

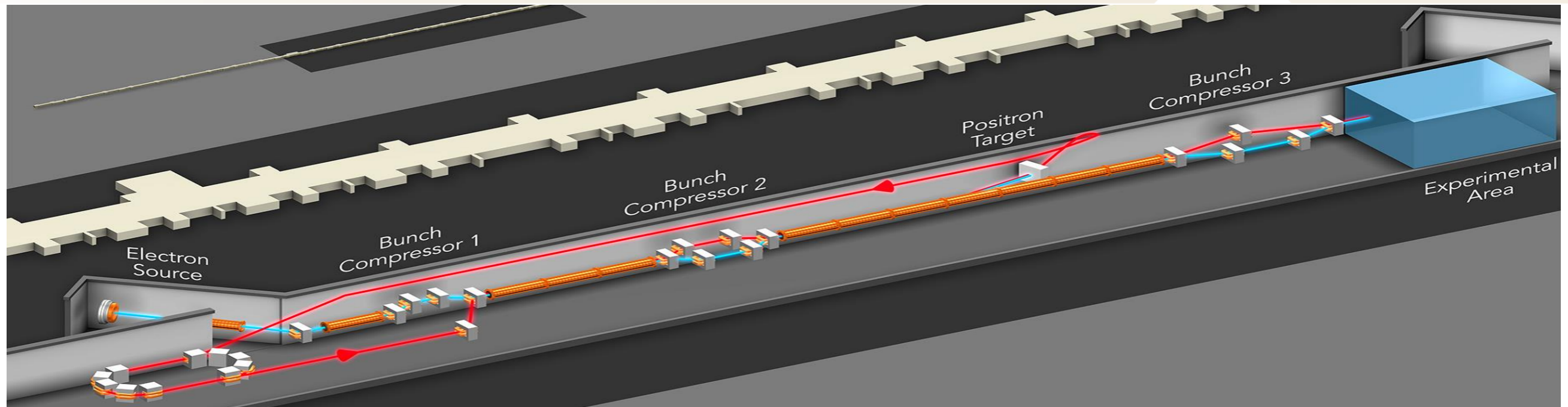
# Commissioning plans

2nd FACET-II Program Advisory Committee Meeting

Jerry Yocky

October 26, 2020

# FACET to FACET-II



## FACET-II Design Parameters:

<i>Electron Beam Parameter</i>	<i>Baseline Design</i>	<i>Operational Ranges</i>
<i>Final Energy [GeV]</i>	10	4.0-13.5
<i>Charge per pulse [nC]</i>	2	0.7-5
<i>Repetition Rate [Hz]</i>	30	1-30
<i>Norm. Emittance <math>\gamma\epsilon_{x,y}</math> at S19 [<math>\mu\text{m}</math>]</i>	4.4, 3.2	3-6
<i>Spot Size at IP <math>\sigma_{x,y}</math> [<math>\mu\text{m}</math>]</i>	18, 12	5-20
<i>Min. Bunch Length <math>\sigma_z</math> (rms) [<math>\mu\text{m}</math>]</i>	1.8	0.7-20
<i>Max. Peak current <math>I_{pk}</math> [kA]</i>	72	10-200

## Key Performance Parameters:

- The threshold KPPs are the minimum parameters against which the project's performance is measured when complete
- The objective KPPs are the desired operating parameters that the project will design to with the intent that those may be achieved during steady operation
- Taking performance from Threshold to Objective will require operations time to optimize accelerator performance

<i>Description of Scope</i>	<i>Units</i>	<i>Threshold KPP</i>	<i>Objective KPP</i>
<i>Beam Energy</i>	[GeV]	9	10
<i>Bunch Charge (e-)</i>	[nC]	0.1	2
<i>Normalized Emittance in S19 (e-)</i>	[ $\mu\text{m}$ ]	50	20
<i>Bunch Length (e-)</i>	[ $\mu\text{m}$ ]	100	20



