LRP: Proton Driver subcommittee meeting 6/27/03
Meeting Minutes Shekhar Mishra

(This is a copy of my notes from the meeting. It could be missing a lot of stuff that was discussed. I am sure I missed several points raised.)

1. **RF Power distribution system optimization**.

I. Terechkine discussed the 8 GeV R&D plan for the next two FY. His talk is attached below. There were several discussions during this presentation.
SNS (proton) and TTF (electron) are two places from where we can get information. The front end Linac at SNS is expected to start commissioning in May 05. As soon as the proton becomes relativistic its beam dynamics is similar to that of electron. TTF can answer many question, while the SNS front end and MEBT is better for front end issues.

Bob asked to set a set of goals for the High Power test of the phase shifter. Bill informed the group that there exists such a list of questions.

There was a long discussion on the main issue of 1 klystron→ 1 cavity or 1 klystron→ several cavities with phase shifters. There were discussion that phase shifter cost could be sizable. There were discussion that SNS try to do 1 klystron → several cavities but stopped. This topic needs detailed technical work and discussion.

Dave Finley brought up the issue of cryo-plant. We do not have a cryo-plant and we need to address this issue now.

Phase Shifter testing: There are phase shifters available at Fermilab which can be used for this test. What lacks is a full design of how to connect everything together. The parameters of such a test and time frame needs to be defined.

Al Moretti presented a different plan to do the phase shifter test with in one month with existing components. A Klystron at Lab G will be used for this test. The test will be done at low power. Ultimate goal is to perform a fast phase shifter test at high power. Again the parameters of these test and goals need to be defined, major question is how fast and how much phase shift we want from this device at a particular power level.

There was discussion of klystron cost vs phase shifter cost. Al present a cost estimate from AFT.

Nikolay presented a simulation of the phase shifter. He pointed that one should look at the sharp edges in the ferrite because they can produce a large electric field. He also presented the temperature dependence and magnetic saturation. He made a point that the ferrite needs to be cooled. He presented a list of questions which is attached.

Granndy presented a discussion on multi-practing and micro-phonics issues in the cavity. There were discussion on why SNS did not follow through on its R&D on lower beta

super-conducting structure. ANL, CEBAF and MSU are doing R&D on these topics. There was a request to discuss this with people doing R&D at other labs.

Tom Nicol presented his cryo-module cost estimate beased on SNS and TESLA. There were discussion on hot vs cold. Bill suggested that we need a list of SRF R&D and specifications. Can the requirements be relaxed if we focus only on proton machine and not worry about electrons.

Next meeting is on 7/3/03 at 3:30 P.M.

8-GeV R&D plan for 2004 and 2005 I. Terechkin

Guidance for the plan - e-mail from B. Kephard of 6/5/03

The R&D items should include:
1) R&D necessary to demonstrate feasibility;
2) R&D required to produce a credible cost estimate;
3) other R&D that would be useful if there were money and people to support it.

We then need a plan for this R&D program with time scale, manpower, and M&S estimates.

I. R&D necessary to demonstrate feasibility

1. It is necessary to release a report on 8-GeV linac design study conducted in 2002 so that future work had a solid base. This work must be completed this year. Required manpower - ???

2. Because the linac make use of the existing accelerating systems, the feasibility of the injector is validated by working experience of SNS linac (ORL) and TTF (DESY).

3. To be prepaired for significant spendings in 2004, some management and organizational work must start this year.

- make analysis of power distribution system and specify requirement for the system procurement
- finalize concept of power distribution system

II. R&D required to produce a credible cost estimate

The next R&D tasks can be suggested for FY 2004:

1. To build a prototype of one element of RF power distribution system.

For this purpose it is necessary to procure a fast phase shifter based of specification developed in 2003 (cost estimate was prepared during the 2002 study by A. M. – lead time is 6 months ??). Using one of available at FNAL 805 MHz, 5 MW, 100 μs klystrons, build a facility for testing the power distribution system. Time scale 1 year

Estimated M&S - $75 k ???, manpower – 9 mm

Intellectual part of this work can be done by BD while technical help can be provided by TD

2. To explore other ways of building power distribution system (for example using ferroelectrics instead of ferrites). The goal is to contact a vendor that is making an R&D in this field and try to get a prototype. Potential benefits are faster response and absence of pulse magnets (cheaper in fabrication). Timescale of this work is 1 year. In the case of positive results, system testing to be made in 2005.

Estimated M$S - $50 k, manpower – 3 mm

Work can be done by TD personnel

3. To start R&D on optimizing input couplers for both SC parts of the linac. Initial stage (RF design) will take about 1 year. In the case of a positive results at this stage, the system must be built and tested in 2005

Estimated M&S - $25k, – 6 mm

Work can be done by TD personnel

4. Analysis of benefits of increasing the accelerating pulse length from 1 ms to 2 ms.

Estimated manpower – 2 mm

Work can be done by BD personnel

5. Put together a proposal for accelerating sections test stand, including needed infrastructure, RF systems, and CryoSystem.

