Preliminary SVT bkg studies with the new simulation

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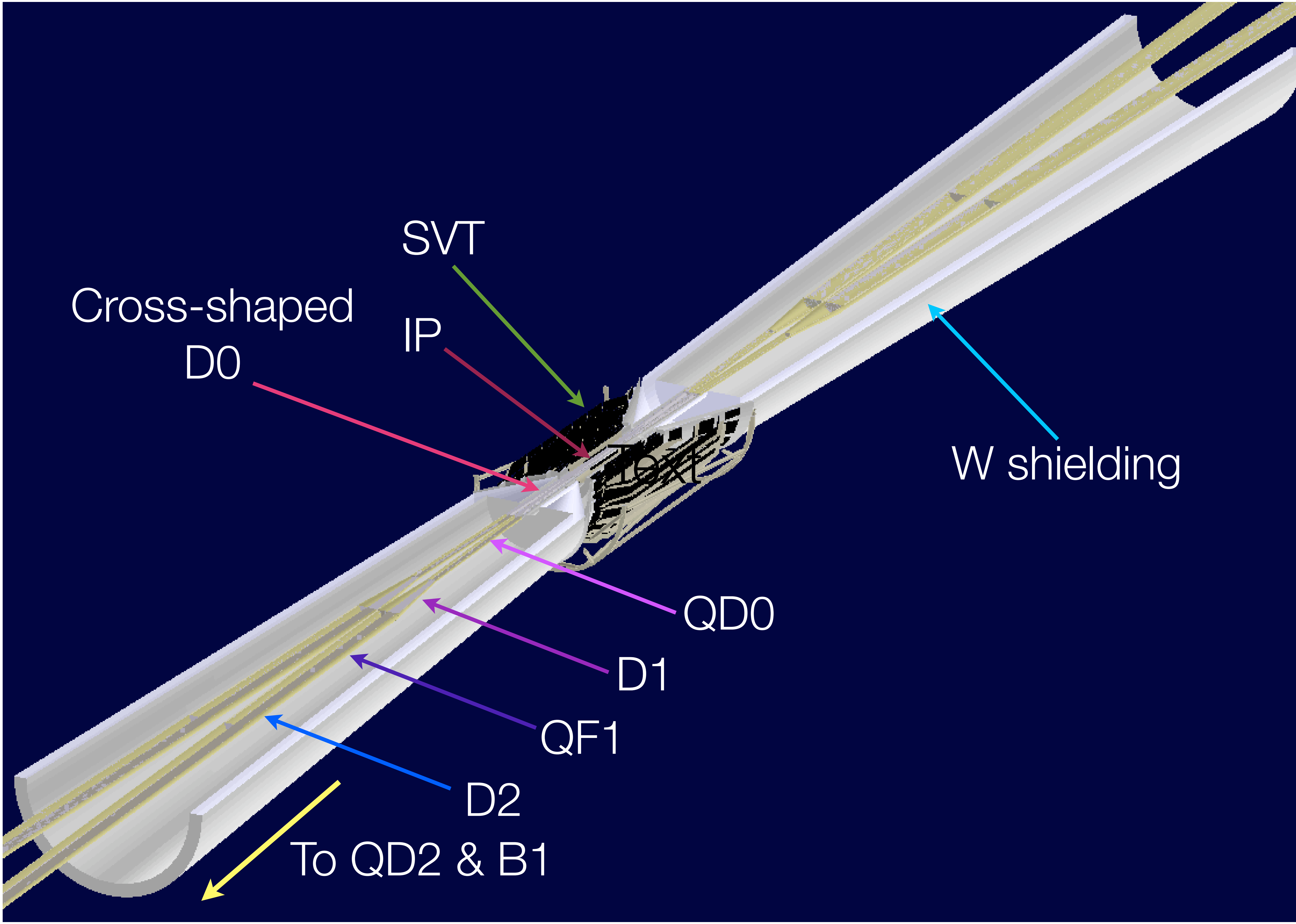
Backgrounds (to be) simulated

- Main processes **expected**@SuperB:
  - **Luminosity**-dependent:
    - radiative (and elastic) Bhabhas
    - pair production
  - **Bunch density**-dependent:
    - Touschek (HER, LER)
  - **Current**-dependent:
    - beam-gas scattering
    - synchrotron radiation

- first bunch of (few, very time consuming) bkg events very recently **simulated** with quite realistic SuperB model:
  - radiative Bhabhas
  - Touschek in the LER
  - pair production
- a **very preliminary** analysis of the SVT bkgs in those events is shown here

