Infield ERL Upgrade Option

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December 13, 2006

Outline

- Constraints/Boundary Conditions
- Impact Minimization
- Utilities/General Layout
- Machine Layout
- Injection/Extraction options
- Conclusions

Infield ERL: Constraints/Boundary Conditions

- An infield ERL must supply beam to existing APS beamlines
- No significant interruption of 5000 hour/year operations
- Preserve stored beam operation with top-up
- Smooth transition to ERL operation
- Infield space is at a premium
- Recirculation will be required to reach 7 GeV

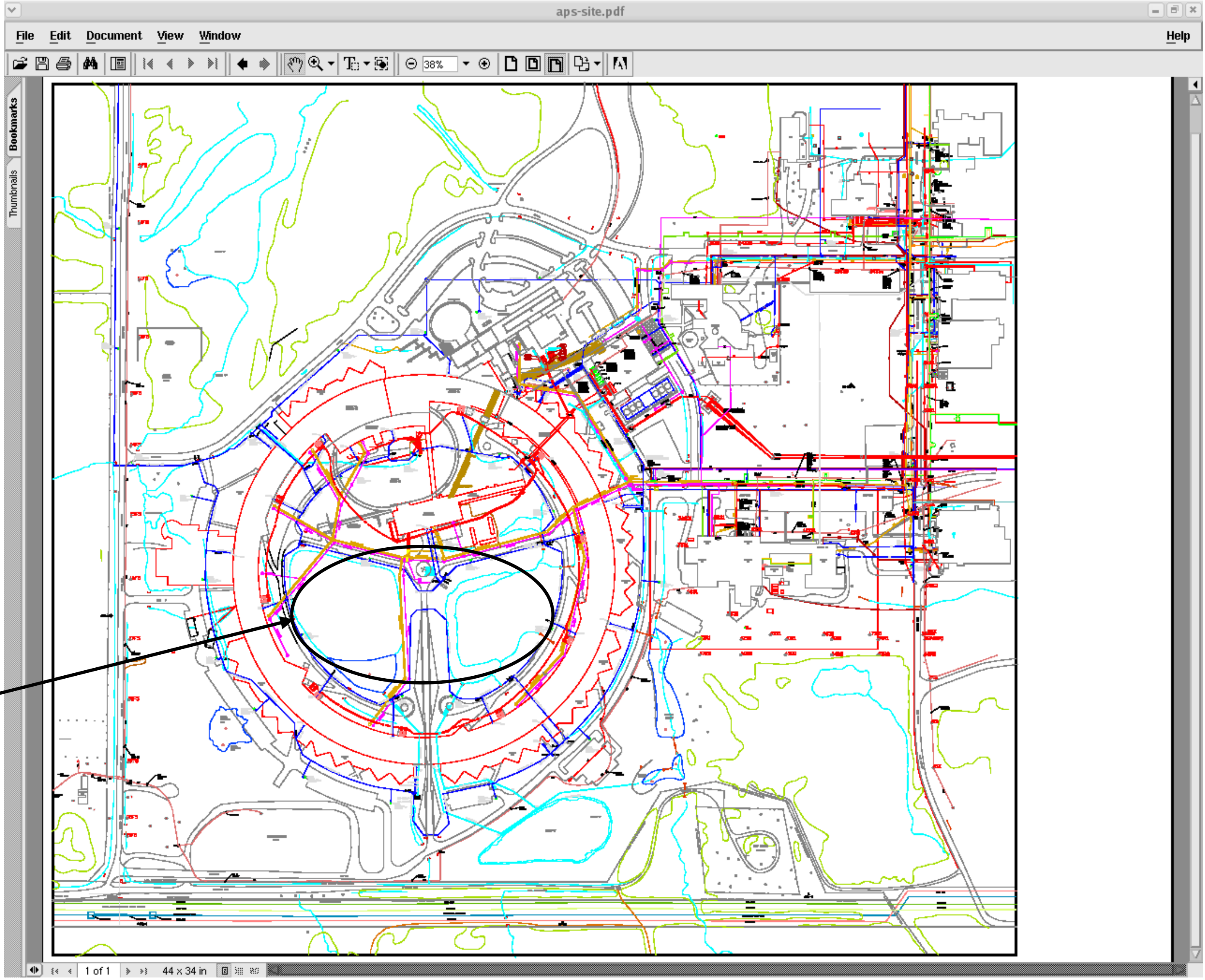
Infield ERL: Impact Minimization

- Infield ERL should minimize environmental concerns
- Minimize interference with existing injector complex
- Minimize interference with other infrastructure/buildings
- Keep transport line bending radii large enough to minimize CSR/ISR emittance growth
- Some utilities may have to be relocated as well as some existing building structures

Infield ERL: Utilities/General Layout

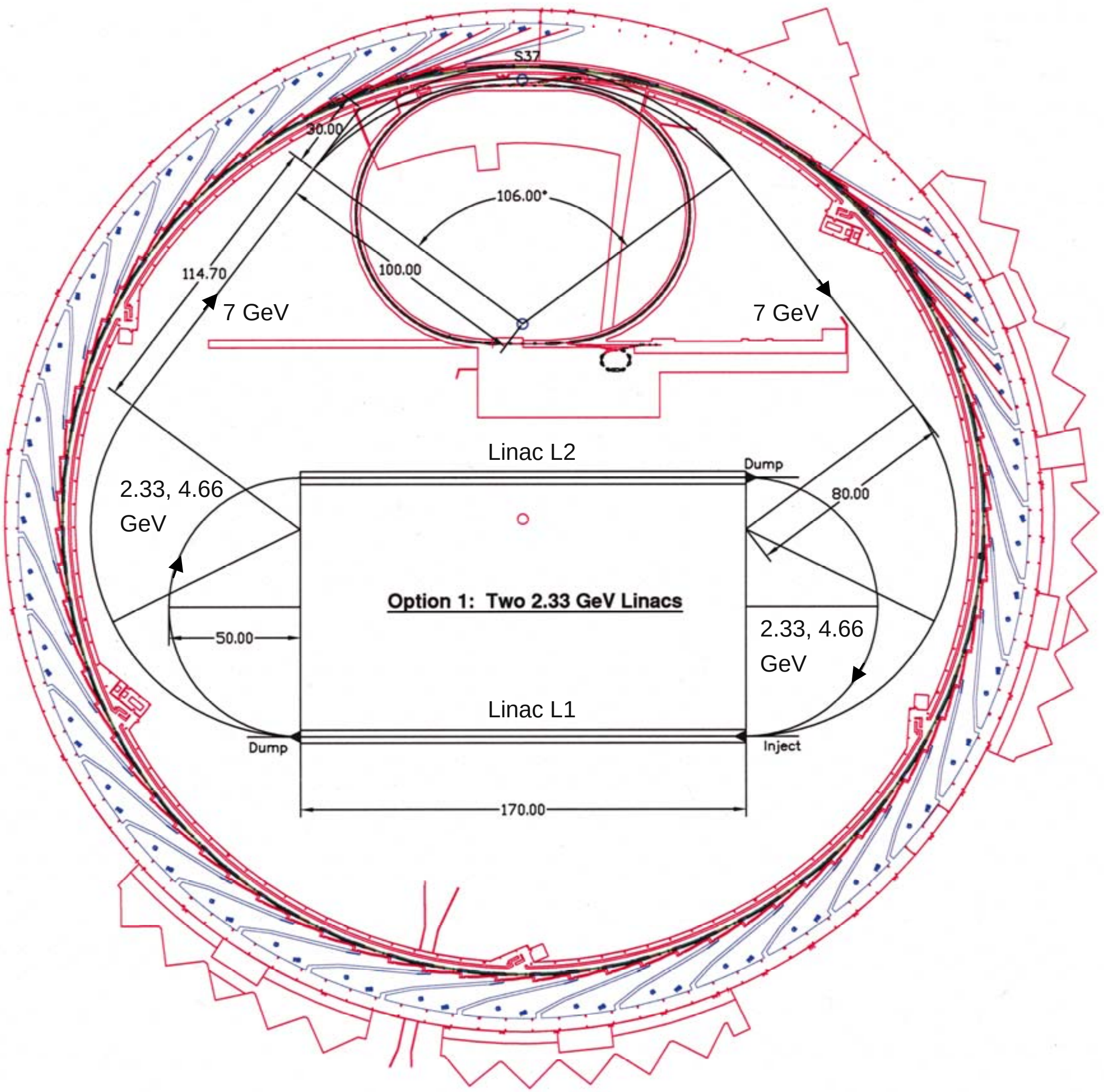
- Dark Gold: DI H20
- Cyan: Storm H20 piping
- Red: Electrical
- Dark Blue: Domestic H20
- Gold/White: Sanitary Sewer
- Magenta: Lab sewer

- Put ERL racetrack in this general area



Infield ERL: Layout Option 1

- Two 2.33 GeV Linacs
- Four low energy recirculation arcs connecting linacs L1 and L2
  - Two at 2.33 GeV
  - Two at 4.66 GeV
- Inject/extract into sector 37
- Can commission energy recovery without disturbing users



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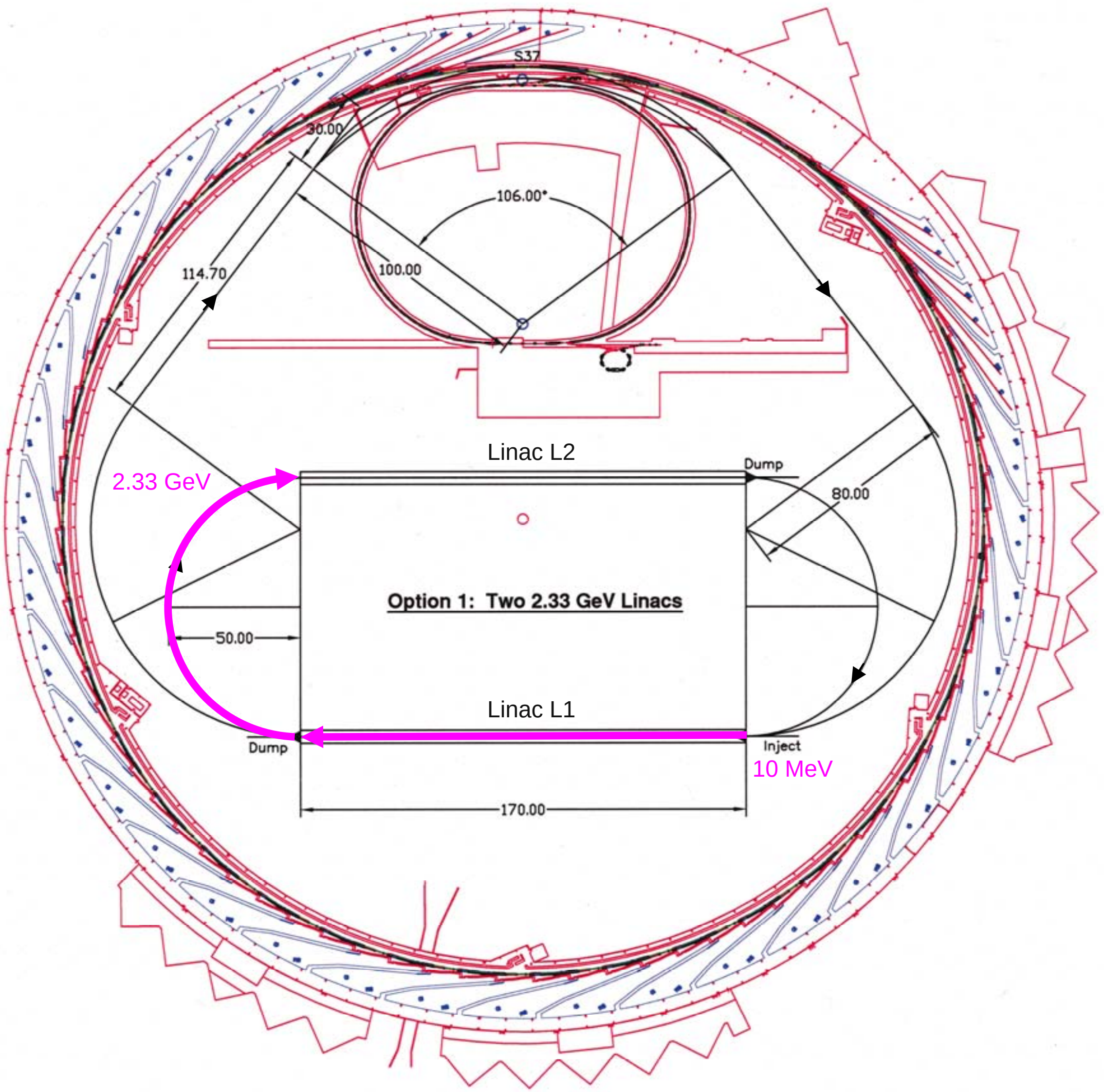

