PRad Beam Commissioning and Run Plan (draft)

PRad Readiness Review
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Tagger and Photon Beam Commissioning

1) **Photon Beam Tuning (1 day):**

- HyCal with GEM on Transporter and off the beam line;
- Target cell off the beam line;
- Tagger radiator out, collimator out;
- Tagger magnet on.

a) establish a good electron beam (E_e = 2.2 GeV, I_e = 5 nA) on the tagger dump;
b) take electron harp scans 2C21A and 2C24A;
check the position, widths and pick to tails ratio;
c) study beam halo by setting the harp wire in the tail region and ramping beam current up to 100 nA;
d) lower beam current to 0.1 nA;
e) insert radiator 10^{-5} r. l.;
f) check tagger counter scalers;
g) setup MOR logic for calibration (gain equalizing) trigger T5 only;

Formation of the HyCal Trigger and Checkout

2) **HyCal Gain Equalizing and Trigger Checkout (1.5 days):**

a) establish HyCal temperature to T=16^{o} and keep it stable;
b) collimator in, 6mm;
c) target cell off the beam;
d) HyCal is in “Bottom Right” position;
e) establish a good timing with HyCal readout;
f) adjust trigger delay if necessary;
g) set the gain value: E=2 GeV to ADC=4000 channel;
h) start the gain equalizing process: scan to each modules center, show the anode and dynode ADC distributions on computer screen, by changing the HV set anode ADC=4000 channel (with ~ 5% precision), save the HV, ADC and anode/dynode ratio;
i) repeat for all HyCal modules (~6 hours).

GEM Calibration and Uniformity Tests

3) **GEM Beam Calibration** **(1.5 days**, **look for possibilities to combine with the item #2):**

a) collimator with smallest diameter in (2.7 mm);
b) insert thin ~ 1% r. l. CH_2 target in the beam;
c) insert 1"x1" small scintillator counter in the beam just after the Vacuum Box;
d) insert radiator 10^{-5} r. l.;
e) ask for photon beam with lowest intensity (I_e = 70 pA);
f) adjust the timing of the scintillator detector vs. tagger;
g) scan the GEM with HyCal with a predefined step size both on X and Y-axis, store the data from GEM, HyCal and scintillator detector;
a) measure the GEM's efficiency vs. position (uniformity).

HyCal Gain Calibration

4) **HyCal Gain Calibration** **(1.5 days)**:

a) run the HyCal with HV unchanged for ~ 3 hours after the “Gain Equalizing”;
b) the beam and the beam line are the same as in “Gain Equalizing”;
c) trigger: all T1-T19 tagger counters, DAQ without the “sparsification”;
d) start from the “Top Left” position with a continuous motion (~1 min/module) “illuminate” all modules, store the data with HyCal’s X,Y position from EPICS;
e) stop the HyCal motion by the end of each row, make new DAQ run with pedestals and LMS, store the files;
f) run on-line calibration programs for constants, store the data.

5) **Configuration change to running configuration with HyCal on the cart (4 days)**

Hydrogen Gas Flow Target Commissioning

6) **Electron Beam Tuning and Target Commissioning (2 days)**

a) target cell off the beam line, no gas flow in the cell and chamber;
b) collimator off;
c) set threshold energy for the HyCal trigger E ~ 0.5xE_e ;
d) request electron beam (E = 2.2 GeV, I = 1 nA);
e) take harp scans 2C21A, 2C24A and 2H01, check position and widths, establish a good electron beam and fix the beam line parameters;
f) record HyCal trigger rate with no cell and no gas flow take one short file with ADCs;
g) electron beam off; insert the target cell in the beamline, still empty, ask for a beam;
h) target cell is empty (no gas flow into the cell and chamber);
i) record HyCal trigger rate, take one short file with ADCs;
j) gas flow in the cell (P_{cell} = 6 torr, P_{cham} = 5 mtorr);
k) record HyCal trigger rate, take one short file with ADCs;
l) move the cell on X-axis by +/- 2 mm with 0.2 mm steps and take HyCal rate;
m) move the cell on Y-axis by +/-2 mm with 0.2 mm steps and take HyCal rate;
n) change the cell angles and record the HyCal rate, get optimal cell direction;
o) center the cell in beam based on those measurements;
p) no gas flow into the cell and chamber, record HyCal rate;
q) gas flow into the cell (P_{cell} = 6 torr, P_{cham} = 5 mtorr);
r) record HyCal trigger rate, take one short file with ADCs;
s) gas flow into the chamber only (P_{cell} = P_{cham} = 5 mtorr);
t) record HyCal trigger rate, take one short file with ADCs (in-beam residual gas effect);
u) If there is no sizable effect between cell in/out, skip following steps.
v) beam off, 12.7 mm collimator in, target cell in, ask for beam;
w) no gas flow in cell, record HyCal rate;

x) gas flow in the cell (P_{cell} = 6 torr, P_{cham} = 5 mtorr), record HyCal rate;
y) beam off, insert 6.4 (?) mm collimator in, take beam and repeat items (w) and (x);
z) make a decision about the size of the collimator.

Physics Data Taking with E_e = 2.2 GeV

7) **Data taking with E_e = 2.2 GeV (5 days)**

a) beam intensity: I_e = 10 nA;
b) collimator in (with the diameter defined in 6 (z);
c) HyCal trigger is set, DAQ is ready, all slow control readout is ready;
d) target cell in with maximum density ($2.x10^{17}$ H/cm^3);
e) take data for 2 days, record all information on disk and on tape;
f) no gas in the cell, take data for 0.5 day (empty target run);
g) gas in the cell, run for 2 days (same as in (e));
h) no gas in the cell, take data for 0.5 day (empty target run);

8) **Change Beam Energy to E_e = 1.1 GeV (0.5 day)**

Physics Data Taking with E_e = 1.1 GeV

9) **Data taking with E_e = 1.1 GeV (4 days)**

a) intensity: : I_e = 10 nA;
b) collimator in (with the diameter defined in 5 (r);
c) HyCal trigger is set, DAQ is ready, all slow control readout is ready;
d) target cell in with maximum density ($2.x10^{17}$ H/cm^3);
e) take data for 2 days, record all information on disk and on tape;
f) no gas in the cell, take data for 0.5 day (empty target run);
g) gas in the cell, run for 1.0 day (same as in (e);
h) no gas in the cell, take data for 0.5 day (empty target run).