Bubble Chamber – Beam Requirements

January 5, 2018

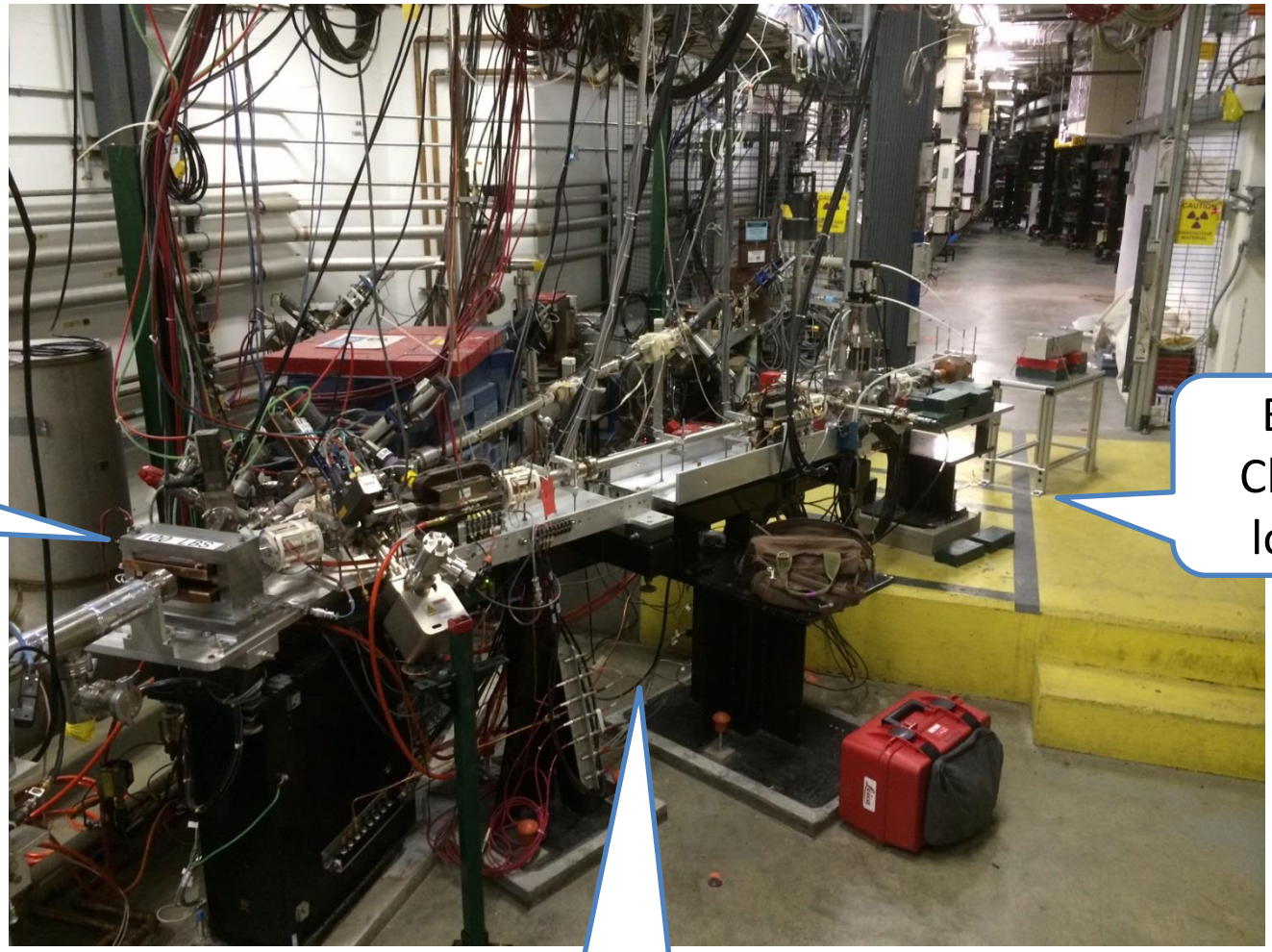
Bubble Chamber Experiment

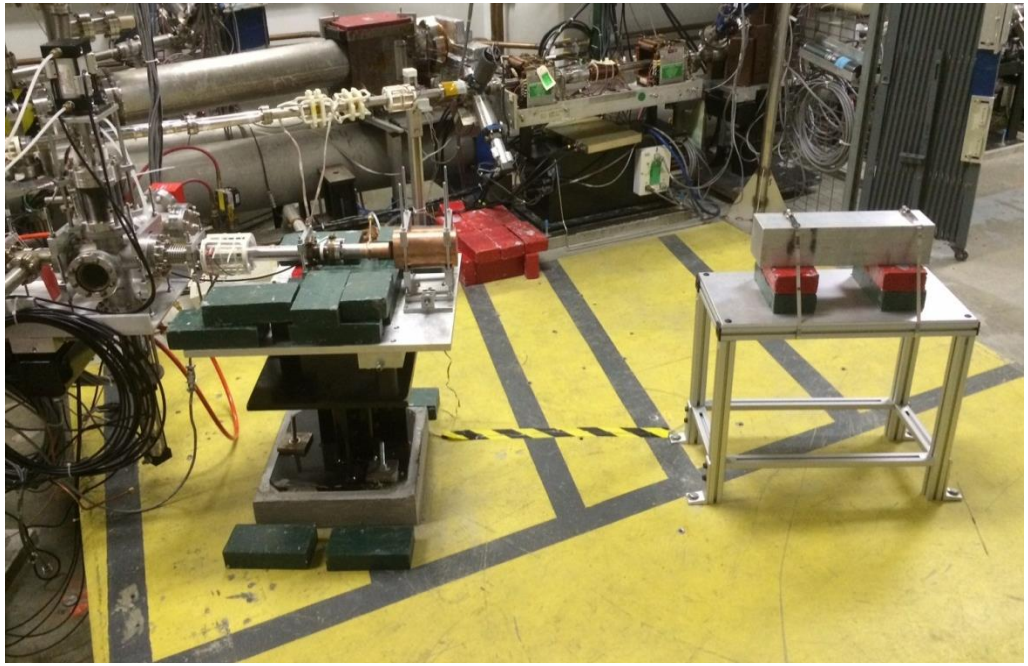
I. Plan to be installed on March 26, 2018

