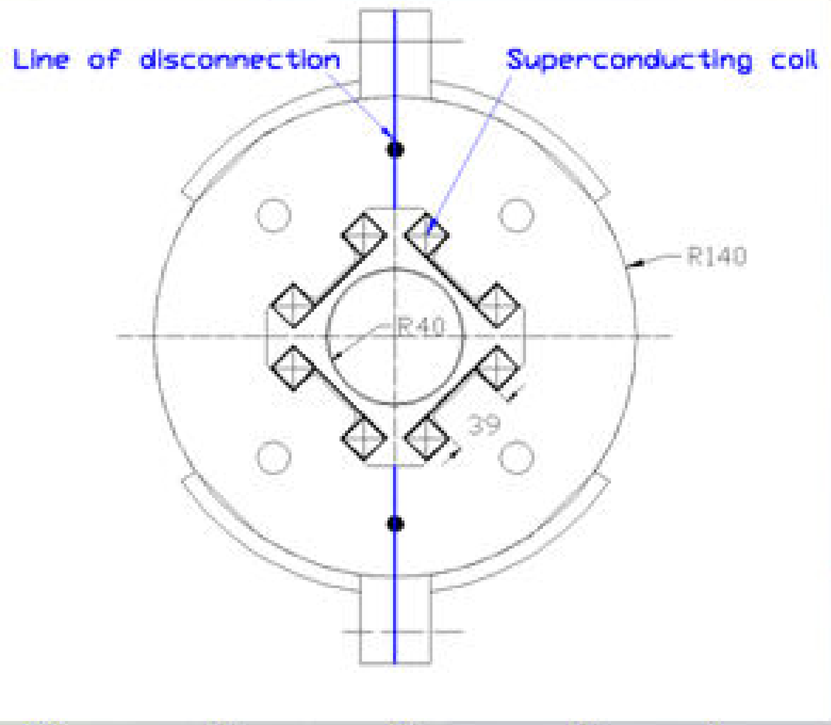
SLAC 4.2K Stand Relocation to FNAL in FY10

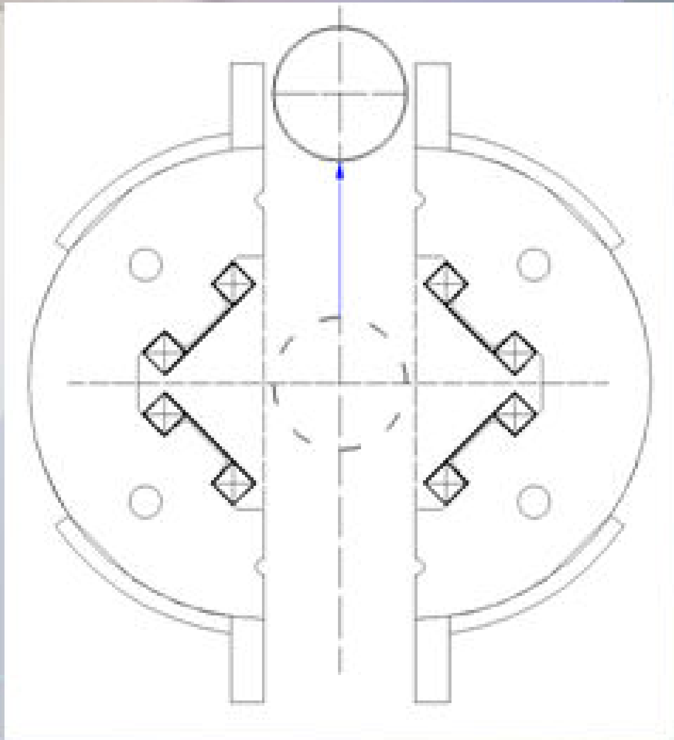
Cryostat 4.2 K LHe

Power supplies
and control
system

- Relocate ILC Quadrupole Test Stand from SLAC to FNAL.
- SLAC stand commissioning at FNAL.
- Upgrade stand cryostat to simplify assembly with the magnet.
- Test the ILC Quadrupole center stability by stretch wire.

Quadrupole Mechanical Concept



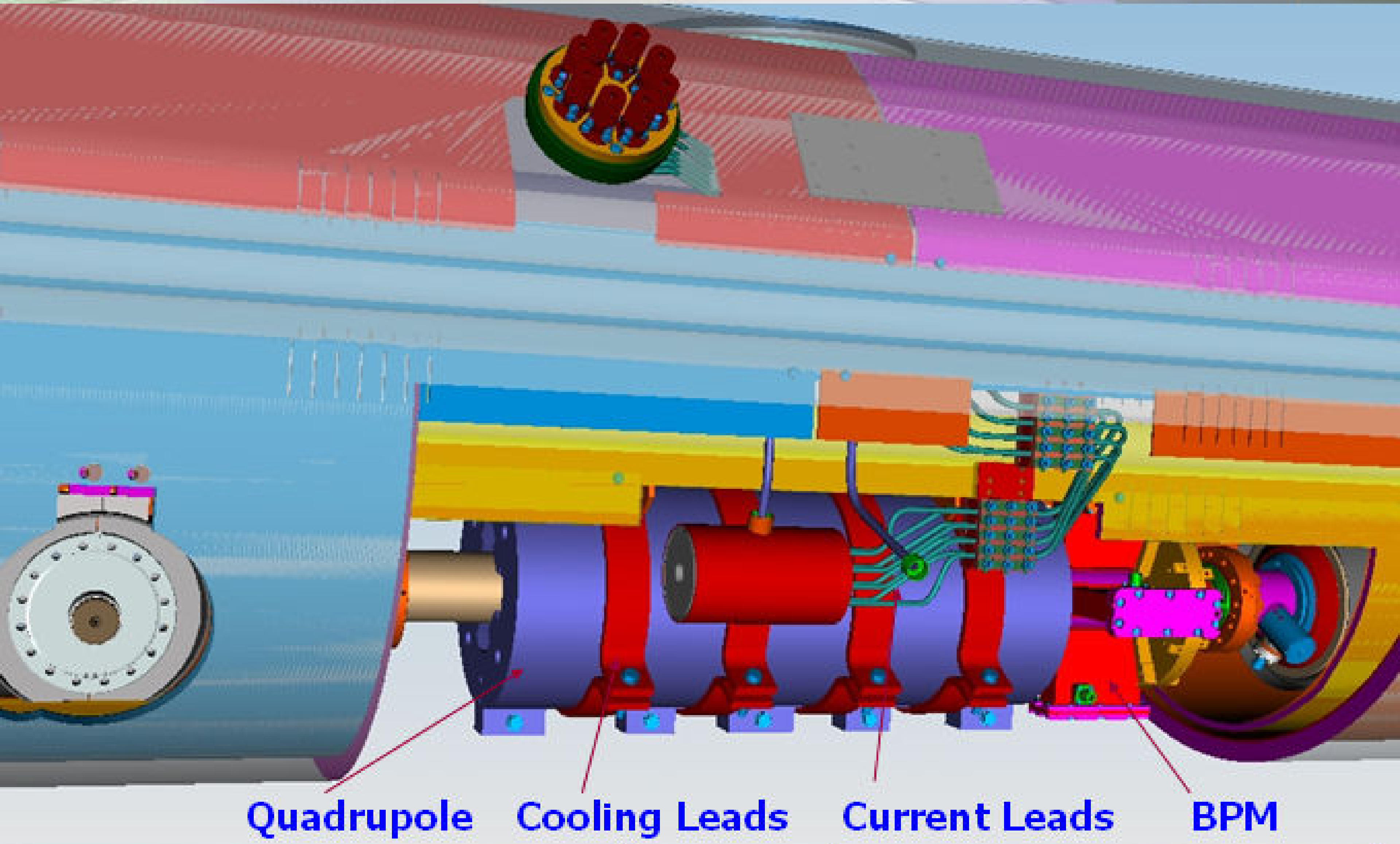


It was chosen the quadrupole design with racetrack coils which easy to split in vertical or horizontal direction.

