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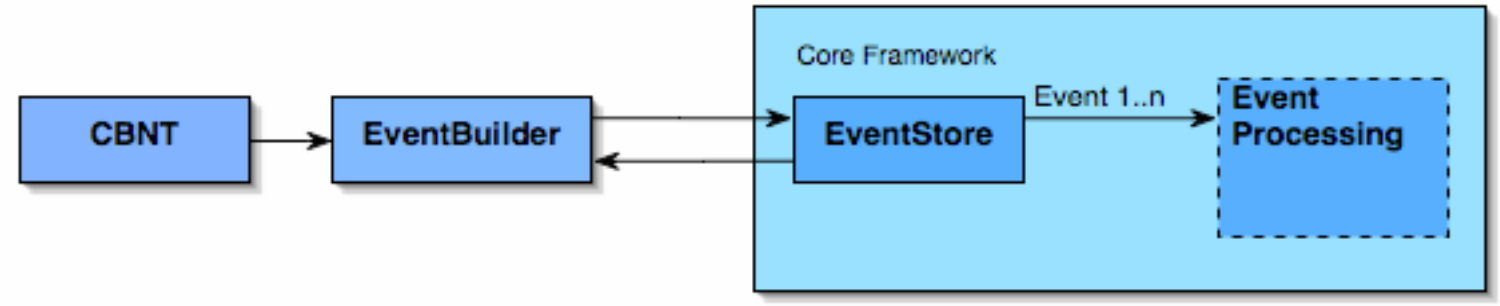
PESAsim – the e/γ analysis framework

- Validation of the framework
- First look at a trigger menu combining several signatures
- Short-term plans

Code structure - event storage

- EventStore



  - Responsible for accessing the persistent storage (i.e. CBNT) and building each FrameworkEvent
  - Factorises event storage from event processing.
  - Can be used to read events sequentially from the file for processing, or buffer all events in memory for speed (automated tuning strategies).

Trigger classes

- Data objects grouped by RoI
- LVL1, LVL2 and EventFilter
  - Each contains a collection of TrigSignatures, each with it's own prescale.
  - The output of all TrigSignatures are OR'ed together to get overall decision at each trigger level.
  - Does their own book keeping, number of events passed, failed etc.
  - Monitors event correlations between TrigSignatures, overlap of numbers of events of each TrigSignature with all others etc.

TrigSignature and TrigSequence

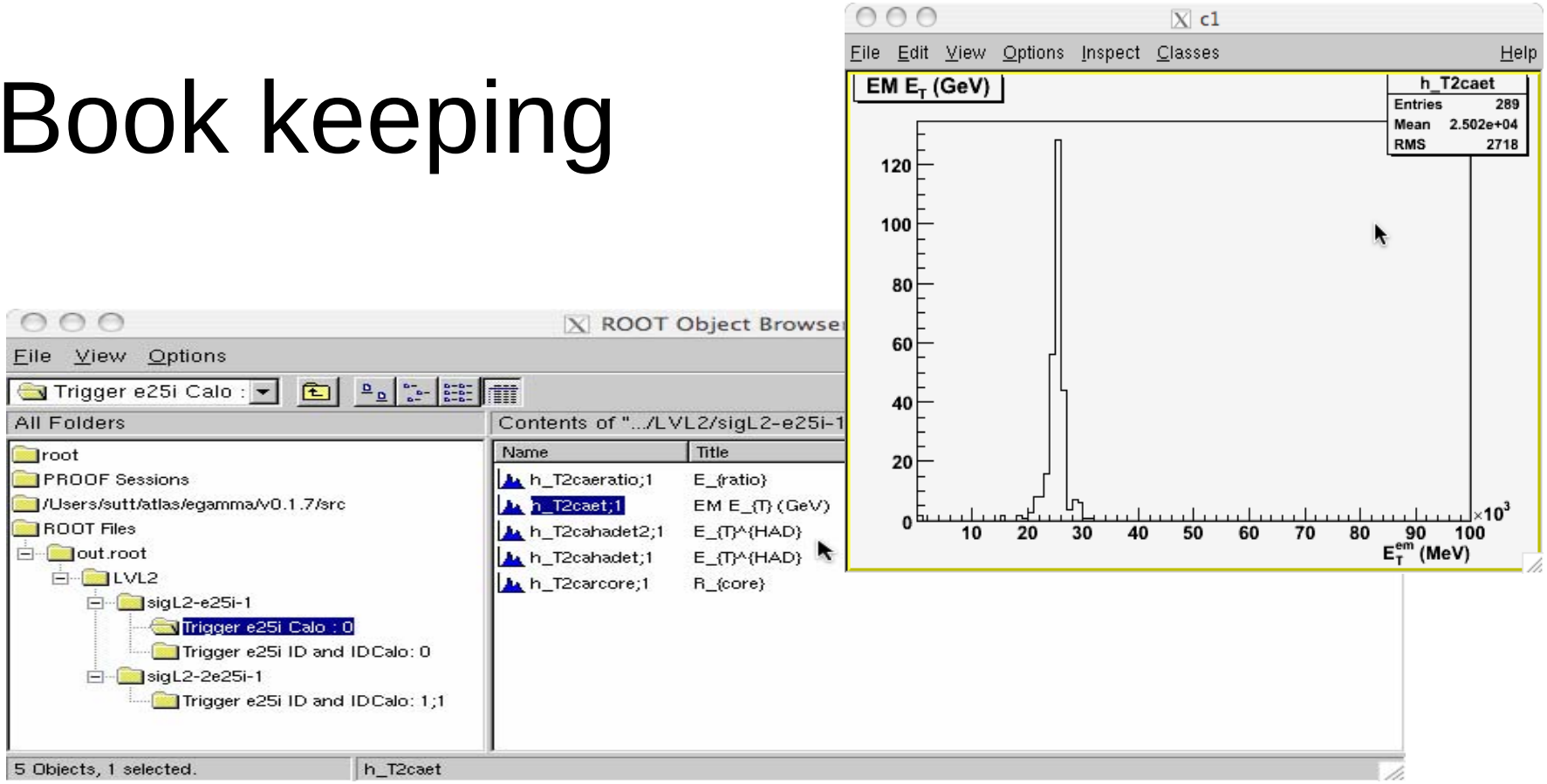
- TrigSignature
  - Contains some number of TrigSequences (corresponding to HLTAlgos in Athena…should probably change class names to make it more transparent).
  - All book keeping (number of events passed, before/after presecale etc) done automatically by the TrigSignature.

