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HINS  $\overline{\text{PMG}}$

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November 2<sup>nd</sup>, 2006



# Agenda

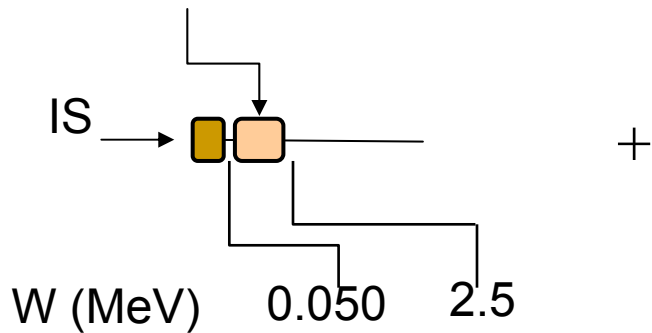
- Civil FY06 Reports (Elaine)
  
- Budget and FY07 Plans
  
- MOU with India
  
- Technical Status
  - Meson Area
  - Beamline Components

# HINS Front End - Stages (1)

HINS

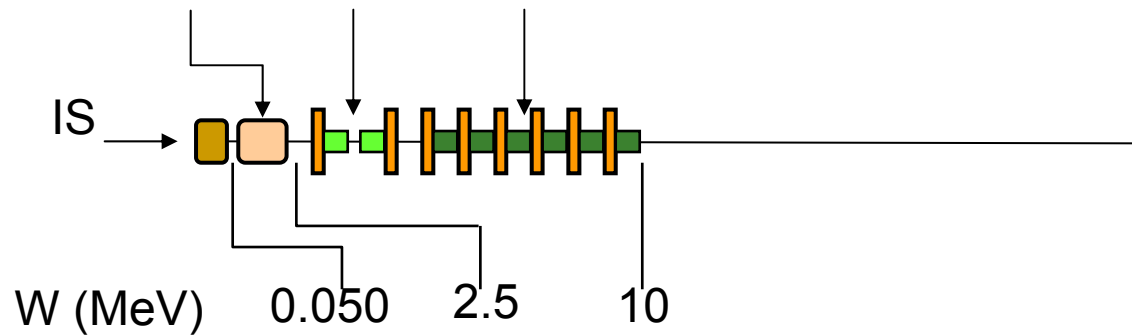
## May AAC

RFQ



- End FY06/Beg FY07
  - Klystron/Modulator/Power Distribution
  - RFQ
  - Test Cryostat/Prototype SSR
  - Klystron & Power Distribution

RFQ MEBT RT-CHSR

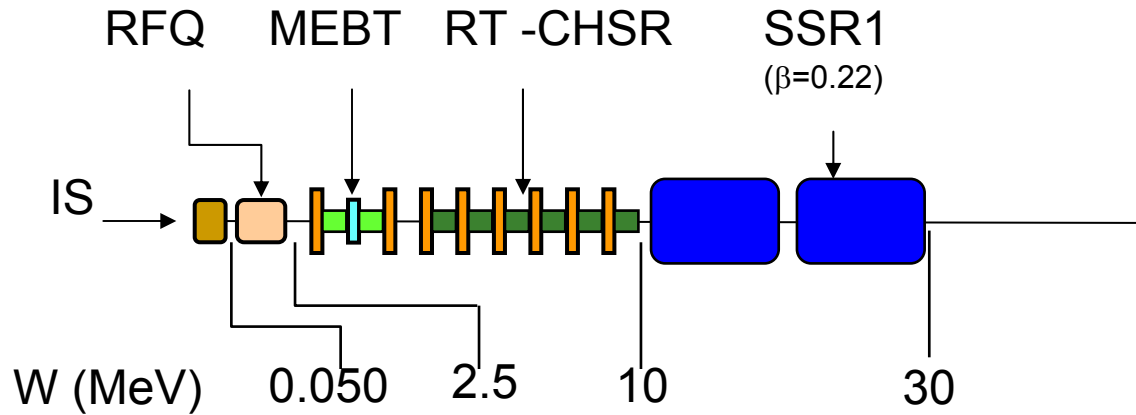


- End FY07/Beg FY08
  - RT Cavities
  - Focusing Solenoids
  - Buncher Cavities

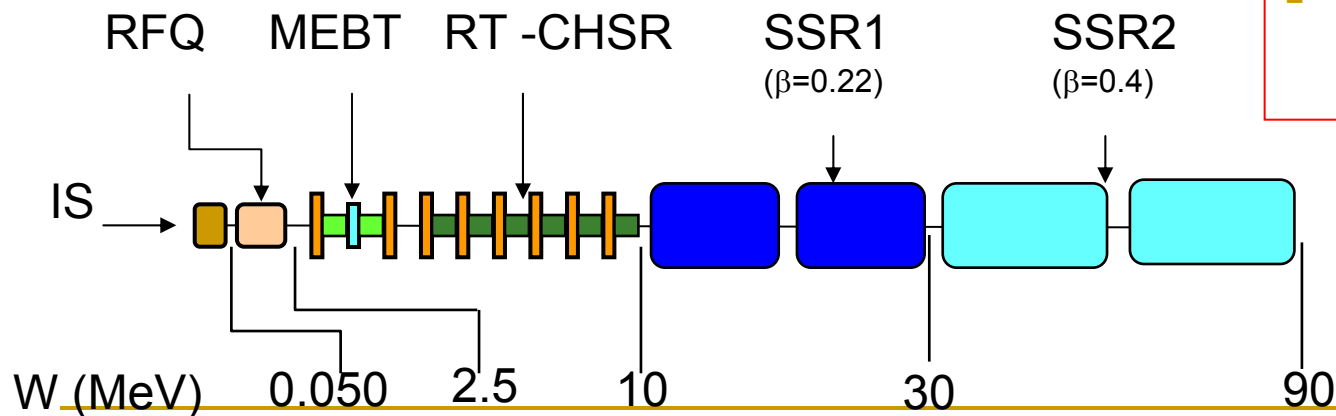
**De-scoping Scenario:  
no Chopper**

# HINS Front End - Stages (2)

May AAC



- End FY08/Beg FY09
- 2 SSR1 cryostats
- Chopper & PS
- Linac Operation



- End FY09/Beg FY10
- 1 SSR2 cryostat
- Linac Operation

**De-scoping Scenario:  
1 SSR2 Cryomodule**

# Budget FY06

## ■ FY06 Efforts (*Project 30.13 since January '06*)

### □ Manpower Total

- AD 0.8 M\$ (17k FTE-h)
- TD 2.2 M\$ (37k FTE-h)

