Testing MCPs in High $\vec{B}$ Facility

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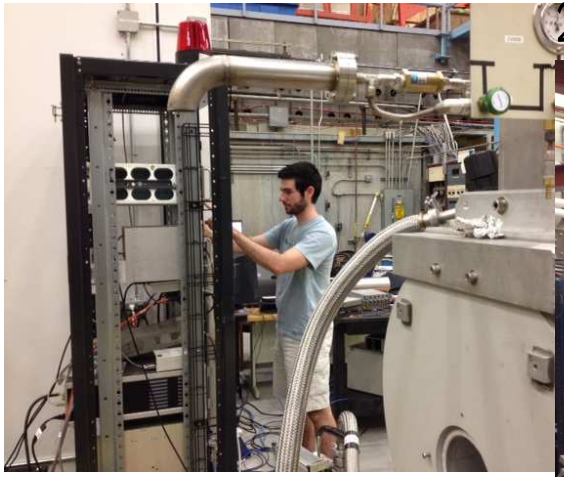
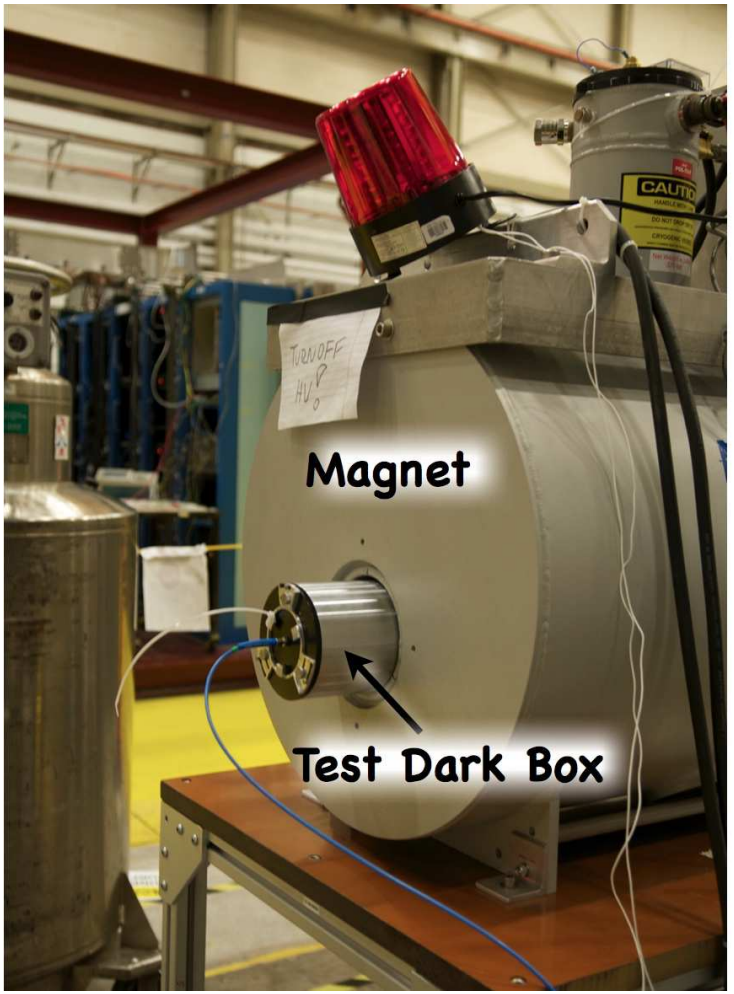
Update of MCPs testing at High$\vec{B}$ Lab

2013 -2014



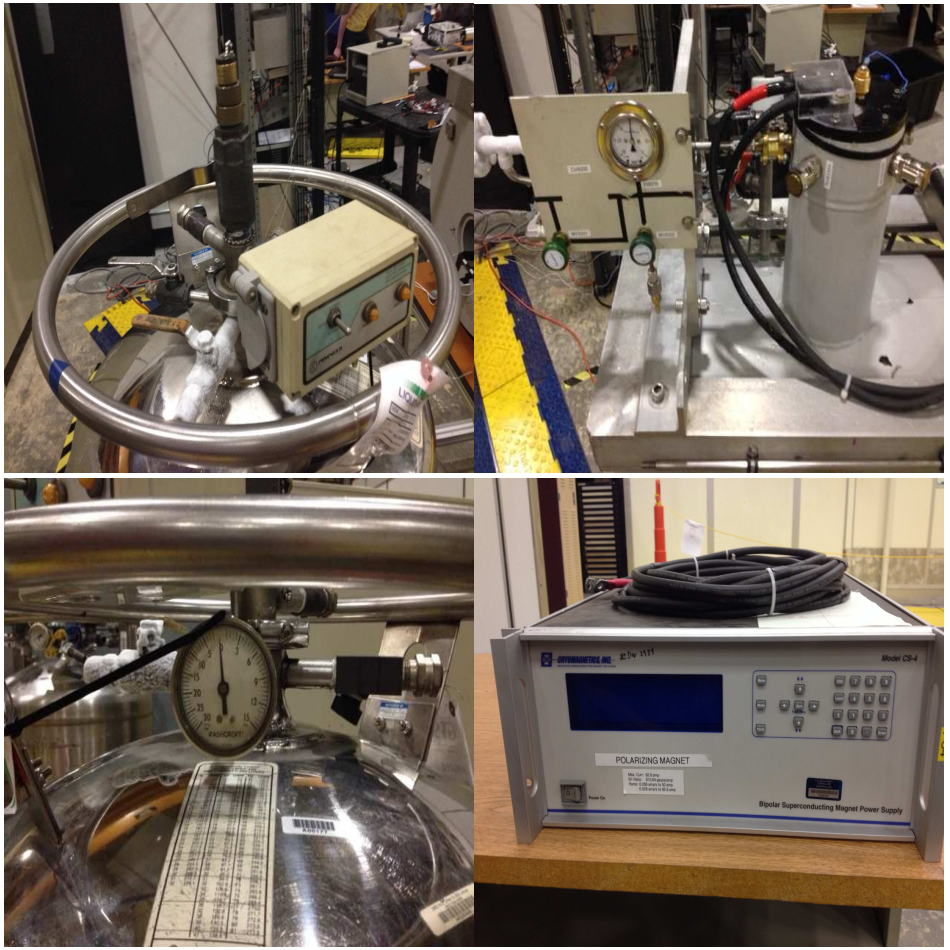
2015

Magnet



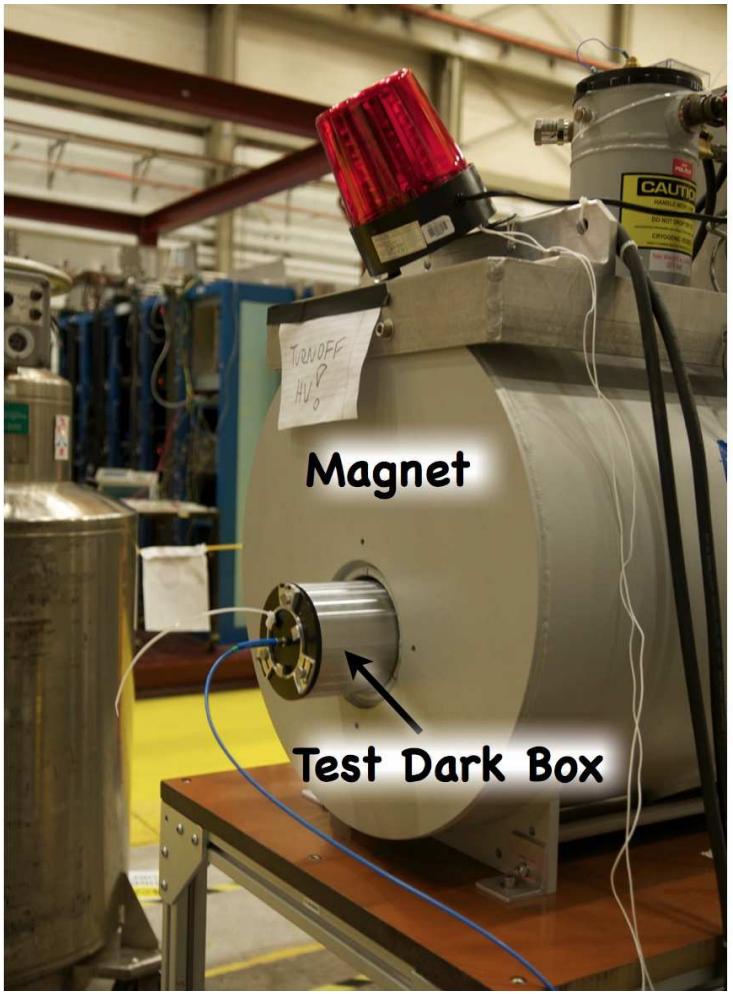
- Superconducting solenoid
  - Diameter: 5-inch, L: 30-inch, warm bore
- $\vec{B}_{max} = 5.1$T at 82.8A
  - Centeral field inhomogenity: $\leq 5 \times 10^{-5}$
  - Cylindrical volume (r =2.5cm,L=5cm)
- Non-magnetic stand for easy access to bore
- Mark down field map boundary on the ground
- Safety beacon's operated by magnetic field

