BI WP13 Meeting #8 2018

WP13 #8 meeting (https://indico.cern.ch/event/755413/) on Monday 8 October in room 866-1-A04.

Agenda:
14:00-14:05 Approval of minutes and previous actions
14:05-14:30 Beam dynamics simulations in electron lens test stand, S. Sadovich
14:30-14:55 Measuring beam size with the BGV – results from the demonstrator in Run2, B. Würkner
14:55-15:20 Status of the Beam Gas vertex profile monitoring instrument development for HL-LHC, R. Kieffer
AOB

Minutes of the previous meeting at https://indico.cern.ch/event/755408/

Approval of minutes and previous actions:
Minutes from the previous meeting were approved.

Measuring beam size with the BGV – results from the demonstrator in Run2 (Benedikt Würkner)
Update on last meeting in May: small recap of how BGV works and details about bunch size.

- Only on 1 beam (B2), gas to increase trigger rate without affecting beam.
- 2 stations with total 8 detector plates.
  - Gas-beam interactions create particles in the very forward directions, with statistics we can establish where these interactions happened. 1E-7mbar Neon pressure (4E-8 mbar N_2 equivalent).
- Figure page 2 shows interaction rates: steps corresponding to each injected train, rate increases with proton energy.
- Full gas injection last 4h total, not running continuously.
- Vertez z-distribution very simular to what gas pressure distribution is estimated to be.
- By injecting gas we increase trigger rate + % of good events.
- Trigger system (very sophisticated) needs to have coincidence between Near-Far + Confirm, while VETO gives a NOT (details can be found in Andreas' presentation at the HiLumi Collaboration meeting). L0 trigger is handed out to the read-out (ODIN) which knows the filling scheme. The read-out will then select on tracks that correspond to bunch passing.
- Pattern recognition algorithm works only with a min and max number of clusters, to then perform track reconstruction.
  - 6kHz (limit imposed by the CPU) with full gas.
  - Algorithm optimised for geometry but very sensitive to alignment
  - Relevant range between 2 to 7 tracks/event
- Correlation of tracks is independent of resolution of measurement, but function of the noise. The longer the integration time, the more precise the fitting.
- One of big problems is asymmetry of detector (sum cut-out phase, to leave room to beam 1). To cope with that Benedikt worked out a calibration curve (correction factors)
- 10% precision with 0.76 s measurement time, improving with integration time. Since this scales as 1/sqrt(N) this means the measurements are independent.
- Comparison with other diagnostics:
  - Use BSRT calibration fill: 12 bunches injected with different emittance then accelerated.
    - WS runs every 30 sec
    - BGV also used (with 6 min integration time, 12 bunches, full gas, not big interaction rate and therefore larger error bars)
    - Results very good (within ±20%).
  - BSRT comparison also shows good agreement at flat-top

- Measurements during ramp compared to expected values are within ±5% in x and ±10% in y.
  WHAT ABOUT LOSSES AND RADIATION? HOW MUCH DO WE GET DOWNSTREAM OF THE BGV?
  Being recorded to estimate .
  NOTE: Sigma_diff should be zero for round beam, and is not due to asymmetry of detectors.
  SHOULD SAY THAT BGV HAS DEMONSTRATED ITS PRINCIPLE AND WE ARE NOT SURE IF WE ARE ABLE TO MAINTAIN THE BGV DURING RUN 3.

Status of the Beam Gas vertex profile monitoring instrument development for HL-LHC (Robert Kieffer)
Description of measuring technique:
Every track is projected onto x-y plane and we look at distance of closest approach

- For HL one device per beam
- On-line processing of data still in work
- Close to stable and automated operated BGV
- Ultimate goal is single bunch measurement.
- Plan shown: plan to install during LS3
- Expected radiation dose at BGV is measured at present by RadMon @ 20cm from BGV + FLUKA simulation to predict at HL-LHC.
- One important parameters for the upgrade is the max rate of events to be able to produce a measurent: not to have dead time we need to be able to read at 25kHz.
- Errors on DOCA mainly comes from multiple scattering in the detectors themselves. Looking into low material budget detectors to reduce multiple scattering.
  - Present demonstrator (SciFi material) has 1.2X0 over X-Y layer. Totem GEM detector seems to have better data.
  - Migromegas, looking for lighter materials
  - GEM structure different, electric field strong only inside holes
  - Comparison of different solutions based on several factors, including MIP signal (how easy will the to find electronics for read-out). GEM seems to be the best compromise (Si better if more money).
    - VMM (read-out) chip (currently the standard at CERN) can be used for any of the detectors.
- New design with GEM
  - 3 layers of detection to better distinguish tracks (trade-off between improving tracking and not being affect by multiple scattering). Will improve noise
  - Almost full cylindrical coverage
  - We want to be able to see clusters closest to beam pipe (where most are) = 6-8 mm distance from beam pipe to detector.
  - Big work also to reduce material around beam pipe.
  - 2 detectors very close with small angle in between will allow to better identify clusters inside detectors.
  - Being considered: VMM front-end, could be read by SRS system (generic system) + CPU network to elaborate data.
  - Total 85kCHF not including the reprocessing algorithm.

  CURRENT ALIGNMENT NOT GOOD ENOUGH FOR VERTEXING
  CURRENT DEMONSTRATION WE HAVE 50-80um RESOLUTION.

Beam dynamics simulations in electron lens test stand (Sergey Sadovich)

- Electron Lens principles described
- Electron beam should maintain shape and be aligned to vacuum chamber
- Several phenomena affect beam dynamics

    - Electron gyration + plasma rotation due to self-charge and bend dynamics
- Simulation of FNAL test stand with CST + comparison to experimental results.
- At FNAL beam is measured with pin-hole FC with beam stirred to measure the transverse profile.
- Profile shape scales with sqrt(V)/B as expected with
- Rotation phase also: $\varphi \approx const \times \frac{\sqrt{V}}{B} L$. In order to judge how the simulation reproduce the experimental data, we decompose the profile with Polar Fourier transform.
- CERN test stand, without drift magnet, will give additional data to understand beam dynamics, since the beam do not move.