### □ M&S Total 5.636 M\$

#### ■ M&S (Cost+Obl.) ~ 3.5 M\$

#### ■ MOUs

- Argonne 700 k\$
- LBL 365 k\$
- BNL 800 k\$
- HBar 50 k\$
- MSU 200 k\$

•Civil	350 k\$
•RF Power System	470 k\$
•Klystron	500 k\$
•IS-MEBT	100 k\$
•RFQ	500 k\$
•Chopper Pulser	50 k\$
•RT Resonators	100 k\$
•Spoke SC Cavities	260 k\$
•Niobium	40 k\$
•Meson Area	220 k\$

# Plans for FY07 M&S (no Overhead)

## ■ Optimum Scenario

### □ 5.3 M\$ M&S

- 550 k\$ for SSR1 in India
- 800 k\$ for 23 RT Sol.
- 850 k\$ for 23 RT Cav.
- 550 k\$ for SSR1 in India
- 250 k\$ Meson Beamline Services

### □ Could live with 3.6 M\$

## ■ Guideline

### □ 0.73 M\$ for M&S

<i>First Priority</i>	<b>Test Cryo</b>	Test Cryostat FNAL	150	20
		Test Cryostat Installation & Accessories	25	
	<b>RFQ</b>	Acceptance Test (RF Power)	20	
		Acceptance Test (Beam Performance)	50	
	<b>SC Spoke Cavit</b>	2 SSR1 Cavitator India	50	
		4 SSR1 He Vessel	60	20
		4 SSR1 Slow Tuner	40	
		4 SSR1 Fast Tuner	40	
		6 Power Couplers (plus Ceramic)	162	
		SC SSR1 Tooling	25	
	<b>MOU Contract</b>	ANL-Shepard (SSR1 India Processing)	175	
		ANL-Ortraumov	250	
		LBNL (Buncher Cavitator Construction)	100	
	<b>Solenoid</b>	SC Wire (23)	50	
		RT Solenoid (23)	140	
		RT Cryostat (23)	540	
		RT Power Leads (46)	70	
	<b>RT Cavitator</b>	RT Cavitator \$2-\$10	550	
		RT Power Couplers (16)	70	
		RT Tuner (32)	72	
		RT Cavitator Services (Pumps, Water, etc.)	100	
		RT Cavitator Tooling	20	
		Rail	50	
		Tooling for Testing	10	
	<b>RF</b>	RFQ-RTIQM	60	
		4-quadrant Power Supply	40	
		325 MHz Klystron Commissioning	20	
		Power Distribution System	80	
	<b>Guest Personnel</b>	G. Galazzi - Eng.	45	
		Vladimir Arzooov - ANL Beam Simulation	90	
	<b>Ion Source</b>	Preparation H+	50	
		Preparation H-	100	
	<b>PD Travel</b>	Overall Travel	50	
	<b>Services &amp; LLR</b>	Control	100	
		Cooling Water	25	
		Crya Installation	60	
		Beam Diagnostic	60	
	<b>Total First Priority</b>		<b>3598</b>	<b>40</b>
<i>Second Priority</i>	<b>Chopper/MEBT</b>	Chopper	100	
	<b>SC Spoke Cavit</b>	SSR1 Full Order (India - 22 Cavitator)	550	
		SSR1 Vessel Full Order (22 Vessel)	330	110
		SSR1 PC Full Order	220	
	<b>RF</b>	Spare Klystron	510	
	<b>Total Second Priority</b>		<b>1710</b>	
	<b>Grand Total</b>		<b>5308</b>	



# Plans for FY07 M&S (no Overhead)

## ■ Survival Scenario

- ~2.7 M\$ M&S (2.5 HINS Project +0.2 TD Credit)
  - RT Cavities #1-#10 (instead of 16)
  - 6 Solenoids (instead of 16)
  - 2 of 4 SC Spoke He Vessels
    - No test of India Cavities

## □ General Direction

- Maintain SC-SSR1 R&D & Critical Collaborations (ANL-LBL)
- Drop “low risk” (from manufacturing point of view) RT Cavities & Sol.
  - High “Beam-Dynamic” risk

<b>Tral Crqa</b>	Tral Crqaal PHAL	150	28
	Tral Crqaal Installation & Assembly	25	
<b>RFQ</b>	Assembly Tral (RF Power)	20	
	Assembly Tral (Beam Performance)	50	
<b>SC Spoke Cavities</b>	2 SSR1 Cavities India	50	
	2 SSR1 He Vessels	30	10
	2 SSR1 Slow Targets	20	
	2 SSR1 Fast Targets	20	
	2 Power Couplers (plus Ceramics)	50	
	SC SSR1 Tooling	20	
<b>MOB Cables</b>	ANL-Shepard (SSR1 India Processing)	-	
	ANL-Oakman	250	
	LBL (Doubler Cavities Construction)	100	
<b>Solenoids</b>	SC Wire (23)	50	
	RT Solenoids (5)	50	
	RT Crqaal (5)	240	
	RT Power Leads (18 of 46)	30	
<b>RT Cavities</b>	RT Cavities B2-B4	550	
	RT Power Couplers (16)	70	
	RT Targets (32)	20	
	RT Cavities Services (Pumps, Water, ...)	50	
	RT Cavities Tooling	20	
	Rail & Misc.	50	
	Tooling for Tooling	10	
<b>RF</b>	RFQ-RT 10Ms	50	
	4-quadrant Power Supply	40	
	325 MHz Klystron Commissioning	20	
	Power Distribution System	80	
<b>General Personnel</b>	G. Galano - Eq.	22	
	Vladimir Anura - ANL Beam Simulati	30	
<b>Ion Source</b>	Preparation H-	40	
	Preparation H-	40	
<b>PD Travel</b>	Overall Travel	50	
<b>Services &amp; L&amp;E</b>	Cables	100	
	Cooling Water	25	
	Crqa Installation	50	
	Beam Diagnostics	50	
		265	38
<b>Clagger/HEDT</b>	Clagger	100	
<b>SC Spoke Cavities</b>	SSR1 Full Order (India - 22 Cavities)	550	
	SSR1 Vessels Full Order (22 Vessels)	350	10
	SSR1 PC Full Order	220	
	2 SSR1 He Vessels	30	10
	2 SSR1 Slow Targets	20	
	2 SSR1 Fast Targets	20	
	4 Power Couplers (plus Ceramics)	100	
<b>Ion Source</b>	Preparation H-	10	
	Preparation H-	50	
<b>MOB Cables</b>	ANL-Shepard (SSR1 India Processing)	175	
<b>General Personnel</b>	G. Galano - Eq.	23	
<b>Solenoids</b>	RT Solenoids (18 of 23)	90	
	RT Crqaal (18 of 23)	324	
	RT Power Leads (36 of 46)	36	
<b>RF</b>	Scarc Klystron	510	
		265	