- TrigSequence
  - Main part of user intervention is on writing his/her own TrigSequence derived classes
  - Facilities for automatic book keeping in place (directories for histograms, event counting, etc)

Some additional features

- TruthEvent
  - Accessible through a method of the trigger elements: `TrigElement::truth()`
- Level 2 and Event Filter track/truth association:
  - Encoded in classes `L2IDTrackTruth` and `EFTrackParticleTuth`
- PreFilter :
  - Selects events to be put into EventStore
- Has a set of PreSelections:
  - Similar to TrigSequences
  - Run on full FrameworkEvent instead of TrigElement/RoI
  - PreFilter accepts AND of PreSelections (instead of OR as in TrigLevel)
- TrigLevel Forced Accept: take a certain fraction of events (from 0 to 1)
- Print sequence efficiency per RoI and per event at end of run

Book keeping



- Example ROOT file:
  - Directories created automatically for each sequence to have its histograms
  - Histograms booked and filled in user TrigSequence derived classes

Validation

- Have completed validation (to within 0.02 %)
  - Large(ish) rome electron sample
  - Small rome dijet sample
- Differences understood, several cuts and selection on old framework may need to be discussed (no details here)
- Have modified PreFilter selection so it is more powerful.
- Simplified user signature creation.
- Example “standard” user driver routines (main) to cover various running scenarios
  - Standard evaluation
  - Parameter scanning
  - Automated tuning
- A New NAME!!! PESAsim - a fast simulation of the PESA algorithms for validation and automated tuning.

```
LVL1  total events  7248
LVL1          eff   6679    0.921496 +-    0.003159
LVL1  passd events  6679  6679

LVL2  total events  6679
LVL2  Calo     eff  6404    0.958826 +-    0.002431  (of LVL1 input) 0.88355
LVL2  ID       eff  5582    0.835754 +-    0.004533                  0.77014
LVL2  IDCalo   eff  5482    0.820782 +-    0.004693                  0.75635
LVL2  passd events  5482

EF    total events  5482
EF    Calo     eff  5095    0.929405 +-    0.003460                  0.70295
EF    ID       eff  4611    0.841116 +-    0.004937                  0.63618
EF    IDCalo   eff  4507    0.822145 +-    0.005165                  0.62183

EF    passd events  4507
```

```
We start with:    7248 MC electrons

* After Level1
Electrons Left:   6677
Events Accepted:  6677
Total Efficiency:                                92.122 %
Total Efficiency after normalisation:            92.122 %
Efficiency w.r.t. Level1:                        100 %
Efficiency w.r.t. Level1 after normalisation:    100 %

* After Level2Calo
Electrons Left:   6403
Events Accepted:  6403
Total Efficiency:                                88.3416 %
Total Efficiency after normalisation:            88.3416 %
Efficiency w.r.t. Level1:                        95.8964 %
Efficiency w.r.t. Level1 after normalisation:    95.8964 %

* After Level2ID
Tracks found by ID: 5585
Efficiency w.r.t. Level1:                        83.6453 %
Efficiency w.r.t. Level1 after normalisation:    92.3335 %

* After Level2IDCalo
Electrons Left:   5482
Events Accepted:  5482
Total Efficiency:                                75.6347 %
Total Efficiency after normalisation:            83.4907 %
Efficiency w.r.t. Level1:                        82.1027 %
Efficiency w.r.t. Level1 after normalisation:    90.6306 %

* After EventFilter Calo
Electrons Left:   5094
Events Accepted:  5094
Total Efficiency:                                70.2815 %
Total Efficiency after normalisation:            77.5815 %
Efficiency w.r.t. Level1:                        76.2917 %