QUADRUPOLE MODEL PARAMETERS

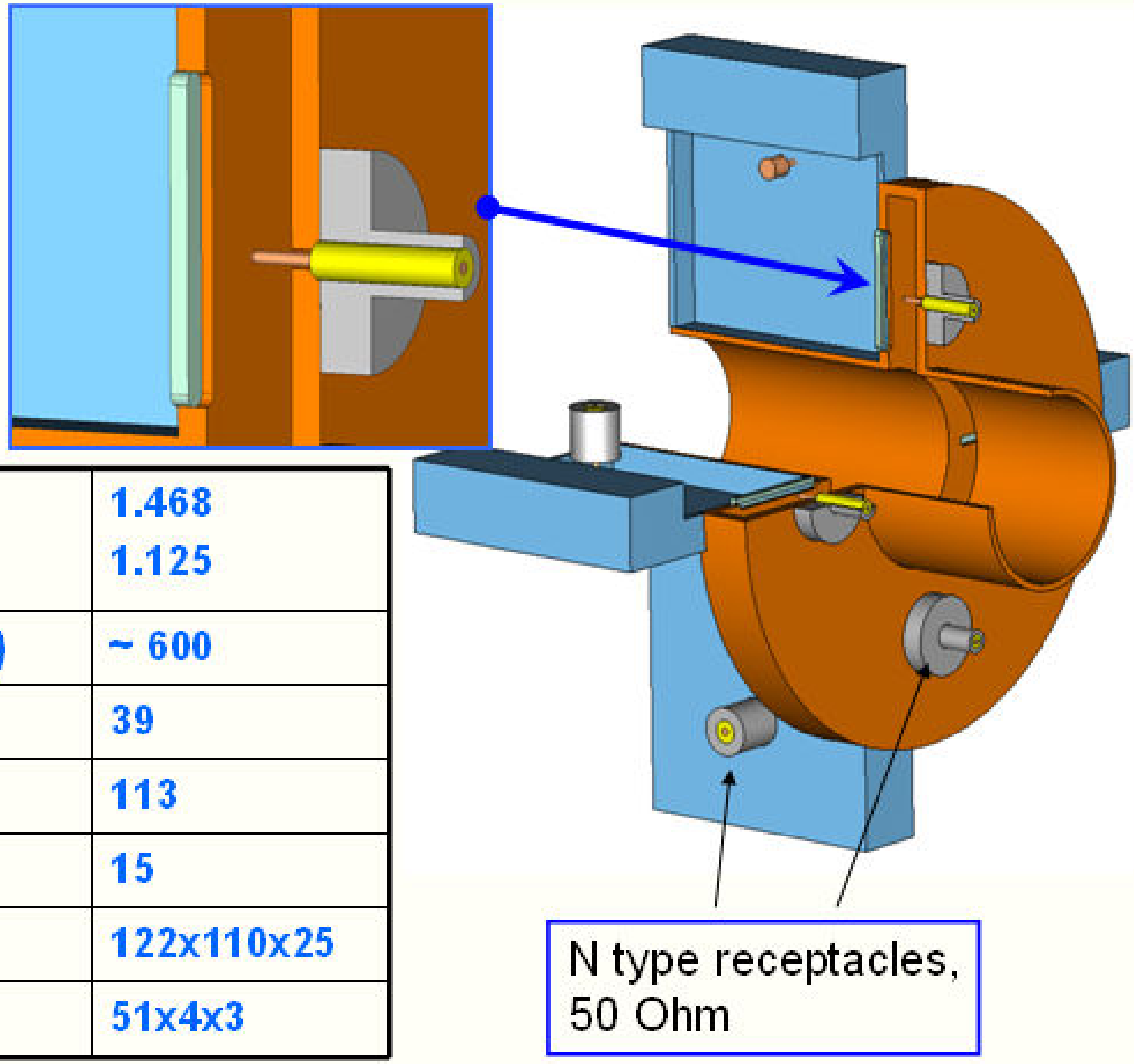
Parameter	Unit	Value
Peak current at 36 T gradient	A	100
Magnet length	mm	680
NbTi superconductor diameter	mm	0.5
Superconductor filament size	µm	3.7
Superconductor critical current at 5 T and 4.2 K	A	200
Coil maximum field	T	3.3
Quadrupole coil number of turns/pole		700
Yoke outer diameter	mm	280

