Cornell University
Laboratory for Elementary-Particle Physics

Status of Fabrication and Test of the Cornell ERL Injector Cryomodule

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Outline

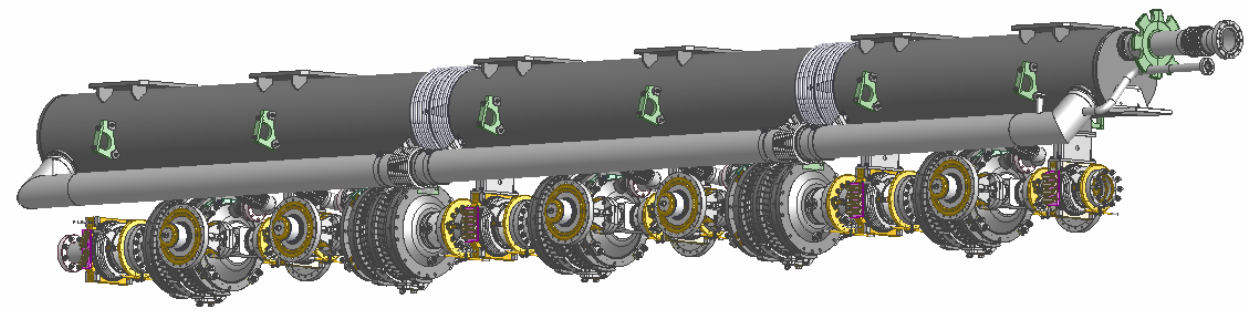
- A nice report on ERL Injector considerations was presented by Sergey Belomestnykh at the ERL 2005 Workshop at JLAB: http://www.lns.cornell.edu/public/ERL/2005/ERL05-10/ERL05-10.pdf
- ERL Injector Beam Requirements
- ERL Injector SRF Answers
- Cornell ERL Injector Innovations
- Cornell ERL Injector Components
- Cornell ERL Injector Schedule
- Cornell ERL Injector 1-cell Horizontal Test Cryomodule

ERL Injector Beam Requirements

- Energy gain 5-15 MeV
- High CW current, 100 mA @ 5MV, 33 mA @ 15MV
- Low emittance, 0.1-1 mm-mrad
- Short bunch, 0.6 mm

ERL Injector SRF Answers

- 2 coax couplers per cavity for beam-impedance symmetry, one 120 kWCW klystron per coupler pair
- 2 cells per cavity ≤15 MV/m deliver all klystron power to beam
- 5 cavities for 5-15 MeV energy gain
- Beamline HOM Loads for aggressive damping due to high current and short bunches



ERL Injector Philosophy

- Use the same cryomodule concept in Injector and main linac.
- Rely on well established and tested performance of the TESLA technology to reduce risk and minimize development time.
- TESLA module has already had several iterations to reduce cost, continue simplification and cost reduction with the Injector to apply to the ERL linac.

ERL Injector Innovations

- Precision fixed surfaces between the beamline components and the HGRP, easy "self" alignment
- HGRP alignment with VV under vacuum
- In-situ bake for cold and warm couplers, no further atmosphere exposure, *no pre-conditioning*
- Tuner stepper easily replaceable while string is in cryomodule
- WPM with jellybean electronics
- 80K and 5K He HEX in Cryo can

