IDS-NF Accelerator Working Group Status and Plans

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IDS-NF Plenary Meeting
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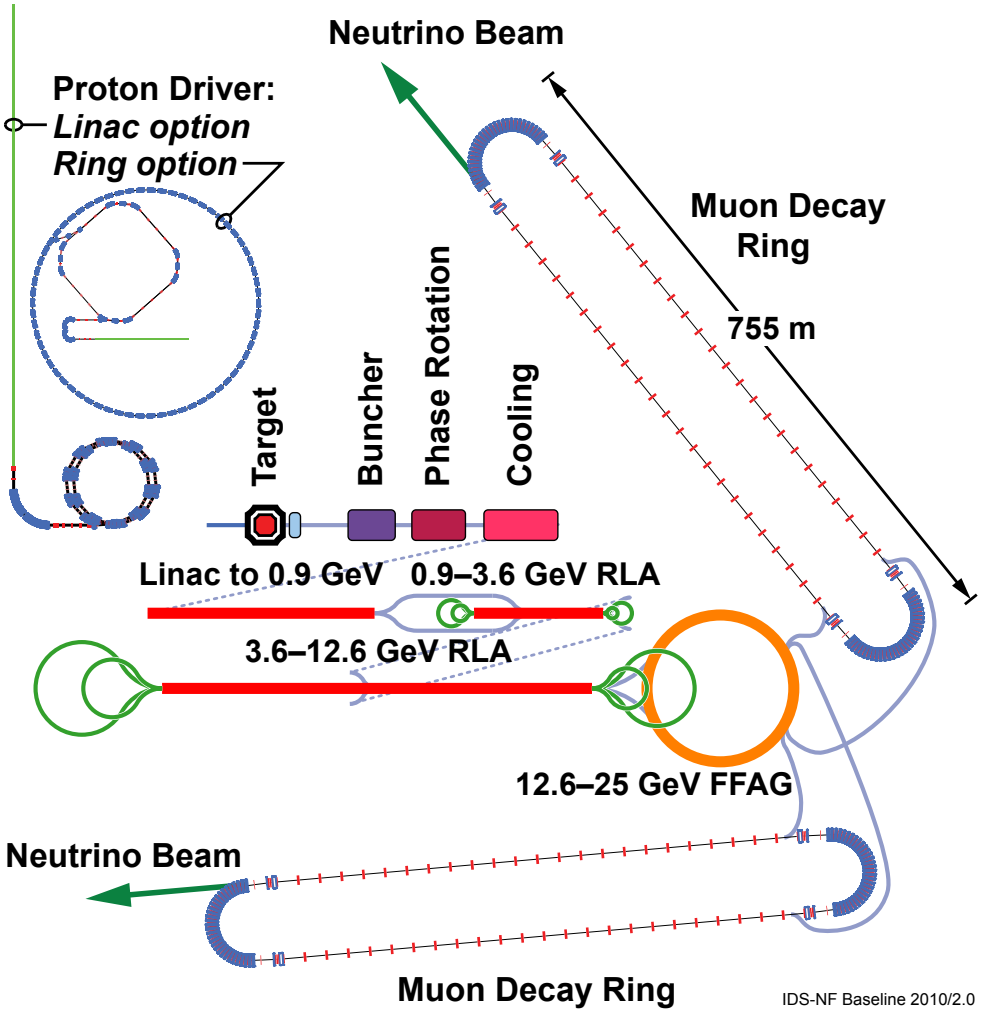
Outline

- Machine overview
- Areas of significant progress
- Goals for this meeting
- Plans for accelerator working group parallel session

IDS-NF Accelerator Overview

- Proton driver, makes protons that hit
- Target, produces pions decaying to muons
- Front end, improves beam phase space distribution
- Acceleration, increases muon energy
- Decay ring, stores muons where they decay to neutrinos, directs them toward detector