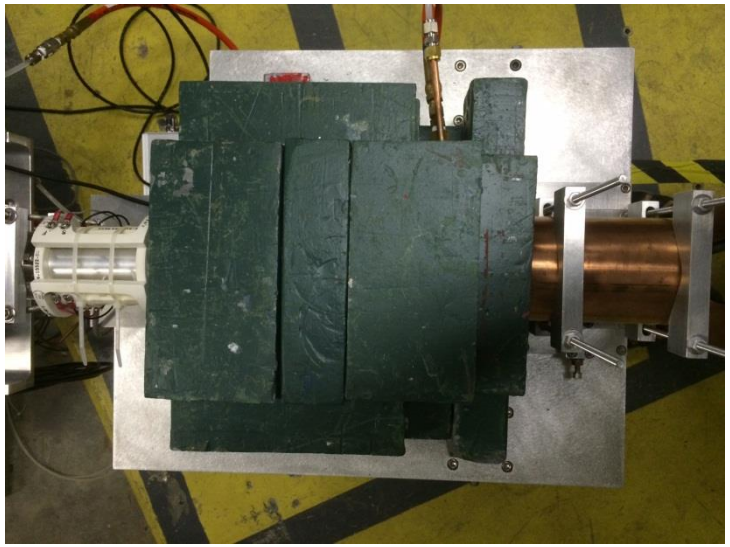
II. April run plan:
- 2 weeks of beam (2 shifts per day)
- Active liquid is C_3F_8
- Beam energy: 4.5 – 5.5 MeV
- Beam current: 1 nA – 100 μA
- Prefer to run with RF at 2K but willing to try 4K

