



Advanced Energy Systems, Inc.

AES/BNL SRF Gun

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Consulting to AES

BROOKHAVEN
NATIONAL LABORATORY





Outline



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- **Injector Summary**
- **Test Facility**
- **Cavity Configuration**
- **QW Choke**
- **Cryomodule Configuration**
- **Major Sub-Components**
- **Status**



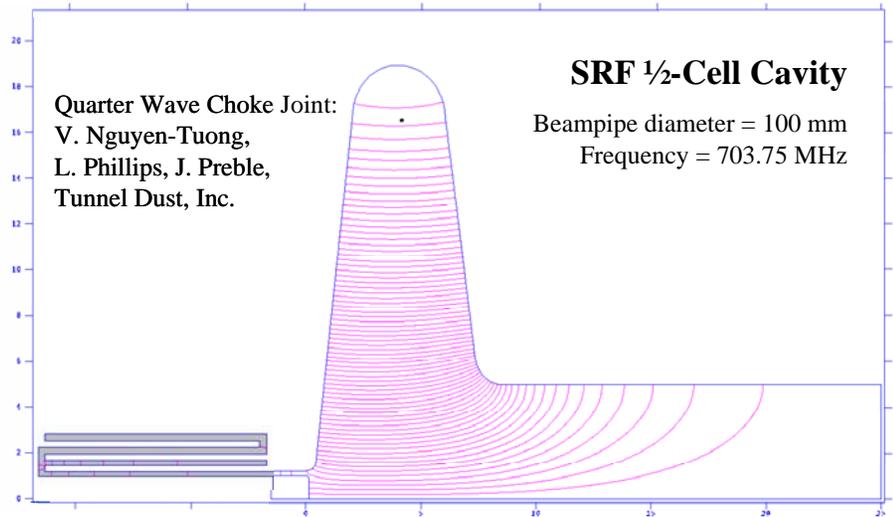


SRF Injector Design



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0.5 Cell, 703.75 MHz, 0.5 A



Objectives & Comments

- Design & fabricate a 0.5-cell Superconducting RF gun & choke joint fed by two 0.5 MW RF power couplers
- Test device on the BNL ERL
- Collaboration with JLAB, BNL, FZR & other FEL stakeholders

Target Parameters

Frequency	703.75	MHz
Energy	2	MeV
Current	500	mA with PRF of 352 MHz
Bunch Charge	1.33	nC
Transverse Emittance*	5.5	mm-mrad rms normalized
Longitudinal Emittance*	42	keV-psec rms
Energy Spread*	3.1	%
Bunch Length*	7.2	psec rms

* No emittance compensation

Schedule

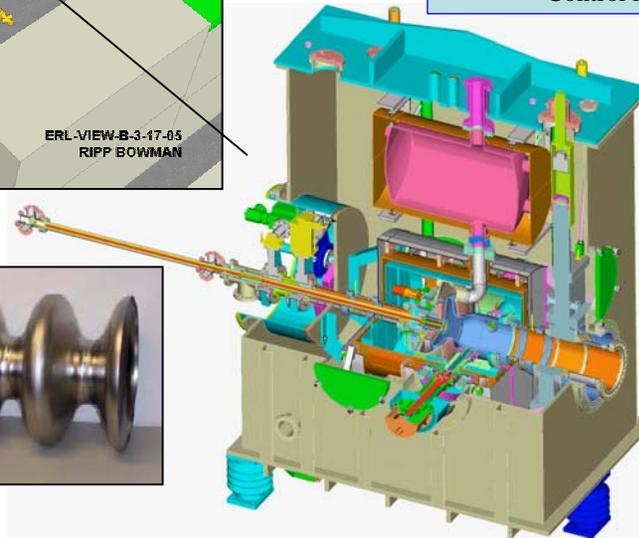
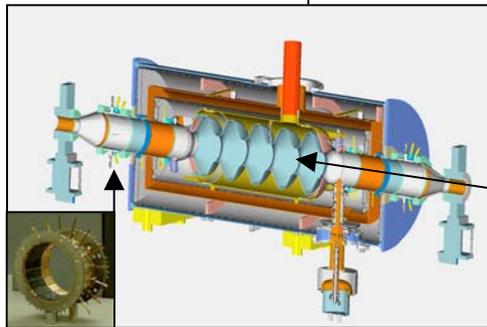
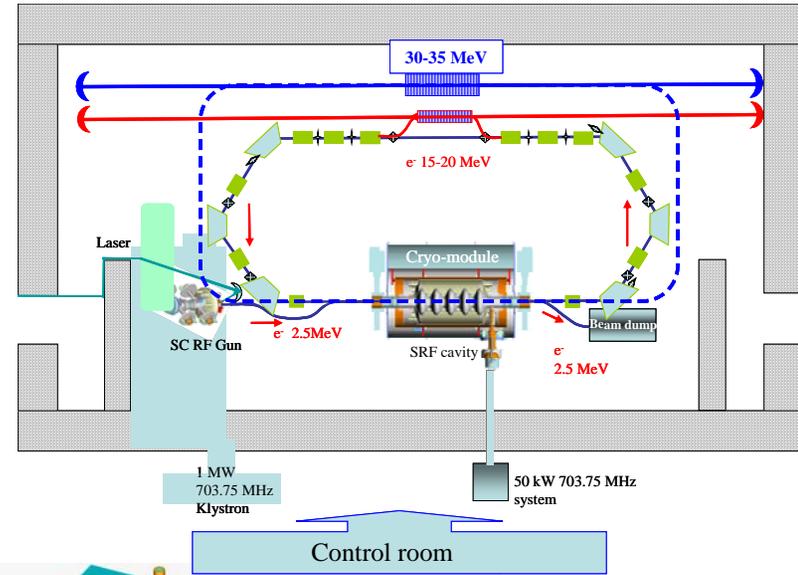
- Choke configuration downselected – 6/04
- Preliminary design review – 1/05
- Niobium ordered – 12/04
- Testing alternate choke joint – completed 3/05
- Final design review 12/05
- Delivery to BNL by ~ 3/08
- Initial testing completed at BNL by ~ 12/08