Neutrino Factory Complex



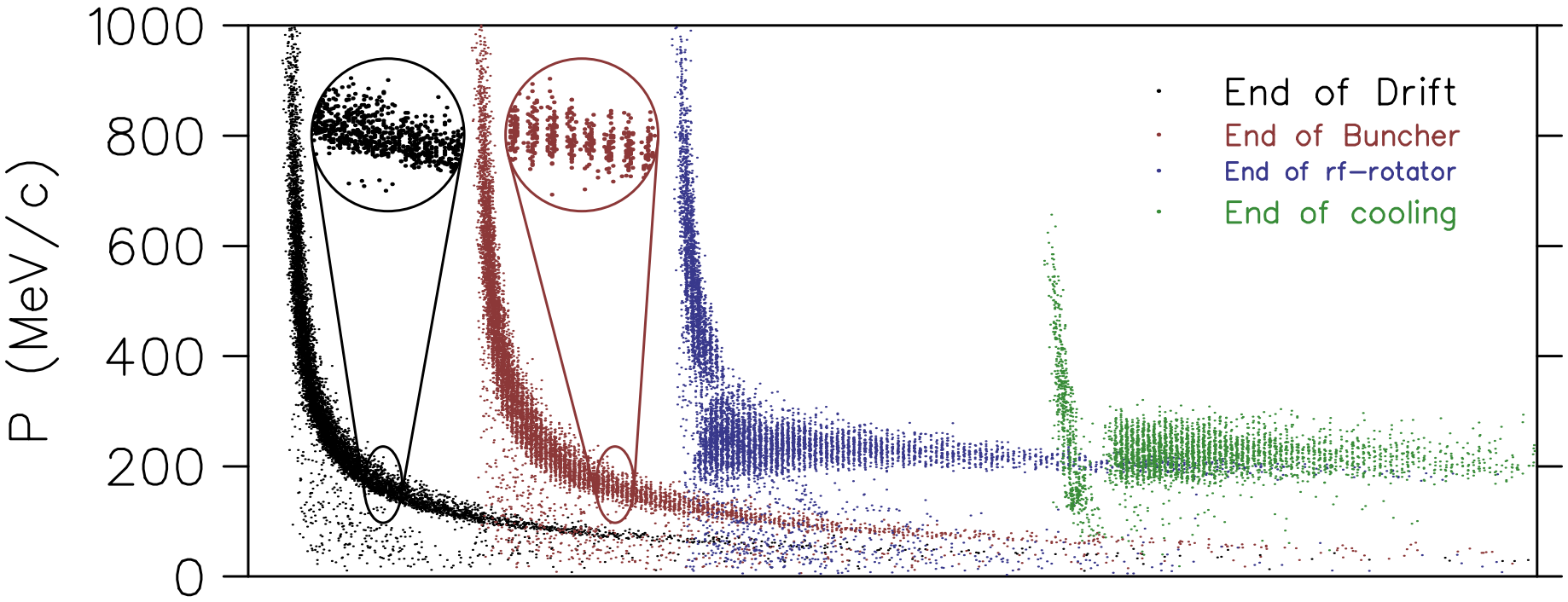
IDS-NF Baseline Accelerator Subsystems

- Proton Driver
  - 4 MW: sufficient flux to get desired muon flux
  - Parameters optimized for capture by front end
  - 50 Hz, 3 bunches, 5–15 GeV, 1–3 ns bunch length
  - Several facility-specific designs
- Target
  - 20 T solenoid capture system
  - Hg jet target

IDS-NF Baseline Accelerator Subsystems

- Front end
  - Constant field (1.5 T) solenoid channel for pions to decay to muons
  - "Neuffer" buncher and phase rotation
    - Create 200 MHz bunch train
    - Reduce large energy spread
  - Transverse ionization cooling channel

