Performance analysis of cryogenic system and cryomodules for the complete superconducting linear accelerator at IUAC, New Delhi.

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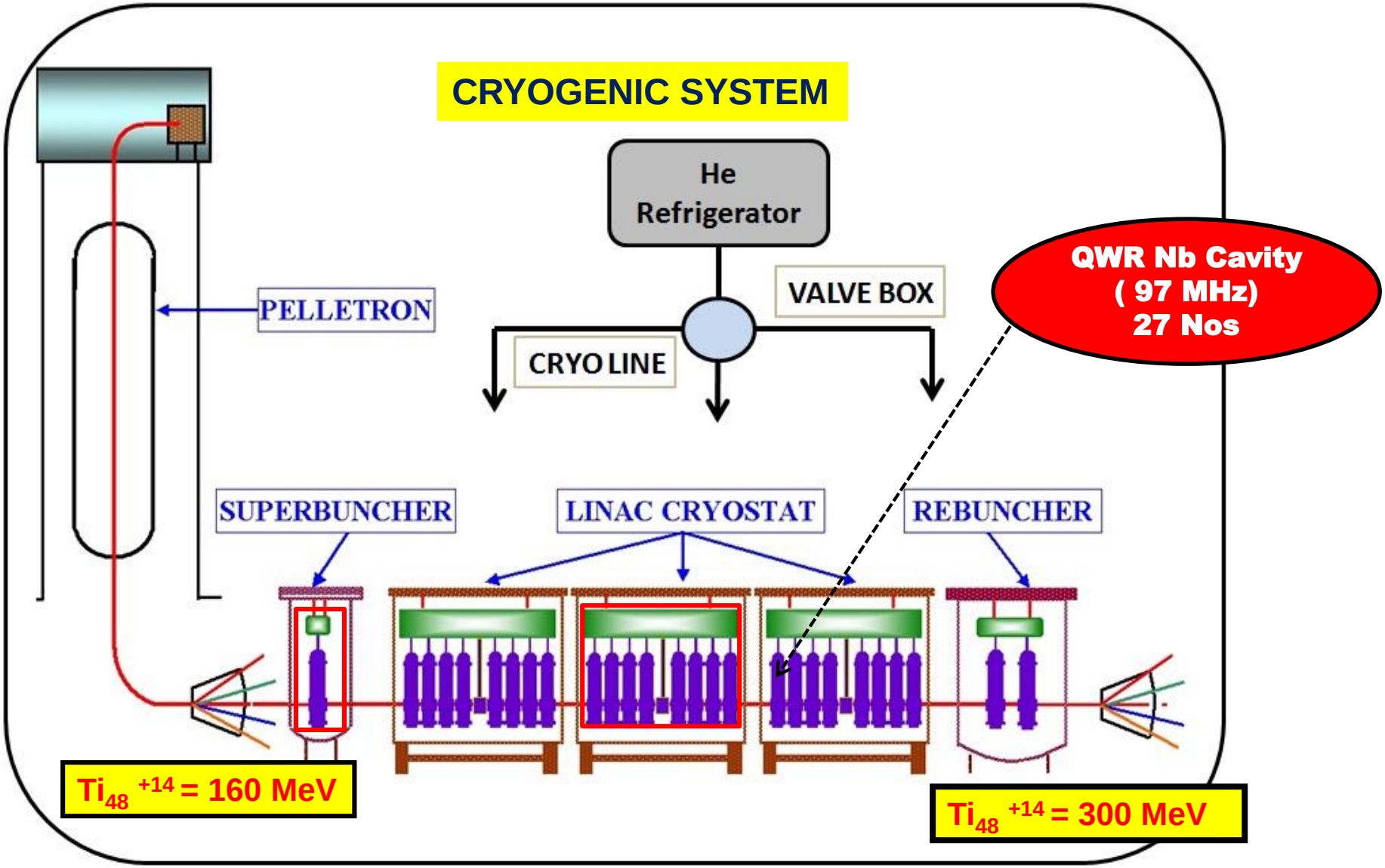
India

