Simulations of Target Experiment

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Targeting Workshop

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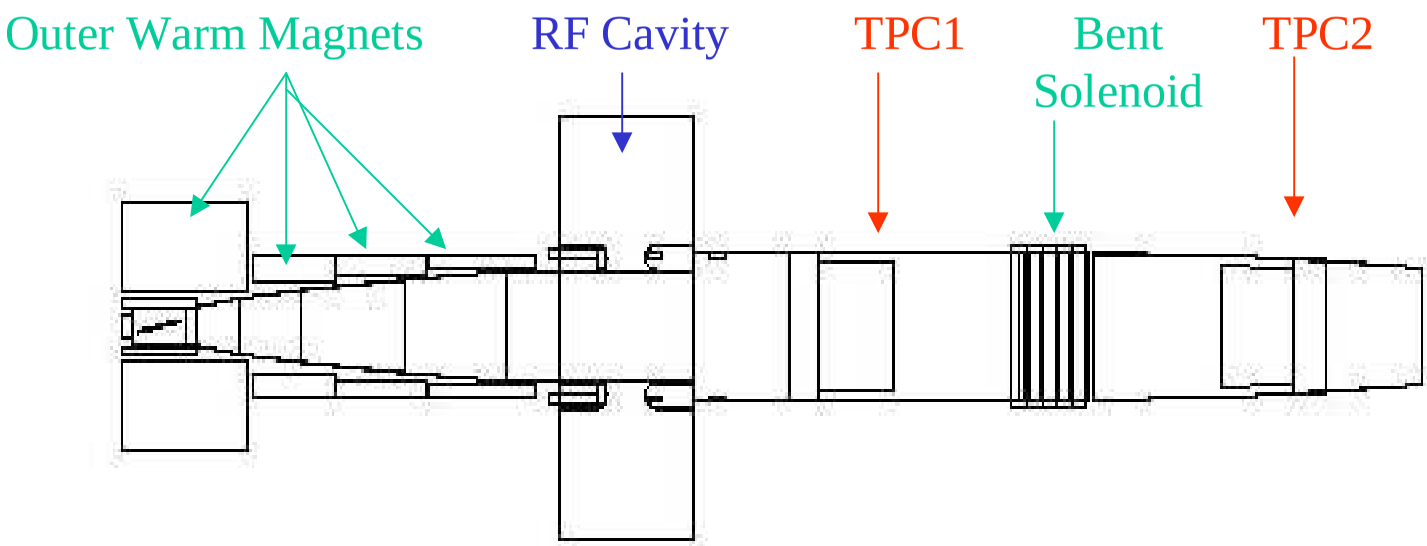
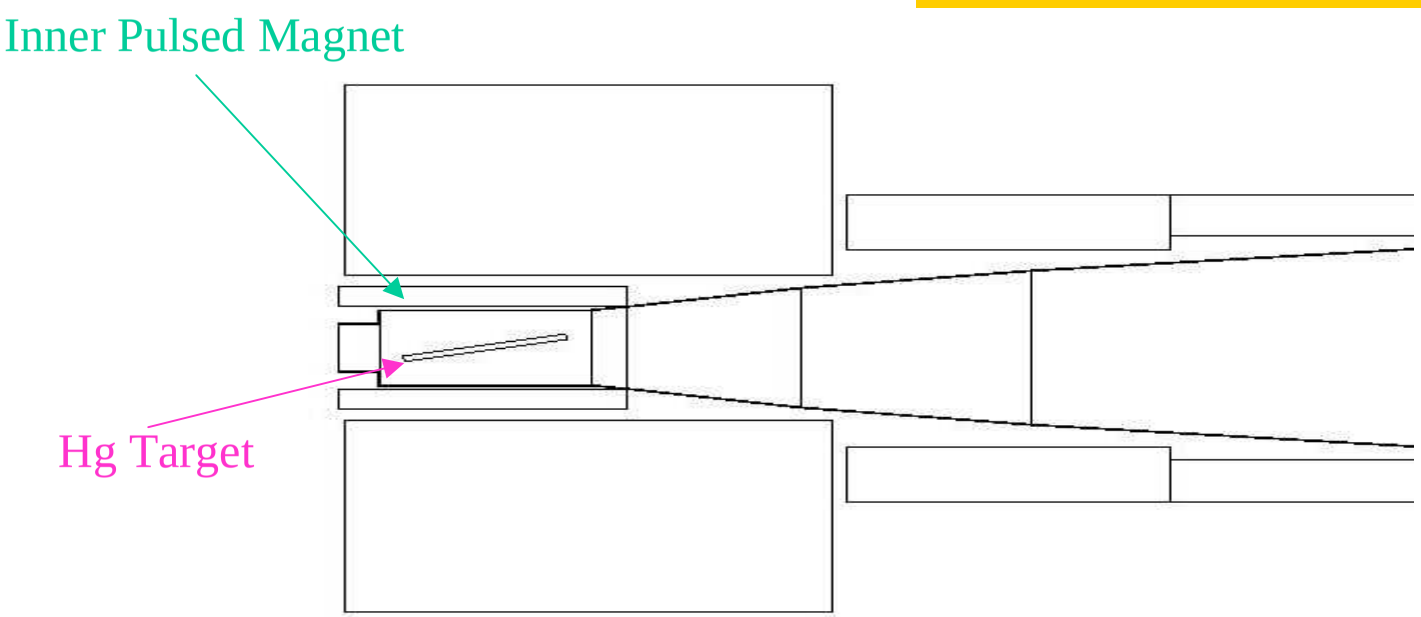
Simulation Goals for the Targeting Experiment

