

ICD-2

**Cryogenics
Overview**

Jay Theilacker

Functional Requirements



- **ICD-2 Cryogenic system supports operation of Linac in CW**
- **Maintain elliptical cavities and spoke cavities at 1.8 K under normal operation**
- **Provide shield flow at multiple temperature levels**
- **No longer supply liquefaction flow for power leads (conduction cooled)**
- **Allow cool-down and warm-up of limited-length strings for repair or exchange of superconducting accelerating components**
- **Protects superconducting RF cavities from over pressurization beyond the component's MAWP during fault conditions.**

Low Energy Linac

- Components are cooled by 2-phase(2 ϕ) He at 1.8 K
- Single string of SR Cryomodules
- String contains 17 Cryomodules
 - 4 x SSR-0 cryomodules
 - 2 x SSR-1 cryomodules
 - 3 x SSR-2 cryomodules
 - 8 x TSR cryomodules
- Cryomodules are fed in series – TESLA like



High Energy Linac



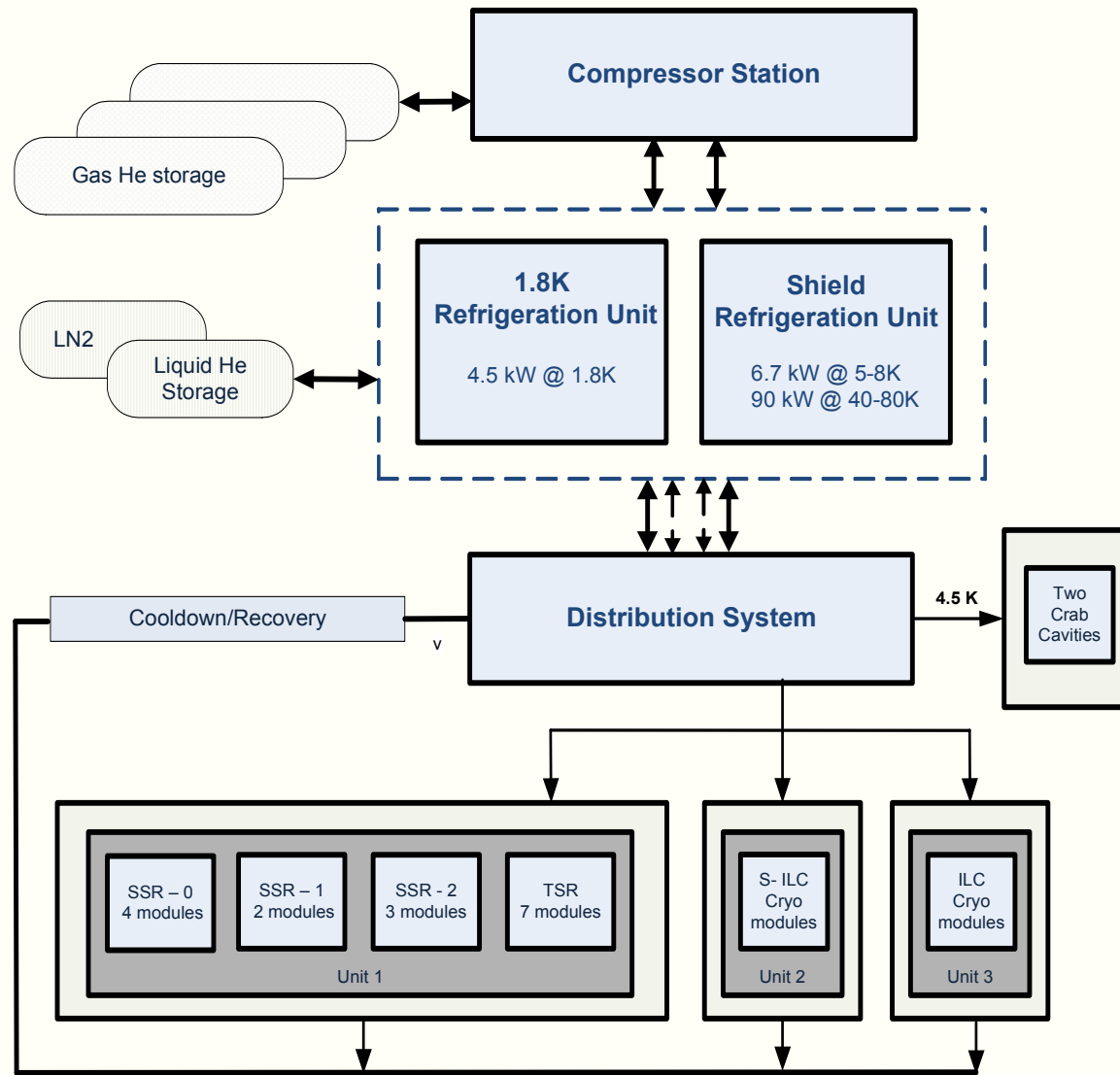
- Revising and resizing the TESLA cryogenic concept
- **Saturated He II cooled cavities @ 1.8 K**
- Helium gas thermal shield @ 5 - 8 K
- Helium gas thermal shield @ 40 - 80 K
- **Single riser from dressed cavity to 2 \emptyset line (needs to be larger)**
- **2 \emptyset line (liquid helium supply and concurrent vapor return) connects to each helium vessel (needs to be larger)**
- **2 \emptyset line connects to gas return once per CM (needs to be larger)**
- Warm-up/cool-down line connects the bottoms of the He vessels
- Helium supply to 2 \emptyset line via JT valve once per Cryo String
- **Two Cryo Strings**
 - 11 S-ILC ($\beta=0.81$) cryomodules
 - 9 ILC ($\beta=1$) cryomodules

ICD-2 Heat Load



Project X ICD-2						
	1.8 K		5 to 8 K		40 to 80 K	
	Static	Dynamic	Static	Dynamic	Static	Dynamic
Heat Load Estimate [W]	216	2,503	2,317	951	17,537	25,801
Static to Total Ratio	8%		71%		40%	
Total Heat Load Estimate [kW]	2.7		3.3		43.3	
Uncertainty Factor	1.3		1.5		1.5	
Overcapacity Factor	1.2		1.2		1.2	
COP [W/W]	940		200		20	
4.5K Equivalent [kW]	26.9					
Plug Power [MW]	6.7					

Conceptual Layout



ICD -2 Issues



- **Issues that need to be addressed by RD & D program:**
 - **Cryogenic Distribution and Segmentation**
 - **Pipe sizing for high flow rates and heat transfer**
 - **Capital and Operational Cost Optimization**
 - **Optimum Operating Temperature**
 - **Heat Load Analysis**
 - **Testing Infrastructure**
 - **Cryomodule testing at CW changes New Muon Lab testing requirements. Input from Workgroup participants would be beneficial.**