Booster Injection / Extraction

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October 4, 2012

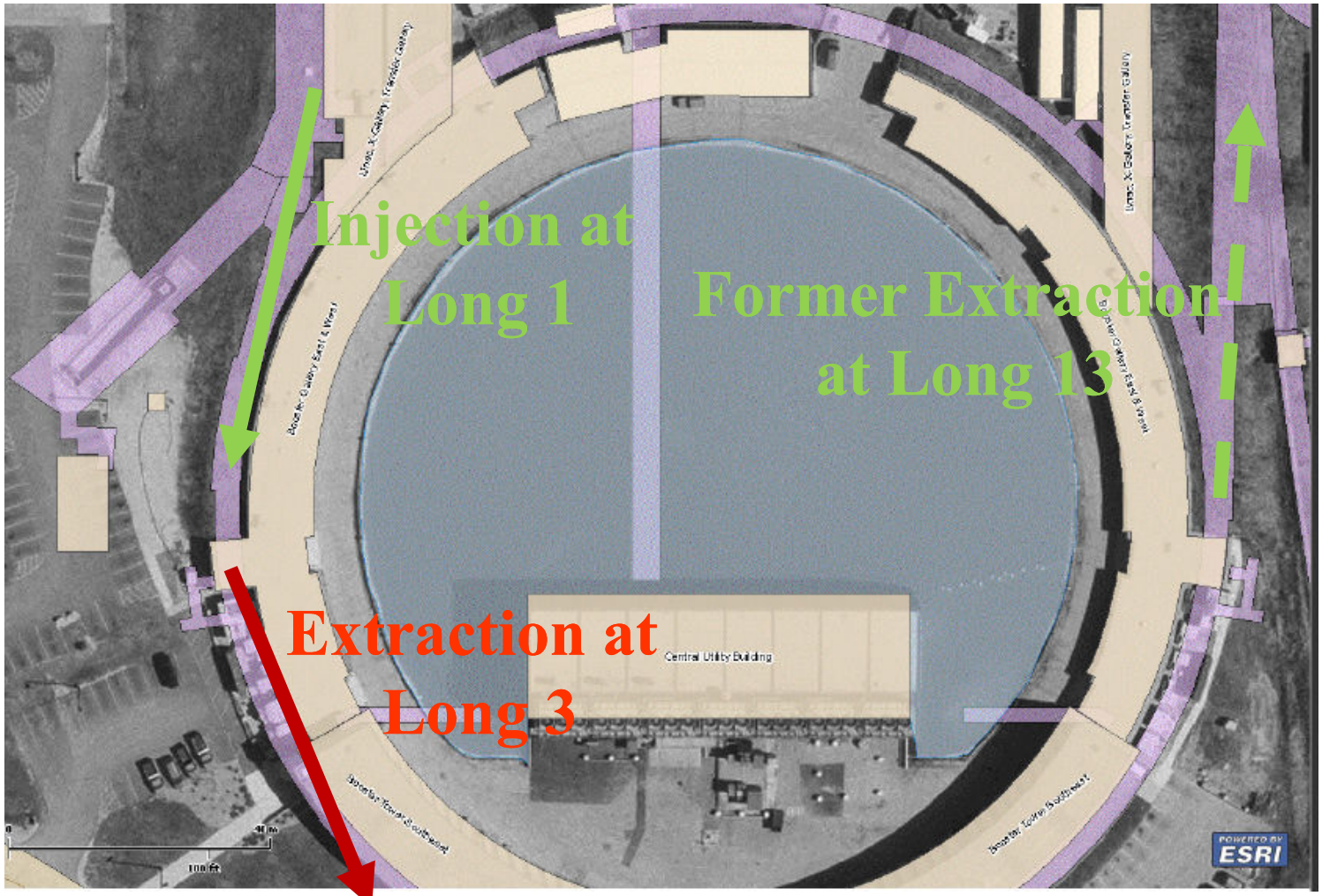
Project X Siting Workshop

Outline

- Booster Lattice
- Injection Insert
- Injection / Extraction Locations
  - All the options
- Booster Shielding