# Photoinjector laser



### Laser Status Table

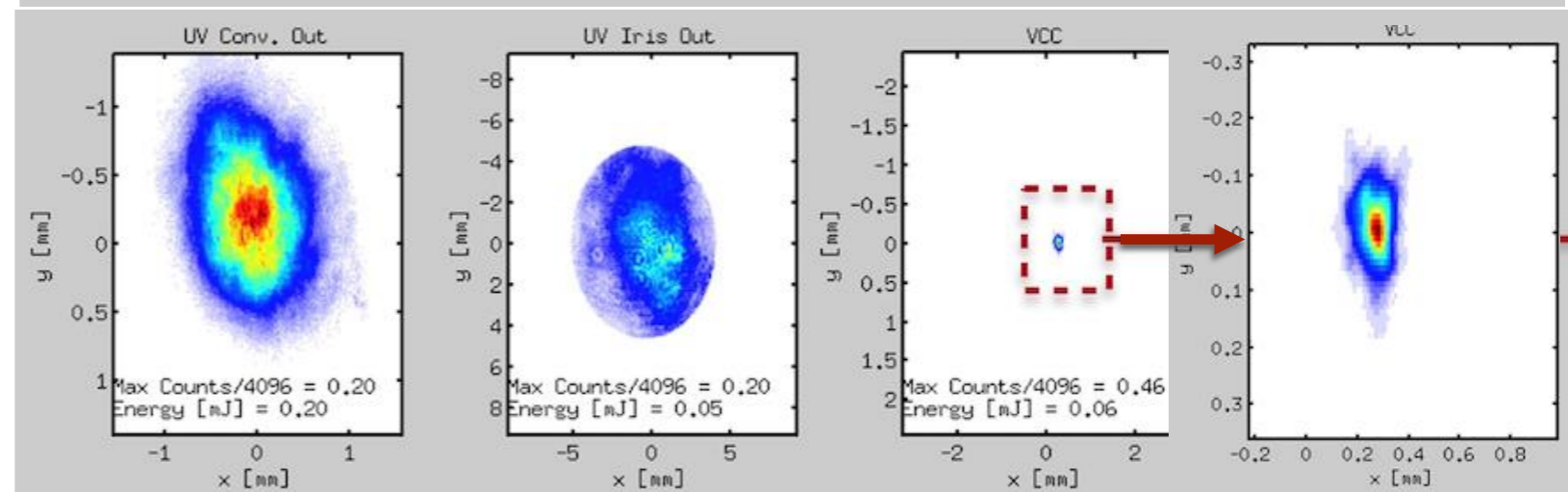
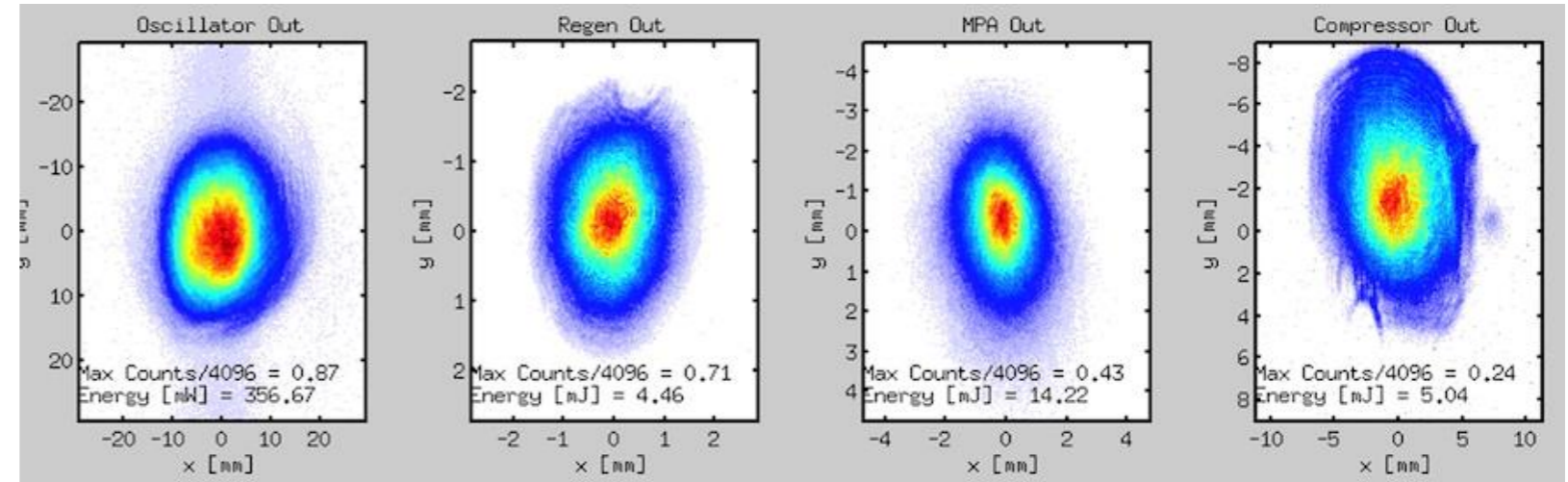
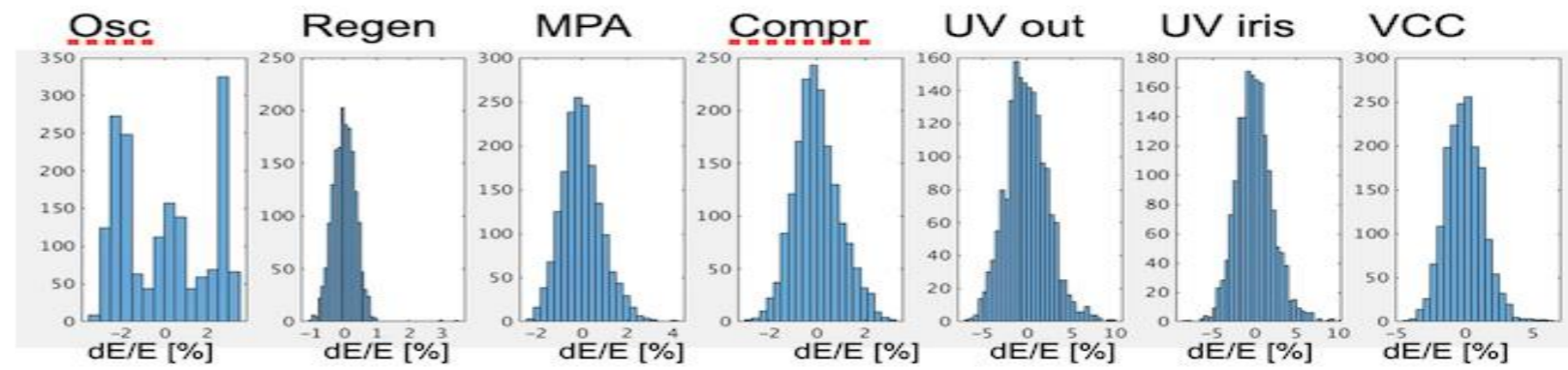
Laser Property [% of ref]	Current	15 Min. RMS	1 Hr. RMS
1 Oscillator Output			
2 Centroid Offset [mm] (x,y)	2.5,1.9	0.41,0.44	0.44,0.45
3 Spot Size [mm] (x,y)	6.2,6.8	0.55,0.14	0.36,0.13
4 Nonuniformity	3.7	1	1
5 Energy (mW, RMS [%],Range/RMS)	330	0.23,4.9	0.23,5.4
6 Regen Output			
7 Centroid Offset [mm] (x,y)	2.2,1.1	1.8,0.16	1.4,0.32
8 Spot Size [mm] (x,y)	0.6,0.69	0.091,0.12	0.078,0.11
9 Nonuniformity	7.5	2.4	2.2
10 Energy (mJ, RMS [%],Range/RMS)	4.5	0.52,14	0.38,20
11 MPA Output			
12 Centroid Offset [mm] (x,y)	1.9,1.5	1.1,1.3	1.2,1.4
13 Spot Size [mm] (x,y)	0.81,1.1	0.2,0.3	0.19,0.32
14 Nonuniformity	10	2.1	2.1
15 Energy (mJ, RMS [%],Range/RMS)	14	0.83,6.3	0.69,7.7
16 Compressor Output			
