ILCroot CLICCT
Tracker and Vertex hits
for latest MARS simulation

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Muon Collider Physics and Detectors Meeting

Jan. 26, 2011
Fermilab

Outline

- Introduction.
- CLICCT Tracker and Vertex hits for MARS photons, neutrons and e+e-.
- Merging MARS background with single muon physics events.
- Conclusion.

Introduction

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- **MARS latest simulation results available since Nov. 18, 2010, see http://www-ap.fnal.gov/~strigano/mumu/mixture/**
  - **mu+ and mu- 750 GeV 2e+12 beams**
  - **10 degrees nozzle geometry**
  - **4.8e+05 simulated mu decays on the length of 26 m for each beam,**
    -25 < Z < 1 for mu+ beam (file excl-25to1m-mupl)
    -1 < Z < 25 for mu- beam (file excl-1to25m-mumi)
    each file has about 5M particles
  - **2.4e+07 simulated mu decays on the length of 164 m for each beam, mostly only muons written to files**
    -189 < Z < -25 m for mu+ beam (incl-mupl-189to25-2p4e7)
    25 < Z < 189 m for mu- beam (incl-mumi-25to189-2p4e7),
    each file has about 0.44M particles
- **0.1M and 1M samples from MARS text files for both beams were joined and converted to ROOT files ready for simulation in ILCroot**

Introduction

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- **To look at CLICCT (tracker and vertex detector) response to ID specific particles:**
  - **additional MARS ROOT files were prepared having only ID specific particles from both muon beams (photons - 1M, neutrons - 1M, e+e- - 0.046M)**
  - **run ILCroot simulation on grid for these samples (use no weights)**
  - **results are corresponding output ILCroot files for hits, SDigits (sum able digits) and Digits**
    - **use official layout of CLICCT (see details in Anna's talk, http://indico.fnal.gov/conferenceDisplay.py?confId=3750)**
    - **ignore the fact that MARS simulation is made for 10 degrees nozzle and official ILCroot version is using 6 degrees nozzle (impact of overlap is minor, see Anna's the same talk)**

CLICCT Tracker and Vertex hits for MARS photons, neutrons and e+e-

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- **Reminder that MARS yields/bunch (weights included) for mu+ and mu- beams, each 2e+12 muons, E = 750 GeV and distance 26 m are:**

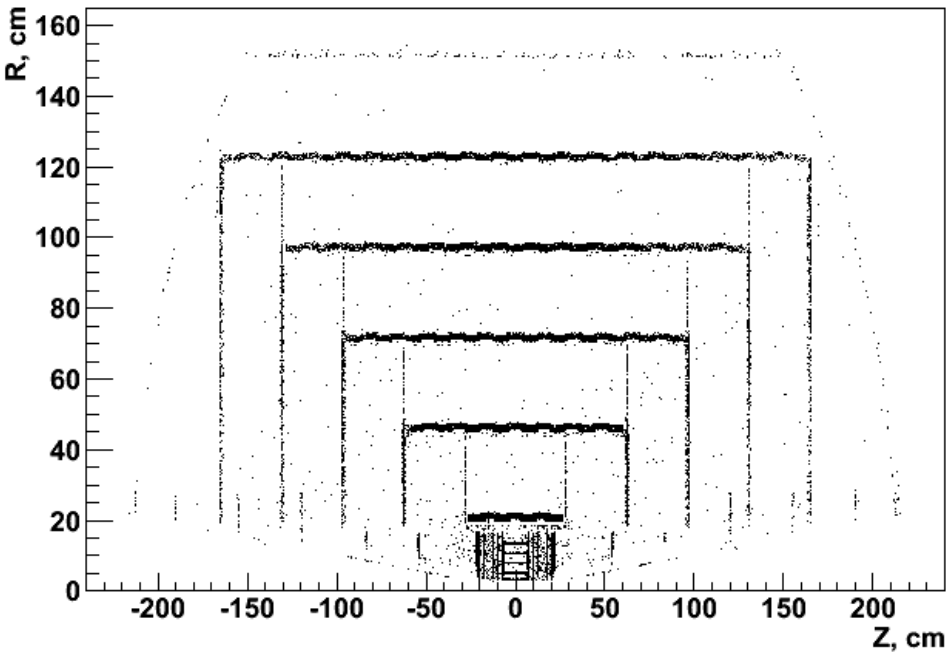
#photons	#neutrons	#e+ e-
~1.8e+08	~4.0e+07	1.0e+06

- **before to make all statistics background simulation in ILCroot it makes sense to answer some questions:**
  - **what fractions of photons, neutrons and e+e- make hits in sensitive volumes of CLICCT?**
  - **their Ptot and Pt dependence ?**
  - **what will be the corresponding fractions for SDigits and Digits?**
  - **…?**

