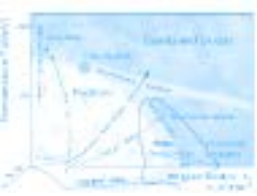




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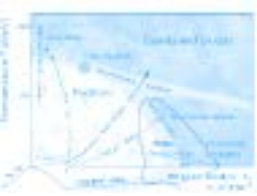


# NICA CRYOGENICS



# PRESENTATION OUTLINE

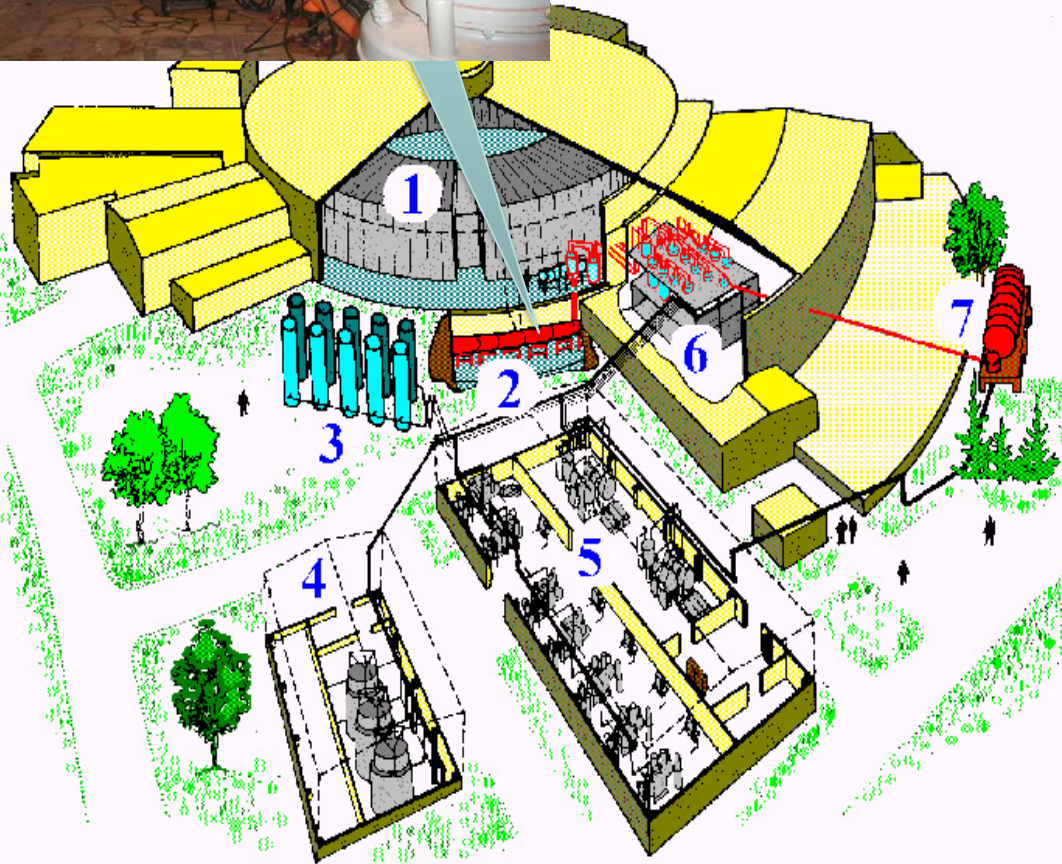
- [NICA Cryogenic System Overview](#)
- [New compressor station](#)
- [Liquid helium distribution system](#)
- [Cryogenic system of the test facility](#)
- [Cooling of the detectors](#)
- [Central helium liquéfier](#)



# PRESENTATION OUTLINE

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# Cryogenic System of the Nuclotron



**Refrigeration capacity  
4000 W at 4,5 K**

- 1 – iron yoke of the synchrotron,
- 2 – ring of the Nuclotron,
- 3 – compressed gas reservoirs,
- 4 – gas-holders,
- 5 – compressor station,
- 6 – helium refrigerators KGU-1600/4.5,
- 7 – liquid helium container

**Conception of Nuclotron cryogenic system included a large number of technical ideas and solutions never used before**

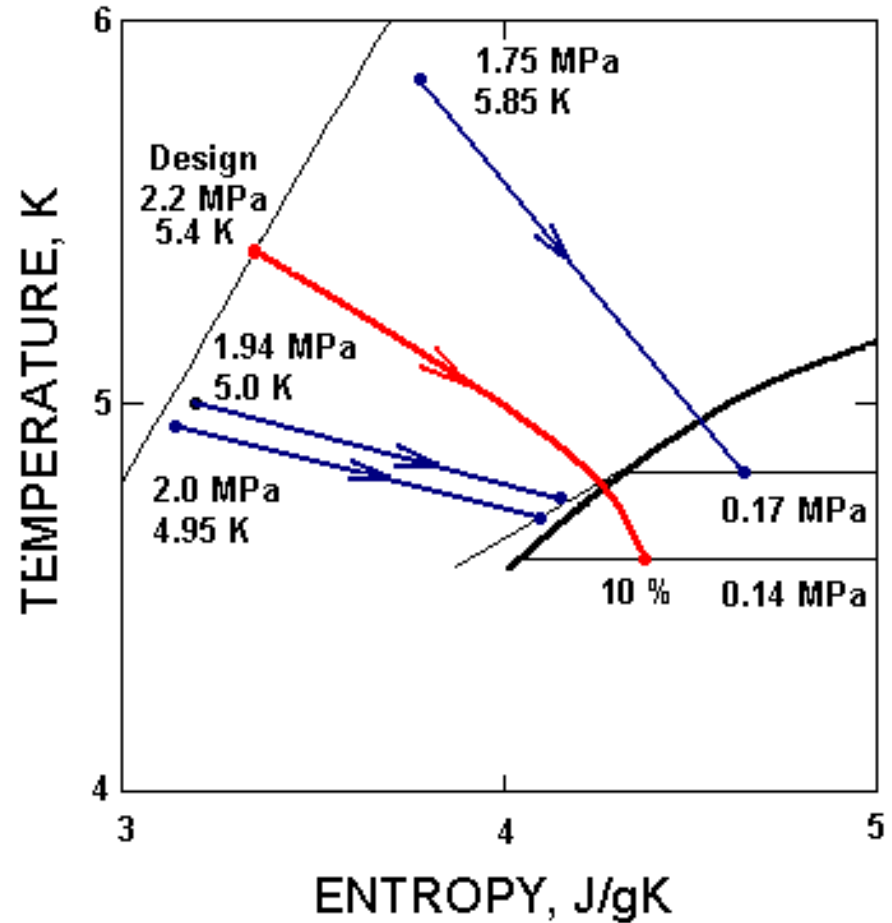


- fast cycling superconducting magnets**
- refrigeration by the two-phase helium flow**
- unusually short cooldown time to LHe temperature**
- parallel connection of about 150 cooling channels**
- jet pumps for liquid helium**
- «wet» turbo expanders**
- screw compressors with a pressure rise of more than**

**25**



# "Wet" turboexpander





NICA

draining and oil-purification units

satellite refrigerator of booster

satellite refrigerators of collider

1000 l/h helium liquefier OG-1000

new compressor station

40 m<sup>3</sup> liquid helium mobile tank

supply first stage of LN<sub>2</sub> system

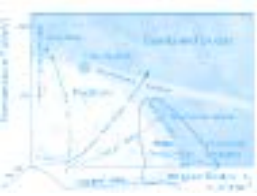
10740 Nm<sup>3</sup>/h nitrogen turbo-compressor

