

FIDUCIALIZATION OF SUPERCONDUCTING RADIO FREQUENCY CRYOMODULES AT JEFFERSON LAB

C. J. Curtis, J. Dahlberg, W. Oren,
J. Preble, K. Tremblay

Thomas Jefferson National Accelerator Facility, 12000 Jefferson Avenue, Newport News, Virginia USA 23606

Operated by the Southern Universities Research Association for the U. S. Department of Energy

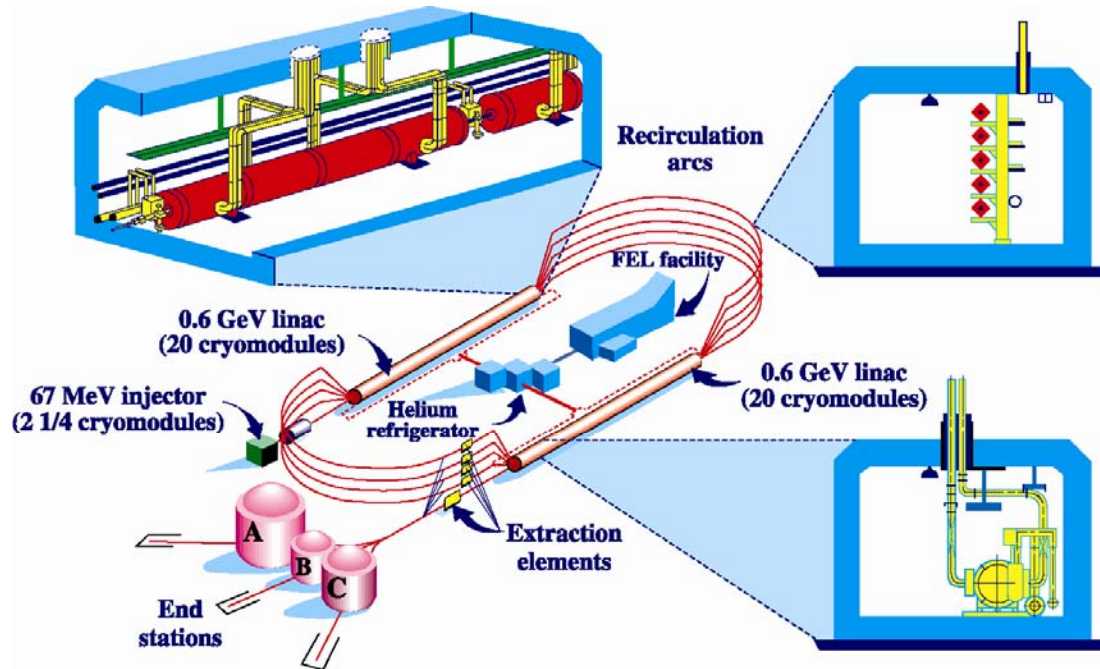


IWAA06

Jefferson Lab Site



CEBAF Overview



Cryomodules

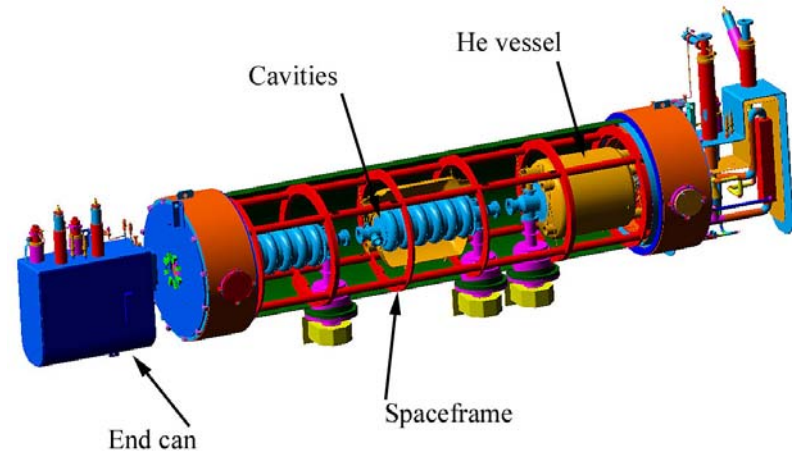
- 42 full cryomodules in CEBAF
- 3 in FEL
- 24 for SNS
 - 1 prototype
 - 11 medium beta
 - 12 high beta
- 2 prototype 12 GeV