- Estimate particle fluxes into various components of the target system.
  - Particular interest in radiation damage from neutron flux.
- Estimate energy deposit in magnet systems.
  - We are interested in the possibility of using superconducting magnets near RF cavity in target exp.
  - We would definitely be using superconducting solenoid in an eventual neutrino factory.
- We are interested in understanding background and measurement problems associated with the measurement of the pion spectrum.
  - Yasuo Fukui will discuss the issues related to the pion spectrum measurement.



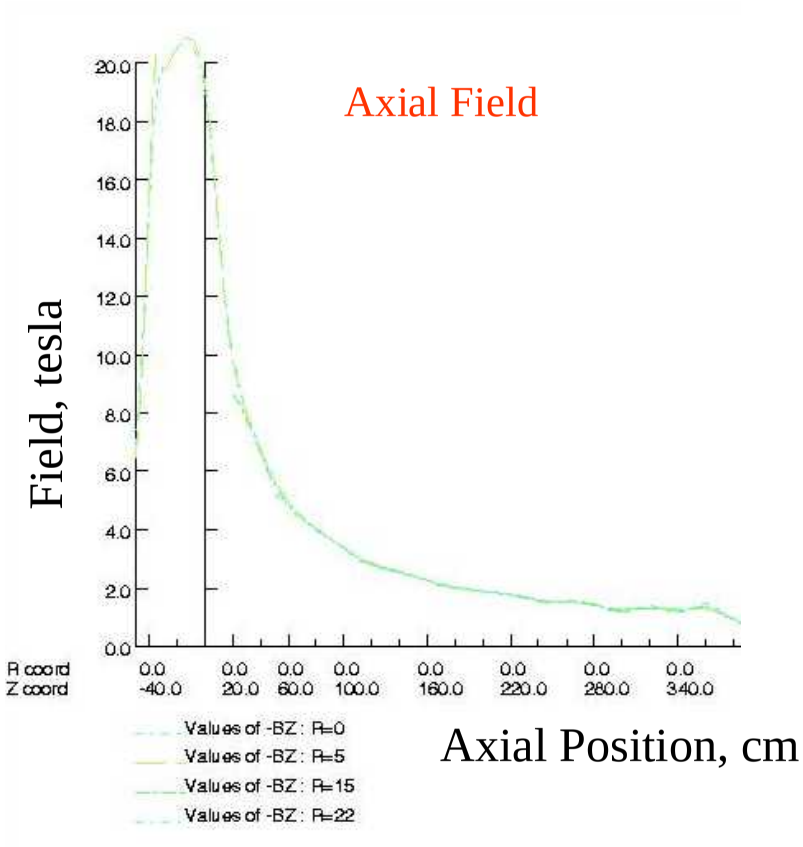
GEANT drawing of E951 geometry

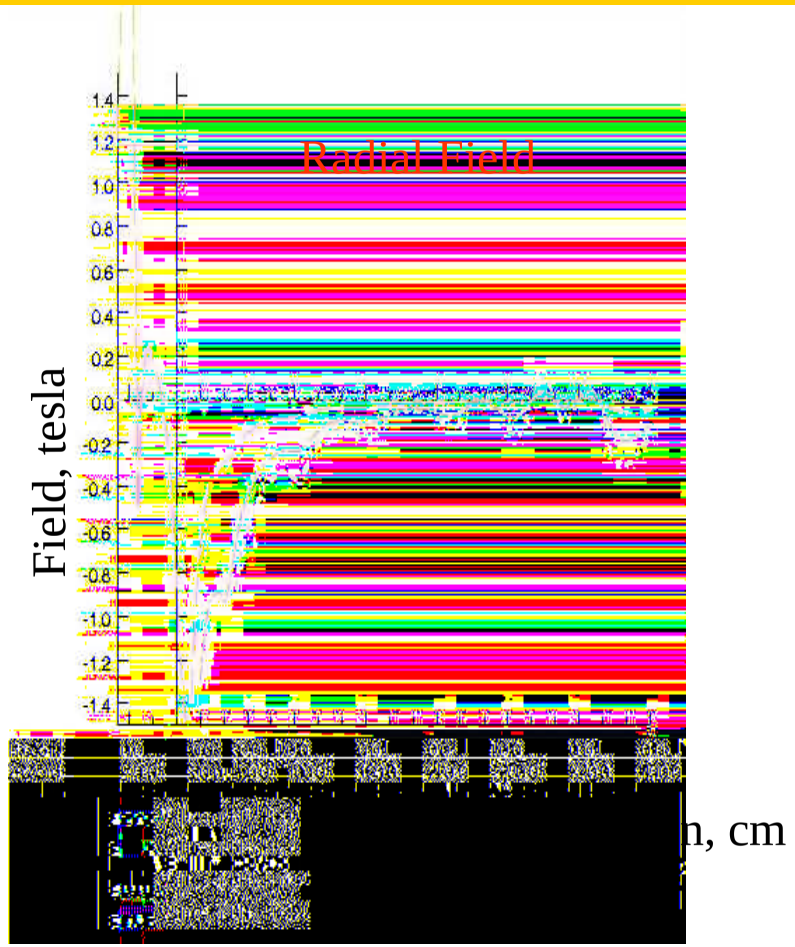


GEANT for Targetry Experiment

- An initial version of a GEANT exists for the targetry experiment.