Efficiency w.r.t. Level1 after normalisation:    84.216 %

* After EventFilter ID
Electrons Left:   4610
Events Accepted:  4610
Total Efficiency:                                63.6038 %
Total Efficiency after normalisation:            70.2102 %
Efficiency w.r.t. Level1:                        69.043 %
Efficiency w.r.t. Level1 after normalisation:    76.2144 %

* After EventFilter IDCalo
Electrons Left:   4506
Events Accepted:  4506
Total Efficiency:                                62.1689 %
Total Efficiency after normalisation:            68.6263 %
Efficiency w.r.t. Level1:                        67.4854 %
Efficiency w.r.t. Level1 after normalisation:    74.495 %
```

- Differences understood - mainly in the L2 ID and EF tracking selection.
- Some, represent bugs in old framework, (included for comparison)
  - eg p_T is a signed quantity, old framework often takes just pt>cut.
- After today should revert to correct use in new framework.

```
LVL1  total events  1237
LVL1          eff   51    0.041229 +-   0.005653
LVL1  passd events  51  51

LVL2  total events  51
LVL2  Calo     eff  14    0.274510 +-   0.062490  (of LVL1 input) 0.011318
LVL2  ID       eff  1    0.019608 +-   0.019415                   0.00080841
LVL2  IDCalo   eff  1    0.019608 +-   0.019415                   0.00080841
LVL2  passd events  1

EF    total events  1
EF    Calo     eff  1    1.000000 +-   0.000000                   0.00080841
EF    ID       eff  1    1.000000 +-   0.000000                   0.00080841
EF    IDCalo   eff  1    1.000000 +-   0.000000                   0.00080841

EF    passd events  1
```

- Again differences understood.

```
We start with:    1237 MC electrons

 * After Level1
 Electrons Left:   51
 Events Accepted:  51
 Total Efficiency:                              4.12288 %
 Total Efficiency after normalisation:          4.12288 %
 Efficiency w.r.t. Level1:                      100 %
 Efficiency w.r.t. Level1 after normalisation: 100 %

 * After Level2Calo
 Electrons Left:   14
 Events Accepted:  14
 Total Efficiency:                              1.13177 %
 Total Efficiency after normalisation:          1.13177 %
 Efficiency w.r.t. Level1:                      27.451 %
 Efficiency w.r.t. Level1 after normalisation: 27.451 %

 * After Level2ID
 Tracks found by ID: 2
 Efficiency w.r.t. Level1:                      3.92157 %
 Efficiency w.r.t. Level1 after normalisation: 3.95353 %

 * After Level2IDCalo
 Electrons Left:  1
 Events Accepted:  1
 Total Efficiency:                              0.0808407 %
 Total Efficiency after normalisation:          0.0814996 %
 Efficiency w.r.t. Level1:                      1.96078 %
 Efficiency w.r.t. Level1 after normalisation: 1.97676 %

 * After EventFilter Calo
 Electrons Left:   1
 Events Accepted:  1
 Total Efficiency:                              0.0808407 %
 Total Efficiency after normalisation:          0.0814996 %
 Efficiency w.r.t. Level1:                      1.96078 %
 Efficiency w.r.t. Level1 after normalisation: 1.97676 %

 * After EventFilter ID
 Electrons Left:   1
 Events Accepted:  1
 Total Efficiency:                              0.0808407 %
 Total Efficiency after normalisation:          0.0814996 %
 Efficiency w.r.t. Level1:                      1.96078 %
 Efficiency w.r.t. Level1 after normalisation: 1.97676 %

 * After EventFilter IDCalo
 Electrons Left:  1
 Events Accepted:  1
 Total Efficiency:                              0.0808407 %
 Total Efficiency after normalisation:          0.0814996 %
 Efficiency w.r.t. Level1:                      1.96078 %
 Efficiency w.r.t. Level1 after normalisation: 1.97676 %
```