17 Centroid Offset [mm] (x,y)	2.3,1.1	1.1,1.1	1.1,1.2
18 Spot Size [mm] (x,y)	2.7,2.8	0.34,0.39	0.34,0.43
19 Nonuniformity	9	2	2.1
20 Energy (mJ, RMS [%],Range/RMS)	5.1	1.9	0.8,12
21 UV Conv. Output			
22 Centroid Offset [mm] (x,y)	1.9,1.2	1.6,1.5	1.6,1.6
23 Spot Size [mm] (x,y)	0.34,0.39	0.2,0.21	0.19,0.2
24 Nonuniformity	8.1	2.1	2.2
25 Energy (mJ, RMS [%],Range/RMS)	0.2	2.2,5.8	2.3,8.3
26 UV Iris Output			
27 Centroid Offset [mm] (x,y)	2.7,2.3	1.5,1.1	1.5,1.2
28 Spot Size [mm] (x,y)	1.8,2.3	0.21,0.4	0.21,0.41
29 Nonuniformity	16	1.9	1.9
30 Energy (mJ, RMS [%],Range/RMS)	0.046	2.6,1	2.3,6.5
31 VCC			
32 Centroid Offset [mm] (x,y)	0.92,0.92	450,28	780,27
33 Spot Size [mm] (x,y)	0.12,0.18	200,18	330,16
34 Nonuniformity	36	NaN	NaN
35 Energy (mJ, RMS [%],Range/RMS)	0.0098	1.2,5.3	1.3,7.5
36 Temperature [deg F]	72	0.02	0.019
37 Humidity [%]	46	1.4	0.93

