OAK RIDGE National Laboratory

An Operationally Integrated Approach to the SNS 2.8 MW Power Upgrade

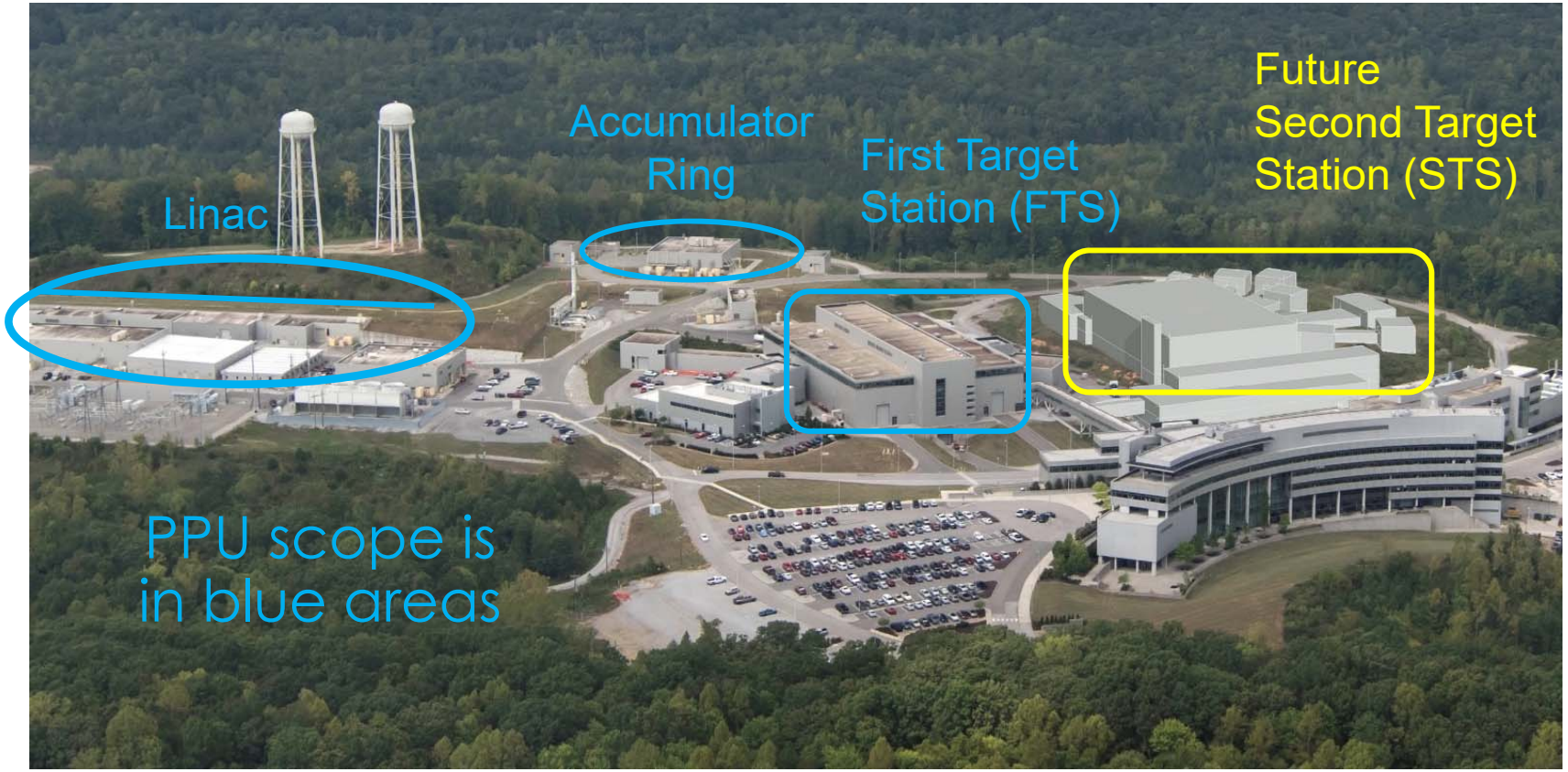
HB 2021 workshop, Chicago Il

John Galambos
Director PPU
October 2, 2021

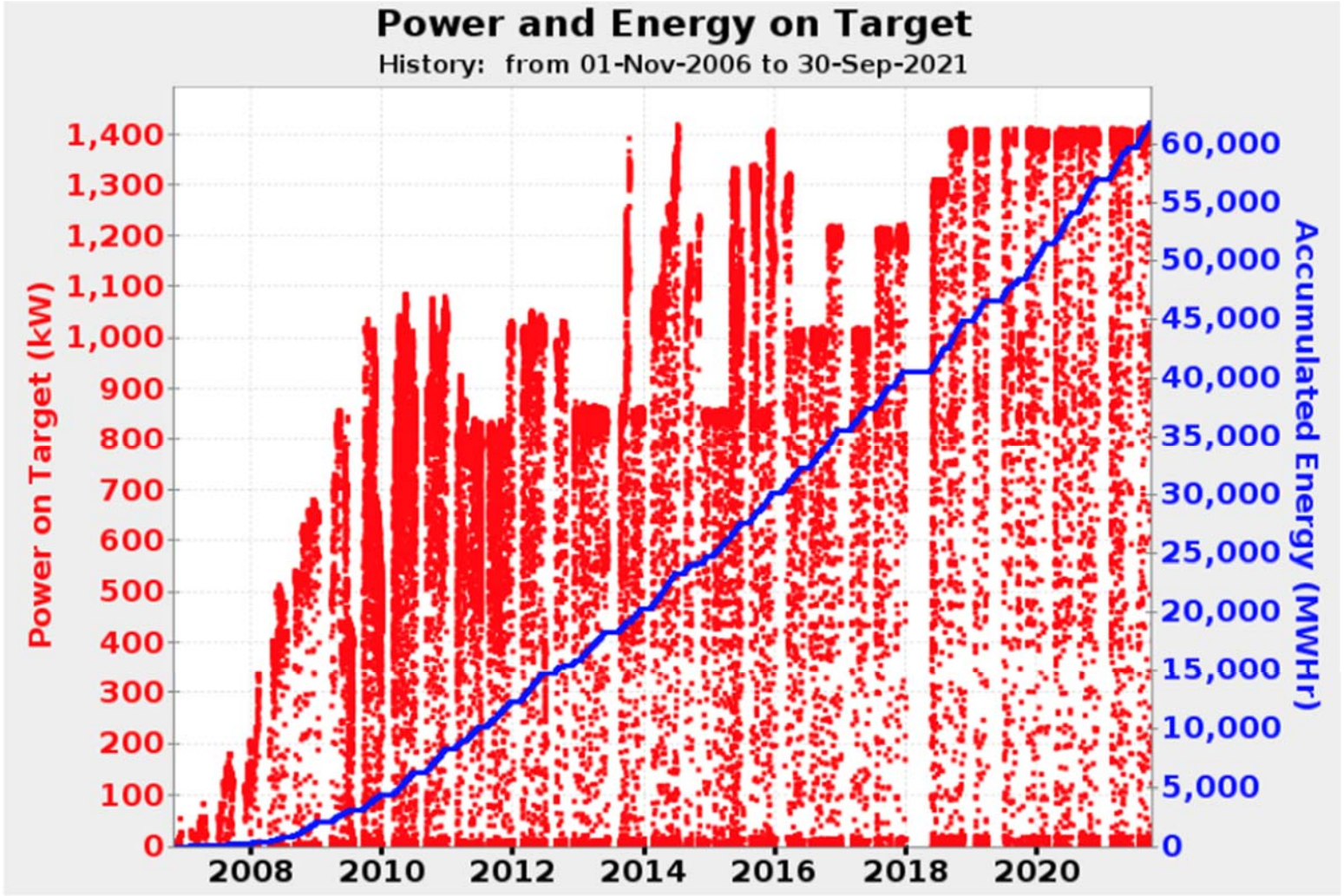
ORNL is managed by UT-Battelle, LLC for the US Department of Energy