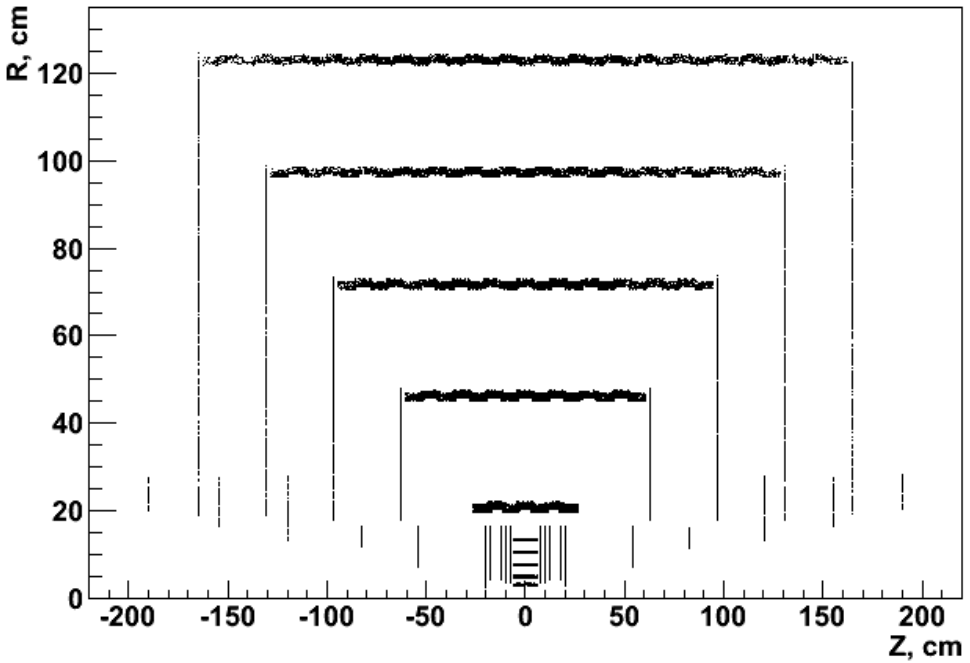
CLICCT Tracker and Vertex hits for MARS photons, neutrons and e+e-

- **Hits from photons, neutrons and e+e- in sensitive volumes of CLICCT**

Z and R coordinates of origin of secondary particles made by photons in ILCRoot detector