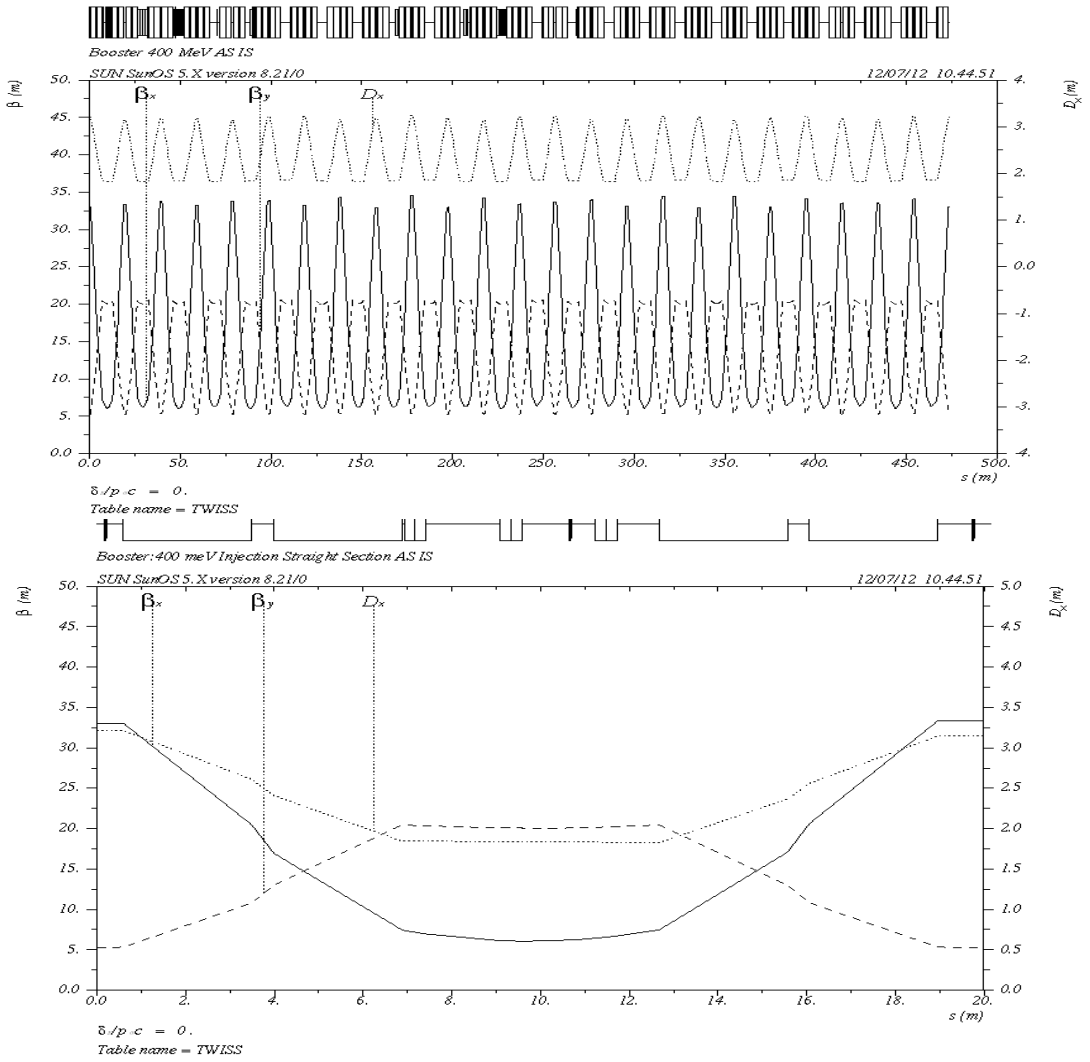
Booster Basics

- 24-fold symmetry



Booster Lattice

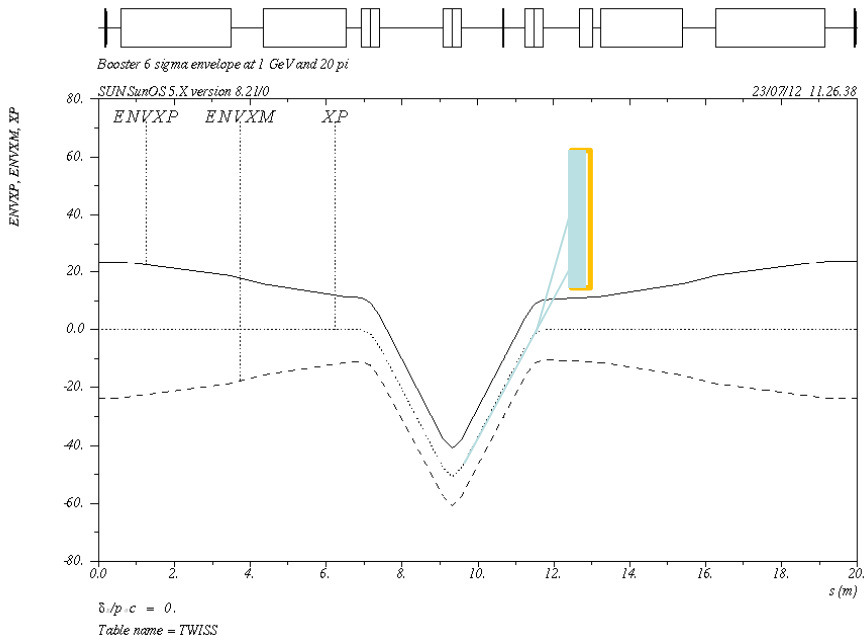
- FOFDOOD Lattice
- Each of 24 periods composed of:
  - 2 F gradient magnets
  - 2 D gradient magnets
  - Short Straight Section “O”
  - Long Straight Section “OO”
- Long straights are, in principle, all capable of injection and extraction
- Many long straights are occupied, but equipment can be moved



Injection Insert