2x6600 Nm<sup>3</sup>/h helium screw compressors

Up to 10 kW @ 4.5 K

More than 200 tons of cold mass

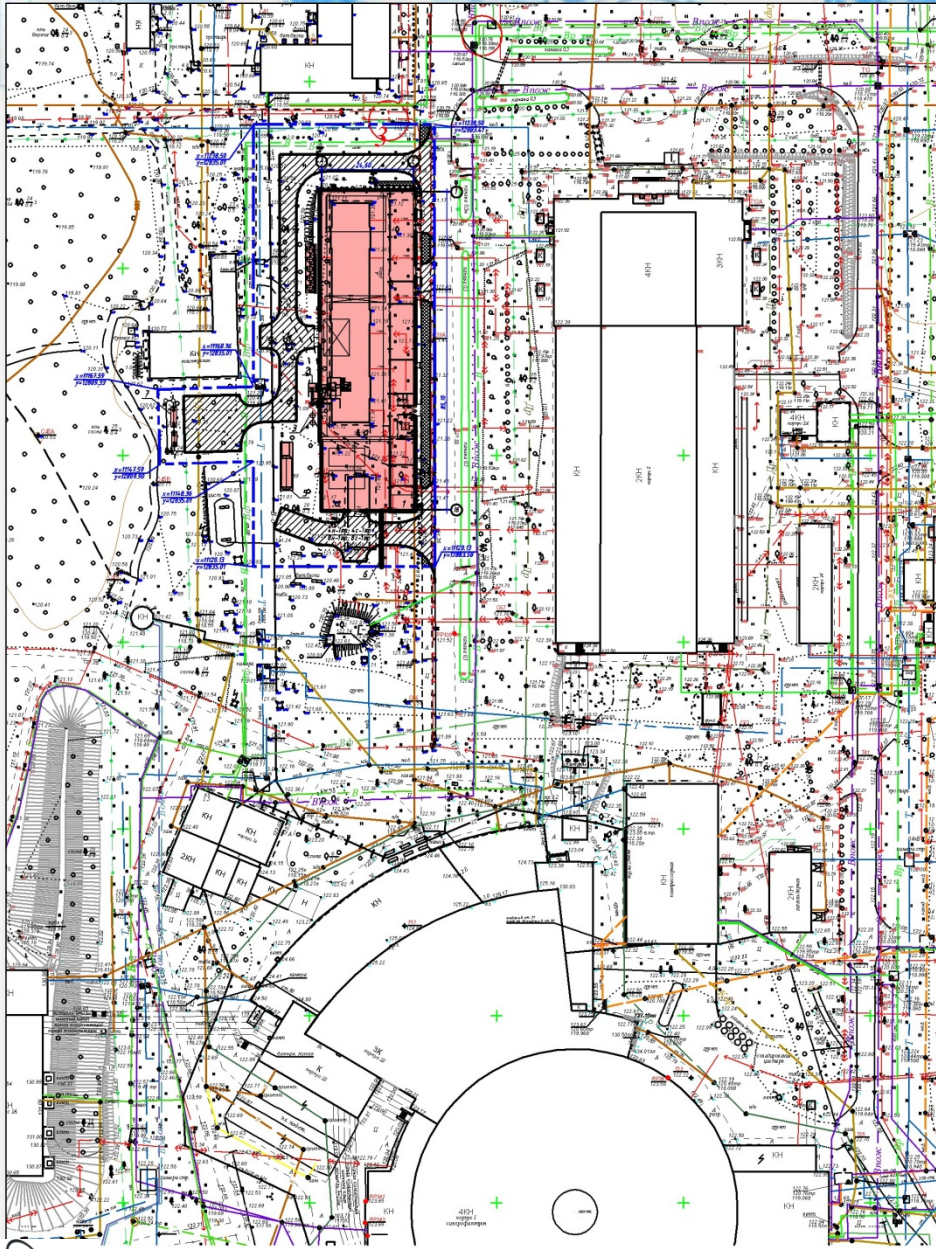
**Cryogenic system of NICA**



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Size of building is  
~2000 m<sup>2</sup>

Engineering has been  
started in April 2016

End of engineering  
project – December 2016

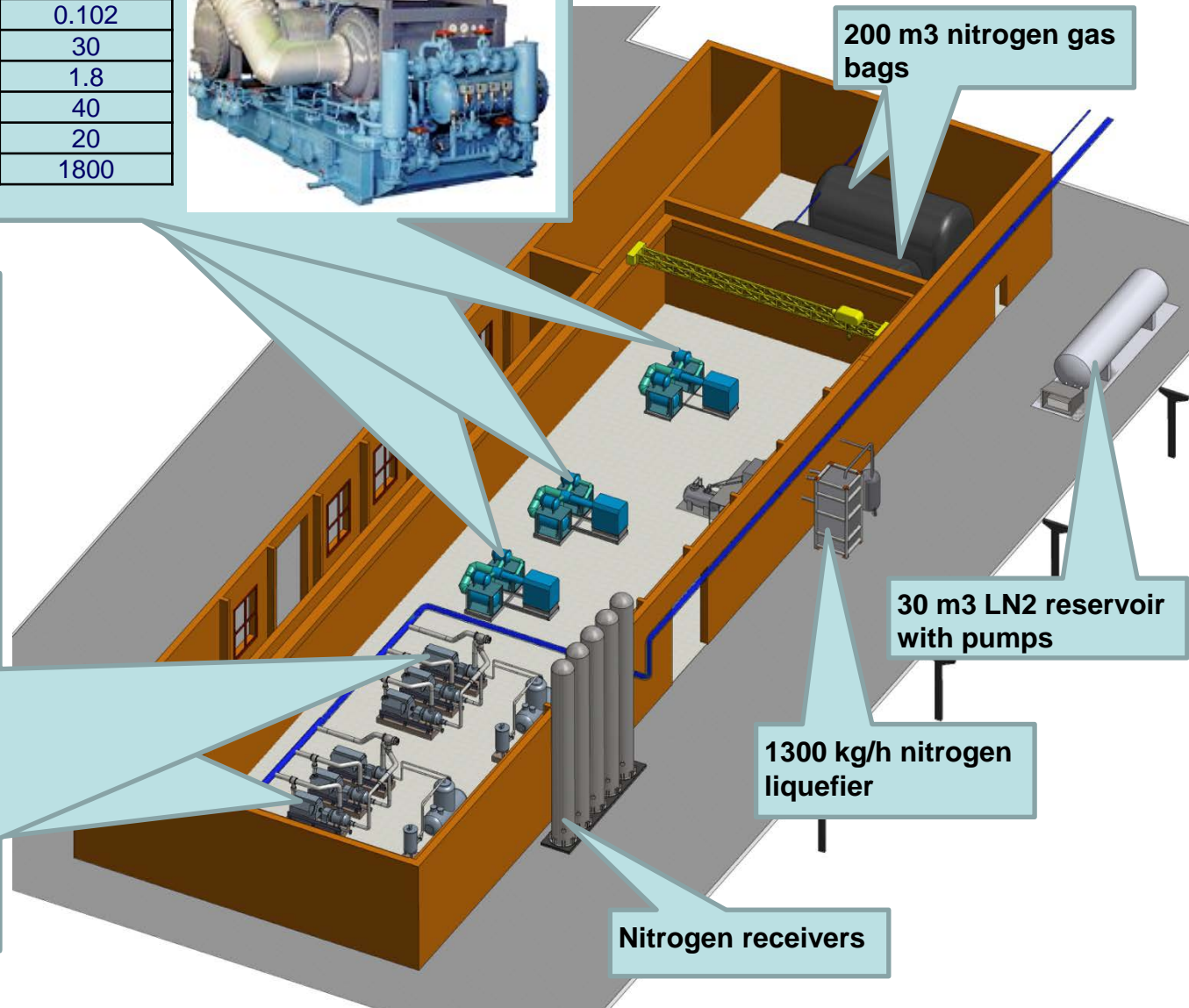
**Nitrogen turbo compressors “Aerocom2-179/18” 2 units in operation, 1 in reserve**

|  |       |
|--|-------|
| Capacity of compressor, Nm <sup>3</sup> /h | 10740 |
| Inlet pressure, MPa                        | 0.102 |
| Inlet temperature, °C                      | 30    |
| Outlet pressure, MPa                       | 1.8   |
| Outlet temperature, °C                     | 40    |
| Temperature of cooling water, °C           | 20    |
| Installed power of electric motor, kW      | 1800  |



