CRYOGENIC SYSTEM

LOADS

REVIEW DESIGN CHALLENGES

INTERFACE WITH RHIC CRYO SYSTEM CONFIGURATIONS

OPERATING COST, COMPRESSOR POWER

LOADS

Item	Budget W	Liq Load	Shield W	Liq Load
	@ 4.35K		40 K	
Cavity Dynamic	40			2.22
Cavity Static	10			0.56
Secondary Cryostat	10			0.56
SUBTOTAL	60			**3.3**
LHe Supply Line	16			0.89
SUBTOTAL	**76**			**4.22**
Lead Flow Intercepts		1.2		1.2
	76			**5.42**
Shield S:45K - R:85K			200	
Shield S:45K - R:300K				

Requirements

Pressure Stability / Fluctuations

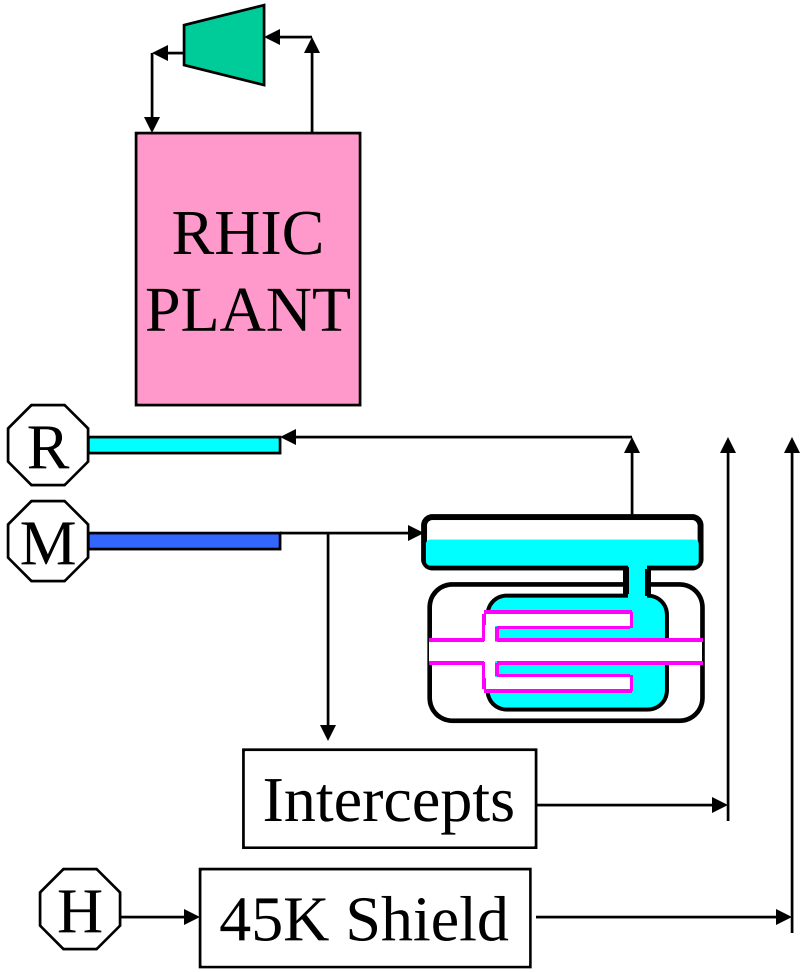
- Tuning Surface
  - Inside Helium Bath
  - Outside Helium Bath
- Rest of Cavity

Temperature

- Conductively cooled portion
  - Main Tuning surface
  - Peak heat flux on far end
- 4.7K limit

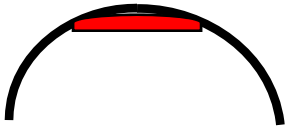
Process Option A-1

- Return to RHIC Cold Vapor Return
- Boiling Point Pressure variation in Rings due to transients in main cryo system
  - Slow variation
  - Compressor Acoustics?
- Boiling point in RHIC RING: 4.45 - 4.5K



Design Challenges

- Tuning
  - Pressure Stability, Pressure fluctuations
    - Vibrations
    - Boiling Noise
    - Other noise sources
      - Compressor Acoustics
- Vapor trapping
  - High temperature gradients