Quadrupole Package Inside Cryomodule

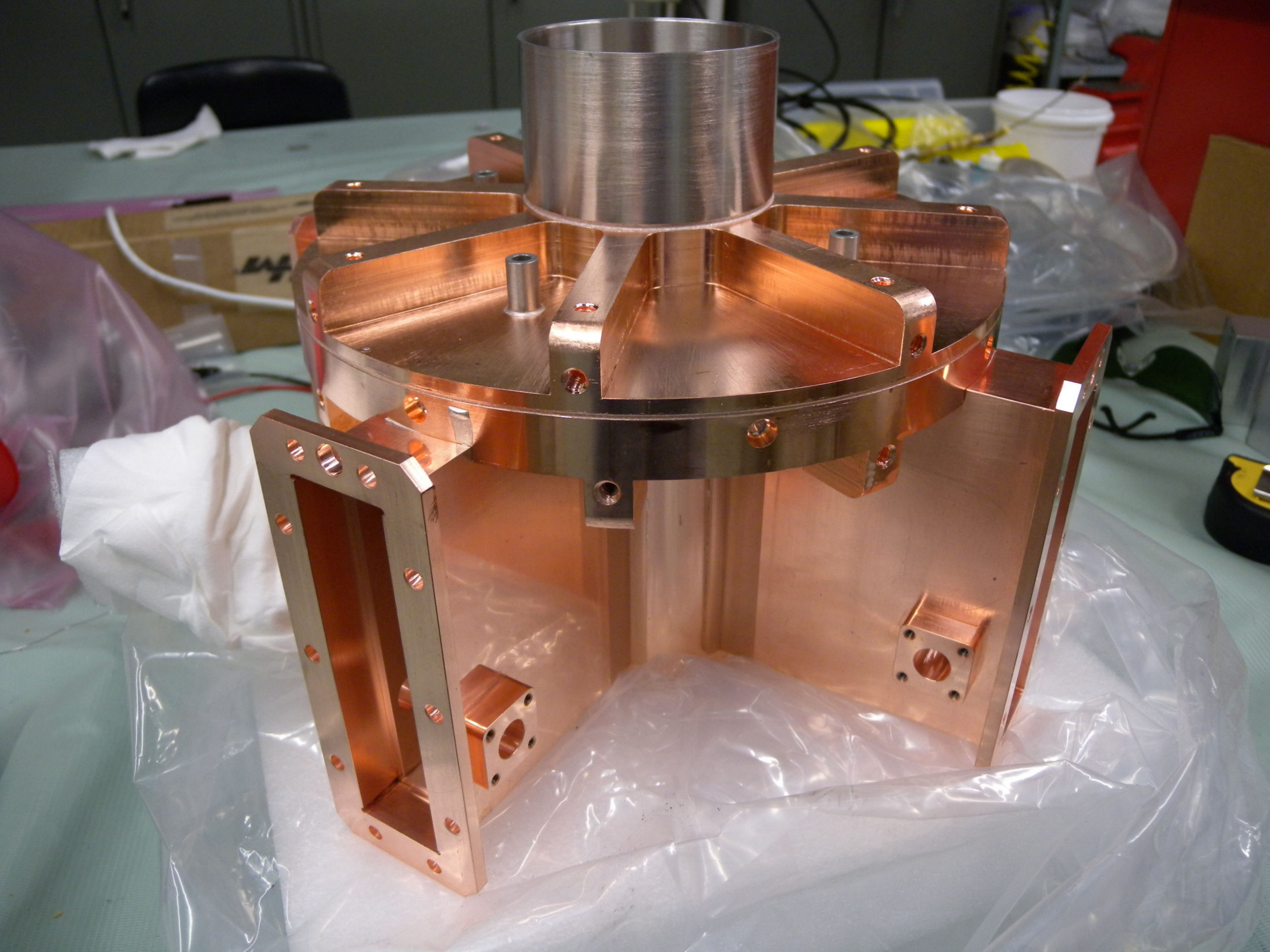


Fermilab L-Band Design

Window –
Ceramic brick of
alumina 96%
$\varepsilon_r = 9.4$
Size: 51x4x3 mm

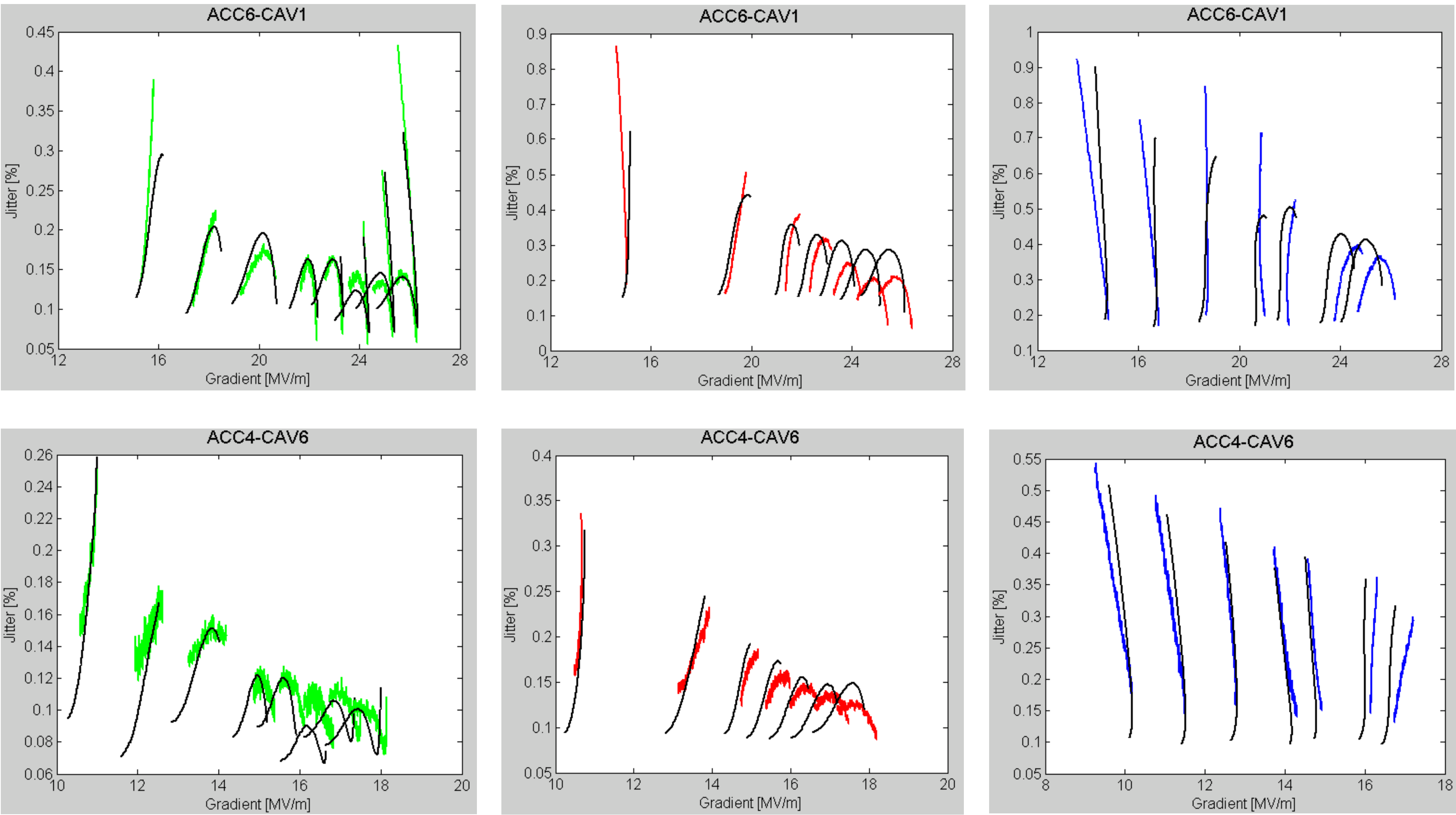


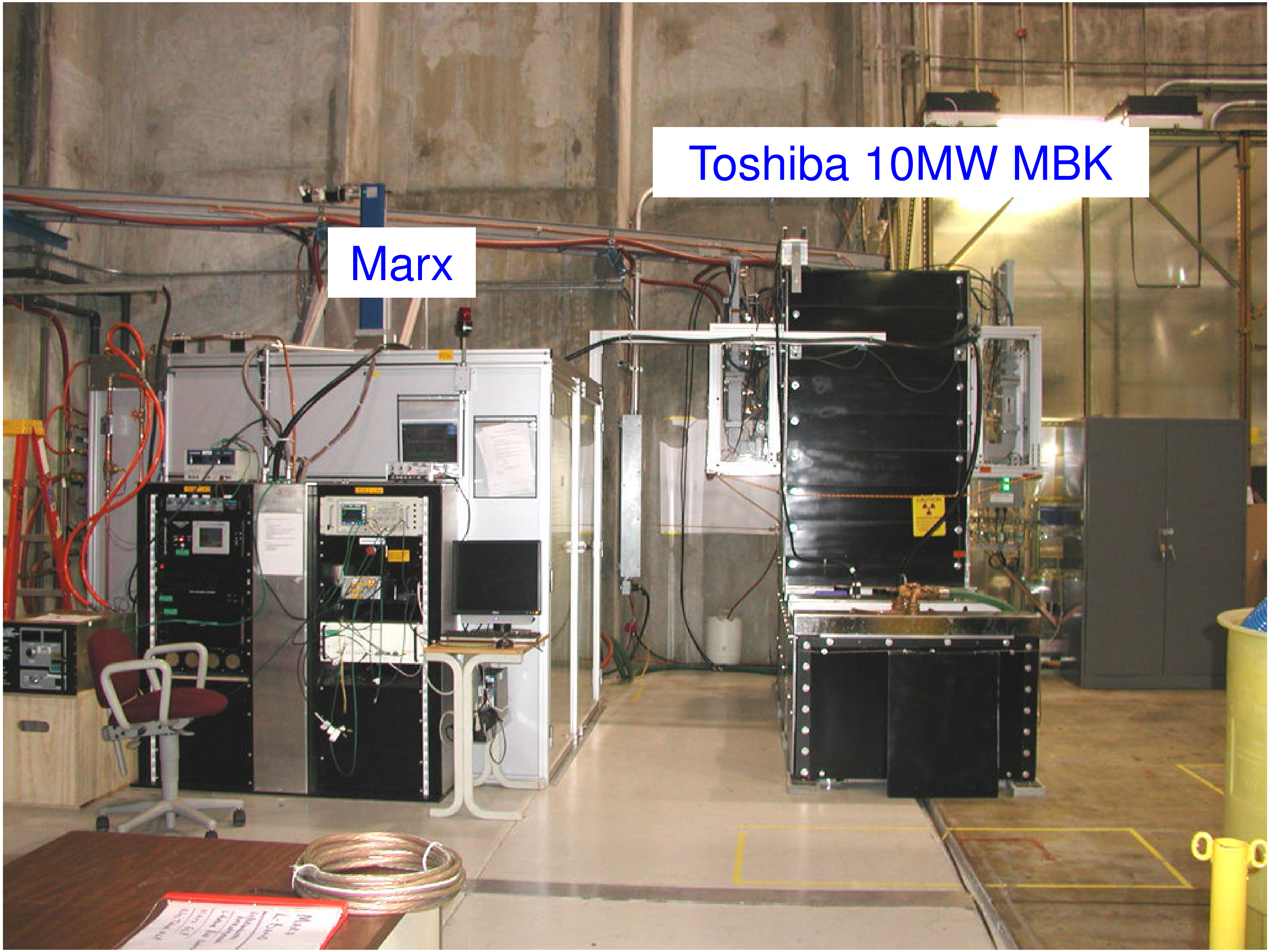
Frequency, GHz, dipole **monopole**	**1.468** **1.125**
Loaded Q (monopole and dipole)	**~ 600**
Beam pipe radius, mm	**39**
Cell radius, mm	**113**
Cell gap, mm	**15**
Waveguide, mm	**122x110x25**
Coupling slot, mm	**51x4x3**



FLASH Cavity Gradient Stability

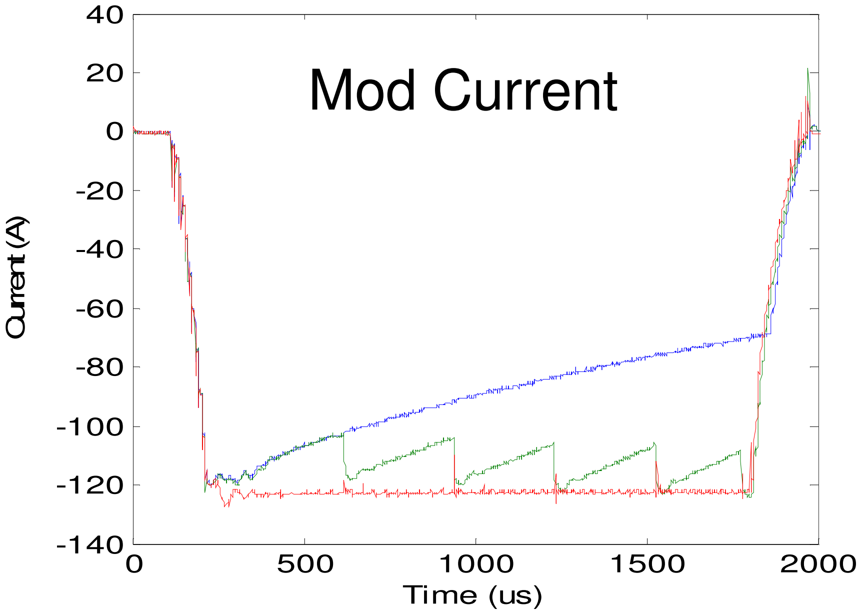
Comparison of beam-off measurements of pulse-to-pulse cavity gradient jitter during the flattop period for different gradients and initial cavity detuning (green, red and blue lines) to a cavity fill model including Lorentz force detuning (black lines) with two degrees of freedom (initial and initial rms detuning)