Magnet Cryogenics/Current Control



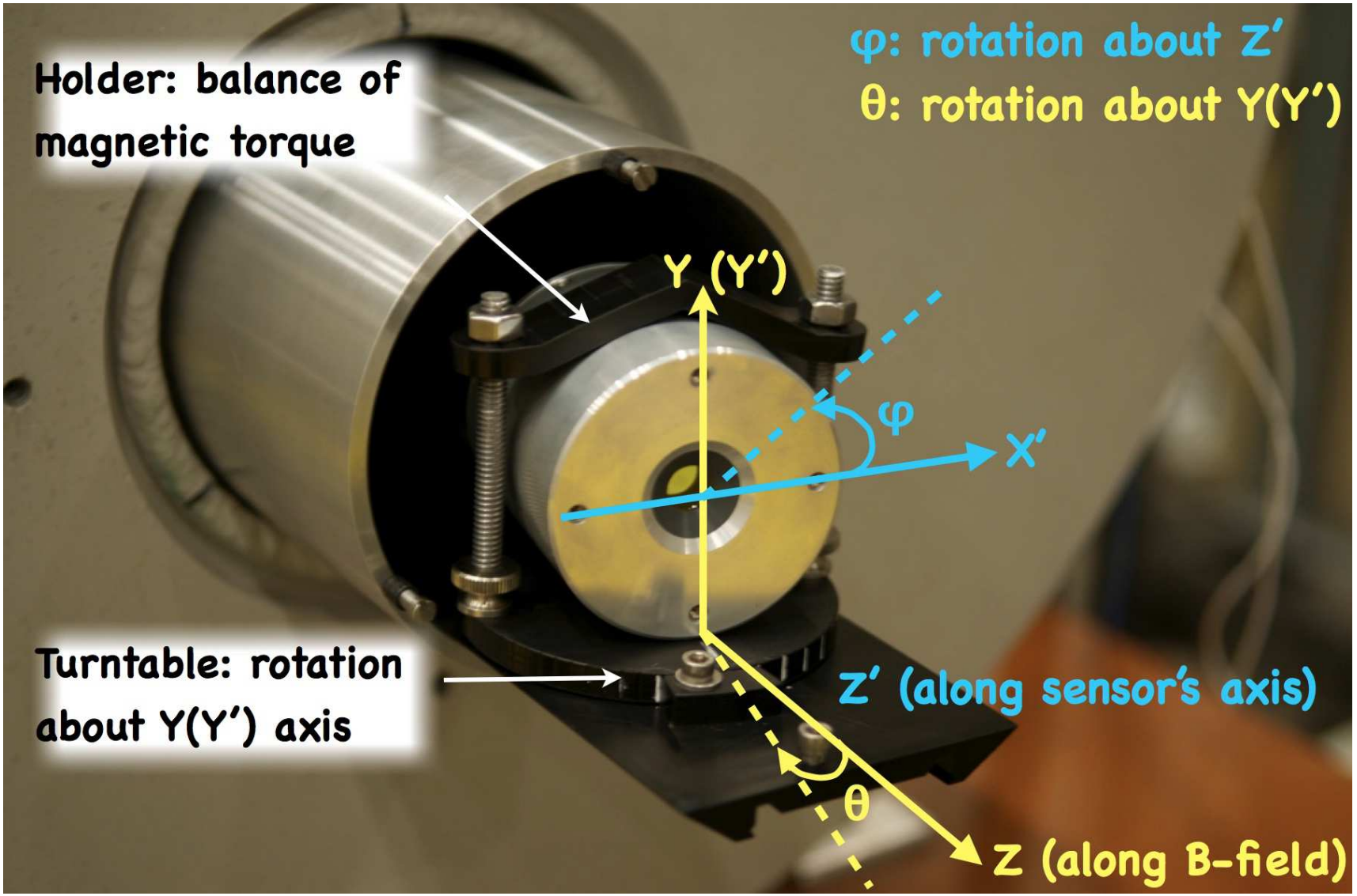
- 250 litter LHe Dewar allows a week measurement !
  → Magenet (50/) is the driving mode
- LHe re-fill procedure
  → Two persons work, they should communicate effectively
  → Practical training is VERY important
  → Follow the EXACT procedure and safety !
  → Always monitor LHe level on magnet, in the Dewar
- Be familiar with accidental incident (We experienced couple of times)
- All detail procedure is on the logbook(both hard copy and Elog)
- Operator should be familiar with magnet current control

Test Dark Box

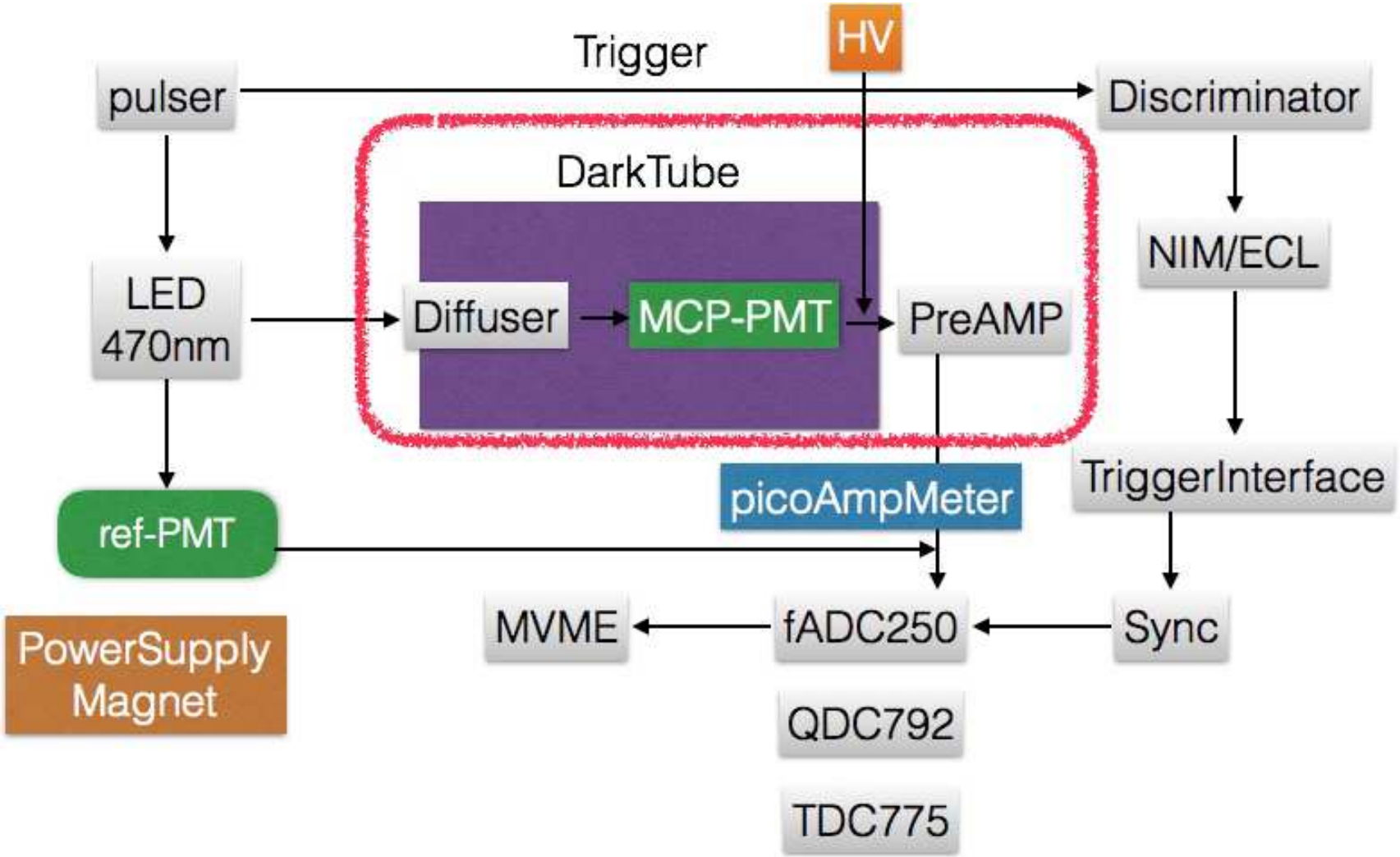


- Non-magnetic, light-tight
- A cylindrical shape
  - D_{in} = 4.5-inch, L=18-inch)
- Install a trail and turn-table allows to tranfort and rotate sensor
- LED light source (470nm) with pulser + optical fiber

