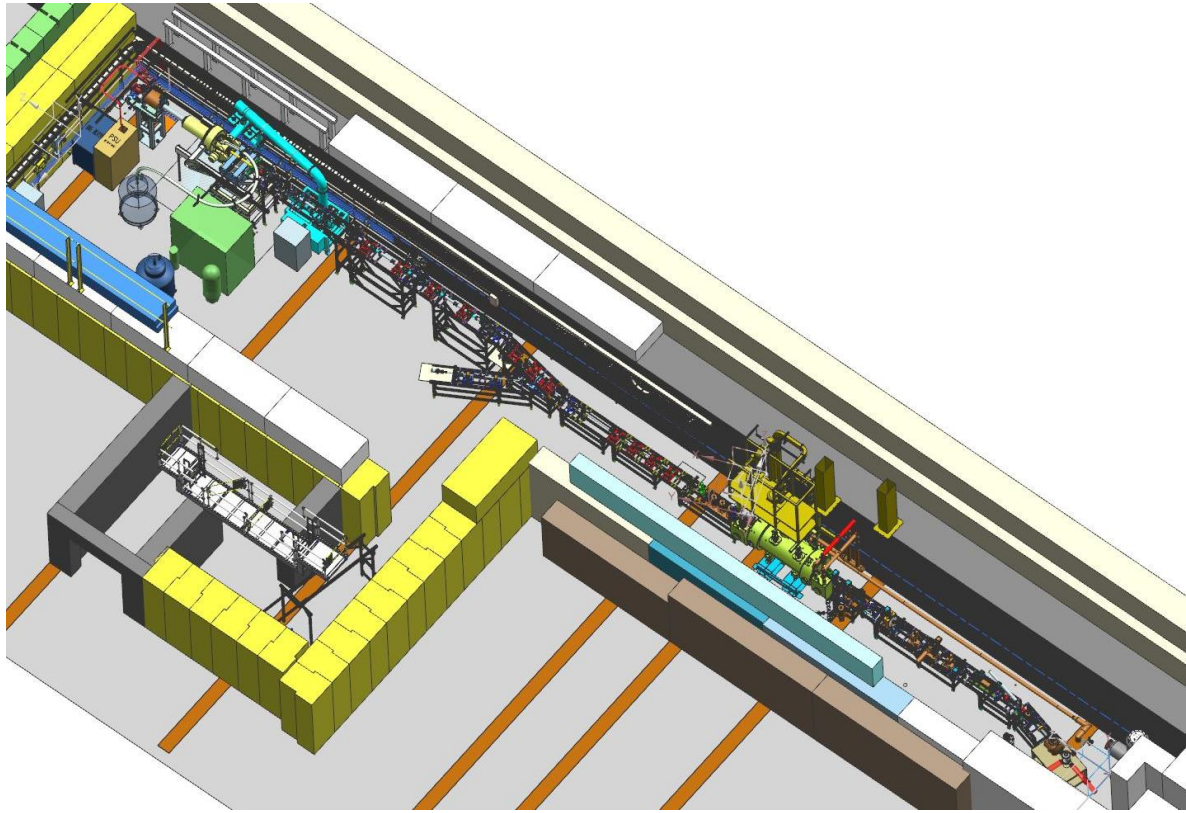
Status of Upgraded Injector Test Facility (UITF)

Matt Poelker

Status of UITF and dependence on CTF LHe (charge #1, 7, 9)

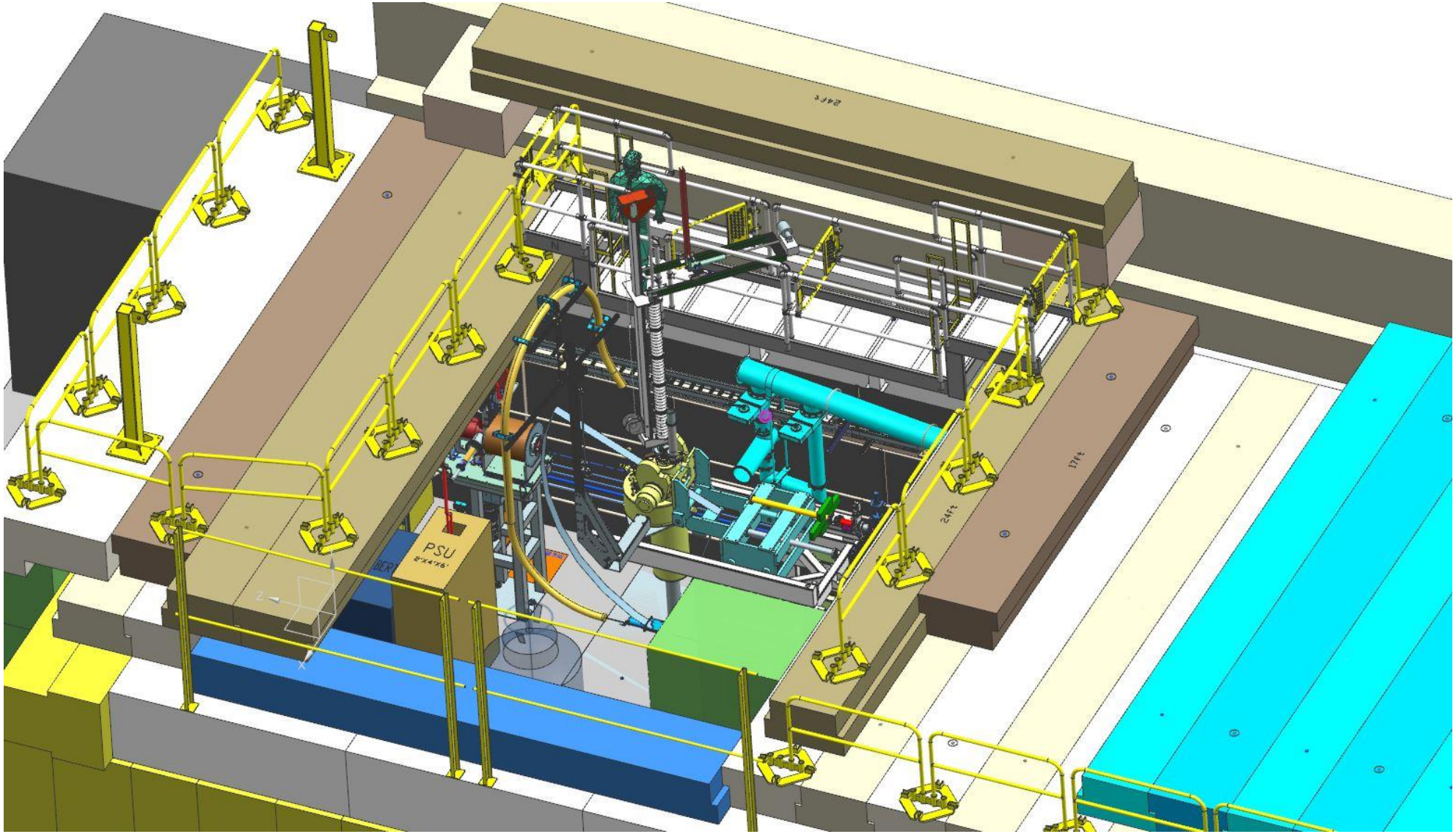
- UITF goals: CEBAF injector, QCM tests, HDIce
- Status of RadCon assessment, ARR, ASE, other approvals
- Status of beam hardware & software control
- Modes/Staff for providing beam