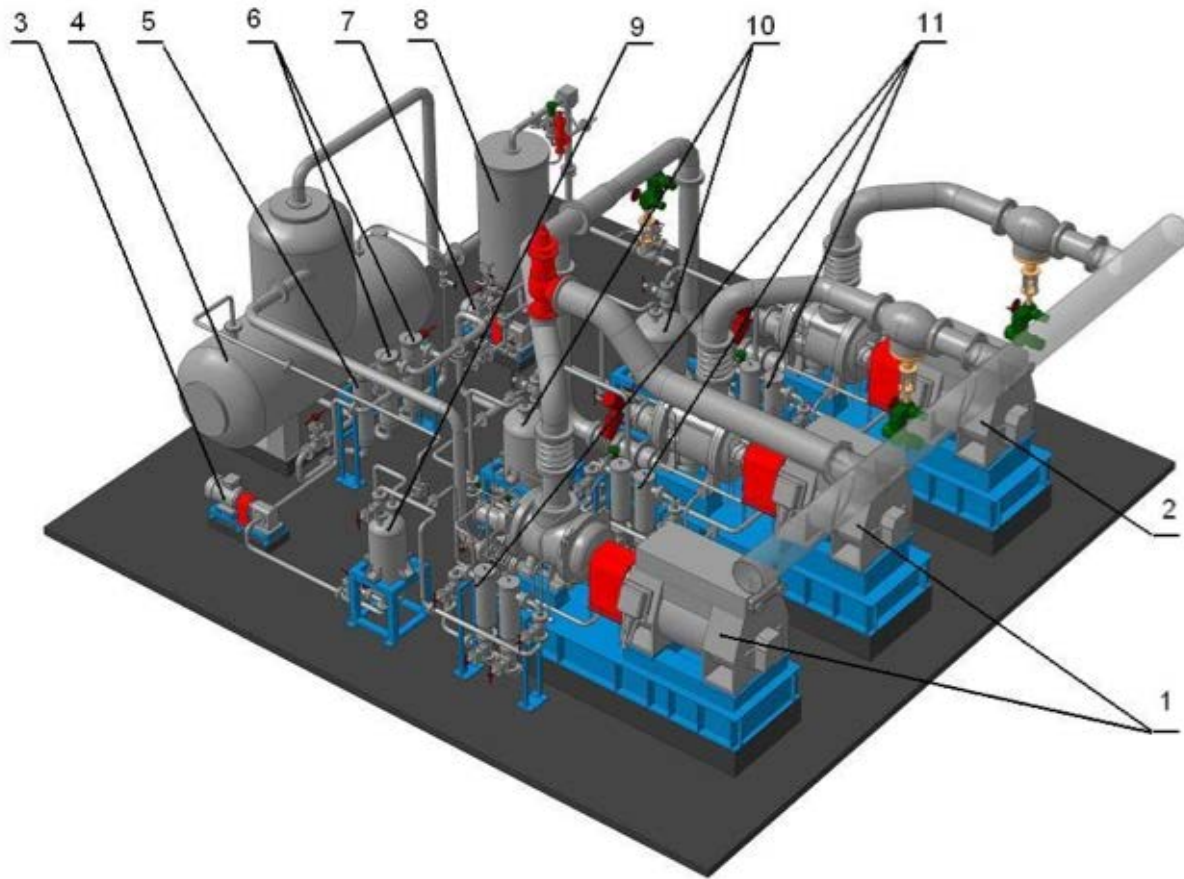
**Helium screw compressors “Kaskad-110/30”**

|   |      |
|---|------|
| Capacity (Nm <sup>3</sup> /h)                 | 6600 |
| Outlet pressure (MPa)                         | 3.0  |
| Total power of electric motors (kW)           | 1600 |
| Voltage (V)                                   | 6000 |
| Number of compression stages                  | 2    |
| Speed (rpm)                                   | 2970 |
| Flow rate of cooling water, m <sup>3</sup> /h | 78   |





# General view of the helium screw compressor aggregate



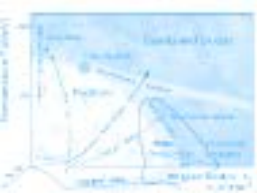
- 1- two primary screw compressors;**
- 2 – screw compressor of the second stage;**
- 3 – oil pump;**
- 4– oil reservoir;**
- 5 - preliminary oil purification of the second stage;**
- 6 – preliminary oil purification of the first stage;**
- 7 – start-up oil pump of the primary screw compressors;**
- 8 – oil separator;**
- 9 – oil cooler of the second stage;**
- 10 - two oil coolers of the first stage;**
- 11 – fine purification oil filters.**