Superconducting LINAC at IUAC, Delhi



IUAC SUPERCONDUCTING CAVITY

Accelerating Structure

ß = .08c

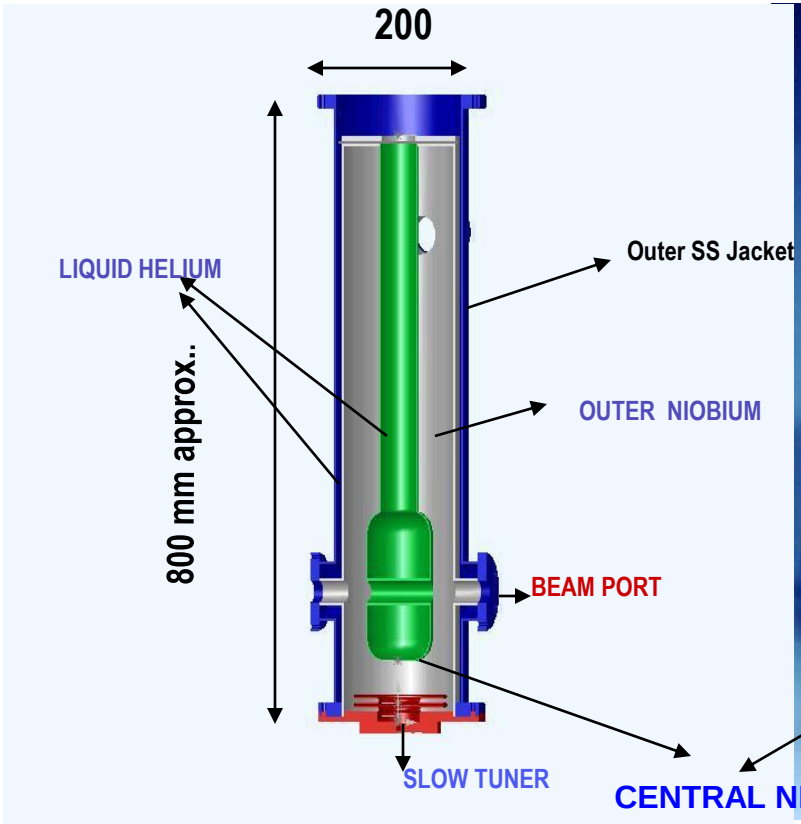
f= 97MHz,

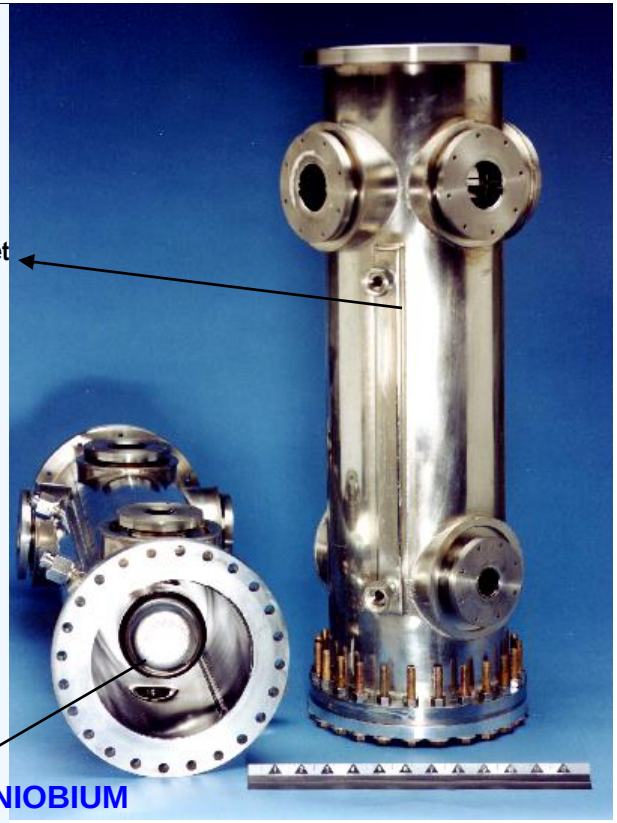
L_{eff} = 16 cm,

E_{acc}= 0.6MV

Cold Mass= 50 kg

Q.Rs=18

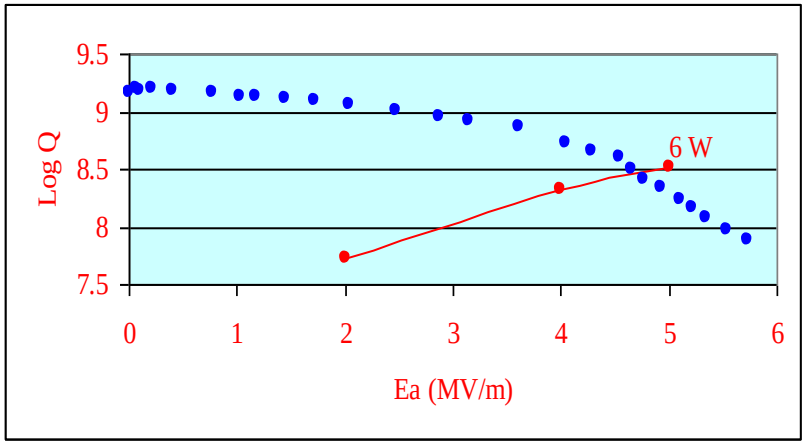




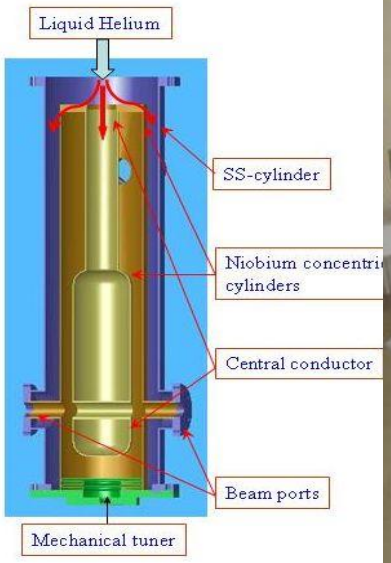
Operating Temperature : 4.2 K and Frequency : 97 MHz

IUAC SUPERCONDUCTING CAVITY

First lot (8 Nos) of QWR was developed at USA in Collaboration with ANL. Remaining 20 cavities were developed in house at IUAC

