



# C<sup>3</sup> Demonstrator Cryogenics and Layout

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# Functionality

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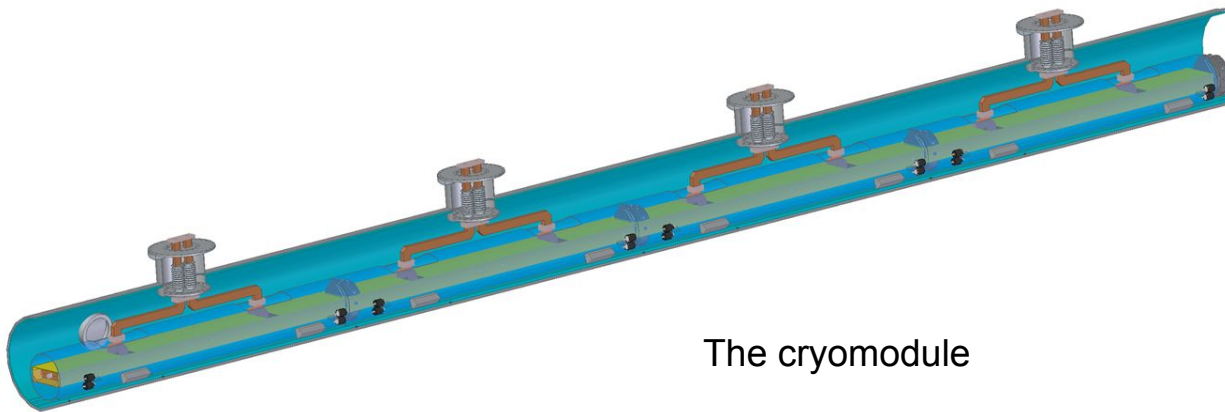


- First step in a baseline design for the Demonstrator Cryogenics
- Mode 1 - Normal Accelerator development
  - LN at nominal height above accelerator sections
  - low LN flow
- Mode 2 - High flow for vibration testing etc, up to 10 kg/sec

# Stages



- The basic mechanical building block is the “Raft”
  - 2 accelerator sections + permanent magnet quad & BPM per raft
- 4 rafts per cryomodule, ~10 m
- 10 cryomodules per Sector, ~100 m
- 10 Sectors per SuperSector, ~ 1 km



The cryomodule

# Demonstrator Linac



- The linac proper will consist of 3 cryomodules
  - Each cryomodule will have 4 rafts, each raft having 2 accelerator sections -
  - But only 18 accelerator sections will be powered
- This will permit demonstration of full fluid flow over the rafts including cryomodule transitions.
- The accelerator sections will be nominally powered for C3-250 gradient (70 MeV/m), but also tested at the C3-550 gradient (120 MeV/m), and the stretch gradient of 150 MeV/m. Operating margins will be explored.