- Basic geometry description:
  - Target
  - Magnets
  - RF cavity
  - Beam containment vessel
  - TPC in bent solenoid as detection (This is may change)
- Magnet Field Description:
  - Cylindrically symmetric field map created from Bob Weggel's description of the magnet system using Opera2D
  - Bent solenoid measurement channel described using elliptical integral description

Magnetic Field In Channel

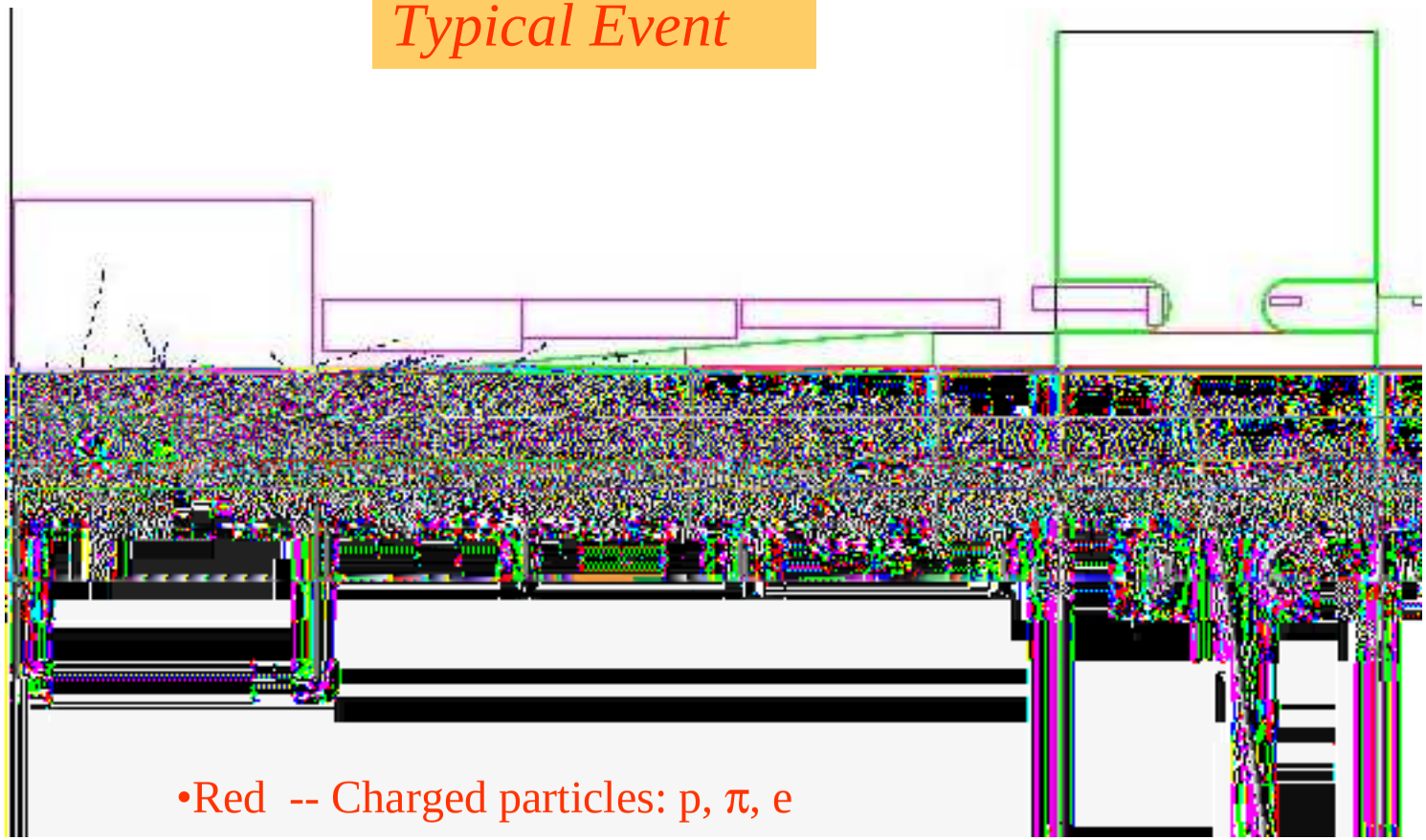




GEANT (continued)

- RF Field Description:
  - Use P. Lebrun's modifications to GEANT Runge-Kutta routines for **E**(t) fields. Some small difficulties with full implementation of DPGEANT.
  - Implemented RF acceleration cavities similar to ICOOL:
    - ICOOL type 2 -- Cylindrical pillbox
    - ICOOL type 4 -- Symmetric circular