# Plans for FY07 M&S (in detail)

HINS

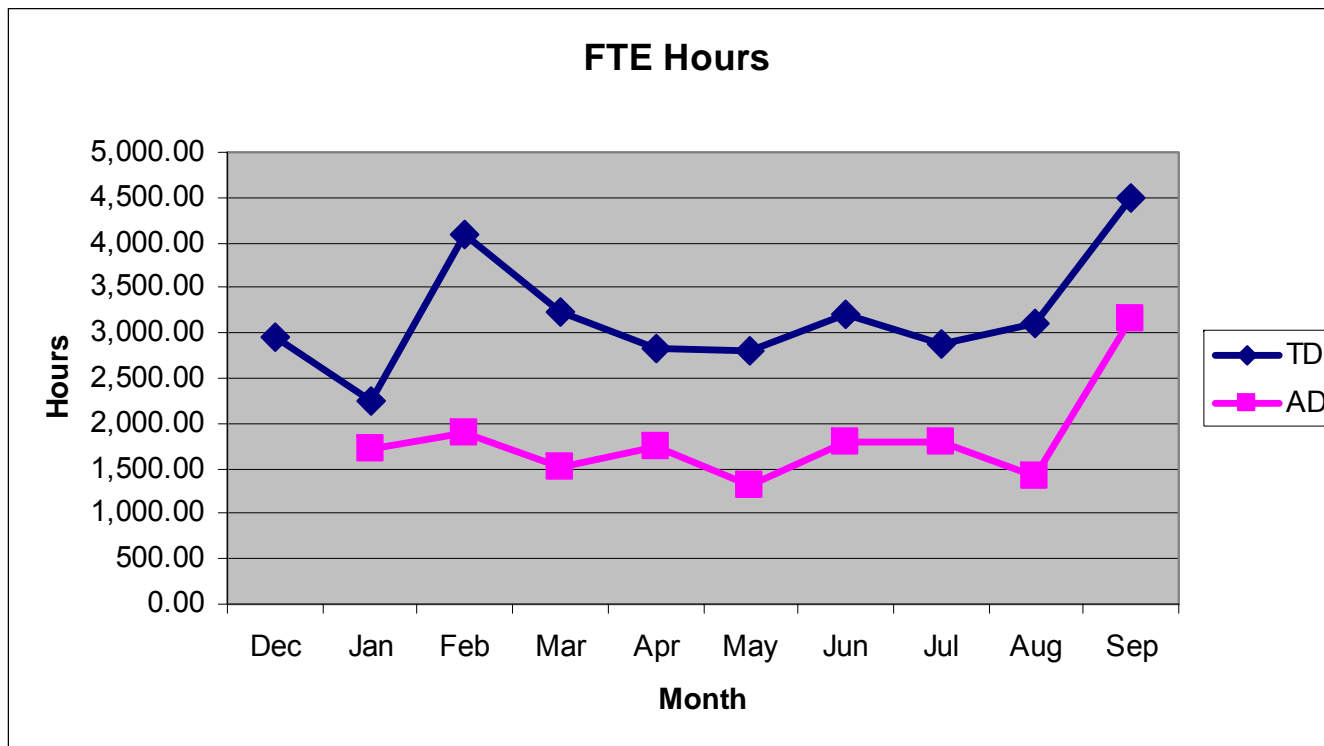
■ Spoke Cavities Test Cryostat	195 k\$
■ RFQ Acceptance Test & Inst.	70 k\$
■ SC Spoke Cavities	210 k\$
□ 2 Cav. To India	
□ 2 He Vessels, Tunes, etc. - <i>instead of 4</i>	
■ MOUs (ANL/Peter+LBL/Buncher Cav.)	350 k\$
■ Solenoids (Wire + 6 Assemblies) – <i>instead of 16</i>	350 k\$
■ RT Cavities (#1-#10) – <i>instead of 16</i>	820 k\$
■ IQM/RF Power Distribution (RFQ+RT Cav.)	200 k\$
■ Visitors	110 k\$
■ Ion Source	80 k\$
■ Travel	50 k\$
■ Services & LLRF	250 k\$

# Plans for FY07 SWF

- Keep Manpower at FY06 level in AD and TD at approximately 3 M\$ level (even if not ideal)
  - ~1.8-2 M\$ in TD
  - ~0.9-1.1 M\$ in AD

↓

Average duty factor in TD ~75%  
Average duty factor in AD ~25%



*Average*  
 TD 3182 h/month  
 AD 1817 h/month

# Accelerator Division Manpower

HINS

## Status

- Many people are interested
  - weekly AD HINS meeting typically draws up to 15 people
- ES&H interlocks group has been particularly responsive and productive
- It is a problem that this program is essentially no one's priority assignment
- Lack of committed resources makes credible scheduling very difficult
- Resources in particular demand are:
  - HL & LL RF Engineers
  - Radiation safety experts
  - Mechanical and electronic techs

