First looks at Tau events for reduced ILD radius

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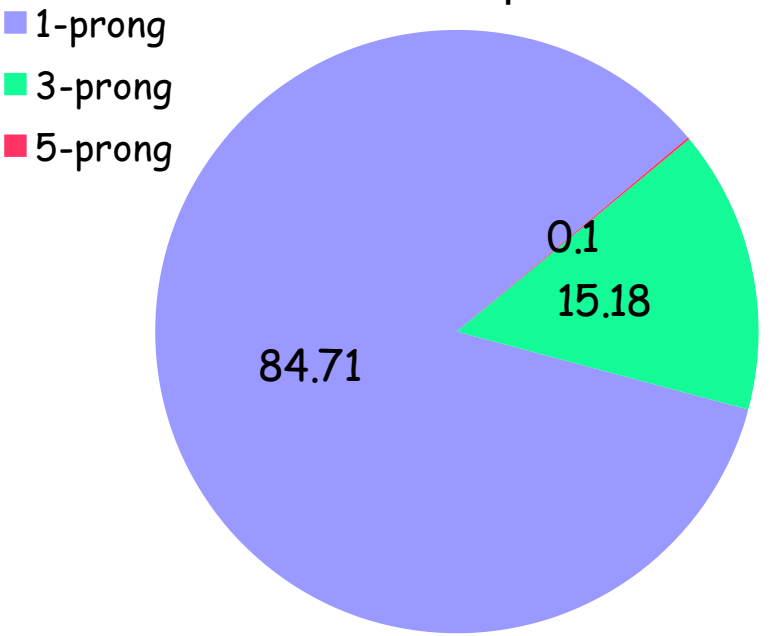
- Tau jet is a key to control ECAL performance
- With reduced ECAL radius, confusion may increase (smaller jet opening angle)
- First look at tau decay using Garlic, ILCsoft v01-16

Tau decay modes

Topologically: 3 decay modes
(1,3,5-prong)

1-prong: single charged pion and
any number of π^0
3-prong: $\pi^+\pi^-\pi^+$

7 tracks: very infrequent

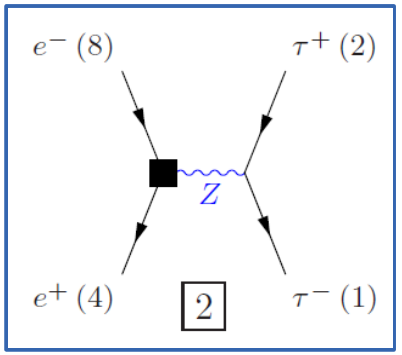


Final state	Branching fraction
$e^-\bar{\nu}_e\nu_\tau$	$17.85 \pm 0.05\%$
$\mu^-\bar{\nu}_\mu\nu_\tau$	$17.36 \pm 0.05\%$
$\pi^-\nu_\tau$	$10.91 \pm 0.07\%$
$\rho^-\nu_\tau$ $(\rho^- \to \pi^-\pi^0)$	$25.52 \pm 0.10\%$
$a_1^-\nu_\tau$ $(a_1^- \to \pi^-\pi^0\pi^0)$	$9.27 \pm 0.12\%$
$a_1^-\nu_\tau$ $(a_1^- \to \pi^-\pi^+\pi^-)$	$8.99 \pm 0.06\%$
24 other modes	10.10%

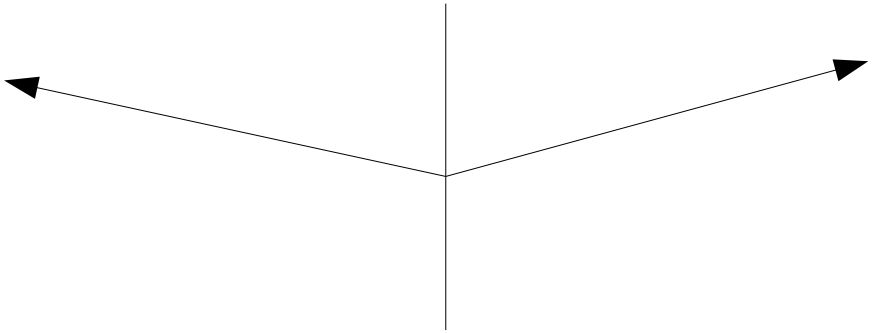
Branching fraction of main decays

Sample(s)

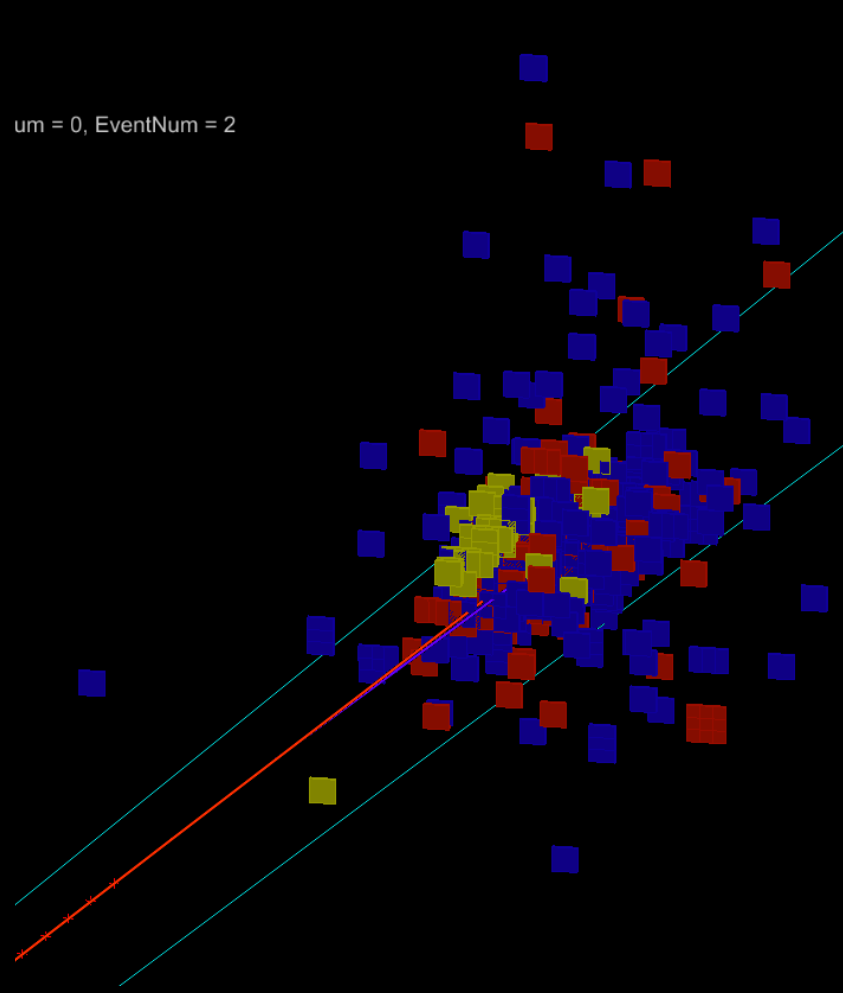
DBD generators
$e^+ e^- \rightarrow Z \rightarrow \tau^- \tau^+$
at 250 GeV C.M. energy
(mixed up with
$e^+ e^- \rightarrow Z \rightarrow \mu^- \mu^+$
$\rightarrow$ preselection of τ events using generator informations)