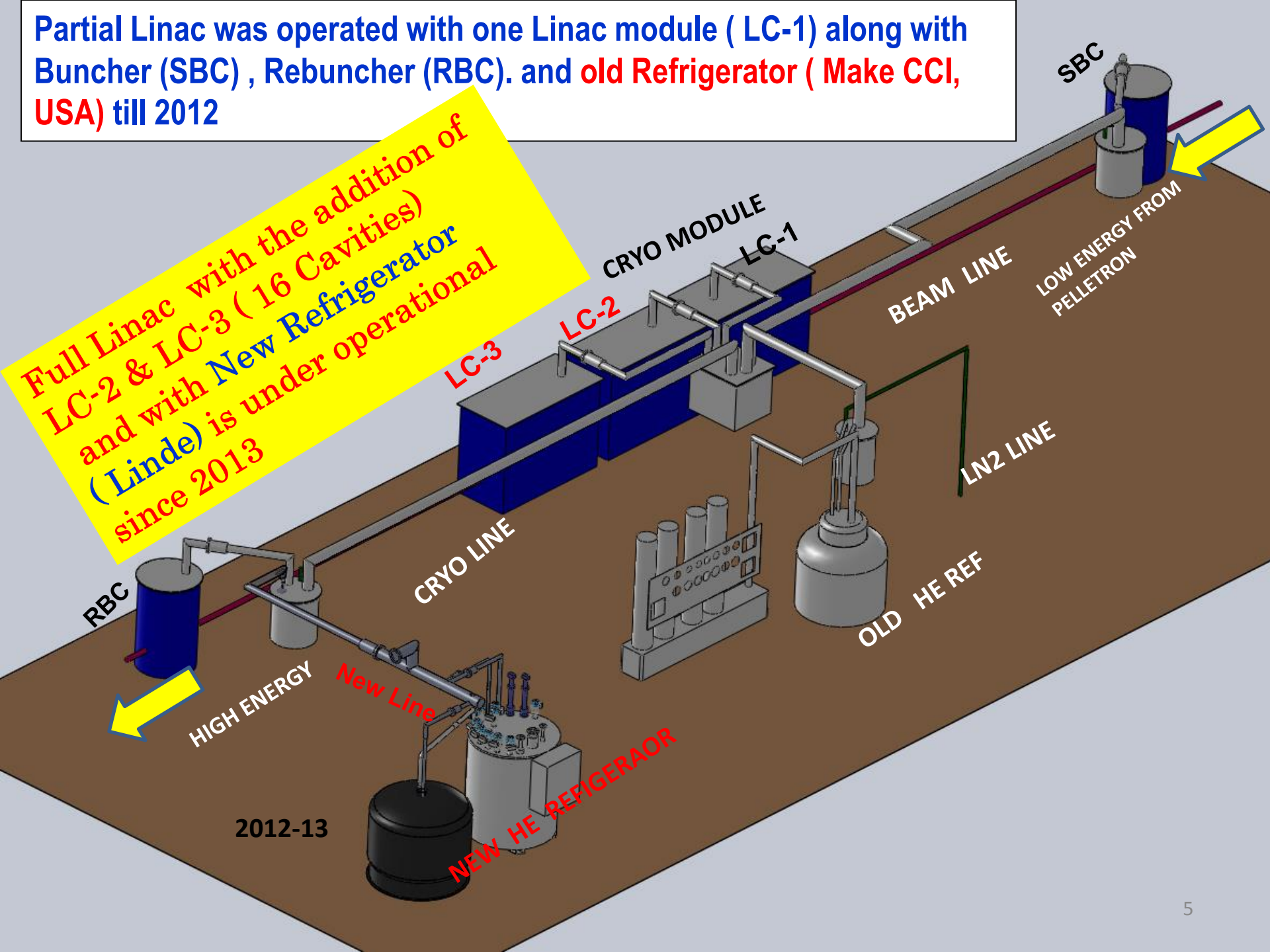


Performance Curve of a Cavity

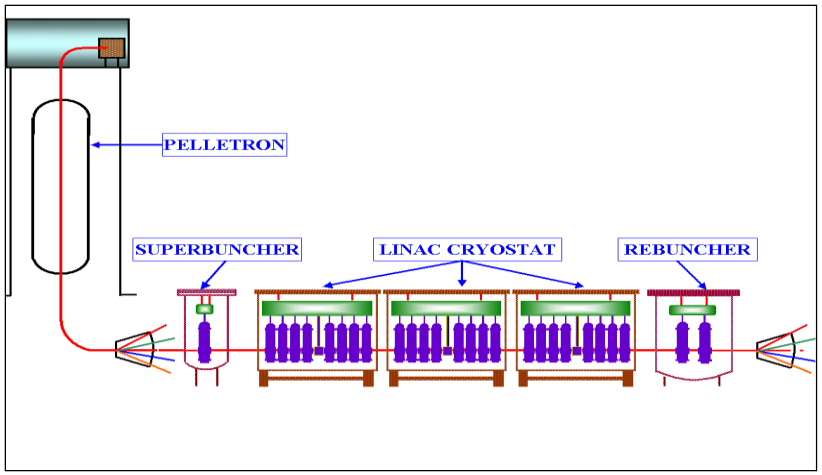


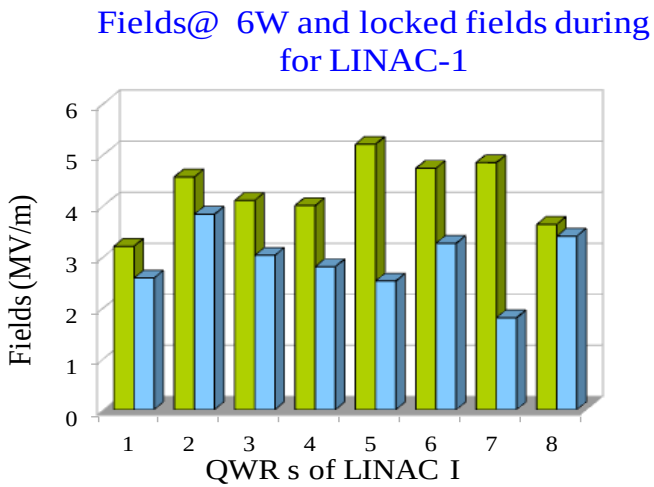
Courtesy ; P N Prakash

Partial Linac was operated with one Linac module (LC-1) along with Buncher (SBC) , Rebuncher (RBC). and old Refrigerator (Make CCI, USA) till 2012



Beam acceleration by all 22 Cavities in (LC-1, LC-2 & LC-3)



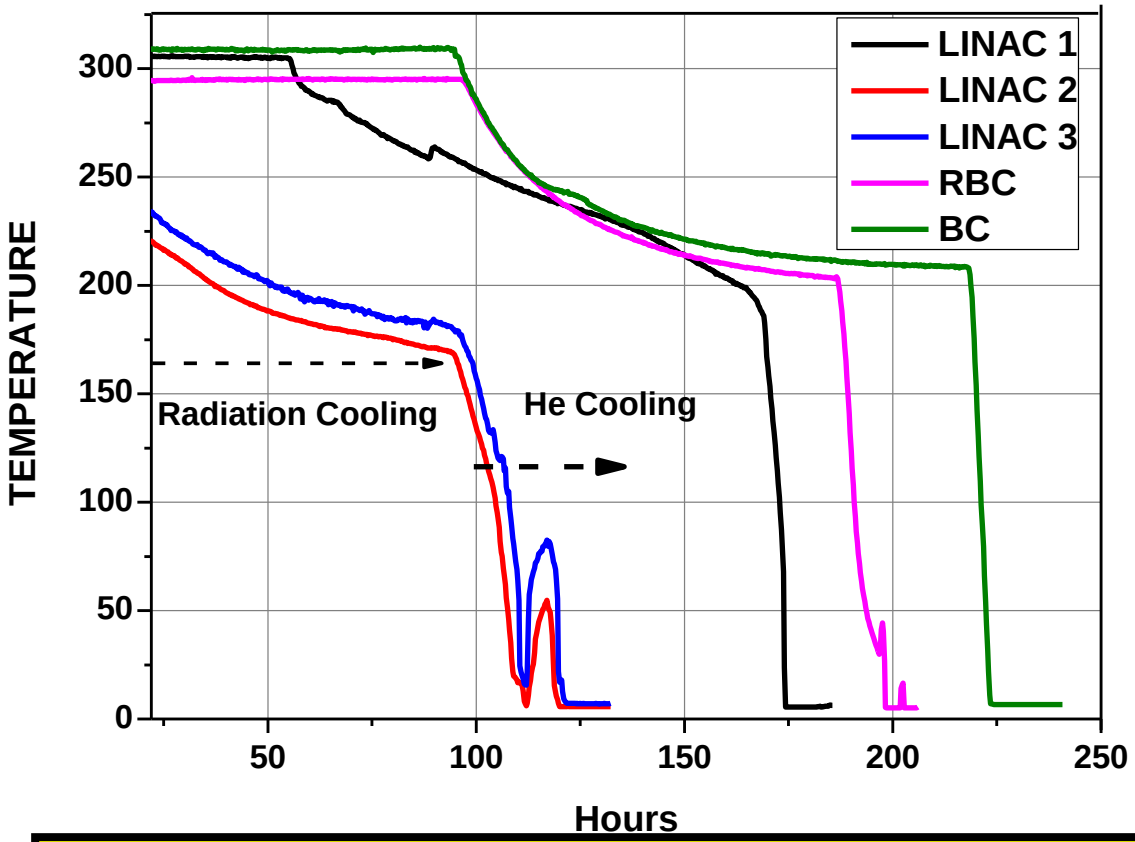


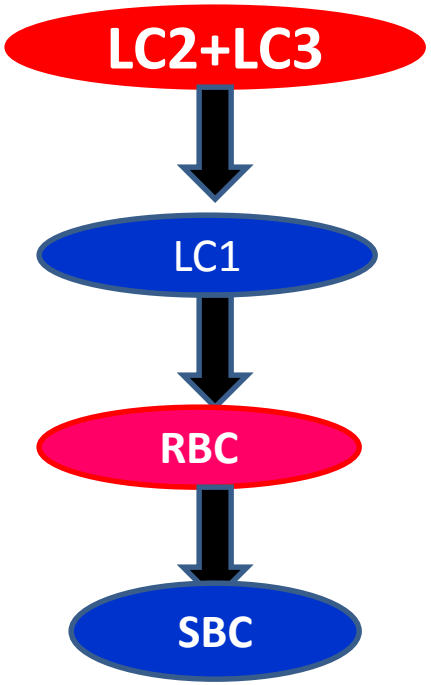
Year	Beam	Energy From Pelletron (MeV)	Energy After Linac (MeV)	Gain MeV	Gain/ Charge
2013	Ti^{+14}	162	270	108	7.7
2014	Ti^{+14}	162	275	113	8.07
2015	Ti^{+15}	168	300	132	8.78