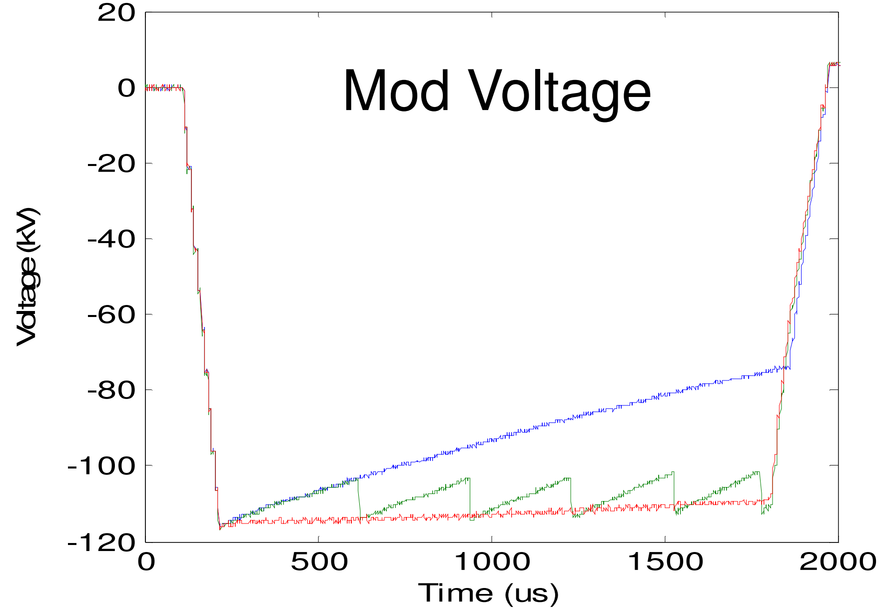


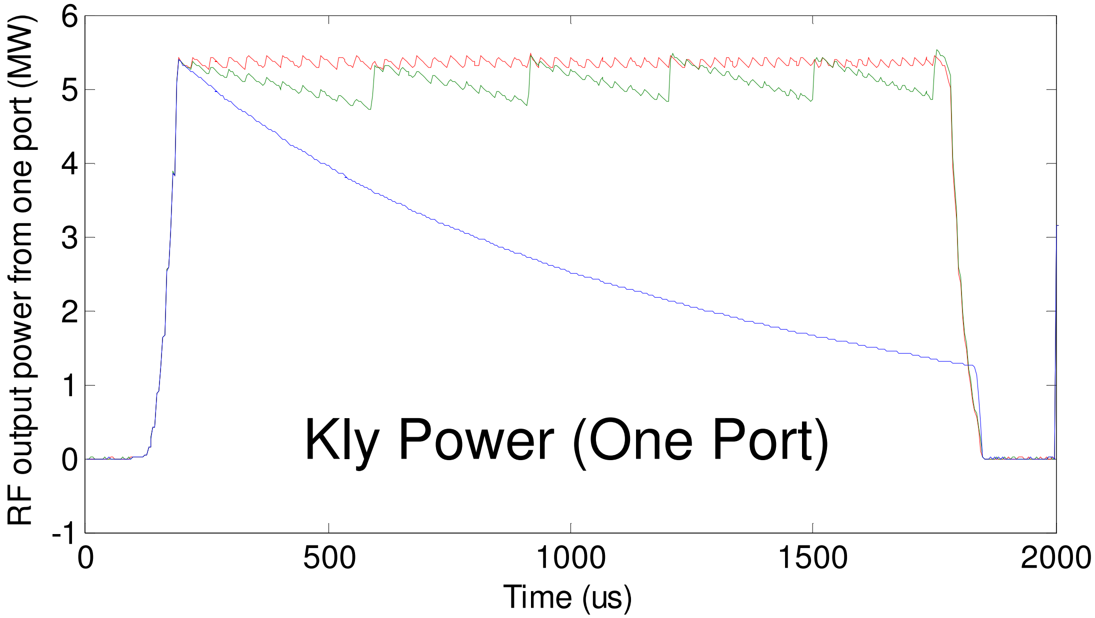


Toshiba 10MW MBK
Marx

Marx Modulator & Klystron Waveforms





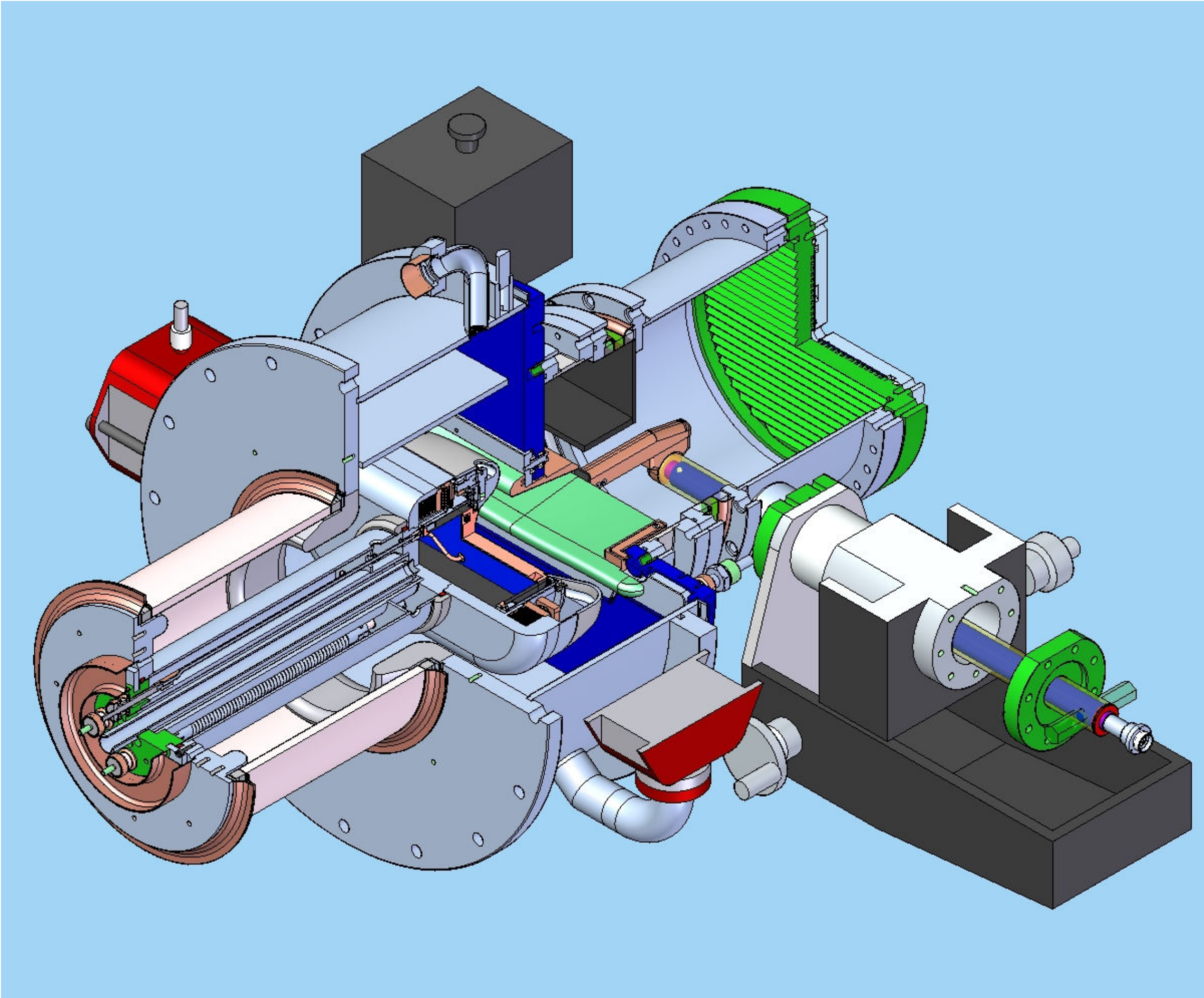


Blue: no droop compensation
Green: with only delay cells
Red: w/ delay cell and vernier

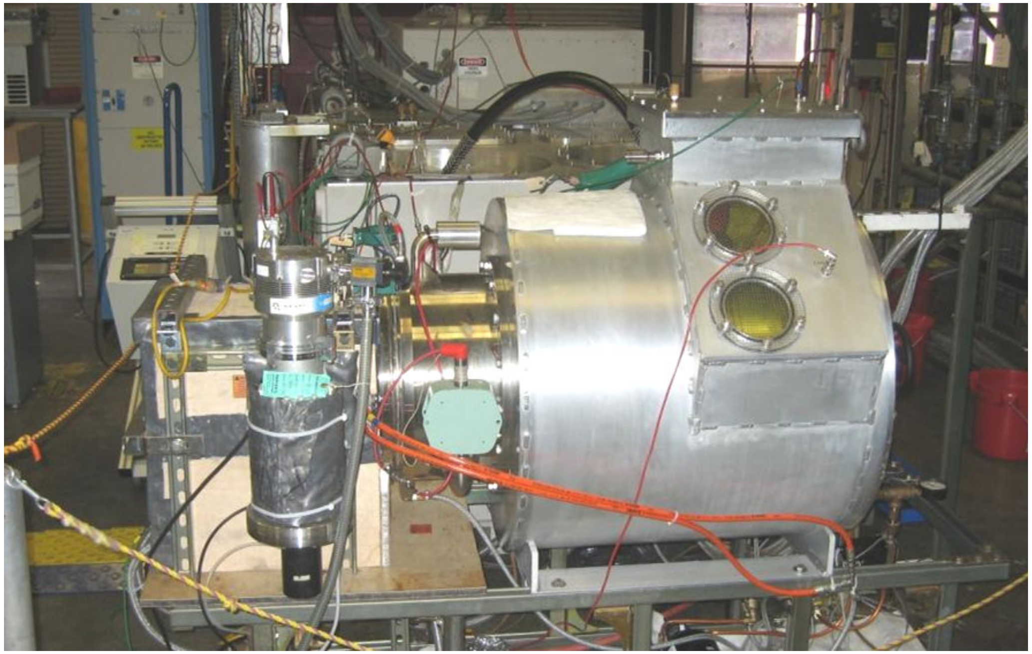
With all compensation, rf power flatness 3%