BNL 0.5A Test ERL



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Overall Summary and Progress



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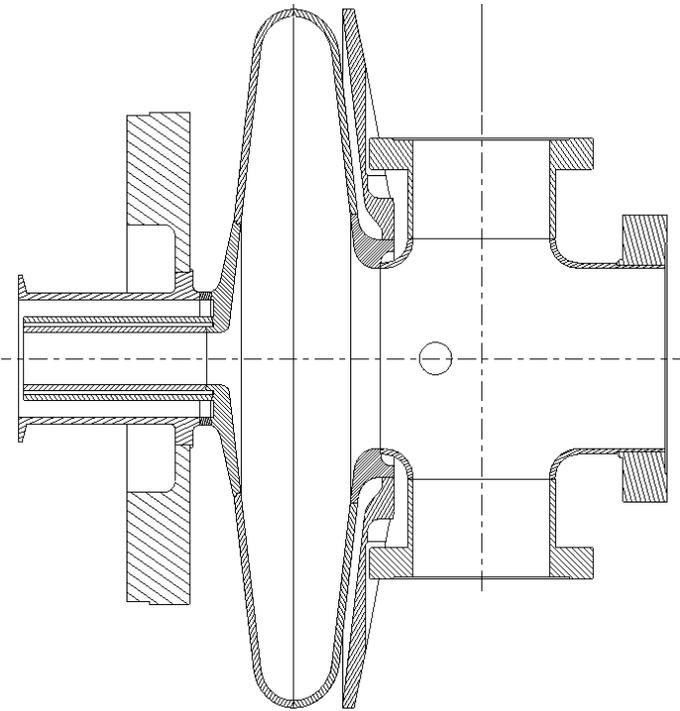
- Cavity Physics Complete
 - Multipacting, HOM analysis, Coupling
 - Rama Calaga will speak to much of this later today
- Final Design of Cavity Complete
 - BUT re-examining some cases based on December '05 FDR comments
- Final Design of Cryomodule well underway
- Cathode Design underway
- Tool fabrication and testing underway
- Cavity beam pipe and port fabrication complete