Improvement

Average Field : 3.5 MV/ m at 5 W Power

TOTAL LINAC COOLING WITH NEW REFRIGERATOR

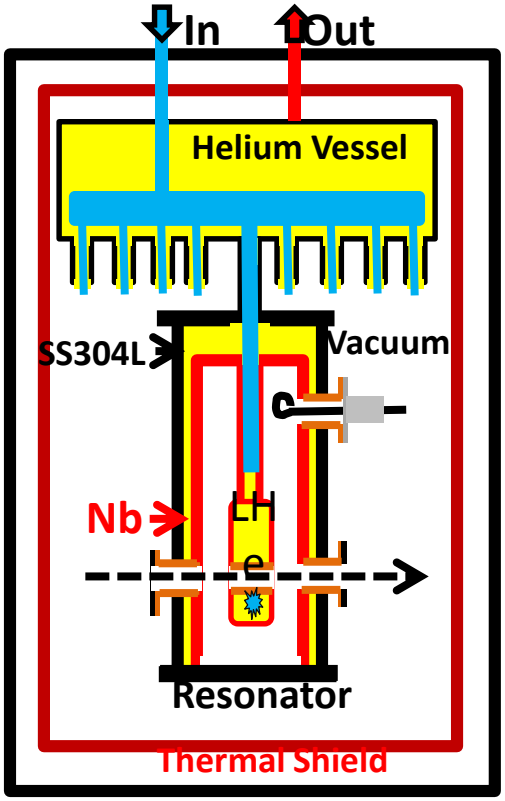


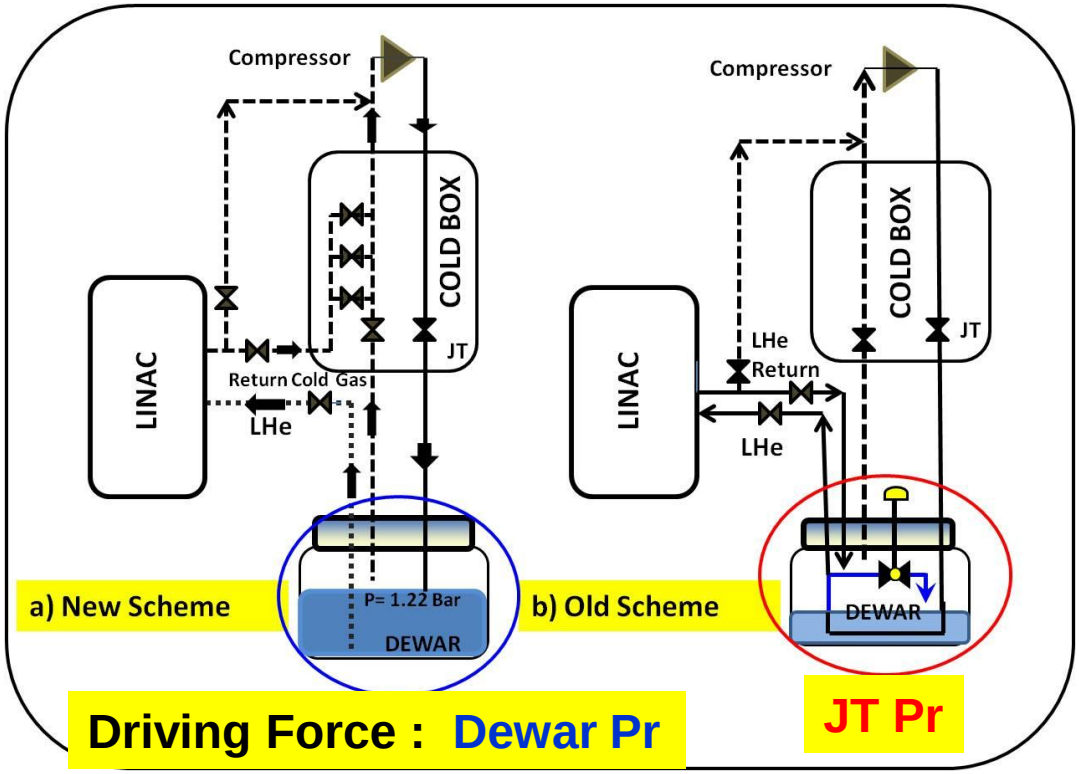


Total 5 days required to cool the linac module in Batch with liquid Helium

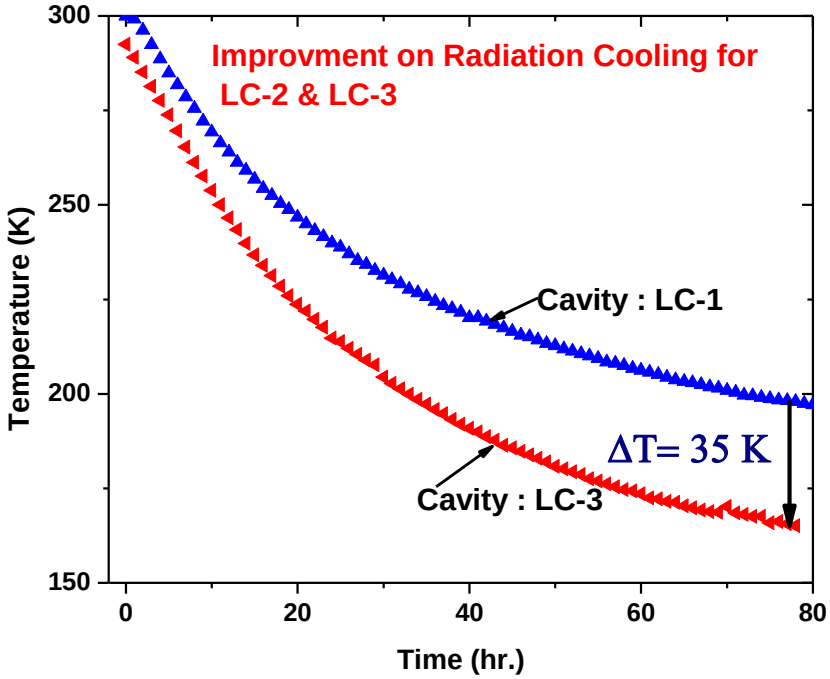
Cooling Philosophy of linac is changed : Because