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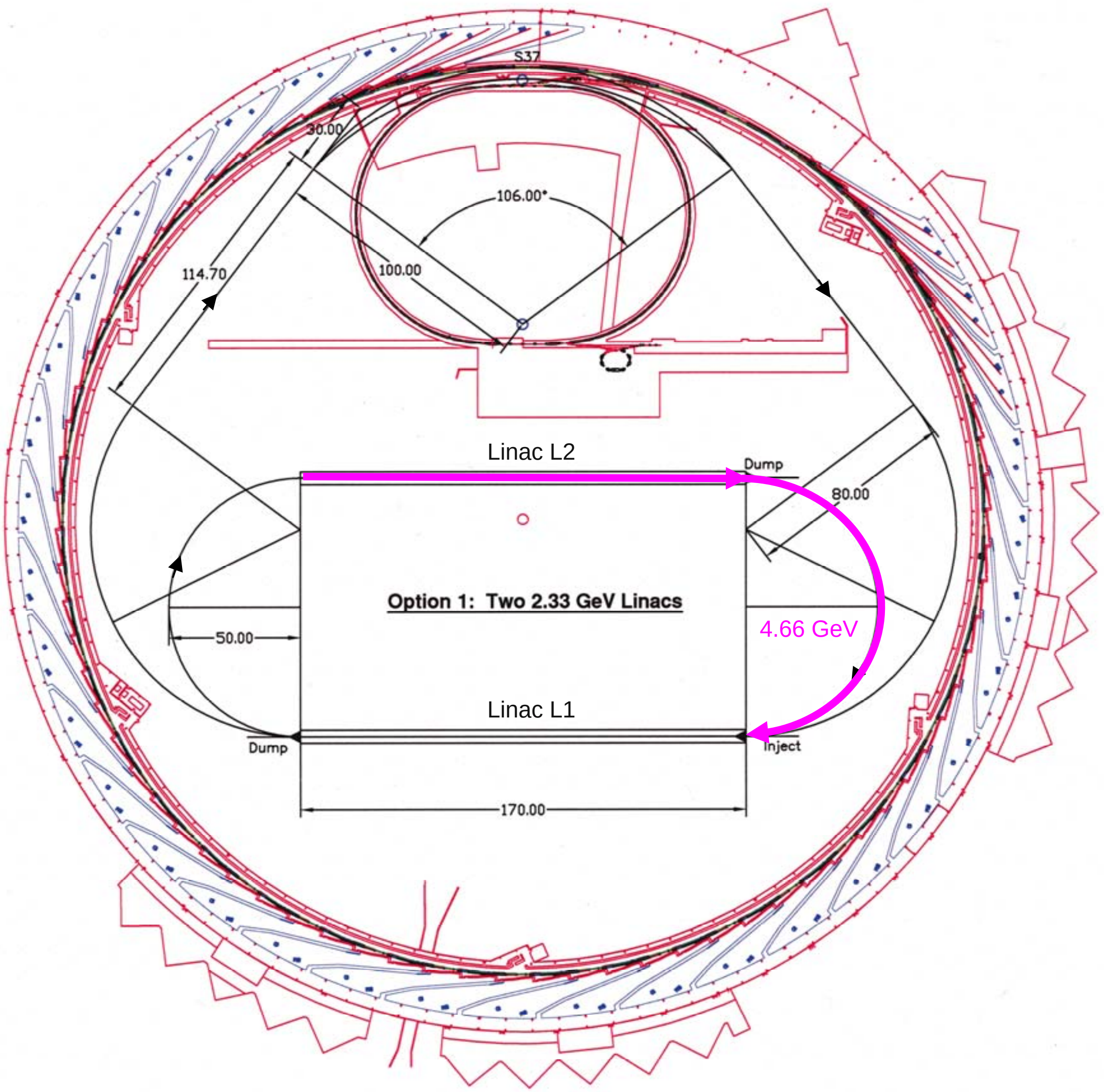

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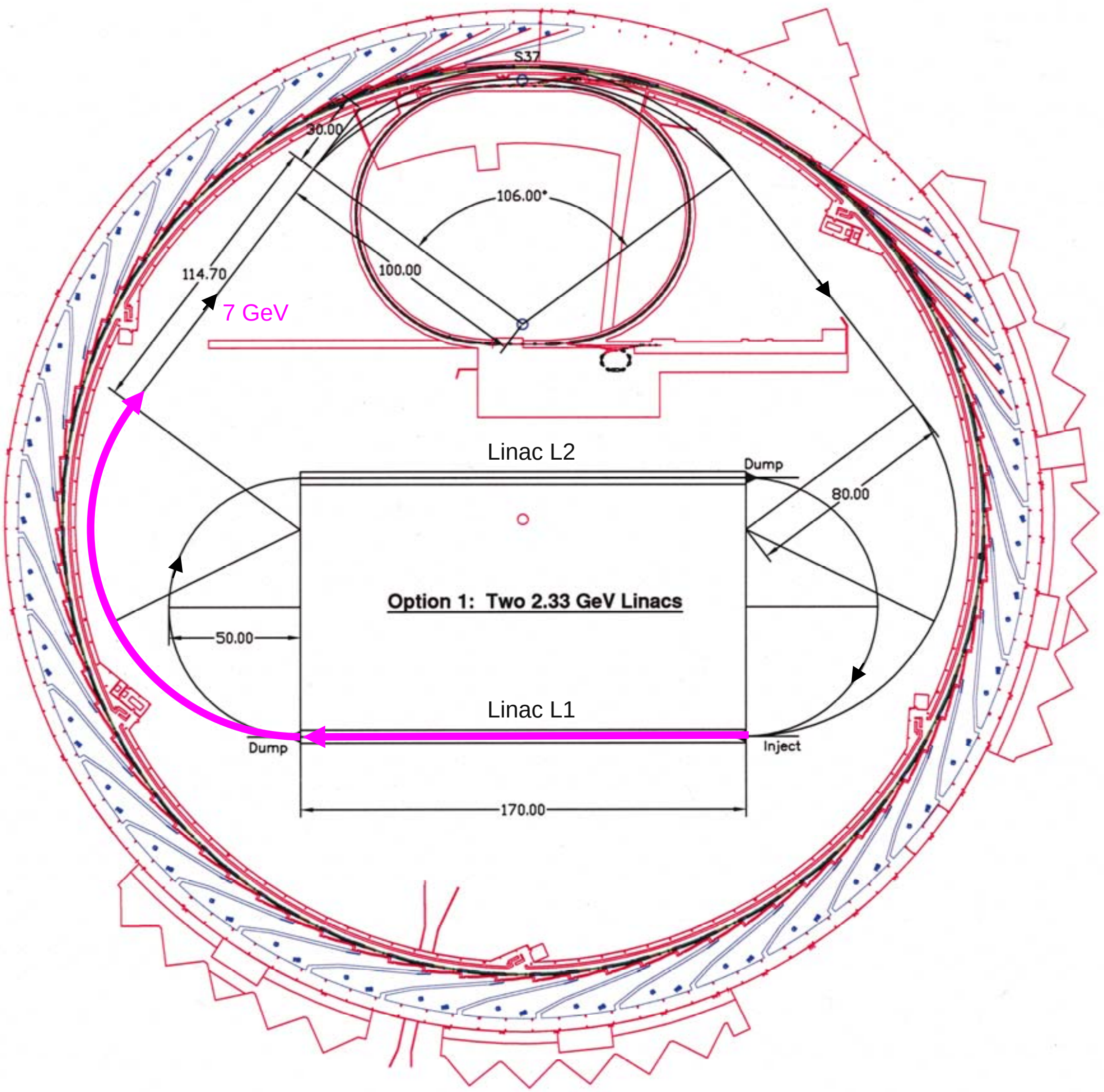