Ran ~ 200 hours thus far – had a few klystron widow arcs and PS problems

Sheet Beam Klystron (SBK) Gun Tester



SBK Gun Test at SLAC Klystron Lab

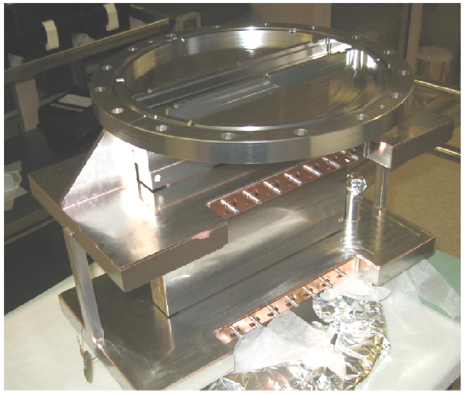


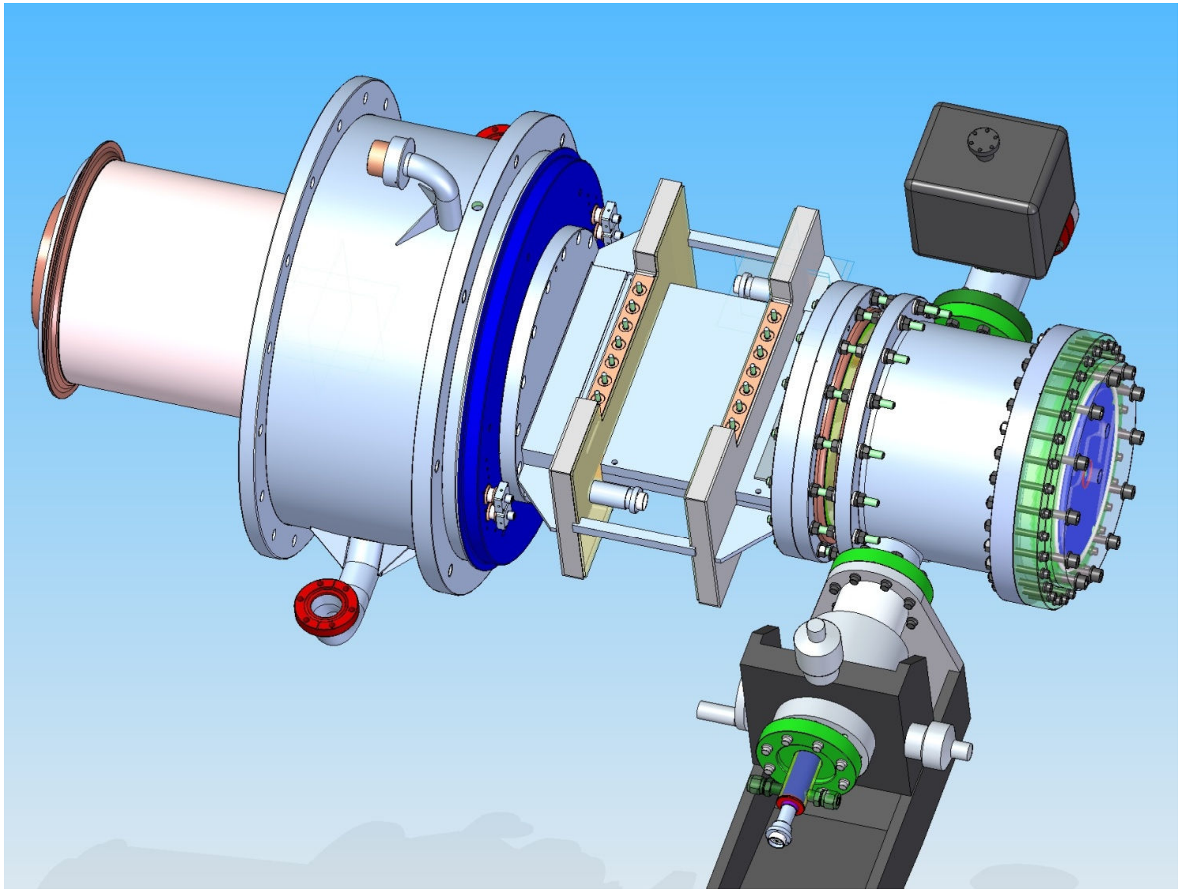
- Tested to 115kV with 1 us pulses at 1 Hz rep rate
  - No HV arcing
  - No RF gun oscillations
  - Perveance 10-20% higher than predicted – can be adjusted
- Discovered shorted focus electrode when attaching bias supply
  - Short found and repaired
  - Diode in preparation for re-installation at test stand

SBK Diode Oscillation Test Device

- Identified oscillations in klystron design with permanent magnet focusing – will probably need > 600 G solenodial focusing to suppress them.

- Building two cavity system to verify instability issues understood versus foucusing strength before building full klystron