HDIce @ UITF – Experimental Readiness Review

November 19, 2019

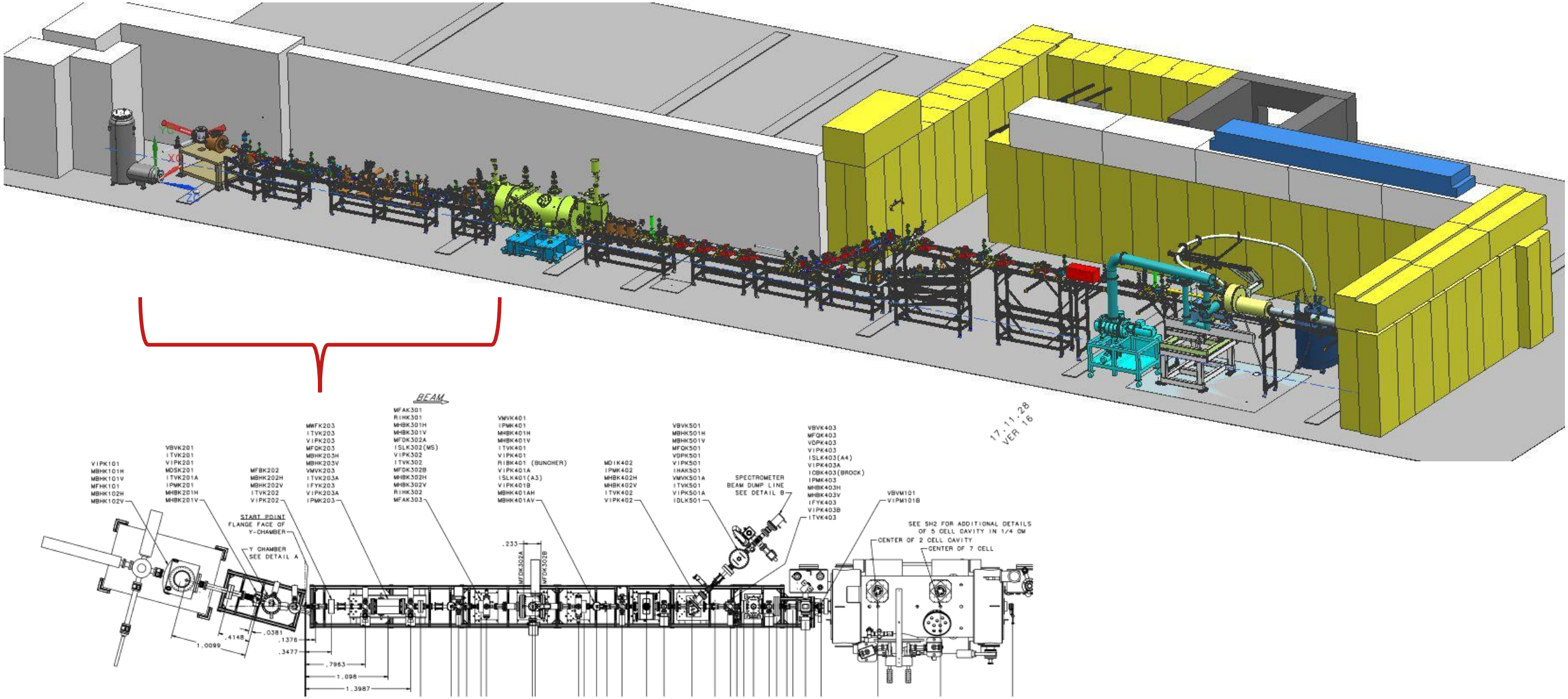
Test the spin-polarized target “HDIce”



UITF is a 10 MeV spin-polarized electron accelerator

the UITF accelerator is built, ready to use….
(buncher not yet commissioned, we have not yet made MeV beam)