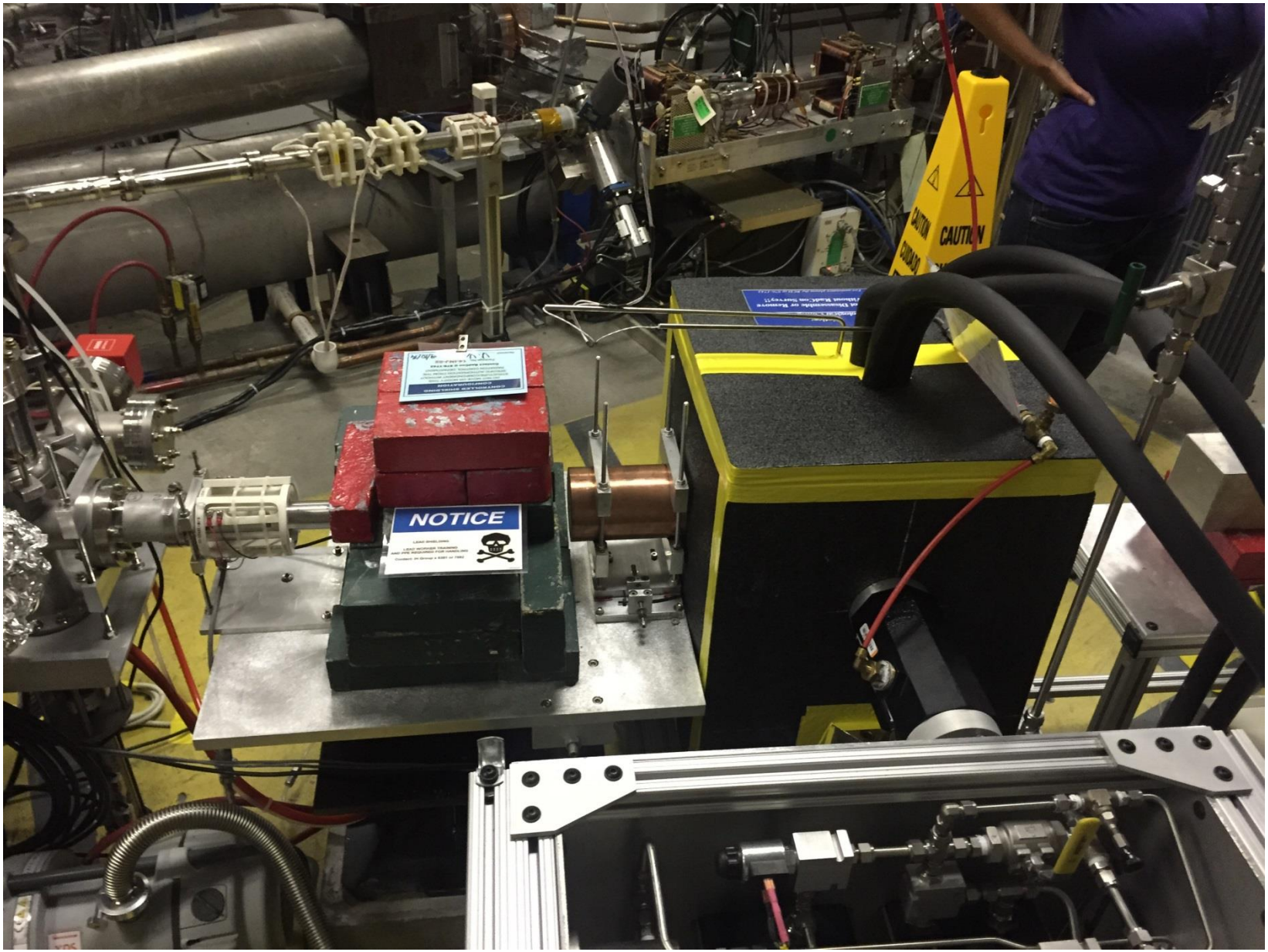
III. Keep chamber installed at 5D line

IV. Plan to run again in August: 2 weeks of beam


5 MeV
Dipole
Bubble
Chamber
location
5D
Spectrometer

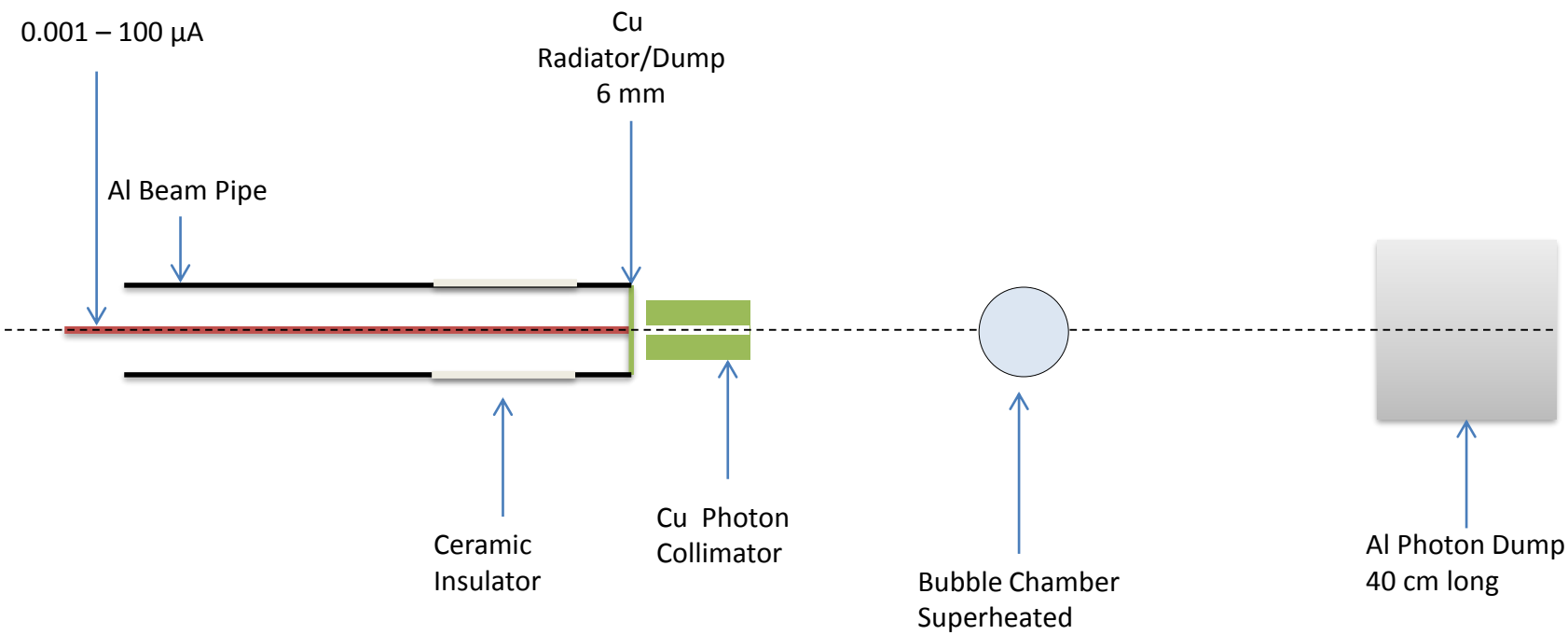




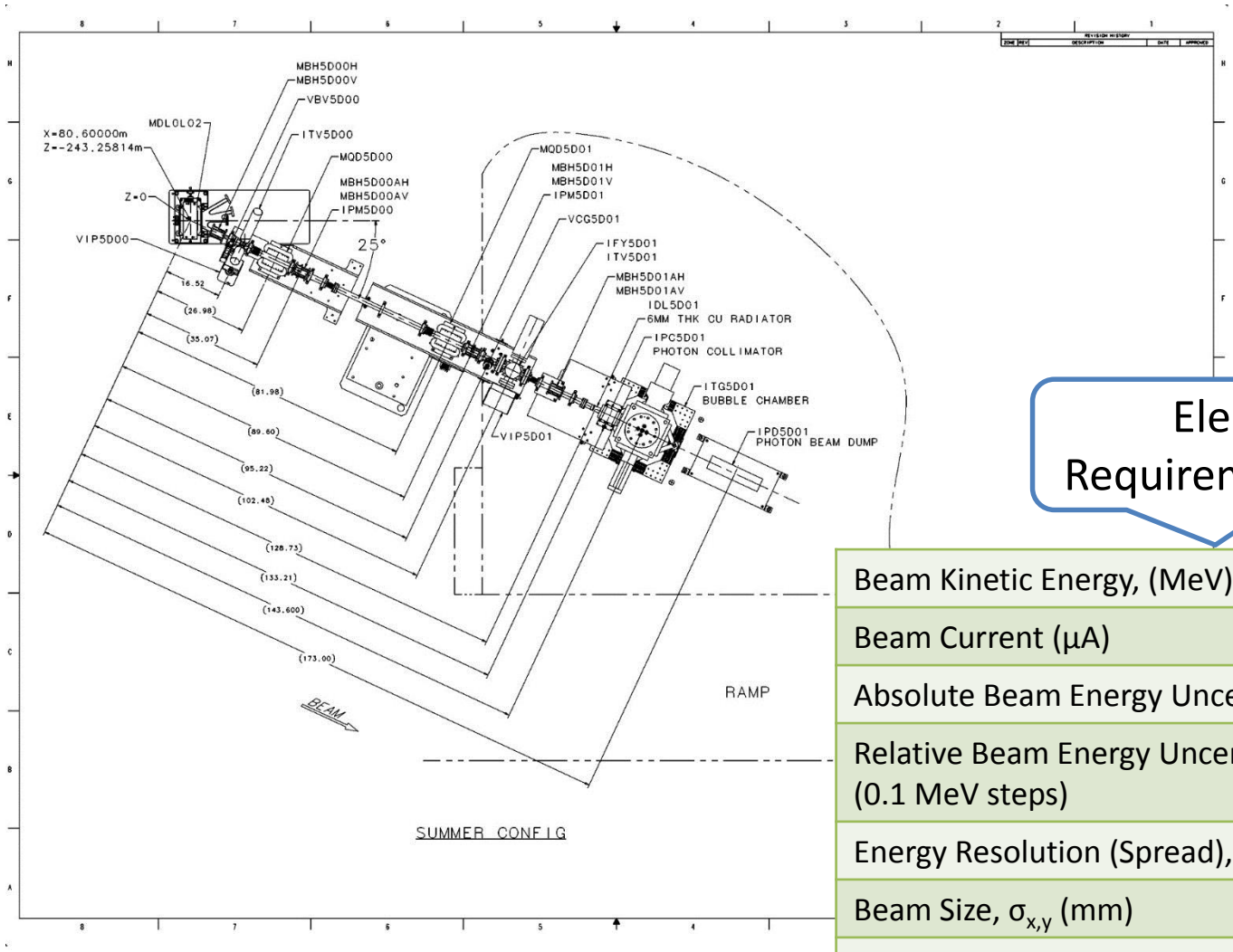

NOTICE
CAUTION

Schematics

- Power deposited in radiator (100 μA and 8.5 MeV) :
  I. 6 mm: Energy loss = 8.5 MeV, P = 850 W
- Pure Copper and Aluminum (high neutron threshold):
  I. $^{63}C(\gamma,n)$ threshold = 10.86 MeV
  II. $^{27}Al(\gamma,n)$ threshold = 13.06 MeV



