Pion capture and transport system for PRISM

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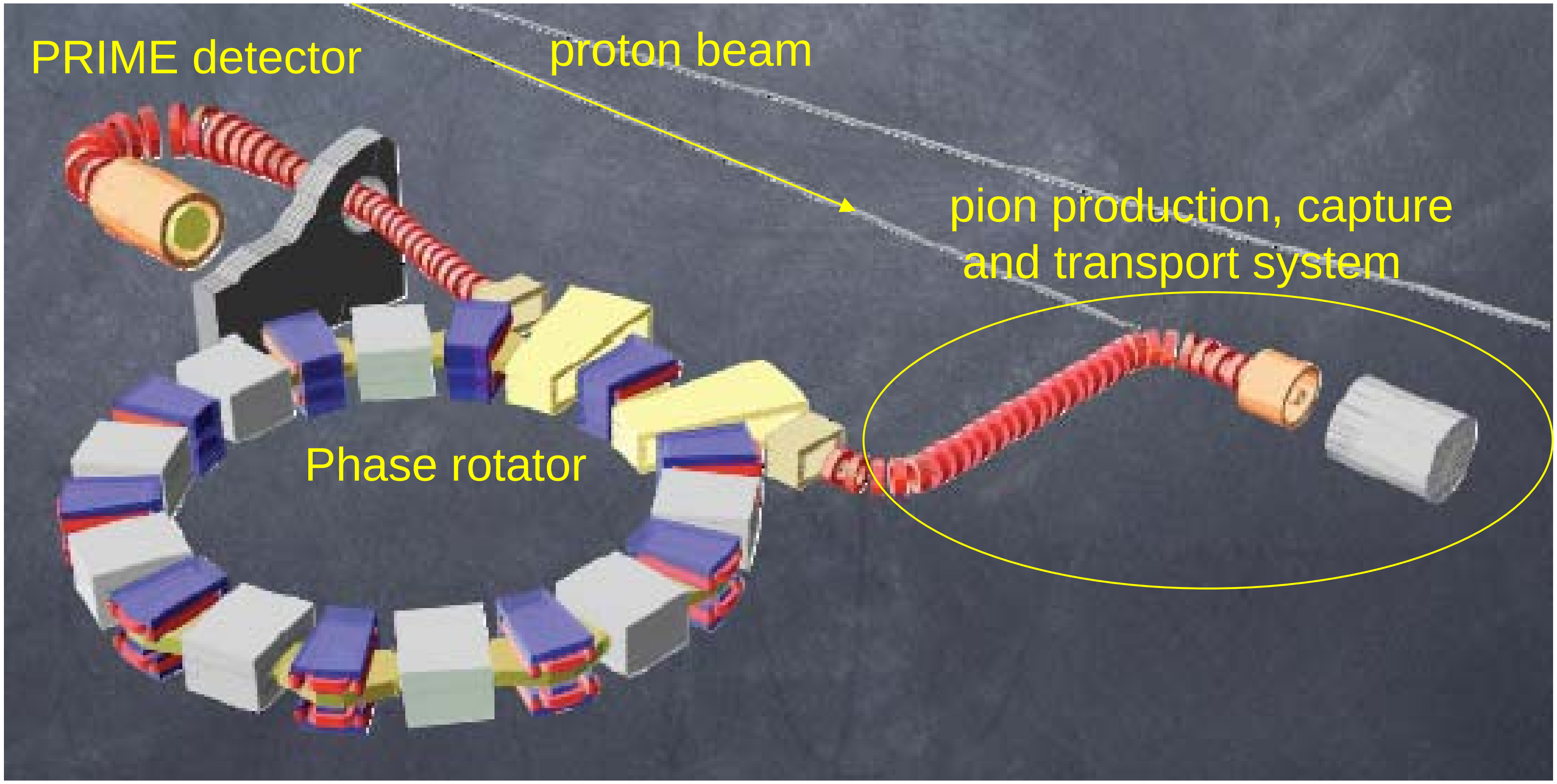
NuFACT06 at UCI