Inside a Cryomodule

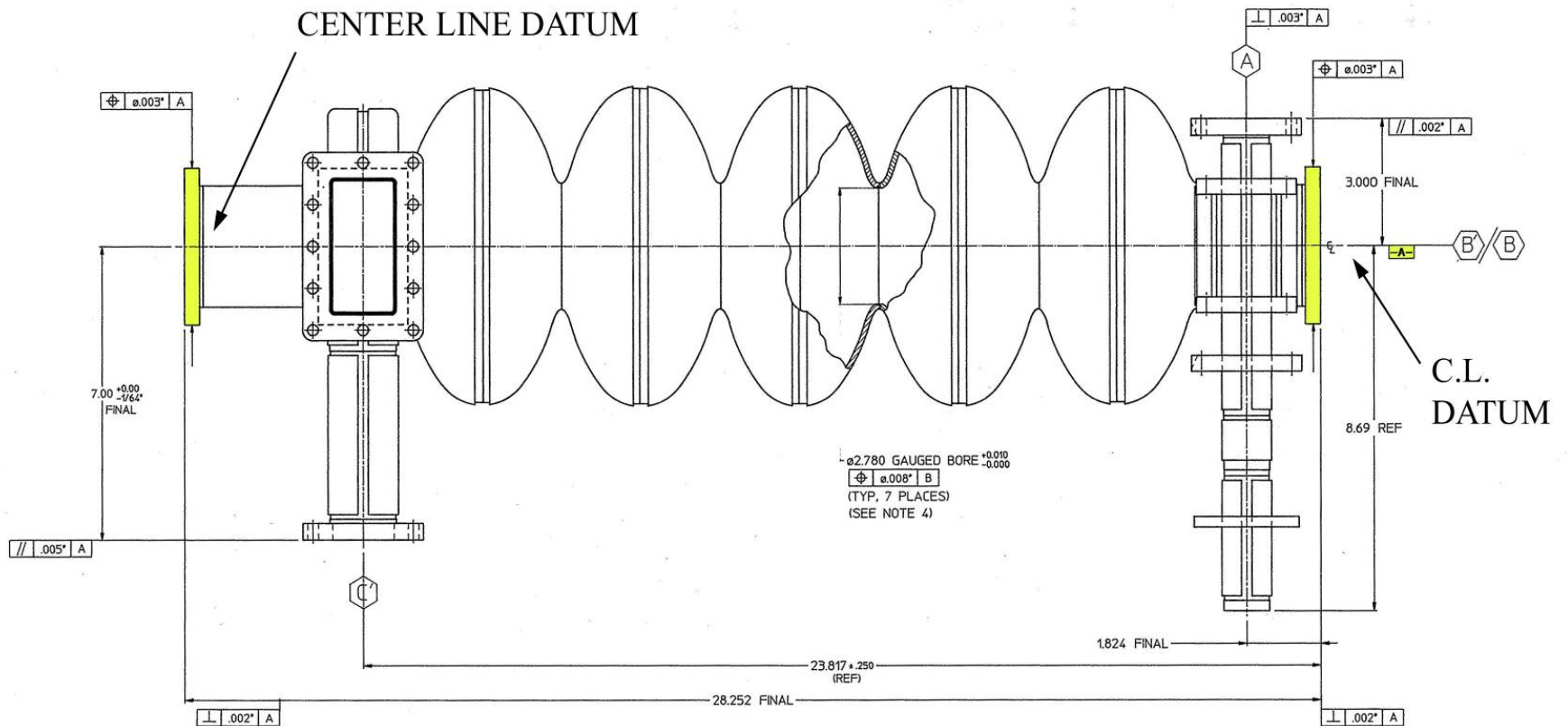
CEBAF Design

- 5 niobium cells per cavity
- Cavities assembled in pairs
- Four cavity pairs per cryomodule
- Cavities in He vessel
- Outer vacuum vessel