Pressure Variation LHe Bath

- Boiling Noise

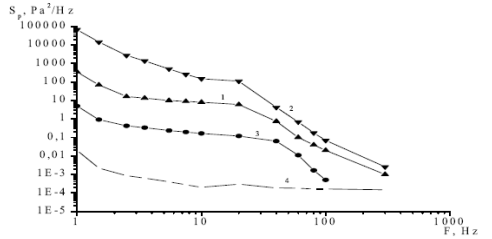


FIGURE 2. Spectrum of pressure fluctuation,1-He, P=2.5*10^4 mWt/cm^2, 2-He, P=3*10^4 mWt/cm^2, 3-N_2, P=5*10^3 mWt/cm^2, 4-He, P=0

- Compressor Acoustic

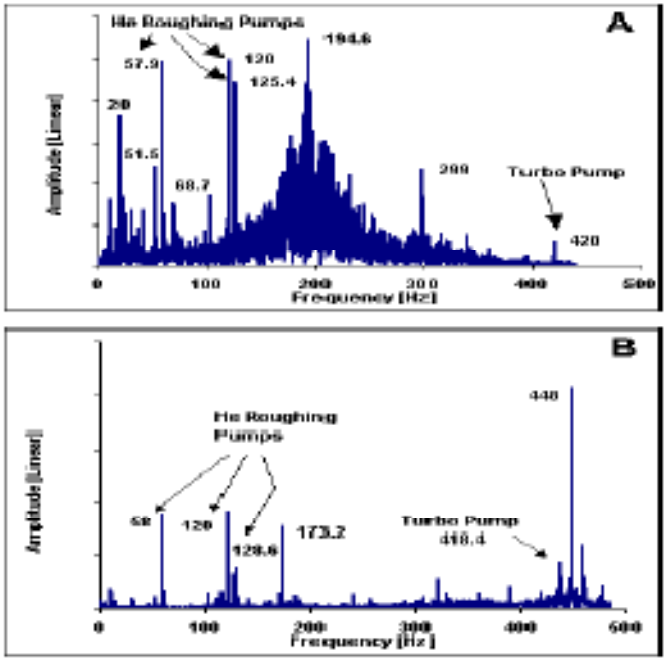
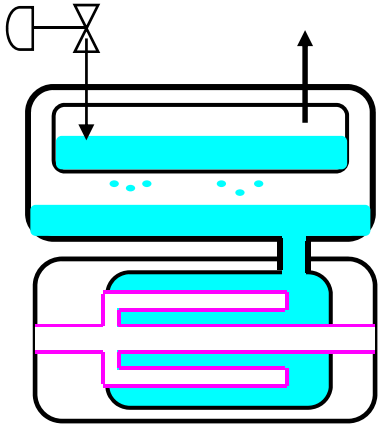
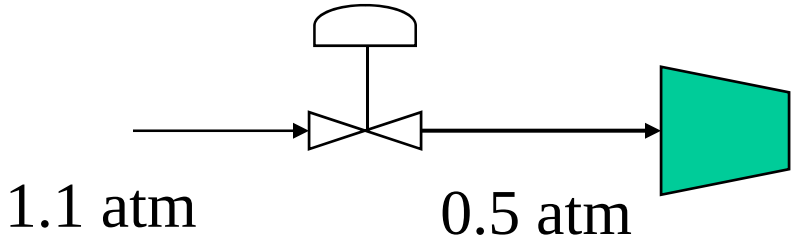


Figure 7. Microphonics spectrum from FFT of (A) cavity's phase lock loop/error signal, and (B) accelerometer on top of Dewar.

