TRIUMF

Canada's National Laboratory for Particle and Nuclear Physics

A Rare Isotope Beam (RIB) is a dish best served cold

Cryogenics system of the ISAC-II superconducting LINAC at TRIUMF

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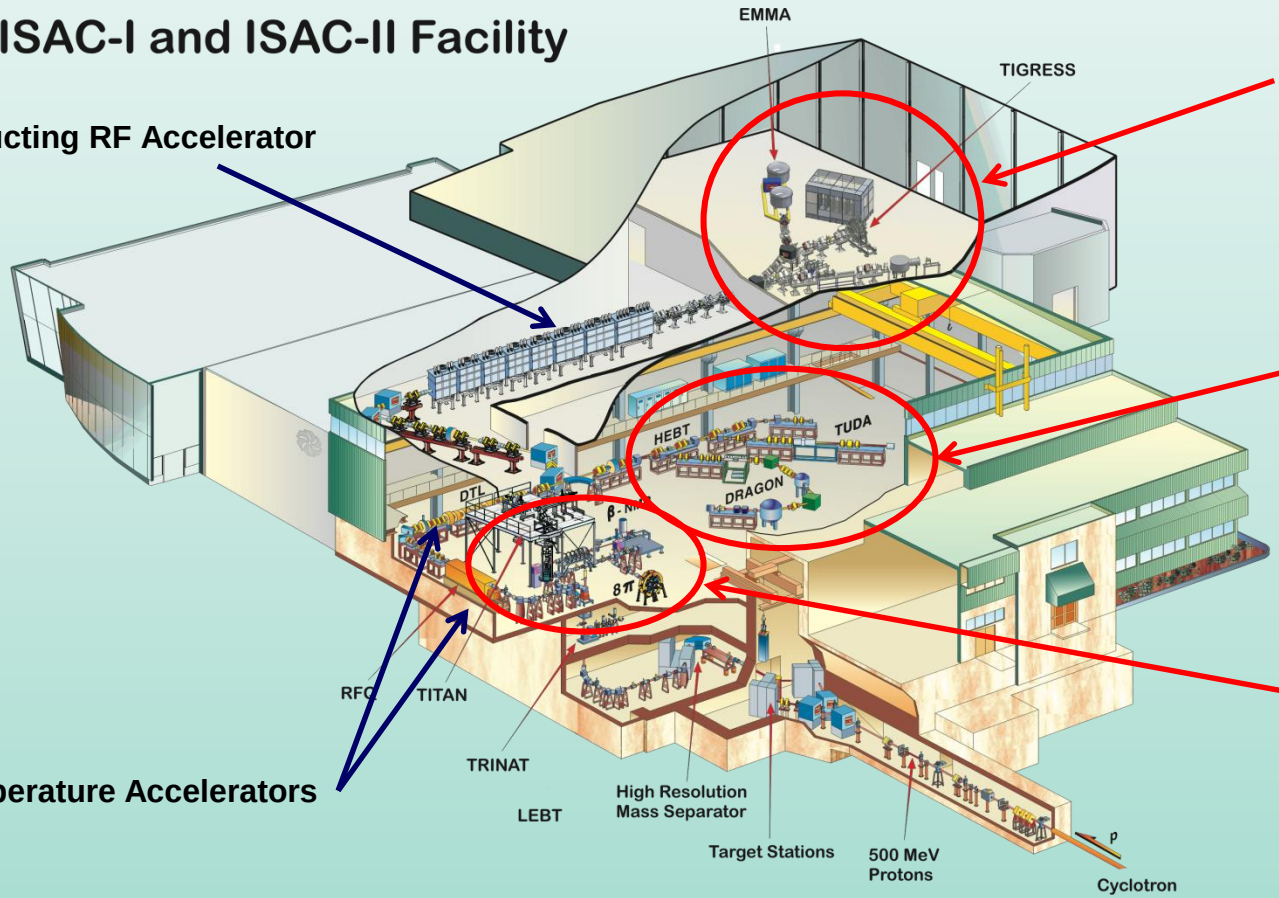
TRIUMF RIB Operations
October 17, 2017


