

W mass direct measurement via $e\nu W$ process

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→ Updates and current status of my study

Today's

- Systematics from hadronization model
 - at first step, check different PYTHIA tunes
 - generated “Default” & “OPAL tune” samples
- W mass resolutions with different technologies of calorimeters
 - silicon & scintillator ECALs
- Simulated 50k events for each at 250GeV & 500GeV
 - today, 250GeV samples only

Default PYTHIA tunings

- PYTHIA parameters : DBD = “OPAL tune”

Turn them off all
→ ‘Default’ PYTHIA tunings

inside “whizard.in”

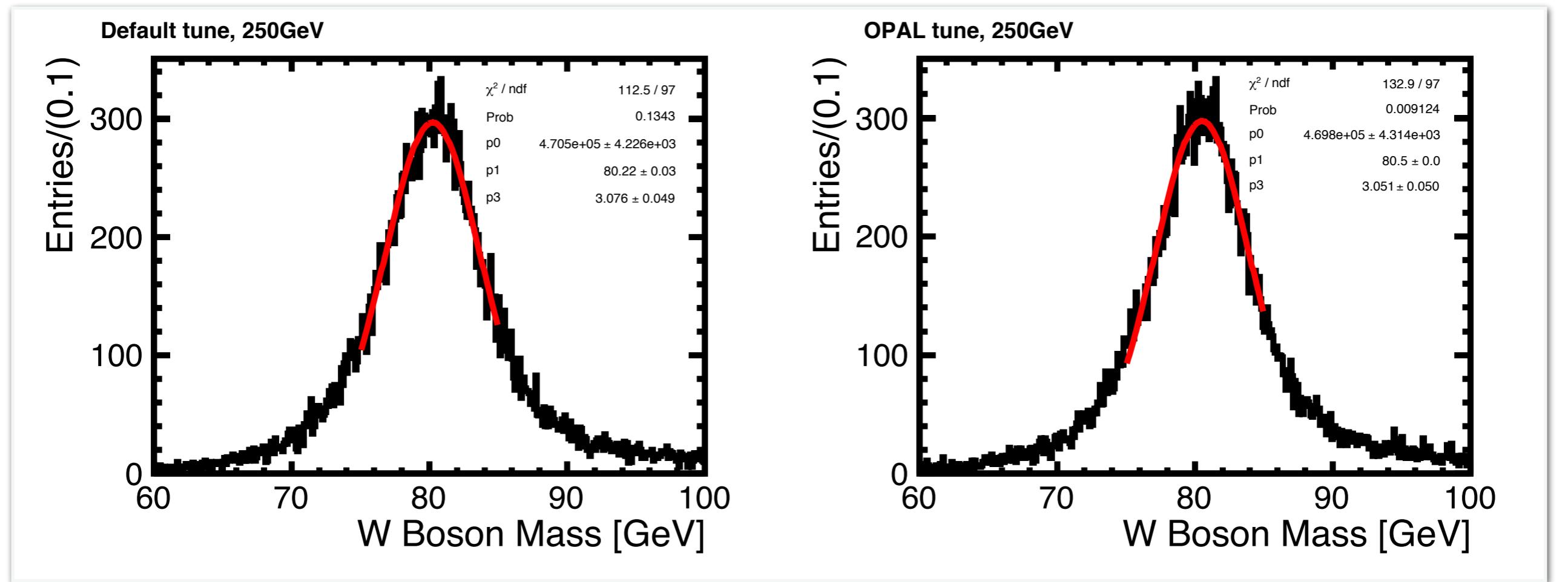
```
&simulation_input
n_events = 10000
write_events_raw = F
keep_beam_remnants = T
write_events_file = "E250-TDR_ws.P4f_sw_sl.Gwhizard-1_95.eL.pR.I106564"
fragment = T
max_file_count = 50
fragmentation_method = 3

! OPAL tune
pythia_parameters = "PMAS(25,1)=120.0; PMAS(25,2)=0.3605E-02;
MSTJ(41)=2; MSTU(22)=20; MSTJ(28)=2;
PARJ(21)=0.40000; PARJ(41)=0.11000; PARJ(42)=0.52000; PARJ(81)=0.25000;
PARJ(82)=1.90000; MSTJ(11)=3; PARJ(54)=-0.03100; PARJ(55)=-0.00200;
PARJ(1)=0.08500; PARJ(3)=0.45000; PARJ(4)=0.02500; PARJ(2)=0.31000;
PARJ(11)=0.60000; PARJ(12)=0.40000; PARJ(13)=0.72000; PARJ(14)=0.43000;
PARJ(15)=0.08000; PARJ(16)=0.08000; PARJ(17)=0.17000; MSTP(3)=1;"

! MWID(25)=2;
! BRAT(212)=0.00044;BRAT(213)=0.0268;BRAT(214)=0.578;BRAT(219)=0.000221;
! BRAT(220)=0.0637;BRAT(222)=0.0856;BRAT(223)=0.0023;BRAT(224)=0.00155;
! BRAT(225)=0.0267;BRAT(226)=0.216
! MDME(219,1)=0; To suppress h-> mu mu decay

write_events = F
write_events_format = 24
bytes_per_file = 500000000
/
```