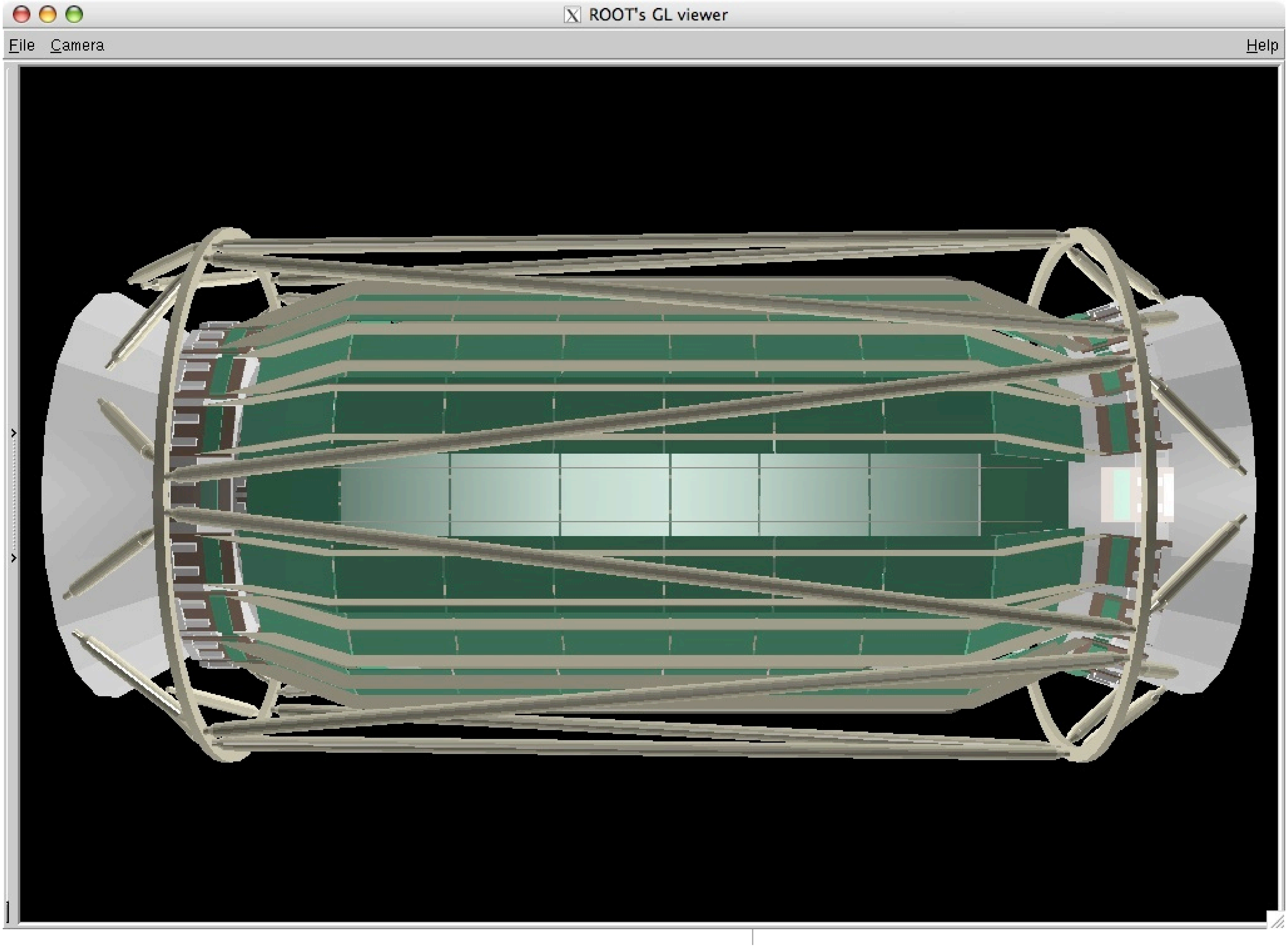
New Interaction Region simulation

- Parameters of new final focus from MAD files of HER/LER FF (Marica)
  - converted to GDML via a custom version of BDSIM (Geant4-based tool for beamline studies) (GM)
    - automatic positioning of all the optics elements (modeled as iron cylinders)
    - automatic addition of straight drift sections (iron cylinders 1 mm-thick)
  - the magnetic field multipole coefficients are also stored (as additional volume attributes) in the GDML file (hacked the Geant4 GDML writer, GM)
    - read-back and setting of correct magnetic field inside not yet fully deployed, temporarily hard-coded into the C++ simulation code
  - some manual work required in order to:
    - have the two beamlines coexist
    - place a cross beampipe around the I.R.
    - place a 3cm-thick W shielding around the beamline (previously was between 6 and 13 cm)