Cavity Configuration



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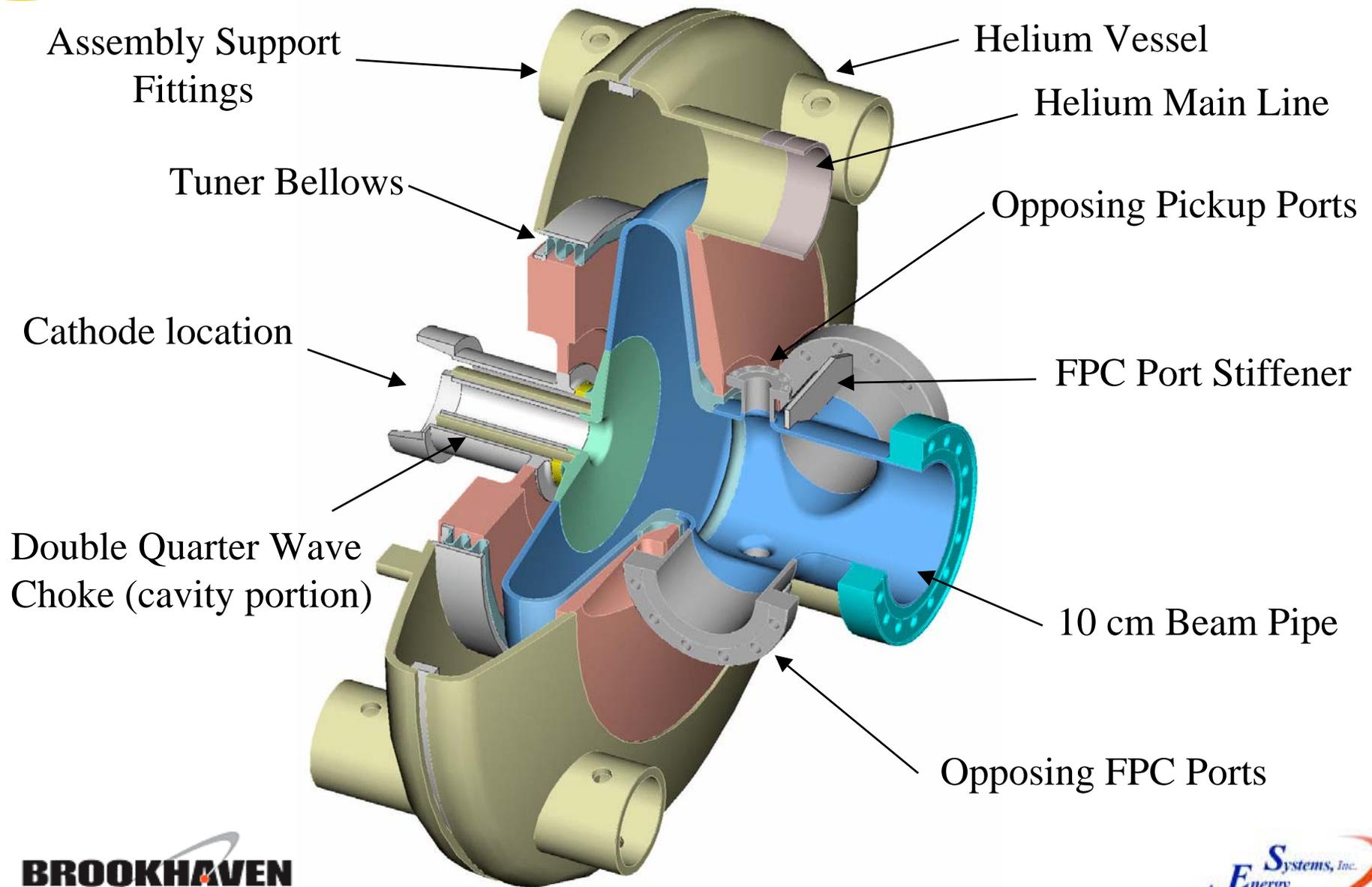
- Formed half cells with machined irises
- 10 cm Beam Pipe diameter
- Machined parts for helium vessel “dish” components
- Close FPC Coupling
- Good field probe pickup-to-cavity coupling
- Geometry optimized to minimize stress from evacuation and over pressure condition
- FPC port stiffeners required



Cavity with LHe Vessel



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Coupling Requirements



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- Beam power fixed at 1 MW
- Cavity power including N/C Cathode Components is 157 W
- Q_{EXT} is 37,000

	SF (SC w Cu Cathode)	
Frequency	703.632	MHz
E0	8.500	MV/m
TTF	0.888	
U	8.366	Joules
Rs	14.92	nanoOhm
Pcav	156.9	W
Q0	2.36E+08	
Pbeam	1.0E+06	W
QL	36973.3	
Qe	36979.1	
Beta	6374.3	
Z	115117	MOhm/m
L (Z)	0.25	m
RsQ	3.52	Ohm
r/Q	96.245	Ohm
ZTT	90745	MOhm/m
Epeak	35.712	MV/m
Hpeak	58736.4	A/m