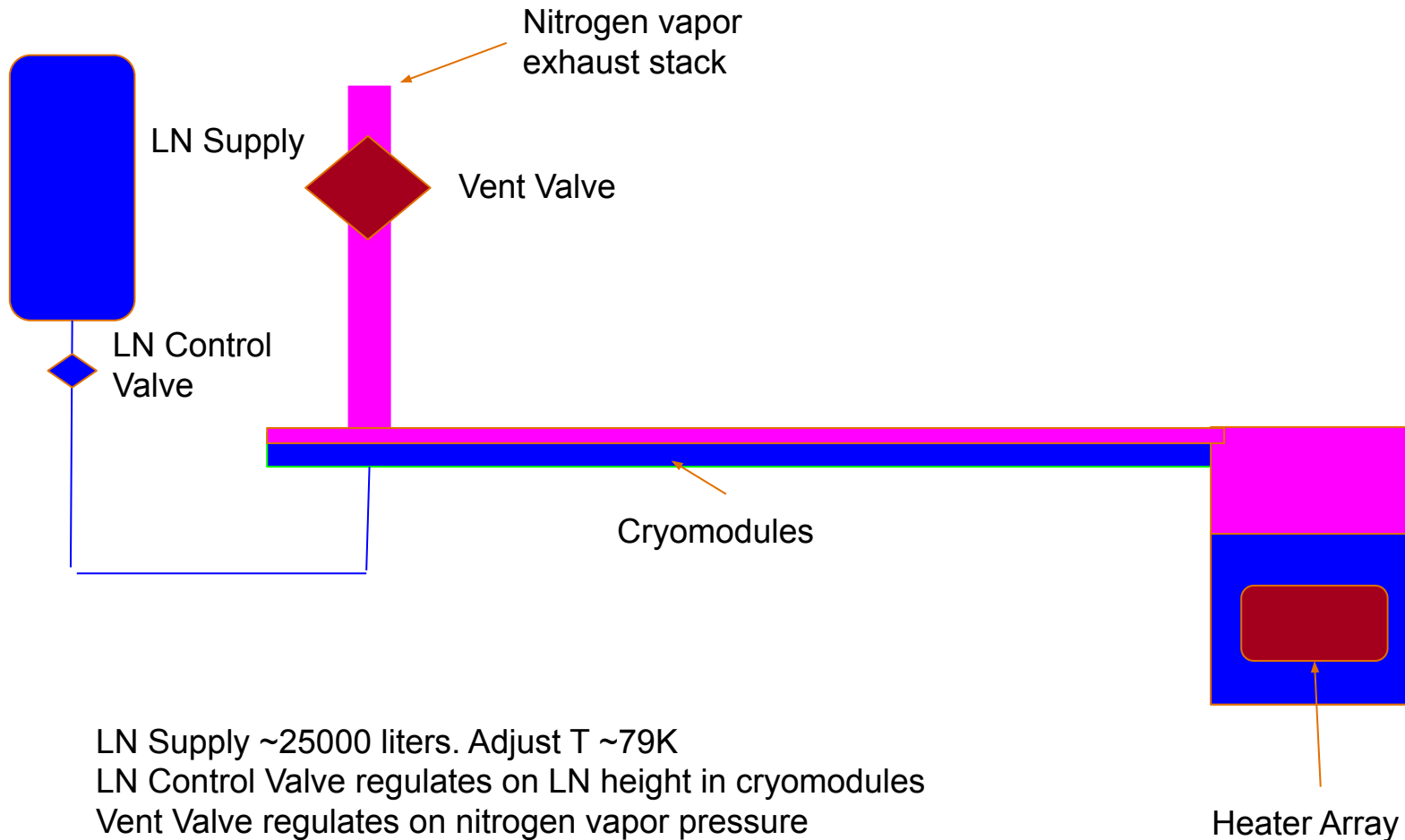
# Cryogenic Loads

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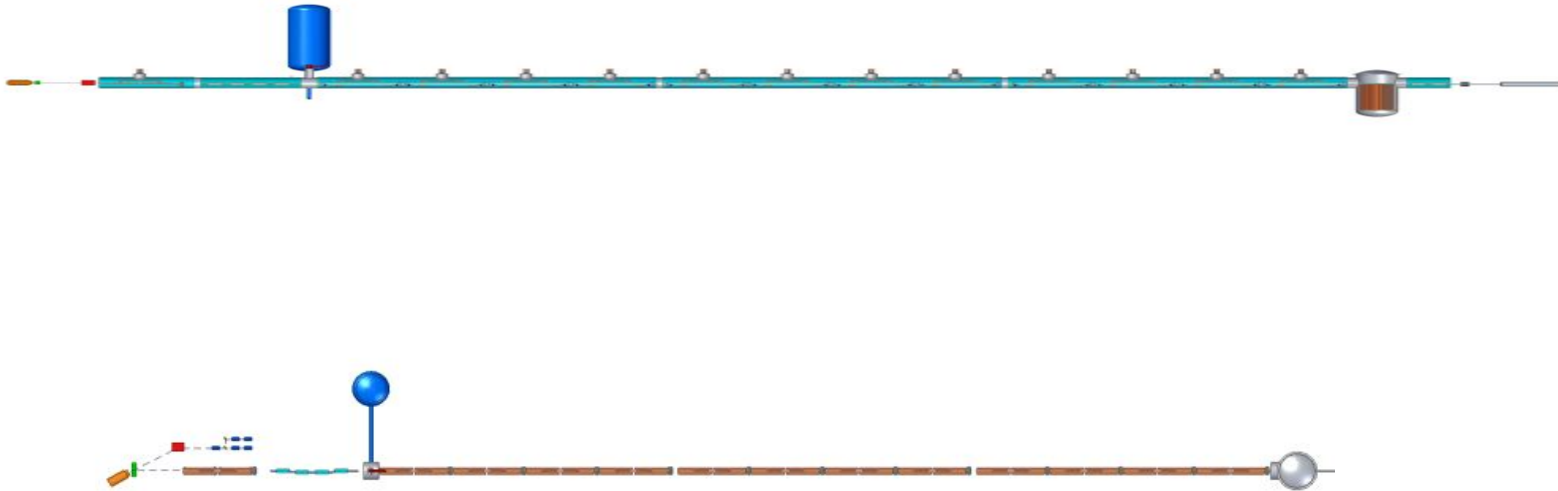


