

Simulation study of top-antitop events reconstruction and measuring the top quark Yukawa coupling at the ILC

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for

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Introduction

- Unique role of the top quark for ILC studies
 - ▶ Top mass is by far the largest and approximates the electroweak (EW) symmetry breaking scale.
 - ▶ Suggests top couples strongly to the physics that breaks the EW symmetry.
 - ▶ Important to investigate properties of the top in detail, for the purpose of probing the symmetry breaking physics as well as to gain deeper understanding of the origin of the flavor structure.
- Our approach to top related MC simulation studies...
 - ▶ Focus on CMS = 500GeV
 - ▶ From the viewpoint of a detector benchmarking study:
 - How well can we reconstruct the top-antitop events using realistic detector model & reconstruction software (method)?
 - ▶ From the viewpoint of a physics feasibility study:
 - To estimate sensitivity of the top quark Yukawa coupling with ttH channel at the ILC earlier phase.

Contents of this talk

- **Analysis status** (sorry, not results!) for both detector benchmarking and physics feasibility MC studies...

Process	$e^+e^- \rightarrow tt \rightarrow 6\text{jets}$	$e^+e^- \rightarrow ttH (H \rightarrow bb) \rightarrow L + 6\text{jets}$
Target	$\Delta m_{\text{top}(3j)}$, A_{FB} (LOI benchmarking)	$\Delta g_{\text{ttH}}/g_{\text{ttH}}$
Generator	WHIZARD 1.40	HELAS + BASES/SPRING w/ QCD threshold enhance corr.
Parton shower / Fragmentation	PYTHIA	PYTHIA
Simulator + Reconstruction	Jupiter (G4 based Full-simulator) MarlinReco (Digitizer + Tracking/Clustering) High performance PFA (PandoraPFA) High performance flavor tagging (LCFIVertex)	JSFQuickSim (Smearing based Fast-sim) Track-cluster matching Cheated jet finder Ordinary b-tagging (Nsig method)
This talk (current status)	- $\Delta m_{\text{top}(3j)}$ comparison between 3 detector geometries	- Effect of QCD corr. & beam polarization for the signal cross section - Signal selection & BG (ttZ & tt) rejection
Problems & Next step	- Double b-tagging under 6jets environment - Kinematical fit to improve 3-jets mass resol. - Vertex charge measurement	- Evaluation of ttg \rightarrow ttbb BG - Find cut value to improve S/B

Aiming for ILD-LOI as our initial goal

A benchmark process: $e^+e^- \rightarrow t\bar{t}b\bar{b}$

- The common Lol benchmarking
 - ▶ ...The evaluation of the detector performance should be based on physics benchmarks, some of which will be the same for all LOIs based upon [an agreed upon list](#) and some which may be chosen to emphasize the particular strengths of the proposed detector... (from “Guideline for the definition of a Letter of Intent ...”)
 - ▶ WWS Software panel in consultation with the detector concepts and the WWS Roadmap panel and starting from the Benchmark Panel Report has drafted a short list of processes
- $e^+e^- \rightarrow t\bar{t}b\bar{b}$: one of the common Lol benchmarking processes
 - ▶ CMS: 500GeV
 - ▶ Observables: $\sigma_{t\bar{t}}$, m_{top} , A_{FB}
 - ▶ Decay mode: 6-jets mode (t→bW, W→qq')
 - ▶ Comments from WWS: [Test b-tagging and PFA in multi-jet events](#) ($m_{\text{top}}=175\text{GeV}$)

Observables & analysis strategy

- σ_{tt} measurement

- ▶ counting signal events => Based on hemisphere analysis (not necessary to full reconstruction of $t\bar{t}$ events)
- ▶ Need realistic BG study w/ full SM background samples

- m_{top} measurement @500GeV (open top region)

- ▶ 3-jets mass: top and anti-top full reconstruction w/ correct jet association => Double b-tagging is powerful tool

Current target!