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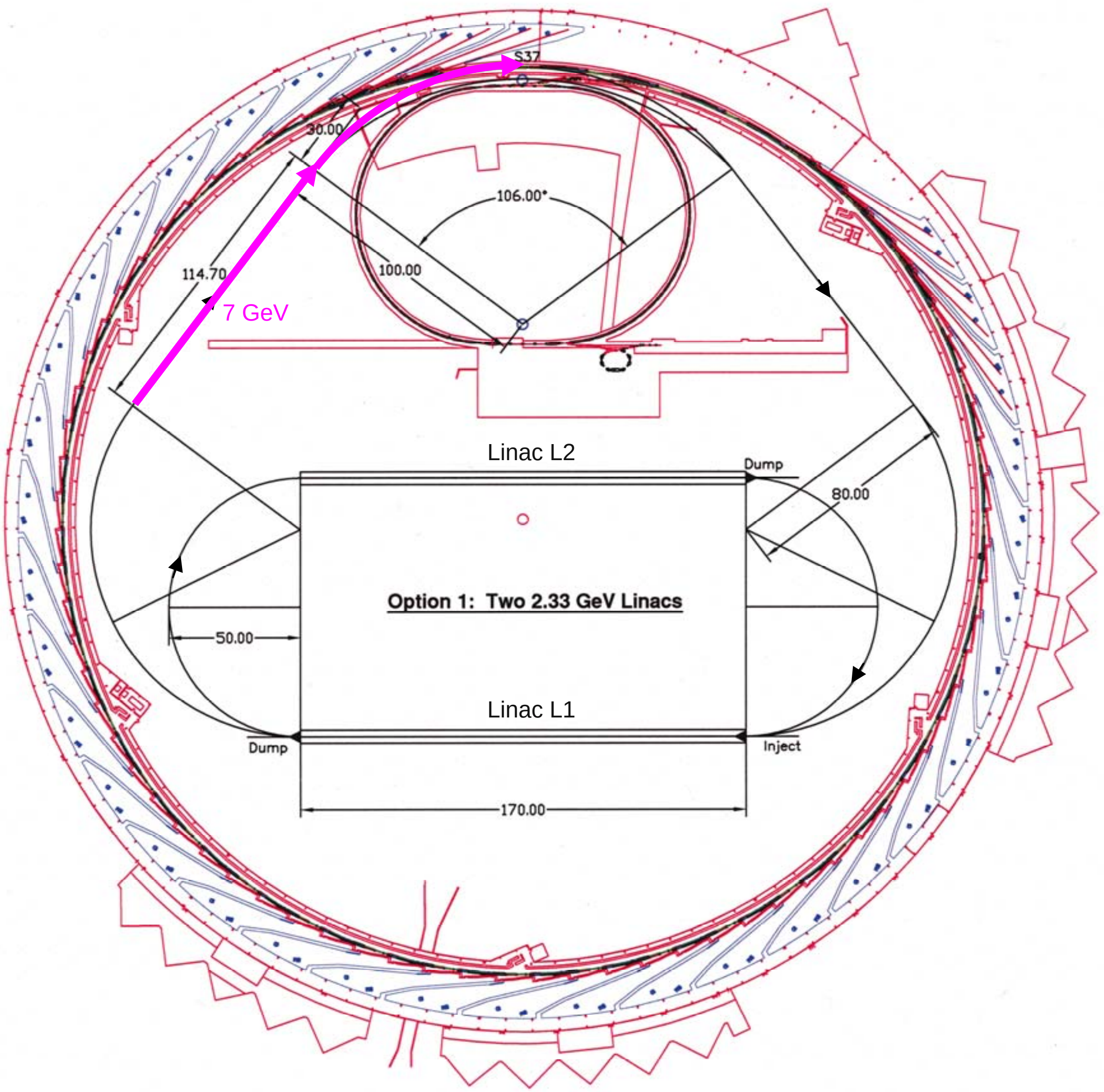

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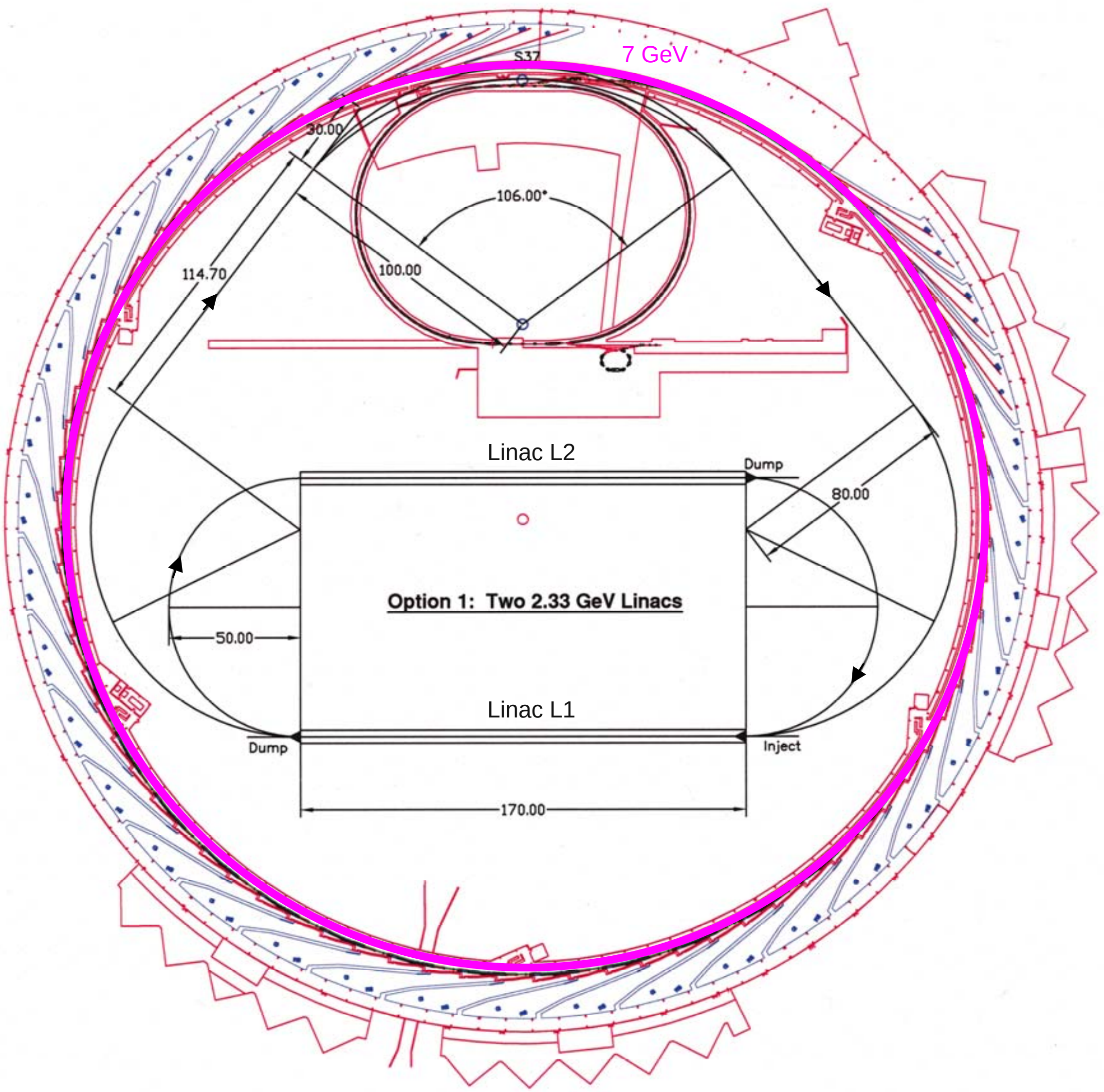

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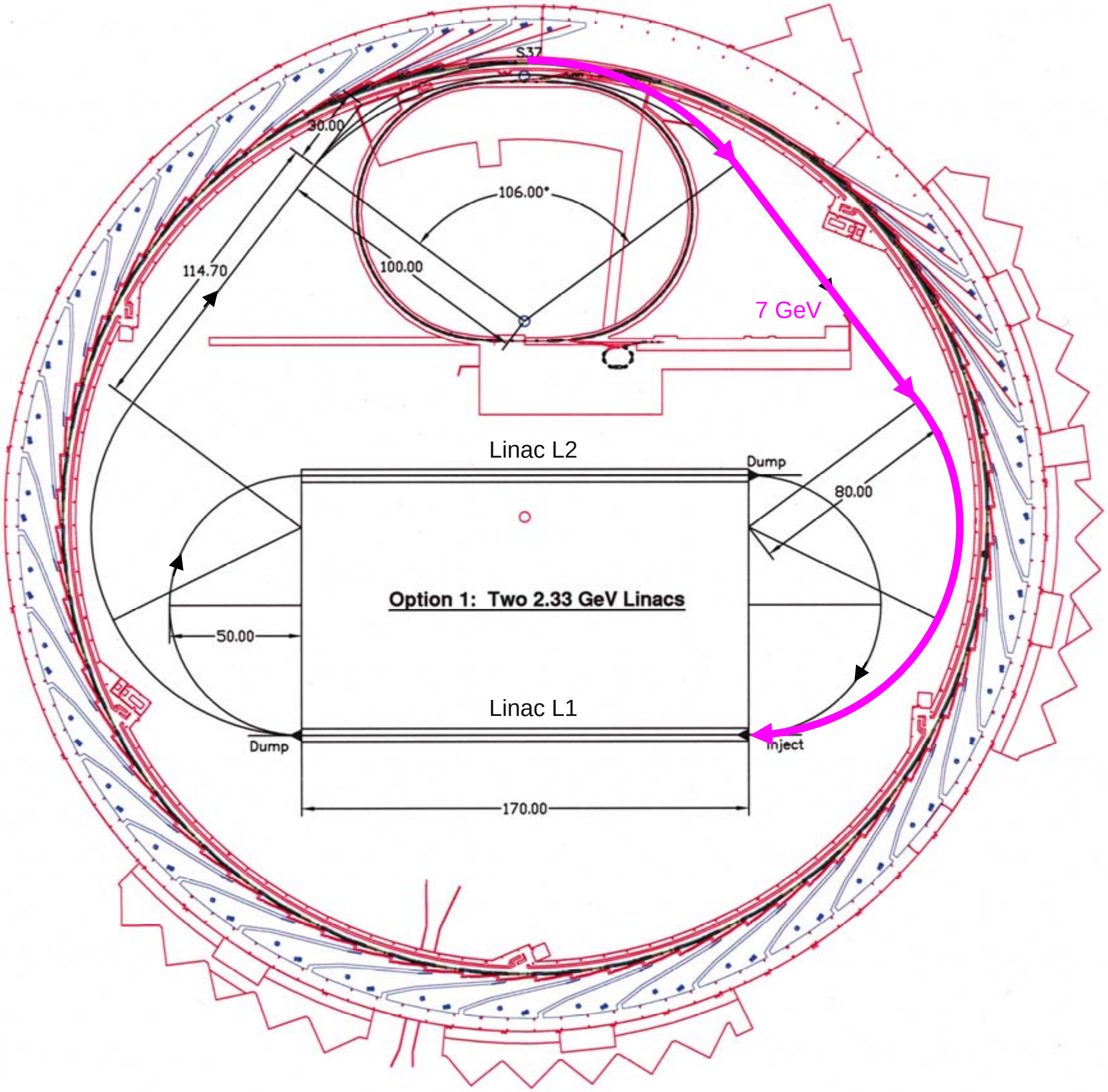

