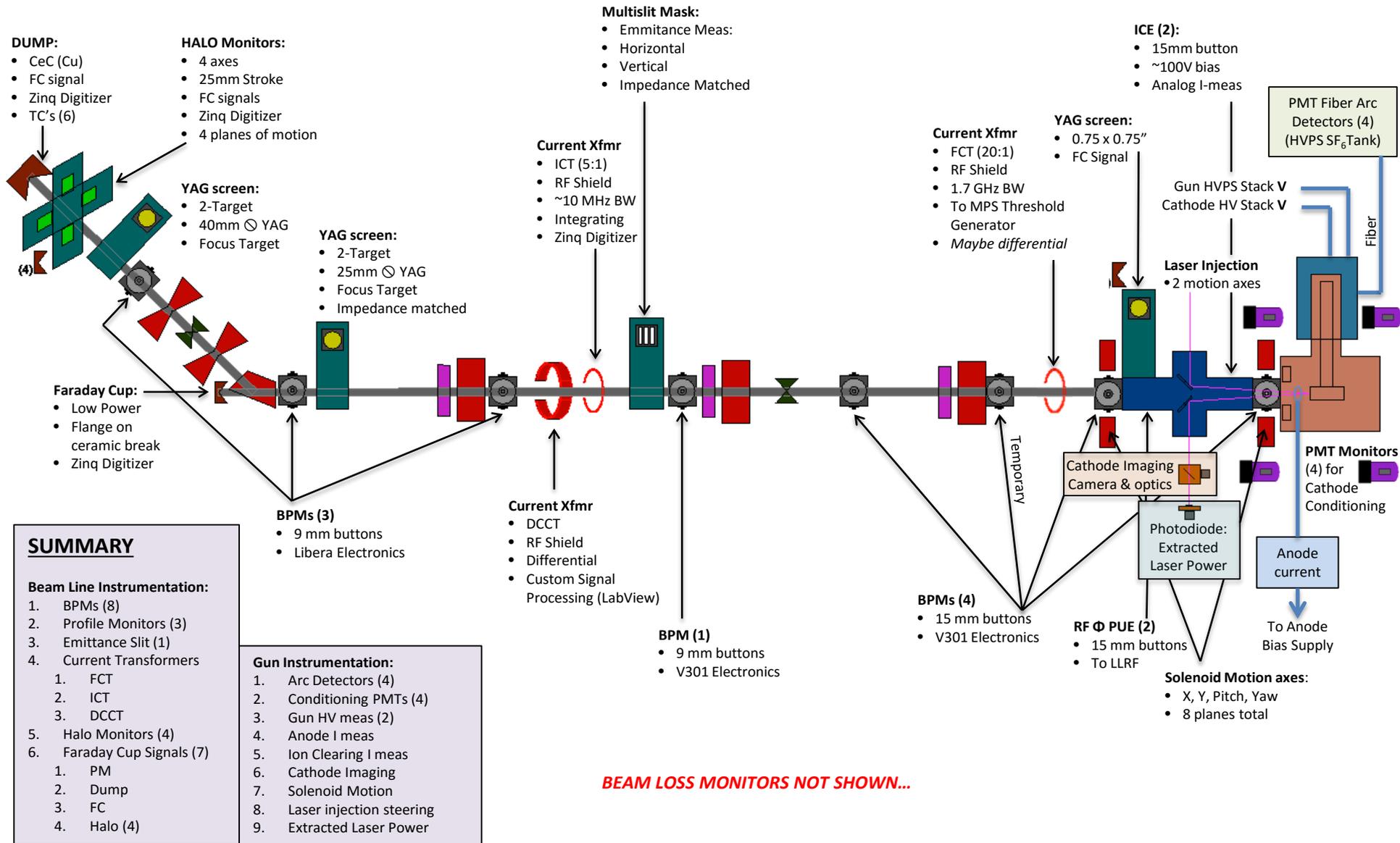


LEReC Instrumentation Gun Test Beam Line Summary

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Gun Test Beam Line – 2016-17



SUMMARY

Beam Line Instrumentation:

- BPMs (8)
- Profile Monitors (3)
- Emittance Slit (1)
- Current Transformers
 - FCT
 - ICT
 - DCCT
- Halo Monitors (4)
- Faraday Cup Signals (7)
 - PM
 - Dump
 - FC
 - Halo (4)

Gun Instrumentation:

- Arc Detectors (4)
- Conditioning PMTs (4)
- Gun HV meas (2)
- Anode I meas
- Ion Clearing I meas
- Cathode Imaging
- Solenoid Motion
- Laser injection steering
- Extracted Laser Power

BEAM LOSS MONITORS NOT SHOWN...