- The normal power dissipation for C3-250 and C3-550 is 2500 w/section. For the stretch gradient, the dissipation increases to 3900 w/section, and the cooling behaviour will be studied.
- The nominal load is 18 klystrons x 2500 watts = 45 kW.
- This corresponds to a mass flow of 0.22 kg/s, or 0.28 l/s.
- The cryostat losses without RF are 3 x 225 w. Add 20% for ends, and consumption is 500 l/day.
- Total load (operating 24 hours) = 25000 liters.
- Use a storage dewar of ~30000 liters and fill by truck.

# Simplified Cryogenic Layout



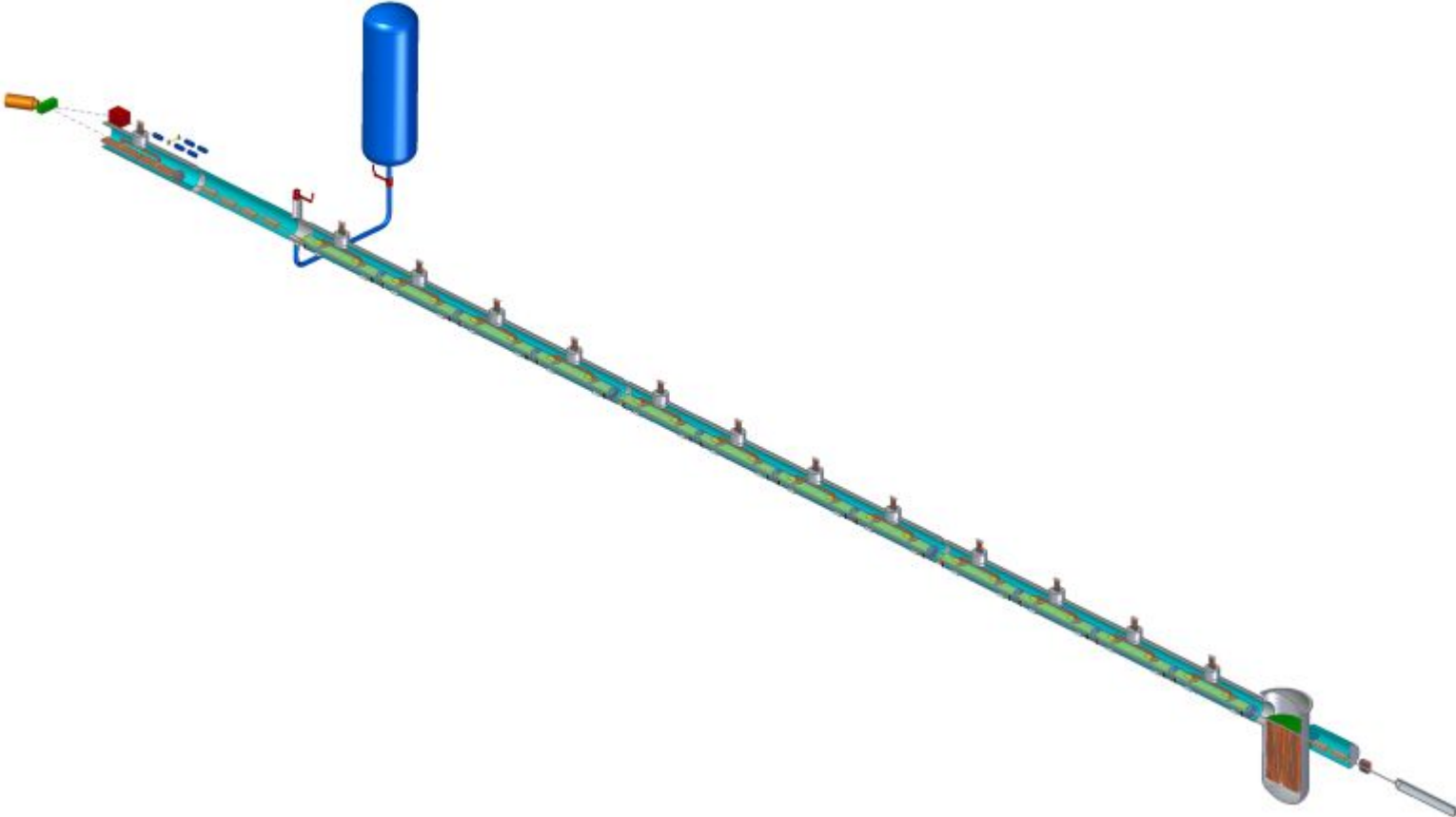
# Overall Layout



Starting from left:

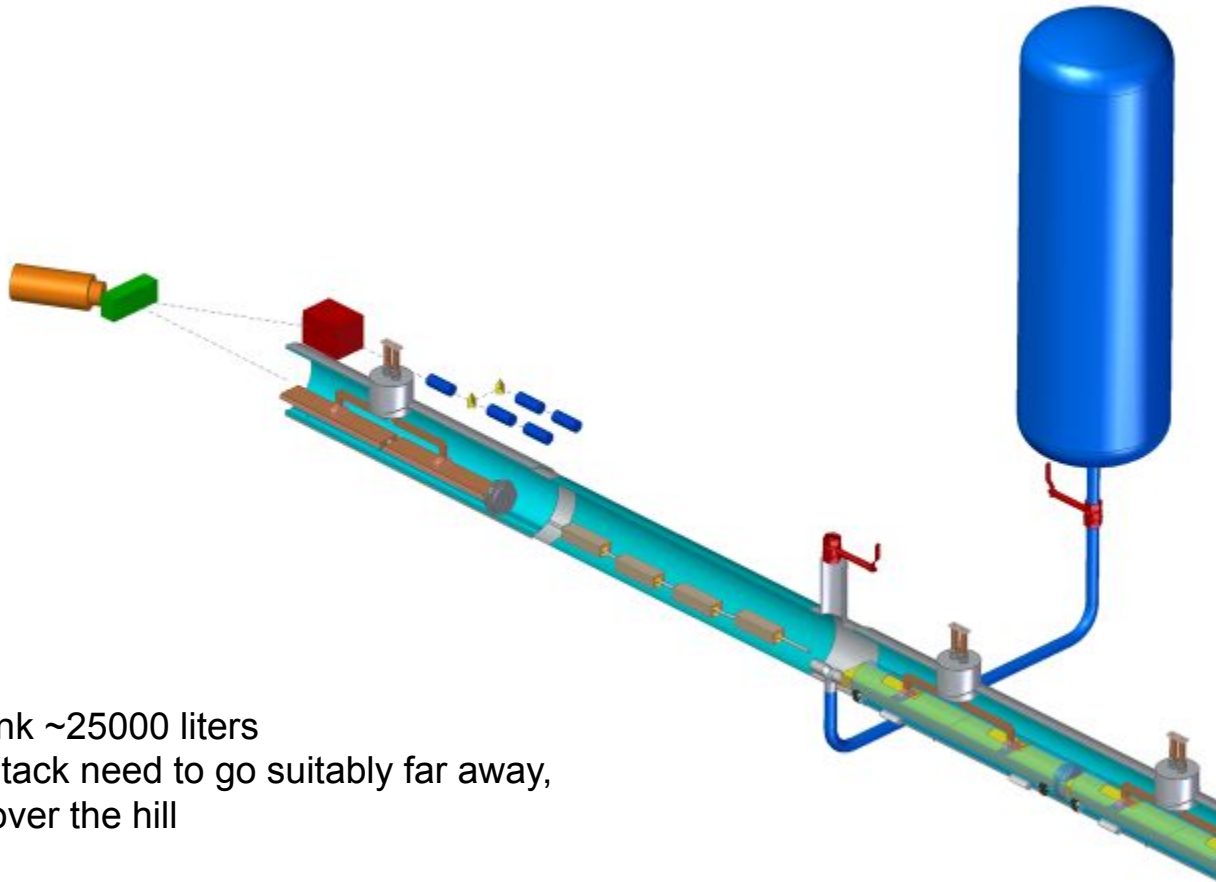
electron gun (warm), S-Band Booster (cold), Bunch Compressor (cold for the convenience of the booster), 3 Cryomodules, "Boiler", Spectrometer (warm), dump (hot)