ISAC-I and ISAC-II Facility
Superconducting RF Accelerator
Room Temperature Accelerators
EMMA
TIGRESS
SEBT
Experiments
(≤6.5MeV/u
at A/Q=6)
HEBT
Experiments
(≤1.5MeV/u)
LEBT
Experiments
(≤60keV/u)
HEBT
TUDA
DRAGON
DTL
8π
RFQ
TITAN
TRINAT
LEBT
High Resolution
Mass Separator
Target Stations
500 MeV
Protons
Cyclotron

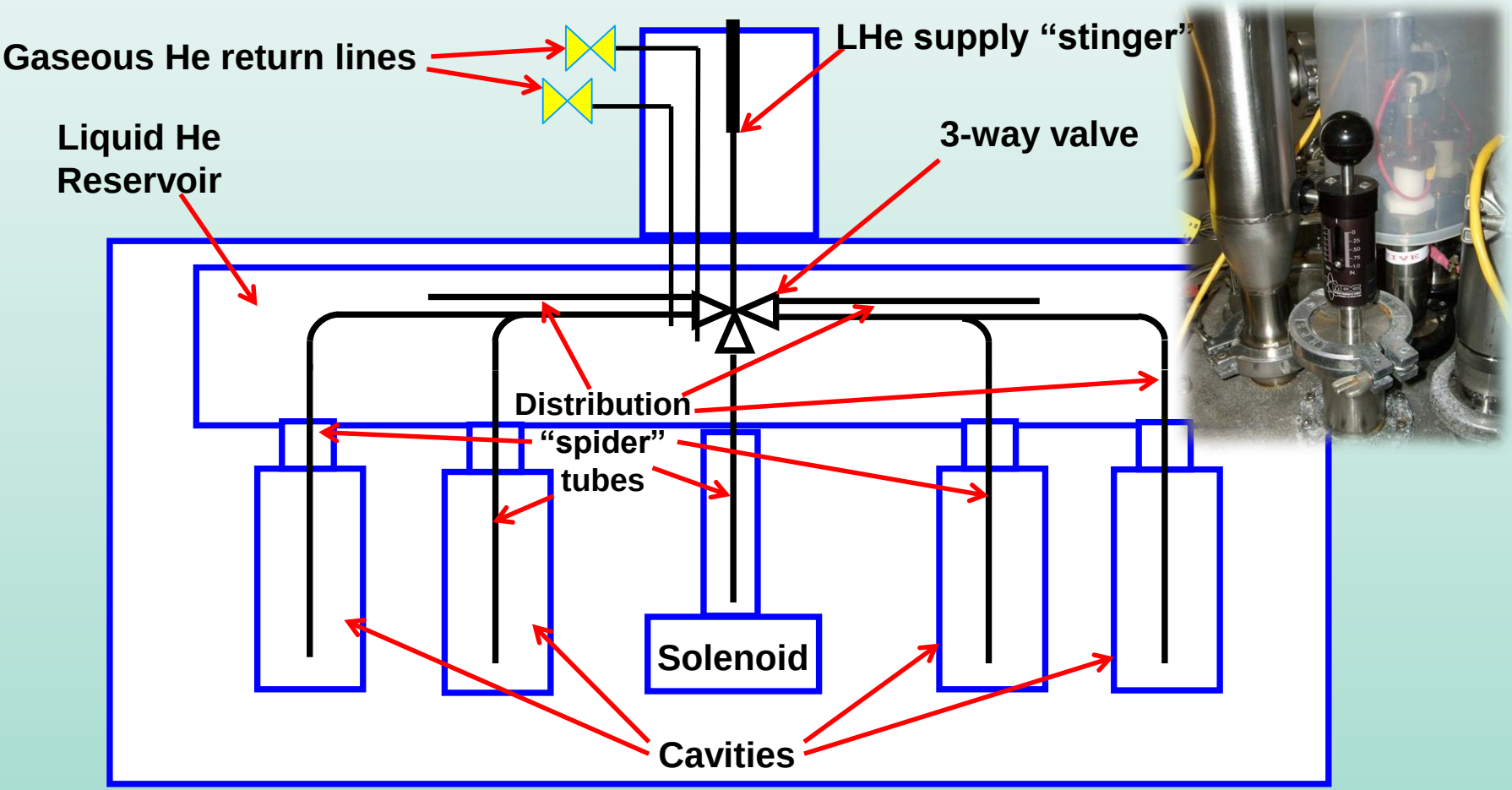
ISAC-II Superconducting RF (SCRF) Accelerator