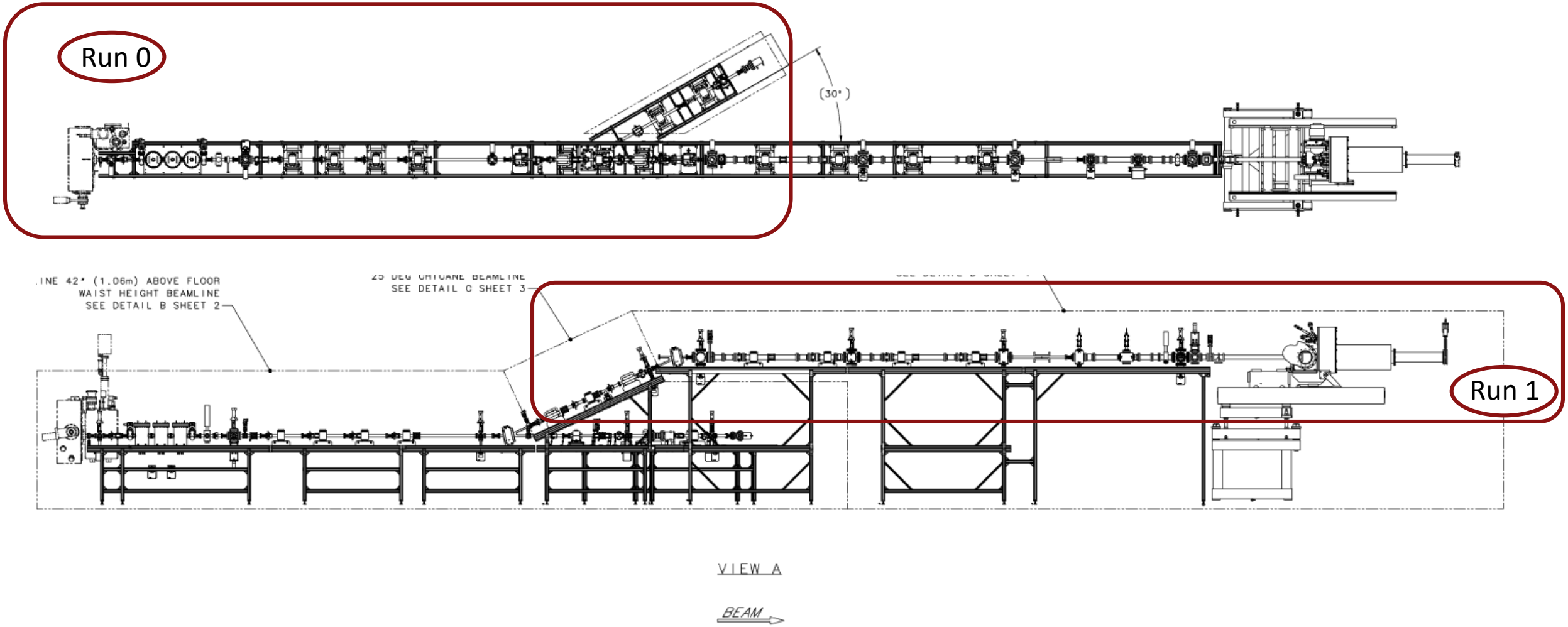
keV beamline commissioned, RF applied to cold “Booster”, no MeV beam yet



Jefferson Lab

MeV beam….the accelerator

Design, construction, songsheets, software, everything is cabled up waiting for hot check out….