Beam Requirements

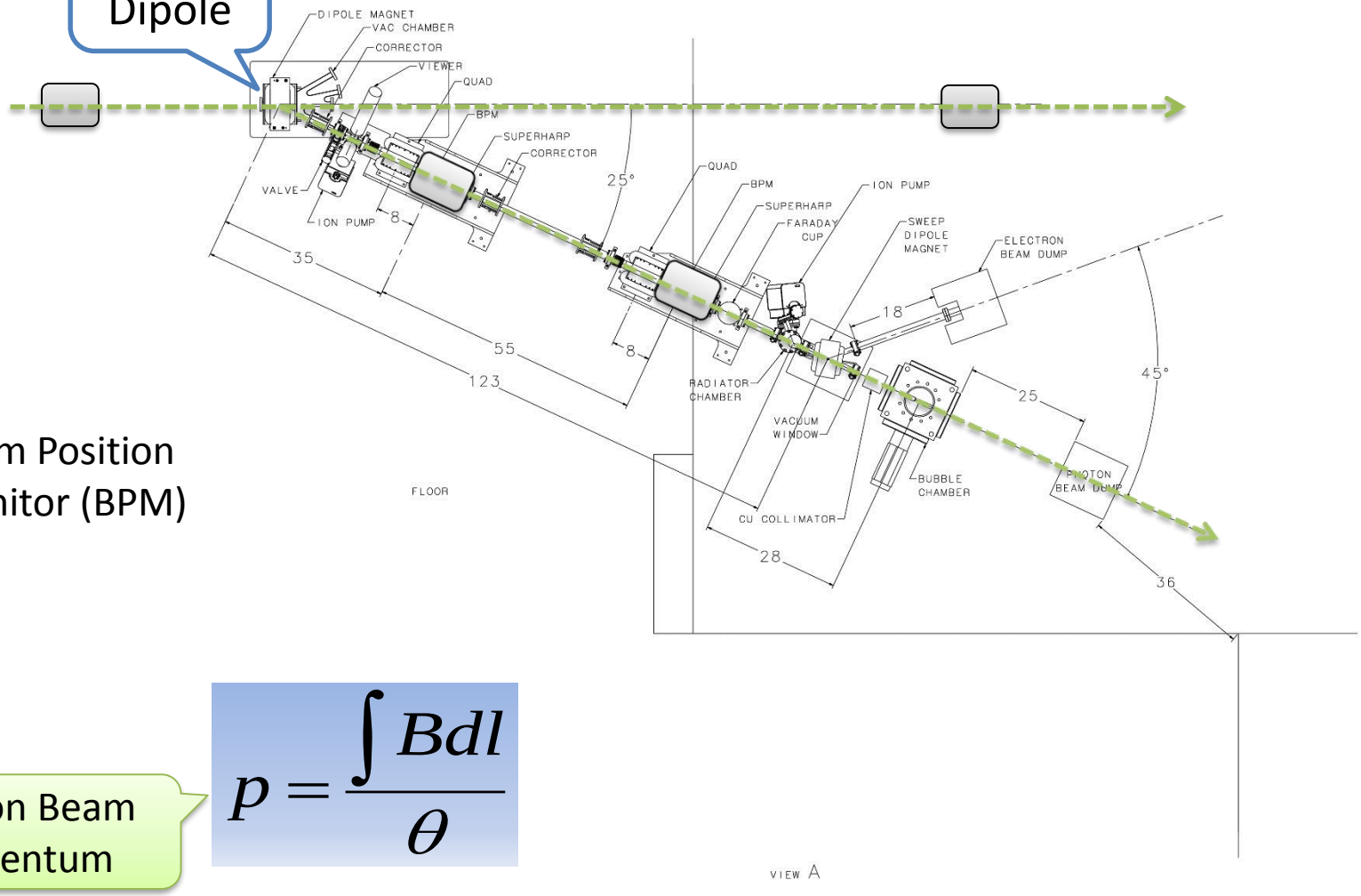


Electron Beam Requirements at Radiator

Beam Kinetic Energy, (MeV)	4.5–5.5
Beam Current (μA)	0.001–100
Absolute Beam Energy Uncertainty	<0.1%