W mass with different tunings



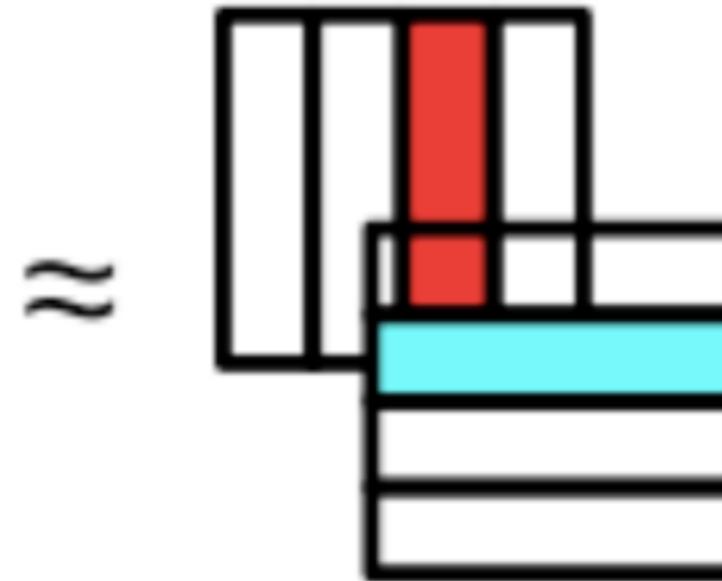
Pythia tuning

	Default	OPAL tune
MPV [GeV]	80.220 ± 0.035	80.497 ± 0.035
relative uncertainty	0.043%	0.044%
Sigma [GeV]	3.076 ± 0.049	3.051 ± 0.050
relative resolution	$3.83 \pm 0.06 \%$	$3.79 \pm 0.06 \%$
mass shift [GeV]	0.278 ± 0.049	—