ISAC-II Superconducting RF (SCRF) Accelerator

- Cavities: Bulk niobium, T_c=9.2K
- LHe-cooled to 4K.

- Stainless steel vacuum tanks.
- LN_2-cooled copper shielding.
- Mu-metal shielding under the copper shielding.

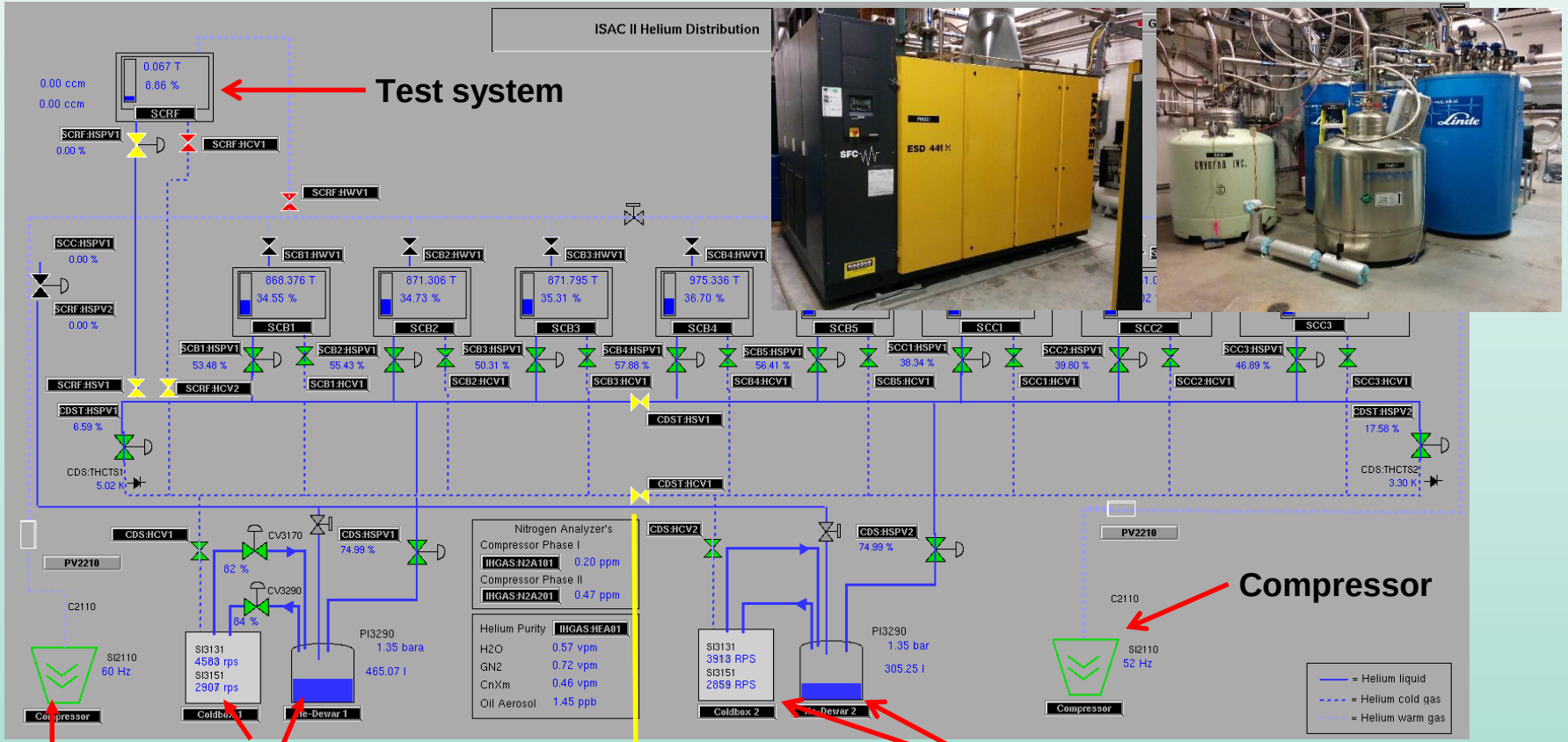