Relative Beam Energy Uncertainty (0.1 MeV steps)	<0.02%
Energy Resolution (Spread), σ_T/T	<0.06%
Beam Size, $\sigma_{x,y}$ (mm)	1
Polarization	None

Beam Energy Measurement

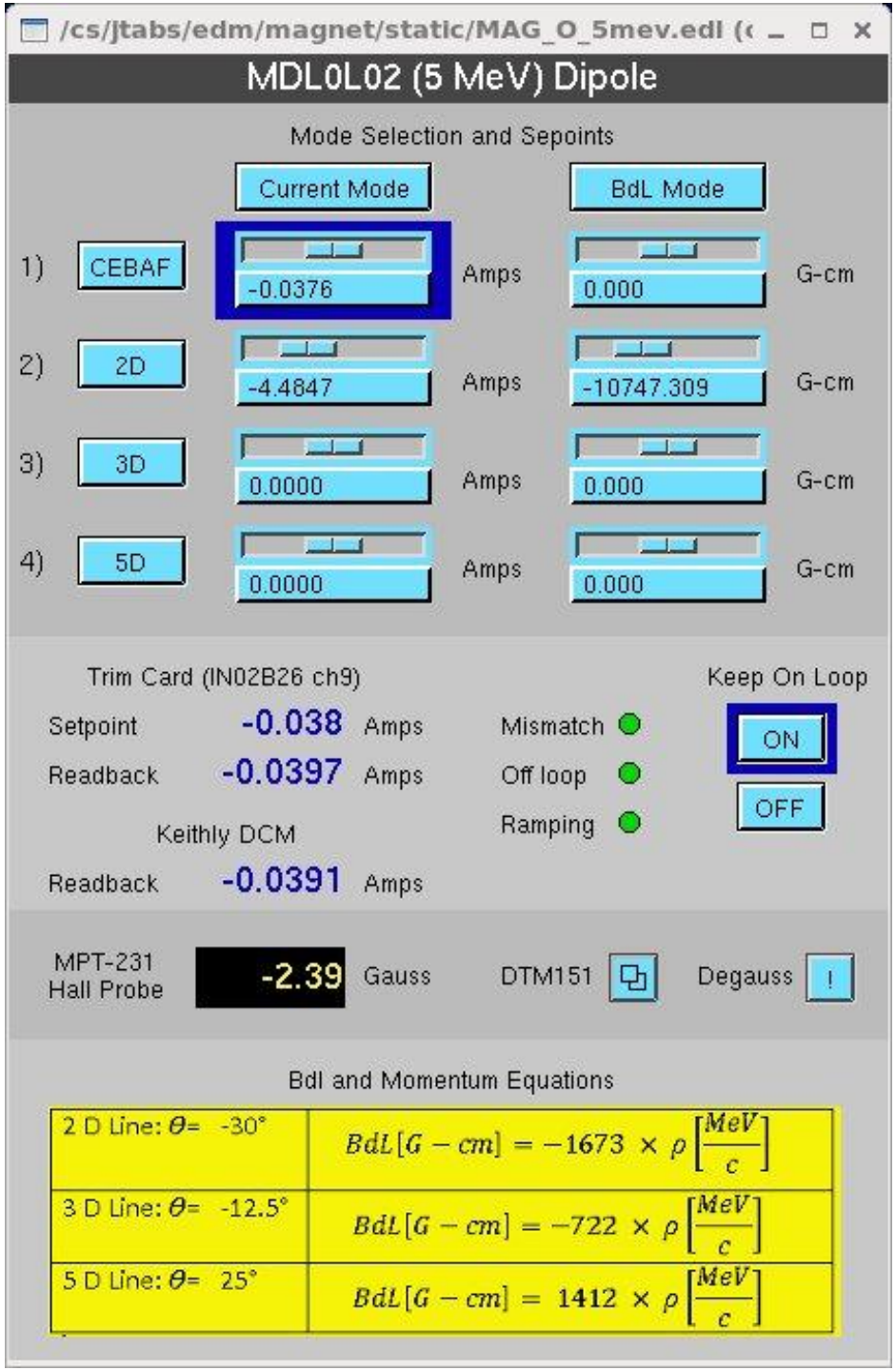
5 MeV Dipole



Beam Position Monitor (BPM)