Other changes compared to TESLA module

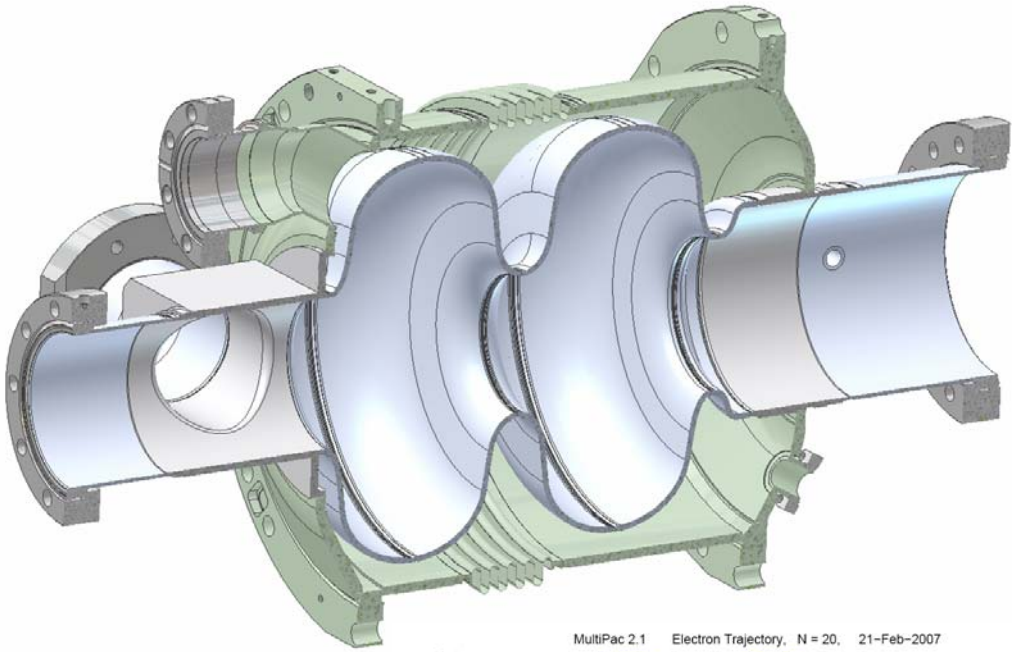
- CW operation with high beam currents.
- Reduced module length for ERL Injector.
- 2-cell cavities instead of 9-cell cavities.
- Larger tube diameter.
- Stainless steel cavity flanges.
- HOM absorbers between cavities.
- Pipes for HOM and Coupler cooling.
- No 5K shield, only a cooling manifold.
- Increase diameter of 2-phase 2K He pipe to 10 cm for CW operation.
- Improve magnetic shielding for very high Q_o, 3 layers.
- Two 62 mm ID input couplers instead of one 40 mm. Increased cooling for high average power.
- New end-cap and feed-cap concept with reduced length.

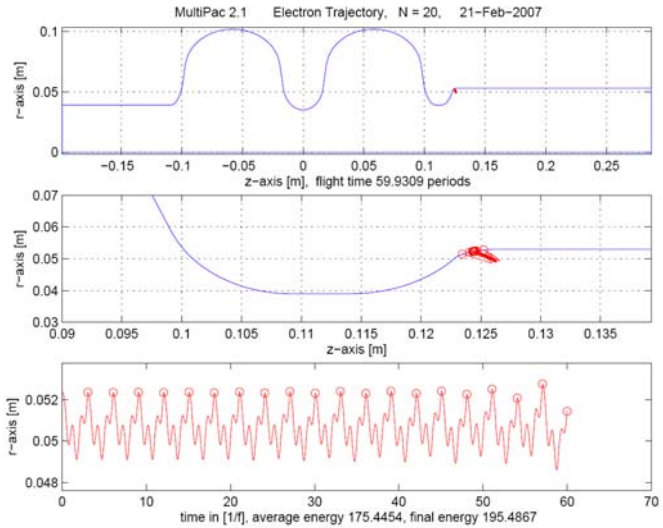
ERL Injector Components

- Cavity
- Input coupler
- HOM dampers
- Tuner
- Cryogenics

ERL Injector Cavity

Frequency	1300 MHz
Cells per cavity	2
R/Q	222 Ω
Voltage	1-3 MV
Gradient	5-15 MV/m
Q_o @ 2K	$>10^{10}$
Q_{ext}	$4.6 \cdot 10^4 - 4.1 \cdot 10^5$
Active length	0.218 m
Total length	0.536 m

