The background image shows a large, modern industrial facility, likely a particle accelerator or similar scientific facility. The ceiling is curved and made of light-colored panels. There are multiple levels of metal walkways with railings, leading through the facility. In the center, there is a large, open area with various pieces of equipment and piping. The overall atmosphere is clean and industrial.

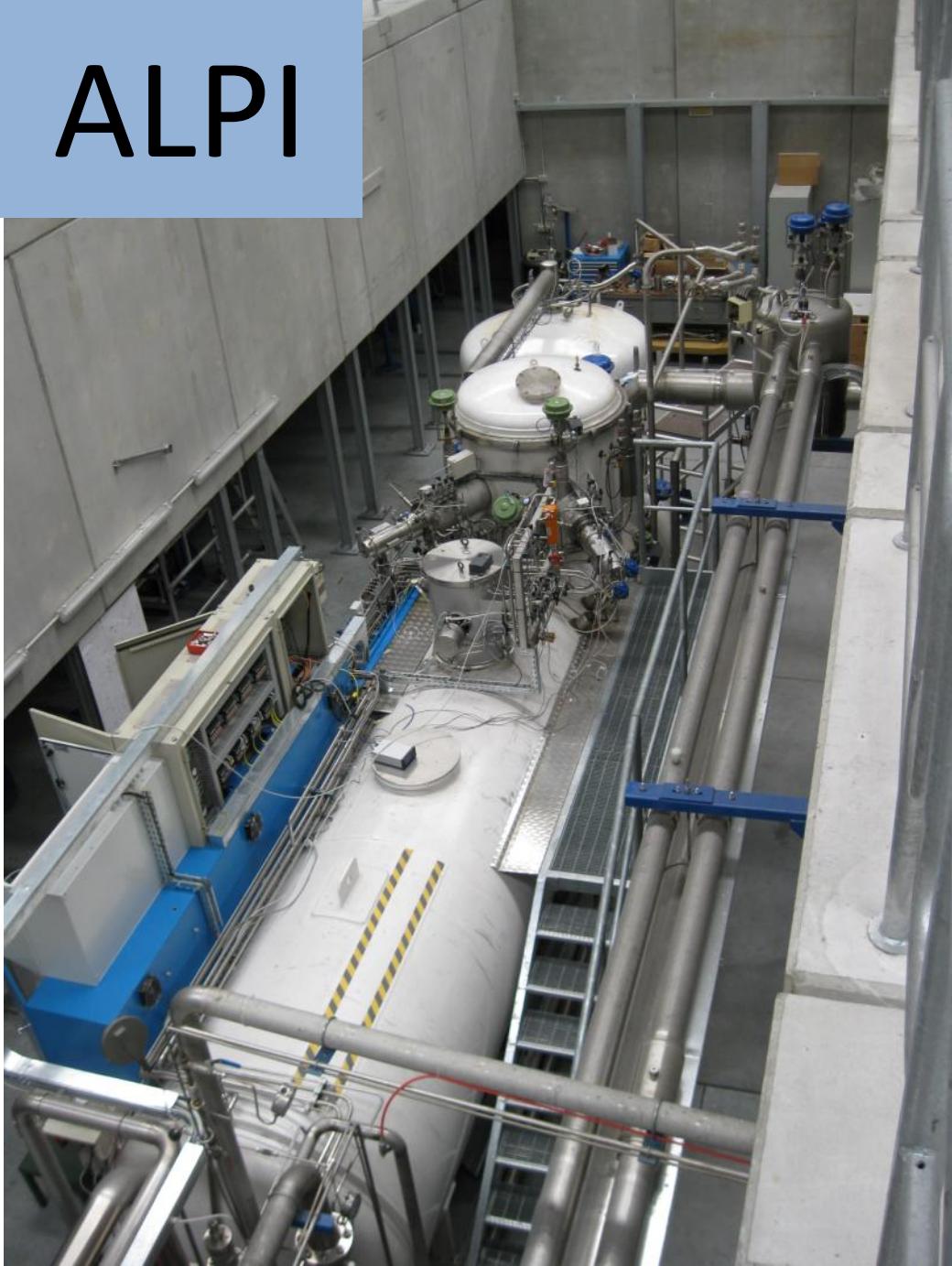
TAC2

Alpi consolidation in
Cryogenics and Cryomodules



Cryogenics
@
Laboratori Nazionali di
Legnaro

ALPI



ALPI refrigerator (150g/s):

1200 W @ 4,5K
and 3900W @ 60-75K
1 supercritical turbine
4 compressor units
1 AUX ColdBox (LN2 bath)@ 80K

ALPI Auxiliary Cold Box (LN2 bath)

BNHeP-13 Helium Gas Circulators:

2 Barber Nichols helium pumps in series:

100g/s @ 6 bar each
 $\Delta p=0,54$ bar each



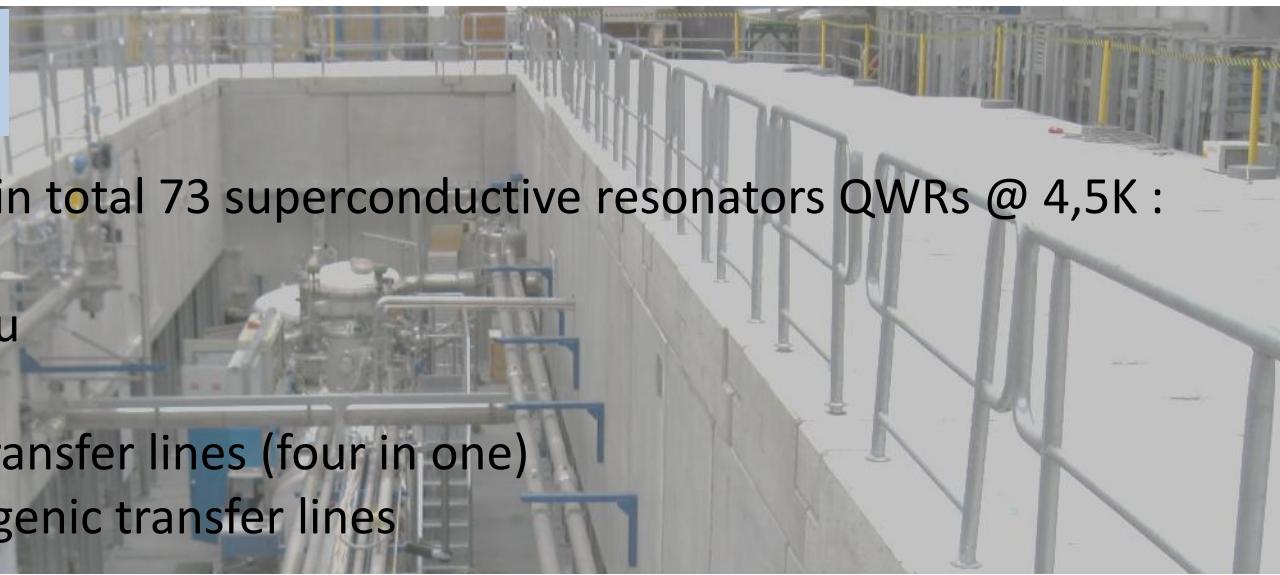
ALPI-LINAC

20 cryo-modules housing in total 73 superconductive resonators QWRs @ 4,5K :

- 16 Nb bulk
- 57 Nb sputtered on Cu

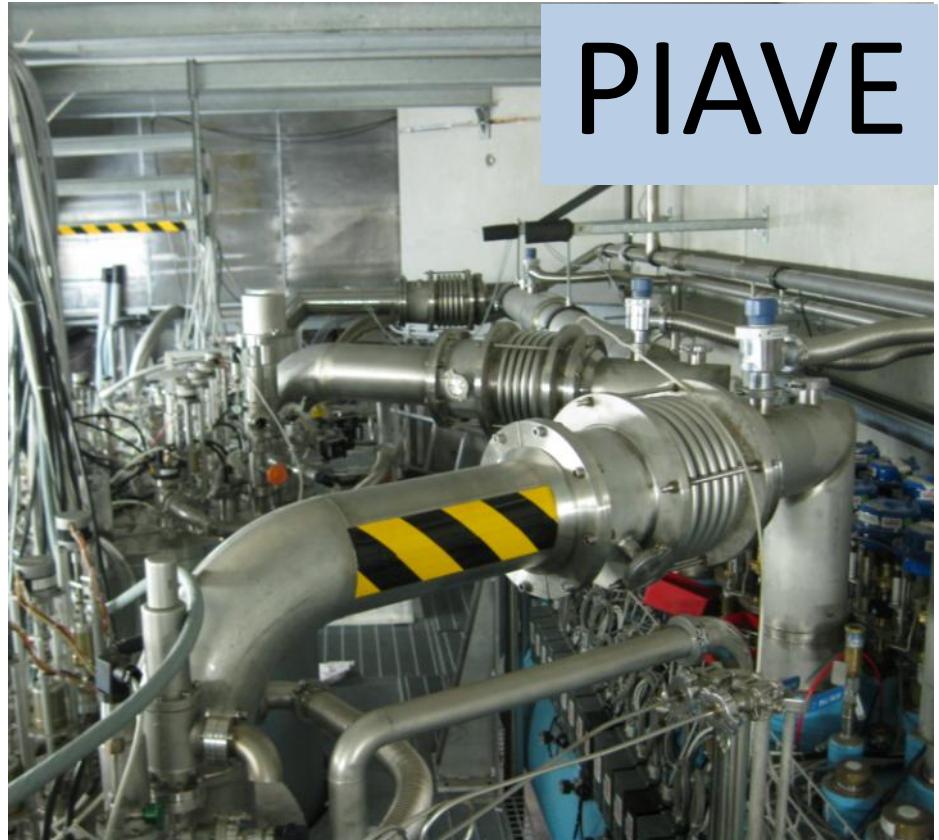
120 m helium cryogenic transfer lines (four in one)

50 m Liquid nitrogen cryogenic transfer lines



(photo by F. Mangiaracina)

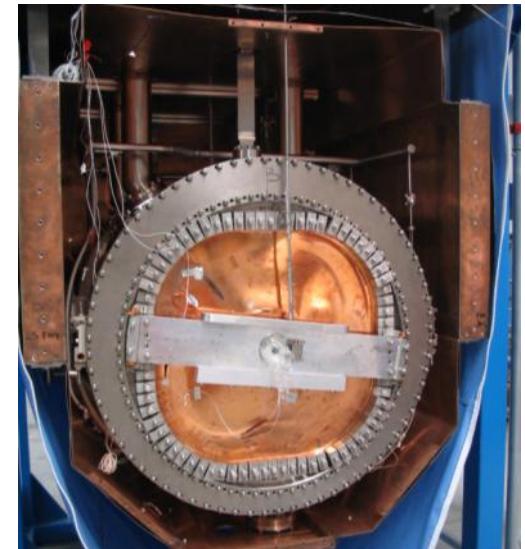
PIAVE



PIAVE Cryoplant – Linde TCF50:
406 W @ 4,5K with LN2 (334 W no LN2)

3 Cryo-modules housing:

- 8 QWRs Nb quarter wave resonators
- 2 Nb Superconducting Radiofrequency Quadrupoles (SRFQs)



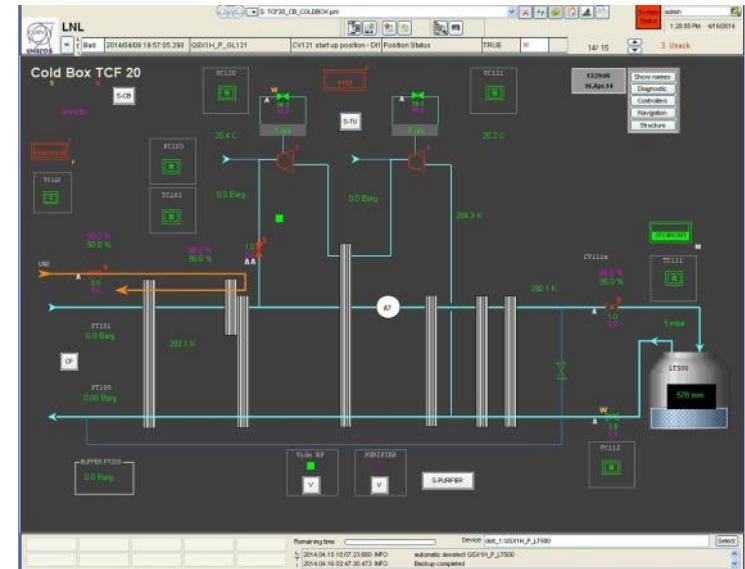


He Liquefier

Linde TCF20 liquefier:
production:
up to 100,000 liter/year
storage: 5000 liter dewar

New Control system with
CERN - UNICOS:

New cabinet
PLC Schneider
SCADA WinCC_OA



Recovery & Purification



Helium Gas recovery system: Upgrade towards UNICOS in progress

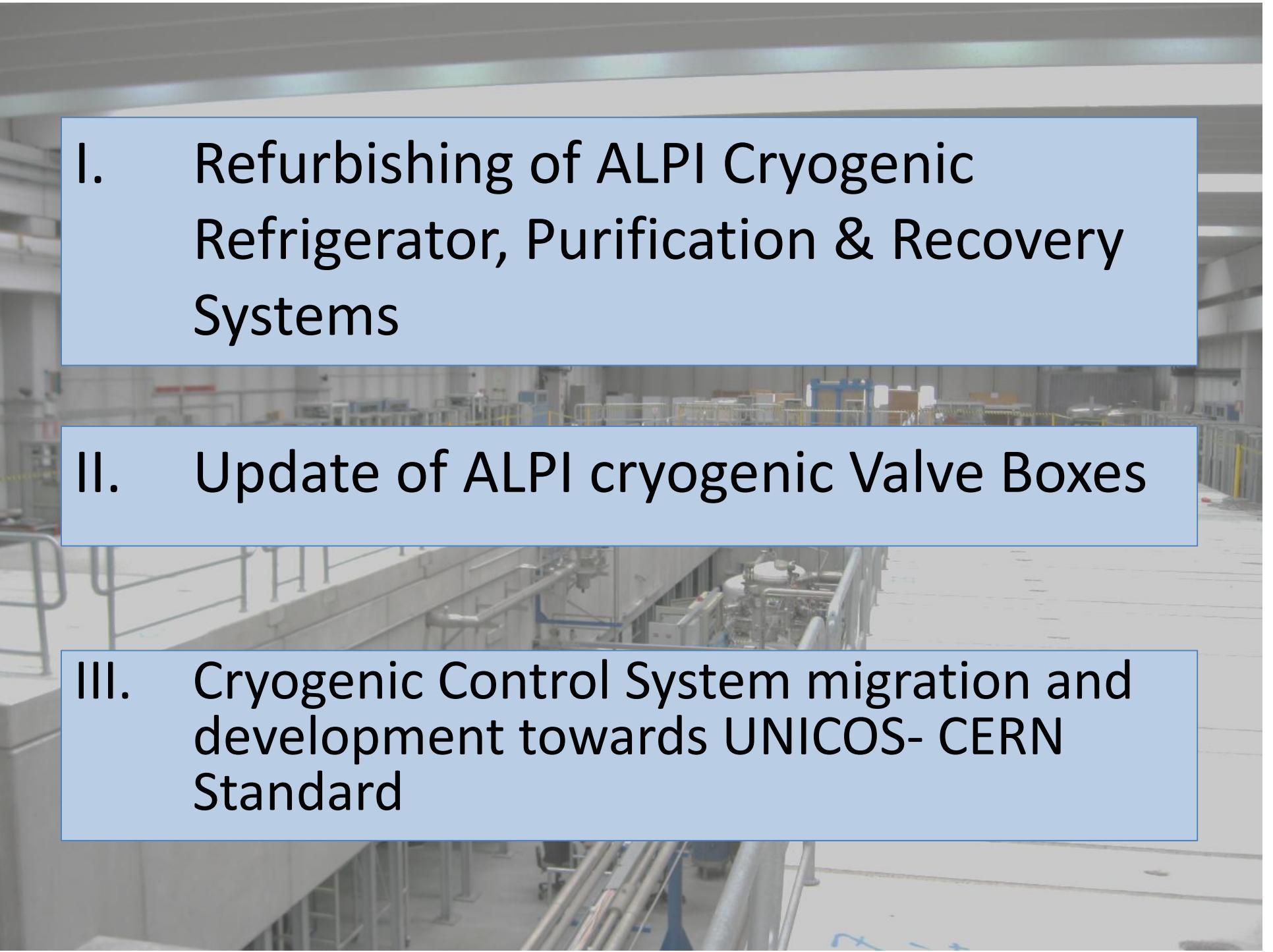
2 tons is the LNL Helium inventory
900 m lines connected to recovery system
4000 m² area served
3 gasometers, total capacity 200 m³
3 piston compressors 200Nm³/h each



Helium Purification:

- 3 x Dryers 70 m³/h
- 1 LN2 Purification Unit: 60 Nm³/h @ He N50
- 3 cryogenic helium purifiers (cryogenic refrigerator)





I. Refurbishing of ALPI Cryogenic
Refrigerator, Purification & Recovery
Systems

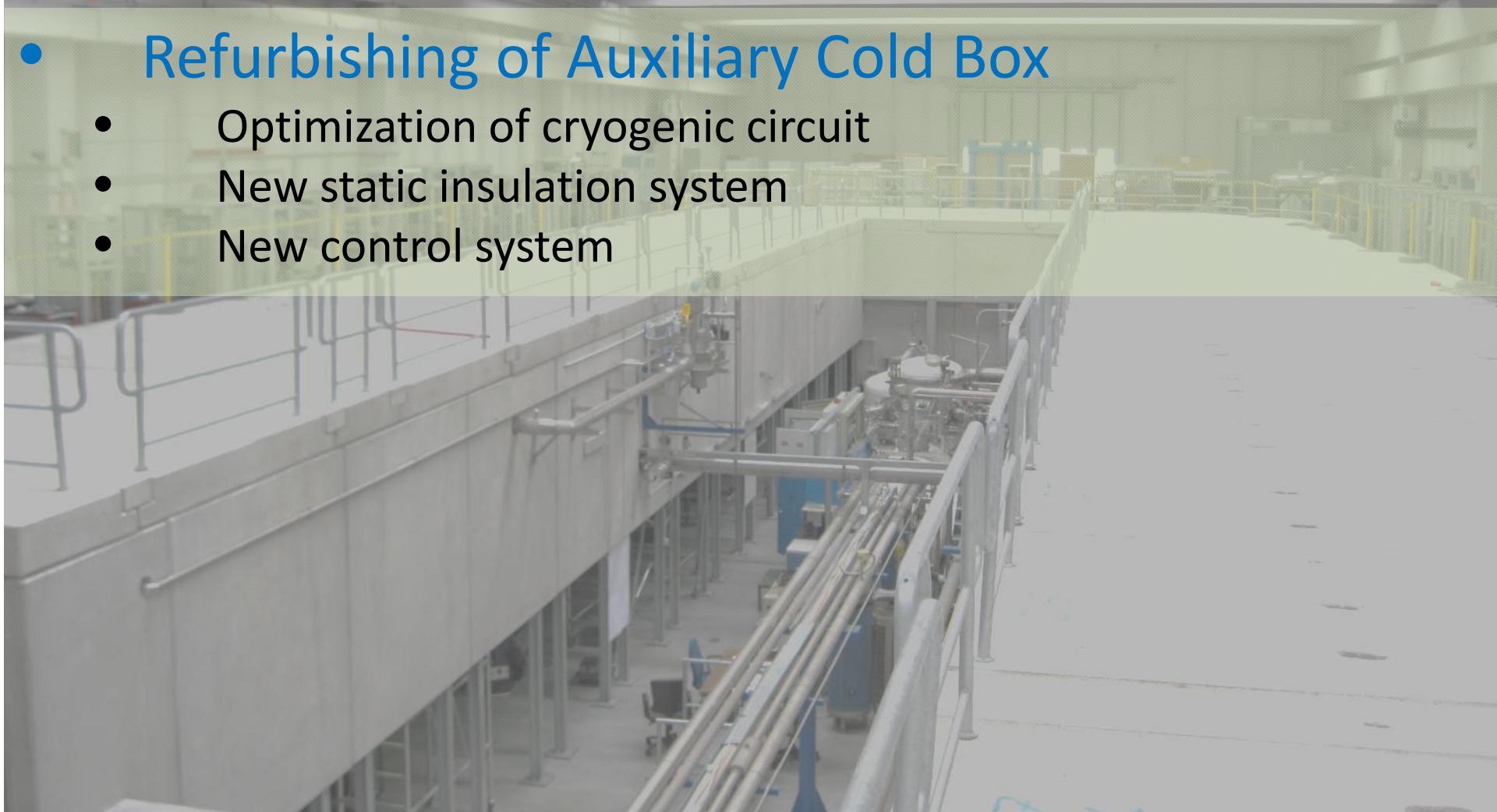
II. Update of ALPI cryogenic Valve Boxes

III. Cryogenic Control System migration and
development towards UNICOS- CERN
Standard

Refurbishing of ALPI Cryogenic Refrigerator, Purification & Recovery Systems

What has been done:

- **Refurbishing of Auxiliary Cold Box**
 - Optimization of cryogenic circuit
 - New static insulation system
 - New control system

