Simulations at NICADD
A Status Report

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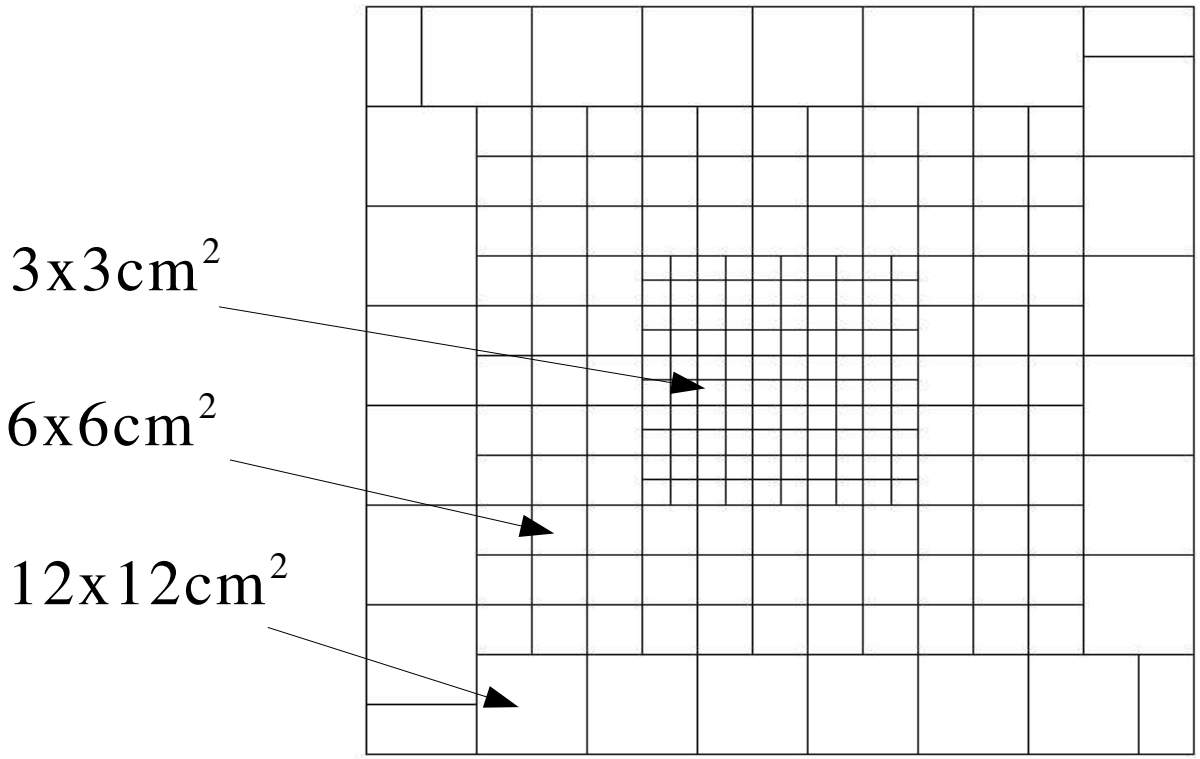
LC-Cal Meeting
March 29, 2004

Outline

- TestBeam news
- LCDG4
  - Recent developments
  - Remaining issues
  - Status and plans
- Summary

Test Beam Simulation News

- TBMokka has been released into Mokka CVS
- Latest test beam geometry (3 HCal cell sizes)



Test Beam Simulation News

- Feedback from DESY (Roman, Felix, Ties,...)
- Cell virtualization: preliminary implementations in HCal
- Cell ganging to be done at post-processing stage (not implemented yet)

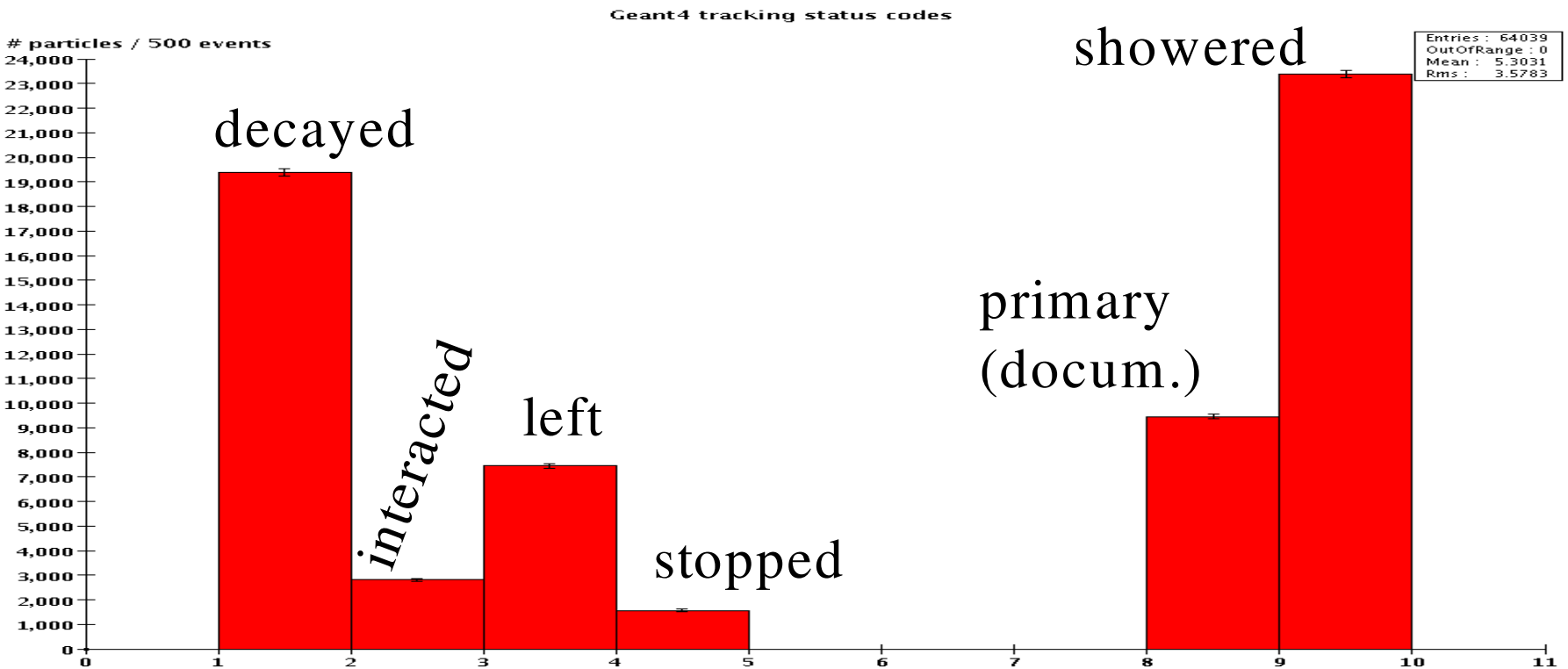
LCDG4: Gismo compliance

- Hits point to all contributing particles (except tracker hits from calorimeter back-scatterings, as in Gismo)
- Particle status codes
- Starting and ending points
- Correct Monte Carlo hierarchy
- All secondaries properly saved, except for shower secondaries
- Calorimeter entrance point: position and momentum
- Production momentum (ok except for preassigned decay products)