1800 kW of electric power

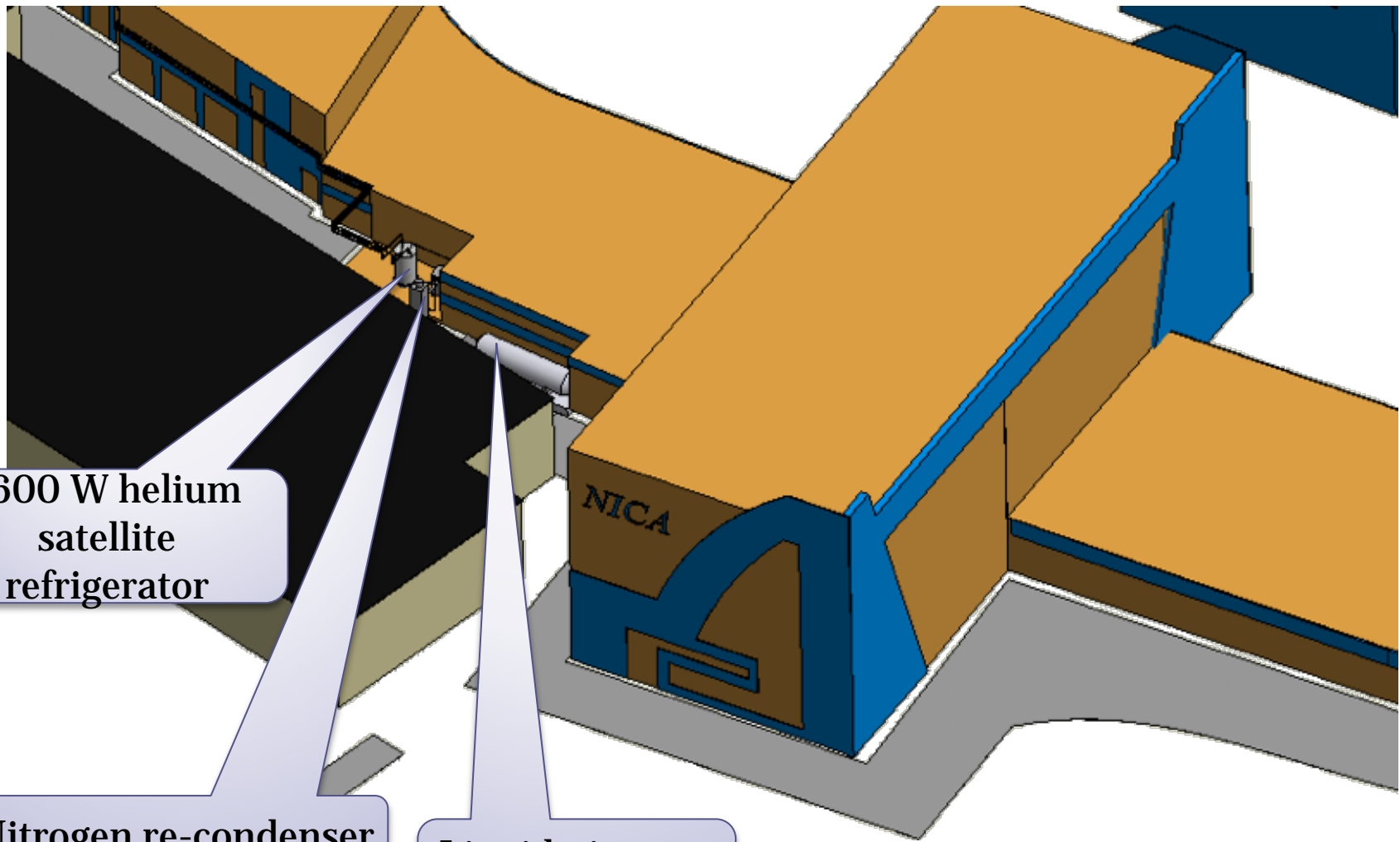
New circulating LN2 system

Great economy compare to today's LN2 system



# PRESENTATION OUTLINE

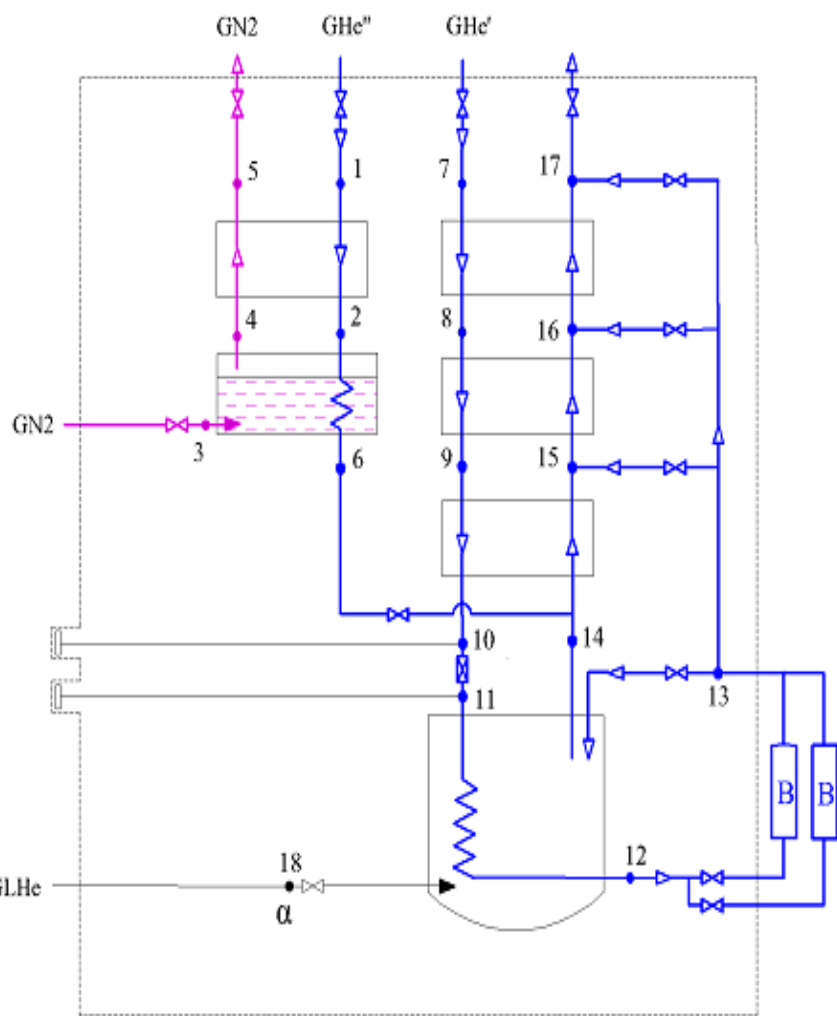
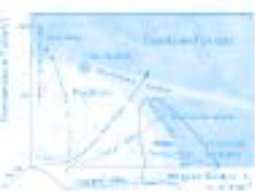
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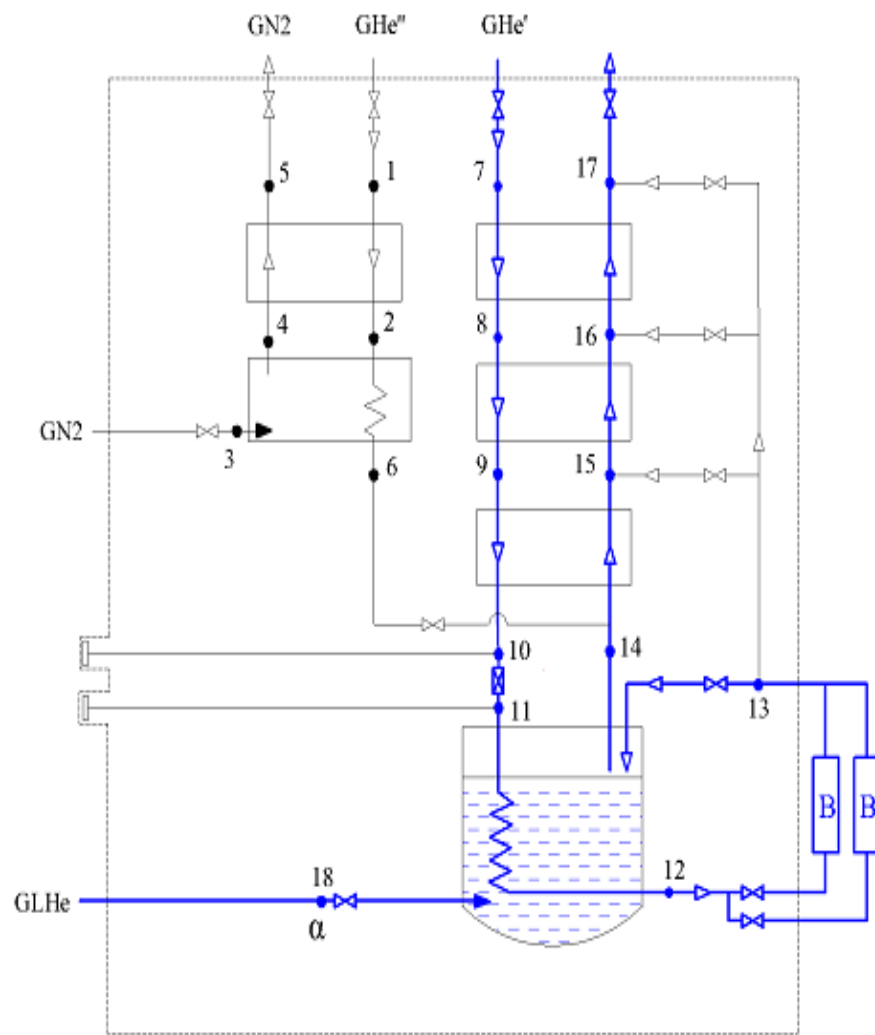
1600 W helium  
satellite  
refrigerator

Nitrogen re-condenser

Liquid nitrogen  
reservoir



First phase of the cool-down period [JINR]