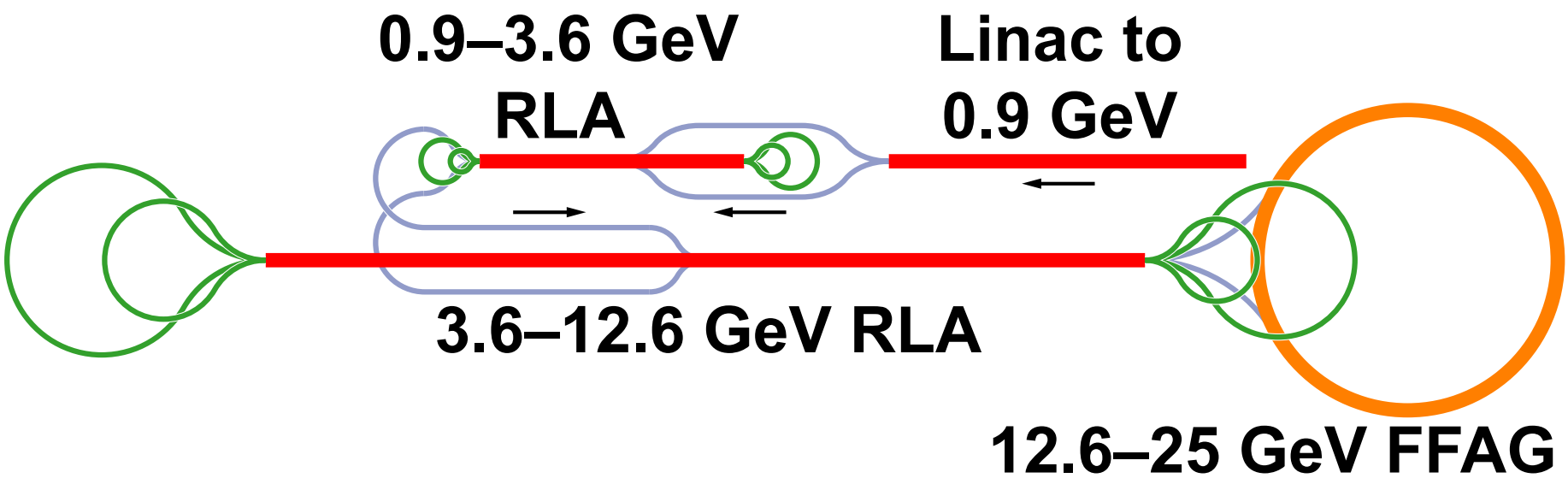
IDS-NF Baseline Accelerator Subsystems



IDS-NF Baseline Accelerator Subsystems

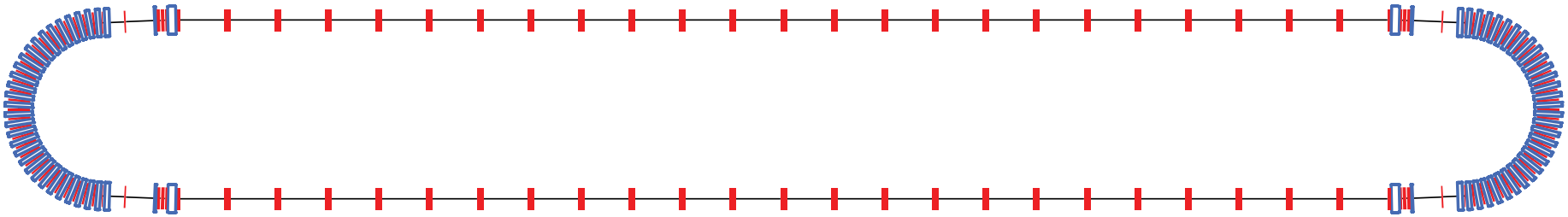
- Acceleration in four stages, 200 MHz SCRF
  - Each stage efficient in its energy range
  - Maximize passes through RF, more difficult at low energies
  - Linac
  - Two recirculating linear accelerators (multiple passes)
  - Fixed field alternating gradient accelerator (more passes, no switchyard)