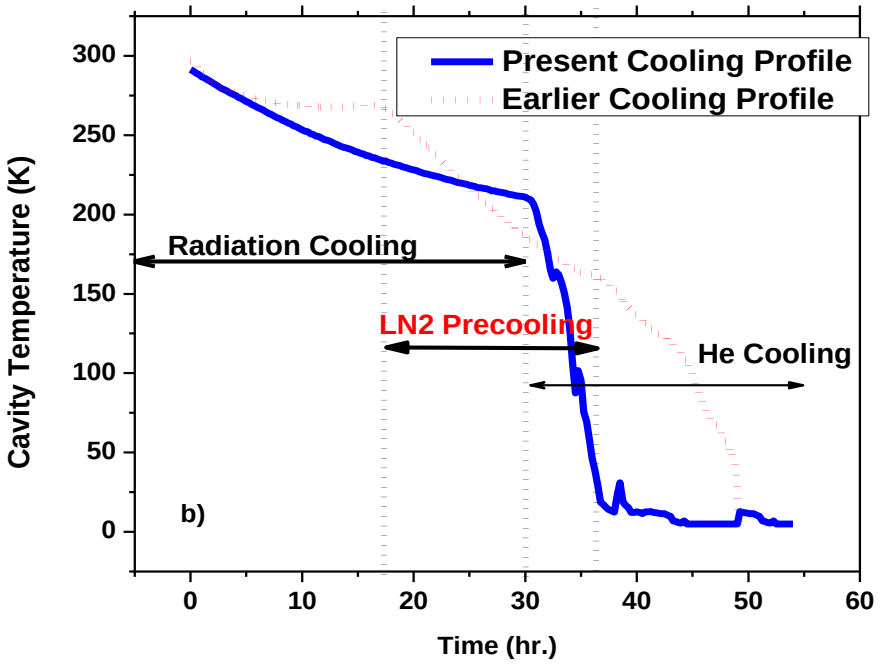
- New Refrigerator Cooling schematic different from earlier
- Effective Radiation Cooling
- Minor Modification on LC-2 & LC-3





Cooling Performance comparison between Earlier and present

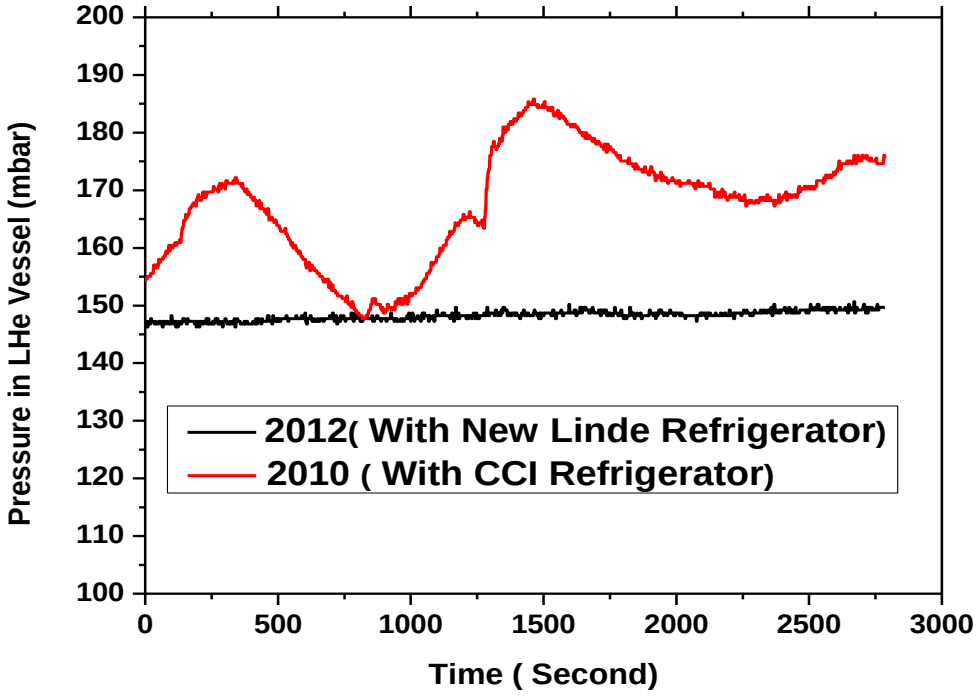




Radiation Cooling Helps to Reduce the cavity Temperature from 210 to 175 K

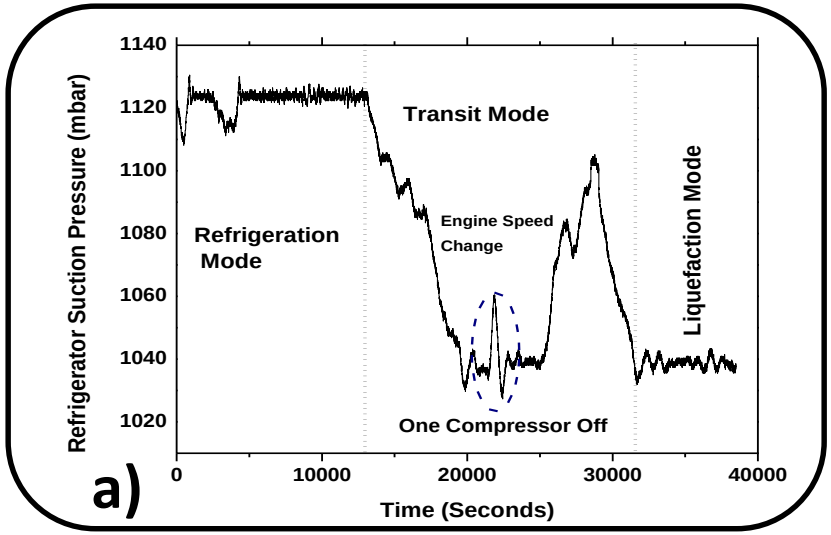
No Liquid Nitrogen Precooling required
Earlier: 3 Stages
Now : 2 stages