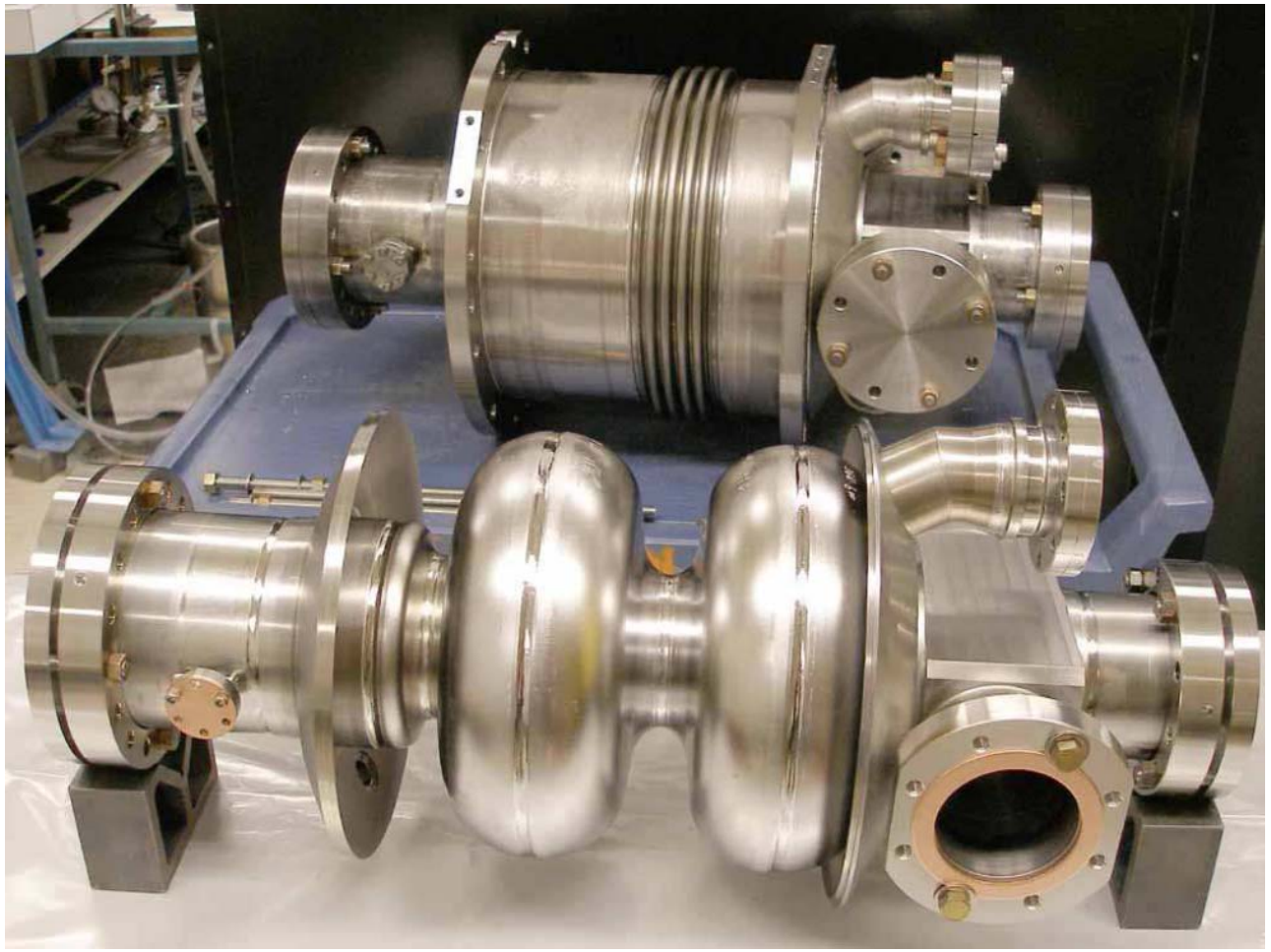




- Ti He vessel
- Brazed conflat flanges
- Mild multipactor at large beam tube transition, very easily processed in vertical tests

ERL Injector Cavity

- 5 cavities tested, all meet specs, E > 15 MV/m (most E > 20 MV/m) , Q > 10^{10} @ 2K
- Only BCP, no 800C treatment
- Two tested for H disease, no H disease