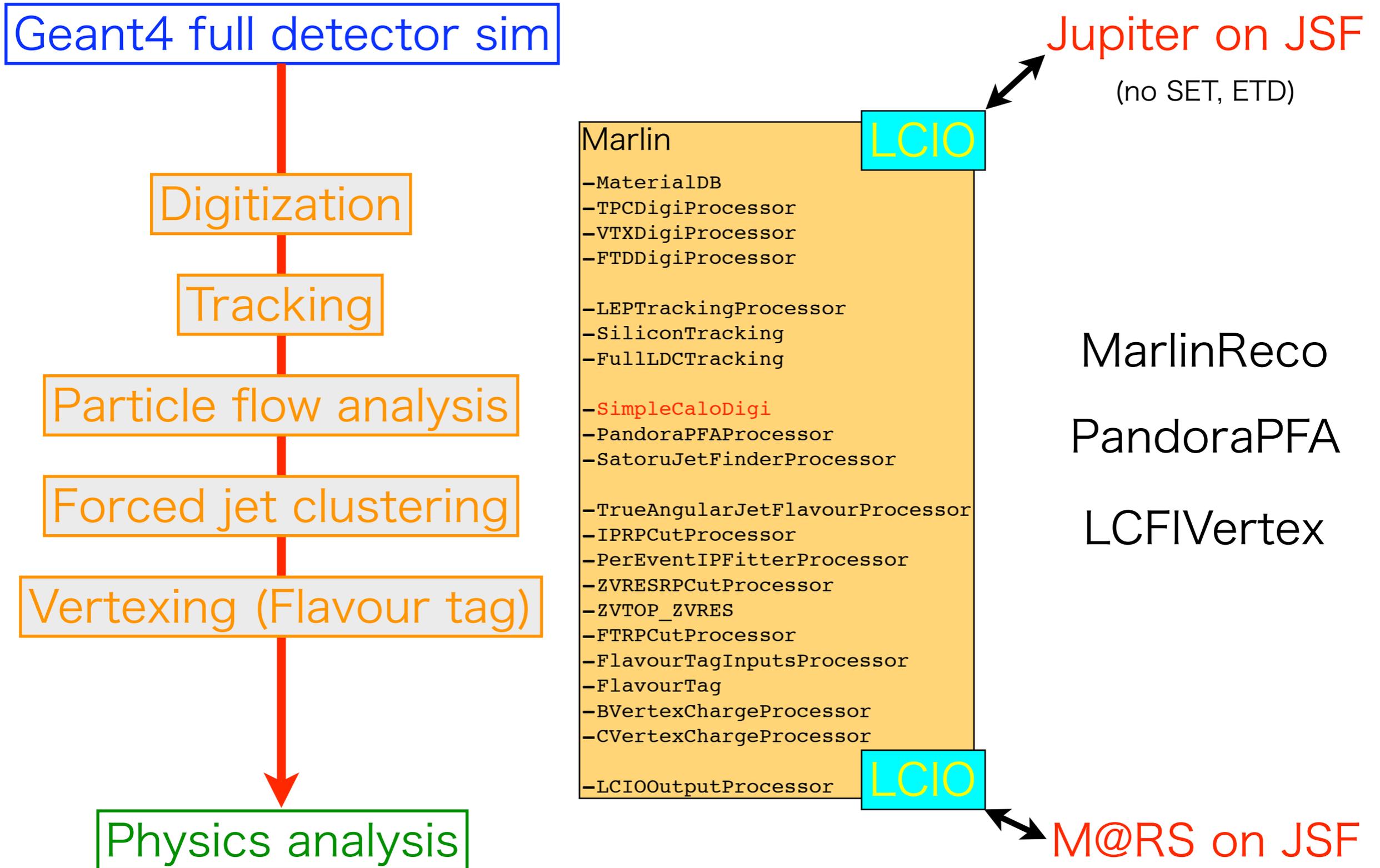
- A_{FB} measurement w/ 6-jets mode

- ▶ Need to know charge of a jet (at least one jet) => Vertex charge information (to reconstruct the vertex charge it is necessary to find all stable tracks from the B-decay chain: charged B-hadrons ~ 40% of the b-jets) Should be next step!