Helium Pressure fluctuation in Cryomodules



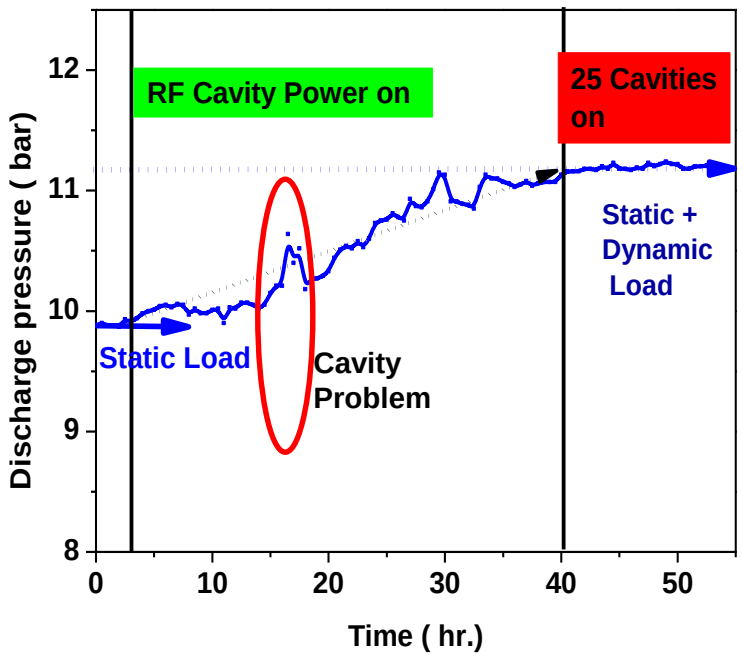
REDUCED WITH NEW REFRIGERATOR

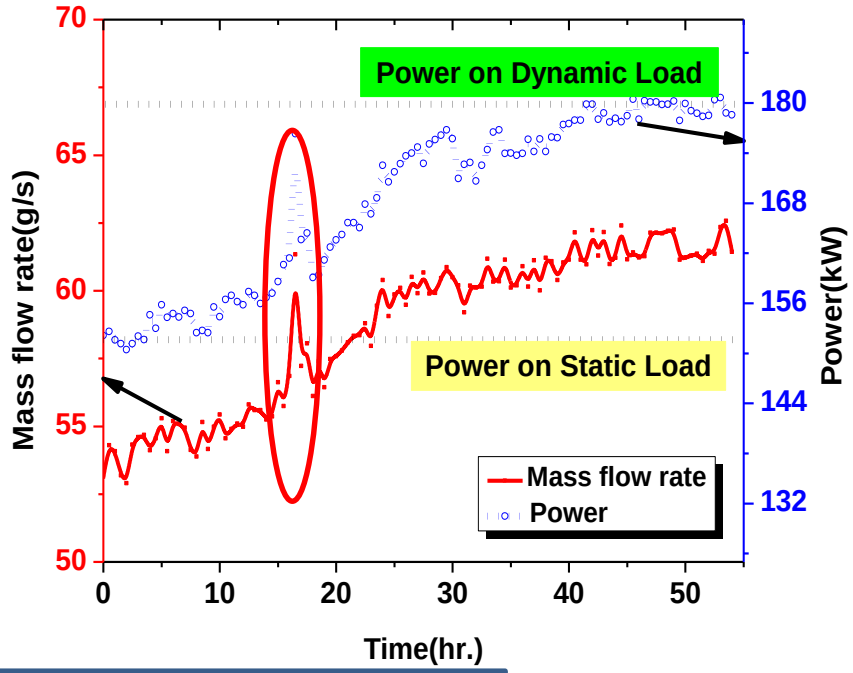
RF LOCKS ARE VERY STABLE



CCI Refrigerator

OPERATION PARAMETERS OF LINDE REFRIGERATOR WITH VARIABLE LOAD FROM LINAC





Refrigeration load : 280 W to 440 W

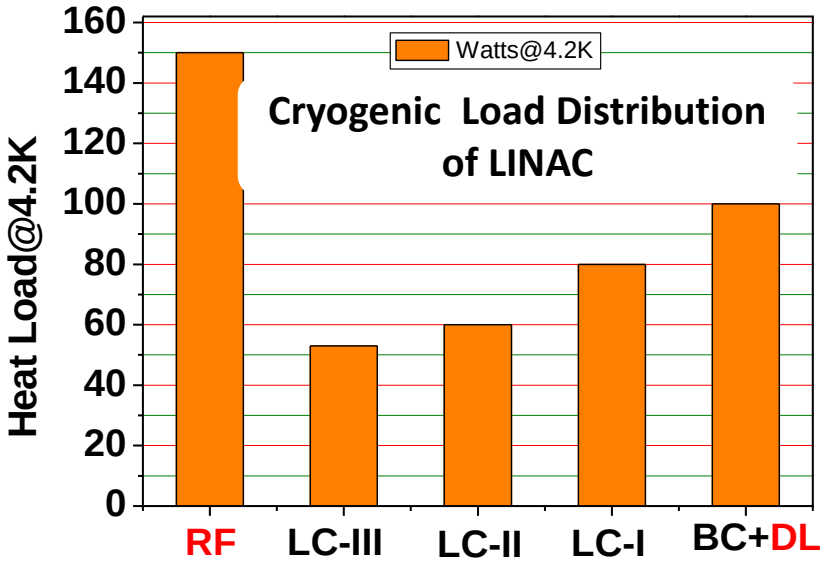
Discharge Pressure : 9.75 to 11.25 bar

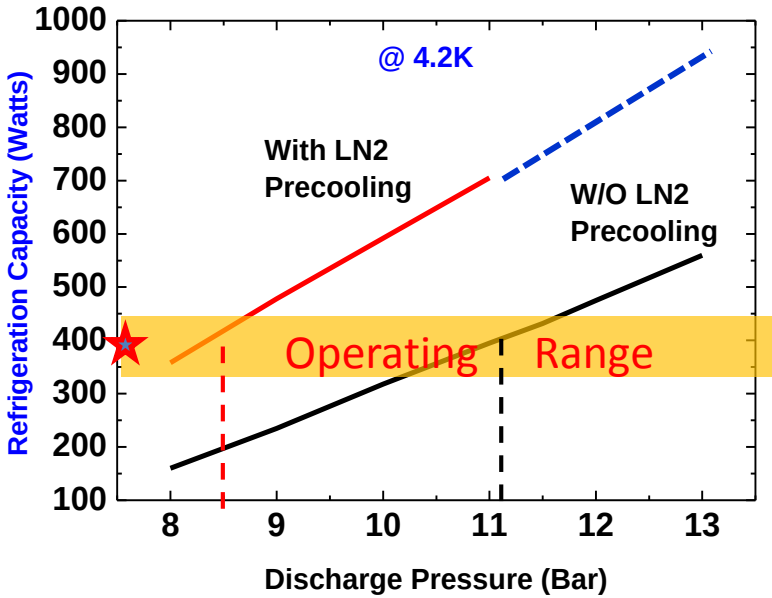
Mass flow rate : 53 g/s to 63 g/s

Power : 150 kW to 180 kW

Preliminary Heat load (4.2 K) contribution by each system :