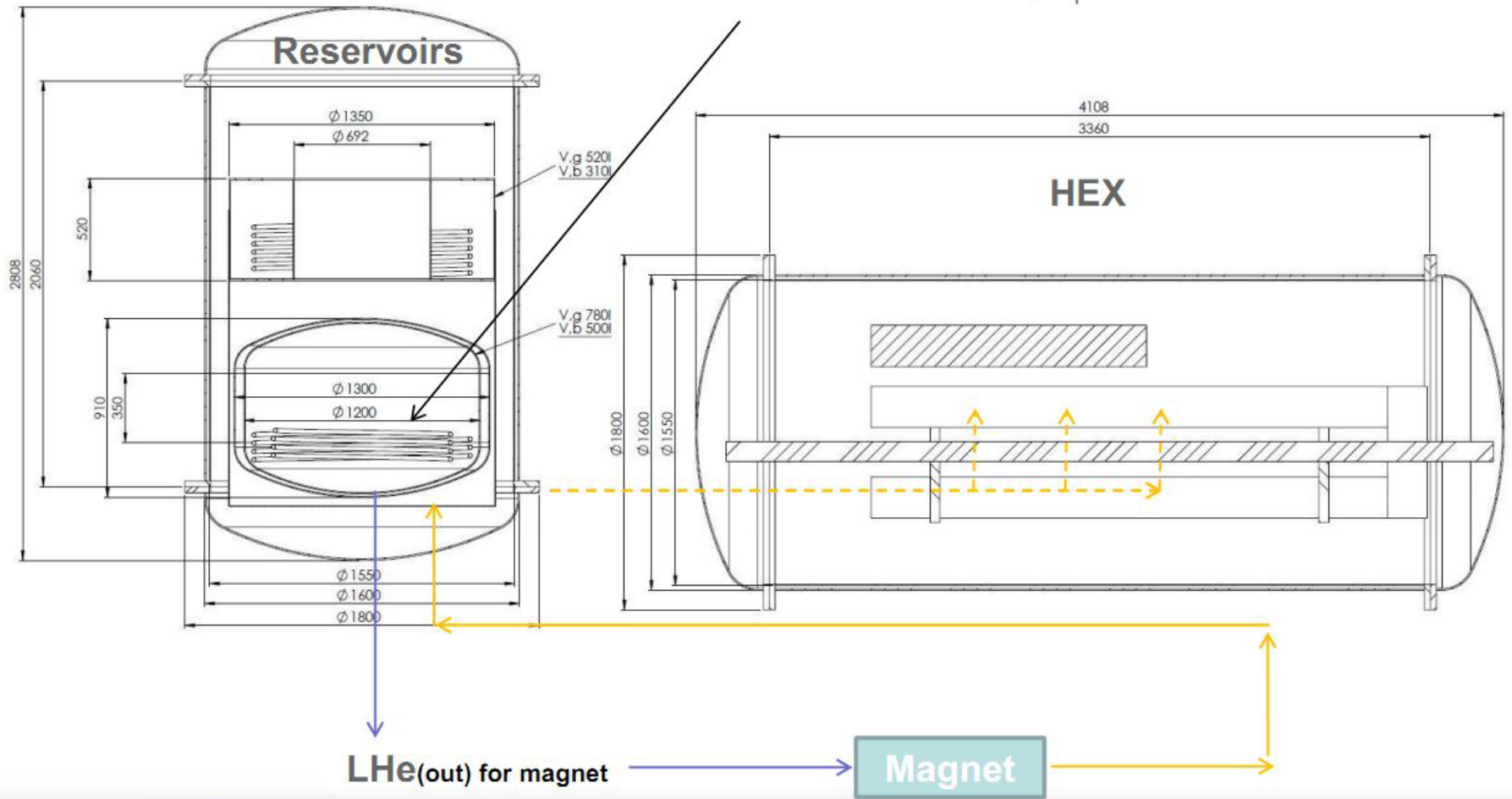


Operation at the liquid helium temperature [JINR]

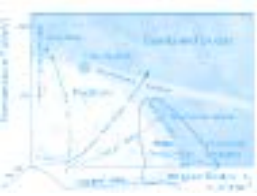


## ► Separated vessels

Subcooler: 20 m,  $D_i$  20 mm

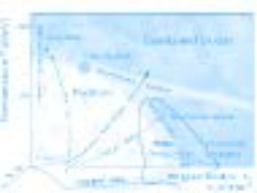






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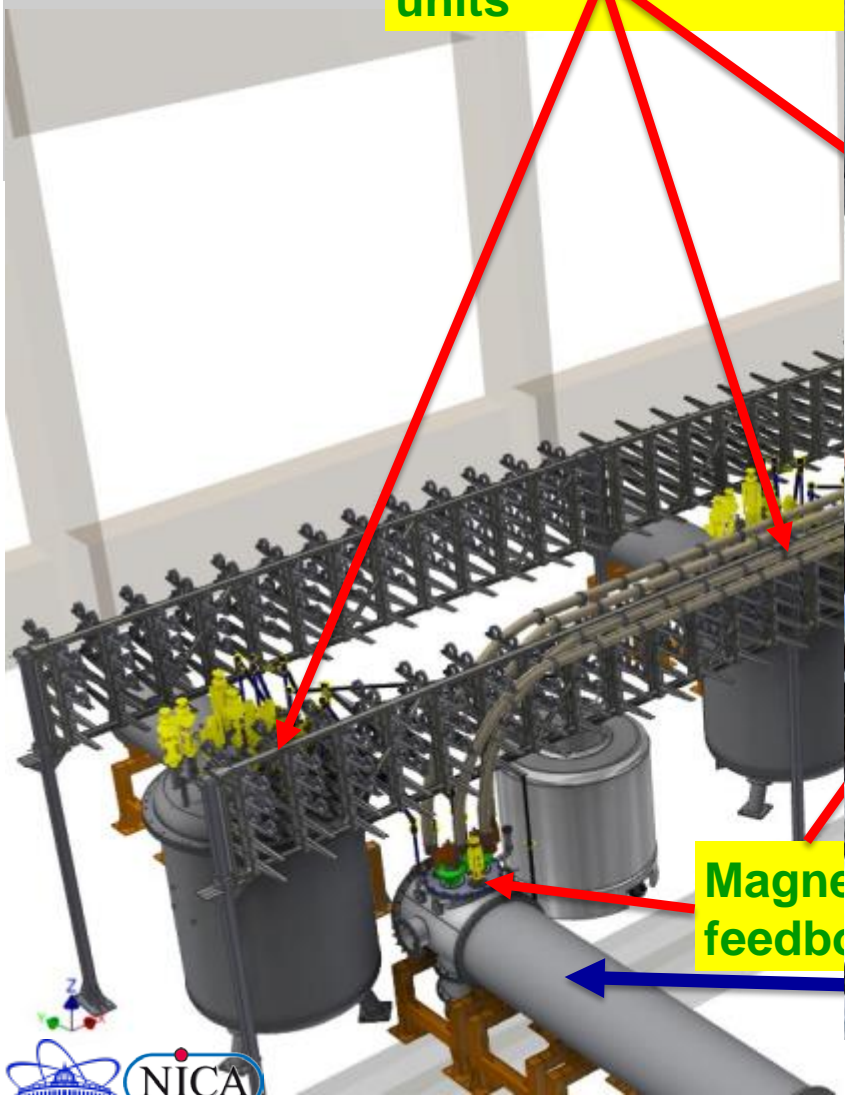
# Sc-magnet unit for NICA facility: totally more than **250 units**



**Facility is under completion**

→ Facility for the assembly and tests of sc-magnets

→ Cryogenic Satellite refrigerator units

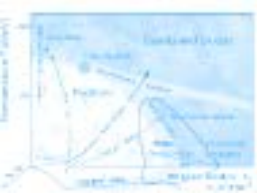


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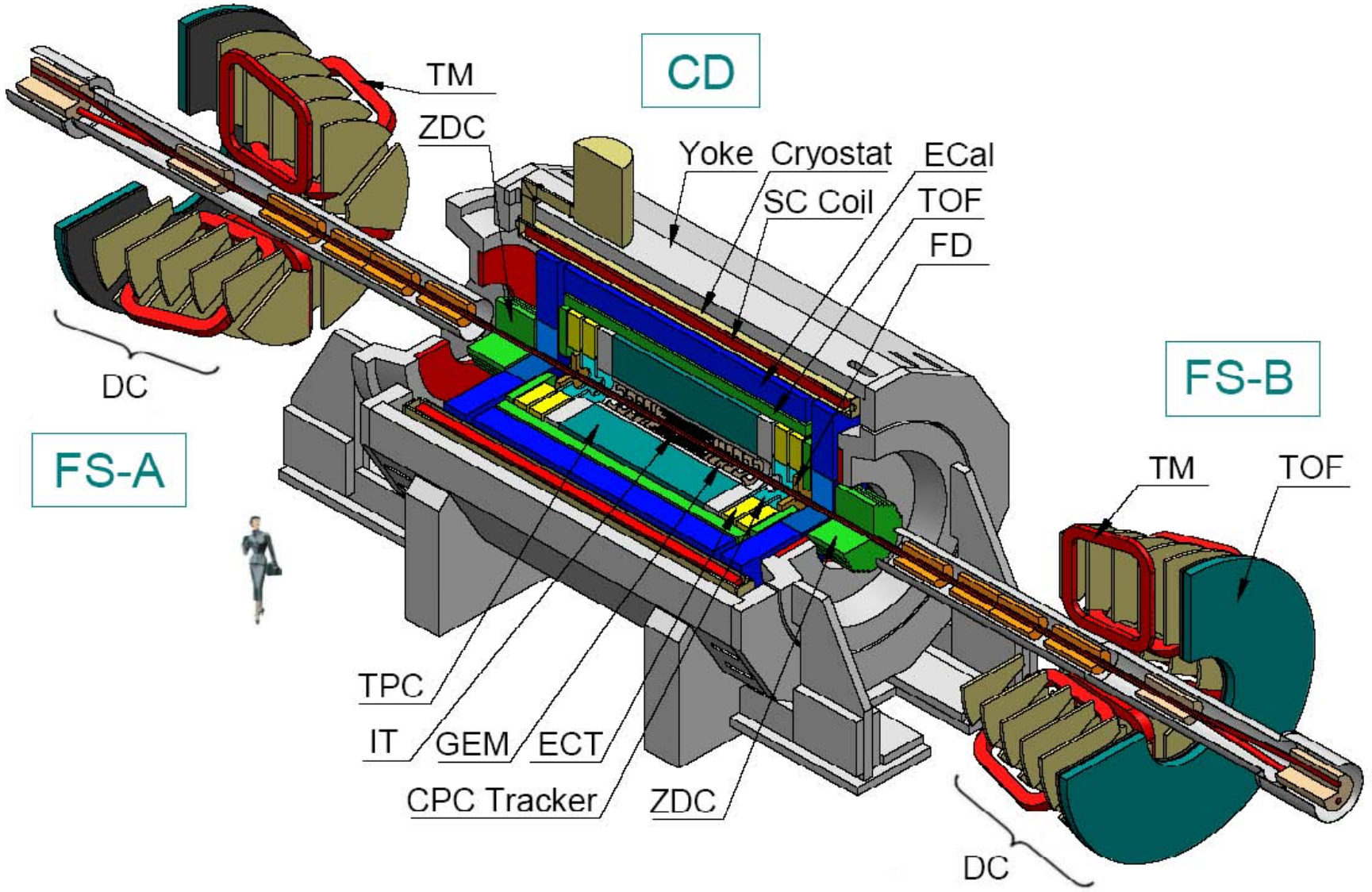