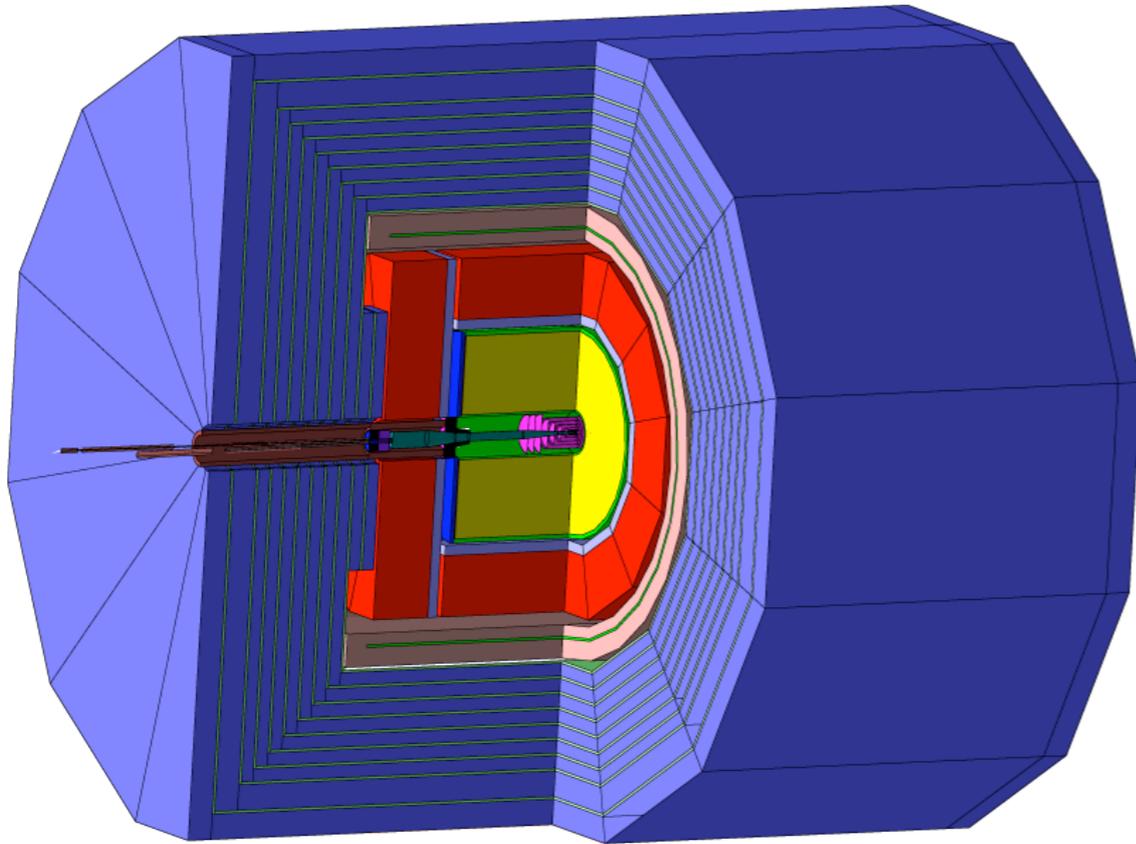
Common input: SLAC SM data samples

- All analyses used in the context of the detector optimization and Lol process need an inclusive sample of the SM Background
 - ▶ SLAC team produced a 2nd generation of a **complete SM sample for 500fb^{-1} at all 4 polarization combinations** (The WHIZARD Monte Carlo version 1.40 is used for parton generation)
 - ▶ Whizard input controls the properties of the colliding electron/positron beams. the spectrum (corresponds to the Guinea-Pig data) represents the default ILC design for $E_{\text{cm}}=500\text{GeV}$ circa Aug. 2005, and **includes both incoming LINAC energy spread and beamstrahlung**
 - ▶ For each event in a derived **StdHep file** the variable IDRUPLH from the common block HEPEV4 is used to identify the process
 - ▶ PYTHIA 6.205 is used for final state QED/QCD parton showering and for the fragmentation of quarks and gluons. Parton showering is performed for all final state fermions with the exception of electrons (**no top quarks appears in process_id**)
- $t\bar{t}$ samples are included in 6-fermion SM samples