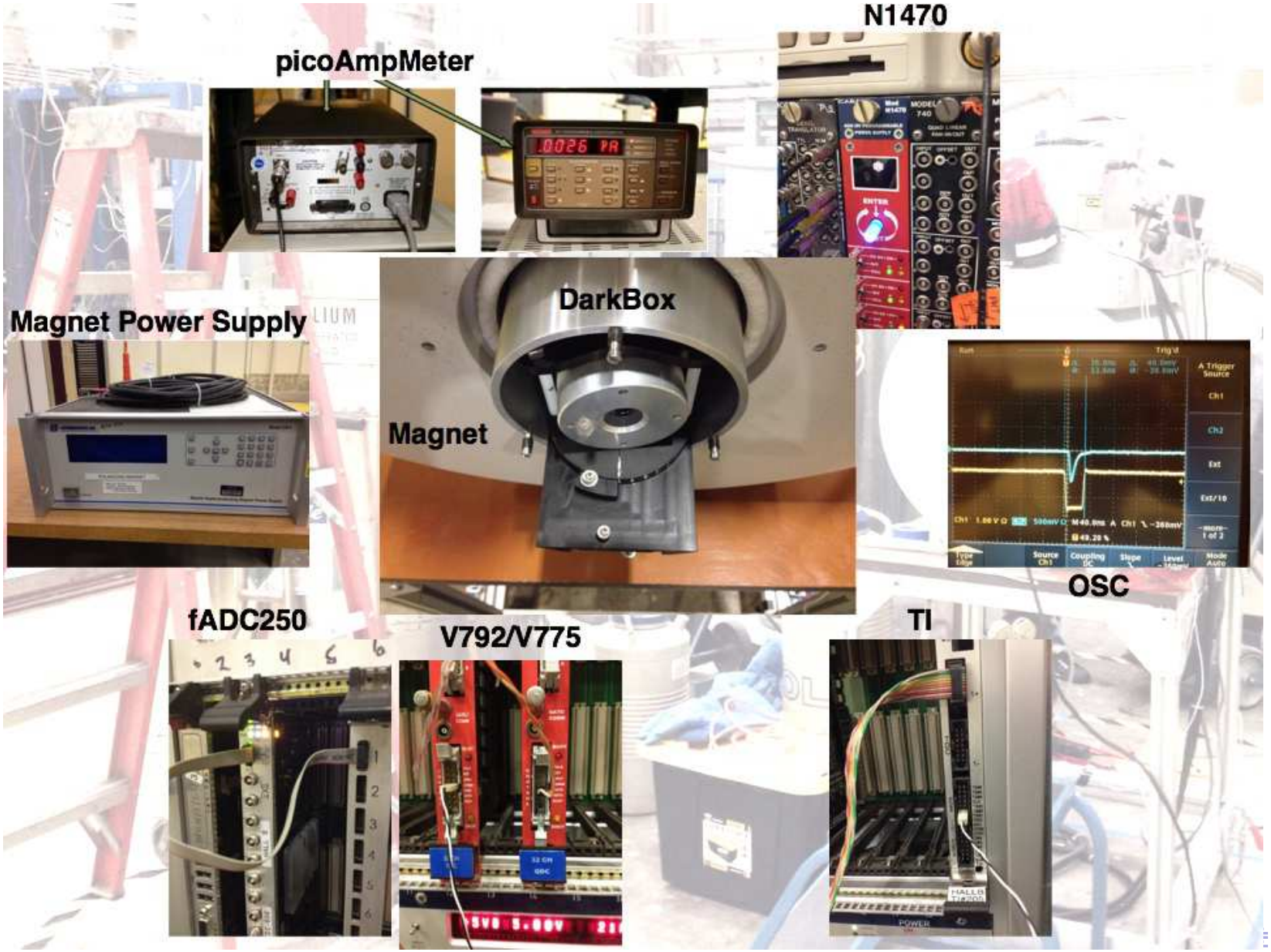
Test Dark Box



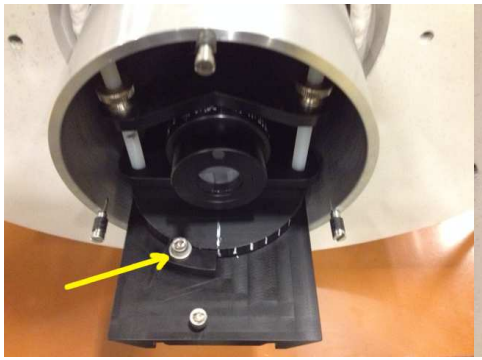
Signal Processing

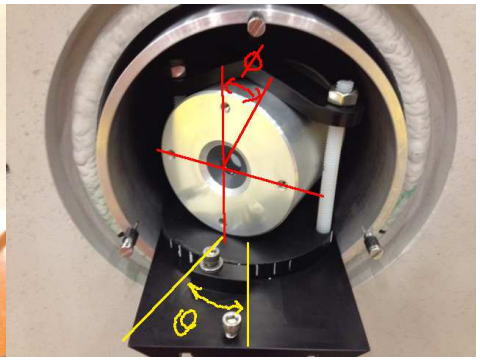


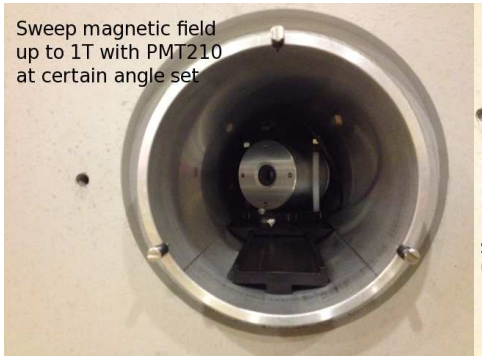
Signal Processing

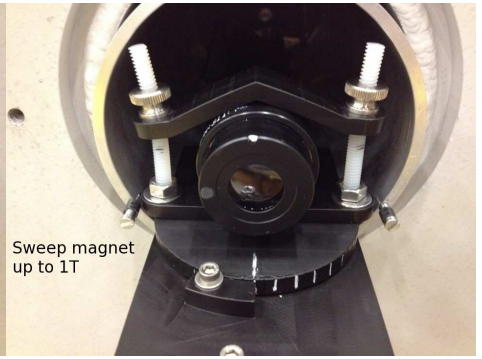


MCP Measurement Strategy



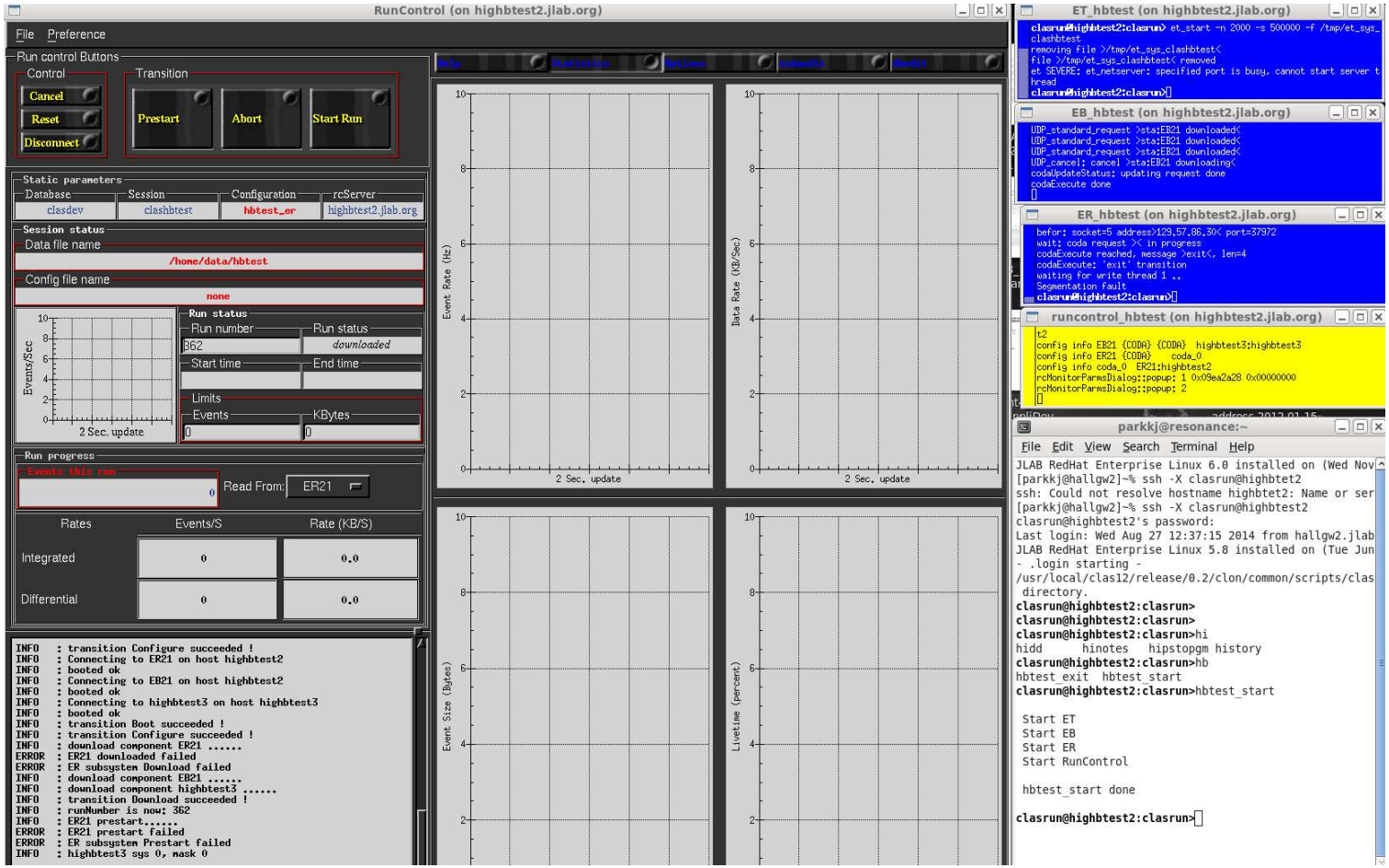






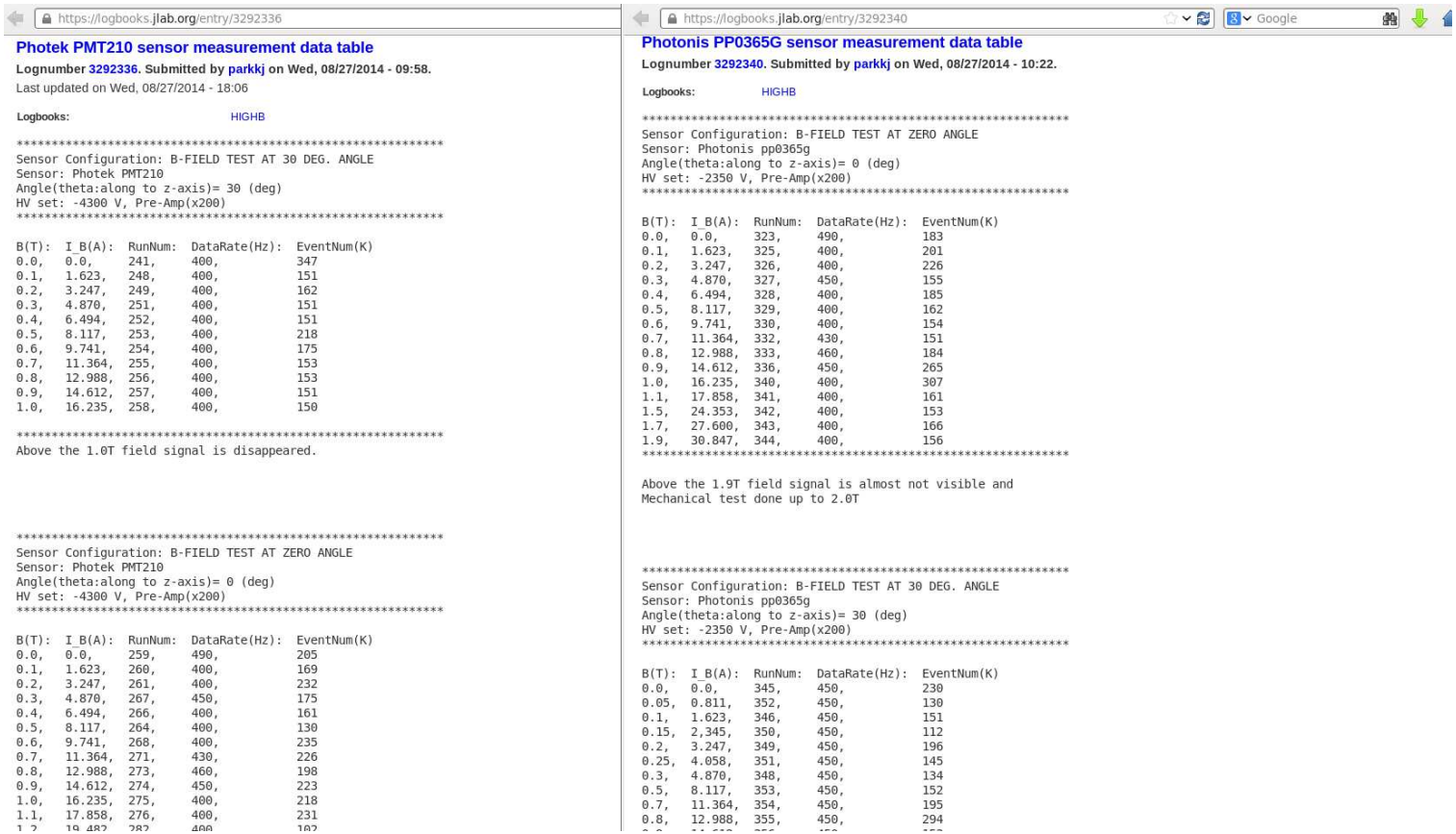
- Test MCPs:
  $\rightarrow$ PP0365g,PMT210/240,Katod,...
- Minimize the Mechanical distortion
  $\rightarrow$ MCP has a magnetizable component as part(coaval?)) $\rightarrow$ Photonis(pp0365g): mechanical test up to 1T (signal disappear)
  $\rightarrow$ Photek210: mechanical test up to 2T (signal disappear)
- Angle(θ) scan with various increments
- Keep same ϕ angle (reference position)
- Photek240 is too big to fit into a turn-table
- Pre-Amp($\times$200) used for both Photonis(pp0365g) and Photek210
- Feeding signal in fADC should be lower than 1V (jumper set: .5/1./2. V)

DAQ



- login: Hall-B network
  → ssh -X username@hallgw.jlab.org → ssh -X clasrun@hightest2.jlab.org
- Start DAQ RunControl GUI : hbtest_start/hbtest_exit
- Connect → Configure (hbtest/hbtest_er) → Download
- Prestart → Go

DATA Storage



https://logbooks.jlab.org/entry/3292336

Photek PMT210 sensor measurement data table

Lognumber 3292336. Submitted by parkkj on Wed, 08/27/2014 - 09:58.