# Another view



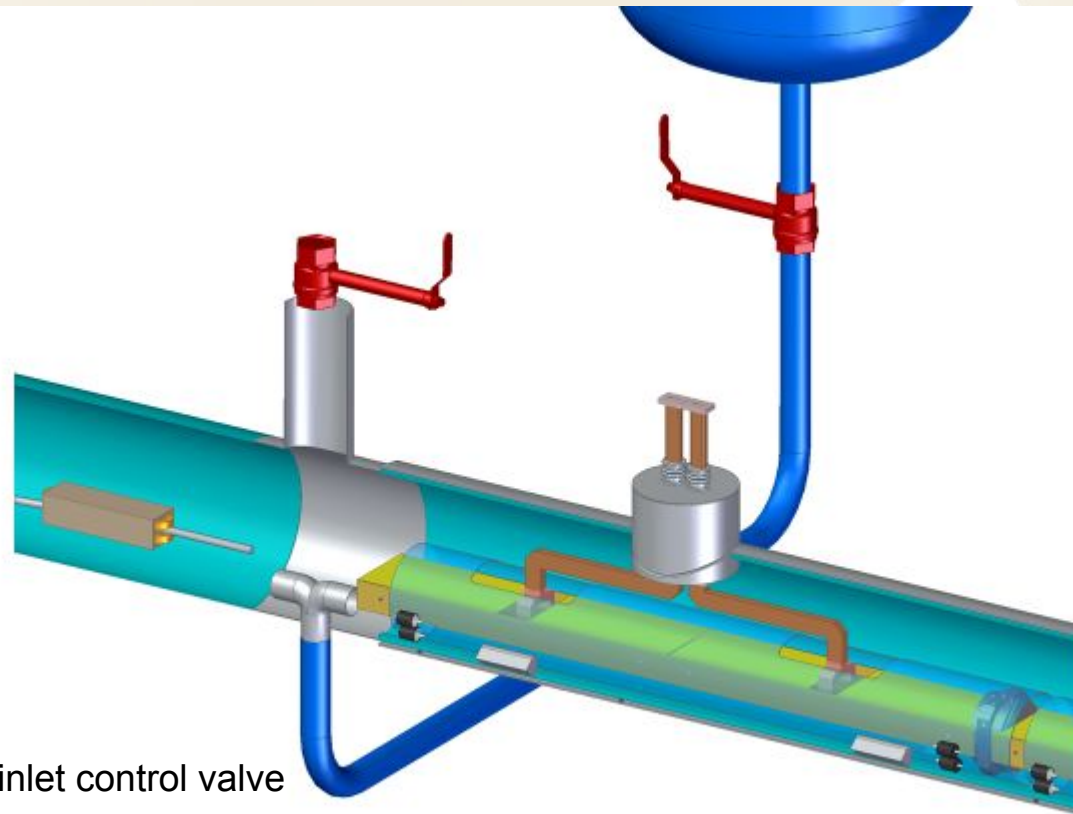


# LN in, vapor out at “SuperSector Cross”



LN Tank ~25000 liters  
Vent stack need to go suitably far away,  
as in over the hill