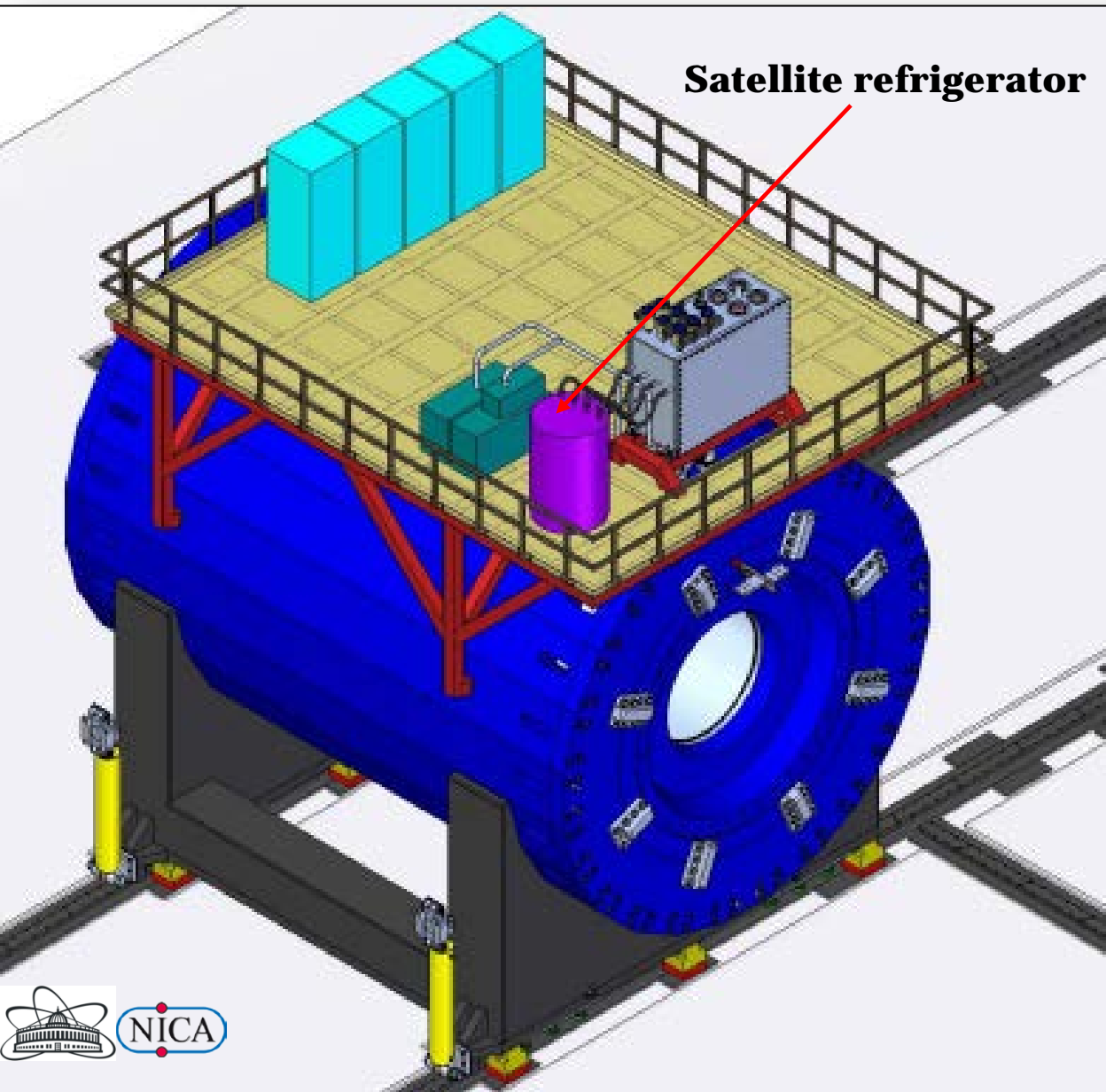
Quads Tests



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**Satellite refrigerator**

Refrigeration capacity is  
100 W @ 4.5 K

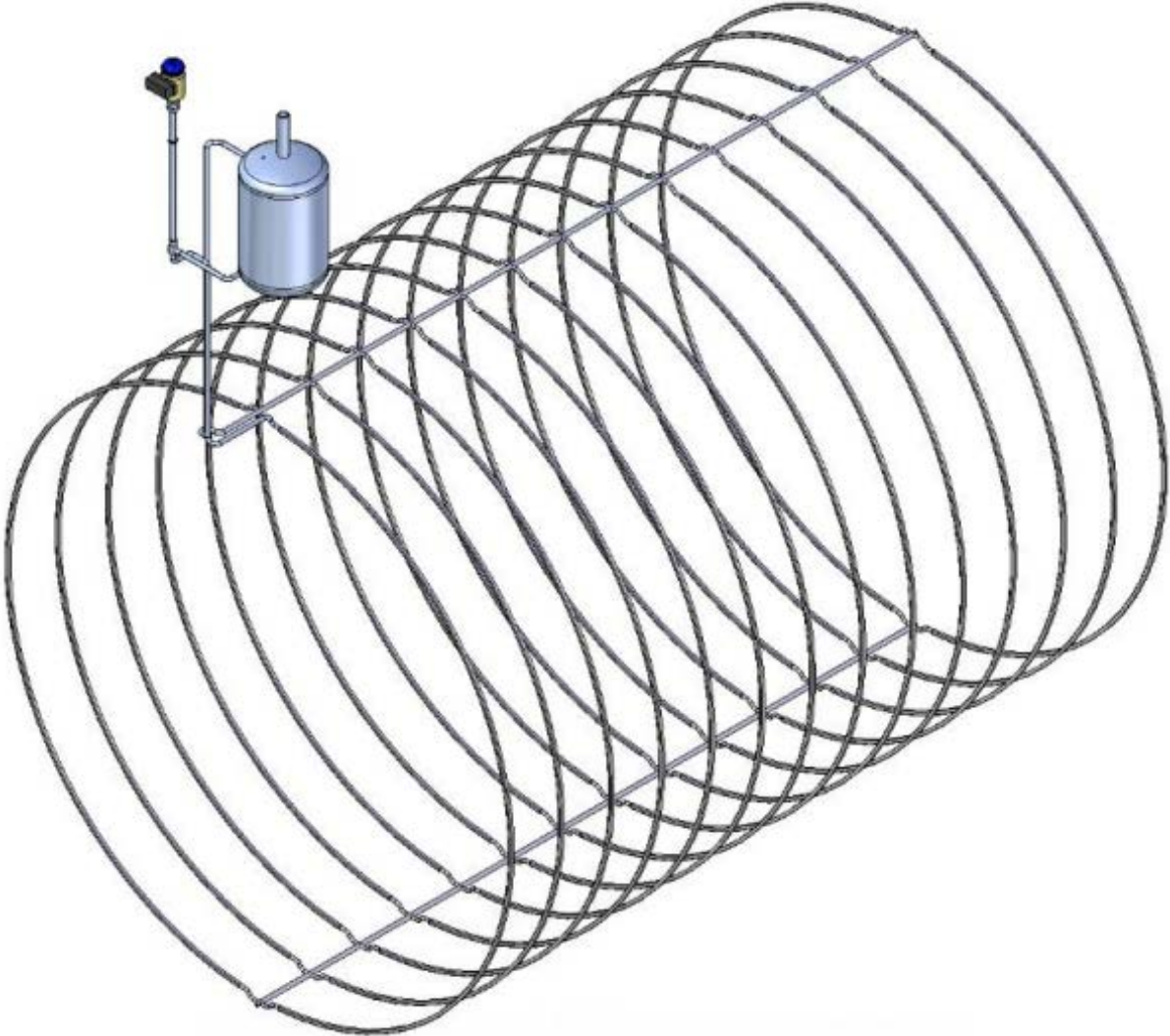
Speed of cooling down is  
1 K/h max

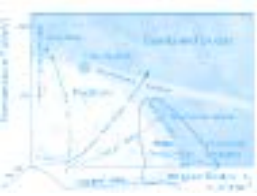
Engineering is done

Manufacturing is about  
to start



# Heat exchanger for the SC coil





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# HELIUM LIQUIFIER OG1000

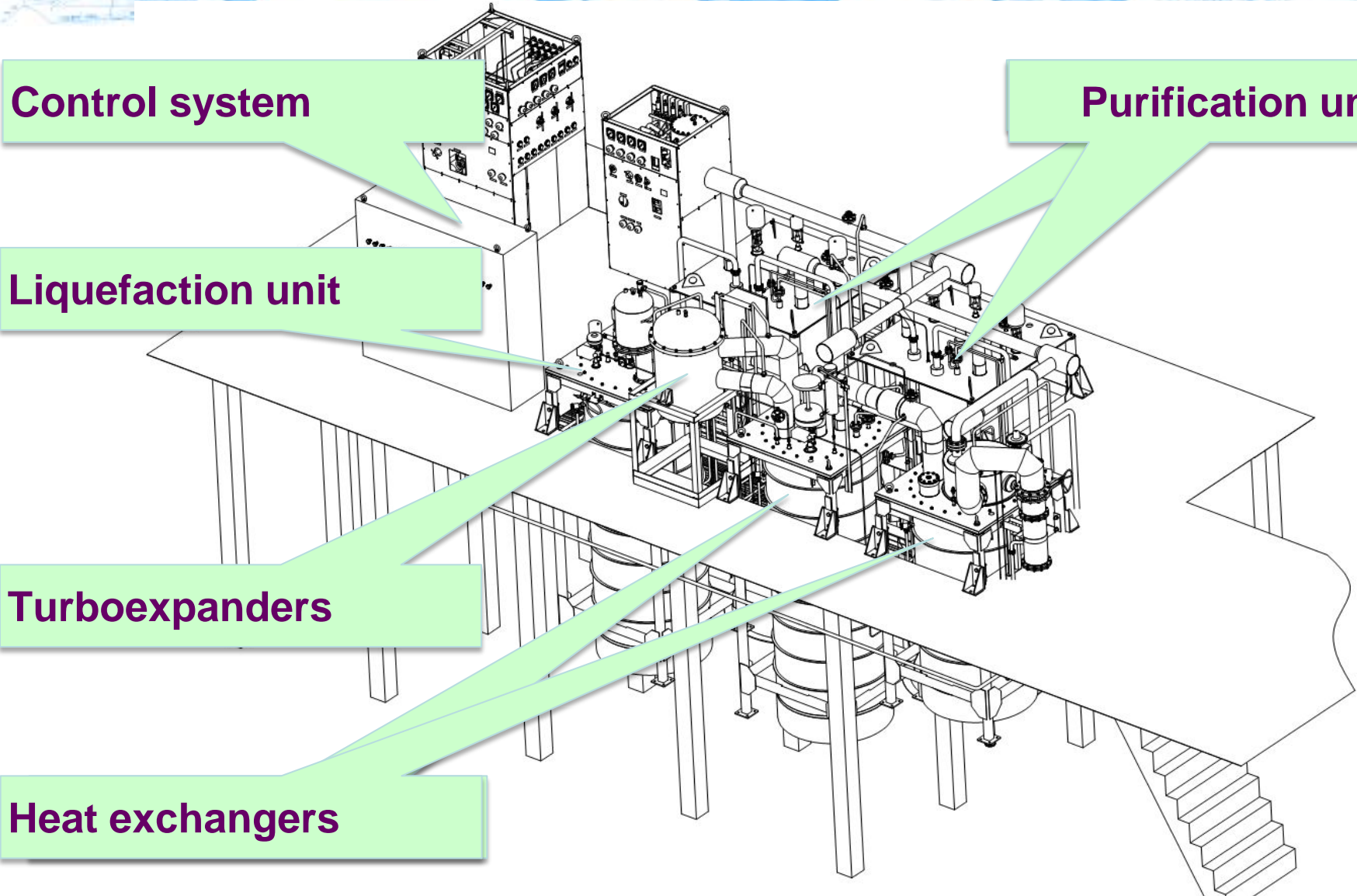
Control system

Purification units

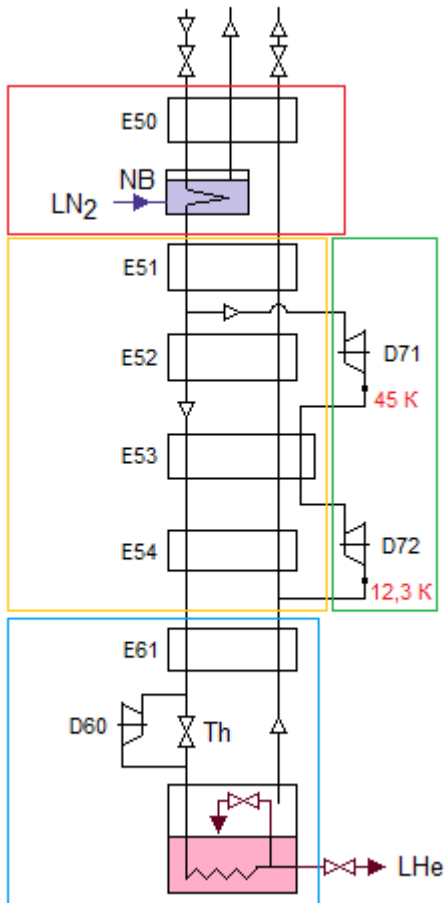
Liquefaction unit

Turboexpanders

Heat exchangers