Compressor Acoustic

- Recondenser
- Sonic Flow

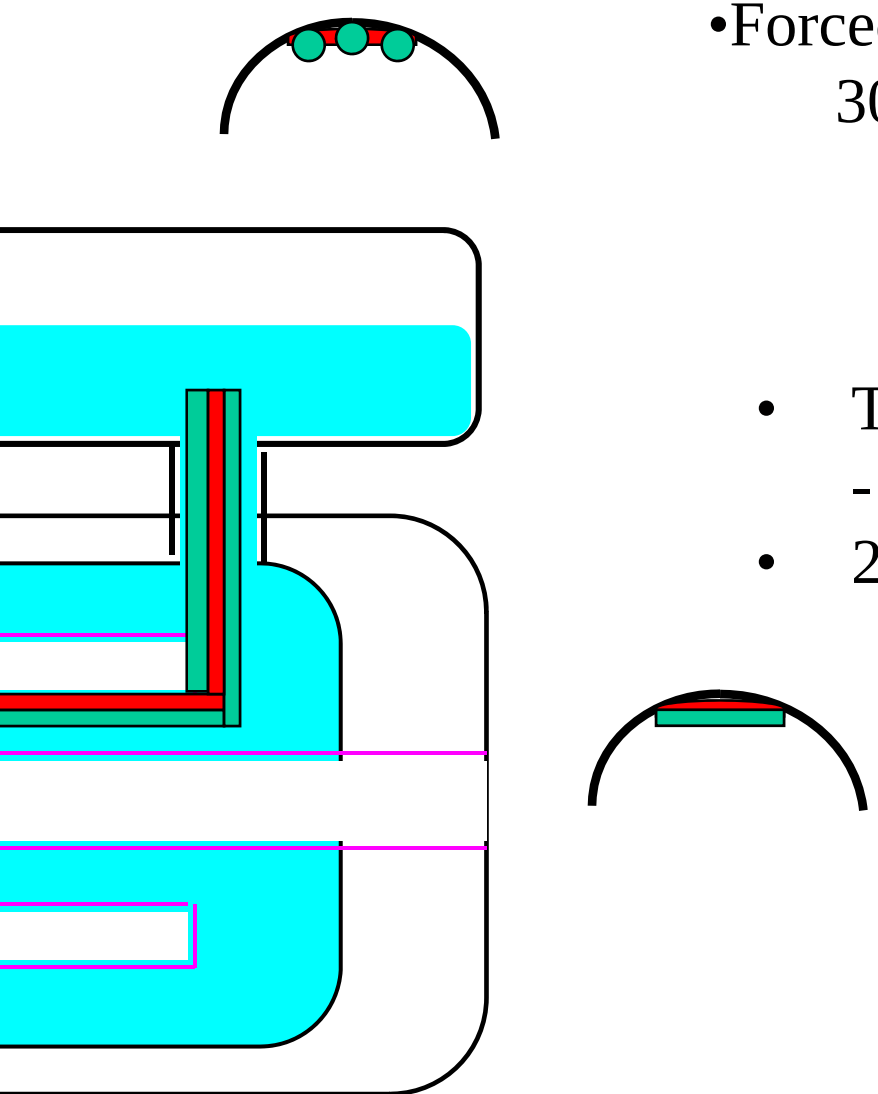




Boiling Noise

- 2.1 K (40 mbar) Superfluid Operation

Vapor Trapping



•Forced Convection cooling channels

300 mK gradient,