Estimated manpower – 4 mm

Work can be done by TD and BD personnel

Total for the FY 04 – $350k

The next R&D tasks can be suggested for FY 2005:

1. To perform testing of power distribution system at specified power, pulse duration, and repetition frequency. ???

Estimated M&S - $350k, manpower – 12 mm

2. Build and test a prototype of an alternative input coupler

Estimated M&S - $50k, manpower - 6 mm

3. Negotiate klystron purchase. Build and test a modulator for a klystron

Estimated M&S - $150k, manpower - 12 mm

Total for the FY 04 – $800k

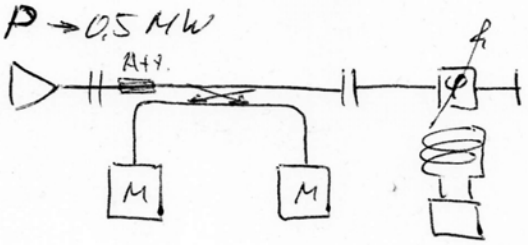
4. **If there is money:** Start procurement of a CryoPlant and RF system for the Test Stand, procure 805 MHz and 1.21 GHz klystrons

Estimated spending – TBD in 2004

Phase Shifter Testing

I Terechkine

1.



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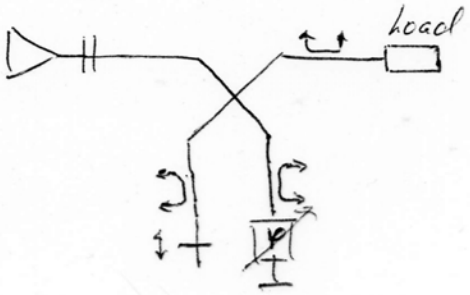


To test:

1. Power test

What do we have if O.K ?

What PSh do we plan to use ?
- how quick ?
- phase shift range ?

Stages:

① Find (order) what is needed (1 week - ?)

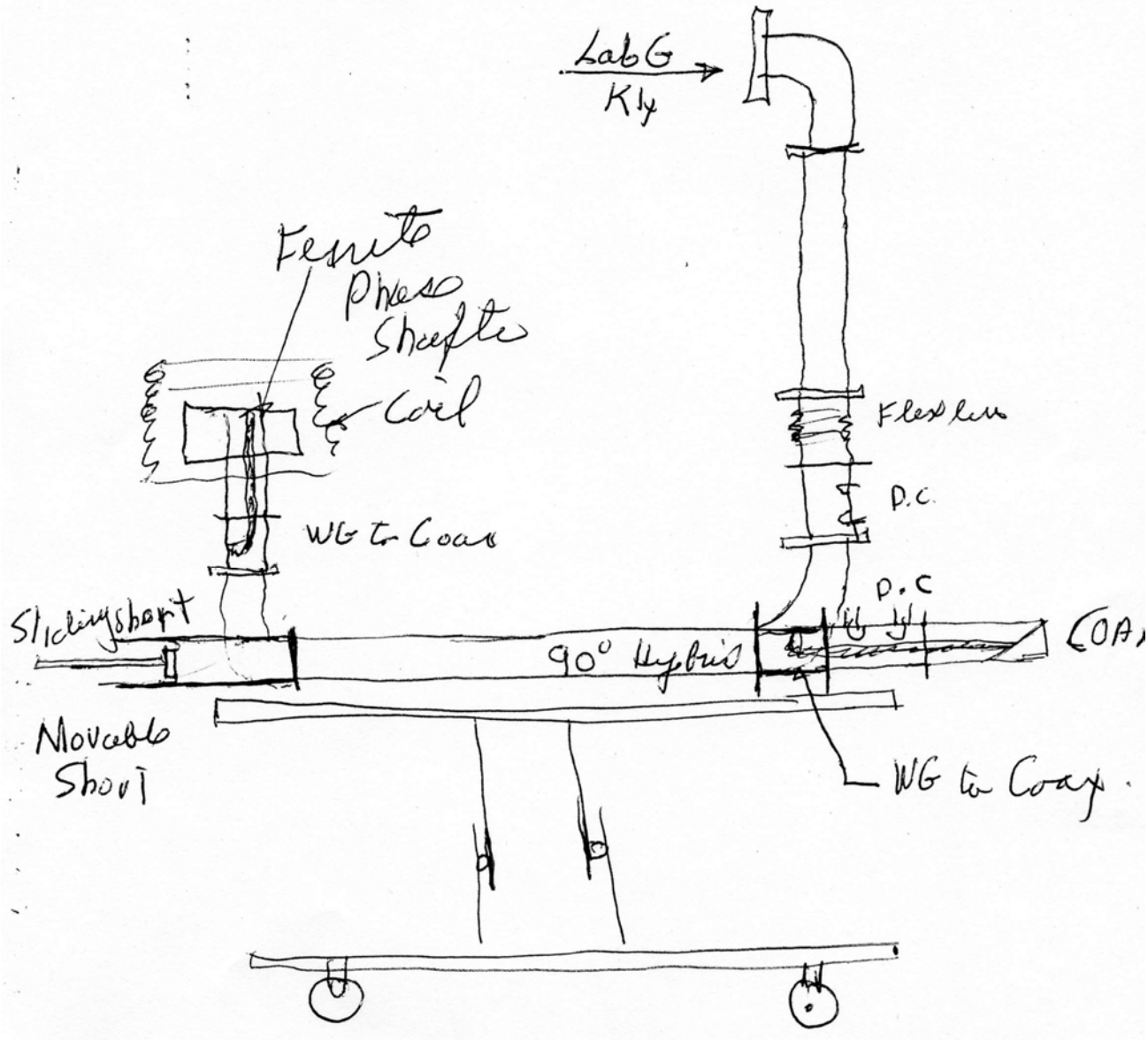
② Assemble

③ Testing (1 week - ?)