Coupling



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- Significant effort to achieve required Q_{EXT} of 37,000 without excessive probe penetration
- FPC port and entire LHe vessel underwent significant adjustment to increase coupling from FPC
- Working to optimize probe to keep penetration under 4mm to reduce effects of FPC kick on beam but baseline configuration is in hand

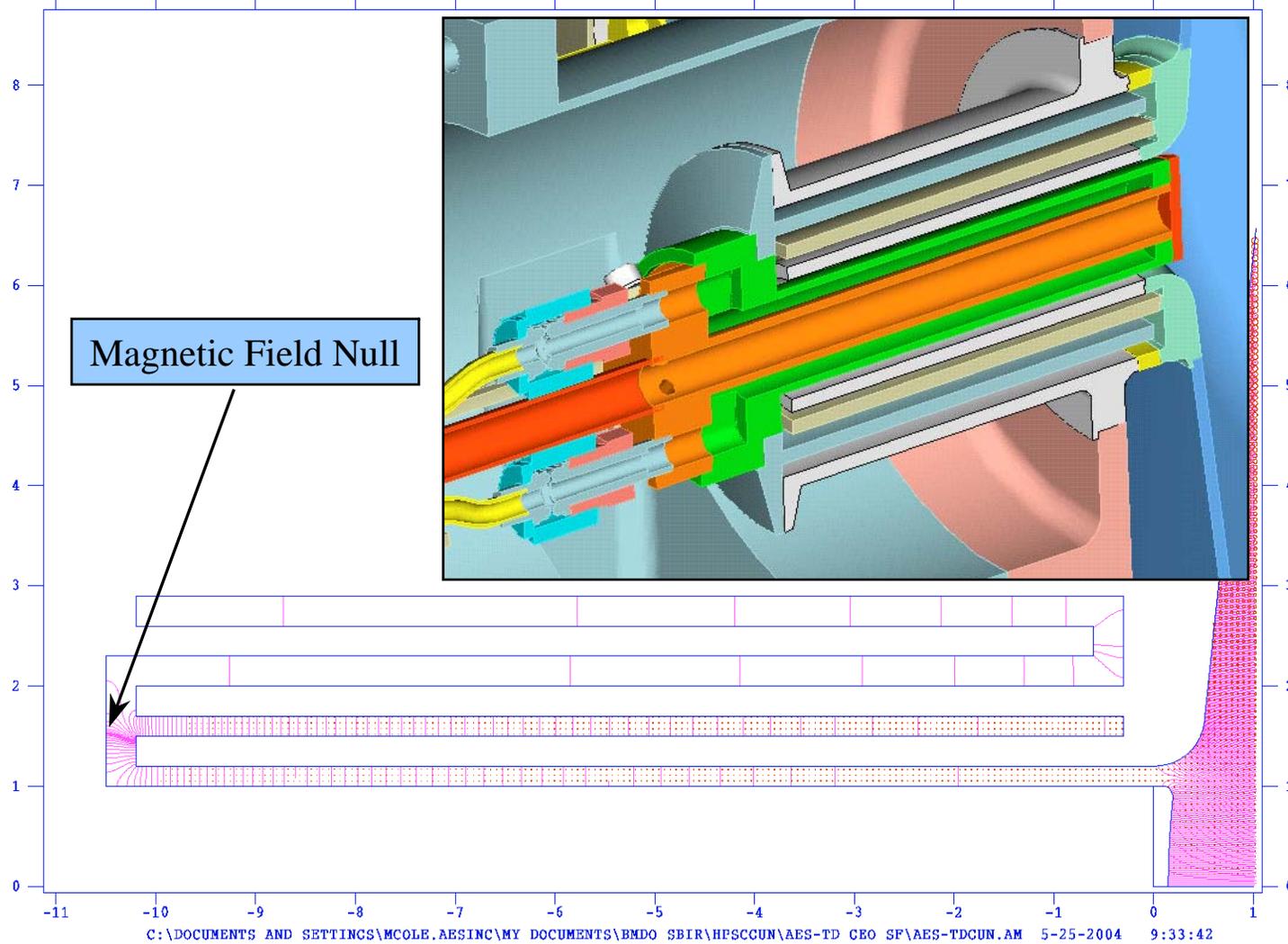


QW Choke



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AES Superconducting Cavity at 748.5 MHz w TD Choke F = 748.51983 MHz