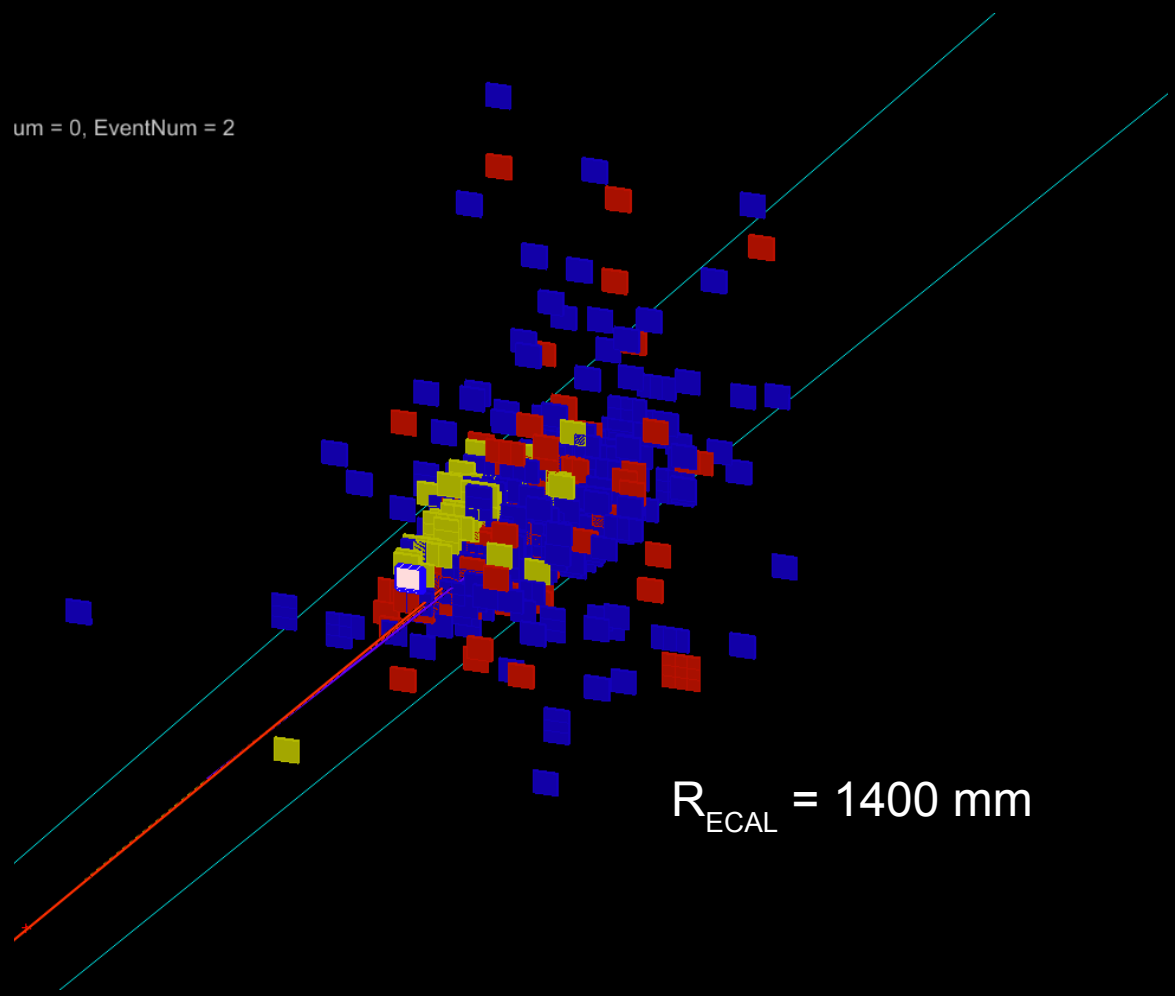
Two tau decays are separated by a plane defined by tau directions.



