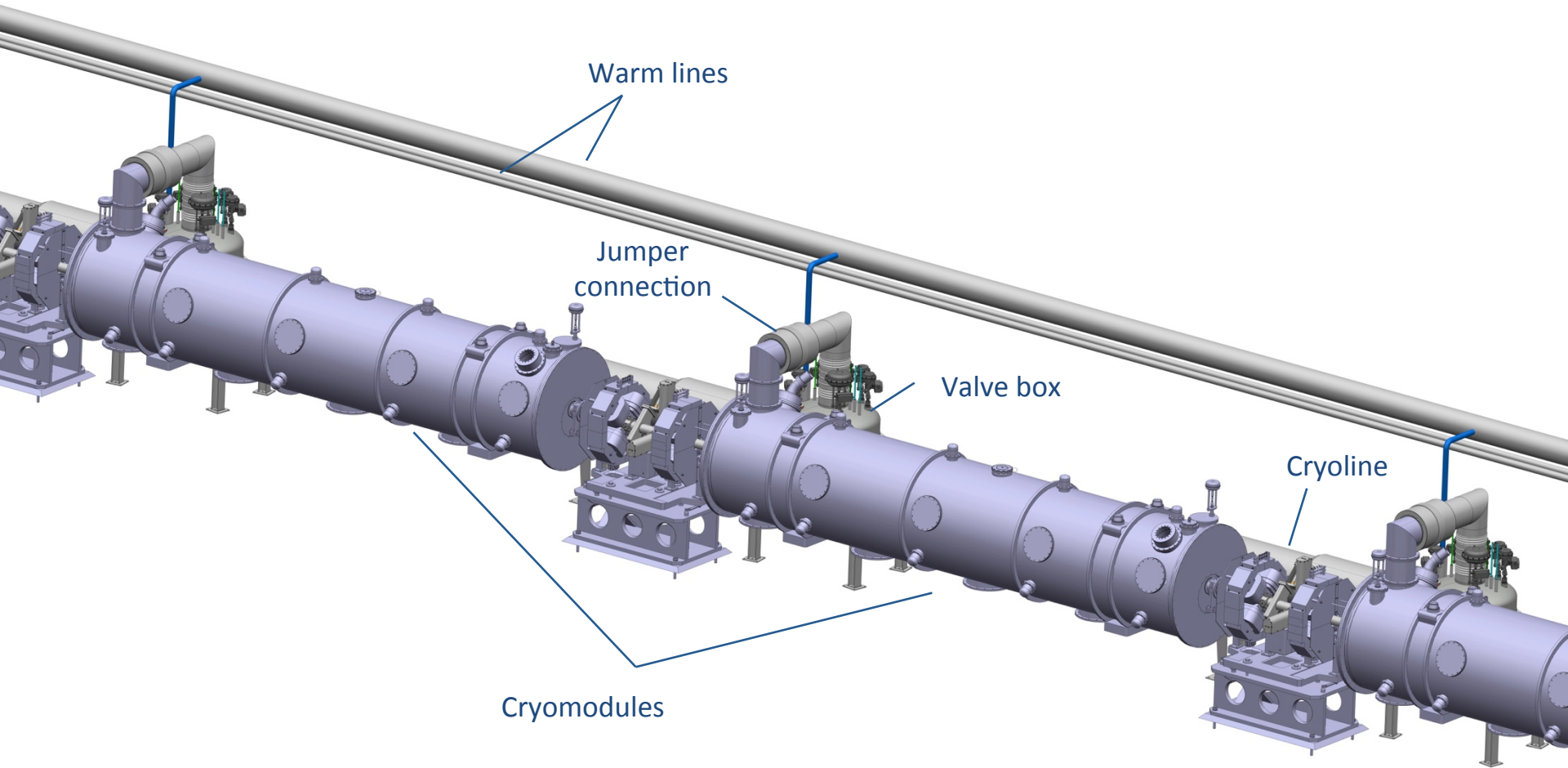
WP12 Vacuum

WP13 Safety and availability

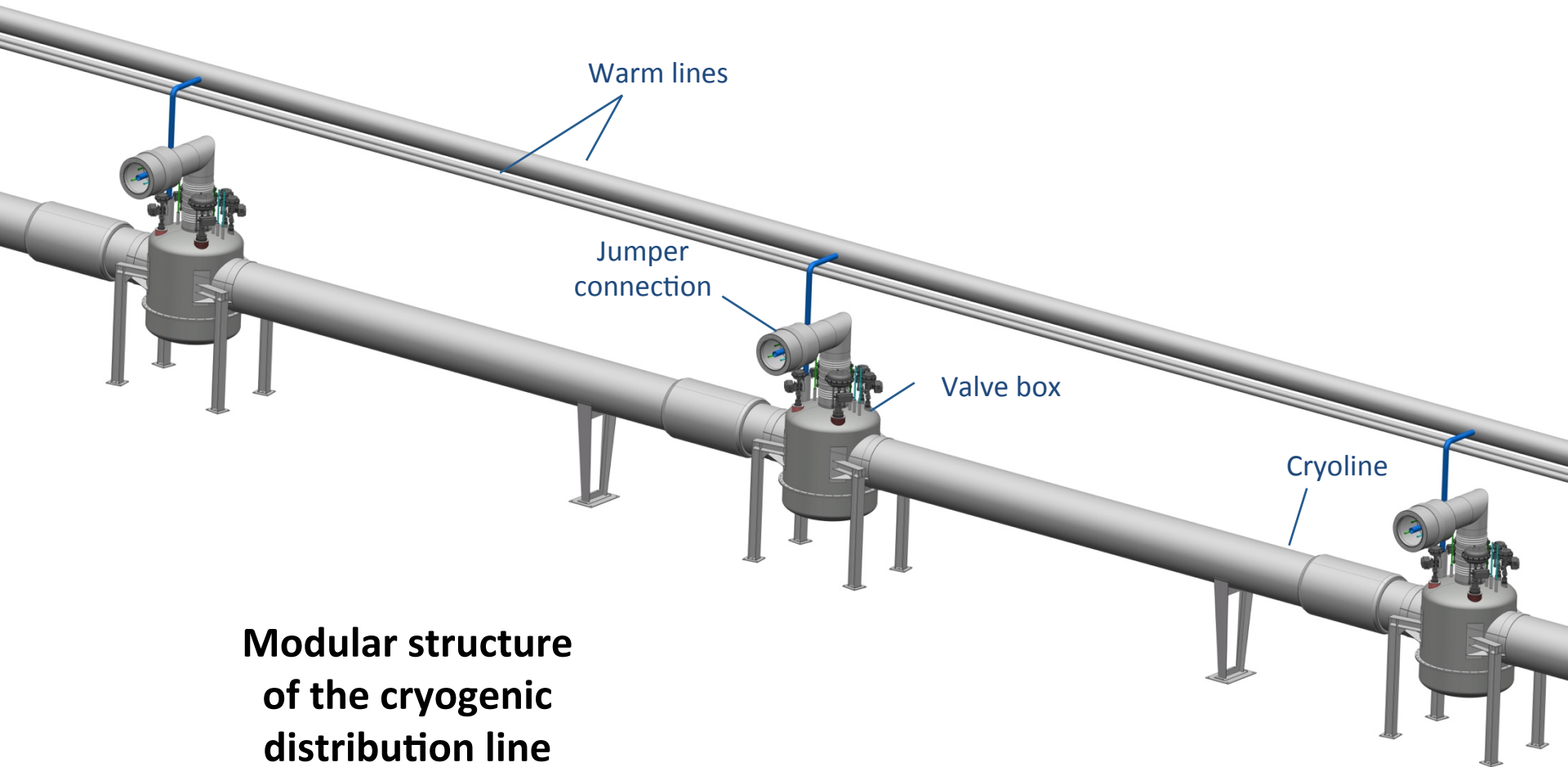
Control system