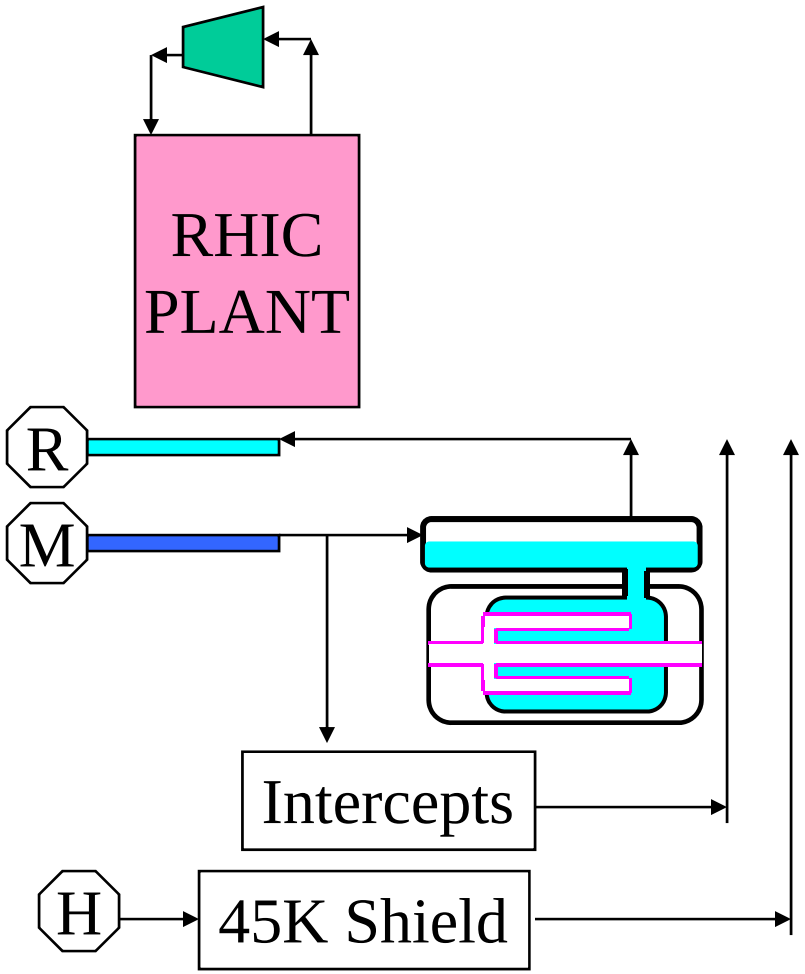
~ 4.65 K on Niobium

Lower Temperature

by lowering Bath Pressure

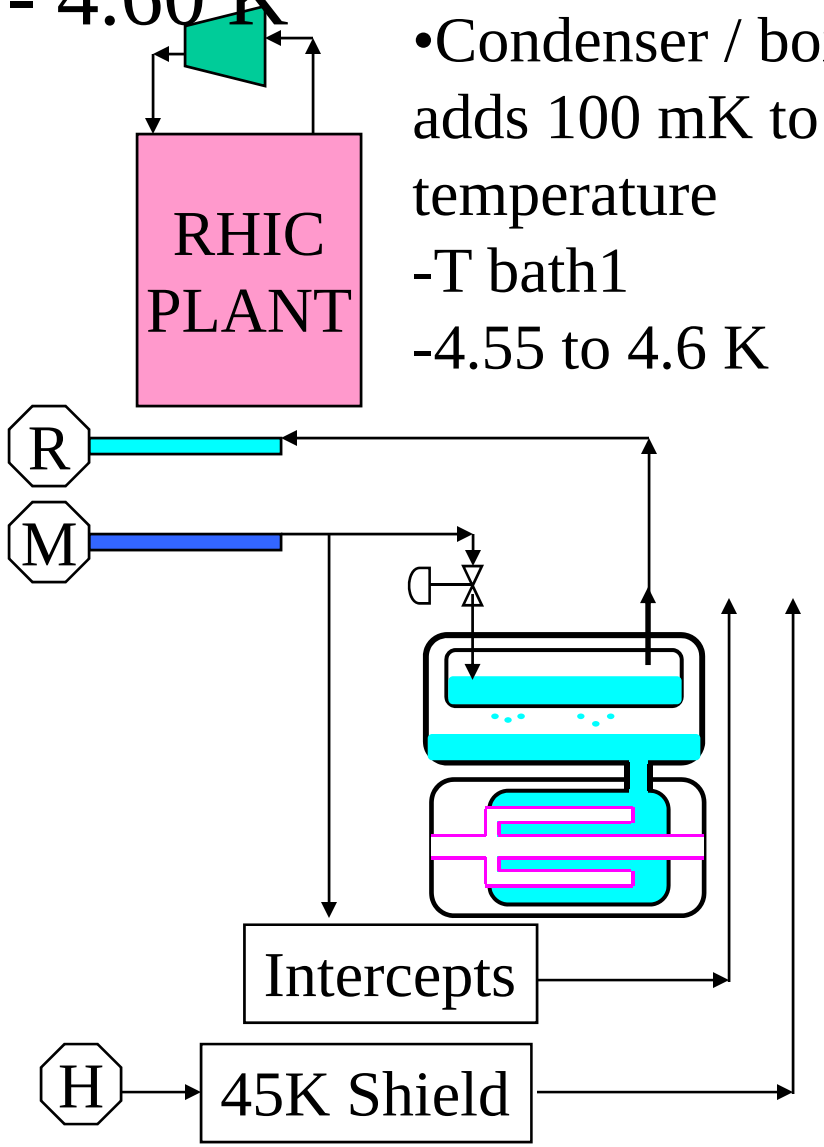
- Thermo-syphon
  - Recirculation rate 10x
- 2.1K Superfluid