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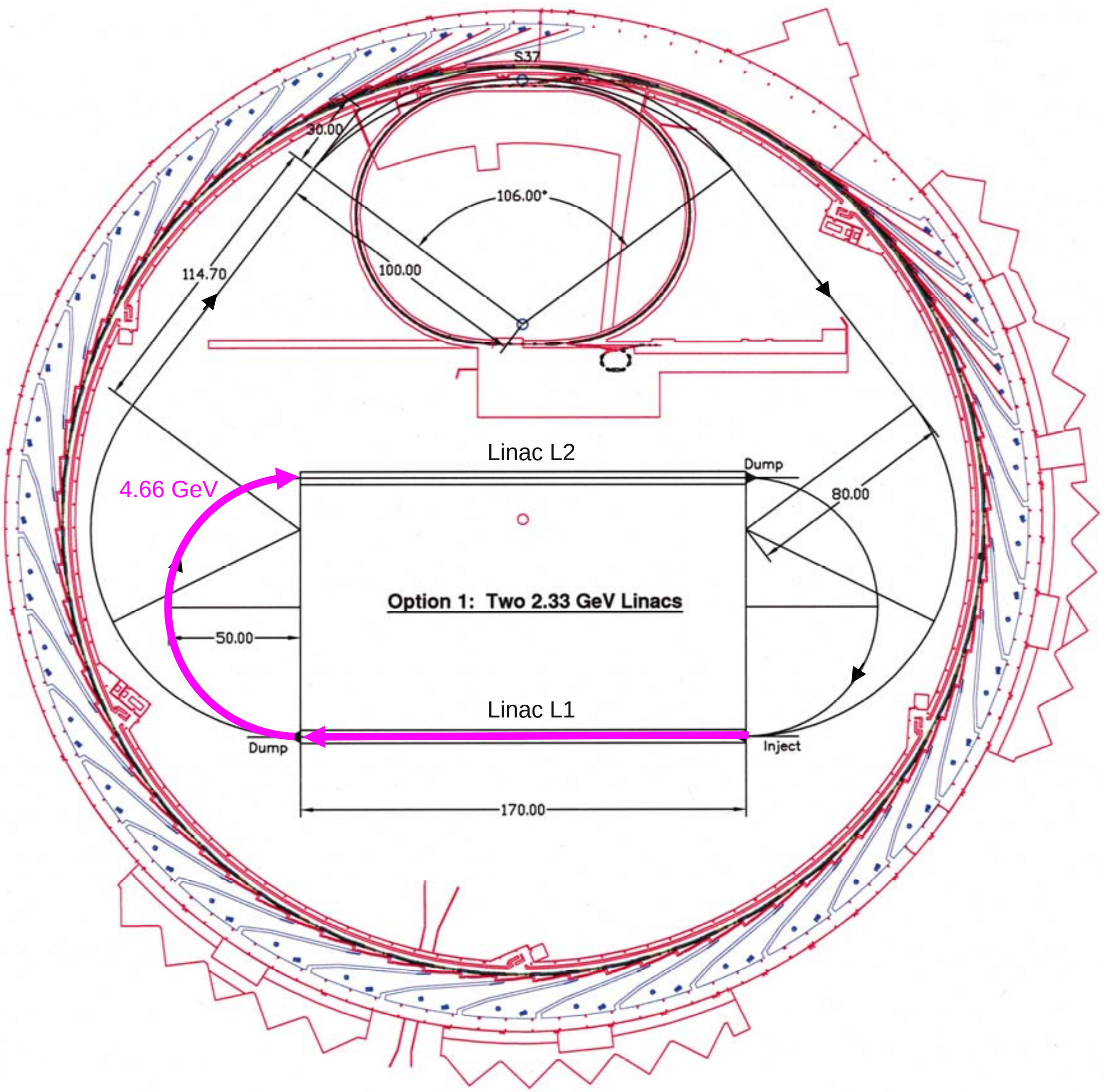

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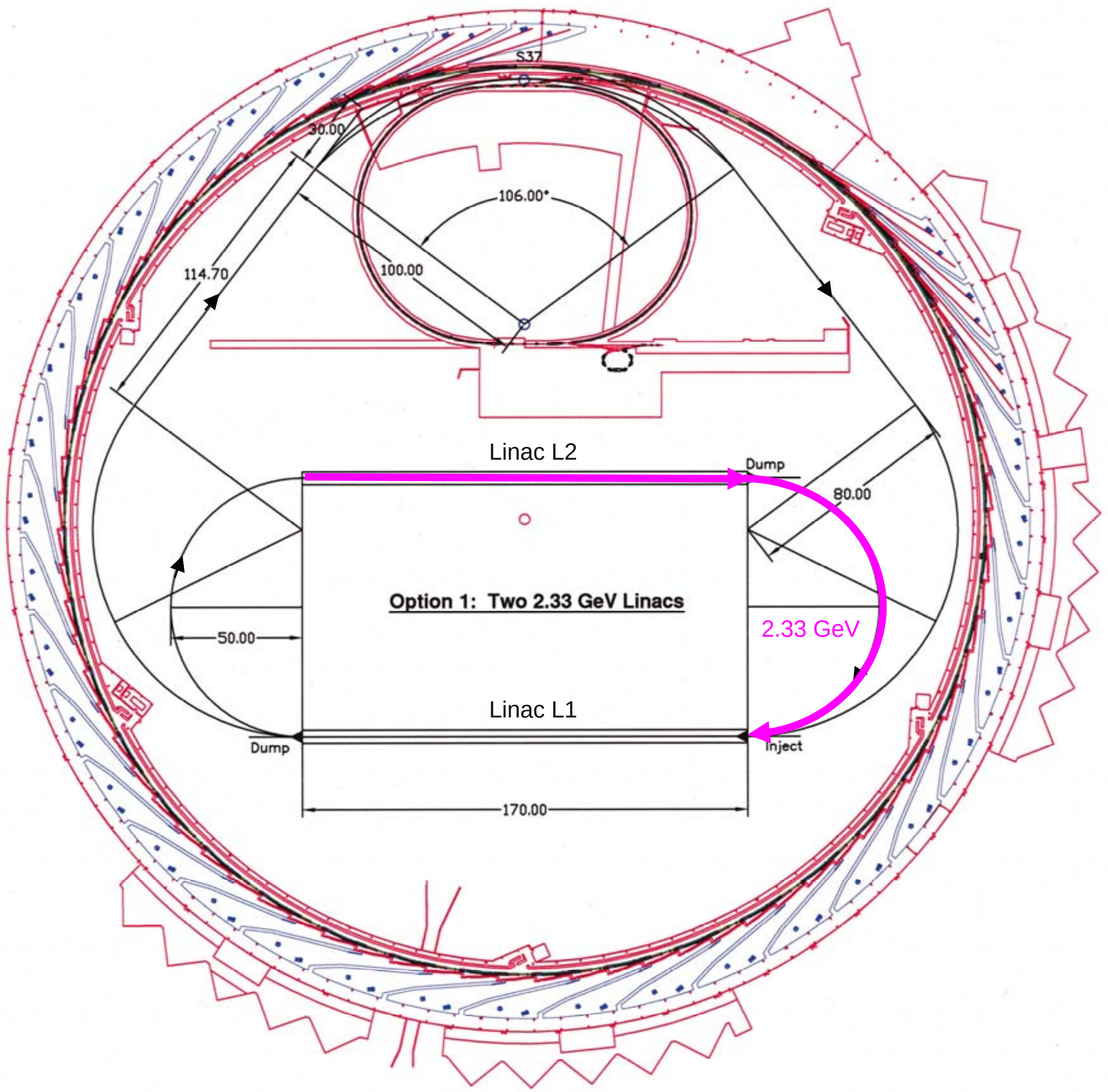