Typical Event



•Red -- Charged particles: p, π, e

•Blue -- Photons

•Black -- Neutral particles: n

•Green -- Muons

Particles Exiting Target

- 2.0 λ Hg target
- Target inclined 150 mrad to axis
- 24 GeV incident proton beam
- 7 mm target radius
- 20 Tesla solenoid field

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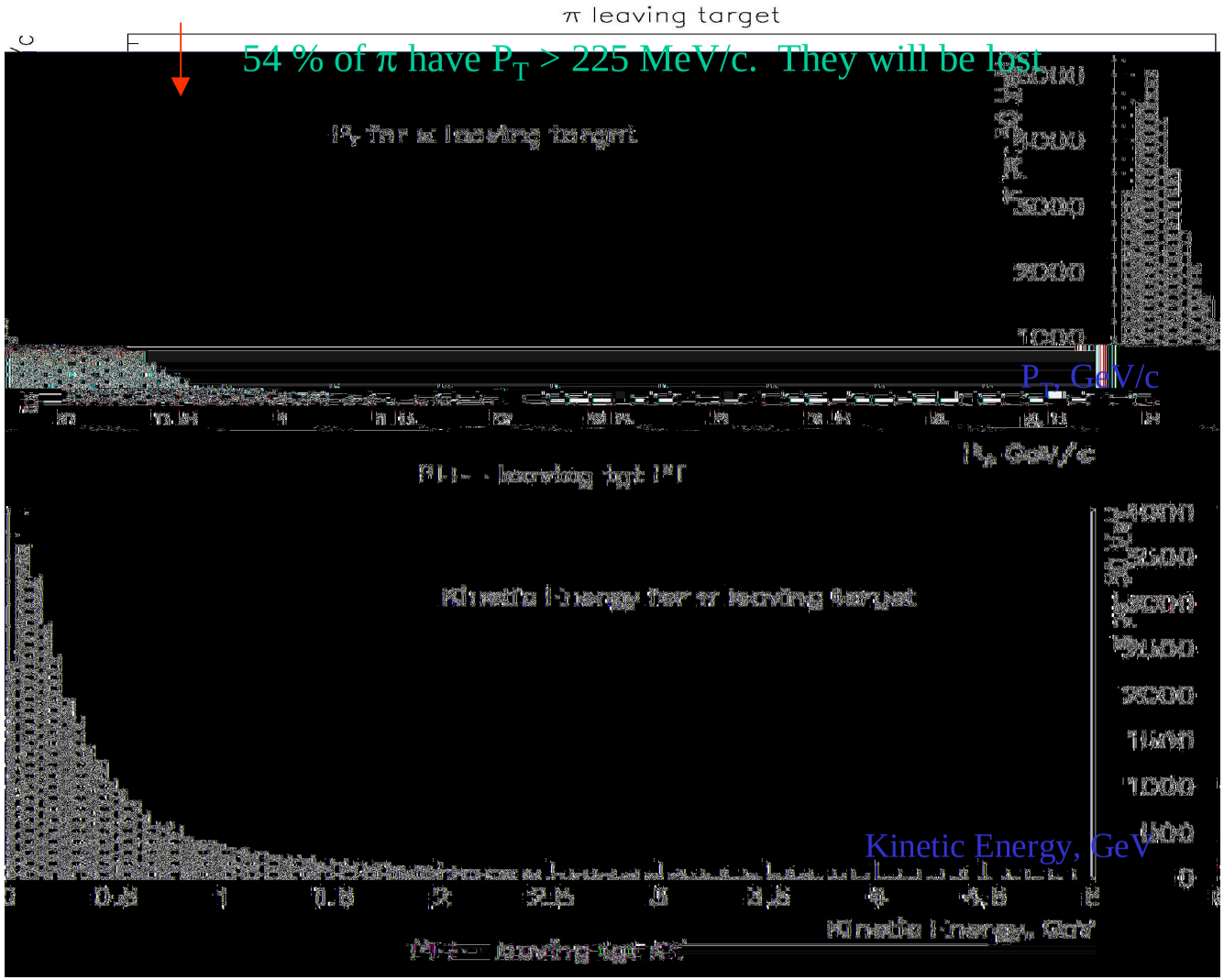