Electron Beam Momentum

$$p = \frac{\int B dl}{\theta}$$


/cs/jtabs/edm/magnet/static/MAG_O_5mev.edl
MDL0L02 (5 MeV) Dipole
Mode Selection and Sepoints
Current Mode
BdL Mode
1) CEBAF -0.0376 Amps 0.000 G-cm
2) 2D -4.4847 Amps -10747.309 G-cm
3) 3D 0.0000 Amps 0.000 G-cm
4) 5D 0.0000 Amps 0.000 G-cm
Trim Card (IN02B26 ch9)
Setpoint -0.038 Amps
Readback -0.0397 Amps
Keithly DCM
Readback -0.0391 Amps
Mismatch
Off loop
Ramping
Keep On Loop
ON
OFF
MPT-231 Hall Probe -2.39 Gauss
DTM151
Degauss
!
BdI and Momentum Equations
2 D Line: θ= -30°
$BdL[G-cm] = -1673 \times \rho\left[\frac{MeV}{c}\right]$
3 D Line: θ= -12.5°
$BdL[G-cm] = -722 \times \rho\left[\frac{MeV}{c}\right]$
5 D Line: θ= 25°
$BdL[G-cm] = 1412 \times \rho\left[\frac{MeV}{c}\right]$

Parameter	Term	Before	Goal
Dipole – field map	$\delta B/B$	0.20%	0.02%
Dipole – power supply	$\delta I/I$	0.20%	0.02%
Position – surveys	$\delta\theta/\theta$	0.01%	0.01%
Position – BPM calibration	$\delta\theta/\theta$	0.05%	0.05%
Stray magnetic field	$\delta\theta/\theta$	0.05%	0.05%
Total	**$\delta P/P$**	**0.30%**	**<0.10%**

I. For Bubble Chamber experiment:

1. Installed new higher field dipole with better uniformity
2. Installed new Hall probe: 0.01% accuracy, resolution to 2 ppm, and a temperature stability of 10 ppm/°C
3. Better shielding of Earth's and other stray magnetic fields
4. Implemented 5 MeV dipole precision DCCT current readback