U.S. DEPARTMENT OF ENERGY

SNS overview



SNS has been operating reliably at 1.4 MW since 2018

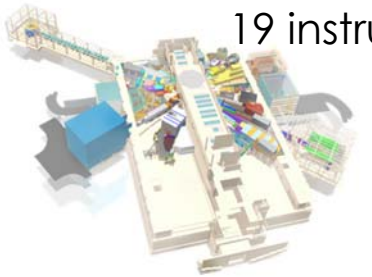


- kmklj

SNS Upgrade Plans

Today

24 instrument positions
19 instruments built



First Target Station

1.4 MW

Accelerator

Now

Future

24 instrument positions
21 instruments built

First Target Station

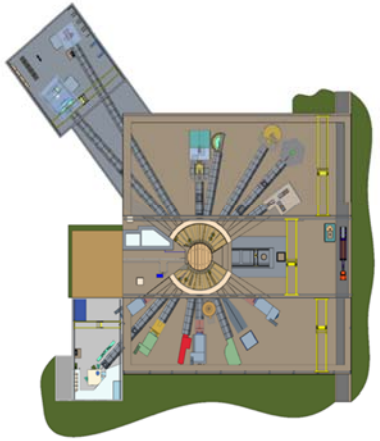
2 MW

Accelerator
2.8 MW capable

Proton Power Upgrade (PPU)

22 instrument slots,
8 initial instruments

Second Target Station (STS)



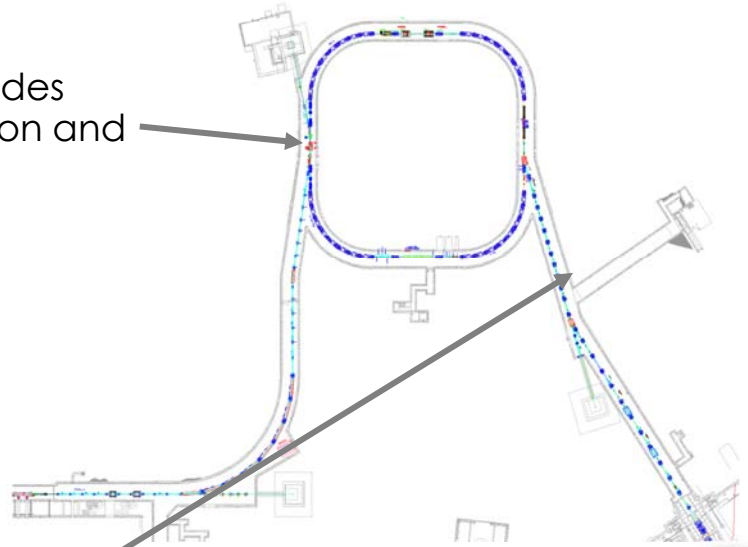
STS Upgrade

Proton Power Upgrade project scope

- Includes scope across much of the neutron source

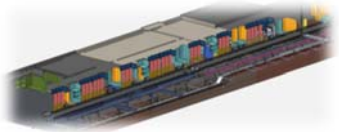
Ring system upgrades
- Primarily injection and extraction

7 new superconducting linac cryomodules



Radio Frequency (RF) system upgrades
- Additions for new cryomodules
- Upgrades for existing systems

Conventional facility upgrades



Target system upgrades

PPU parameters

	SNS 1.4 MW	PPU full upgrade capability	PPU FTS 60 Hz operation
Proton beam power capability (MW)	1.4	2.8	2.0
Beam energy (GeV)	1.0	1.3	1.3
RFQ output peak beam current (mA)	33	46	46
Average linac chopping fraction (%)	22	18	41
Average macropulse beam current (mA)	25	38	27
Energy per pulse (kJ)	23	47	33
Pulse repetition rate (Hz)	60	60	60
Macro-pulse length (ms)	1	1	1
FTS decoupled moderator brightness/pulse (AU)	1	2.04	1.43
FTS coupled moderator brightness/pulse (AU)	1	2.16	1.51