Analysis framework



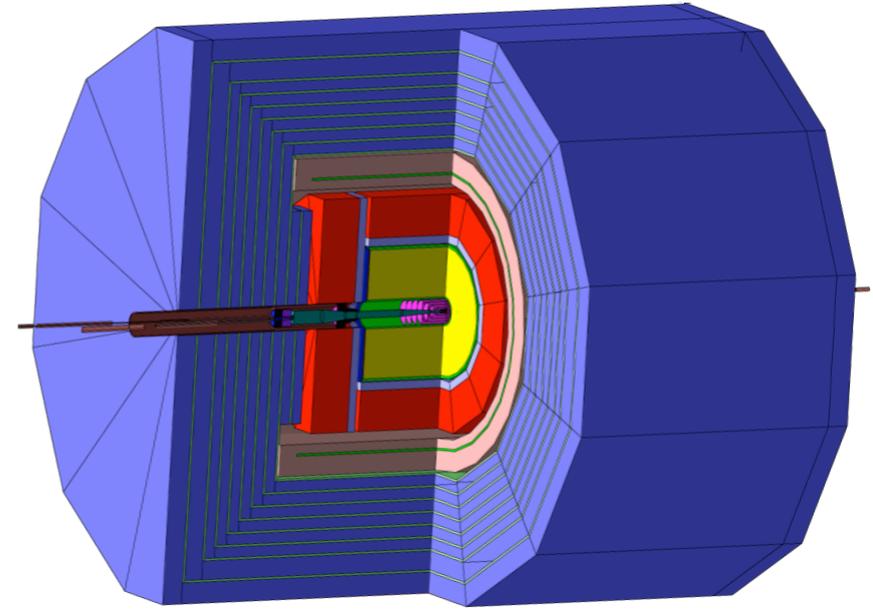
3 detector geometries: B&R



GLD

$B = 3$ Tesla

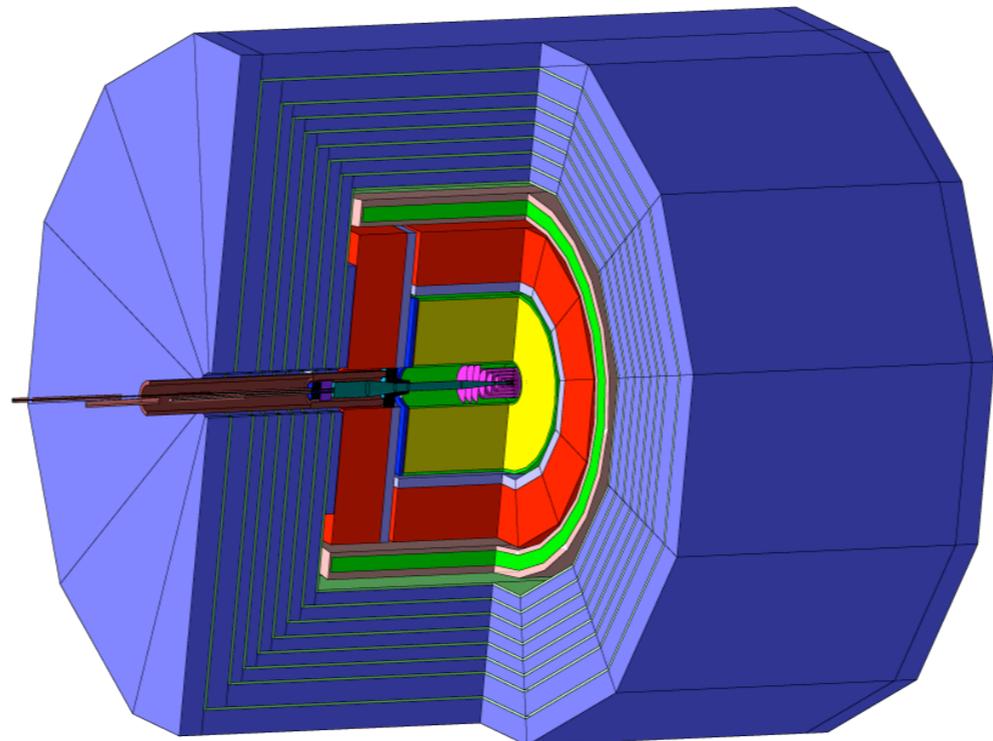
$R_{\min}(\text{ECAL}) = 210\text{cm}$



J4LDC

$B = 4$ Tesla

$R_{\min}(\text{ECAL}) = 160\text{cm}$



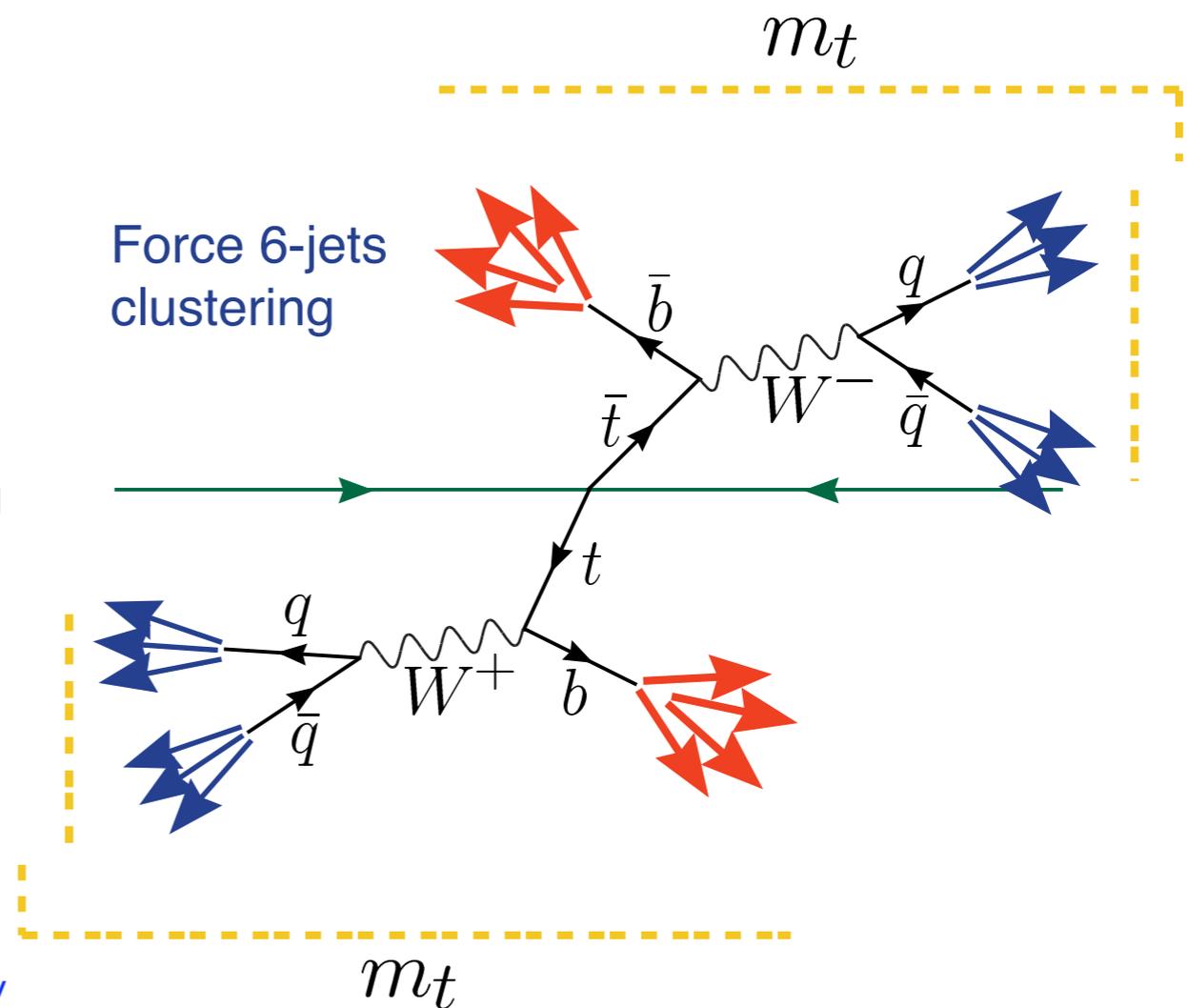
GLDPrim

$B = 3.5$ Tesla

$R_{\min}(\text{ECAL}) = 185\text{cm}$

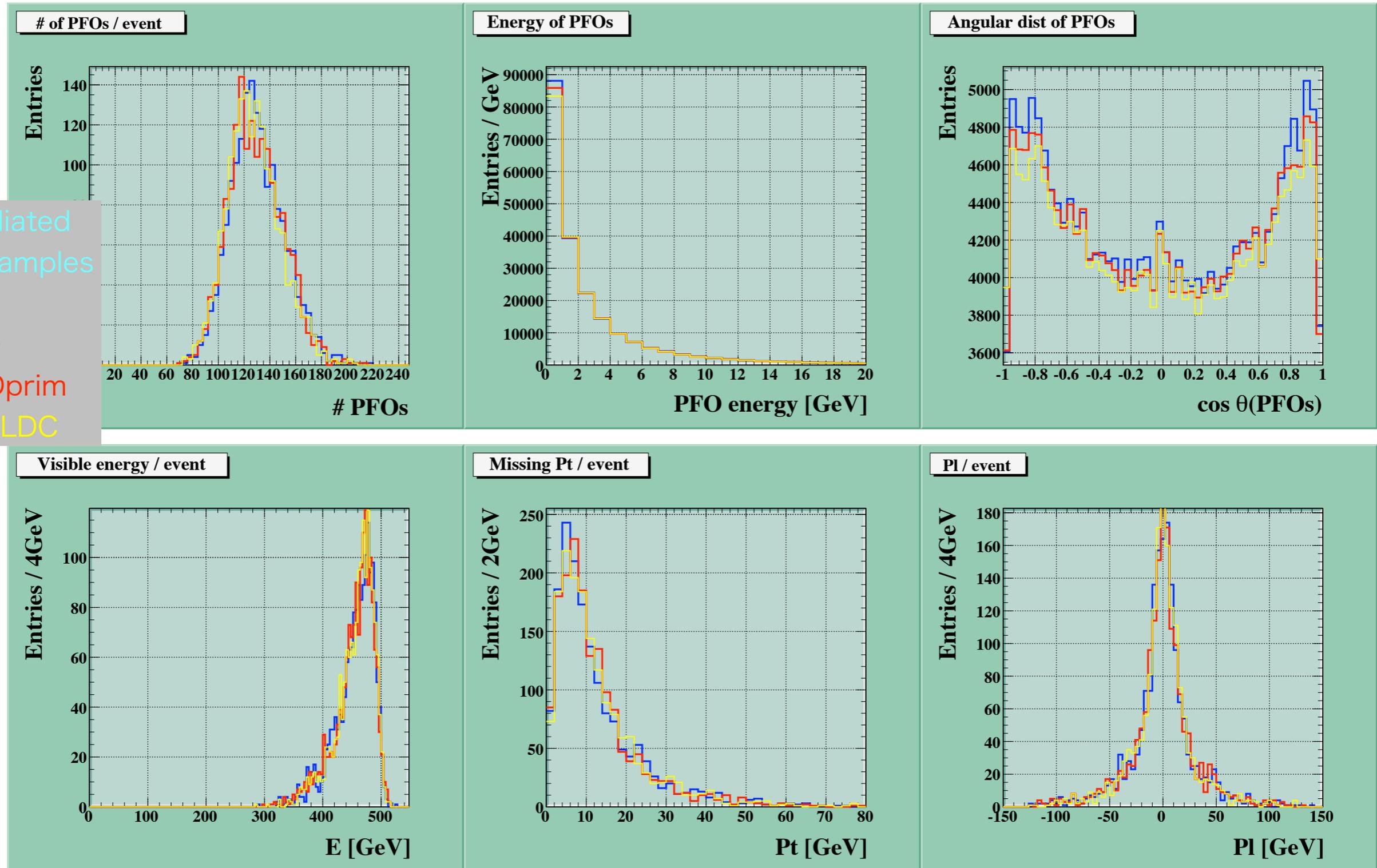
ttbar -> 6jets reconstruction

- I) Force 6-jets clustering
- II) Confirm $\text{Max_cos } \theta_{\text{jet}}$ should be less than 0.99
- III) Choose all the 15-possible pairs out of 6-jets => W_1 candidate
- IV) Choose all the 6-possible pairs out of remaining 4-jets => W_2 candidate
- V) **Remaining 2-jets should be b-jets**: flavor tagging (charm/bottom tagging) is very important to eliminate both combinatorial and process BGs
- VI) There are **2 possibilities to attach a b-jet to W_1 and W_2 candidates**
- VII) Store all solutions w/ $\chi^2 = (m_{w1} - m_w)^2 / \sigma_{mw}^2 + (m_{w2} - m_w)^2 / \sigma_{mw}^2 + (m_{t1} - m_t)^2 / \sigma_{mt}^2 + (m_{t2} - m_t)^2 / \sigma_{mt}^2$
- VIII) Sort solutions according to χ^2 : **choose the best solution**