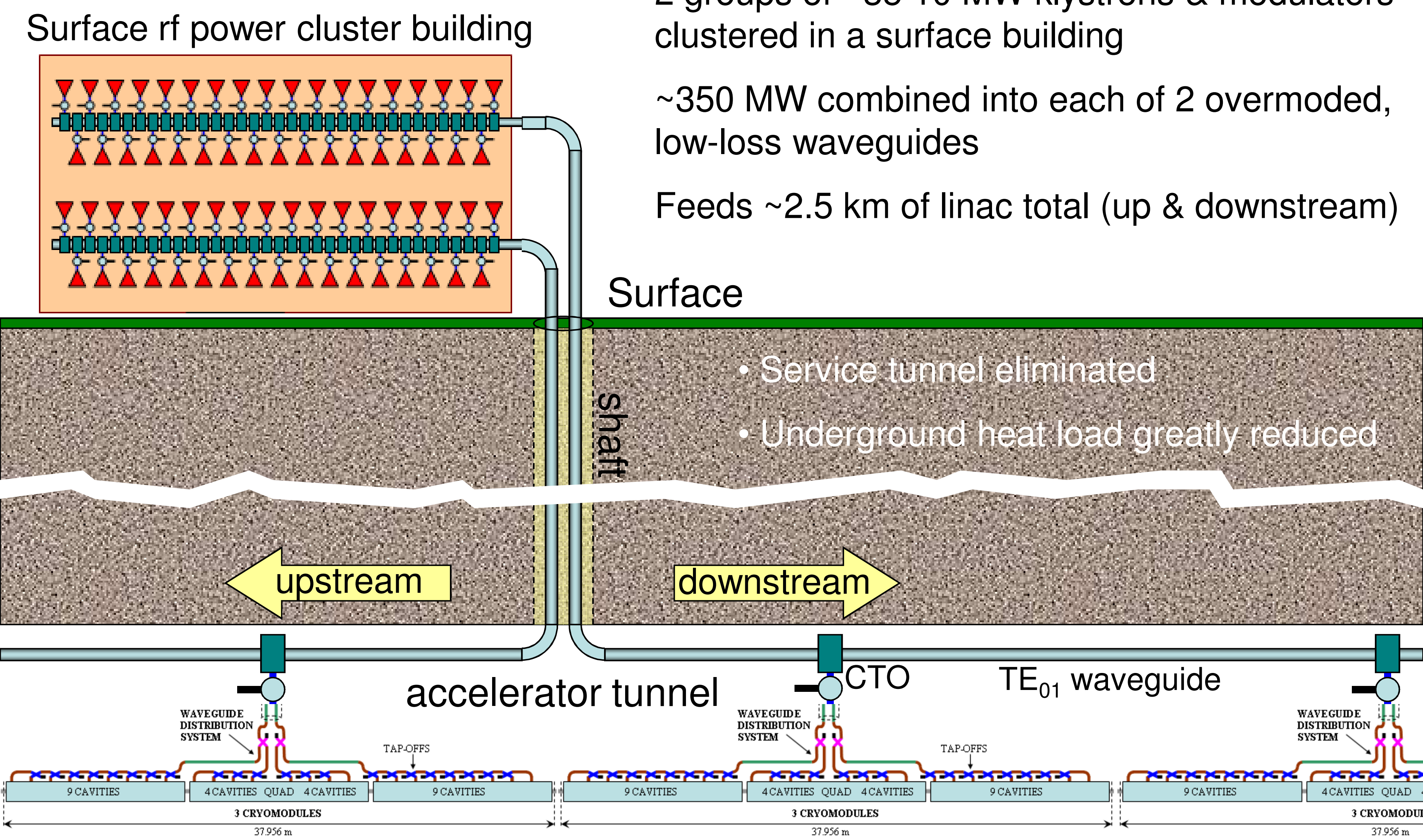


Klystron Cluster Layout

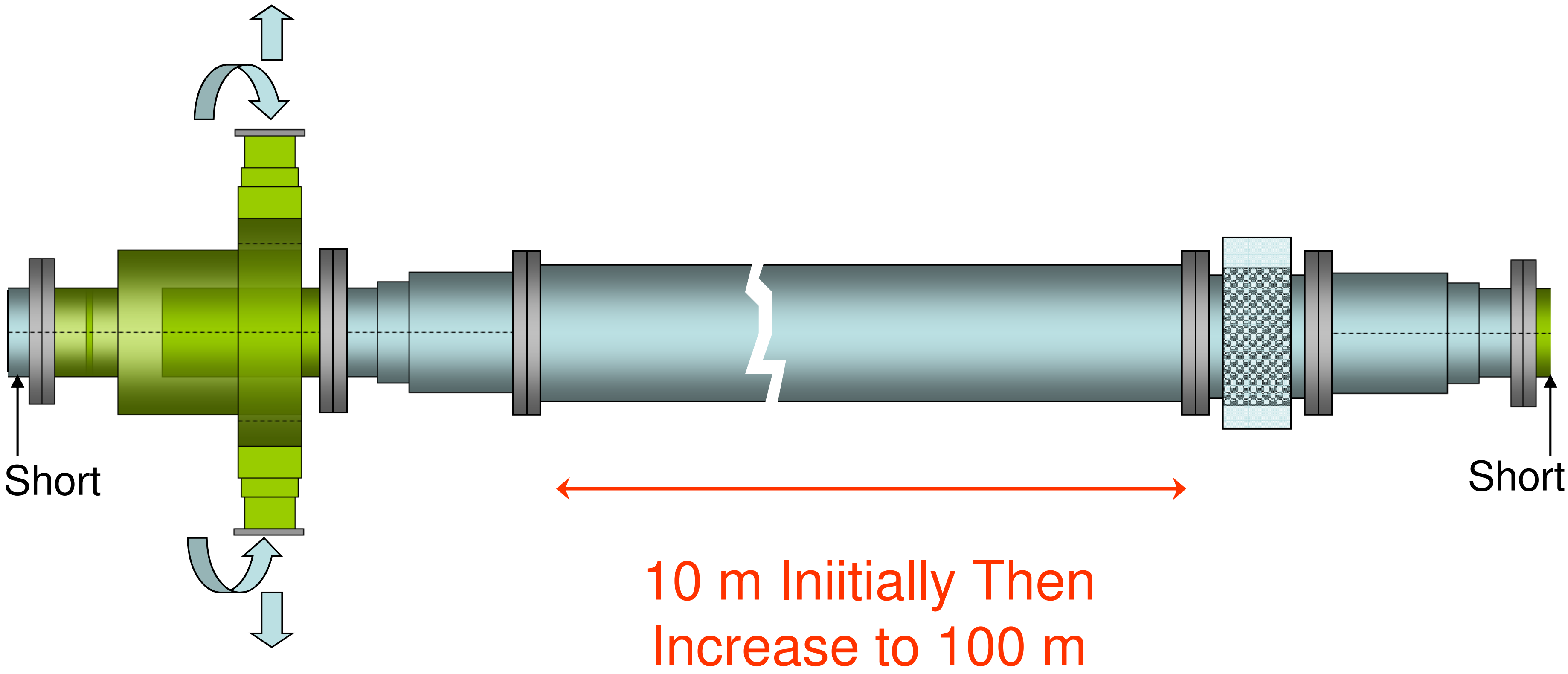
2 groups of ~35 10 MW klystrons & modulators clustered in a surface building

~350 MW combined into each of 2 overmoded, low-loss waveguides

Feeds ~2.5 km of linac total (up & downstream)

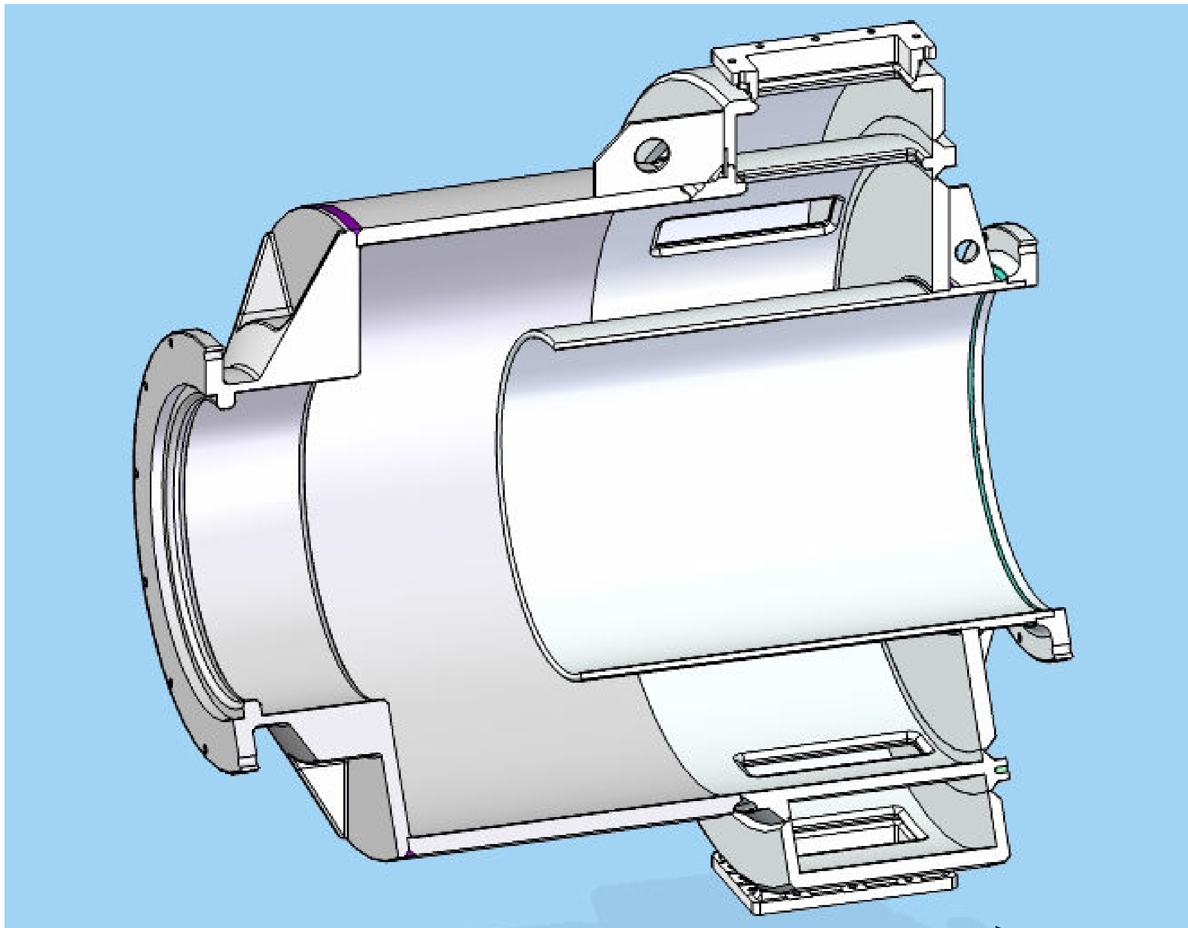


Test 350 MW Power Handling with Tapoff Feeding Resonant Line



Coaxial Tap-Off (CTO)
with wrap-around power extraction

We have informal bids and will order two 3-dB CTO's soon.

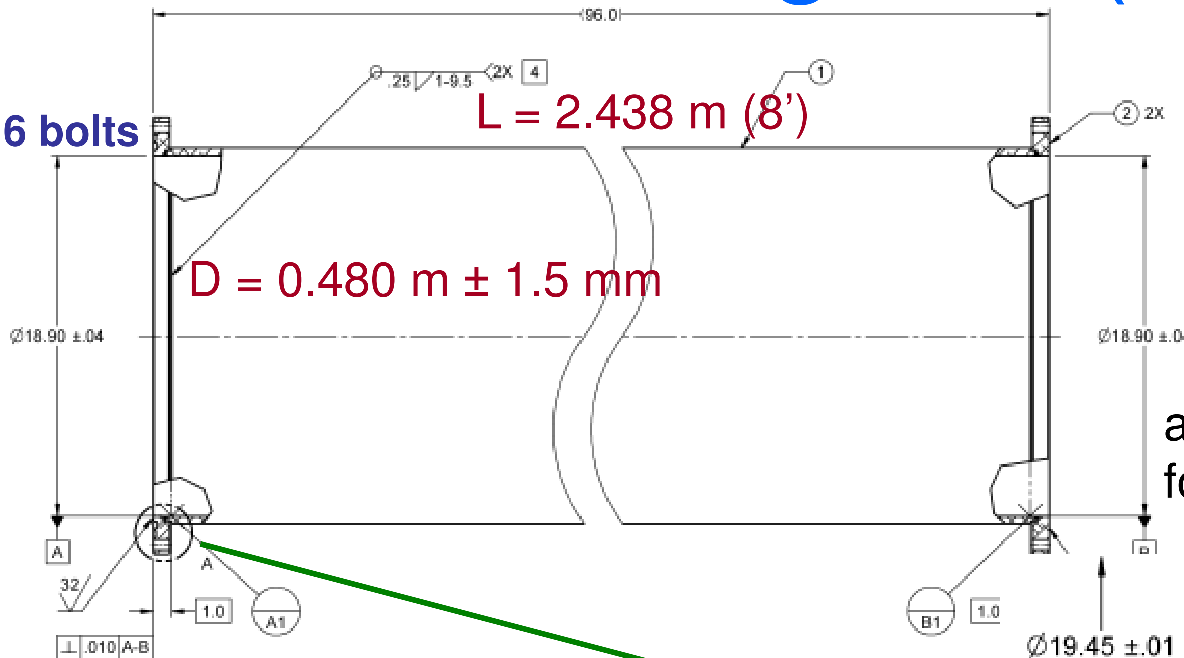


Aluminum, Welded

35.51"
(0.902 m)