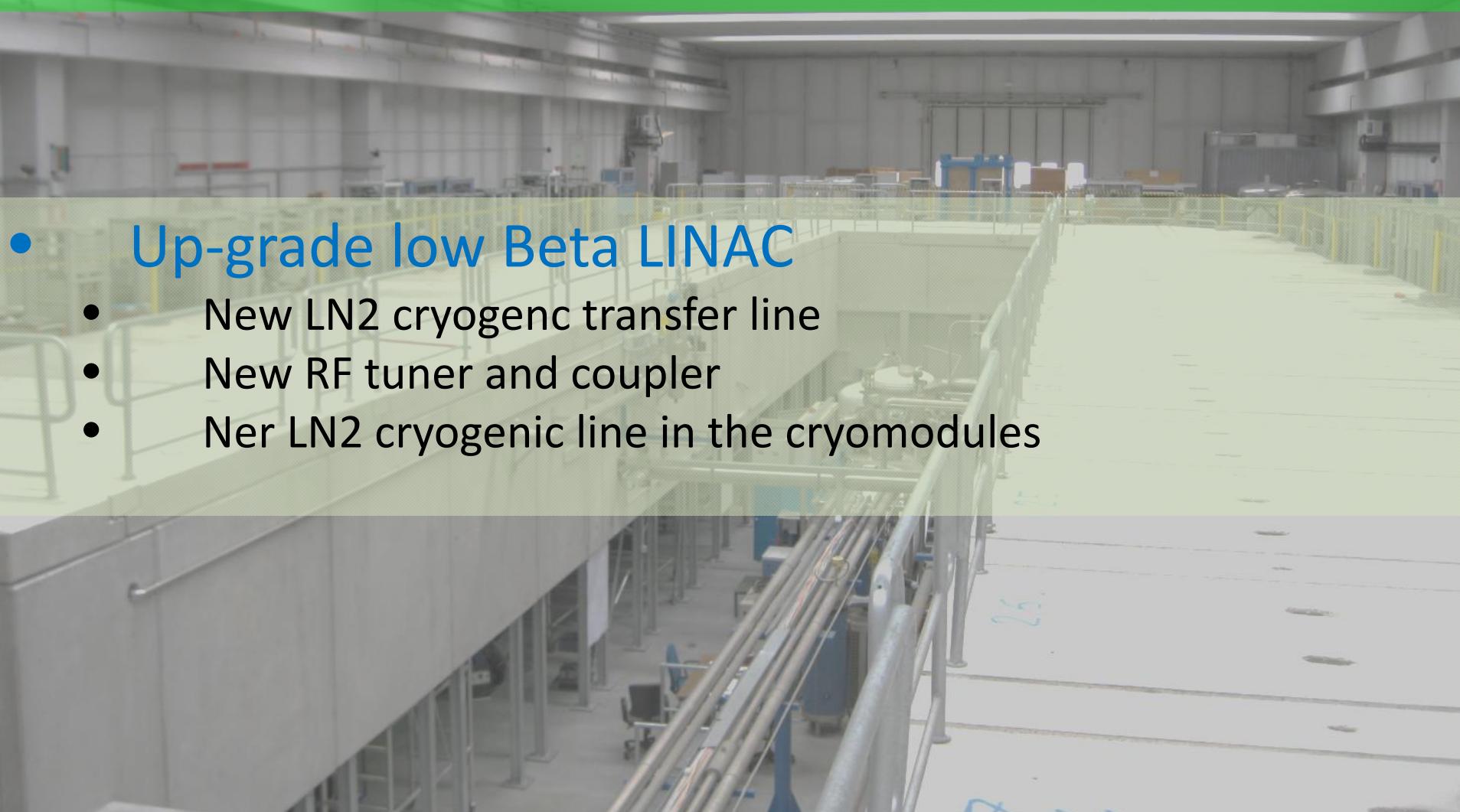




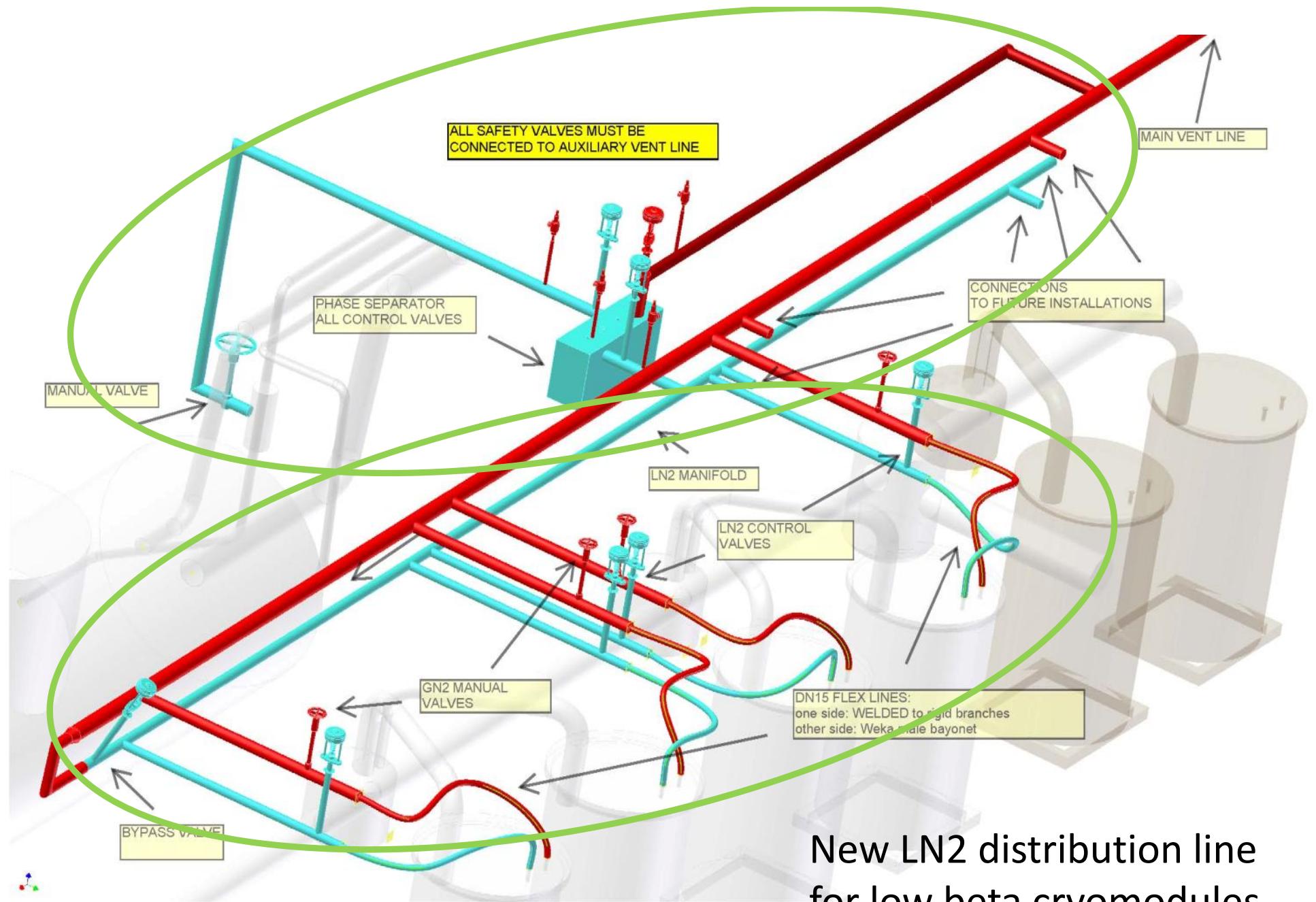
Refurbishing of Auxiliary Cold Box

Refurbishing of ALPI Cryogenic Refrigerator, Purification & Recovery Systems

What has been done:

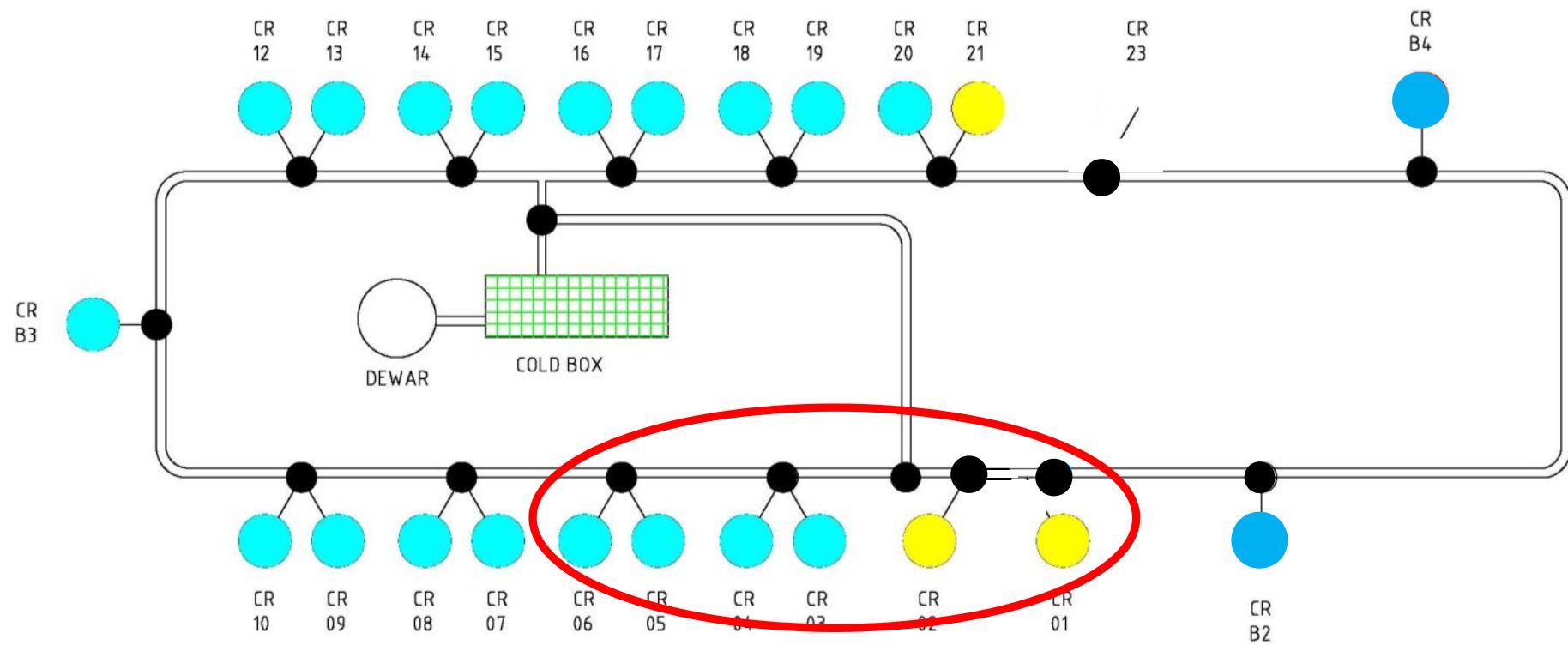


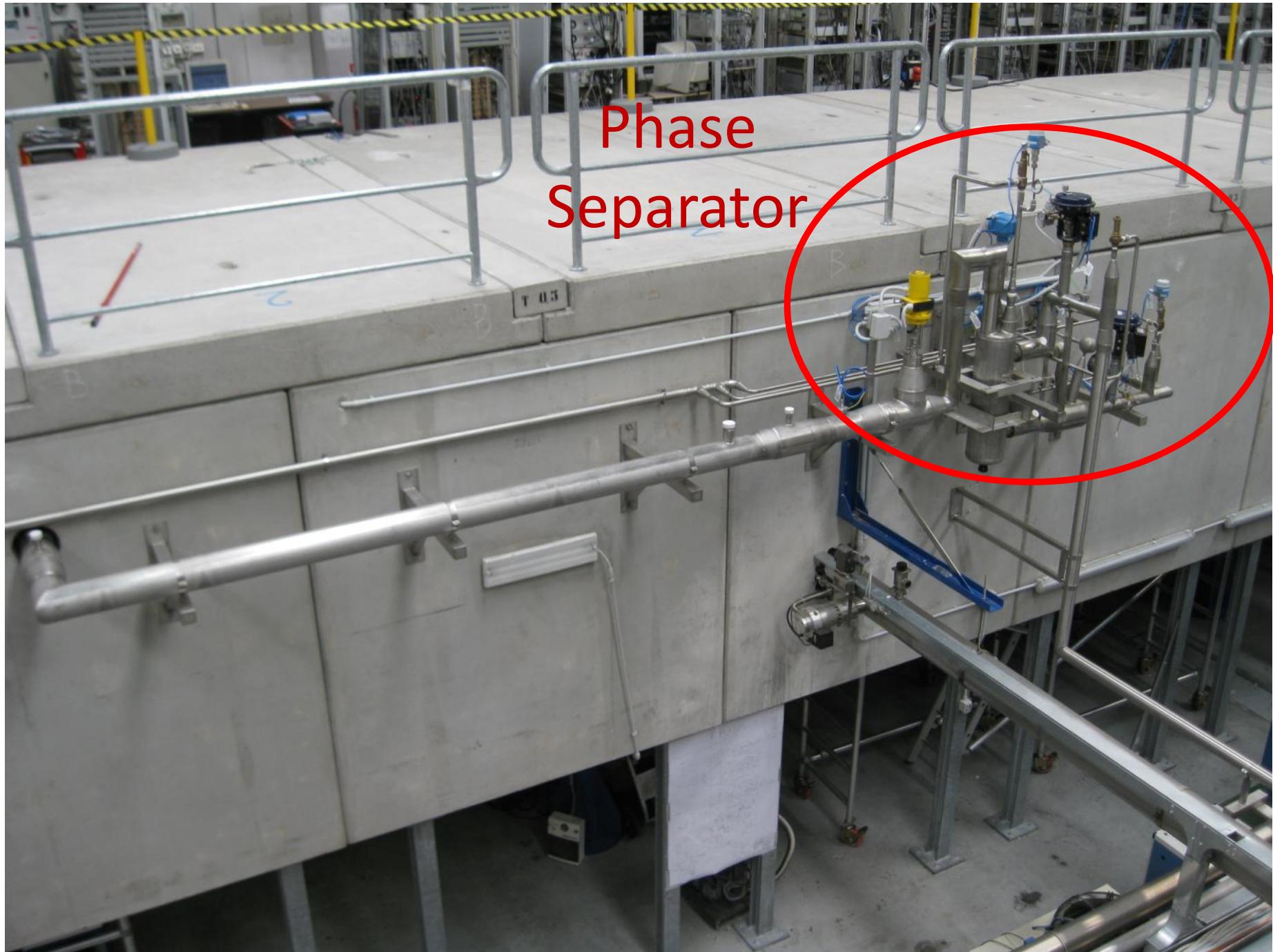
- Up-grade low Beta LINAC
 - New LN2 cryogenic transfer line
 - New RF tuner and coupler
 - New LN2 cryogenic line in the cryomodules



New LN₂ distribution line
for low beta cryomodules

LN2 distribution line for low beta cryomodules





Phase
Separator

Low Beta Cryomodules Up-grade

- new coupler installation
- new LN2 line in the cryomodules
- New RF tuner



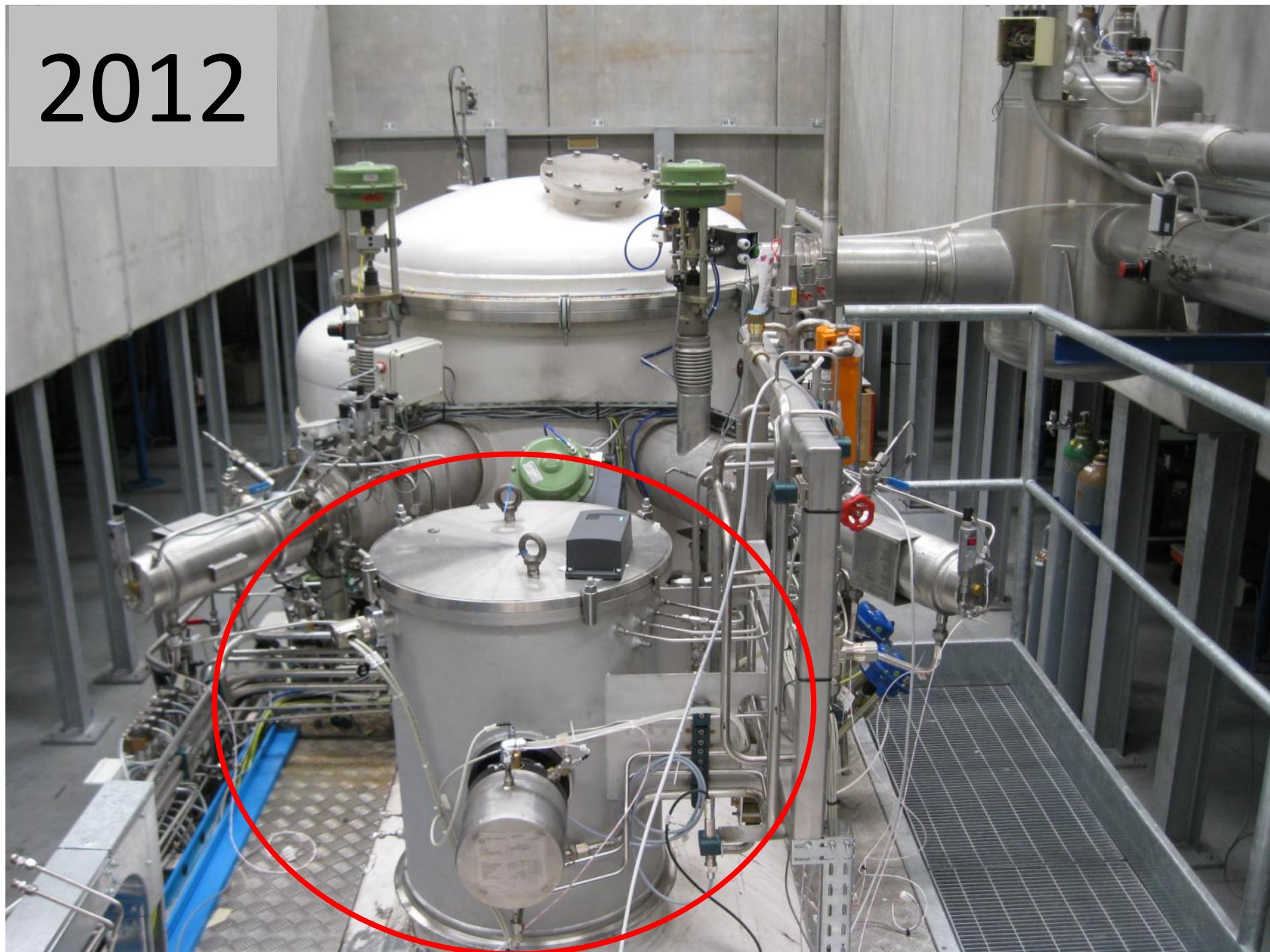
Refurbishing of ALPI Cryogenic Refrigerator, Purification & Recovery Systems