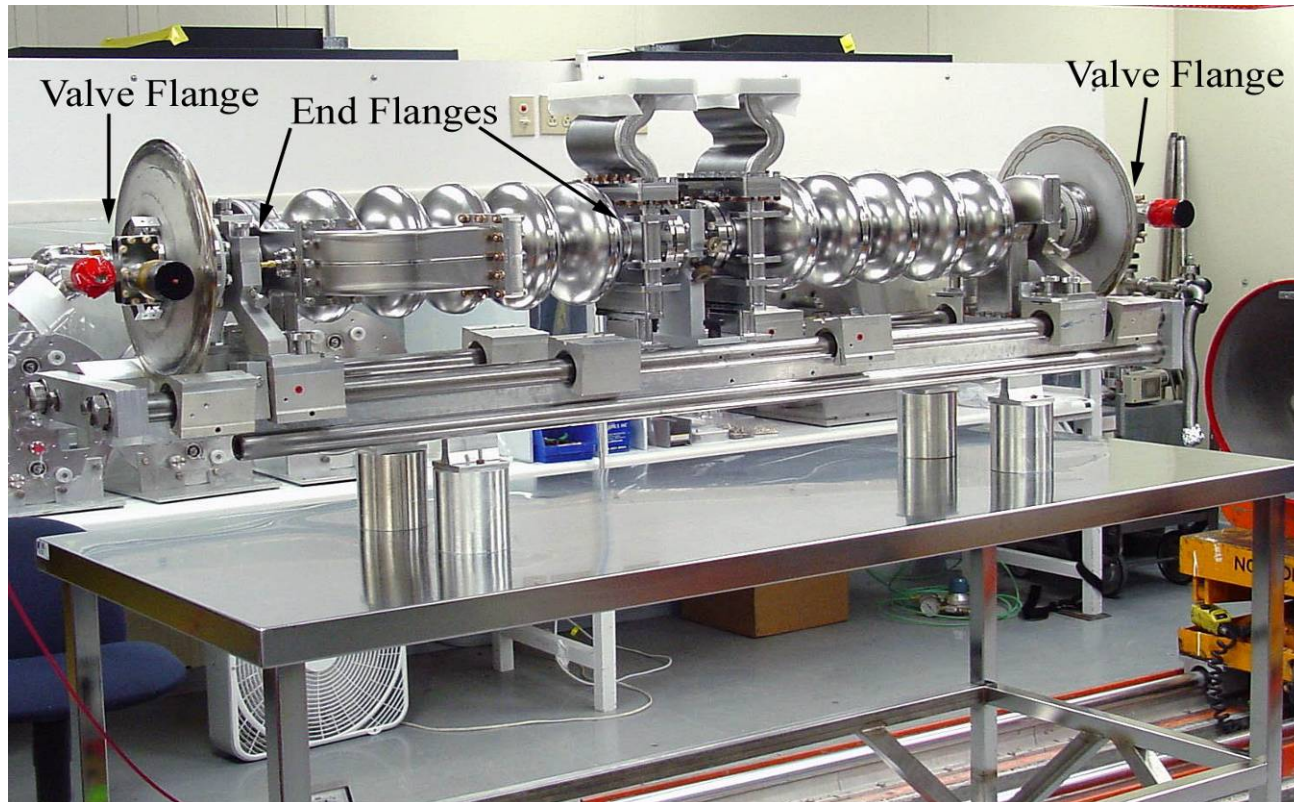


Alignment Specifications

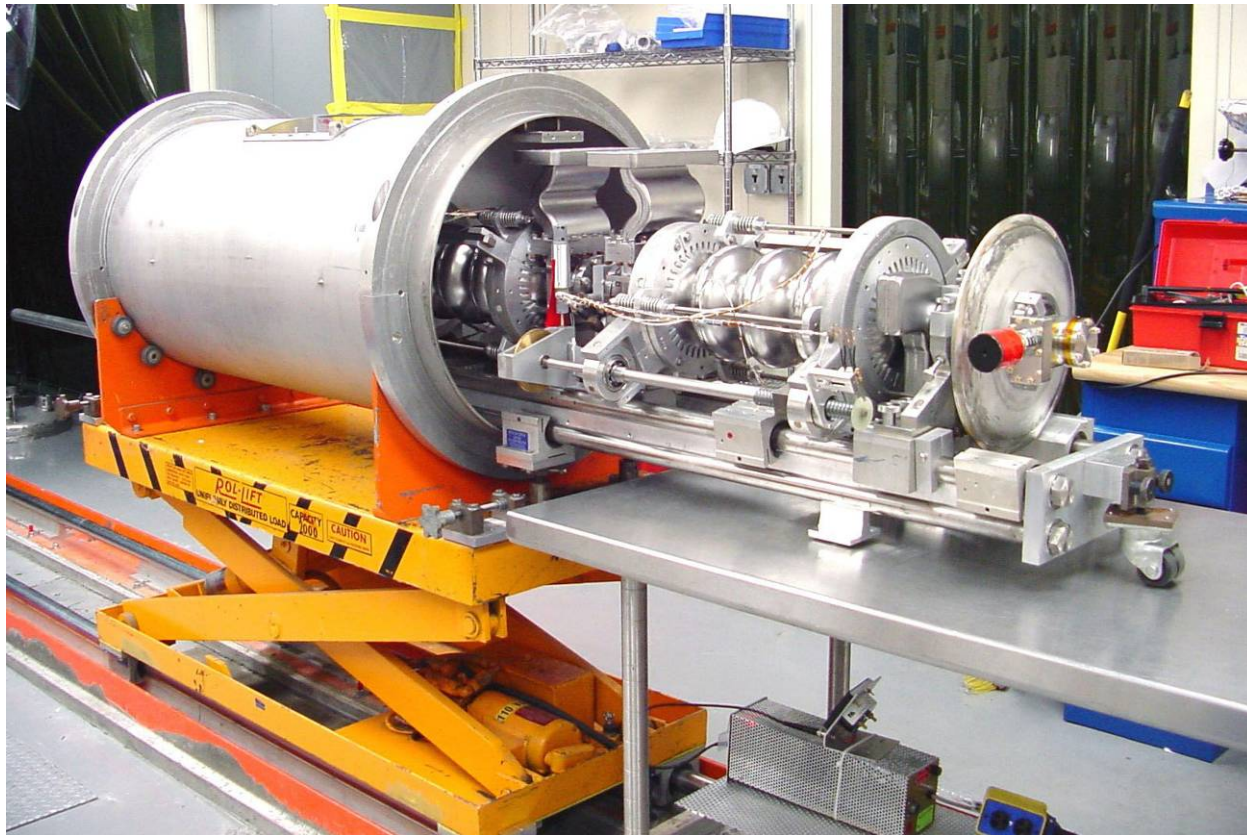
- Total less than 2 mrad
- 3 Major Error Sources:
 - Individual cavities – 0.5 mrad
 - Cavity Pairs – 1.25 mrad
 - Linac alignment – 0.1 mrad