Main questions remains though.

1. Phase Shifter test Plan

A. Moretti



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ADVANCED FERRITE TECHNOLOGY

AFT - Spinnerei 44 - 71522 Backnang

Fermi Labs

USA

Fax: tel

Delivery address

Fermi

USA

Offer

file #	
record #	2004-30052
date	01.06.2003
customer code	D104197

please refer to for all questions

reference		valid until	03.09.2003	our USt/IDNr	DE 159656237
your reference	Bob/ PAC	method of shipm		Author	Niedermaier
your record	verbal/ email	delivery condition	Ex Works	Telefon	+49 7191 9659 14
your IDNo				Unsere StNr	

Item	Article No.	description	date	quantity	Q'ty Unit	unit price	total price	SC
1	3-0000805223-225-00	805 MHz 550kWp CPMS (IQ-MOD), 1ms@180deg	01.06.2003	1	piece	170.000,00	170.000,00	3
alternative :								
2	3-0000805223-225-01	805 MHz 550kWp CPMS (IQ-MOD),10ms@180deg	01.06.2003	1	piece	120.000,00	120.000,00	3
alternative :								
3	3-0000805223-225-02	805 MHz 550kWp CPMS (IQ-MOD),10ms@360deg	01.06.2003	1	piece	190.000,00	190.000,00	3

4. same (3) 1ms

$300,000

previous balance 170.000,00

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Gesellschaft mit beschränkter Haftung
Geschäftsführer: Dr. Wolfgang Arnold
Wolfgang Weiser

Bankverbindungen
Deutsche Bank, BLZ: 602 700 73, Kto: 202 8660
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8 GeV Linac Cryomodule
Cryomodule Cost Estimate
March 26, 2002

Revised:	26-Mar-02	

Tom Nicol

	Total M&S	Assembly labor
EDIA	na	$1,843,493
Beta = 0.47 modules	$2,186,772	$90,280
Beta = 0.61 modules	$3,040,158	$135,419
Beta = 0.81 modules	$6,813,702	$315,978
Beta = 1 modules	$35,933,512	$1,670,171
Grand totals	**$47,974,144**	**$4,055,341**
	$52,029,485	

8 GeV linac cryomodule cost estimate - Mar 26, 2002.xls

8 GeV Linac Cryomodule
Cryomodule Cost Estimate
March 26, 2002

Revised:	26-Mar-02	

		EDIA		
Name	**Labor rate (*)**	**FY200X**	**FY200X+1**	**FY200X+2**
T.Nicol (engineer)	$79,331	75%	75%	75%
T. Page (engineer)	$79,331	75%	75%	75%
Engineer X	$79,331	75%	75%	75%
Engineer Y	$79,331	75%	75%	75%
Engineer Z	$79,331	75%	75%	75%
S. Meredith (drafter)	$48,526	100%	100%	50%
A. Knauf (designer)	$79,331	100%	100%	50%
Designer X	$79,331	100%	100%	50%
Designer Y	$79,331	100%	100%	50%
Designer Z	$79,331	100%	100%	50%
Engr lab technician	$48,526	25%	25%	25%
Grand total for EDIA		**$1,843,493**		

*:Labor rates are those in place during the LHC IRQ program.

8 GeV Linac Cryomodule
Beta = 0.47 Cryomodule Cost Estimate
March 26, 2002

Revised:	26-Mar-02	

		Beta = 0.47			
Description	**Units**	**Units reqd**	**Unit cost**	**Ext total**	**Estimated cost basis**
Vacuum vessel	ea	1	$30,880	$30,880	LHC Q2 scaled by diameters (40/36), plus 10% for additional coupler penetrations.
MLI (all)	ea	1	$6,730	$6,730	LHC Q2 MLI plus one additional shield blanket.
50K to 70K shield	ea	1	$7,865	$7,865	LHC Q2 shields, extrusion, transition joints, machining, plus 10% for additional coupler penetrations.
5K shield	ea	1	$7,865	$7,865	LHC Q2 shields, extrusion, transition joints, machining, plus 10% for additional coupler penetrations.
Support	ea	8	$5,500	$44,000	LHC IRQ supports.
Invar tie bars	ea	14	$1,650	$23,100	Based on Q2P1 parts.
Gas return pipe	ea	1	$1,000	$1,000	LHC Q2 heat exchanger outer shell.
2K two-phase supply	ea	1	$500	$500	LHC Q2 pumping line.
Cooldown/warmup line	ea	1	$500	$500	LHC Q2 cooldown line.
Piping supports	ea	8	$350	$2,800	LHC IRQ pipe supports.
Helium vessel attach brackets	ea	16	$580	$9,280	Based on Q2P1 parts.
Magnetic shields	ea	2	$10,000	$20,000	SNS cost of $500,000 total for 23 sets (2 shields/module).
Cavity	ea	8	$40,000	$320,000	SNS cost of $40,000 each. All but final chemistry. Includes Nb and HOM couplers.
Coupler	ea	8	$30,000	$240,000	SNS cost.
Tuner	ea	8	$11,000	$88,000	SNS estimate. Includes motor ($2200),harmonic drive ($1000), frame ($6000), piezo tuners ($1500).
Helium vessel	ea	8	$10,000	$80,000	SNS cost of $10,000 each.
Intercryomodule bellows	ea	16	$750	$12,000	Estimate. Bellows between cavities and in internal piping.
Quadrupoles	ea	9	$20,000	$180,000	TESLA cryomodule quadrupole and BPM.
Instrumentation	lot	1	$1,000	$1,000	Estimate.
Interconnect parts					
Interconnect shield bridge	ea	1	$250	$250	SSC interconnect shield bridge.
Interconnect bellows	lot	1	$10,866	$10,866	LHC IRQ.
Squirm protectors	lot	1	$1,250	$1,250	Based on Q2P1 parts.
Interconnect piping	lot	1	$500	$500	Estimate.
Vacuum sleeve	ea	1	$5,000	$5,000	Based on MTF turnaround end sleeve.
Total parts cost per completed assembly				**$1,093,386**	
Number of assemblies				**2**	
Total parts cost per lot of assemblies				**$2,186,772**	