Example

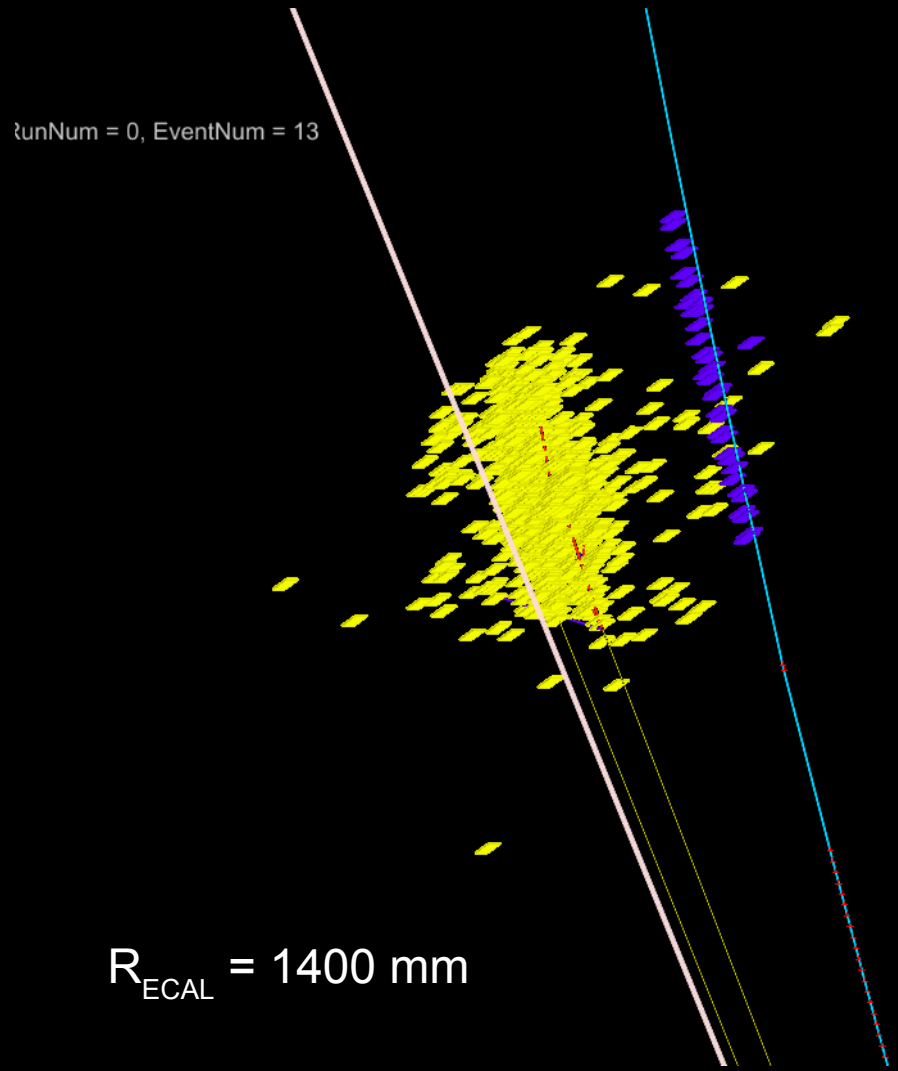


R_{ECAL} = 1843 mm

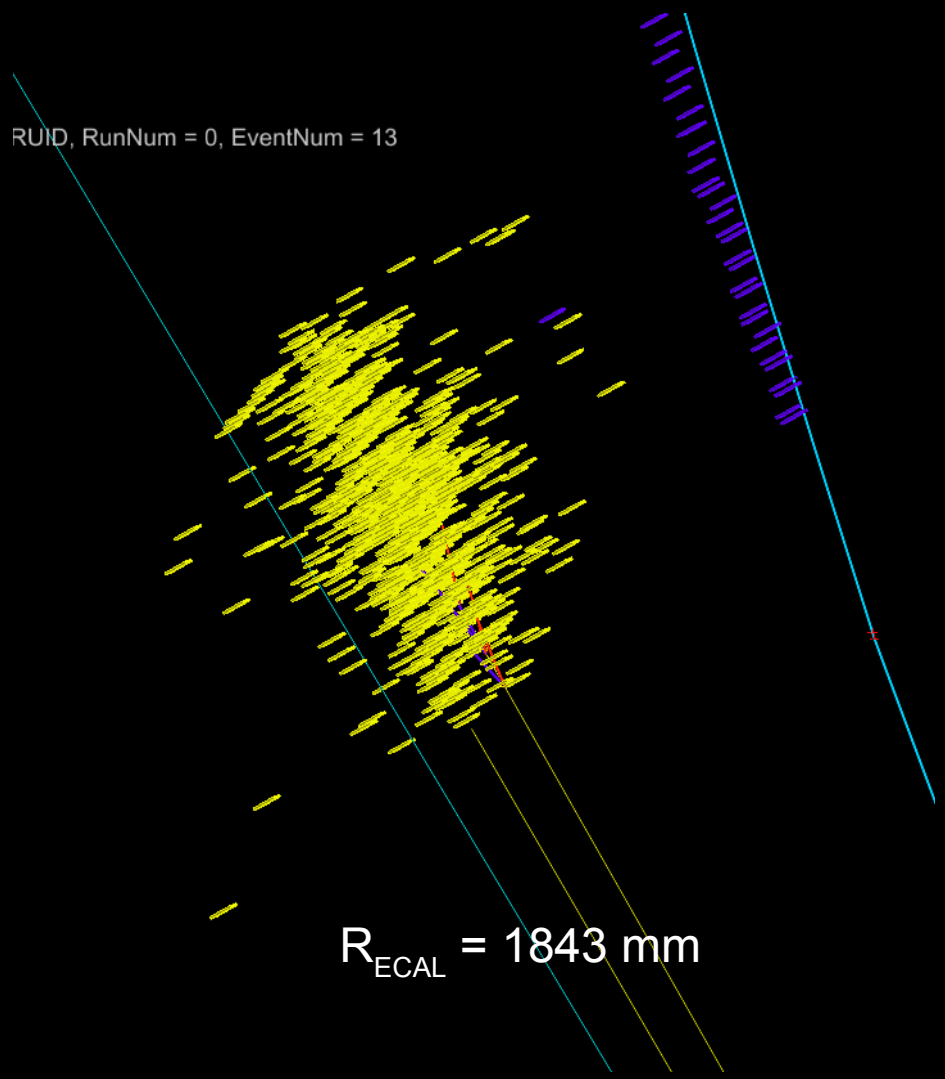


R_{ECAL} = 1400 mm

Example (2)

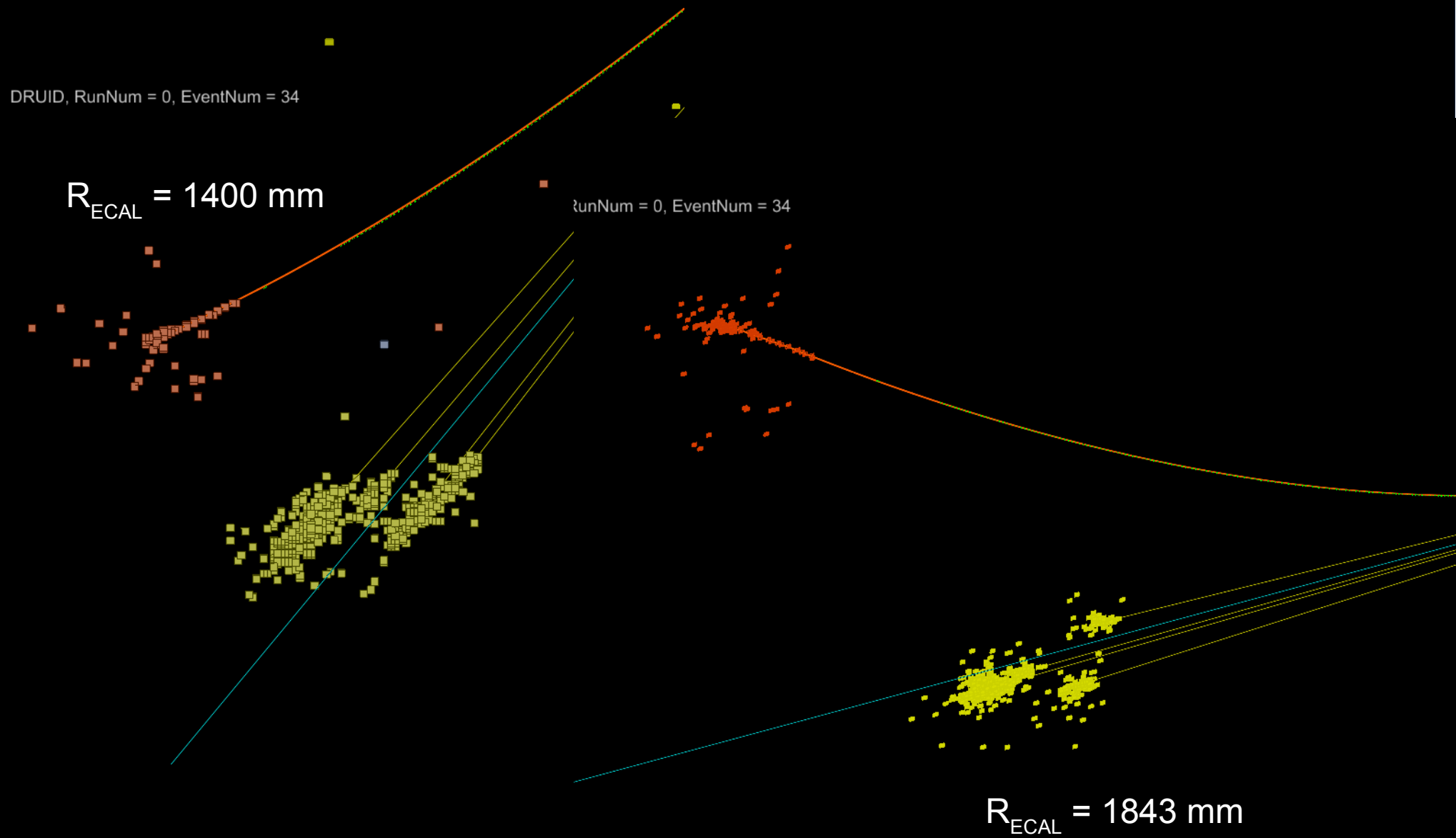


R_{ECAL} = 1400 mm



R_{ECAL} = 1843 mm

Example (3)


DRUID, RunNum = 0, EventNum = 34
R_{ECAL} = 1400 mm
RunNum = 0, EventNum = 34
R_{ECAL} = 1843 mm

