CRYOGENICS R&D PLAN

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Project X Collaboration Meeting
September 8th, 2010

OUTLINE

- R&D Plan goals
- Scope
- R&D Plan
- Summary

GOALS

Cryogenic R&D plan is developed to mitigate the following risks that may affect cryogenic system performance, cost and schedule:

- Reduction in system reliability and availability
- Unwarranted system capital, operational and maintenance costs
- Unknown heat loads for all components and systems

SCOPE

Cryogenic system scope activities are organized within four primary elements:

1. Infrastructure for cavity and cryomodule testing
2. Cryogenic distribution and segmentation
3. Capital and operating cost optimization
4. Heat load

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TESTING INFRASTRUCTURE ISSUES

- Cryogenic infrastructure required to support R&D test facilities at the Meson Detector Building (MDB) and New Muon Lab (NML)
  - Horizontal dressed cavity, spoke and elliptical, testing at MDB
  - Spoke cryomodule(s) test at MDB
  - Cryomodule test facility at NML
- Finalize cryogenic testing requirements
- Define infrastructure needs
- Infrastructure optimization

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DISTRIBUTION AND SEGMENTATION ISSUES

- Pipe sizing for high flow rates and heat transfer
- Operating pressure tolerance
- JT valves and low pressure heat exchangers location
- Liquid level control in long strings operated in CW mode
- Tunnel component capacities and location definition
- Component over pressure protection
- Cryogenic string size limits and segments
- Tunnel ODH mitigation strategy
- Low pressure bayonets performance

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COST OPTIMIZATION ISSUES

- Optimum cavity operating temperature
- Cryomodule shield and intercept operating pressures and temperatures
- Efficient coverage of a wide range of heat loads
- Effective utilization of existing Fermilab cryogenic assets

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HEAT LOAD ISSUES

- Static and dynamic heat load analysis for all components and sub systems
- Define tolerances and uncertainties for static heat leak, RF generated heat leak, and beam induced heating
- Fault scenarios heat flux study

R&D PLAN

- Prior to CD-0 (by January 2011)
  - Pre-conceptual strategy for cryogenic distribution systems
  - Identify preferred operating temperature and options for segmentation
  - Finalize test areas cryogenic functional requirements
  - Complete heat flux study
  - Complete cryogenic temperature transmitter
  - Develop strategy for test stands

R&D PLAN (2)

- Between CD-0 and CD-1 (by July 2012)
  - Refine cryogenic distribution and segmentation strategy
  - Develop liquid helium level control strategy
  - Simulation and validation of major cryogenic distribution components
  - Technical specification and interface requirements documentation
  - System tests needs and requirements
  - ODH mitigation strategy
  - Integrated cryomodule safety strategy
  - Low pressure bayonet performance study
  - Cryogenic plant cycle studies

R&D PLAN (3)

- Between CD-1 and CD-2 (by August 2013)
  - Capital and operational cost optimization study
  - Turndown capabilities requirements
  - Define cryogenic system over capacity factors
  - System P&ID and layout of cryogenic distribution system
  - Complete infrastructure for cavity and cryomodule testing
  - Complete Heat Load study
- Between CD-2 and CD-3 (by September 2014)
  - Complete final designs

FY 2011 to 2012

ID	Task Name	Start	Finish
1	**CRYOGENIC DISTRIBUTION**	**10/1/2009**	**6/29/2012**
2	Pre-conceptual strategy for cryogenic distribution systems	9/3/2010	1/10/2011
3	Complete heat flux study	10/1/2009	12/1/2010
4	Define cryogenic distribution and segmentation strategy	1/10/2011	4/1/2011
5	ODH mitigation strategy	9/1/2011	6/29/2012
6	Integrated cryogenic string relieving analysis	1/10/2011	9/1/2011
7	**HEAT LOAD**	**9/3/2010**	**6/29/2012**
8	Simulation and validation of major cryogenic distribution components	9/3/2010	6/29/2012
9	Low pressure bayonet performance study	1/10/2011	6/29/2012
10	**TESTING INFRASTRUCTURE**	**6/1/2010**	**6/29/2012**
11	Finalize test areas cryogenic functional requirements	6/1/2010	10/1/2010
12	Develop strategy for test stands	9/3/2010	1/10/2011
13	CD for testing infrastructure	1/10/2011	6/29/2012
14	**COST OPTIMIZATION**	**6/1/2010**	**9/30/2011**
15	Identify preferred operating temperature and options for segmentation	6/1/2010	9/1/2010
16	Complete cryogenic temperature transmitter	9/3/2010	10/1/2010
17	Identification of potential vendors	9/3/2010	6/3/2011
18	Cryogenic plant cycle studies	1/10/2011	9/30/2011
19	Technical spec and interface req's doc's for the Px cryogenic system	1/10/2011	6/29/2012
20	Preliminary layout of cryogenic distribution system	1/10/2011	6/29/2012
21	Preliminary system P&ID	1/10/2011	6/29/2012
22	Preliminary components lists	1/10/2011	6/29/2012
23	Conceptual Design Report	1/10/2011	6/29/2012
24	PM documentation	2/1/2012	6/29/2012

ISSUES THAT NEED RESOLUTION SOON

- Finalize cryogenic testing requirements
- Cryogenic system lifecycle and availability requirements
- Superconducting components requirements specification
  - Operating pressure and temperature tolerances
  - 325 MHz and 650 MHz shields and intercepts operating temperatures
  - Finalize cavity MAWPs
  - Thermal cycling limits
  - Relieving and fault scenarios
  - Estimated heat loads
  - Interface definition
- Commissioning scenarios
- Refine future upgrade scenarios

SUMMARY

- IC-2 v2 is technically feasible
- A study will be performed to ensure that the Project X cavity operating temperature and segmentation layout are optimized for the combined capital and operating cost while maintaining system reliability
- R&D plan leads to final system design (normal and fault) parameters definition