Interconnect bellows	**No/trplt**	**Unit cost**	**$/inter**
Gas return bellows	1	$1,141	$1,141
2K two-phase bellows	1	$1,640	$1,640
Cooldown/warmup bellows	1	$750	$750
Shield bellows	4	$475	$1,900
Beam tube bellows	1	$435	$435
Vacuum bellows	1	$5,000	$5,000
Total per interconnect			$10,866

			Beta = 0.47		
Labor type	**Units**	**Unit cost**	**No. reqd**	**Hrs each**	**Ext total**
Tech (incoming insp)	hr	$33.13	1	80	$2,650
Coupler HPP	hr	$33.13	2	128	$8,481
Cavity to helium vessel	hr	$27.73	2	128	$7,099
Tech (supervision)	hr	$27.73	1	120	$3,328
Tech (assembly)	hr	$27.80	4	160	$17,747
Weldor	hr	$39.80	1	80	$3,184
Tech (inspection)	hr	$33.13	1	80	$2,650
Total cost per completed assembly					**$45,140**
Number of assemblies					**2**
Total cost per lot of assemblies					**$90,280**

8 GeV Linac Cryomodule
Beta = 0.61 Cryomodule Cost Estimate
March 26, 2002

Revised:	26-Mar-02	

		Beta = 0.61			
Description	**Units**	**Units reqd**	**Unit cost**	**Ext total**	**Estimated cost basis**
Vacuum vessel	ea	1	$30,880	$30,880	LHC Q2 scaled by diameters (40/36), plus 10% for additional coupler penetrations.
MLI (all)	ea	1	$6,730	$6,730	LHC Q2 MLI plus one additional shield blanket.
50K to 70K shield	ea	1	$7,865	$7,865	LHC Q2 shields, extrusion, transition joints, machining, plus 10% for additional coupler penetrations.
5K shield	ea	1	$7,865	$7,865	LHC Q2 shields, extrusion, transition joints, machining, plus 10% for additional coupler penetrations.
Support	ea	8	$5,500	$44,000	LHC IRQ supports.
Invar tie bars	ea	14	$1,650	$23,100	Based on Q2P1 parts.
Gas return pipe	ea	1	$1,000	$1,000	LHC Q2 heat exchanger outer shell.
2K two-phase supply	ea	1	$500	$500	LHC Q2 pumping line.
Cooldown/warmup line	ea	1	$500	$500	LHC Q2 cooldown line.
Piping supports	ea	8	$350	$2,800	LHC IRQ pipe supports.
Helium vessel attach brackets	ea	16	$580	$9,280	Based on Q2P1 parts.
Magnetic shields	ea	2	$10,000	$20,000	SNS cost of $500,000 total for 23 sets (2 shields/module).
Cavity	ea	8	$40,000	$320,000	SNS cost of $40,000 each. All but final chemistry. Includes Nb and HOM couplers.
Coupler	ea	8	$30,000	$240,000	SNS cost.
Tuner	ea	8	$11,000	$88,000	SNS estimate. Includes motor ($2200),harmonic drive ($1000), frame ($6000), piezo tuners ($1500).
Helium vessel	ea	8	$10,000	$80,000	SNS cost of $10,000 each.
Intercryomodule bellows	ea	16	$750	$12,000	Estimate. Bellows between cavities and in internal piping.
Quadrupoles	ea	5	$20,000	$100,000	TESLA cryomodule quadrupole and BPM.
Instrumentation	lot	1	$1,000	$1,000	Estimate.
Interconnect parts					
Interconnect shield bridge	ea	1	$250	$250	SSC interconnect shield bridge.
Interconnect bellows	lot	1	$10,866	$10,866	LHC IRQ.
Squirm protectors	lot	1	$1,250	$1,250	Based on Q2P1 parts.
Interconnect piping	lot	1	$500	$500	Estimate.
Vacuum sleeve	ea	1	$5,000	$5,000	Based on MTF turnaround end sleeve.
Total parts cost per completed assembly				**$1,013,386**	
Number of assemblies				**3**	
Total parts cost per lot of assemblies				**$3,040,158**	

Interconnect bellows	**No/trplt**	**Unit cost**	**$/inter**
Gas return bellows	1	$1,141	$1,141
2K two-phase bellows	1	$1,640	$1,640
Cooldown/warmup bellows	1	$750	$750
Shield bellows	4	$475	$1,900
Beam tube bellows	1	$435	$435
Vacuum bellows	1	$5,000	$5,000
Total per interconnect			$10,866