Preliminary report by Dave Johnson

- Tight space for 1 GeV
  - SNS has 12.5 m between quads vs. 6m @ Booster
- Horizontal injection required by magnet geometry and lattice
- Use similar 3-magnet arrangement for injection bump
- Need an absorber for stripped electrons, H^0, H^-
- Proposal: Shorten/strengthen the dipoles surrounding the straight as part of the insert
  - Add space for injection

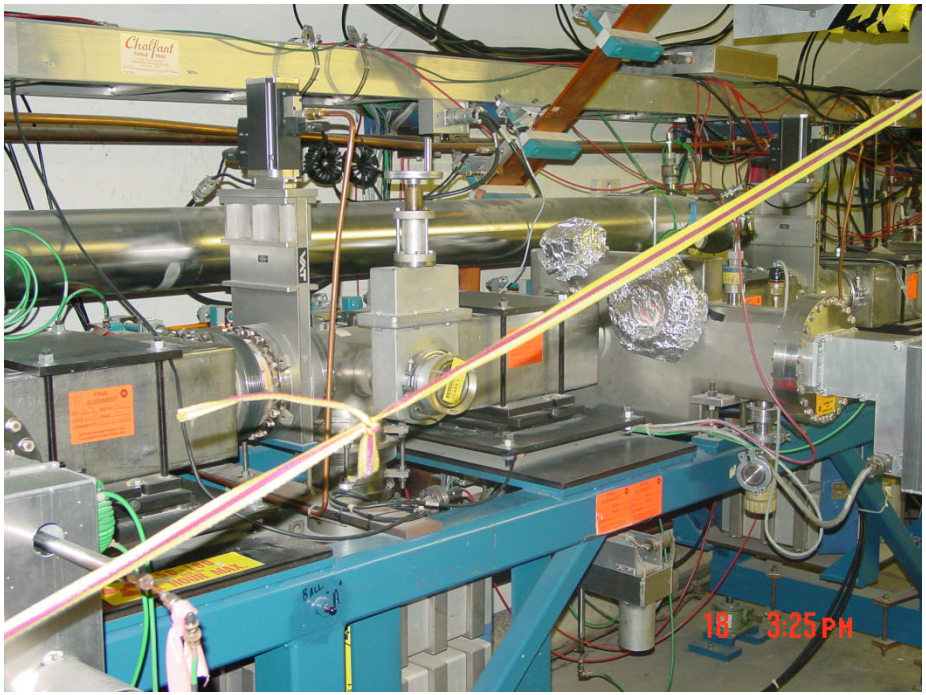


Injection Insert (continued)