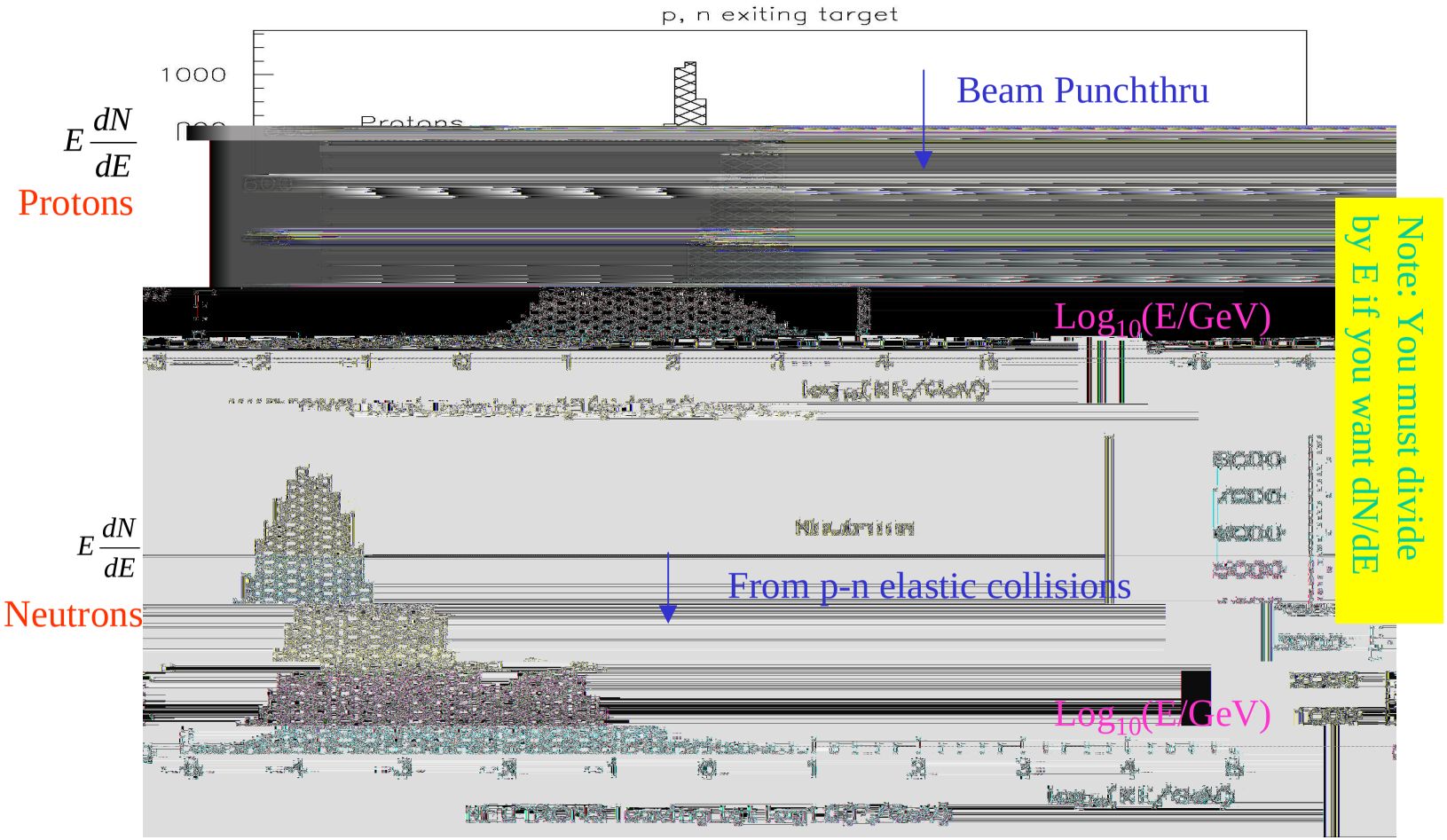
Particle	Hi Energy	All Energies
gammas	263.4	461.655
$e^{+/--}$	25.38	53.4
ν	1	9.425
$\mu^{+/-}$	0.04	0.105
$\pi^{+/-}$	6.98	21.28
n	50.76	55.13
p	5.5	7.435
Pp cut	0.001	0.0001
Pe cut	0.001	0.0001
Pn cut	0.001	2.15E-12
Pmu cut	0.001	0.0001