Current data taken at 10-19-2020 04:48

Start Live Table

All RMS values given as a percent difference from the mean

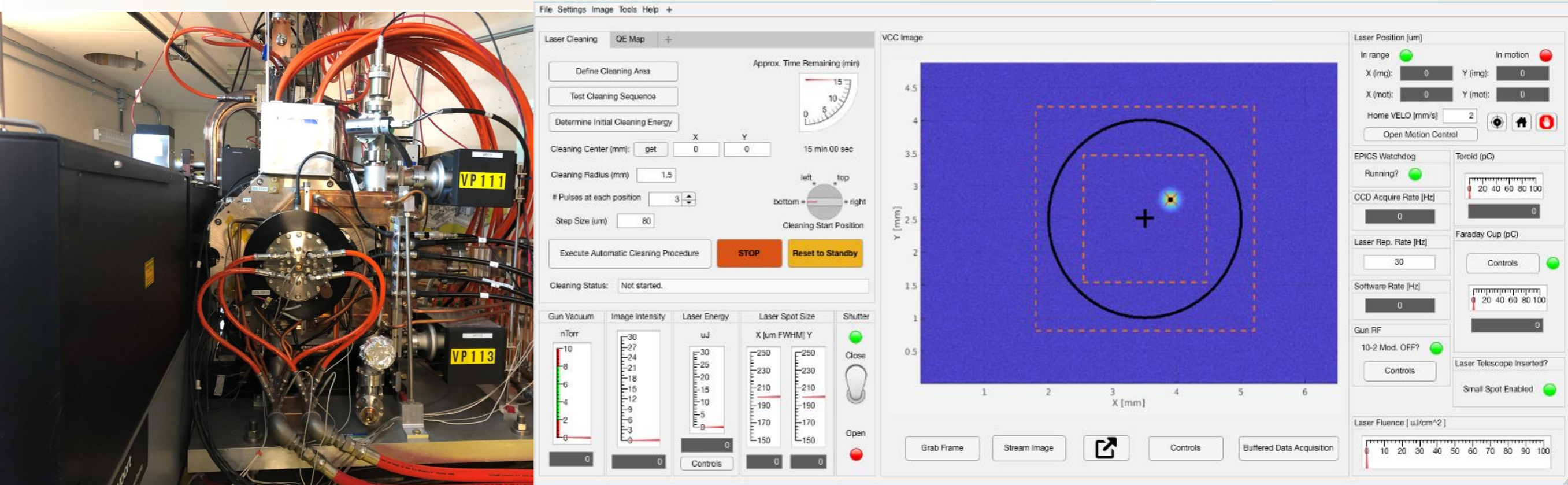
Stop Live Table



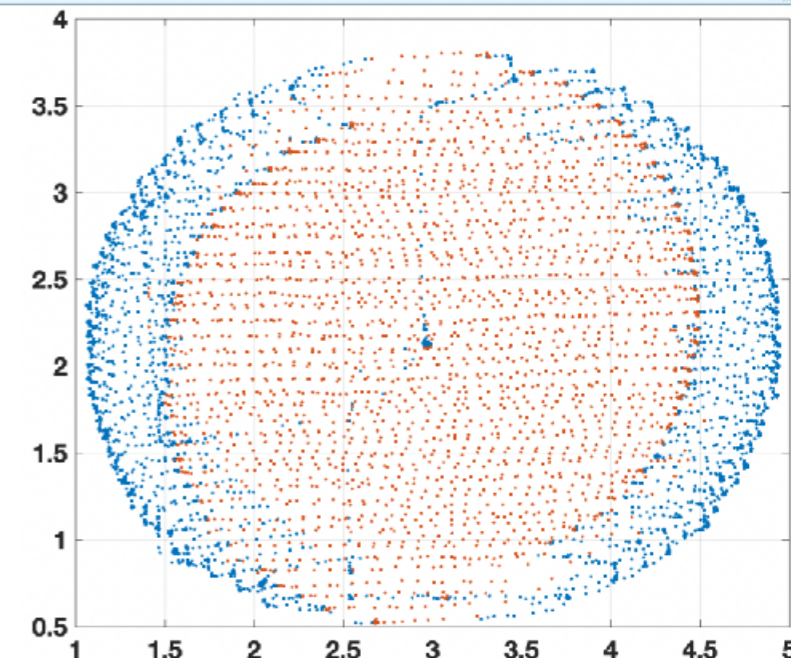
Photoinjector laser is ready for laser cleaning and single bunch operations, Improvements will continue towards better uniformity and two pulse mode



# Photoinjector and laser cleaning



- Gun processed to 10MW with 1us long RF pulse
  - Gun scrubbed in 2018 AIP operations
- Laser spot optimized for cleaning
- Cleaning procedure/GUI checked out
  - Efficiency
  - Safety