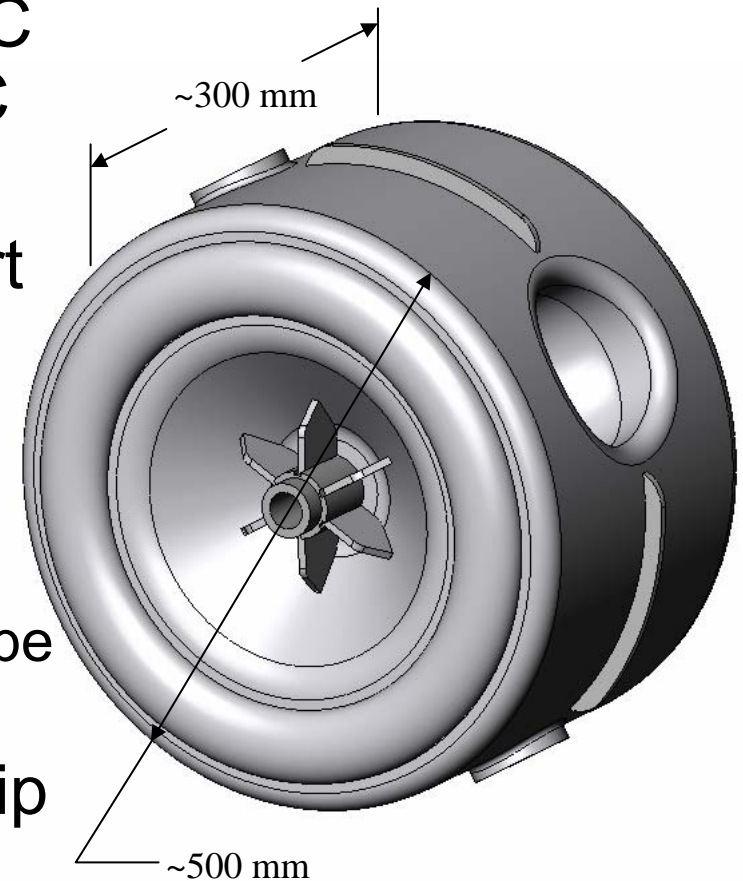
- September AD Manpower utilized
- Note that 44%, 6 FTE, went to modulator which is near completion

Values are in percent time - dividing by 100 gives FTE count

Task	Name	Total
PD Accelerator Controls & Software		21
PD Civil - FESS		3
PD Ion Source Through MEBT		83
PD Klystrons		13
PD LCW		91
PD Machine Design SWF		176
PD Meson Facility		174
PD MI RF Upgrade		8
PD MI Transfer Line		10
PD Modulators, Pulse Transformers & Power Supplies		599
PD Project Management SWF		18
PD RF Controls		3
PD RF Distribution		159
PD System Engineering		5
PD Vacuum		8
Grand Total		1371

# MOU with INDIA - IUAC

- Signed MOU with INDIA –IUAC for full production of 2 SSR SC Cavities
- Total cost ~50k\$ “on best effort basis”
- Nb from FNAL.
  - Certainly enough for 1 SSR1, maybe enough for 2 SSR1s (depending on usage at US/Europe vendors)
- MOU in Shekhar’s hands on trip to India for signatures with R. Staffin