Buildings (accelerator and cryoplant)

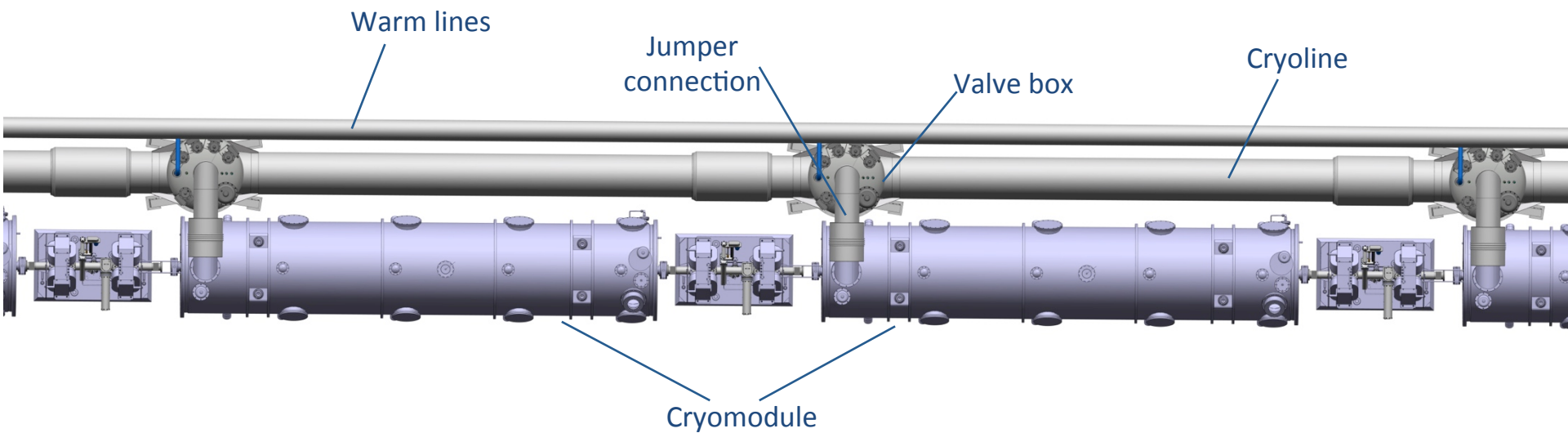
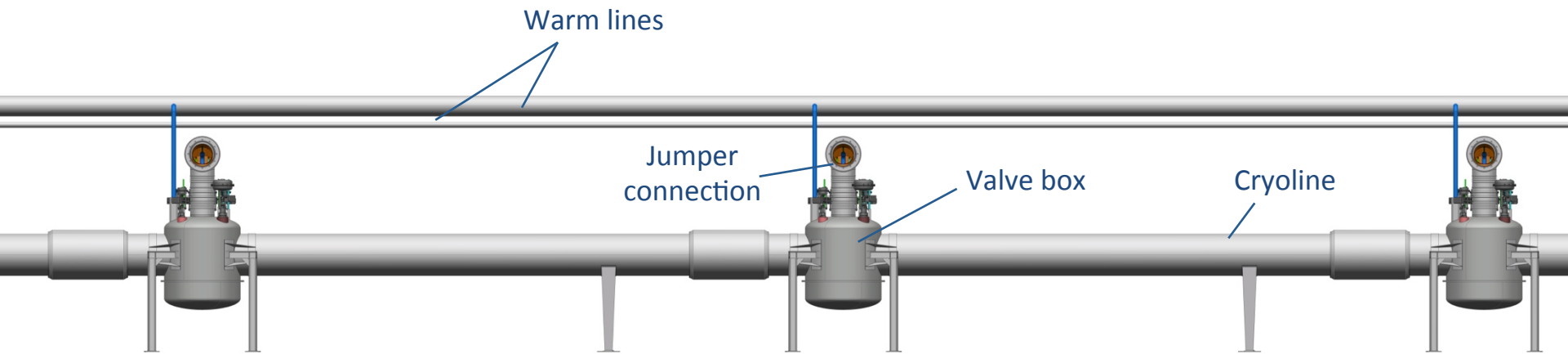
Linac CDS isometric