OPTION A-1
4.45 - 4.50 K

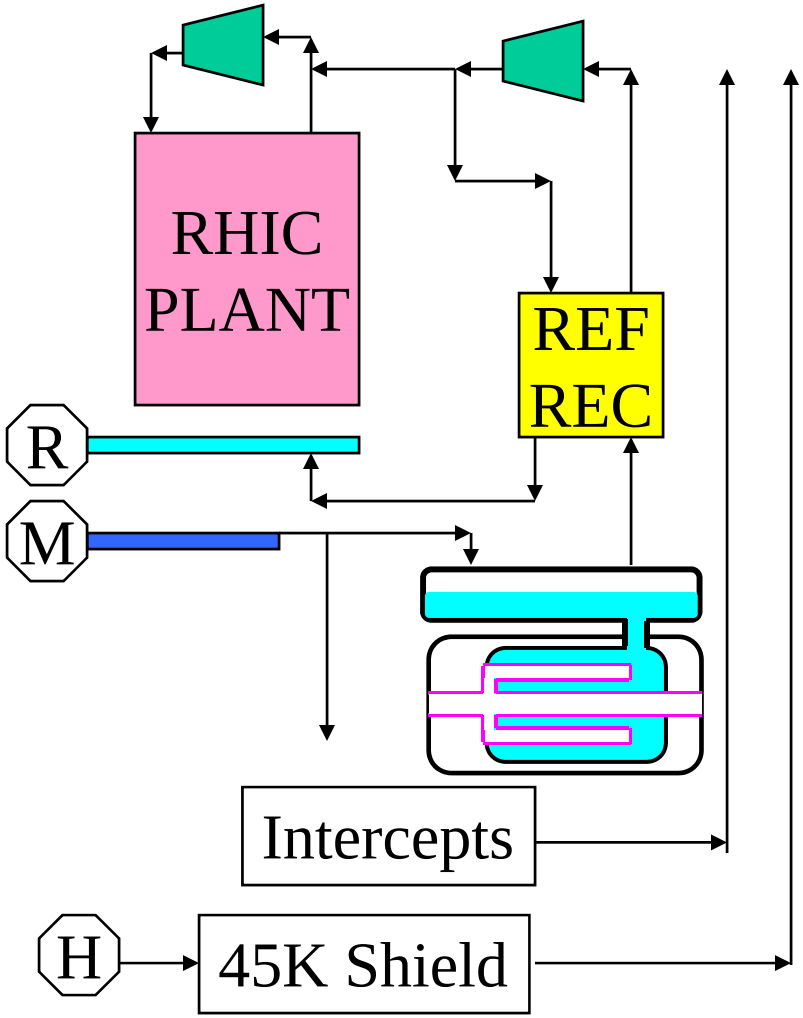


OPTION A-2
4.55 - 4.60 K

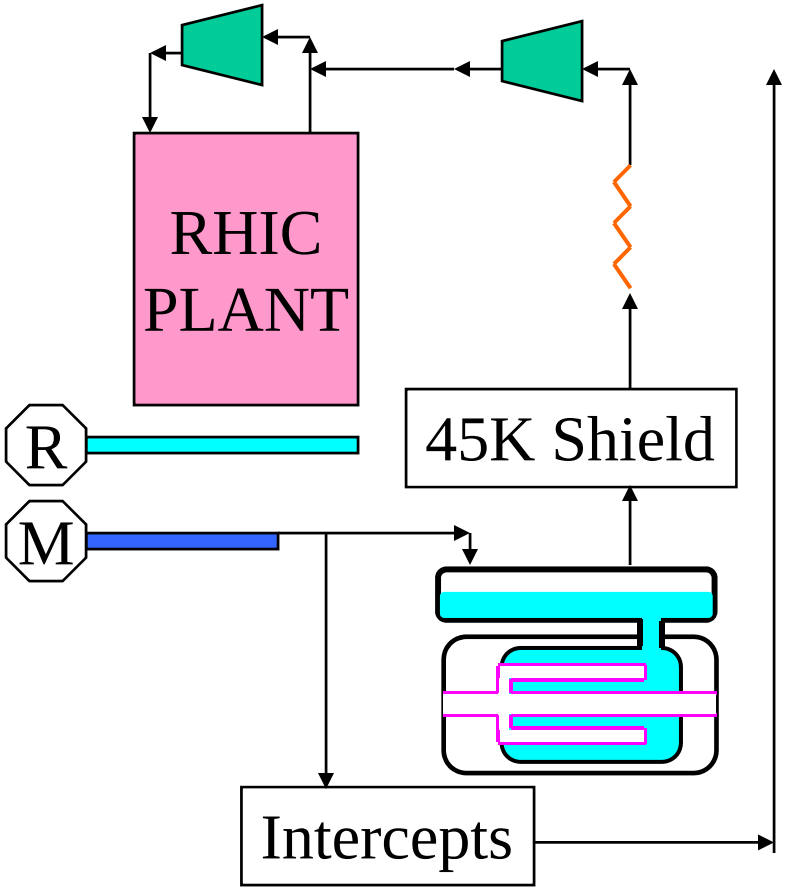
•Condenser / boiler adds 100 mK to temperature
-T bath1
-4.55 to 4.6 K



