ICD-1

Cryogenics Overview

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Outline

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- Charge to the Cryogenics Work group
- Cryogenics Scope
- ICD-1
  - Requirements
  - Heat Load
  - Low Energy Linac
  - High Energy Linac
  - Conceptual Layout
- ICD-1 Issues
- RD & D plan
- Conclusion

Charge to the Workgroup

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- Discuss potential modifications to ICD-1 and ICD-2
- Discuss potential modifications to the existing RD&D plan for ICD-2
- Establish goals and work plan for FY2010 (elements and sequencing)
- Provisional distribution of responsibility, and funding, for FY2010
- Identify any issues related to the above that need resolution

Cryogenics Scope

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- Cryogenic Plant
- Cryogenic Distribution System
- Ancillary Systems

ICD-1 Requirements

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- ICD-1 Cryogenic system supports operation of Pulsed Linac
- Maintain elliptical cavities at 2.0 K and spoke cavities below 4.5 K under normal operation
- Provide shields flow at multiple temperature levels
- Supply liquefaction flow for power leads
- 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.

Heat Load

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Project X ICD									
25 MV/m, 1.5 msec, 5Hz, 20 mA, 1.25 FT	Qty [#]	Heat Load							
		2K		4.5K		5K		40K or 80K	
Item		Static	Dynamic	Static	Dynamic	Static	Dynamic	Static	Dynamic
WRF Solenoid	19	-	-	42	99	-	-	536	-
SSR1	2	-	-	42	1	-	-	1003	2
SSR2	3	-	-	62	10	-	-	1279	8
TSR	7	-	-	93	50	-	-	1965	40
S-ILC	7	27	17	-	-	69	18	517	477
ILC-1	9	35	43	-	-	105	47	727	1,226
ILC-2	28	110	133	-	-	328	146	2,260	3,813
SCB, End Boxes, etc	1	50	-	100	-	-	-	500	-
Auxiliary Load	1	-	-	-	-	-	-	1000	-
Estimated, [W]		222	193	338	160	502	211	9787	5566
Design Capacity, [kW]		0.8		1.0		1.4		29.9	
4.5K Eqv [kW]		**8.2**							

Low Energy Linac

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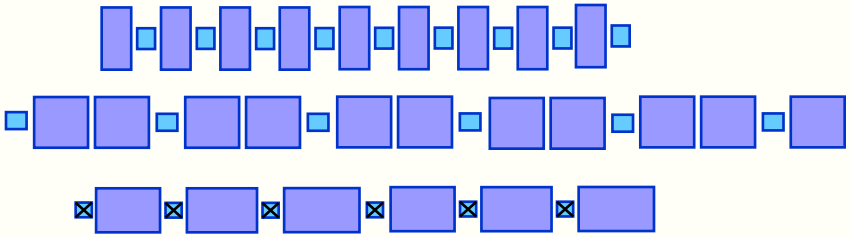
- Components are cooled by 2-phase(2∅) He at 4.5 K
- Two Strings: Upstream solenoids and SR Cryomodules
- Strings are fed in parallel
- One String contains 19 solenoids between warm RF
- Individual Solenoids are fed in parallel
- 2∅ line (liquid helium supply and concurrent vapor return) connects to each solenoid
- Second String contains 12 Cryomodules
  - 2 x SSR-1 cryomodules
  - 3 x SSR-2 cryomodules
  - 7 x TSR cryomodules