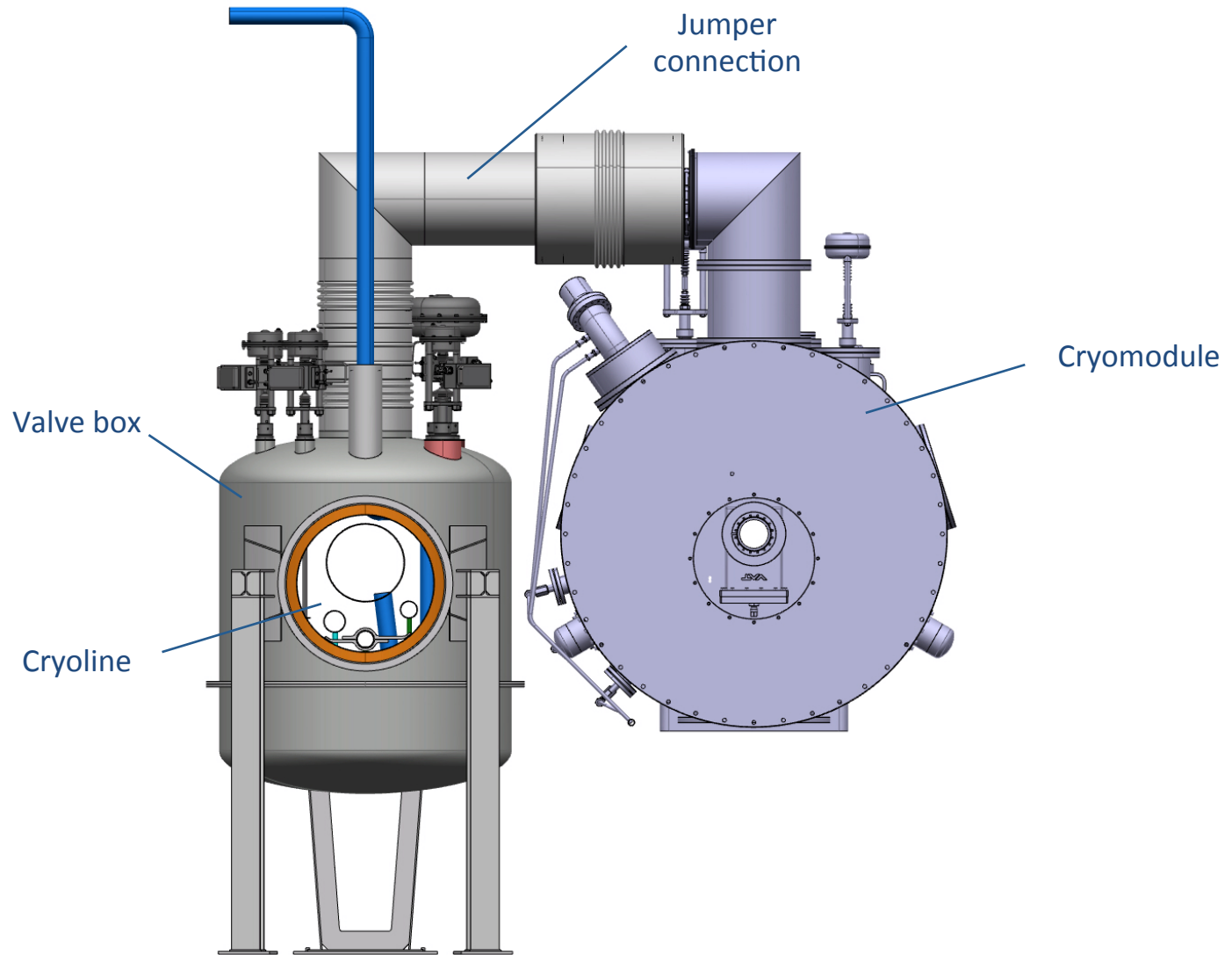
Linac CDS isometric



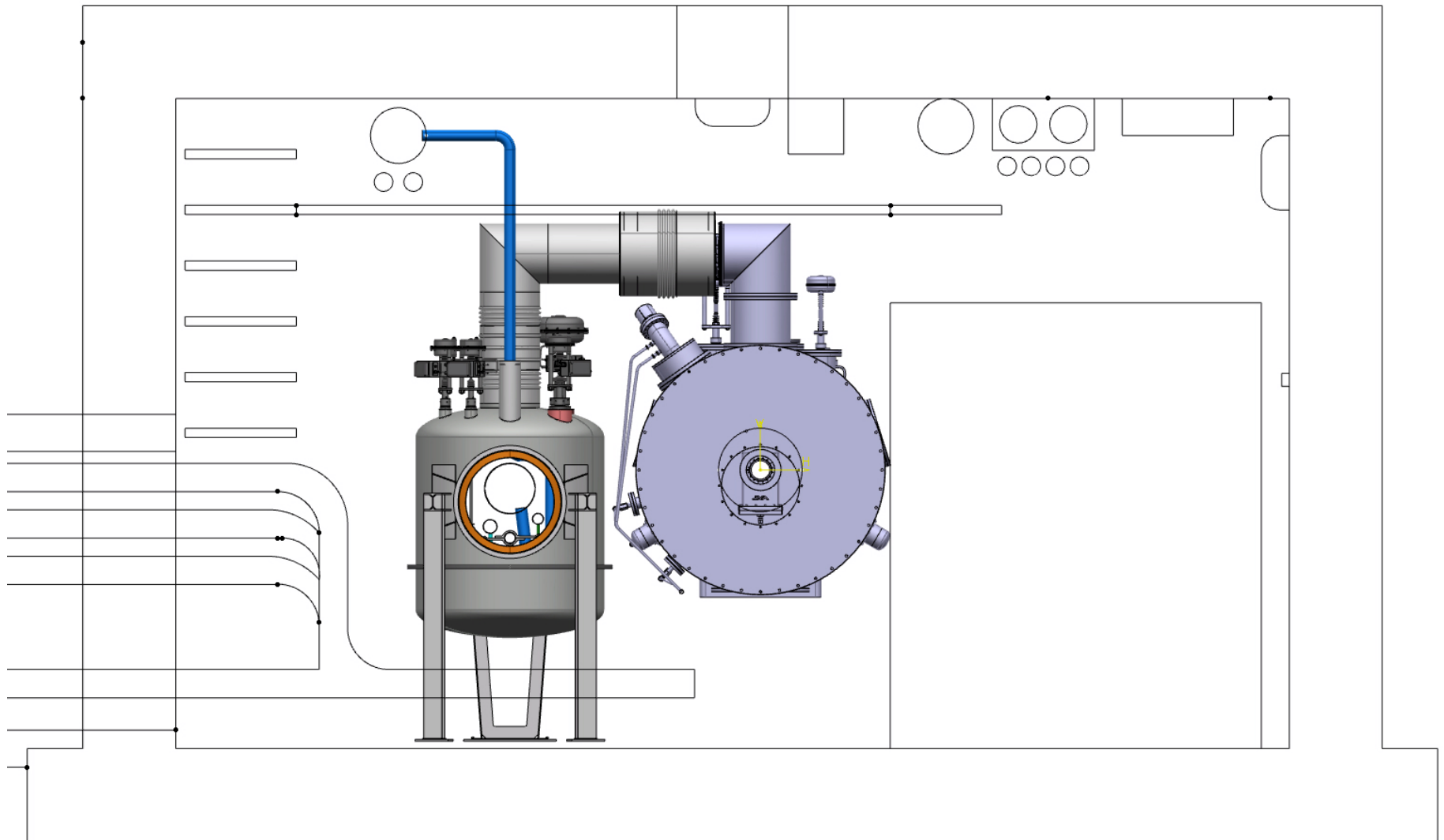
Linac CDS side and top view



Linac CDS front view



Linac CDS - position in the tunnel



Warm lines

Helium recovery line, 1.05-1.3 bar, 80-300 K

Purge return line

HP line, 10 bar, 300 K

TS supply, 40 K, 19.5 bar

TS return, 50 K, 19 bar

He supply, 4.5 K, 3 bar

VLP line, 4 K, 27 mbar