# Close up of Cross

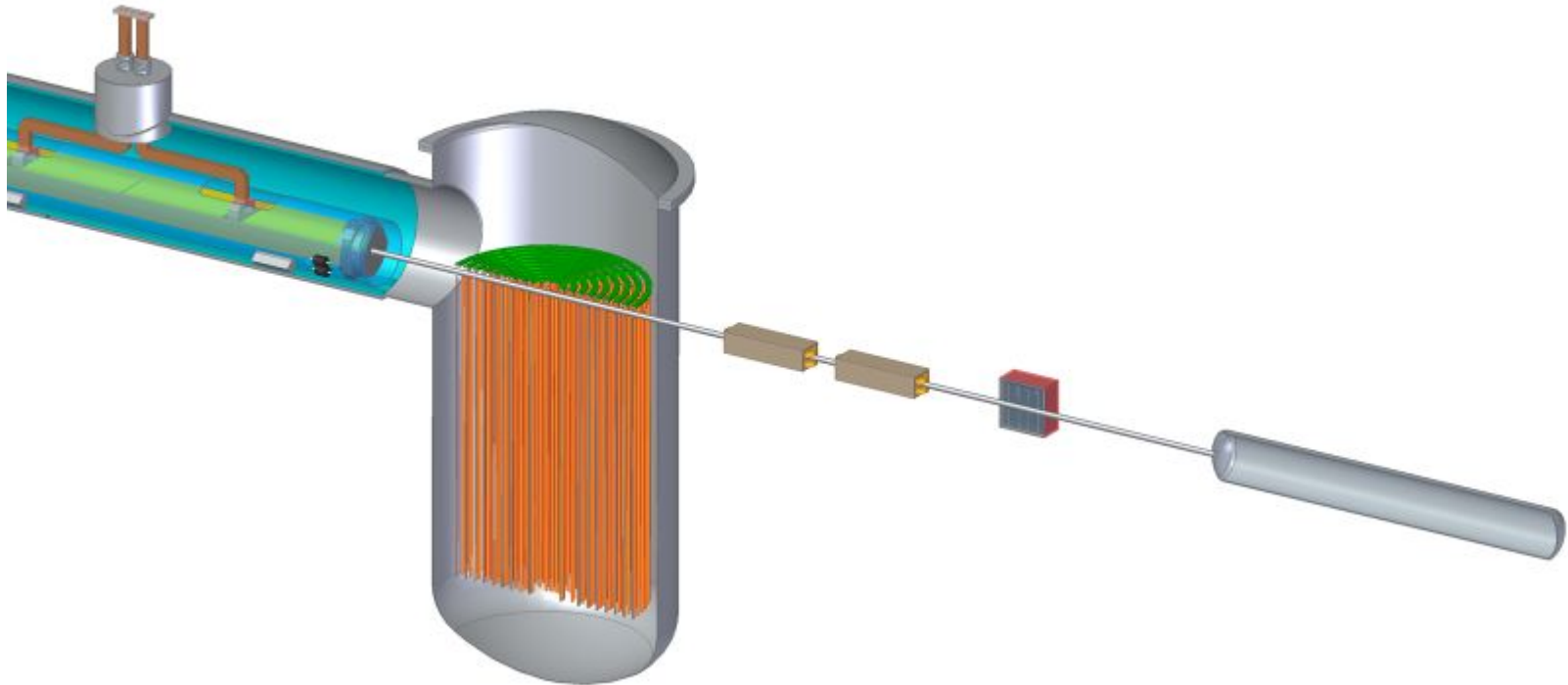


LN comes in from bottom, inlet control valve regulates on liquid level.

Outlet valve regulates on pressure of vapor in cryomodules.