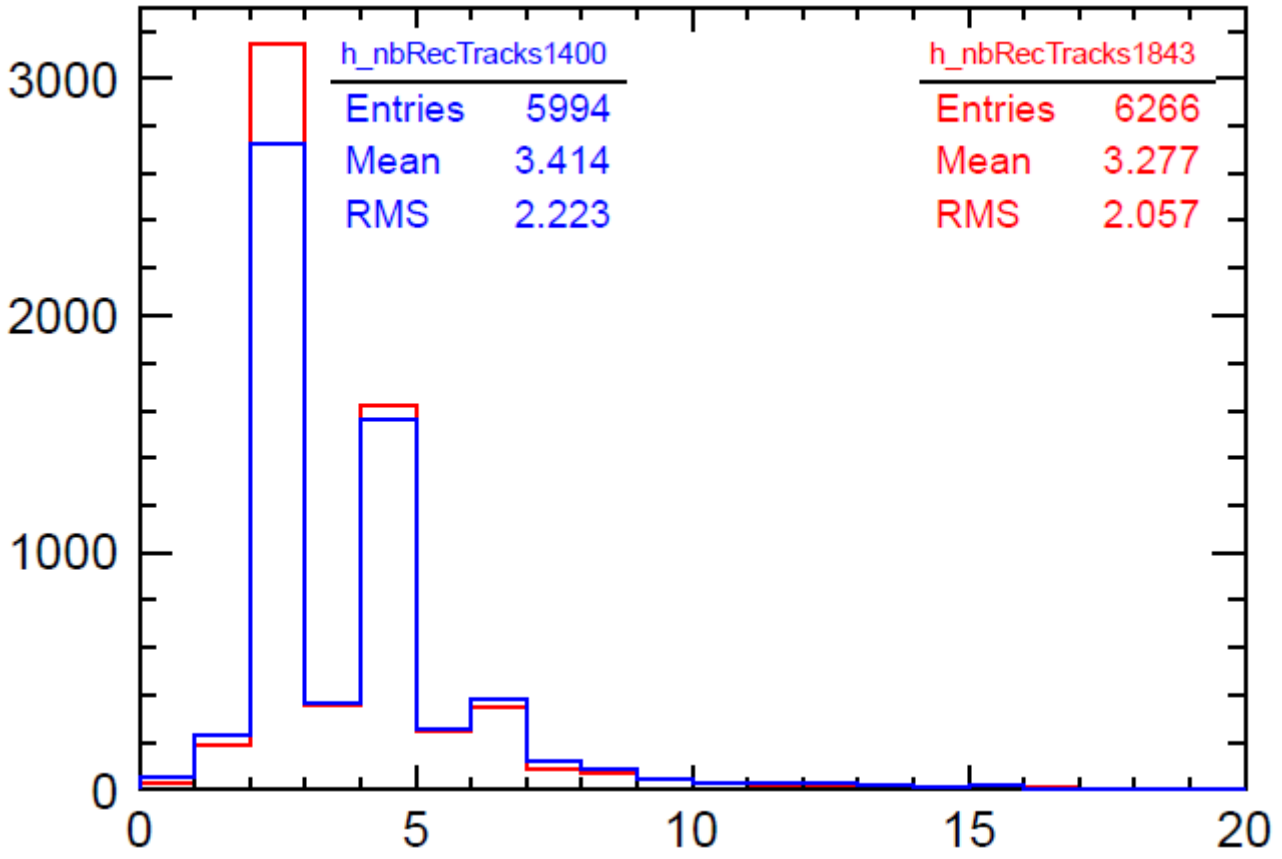
"Counting" procedure

- Since each process is decay of two τ's
  → need to separate the two "sets" of final states (τ^+ & τ^-)
- Selection of particles which belong to final states only

1 track+ 0 γ	1tr + 1 γ	2 γ	3 γ	4γ	5γ
π + ν	M_j < 0.25: π + ν	rho-nu: 1.45 <Mj<M_T	mainly a1 1.45 <Mj<M_T	M_{jet} < 0.25: pi-nu otherwise: a1	0.6 GeV< M_j < m_T: a1
	M_j < 1.45 rho	cut based on M_{jet}			

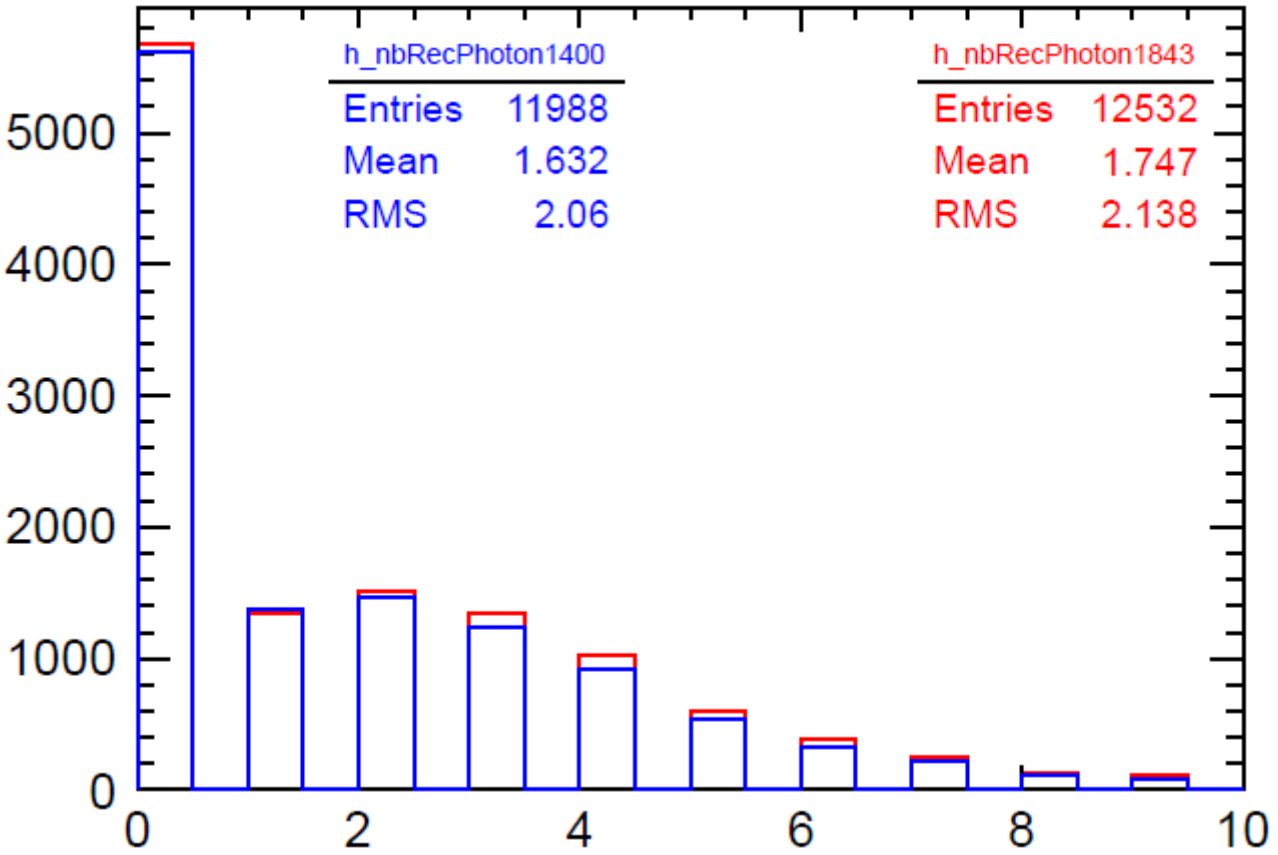
Cut values taken from Marcel R.'s thesis.
→ to be reoptimised.