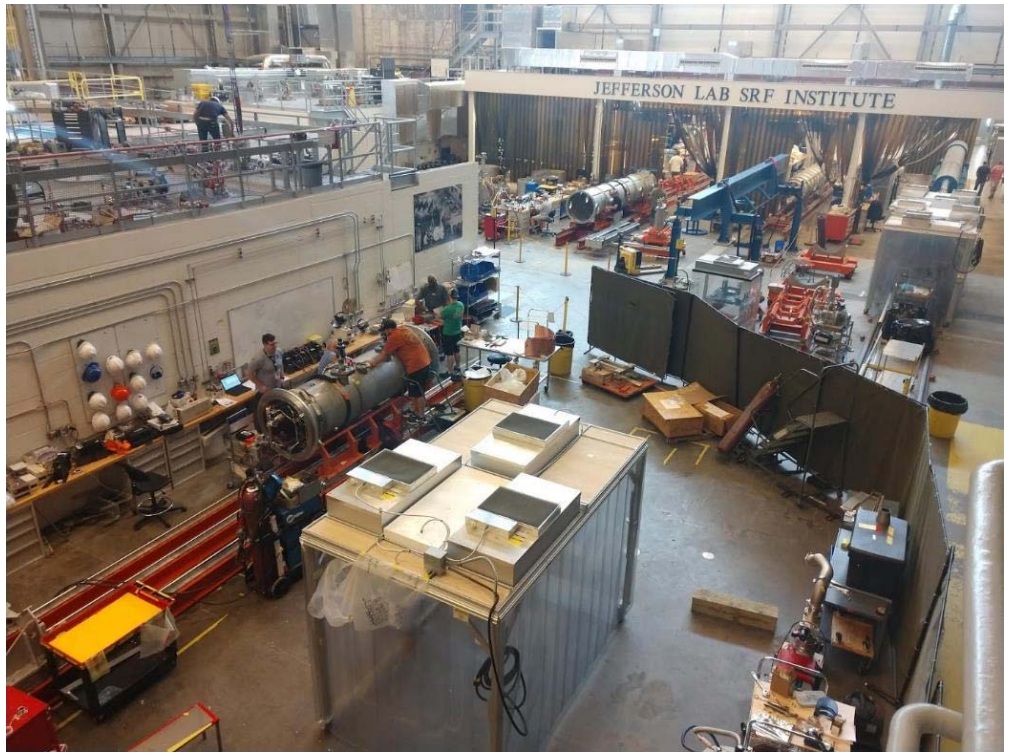
30% energy increase

50% current increase

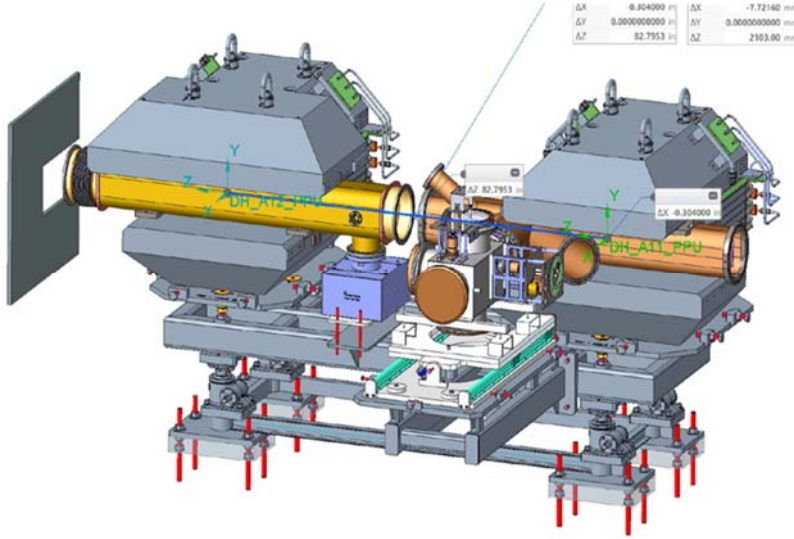
No change

Partnering is a key element of the PPU strategy

Primary partner JLab has extensive cryomodule fabrication experience



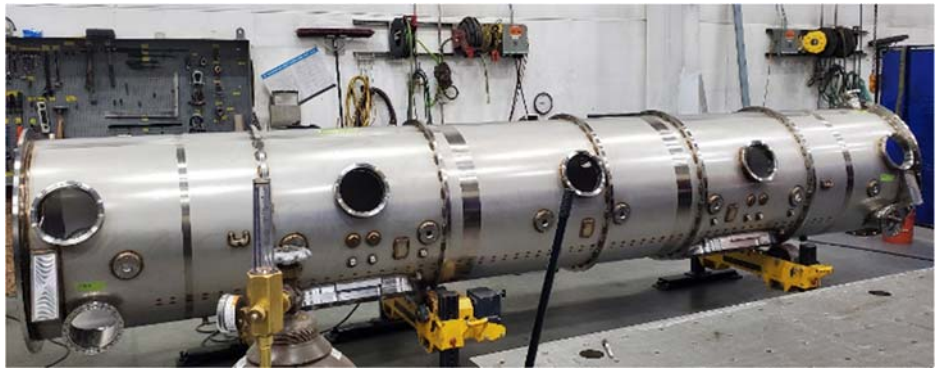
FNAL is designing and overseeing fabrication of new injection magnets



LBNL collaboration on LLRF development

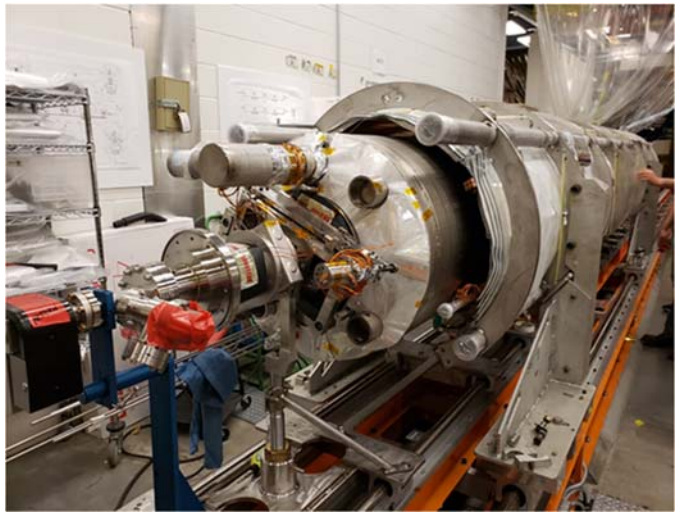
Superconducting RF systems: cryomodule production ramping up

- 7 new cryomodules + 1 spare
  - Cavities received in good shape
  - Cryomodule production proceeding well at partner JLab



Cryomodule vacuum vessel

String assembly



Cold mass assembly

RF Systems: largely procurements

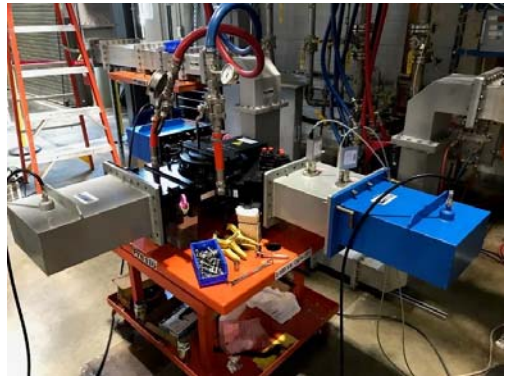
Klystrons being received on site (working too!)

Transmitter cooling cart at vendor

LLRF test operation on SNS

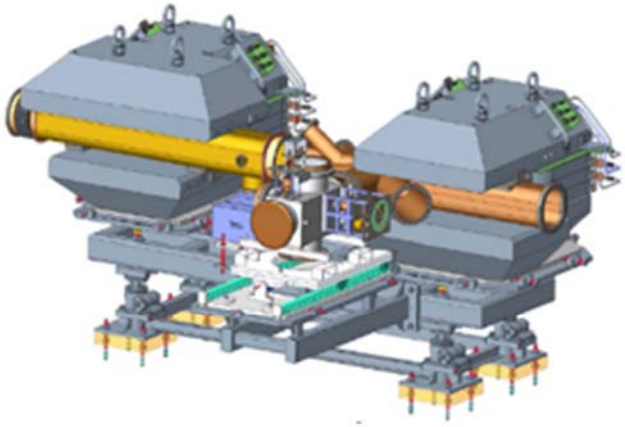
HVCM fabrication at vendor

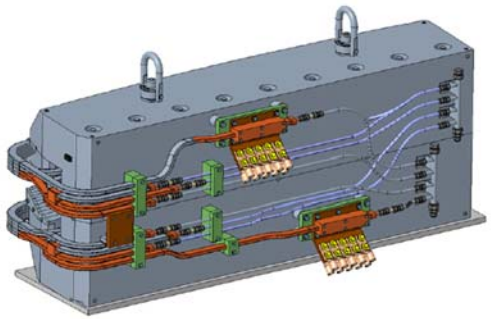
1st article circulator received



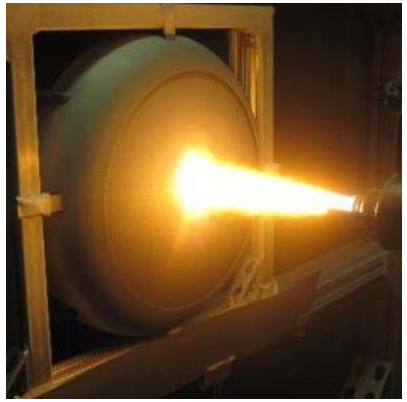
Ring systems: injection magnet, focus on fabrication