Last updated on Wed, 08/27/2014 - 18:06

Logbooks: HIGHB

```
************************************************************
Sensor Configuration: B-FIELD TEST AT 30 DEG. ANGLE
Sensor: Photek PMT210
Angle(theta:along to z-axis)= 30 (deg)
HV set: -4300 V, Pre-Amp(x200)
************************************************************

B(T):  I_B(A):  RunNum:  DataRate(Hz):  EventNum(K)
0.0,   0.0,     241,     400,           347
0.1,   1.623,   248,     400,           151
0.2,   3.247,   249,     400,           162
0.3,   4.870,   251,     400,           151
0.4,   6.494,   252,     400,           151
0.5,   8.117,   253,     400,           218
0.6,   9.741,   254,     400,           175
0.7,   11.364,  255,     400,           153
0.8,   12.988,  256,     400,           153
0.9,   14.612,  257,     400,           151
1.0,   16.235,  258,     400,           150

************************************************************
Above the 1.0T field signal is disappeared.



************************************************************
Sensor Configuration: B-FIELD TEST AT ZERO ANGLE
Sensor: Photek PMT210
Angle(theta:along to z-axis)= 0 (deg)
HV set: -4300 V, Pre-Amp(x200)
************************************************************

B(T):  I_B(A):  RunNum:  DataRate(Hz):  EventNum(K)
0.0,   0.0,     259,     490,           205
0.1,   1.623,   260,     400,           169
0.2,   3.247,   261,     400,           232
0.3,   4.870,   267,     450,           175
0.4,   6.494,   266,     400,           161
0.5,   8.117,   264,     400,           130
0.6,   9.741,   268,     400,           235
0.7,   11.364,  271,     430,           226
0.8,   12.988,  273,     460,           198
0.9,   14.612,  274,     450,           223
1.0,   16.235,  275,     400,           218
1.1,   17.858,  276,     400,           231
1.2,   19.482,  282,     400,           102
```

https://logbooks.jlab.org/entry/3292340

Photonis PP0365G sensor measurement data table

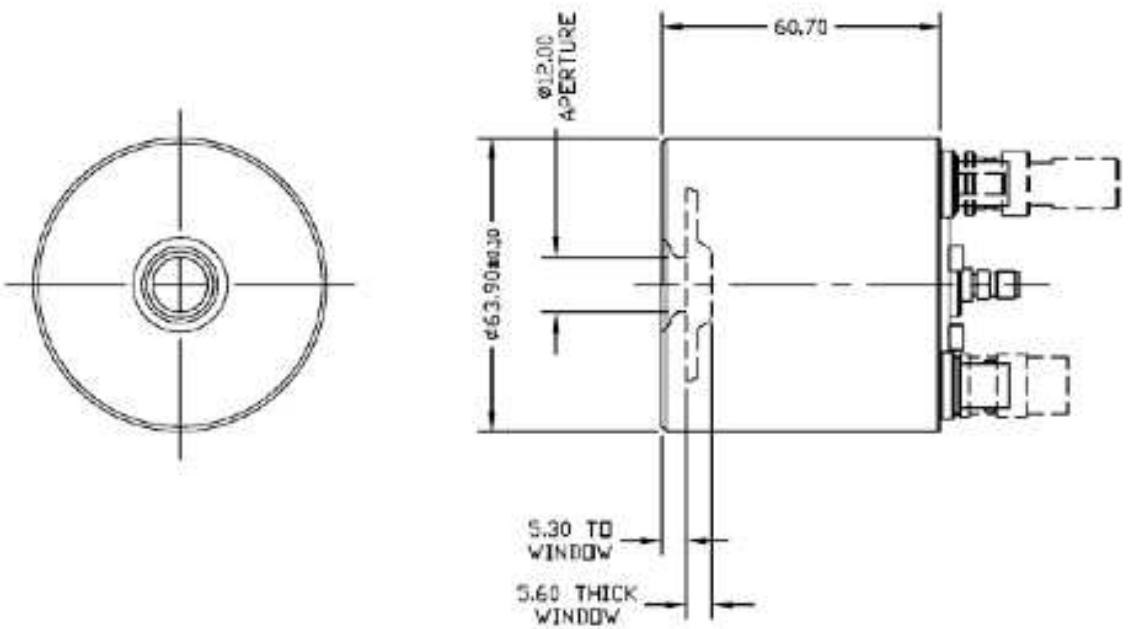
Lognumber 3292340. Submitted by parkkj on Wed, 08/27/2014 - 10:22.

Logbooks: HIGHB

```
************************************************************
Sensor Configuration: B-FIELD TEST AT ZERO ANGLE
Sensor: Photonis pp0365g
Angle(theta:along to z-axis)= 0 (deg)
HV set: -2350 V, Pre-Amp(x200)
************************************************************

B(T):  I_B(A):  RunNum:  DataRate(Hz):  EventNum(K)
0.0,   0.0,     323,     490,           183
0.1,   1.623,   325,     400,           201
0.2,   3.247,   326,     400,           226
0.3,   4.870,   327,     450,           155
0.4,   6.494,   328,     400,           185
0.5,   8.117,   329,     400,           162
0.6,   9.741,   330,     400,           154
0.7,   11.364,  332,     430,           151
0.8,   12.988,  333,     460,           184
0.9,   14.612,  336,     450,           265
1.0,   16.235,  340,     400,           307
1.1,   17.858,  341,     400,           161
1.5,   24.353,  342,     400,           153
1.7,   27.600,  343,     400,           166
1.9,   30.847,  344,     400,           156
************************************************************

Above the 1.9T field signal is almost not visible and
Mechanical test done up to 2.0T



************************************************************
Sensor Configuration: B-FIELD TEST AT 30 DEG. ANGLE
Sensor: Photonis pp0365g
Angle(theta:along to z-axis)= 30 (deg)
HV set: -2350 V, Pre-Amp(x200)
************************************************************

B(T):  I_B(A):  RunNum:  DataRate(Hz):  EventNum(K)
0.0,   0.0,     345,     450,           230
0.05,  0.811,   352,     450,           130
0.1,   1.623,   346,     450,           151
0.15,  2,345,   350,     450,           112
0.2,   3.247,   349,     450,           196
0.25,  4.058,   351,     450,           145
0.3,   4.870,   348,     450,           134
0.5,   8.117,   353,     450,           152
0.7,   11.364,  354,     450,           195
0.8,   12.988,  355,     450,           294
```

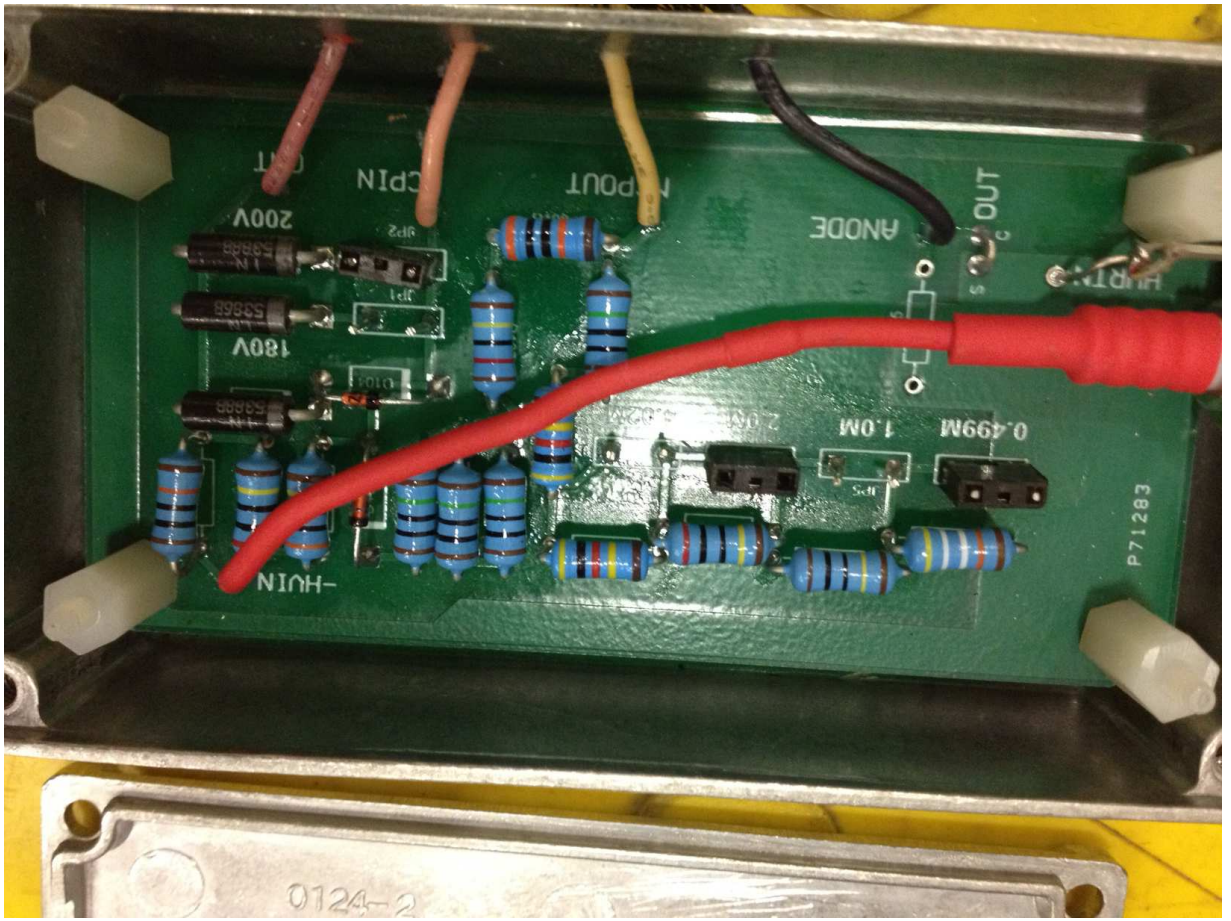
- DATA tables are available:
  → Photek: `https://logbooks.jlab.org/entry/3292336`
  → Photonis: `https://logbooks.jlab.org/entry/3292340`
- local computer : hightest2.jlab.org
- ifarm (volatile disk) : /volatile/eic/commissioning/
- Tape Silo: /mss/home/parkkj/highBtest/