QW MP Analysis and Testing



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- Analysis performed on various surface
 - Smooth
 - Rectangular grooves
 - Triangular Grooves
- Triangular grooves greatly reduced MP in simulations
- Testing performed to verify analysis
- Tests performed at RT with Cu
- Successfully verified results from analysis

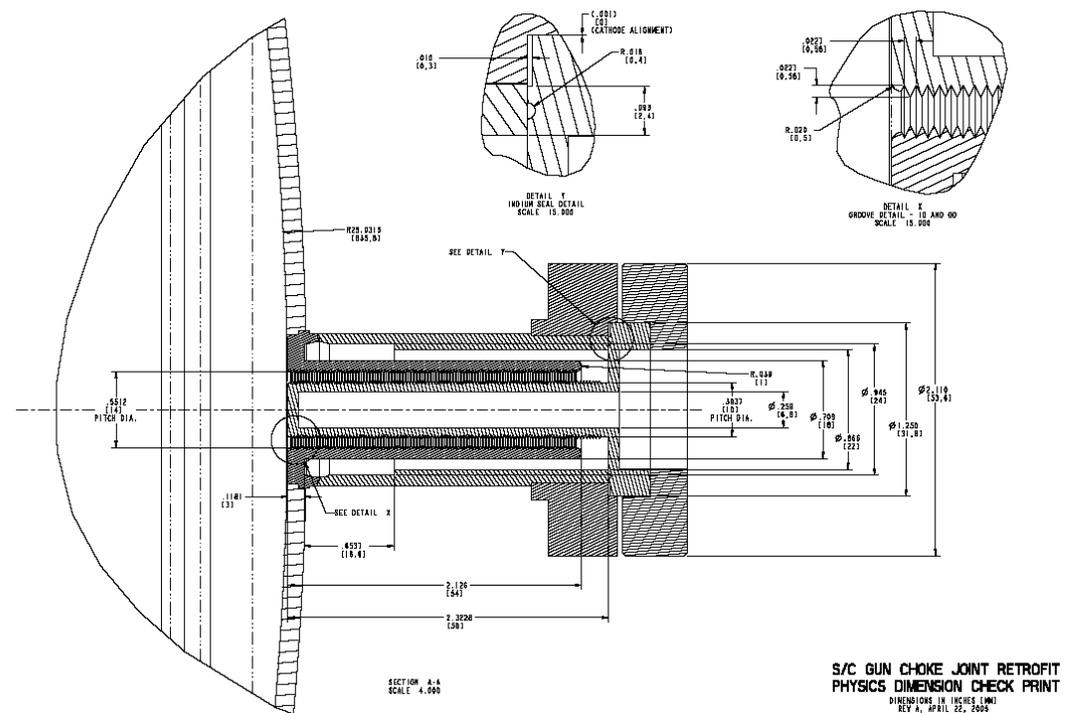
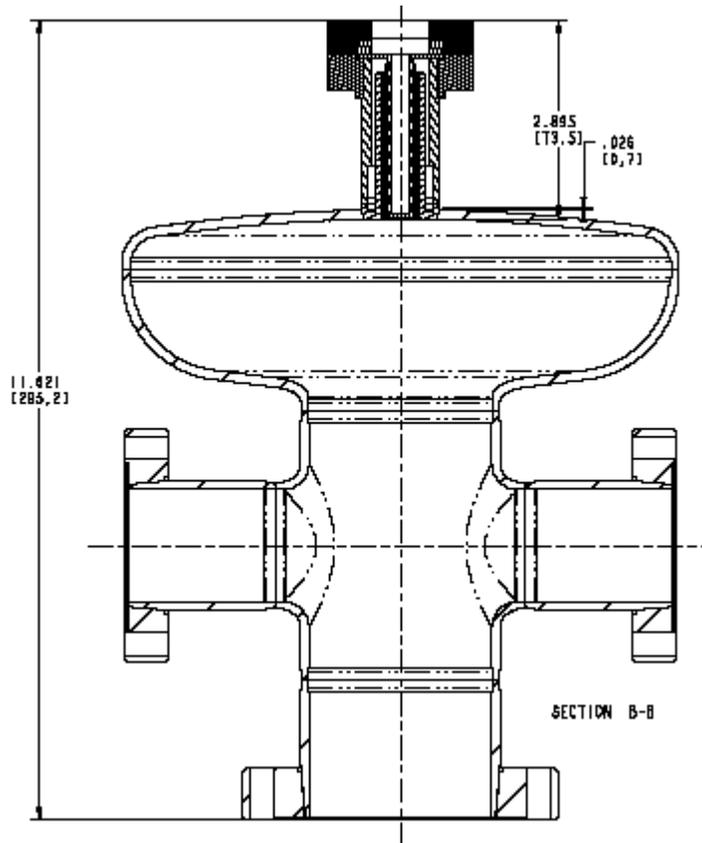