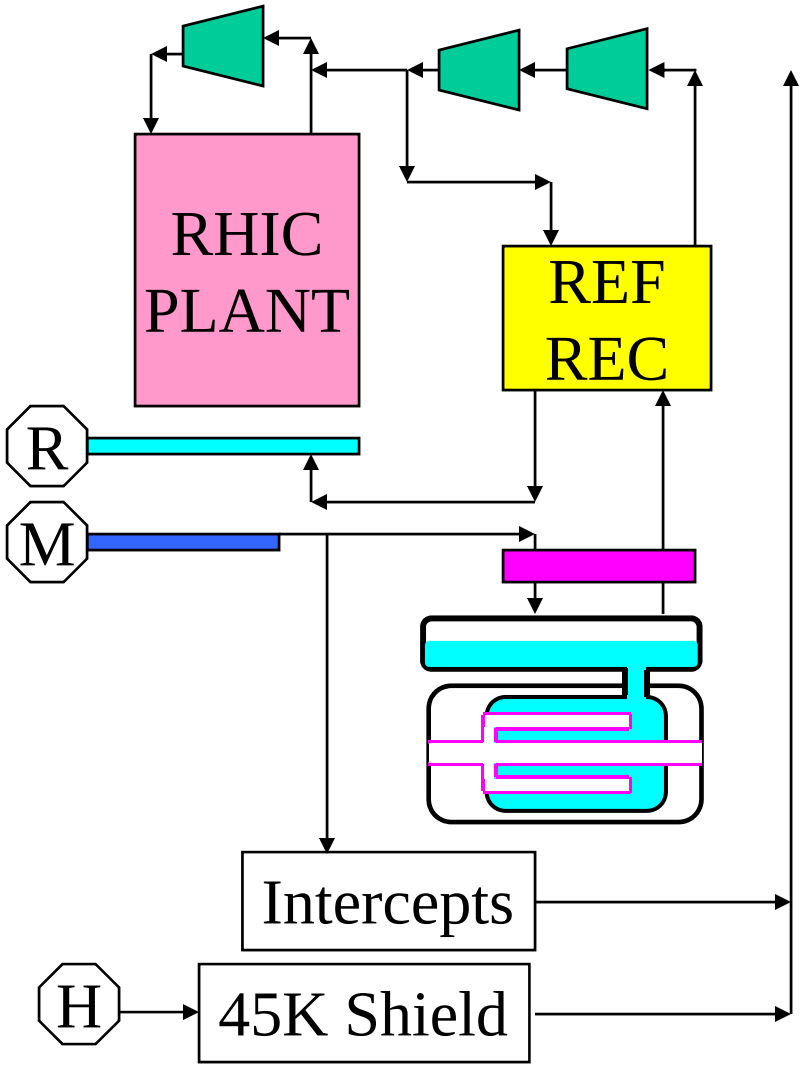
OPTION B-1
4.35 K



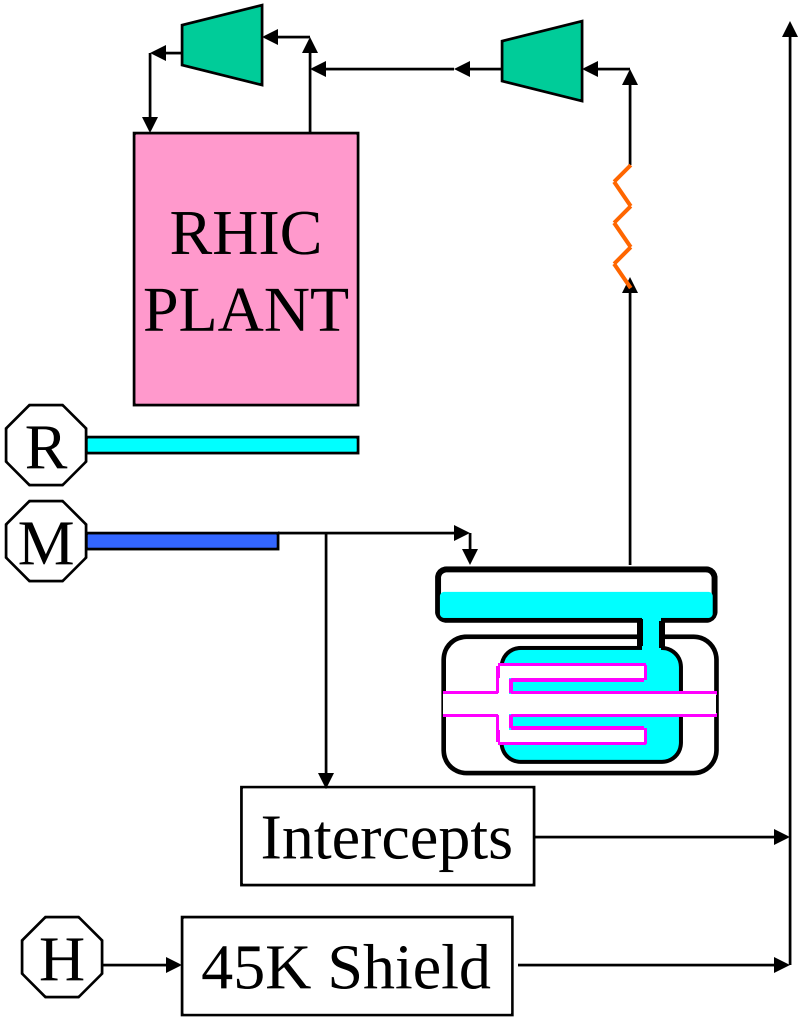
OPTION B-2
4.35 K



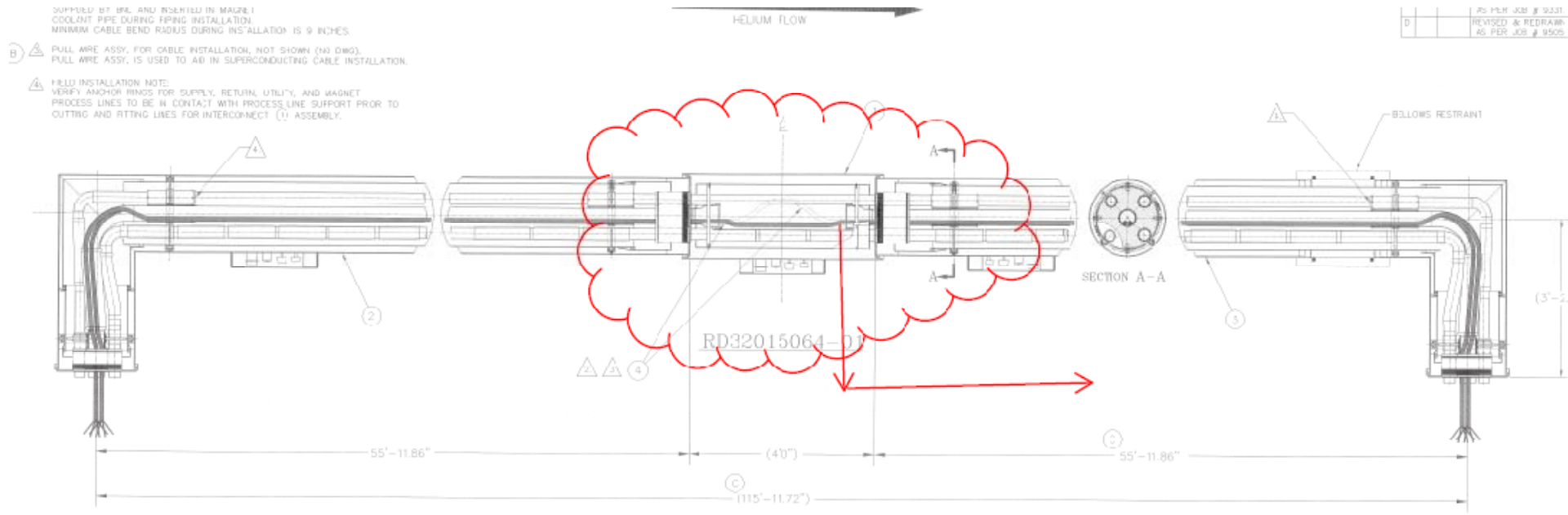
OPTION C-1
2.1 K



OPTION C-2
2.1 K



RHIC VJR TAP-OFF / TIE IN POINT



DESCRIPTION	PART NO.	ITEM NUMBER			
		1	2	3	4
VJR Q3 TO Q4 ASSEMBLY	RD32015054-01	RD32015074-01	RD32015205-02	RD32015205-01	02015001
VJR Q3 TO SPIN ROTATOR ASSEMBLY	RD32015064-03	RD32015074-01	RD32015205-39	RD32015205-01	02015001

		OPTION A		OPTION B-1		OPTION B-2		OPTION C-1		OPTION C-2	
		4.5K OPERATION		4.35K OPERATION		4.35K OPERATION		2.1K OPERATION		2.1K OPERATION	
				1 g/s for Shield		1 g/s for Shield				2K-4K HX	
		Return as ref Load		With Recovery		Return As Liquefactio		With Recovery		Return As Liquefaction	