IDS-NF Baseline Accelerator Subsystems

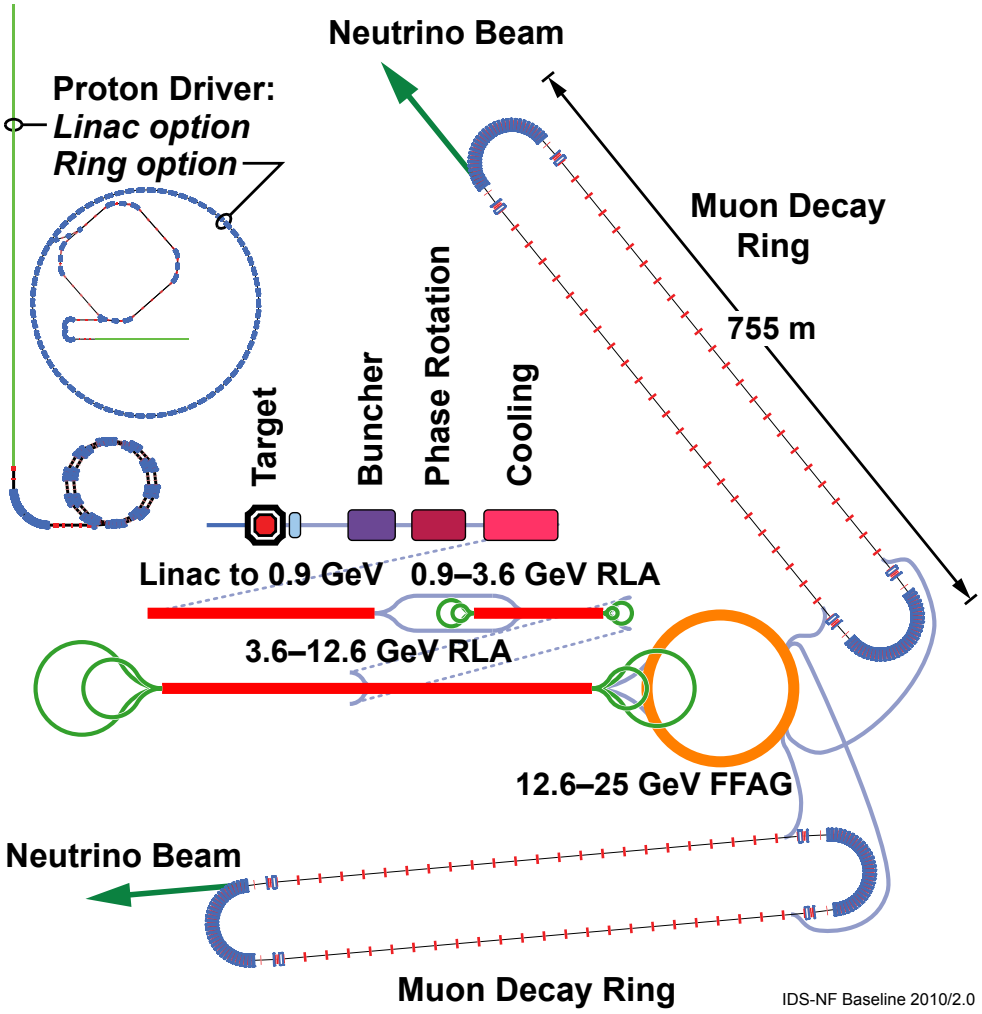


IDS-NF Baseline Accelerator Subsystems

- Two 25 GeV racetrack-shaped decay rings
  - Two detector baselines: 3000–5000 km, 7000–8000 km
  - Racetrack maximally flexible
  - In-ring diagnostics for current, energy and its distribution (polarimeter)