SVT
Cross-shaped
D0
IP
Text
W shielding
QD0
D1
QF1
D2
To QD2 & B1

More detailed SVT model

- The previous (CDR) simulation used a simplified SVT model:
  - 6 cylinders in the barrel (L0 @r=1.2 cm, 50 μm thick, L1-5 @same r as in BaBar)
  - 2 wedges in the forward and backward directions (L4-5, like current SVT)
- The current simulation uses a more realistic SVT model:
  - the BaBar SVT, with 5 layers of Si wafers, ribs, supporting cones (obtained directly from the full BaBar Geant4-based MC, EP)
  - + inner L0 (r=1.5 cm, 9 cm long, 300 μm thick)
- The hit-counting algorithm has remained the same as in the CDR simulation
  - in every layer, 1 SVT hit = sum of all the Geant4 hits with $|\Delta z|<50$ μm, $|\Delta r|<50$ μm and $|\Delta r|<300$μm (may be inappropriate for MAPS in L0)


ROOT's GL viewer
File
Camera
Help

Radiative Bhabha's ($e^+e^- \to e^+e^-\gamma$)

- showers and backscattered particles in the downstream beamline elements
- 10 BX (frequency=209 MHz → 50ns) simulated with E_γ > 10% E_{beam} (simulation interfaced to BBBREM generator by EP)
- In the CDR: rate O(100kHz) @ 1.2 cm, lower in outer layers
- With the current FF (stat. errors only, due to limited MC stat.):

Layer	Rate e-	Rate e+
0	1.0±0.5 MHz/cm^2	1.5±0.6 MHz/cm^2
1	negligible	negligible
2	negligible	negligible
3	negligible	negligible
4	negligible	negligible
5	negligible	negligible

- higher in L0, but tolerable
- more stat. needed
- investigate shielding close to L0

Touschek background

- Intra-bunch Coulomb scattering ⇒ depends on bunch density ⇒ beamline optics
- Major source of concern during CDR finalization
- Simulation interfaced to external generator of Touschek particles provided by Manuela Boscolo (LNF), which takes into account
  - lattice optical functions
  - possible collimators
- With CDR FF, expected rate in L0 was 23 MHz/cm^2! With new FF and scrapers:

preliminary

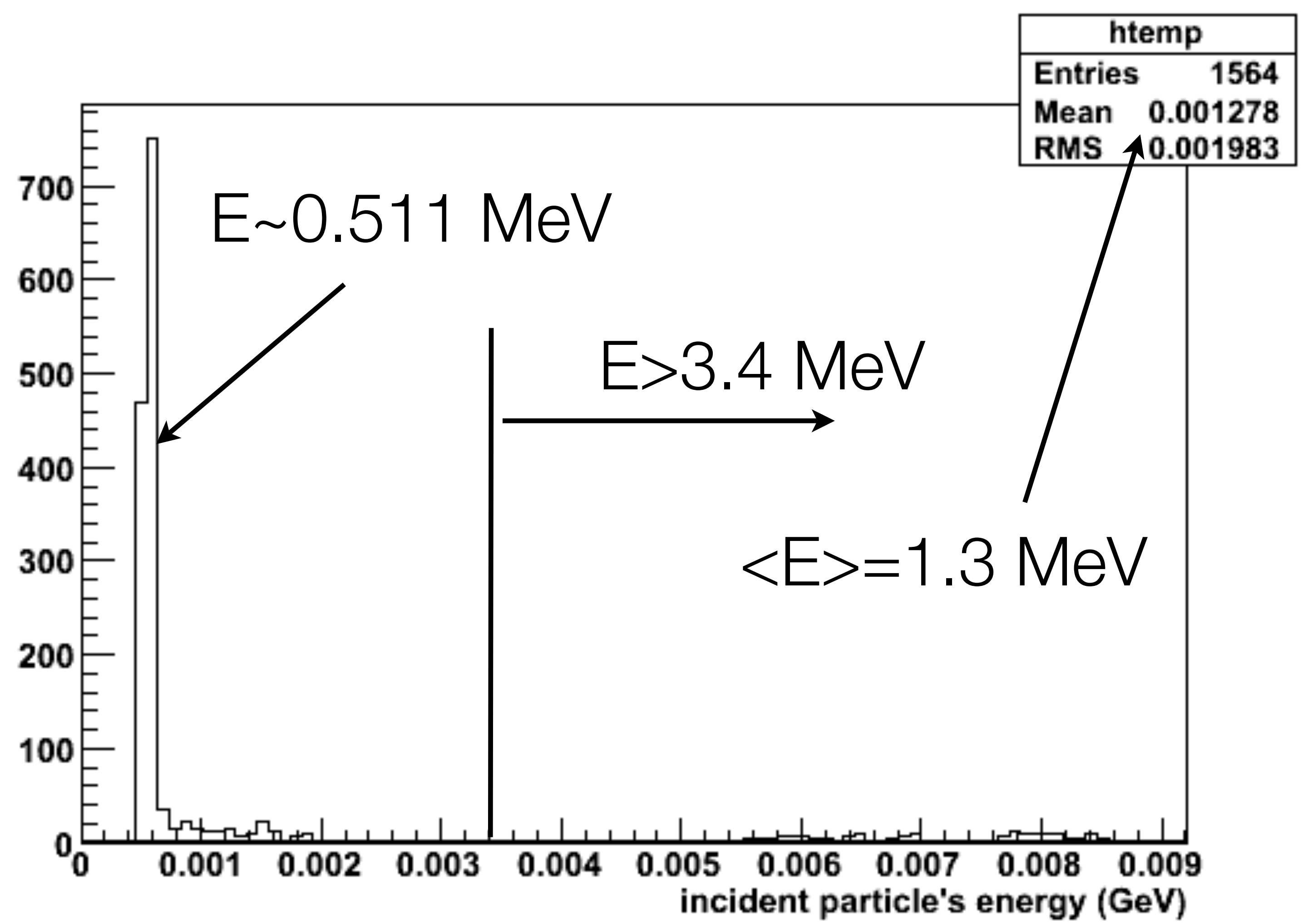
Layer	e- from LER	e+ from LER	e- from HER	e+ from HER
0	12.8±1.4 kHz/cm^2	1.3±0.1 kHz/cm^2	537±17 kHz/cm^2	170±10 kHz/cm^2
1	5±2 Hz/cm^2	2.9±1.5 Hz/cm^2	50±3 kHz/cm^2	20±2 kHz/cm^2
2	6±2 Hz/cm^2	2.9±1.3 Hz/cm^2	16±1 kHz/cm^2	7.2±0.9 kHz/cm^2
3	324±80 Hz/cm^2	8.4±1.5 Hz/cm^2	6.4±0.5 kHz/cm^2	0.8±0.1 kHz/cm^2
4	127±35 Hz/cm^2	0.05±0.01 Hz/cm^2	1.2±0.1 kHz/cm^2	0.12±0.03 kHz/cm^2
5	19±5 Hz/cm^2	5±1 Hz/cm^2	0.56±0.06 kHz/cm^2	~0 Hz/cm^2

Pair production ($e^+e^- \rightarrow e^+e^-e^+e^-$)

- Very high production rate (σ~7.3 mbarn ⇒ R~7.3GHz at $L=10^{36}cm^{-2}s^{-1}$)
- Soft particles, typically loop in solenoidal field and affect only the tracker
- Not fully simulated with Geant4 for CDR - bkg estimate based on kinematics
  - Expected average rate = O(15MHz/cm^2) @r=1.2cm, 5MHz/cm^2 @r=1.5cm assuming perfectly helical trajectories, using GuineaPig
- Recently simulated 700 events (~100ns) (interface to Diag36 by EP)
  - bkg mainly due to electrons (positrons annihilate before hitting the SVT)
  - between O(100) and O(5) kHz/cm^2 in L1-5
  - discrepancies between the expected rate and momentum distribution of incident particles in L0 currently not understood

Pair production bkg in L0

- Energy spectrum of slow e± particles hitting the L0 softer than expected
  - in the pure helical case, only tracks with pT>3.4 MeV reach the L0 @1.5 cm
  - we see hits due to particle with total energy down to the e rest mass:

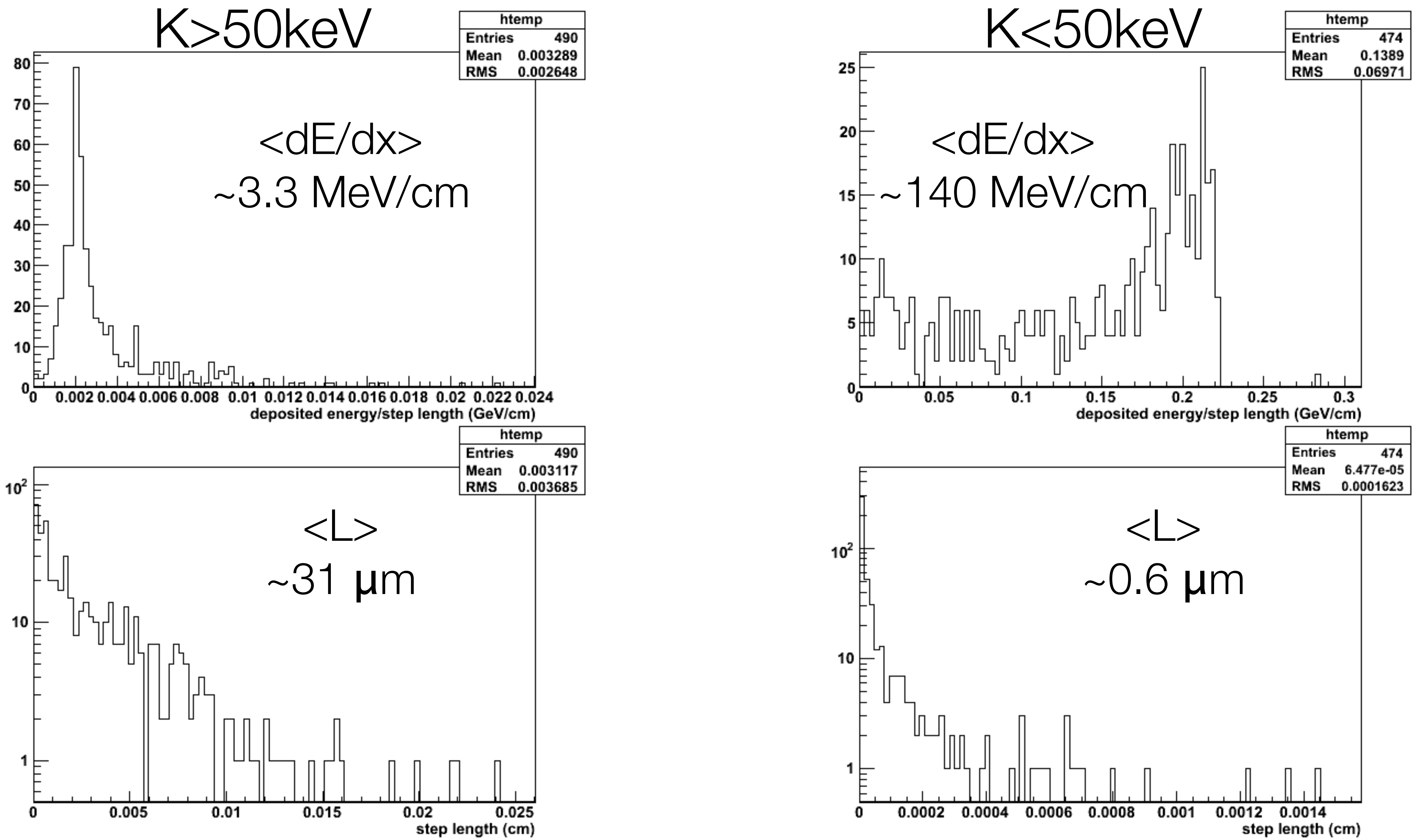


More on pair production and L0

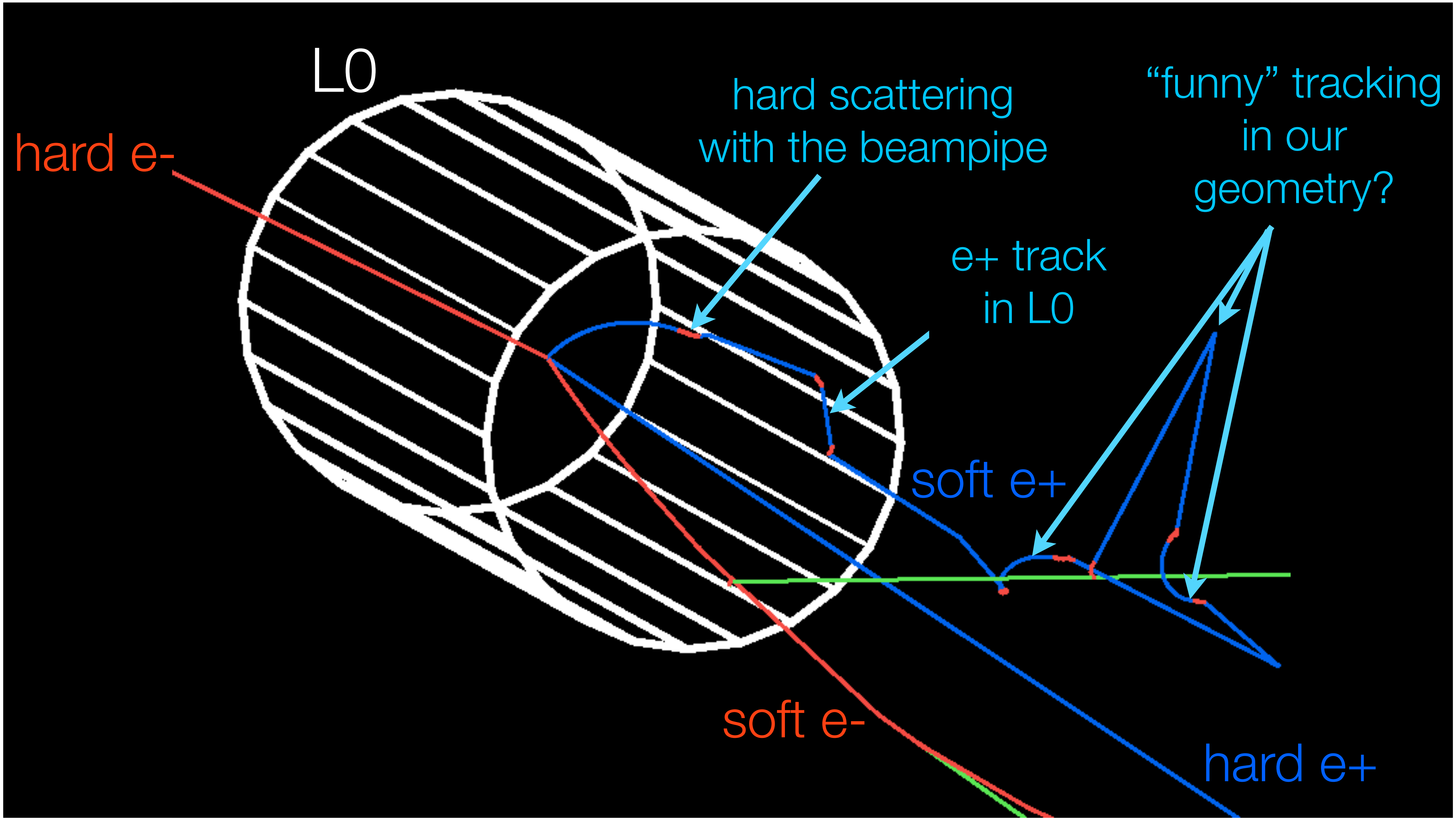
- Naive hit-counting yields a ~5x higher bkg hit rate than expected
  - is there a problem with the way we (don't?) deal with low-energy secondaries?
    - do we have to tune production cuts for secondary particles in the Geant simulation?
    - include in the offline analysis the total energy of the cluster?
  - is this just the effect (non-negligible) of hard scattering of soft particles?
  - do we need to add an Au/Ta foil to central beampipe?
  - is there something strange going on with the Geant4 tracking?
  - do we have to model adequately the charge collection in the silicon thickness (only the charge in the thin epitaxial layer is collected by MAPS)?

Secondary particles (delta rays)?

- Looking at incident kinetic energy, deposited energy and step length there are clearly two different regimes



Looking at one peculiar event



Conclusion

- Two main goals achieved:
  - realistic FF and SVT models implemented in Geant4 bkg simulation
  - preliminary study of main bkg sources encouraging (apart not-yet-understood background from soft particles in pair production), but needs more statistics
- Still lots of important work to do:
  - Extensive debug of geometry/fields/tracking, understanding soft particles' bkg
  - Reconsider definition of physical hits
  - Implement digitization
  - Include single beam bkgs (lost beam, SR) in simulation and study impact on detector
- We are lacking both expertise AND manpower. You are welcome to JOIN us!