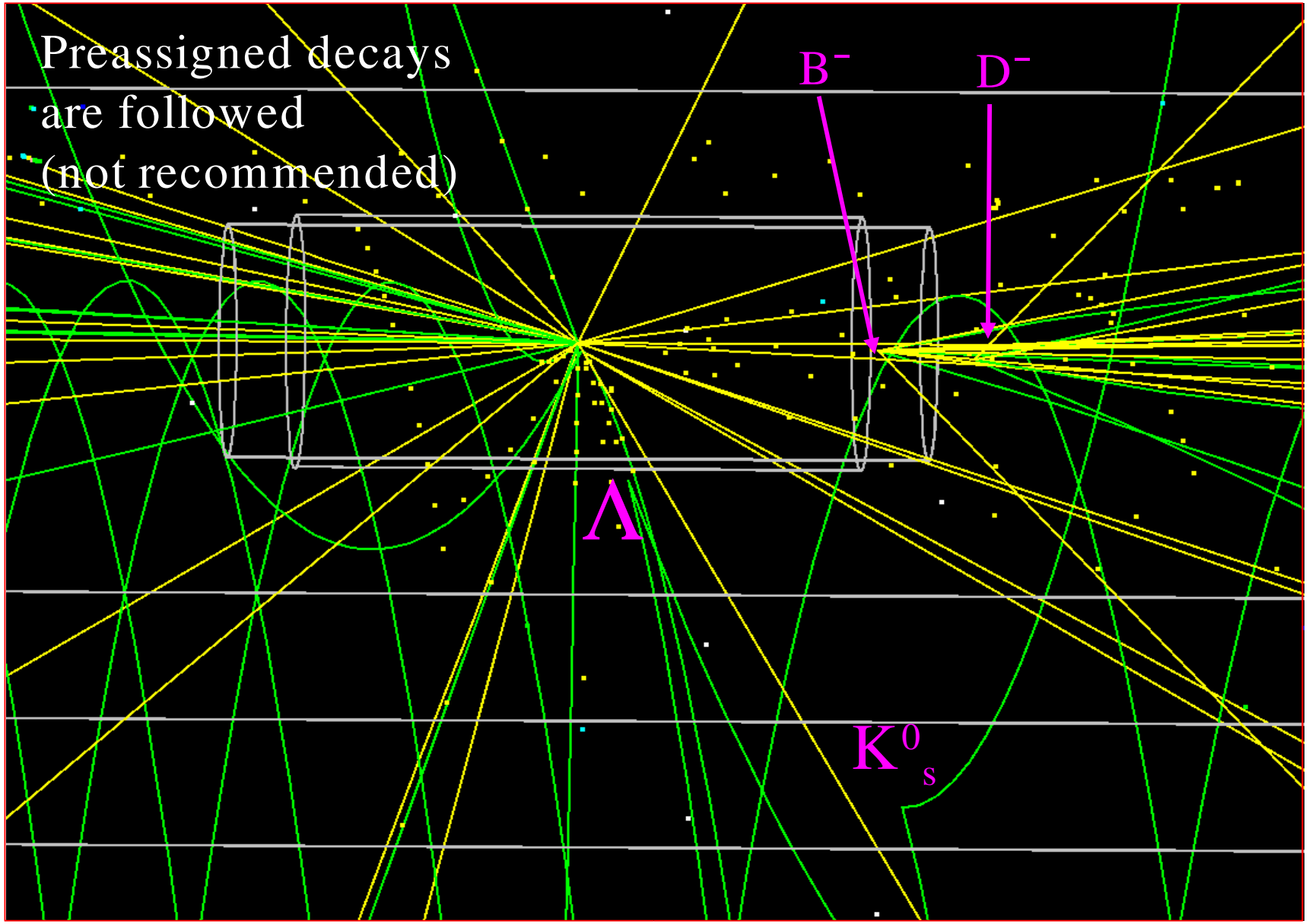
Particle Status Codes

0 – active
1 – decayed
2 – interacted
3 – left detector
4 – stopped
5 – looping
6 – lost
7 – stuck
8 – primary
9 – showered
10 – maxsteps

(fully implemented, or not to be implemented)



Starting and ending points



Correct MCParticle hierarchy

Welcome | MC Tree | View 1

Run 10 Event 0
- HepEvt (mass=0.0 id=99999999 charge=0)(E=0 status=3)(gismoStatus=8)
  - e- (mass=5.11E-4 id=11 charge=-1)(E=45.500 status=3)(gismoStatus=8)
    - e- (mass=5.11E-4 id=11 charge=-1)(E=45.500 status=3)(gismoStatus=8)
      - e- (mass=5.11E-4 id=11 charge=-1)(E=45.500 status=3)(gismoStatus=8)
        - Zo (mass=91.187 id=23 charge=0)(E=90.939 status=3)(gismoStatus=8)
          - c (mass=1.4 id=4 charge=0.667)(E=45.477 status=3)(gismoStatus=8)
            - c (mass=1.4 id=4 charge=0.667)(E=43.924 status=2)(gismoStatus=1)
              - unknown (id=92)(E=90.939 status=2)(gismoStatus=1)
                - D*0 (mass=2.0071 id=423 charge=0)(E=31.152 status=2)(gismoStatus=1)
                - pi0 (mass=0.13497389999999998 id=111 charge=0)(E=4.0177 status=2)(gismoStatus=1)
                - rho+ (mass=0.7683 id=213 charge=1)(E=1.8167 status=2)(gismoStatus=1)
                - pi0 (mass=0.13497389999999998 id=111 charge=0)(E=0.39386 status=2)(gismoStatus=1)
                - rho- (mass=0.7683 id=-213 charge=-1)(E=3.5983 status=2)(gismoStatus=1)
                - eta (mass=0.5474500000000001 id=221 charge=0)(E=0.93681 status=2)(gismoStatus=1)
                - K(892)*+ (mass=0.8915900000000001 id=323 charge=0)(E=1.6848 status=2)(gismoStatus=1)
                - phi (mass=1.019412 id=333 charge=0)(E=1.2191 status=2)(gismoStatus=1)
                  - K- (mass=0.49364600000000003 id=-321 charge=-1)(E=0.64408 status=1)(gismoStatus=9)
                  - K+ (mass=0.49364600000000003 id=321 charge=1)(E=0.57504 status=1)(gismoStatus=1)
                    - pi+ (mass=0.1395675 id=211 charge=1)(E=0.18440 status=4)(gismoStatus=1)
                    - pi0 (mass=0.13497389999999998 id=111 charge=0)(E=0.16835 status=4)(gismoStatus=1)
                    - pi0 (mass=0.13497389999999998 id=111 charge=0)(E=0.22175 status=4)(gismoStatus=1)
                - K*-(892) (mass=0.8915900000000001 id=-323 charge=-0)(E=1.3484 status=2)(gismoStatus=1)
                - rho0 (mass=0.7683 id=113 charge=0)(E=0.91559 status=2)(gismoStatus=1)
                - K+ (mass=0.49364600000000003 id=321 charge=1)(E=2.2225 status=1)(gismoStatus=1)
                - K*-(892) (mass=0.8915900000000001 id=-323 charge=-0)(E=14.734 status=2)(gismoStatus=1)
                - D*0-bar (mass=2.0071 id=-423 charge=-0)(E=26.898 status=2)(gismoStatus=1)
                  - D0-bar (mass=1.8645 id=-421 charge=-0)(E=25.040 status=2)(gismoStatus=1)
                    - K+ (mass=0.49364600000000003 id=321 charge=1)(E=4.0586 status=1)(gismoStatus=1)
                      - mu+ (mass=0.105658 id=-13 charge=1)(E=0.23565 status=4)(gismoStatus=1)
                        - e+ (mass=5.11E-4 id=-11 charge=1)(E=0.030347 status=4)(gismoStatus=9)
                        - nu_e (mass=0.0 id=12 charge=0)(E=0.037843 status=4)(gismoStatus=3)
                        - nu_mu_bar (mass=0.0 id=-14 charge=-0)(E=0.035979 status=4)(gismoStatus=3)
                      - nu_mu (mass=0.0 id=14 charge=0)(E=0.23553 status=4)(gismoStatus=3)
                    - a1- (mass=1.23 id=-20213 charge=-0)(E=20.982 status=2)(gismoStatus=1)
                      - rho0 (mass=0.7683 id=113 charge=0)(E=17.098 status=2)(gismoStatus=1)
                        - pi+ (mass=0.1395675 id=211 charge=1)(E=2.6499 status=1)(gismoStatus=9)
                        - pi- (mass=0.1395675 id=-211 charge=-1)(E=14.448 status=1)(gismoStatus=2)
                          - pi- (mass=0.1395675 id=-211 charge=-1)(E=14.444 status=4)(gismoStatus=9)
                          - e- (mass=5.11E-4 id=11 charge=-1)(E=3.2899E-3 status=4)(gismoStatus=2)
                      - pi- (mass=0.1395675 id=-211 charge=-1)(E=3.8838 status=1)(gismoStatus=9)
                  - gamma (mass=0.0 id=22 charge=0)(E=1.8573 status=1)(gismoStatus=9)
          - c_bar (mass=1.4 id=-4 charge=-0.667)(E=45.461 status=3)(gismoStatus=8)
            - gluon (mass=0.0 id=21 charge=0)(E=3.3701 status=2)(gismoStatus=8)