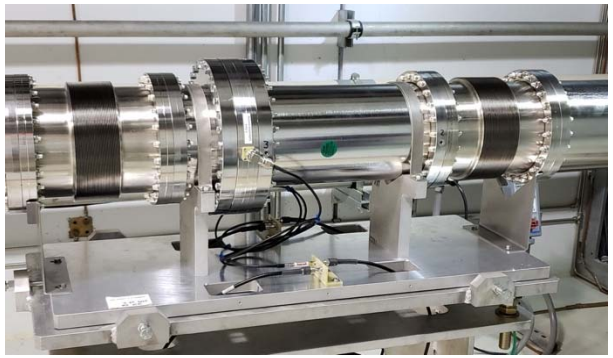
FNAL is fabricating new injection magnets





Injection dump imaging system:
on track for install in FY22

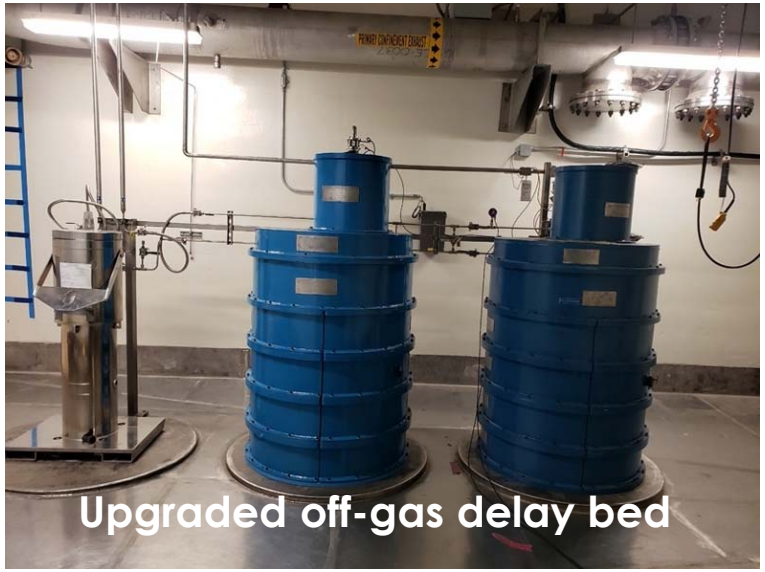




Current pickups in tunnel for beam power limiting system

Target systems: target manufacture and sub-system component fabrication going well