Nb of recontructed tracks

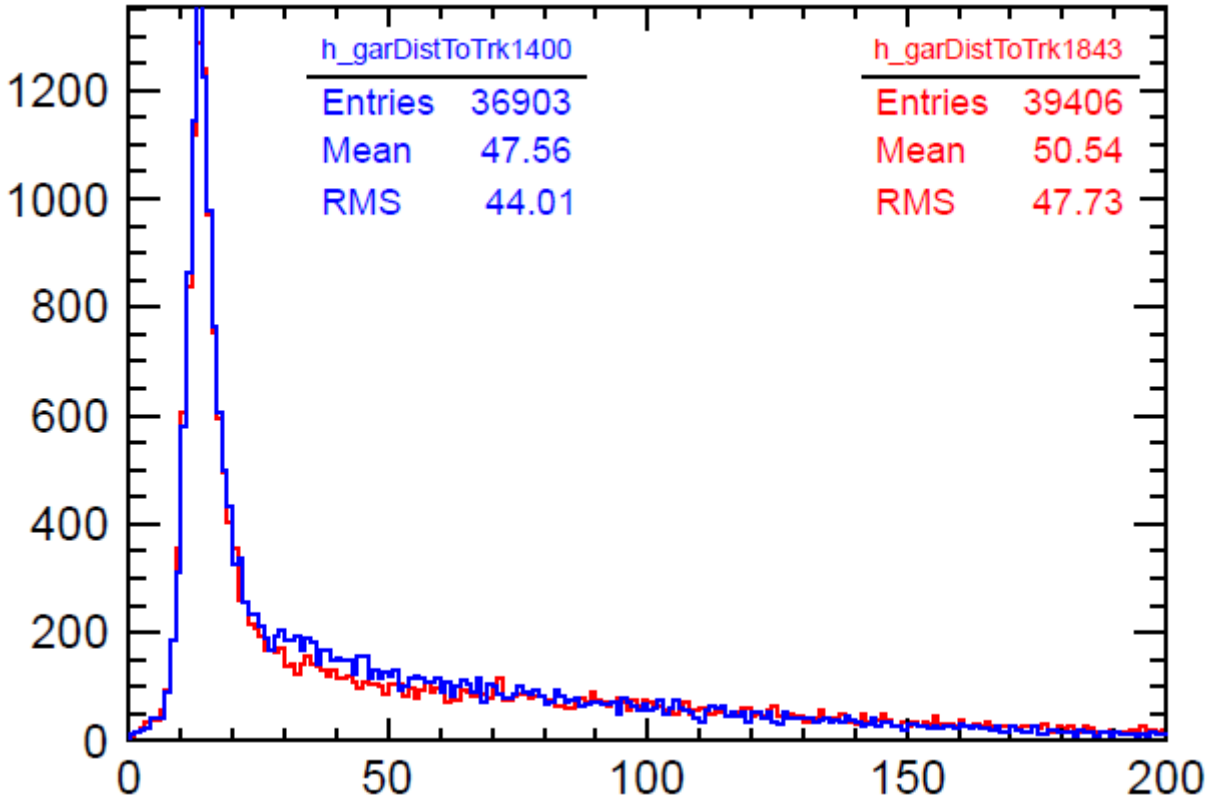


- Slight difference observed in number of reconstructed tracks between R_{ECAL}=1843 and R_{ECAL}=1400mm

Nb of recontructed photons



Garlic cluster: distant to closest track



- For all reconstructed clusters
- → very similar between two ILD setups

Reconstructed event selection

- Use only **1-prong event** for the moment
- MC process known → used to diffentiate invariant mass, photon distance to track, …
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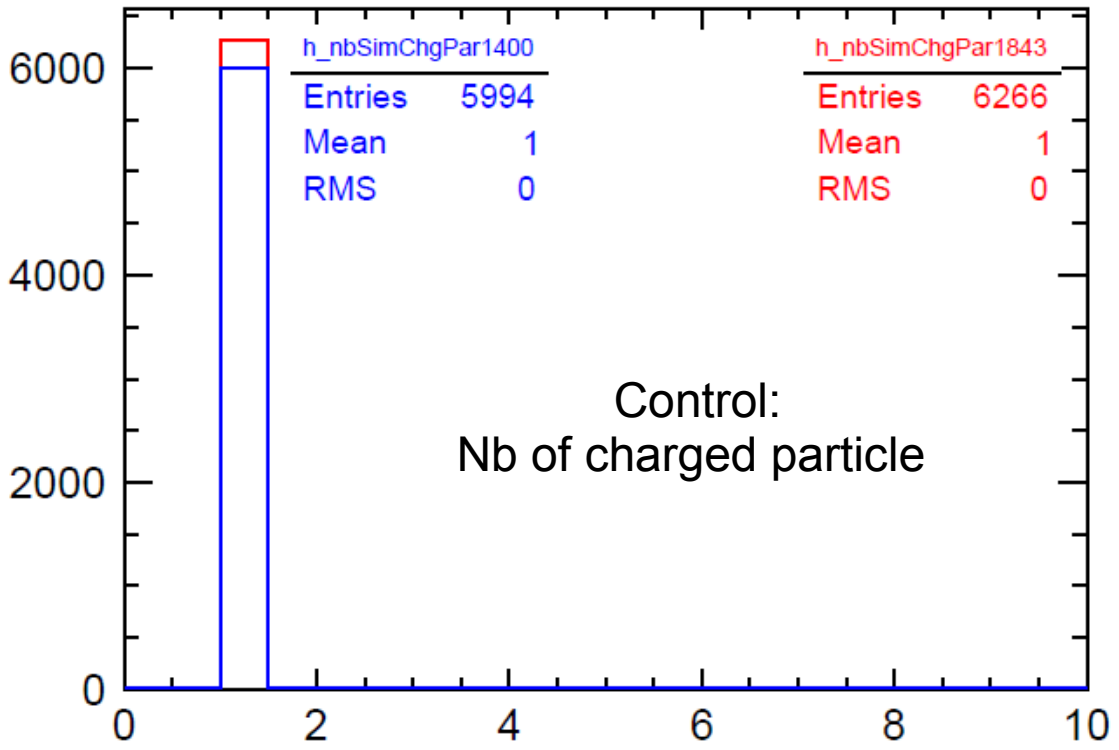
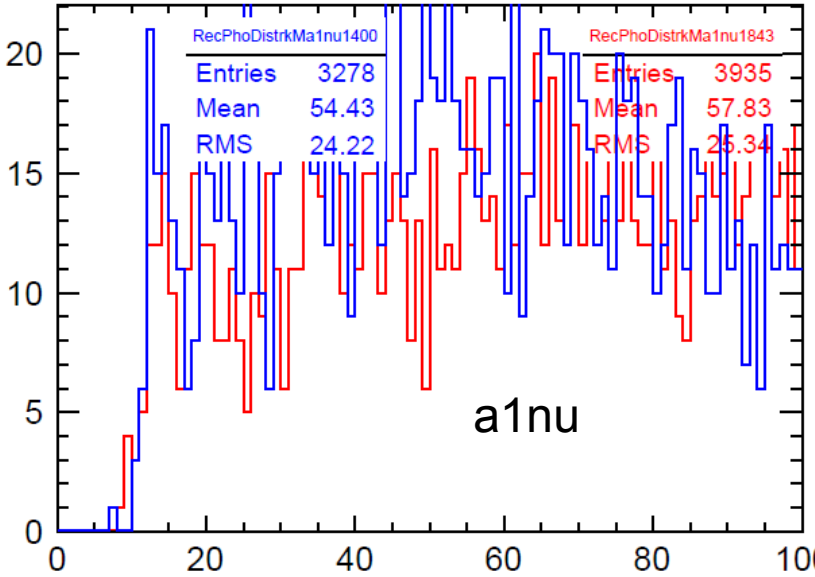
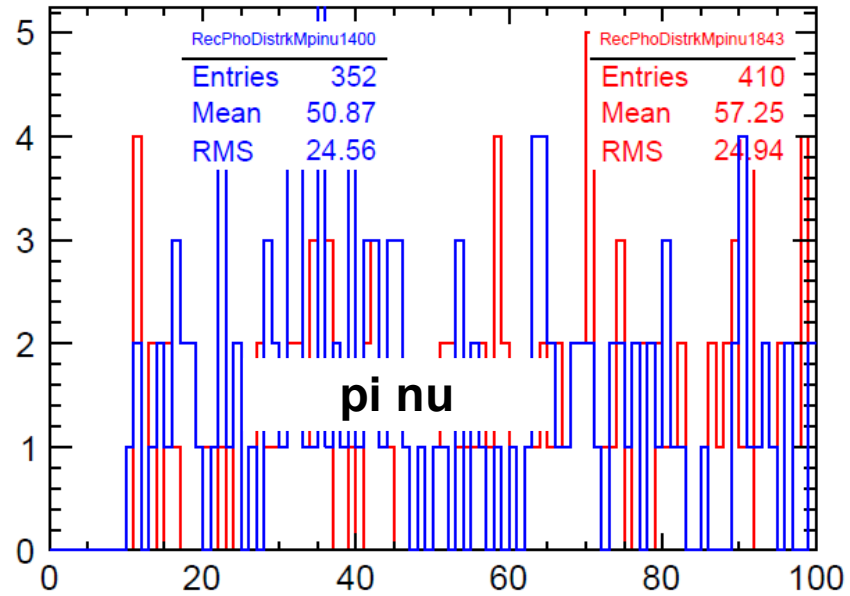
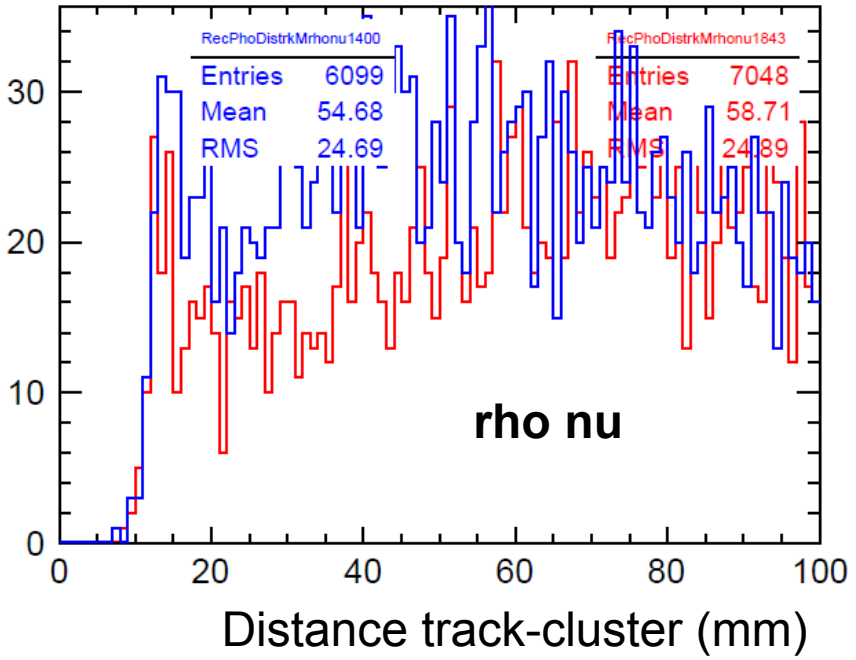