What has been done:



- Up-grade Cold Box: Supercritical Turbine
 - Installation of III turbine on the Cold Box
 - New cabinet for the
 - Up-grade of CBX control system

2012





Supercritical TurbineProcess condition:

Inlet pressure: 15,8 bar abs
Outlet pressure: 2,8 bar
Inlet temperature: 5,1 K
Outlet temperature: 4,8K
Nominal speed: 1670 Hz
Mass Flow @ 5,4 K: up to 33 g/s
Refrigeration Power: 416W

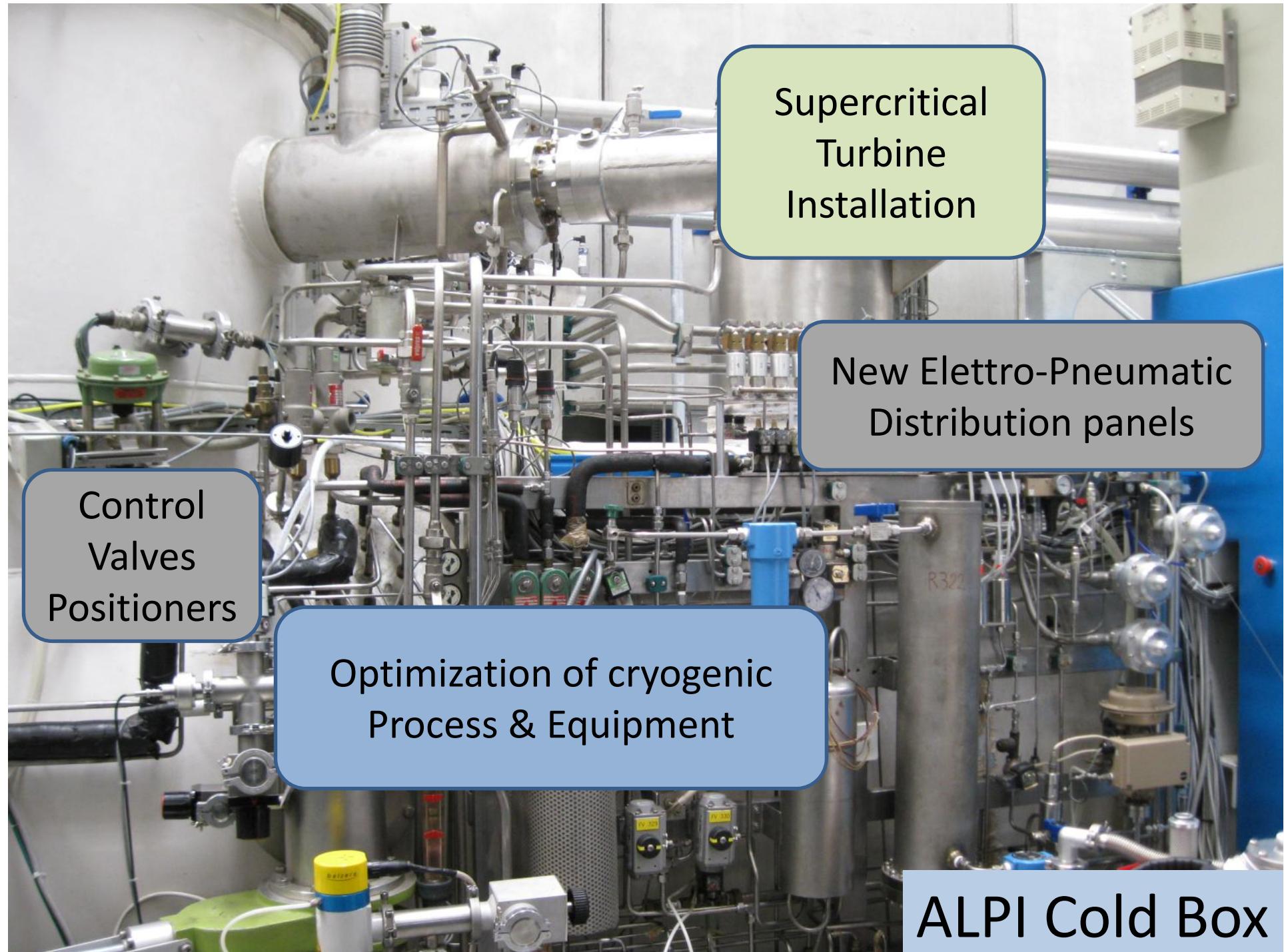


Refurbishing of ALPI Cryogenic Refrigerator, Purification & Recovery Systems

....and what we have to do:

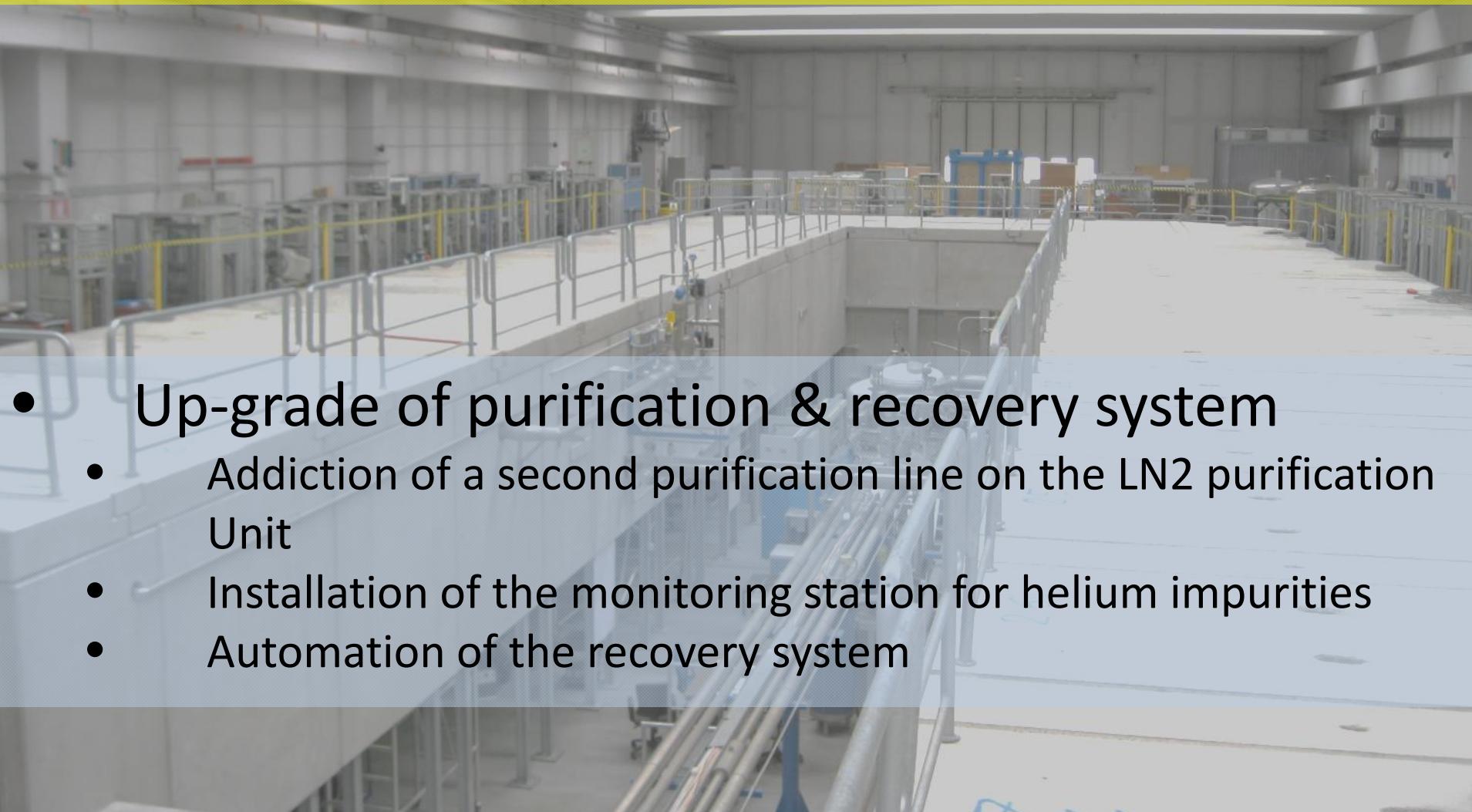
- Refurbishing of ALPI Cold Box
 - New positioners for the Control Valves
 - New Elettro-Pneumatic Distribution panels
 - Cryogenic process and equipment optimization



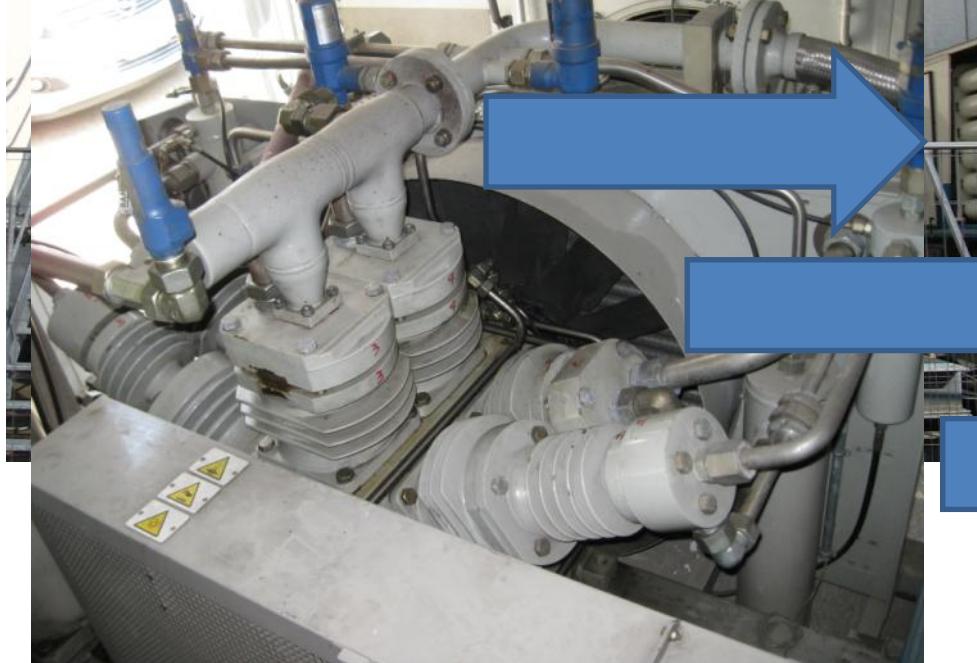


Refurbishing of ALPI Cryogenic Refrigerator, Purification & Recovery Systems

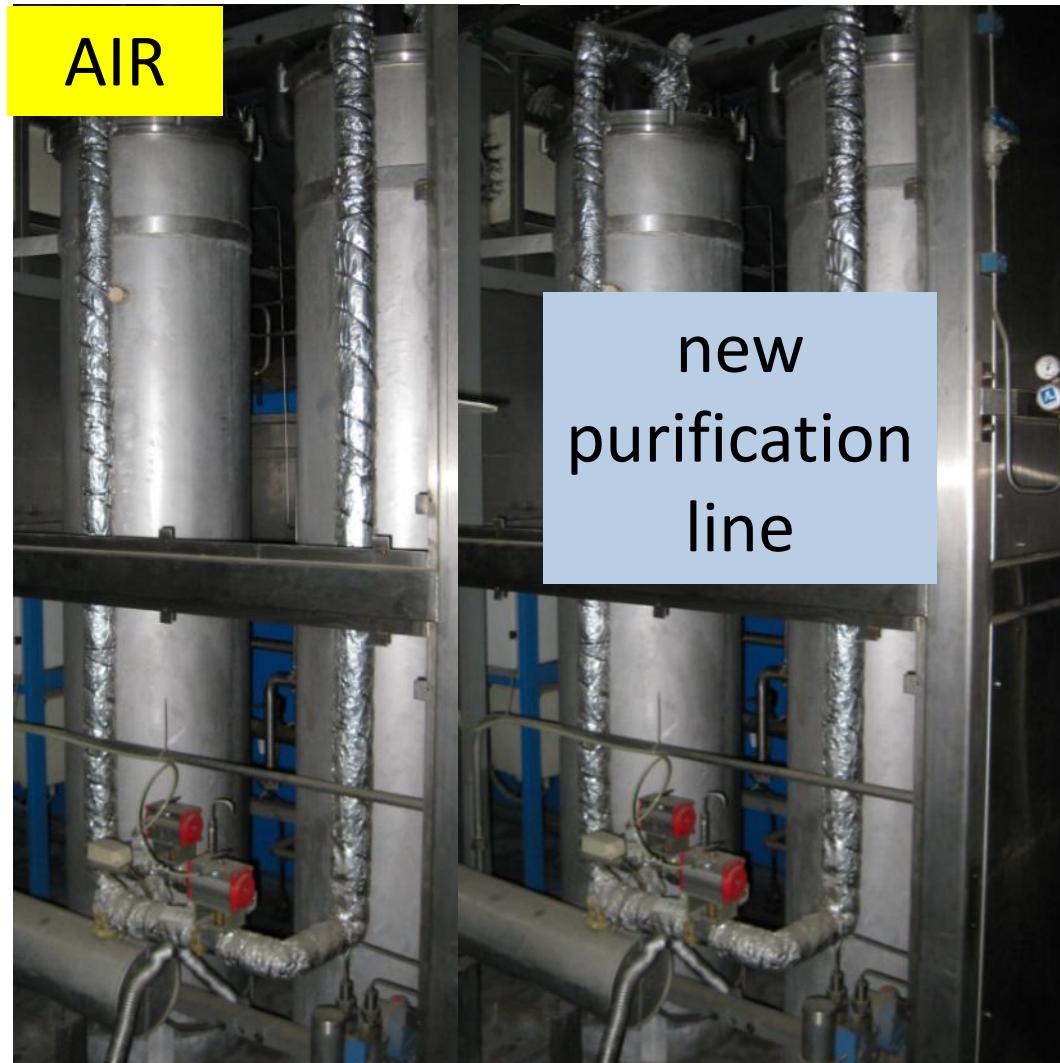
....and what we have to do:



- Up-grade of purification & recovery system
 - Addiction of a second purification line on the LN₂ purification Unit
 - Installation of the monitoring station for helium impurities
 - Automation of the recovery system



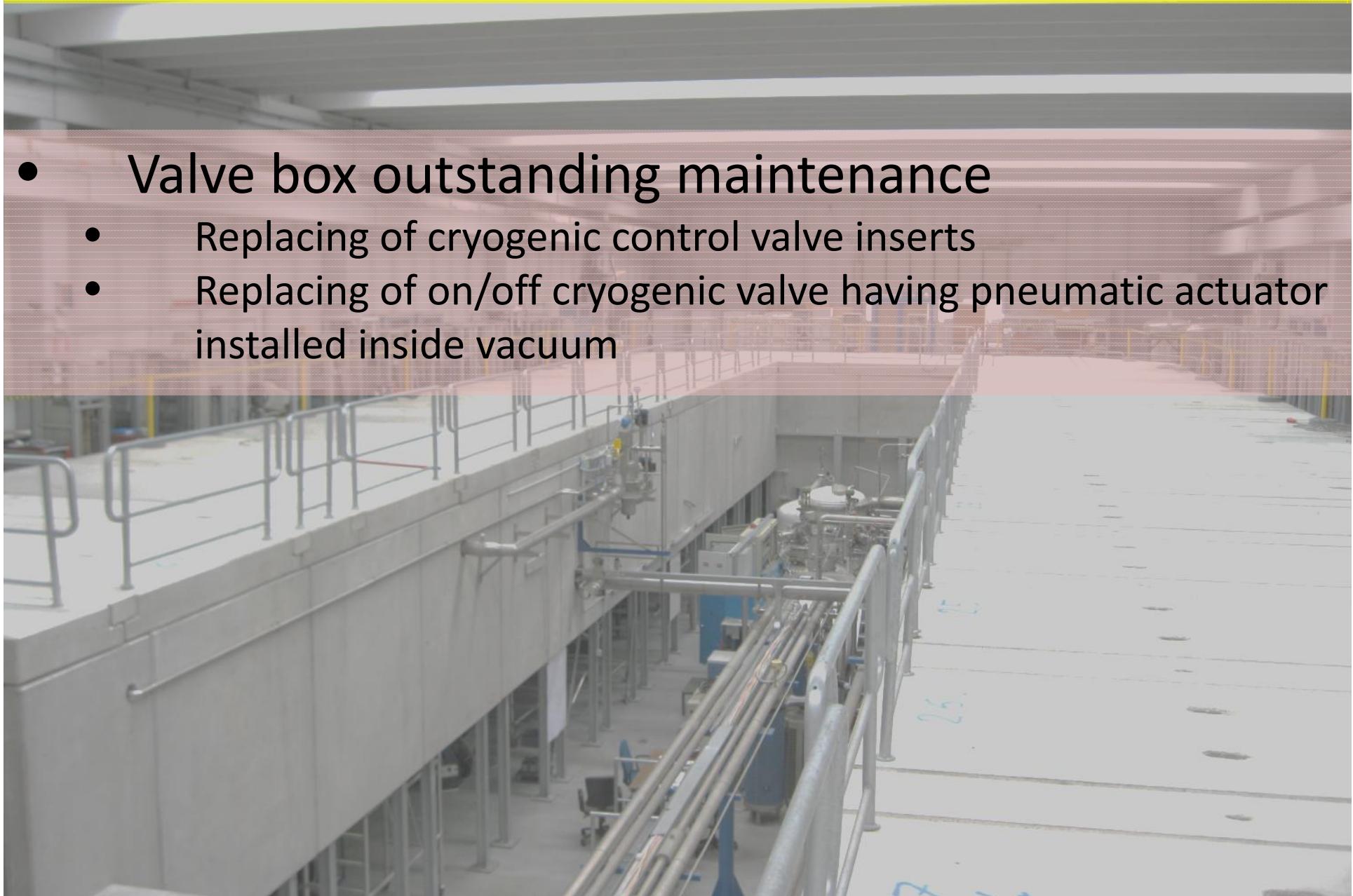
Recovery System



Purification System

Renewal of ALPI valve boxes

- Valve box outstanding maintenance
 - Replacing of cryogenic control valve inserts
 - Replacing of on/off cryogenic valve having pneumatic actuator installed inside vacuum



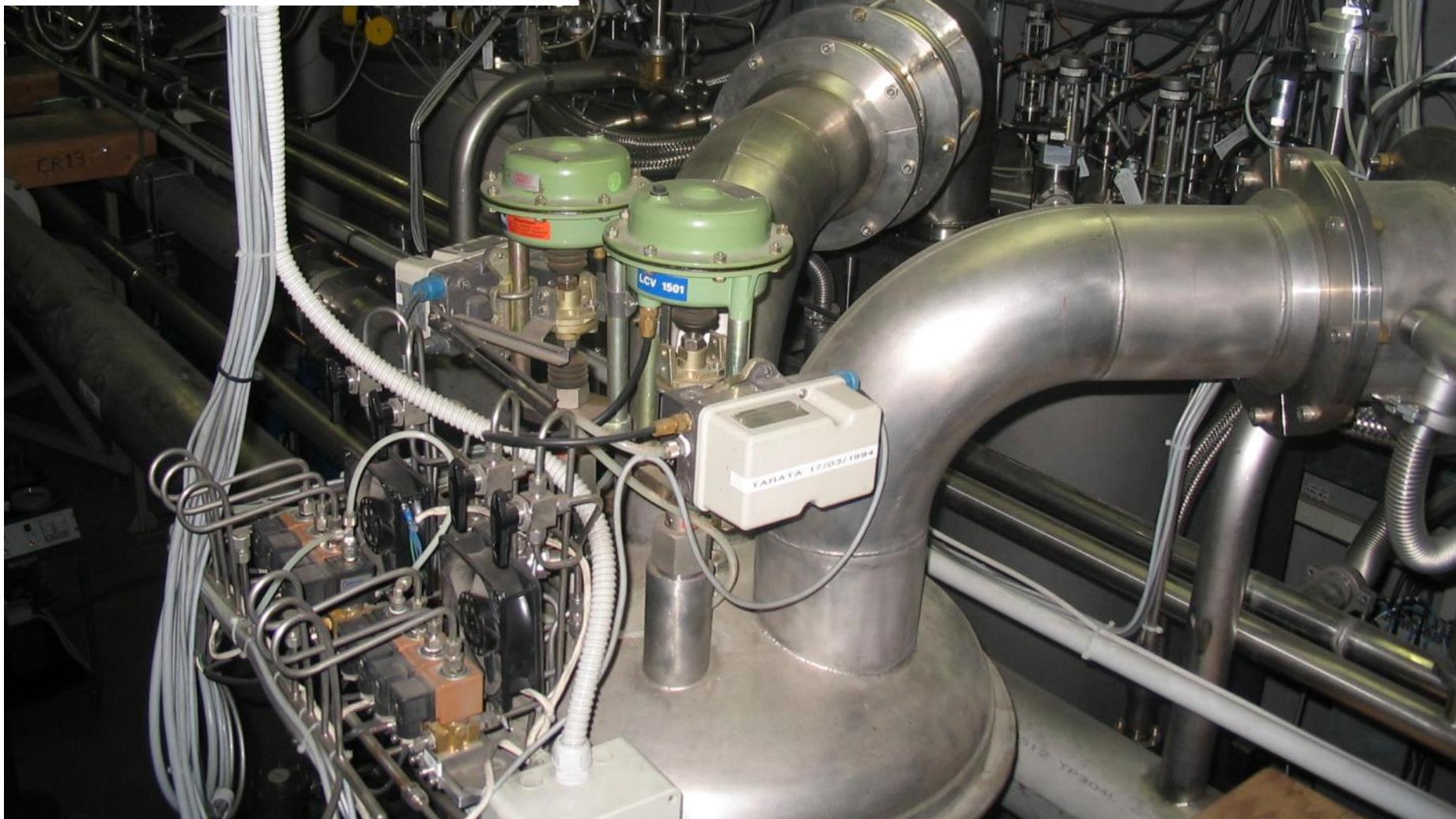
ALPI valve boxes serve the cryomodules to supply LHe and Cold He Gas

Single: 1 Contro Valve (Lhe IN)

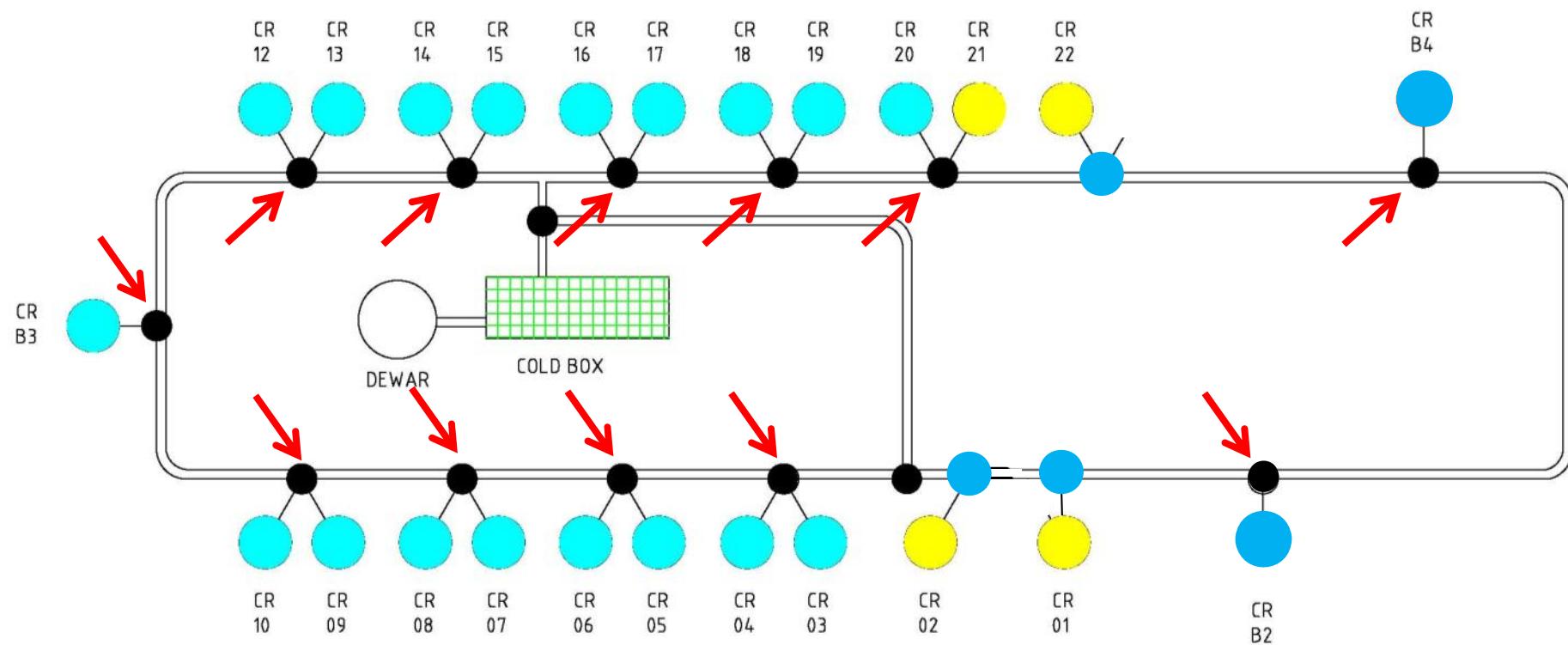
3 ON/OFF valves

Double: 2 Contro Valve (Lhe IN)