Instrumentation Details

- **Gun Current Monitor**
 - Stand alone digitizer monitoring a shunt resistor on top of the gun HVPS inside the SF6 tank.
 - This will be used during processing only
 - Q/ Will the shunt resistor might be removed afterwards?
 - Uses a power over fiber link to remotely power the unit.
 - Waiting on comments from Laser Safety Officer on use of the device... specs sent by email on 4/22/16.
 - Mike Costanzo is leading the entire implementation of this device.
- **PMT Arc Detectors**
 - PMTs installed in the SF6 tank by Cornell were used to detect arcs during HVPS conditioning and operation
 - We plan to move them outside of the SF6 and relay their sensitivity with fibers into the SF6. Fiber feedthroughs will be used instead of trying to find SHV feedthroughs.
 - ACTION: We still need to identify a proper light collecting end for the fibers. The plan is to check how the RF arc detectors work.
- **Gun HVPS SF6 Tank Fiber Temperature Sensors**
 - Suggested to have Cornell install these – prudent for LEReC's operational status
 - Need confirmation from Joe T/ Cornell of the status
 - Q/ what type of controls interface required?
- **Gun HVPS Differential Water Flow**
 - Required to guard against a water leak in the SF6 tank!
 - Specs to be given to the water group....
- **HVPS Stack Voltage**
 - Voltage divider signal to O-scope
 - Q/ Should we log continuously?
 - With what resolution?
- **Cathode HV Stack Voltage**
 - Voltage divider signal to O-scope
 - Q/ Should we log continuously?
 - With what resolution?

Instrumentation Details

- **Anode bias & current**

- Keithley 6514 Electrometer with bias supply “on top”
- bias Tee for monitoring fast transients on O-scope
- 10's of pA (+) for ion current during operation
- 10's of nA (-) for emission during conditioning
- Q/ Type of low loss cable... maybe Heliax... something else?
- Don searching for suitable power supply (likely a Spellman)

- **Cathode Imaging**

- Camera on laser extraction port
- Need to separate specular reflected beam from image of diffuse reflection of beam off the cathode. No perfect solution yet...
 - Laser mirror too small for off-axis imaging....
- Projected illumination through dichroic mirror on incoming optics table
 - Need to coordinate with Zhi
- Photodiode to measure extracted laser power
- Fast gated color camera
 - Imperex B1610
 - Low trigger jitter, 5usec min shutter
- Plan to borrow spare laser mirror and polished blank cathode puck for optics mock-up
 - Need to confirm availability of blank puck

- **Laser controls & Instrumentation**

- Q/ how many cameras?
- Q/ how many servo devices?
- Q/ how many photodiodes or other detectors?
- Laser average power electronics for MPS
 - LPF + Integrator
 - *Alternative fast pulse counter*
 - Matt P. working on electronics design

Instrumentation Details

- **Gun Profile Monitor**
 - B 1610 fast gated monochrome camera
 - 0.75x.075" YAG crystal
 - Faraday Cup Signal from SS mirror
 - Zinq digitizer
- **Motion (14 planes)**
 - Solenoids motion – 2 x 4 planes
 - X, Y, Pitch, Yaw
 - Resolvers?
 - Need Status...
 - Booster Cavity – single plane
 - 2.1 GHz Cavity – single plane
 - Halo Monitors 4 x single planes
- **Laser Mirror Motion**
 - X, Y
 - Q/ has controller & actuator been chosen?
- **Ion Clearing Electrodes (2)**
 - 100V – 1kV_{max} Negative DC power supply ($\sim 100\mu\text{A}$)
 - need to monitor analog voltage & current
 - bias Tee for monitoring fast transients on O-scope
- **RF Phase PUE (2)**
 - 15mm buttons with 2 Heliax cables to LLRF

Instrumentation Details

- **BPMs**

- 8 BPMs total
- Two button sizes (9 & 15mm) and two electronics types

BPM #	Button	Electronics	
1	15 mm	V301	
2	15 mm	V301	
3	15 mm	V301	<i>Temporary</i>
4	15 mm	V301	
5	9 mm	V301	
6	9 mm	Libera	
7	9 mm	Libera	
8	9 mm	Libera	

- - Need phase measurement for Time of Flight energy measurement
 - Plan to test in-tunnel amplifiers with cable switches
 - All electronics, buttons & chambers are on order

Instrumentation Details

- **FCT**
 - 1.7GHz BW, 20:1 ratio
 - study to determine in-flange version (\$\$\$) or we build our own clamshell + ceramic break
 - Karim Hamdi, Matt Paniccia
 - For use with MPS for Beam Mode / Machine Mode Protection Scheme
 - Buffer needed for parallel signal on scope
 - Do we need pulse mode differential current protection?
 - Would need 2 or 3 more FCTs – one at each dump...
- **ICT**
 - 5:1 ratio, from ERL
 - used with Zinq digitizer
 - Buffer needed for parallel signal on scope
 - no longer limited to 7us
 - BW limited to ~10MHz (macro bunch mode only)
 - Shield designed – needs fabrication
- **DCCT**
 - Two from ERL
 - 100 kHz BW
 - 1 – 5 uA sensitivity with 1 second averaging
 - Needs continued development of electronics for diff. mode
 - Buffer needed for parallel signal on scope