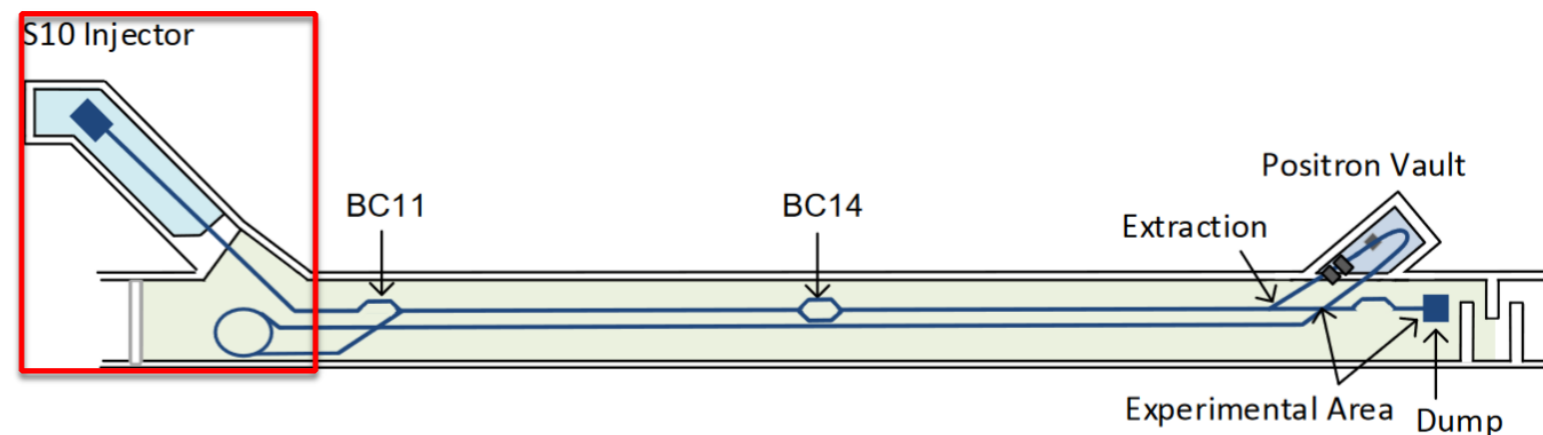
Laser cleaning ready for execution week of 10/26



# 135 MeV Injector



- Injector modulators upgraded with “Mission Readiness” hardware that allows for more stability
- New PLC code checkout
- New Low-Level RF (LLRF) checkout
- New infrastructure to replace old CAMAC hardware commissioned
- RF processing in injector stations proceeding
- Checkout of diagnostics
  - Profile monitors, wire scanner, & Faraday cups
  - BPMs & Toroid
  - Bunch length monitor & deflecting cavity



Injector modulators for Gun, L0A, L0B and Tcav have new technology for better stability  
Characterization of 135 MeV beam Weeks of 10/26 and 11/2.