Test target #1 at SNS

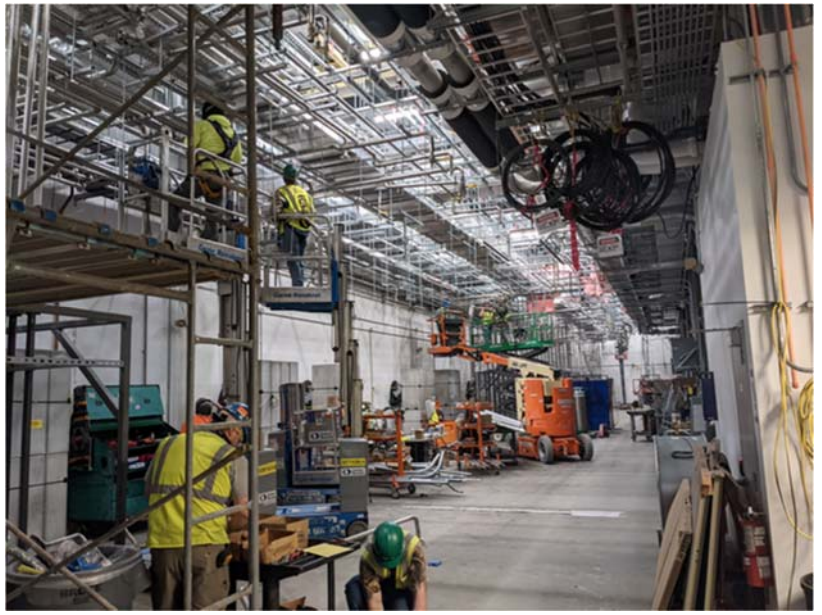

Upgraded off-gas delay bed

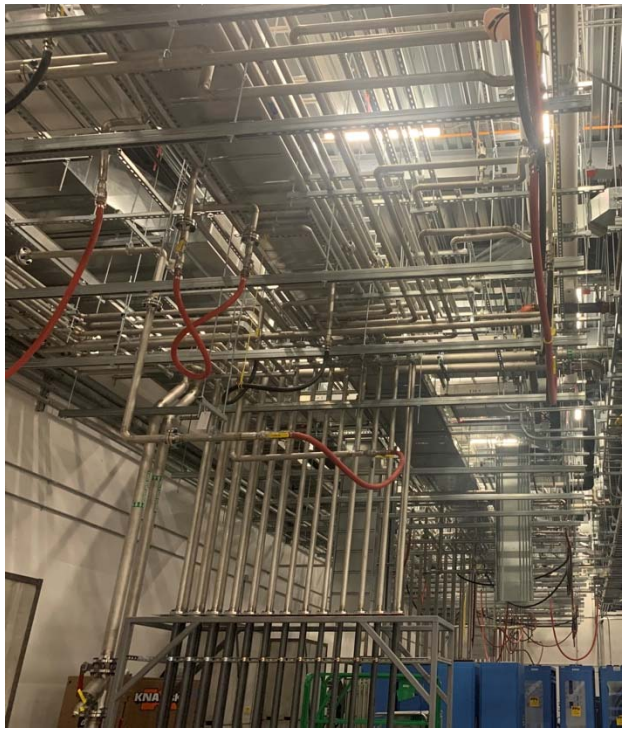

Mercury pump overflow tank mockup test

Conventional facilities: klystron gallery buildout is complete: BIM helped

Complicated piping sections are fabricated offsite

And lifted / positioned into place: easier than fabricating in place

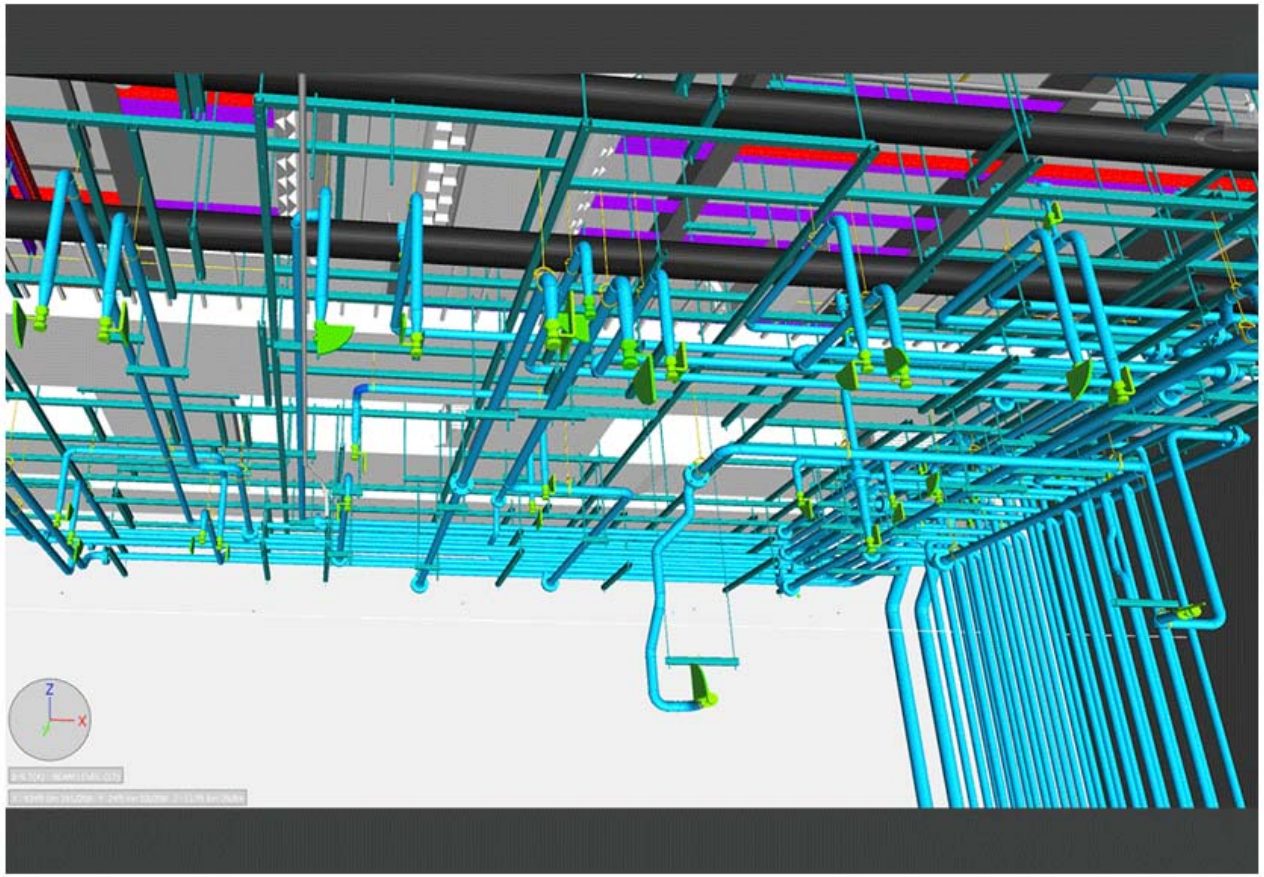




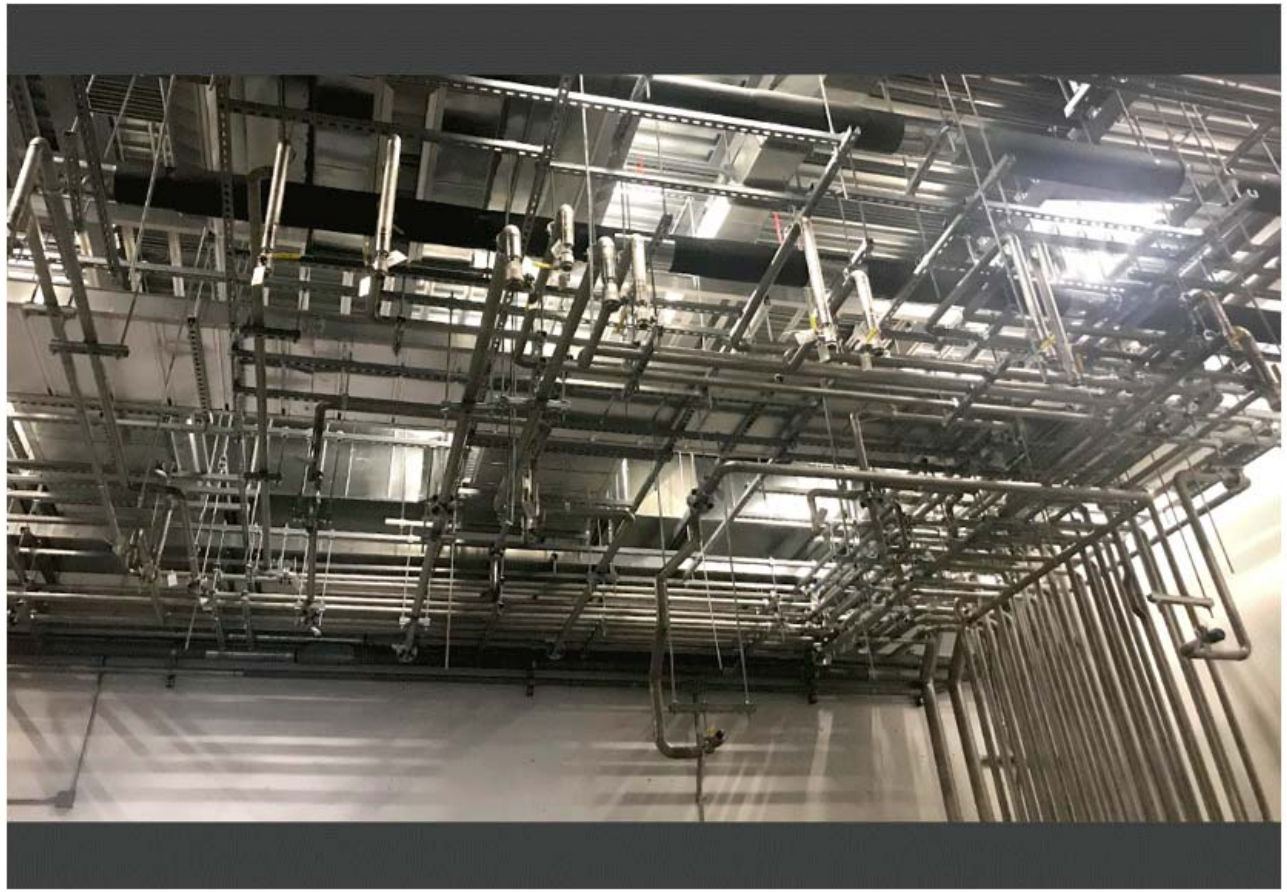
(BIM = Building Information Modeling)