Instrumentation Details

- **Emittance Slit**
 - Design not begun yet – beginning mid July (Gary W., Dan Weiss)
 - Dual plane Multi Slit mask (H + V)
 - 3 position pneumatic cylinder needed
 - Impedance matched chamber
- **ERL style Profile Monitor**
 - PM in transport
 - Increased YAG to 25mm aperture
 - Impedance matched chamber modifications
 - New parts fab in July – assembly in August
 - PM in Diag. Dump
 - 40mm YAG aperture
 - not impedance matched
 - assembly & survey underway
- **Faraday Cups (3)**
 - Gun PM, Diag. Dump, Transport Flange
 - Processed by Zinq digitizer
 - No bias *but* bias cables being pulled
 - Buffer needed for parallel signal on scope
- **Temperature Monitoring**
 - Diag. Dump (2)
 - Upstream beam pipe (4)

Notes from this meeting

(6/17/16)

- The status of beam line devices are as follows. The only **critical item not yet started** is the emittance slit.
 - BPMs – **Buttons, chambers, electronics on order**
 - Gun Profile Monitor – **(Sumanta/J. Halinski) drawings near completion**
 - FCT(s) – **(K. Hamdi/M. Paniccia) order being prepared**
 - ICT – **(K. Hamdi/ M. Paniccia) shield drawings ready to be fabricated**
 - DCCT – **(K. Hamdi/L.Desnato) shields installed**
 - Emittance Slit – **designer (G. Whitbeck) assigned but not started yet...**
 - Transport Profile Monitor – **(G. Whitbeck/ D. Weiss) drawings nearly ready for fab, mod's underway**
 - Dump Profile Monitor – **(G. Whitbeck/ D. Weiss) assembled and in survey**
 - Halo Monitors – **(J. Corbin/J. Fite) new chamber being designed**
- A single FCT is now planned to go where the Booster Cavity will be. This will provide the MPS with the beam power for it to determine if the beam power is allowed in the current machine configuration.
 - A shield for the ceramic still needs to be designed.
 - The FCT aperture should be large enough to accommodate the shield without decreasing the beam pipe aperture.
 - We are waiting on input from Bergoz on whether differing FCT ID's will affect the matching of FCT's. The high power beam dump line will likely have larger ID than the injection transport line.
 - Differential current measurements were discussed. The two DCCT's from ERL require significant averaging time to arrive at a high resolution. The newly announced 3us MPS response requirement suggests the use of multiple FCTs for differential current measurement.
 - A second FCT is being considered in the Gun diagnostic bump line to help develop the differential signal processing for the full LEReC where the FCT would be moved to the high power dump beam line after the cooling section.
 - Moreover, the RF diagnostic beam line may also need to be fitted with a 3rd FCT in a differential arrangement for use when the beam is steered to that line's beam dump.
- The gun current measurement circuit installed inside the SF6 tank (laser powered over fiber) is used for gun conditioning with a high value shunt resistor for sensitivity.
 - This will not be used for operational gun current measurement. To do so, a smaller shunt resistor would have to be installed instead of the shorting bar that usually replaces the resistor. Alexei & Joe have expressed concern with adding an operational shunt resistor. **Thus the only gun current will be the power supply current read back.**
 - This should be discussed further. Although an arc would cause an overvoltage in the measurement electronics, an over-voltage suppressor would protect it.
- So far the two HV stack voltage dividers (one in the gun HVPS and the other in the cathode tank) were planned to be monitored by the O-scope directly.
 - We need to decide if dedicated voltmeter instruments need to be purchased to monitor these voltages where a wide selection of gains could be used.
 - Although the operational value is not expected to change, we need a high resolution measurement at a constant value.
- Cornell uses a beam stabilization system for the laser. Is Zhi planning to install the same system in the laser & tunnel?
- The Zynq digitizer platform needs to be reviewed to ensure that it can handle digitizing multiple channels with sufficient memory
 - 8 channels are needed for the Gun test for these signals: ICT, PM FCT, 4 Halo Mon FCT's, 2 dump FC's
 - Up to 6 channels will need to be viewed at the same time (4 halo's, ICT & dump FC)
- The 4 Halo Monitors upstream of the Gun Diagnostic Dump will have FC signals viewable on the O-Scope.
 - Should we outfit these with fast comparators to trip the MPS?
 - The question was asked "Why were these not used in the transport to measure beam halo?" This may have been a preference of Dmitry. Perhaps he can comment here...
- There was a concern of secondary electrons emitted by the Gun Profile Monitor (when inserted) sending electrons back to the gun.
 - It was pointed out that the Anode would likely collect these reflected electrons.
 - ANYONE PLEASE COMMENT HERE...
- ON the question of biasing Faraday Cups (FC):
 - Bias cables will be run into the tunnel; however, we did not bias the ERL FC's as it was desired to make DC measurements of the dark current. Biasing requires capacitively coupling the FC signal.
 - We will proceed with unbiased FC's until a need for biasing is shown; where we will have to trade the dark current measurement for biasing.
 - Amplifiers are planned for the FC signals for increased sensitivity.
 - Selectable termination resistors is also a possibility... TBD
 - All FC signals should be logged.