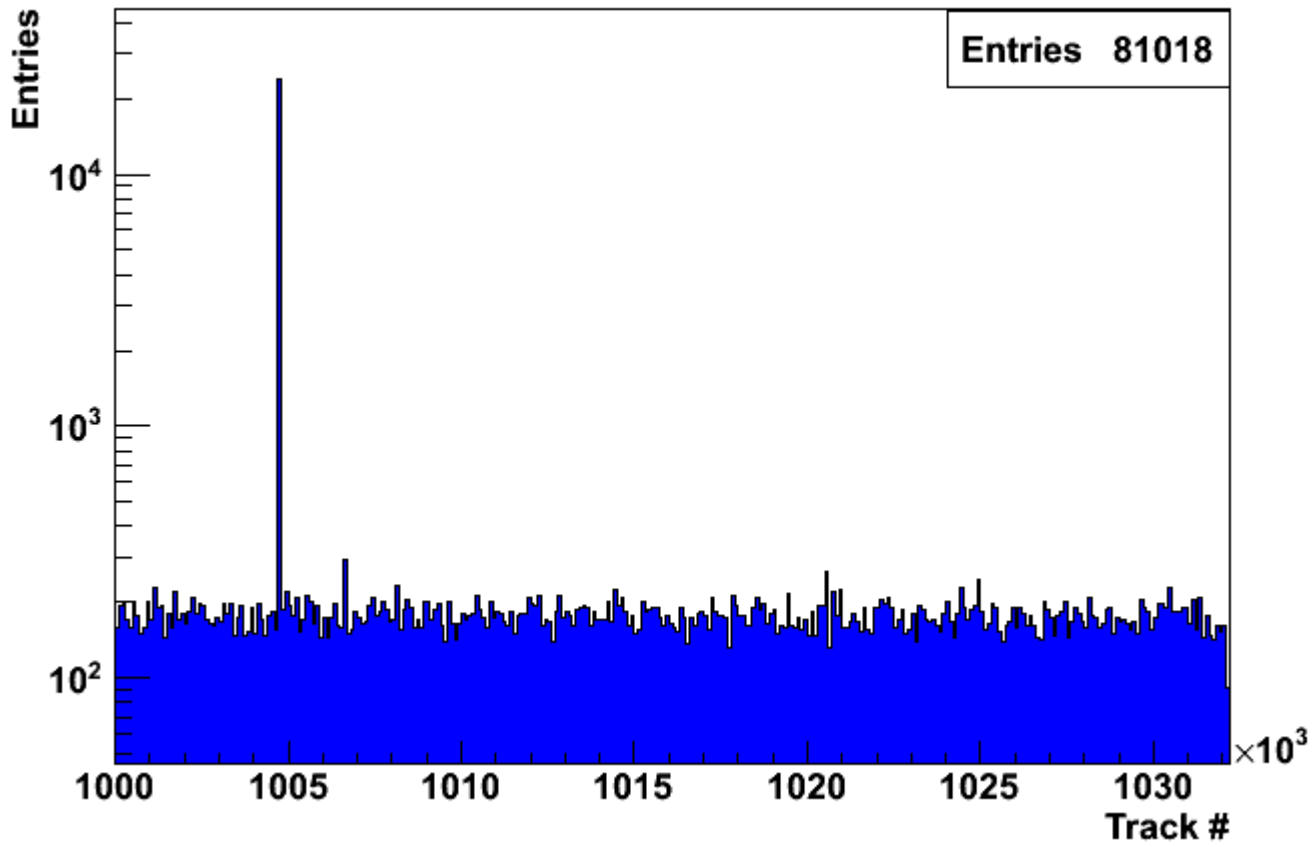


Z and R coordinates of the hits from the secondary particles (mostly e-) produced by the photons



CLICCT Tracker and Vertex hits for MARS photons, neutrons and e+e-

- **Number of CLICCT hits per primary/secondary particle**
  - 1M photons sample
  - hits are produced by secondary particles stopping in sensitive volumes or leaving sensitive volumes
  - one track has abnormally high hit occupancy (discussed later)