Distribution w/ particle flow objects

- Before force 6-jets clustering is performed



Distribution for jets

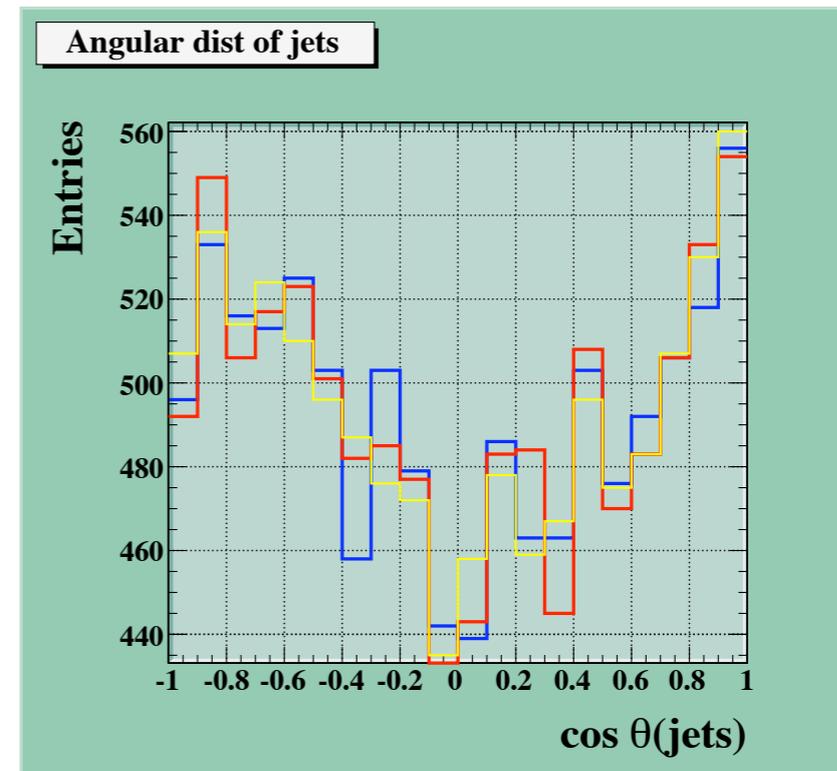
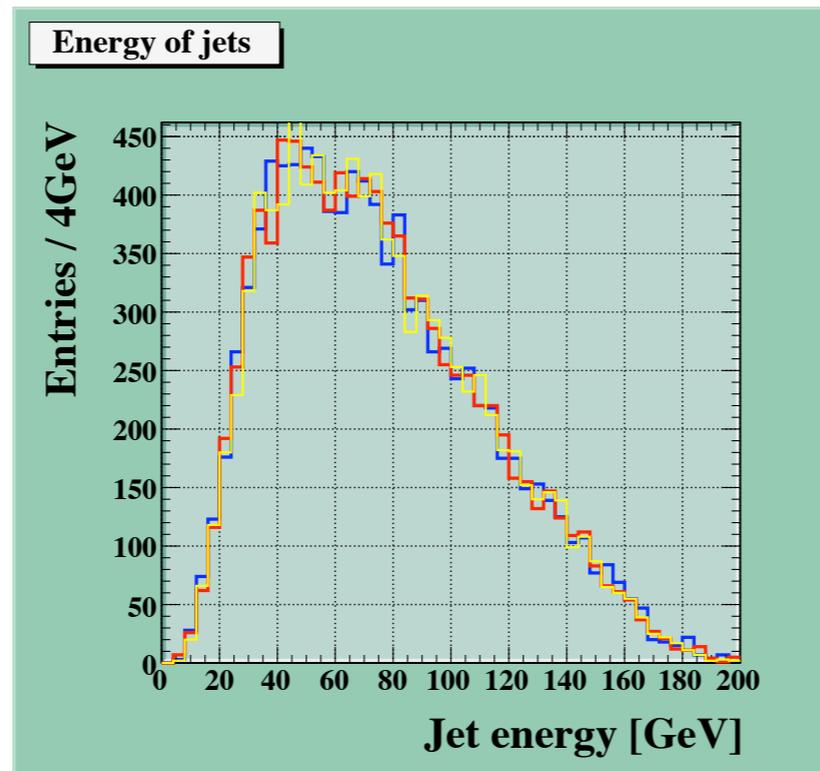
- After force 6-jets clustering is performed

ttbar mediated
bbuddu samples

Blue: GLD

Red: GLDprim

Yellow: J4LDC

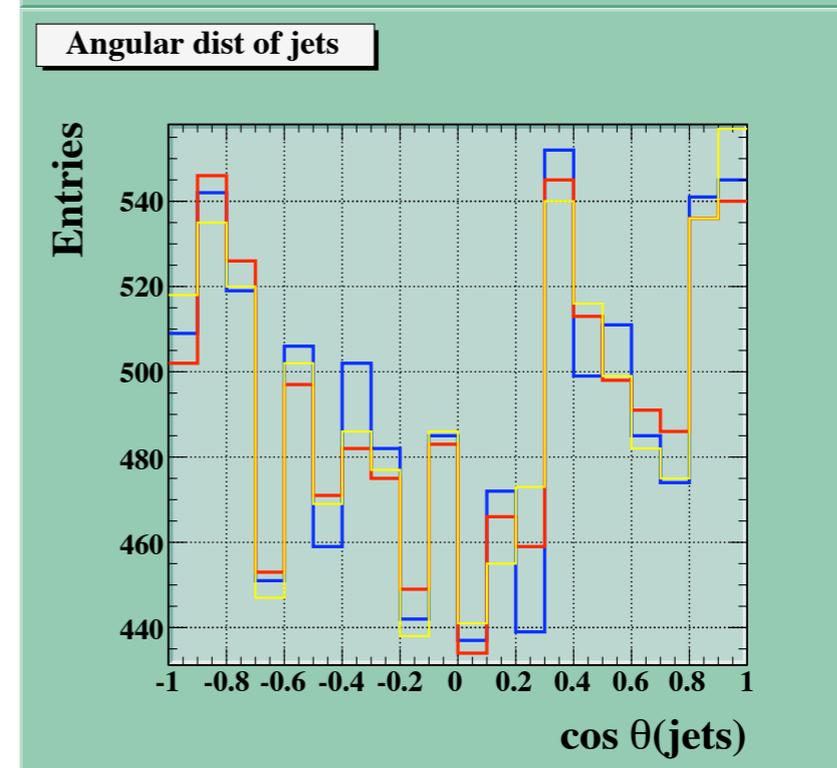
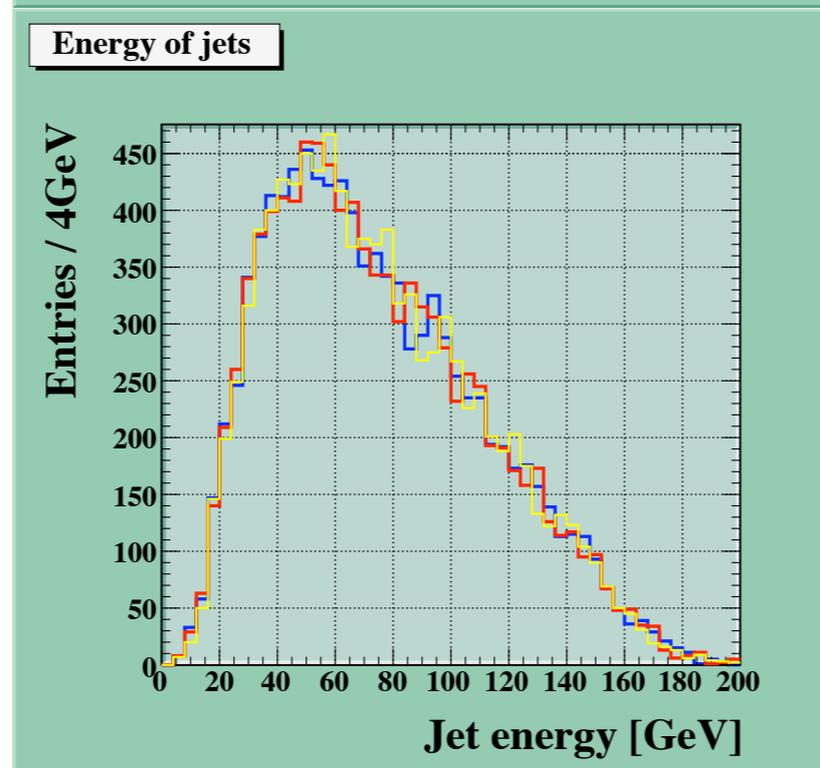