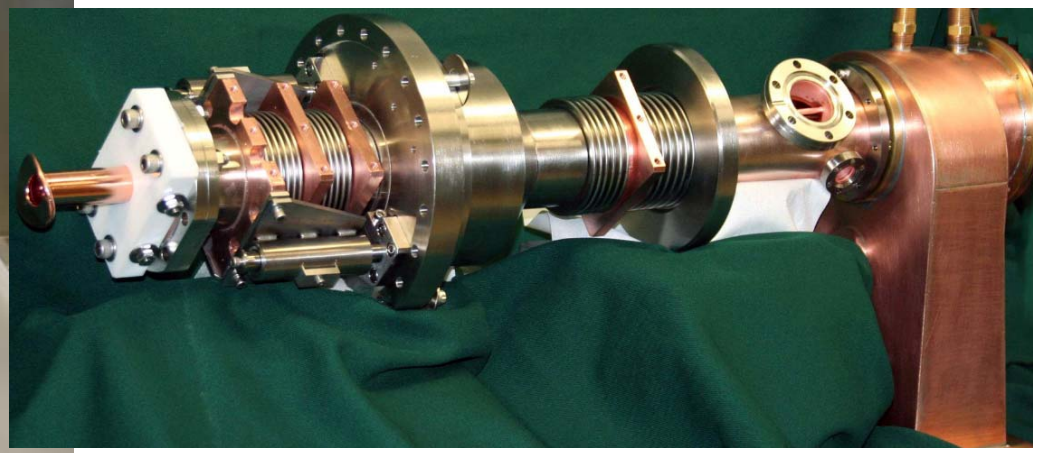
ERL Injector Input Couplers

Tuesday 24 April 2007

13:45->15:30 WG 4: Input & HOM coupler

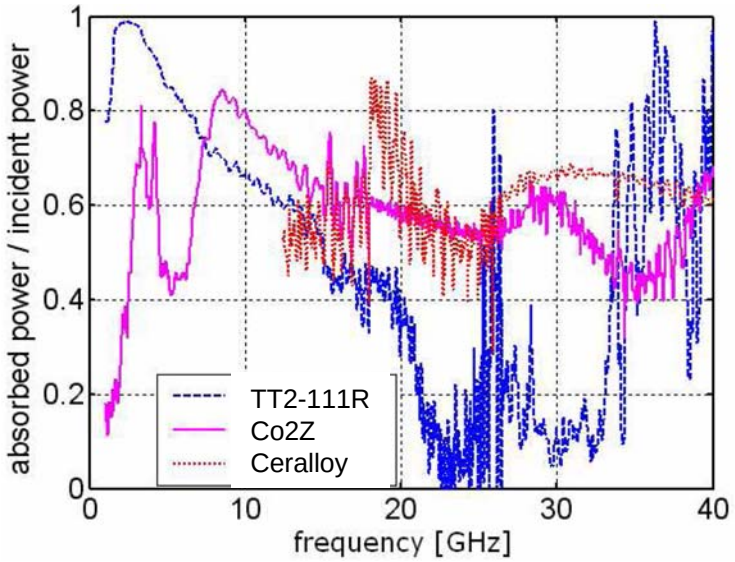
13:55 High power tests of the prototype input couplers for the Cornell ERL injector (20') **S. Belomestnykh (Cornell)**

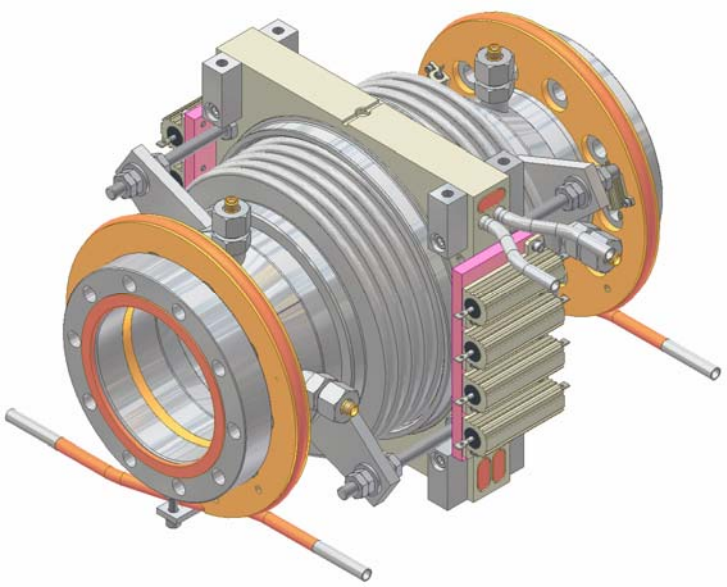
- Proto-types tested to 50 kWCW, 80 KW pulsed, designed for 75 kWCW

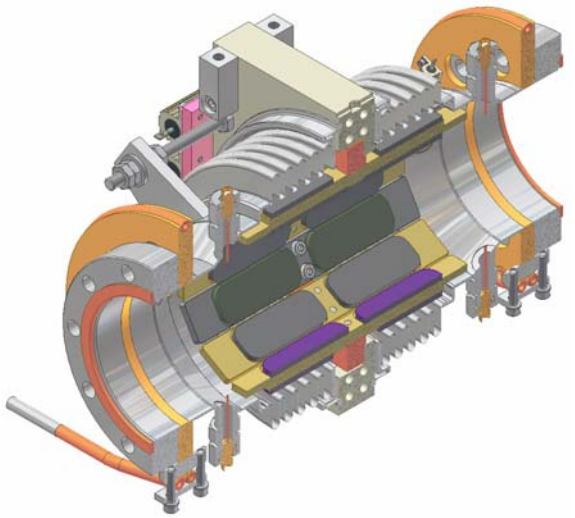


ERL Injector HOM Dampers

Total # loads	3 @ 78mm + 3 @ 106mm
Power per load	26 W (200 W max)
HOM frequency range	1.4 – **100 GHz**
Operating temperature	80 K
Coolant	He Gas
RF absorbing tiles	TT2, Co2Z, Ceralloy