MP Testing with Nb at 2K



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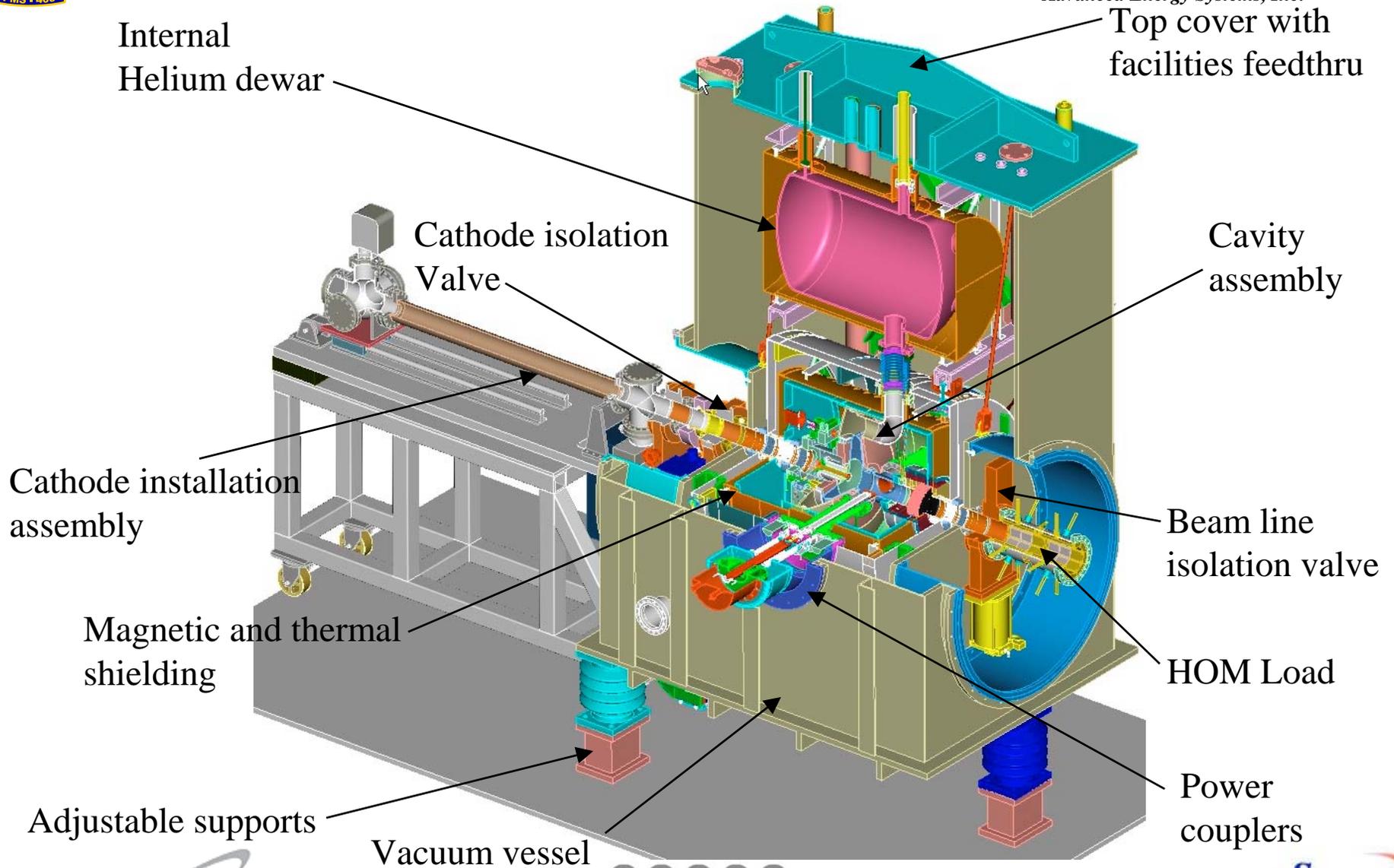
- Would like to verify RT Cu results at 2K with Nb
- AES has partially modified a 1.3 GHz cavity for BNL which is undergoing testing, further modifications likely