PRISM/PRIME project

- Phase Rotated Intense Slow Muon source
- Collect 68MeV/c μ^-

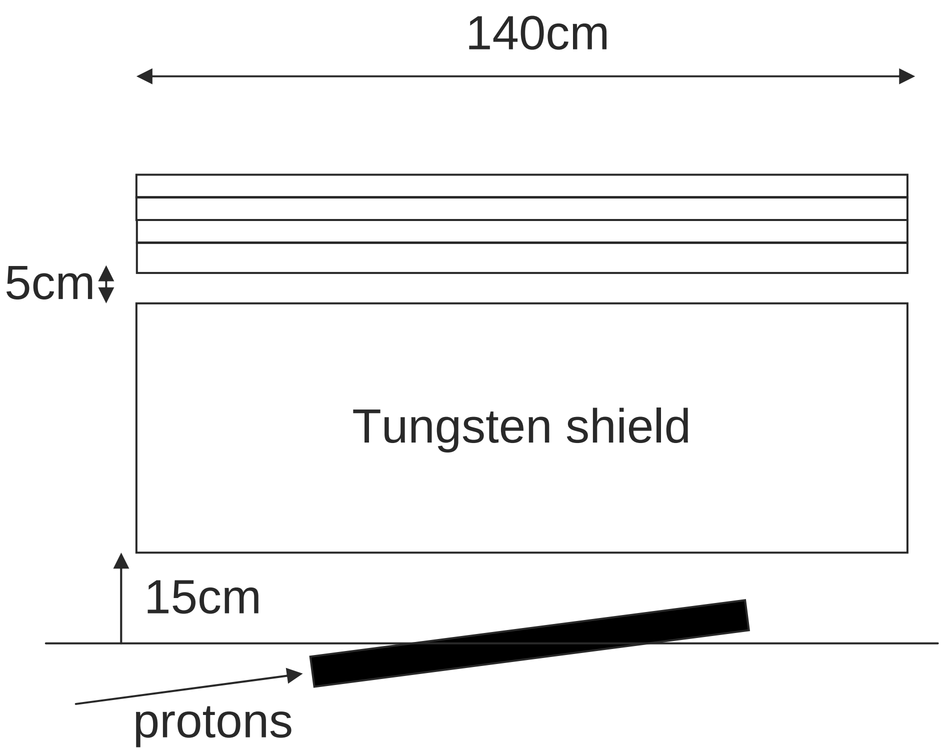


Concepts of pion capture/transport system for PRISM

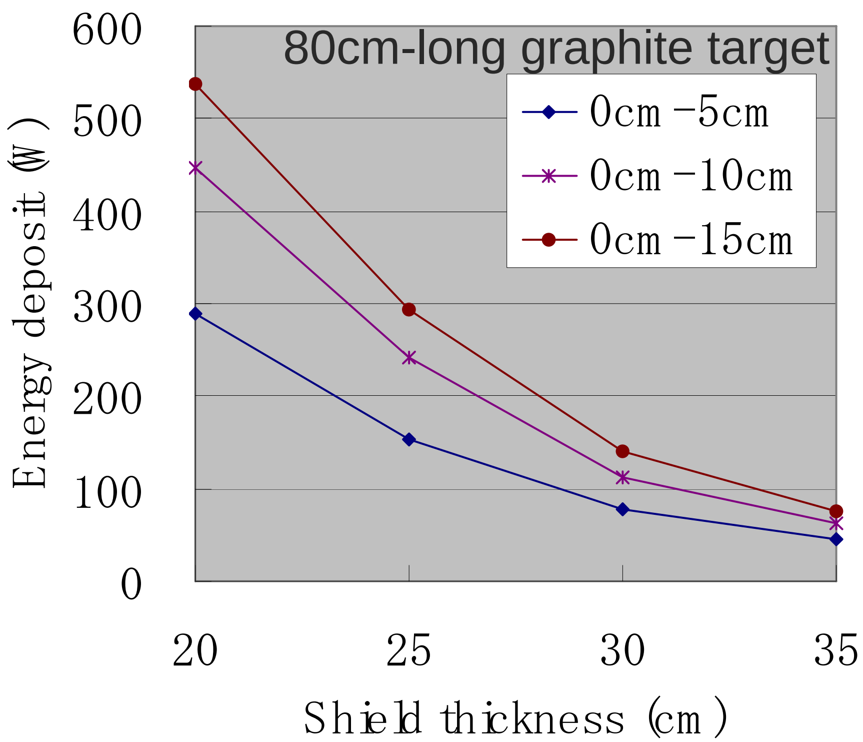
- Capture low-energy pions produced in Graphite target with 6T solenoid field
  - Low-Z material
    - to avoid absorption in the target
  - Collect backward pions from the target
    - Direction of emitted low energy pions is almost isotropic
    - helps to reduce radiation heating on cold mass (avoid high energy hadrons)
  - Tilt target by 10 deg. to implement proton beam pipe
  - Energy deposit on superconducting coil of capture solenoid < 100W
  - Al-stabilized SC coil to reduce cold mass
- Transport pions+muons in long 2T solenoid channel
  - Bent solenoid channel
    - Target should be off-site from experimental area
    - Reduce background by wiping out higher energy particles
- The first trial of conceptual design has been done.

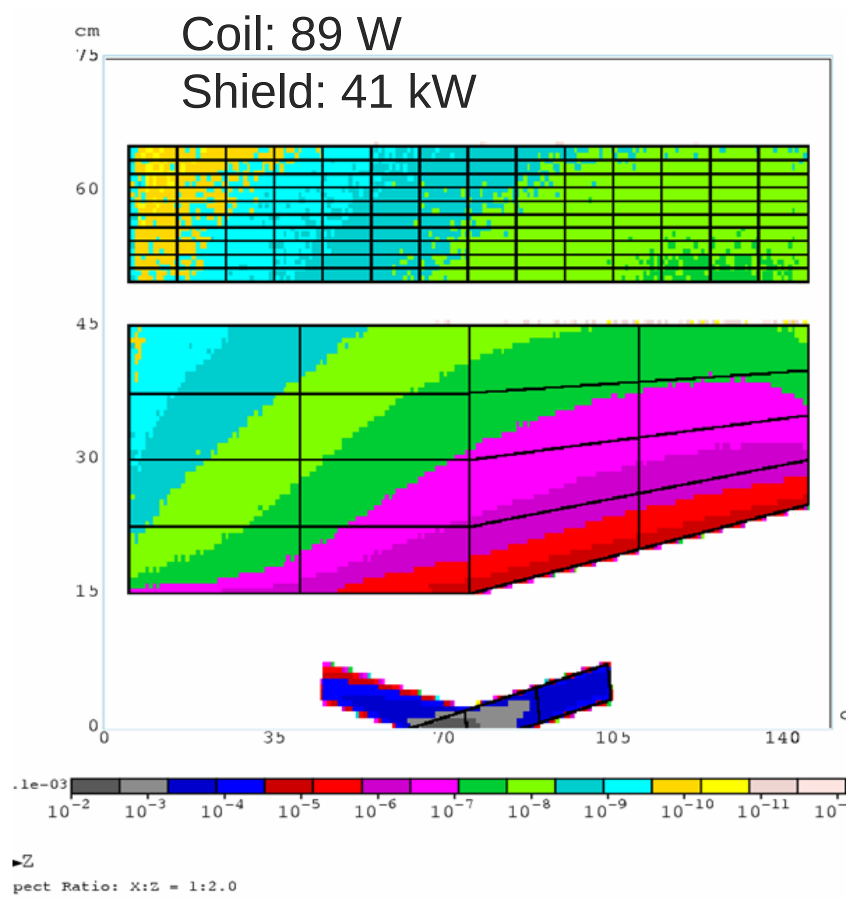
Heat load estimation
MARS Simulation

- MARS15(04)
- Primary beam
  - 40GeV
  - size σ=1.0cm
  - 10^{14} protons/sec
- Target
  - Graphite (1.7g/cm^3)
  - radius=2cm
- Magnetic field
  - uniform 6Tesla
  - Solenoid inner R=15cm
- Coil
  - Al-stabilized superconducting Coil
    - 71%Al + 11%NbTi + 14%Cu + 4%G10-tape
    - density 3.1 g/cm^3



