Progress this week on the Plume

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Everything we've tried so far

- Fix primary target back-scatter monitor, re-tune position/angle on target for maximum secondary yield. No noticeable effect on experiment.
- Implement two-scintillator coincidence between upstream end of MC7 and just before NOvA target: F:MC7SC2. Tuning to improve secondary throughput.
- Got NOvA target MWPC functioning consistently and remotely-viewable. Tune up position and spot size on target. No noticeable effect on experiment. Secondary beamline trims do not move the plume.
- Scan secondary beam momentum-selection collimator vertical opening to see if plume goes away; plume dissipates continuously as opening closes.
- Scan MC6D momentum selection dipole string with rest of beamline off; plume dissipates but does not appear to move.
- Run at negative polarity -64 GeV/c mode. Plume is gone, but secondary yield too low to be useful.
- Mike and Andrew slide MWPC in MC7 upstream end up and down to see if they could identify the plume; they could not.
- Ran with maximum primary yield allowed with MC2 pinhole collimator in; data consistent with very low rate on target.
- Carol and Adam accessed MC6 and MC7 to do a radiation survey and better understand the geometry of the shielding and line-of-sight to the plume. No obvious holes in shielding identified.
- MC2 pinhole collimator put in beam, tuned up for maximum rate on MC6 target (~5E6 ppp): unclear if detector data is significantly different from background
- Running at 8mm momentum collimator opening since studies showed this may have an improved secondary yield to plume intensity. Data analysis says reduced halo rate not worth reduced tertiary yield.
- Took experimental runs (~10 spills or so each) for beam to Meson absorber, beam only to Mtest, and no beam at all. All consistent with no hits on NOvA detector; plume is not coming from absorber shine or Mtest scraping.

Summary of effects on the plume

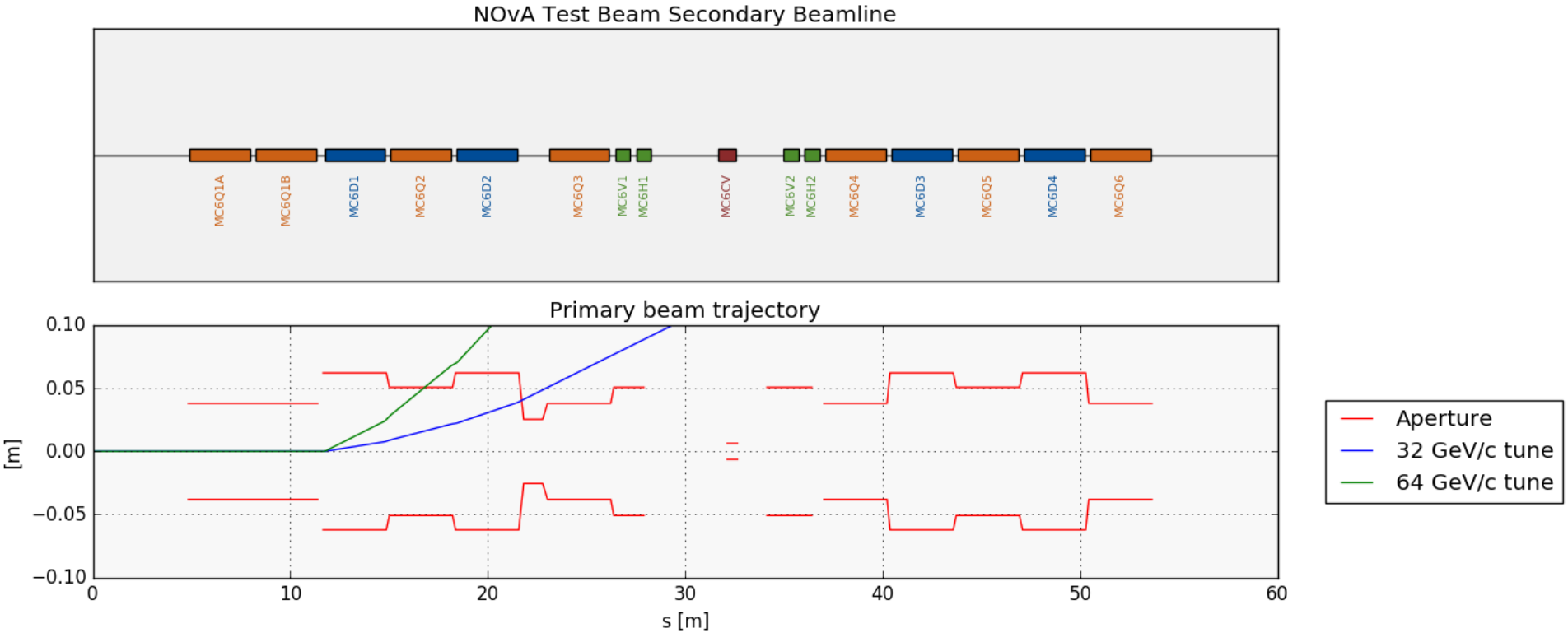
Does affect plume:

- MC6CV momentum-selection collimator opening gap changes apparent intensity of the plume.
- Scanning MC6D with all other magnets (trims and quads) off does not appear to move the plume, but does change its intensity.
- Running 64 GeV/c negative polarity makes plume go away, but secondary yield is too low to be useful to the experiment.
- Increased beam intensity appears to increase plume intensity
- Turning off the beam removes the plume.
- Pinhole collimator in MC2 makes plume go away, but rate is so low that it may just be an intensity effect.

Does not affect plume:

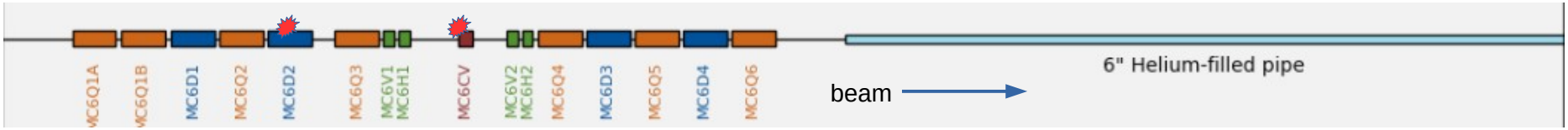
- Changing position/angle on the primary target
- Secondary beamline dipole trims do not appear to move the plume.
- Changing position and spot size on secondary (NOvA TB) target

Primary beam dump locations



- Using TRANSPORT (beam optics simulation), determined where 120 GeV/c beam dumps into aperture after passing through or around primary target
- Fixed-aperture scraped upstream of Q3 likely first place primary beam intercepts aperture in 64 GeV/c mode; likely not enough steel to completely stop it
- Lower-momentum modes mean primary beam dumps further upstream

Hot spots in MC6 secondary beamline



MC6 secondary beamline plan (top) view

- Asymmetric hot spots verified on West side, upstream ¼ of MC6D2, as well as West and ~1cm high on MC6CV upstream face.
- Same spots were identified before target position/angle scan, appear unchanged.
- May suggest horizontal alignment issue, consistent with target angle scan results.
- Poring over alignment data this week to determine issues.
- Will work with alignment stationing data to draw line-of-sight from plume upstream.

Next steps

- Moving scintillator array to trace back origin point of plume (Mike/Andrew/Evan/Yagmur in progress). Likely delayed pending in-person availability.
- Scrutinize alignment data to determine possible errors and line-of-sight between beamline loss points and plume. *In particular, are the scrapers in MC6 aligned? Is there a mismatch between primary and secondary beamlines?*
- Run lower-momentum mode (40 GeV/c or so), see if secondary yield to plume intensity is improved.
- Remove MC6 primary target, keep secondary beamline tuned to 64 GeV/C, see if plume remains. Likely on-hold pending personnel availability. RSO thinks it's reasonable to do.
- Experiment working to better understand detector capabilities and whether anything we've tried has impacted tertiary yield vs. FEB shutoff.
  - Re-doing collimator scan (today) at 64 GeV/c with old FEB firmware to look at FEB shutoff rates.