Cryoline

Valve box

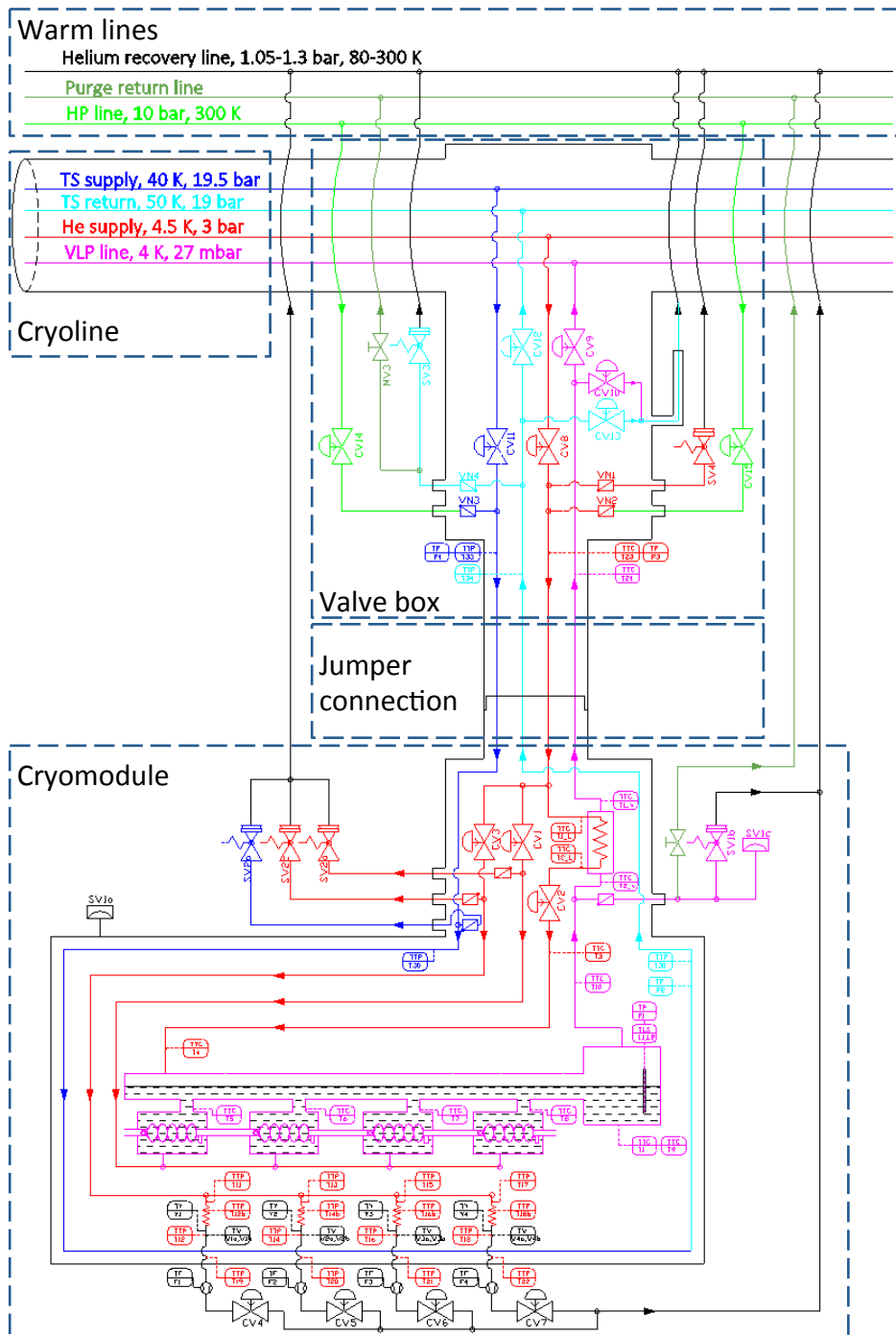
Jumper connection

Cryomodule

Linac CDS PID



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Linac CDS - Cryomodule interface specification

Interface sheet has to describe as follows:

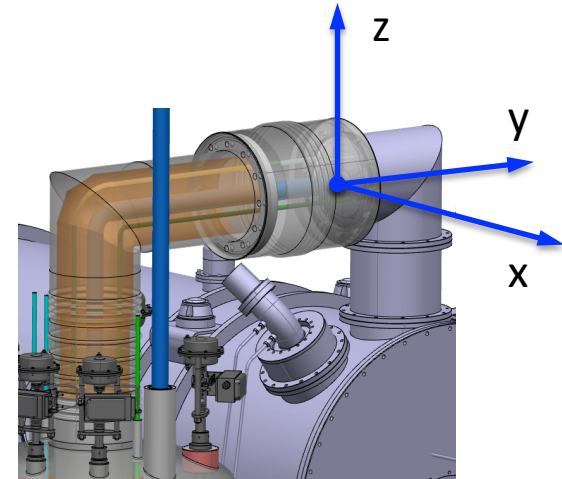
- precise location of the interface plane center (x, y, z)
- vacuum jacket diameter and wall thickness
- diameters and wall thicknesses of the process pipes
- thermal shield diameter and fixation points
- materials (pipes, thermal shield)
- cross sections for both sides
- maximum allowable dislocation tolerances ($\Delta x, \Delta y, \Delta z$)
- maximum allowable angle tolerances ($\alpha_x, \alpha_y, \alpha_z$)
- maximum acceptable forces (F_x, F_y, F_z)
- maximum acceptable moments (M_x, M_y, M_z)
- ...