- See: https://neutrons.ornl.gov/klystron-virtual-tour

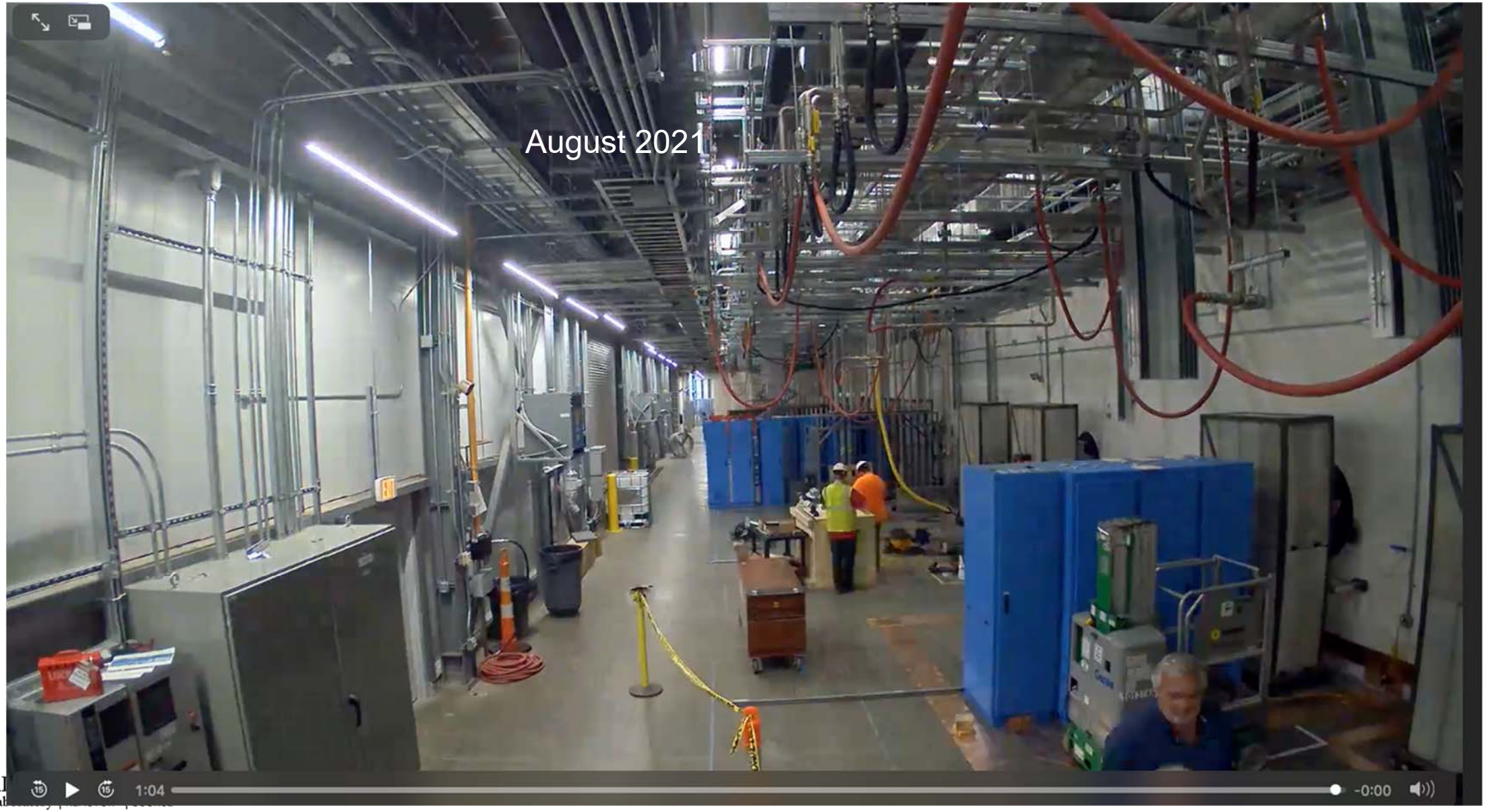
BIM transformation from virtual to reality



BIM transformation from virtual to reality



Klystron gallery activity videos



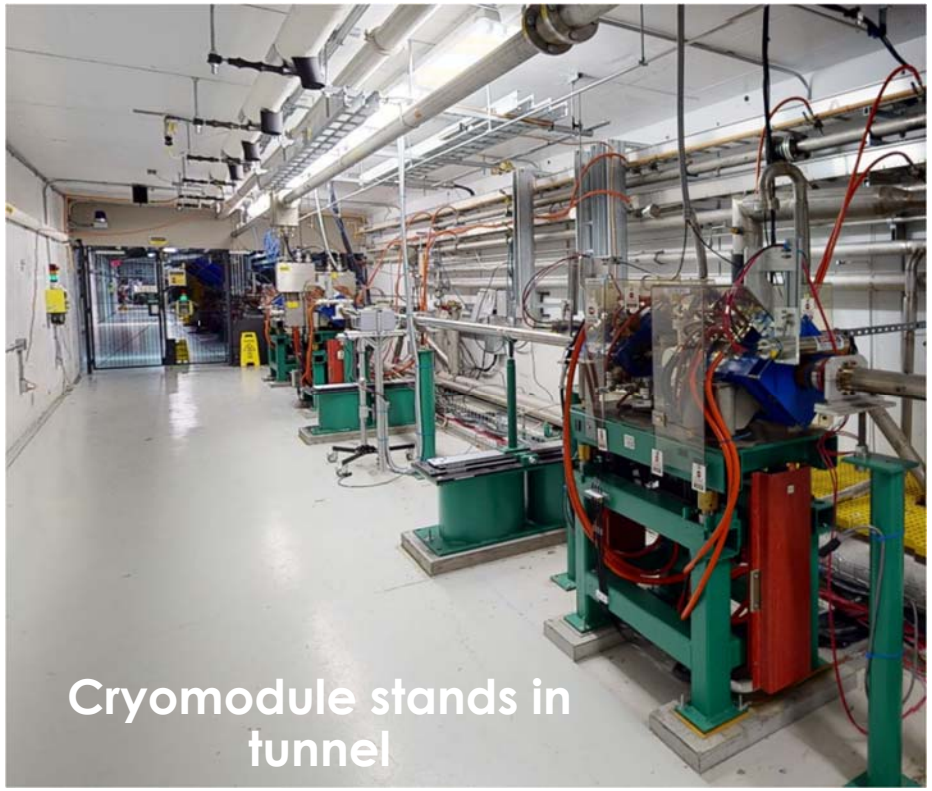
Some onsite activities can occur during beam operation