			Beta = 0.61		
Labor type	**Units**	**Unit cost**	**No. reqd**	**Hrs each**	**Ext total**
Tech (incoming insp)	hr	$33.13	1	80	$2,650
Coupler HPP	hr	$33.13	2	128	$8,481
Cavity to helium vessel	hr	$27.73	2	128	$7,099
Tech (supervision)	hr	$27.73	1	120	$3,328
Tech (assembly)	hr	$27.73	4	160	$17,747
Weldor	hr	$39.80	1	80	$3,184
Tech (inspection)	hr	$33.13	1	80	$2,650
Total cost per completed assembly					**$45,140**
Number of assemblies					**3**
Total cost per lot of assemblies					**$135,419**

8 GeV Linac Cryomodule
Beta = 0.81 Cryomodule Cost Estimate
March 26, 2002

Revised:	26-Mar-02	

		Beta = 0.81			
Description	**Units**	**Units reqd**	**Unit cost**	**Ext total**	**Estimated cost basis**
Vacuum vessel	ea	1	$30,880	$30,880	LHC Q2 scaled by diameters (40/36), plus 10% for additional coupler penetrations.
MLI (all)	ea	1	$6,730	$6,730	LHC Q2 MLI plus one additional shield blanket.
50K to 70K shield	ea	1	$7,865	$7,865	LHC Q2 shields, extrusion, transition joints, machining, plus 10% for additional coupler penetrations.
5K shield	ea	1	$7,865	$7,865	LHC Q2 shields, extrusion, transition joints, machining, plus 10% for additional coupler penetrations.
Support	ea	8	$5,500	$44,000	LHC IRQ supports.
Invar tie bars	ea	14	$1,650	$23,100	Based on Q2P1 parts.
Gas return pipe	ea	1	$1,000	$1,000	LHC Q2 heat exchanger outer shell.
2K two-phase supply	ea	1	$500	$500	LHC Q2 pumping line.
Cooldown/warmup line	ea	1	$500	$500	LHC Q2 cooldown line.
Piping supports	ea	8	$350	$2,800	LHC IRQ pipe supports.
Helium vessel attach brackets	ea	16	$580	$9,280	Based on Q2P1 parts.
Magnetic shields	ea	2	$10,000	$20,000	SNS cost of $500,000 total for 23 sets (2 shields/module).
Cavity	ea	8	$40,000	$320,000	SNS cost of $40,000 each. All but final chemistry. Includes Nb and HOM couplers.
Coupler	ea	8	$30,000	$240,000	SNS cost.
Tuner	ea	8	$11,000	$88,000	SNS estimate. Includes motor ($2200),harmonic drive ($1000), frame ($6000), piezo tuners ($1500).
Helium vessel	ea	8	$10,000	$80,000	SNS cost of $10,000 each.
Intercryomodule bellows	ea	16	$750	$12,000	Estimate. Bellows between cavities and in internal piping.
Quadrupoles	ea	3	$20,000	$60,000	TESLA cryomodule quadrupole and BPM.
Instrumentation	lot	1	$1,000	$1,000	Estimate.
Interconnect parts					
Interconnect shield bridge	ea	1	$250	$250	SSC interconnect shield bridge.
Interconnect bellows	lot	1	$10,866	$10,866	LHC IRQ.
Squirm protectors	lot	1	$1,250	$1,250	Based on Q2P1 parts.
Interconnect piping	lot	1	$500	$500	Estimate.
Vacuum sleeve	ea	1	$5,000	$5,000	Based on MTF turnaround end sleeve.
Total parts cost per completed assembly				**$973,386**	
Number of assemblies				**7**	
Total parts cost per lot of assemblies				**$6,813,702**	

Interconnect bellows	**No/trplt**	**Unit cost**	**$/inter**
Gas return bellows	1	$1,141	$1,141
2K two-phase bellows	1	$1,640	$1,640
Cooldown/warmup bellows	1	$750	$750
Shield bellows	4	$475	$1,900
Beam tube bellows	1	$435	$435
Vacuum bellows	1	$5,000	$5,000
Total per interconnect			$10,866

			Beta = 0.81		
Labor type	**Units**	**Unit cost**	**No. reqd**	**Hrs each**	**Ext total**
Tech (incoming insp)	hr	$33.13	1	80	$2,650
Coupler HPP	hr	$33.13	2	128	$8,481
Cavity to helium vessel	hr	$27.73	2	128	$7,099
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Tech (assembly)	hr	$27.73	4	160	$17,747
Weldor	hr	$39.80	1	80	$3,184
Tech (inspection)	hr	$33.13	1	80	$2,650
Total cost per completed assembly					**$45,140**
Number of assemblies					**7**
Total cost per lot of assemblies					**$315,978**