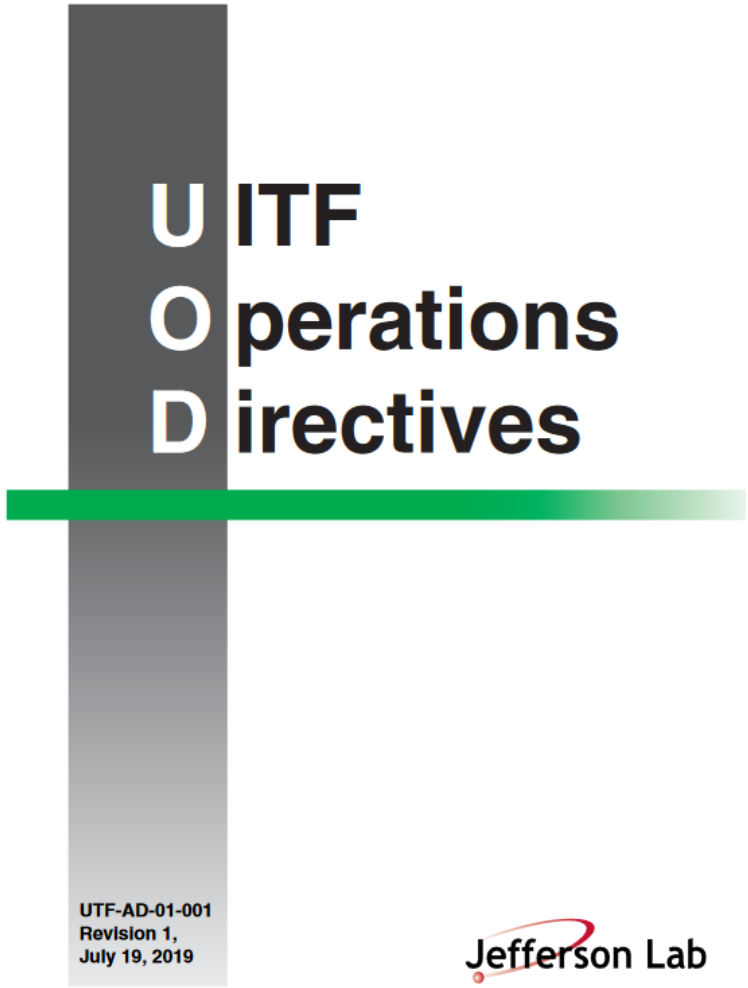


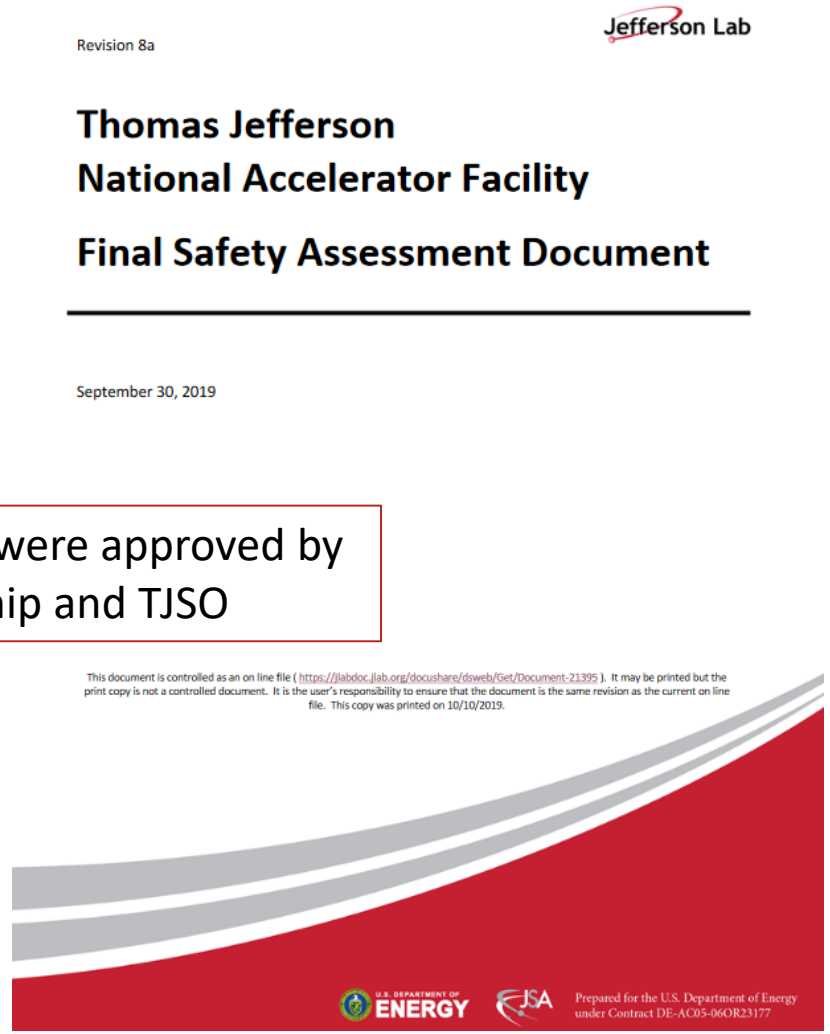
Past Reviews of UITF

- Review #1: UITF Operations Review, aka “will it work?” March 18, 2016
  - https://wiki.jlab.org/ciswiki/index.php/UITF_Meeting_-_March_18,_2016
- Review #2: UITF Safety Review, May 10, 2016
  - https://wiki.jlab.org/ciswiki/index.php/UITF_Meeting_-_May_10,_2016
- Review #2.5: PSS BCM review *, October 21, 2016
  - https://wiki.jlab.org/ciswiki/index.php/UITF_Meeting_-_October_21,_2016
- Review #3: Conduct of Operations Review, April 24, 2019
  - https://wiki.jlab.org/ciswiki/index.php/UITF_Meeting_-_April_24,_2019
- Shielding Design Package, June 2019, JLAB-TN-18-020
- Accelerator Readiness Review: June 26-28, 2019
  - https://www.jlab.org/indico/event/322/timetable/#20190626

* the PSS BCM, once deemed necessary now deemed optional, following detailed shielding assessment

Official Documentation





These documents were approved by Lab Leadership and TJSO

https://wiki.jlab.org/ciswiki/index.php/UITF_Official_Documents

https://www.jlab.org/eshq/ProgramDocs

Official Documentation

UITF Safety Documents

UITF cave 2 catwalk engineering calculations media:catwalk engineering calculations from Tom Renzo.pdf

UITF Cave2 ceiling roof tile removal, OSP and THA, revision 2, in review media:UITF Cave2 ceiling roof tile removal OSP.pdf**** media:UITF Cave2 ceiling roof tile removal THA.pdf

Shielding Design Package from Vashek, approved by SCMB File:JLAB-TN-18-020 Radiation Safety Aspects of the Upgraded Injector Test Facility Vashek Vylet.docx, Photos of trench foam and lead shielding media:UITF trench shielding with photos.xls

Cool and Operate HDice IBC and its superconducting magnets in cave2 of UITF ENP-18-80380-OSP File:Cool and Operate HDice IBC and its superconducting magnets in cave2 of UITF ENP-18-80380-OSP.pdf

UITF 748.5 MHz Buncher Cavity Operation at the Upgraded Injector Test Facility: Revised OSP #82655 File:Revised OSP 82655 748.5 MHz Buncher Cavity Operation at the Upgraded Injector Test Facility.pdf and File:Revised THA for 748.5 MHz Buncher Cavity Operation at the Upgraded Injector Test Facility.pdf. These files can be accessed at https://mis.jlab.org/mis/apps/mis_forms/operational_safety_procedure_form.cfm?ENTRY_ID=82655

UITF Commissioning the QCM with RF, no beam acceleration, revision2: https://misportal.jlab.org/mis/apps/mis_forms/operational_safety_procedure_form.cfm?entry_id=82424 File:OSP 82424 QCM Operation at the Upgraded Injector Test Facility (UITF) revision 2.pdf****File:OSP 82424 QCM Operation at the Upgraded Injector Test Facility (UITF) revision 2.docx

UITF Commissioning the QCM with RF, no beam acceleration, Task Hazard Analysis, revision2: File:THA for the OSP 82424 QCM Operation at the Upgraded Injector Test Facility (UITF)revision2.pdf

UITF SF6 tank pressure vessel assessment PS-ACC-17-001 can be found in DOCUSHARE at https://jlabdoc.jlab.org/docushare/dsweb/View/Collection-38867 (Note, the pressure vessel assessment for a similar SF6 tank used at CEBAF can be found at https://jlabdoc.jlab.org/docushare/dsweb/View/Collection-38417)

UITF QCM Vacuum Vessel assessment: File:QCM Vacuum Vessel Assessment by Gary Cheng.docx

UITF Laser OSP: File:LOSP ACC-17-64784.pdf

UITF keV Beam Operations OSP (note this is revision3 of previously approved OSP): File:OSP UITF keV beam operations approved revision3.docx **** File:OSP UITF keV beam operations approved revision3.pdf **** File:OSP-UITF keV beam operations approved revision3 approved OSP format with signatures.pdf

UITF keV Beam Operations THA (note this is revision3 of previously approved THA): File:THA UITF keV beam operations approved revision3.pdf

UITF sweep procedure, updated 6/25/2019: available on Docushare at https://jlabdoc.jlab.org/docushare/dsweb/View/Collection-27494/ and here: File:UITF sweep procedure S6024.pdf

UITF Final Approved ODH Assessment: File:UITF ODH Assessment.pdf and available at https://misportal.jlab.org/railsForms/oxygen_deficiency_reviews/74180/edit

UITF Industrial Hygiene Assessment for SF6 exposure: File:UITF SF6 assessment.pdf