Photon distant to closest track



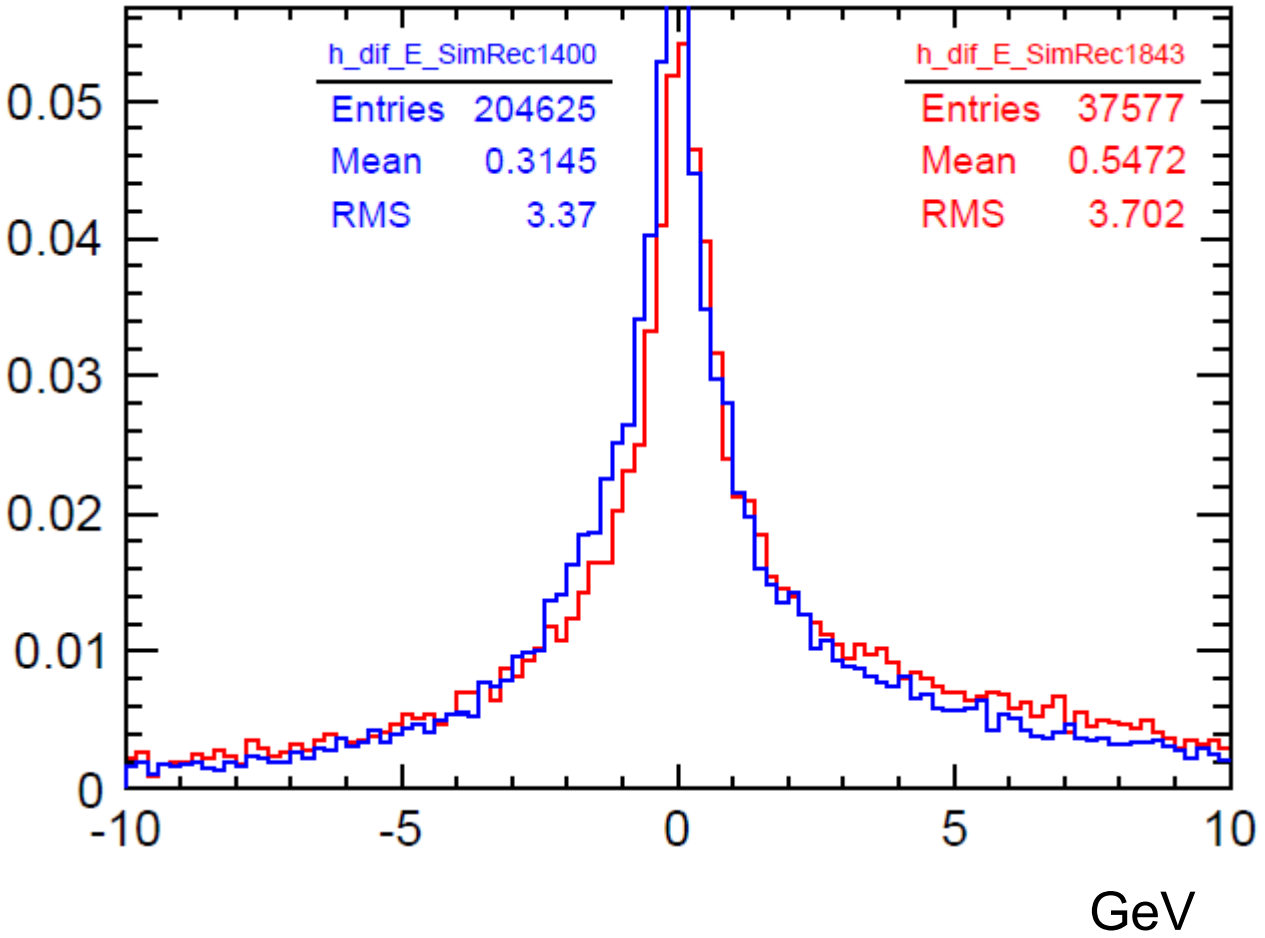
- Reconstructed invariant mass distribution for known MC process
- Cluster is photon if largest contribution comes from photon
-
- → cut at 15 mm