mech. design: Gordon Bowden
drawing: Bob Reed

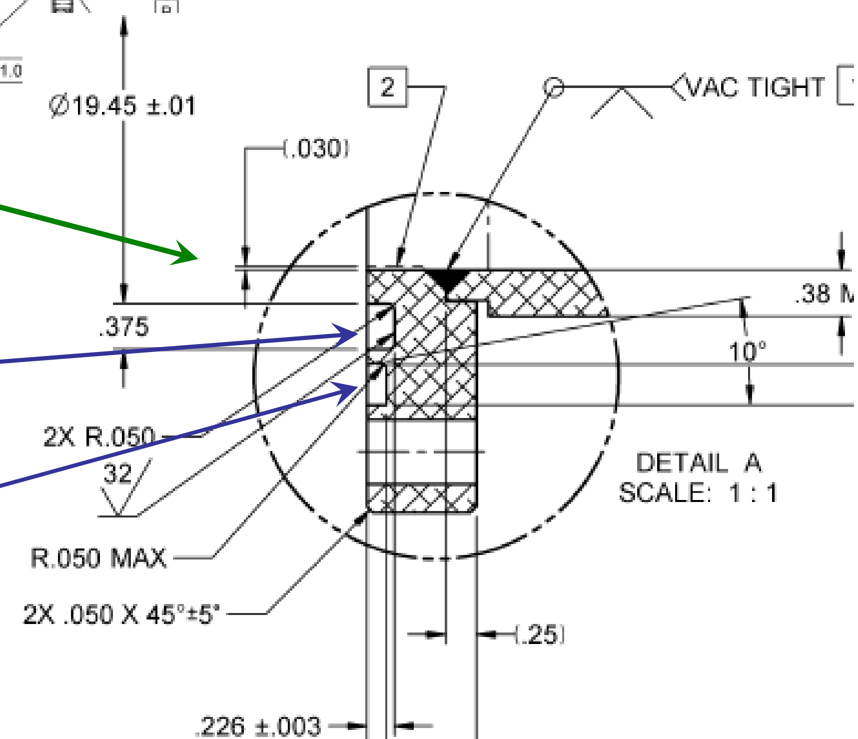
Main Waveguide ('Big Pipe')



We've placed an order for 4, 9.75 m sections

due in January 2010

aluminum,
formed & welded



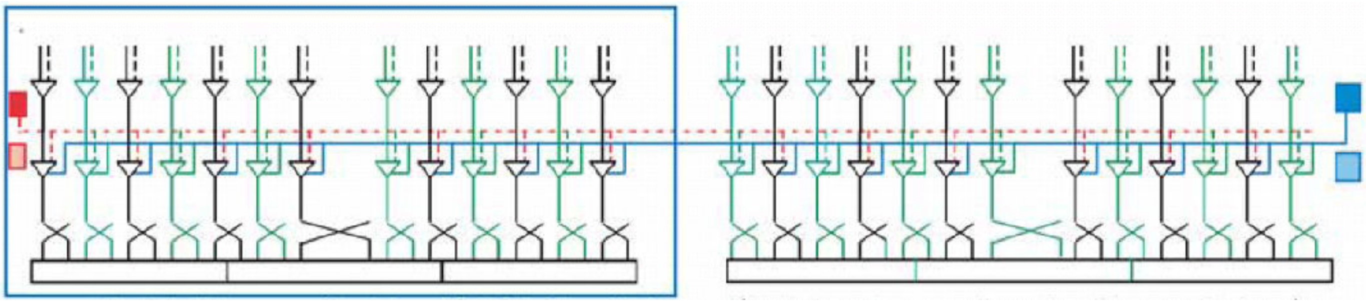
one-side double grooved flanges:

vacuum seal – Viton® fluoroelastomer O-ring

rf back-up seal – Bal Seal® canted coil contact spring

Distributed RF Scheme (DRFS)

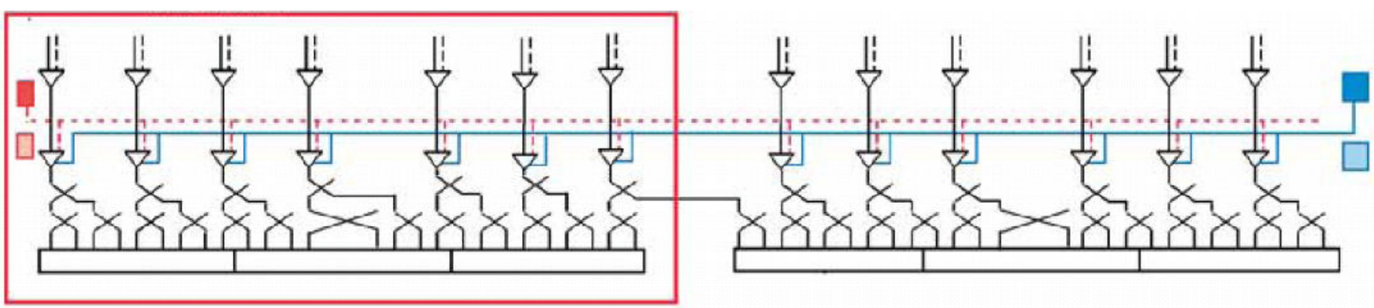
Standard Scheme: One DC PS/MA modulator drives
26 klystrons (6 cryomdoules)



High availability
with backup DC PS
and MA modulator

Maximum efficient
usage of SC cavity

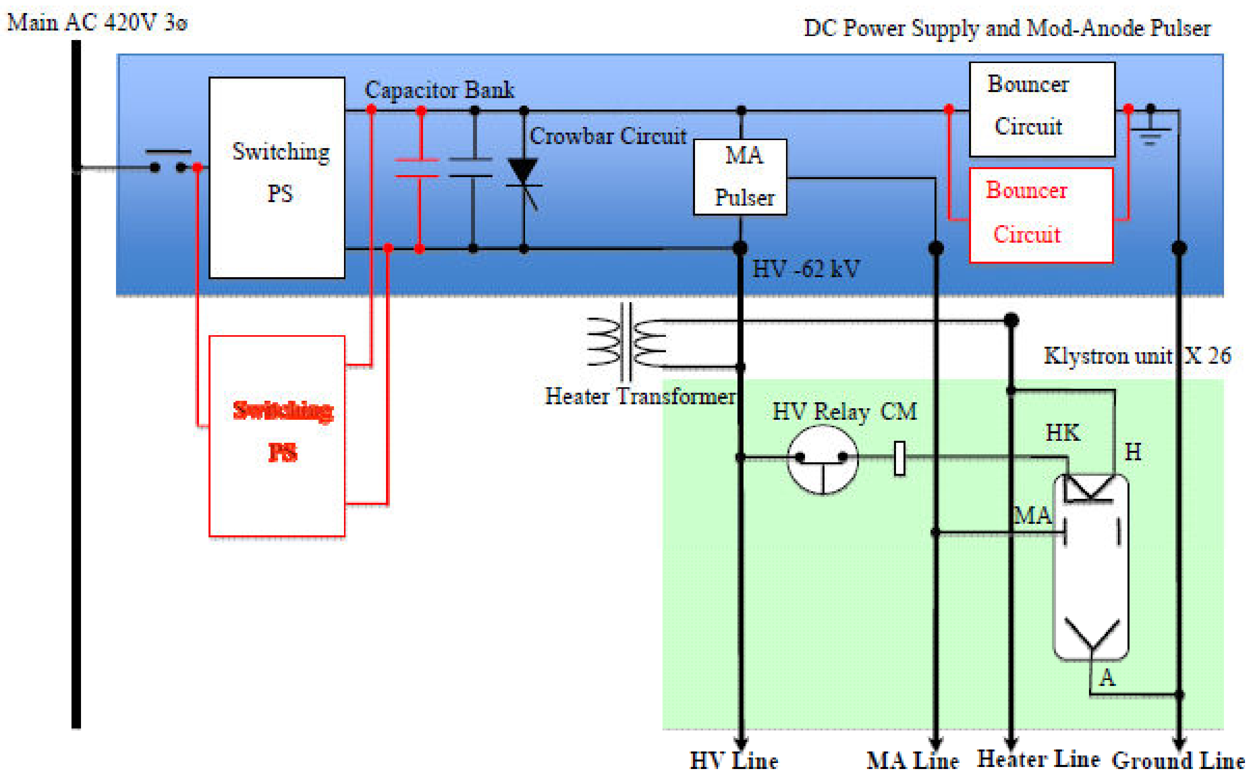
Low Power Option



Low Power Option

Aiming for the easy
upgradeability to
standard scheme
Low cost
Partial sacrifice of
DRFS operability