Photek210 Drawing



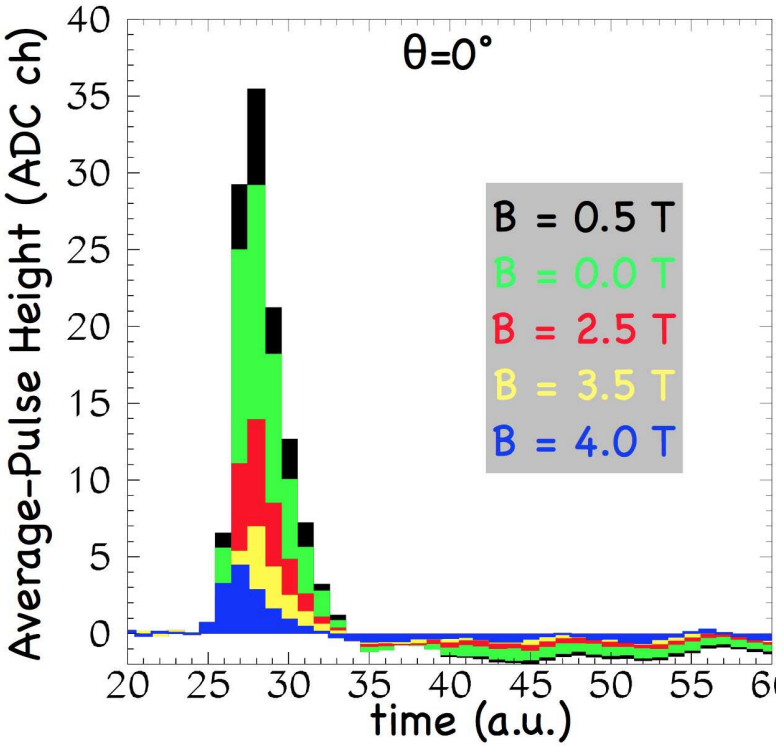
- Single, Chevron, Gain $\sim 10^6$ (2MCPs)
- FWHM 100ps

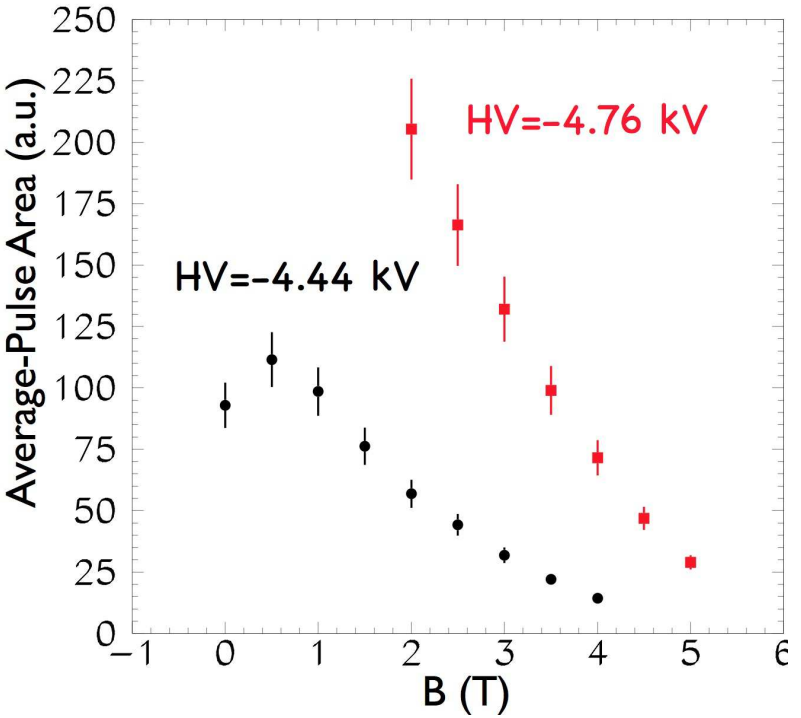
Photek210 Voltage Divider



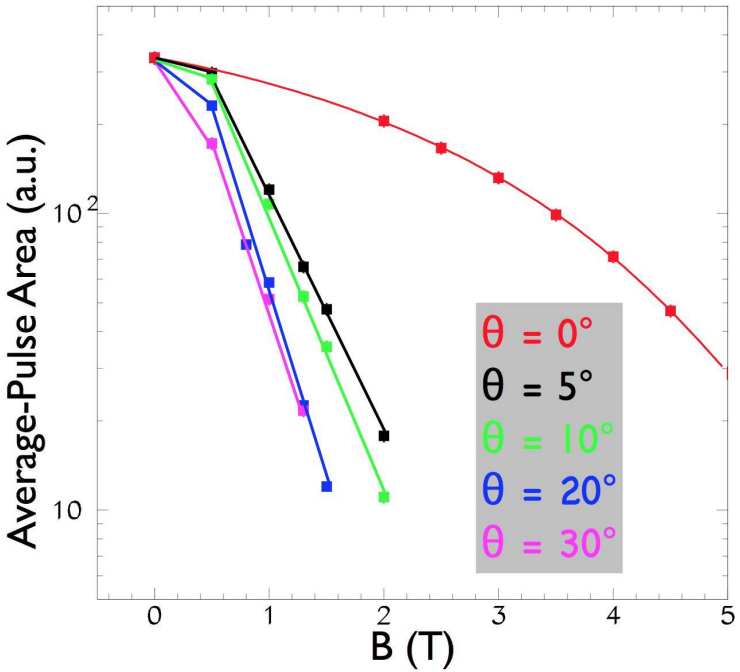
- Allow to provide voltage separately to Cathod-MCP, MCP-MCP, MCP-Anode
- Allow to combination of different voltage sets

Selected Preliminary Result





Selected Preliminary Result



- Photek210, 3μm pore, Voltage: -4.76kV

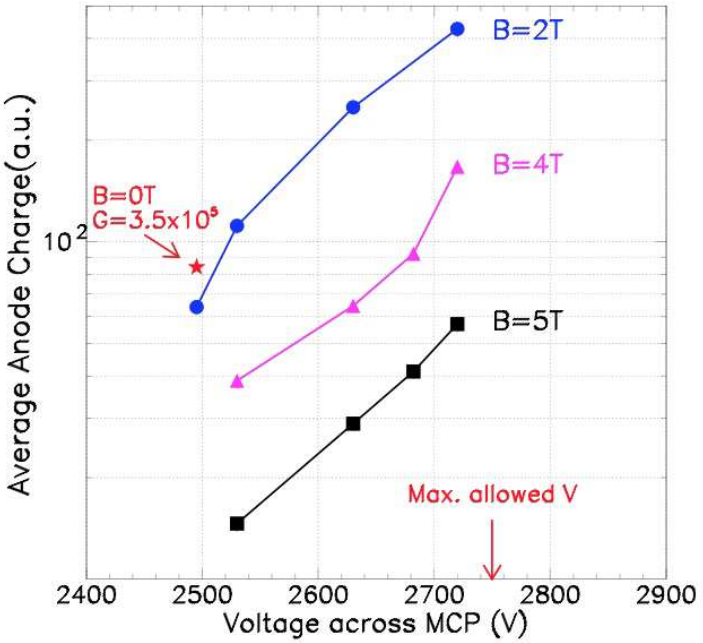
  - Normalized to the nomial point at 0T and 0(deg)