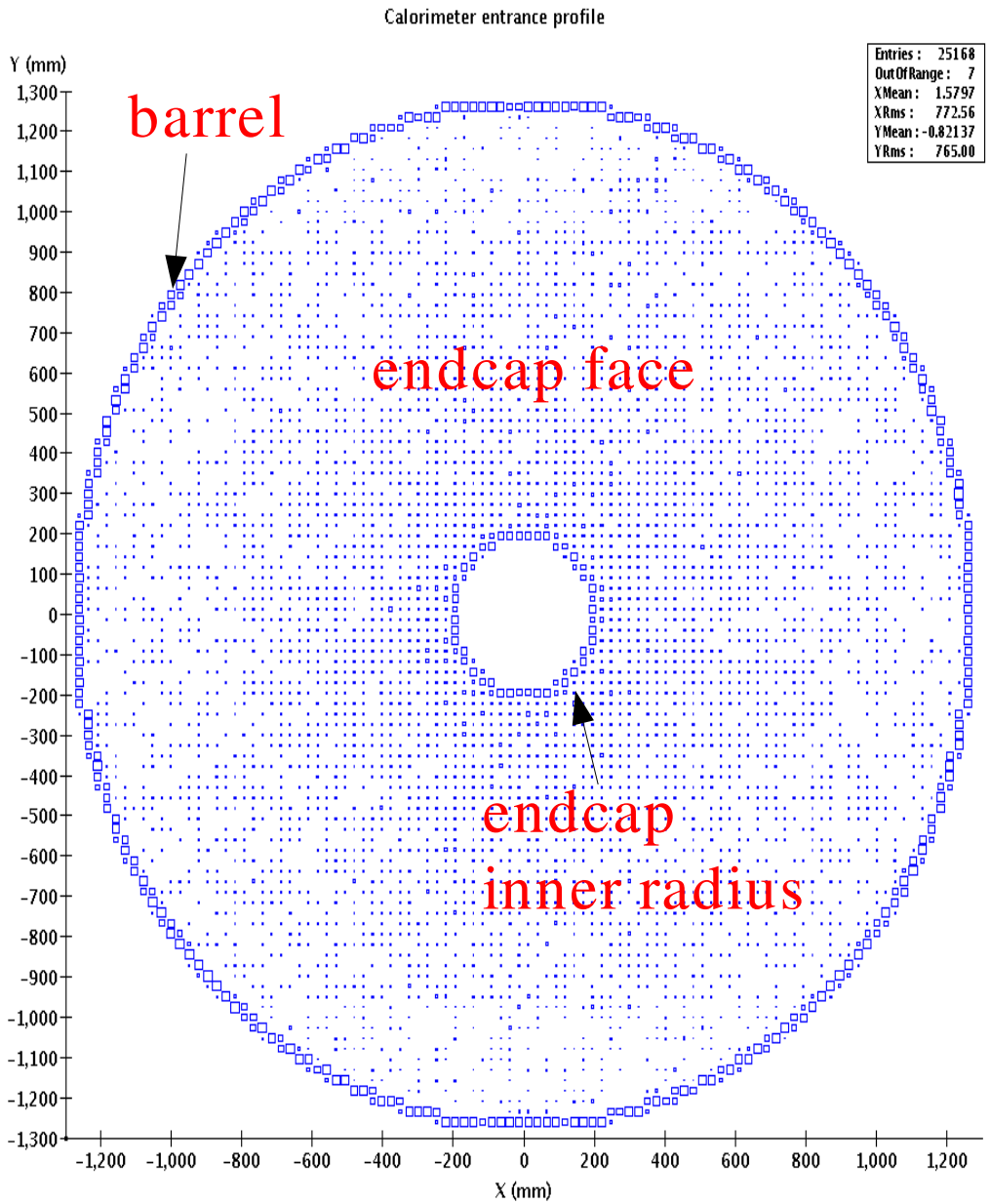
pre-Cal interaction (inelastic)

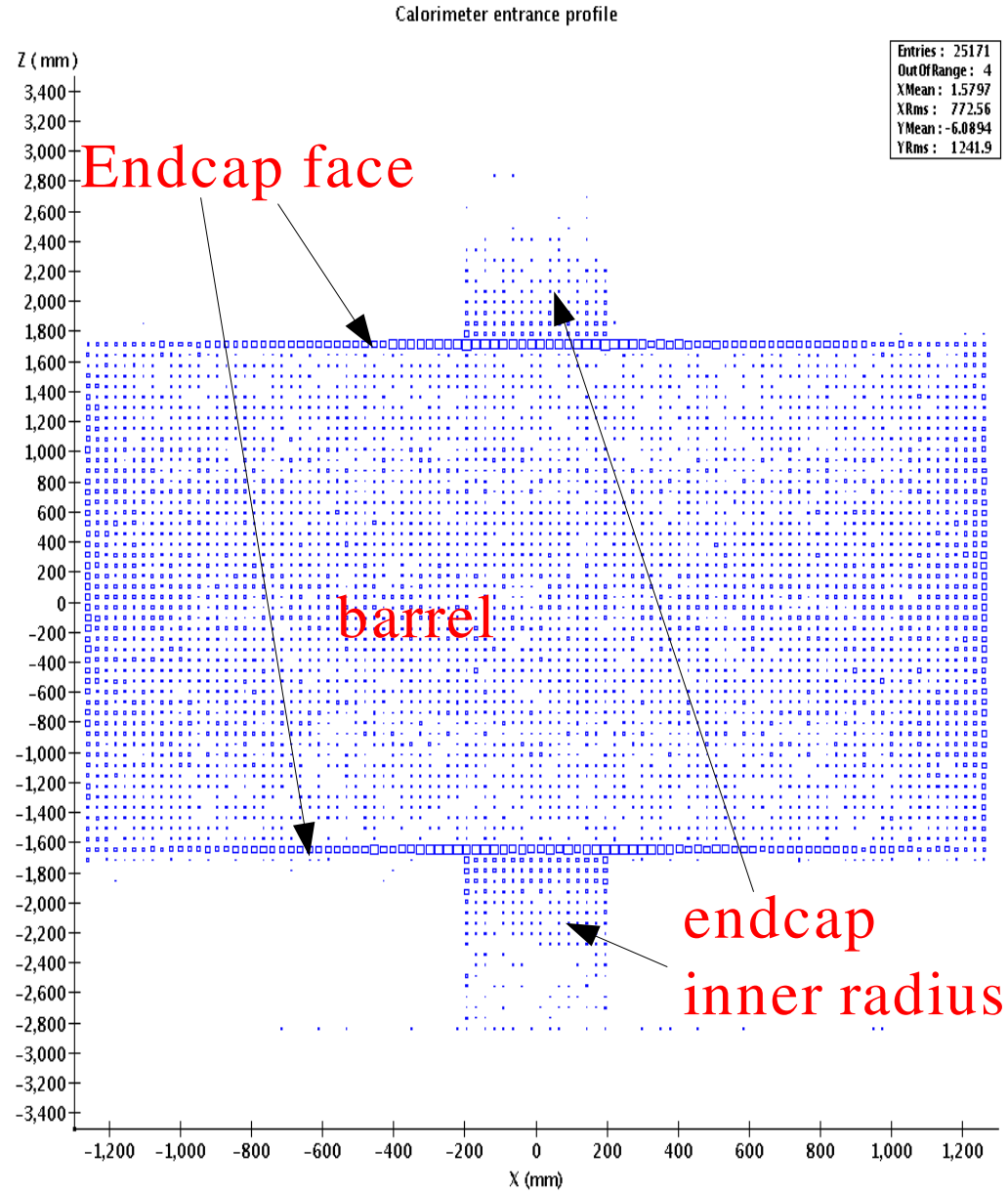
decay sequence

pre-Cal interaction (non-destructive)