Cooling Down Cavities



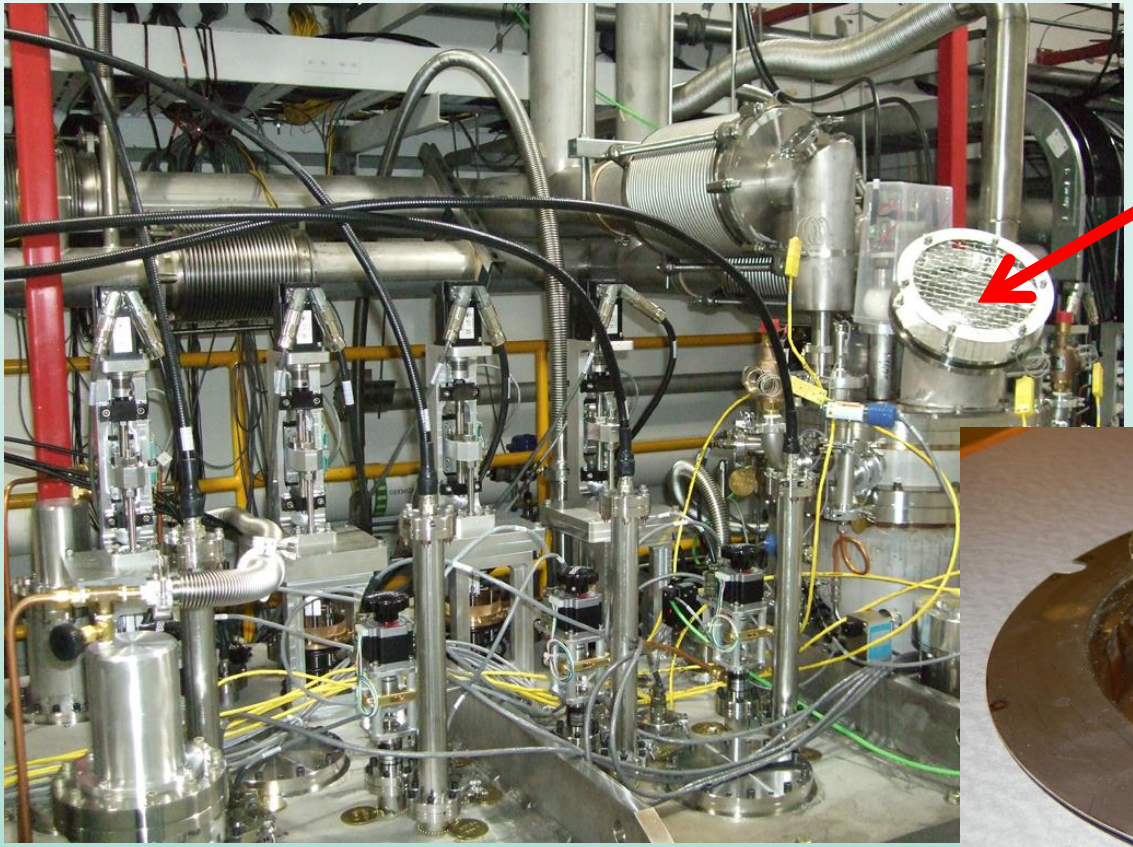
Cooling Down Cavities

- Quick cooldown to reduce the chance of Q-disease.
  - Must cool down from ~150K to 50K in less than 1h.
  - Usually within ~30 minutes.
- Cryomodule solenoid off during cooldown