Heat load on coil

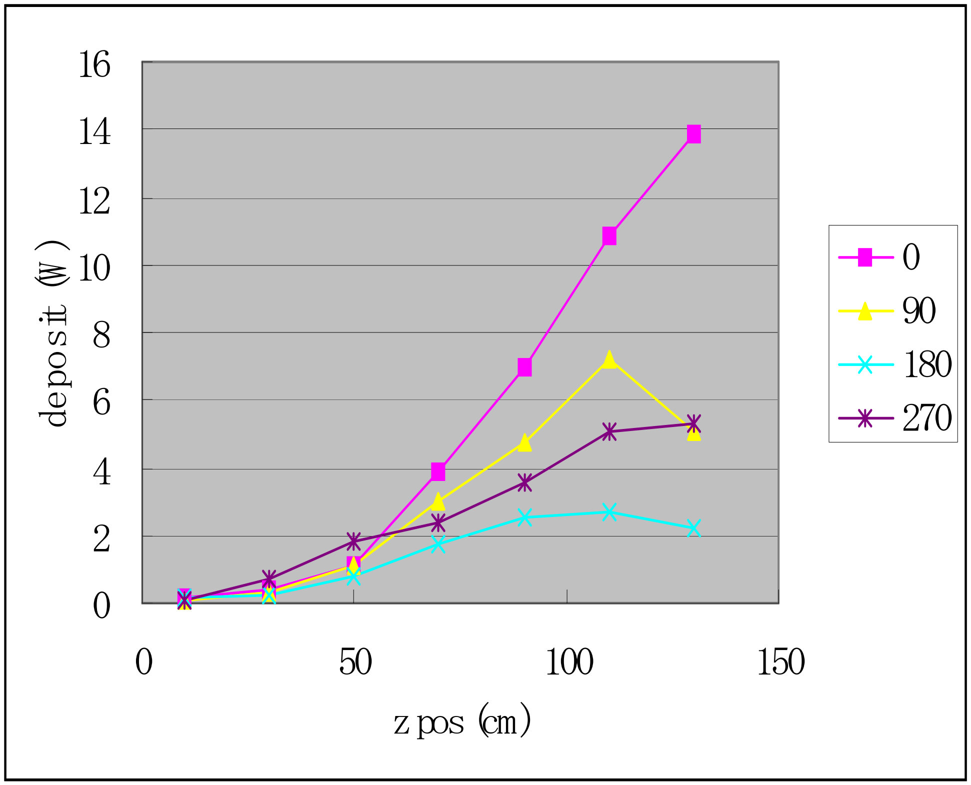


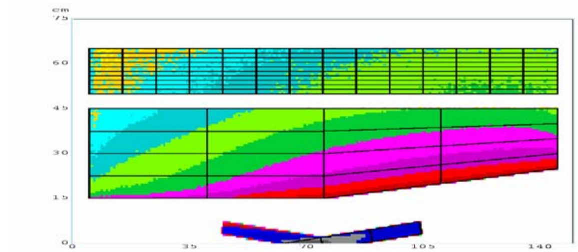


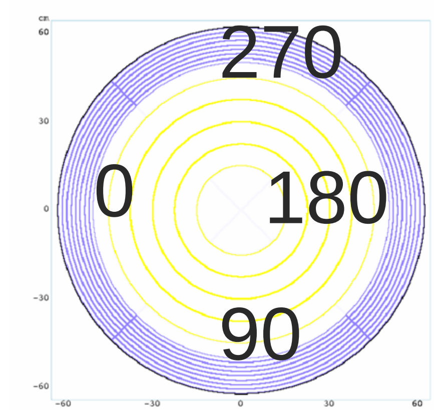
→Choose

- thickness of shield = 30cm
- thickness of coil = 12cm → 17 A/mm^2
- target length = 60cm