Cryomodule Configuration

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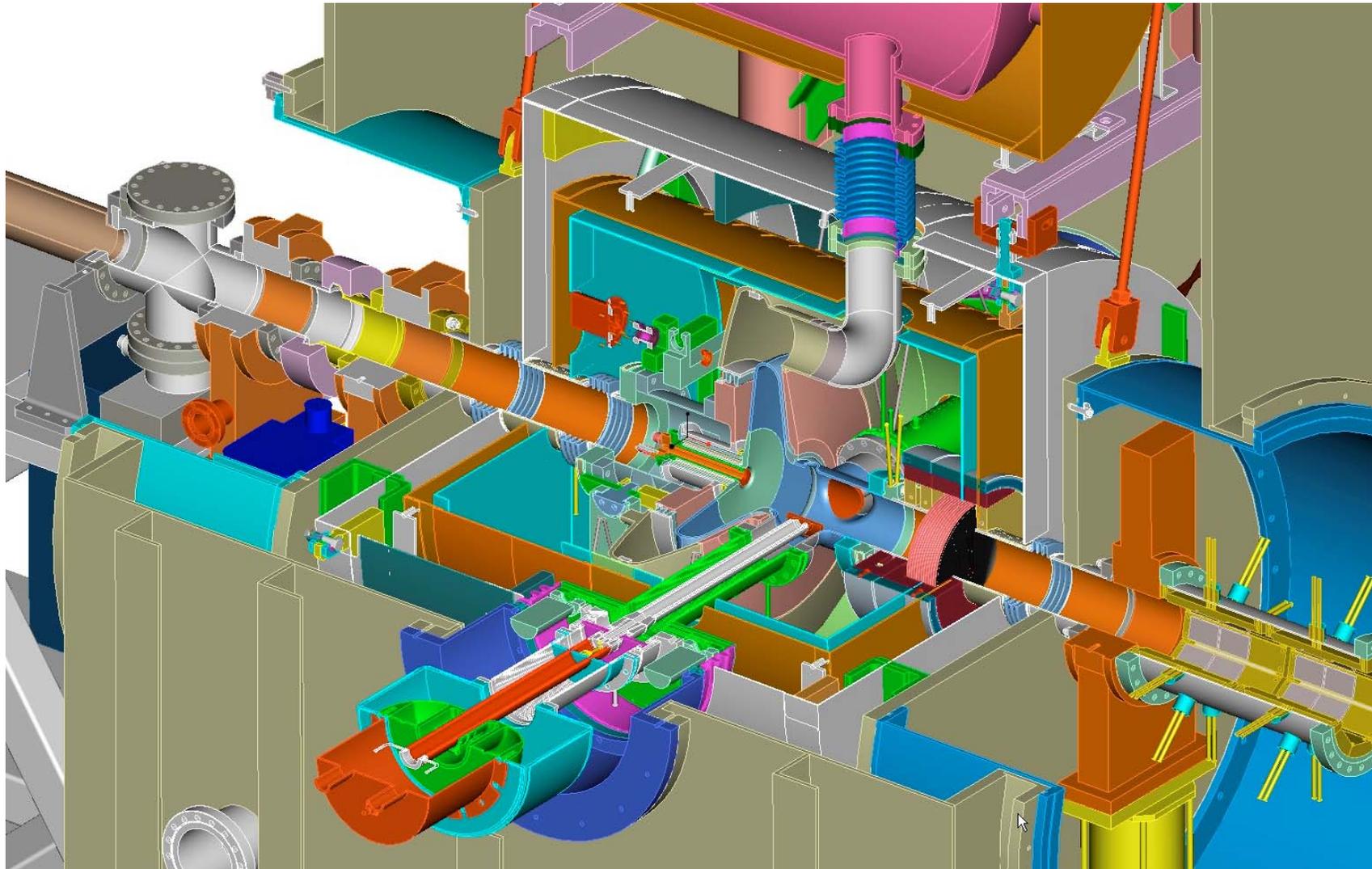