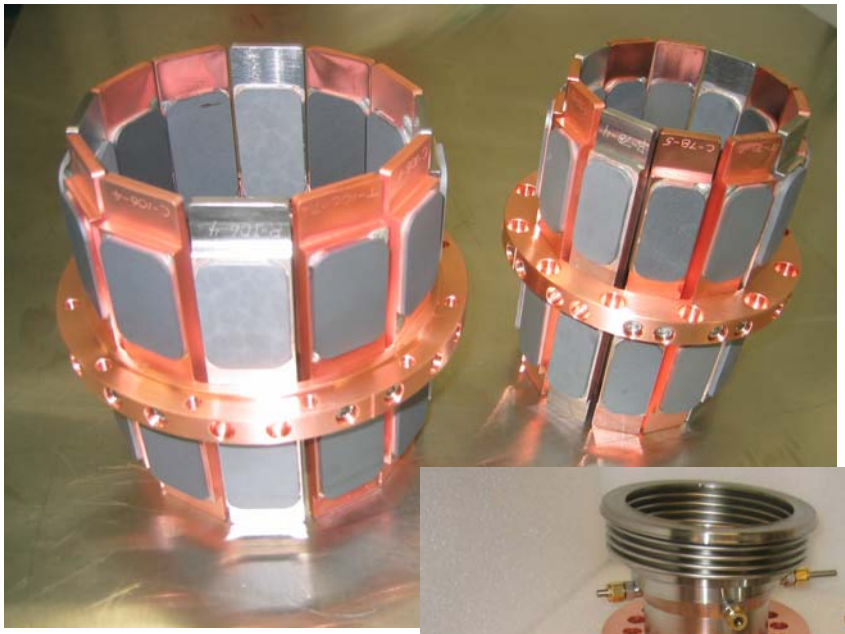






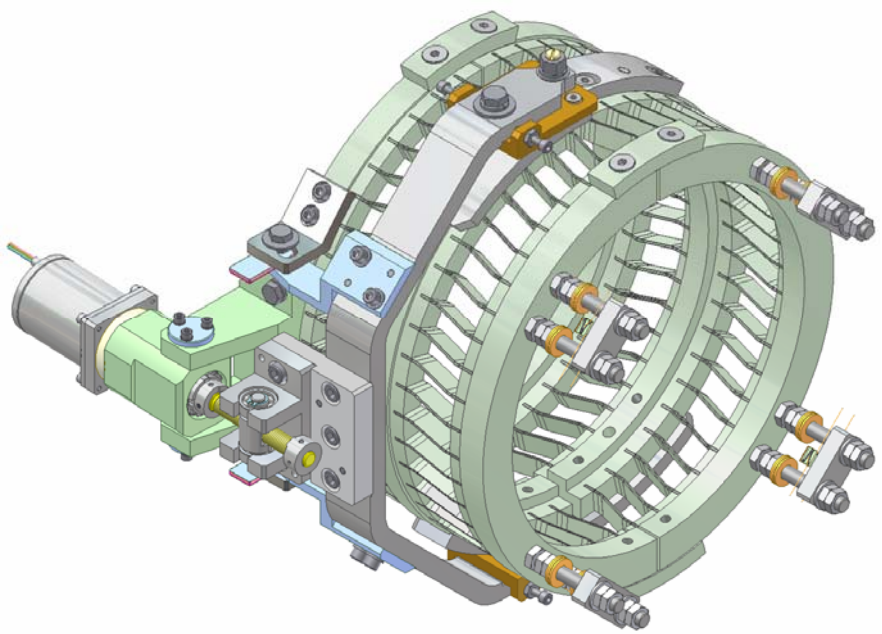
ERL Injector HOM Dampers

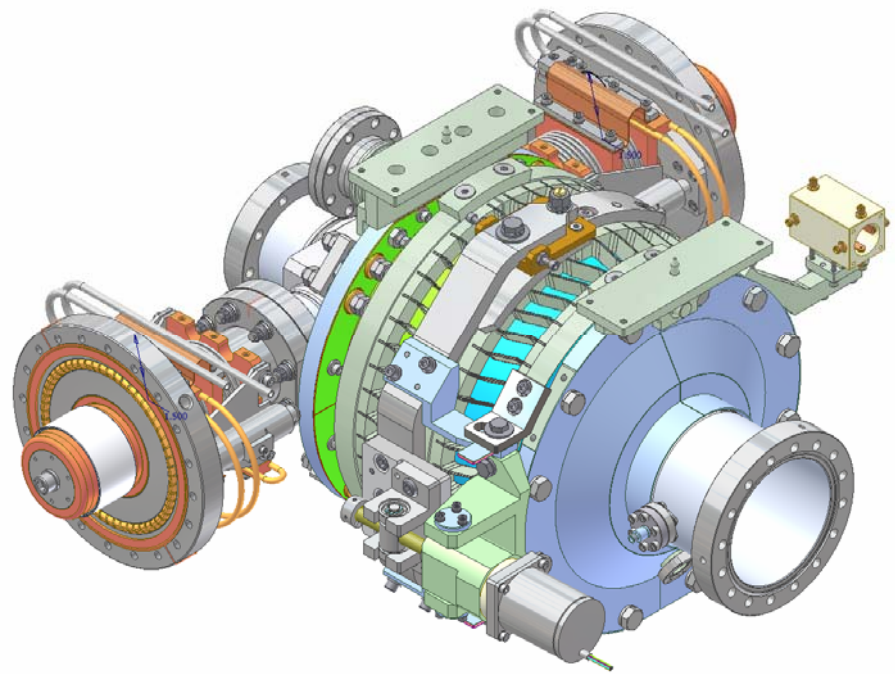
2 proto-types fab'ed by LEPP
6 production loads fab'ed by ACCEL



ERL Injector Tuner

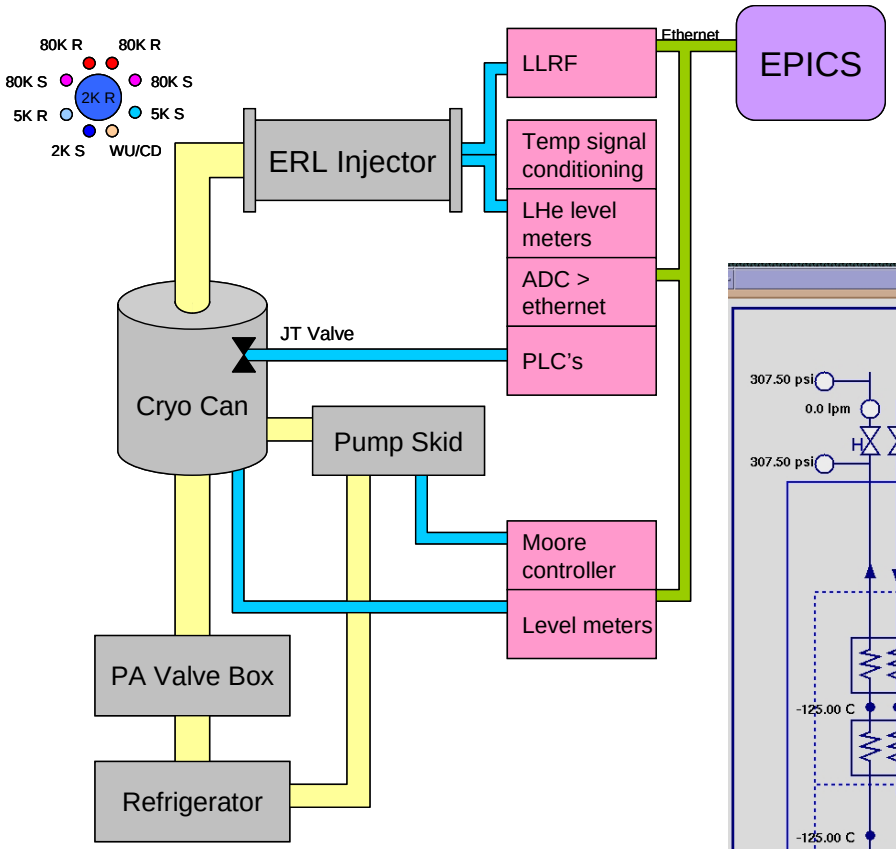
- Modification of a DESY proto-type INFN blade tuner, collaboration with UPenn
- Added piezos
- Stepper motor easily replaceable while cavity string is in cryomodule
- µphonics feedback bandwidth using tuner: ~0.1 Hz stepper + ~1000 Hz piezo
- Cavity frequency bandwidth: 500 kHz stepper + 5 kHz piezo