Liquid Helium Distribution

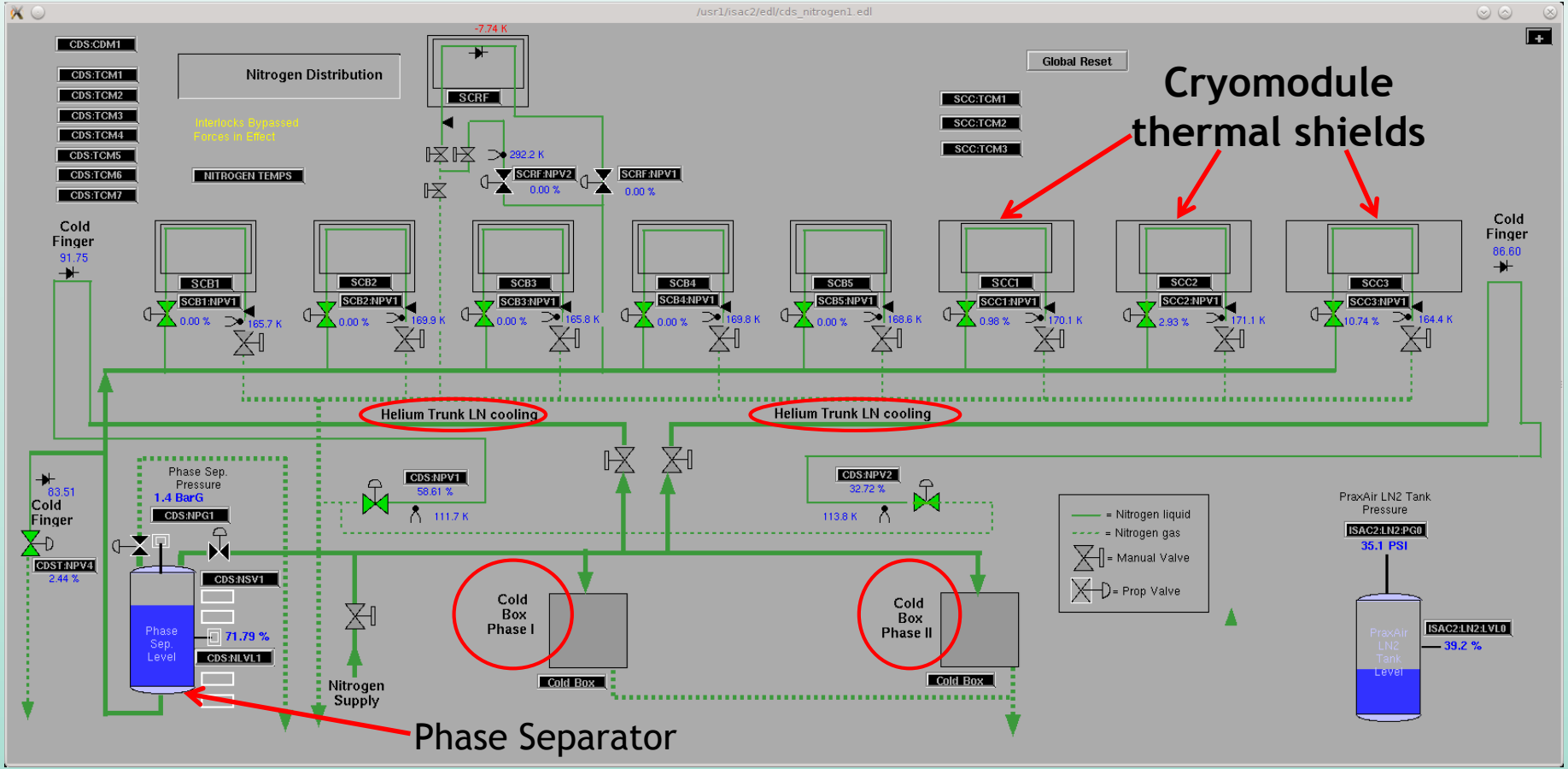


Burst Discs



- LHe loss isn't desirable, however.
- 3400 litres in the cryogenics system.
  - LHe ~C$18 (~US$15, ~€12) a litre.
  - About C$61,000 (~US$49,500, ~€41,500).
  - Still, far less significant than equipment damage if pressure goes too high!