# Cooling Tower 1201 - expected completion Oct 31

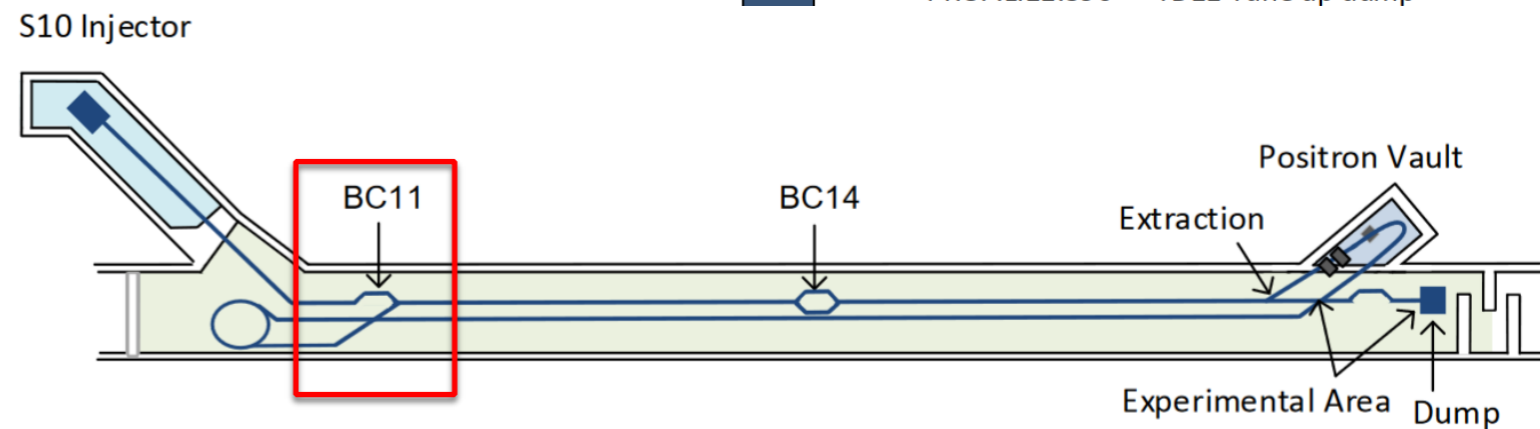
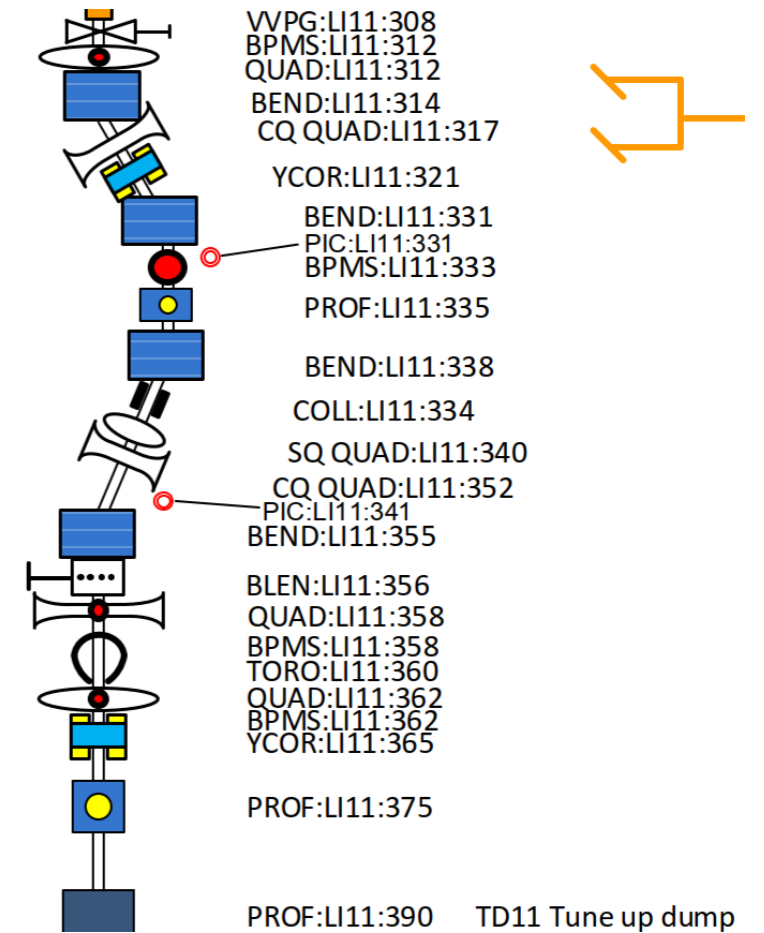
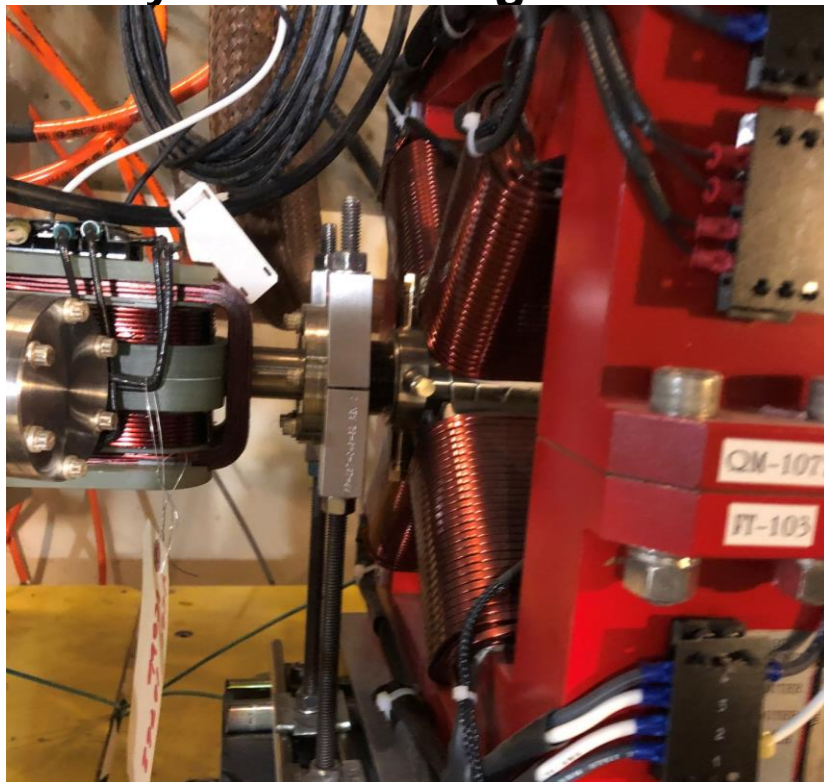


