PIP-II uptime, availability, maintainability, and operability requirements

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Workshop on Maintaining PIP-II within the Accelerator Complex

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A Partnership of:
US/DOE
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Outline

- Workshop drivers, charge, and goals
- Requirements for PIP-II availability and maintenance
  - Beam Availability for LBNF and duration of the run
- Requirement to maintain SRF linac cold (no thermocycling)
  - Experience at other SRF Linac facilities
- Summary

Drivers for the Workshop

- We need to talk…
- This is not a review. This is a workshop.
- Project is in the final design stage. Some maintenance and operational requirements and their compatibility with the PIP-II design have not been discussed. PIP2IT revealed difference in expectations for maintenance of Cryo/SRF linac.
  - Need to define high-level operational and maintenance requirements for cryoplant and linac and ensure everybody is on same page. Does the PIP-II design, including support systems, meet these requirements?
  - Is the design of PIP-II systems compatible with required maintenance duration and availability
- We need to understand high level interfaces with AC complex and FESS/CF
- What are expectation for availability and maintenance for the Accelerator Complex in PIP-II era. Does the PIP-II design meet those requirements? Can we increase the beam time on LBNF target?

Charge and Goals of the Workshop

- Understand the projected beam availability per year of the AC in the PIP-II era (and can it be improved). What drives the duration of yearly planned AC shutdowns and can the duration be shortened?
- Define the operational expectations for PIP-II, especially with regards to cryoplant and cryomodules during scheduled AC shutdowns. Is the design of PIP-II systems compatible with these operational requirements.
  - We keep the linac cold during maintenance – is design of PIP-II, CF, and AC systems compatible with this requirement including maintenance and failures
- Identify the interfaces between the AC, Lab infrastructure and PIP-II. What are the expectations for maintenance and operation? Are there redundancies in systems to maintain operability?
  - Identify expectations for PIP-II maintenance and availability from the AC
  - Identify AC and Lab's systems that can affect PIP-II operations when they are maintained or fail.

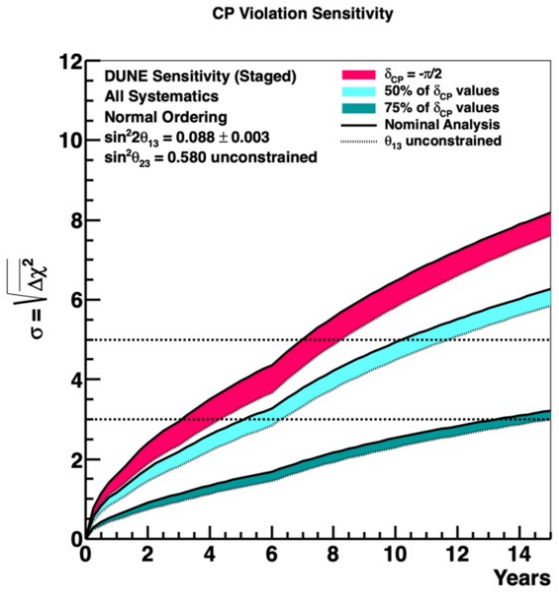
PIP-II Availability and Maintenance Requirements

- PIP-II Global Requirements Document (GRD, ED0001222) defines requirements for beam maintenance and linac and AC availability
  - Availability – ratio of time when beam is available for experiments to scheduled time
  - Is the linac beam recovery time included in maintenance?

I3	Scheduled Maintenance Weeks/Year	8
I4	SRF Linac Operational ~~Reliability~~ *availability*	90%
I5	60-120 GeV Operational ~~Reliability~~ *availability*	85%

Time to Discovery Depends on Beam Uptime On LBNF Target (and other factors)

- DUNE FD Technical Design Report assumes 56% of beam time on the LBNF target
- Mary's talk: Maintenance and beam recovery: 14 weeks. Availability: ~81%. Total beam on target: 59%.
- Improvement:
  - Maintenance reduction by 2 weeks gives ~3.5% increase
  - Availability increase by 5% give effective increase of beam time on target by 3.5% or 2 weeks



Requirement: Keep Linac Cold During Maintenance (no thermocycling) as long as feasible

- Experience with PIP2IT showed that warming up cavities sufficiently to release and move gas around can change performance of SRF cavities
- Warming up and cooling down linac will likely change performance of the PIP-II linac, will introduce uncertainty, require significantly longer commissioning time, has risk of cryo system failures

- Requirement: Keep linac cold, preferably at 2-4K but not exceeding ~20K, during maintenance for as long as possible, preferably forever.

Experience with Other SRF Linac

- Other SRF linacs are operated cold, without thermocycling, for extended periods of time
- SNS, E-XFEL, JLab, FRIB
- SNS: Linac and CDS never thermocycled (except individual CMs, 1-3 CM per cycle). One in-line spare warm compressor in each stage. An emergency generator/UPS for cryo controls and small equipment (not for main CHL). Only allow 8-hours shutdown. During 8-hours shutdown, about half of liquid helium in cryomodules evaporates but still cryomodules and transfer lines are cold. 4K durng shutdowns. More in today's talk by Matt Howell.
- E-XFEL: 4.5 years cold and counting. Two cold-boxes and sets of compressors allow maintaining the CPs without warming them up. Spare warm compressors to support cold compressors in case of problems. Plan is not to warm up until 2024, when safety valves need to be checked (every 7 years). Plan is to add redundancy to avoid warming up next time. Recent test to let linac temperature drift showed that FE CM reached 10K and main linac was still at ~4K after 10 hours without cooling. (information provided by H. Weise)