CLICCT Tracker and Vertex hits for MARS photons, neutrons and e+e-

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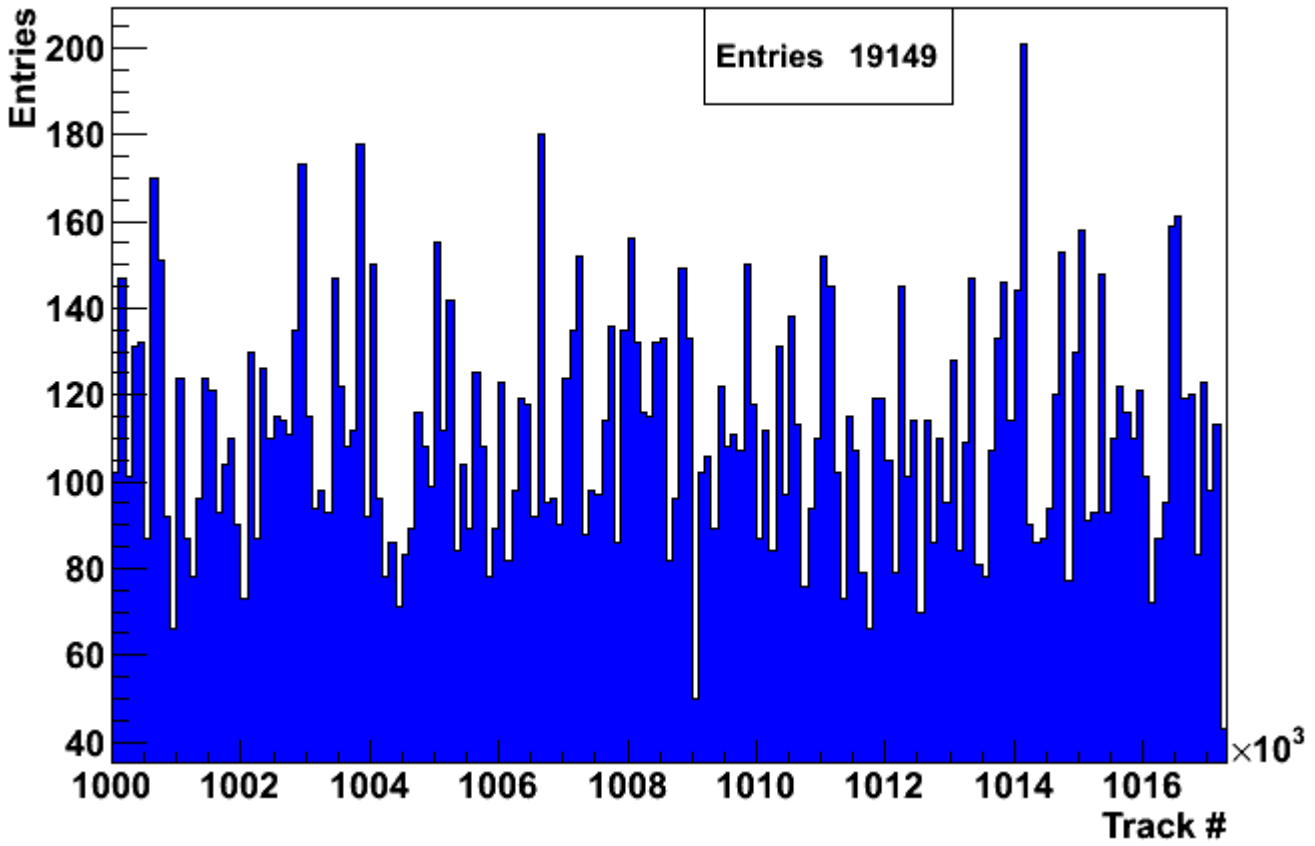
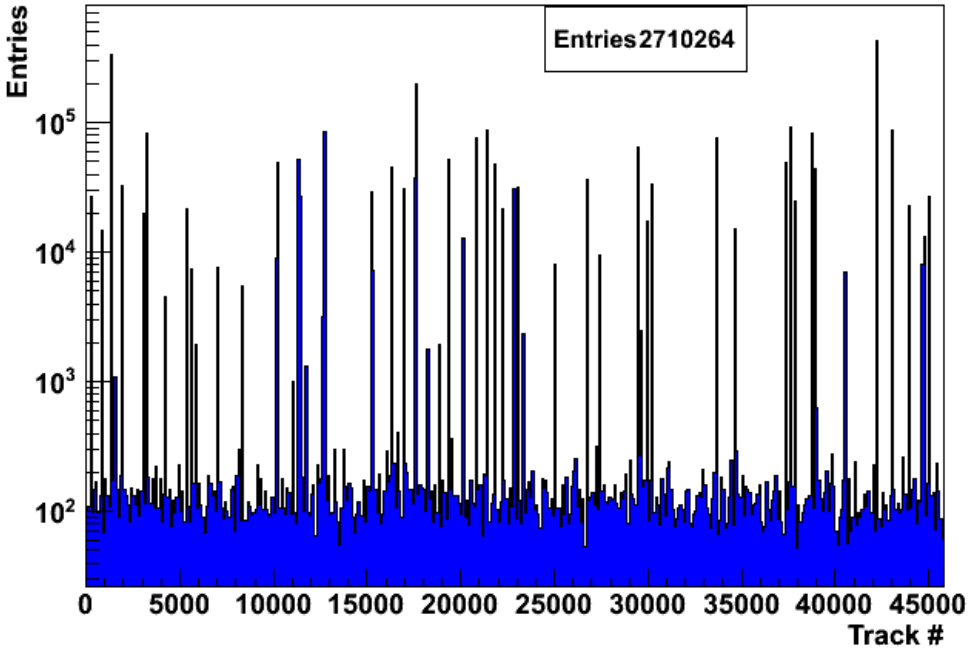
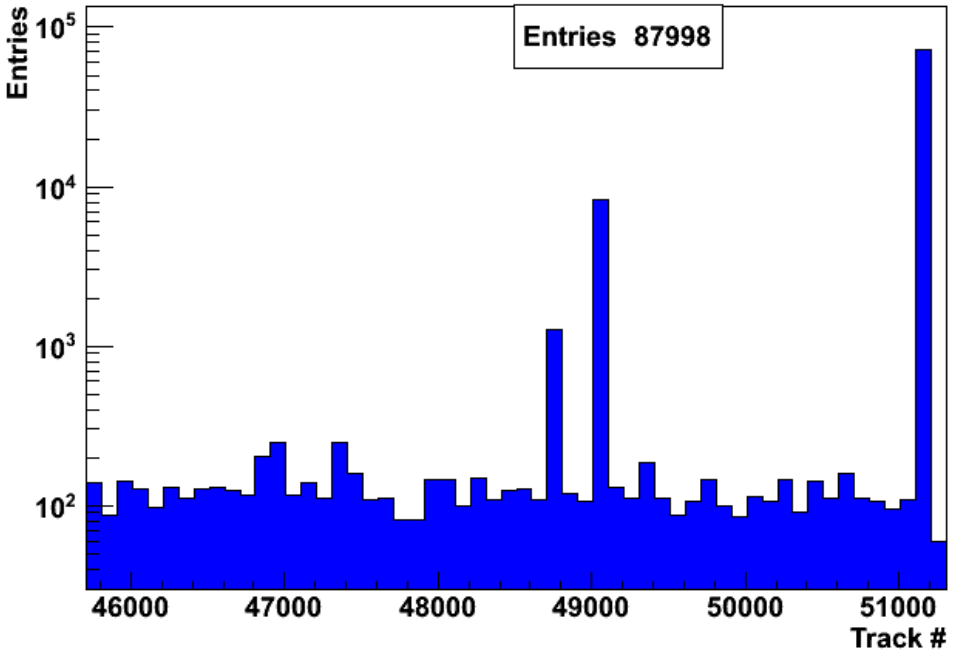
- **Number of CLICCT hits per primary/secondary particle**
  - **1M neutrons sample**
  - **hits are produced by secondary particles stopping in sensitive volumes or leaving sensitive volumes**