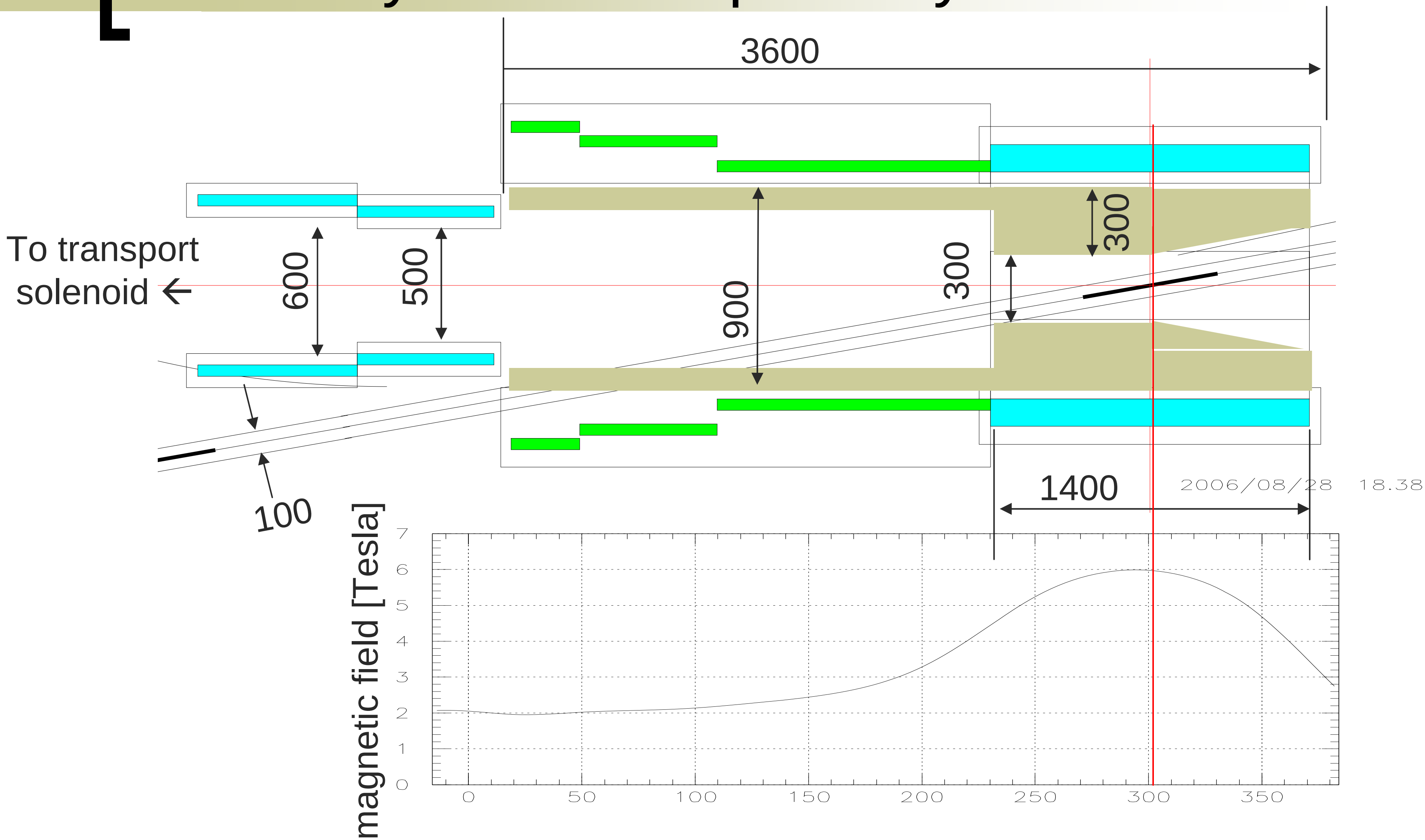
Spatial distribution of deposit energy





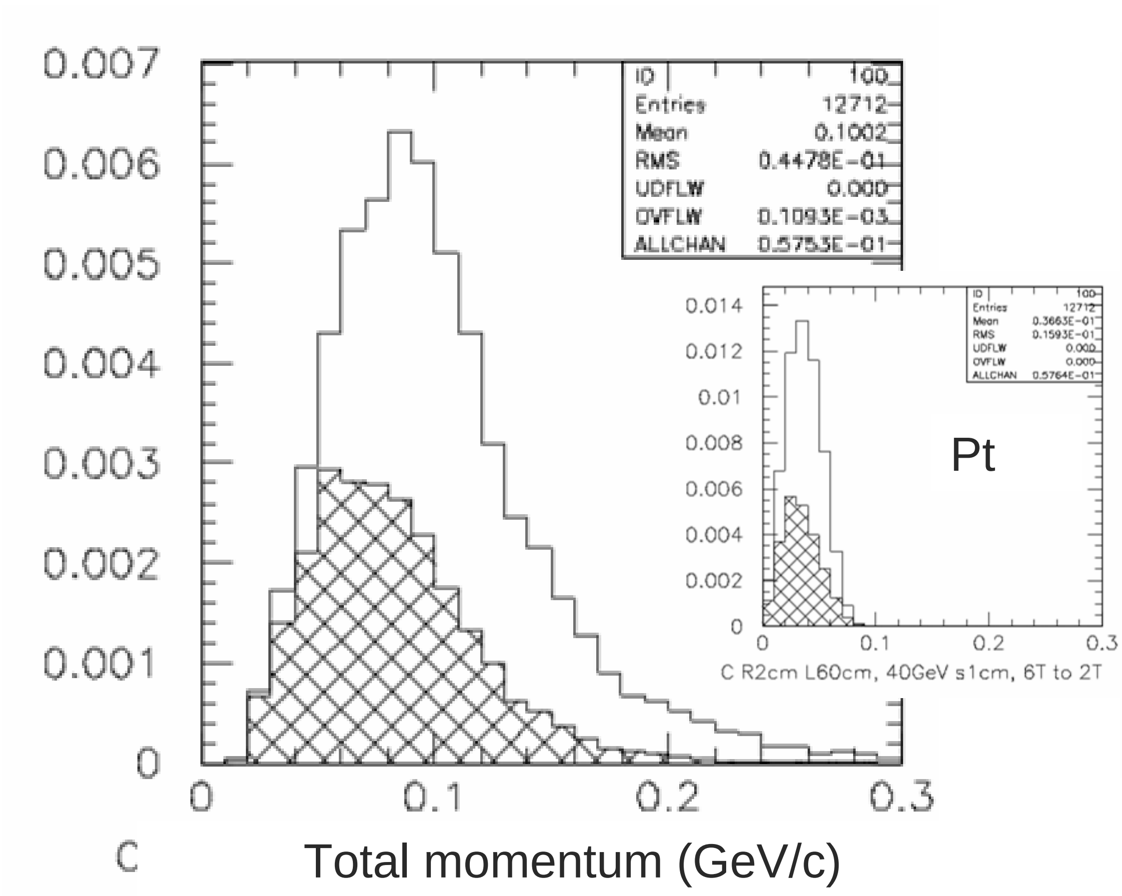


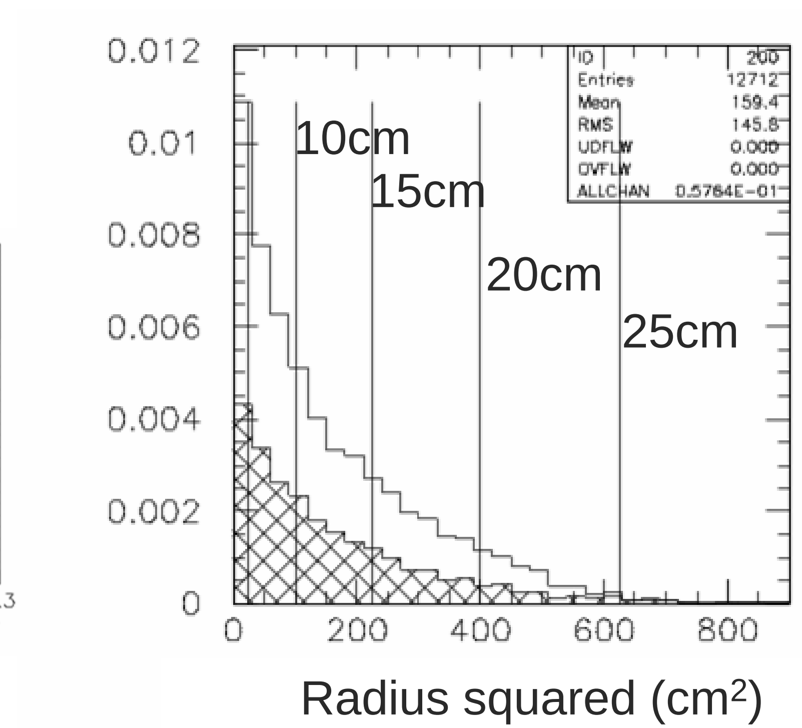