Neutrino Factory Complex



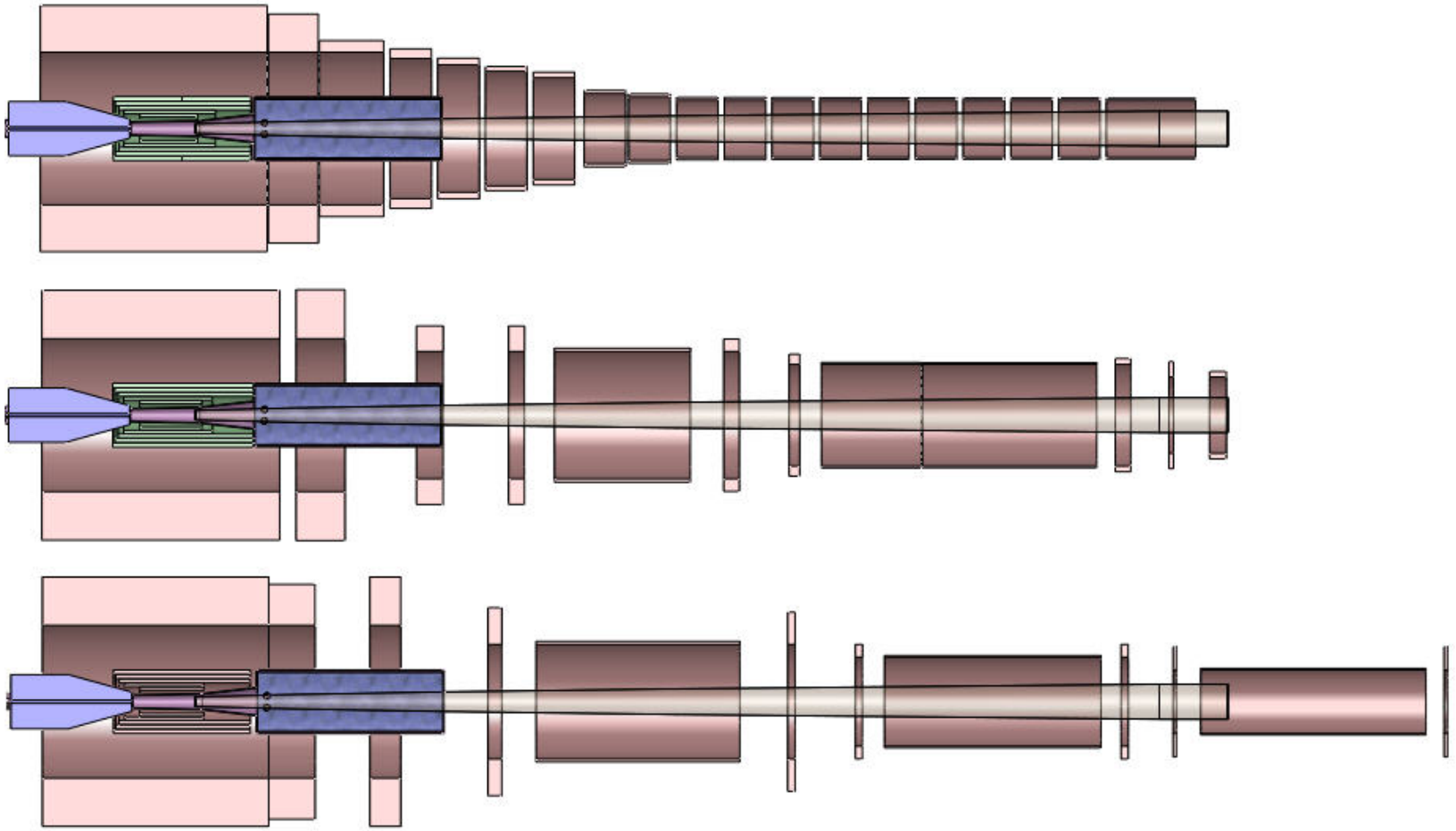
Areas of Significant Progress

- Improved solenoid capture system design, more space for radiation shielding
- Chicane at beginning of front end to localize particle loss
- New linac/RLA designs with improved acceptance
- Significant progress on costing (later talks)
- Other areas of steady progress toward finalizing design

Target

- Energy deposition in SC solenoids too high in earlier design
- Reconfigured solenoids to enable better shielding
  - Larger aperture solenoids near target
- Subsequent reconfiguration to make space for cryostats
- Significant engineering on solenoids