Shower secondaries are not saved

Cal entrance: position, momentum



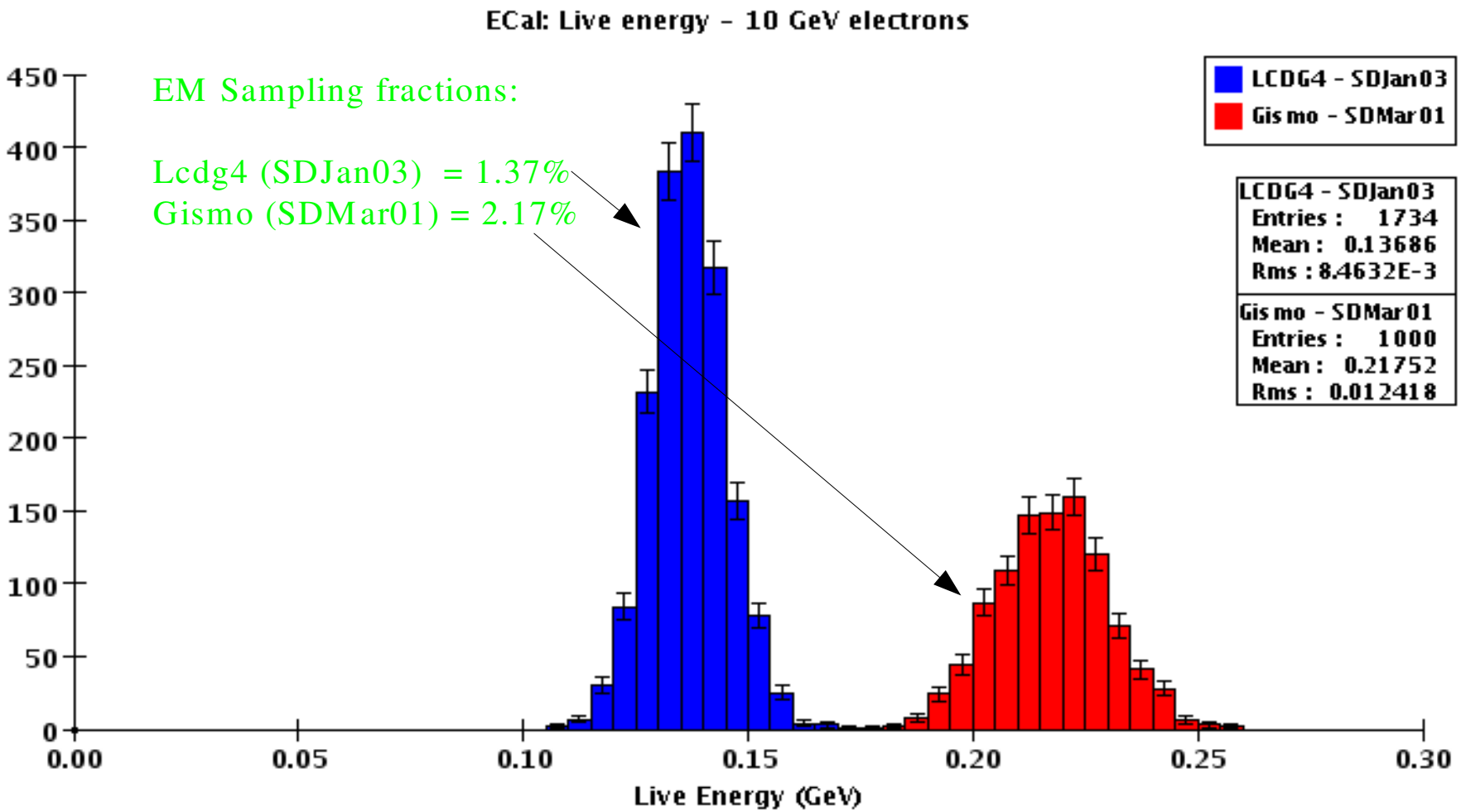


LCDG4: Remaining issues

1. Discrepancy in EM live energy (LCDG4 & Gismo)
2. Discrepancy in number of calorimeter hits
3. Large number of HCal hits in the ECal/HCal interface

Issue 1: ECal Elive discrepancy

Differences in EMCal depositions between LCDG4 and Gismo



Issue 1: ECal layering changes

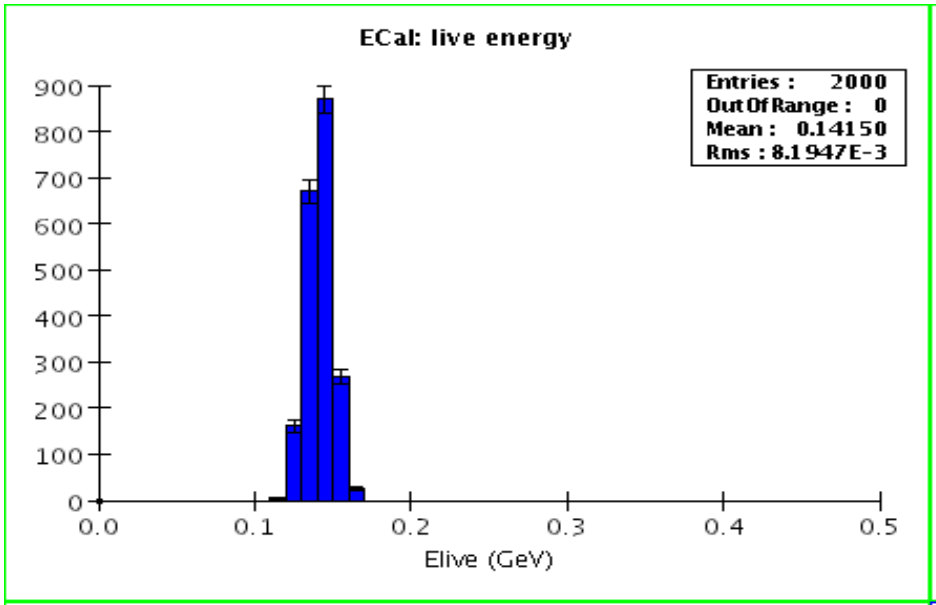
- SDMar01:

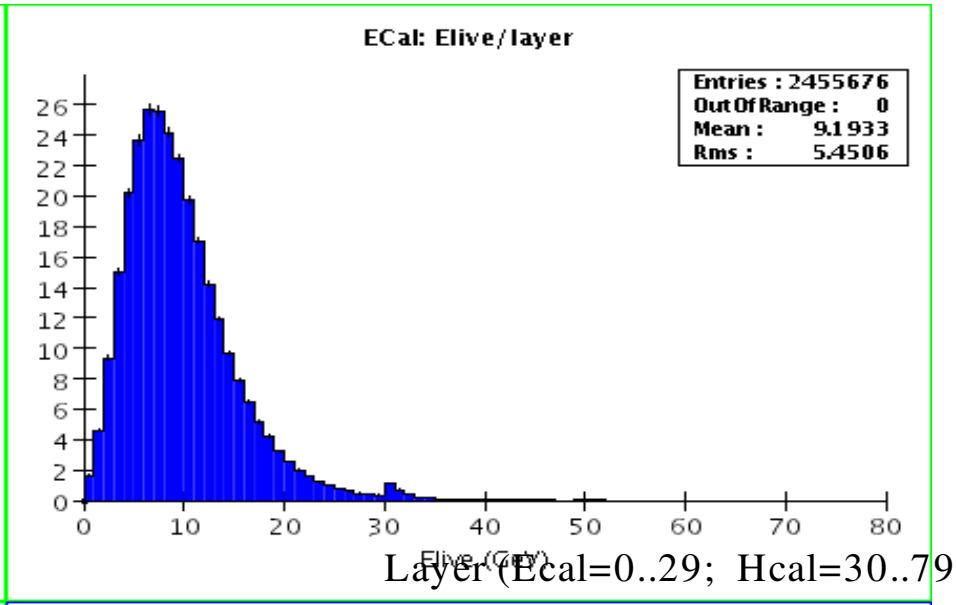
```
<layering n=30>
   <slice material = "W"  width = 0.25 />
   <slice material = "Si"  width = 0.04  sensitive = "yes" />
   <slice material = "G10" width = 0.2 />
   <slice material = "Air"  width = 0.01 />
</layering>
```

- SDJan03:

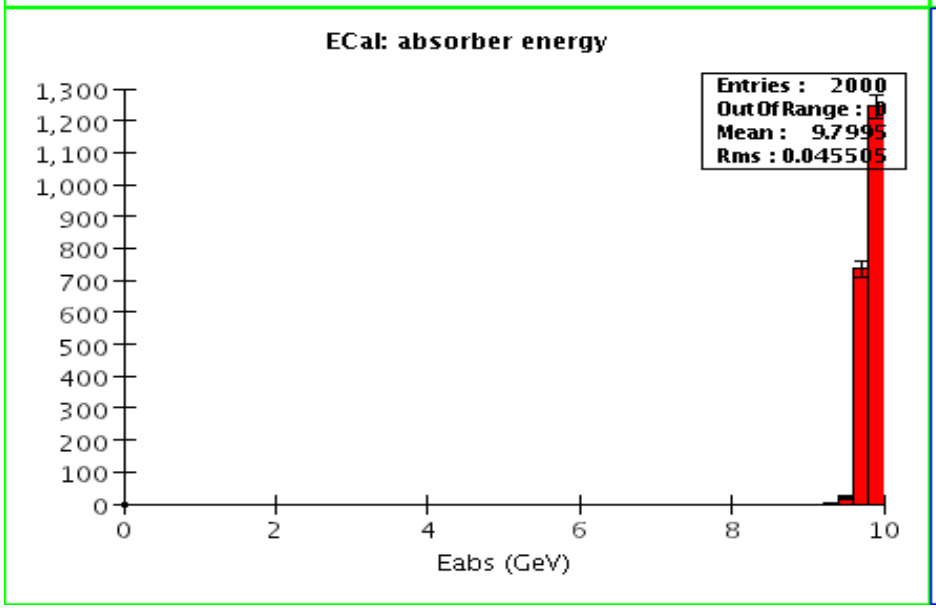
```
<layering n=30>
   <slice material = "W"  width = 0.25 />
   <slice material = "G10" width = 0.05 />
   <slice material = "Si"  width = 0.04  sensitive = "yes" />
   <slice material = "Cu" width = 0.1 />
   <slice material = "Air"  width = 0.06 />
</layering>
```