Geometry of Pion Capture System



π^-,μ^- distributions @3m

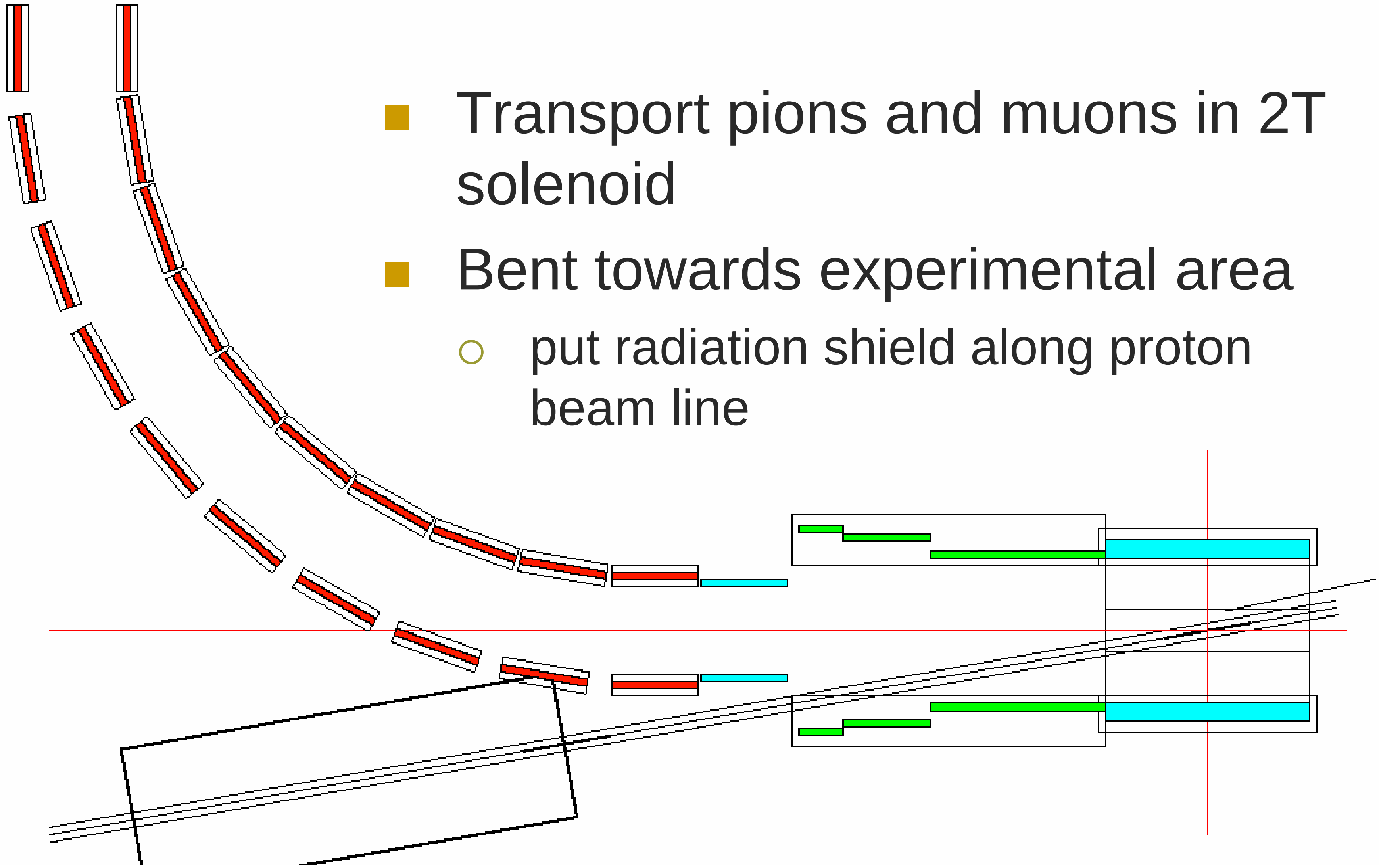
- 0.058 $\pi^-+\mu^-$/POT @3-meter downstream traget