CLICCT Tracker and Vertex hits for MARS photons, neutrons and e+e-

- **Number of CLICCT hits per primary/secondary particle**
  - 0.046M e+e- sample
  - hits are produced by primary (left) and secondary (right) particles, stopping in sensitive volumes or leaving sensitive volumes
  - significant contribution of high occupancy hits

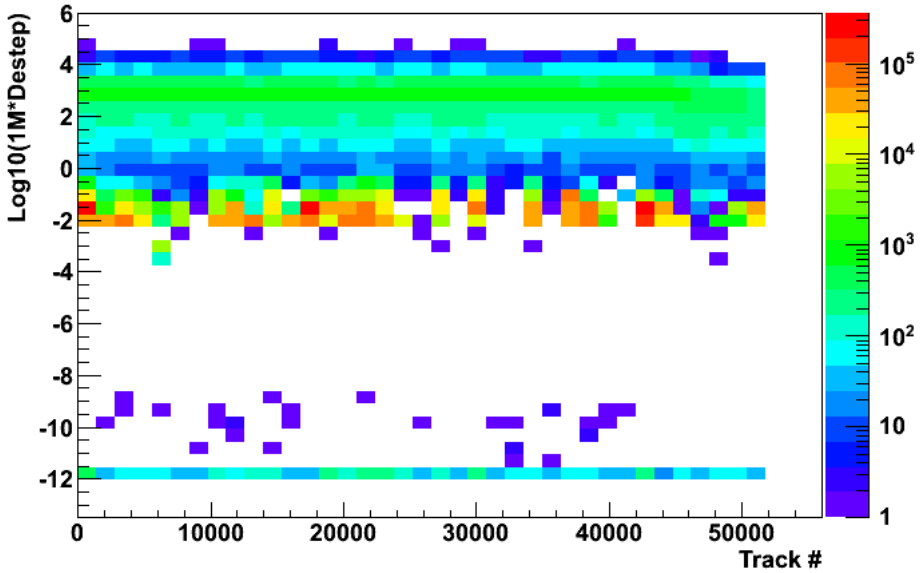


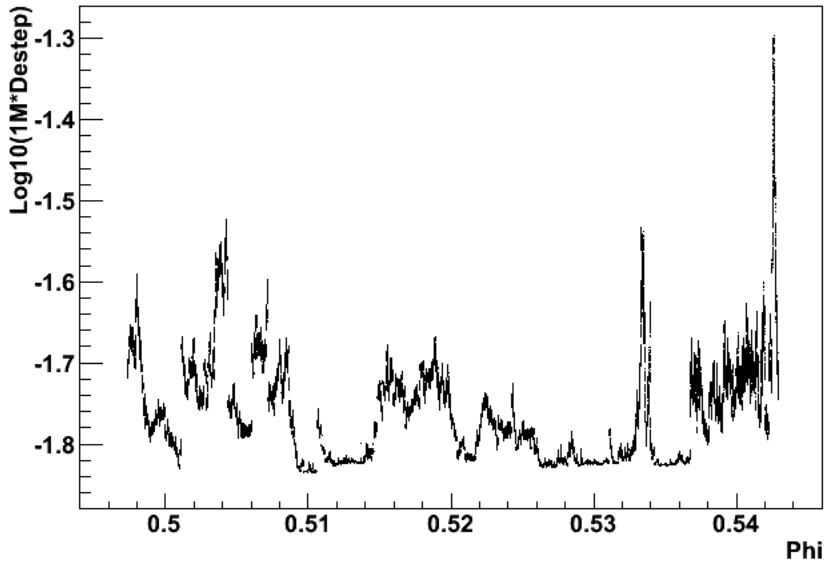


CLICCT Tracker and Vertex hits for MARS photons, neutrons and e+e-

- **Tracks with high occupancy hits (example from e+e- sample)**

  - the hits with low deposited energy, Log10(1m*Destep) ~ -1.7 (see picture on the top)
  - e- primary track #42221 having 428495 hits with fStatus!=65
  - almost all hits are in ~500 micron region of the Si at R~3.23 cm and Z=-5.15 cm (first layer of the vertex barrel)
  - hits are produced by e-, leaving and returning back to the sensitive volume of Si along its spiral trajectory in magnetic field (as suggested by Vito)
  - no impact on SDigits (these hits are summed in SDigits into one or more signal)