π Momentum Distributions Leaving the Target

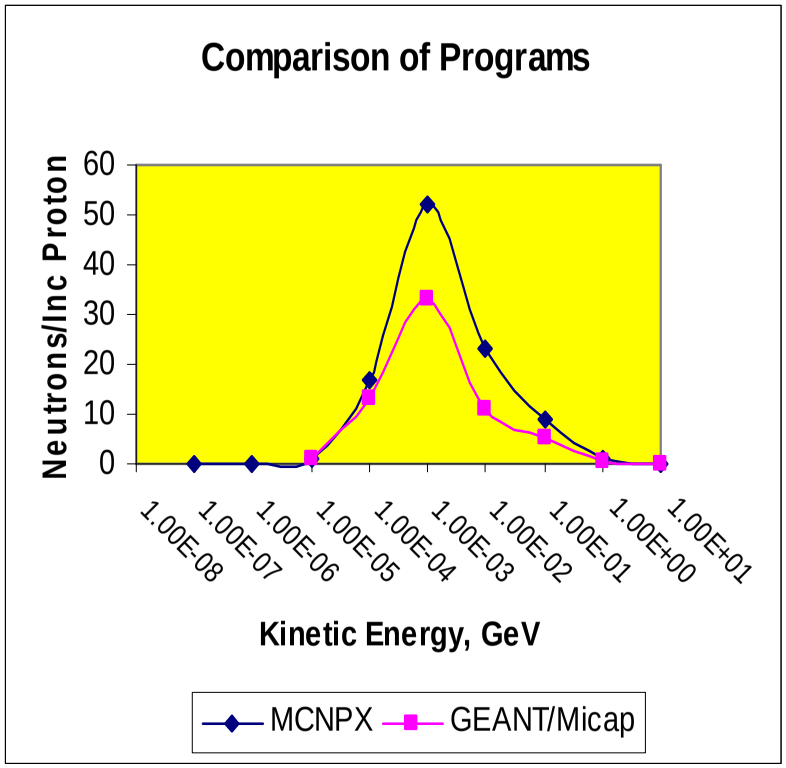


Energies of Neutrons and Protons as They Leave the Target

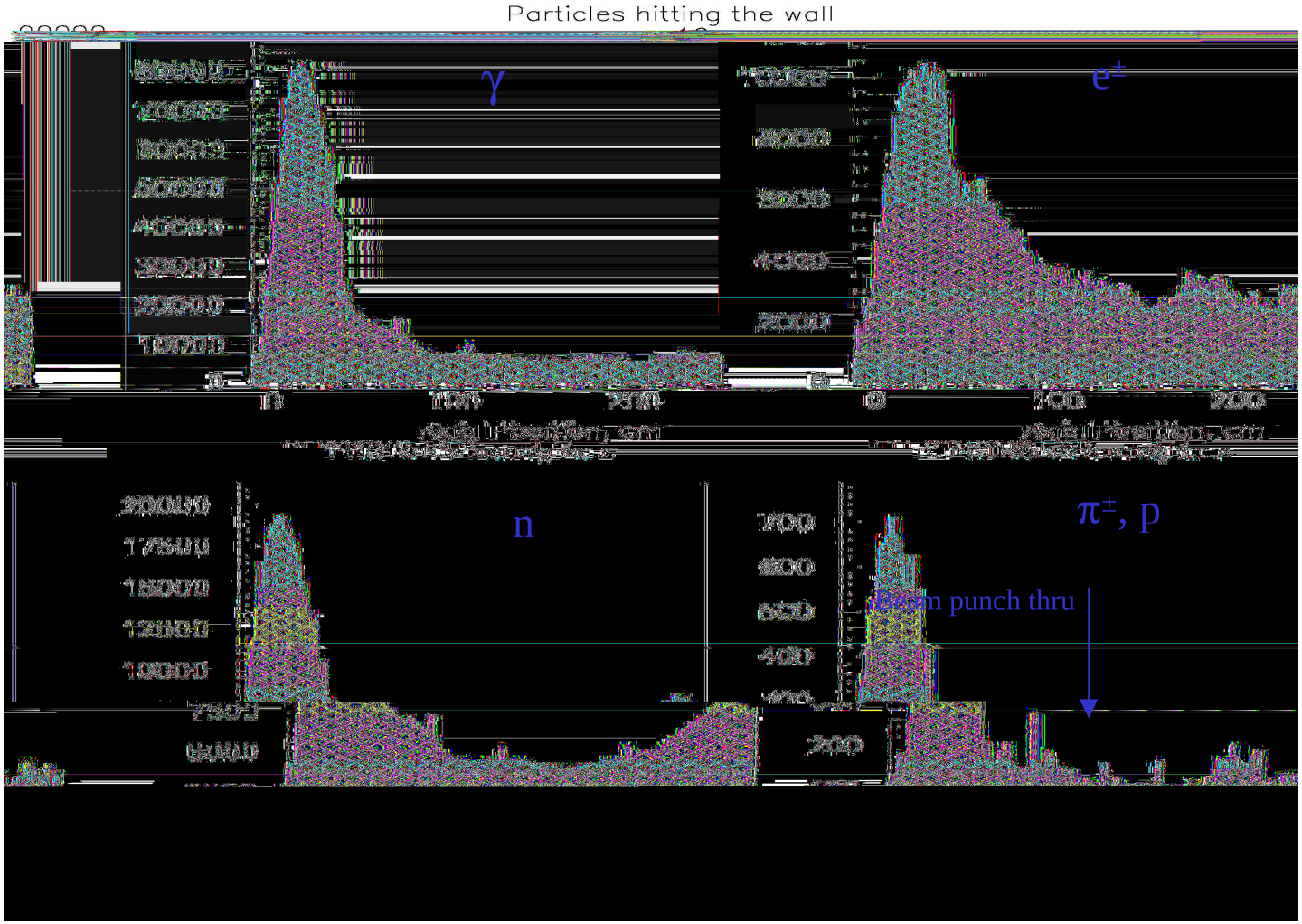


Comparison of MCNPX to GEANT

- As a validity check of the particle production rate, MCNPX was run with a similar geometry.
  - MCNPX show ~50% more neutrons.
- I am trying to get a e/γ sample for comparison but MCNPX is extremely slow and the job is still running.