UITF TOSP_high voltage conditioning a new photogun with 225kV Spellman supply: File:UITF TOSP gun HV conditioning.pdf **** File:UITF THA gun HV conditioning.pdf

https://wiki.jlab.org/ciswiki/index.php/UITF_Safety_Documents

Radiation Shielding Assessment and Commissioning Plan

JLAB-TN-18-020

Radiation Safety Aspects of the Upgraded Injector Test Facility

Vashek Vylet

Abstract

Upgraded Injector Test Facility (UITF) is a new 10 MeV electron accelerator designed to test advanced concepts in the design of accelerator guns, accelerator diagnostic devices, detectors and other equipment to be used in JLab's CEBAF accelerator, experimental halls and possible future installations. The facility consist of a heavily shielded existing electron gun test area, Cave 1, currently housing an electron linac with a short "1/4" cryogenic accelerator module (¼-CM). A new area, Cave 2, has been added to provide space for testing experimental equipment. The use of a cryogenic gas, liquid helium, and the requirement of movable roof panels presented challenges for shielding design. A large opening in the side shielding wall just under the the roof shielding is required to keep the facility at the desired Oxygen Deficiency Hazard 0 level. This text presents a radiation safety assessment for normal operation and accident scenarios using a combination of Monte Carlo and simpler shielding calculation techniques.

https://wiki.jlab.org/ciswiki/index.php/UITF_Safety_Documents

Shielding is adequate for 100 uA CW beam

UITF Commissioning Plan

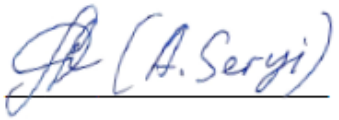
Version 4

November 13, 2019 (Poelker)

Approvals:

Matt Poelker

UITF Facility Manager



Andrei Seryi

Accelerator Division AD

Pre-commissioning Tasks:

QCM cooldown to 2K: schedule the cool down of the QCM at least two days in advance of UITF commissioning, coordinating activities with Cryo and SRF. CTF piping must be reconfigured, restoring LN2 flow to the QCM shield line and sending LHe to UITF instead of the CMTF. Staff from the SRF Institute check insulating vacuum using a turbo pump cart, and oversees cooldown from RT to 4K, and from 4 to 2K.

Hot Check Out: one week in advance of commissioning, using the System Readiness tool or via direct communication with group leaders/system owners. Document the status of each:

https://wiki.jlab.org/ciswiki/index.php/UITF_Official_Documents

“Standard” tools available at UITF, just like at CEBAF

- Low duty factor modes of operation: Viewer Limited and Tune Mode
- Viewers, BPMs, harps, current monitoring
- Spectrometers, Yao cavity, and Brock bunchlength monitor
- Ditherer to center beam in solenoids and quads
- Elegant to predict device settings
- Archiver, save/restore, twiddle save
- Frame grabber, viewer image fitting tool, StepNGraph
- Machine protection (FSD), chime
- …
- The elevated beamline is “normal”, no anticipated problems putting beam on the viewer and Faraday Cup upstream of the IBC
- (unique beam for HDIce, 1nA or less, how to “see” this beam?)

Table 1 of the UITF ARR Plan, presented to ARR Review Committee June 26-28, 2019

Jefferson Lab will conduct the ARR under the conditions shown below in ***Table 1 - Operating Parameters for Commissioning and Operations.***

Table 1 - Operating Parameters for Commissioning and Operations

ARR Phase	Beam Termination	Beam Mode	Beam Current (nanoA)	Beam Energy (keV)
Commissioning	Beam in the injector up to but not including the QCM	CW	1.0E+05	200
	Beam to post-QCM cup and dumps	Tune-Mode*	1.0E+02	10,000
	"beam spill tests**" with RCD	CW	Up to 1.0E+4	10,000
Operations	Beam in the injector up to but not including the QCM	CW	1.5E+07	200
	Beam to post-QCM cup and dumps	CW	1.0E+05	10,000

*Tune-Mode beam is ensured by one hardware and one administrative method.

Acceptable Hardware Methods:

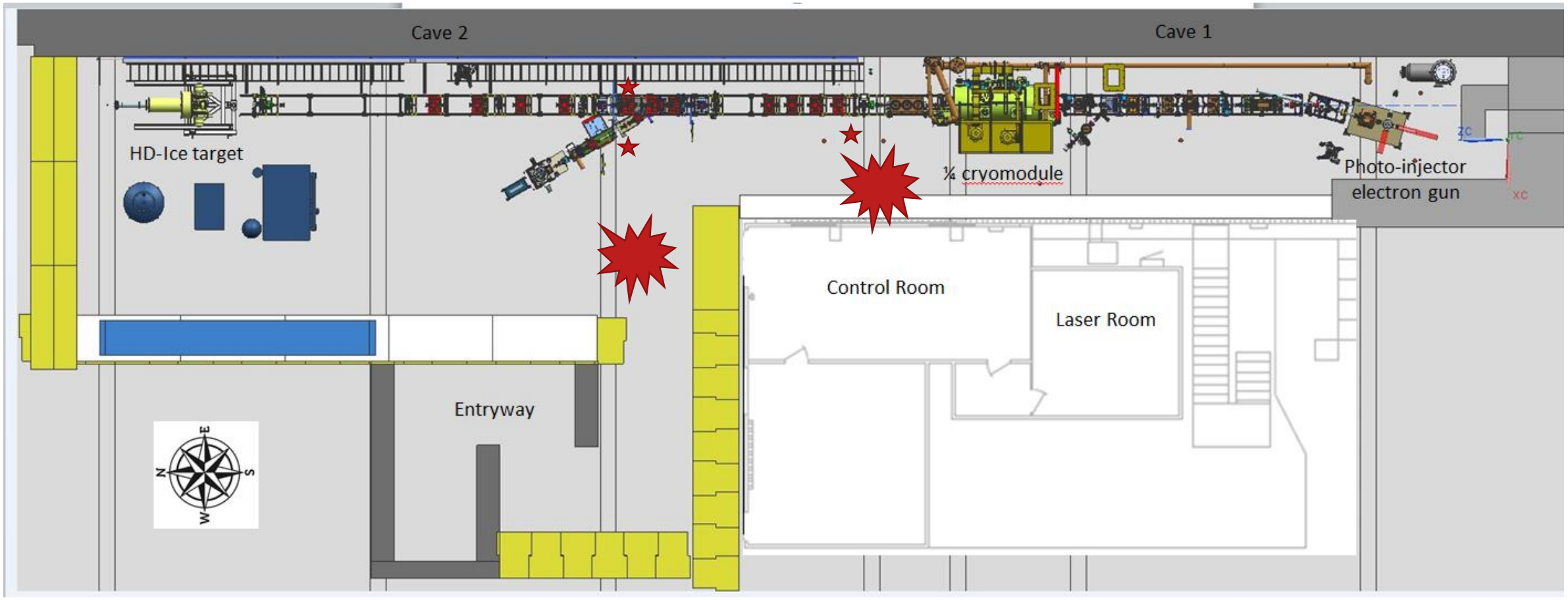
1) beam current monitors set to trip on CW
2) current limit on the gun high voltage power supply