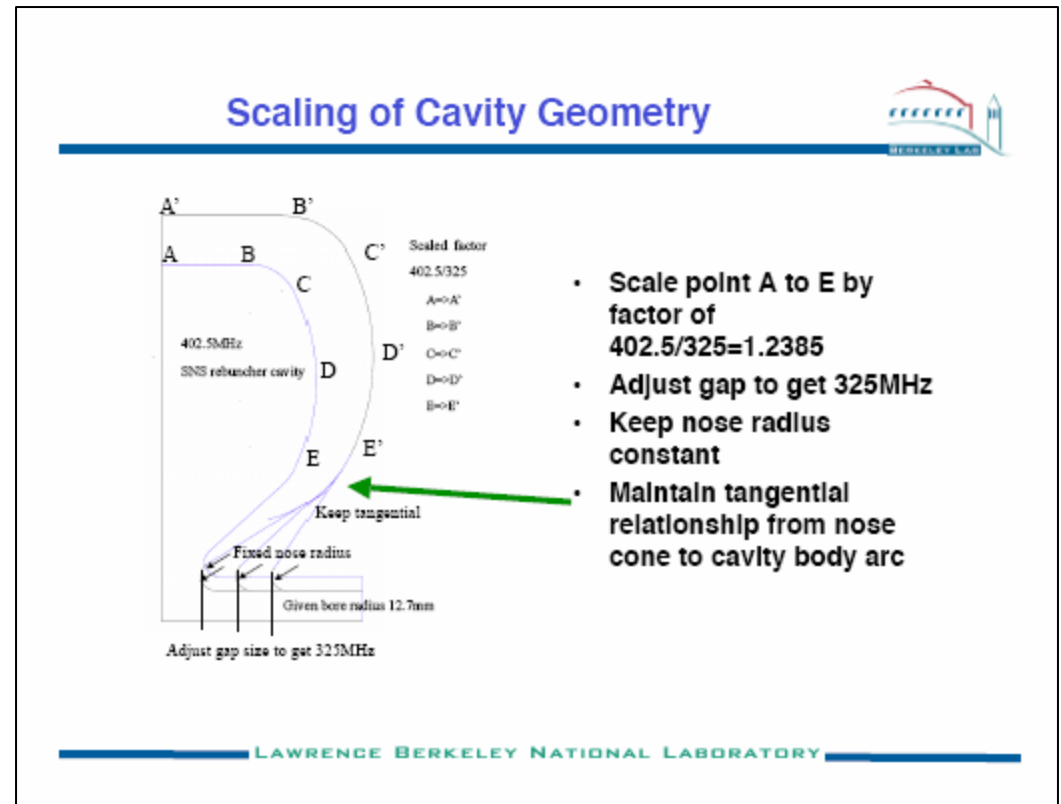


## ■ Laser Profile Monitor

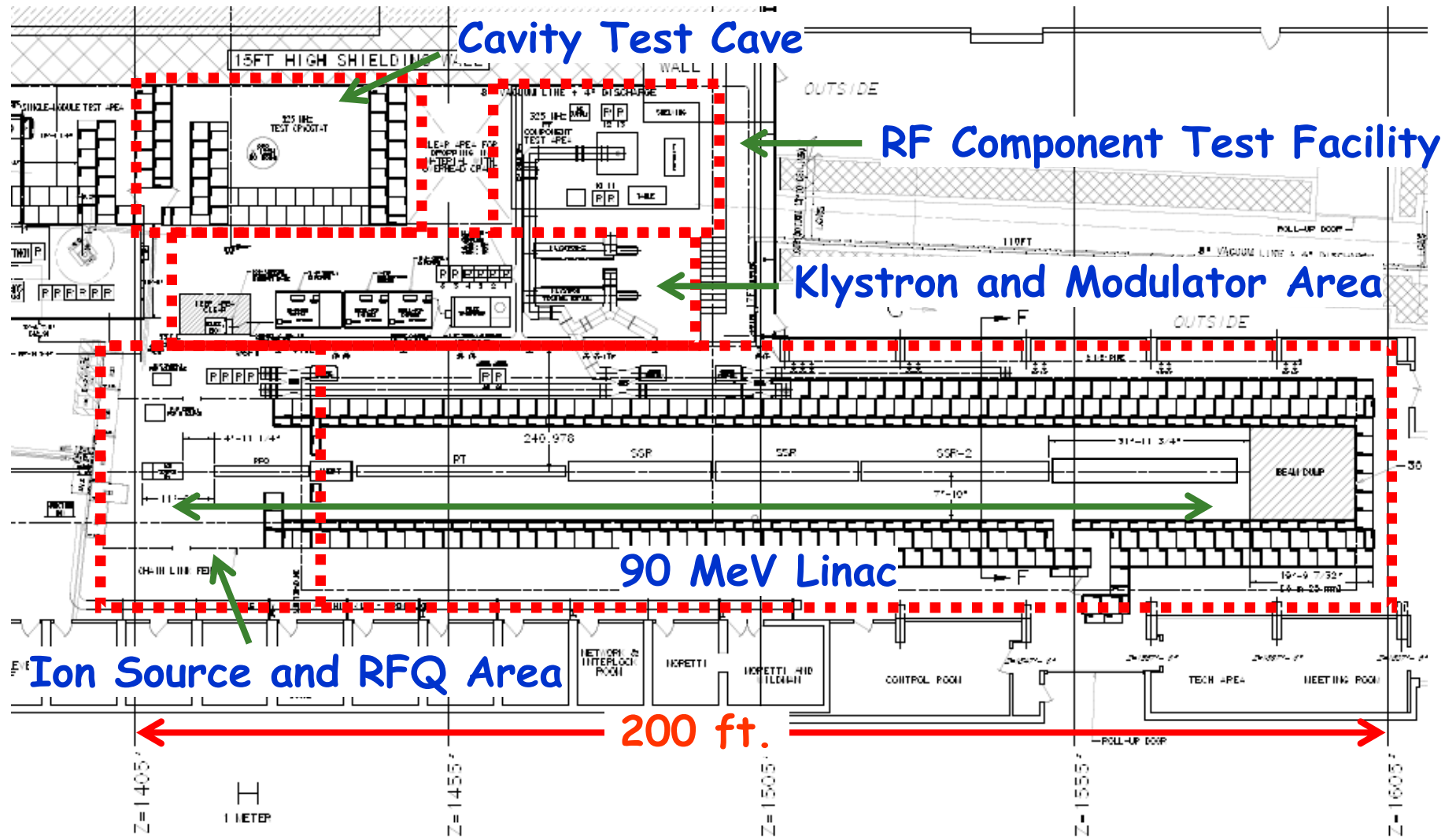
- Preliminary design of the chamber and electron optics are finished.
- 3D model in OPERA to study optics is underway
- We should be receiving a drawing and results of the OPERA study in near future
- Electron detector to be installed should work from 750 KeV to well above 100 MeV.
- Scanning platform (motor + mirrors) should be able to scan a 2 cm beam in 180 us according to info. from vendor.
- Plan to install chamber and laser in 750 KeV beam line for initial tests in Nov. (date of the test has not been finalized)  
– FNAL should be present for these tests.
- Data acquisition system is being developed in parallel. (no further detailed info at this time)

# MOU with BNL

- Buncher Cavities Design
  - Pre-Design meeting on Septemebr 21<sup>st</sup>
  - Agreed on parameters
  - Scaled SNS rebuncher meets HINS requirements
  - To schedule “Design-Go-Ahead” Meeting in November '06.



# Technical Status – Meson Area







# Meson Status November 2, 2006

HINS

- Power distribution and water system infrastructure for klystron, RF component test area and cavity test cave essentially complete
- Klystron cooling water connected and circulating
- Pulse transformer and klystron cathode oil tanks filled
- Waveguide installed to RF component test area
- RF component test area shielding cage assembly 80% complete
- Safety interlock boxes and chassis' installed
- Timing system and computers for controls are installed
- Working with AD ES&H to define and write necessary safety documentation
- **Still waiting on klystron modulator**

# Meson Schedule 2006

HINS

original dates from May '06 (red May/August updates) green as of 11/1/06

- Short “mock” Linac cave section available
  - May 2006 ✓ (nothing yet modeled or installed)
- Klystron modulator completion
  - July 2006 (late July) (late September) (late October) (begin testing in November 2006, maybe ready for klystron in Dec.)
- 325 MHz RF power system commissioning
  - July 2006 (early August) (early October) (November) (~Dec.15)
- 325 MHz component testing in RF test area
  - Starting August 2006 (delayed due to Modulator) (~ Dec. 15)
- 325 MHz RT cavity power testing in cavity test cave
  - September 2006 (delayed due to Modulator) (mid-January 2007)
- Superconducting cavity test cryostat installation
  - October 2006 (Spring '07) (Summer '07) (late summer 2007)
- Ion Source installation in Meson
  - November 2006 (January '07) (CC2 shows no sign of going away!!)

# Meson Schedule 2007

HINS

original dates from May '06 (red May/August updates) green as of 11/1/06

- RFQ (now in procurement) delivery and power testing
  - January 2007 (~6 months from June 30, 2006 order date) (~6 months from Sept. 14, 2006 review date) (May 2007)
- Production quantity RT cavity and coupler delivery & testing
  - Starting February 2007 (May 2007)
- 2.5 MeV beam tests
  - Beginning February 2007 (April 2007) (June 2007?) (CC2 !!)
- First SC spoke resonator power tests in test cryostat
  - April 2007 (Fall 2007 ? )
- Linac cave construction and utilities installation
  - May 2007 (October 2007)
- Demonstration of multiple Room Temperature cavity RF distribution and independent amplitude & phase control
  - July 2007 (FY08)
- Beam accelerated through first 'N' RT cavities
  - September 2007 (optimistic) (FY08)

# Meson Schedule 2008

HINS

original dates from May '06 (red May/August updates) green as of 11/1/06

- Full 10 MeV RT linac installed
  - April 2008 (October 2008)
- R&D beam operations at 10 MeV
  - Starting May 2008 (January 2009)
- First SC spoke resonator cryomodule installation
  - October 2008
- Tests of RT + SC cavity RF distribution and independent amplitude & phase control
  - November 2008
- Beam through first SC spoke cryomodule
  - December 2008 (optimistic)