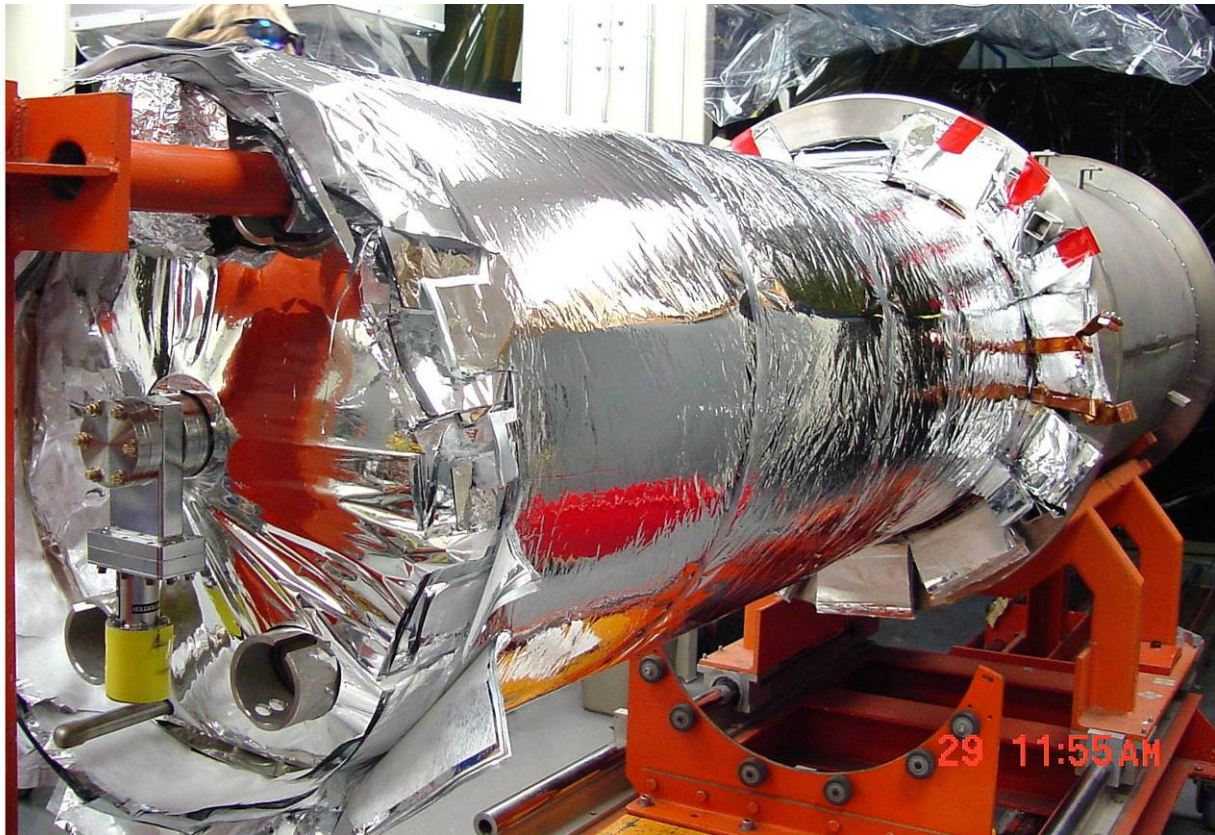
Cryomodule Assembly 1: Cavity Pair



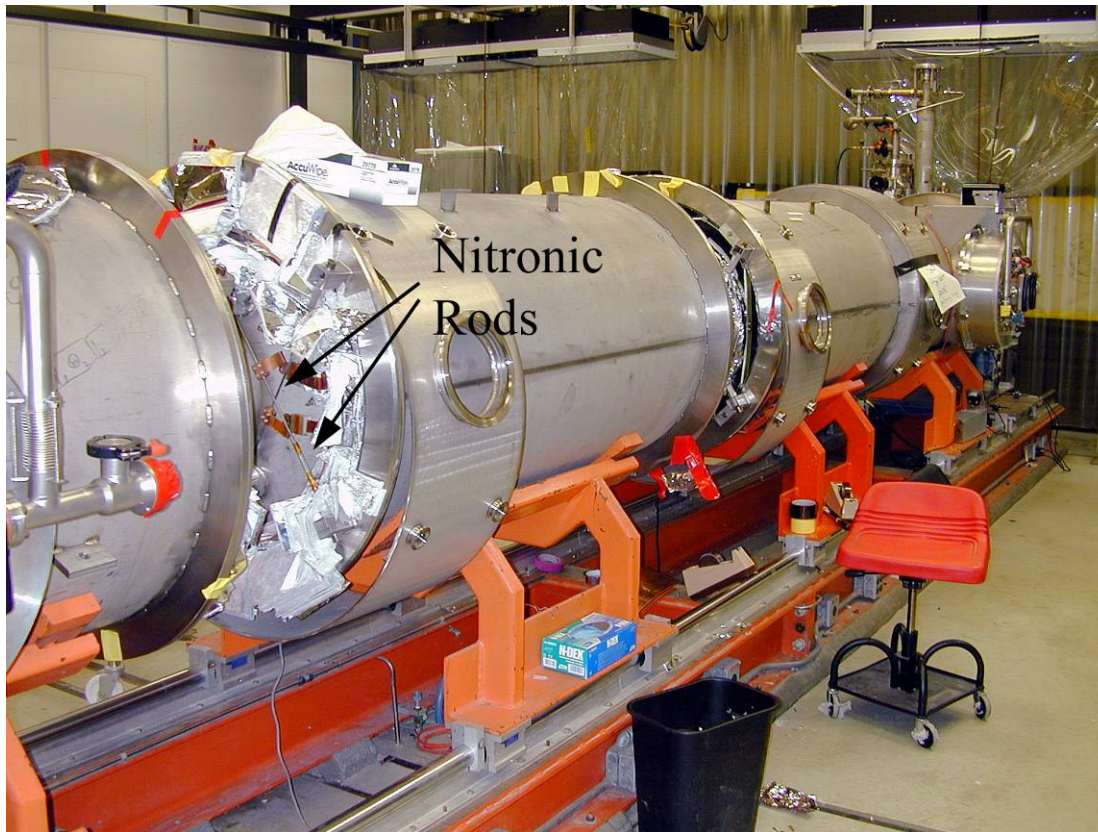
Cryomodule Assembly 2: Helium vessel



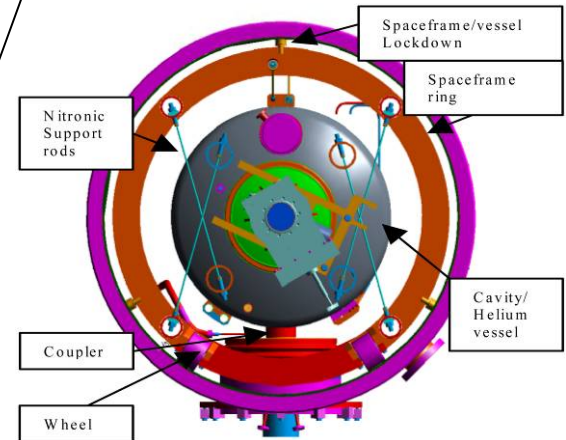