Acceptable Administrative Methods:

1) button for CW disabled in software
2) posted operator instructions and trained operators

** "spill tests" with RCD representing less than 10% of total commissioning time

Commissioning process “break points”, verify shielding is adequate



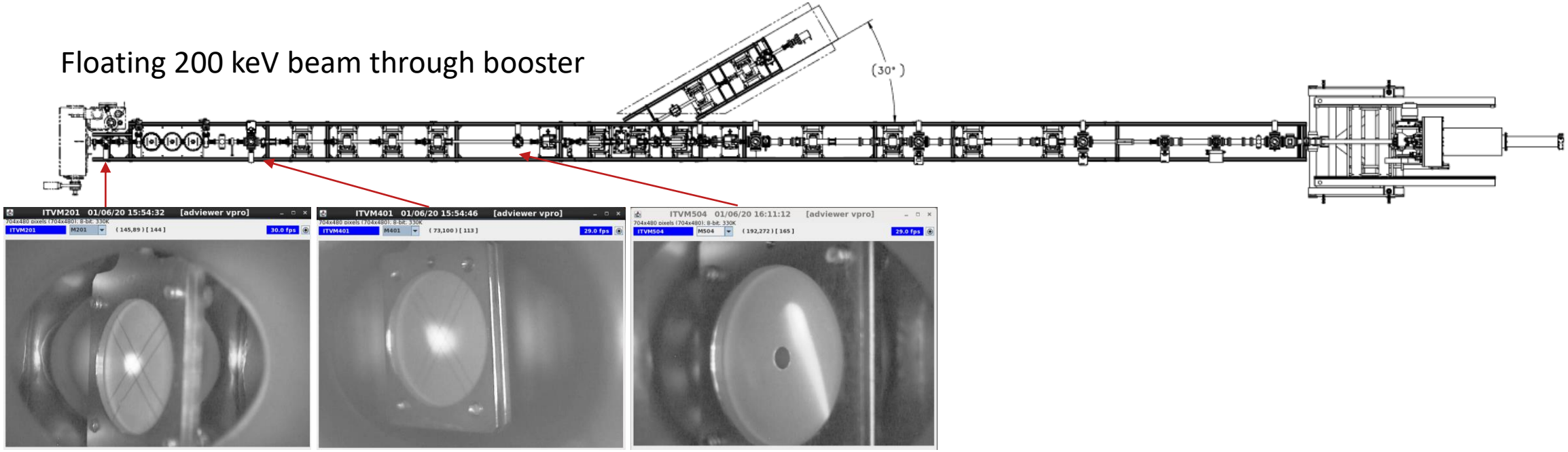
★ BLM locations (ILMM401, 601 and 701)

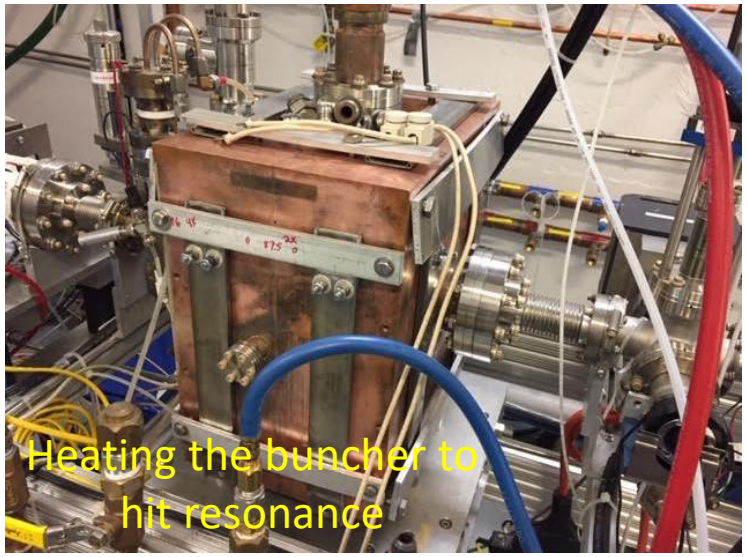
Good locations for spill tests:
proximity to control room and labyrinth

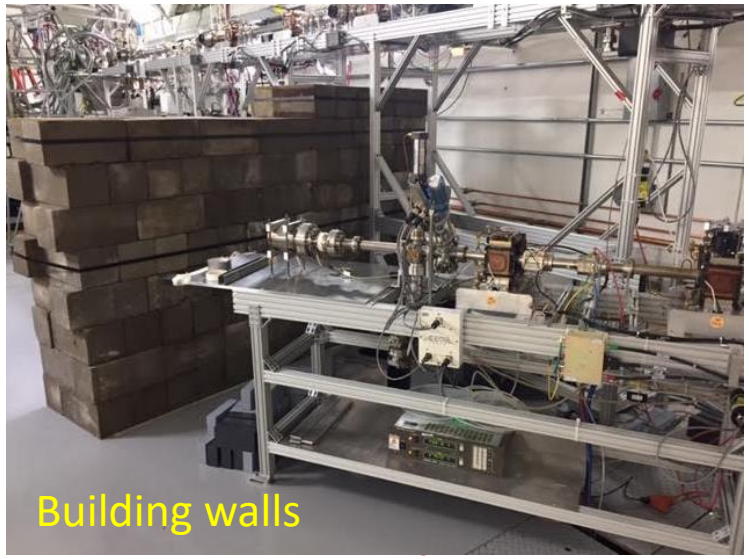
Jefferson Lab

UITF status today

Floating 200 keV beam through booster







UITF “schedule”