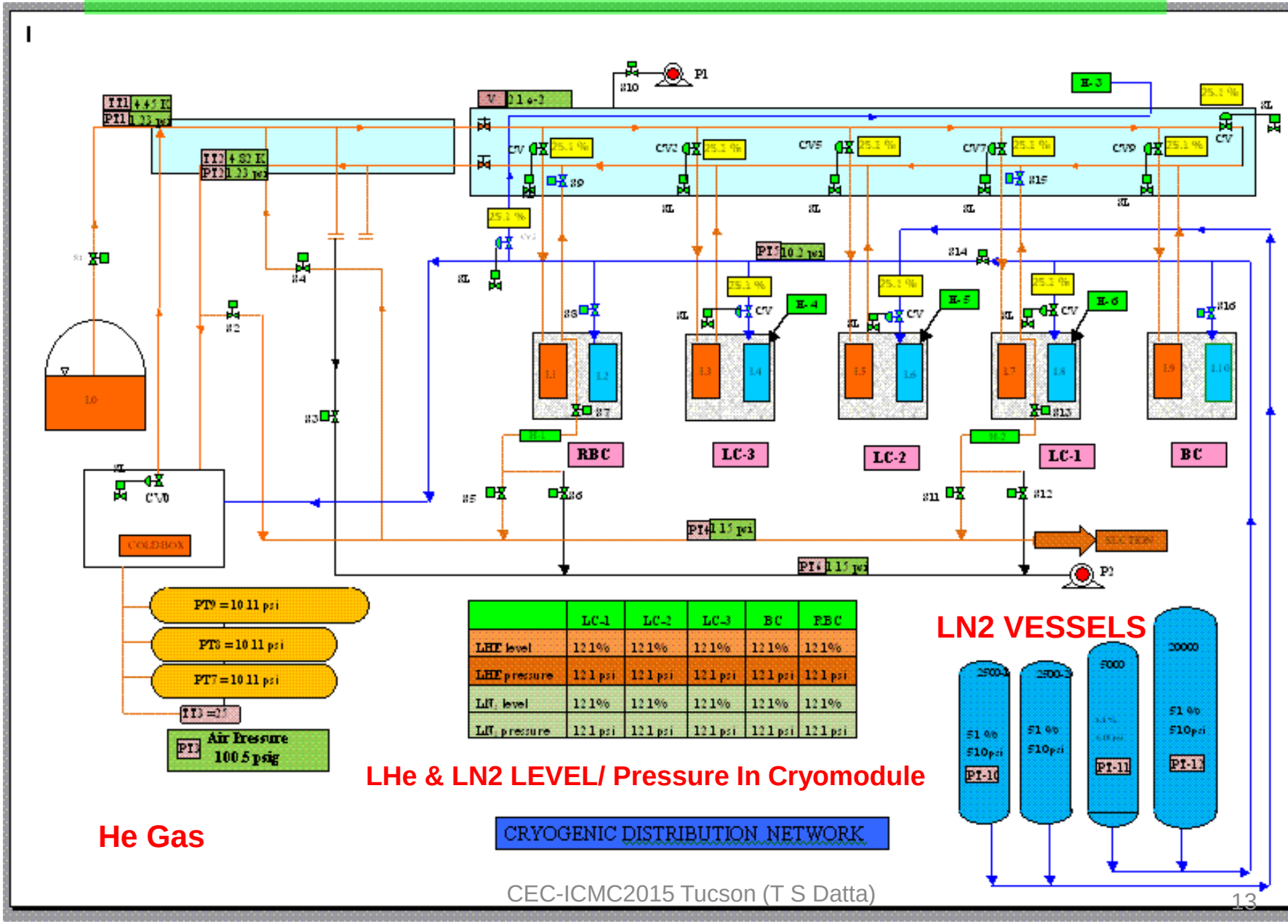
Total Load ~ 430- 450 W . Refrigeration capacity : 550 W (W/0 LN2)





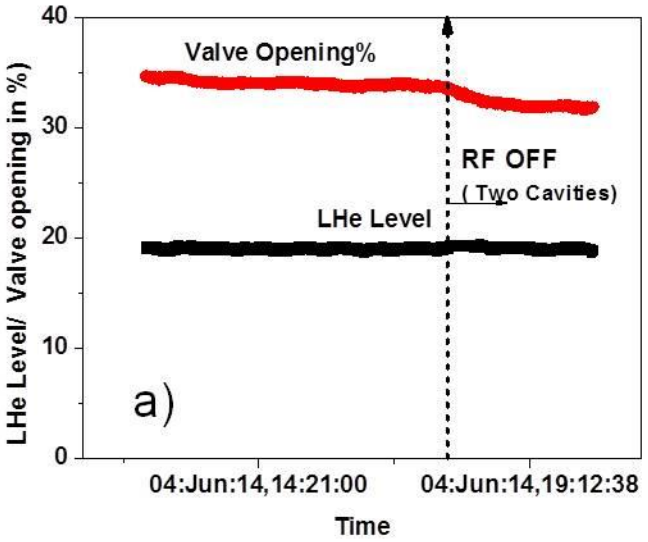
Measured load of Linac

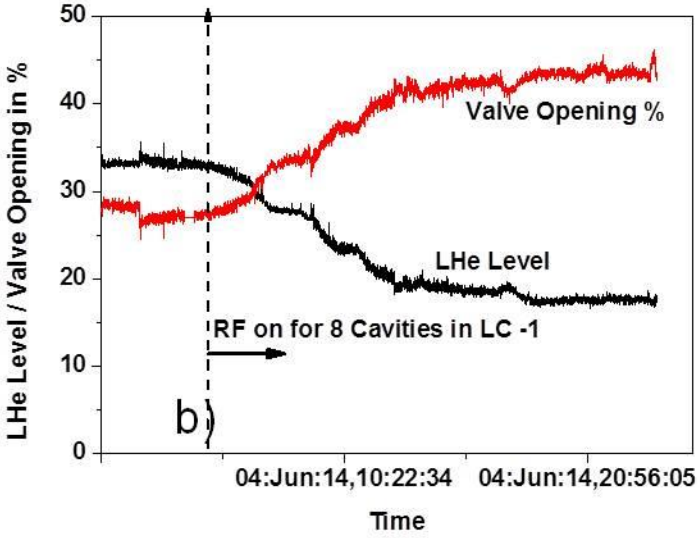
Complete Automation of Cryogen Distribution System



	LC-1	LC-2	LC-3	BC	PBC
LHE level	12 1%	12 1%	12 1%	12 1%	12 1%
LHE pressure	12 1 psi	12 1 psi	12 1 psi	12 1 psi	12 1 psi
LN2 level	12 1%	12 1%	12 1%	12 1%	12 1%
LN2 pressure	12 1 psi	12 1 psi	12 1 psi	12 1 psi	12 1 psi