Linac CDS - Cryomodule interface specification

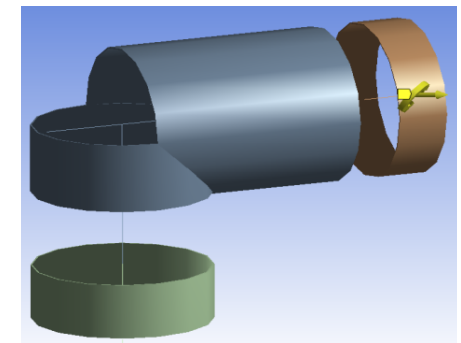
Specification of the mechanical loads:

1. Specification of the max. allowable dislocations
(for installation adjustment)

$$\left. \begin{array}{l} \Delta x = \pm 20 \text{ mm} \\ \Delta y = \pm 20 \text{ mm} \\ \Delta z = \pm 5 \text{ mm} \end{array} \right\} \text{example values}$$



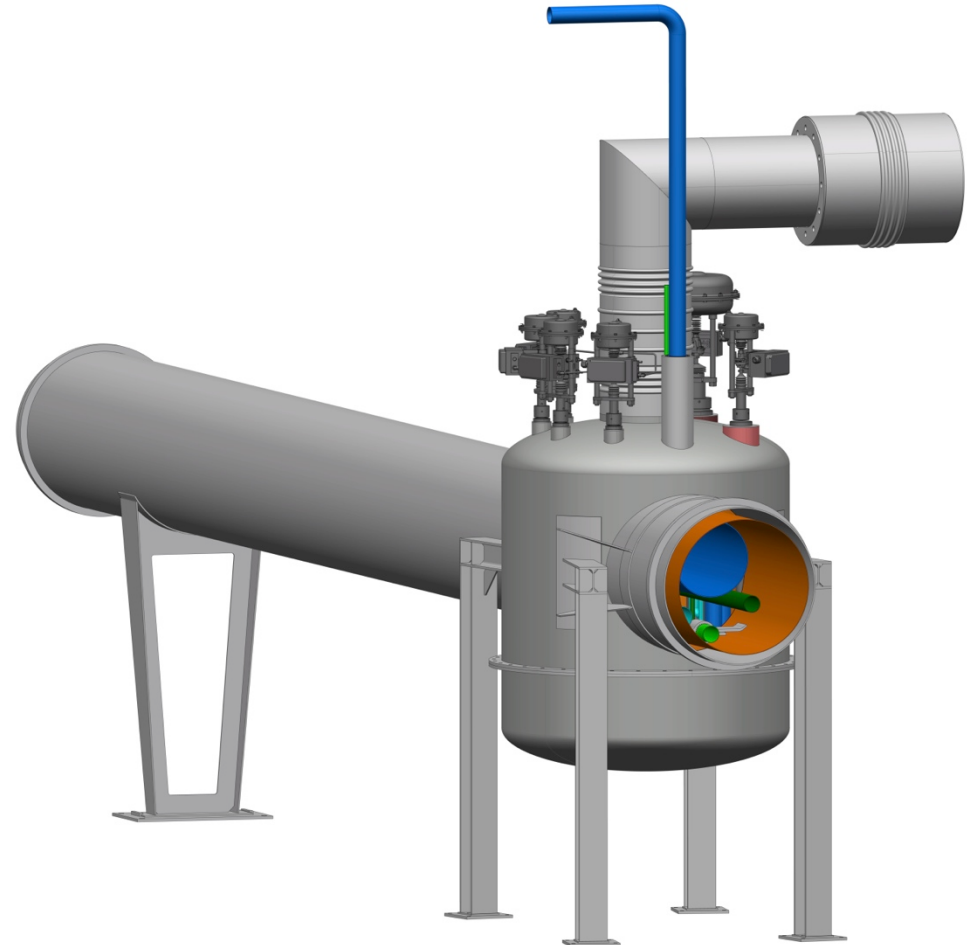
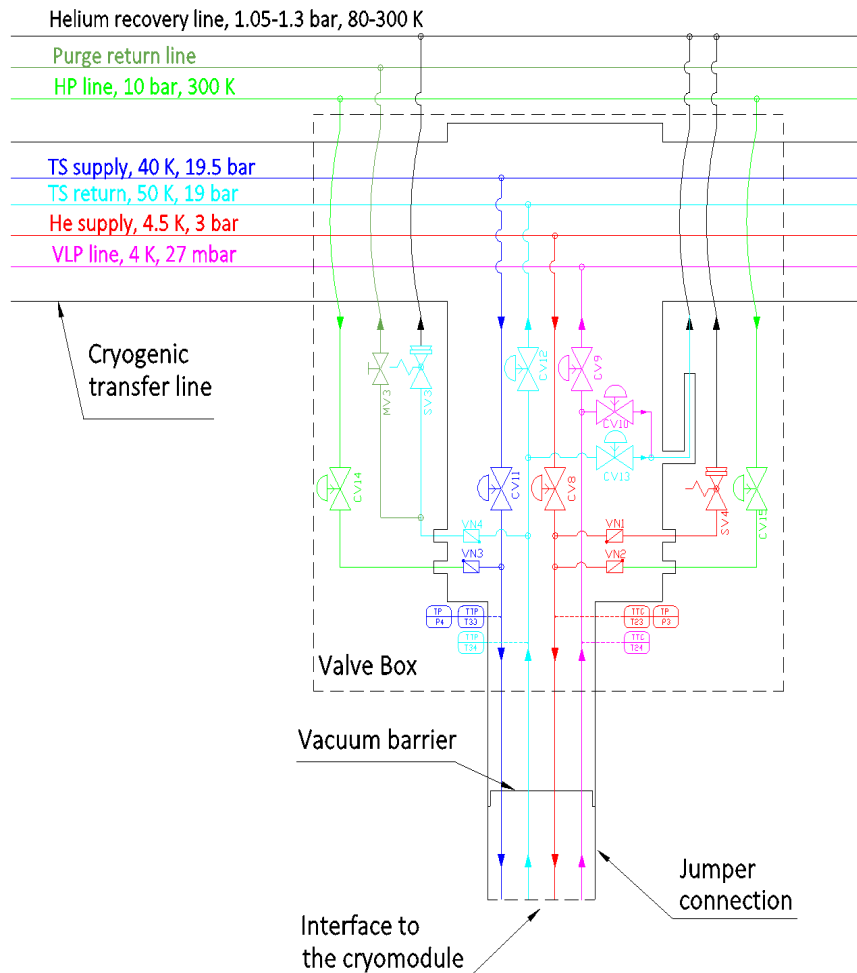
2. Mechanical and thermo-mechanical analysis
maximum allowable dislocations
+ production assembly tolerances
+ maximum displacements (at the worse operation or failure mode conditions)