HDIce run schedule

Run#	X	0	1	2	3	4
Objective	IBC installation	Booster Commissioning	Aperture target/Empty Target	Unpolarized Target	Polarized Target	Polarized Target
Tiles OFF and ON sequence	OFF/ON	not required	OFF/ON	OFF/ON/OFF/ON	OFF/ON/OFF/ON/OFF/ON	OFF/ON/OFF/ON/OFF/ON
# times Neil visits the rooftop	2 (done)	0	2	4	6	6

done

After LCLS2 testing finished at CMTF, May 2020

Buncher commissioning January

Booster commissioning when opportunity presents itself

Back Up Slides

Unique aspect of HDIce testing: low current CW, ~ 1 nA

After threading normal viewer-limited and tune-mode beam (100 nA avg current) to last viewer, we will:

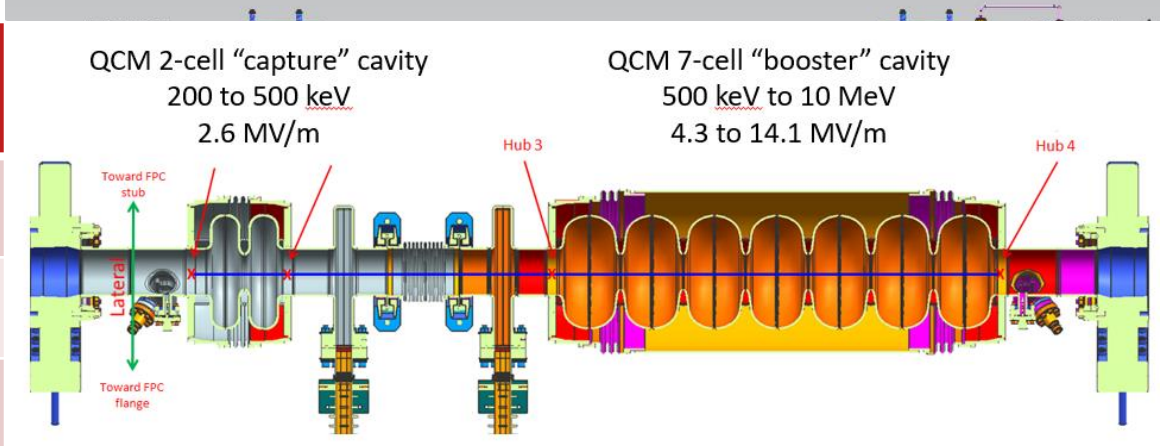
- insert the chopper slit to obtain nA CW beam at Faraday cup in front of IBC. Chopper slit current (i.e., beam that is dumped) serves as good gun current monitor
- use viewers in CW mode as current monitors, one viewer in front, two dump viewers behind IBC. Viewer image intensity cross-calibrated against Faraday cup. Downstream viewer provides real-time current and position monitoring
- apertures with proper holes prevent dumping beam on cell walls
- radiation monitors at apertures in front of IBC, and behind IBC. Beam trips OFF when radiation levels exceed nominal good readings
- Rogowski coil (we hope) provides real-time beam position and current monitoring at nA current, it will serve as go/no go indicator, with fsd interlock to trip OFF beam

Features that protect HDIce

Note, we already tested Booster with RF at UITF (no beam acceleration)

QCM commissioning results at UITF

	Cavity 7 (2-cell)	Cavity 8 (7- cell)
QextFPC	6.2E+06	9.9E+06
QextFP	2.9E+12	2.3E+12
Emax (MV/m)	16.5	18.0
Emaxop (MV/m) (1 Hour run)	16.0	18.0
Limit	Quench	Forward Pwr
FE onset (MV/m)	11.5	16.0
RF heat load at typical operating gradients	9.5E+09 (< 1W at 6 MV/m)	1.2E+10 (~12 W at 6 MV/m)
Static heat load	20 W	



Inside the QCM

Maximum beam energy at UITF?
16 MV/m x 0.7m = 11.2 MeV

(7-cell cavity effective length 0.7 m)

Approved UITF Operators (underlined names)

Gun Group (Center for Injectors and Sources)
Scientists: J. Grames, C. Hernandez-Garcia, M. A. Mamun, M. Poelker, R. Suleiman, M. Stutzman and S. Zhang
Technical staff: P. Adderley, B. Bullard, (plus replacement for John Hansknecht)
Graduate Students: G. Palacios, S. Wijiethunga, J. Yoskovitz

Injector Group
Scientists: R. Kazimi, Y. Wang, A. Hofler

24/7 operations seems required - there is insufficient staffing to support 24/7 operations

Post Start Findings of ARR – need to be addressed before "Operations"

Found: 52 records matching your search criteria

Click on the record number to see the full details.

ACTION_#	ACTION_OWNER	ORG	DESCRIPTION	COMPLETE_BY	COMPLETED
IA-2019-03-02-01	Poelker, Matthew	Ctr for Injectors&Sources	Develop UITF Specific Training Module (i.e. Model Operator training programs) and records consistent with Jefferson Lab training, using the graded approach. Please provide the following closure evidence: "Training Module Title, and List of those requiring it (having it on their JTA's)"	2020-06-30	open
IA-2019-03-04-02	Poelker, Matthew	Ctr for Injectors&Sources	Continue to turn Test Plans into formal documentation for Operations use and training purposes. Please provide the following closure evidence: "Updated Test Procedures and method of dissemination"	2020-06-30	**2019-11-04**
IA-2019-03-05-01	Poelker, Matthew	Ctr for Injectors&Sources	Install additional "operator aids" (e.g. more easily visible alarm lights) to help operators recognize alarm conditions from the Rapid Access Radiation Monitor. Please provide the following closure evidence: "Description of additional operator aids and pictures of same"	2020-06-30	open