Cryomodule Assembly 3: Vacuum vessel



Cryomodule Assembly 4: Cryomodule



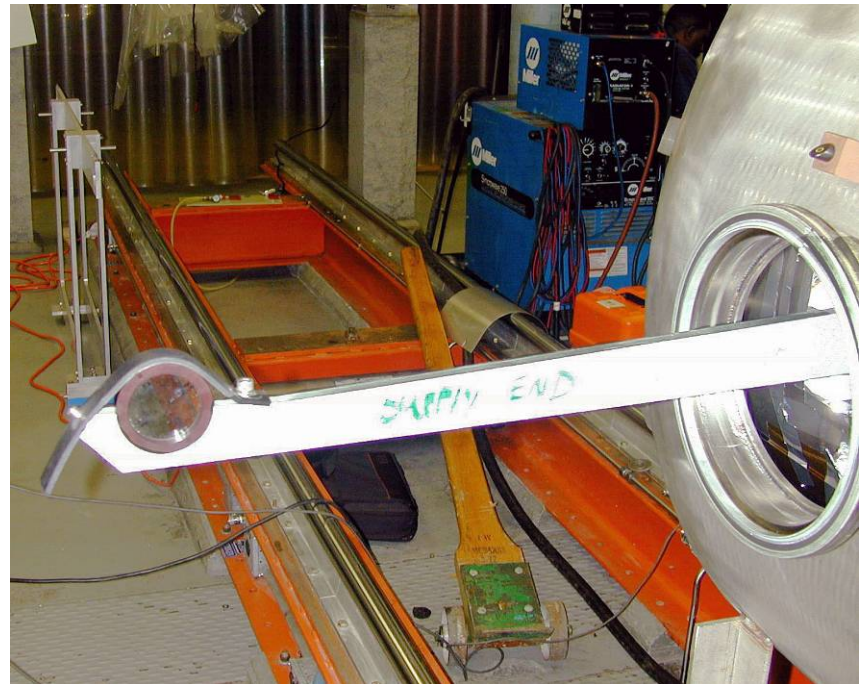
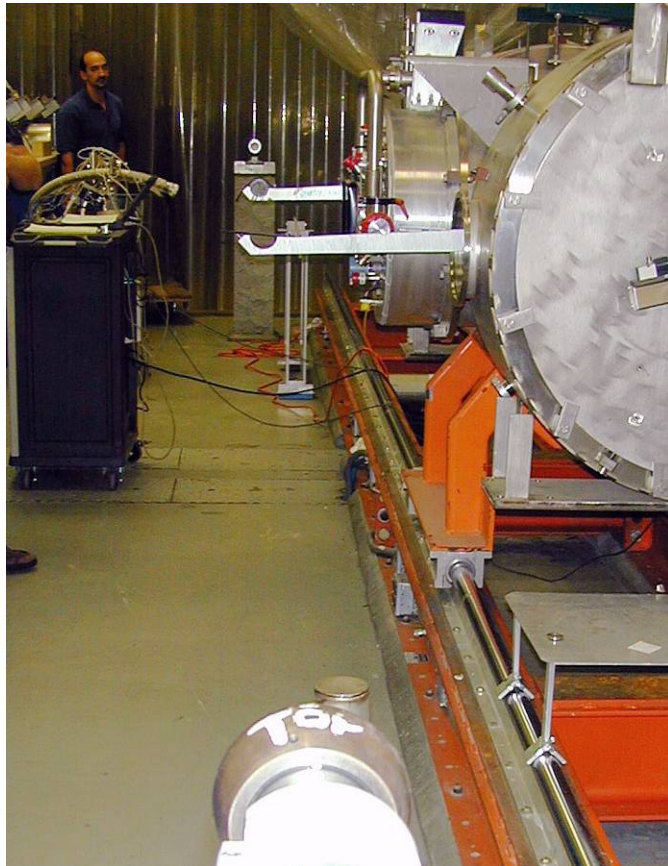
Granite
Pier