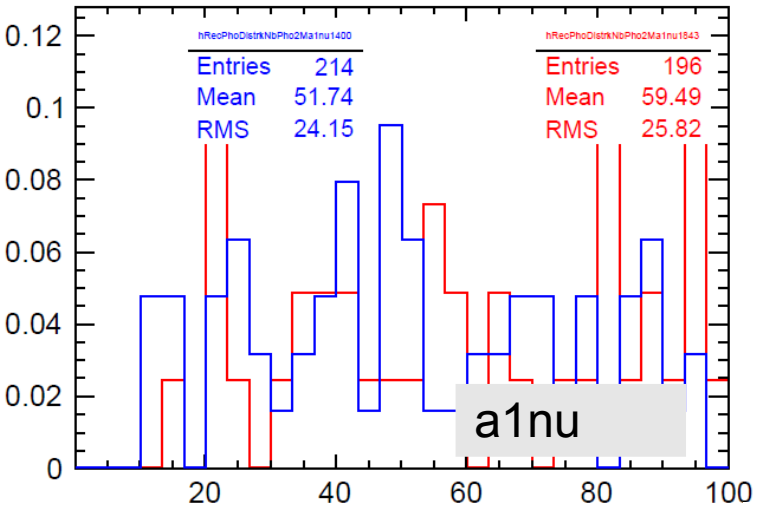
Difference Rec-Sim energy

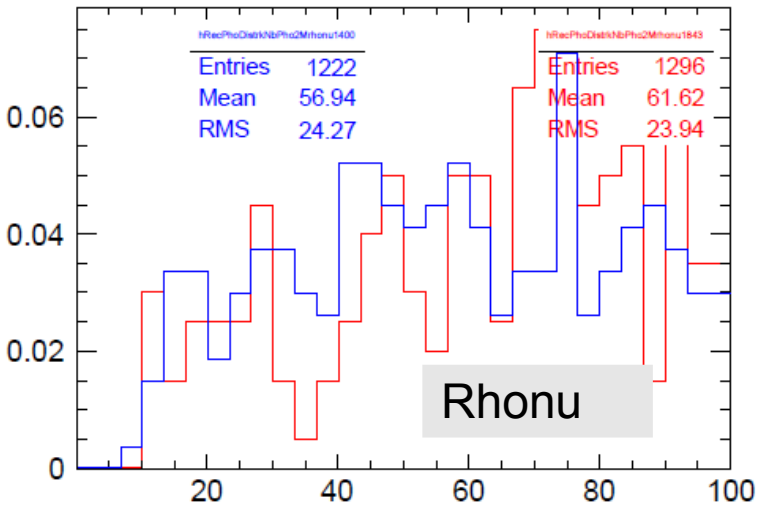
- Difference $E_{rec} - E_{sim}$ is similar for R_{ECAL} = 1843 and 1400 mm.

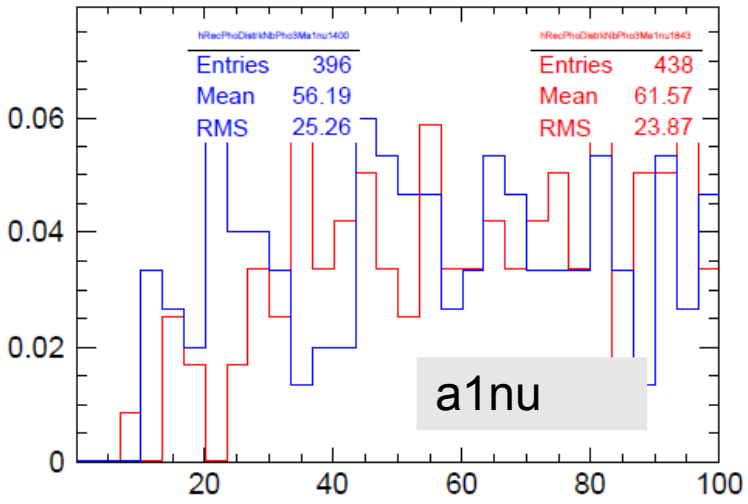


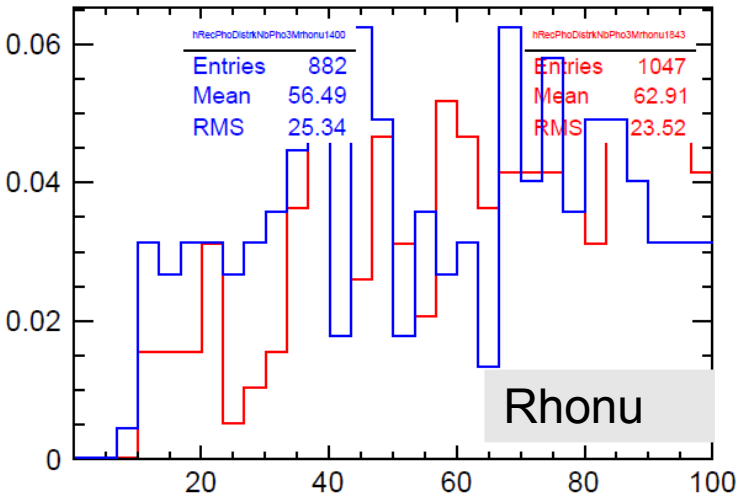
(Histograms are normalised to 1.)