Target



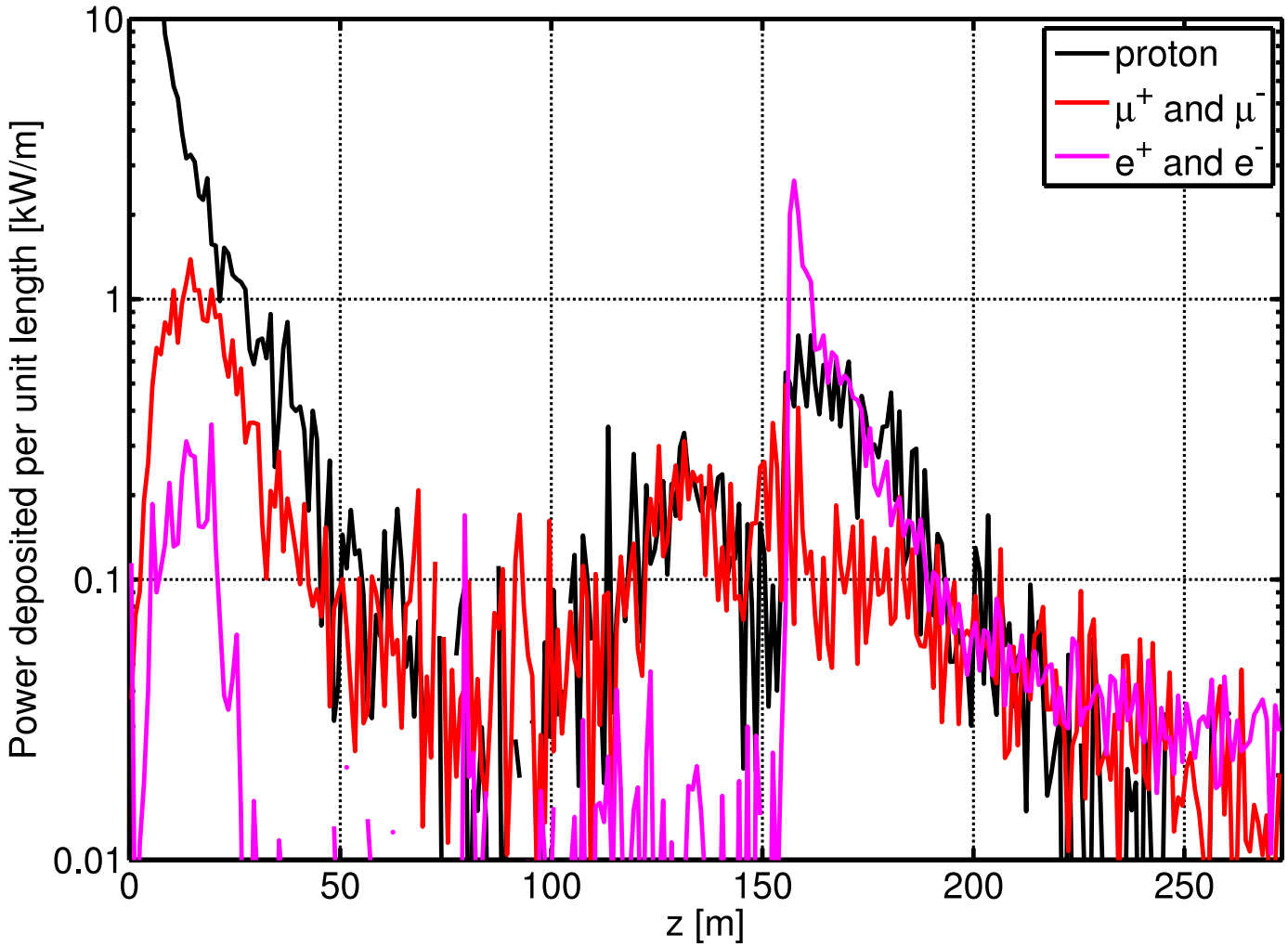
Target

- Important work needed to reach RDR
  - Design of mercury circulation system
  - Layout of target hall
  - Design of remote handling systems
  - Final focus of proton beam to target
- Some resources for this committed at US side, but likely not enough

Front End

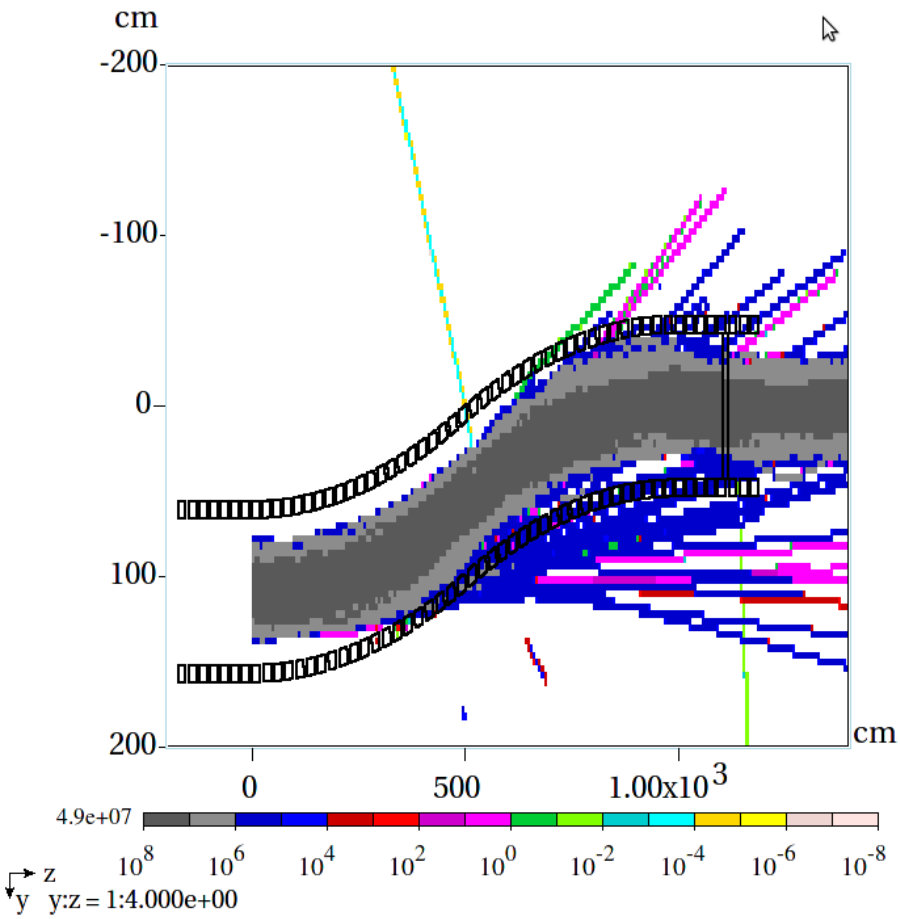
- Energy deposition in front end a significant problem
- Address with a chicane and absorber
  - Chicane bends only lower energy particles
    - High energy particles deposit energy in well-defined location
  - Absorber after chicane stops lower energy undesirables
  - Good performance, some modest loss ($\approx 20\%$)
  - Some lattice modifications required
- Engineering has identified layout issues, may require significant lattice modifications