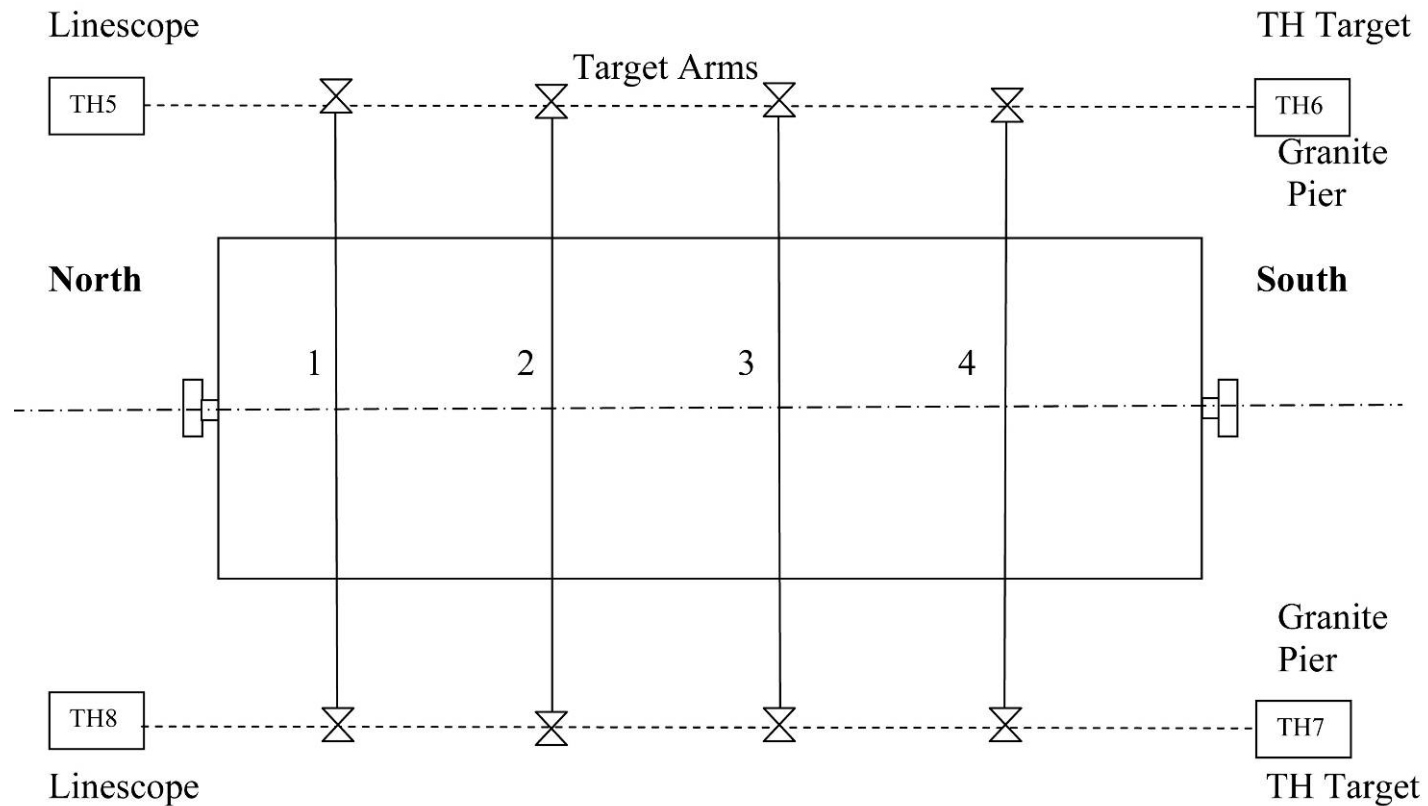
Cryomodule Alignment Piers



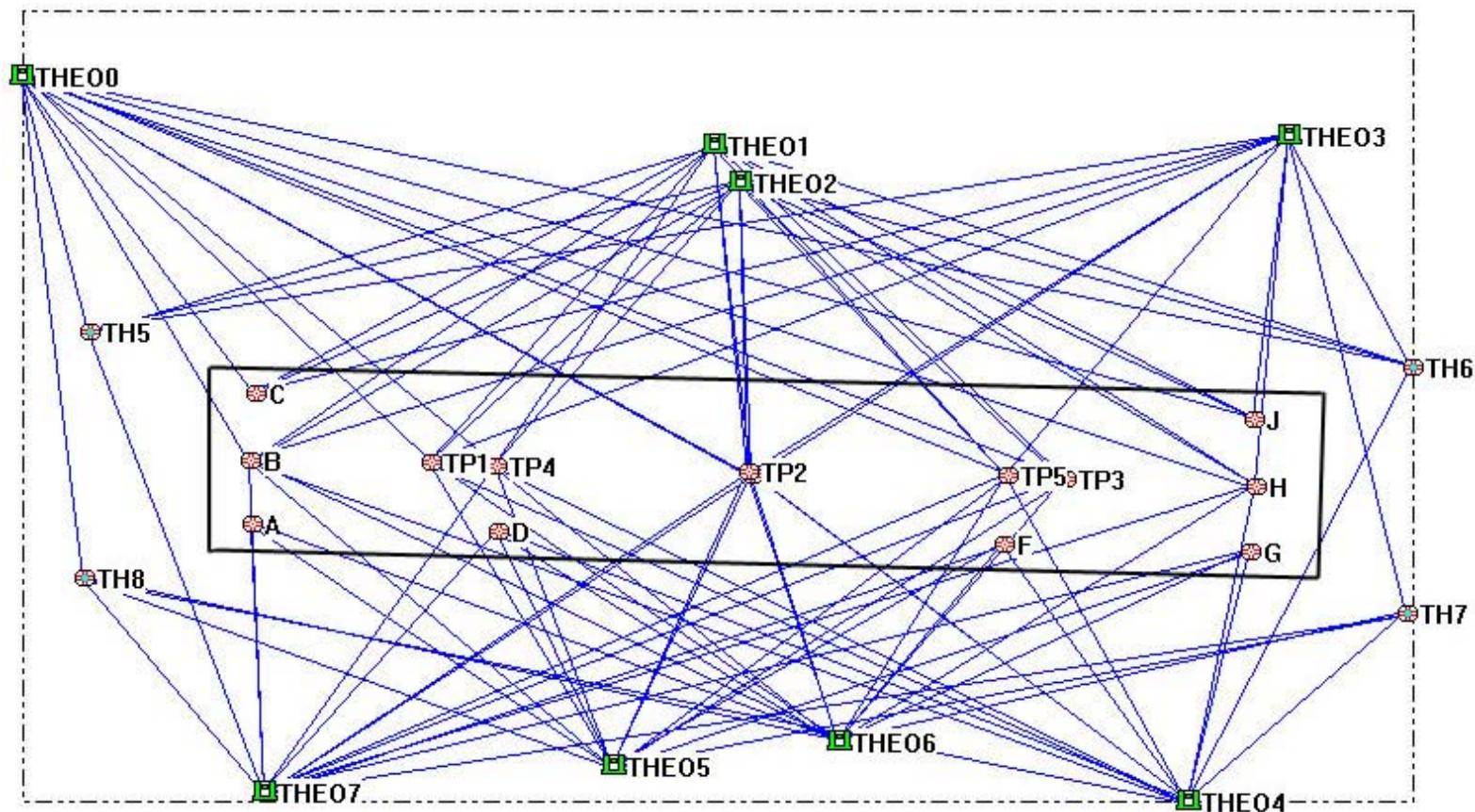
Cryomodule Alignment Arms



Cryomodule Alignment Scheme



Fiducialization Scheme



Cryomodule Fiducialization



Fiducialization Results – Theodolites, Aug 1992

Cryomodule 23

	SZ	SX	SY
TH1	0.010	0.033	0.030
TH2	0.068	0.027	0.024
TH3	0.068	0.032	0.028
TH4	0.016	0.042	0.023
A	0.027	0.039	0.020
B	0.023	0.035	0.017
C	0.027	0.033	0.022
D	0.043	0.033	0.017
E	0.047	0.025	0.013
F	0.056	0.026	0.018
G	0.060	0.028	0.022
H	0.059	0.025	0.017
J	0.060	0.026	0.019
TP1	0.036	0.033	0.023
TP2	0.048	0.029	0.019
TP3	0.056	0.027	0.020
TP4	0.038	0.028	0.015
TP5	0.052	0.023	0.014
Avg	0.044	0.030	0.020

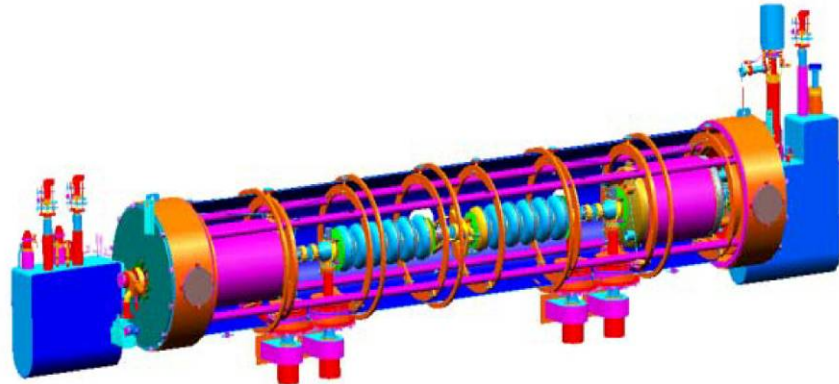
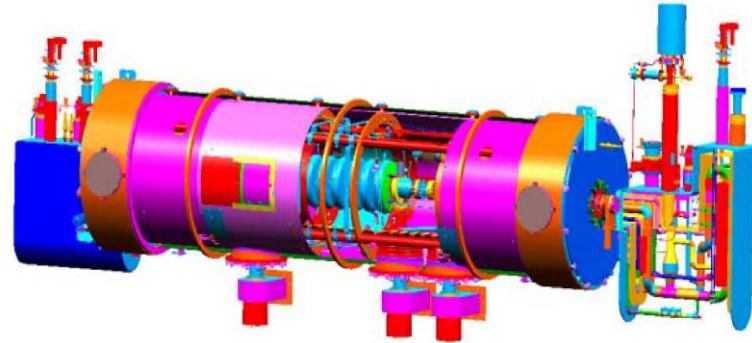


