PIP-II Cryogenics

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Scope

- Cryogenic plant
- Cryogenic distribution system
- Ancillary systems (purification system, cryogenic storage, etc.)
Function Requirements

• Provide sufficient cooling at appropriate temperature levels to enable operation of the SRF cavities and other cryogenic components within their respective operational conditions

• Ensure that the system shall support controlled cool-down and warm-up of cryomodules

• Ensure that the system and its components comply with the Fermilab ES&H manual

• Provide for proper protection of process fluids from contamination

• Operate as efficiently as is practical over a wide range of operating requirements

• Allow installation/removal of a cryomodule under cold conditions
Modes of Operation

• Controlled Linac cool down and warm up.
• Linac liquid helium fill
• 4.5 K standby
• 2 K standby
• 2 K design operation
Architecture

Compressor System

Cold Box

Distribution Box

Cryomodules:
- HWR
- SSR1
- SSR2
- LB650
- HB650

Cryogenic Transfer Lines

Gas Header

He Gas Tanks

LHe Dewar

Fermilab

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Cryoplant capacity

- Installed cryogenic capacity - $Q_{\text{installed}}$

$$Q_{\text{installed}} \rightarrow (Q_{\text{static}}, Q_{\text{dynamic}}, F_{\text{us}}, F_{\text{ud}}, F_{\text{overcapacity}}), \text{ where}$$

$Q_{\text{static}}$ – static heat load
$Q_{\text{dynamic}}$ – dynamic heat load
$F_{\text{us}}$ – static heat load uncertainty of estimate factor
$F_{\text{ud}}$ – dynamic heat load uncertainty of estimate factor
$F_{\text{overcapacity}}$ – cryogenic system degradation and extra capacity for cooldown

Best estimate at the time of the estimate (50/50)
Cryoplant technology

Sub-atmospheric compressors

Warm helium compressors

~51 kPa

CC3
CC2
CC1

~2.7 kPa

Cold Box

Cryomodules
Cryopplant acquisition

- Cryogenic plant is one of three major components of the Linac cryogenic system.

- Cryopplant acquisition is a complex process that requires significant effort and expertise.

- Cryogenic plant is usually a critical path for a project and requires earlier procurement.
Acquisition timeline

- Functional requirements specification
- Acquisition plan
- Technical requirements specification (TRS)
- Internal and external TRS reviews
- Submit Cryogenic Plant Requisition
- Receive Proposals
- Evaluate Proposals
- Award Contract
- Basic engineering
- Order long lead items
- Detailed engineering
- Fabrication
- Installation
- Commissioning

Months
Next steps

- Physics requirements
  - CW and/or Pulsed

- Next iteration on:
  - Baseline heat loads - $Q_{\text{static}}$ and $Q_{\text{dynamic}}$ 
    (50/50 estimate)
  - Functional Requirements
  - Interface definitions

- IIFC work on CW cryoplant
Thank you!