2 designs of ScECAL



05 x 05 tile



45 x 05 strip w/ SSA*

*arXiv:1415.4456

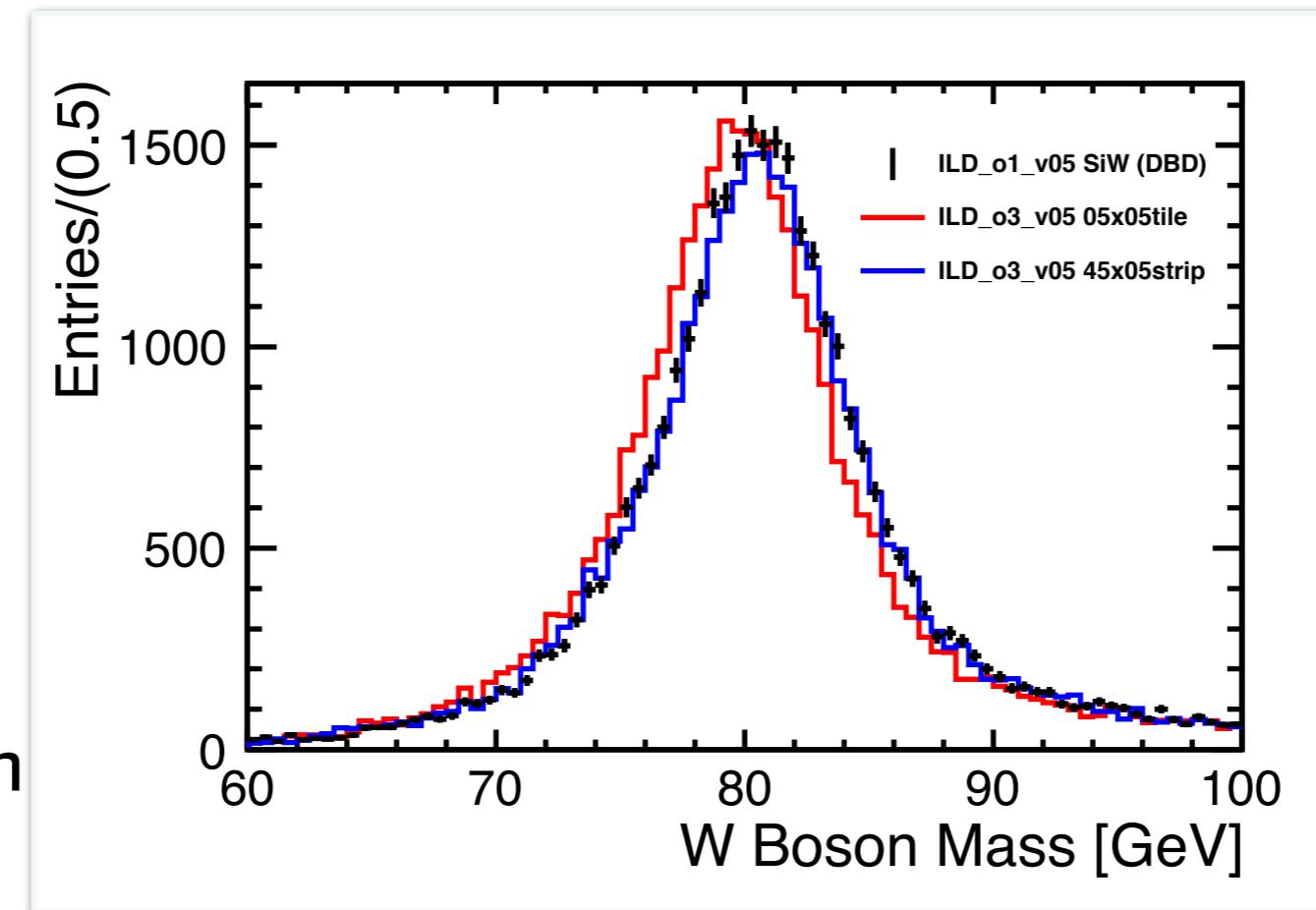
parameter	value
PPD size	0 mm
number of layers	20 + 9
radiator thicknesses	2.1 & 4.2
scintillator thickness	1.0 mm

Available with “ILD_o3_v05”

m_W resolution vs ECAL technologies

made from exactly same event files, which were generated by Whizard

~35k entries for each



calorimeter energy scale has already been calibrated

mass scale has not been calibrated yet

ECAL technologies	05x05 SiW	05x05 Sc-tile	45x05 Sc-strip
MPV [GeV]	80.497 ± 0.035	79.701 ± 0.034	80.521 ± 0.037
relative uncertainty	0.044%	0.042%	0.046%
Sigma [GeV]	3.051 ± 0.050	2.974 ± 0.047	3.110 ± 0.052
relative resolution	$3.79 \pm 0.06 \%$	$3.73 \pm 0.06 \%$	$3.86 \pm 0.07 \%$

Summary

- Study of hadronization systematics;
 - If our knowledge of hadronization is not so accurate like as the difference between ‘Default tune’ and ‘OPAL tune’ of PYTHIA parameters, it causes critical systematic error.
 - in this study, 278MeV on W mass measurement
 - but it could include the effects of PFA tunings
- W mass resolution study with different ECAL technologies;
 - Comparing results, scintillator-ECAL with SSA degrades 0.07 point in relative resolution.
- For the next;
 - Investigate detailed reasons, what causes these results.
 - Estimate a solid value of systematic error from hadronization.