Transport solenoid channel

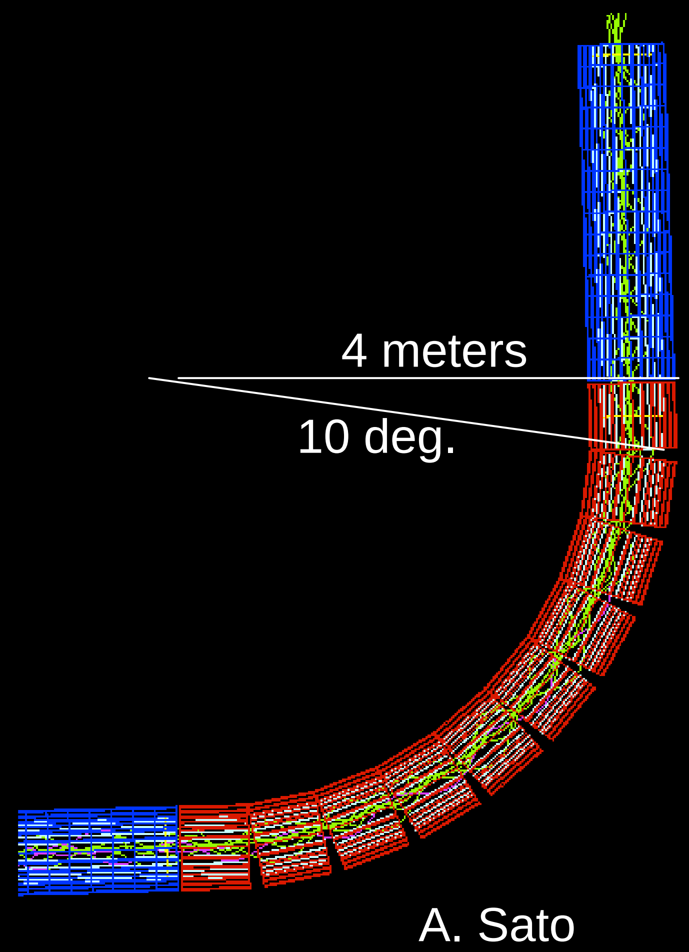
- Transport pions and muons in 2T solenoid
- Bent towards experimental area
  - put radiation shield along proton beam line