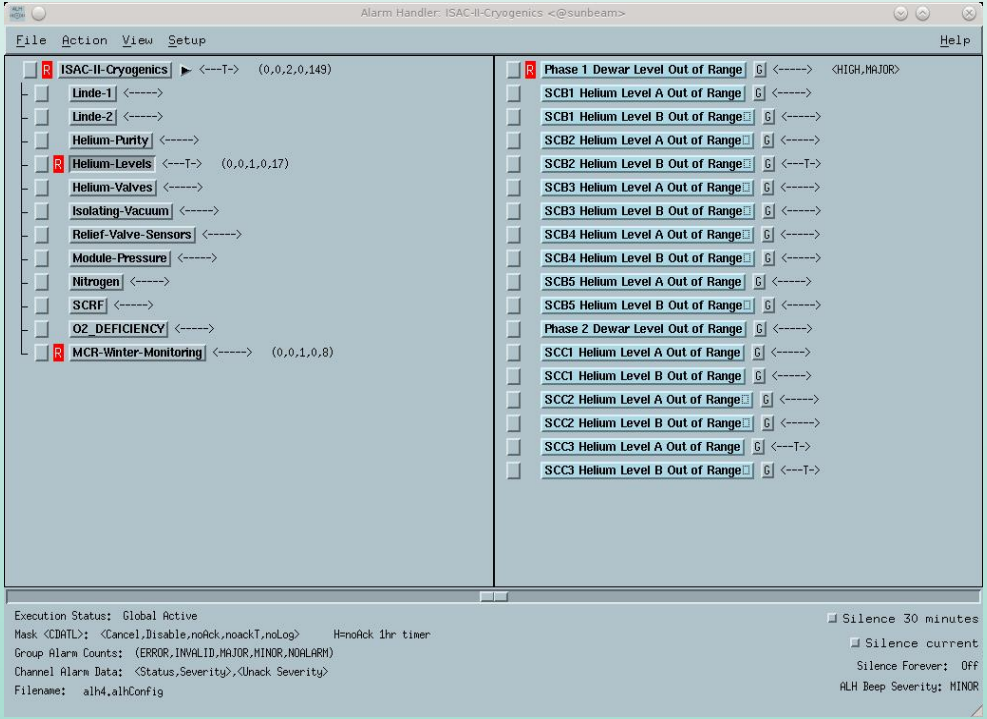
Liquid Nitrogen System



Operations' Role

- Cryogenics staff normally on site only during regular business hours.
- Operations monitors cryogenics system other times.

- "First responders" during a situation
- On-site "hands" for expert help
- Alarm handler for warnings



Some Challenges

Power outages / bumps

- Power outages and some power bumps trip off compressors.
- Recovery compressor to prevent / minimize LHe loss.

  - Presently manual on only.