F&O's CT1201 maintenance project was delayed due to COVID-19 and subcontractor  
Temporary cooling towers in Sectors 10 and 11 are used to support 135MeV commissioning



# L1: 335MeV electrons through BC11 to TD11

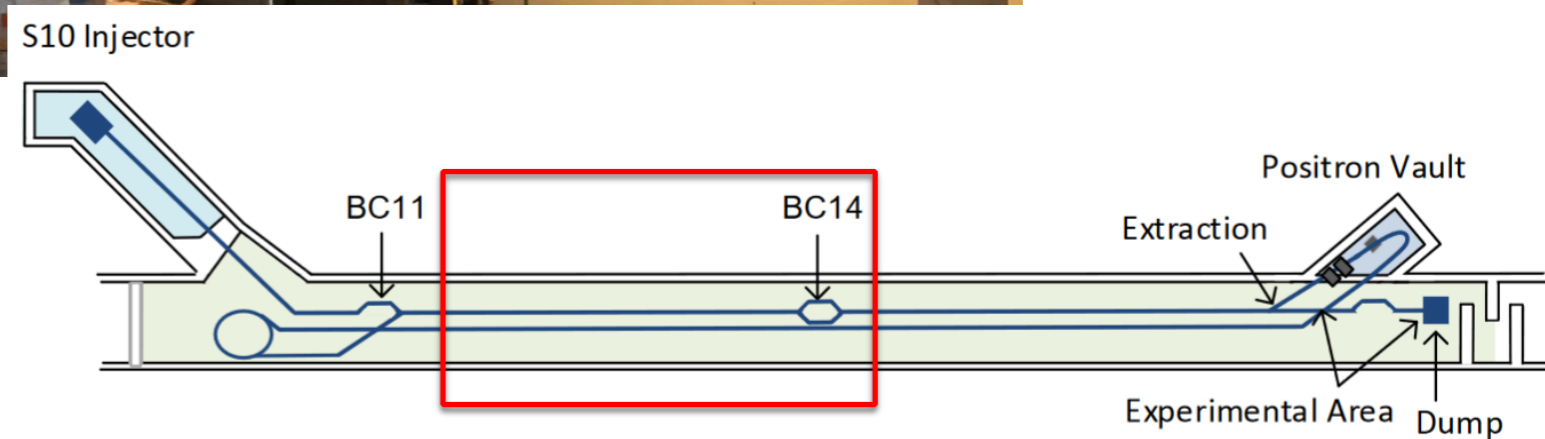
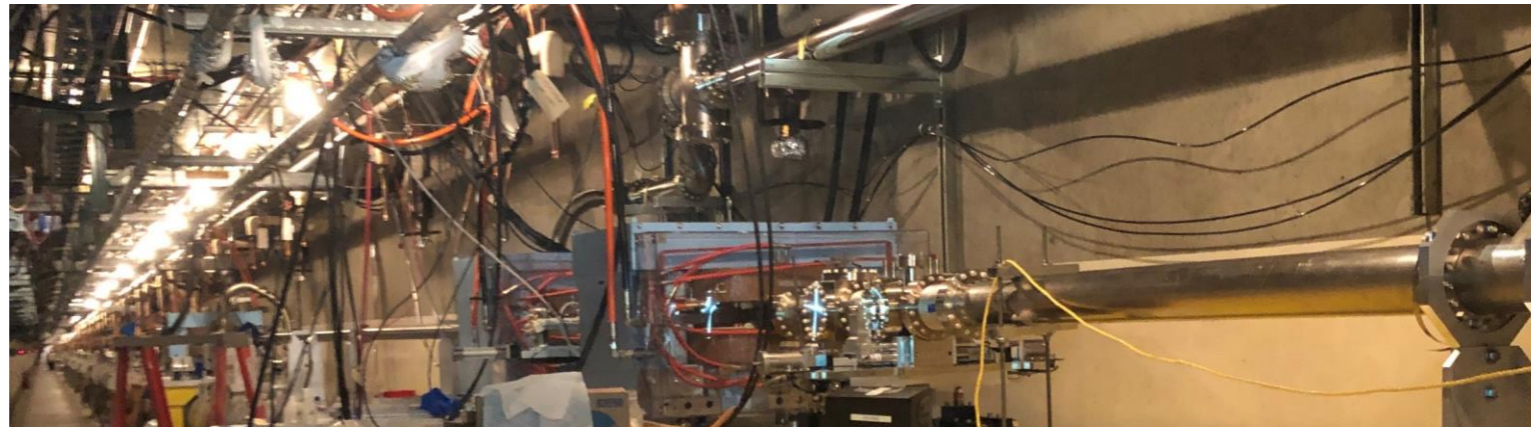
- Establish beam through BC11 chicane
- Tune beam profile on TD11 tune-up dump
- Two RF stations in L1 linac, utilizing legacy control system
- BPM checkout and timing
- Bunch length monitor commissioning
- Profile monitor and toroid checkout
- Verify lattice through TD11