CLICCT Tracker and Vertex hits for MARS photons, neutrons and e+e-

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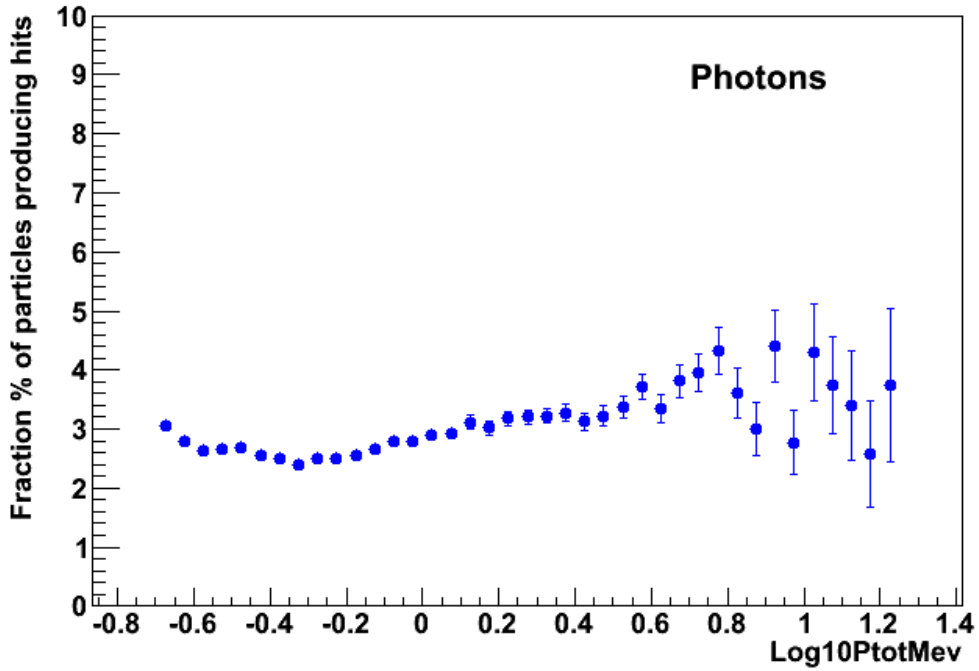
- **Fractions of photons, neutrons and e+e- making hits in sensitive volumes of CLICCT**

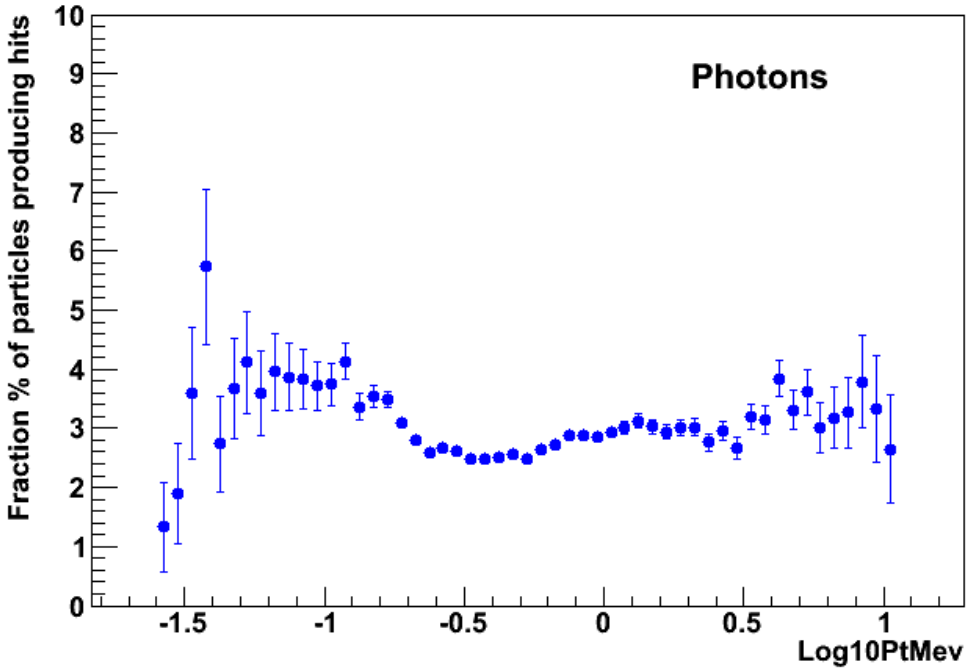
	photons	neutrons	e+e-
Absolute MARS yields, # of particles (weight included, both beams)	~1.8e+08	~4.0e+07	~1.0e+06
Fraction of particles producing hits in CLICCT sensitive volumes	~2.8%	~0.1%	~42%

- Photons Ptot ~ 0.2 – 10 MeV
  Neutrons Ptot ~ 13 – 1000 MeV, Tkin ~ 0.09 – 430 MeV
  e+e- Ptot ~ 0.5 – 320 MeV, Tkin ~ 0.2 – 320 MeV