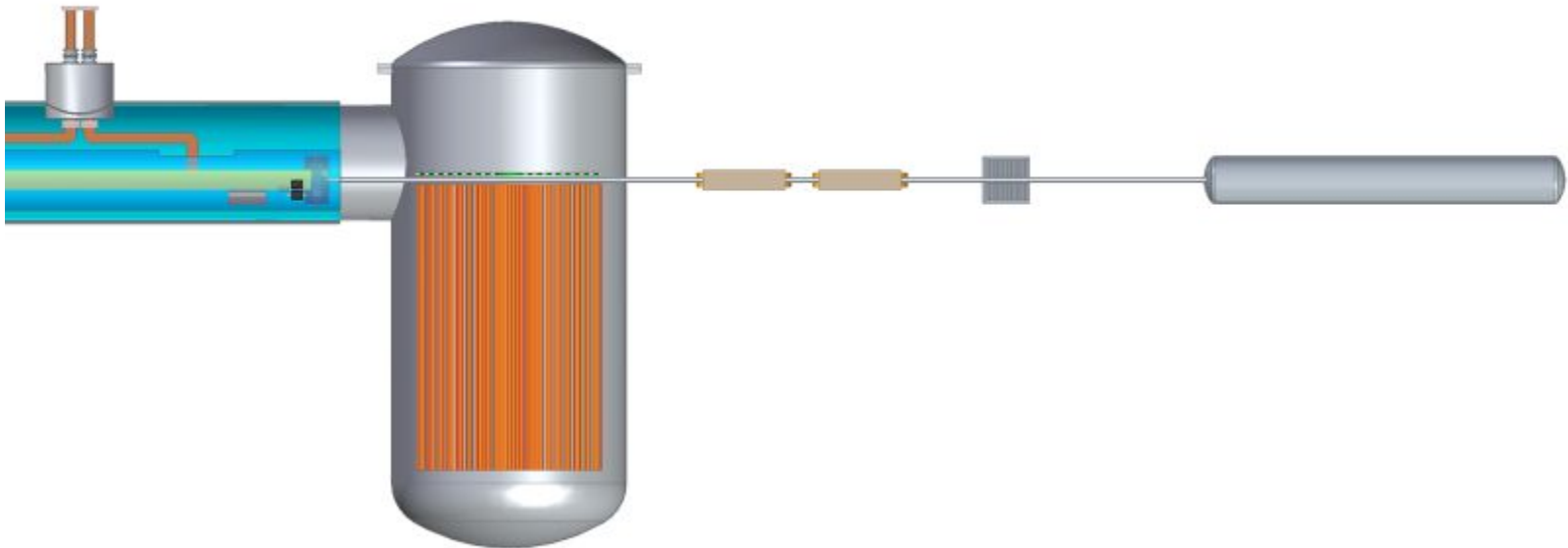
Both may require some feed-forward.

# Boiler



LN in boiler at same level as in cryomodules, covering Calrod array.