Checkout and commissioning are planned for the week of 11/9

# L2: 4GeV to BC14

- Establish 4GeV beam through L2 linac and through BC14 chicane
- Tune RF stations
- Tune beam profile
- Verify lattice through BC14
- ~30 L2 RF stations utilizing legacy control system, 6 currently undergoing maintenance for modulator or tube issues (not all RF needed for KPP verification)

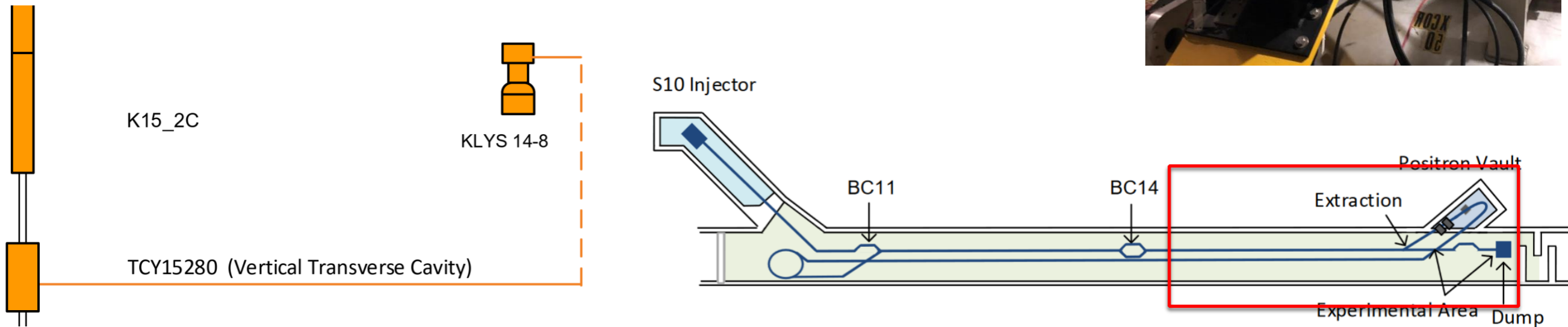
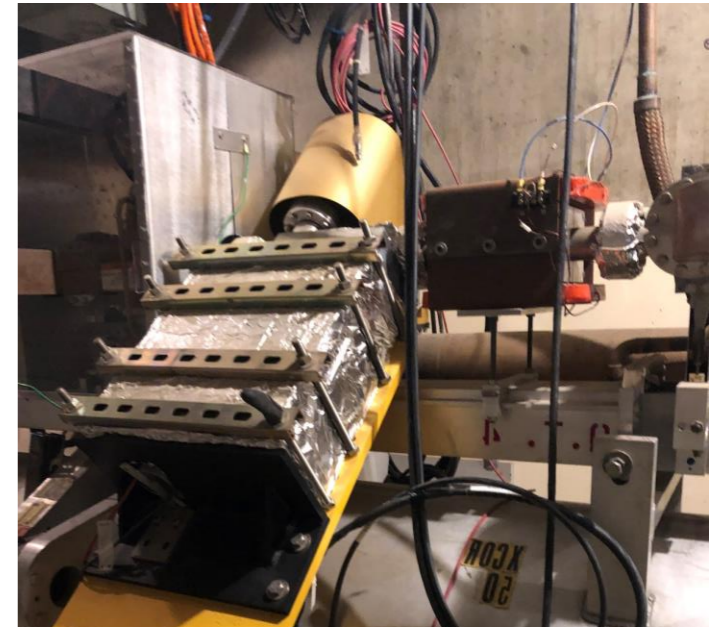


Checkout and commissioning are planned for the week of 11/16



# L3: 10GeV to “W” chicane in Sector 20

- Establish 9-10GeV beam through L3 and into FACET chicane
- ~40 RF stations utilizing legacy control system, 10 currently undergoing maintenance for modulator or tube issues (not all RF needed for KPP verification)
- Commission L3 transverse cavity at 15-2 900 girder
- Commission new sector 19 optics and match into the FACET chicane
- Establish beam to FACET dump
- Diagnostics checkout



Checkout and commissioning are planned for the week of 11/23

# Conclusion

- FACET-II injector commissioning is under way
- Bunch compressor chicanes commissioning and linac re-commissioning through month of November
- Establish threshold key performance parameters of  $>100\text{nC}$  charge,  $>9\text{GeV}$  energy,  $<100\mu\text{m}$  bunch length,  $<50\mu\text{m}$  emittance early December

Threshold KPP expected first week of December