Upgrade Injector Test Cave: Big Picture meeting, September 29, 2014

(poelker)

The usual suspects + Trent Allison and John Musson, who were invited to tell us about nanoAmp bpms, stripline bpms and BCMs.

Our meeting today focused on two topics: 1) nanoAmp BPMs/stripline BPMs/beam current monitoring and, 2) modeling the beamline

nanoAmp BPMs/stripline BPMs/beam current monitoring

1) nanoAmp BPMs and stripline BPMs have an aperture ~ 1.5 inch diameter
2) each three-cavity nanoAmp BPM is ~ 1 m long. It lives in a temperature controlled box
3) Two cavities for beam position monitoring, and one cavity for current monitoring.
4) The current monitoring cavity is a generic BCM cavity used at many locations at CEBAF.
5) We want to use the sensitive "down converter" recently developed by Trent and John, to provide accurate monitoring at sub nA level.
6) step files for three cavity nA BPMs, and BCMs should exist, these will be given to Joe Gubeli
7) ~ 100pA seems to be the lowest current that can be accurately measured, with 1 Hz averaging time. Beam position measured to 100um resolution
8) 100um resolution requires 1mm offset, beam into the cavity. Which reduces the aperture.
9) Trent and John would rather make all measurements using new stripline BPMs, designed by Pavel E., and improved upon by Trent and John and company. These devices are not sensitive to where beam enters the device. But they might not work at 100pA
10) John H. suggested we might help ourselves by running the laser at a subharmonic of 1497 MHz, to reduce the impact of 1497 MHz RF noise radiating from klystrons, wreaking havoc on our low current measurements with BPMs. Trent and John concurred. They also suggested we could shield the devices in some sensible way, to reduce impact of RF noise.
11) Rastered beam, we are just going to measure the centroid, which is fine.
12) We can operate in tune mode at 8uA to take advantage of all the diagnostic features afforded by our BPMs, e.g., perform an FFT to show frequency content on beam. This might be available even at 100pA. But maybe we can't see fast transients.
13) John and Trent look forward to using the Test Cave to help improve beam diagnostics.

Modeling the beamline

1) Joe Grames is making progress modeling the beamline using Elegant. He has first pass quad locations for the chicane beamline and a straight beamline. He will continue to refine, and is now going to focus on beamline upstream of ¼ CM. He passes this stuff to Joe Gubeli who is working on an overall beamline drawing.
2) Joe Grames mentioned that the solenoid at HDIce target over-focuses the beam, transforming a beam that is ~ 250um in diameter at target to 1.5" at dump one meter away. At 7 MeV. He

has not worked to reduce the size of the beam at dump just yet, using upstream quads. From a beamline optics point of view, this is not too problematic, but….

3) Joe Grames fears multiple scattering inside the solid target will increase the size of beam at dump, and maybe even result in electrons hitting target walls?
4) Based on our experience with 5 MeV Mott, expect electrons from dump to come back to target
5) We cannot reduce the solenoid current/field, the target won't stay polarized.
6) A sweeper magnet, bending the beam around a corner enroute to dump, might help minimize ill effect of dump-scattered electrons
7) All this points to a need to montecarlo the target and dump, to better appreciate how electrons interact with material. Joe can run G4Beamline, and he can show Charles how to do this.
8) Al Gavalya might have a step file of the Hall A 6 GeV raster, which is what we will be using.

How to know the HDIce target is still polarized?

- Plan A: periodic NMR measurements
- Plan B: some real-time scatter asymmetry

Running log of things we need to purchase or manufacture:

RF-related

1) Klystrons (x3) and power supplies, 10 kW electrical power feeding these three racks with power supplies and klystrons
2) RF waveguides ($100/ft, check building 31, might have enough)
3) Stub tuners
4) Control Modules (x6), old ones would be fine
5) Interface to MPS, e.g., trip RF power when certain things happen
6) VME crates (x2, maybe 3)
7) 500 W chopper amplifiers (x4), 30k$ per amp. Could start with just two.
8) Water heaters and feedback electronics to maintain choppers and buncher at constant temp, to stay resonant at 1497 MHz, copy Joe Gubeli's design
9) If we don't get a buncher from FEL, we need to purchase a new one….

Beam diagnostic related

1) Hari might be right, there might be old stainless steel nanoAmp bpms for the taking. Are these in Hall C (A?). John Musson thought there was one available in BSY (fyi, it costs 100k$ for the nA BPM stuff that lives inside the oven box, including the oven). But Trent and John point out that these "free" nA BPMs will need to be copper coated, to improve low current resolution. This costs a few thousand dollars. A place in Gloucester….
2) nanoAmp BPM electronics?

3) Stripline BPMs, at about 800$ per item
4) YAG viewer wafers
5) BCM cavity in Cave 1 + receiver

Magnets

1) Two chicane dipoles (assuming we build a chicane)
2) 11 quads
3) Haimsons
4) 15 degree dipole magnet (x2)