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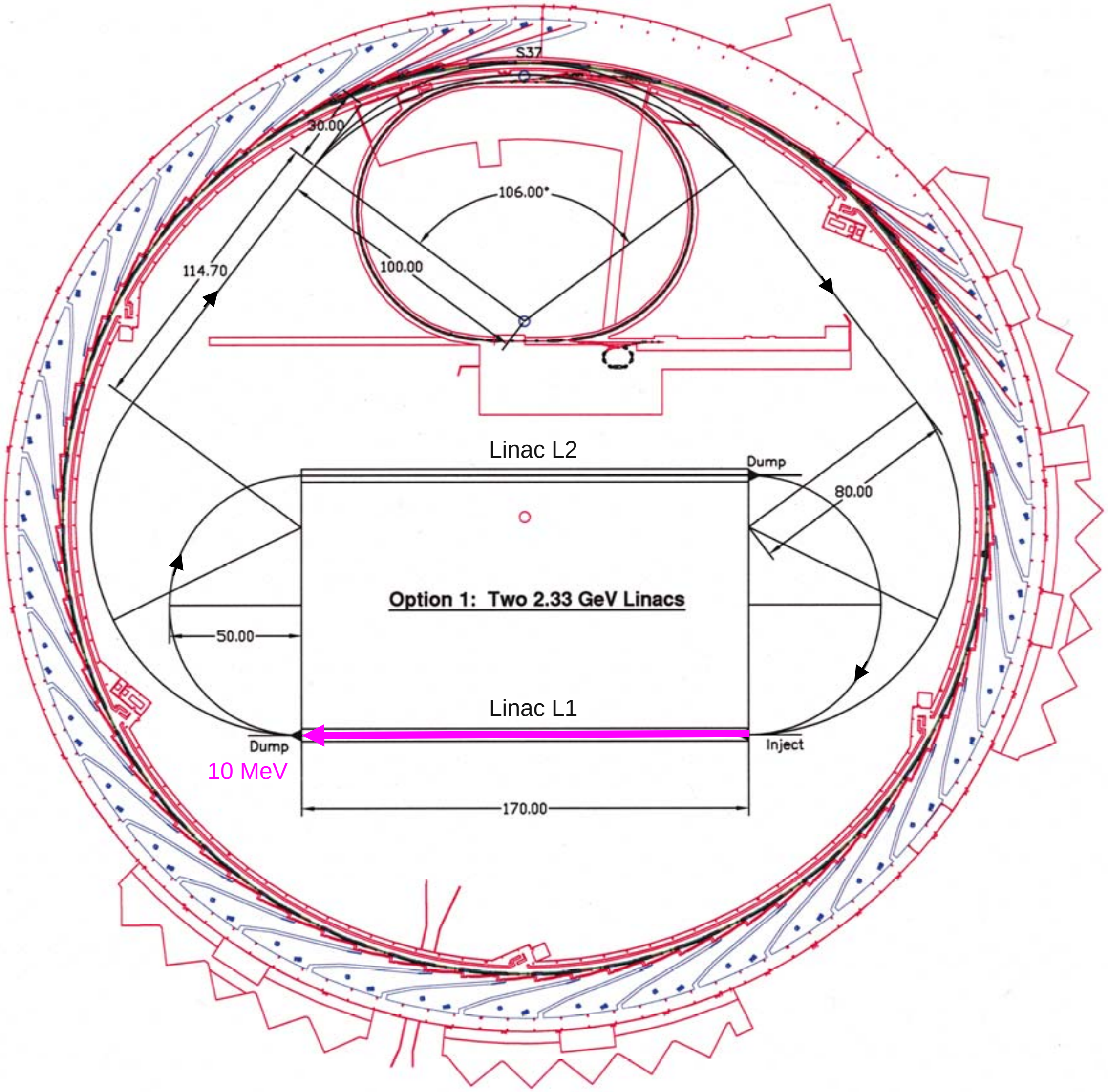
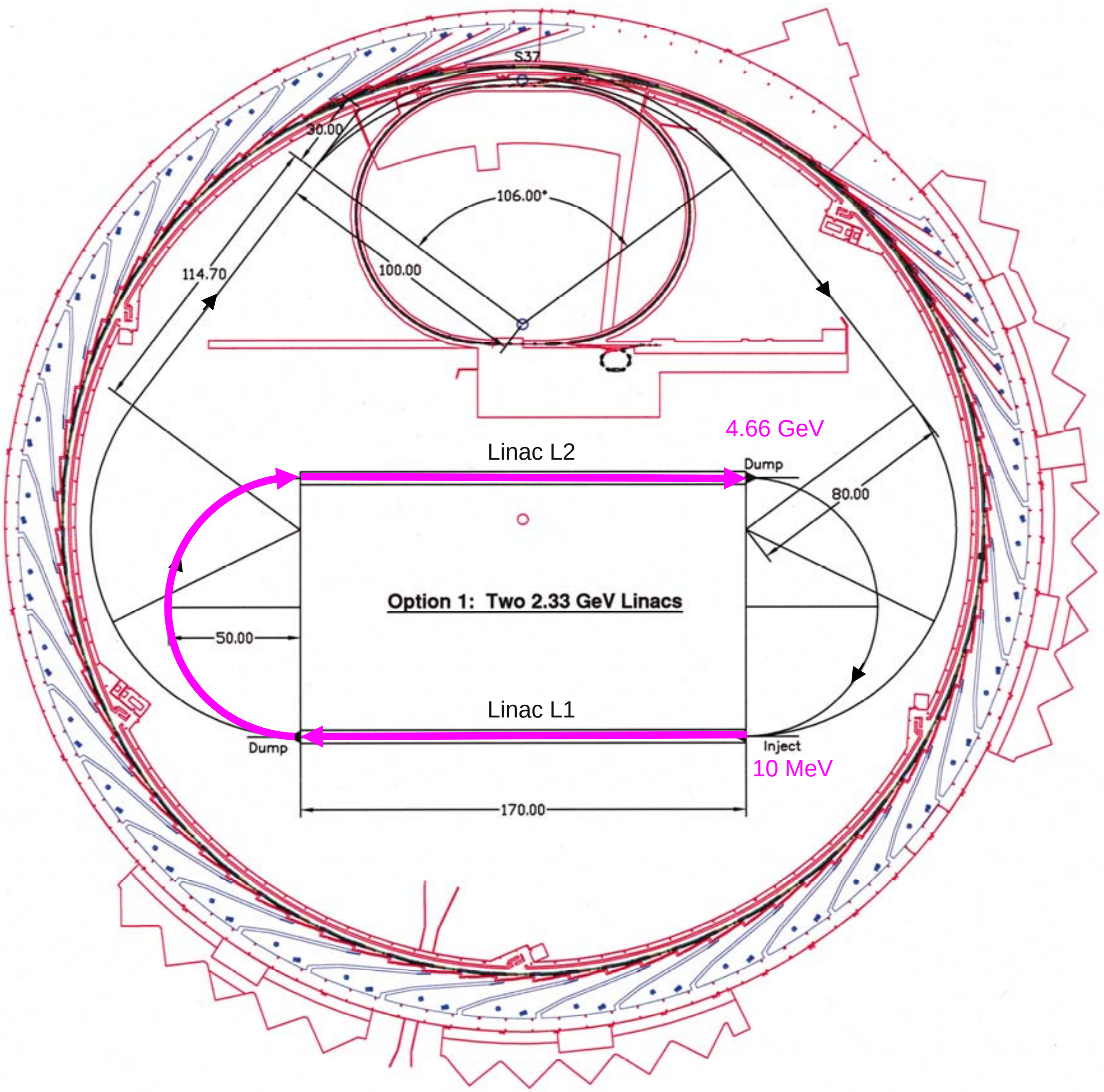
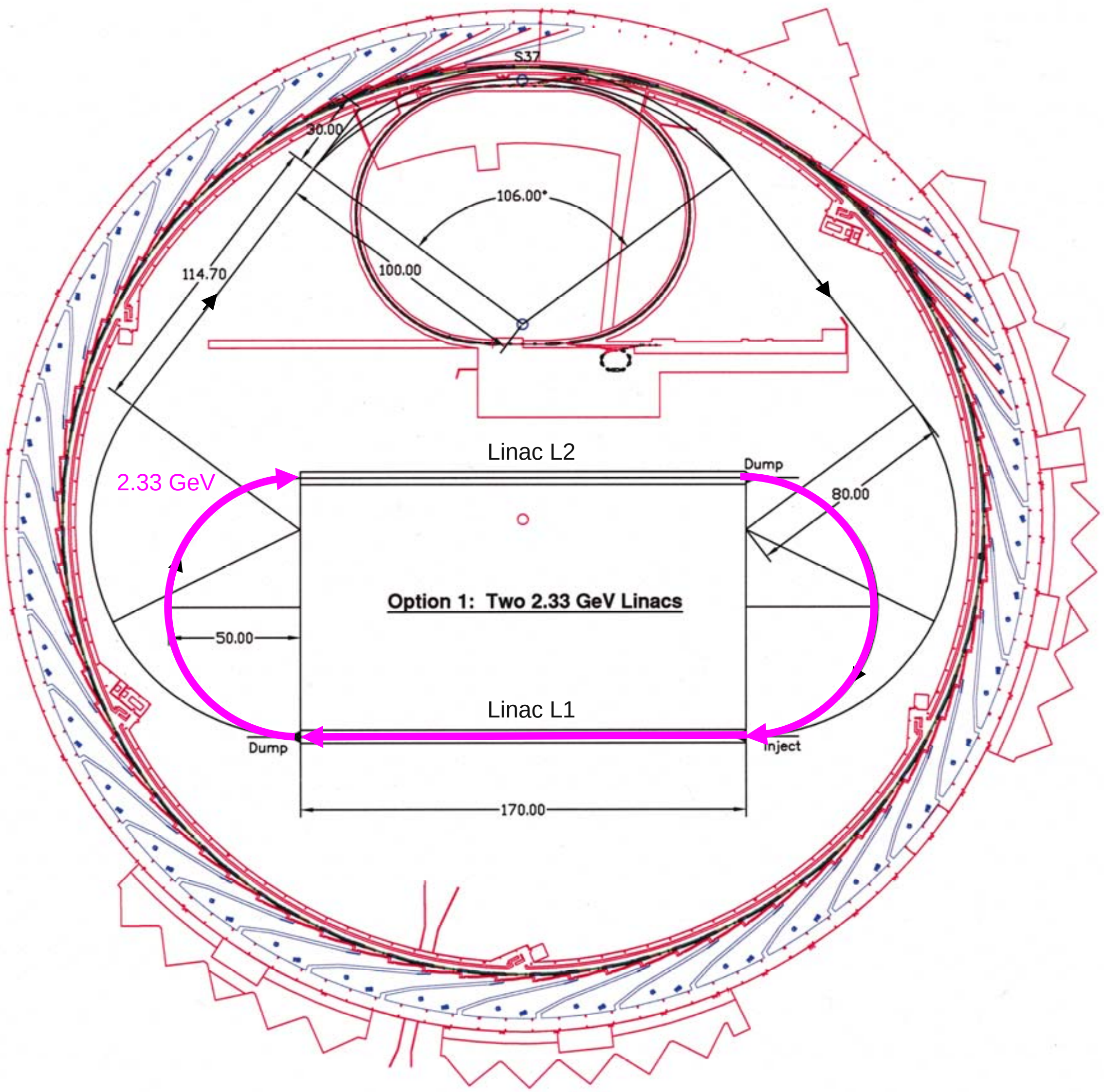


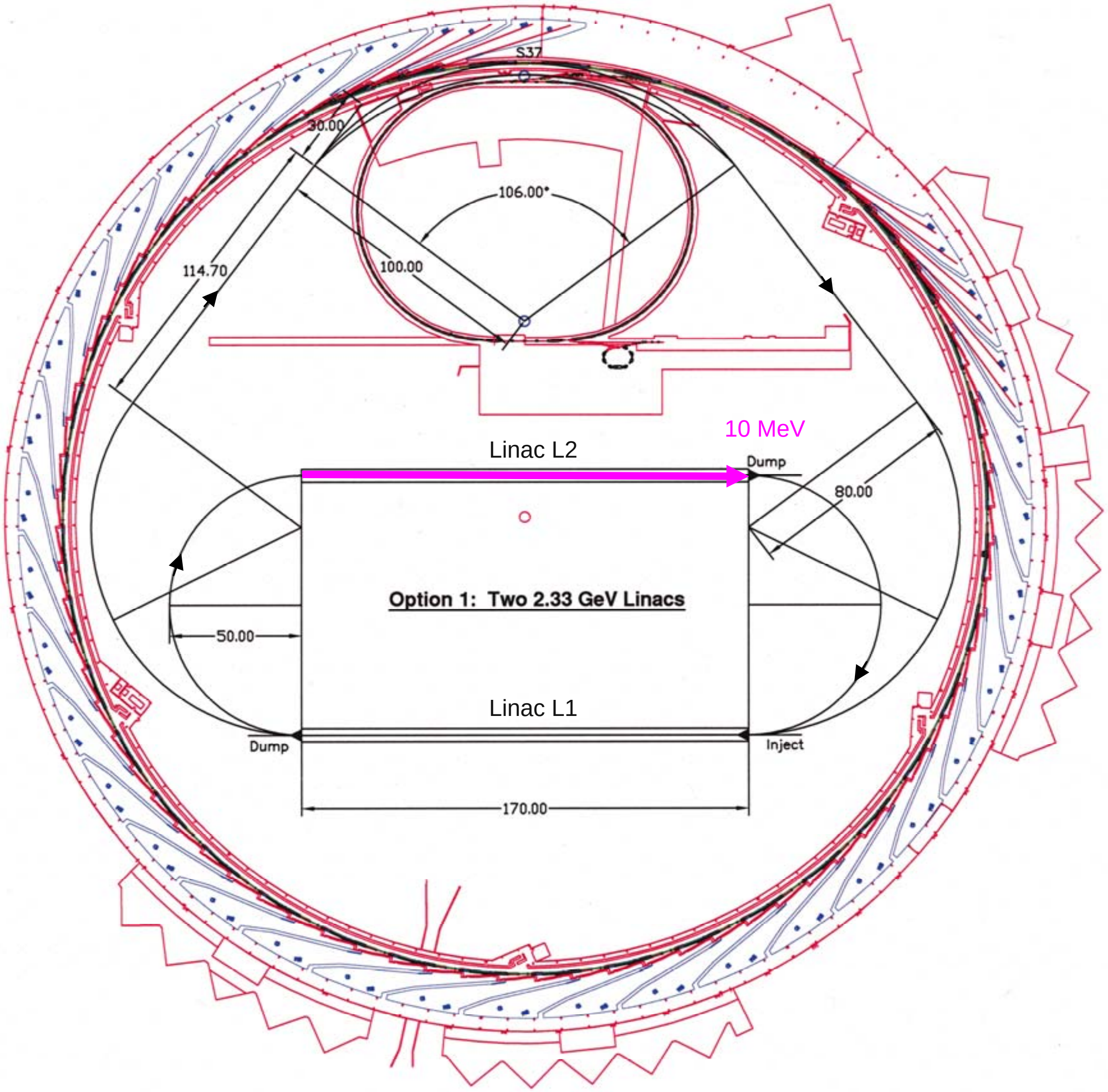
Infield ERL: Layout Option 1, 4.66 GeV Energy Recovery