# Cavity Test Cave Layout

HINS





# Klystron and Waveguide

HINS





# RF Component Test Area Cage

HINS



# Electronics Installed



Klystron solenoid power supplies

Klystron and modulator interlocks



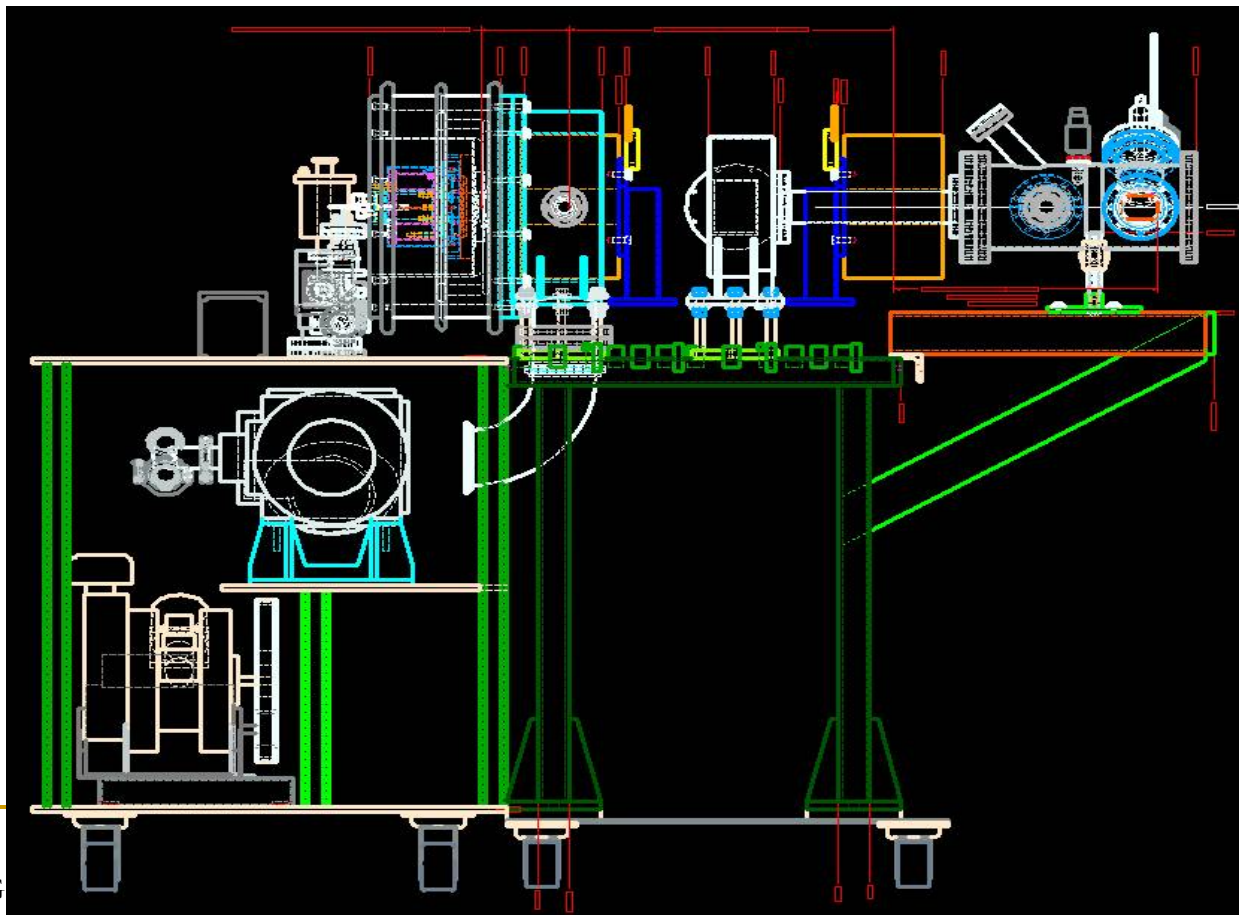
Control system timing crate

Personnel safety interlocks

# Beamline Elements – Ion Source

HINS

- Ion Source: first H<sup>+</sup> current in MS6 !
  - C. Schmidt, D. Moehs, H.Piekarz





# Beamline Elements – Ion Source

HINS



# Beam Elements – Ion Source

HINS



SC Magnets  
at Fermilab

## First tests and results

Arc Supply Modulator Timing

66  $\mu$ sec      66 msec      66  $\mu$ sec



- ❖ **Test settings**
  - H<sub>2</sub> flow 120 mTorr
  - Filament 20 A
  - IS magnet 25 V, 0.5 A
  - LEBT 600 A / 500 A
  - Acc. Pot. = (10 – 50) KV
- ❖ **DC beam**
  - Arc supply 160 V, 1 A
  - IS current ~ 400  $\mu$ A,
- ❖ **Pulsed beam**
  - Arc supply 450 V, 60 A
  - IS current ~ 15 mA

### Conclusion:

We have a system to explore  
the ion source and LEBT

## Plans

- Numi 50 kV HV
  - Stable Output Current
- Filament 300 V HV
  - 66  $\mu$ sec to ~3 msec
- H- in MS6 (?)