# HELIUM LIQUIFIER OG1000

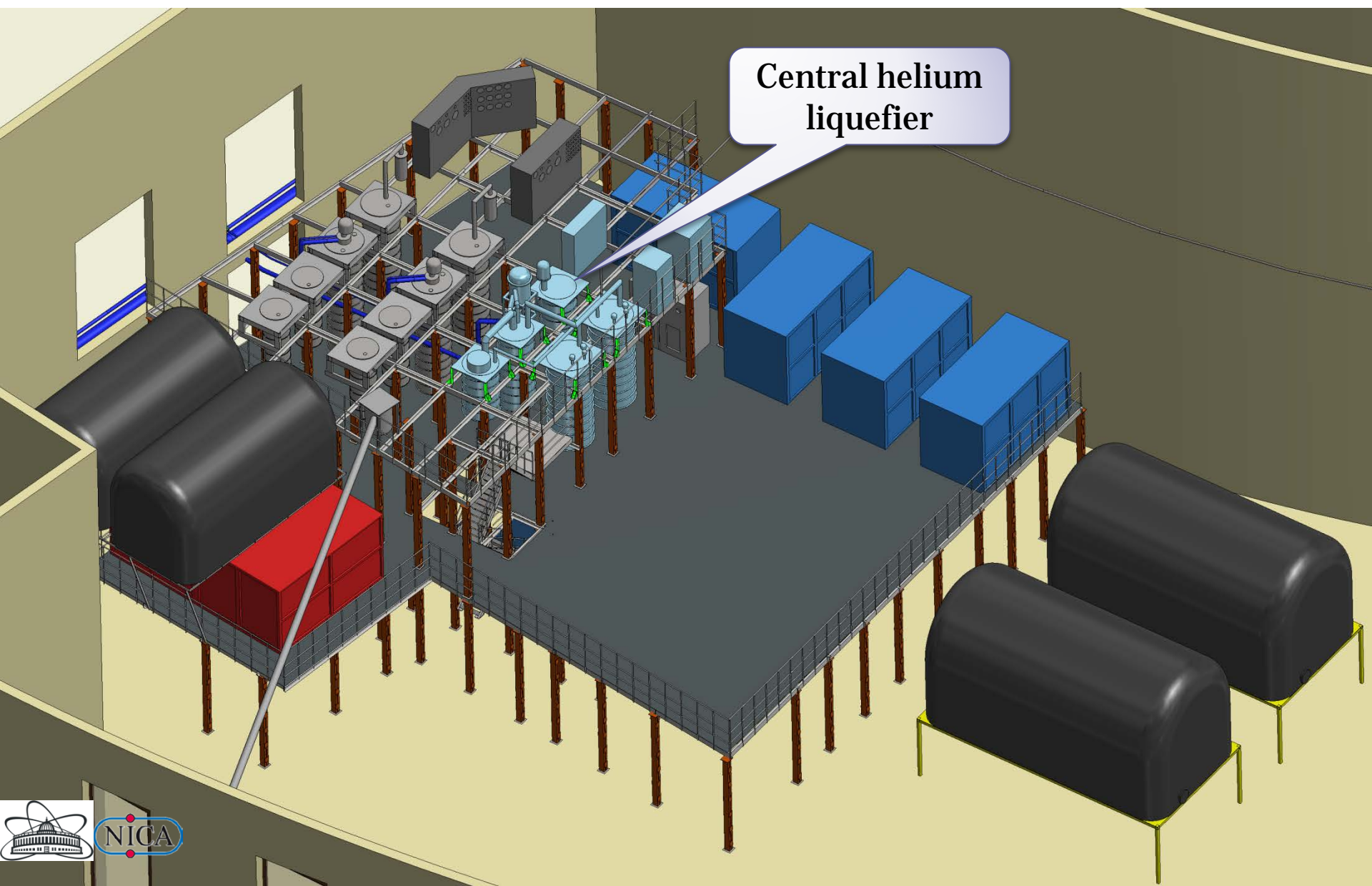


|   |          |
|---|----------|
| Operating gas                                   | helium   |
| Capacity, l/h                                   | 1100±100 |
| Liquid nitrogen consumption, kg/h               | ≤560     |
| Energy consumption, kW                          | 1760     |
| Compressed helium pressure, MPa                 | 2,5      |
| Compressed helium flow rate, Nm <sup>3</sup> /h | 6600     |
| Total mass, kg                                  | 14000    |
| External dimensions, m×m×m                      | 5×5×10   |

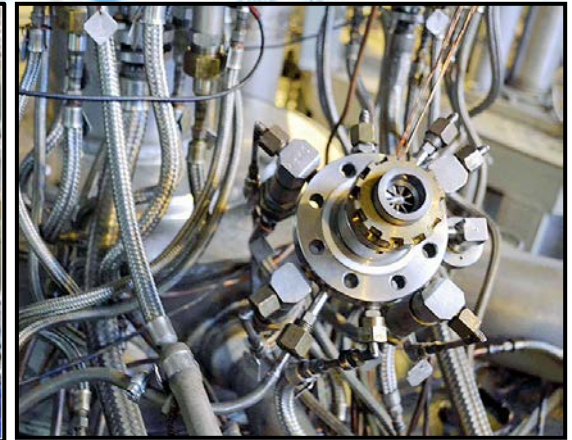
The principal scheme of the liquefier OG – 1000:  