Front End

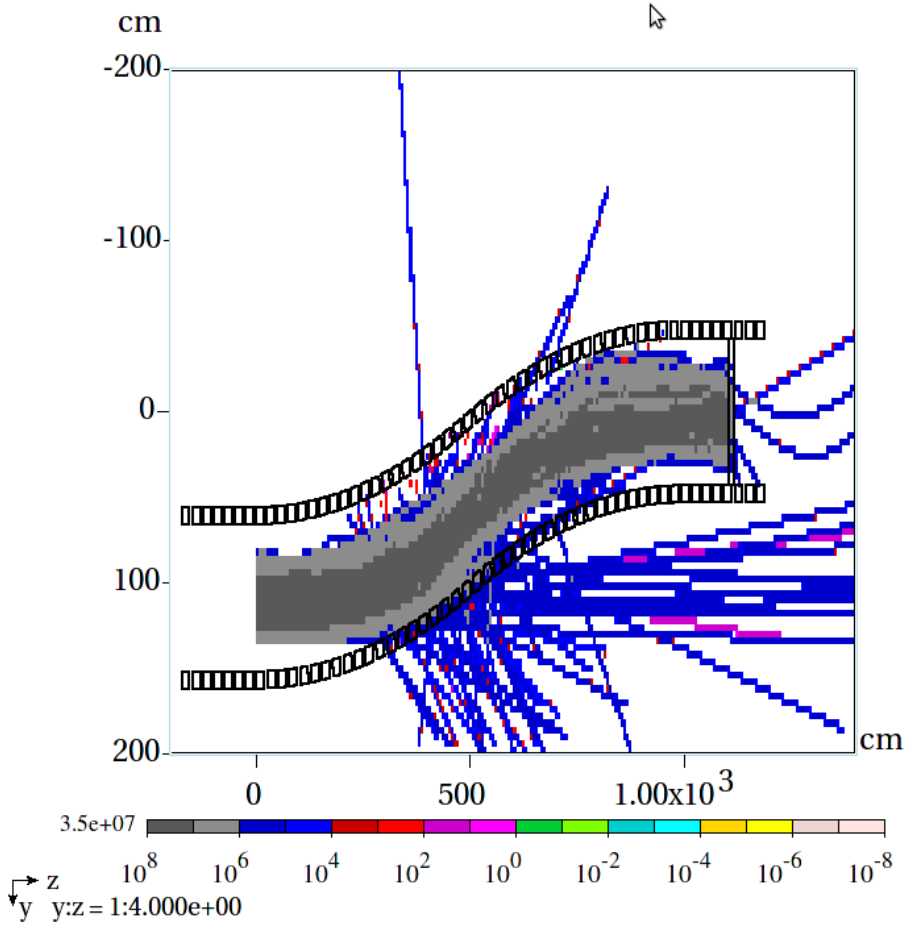

10
1
0.1
0.01
0
50
100
150
200
250
z [m]
Power deposited per unit length [kW/m]
proton
μ+ and μ-
e+ and e-