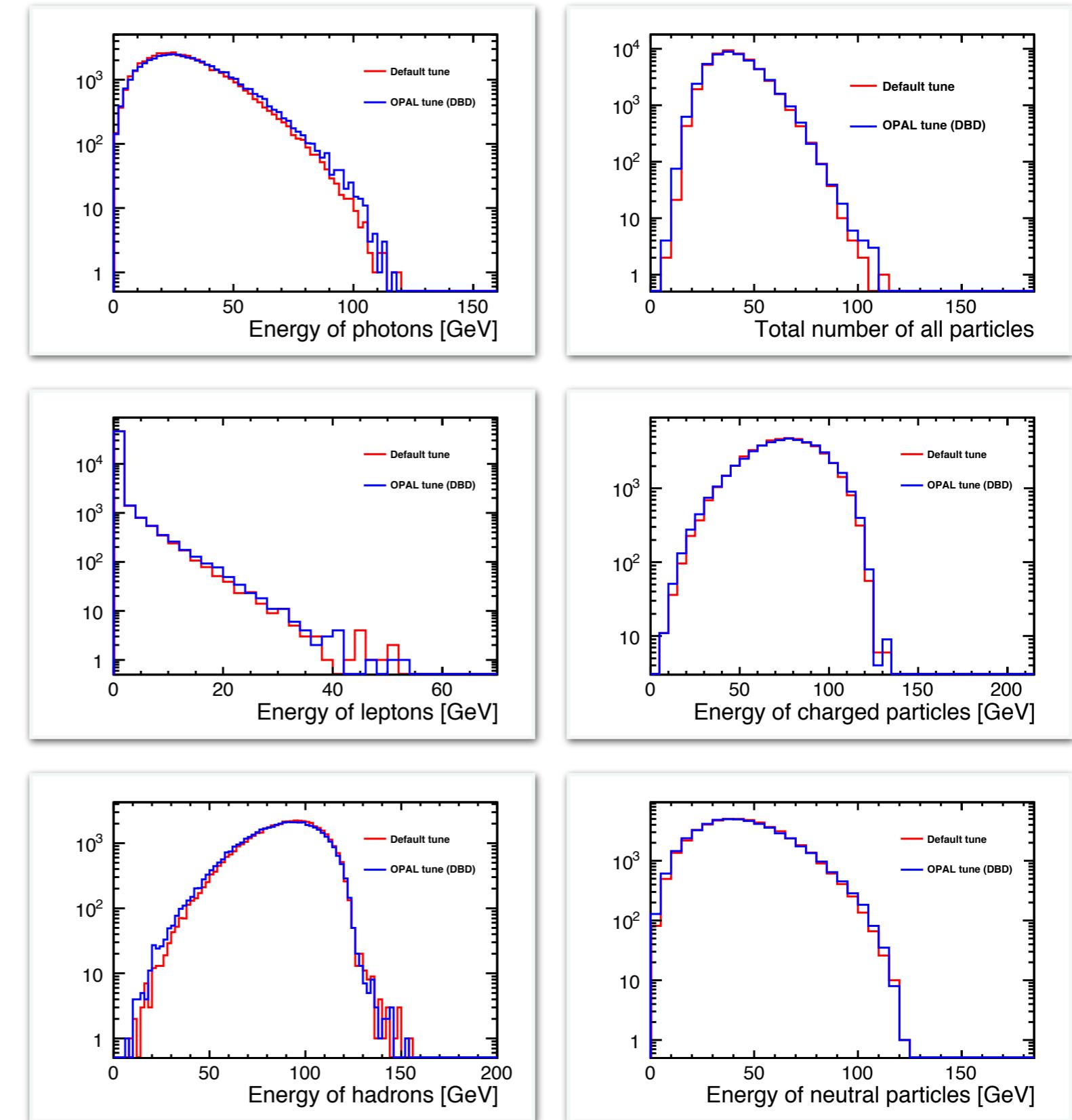
Back up

Reconstruction & selection

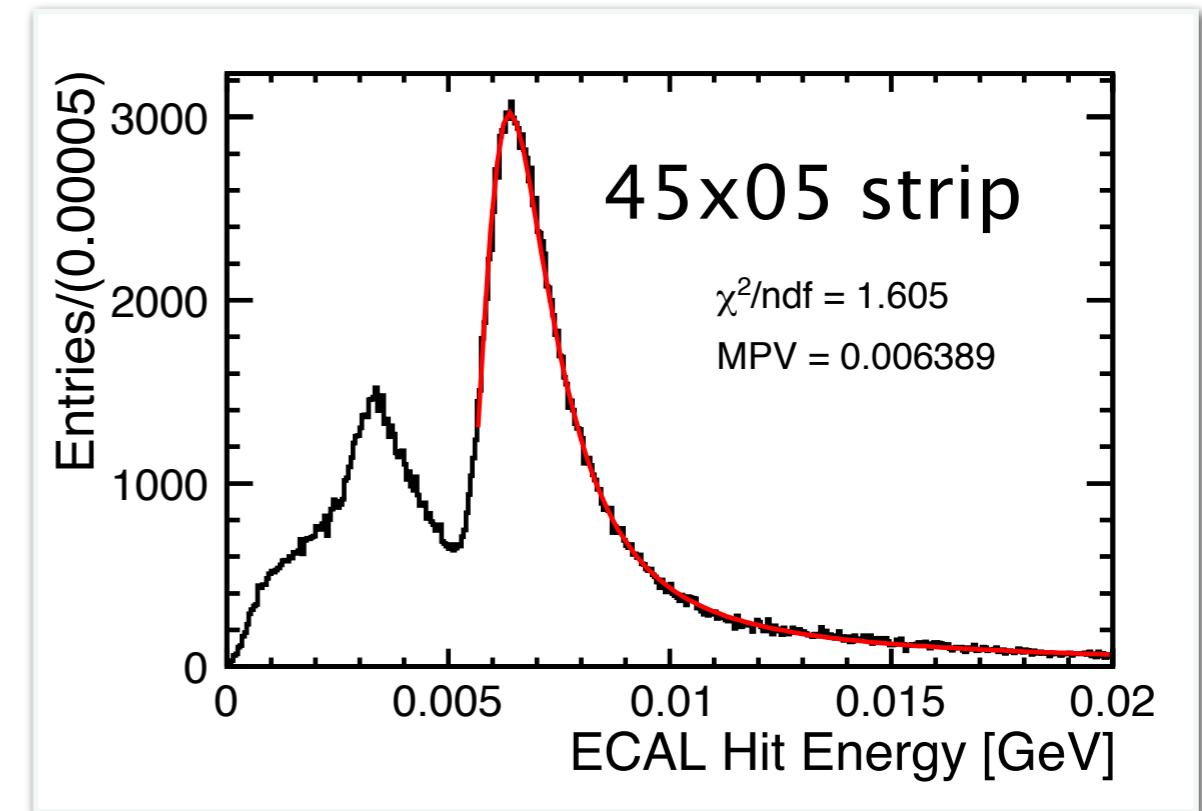
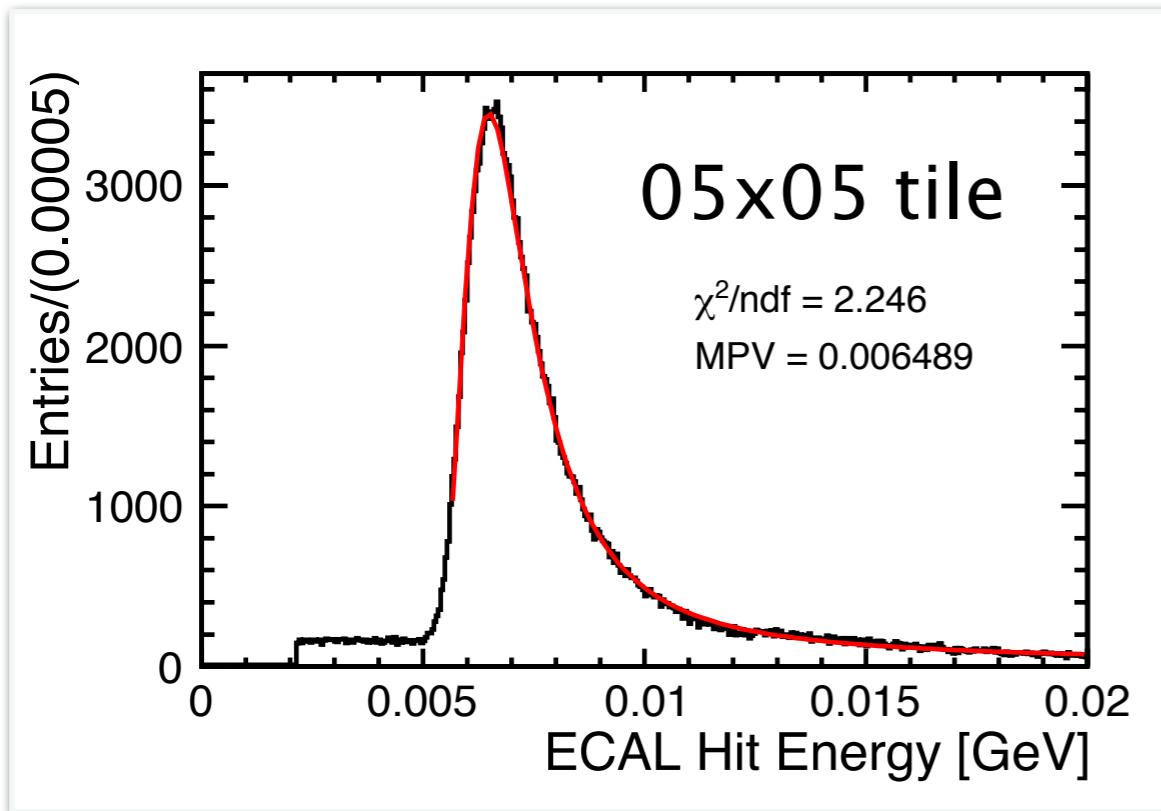
- Require exactly 1 isolated electron
- Perform jet clustering algorithm with remained PFOs into 2 jets
 - durham y -cut at 250 GeV (forced 2-jet, no cut)
 - k_T algorithm at 500 GeV (forced 2-jet, $R=1.5$)
- See invariant mass of 2 jets \rightarrow W mass distribution