6 ON/OFF valves



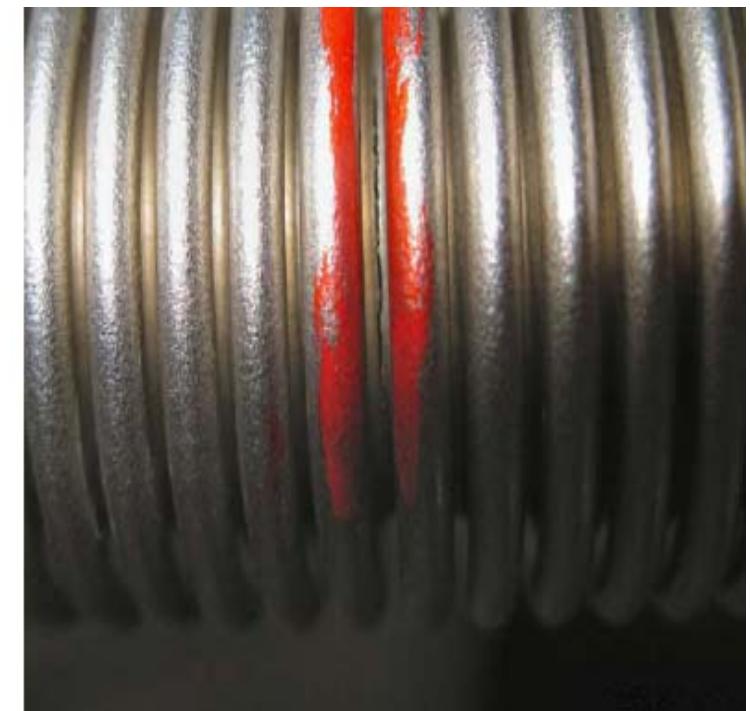
Cryogenic Valves Renewal



approx 10,000 cycles
using 20 years

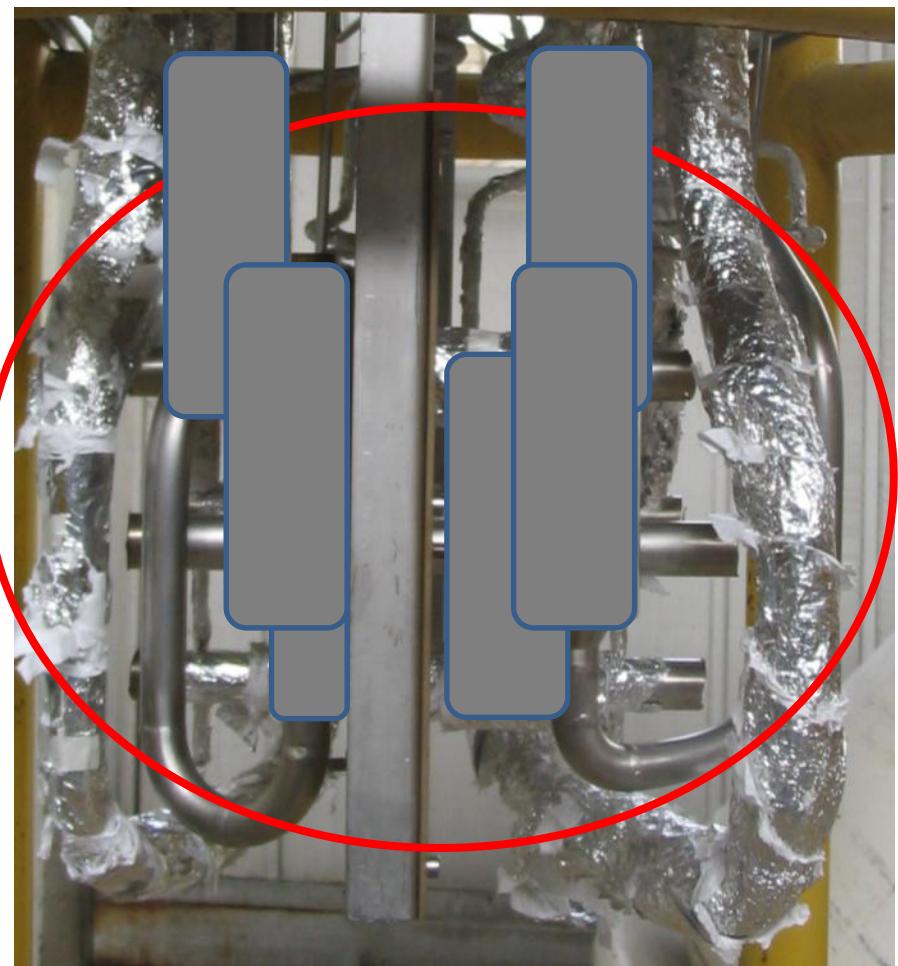
Cryogenic Control Valve insert

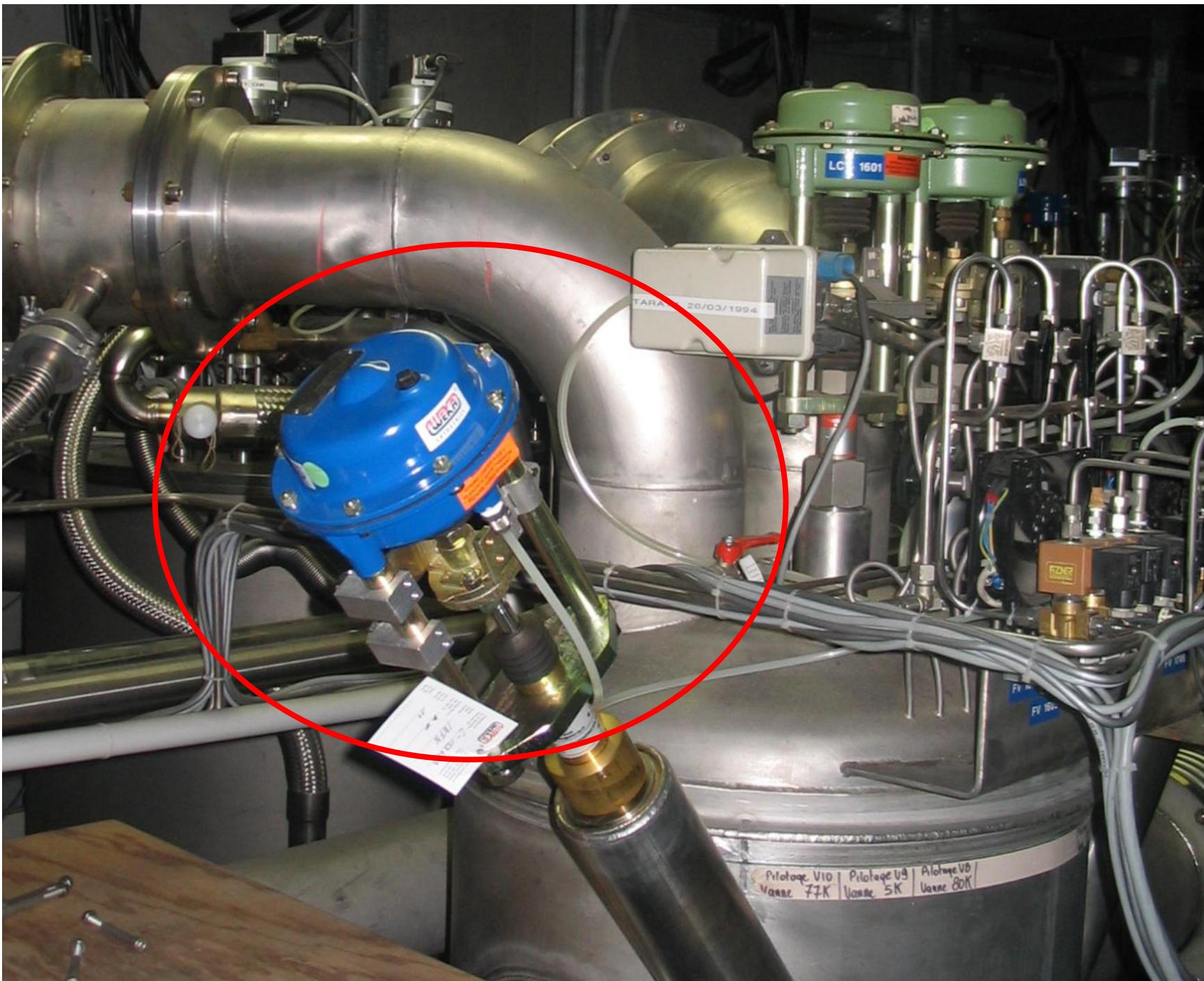
Test soffietto con Millebolle





Cryogenic on/off valve
replacing



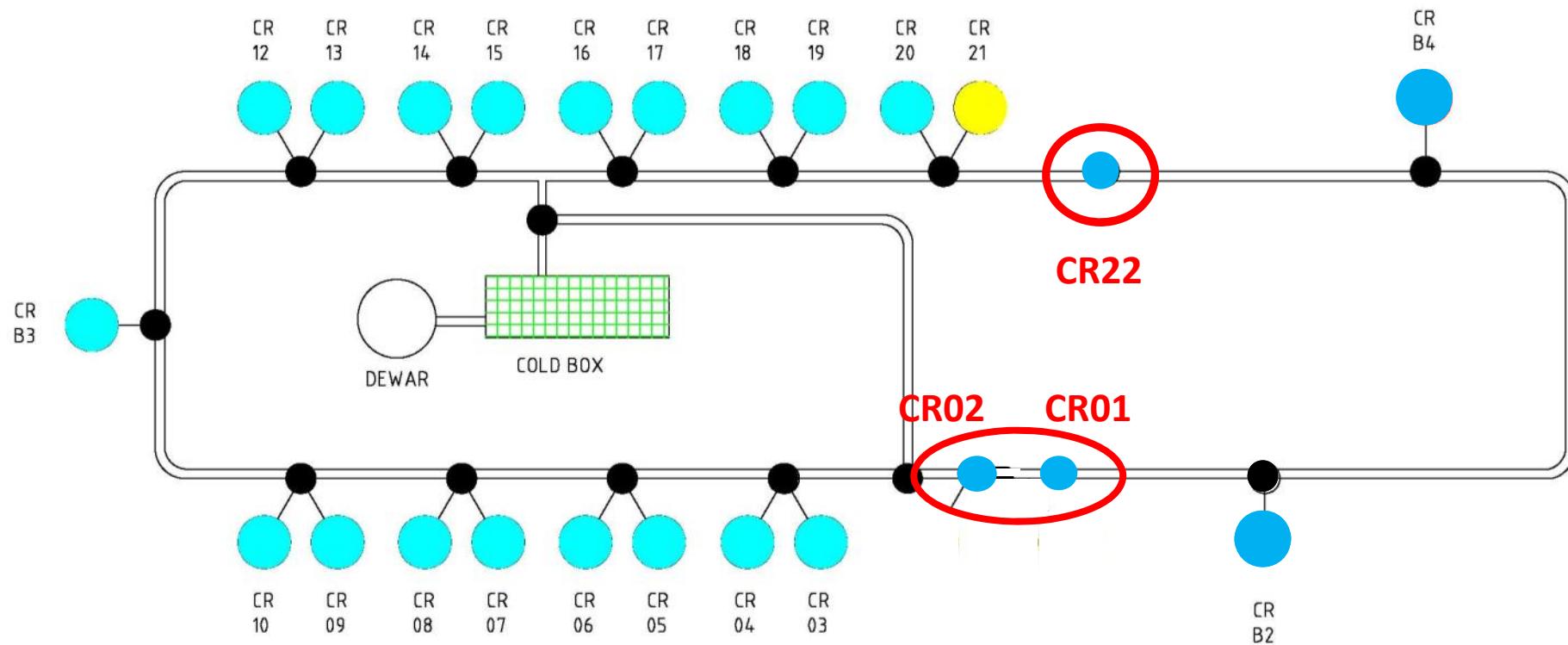


Renewal of ALPI valve boxes