- Employ transverse phase-space painting
- Foil heating must be managed
  - Large number of turns (~600) -> numerous secondary foil interactions
  - Probably manageable, but may require advanced foils:
    - Diamond a la SNS
    - Rotating
- Overall, injection looks promising at any long straight from a lattice point of view

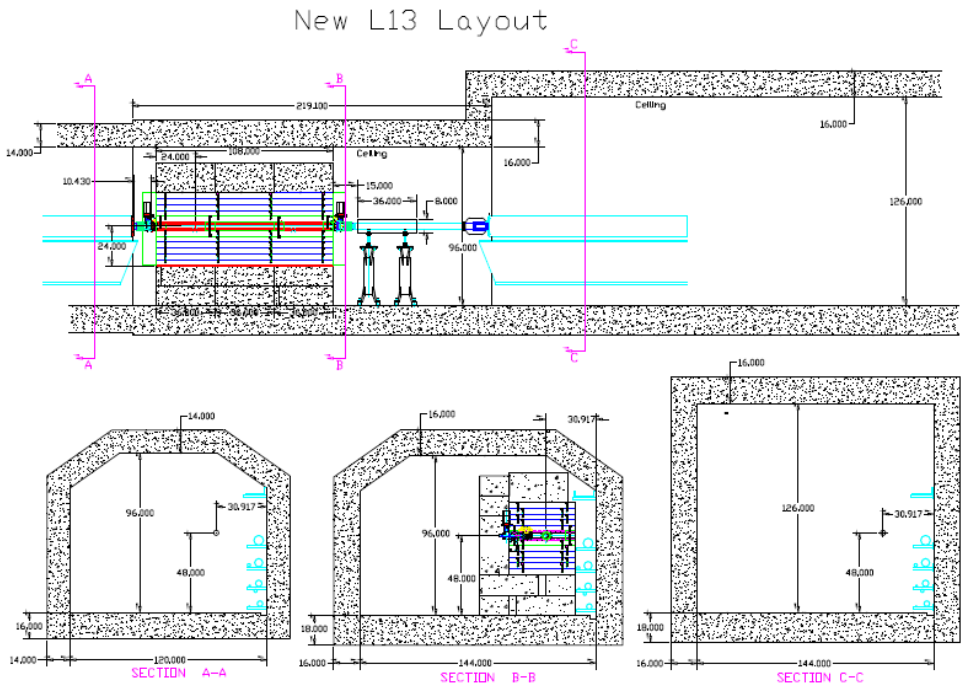
Points of Entry

- Entering through the linac enclosure (Parking-Lot Filler):
  - Can use existing hole and injection period
    - Beamline and insert would have to be replaced
  - Shielding will be an issue