October 26, 2006

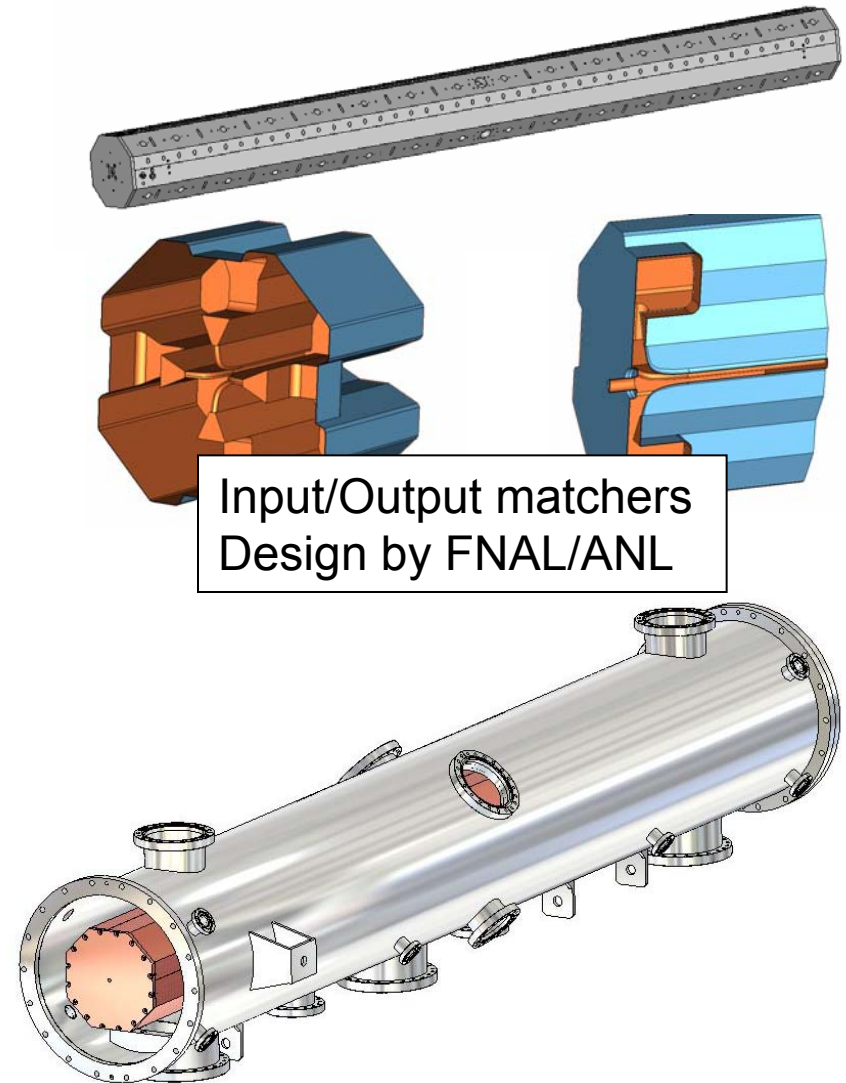
HINS Meeting

Henryk Piekarczyk

# Beam Elements - RFO

HINS

- Production Readiness Review at AccSys (9/21/06)
  - Material Certification received
  - Vacuum ports specified
  - Mechanical tuner designed by AccSys, motor and motor control by FNAL
  - Final inspection of vanes performed by FNAL at manufacturer (Lucas, Seattle)
- (Possible) Schedule
  - Start in January (Lucas Backlog)
  - Vanes machining – 14 weeks
  - AccSys Assembly – 4 weeks
  - Shipment – 2 weeks
  - RFQ at FNAL ~ May 2007



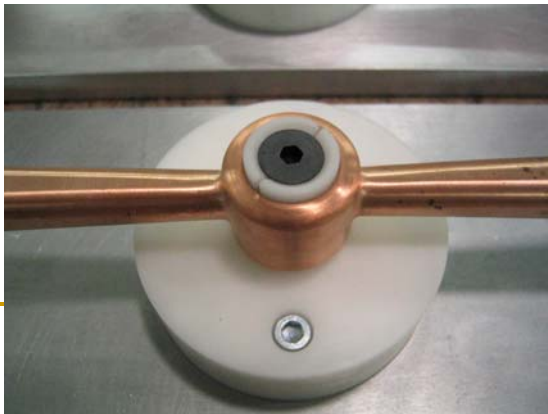
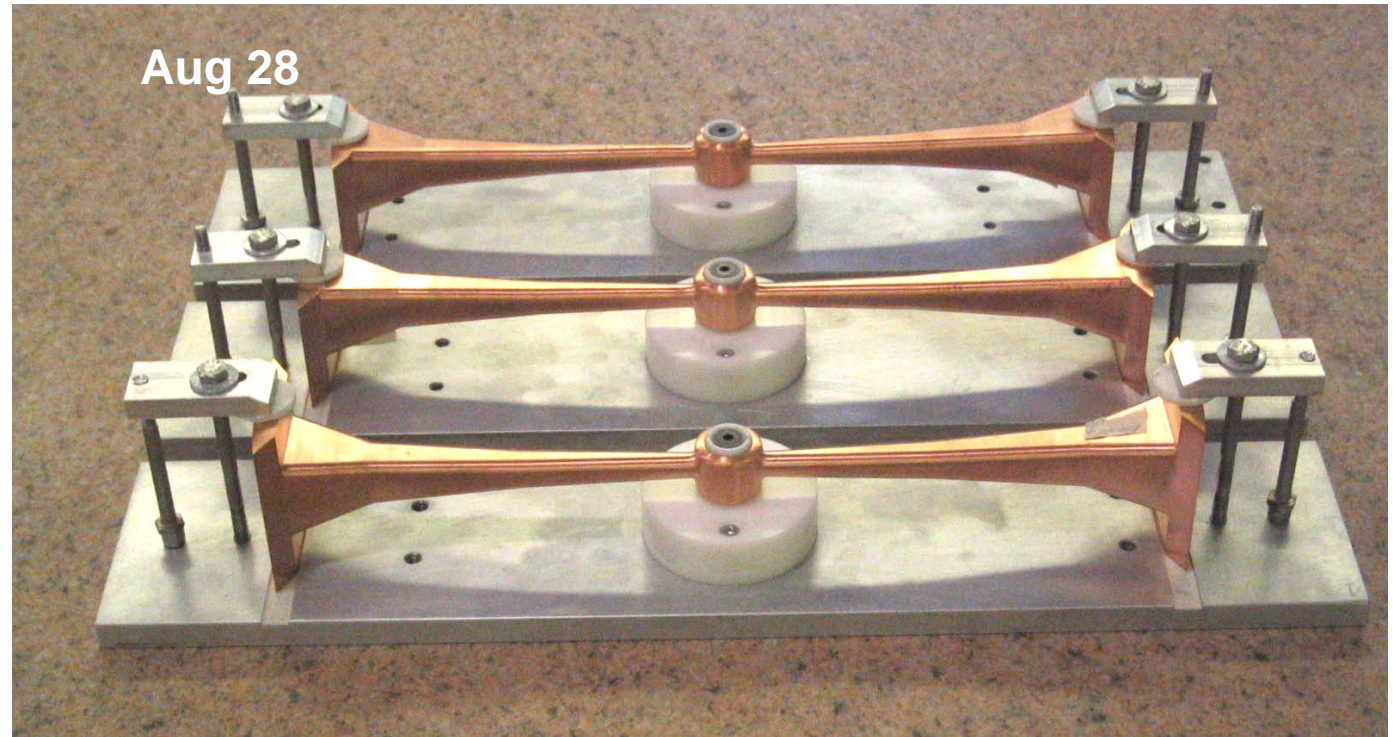