8 GeV Linac Cryomodule
Beta = 1 Cryomodule Cost Estimate
March 26, 2002

Revised:	26-Mar-02	

Description	Units	Beta = 1 Units reqd	Unit cost	Ext total	Estimated cost basis
Vacuum vessel	ea	1	$41,180	$41,180	LHC Q2 scaled by diameters (40/36) and length (16/12), plus 10% for additional coupler penetrations.
MLI (all)	ea	1	$8,970	$8,970	LHC Q2 MLI plus one additional shield blanket, scaled by length (16/12).
50K to 70K shield	ea	1	$10,490	$10,490	LHC Q2 shields, extrusion, transition joints, machining, scaled by length (16/12), plus 10% for additional coupler penetrations.
5K shield	ea	1	$10,490	$10,490	LHC Q2 shields, extrusion, transition joints, machining, scaled by length (16/12), plus 10% for additional coupler penetrations.
Support	ea	8	$5,500	$44,000	LHC IRQ supports.
Invar tie bars	ea	14	$1,650	$23,100	Based on Q2P1 parts.
Gas return pipe	ea	1	$1,000	$1,000	LHC Q2 heat exchanger outer shell.
2K two-phase supply	ea	1	$500	$500	LHC Q2 pumping line.
Cooldown/warmup line	ea	1	$500	$500	LHC Q2 cooldown line.
Piping supports	ea	8	$350	$2,800	LHC IRQ pipe supports.
Helium vessel attach brackets	ea	16	$580	$9,280	Based on Q2P1 parts.
Magnetic shields	ea	2	$10,000	$20,000	SNS cost of $500,000 total for 23 sets (2 shields/module).
Cavity	ea	8	$40,000	$320,000	SNS cost of $40,000 each. All but final chemistry. Includes Nb and HOM couplers.
Coupler	ea	8	$30,000	$240,000	SNS cost.
Tuner	ea	8	$11,000	$88,000	SNS estimate. Includes motor ($2200),harmonic drive ($1000), frame ($6000), piezo tuners ($1500).
Helium vessel	ea	8	$10,000	$80,000	SNS cost of $10,000 each.
Intercryomodule bellows	ea	16	$750	$12,000	Estimate. Bellows between cavities and in internal piping.
Quadrupoles	ea	2	$20,000	$40,000	TESLA cryomodule quadrupole and BPM.
Instrumentation	lot	1	$1,000	$1,000	Estimate.
Interconnect parts					
Interconnect shield bridge	ea	1	$250	$250	SSC interconnect shield bridge.
Interconnect bellows	lot	1	$10,866	$10,866	LHC IRQ.
Squirm protectors	lot	1	$1,250	$1,250	Based on Q2P1 parts.
Interconnect piping	lot	1	$500	$500	Estimate.
Vacuum sleeve	ea	1	$5,000	$5,000	Based on MTF turnaround end sleeve.
Total parts cost per completed assembly				**$971,176**	
Number of assemblies				**37**	
Total parts cost per lot of assemblies				**$35,933,512**	

Interconnect bellows	No/trplt	Unit cost	$/inter
Gas return bellows	1	$1,141	$1,141
2K two-phase bellows	1	$1,640	$1,640
Cooldown/warmup bellows	1	$750	$750
Shield bellows	4	$475	$1,900
Beam tube bellows	1	$435	$435
Vacuum bellows	1	$5,000	$5,000
Total per interconnect			$10,866

Labor type	Units	Unit cost	Beta = 1 No. reqd	Hrs each	Ext total
Tech (incoming insp)	hr	$33.13	1	80	$2,650
Coupler HPP	hr	$33.13	2	128	$8,481
Cavity to helium vessel	hr	$27.73	2	128	$7,099
Tech (supervision)	hr	$27.73	1	120	$3,328
Tech (assembly)	hr	$27.73	4	160	$17,747
Weldor	hr	$39.80	1	80	$3,184
Tech (inspection)	hr	$33.13	1	80	$2,650
Total cost per completed assembly					**$45,140**
Number of assemblies					**37**
Total cost per lot of assemblies					**$1,670,171**