Front End

Muons



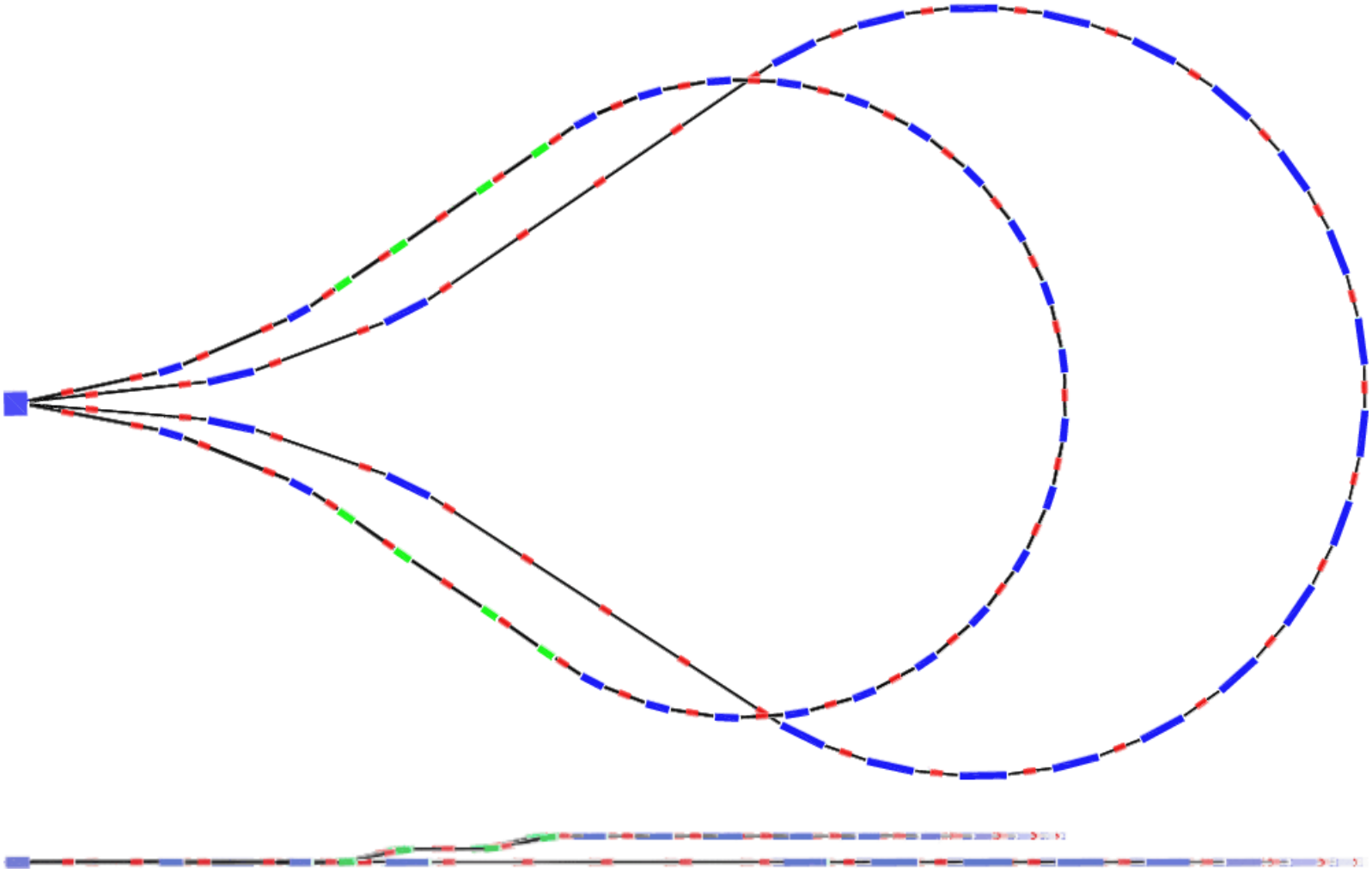
Protons



Low Energy Acceleration

- Updated designs of linac and first RLA
  - Larger transverse acceptance in linac and first RLA
  - Improved handling of arc crossings
  - New matching sections requiring less chromatic correction
- More effort needed here
  - Completion of lattice designs
  - 6-D tracking beginning to end
    - Expect transverse/longitudinal coupling issues similar to those in FFAG
    - Matching of distributions between parts
  - Layout of the lattice

Low Energy Acceleration



Goals for the Accelerator Working Group

- Make decisions on straightforward baseline changes
  - These should be easy decisions
  - New solenoid configuration near target
  - Use a chicane to localize front end particle loss
  - New linac/RLA configuration
- Deal with large θ_{13}
  - Decide new accelerator configuration
  - Plan work to implement

Goals for the Accelerator Working Group

- Plan out a process for major baseline changes
  - Dropping target field to 15 T
  - When to take a snapshot of the target configuration
  - New cooling lattice to reduce magnetic fields on cavities
    - Particular consideration given to a bucked coil lattice
  - Modifying cooling lattice in light of engineering design
- Review of the costing
  - Ensure lattice designers get information to engineers
  - Ensure engineering constraints get fed back to lattice designers
  - Determine where we need engineering resources

Cooling Lattice Update

- Biggest item to discuss after large θ_{13}
- RF cavities break down at lower RF gradients when in magnetic fields
- Precise limitations not well-understood at this time
- One proposed solution appears to have good performance while magnetic fields at cavities: bucked coil lattice
  - Review status of solution
  - Look at other solutions
  - Propose plan to come to a decision on adoption

Accelerator Working Group Session Outline

- Status reports of subsystems
- Review of "easy" baseline updates
- Discussion of planning process and timeline for major baseline updates
  - Not generic
  - Specific time allocated for discussion of specific updates
  - Updates selected which are likely needed and/or have a recognized benefit
- Planning acceleration modifications for large θ_{13}
- Discussion of costing needs
- Short talks on very low energy neutrino factory

Large θ_{13}

- In accelerator working group, decide how to modify the machine to take into account large θ_{13}
- By end of this plenary, we need to know what to do
- Expect simply a new energy and baseline choice
- Or do we cut our losses?
  - Best machine looks nothing like IDR, go back one step
  - Give up entirely
- Difficult to see a luminosity-upgradable scenario achieving any real cost reduction for a first stage

Summary

- Progress on significant issues in IDS-NF
  - New solenoid configuration to reduce energy deposition
  - Chicane to confine energy deposition in front end
  - Update low energy acceleration scheme
  - Everything else moving along nicely as well
- Some major lattice modifications need to be discussed
  - In particular changes for large θ_{13}
  - Other areas, motivated by engineering and physics challenges
- The RDR is coming up soon! Time to panic!