IWAA06

Second Generation Cryomodules

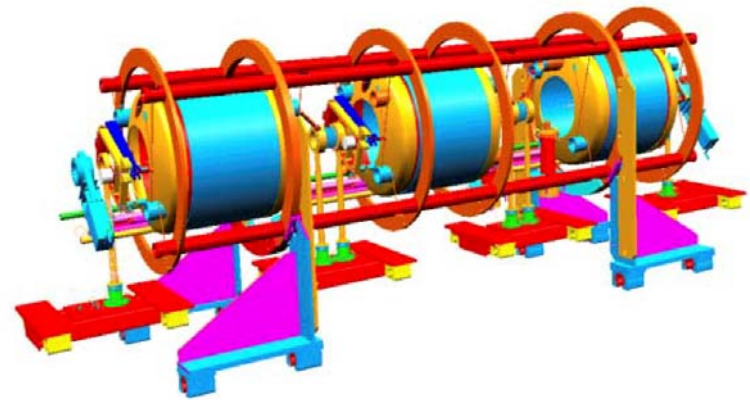
SNS Design

- 6 cells per cavity
- Medium β : 3 Cavities
- High β : 4 Cavities
- Spaceframe



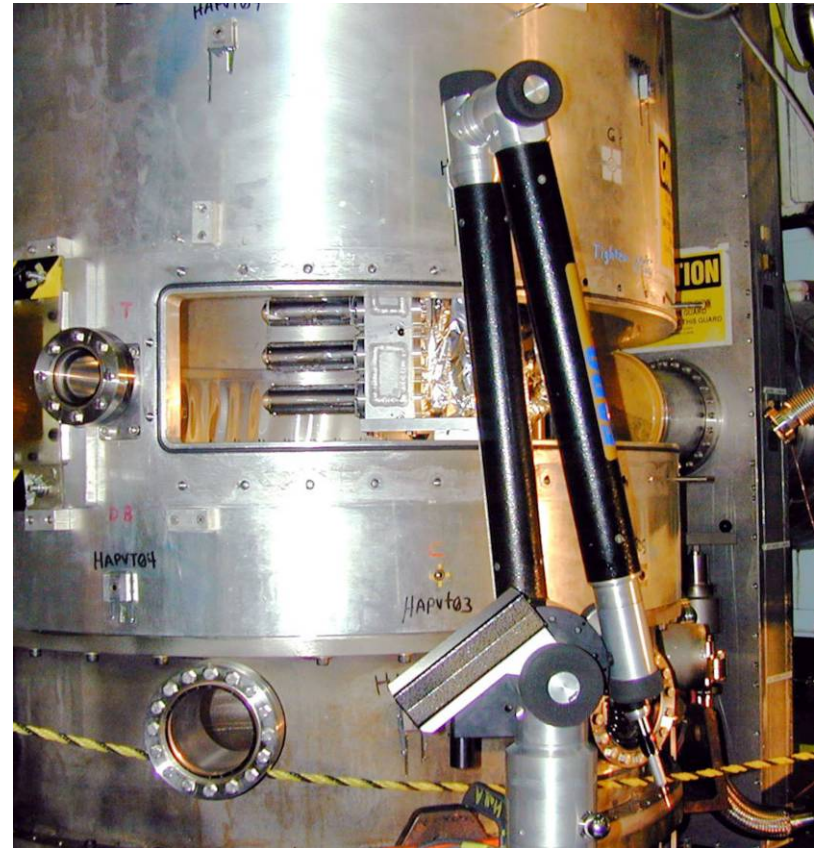
Spaceframe Advantages

- Insertion of entire cavity string
- Vacuum vessel made as one unit
- Transportation stability



Faro PCMM Arm

- 2.4m working volume
- 0.051mm 2σ accuracy
- Used at JLab for:
 - Fiducialization
 - QA\QC measurements
 - Small scale alignment