  Remark1) $\theta = 0$ (deg),
  $\rightarrow$ linearly decrease signal as increaseing $\vec{B}$

  Remark2) $\theta > 0$ (deg),
  $\rightarrow$ exponentially decrease signal $\vec{B} > 0.5$T

  Remark3) No significant ϕ angle dependent was observed

Selected Preliminary Result



- Photek210, Modification voltage divider
- $\theta = 0$ (deg)

  - Change voltages: Cathod-MCP, MCP-MCP, MCP-Anode

  - Study of volatge correlation w.r.t gain

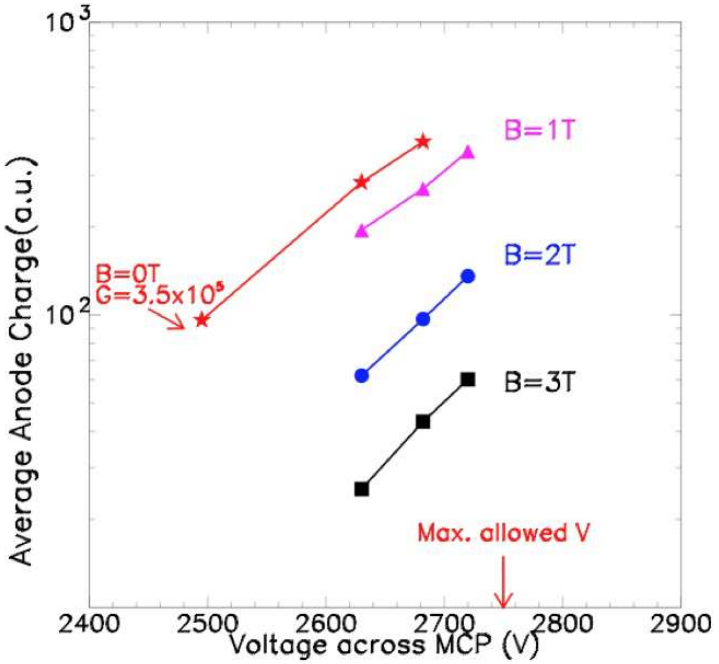
  - testing all possible combination voltages with various θ, ϕ, $\vec{B}$ sets - MCP-MCP volatage change is the most sensitive

  - Overall preliminary uncertainty 5%

  - Recover gain at standard HV set by maximize HV(MCP-MCP)

  - Gain can be recoverable up to 5T

Selected Preliminary Result



- Photek210, Modification voltage divider
- $\theta = 10$ (deg)

  - Control voltages: Cathod-MCP, MCP-MCP, MCP-Anode

  - Study of volatge correlation w.r.t gain

  - testing all possible combination voltages with various θ, ϕ, $\vec{B}$ sets - MCP-MCP volatage change is the most sensitive

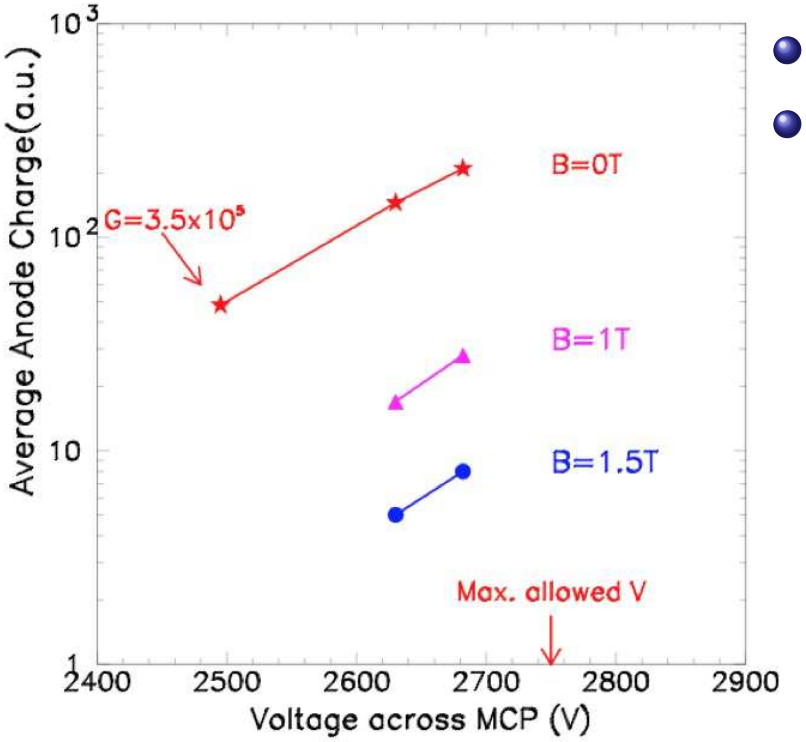
  - Overall preliminary uncertainty 5%

  - Recover gain at standard HV set by maximize HV(MCP-MCP)

  - Gain can be recoverable up to 3T

[** Note: The plot is not normalized by $\theta = 0$(deg) and 0T]

Selected Preliminary Result



- Photek210, Modification voltage divider
- $\theta = 40$ (deg)

  - Control voltages: Cathod-MCP, MCP-MCP, MCP-Anode

  - Study of volatge correlation w.r.t gain

  - testing all possible combination voltages with various angle, $\vec{B}$ sets - MCP-MCP volatage change is the most sensitive

  - Overall preliminary uncertainty 5%

  - Recover gain at standard HV set by maximize HV(MCP-MCP)

  - Gain can be recoverable up to 1T

[** Note: The plot is not normalized by $\theta = 0$(deg) and 0T]

Summary

- The high $\vec{B}$ facility has been established and fully functional
  - Superconducting magnet is working very smooth with various modes/fields
  - Own DAQ, Data process allows to have quick feedback of measurement
  - All data(raw/evio/root) have been stored JLab tape silo
- Data collections: Photek PMT210, 240, Photonis,...
  - Data contains: fADC, QDC, TDC
  - Converting raw data to ROOT/Ntuple/XML for analysis

Summary

- Photek PMT210: overall good response θ =0(deg) up to $\vec{B}$ =5T
  - Total collected charege is maximum ar $\vec{B} \sim 0.5$T
  - The collected charge shows exponenetial decrease as $\vec{B}$ increase for θ >5(deg)
  - θ >5(deg), good response up to $\vec{B}$ =2T
  - The collected charge drops significant between θ =0(deg) and θ =5(deg)
  - θ >5(deg), it shows a slow change
- Photek PMT240: overall good response θ =0(deg) up to $\vec{B}$ =2T

Summary

- Increasing the potential difference across the channel plates is a powerful means to recover the loss in gain due to the effect of the magnetic field.
- Gain recovery is strongly correlated with the angle between the MCP and field axes:

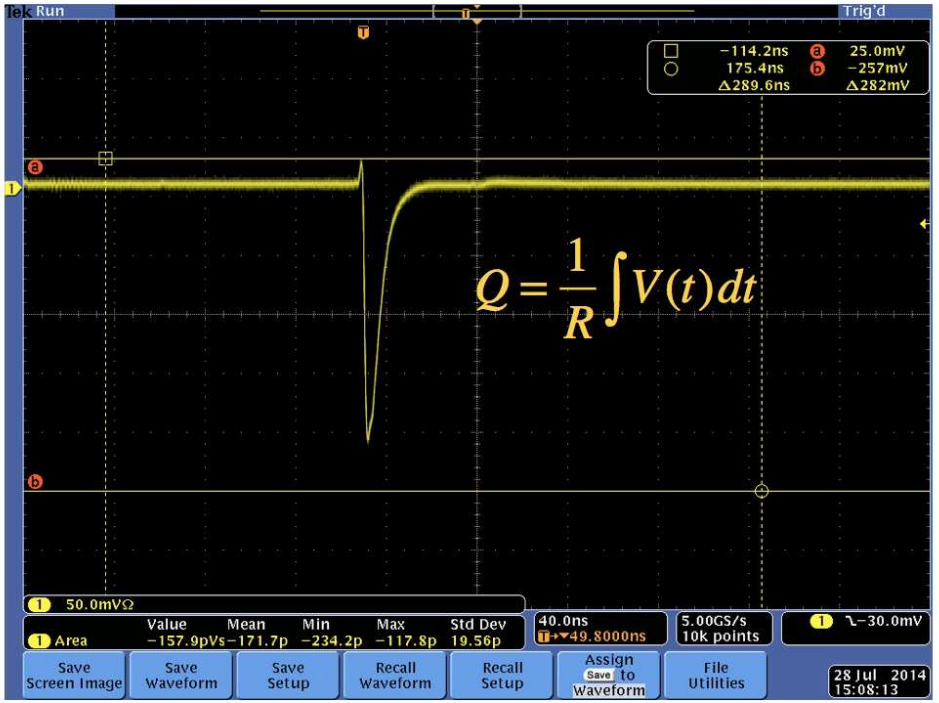
  - The larger θ angle, the more limited is the range of fields where the sensor can be operated at the same gate.
- Overall, other optimizations for gain recovery need to be implemented if the orientation of the sensor relative to the field varies significantly
- Data at 20 deg and -20 deg are under analysis.

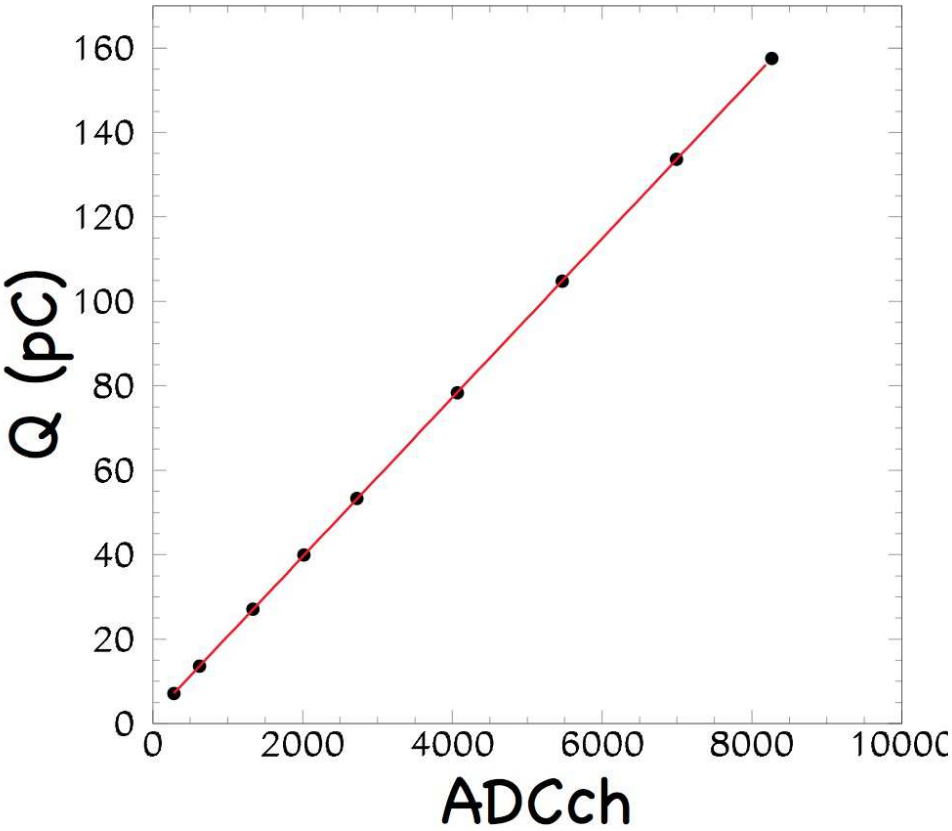
BACKUP

Charge Calibration using Phillips7120

- Oscilloscope set(1GHz): sample integration : to calculate charge
- Set one of charge (Q) modes (300 pC) in Phillips7120
- ADJ. is set certain value (to make sure you can read -DC[V])
- Remove the horizontal offset by constant fit
- $Q = \frac{1}{R} \int V(t)dt$, where $R = 50\Omega$
- Calculation : use the "KaleidaGraph"
- Choose range before pulse (in order to remove offset)
- Fit it with constant take "mean" value
- Subtraction mean to pulse value
  Formula Entry: $C_2 = C_1$ - mean
- Integration (macro) in time window (timing range is given by screen set)
- Pulse measurements done with 4 sets of voltage change
- $Q = 31.08$ (pC/V) $\times$ V(V) + 1.597 (pC)

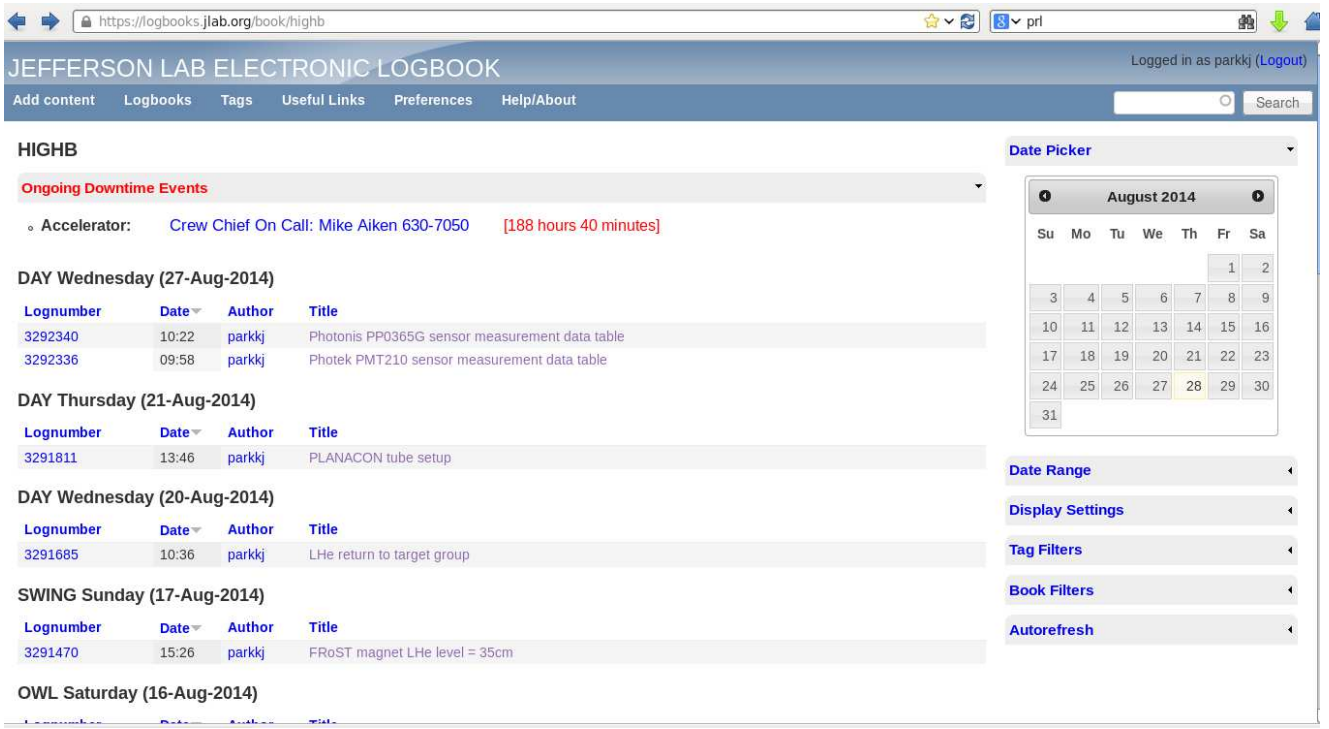
Charge Calibration using Phillips7120





- Q [pC] $= (1.9 \pm 1.2) + (0.01883 \pm 0.00039) \times ADC_{ch}$

E-LOGBOOK



- link : https://logbooks.jlab.org/book/highb