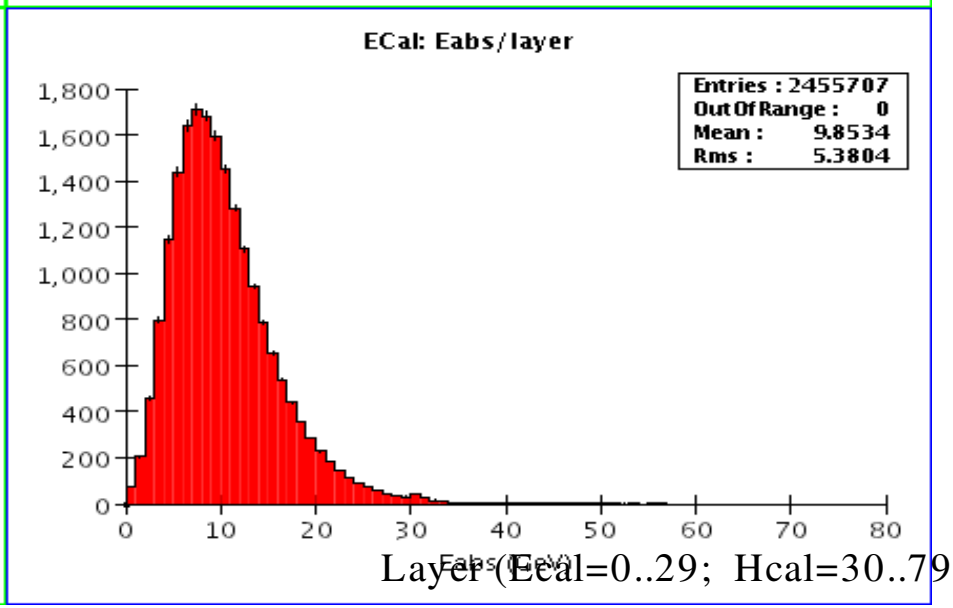
Issue 1: ECal E_{live} and E_{abs}





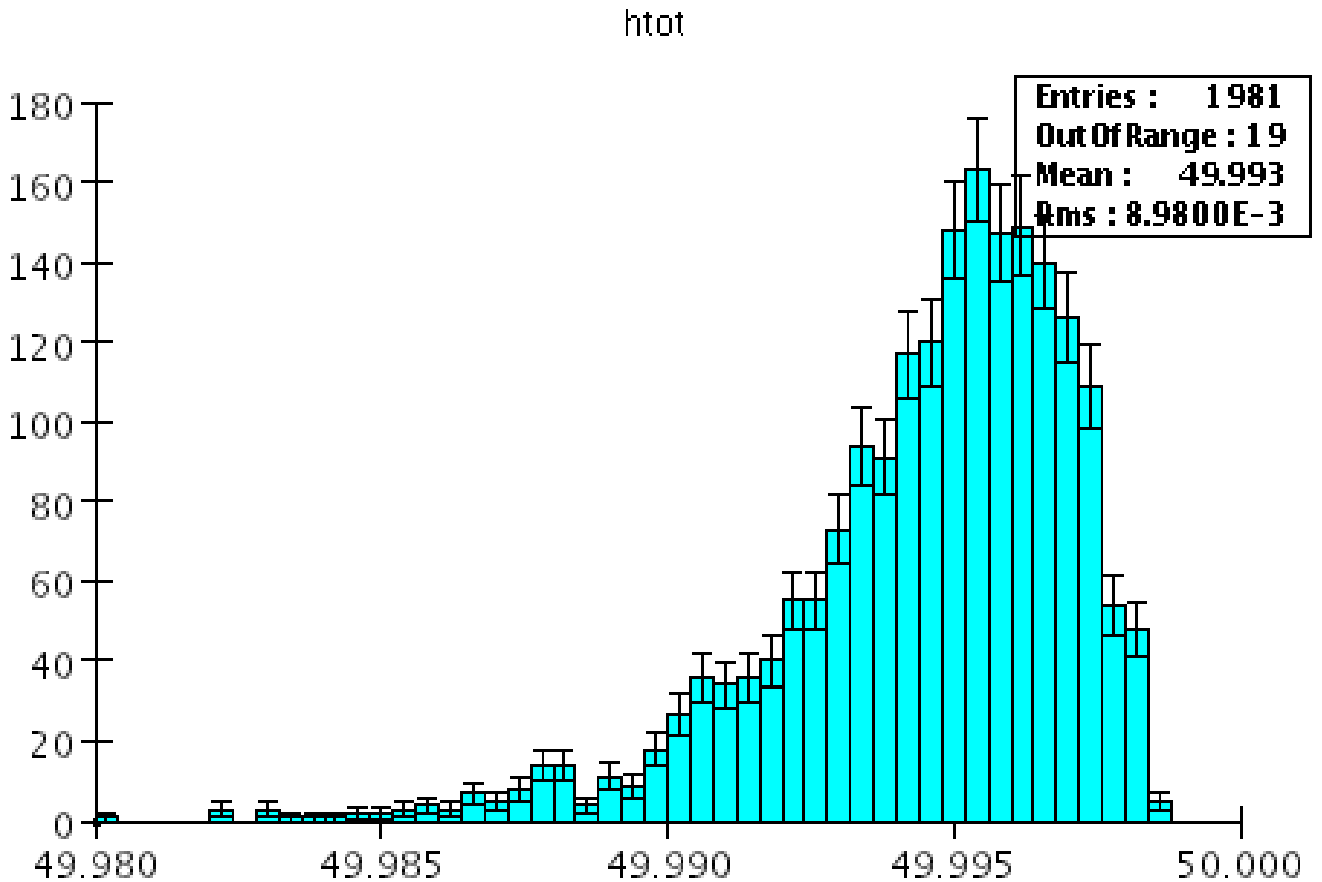
Layer (Ecal=0..29; Hcal=30..79)





Layer (Ecal=0..29; Hcal=30..79)

Issue 1: Incorrect account of energy?

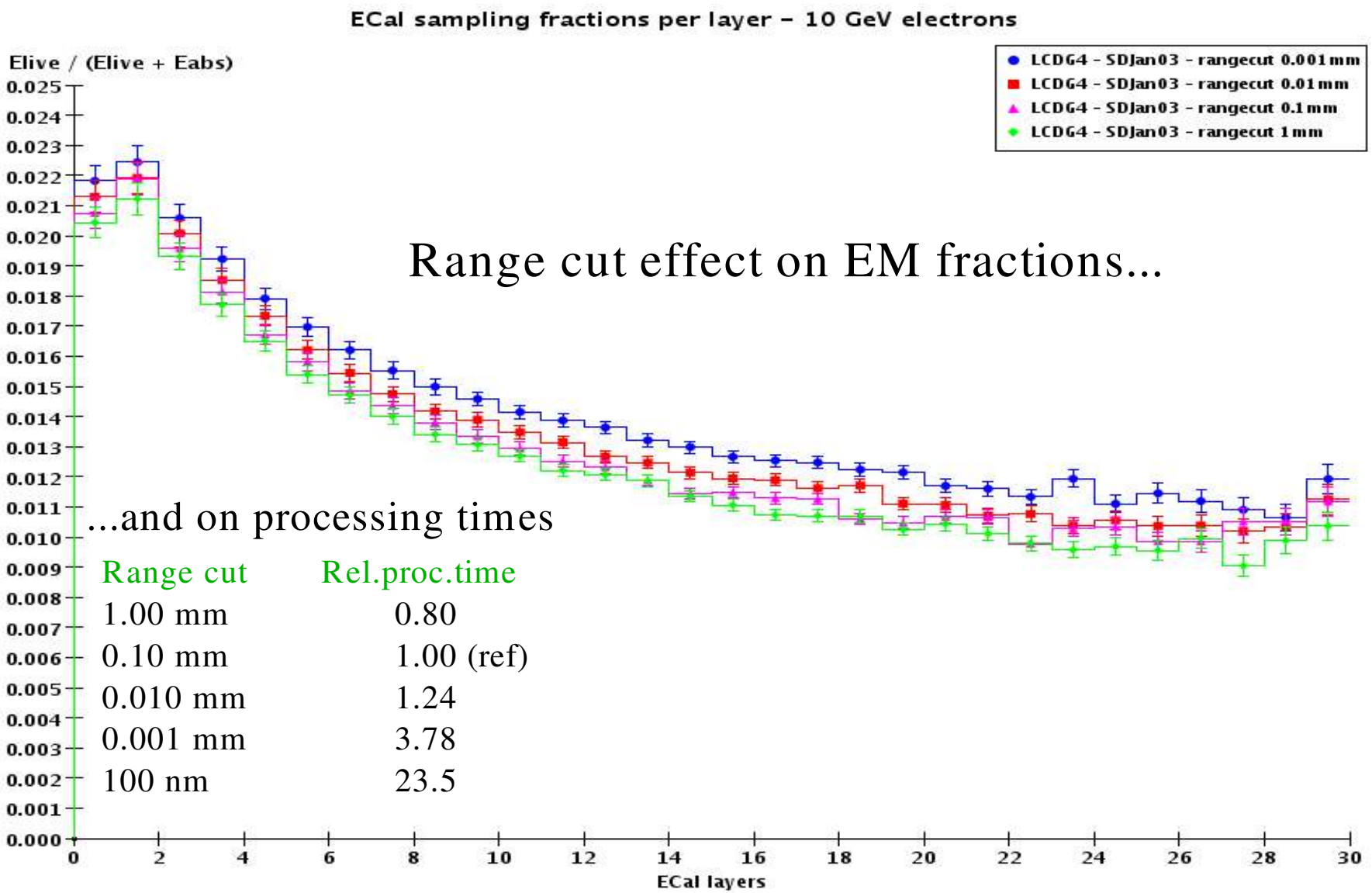


Energy (GeV)

About 7 MeV of energy per 50 GeV electron is lost before the calorimeters.