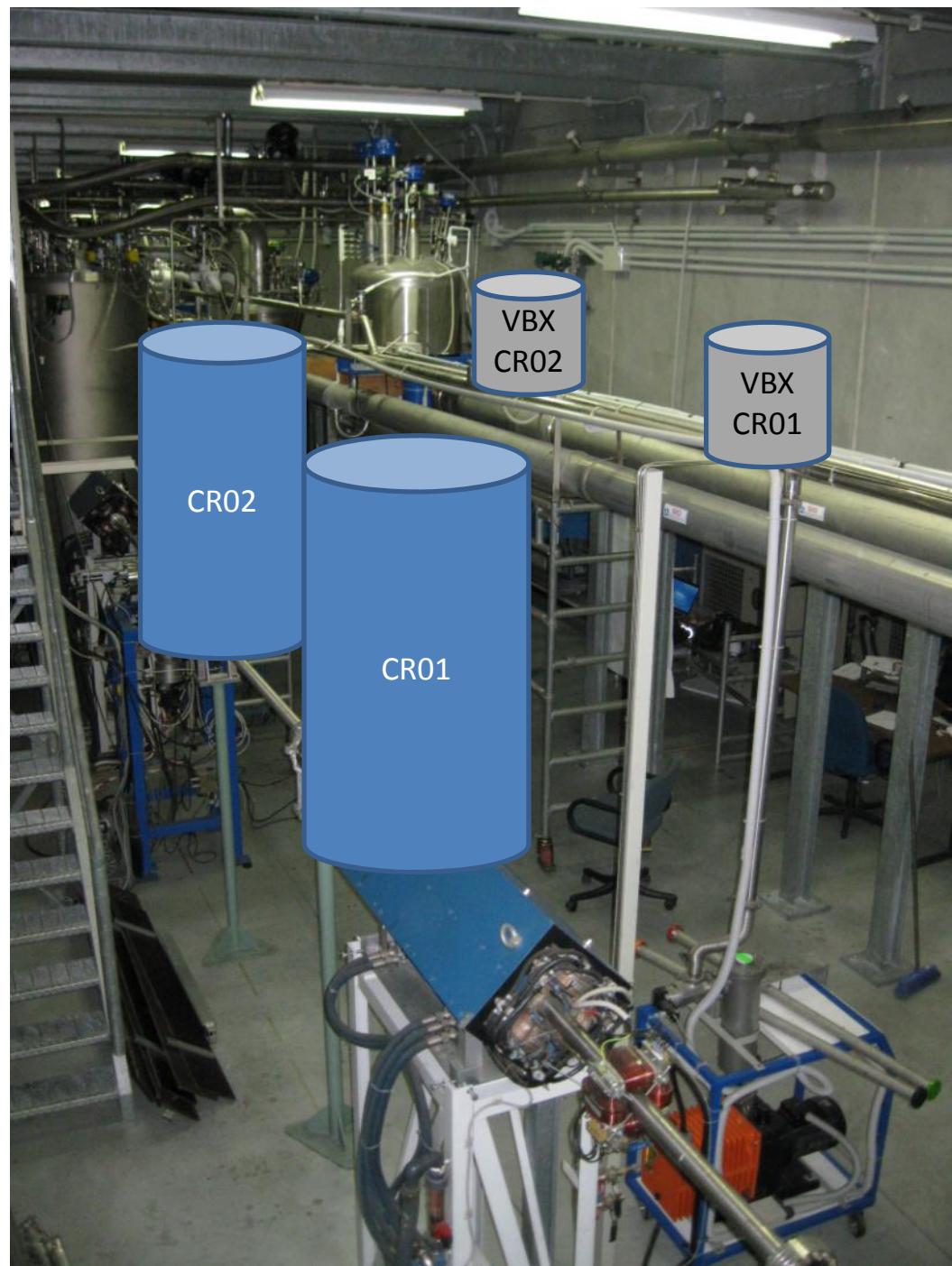


- New Valve Boxes
 - new valve boxes for CR01, CR02, CR21, CR22 (new Lay-out)

Helium Transfer lines new valve boxes



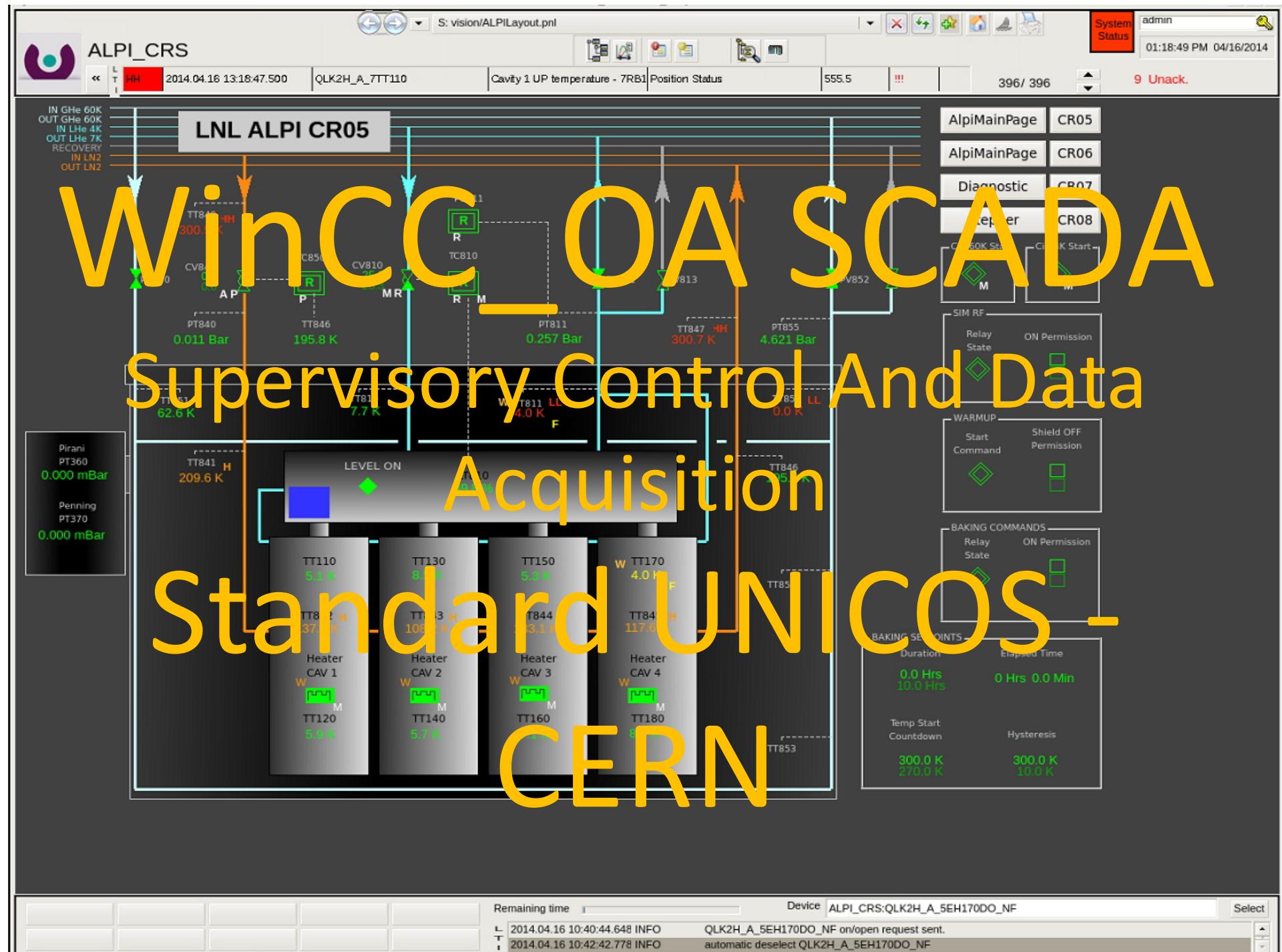
ALPI - LINAC



Cryogenic Control System migration and development towards UNICOS- CERN Standard

- Helium Liquefier Linde TCF20 2012
- ALPI – LINAC Cyomodules 2014-2015
- ALPI Cryogenic Refrigerator 2015-2016