Cryomodule Cutaway



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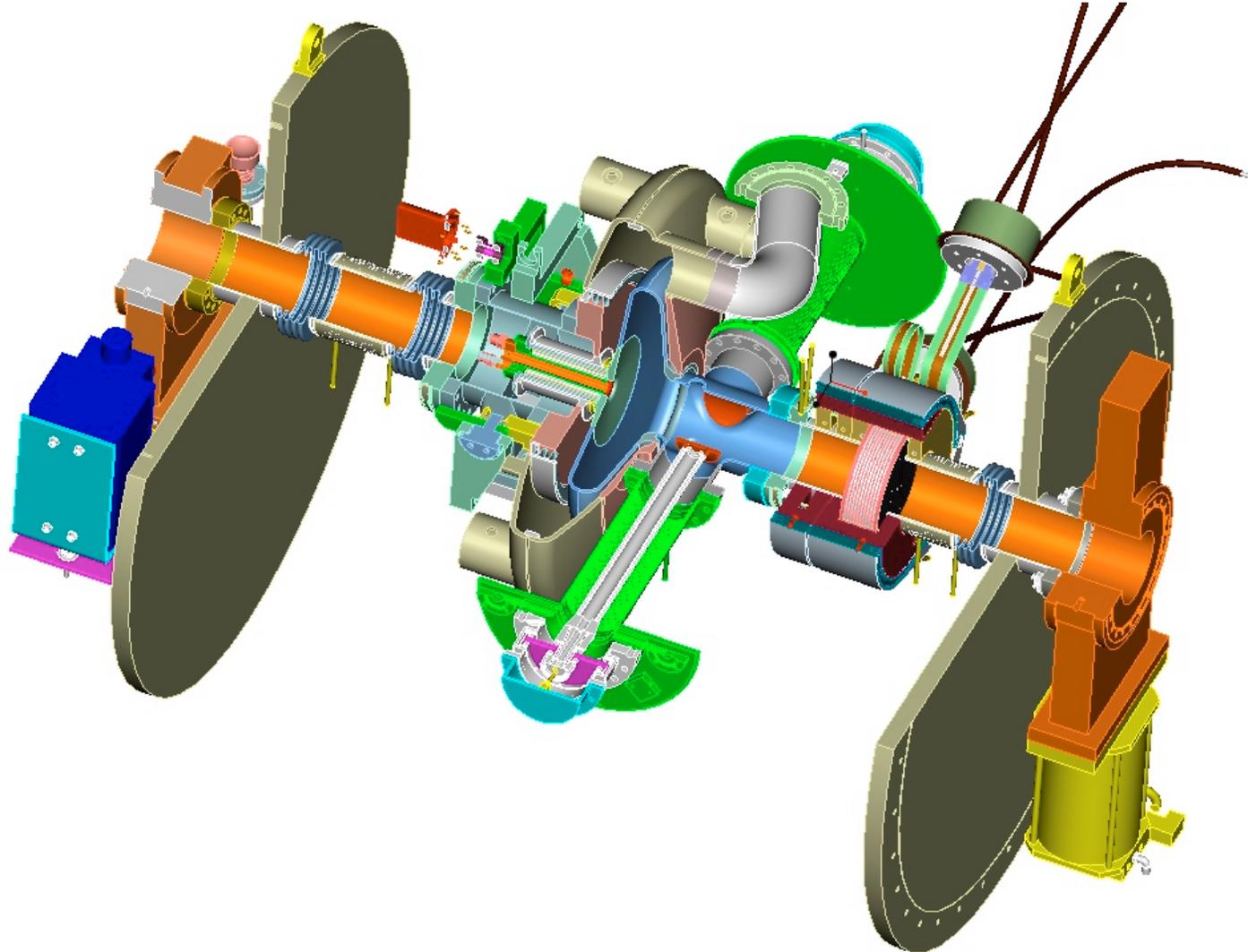




Cavity String



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HTS Solenoid



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- Being designed by SMD at BNL
- Test of HTS wires and coils
 - Wire is in house
 - Fabrication tests have begun
- Fabricate and test solenoid
- Fabricate and test HTS leads
- Assist with installation and integration
- Effort directly supported by Navy





Power Couplers



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- Fabricated by CPI
- Four prototypes delivered to JLAB for use in their Injector Test Stand at reduced power requirement
- Currently undergoing incoming inspection and Q/A
- Will be process at SNS
- SRF Gun FPCs will be evolution of this design
- Test and Processing cart will be built for use at BNL



2006 Technical Work Goals



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- Complete analysis in response to FDR comments
- Complete integration of modified HTS Solenoid with Bucking Coil into cryomodule
- Complete fabrication prototyping of cavity welds
- Complete end groups
- Support integration with cathode transport cart