Fermilab

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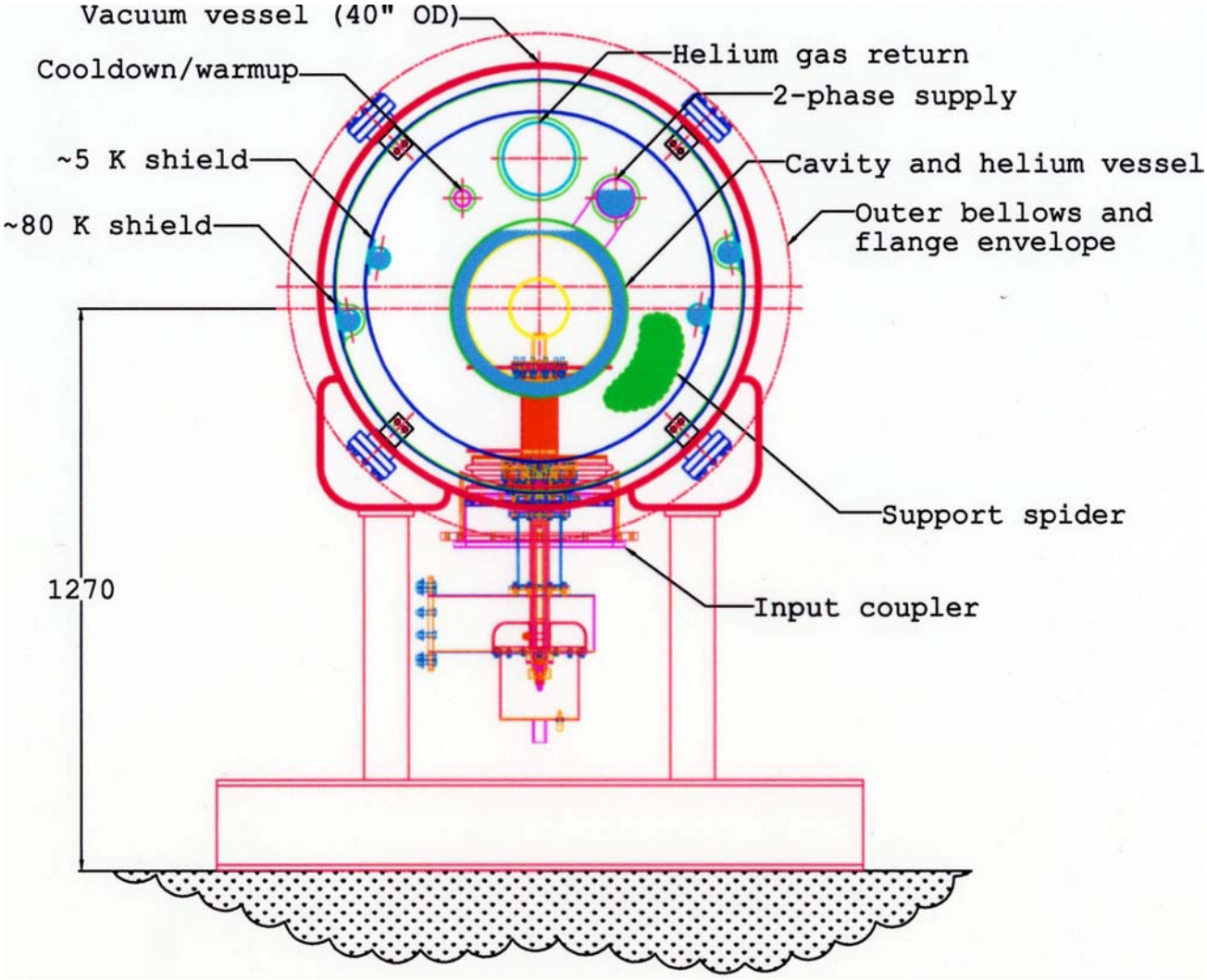
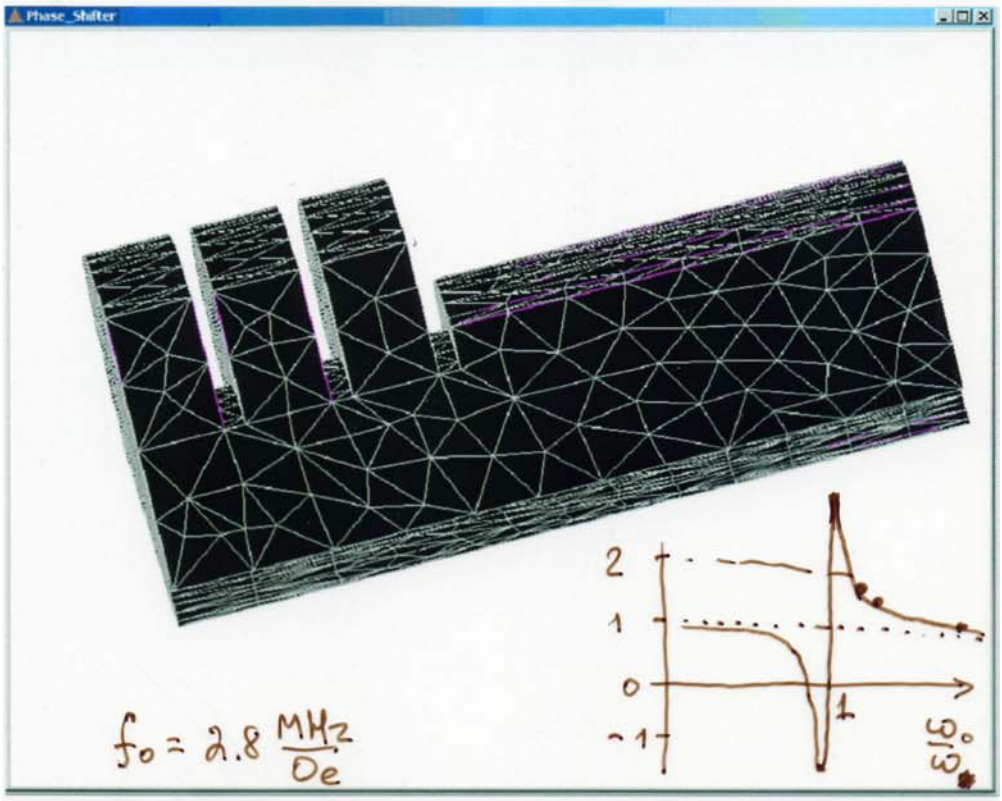
Superconducting RF R&D
General and Cryomodule-specific