# Boiler

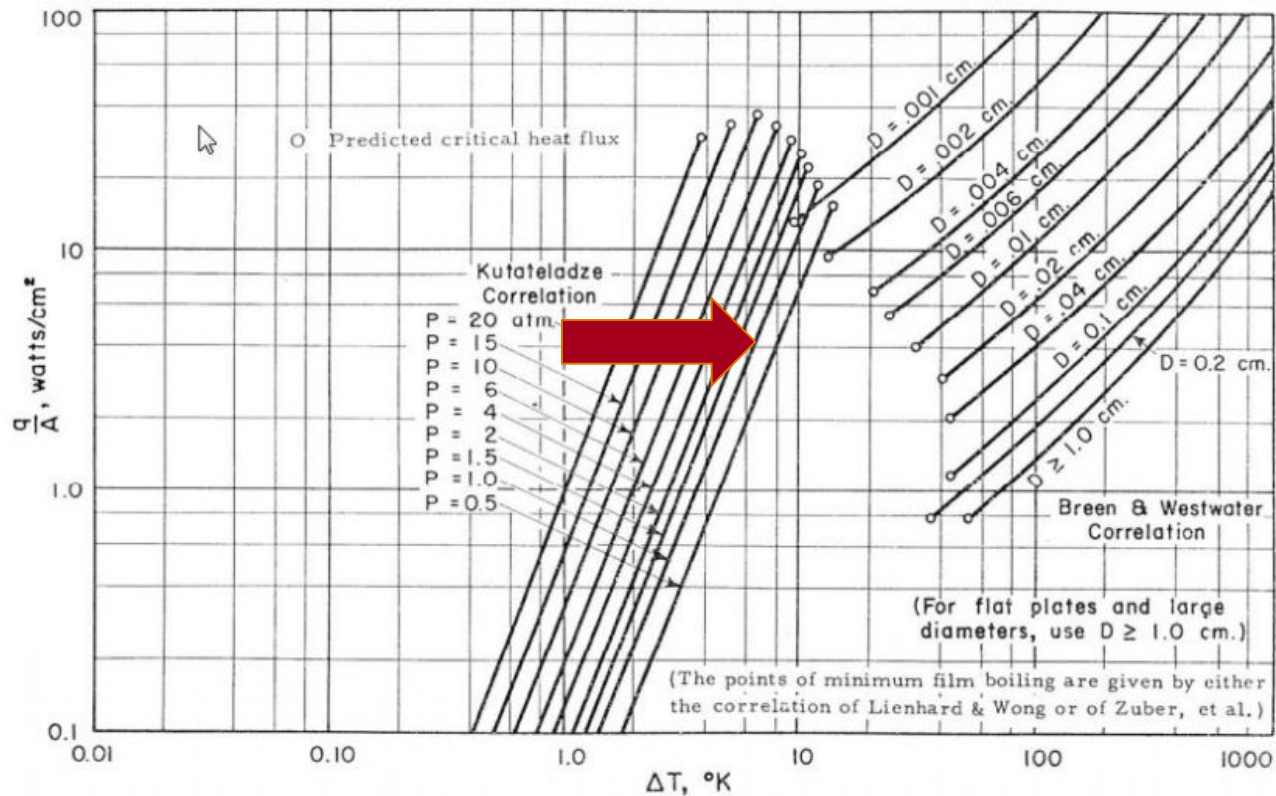


900 Calrods,  $4 \text{ W/cm}^2$ ,  $\sim 2 \text{ MW}$  total.

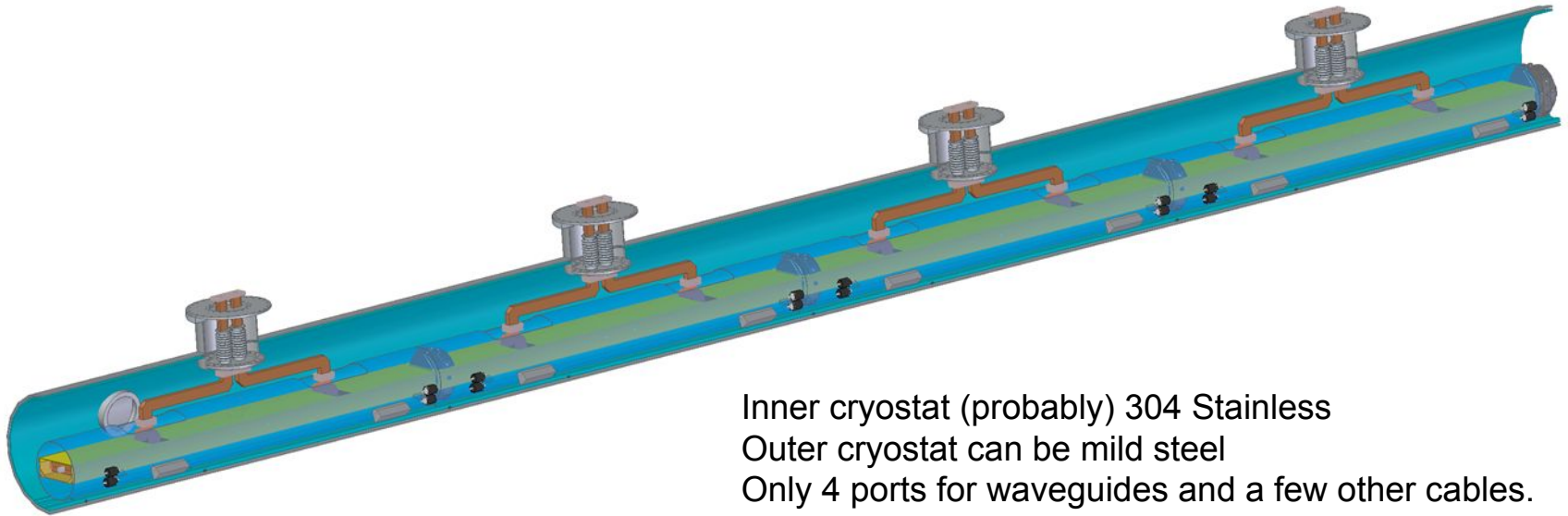
Pick 4 watts/cm<sup>2</sup>



## Prediction of Nucleate/Film Boiling for Nitrogen



# The Cryomodule



Inner cryostat (probably) 304 Stainless  
Outer cryostat can be mild steel  
Only 4 ports for waveguides and a few other cables.

Plan (hope?) to have only welded joints in cryostat -  
no bolted flanges or other connectors. Weld preps  
designed for “can opener” removal.

Note that Cryomodule fits in standard 40' ISO  
container for transport.