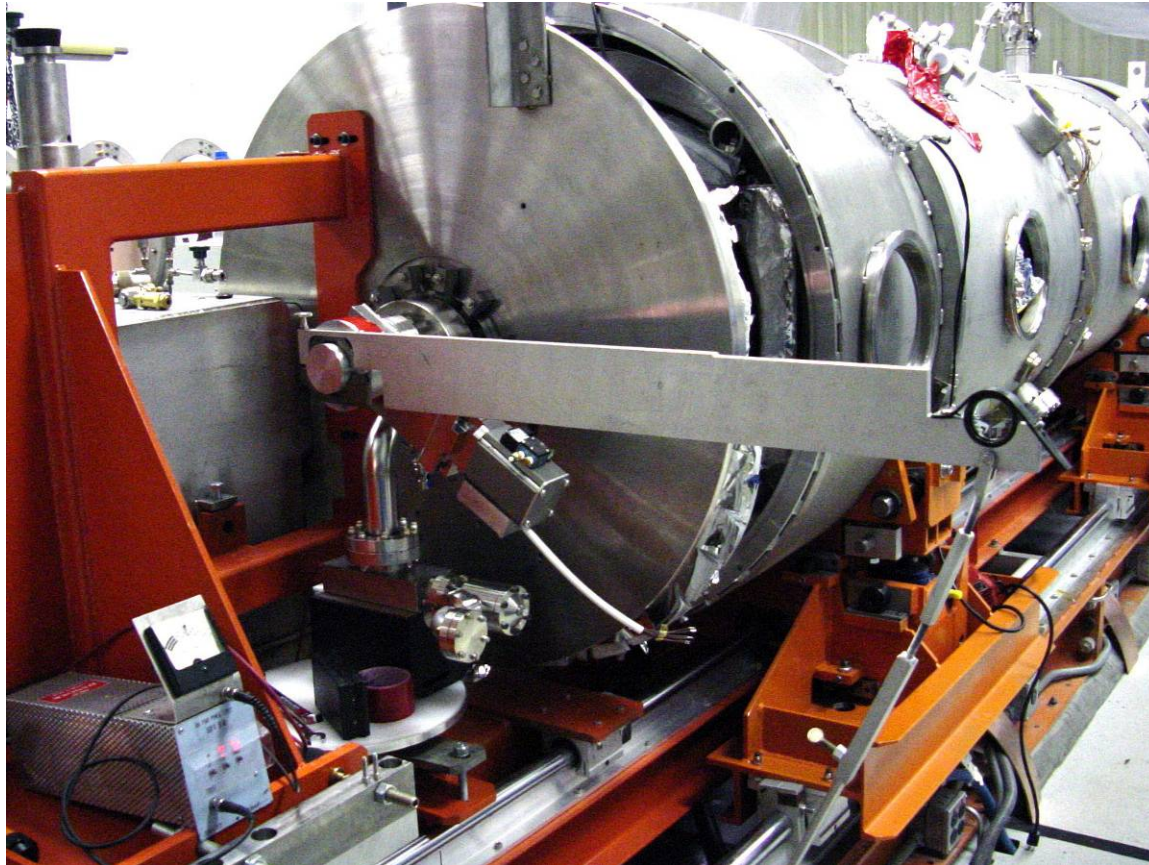


Leap Frog Tests

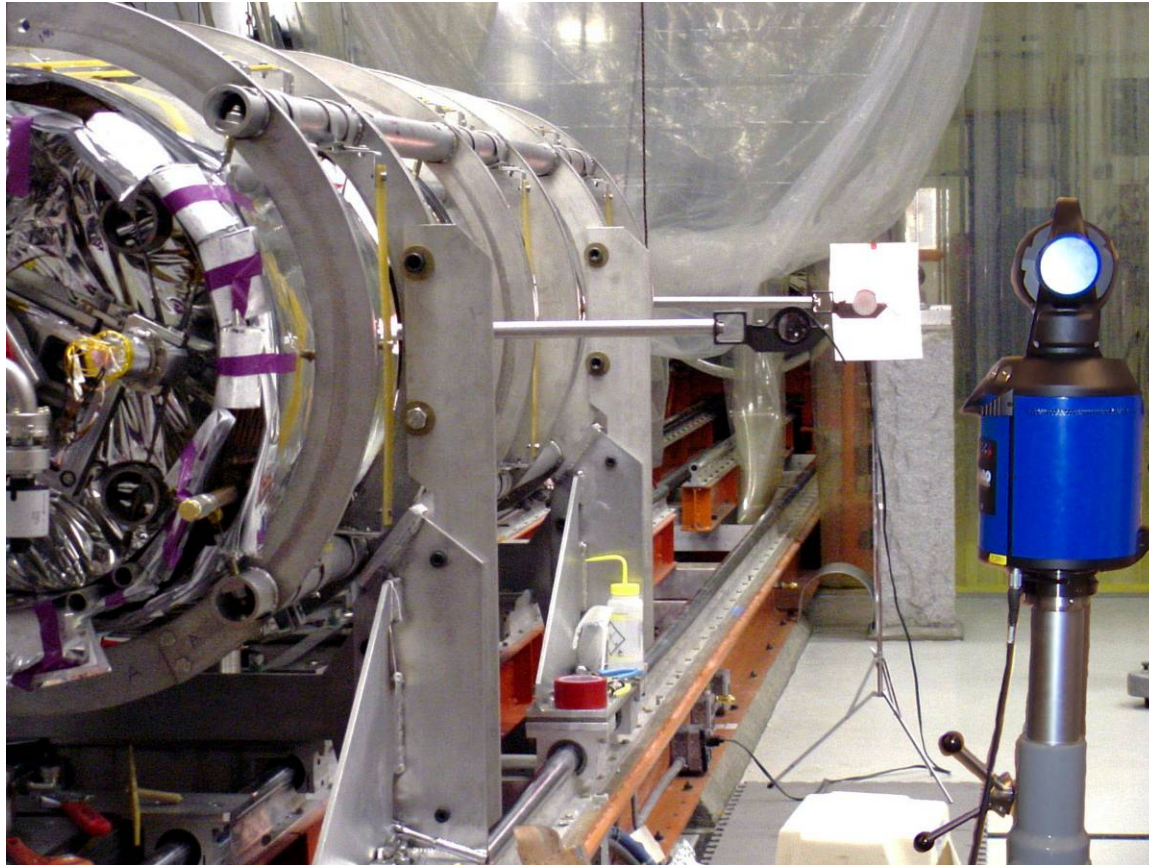
Starting and ending on 6 common points

	DX	DY	DZ
1-1A	0.109	0.792	0.198
2-2A	0.008	0.496	0.053
5-5A	0.091	0.538	0.083
9-9A	0.116	0.431	0.138
11-11A	0.146	0.610	0.024
13-13A	0.115	0.880	0.168

SNS Target Arms



Laser Tracker



Tracker vs. Theodolite

	Tracker				Theod.		
	z	x	y		z	x	y
TH1	0.018	0.014	0.017		0.072	0.035	0.032
TH2	0.015	0.011	0.010		0.032	0.016	0.017
Pt6	0.009	0.009	0.006		0.026	0.020	0.012
Pt7	0.009	0.009	0.006		0.032	0.020	0.013
Pt8	0.010	0.009	0.007		0.041	0.021	0.015
Pt9	0.010	0.009	0.008		0.047	0.022	0.016
<u>Pt10</u>	<u>0.012</u>	<u>0.010</u>	<u>0.009</u>		<u>0.052</u>	<u>0.024</u>	<u>0.018</u>
Avg.	0.012	0.010	0.009		0.043	0.022	0.018

Future Improvements / Conclusion

- Fiducialization survey – Improvement unlikely
- Fixturing – Arms need care to use
- Assembly Process – Datums
- Industrialization and Standardization