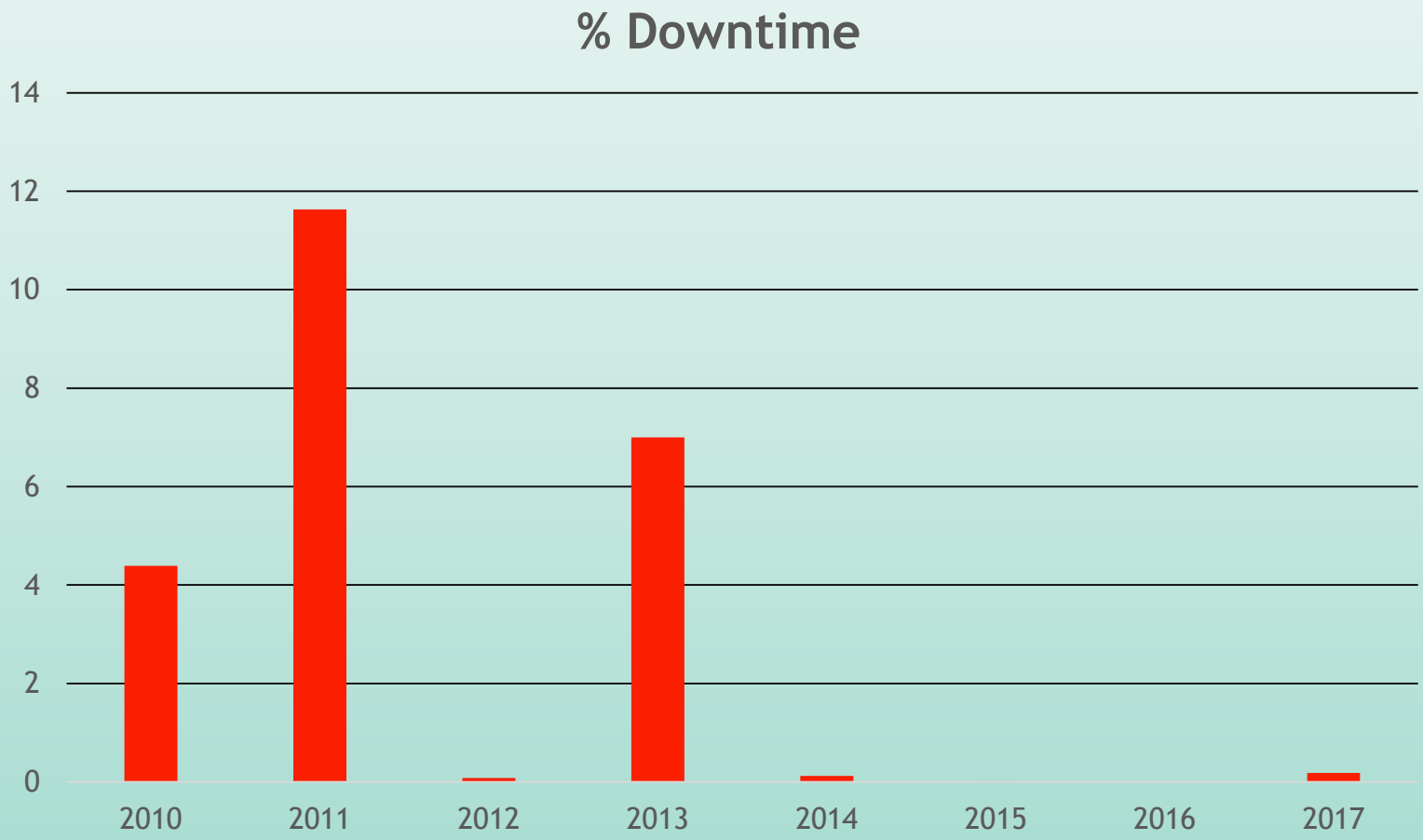
Power outages / bumps

- Growing pains incident on Nov. 26, 2006.
- Things learned, subsequent and future upgrades:
  - Independent mini air compressor, on emergency diesel generator, installed.
  - Recovery compressor “auto-on” when cold box trips – work in progress

Impurities in the He inventory

- Can reduce heat exchanger performance, damage cold box turbines.
- Originally impurity sensors only detected N_2.
- Need < 5ppm N_2 impurity to operate.
- Contamination incident June 29, 2013.
- After incident:
  - Pressure transducer was moved.
  - Installed check valve.
  - Installed new sensors that also detect H_2O, hydrocarbons, oil aerosols.

Reliability Statistics



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- Violeta Toma, Operations Manager

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Thank You!
Merci!
Qapla'