Probably OK!

EM Sampling fraction per layer



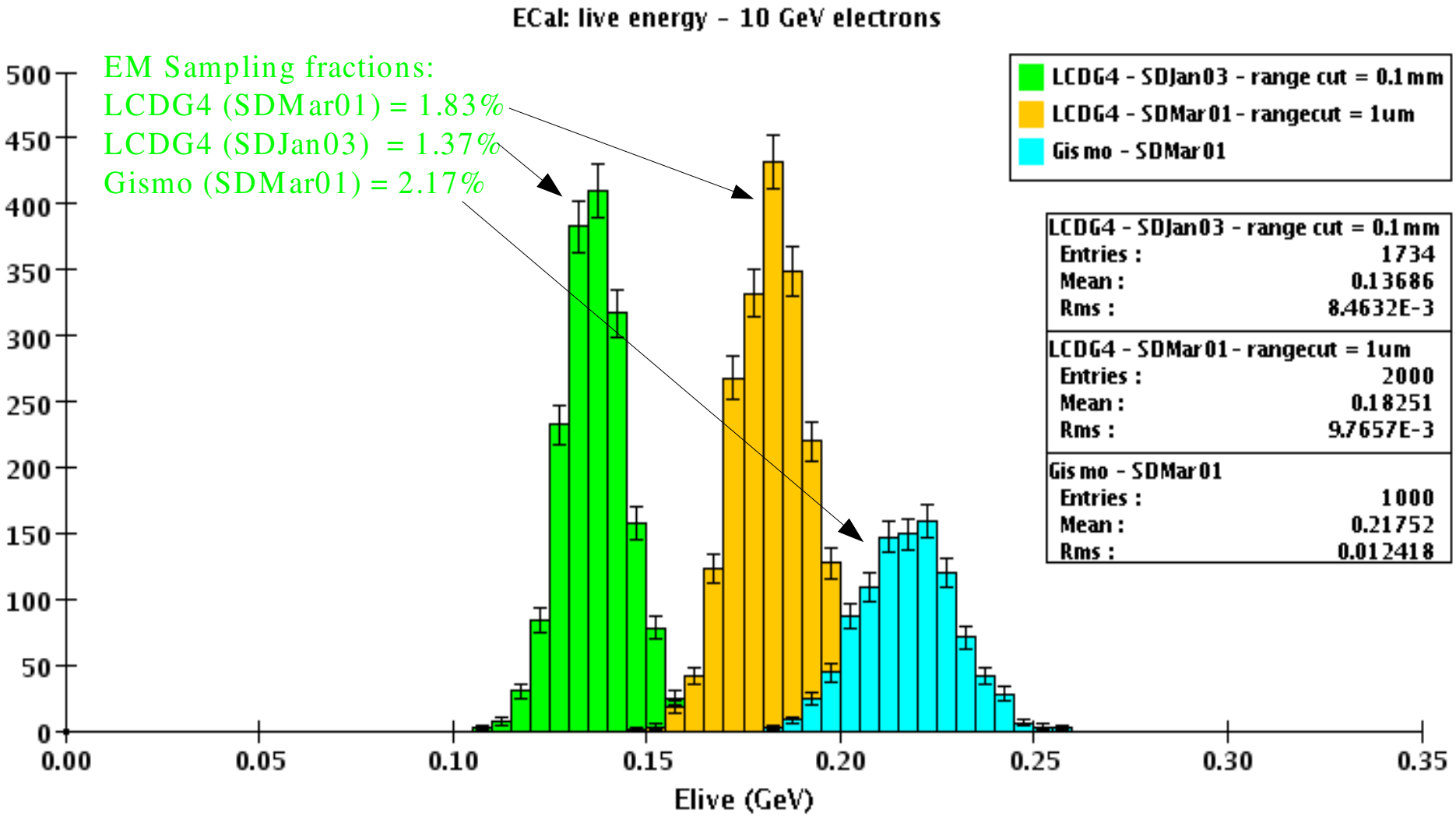
Range cut effect on EM fractions...

...and on processing times

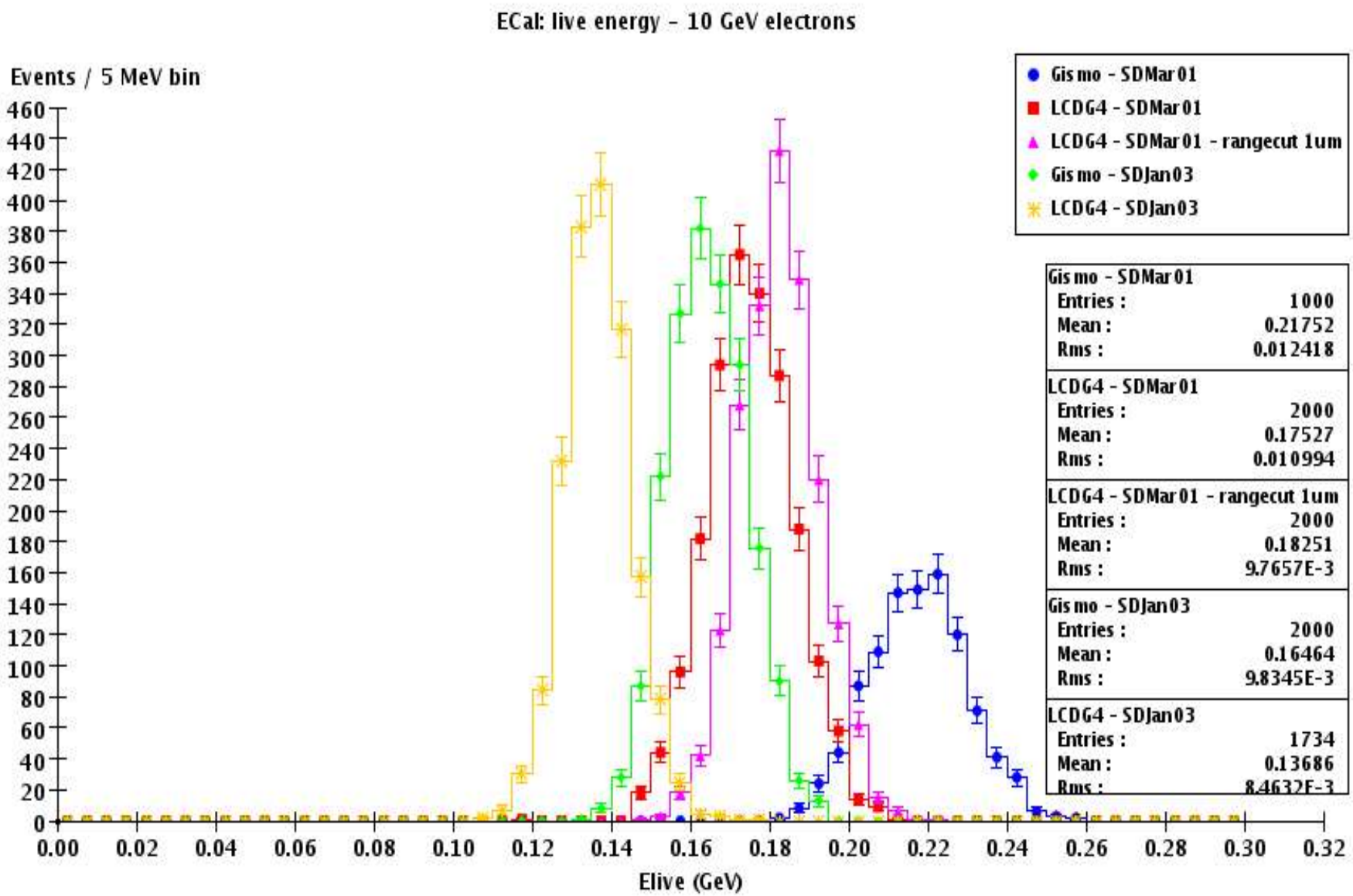
Range cut	Rel.proc.time
1.00 mm	0.80
0.10 mm	1.00 (ref)
0.010 mm	1.24
0.001 mm	3.78
100 nm	23.5