Item		4.5K RHIC Load		4.5K RHIC Load		4.5K RHIC Load		4.5K RHIC Load		4.5K RHIC Load	
		Carnot work	Compr Power	Carnot work	Compr Power	Carnot work	Compr Power	Carnot work	Compr Power	Carnot work	Compr Power
		kW	kW	kW	kW	kW	kW	kW	kW	kW	kW
Cavity Dynamic						14.8	78.1				66.4
Cavity Static						3.7	19.5				16.6
Secondary Cryostat						3.7	19.5				16.6
SUBTOTAL		4.05	21.3			**22.3**	**117.2**				**99.6**
LHe Supply Line		1.08	5.7			5.9	31.3				26.6
SUBTOTAL		**5.1**	**27.0**	**13.0**	**68.4**	**28.2**	**148.5**	**13.0**	**68.4**	**24.0**	**126**
Lead Flow Intercepts		8.0	42.2	8	42	8.0	42.2	8.0	42.2		42.2
		13.2	**69.2**	**21.0**	**110.7**	**36.2**	**190.7**	**21.0**	**110.7**	**24.0**	**168.4**
Shield S:45K - R:85K											
Shield S:45K - R:300K		1.64	8.7	included		included		1.64	8.7	1.64	8.7
TOTAL	**kW**	**13.2**	**78**	**21.0**	**111**	**36.2**	**191**	**21.0**	**119**		**177**
2X (TWO CAVITIES)			**156**		**221**		**381**		**239**		**354**
Recovery Compressor	kW				**80**		**80**		**80**		**80**
2.1K vacuum Pumps	kW								**110**		**110**
Total Power	kW		**156**		**301**		**461**		**429**		**544**
Electric Cost	$/MW-hr		80		80		80		80		80
Electric Cost	$/hour		12.46		24.11		36.91		34.29		43.54
Runtime	Hours		5000		5000		5000		5000		5000
Cost	$		62,296		120,529		184,574		171,449		217,677

Other Operational Issues

- Cooldown
  - Follows RHIC ring cooldown to allow beam tube vacuum to establish
- Warmup
  - Heaters
  - Warm helium
- Double isolation valves, in case of repairs

- Damper Transients
  from Dynamic load during ramping / damper retraction
  Heat Load