Generator level

- Default & OPAL tune, 50k events for each
- difference can be seen in number of particles in jets, energy fraction of jets, etc...
- maybe more clear differences after PFA...



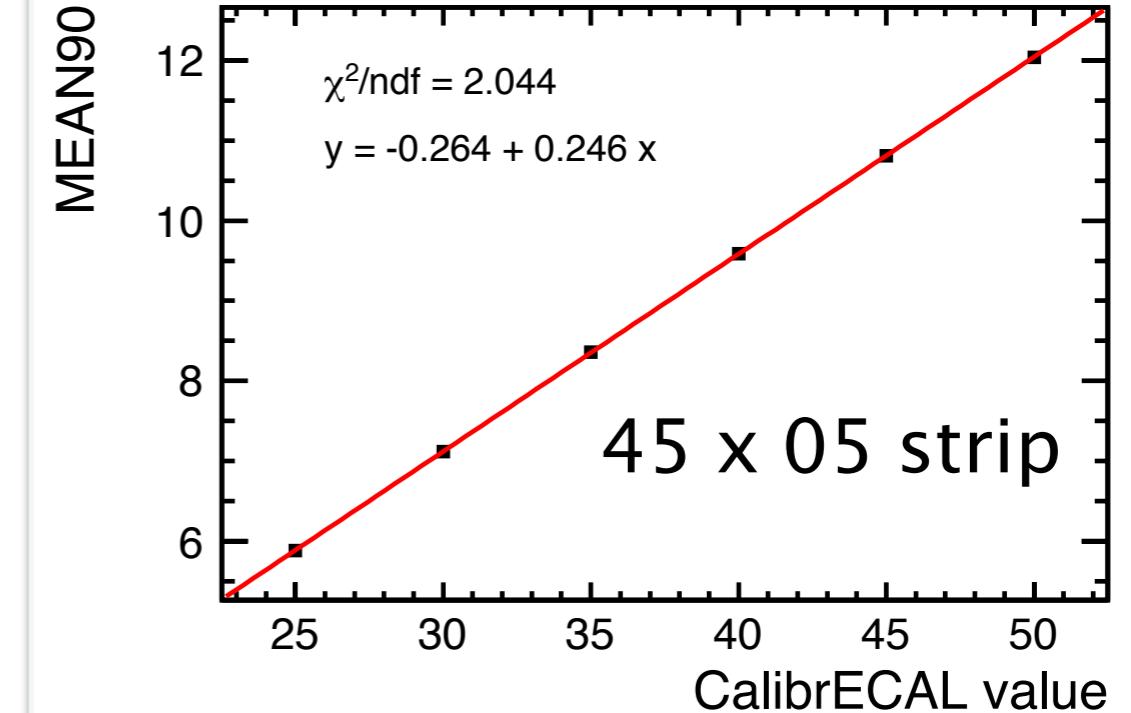
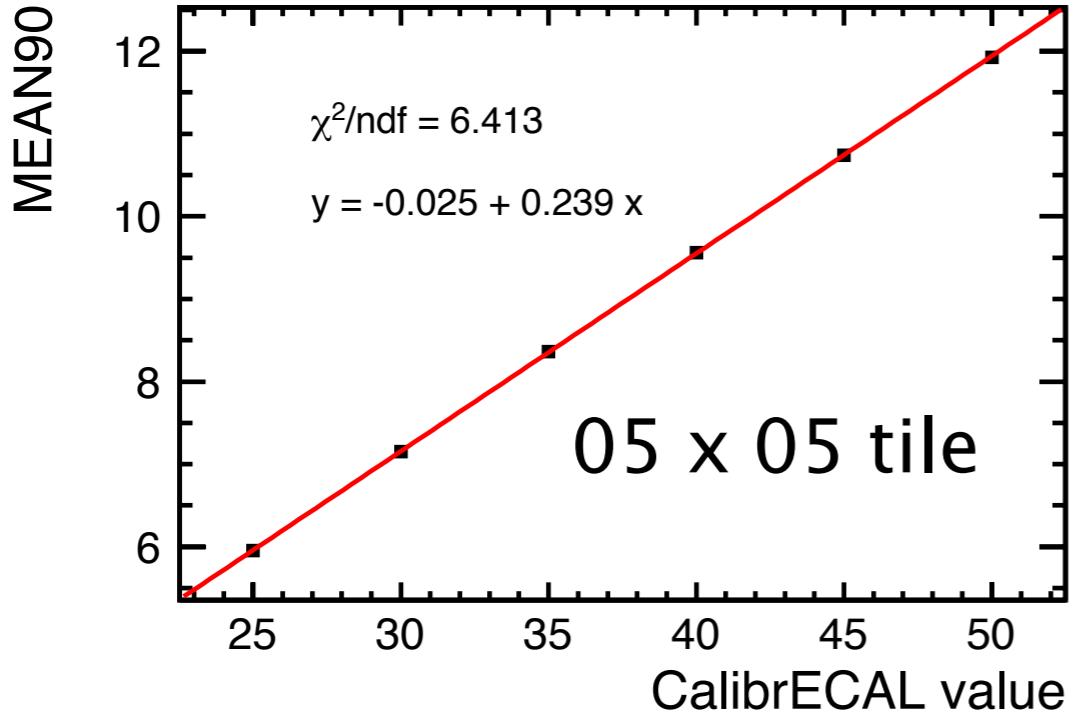
MIP constant at ScECAL



- Shoot 10k single particles; 10GeV muons
- Entries from an energy value of each ScECAL hit
- Fitting function : Landau X Gaussian + BG(expo.)

Segmentation	05 x 05 tile	45 x 05 strip
MPV value [GeV]	6.489×10^3	6.389×10^3
MIP constant	154.1	156.5

ScECAL energy coefficient



- Shoot 10k single particles; 10GeV photons
- Scan Mean90 values along ‘CalibrECAL’ factor

Segmentation	05 x 05 tile	45 x 05 strip
Reduced χ^2	6.413	2.044
Model function	$y = -0.025 + 0.239x$	$y = -0.264 + 0.246x$
Energy factor	41.95	41.72