ttbar mediated
bbcsc samples

Blue: GLD

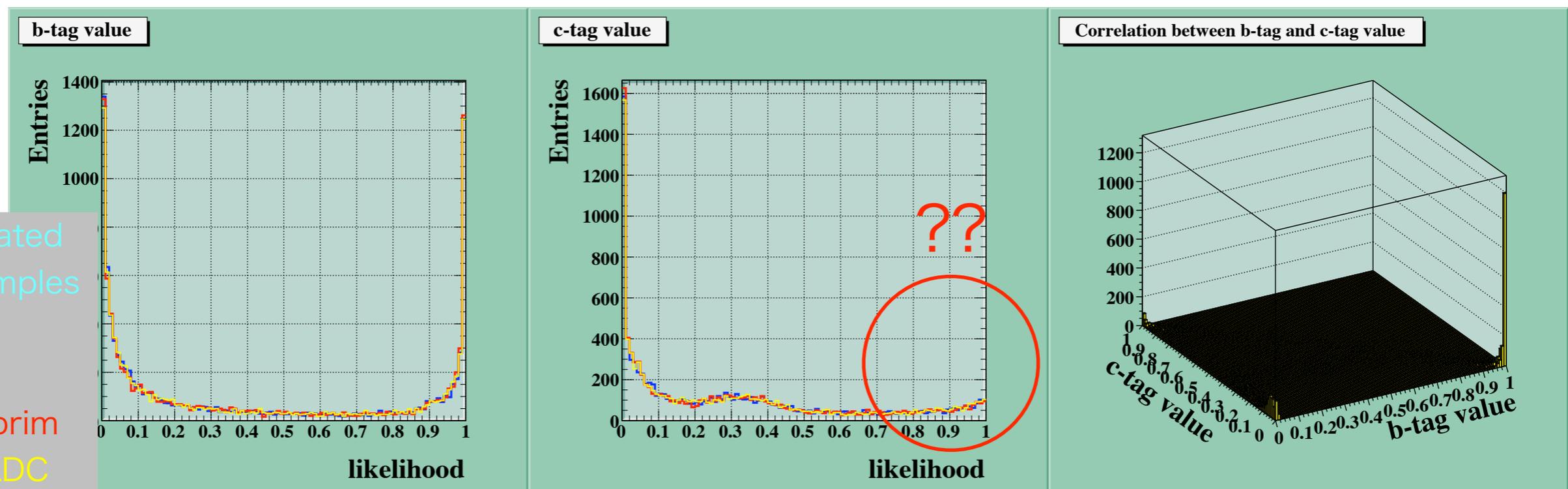
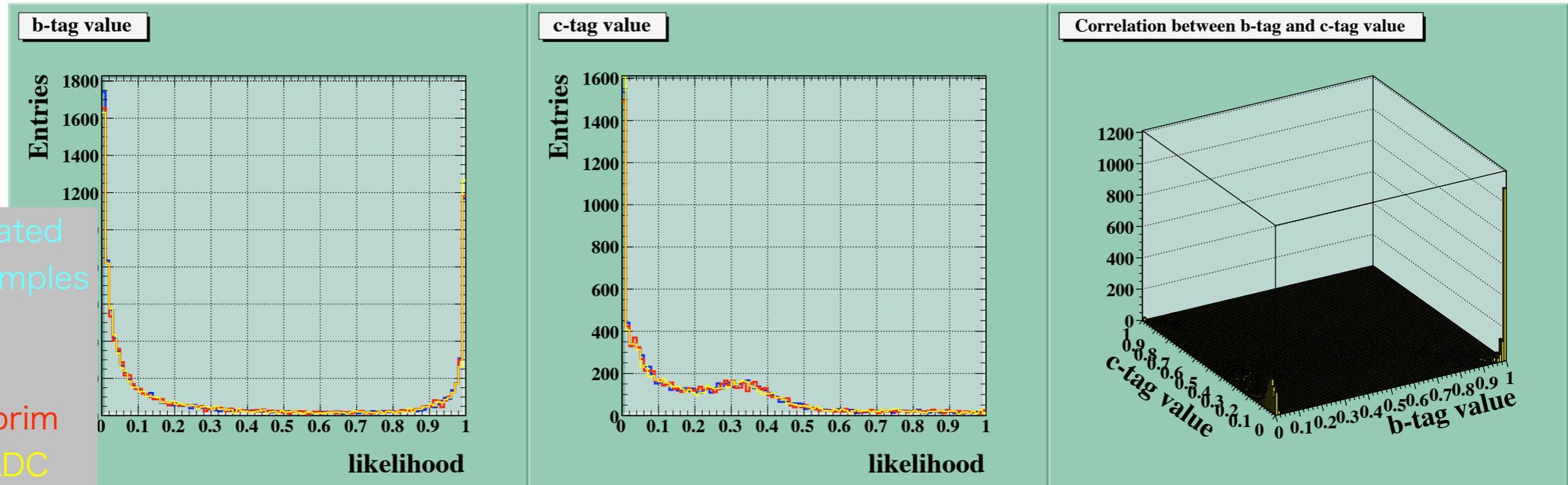
Red: GLDprim