CLICCT Tracker and Vertex hits for MARS photons, neutrons and e+e-

- **Fraction of primary particles producing hits, vs Ptot and Pt for photons (thru secondary particles)**





CLICCT Tracker and Vertex hits for MARS photons, neutrons and e+e-

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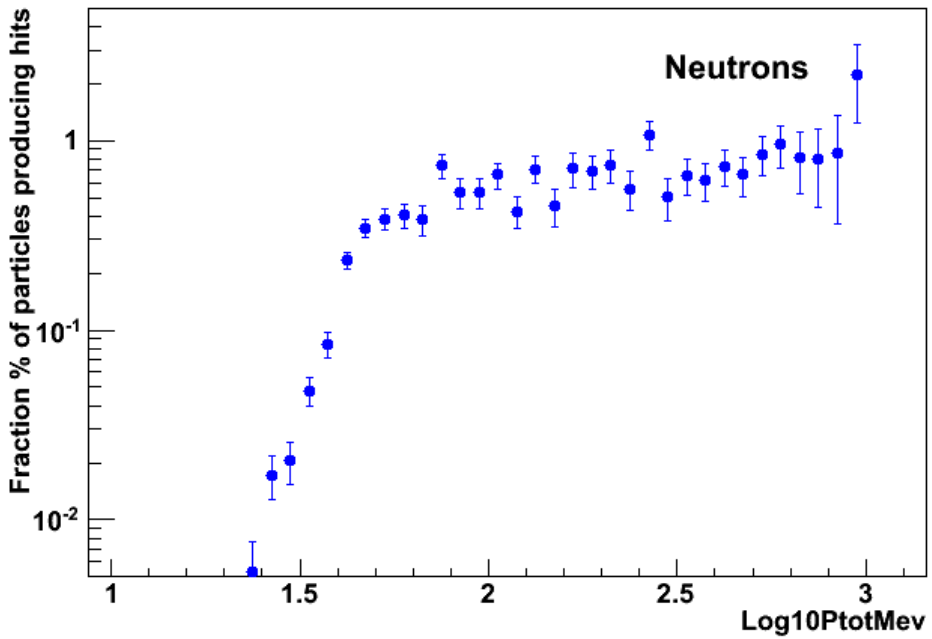
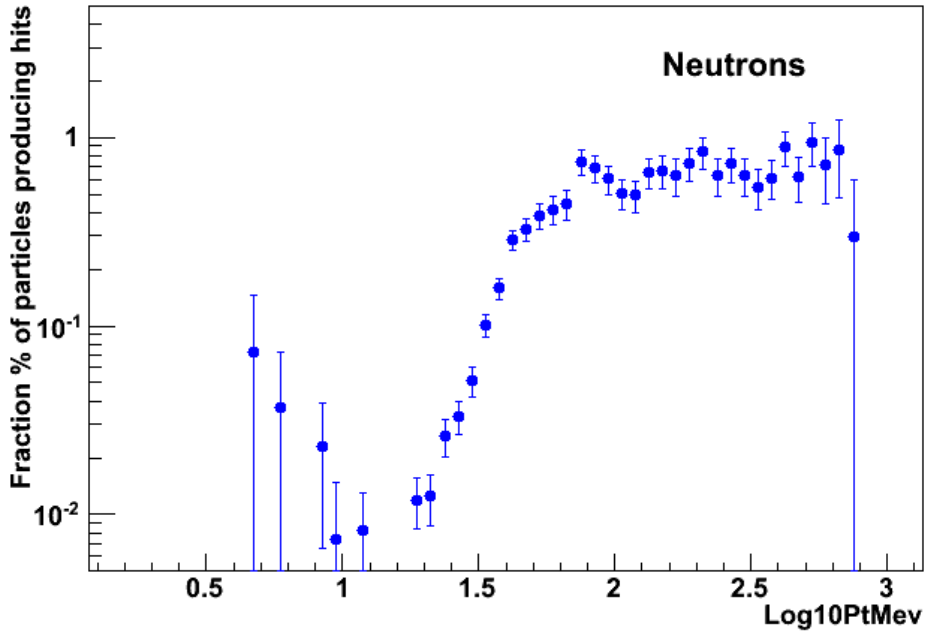
- **Fraction of primary particles producing hits, vs Ptot and Pt for neutrons (thru secondary particles)**