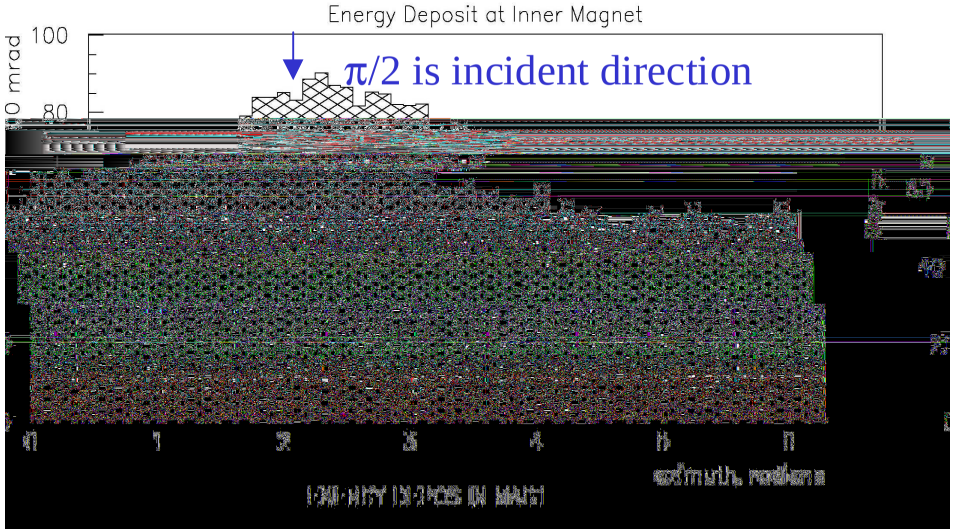
Where Do Particles Hit



Energy Deposited in Inner Magnet

- Inner coils of solenoid system occupy the radial space 10.7 to 17.8 cm from the axis.
- The inner coils subtend from 27°→153°. That is 89% of the solid angle.
- The table indicates that 8.7% of beam energy is deposited in the *Inner Coils!*
- A 50 TP proton beam will deposit *0.79 joules/cm*^{3} on average.
- ~3 μjoule in *minimum propagating zone* will quench a magnet
  - MPZ is ~1 cm × (0.75 mm)^2

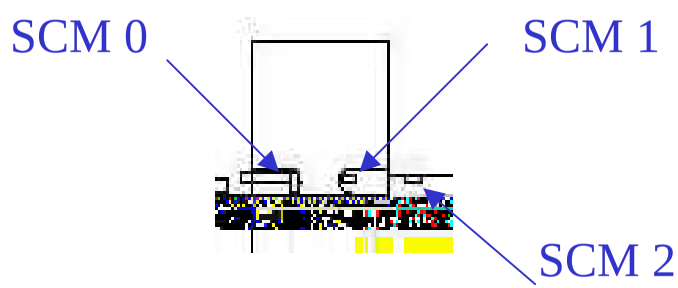
Particle Type	Energy per Incident Proton (GeV)	Energy deposited per pulse (joule/cc)
Photons	0.14535	0.054982
Electrons	1.31295	0.496655
Neutrals	0	0
Chg Hadrns	0.6212	0.234983
Muons	0.00355	0.001343
Heavy Ions	0.0042	0.001589
Total	2.08725	0.7895



Energy Deposited in Superconducting Coils

- Can we use SC magnets to provide the field at the cavities?
- Adjacent table shows energy deposited near 1st RF cavity.
  - SCM 0 can't be SC.
  - SCM 1 can't be SC.
  - SCM 2 is questionable

Magnet	Energy Deposited Per Proton	Energy Deposited Per 50 TP Pulse
	(GeV)	(joules/cm^3)
SCM 0	0.0276	0.0426
SCM 1	0.0164	0.0253
SCM 2	0.00094	0.0012