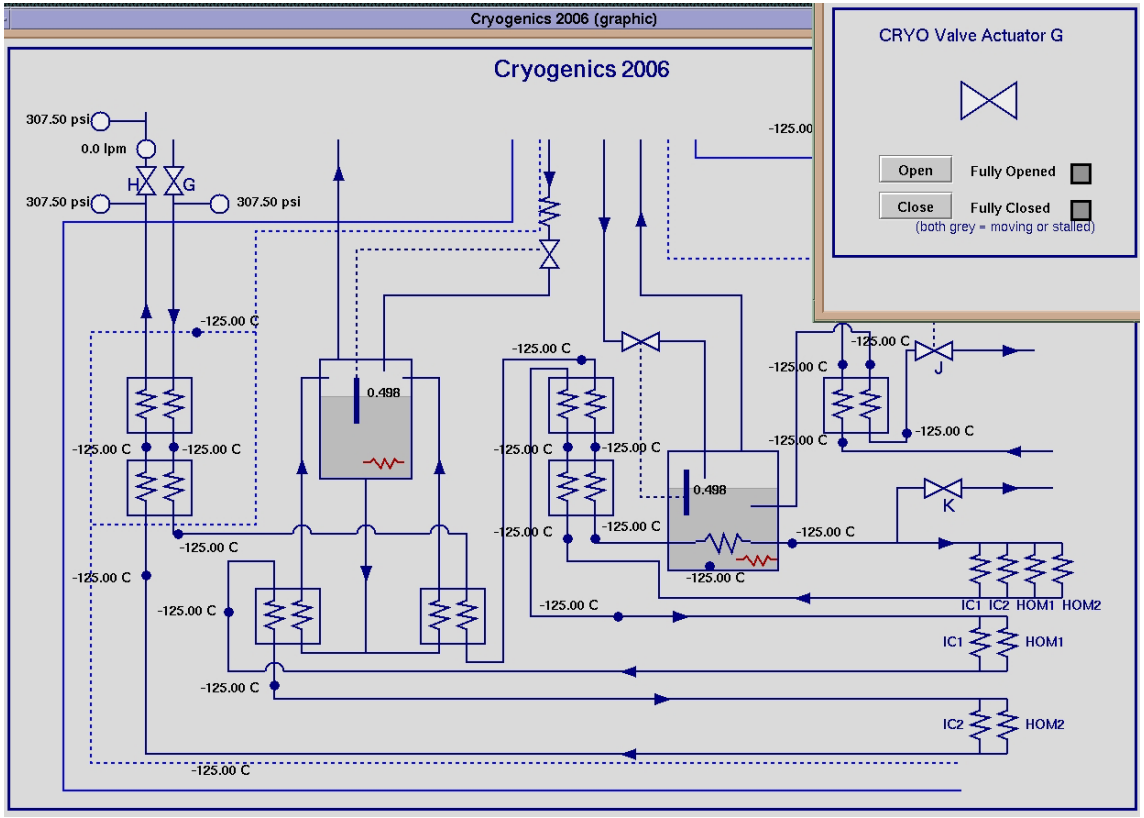


ERL Injector Tuner

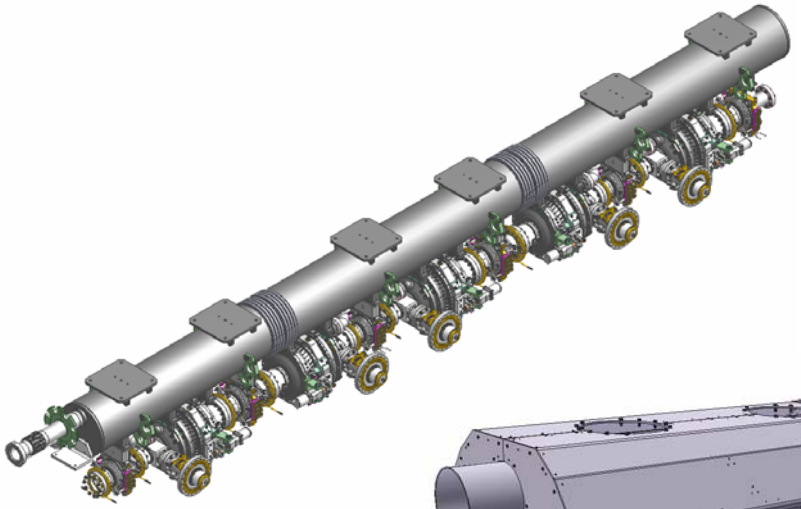
ERL Injector Cryogenics

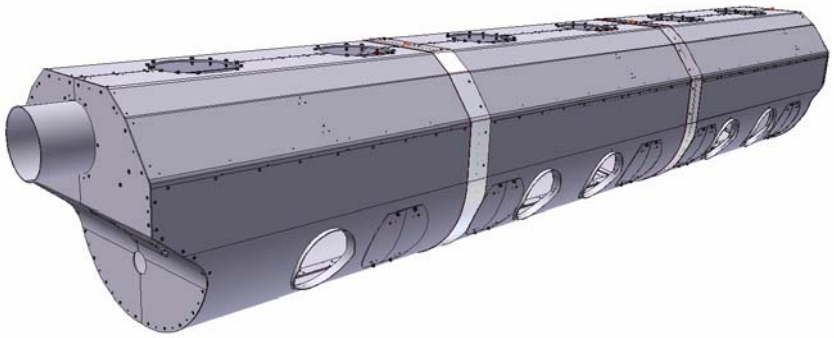


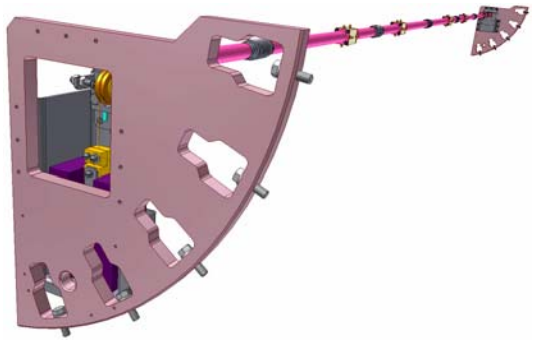
2K Cavity	25 W
5K Coupler + HOM Load	68 W
80 K Coupler	696 W



ERL Injector Cryovessel







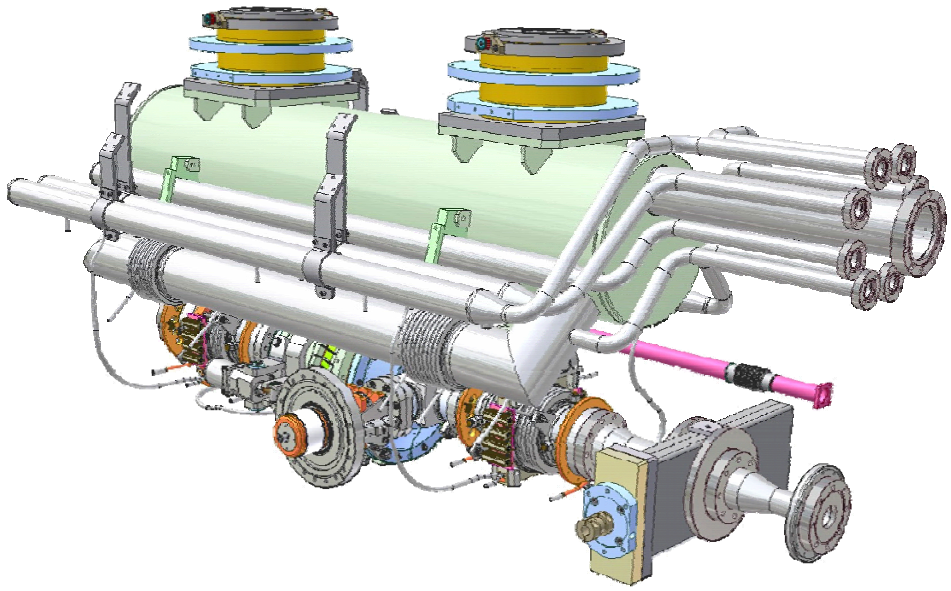
- Injector length 5m
- Careful cost tracking
- Close interaction with vendors

ERL Injector Schedule

- 6 Cavities fab'ed and vertical tested at LEPP, 5/07
- 6 Tuners fab'ed by Incodema, delivered 4/07
- 6 HOM loads fab'ed by ACCEL, 7/07
- 10 Couplers fab'ed by CPI, 6/07-8/07
- Cryovessel drawings ACCEL, 4/07
- Cryovessel bids 5/07, delivery 9/07
- Cryomodule assembly 8/07 – 1/08

ERL Injector Horizontal Test

- Perform a horizontal test of a 1-cavity cryomodule to de-bug the Injector design, the Horizontal Test Cryomodule (HTC)
- Use LEPP proto-type HOM Loads
- HTC cryovessel fab'ed by Meyer Tool & Mfg, delivered 2/07 – 4/07
- HTC assembly in progress
- HCT test 6/07



ERL Injector Horizontal Test

- HTC animation

ERL Injector Horizontal Test

The HTC Vacuum Vessel will also be used as an ERL Linac 5-cell cavity test cryomodule

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