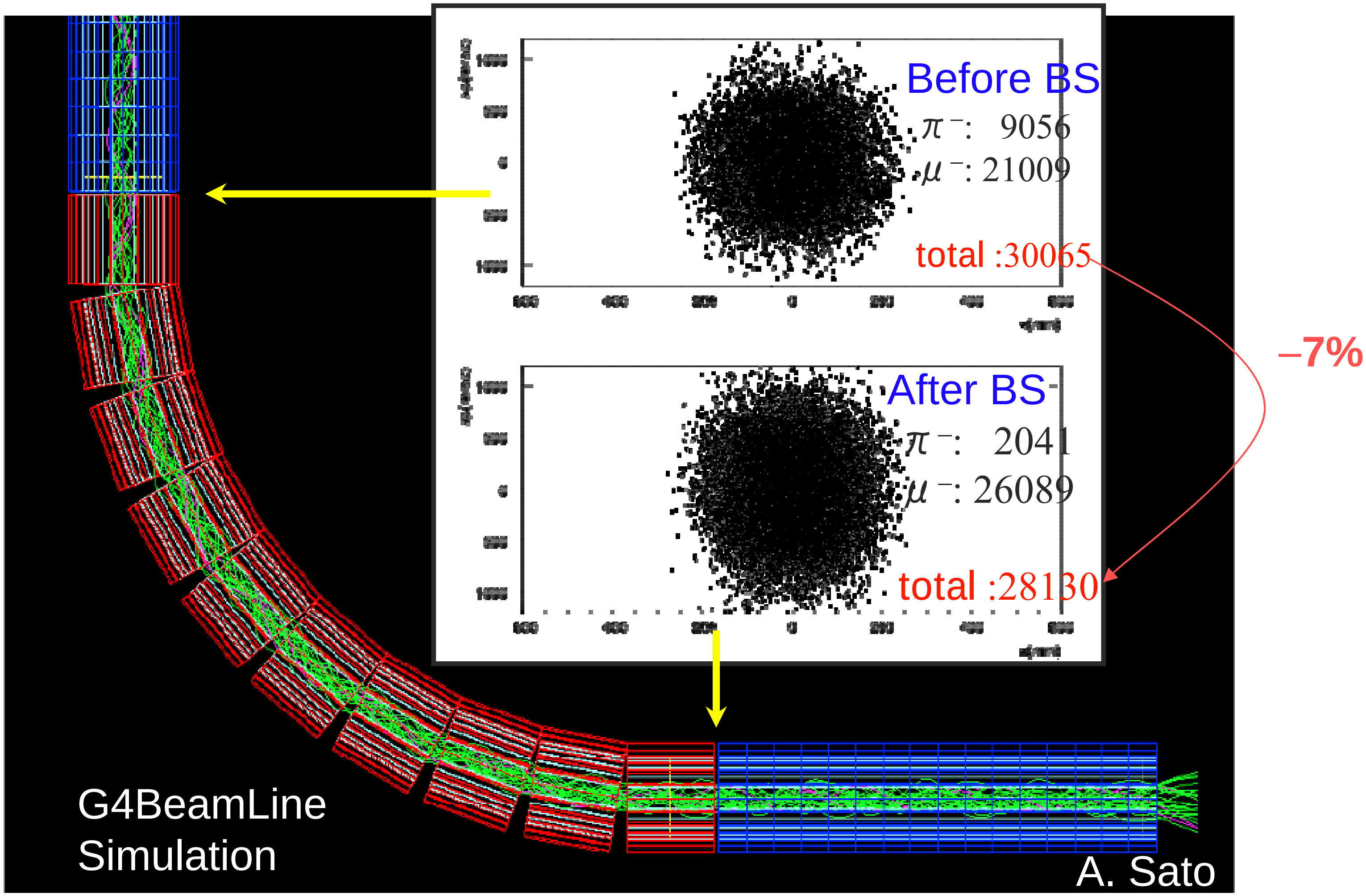
Parameters of transport solenoid

arc radius : 4000 mm
bend angle : 90 deg.
Bs : 2 T
By : 0.05 T

coil inner raduis : 350 mm
(inner wall : 50mm)
coil thickness : 50.0 mm
coil length : 629.0 mm
current : 36.5 A/mm^2
step angle : 10 deg.



Transport loss in bent solenoid



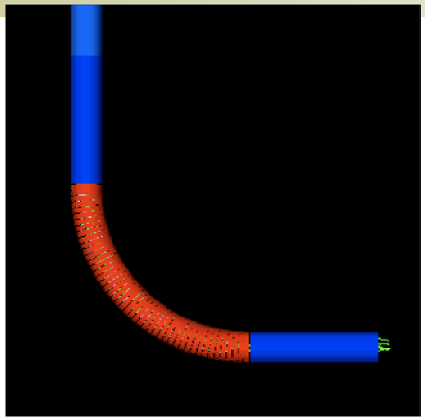
Summary

- Conceptual design of pion capture solenoid and transport bent solenoid has been performed for PRISM
- Heat load on coils of capture solenoid can be less than 100W as 40 GeV proton beam injected, assuming 0.6MW beam power.
- Design works for the solenoid magnets are being started in collaboration with KEK

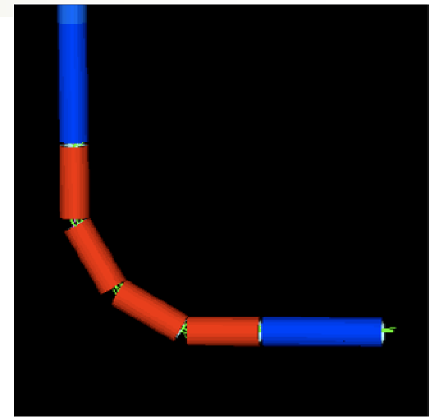
- To improve pion yield
  - Reduce beam spot size on target
  - Field gradient around the target
    - acceptance would increase by mirroring forward pions
- To fit to FFAG acceptance (H: 40π mm-rad, V:6.5π mm-rad)
  - optimize field profile in the capture system to reduce muon emittance. (keep higher field?)

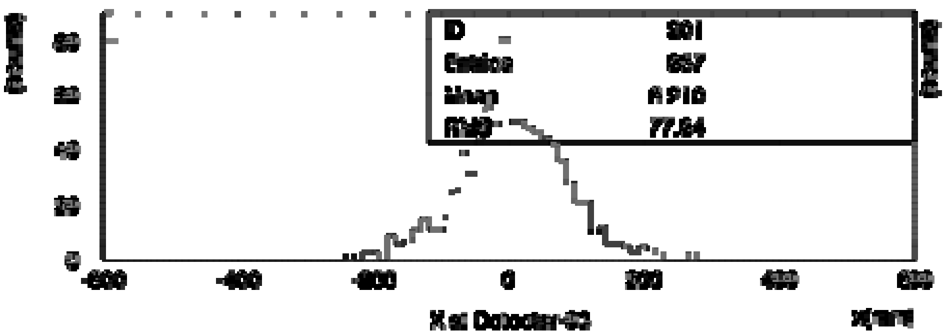
Horizontal position/direction distribution at exit of transport solenoid