CLICCT Tracker and Vertex hits for MARS photons, neutrons and e+e-

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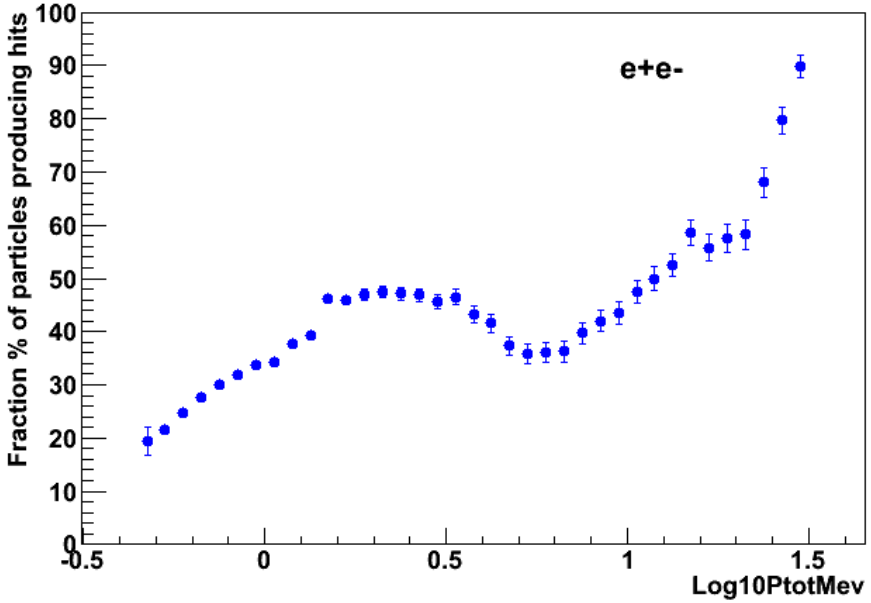
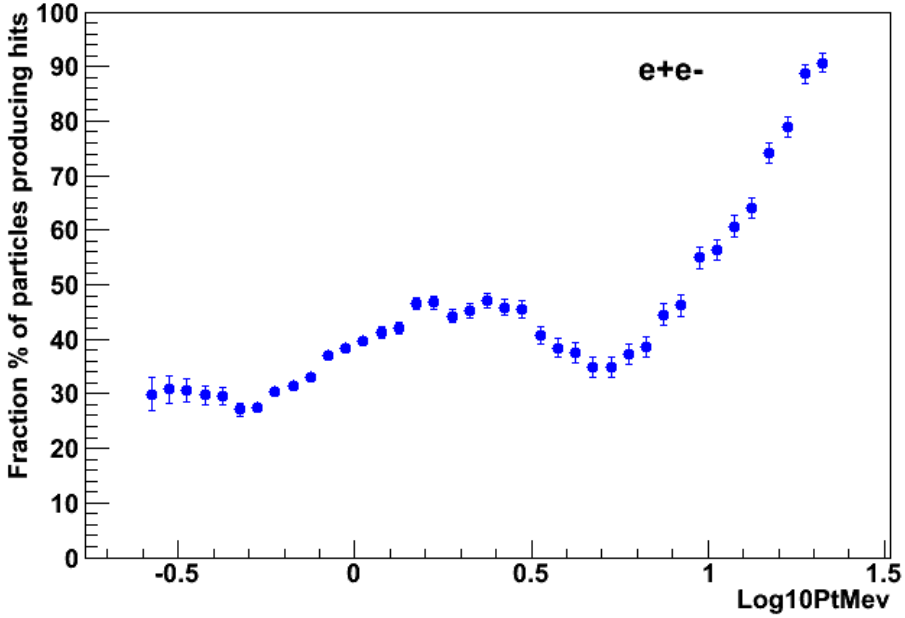
- **Fraction of primary particles producing hits, vs. Ptot and Pt for e+ and e-**





Merging MARS background with single muon physics events

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- Before to start ALL statistics MARS background simulation and merge it with physics events
  - do it step by step
  - start from small background samples, 1e+05 and 1e+06 particles.
  - merge them with physics events with 10 mu- per event
  - look at muon efficiency reconstruction in CLICCT vs. background level; it can happen that reconstruction fails before we come to full statistics background.
- Made successful attempt to merge 1e+05 sample of MARS background (all IDs) with one physics event (10 gun muons per event) in ILCroot
- The reconstruction code (modified from Vito's code) was successfully run for one 10 muons event merged with MARS 1e+05 background
- Analysis is in progress, need to use Anna's Comparison code (after modification with Anna's help)

Conclusion

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- The latest MARS background samples for photons, neutrons (with statistics ~1M) and e+e- (~0.05M) were simulated in ILCroot for CLICCT (tracker and vertex detectors).
- The fractions of background particles producing hits in sensitive volume of CLICCT were found to be:
  photons ~ 2.8%,
  neutrons ~ 0.1%
  e+e- ~ 42%
- Successful attempt was made to merge MARS background and physics event and reconstruct the muon tracks in CLICCT.
- Plan:
  - Find the fractions of photons, neutrons and e+e having SDigits and Digits
  - Work on analysis of merged data (with help from Anna) to get muon reconstruction efficiency vs. MARS background level
- Thanks to Vito Di Benedetto, Anna Mazzacane and Corrado Gatto for valuable help.