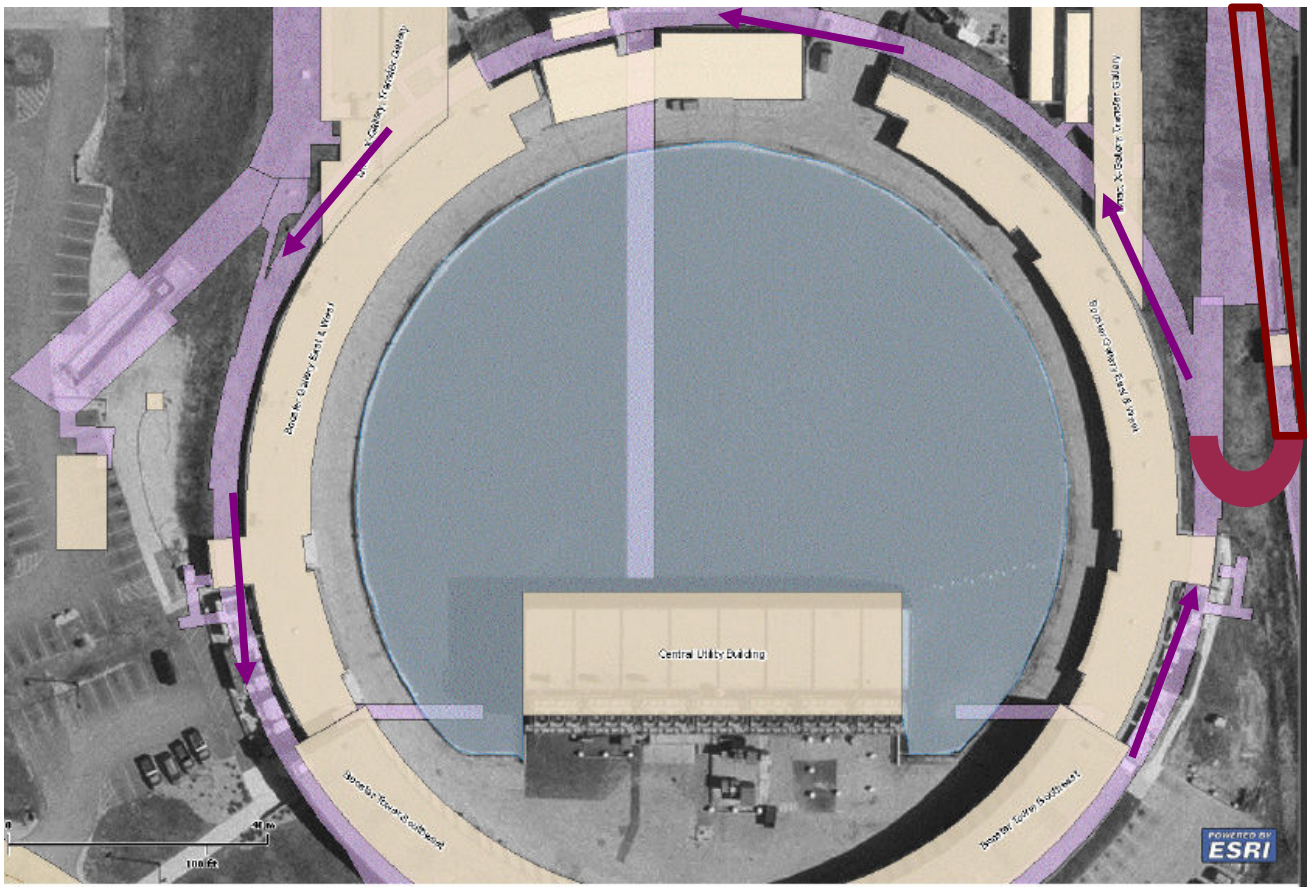
Points of Entry

- Injection from Tevatron tunnel (Paper Clip – from south)
  - Requires a new transfer tunnel into the Booster
- Use old extraction location at Long13
- Long 13 will be occupied by 40 tons of radioactive steel and concrete
  - Not impossible to move



Points of Entry

- Injection from Tevatron/Switchyard (Hook – from north)
  - Part of a previous proposal to site PrX in Transfer tunnel / switchyard
- Also uses Long 13