Rome Jet Sample - with e

```
LVL1  total events  3
LVL1          eff  1    0.333333 +-   0.272166
LVL1  passd events  1  1

LVL2  total events  1
LVL2  Calo    eff  1    1.000000 +-   0.000000  (of LVL1 input) 0.33333
LVL2  ID      eff  0    0.000000 +-   0.000000                  0
LVL2  IDCalo  eff  0    0.000000 +-   0.000000                  0
LVL2  passd events  0

EF    total events  0
EF    Calo    eff  0    0.000000 +-   0.000000
EF    ID      eff  0    0.000000 +-   0.000000
EF    IDCalo  eff  0    0.000000 +-   0.000000

EF    passd events  0
```

- Really just a consistency check.
- Everything seems fine.

```
|
|We start with:    3 MC electrons
|
| * After Level1
| Electrons Left:   1
| Events Accepted:  1
| Total Efficiency:                                33.3333 %
| Total Efficiency after normalisation:            33.3333 %
| Efficiency w.r.t. Level1:                        100 %
| Efficiency w.r.t. Level1 after normalisation:    100 %
|
| * After Level2Calo
| Electrons Left:   1
| Events Accepted:  1
| Total Efficiency:                                33.3333 %
| Total Efficiency after normalisation:            33.3333 %
| Efficiency w.r.t. Level1:                        100 %
| Efficiency w.r.t. Level1 after normalisation:    100 %
|
| * After Level2ID
| Tracks found by ID: 0
| Efficiency w.r.t. Level1:                        0 %
| Efficiency w.r.t. Level1 after normalisation:    0 %
|
```

Validation summary:

- Validation complete, at some level. Need limit of large statistics.
- During the validation several bugs and inconsistencies were discovered in both the old and new frameworks.
- Bugs in the new framework were corrected.
- Bugs in the old framework were “added” to the new framework for comparison purposes.
- These should now be removed from the new framework and we should discuss making the old framework obsolete.
  - How large a sample do people require before we move over officially.
- Details of bug fixes can be discussed by email.

Z→ee – using menu of 3 signatures

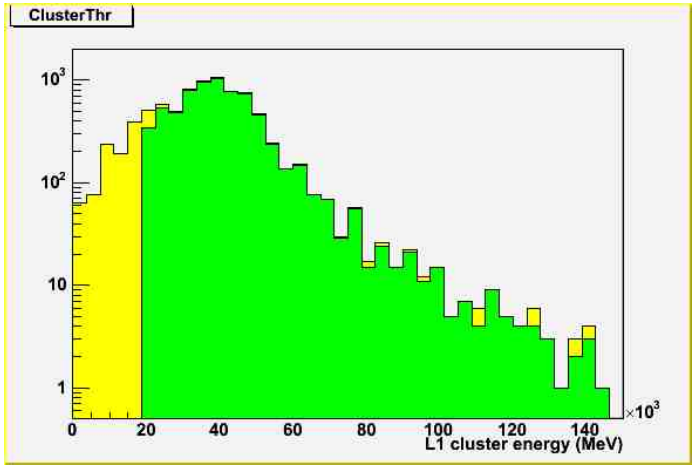
- Combined e25i, 2e15i and e60 in the new framework
  - Still ongoing work
  - These were running simultaneously
- All cuts from Monika's Wiki page except for EF track isolation in EFID sequence
  - No tracking cuts at level 2 for 2e15i or e60, following recipe in wiki
- 4468 Z→ee events from an old production, no pileup
- 234634 "di-jet" events with pileup from sample 4814 (E_T>17GeV)