Issue 1: ECal Elive

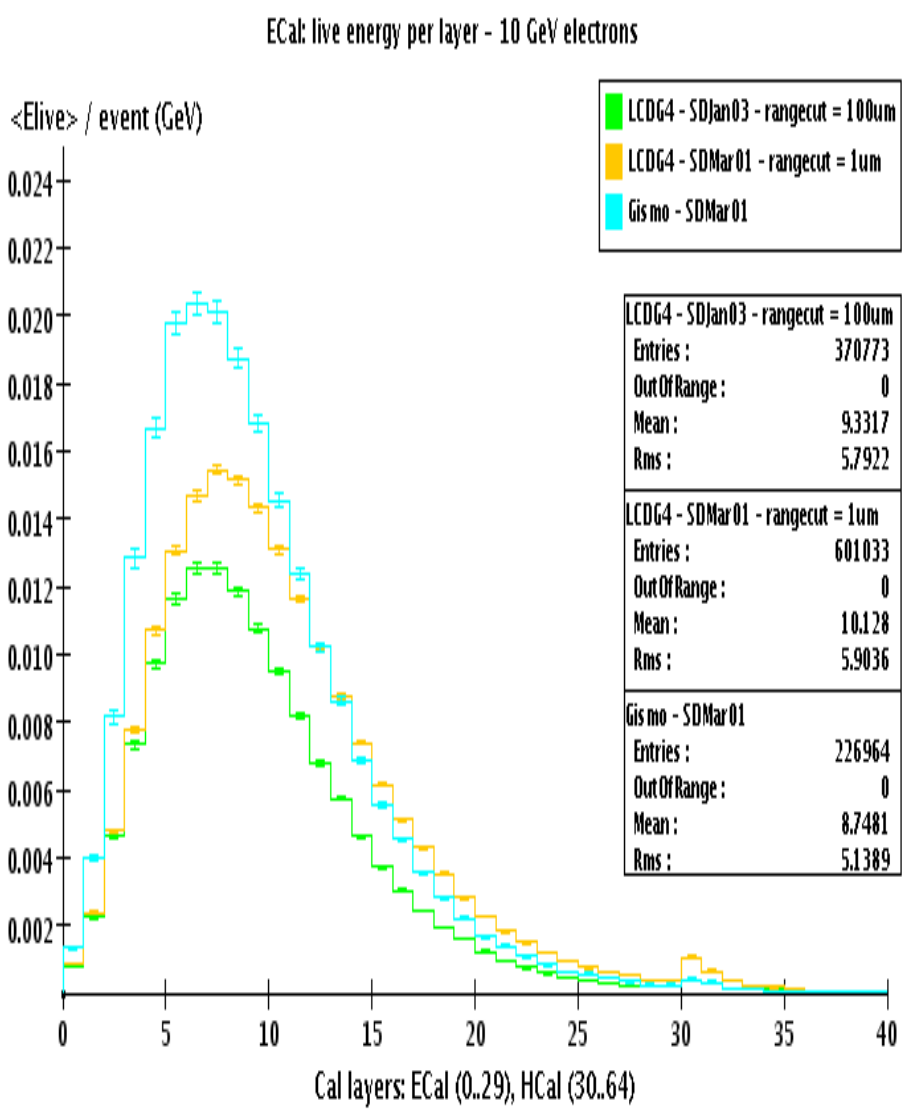
Differences in EMCal depositions between LCDG4 and Gismo

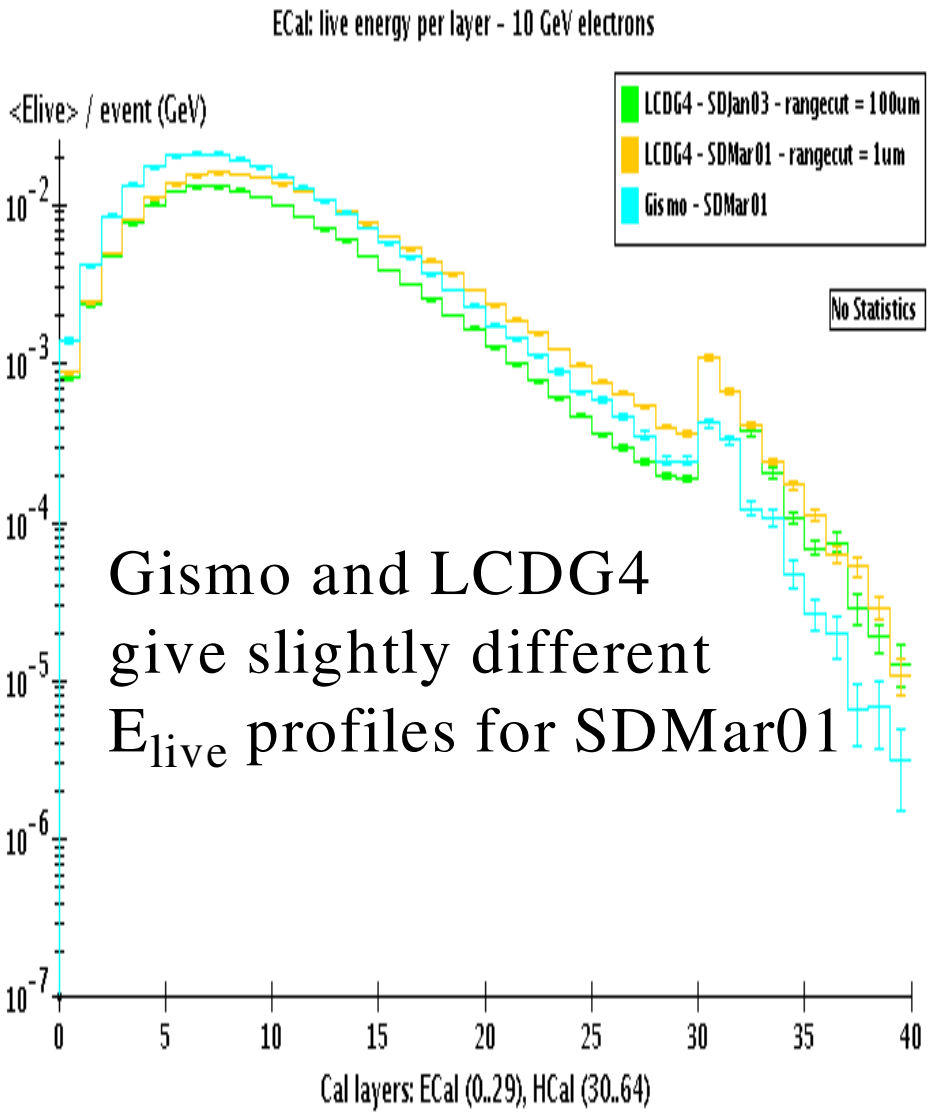


Just off the press!!!



Issue 1: ECal E_{live} per layer





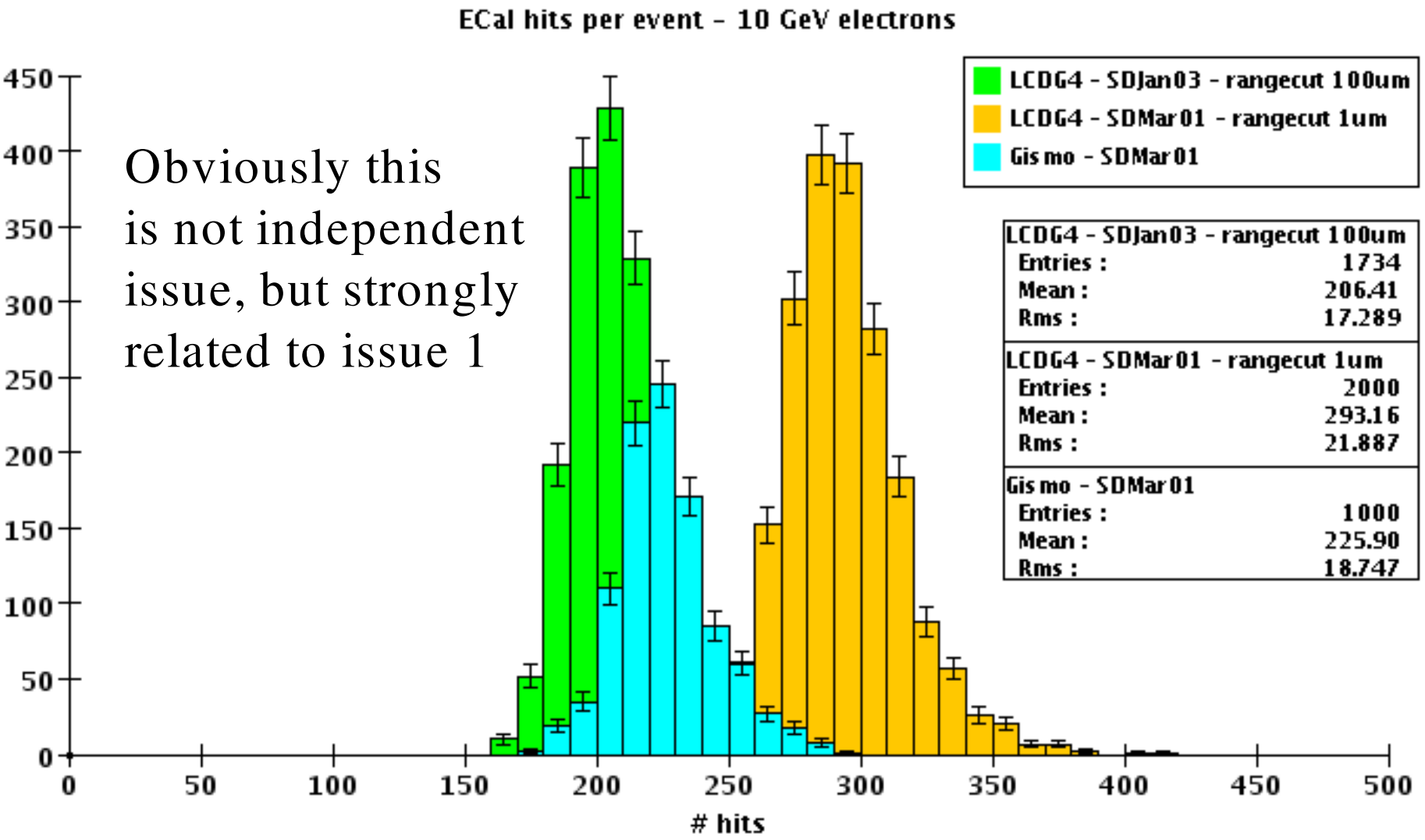
Gismo and LCDG4 give slightly different E_{live} profiles for SDMar01

Issue 1: radiation lengths?