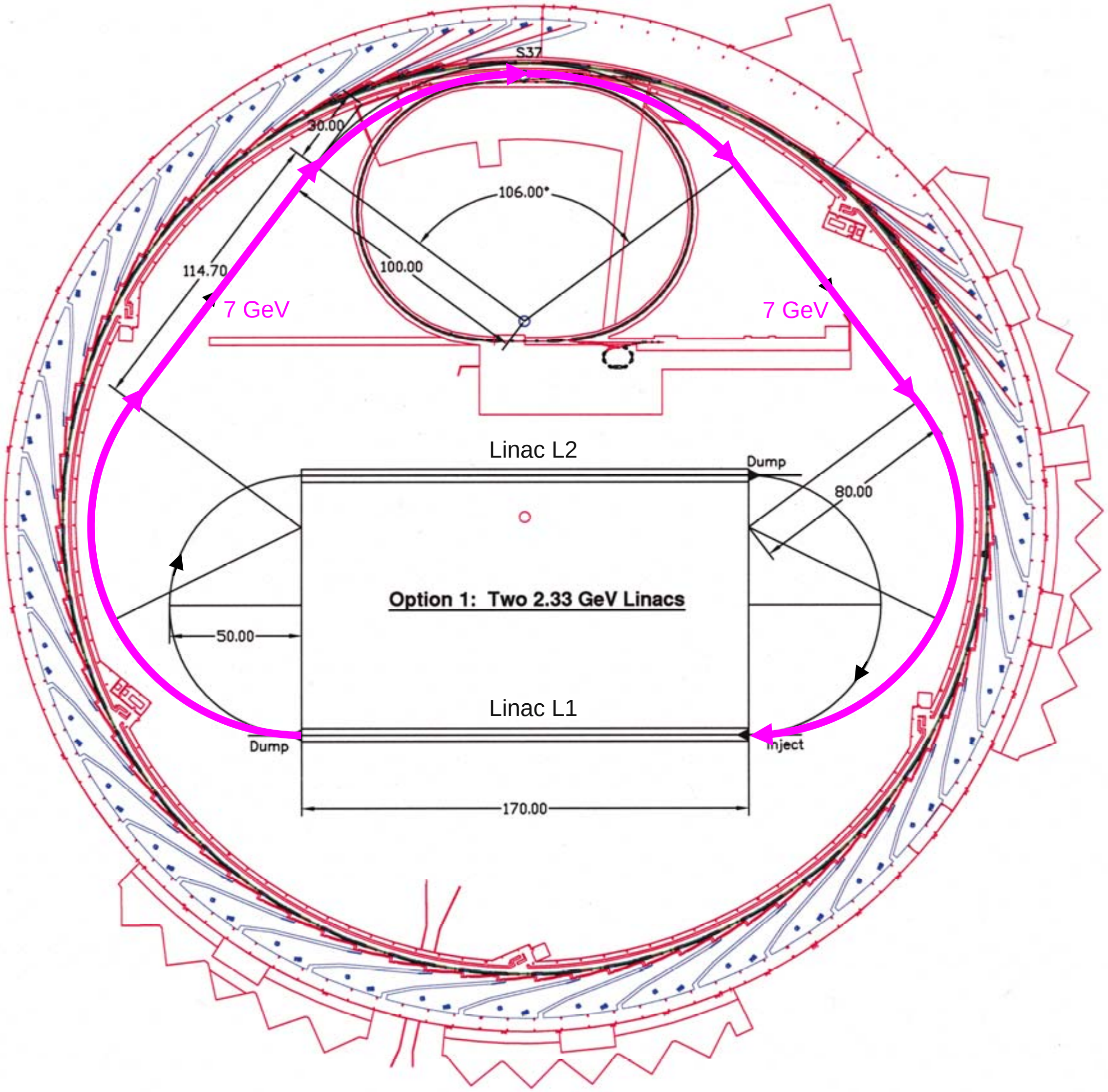
Infield ERL: Layout Option 1, 4.66 GeV Energy Recovery



Infield ERL: Layout Option 1, 4.66 GeV Energy Recovery



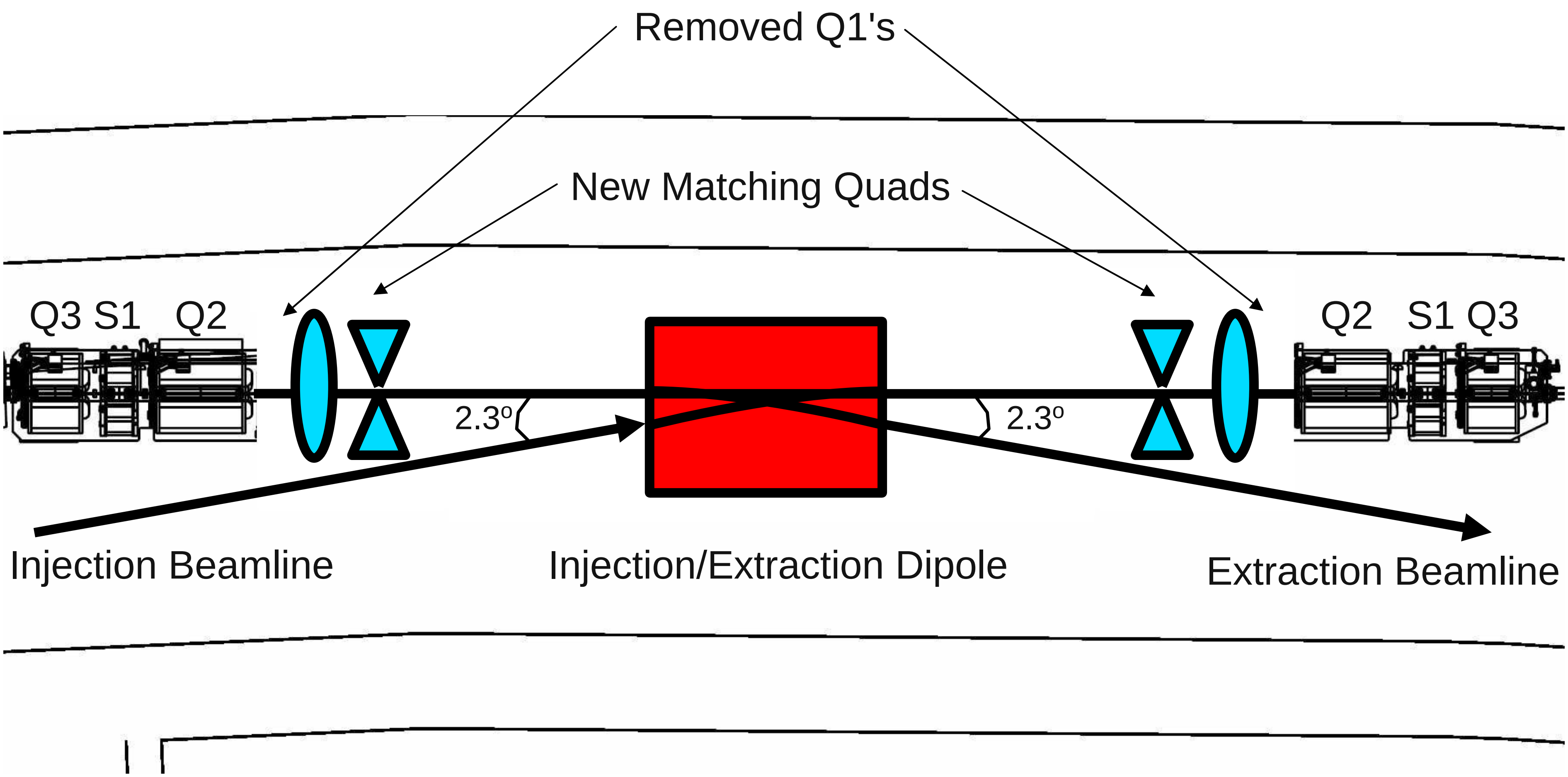
Infield ERL: Layout Option 1, 7 GeV Energy Recovery



Infield ERL: Layout Summary

- Use 2 linacs in racetrack configuration with total energy gain of 2.33 GeV / linac, 170 m length each.
- Implies an effective gradient of 13.7 MV/m
- Implies 22.8 MV/m cavities with 60 % fill factor (A. Nassiri's talk)
- Requires 102 (~1 m) cavities per linac
- Linacs are relatively short so linac optics should be less severe than the outfield ERL option
- Can commission energy recovery without disturbing users
- Build in path length adjustment to optimize energy recovery
- Injection/extraction area has interference issues