- Cryomodules are fed in series – TESLA like

High Energy Linac

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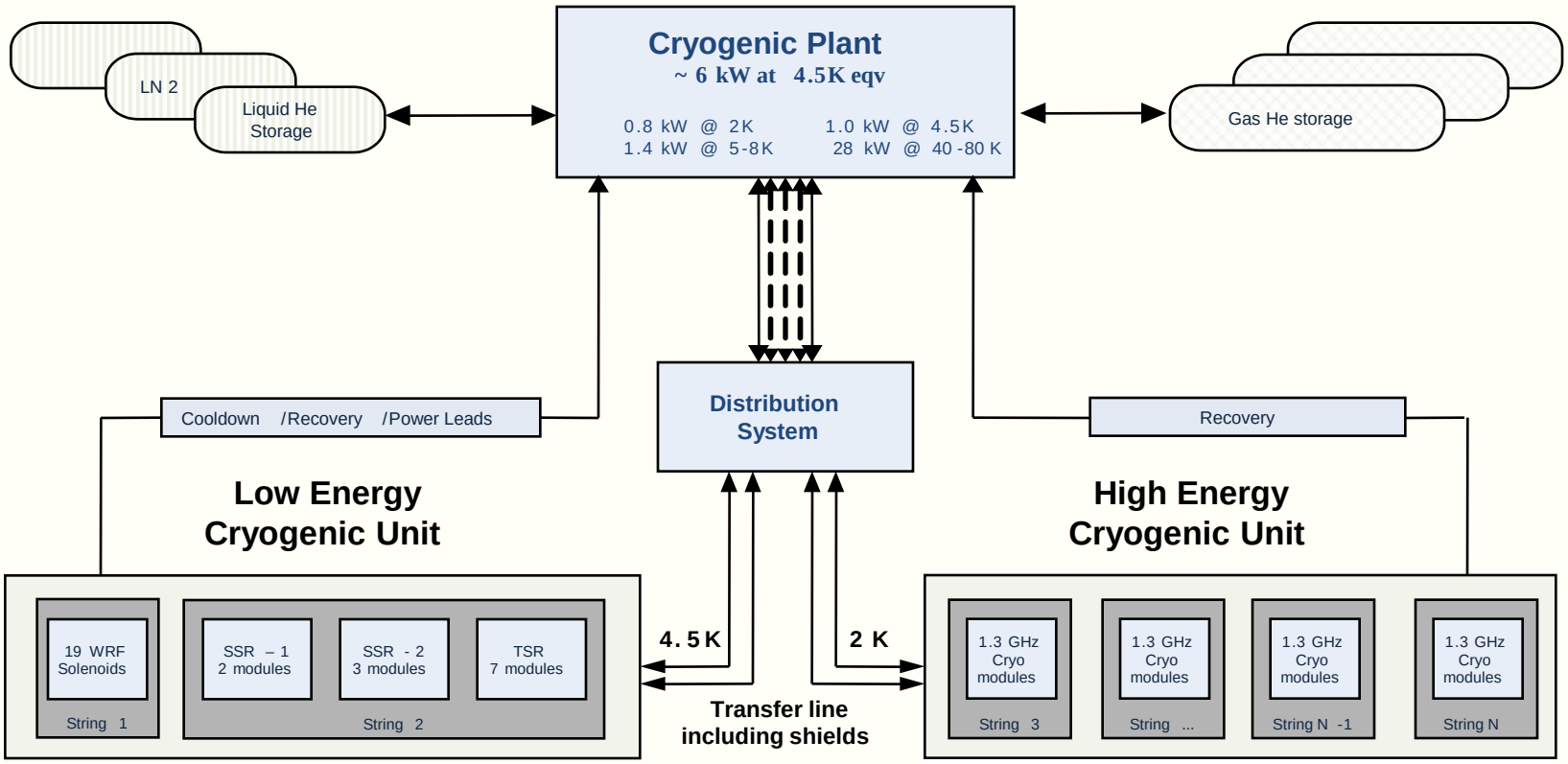
- Revising and resizing the TESLA cryogenic concept
- Saturated He II cooled cavities @ 2 K
- Helium gas thermal shield @ 5 - 8 K
- Helium gas thermal shield @ 40 - 80 K
- 2∅ line (liquid helium supply and concurrent vapor return) connects to each helium vessel
- 2∅ line connects to gas return once per module
- A small diameter warm-up/cool-down line connects the bottoms of the He vessels
- Subcooled helium supply line connects to 2∅ line via JT valve once per Cryo String
- Cryo String – 4 to 10 cryomodules

Conceptual Layout



ICD -1 Issues

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- **Issues that are being addressed by RD &D program:**
  - **Cryogenic Distribution and Segmentation**
  - **Capital and Operational Cost Optimization**
  - **Heat Load Analysis**
  - **Testing infrastructure**

ICD -1 RD & D Plan

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Project X Cryogenic System RD&D Plan																
ICD -1		FY09				FY10				FY11				FY12			
WBS	Description	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
1.7.1.	Cryogenic Distribution and Segmentation																
1.7.1.1.	Study existing cryomodules thermal cycling experience																
1.7.1.2.	Process development																
1.7.1.2.1.	2K heat exchanger																
1.7.1.2.2.	steady state modes																
1.7.1.2.3.	transient modes																
1.7.1.2.4.	fault scenarios																
1.7.1.2.5.	maintenance scenarios																
1.7.1.2.6.	commissioning scenarios																
1.7.1.3.	Tunnel distribution components capacities and location definition																
1.7.1.4.	Components over pressure protection study																
1.7.1.5.	Define cryogenic string size limits and segments																
1.7.1.6.	Liquid helium level control strategy development																
1.7.1.7.	Development of tunnel ODH mitigation strategy																
1.7.1.8.	Cryogenic Instrumentation																
1.7.2	Capital and Operational Cost Optimization																
1.7.2.1.	Shields operating parameters optimization																
1.7.2.2.	Cryogenic Plant Cycle																
1.7.2.3.	System lifecycle cost optimization																
1.7.2.4.	Effective utilization of existing Fermilab cryogenic assets																
1.7.3	Heat Load Analysis																
1.7.3.1.	Investigate static and dynamic loads for all components and sub systems.																
1.7.3.2.	Define overcapacity and uncertainty factors																
1.7.3.3.	Fault scenarios heat flux study																
1.7.4	Testing infrastructure																
1.7.4.1.	Determine cryogenic testing requirements																
1.7.4.2.	Define infrastructure needs																
1.7.4.3.	Infrastructure optimization																

Conclusion

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- ICD-1 RD&D work is progressing
- Collaboration is essential for the success of the RD&D plan implementation
- Thanks to all participants and collaborators for their contribution