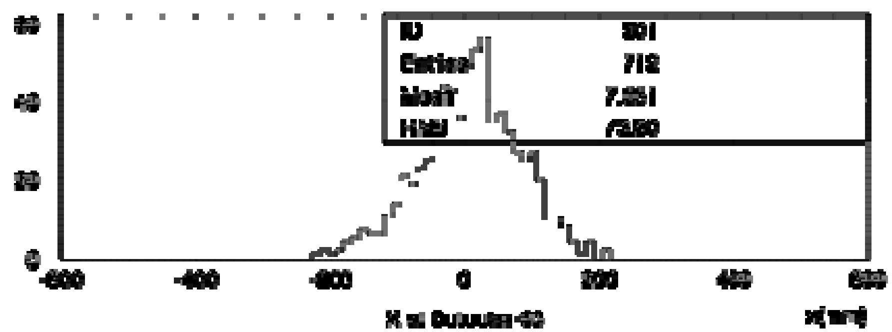
Smooth curve

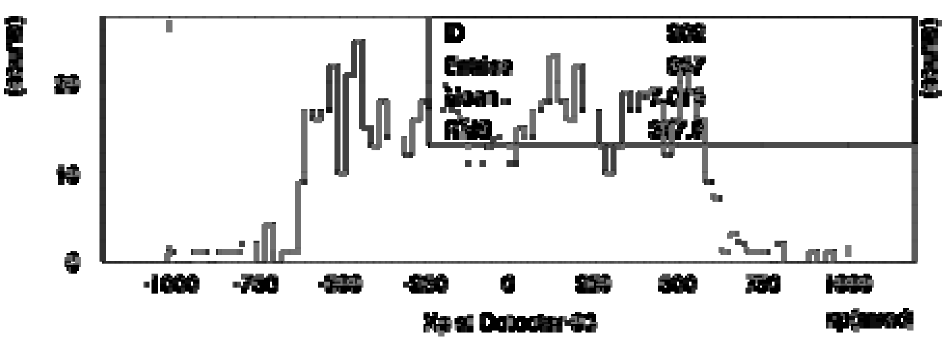


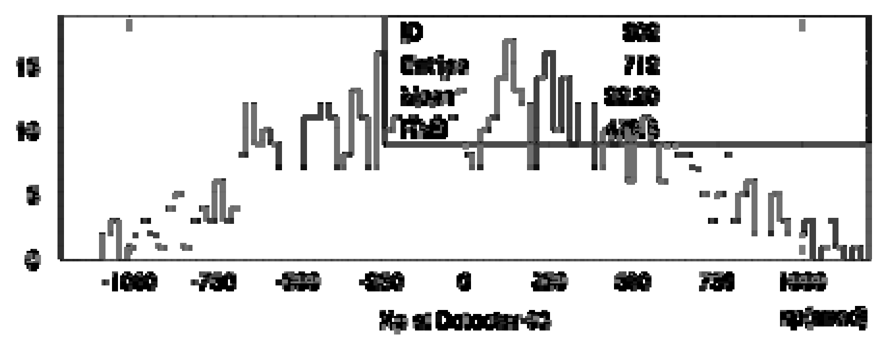
bend in 3 steps

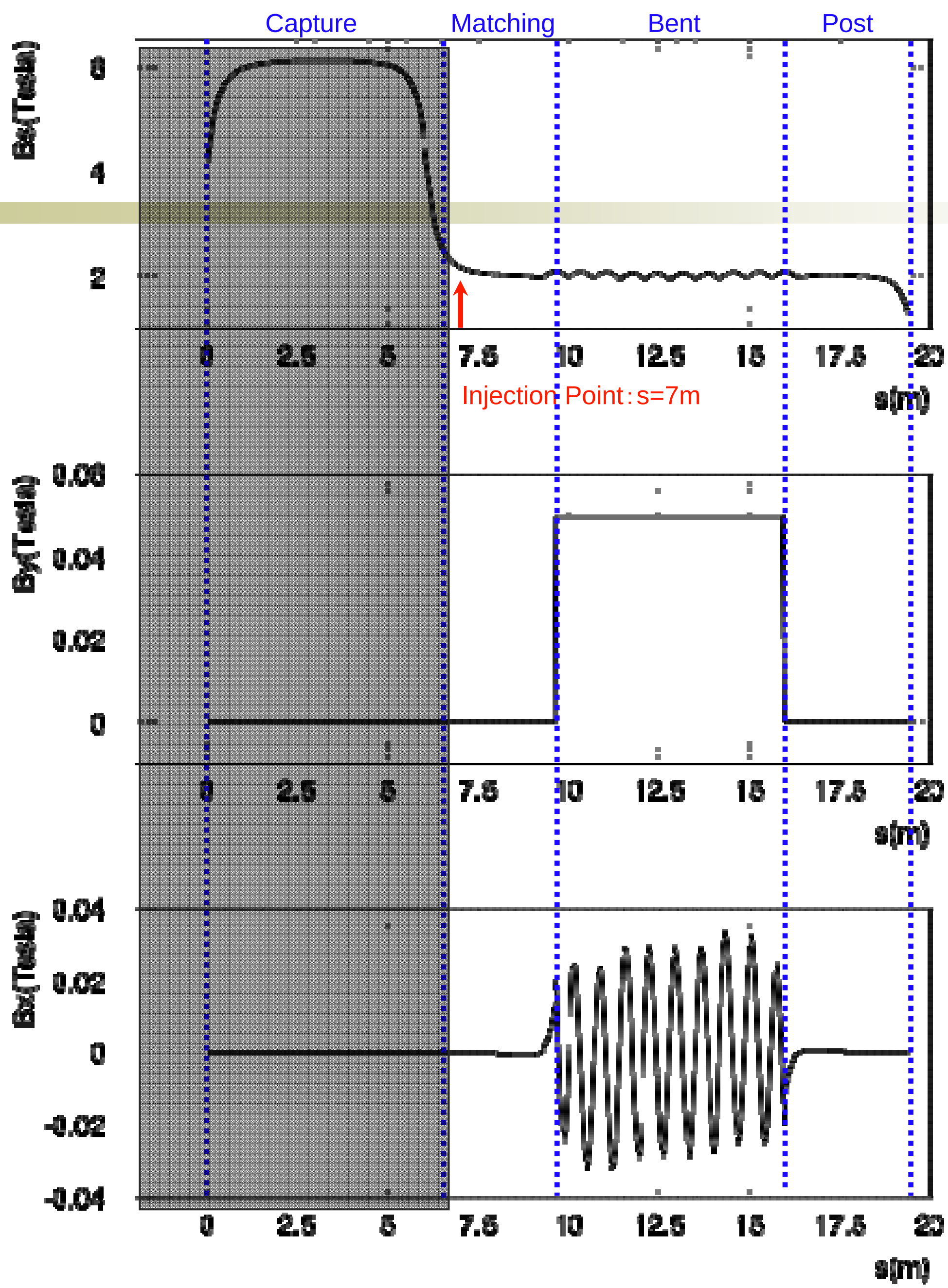











Capture
Matching
Bent
Post
Bz(Tesla)
Injection Point : s=7m
s(m)
By(Tesla)
Bx(Tesla)