Infield ERL: Sector 37 Common Dipole Injection Scheme

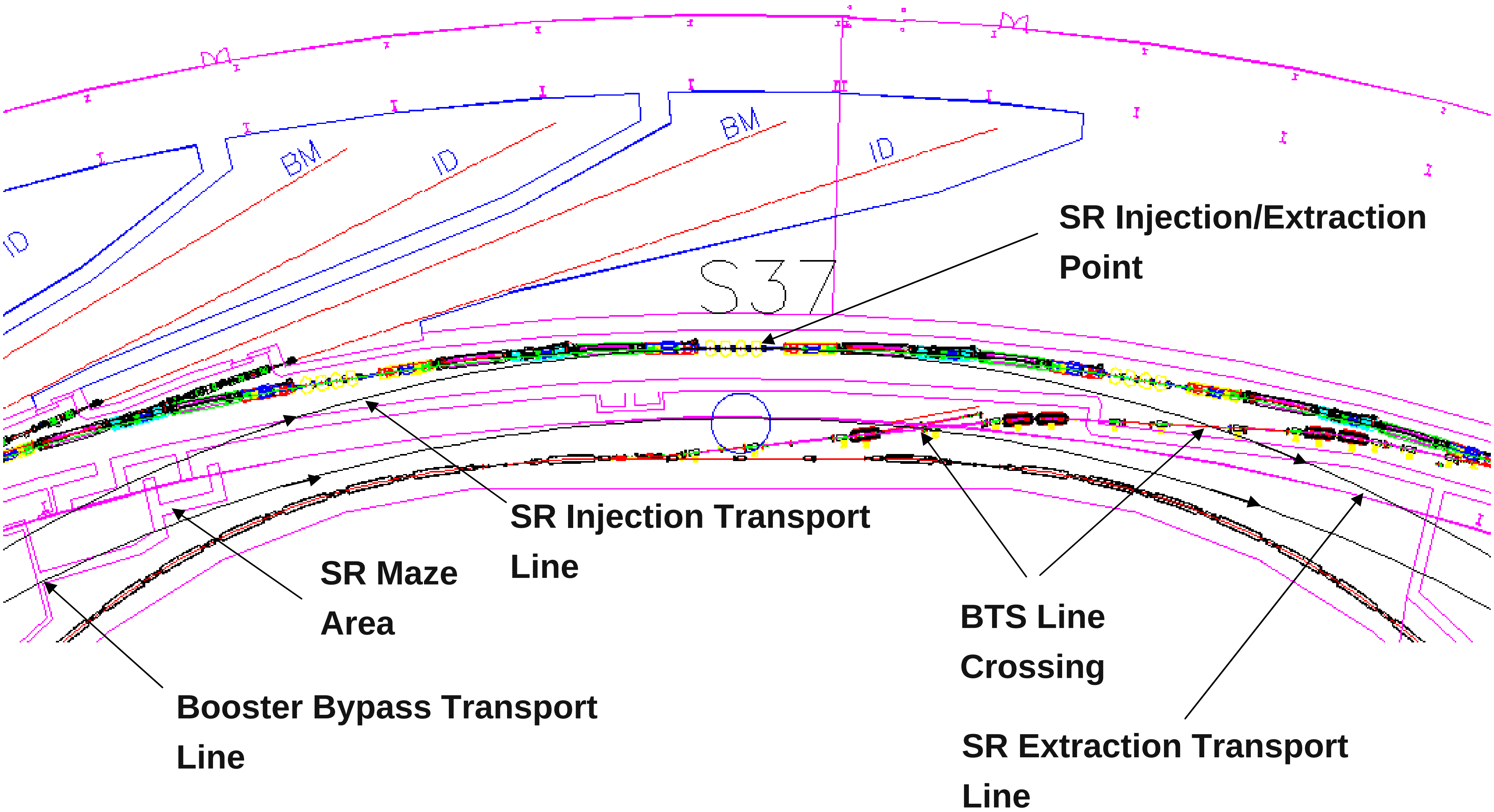


Remove 4 rf cavities and relocate

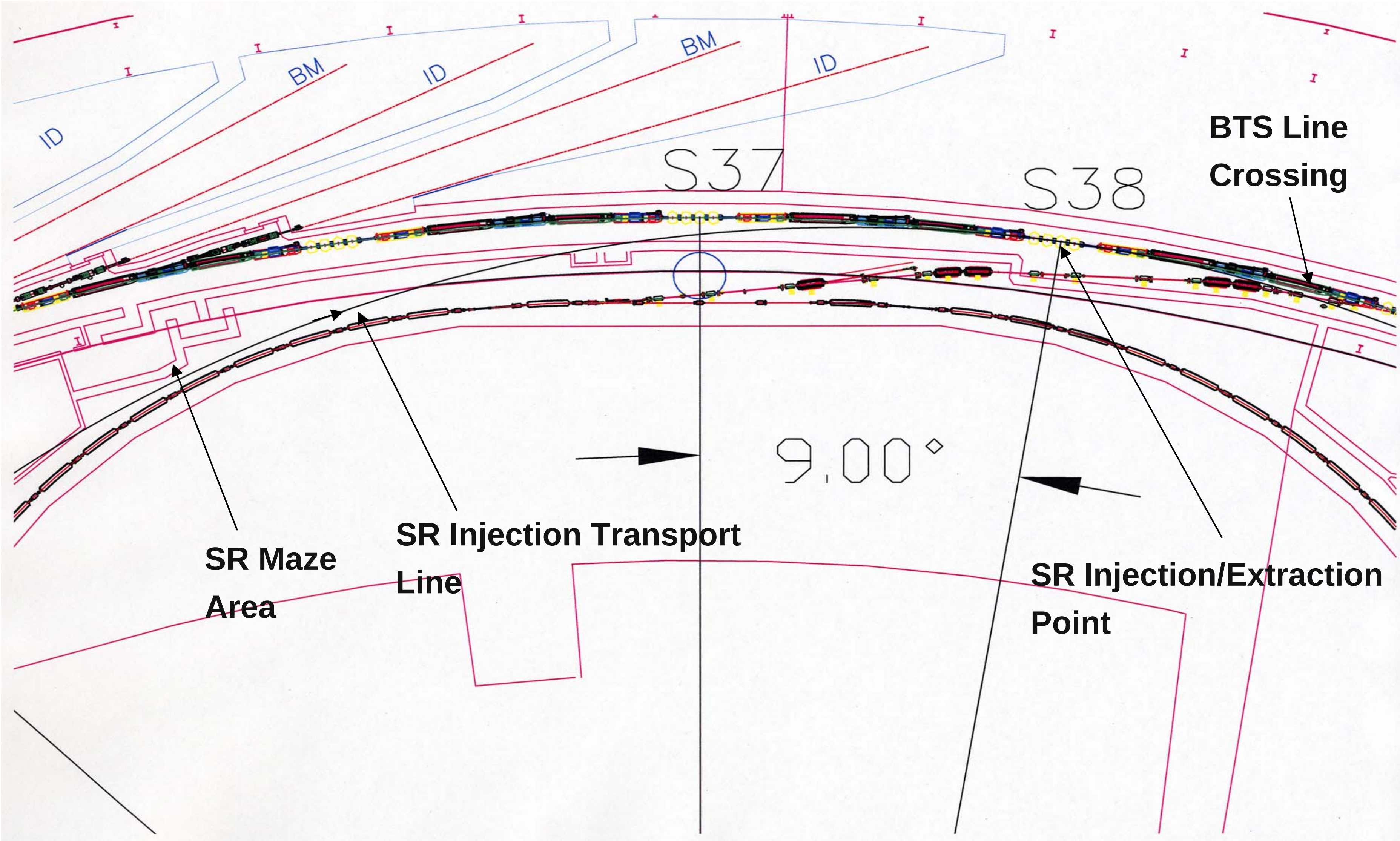
Infield ERL: Injection/Extraction Summary

- Inject/Extract into/out-of APS using a common dipole in sector 37
- Dipole length could be as short as 1.5 m bending at 2.3 degrees
  - Make space for matching doublets
  - Avoid interference of injection/extraction beamlines with ring magnets
- Follow Decker's suggestions to move sector 37 rf cavities
  - Only 4 to relocate (maybe only 2 if rf requirements are met with 14 cavities)
  - Could put up to 3 in sector 38 after relocating IK1, Q1
  - Remaining cavity could go in sector 35, 36 or 40
- ERL beam passes through all rf cavities

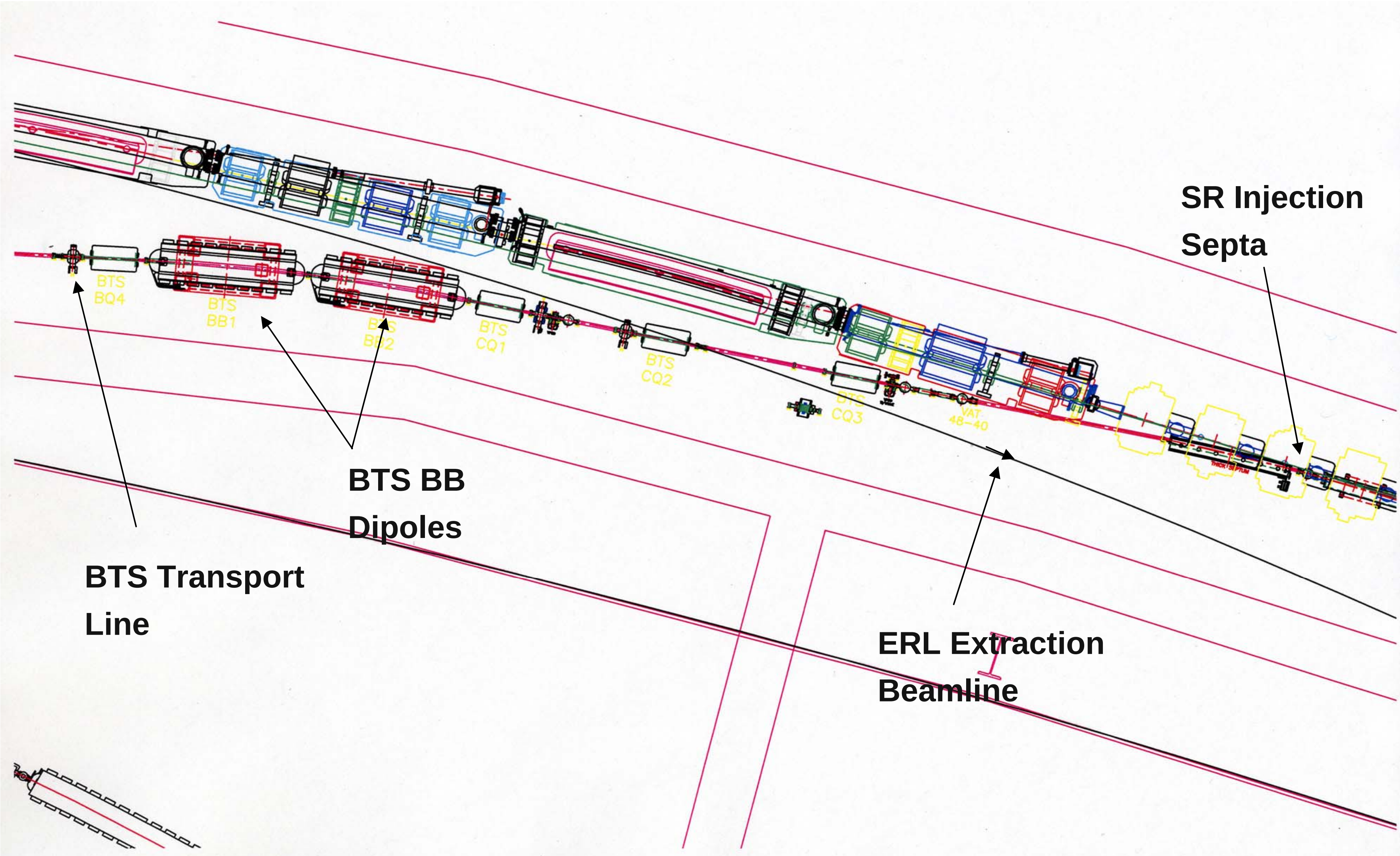
Infield ERL: Sector 37 Injection/Extraction Detail