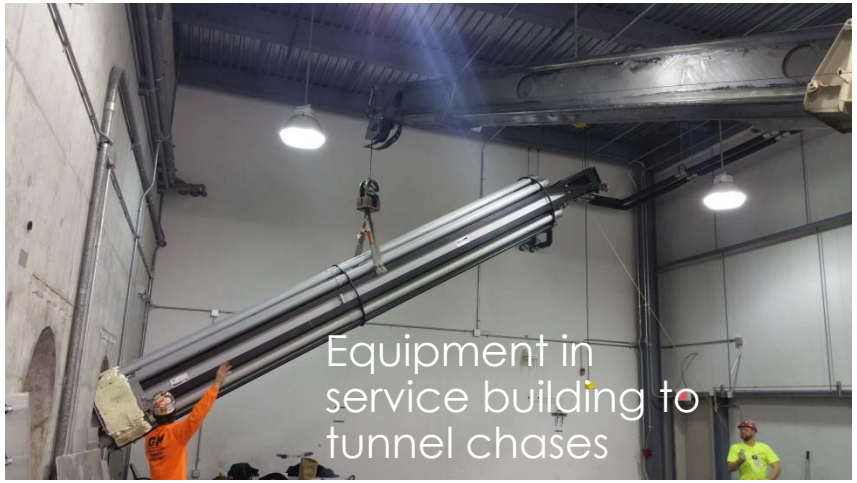
Service building round plane to equipment racks

Remote serviceability testing for target system upgrade mockup

Installation of cable tray drops and equipment racks

Other onsite activities require beam off

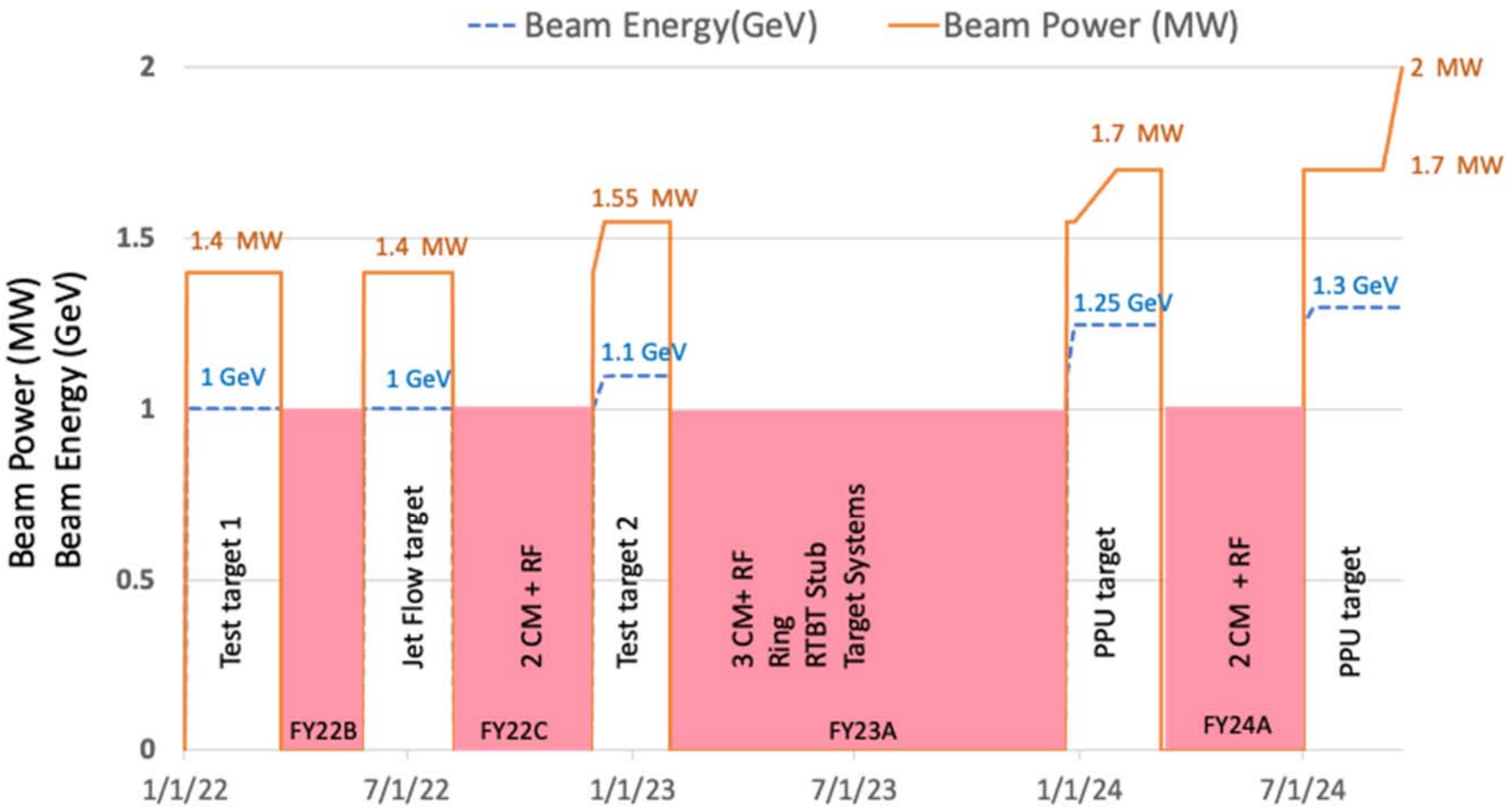




shield blocks mounted on rollers for quick reconfiguration

Gradual power ramp-up over 2023-2024 requires coordination with operations

- Incorporates new equipment as it arrives – red shaded areas indicate downtimes
- One 10 month extended outage in 2023