Modulator in Full Power Scheme



Items	No	MTBF (hrs)
DC Power Supply	1	50,000
possibly having redundancy	+1(Back-up)	>100,000 (Failure free/y)
Modulating Anode Modulator	1	70,000
possibly having redundancy	+1(Back-up)	>100,000 (Failure free/y)
MA Klystron	13	110,000-120,000 (KEK's recent 10 years data)

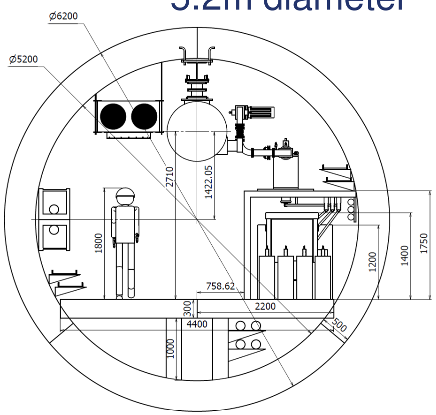
R&D schedule of DRFS at KEK

- Task force team of DRFS starts and try to solve the problems of DRFS.
- Prototype RF unit is manufactured in FY09
- Further R&D required for the DRFS RF system is continued in FY09
- Prototype will be evaluated in the S1 global test
- And then installed in the buncher section of STF-II aiming for the realistic operation.
- After fixing the scheme, collaborative CFS work and realistic cost estimation will be performed in FY09.
- Evaluation of Vibration of cryomodules due to the hanging-down structure from ceiling is planed.

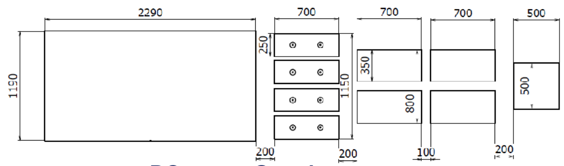
	FY2009				FY2010				FY2011			
	Apr-09	Jul-09	Oct-09	Jan-10	Apr-10	Jul-10	Oct-10	Jan-11	Apr-11	Jul-11	Oct-11	Jan-12
ILC Schedule												
KEK Schedule						S1 Global	DRFS Install					
MA Klystron #1	Design	#1 MA Kly Manufacturing			Test							
MA Modulator #1		Design	#1 Manufacture									
DC Power supply #1		Design	#1 Manufacture									
PDS of #1			Manufacture									
MA Klystron #2			Design		#2 MA Kly Manufacturing							

DRFS Full Power Layout

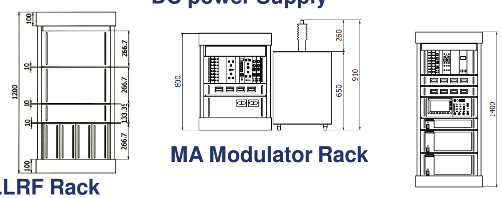
5.2m diameter



Components Size



DC power Supply

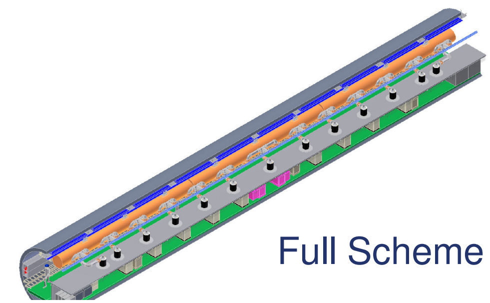


LLRF Rack

MA Modulator Rack

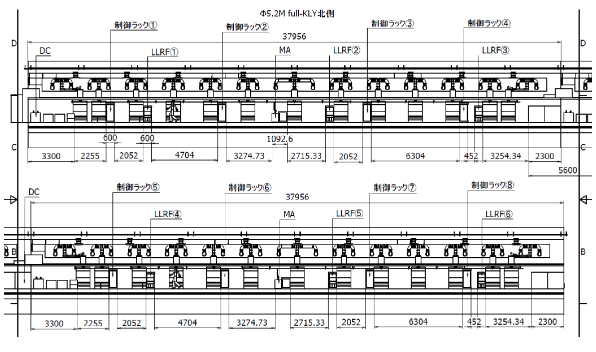
Control Rack

Full Scheme to Half Option

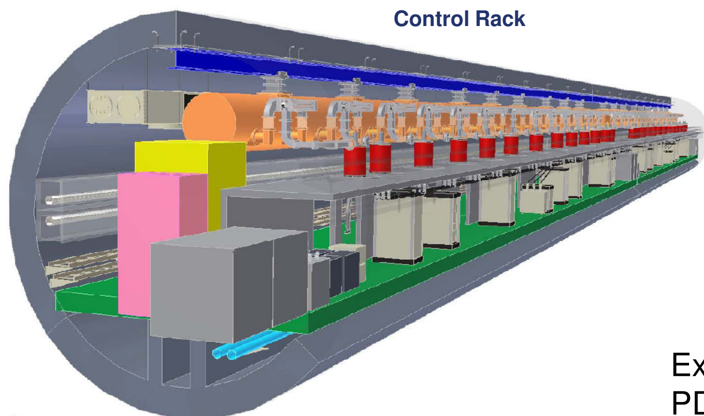


Full Scheme

Low Power Option

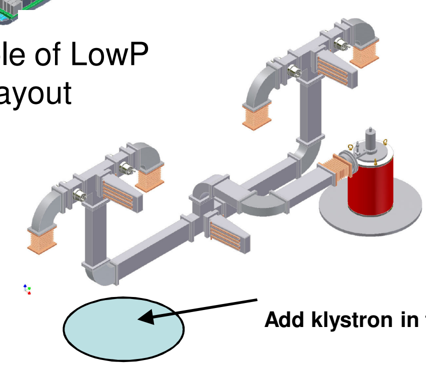


2 RDR-RF units Layout



3D View of DRFS

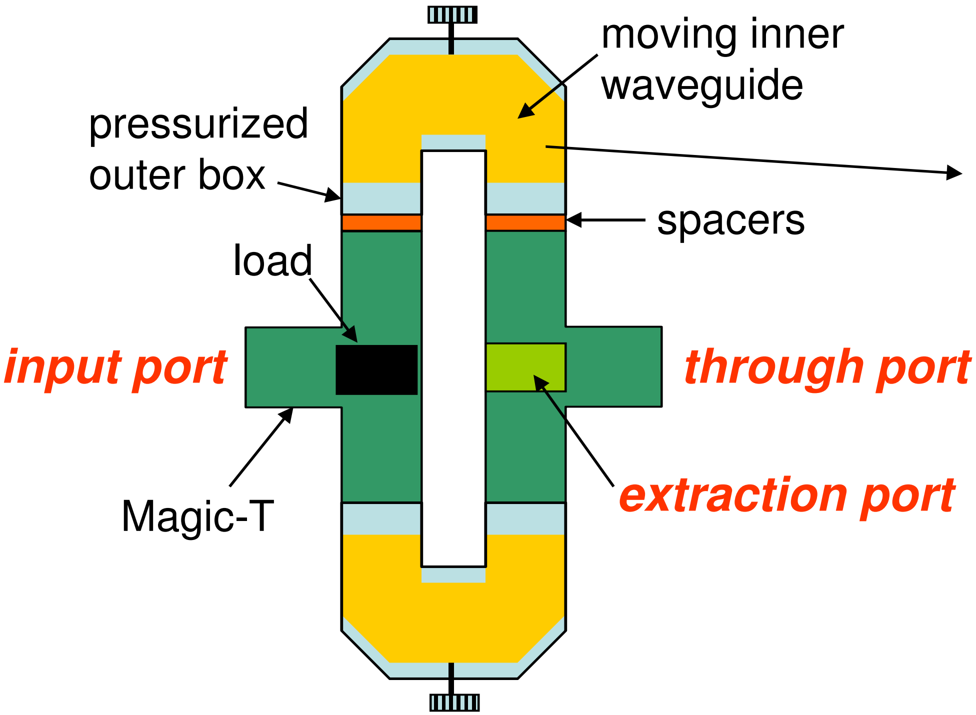
Example of LowP PDS Layout



HLRF Issues

- DRFS
  - Klystron lifetime
  - Modulator cost with redundancy
  - Layout (map RDR components into single tunnel) and issues of ceiling mounted CM
- Klystron Cluster
  - RF breakdown in transmission line
  - Cost of transmission line and vacuum -vs- pressurized operation
  - LLRF control

New SLAC Power Splitter



- Input and through ports are in-line
- Trombone phase shifters take advantage of required U-bends
- Match of phase shifters nominally unaffected by position

Flattop Operation with a Spread of Cavity Gradients