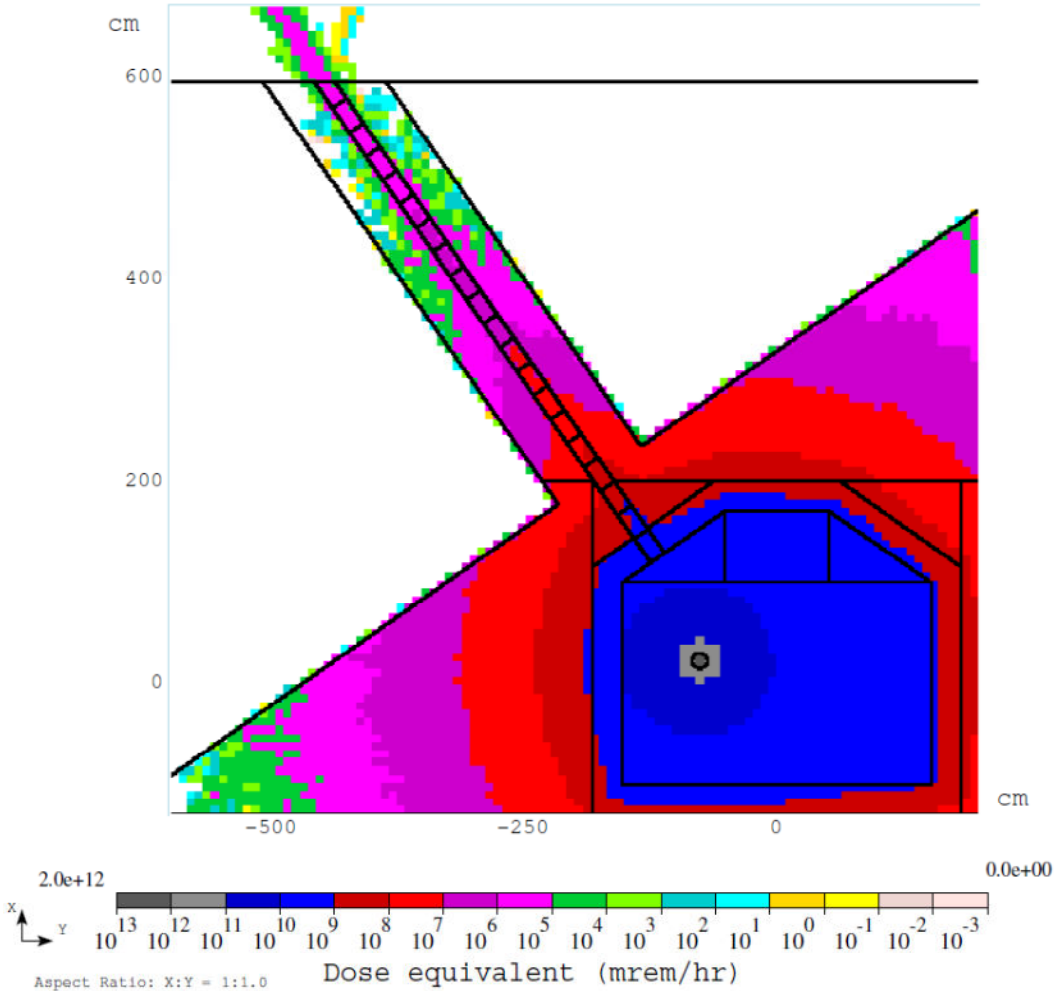


Points of Entry

- Inject directly from North
  - Reverse Booster direction
  - Use old transfer hall
- Extract into Tevatron tunnel going south
- Rejoin MI-8 line further along

Shielding - 1 MW Transfer

- Booster shielding is inadequate
- A lot of work going on to allow our present upgrades to produce beam
  - Max. 80 kW
  - Solutions are not yet agreed upon!
- 1 GeV in Linac hall will require enhanced shielding
- 1 MW transferred though the Booster tunnel is highly suspect
  - 1 GeV at high-power is particularly pernicious because the loss can be very localized
- Extraction location?
  - MI-8 line?
  - Long 13?



Summary

- Solid concept of how to make an injection insertion at 1 GeV
  - Requires modified gradient magnets
  - Foil is the most significant issue
- Various options for injection and extraction
  - All require construction of some sort
- Shielding in Booster is a concern at all levels
  - Injection scheme
  - Transferred beam
  - Accelerated beam