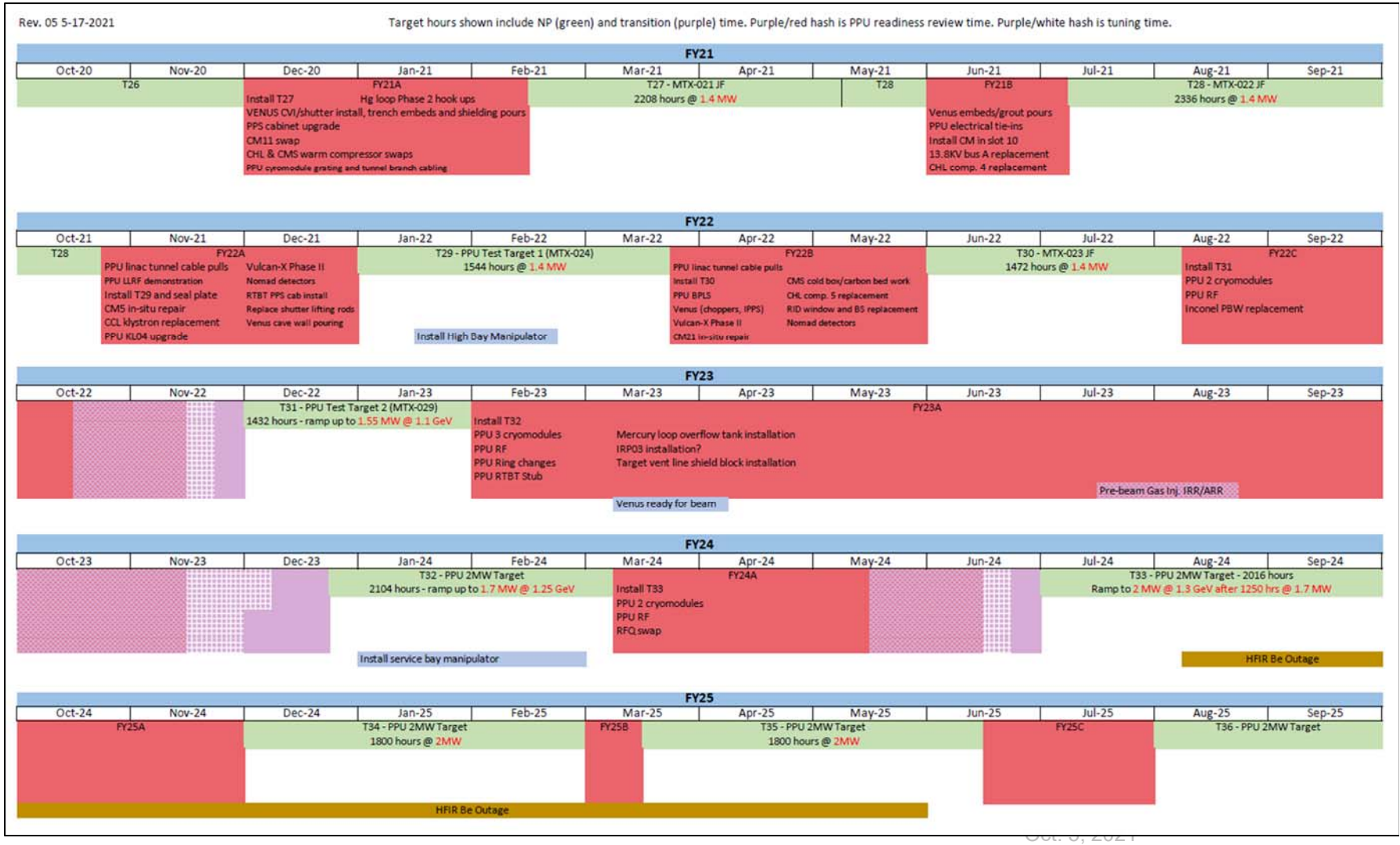


SNS operations and PPU schedules are synchronized

5 year plan

Red periods are outages

Green periods are run periods

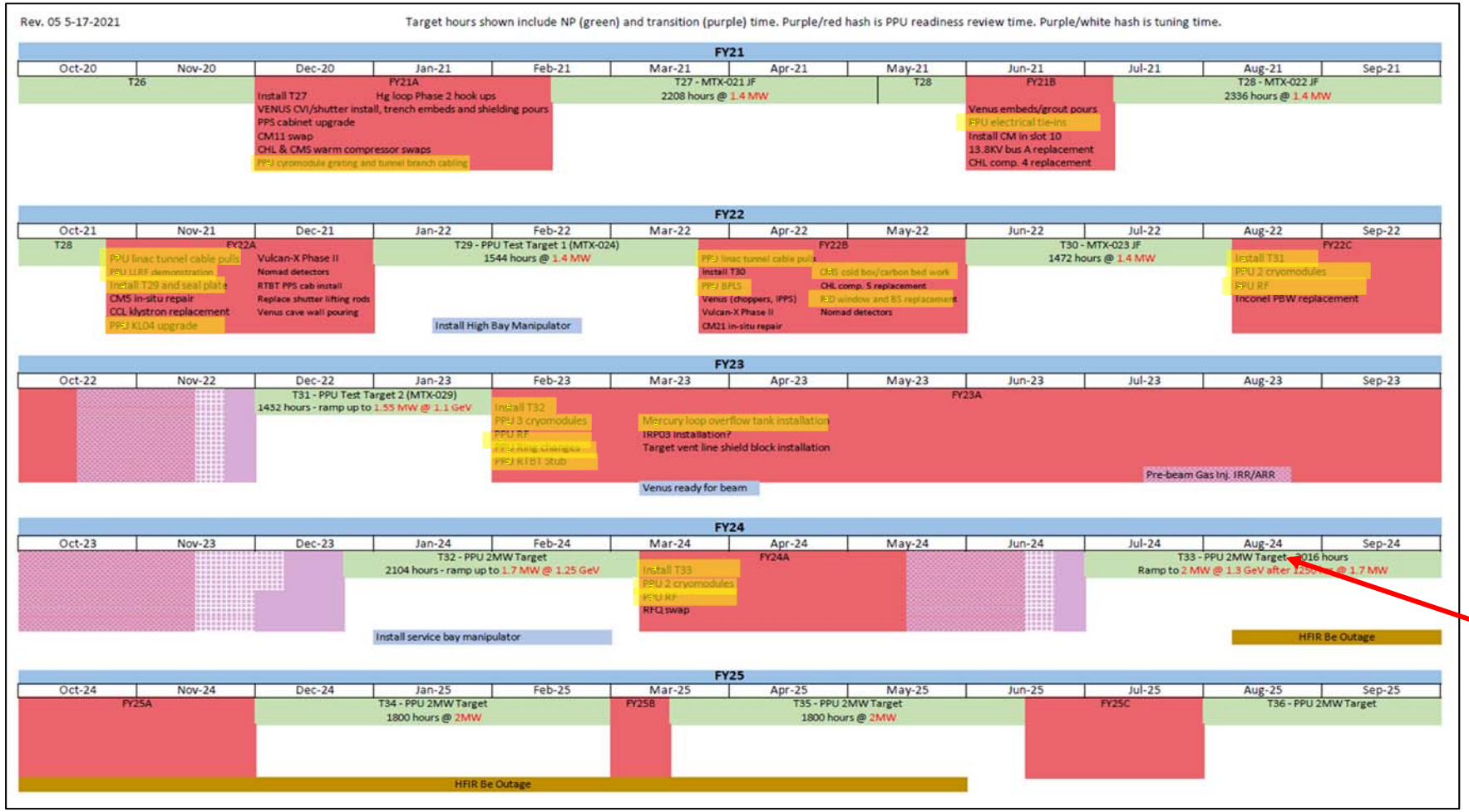


- Directorate level negotiation with input from DOE
- PPU early finish prioritized

SNS operations and PPU schedules are synchronized

PPU activities will play important role in outages next2 years

Highlighted items are PPU related



FY21:

Now

FY22:

FY23:

FY24:

FY25:

Early finish

Summary

- PPU is well into the fabrication construction project stage
- The plan is to implement upgrades in stages over ~ 2 years
  - Interleaved with operational runs
  - Starting soon!
- This requires a carefully choreographed "dance" with operations and the project
- 2.8 MW accelerator power capability expected in 2025