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Energy Deposition
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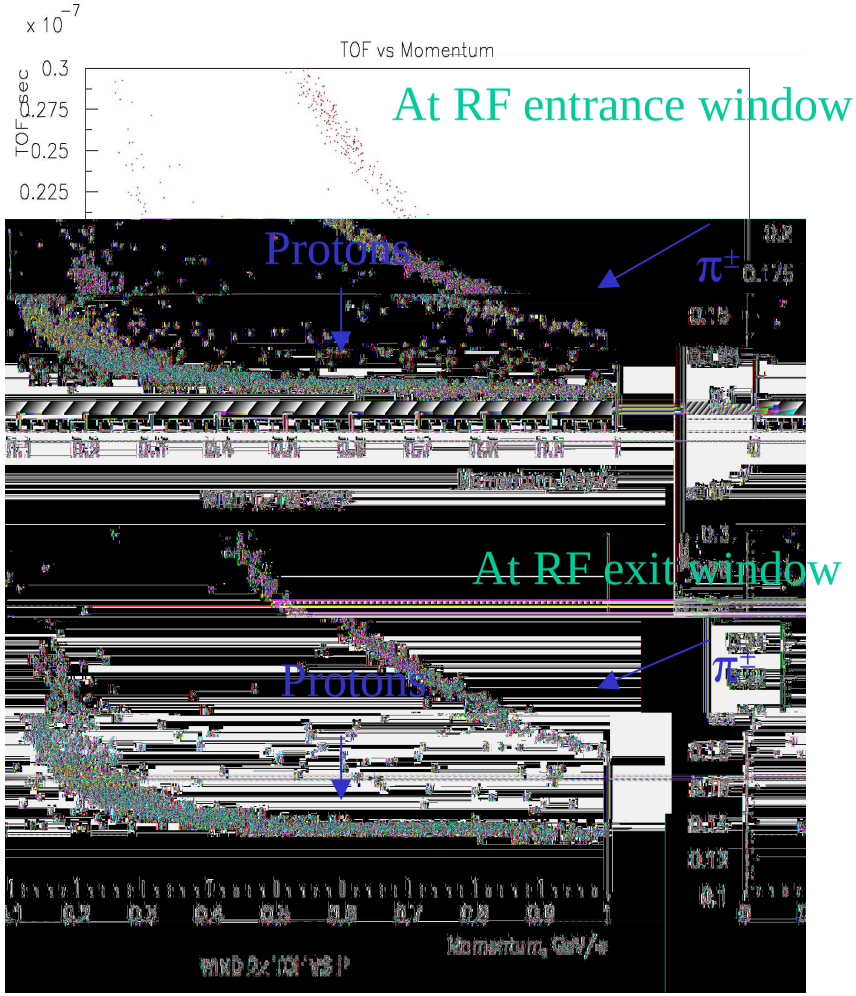
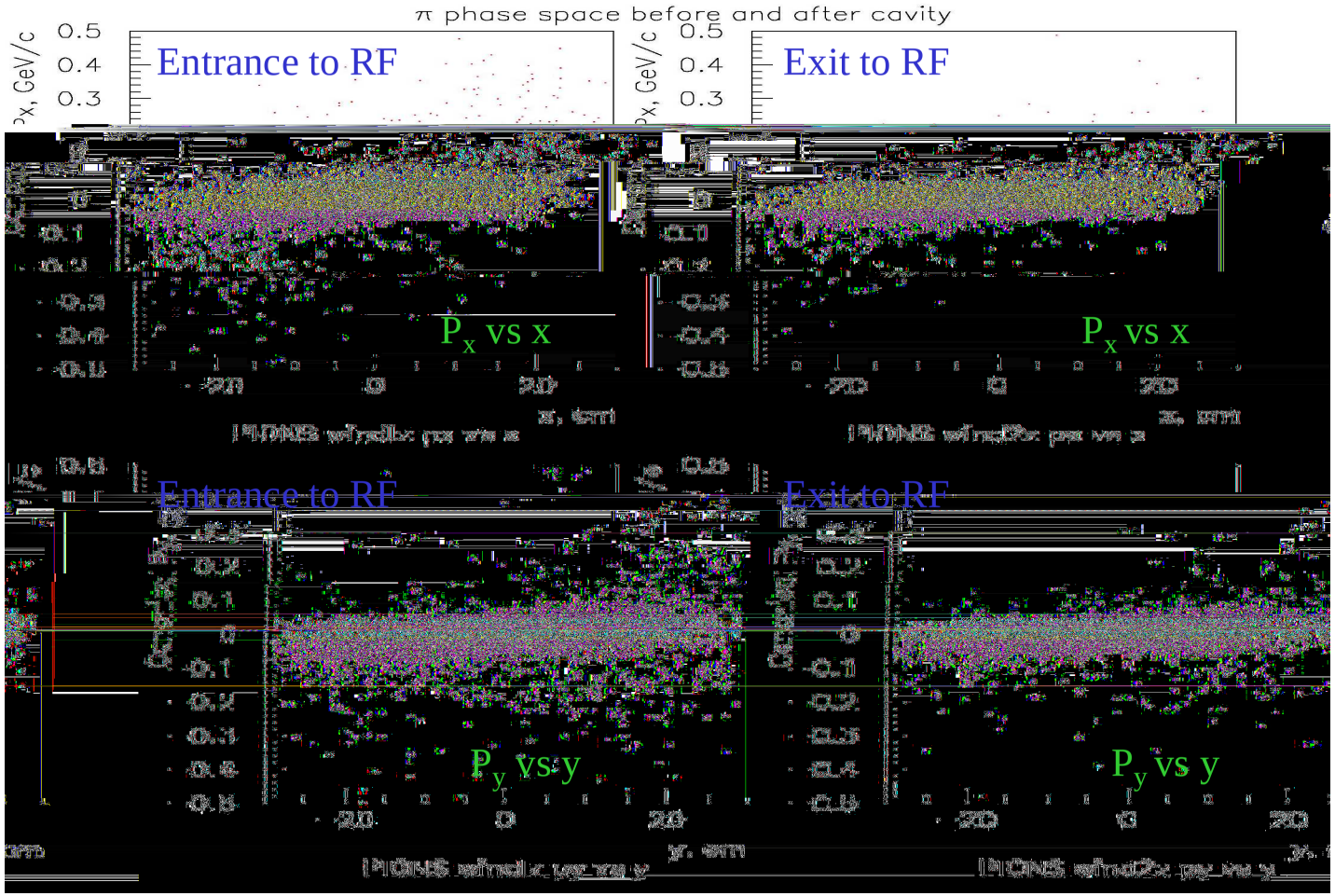
Time of Flight

- Figures show TOF vs. p for charged hadrons at the entrance and exit windows to the RF cavity.
- There appears to be clean separation between π and protons since the protons are slower.
- However I have assumed no longitudinal spread in the incident proton beam!
- Y. Fukui will examine the detection issues in the next talk.



Phase Space Variables at the Entrance and Exit of the RF Cavity