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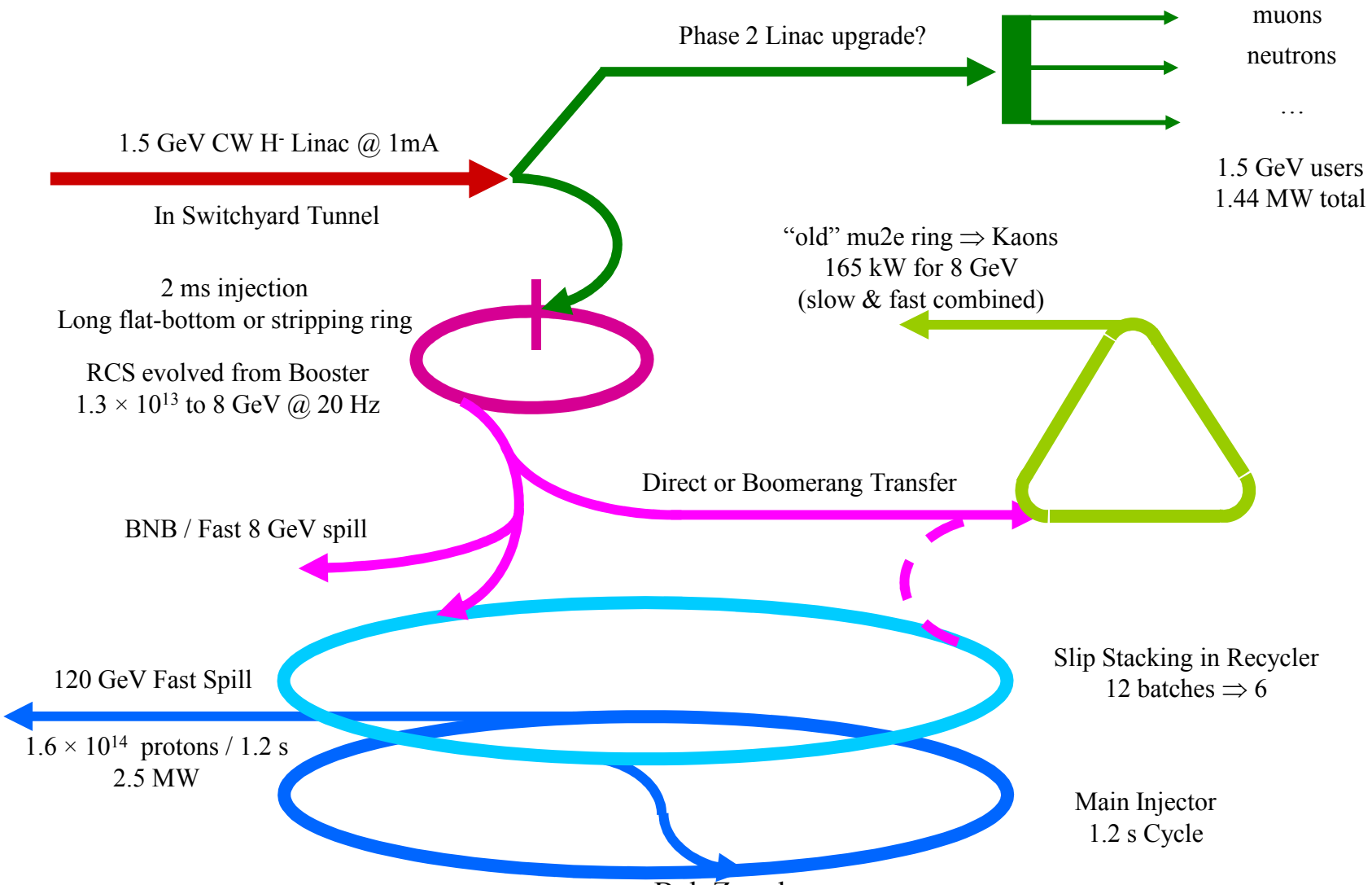
PrX IC-α


Phase 2 Linac upgrade?
muons
neutrons
…
1.5 GeV users
1.44 MW total
1.5 GeV CW H- Linac @ 1mA
In Switchyard Tunnel
"old" mu2e ring ⇒ Kaons
165 kW for 8 GeV
(slow & fast combined)
2 ms injection
Long flat-bottom or stripping ring
RCS evolved from Booster
1.3 × 10^13 to 8 GeV @ 20 Hz
Direct or Boomerang Transfer
BNB / Fast 8 GeV spill
Slip Stacking in Recycler
12 batches ⇒ 6
120 GeV Fast Spill
1.6 × 10^14 protons / 1.2 s
2.5 MW
Main Injector
1.2 s Cycle