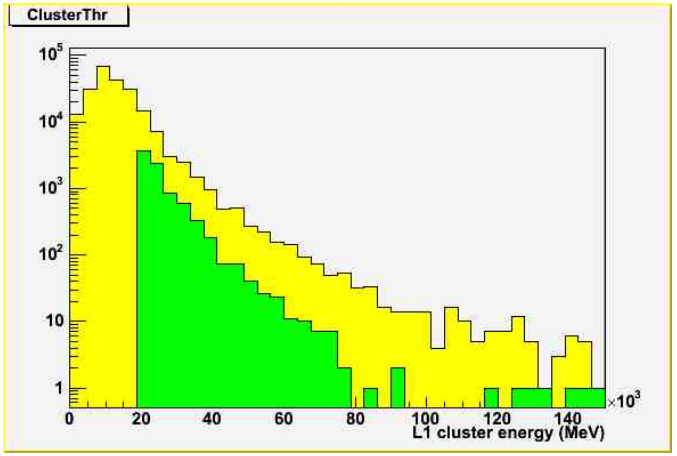
A few plots

Z->ee

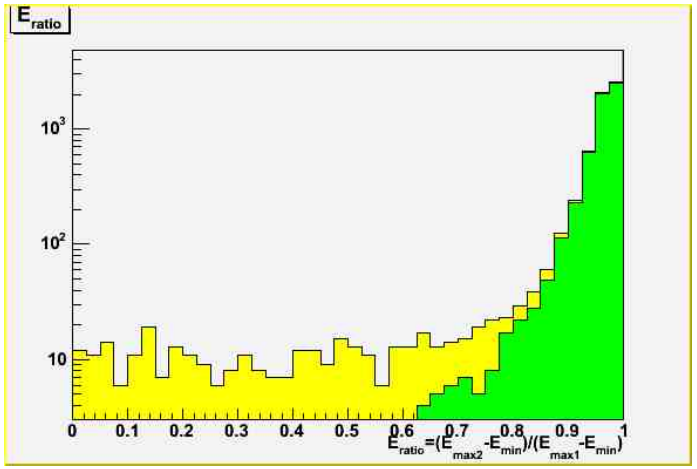
Jets

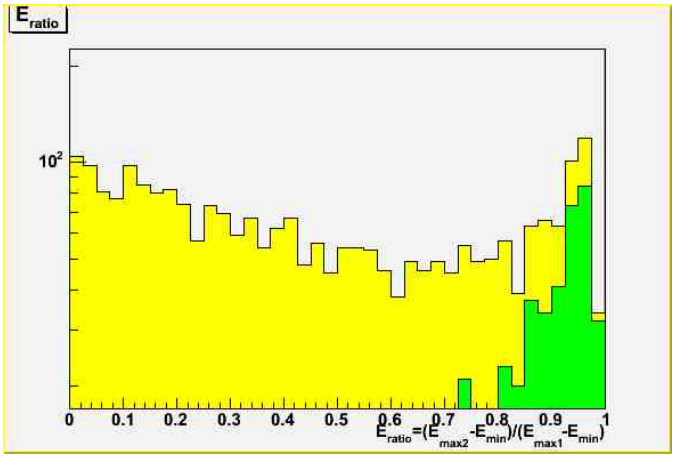
LVL1





LVL2





Performance & comparison with old

- No preselection cuts applied here: comparison with Monika's results (with preselection) will be done asap.
- Absolute efficiencies shown in table

	LVL1	LVL2	EF	Monika
2e15i	70.8±0.6%	60.7 ±0.7%	35.9 ±0.7%	67.2%
e25i	92.5 ±0.4%	84.2 ±0.5%	80.5 ±0.6%	92.9%
e60	23.4 ±0.4%	20.6±0.6%	16.4 ±0.5%	20.4%
All	93.2 ±0.4%	87.4 ±0.5%	82.3 ±0.6%	94.8%

Overlaps:

Interesting to note correlations between different signatures: much larger in signal than in background (makes sense)

Z->ee: 4468 events

EvFilt	e25i	e60	2e15i
e25i	3598	692	1551
e60	692	732	376
2e15i	1551	376	1603

LVL2	e25i	e60	2e15i
e25i	3761	868	2596
e60	868	921	725
2e15i	2596	725	2714

LVL1	e25i	e60	2e15i
e25i	4131	1042	3233
e60	1042	1046	907
2e15i	3233	907	164

Jets: 234634 events

LVL1	e25i	e60	2e15i
e25i	8153	143	492
e60	143	1024	14
2e15i	492	14	1370

LVL2	e25i	e60	2e15i
e25i	147	1	5
e60	1	43	1
2e15i	5	1	50

EvFilt	e25i	e60	2e15i
e25i	46	1	2
e60	1	1	0
2e15i	2	0	2

Conclusions:

- Validation work basically done
- We should switch to using PESAsim!
- Demonstration of the framework in the Calorimeter Trigger Software tutorial on Monday
- Documentation should be ready next week
  - Including Wiki page, tutorial, writeup etc