Material	Radiation lengths (cm)			
	PDG	Geant	G4-PDG	Gismo
W	0.35	0.350	0.00%	?
Si	9.36	9.094	2.84%	?
Cu	19.40	16.716	13.84%	?
G10	1.43	1.440	-0.70%	?
Air	30420	30551	-0.43%	?

There are some discrepancies with LCDG4 and PDG, but below the 3% level (SDMar01 has no copper). Maybe Gismo's discrepancies are above 10% level?

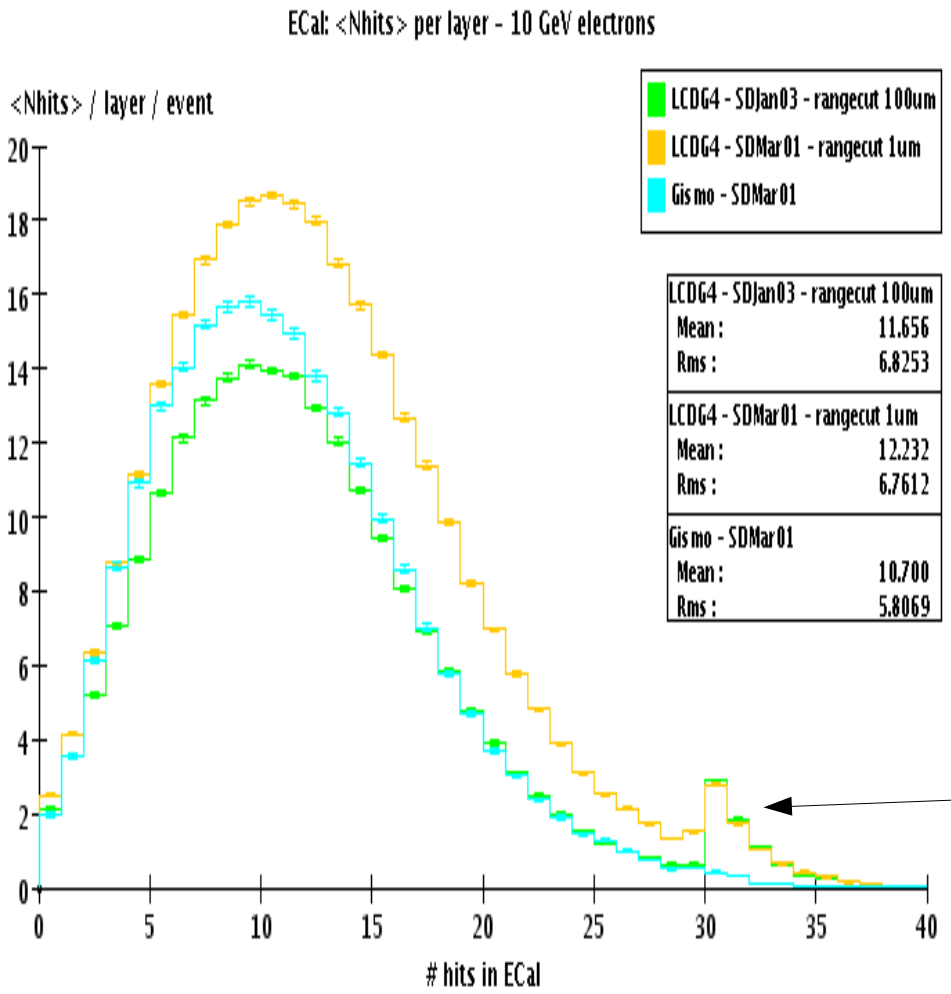
Issue 2: Number of ECal hits per event

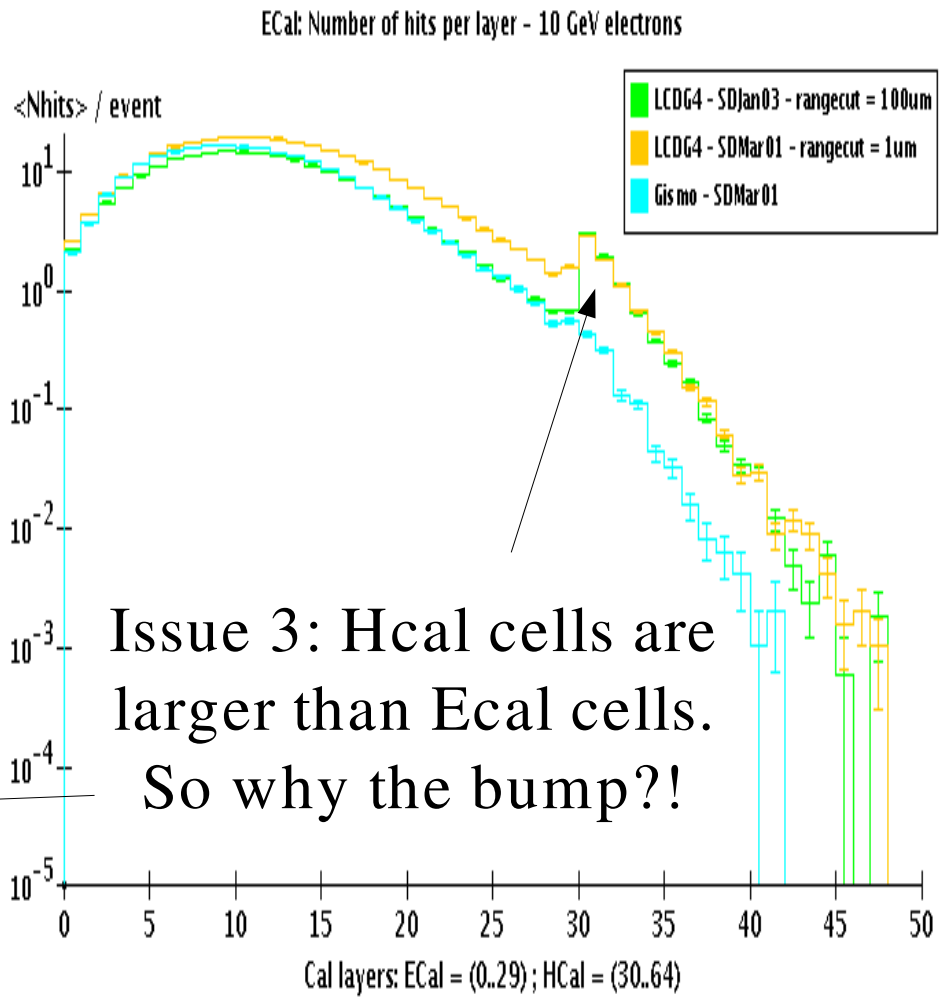


Obviously this is not independent issue, but strongly related to issue 1

Issues 2 and 3: Nhits per layer

Issue 2: LCDG4+SDJan03 is now closer to Gismo+SDMar01 than LCDG4+SDMar01





Issue 3: Hcal cells are larger than Ecal cells. So why the bump?!

Next steps

- Update momenta for preassigned decay products
- Checks for memory leaks and optimization
- Brief investigation on the ECal/HCal interface
- Release, documentation and data production (Argonne)
- Visualization improvement (virtual cells)
- Merge projective and non-projective versions
- Different range cuts per subcomponent (ECal)
- LCIO output
- More realistic geometries (medium term)

Summary

- Most of E_{live} discrepancies reported are due to the additional copper slab in ECal layering (SDJan03)
- Under 20% discrepancy at this point
- Further investigation: look at radiation lengths and material compositions at Gismo
- Lots of LCDG4 data will be available in time for Argonne workshop (first week of June)
- New geometry system: discussions under way. Goal: proposal ready for comments by Argonne