# Beam Elements – RT Spoke Cavities

HINS

Aug 28

Parts were transported using special fixtures fabricated for machining purposes that are now used also for handling





# Beam Elements – RT Spoke Cavities

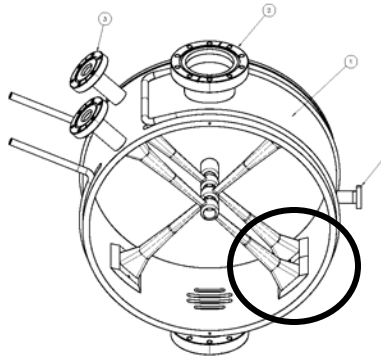
HINS

## ■ CMM QC Results

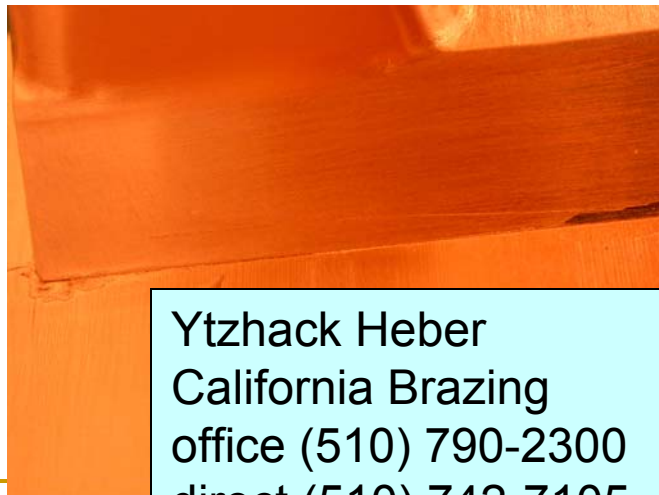
Feature / tolerance	Spoke 1	Spoke 2	Spoke 3
Length of stems 181.925 – 181.950mm	181.895 - 182.000 181.915 - 182.068 $\Delta = 0.000-0.173$	181.933 - 182.067 181.908 - 181.948 $\Delta = 0.000-0.159$	181.893 – 181.932 181.936 – 181.999 $\Delta = 0.004-0.106$
Length of drift tube 23.132 – 23.182mm	23.162 - 23.172	23.153 – 23.179	23.153 – 23.184
OD of drift tube 0 / +2 mil	-2.5 / +1.0	-1.5 / +1.5	-2.0 / +3.0
ID of drift tube -4 / 0 mil	-3.5 / -2.5	-4.0 / -2.0	-3.5 / -2.0

# Beam Elements – RT Cavities

## ■ Brazing



\*NOTE\*  
VIEW SHOWN WITH \*END WALL ASSEMBLY\* HIDDEN.



Ytzhack Heber  
California Brazing  
office (510) 790-2300  
direct (510) 742-7105



# Beam Elements – SC SSR1

## ■ Cavity Manufacturing

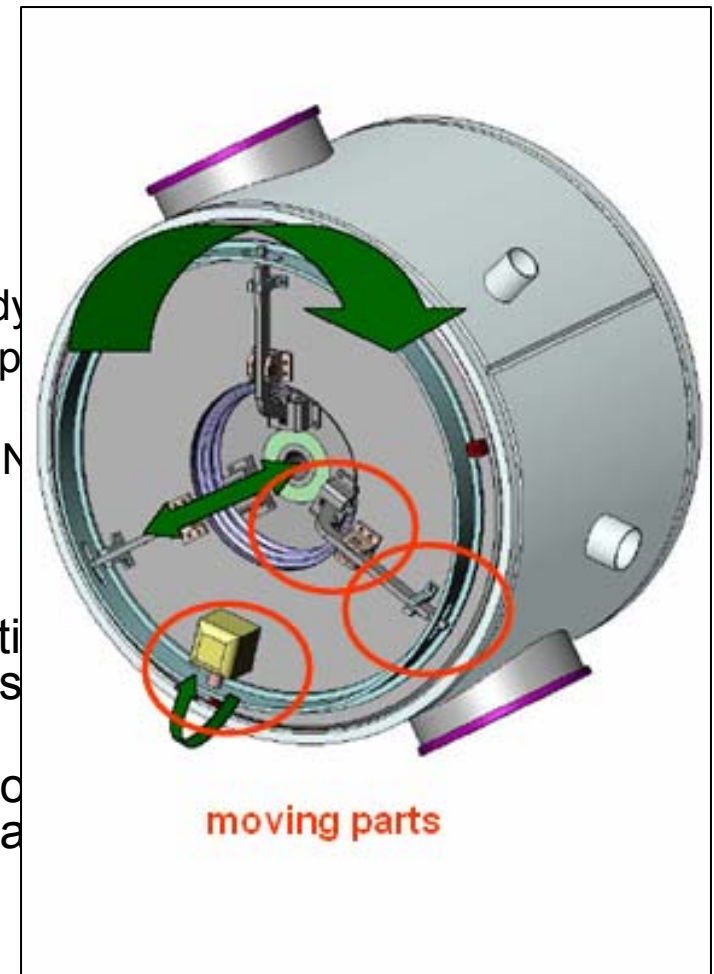
### □ @ Zanon

- All manufacturing drawings are ready
- Fixturing design is currently ongoing
- Schedule
  - First Week of December '06: All Fixturing ready
  - End of December '06: tests of Cu sheets complete
  - Mid January '07: Nb forming starts
  - Brazing: sometimes between now and end of Nov

### □ @ Roark

- Manufacturing drawings ready
- Weld samples in progress (circular weld test samples will be ready by Nov. 3<sup>rd</sup> but still some efforts are needed)
- Brazed parts complete. Leak check, cold shock and load test expected to be completed no later than Nov. 10<sup>th</sup> (next week)

### □ Slow Tuner work converging by end CY06



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# Beam Elements – $\beta=0.81$ EM Tuner

*HINS*

- Potential Interference with duration of Capture Cavity testing in Meson in present cave
  - RFQ delivery by May 2007. Would like to refurbish area/install ion source ~February '06
- Suggestion of using HINS modulator/pulse transformer (4 msec) for 1.3 GHz Klystron test
  - HINS need RF immediately for
    - RF testing (325 MHz klystron, power distribution - now)
    - Cavities Testing (RT cavities - Jan, RFQ - May, etc.)