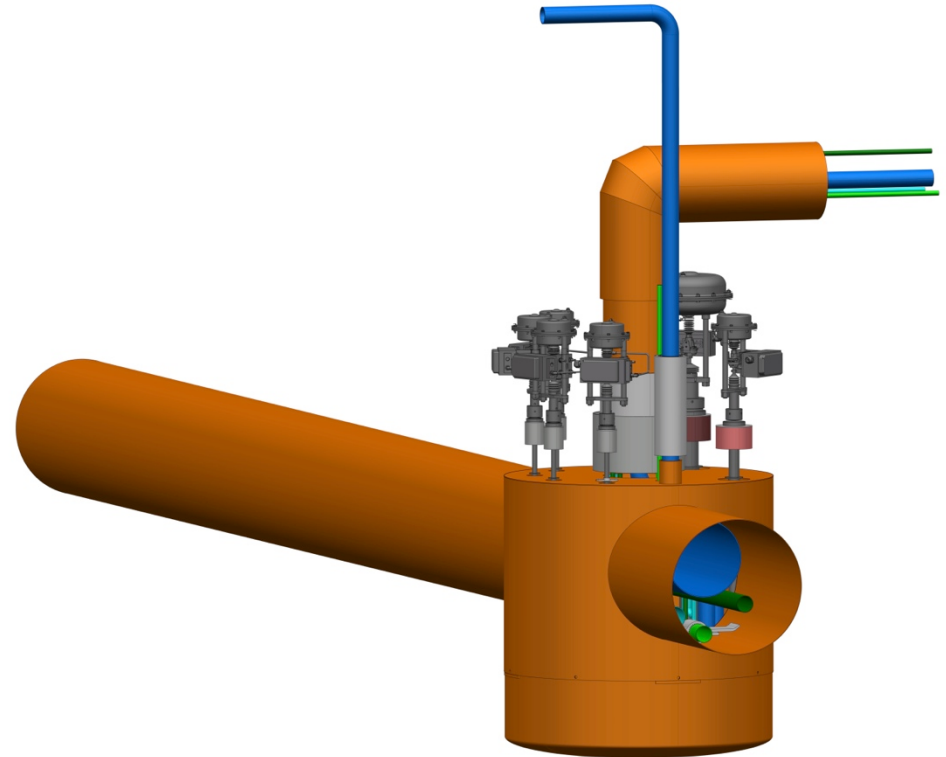
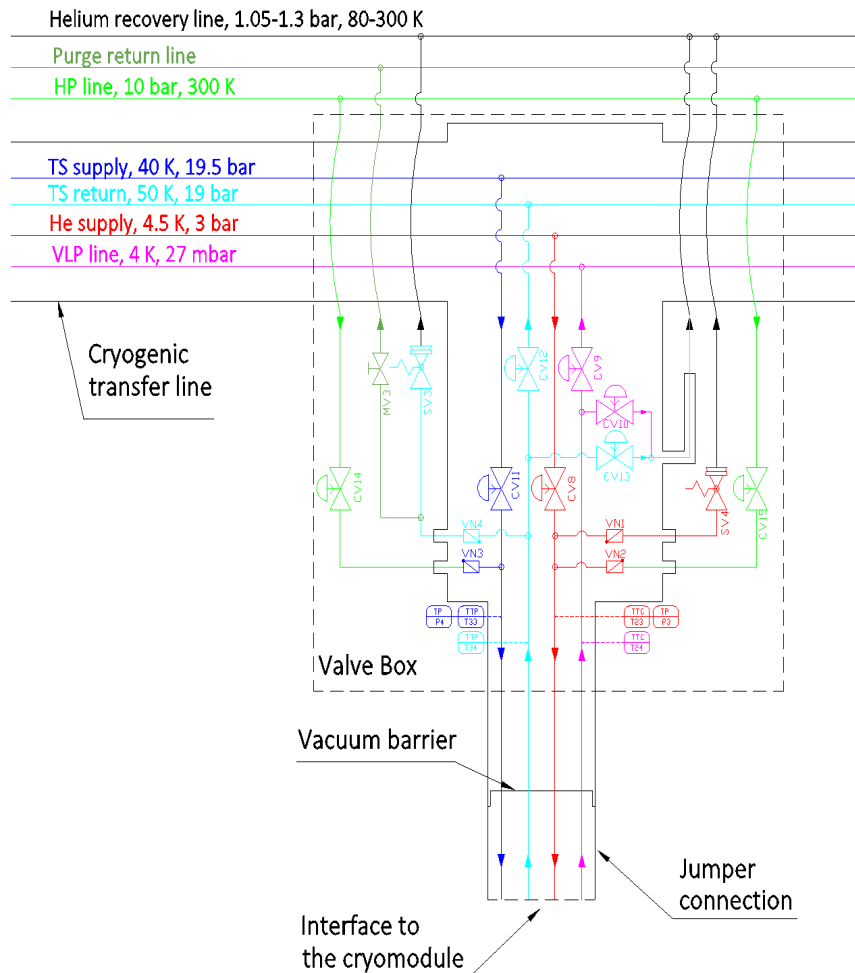
3. Determination of maximum acceptable forces and moments