π^0 identification





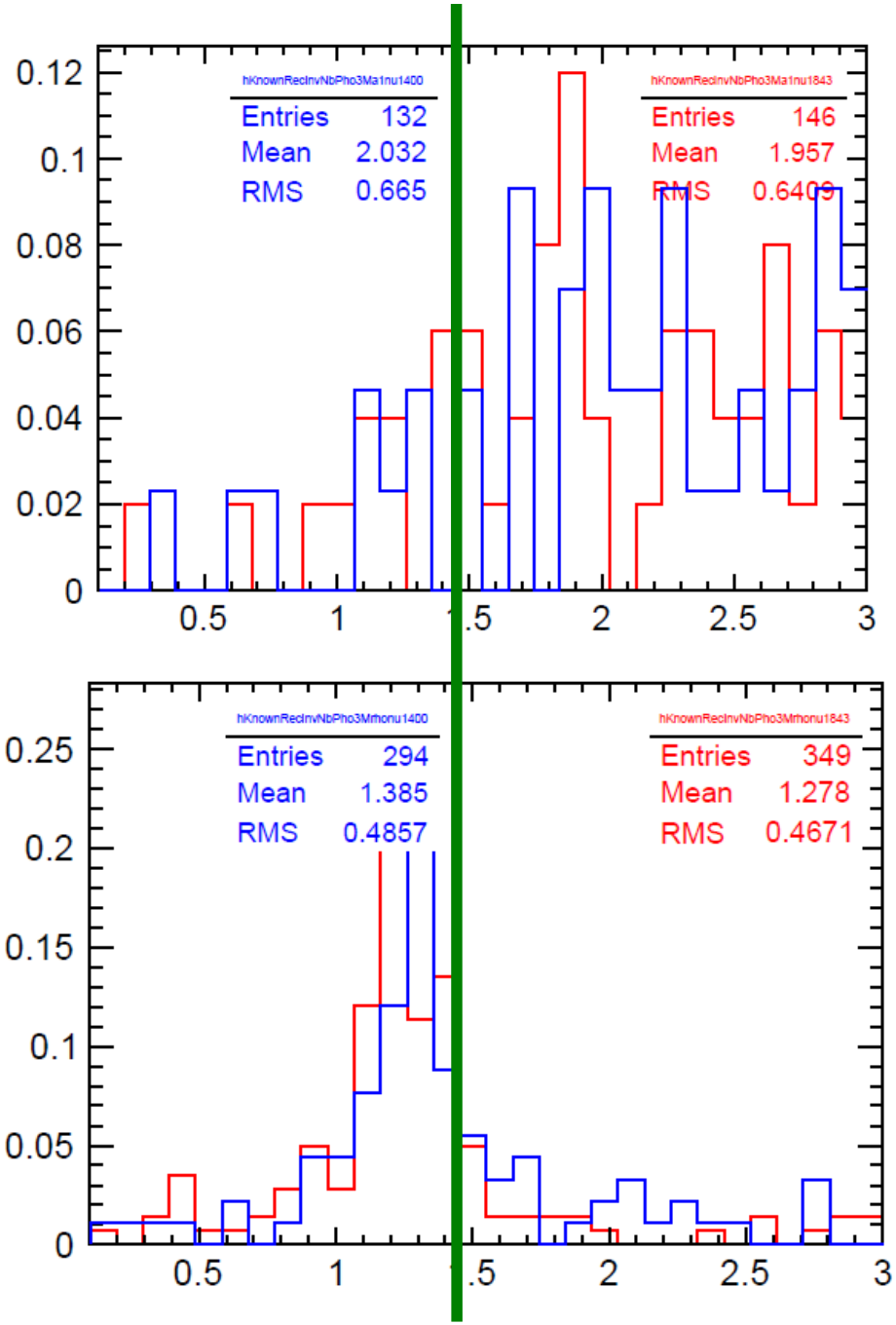


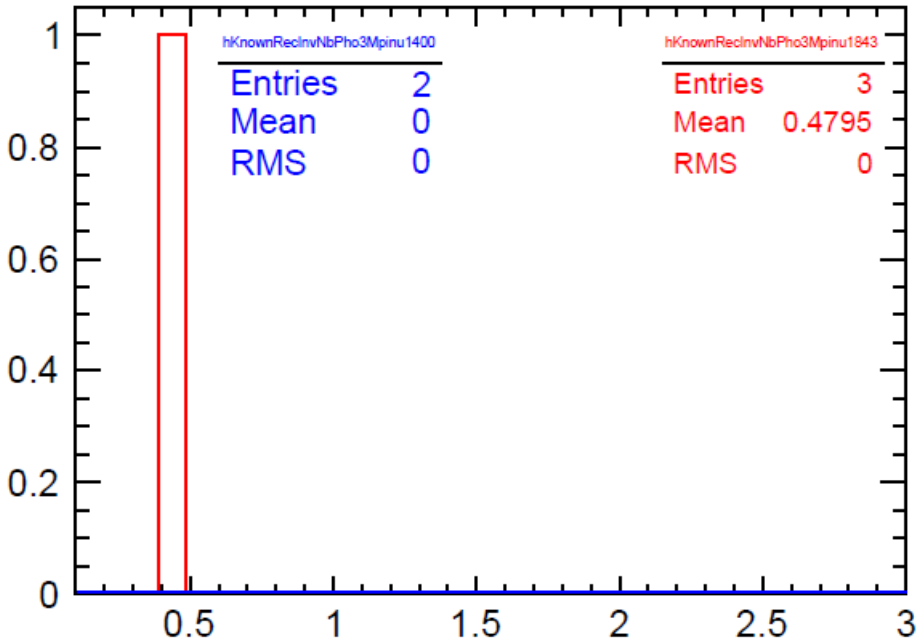


Photon distance to closest track (mm)

To look at photon energy vs distance to closest track (for better π^0 identification)

Cut verification

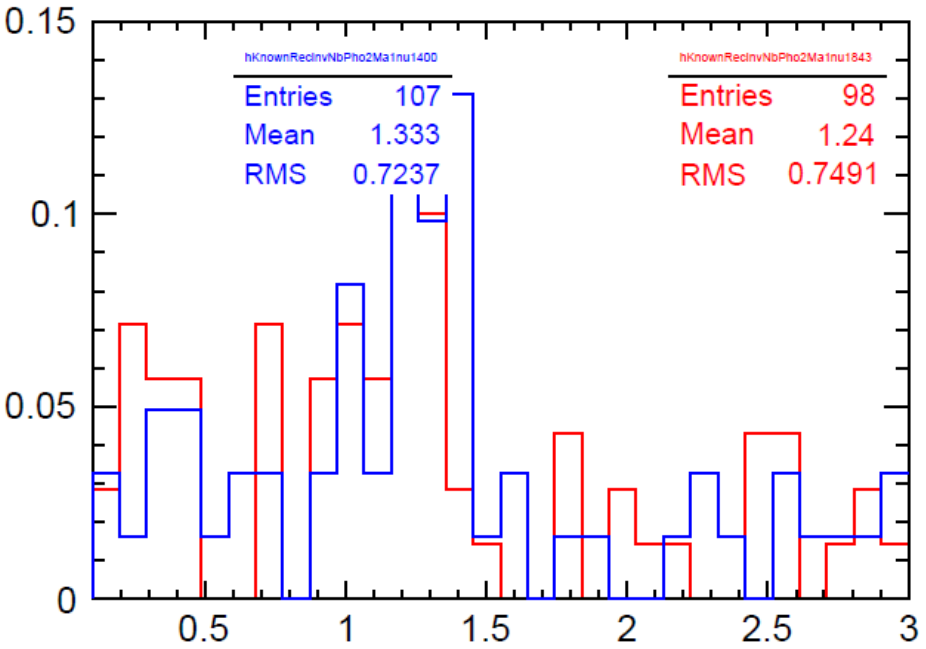


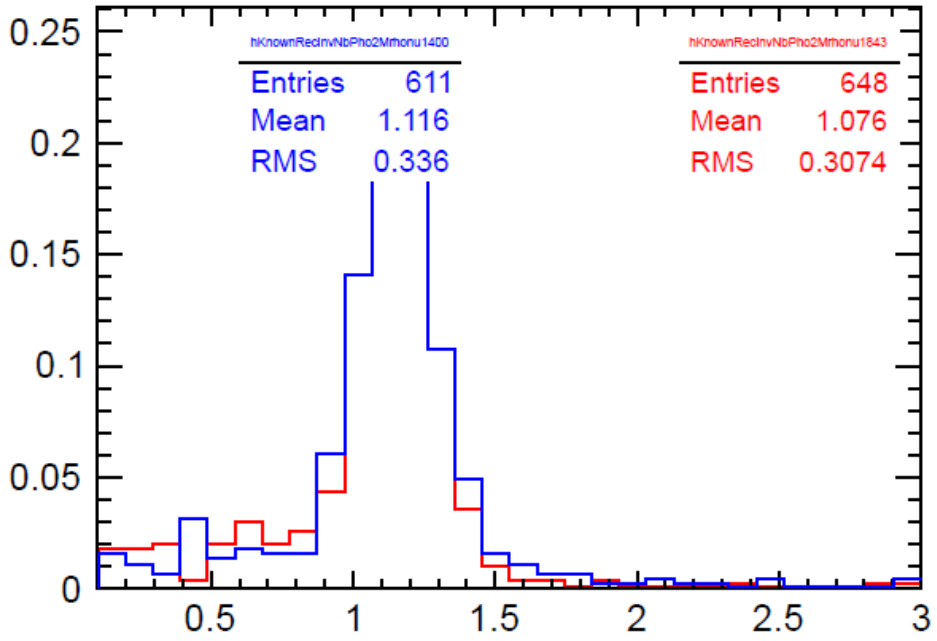


Nb of photons = 3

- Distribution of reconstructed Invariant mass for for known MC process

Cut verification





Nb of photons = 2

Summary

- First look at tau decay using Garlic for ILD with reduced radius
- Difference between reconstructed & simulated energy of tau final states are similar for R_{ECAL} = 1.8 and 1.4m
- To look at tau decay branching fraction in reconstructed events.

- On going work: jet energy resolution for R_{ECAL} = 1450 mm with reduced ECAL number of layers.
  Being performed by Dan YU (internship student at LLR).

Backup

Process counting

R_{ECAL}	a1nu	pi-nu	rho-nu
1843	1027	224	1988
1400	955	209	1903
Ratio 1843/1400	1.075	1.072	1.045
Fraction to total 1843	0.32	0.069	0.61
Fraction 1400	0.31	0.068	0.62