Standard electric components

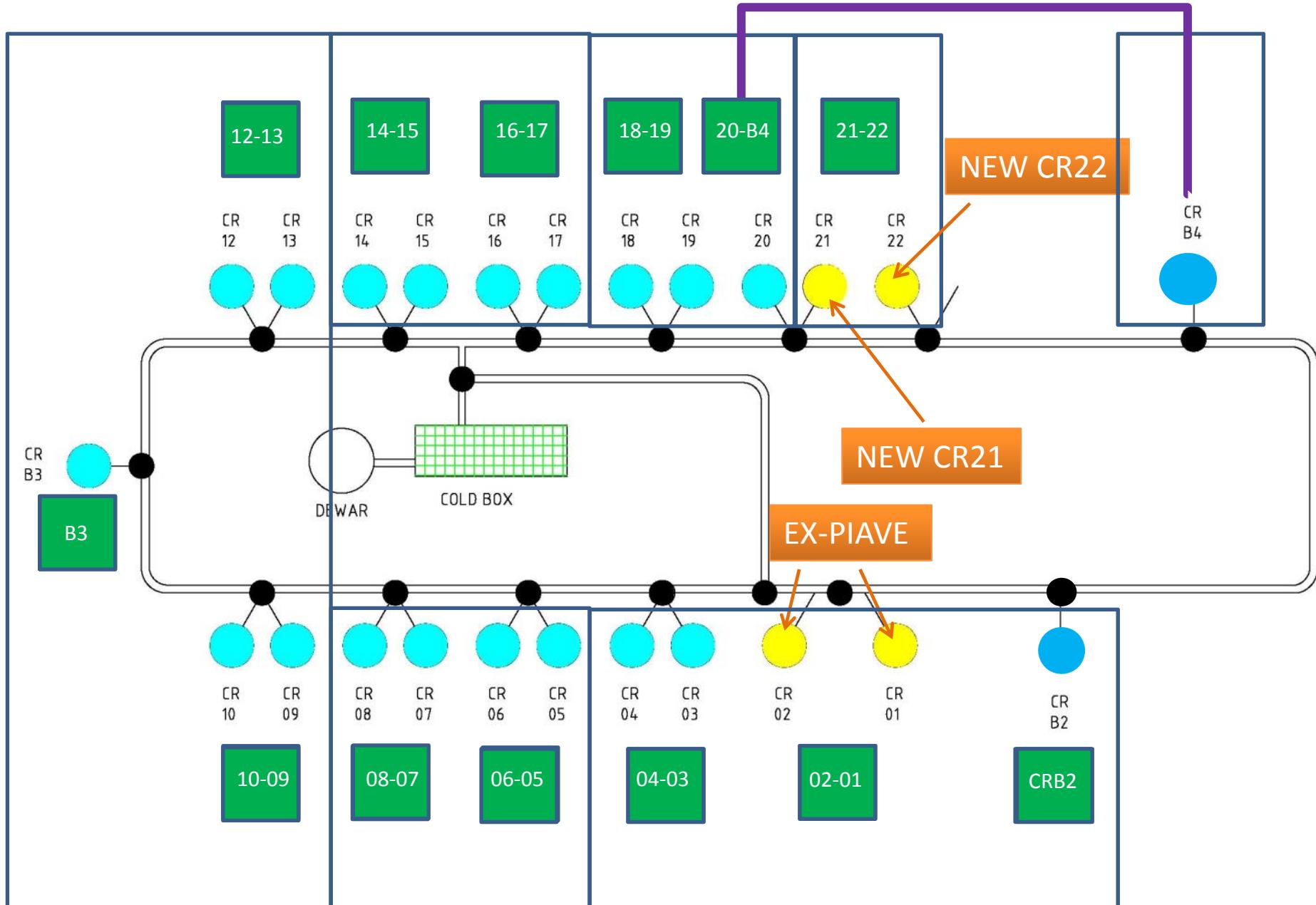
&

Standard Programming Style

Standard UNICOS -

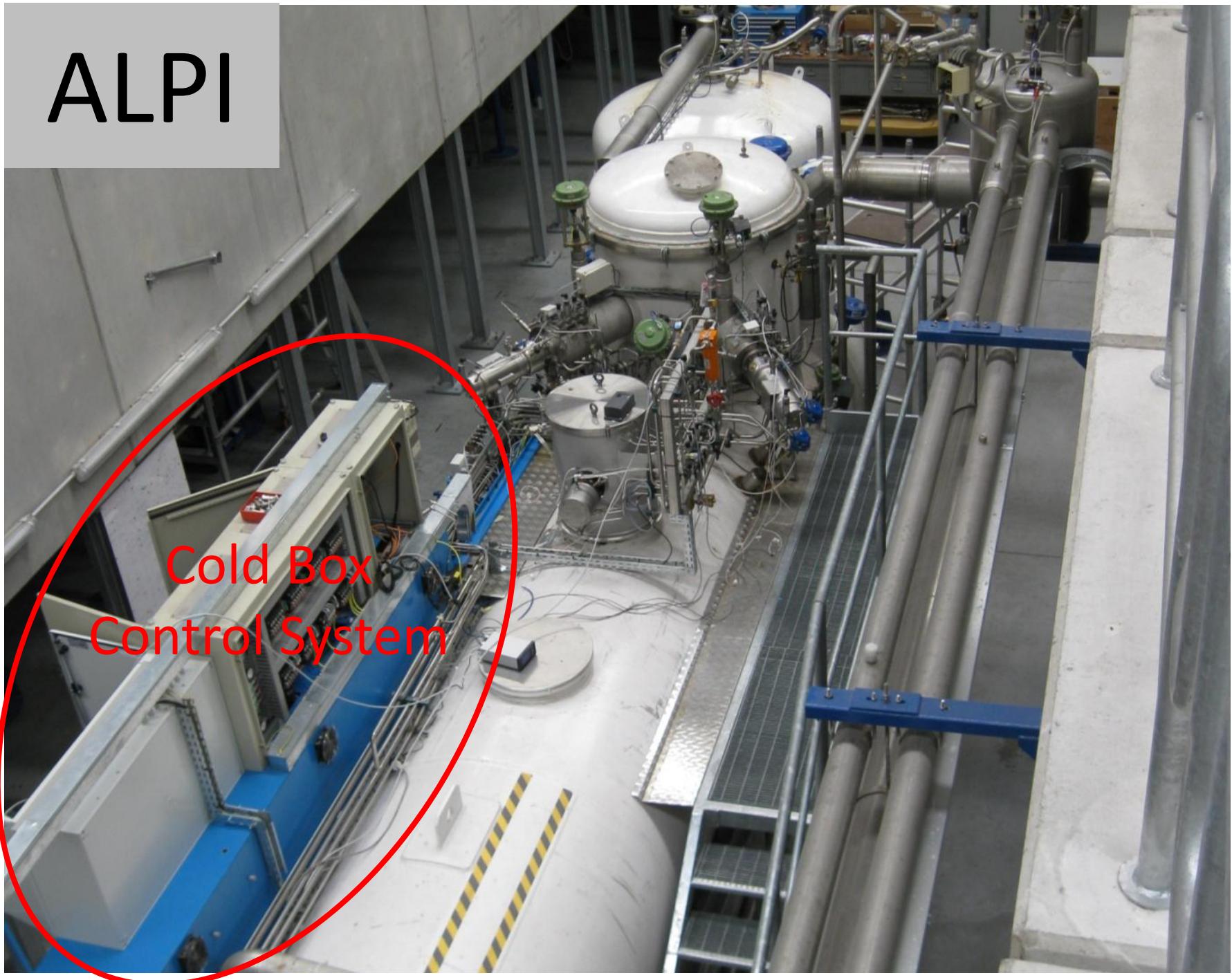
CERN

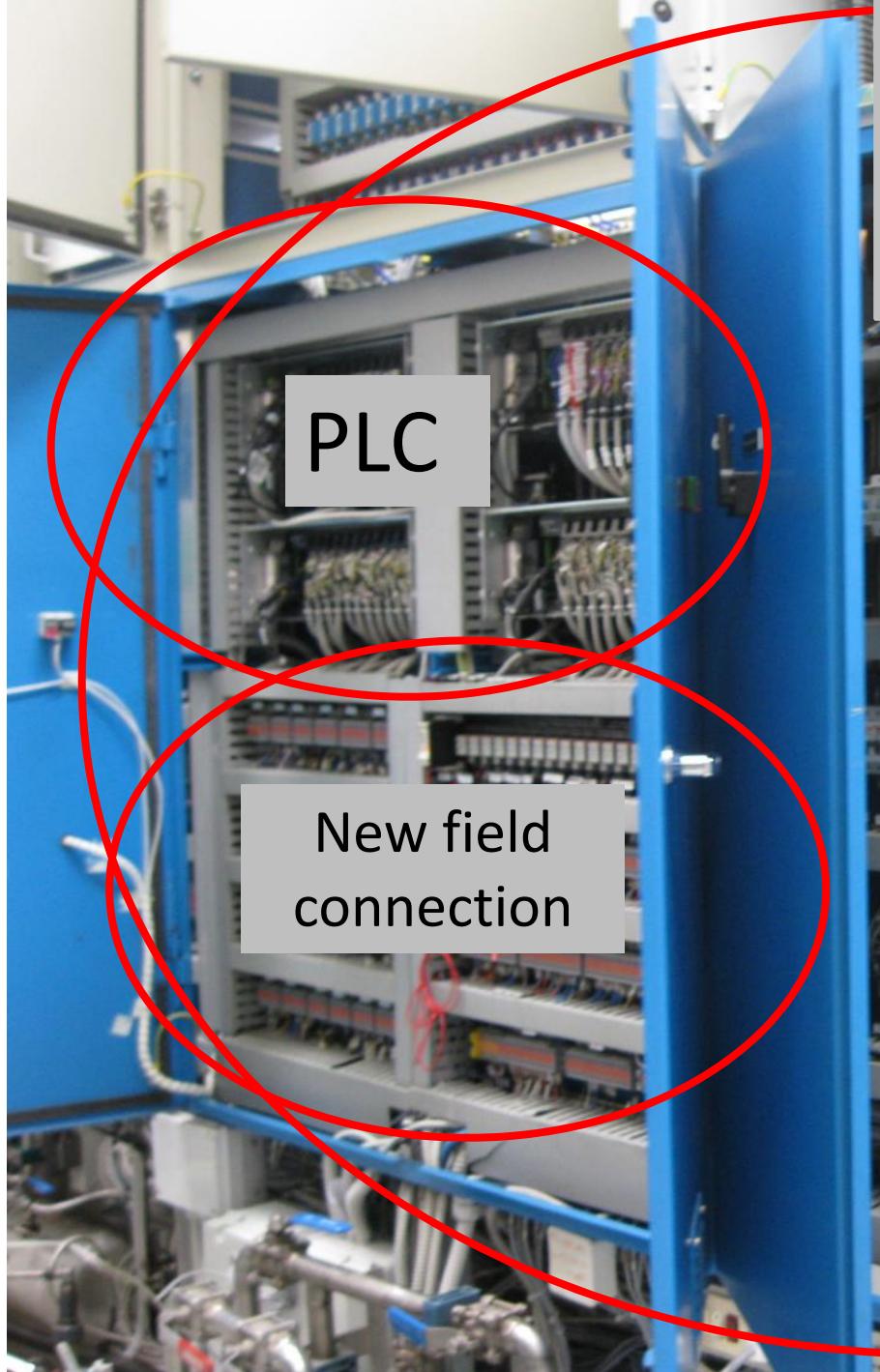




Linac Lay-Out

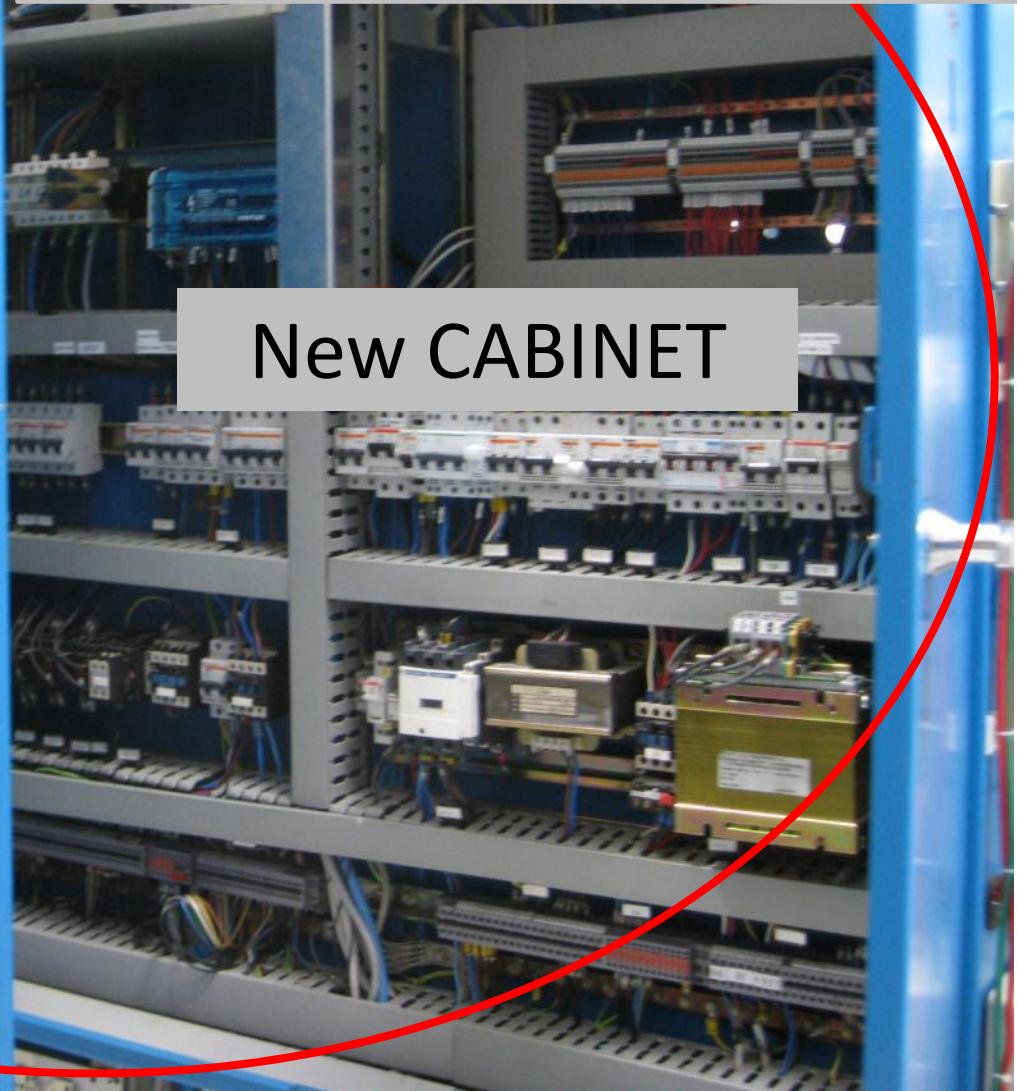
ALPI





Control System: STANDARD UNICOS

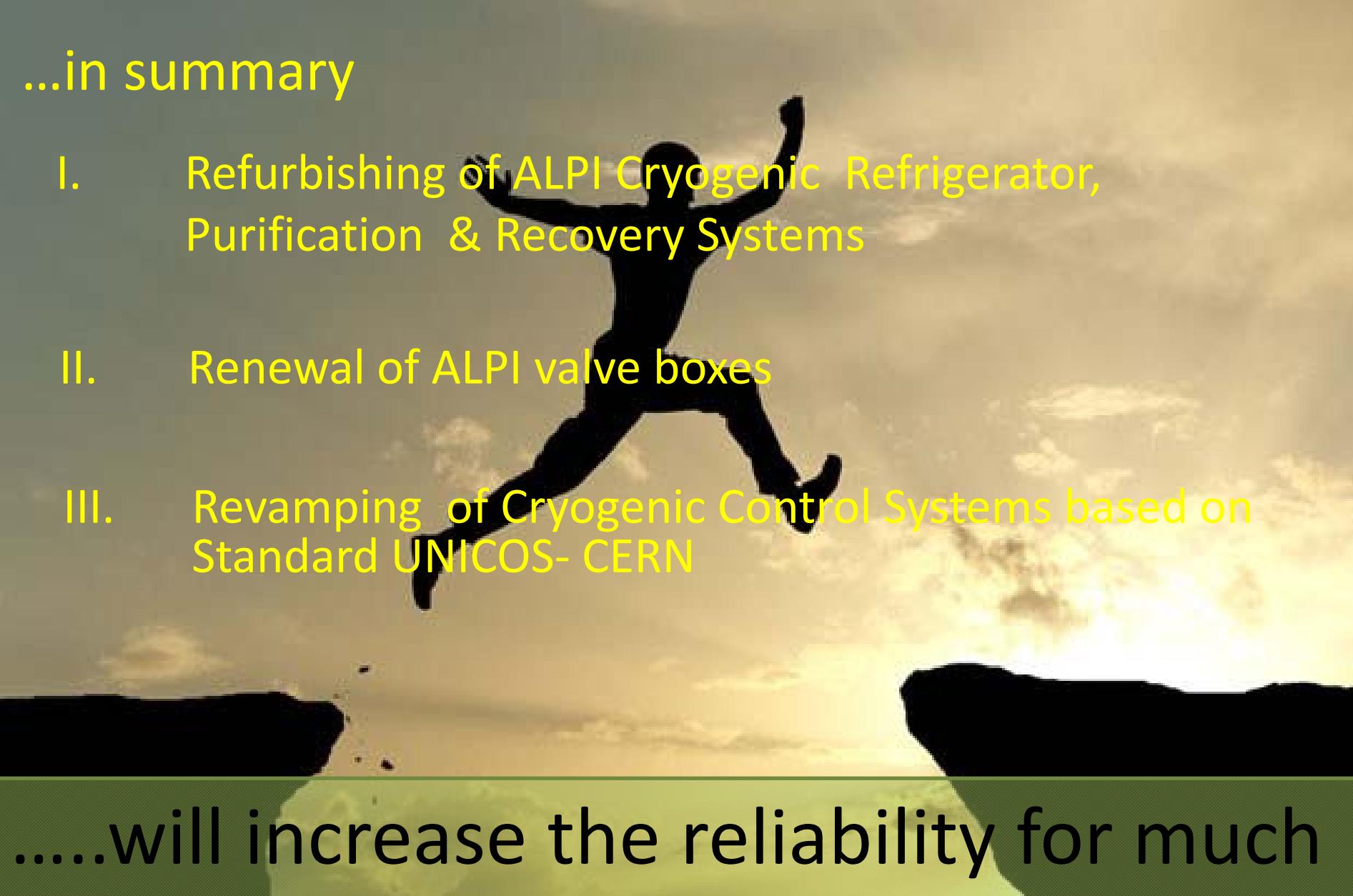
- New Main Cabinet
- New Control System
- New Supervision



Cryogenic Control System migration and development towards UNICOS- CERN Standard

- 
- Helium Liquefier Linde TCF20 2012
 - ALPI – LINAC Cyomodules 2014-2015
 - ALPI Cryogenic Refrigerator 2015-2016
 - Helium Purification System 2015-2016
 - Helium Recovery System 2016-2017
 - PIAVE Cryogenic Refrigerator

...in summary

- 
- I. Refurbishing of ALPI Cryogenic Refrigerator, Purification & Recovery Systems
 - II. Renewal of ALPI valve boxes
 - III. Revamping of Cryogenic Control Systems based on Standard UNICOS- CERN

.....will increase the reliability for much more than others 20 years