II. Relative beam energy uncertainty <0.02% is required

Beam Position Measurement

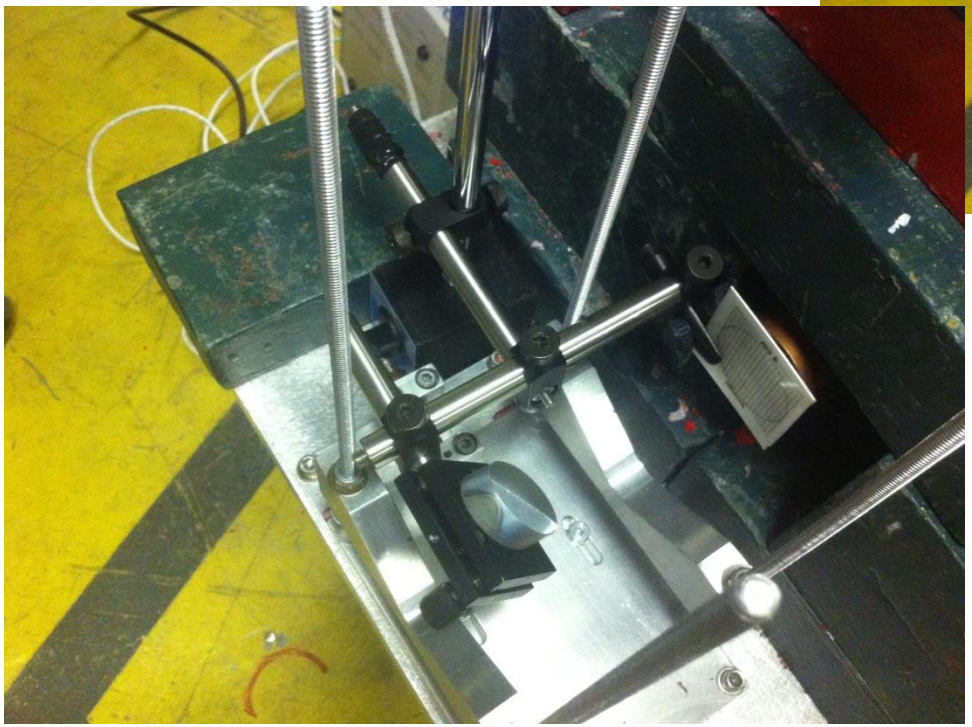
I. Keep beam centered on collimator

II. Measure beam position on radiator – use x-ray fluorescent screen

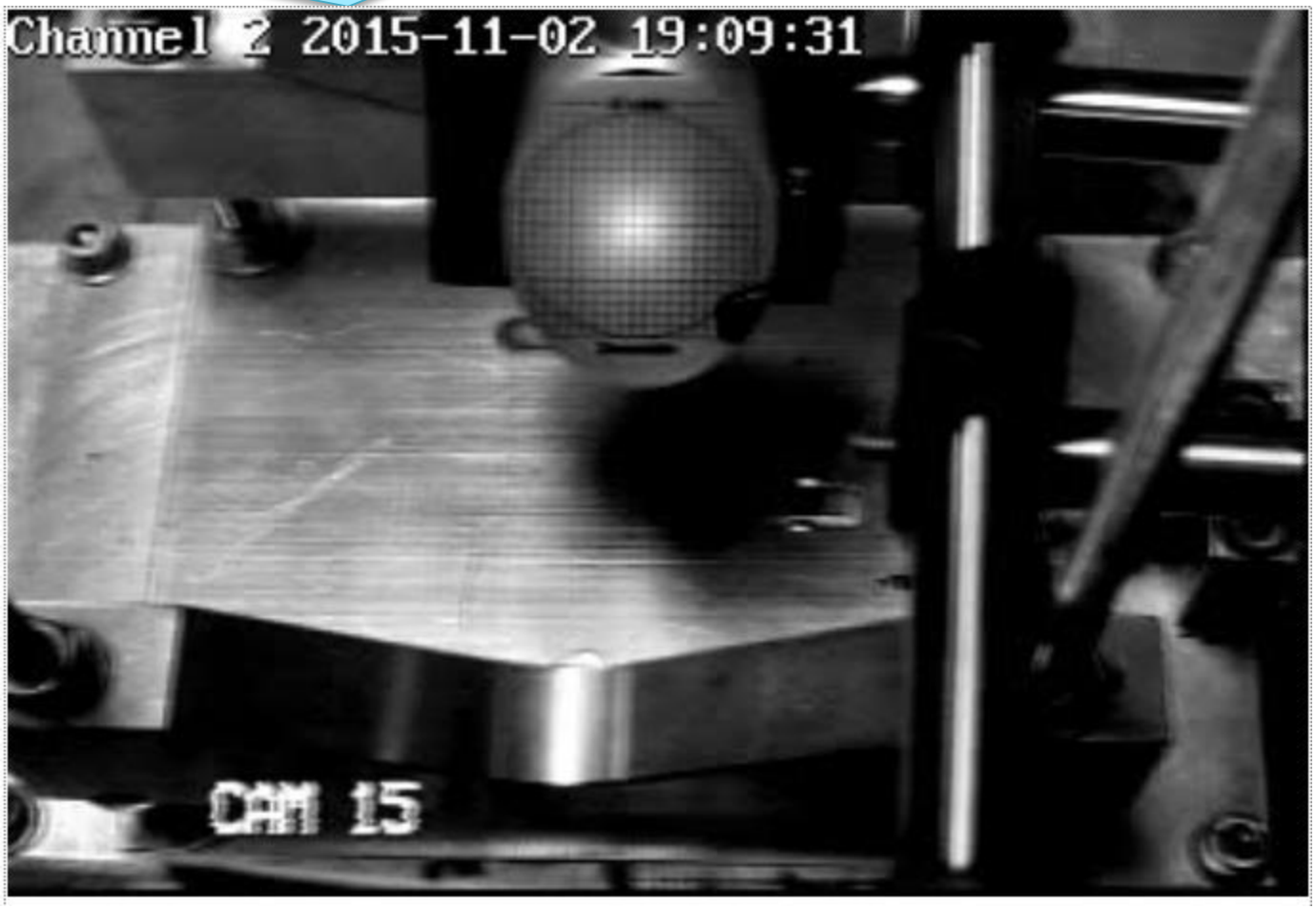
III. Survey 5D line (radiator and collimator)

- x-ray fluorescent screen was installed in front of radiator on Nov 2, 2015

- This screen has a special coating that illuminates under x-rays and emits a green light



0.5 µA centered on x-ray screen



Need to develop procedure to center beam on radiator using 5D line BPMs and viewers for different beam energies while accounting for earth's magnetic field

Beam Current Measurement

I. Approved to run 10 μA CW and total energy of 10 MeV – needs approval to run at 100 μA

II. Calibrate BCM and measure nA beam currents

III. Re-isolate radiator to measure beam current

IV. Stop beam when chamber is unstable while quenching a bubble