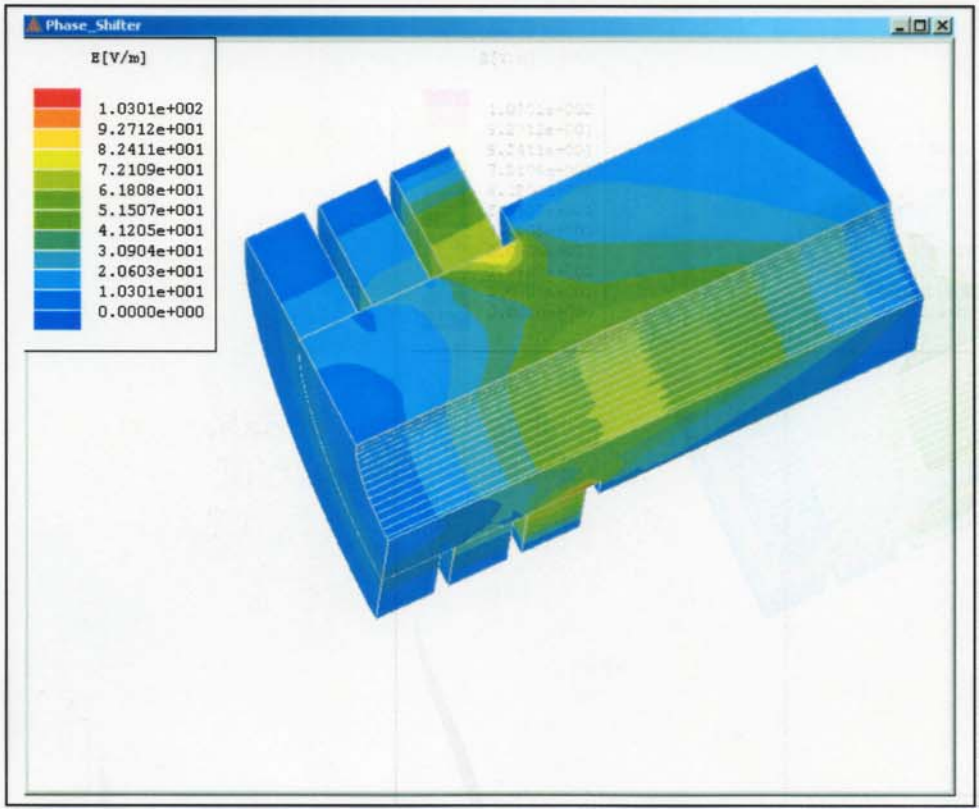
- Input and HOM couplers
- Tuners
- Cavity manufacturing and tuning
- Chemical processing
- Cavity testing
- Suspension system development
- Cavity and helium vessel alignment
- Ground motion effects and damping
- Assembly procedures to ensure cleanliness
- Cryomodule interconnections – especially beam vacuum


Vacuum vessel (40" OD)
Helium gas return
Cooldown/warmup
2-phase supply
~5 K shield
Cavity and helium vessel
~80 K shield
Outer bellows and
flange envelope
Support spider
1270
Input coupler

Phase Shifter Simulation (HFSS)

Parameters: $\varepsilon=14.5$; $tg\delta=5.\varepsilon-4$ ⟹ $\Delta\phi/\Delta\mu=160°$

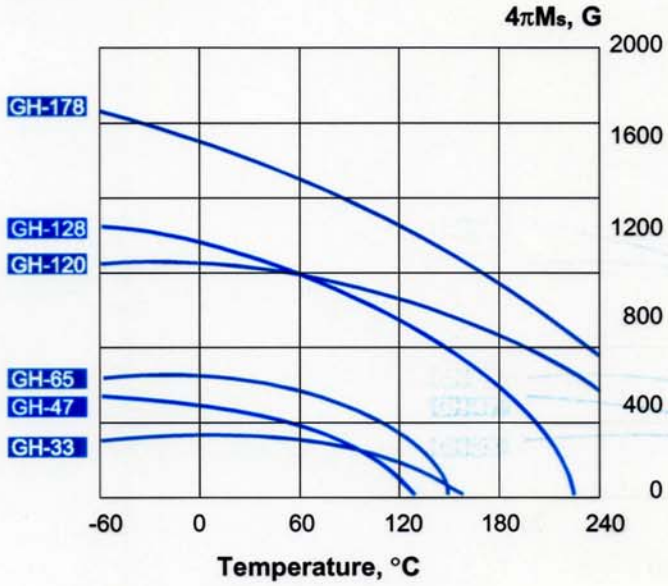




The garnets of this group feature extremely good threshold characteristics. They are used in devices which must operate at high peak power levels.

Material grade	$4\pi M_s$ G	ΔH (-3dB) Oe ±20%	ε' ±5%	$tg\delta_\varepsilon \cdot 10^4$	g_{eff} ±3%	T_c °C nomin.	ΔH_k Oe nomin.
GH 178	1780±5%	25	15.1	≤2	1.99	280	3.5
GH 128	1280±5%	60	15.1	≤2	2.00	225	16
GH 120	1200±5%	100	15.0	≤2	2.01	275	15
GH 65	650±5%	45	14.7	≤2	2.01	150	16
GH 47	470±25G	45	14.5	≤2	2.00	130	19
GH 33	330±25G	160	14.2	≤2	2.02	160	26

Saturation magnetization vs. temperature



Questions:

1. Do we need fast phase shifter for H- (or e-) operation only?

Is it enough to have Mechanical and Piezoelectric tuners in cavity to correct microphonics and Lorentz forces.
TESLA – Yes. Driver has lower Qext.
SNS -- ?

2. How fast phase shifter should be ?
100 μs vs. 100 ms

3. Are we planning to use LB and MB section for e- beam?

LB	ϕ slip°	M	G(MV/m)	dE(MV)
0.47	600	-0.19	2.5	20
0.61	450	-0.13	2.1	35
0.81	100	0.54	11	550

4. Price of fast phase shifter vs. 550kW klystron price?

805 MHz phase shifter …. 10k$, 100k$ - ?
550kW klystron 50k$???
1207 MHz

(2.5MW 402 MHz * 135kV*40A → cost =104k$
5 MW 805 MHz * 140kV* → cost = 130k$
0.5MW 805MHz * 75kV * 11A → cost ???)