Infield ERL: Sector 38 Injection/Extraction Detail

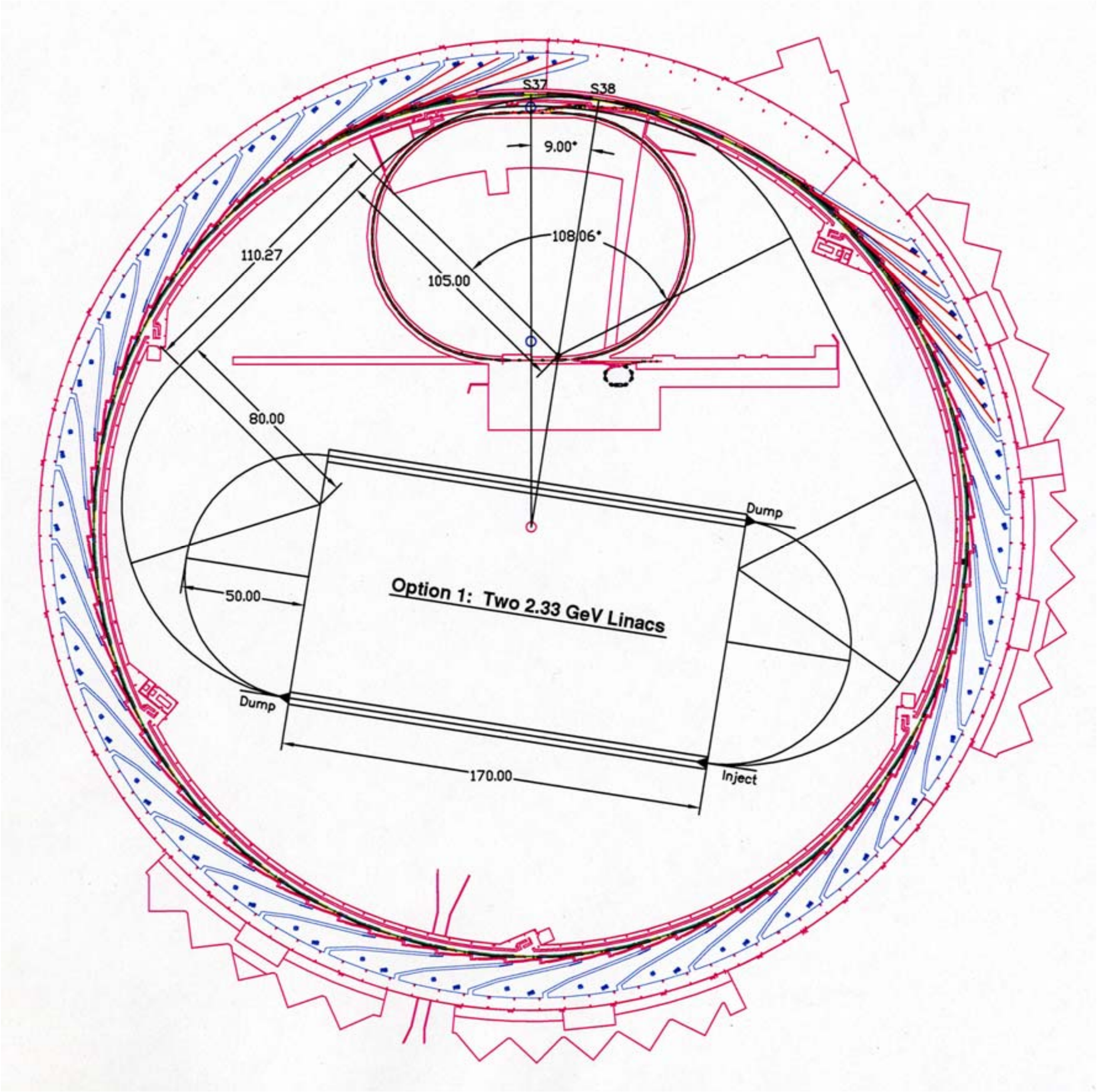


Infield ERL: Sector 38 Injection/Extraction BTS Detail

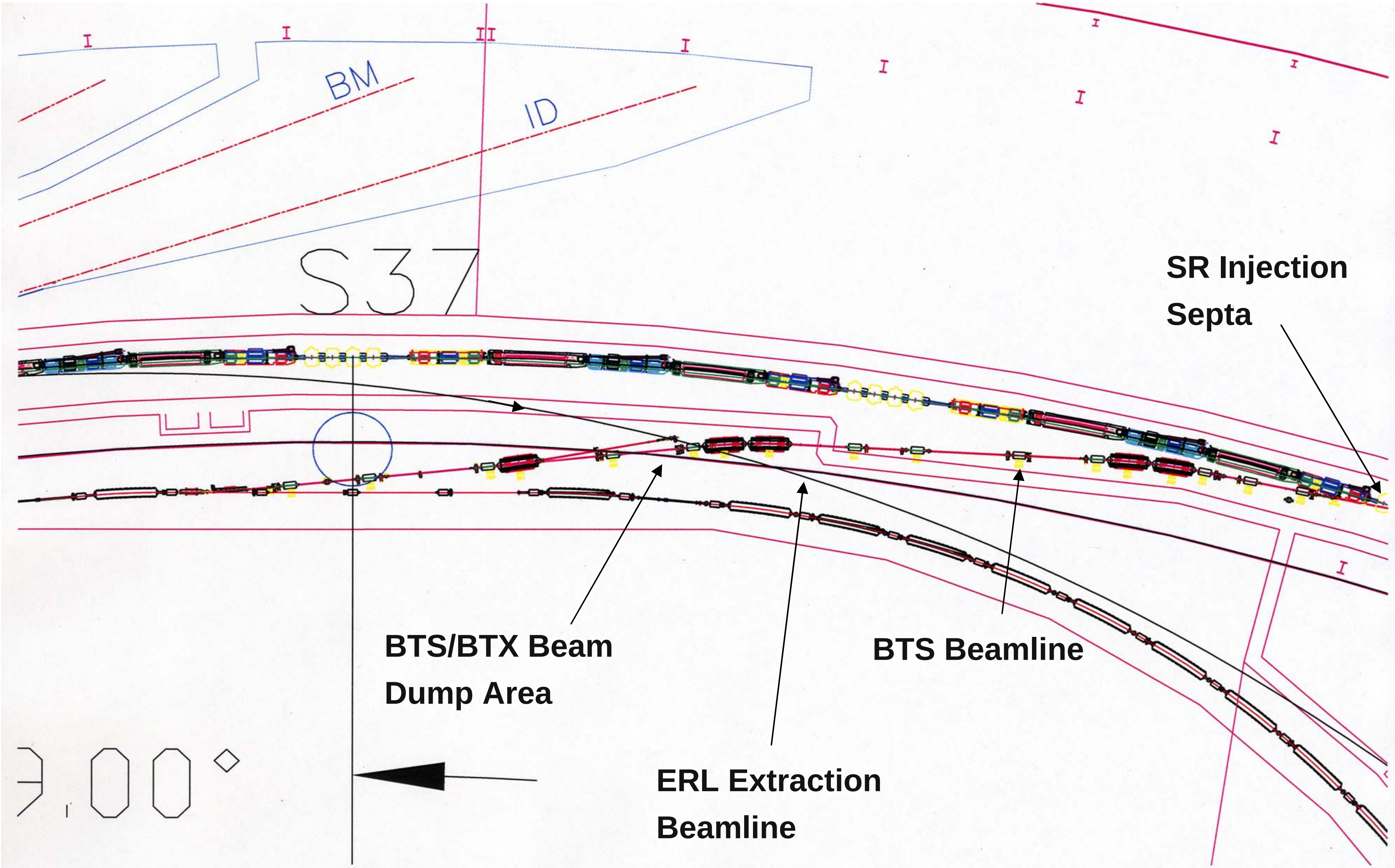


Infield ERL: Sector 38 Injection/Extraction Layout

ERL Complex rotated by
9 degrees clockwise

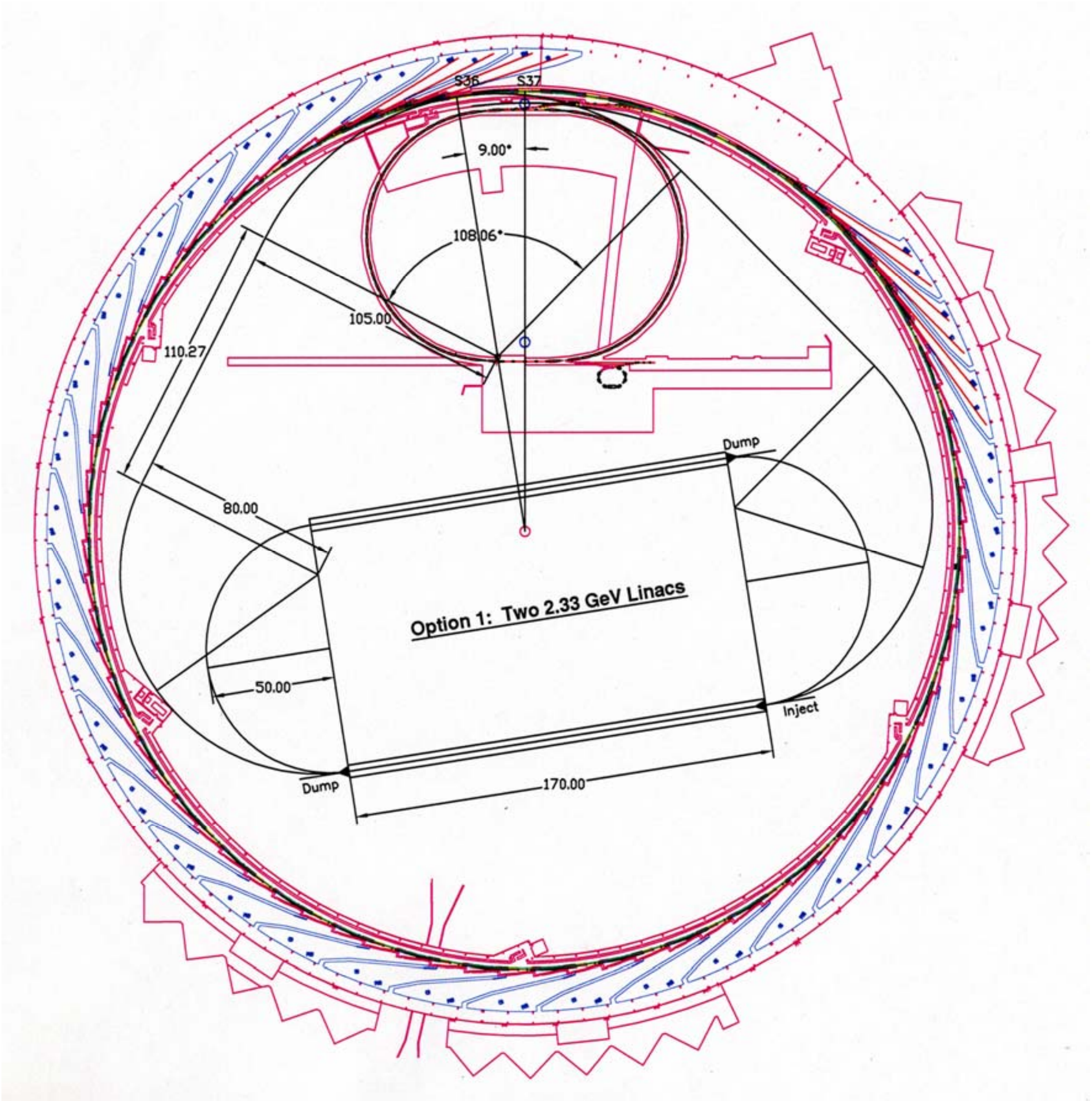


Infield ERL: Sector 36 Injection/Extraction Detail



Infield ERL: Sector 36 Injection/Extraction Layout

ERL Complex rotated by
9 degrees counterclockwise



Infield ERL: Conclusions

- In general, more gradient allows more compact configurations
  - Fewer recirculation and shorter linacs
  - Fewer rf cavities/cryogenics than for outfield option
  - Must maintain high cavity Q
- Interference with utilities/building structures is unavoidable due to lack of space
- Interference at injection would be minimized by injecting into sectors 36 or 38 instead of 37
- Must relocate up to four existing storage ring cavities removed from sector 37 (or 36,38) (maybe only two)
- Need to evaluate multipass BBU impact for each option

Infield ERL: Conclusions cont.

- Get 40 % emittance increase at injection in the APS ring
  - nearly all due to 7 GeV arcs
  - Similar to one of the "outfield" options (M. Borland's talk)
- Difficult to eventually add an FEL option due to space
- **Commission energy recovery without disturbing users**
- Option looks feasible. Details of injection/extraction need further development