LESA/LDMX Interface

Last edited 2022-03-24

Next meeting: 4/13 2pm (TBC)

Near Term Efforts identified at 2022-03-24 meeting:

1. **Configuration of beamlines**
    - LDMX downstream of test beam? Or deflect one or the other? Geometry and magnet constraints on each.
    - Plan to engage Carsten at 4/13 meeting to understand the boundary conditions
2. **Stopper**
    - Understand whether Alev's proposed S30XL stopper has large enough aperture to handle spread-out beam, power limitations, and tolerance to localized heating if quads over-focus the beam. (Tor is following up with Alev)
3. **Define hand-off between different instrumentation sets for low-current tuning**
    - ACMs for LESA line spec'ed to 10 nA (design on S30XL (ops?) budget, envisioned to proceed as electrical engineers roll off LCLS-II work)
    - Want a downstream diagnostic in ESA with sufficient resolution to verify bunch charge < 10^3 e at 40 MHz *(clarify this)*
    - Expect that LDMX can be used at and below this level of current to characterize beam size and current.
        - First layer of ECAL is key
        - TS and tracker could be used too but provide only 1d information
        - Deeper ECAL layers should be powered down at these multiplicities, to avoid damage to silicon.
    - If new diagnostic is required, should start work this year.
    - Should define these transitions more carefully and seek review from LDMX ECal subsystem experts. (Want to have a slide on this for "summer 2022" LDMX review)
4. **Modeling of beam and backgrounds (potentially good project for student interested in both accelerator and detector physics).** Includes:
    - Better understand initial beam shaping using spoiler and collimators in A-line
    - Model propagation downstream and generation of beam backgrounds between spoiler and LDMX
    - Backgrounds at the detector, and their impact on physics analysis (on their own and when overlayed with standard events) quads
    - Uniformity of spot size -- and its impact on multi-electron performance of trigger scintillator, veto performance, etc
    - What particles does LDMX receive when beam is on upstream stopper? (Feeds into hardware design and understanding when DAQ and subsystems should be turned off)

List as of 2022-03-02

Protection of the Detector (overlaps others):

- Tune-up on stopper
    - Should understand flux (and spatial profile) of penetrating charged particles downstream of stopper, make sure it's low enough to not pose a concern.
    - Can mitigate by turning off HV during tune-up.

- Test beam use with LDMX is installed "downstream" (?)
- Accident during normal operation
    - This is an important one but very (unrealistically) difficult to simulate. Main concern is large # of electrons.
    - Tracker: 60 um x10cm. Large beam will spread the charge out. But 1k-10k electrons in one cell starts to do damage
    - ECal: few sq mm sensors but designed to take 1-10k MIPs in one cell.
- Drifting beam (seems to be mild for LDMX because current is so low. This could be an RP issue more than an LDMX issue)
- Mechanism: Insertible stopper? Dipole to switch between beam onto detector vs. shielding block in the tunnel with a few-inch hole in it

Impact of LDMX on general RP (already part of Ludovic's DMNI work plan):

- LDMX needs to work well enough as a dump
- Potentially blocking radiation instrumentation downstream

Beam shaping and collimation:

- **More complete study of A-line spoiler+collimator configuration to get down to 1e/bunch, mm-scale spot**
    - May be able to use Ludovic's integrated FLUKA model as a starting point to study this
    - Potentially LDMX Lund collaborator? SLAC student with accelerator+detector interests?
    - (Can integrate with next bullet, larger spot)
- **Methods of generating 2x8cm (?) spot at detector: if quads, where and what field?**
- How do we tune the spot?
- Is beam pipe in LDMX design sufficiently large given the expected beam profile? Are there RP/beam-stay-clear concerns?
- Non-rectangular shape and non-uniform density: what is achievable and what is tolerable for physics?

Set-up and Tuning techniques

- What are the procedures for establishing beam into ESA and to LDMX?

    - Start with tune beam (low rate LCSL-II bunches) to stopper (no spoiler)
    - Insert stopper, want instrumentation at a couple of locations to make sure we have the optics we expect & measure the degree of current attenuation
    - Switch to LESA low-current beam.
    - Detector granularity sufficient to do a measurement from 1000e/bunch on down to 10^-3e/bunch.
    - Rough procedure:
- What beam parameters in ESA need to be demonstrated before we use LDMX as instrument for further beam tuning? (e.g. Beam position, max spot size, current)? Do we have instrumentation needed to do that? If not, what simple instruments can be added for this stage?
- Before we're ready to run beam into LDMX, how do we protect LDMX? Stopper? Dipole? RP and accident-case consequences of each?
- Timeline driven by figuring out what instrumentation we don't yet know we'll need.

Diagnostics, collimator, and stoppers:

- Should spec a stopper (PEP-II stopper? Can it handle large beam?)
- Want instrumentation to quantify beam size upstream of LDMX.
- Real-time current monitoring not needed from LESA (LDMX will provide).
    - few us latency? Could make faster dedicated path (100s of ns including propagation time).
    - Feedback wraps back to laser; ms timesale.
- Want some dedicated current/charge diagnostics too, for when LDMX DAQ isn't running.

Test-Beam:

- Do we run test-beam experiments upstream of LDMX, in existing shielding?
- What are limits on current for test-beam based on protecting LDMX and hall from irradiation?
    - e.g. are detector irradiation tests that call for unattenuated 10nA beam on detector compatible with this setup?
- Test-beam users may want a lot of different kicker & laser timing structures. Can we add these "on demand"? Does this increase risk of accidentally delivering full LCLS-II beam for a while (presumably onto stopper, not LDMX) and are there associated RP concerns?
    - This doesn't seem like a big issue. Should be fundamentally doable, but may not be set up for it right now.

What are beam-related backgrounds at LDMX?

- Impurities from upstream
- Halo interacting with beam pipe
- Secondaries showering in LDMX >~1% can be a concern. 10^-2 suppression should be achievable with energy collimated beam