 E50, E51, E52, E53, E54, E61 – heat exchangers;  
 D71, D72, D60 – turbo expanders;  
 Th – throttle;  
 NB – bath of liquid nitrogen.



Central helium  
liquefier



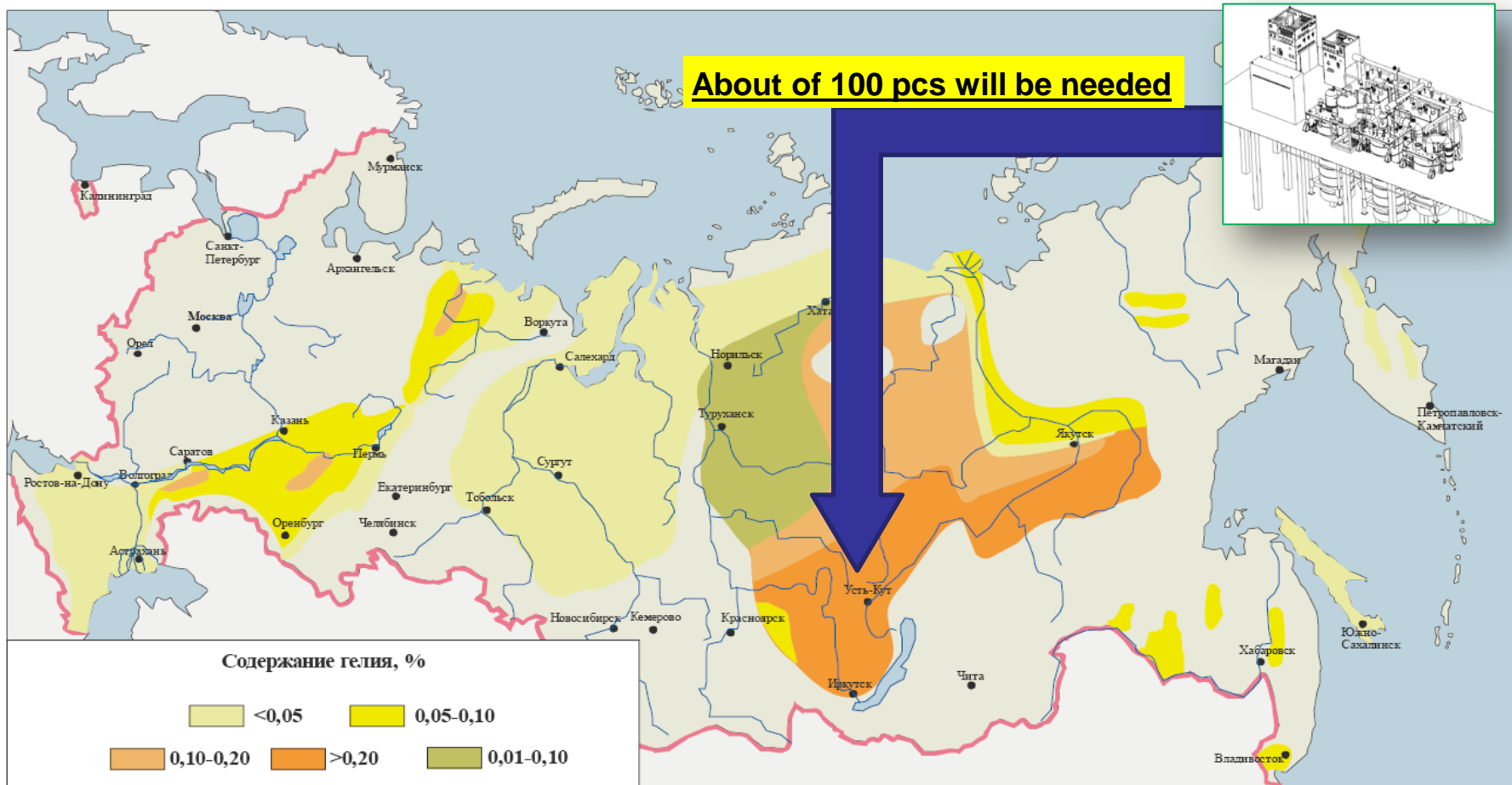
# Commissioning and successful test of the 1000 l/h helium liquefier



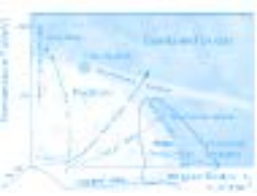
**The largest helium liquefier in Russia was installed and successfully launched at JINR**

# Helium and its sources for industry

According to experts the Kovykta gas condensate field contains about 25% of world helium reserves



## Helium concentration in the gas fields of Russia



**THANK YOU FOR YOUR ATTENTION!**