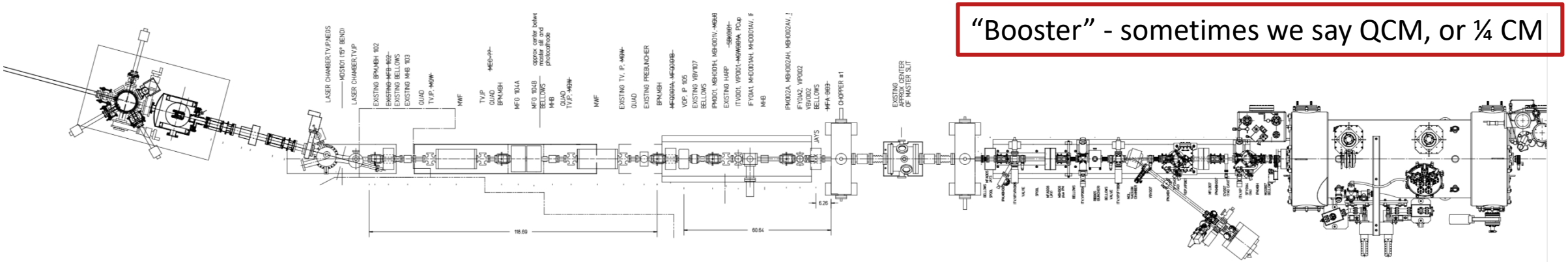
Post-start Findings will need to be addressed after Commissioning:

- Consider modeling operator training program and records consistent with other Jlab accelerators using a graded approach.
- Consider incorporating Human Performance Improvement principles in UITF Operations
- Use the process/steps from the Commissioning Test Plan to develop a Start Up Procedure to be used in subsequent start ups. Continue to turn Test Plans into formal

UITF “schedule”

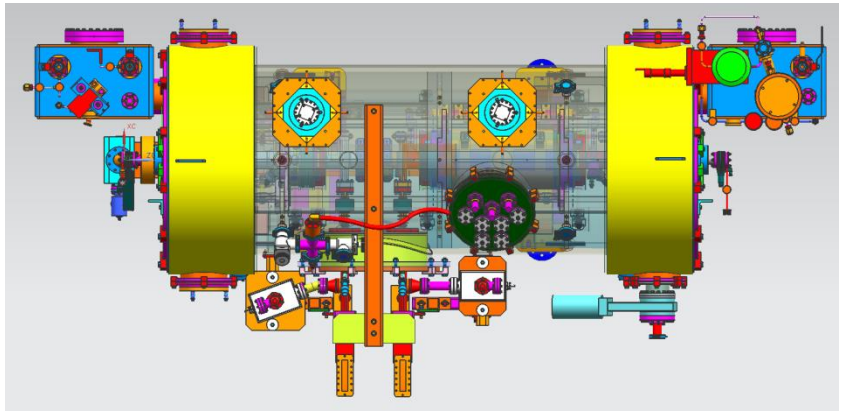
Task	Comment
Restore 200 kV beam operation (photogun bakeout, HV conditioning, activate photocathode)	Gun HV conditioning now
Commission the 200 kV buncher cavity	Having trouble hitting resonance
Obtain permission from TJSO to commission the "waist-height" accelerator	EH&S approval, Andrei to ask Stuart to ask TJSO
Set a date for commissioning "waist-height" beamline (Run #0)	hard to do without having permission to commission
coordinate with Cryo and SRF, u-tube swap at CTF, booster cool down	
Engineering gets two weeks notice for HCO	
HDIce completes work inside enclosure: magnet, dump, halo counter installation	now through…..
administrative tasks: beam authorization, shift plans, coordinate control room staffing approved operators	
Commission the Booster	estimate one week of beam, no access to the enclosure
Obtain permission to operate UITF accelerator to test HDIce, another round of signatures	**Is this time consuming?**
Set a date for commissioning the elevated beamline (Run #1)	
installation work, HDIce specific controls and diagnostics	
Engineering gets two weeks notice for HCO	
accelerator checks: beam size, energy spread, stability	
HDIce specific checks: ragowski coil BPM calibration, raster magnets, fsd functionality, current calibration	
Remove Booster and install at CEBAF	May-20
Install CEBAF 1/4 CM	

Test the Booster before installing at CEBAF in 2020



"Booster" - sometimes we say QCM, or ¼ CM

- **Increase gun voltage** and Wien filters for **200 kV operation** to suppress space-charge effects and improve parity quality beam
- **Locate Wien filters** (energy filters) upstream of pre-buncher cavity and install quadrupoles to better compensate astigmatism
- **Increase aperture of chopper and beam line solenoids** to suppress existing astigmatism and improve parity quality beam
- **Install new SRF booster** that eliminates warm-rf capture cavity, RF deflection and x/y coupling



Our new "booster":
2 cell capture section + 7 cell cavity, should provide 10 MeV beam and introduce no x/y coupling, allow better matching, more adiabatic damping

Uses of UITF: workshop on December 12, 2018

Application	Beam Energy	Beam Current	Experiment Duration	Notes	Presenter
Commission QCM for CEBAF	6 MeV, but prefer up to 10 MeV	up to 100 uA	three or four 1-week long tests	tests complete before long shutdown of 2020, when QCM to be installed at CEBAF	R. Kazimi
Commission HDIce for CEBAF	~ 8 MeV	up to 100 nA for tuning, 0.25 to 5 nA for production	four or five run periods, two-weeks long each	target provides transverse polarization required for 3 A-rated Hall B experiments	A. Sandorfi
Manufacturing polarized targets for CEBAF via DNP	10 to 18 MeV	1 to 10 uA	hours, days	likely some R&D to determine optimum polarizing conditions	C. Keith
Bubble Chamber astrophysics	4 - 10 MeV	0.01 to 100 uA	3 weeks, ~ 3 runs/year	UITF better location than CEBAF injector, when CEBAF shutdowns are short	R. Suleiman
MeV parity violation experiment	10 MeV	milliamps preferred, will reduce experiment duration	months to years	requires polarized electron beam, transmission geometry offers advantages	R. Carlini
Testing Nb_3Sn-coated cavities	determining the beam energy of test cavity is point of test	up to 100 uA	as many tests as possible	Nb3Sn cavities require only 4K Helium	G. Eremeev
Wastewater treatment	2- 10 MeV	100 uA	imagine week-long test durations over three years	together with local partners	G. Ciovati
Polarized positron source	5 - 10 MeV	up to 100 uA	staged tests, likely many required, 1-week long duration	requires polarized electron beam	J. Grames
EIC: fast kicker tests	5 - 10 MeV	up to 100 uA	two 1-week long tests	together with sbir-partner	H. Wang
EIC: testing high bunch charge	5 - 10 MeV	up to 100 uA	two 1-week long tests	requires polarized electron beam	J. Grames and J. Guo

https://wiki.jlab.org/ciswiki/index.php/UITF_Meeting_-_December_12,_2018