$F_x = + 500 \text{ N} \quad -500 \text{ N}$	$M_x = + 239 \text{ Nm} \quad -239 \text{ Nm}$	} results based on example values
$F_y = + 3013 \text{ N} \quad -3013 \text{ N}$	$M_y = + 143 \text{ Nm} \quad -143 \text{ Nm}$	
$F_z = + 606 \text{ N} \quad -606 \text{ N}$	$M_z = + 165 \text{ Nm} \quad -165 \text{ Nm}$	

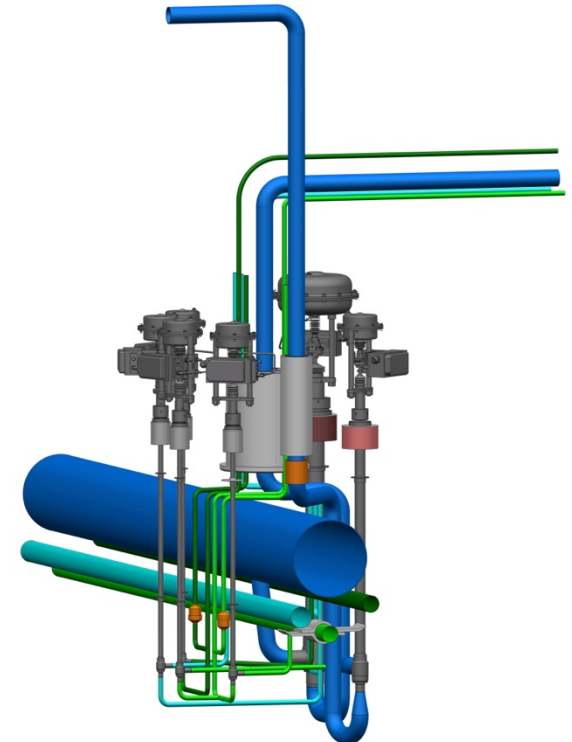
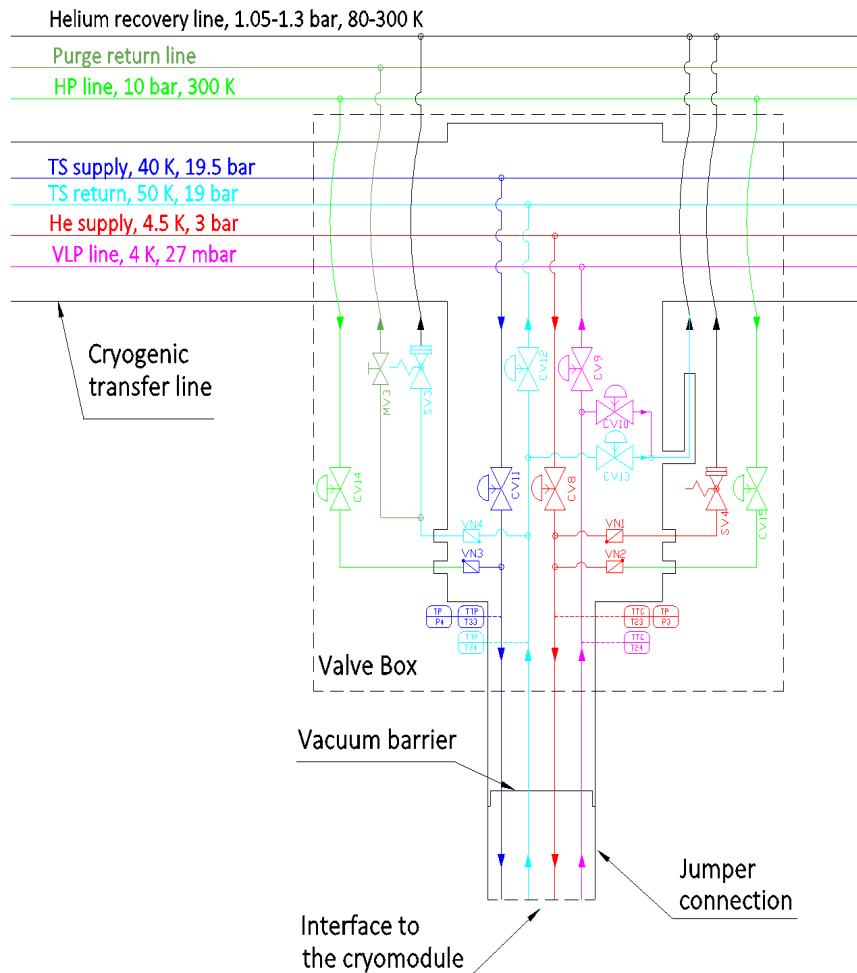
Prototype valvebox



Prototype valvebox



Prototype valvebox



Conclusions and open issues