Two Modes of LHe Supply Valves operation of Cryomodule



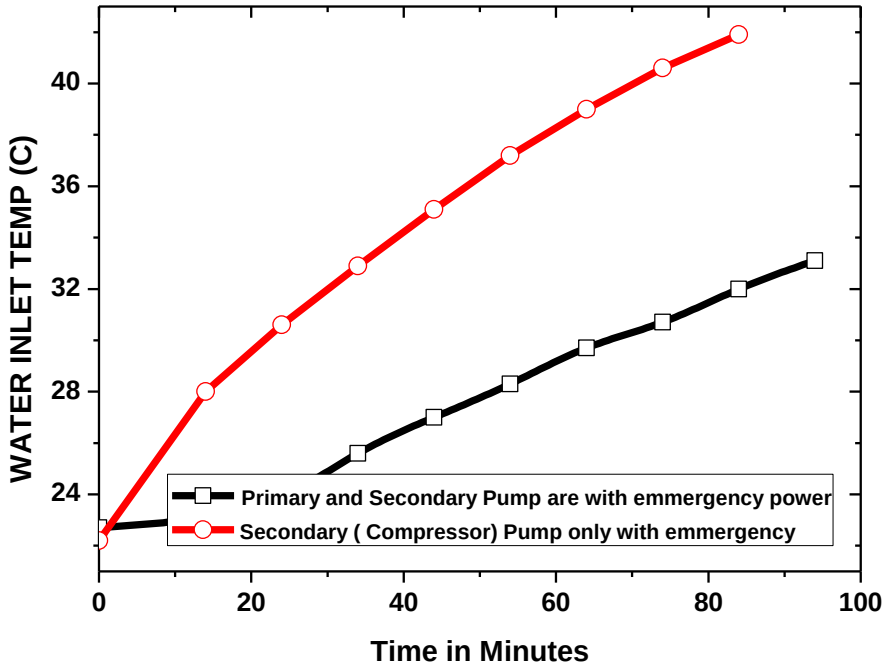


Power Supply in India is not very Stable

Main system like Helium Compressor, Cold box, control system are connected through UPS and back up Generator..

Auxiliary system like chiller air supply are not with emergency power

Compressor of when water inlet temp crosses 45 C



Temperature Reading Fluctuation

Good Cavity

Temperature Sensor : DT- 470

Fluctuation starts : Once cavity Comes out from Multipactoring Barrier

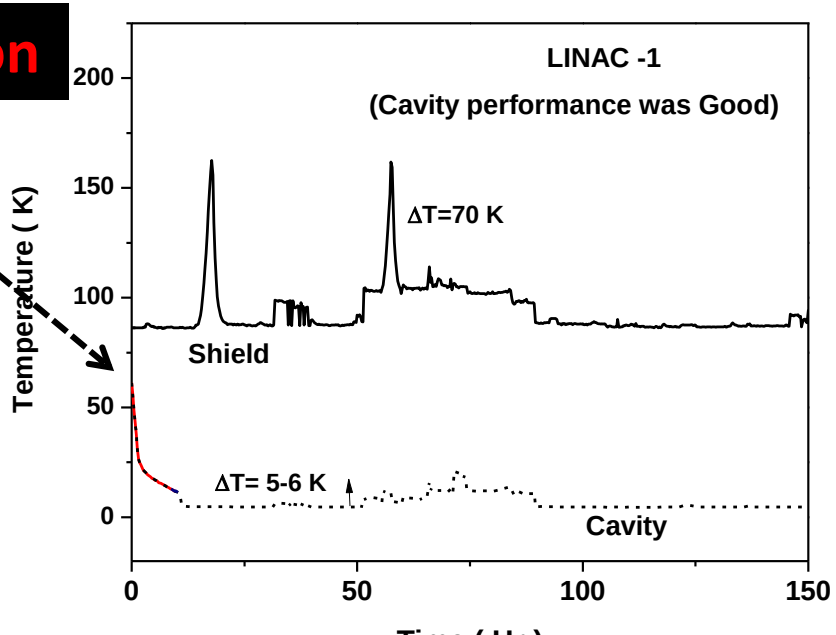
Noted

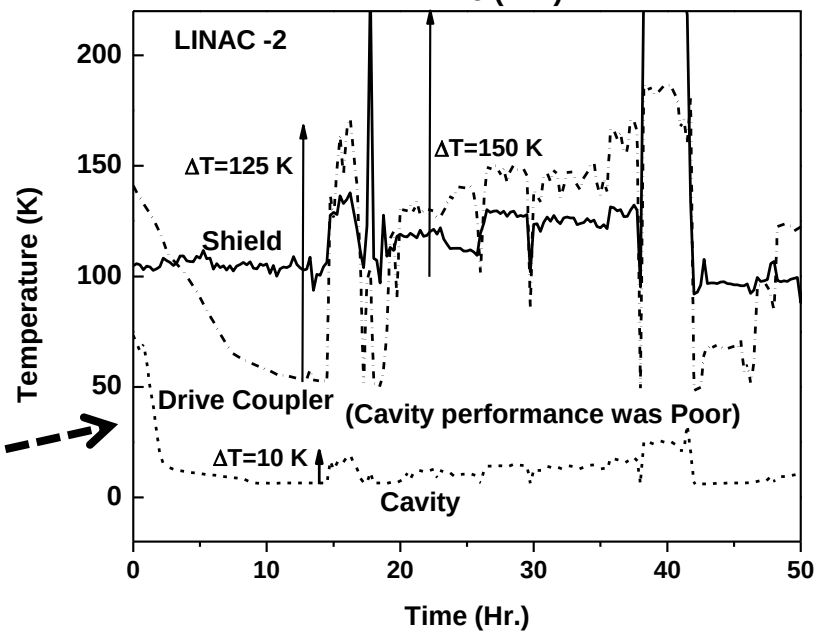
Good Cavity : Fluctuation less

Reduced by Twisted cable, Filter

Yet to be solved ????

Poor Performance





CONCLUSION

1. Superconducting Linac is being operational for expt with high energy heavy ion beam with almost double energy

2. At present Load, Linac run can be managed on running Linde refrigerator (LR 280) without LN2 Cooling

3. Radiation Cooling is much more effective for the recent cryomodules and liquid nitrogen precooling stage is discarded

4. Helium Pressure fluctuation is reduced and RF lock is very stable

1. Power cut is common problem In India. Precaution are taken with UPS and back up generator
2. Shortly High Current Injector will be the another source for LINAC.

ICEC 26 - ICMC 2016

March 7-11, 2016

Manekshaw Centre, New Delhi, India

Thank You

Welcome to Delhi

Hosted by

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Contact : secretariat@icec26-icmc2016.org