Yellow: J4LDC



b-tag and c-tag value (LCFIVertex)

- After force 6-jets clustering is performed

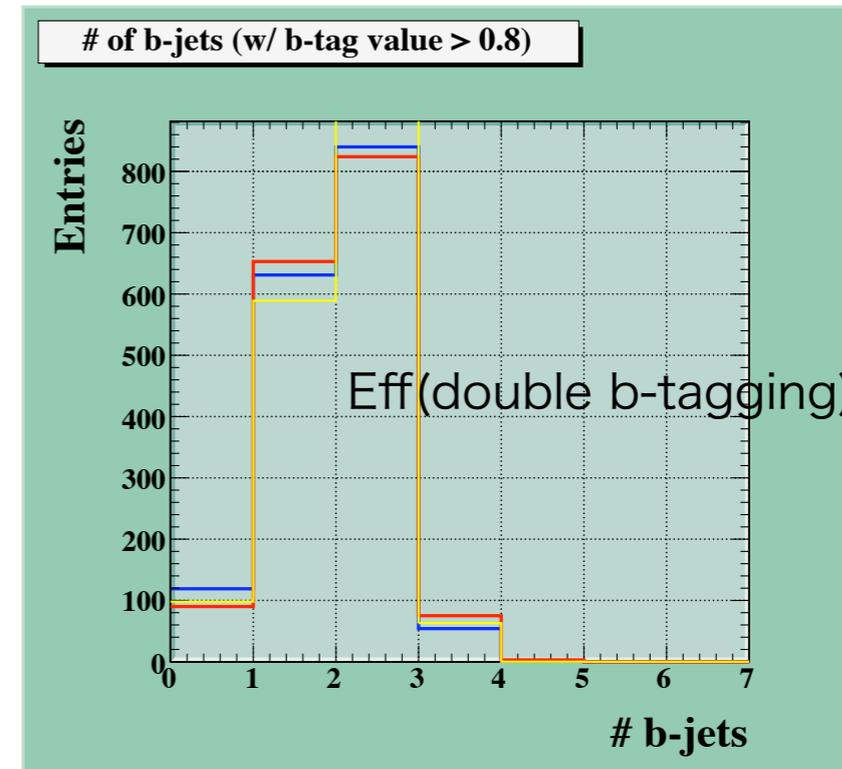
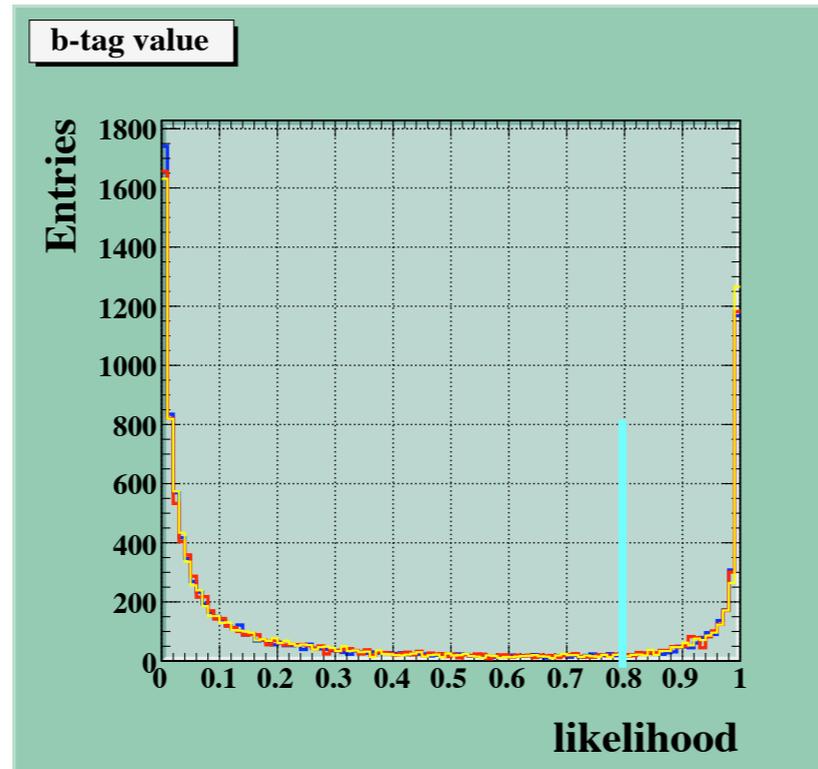


b-tagging using b-tag value

- Double b-tagging efficiency: worse than expected

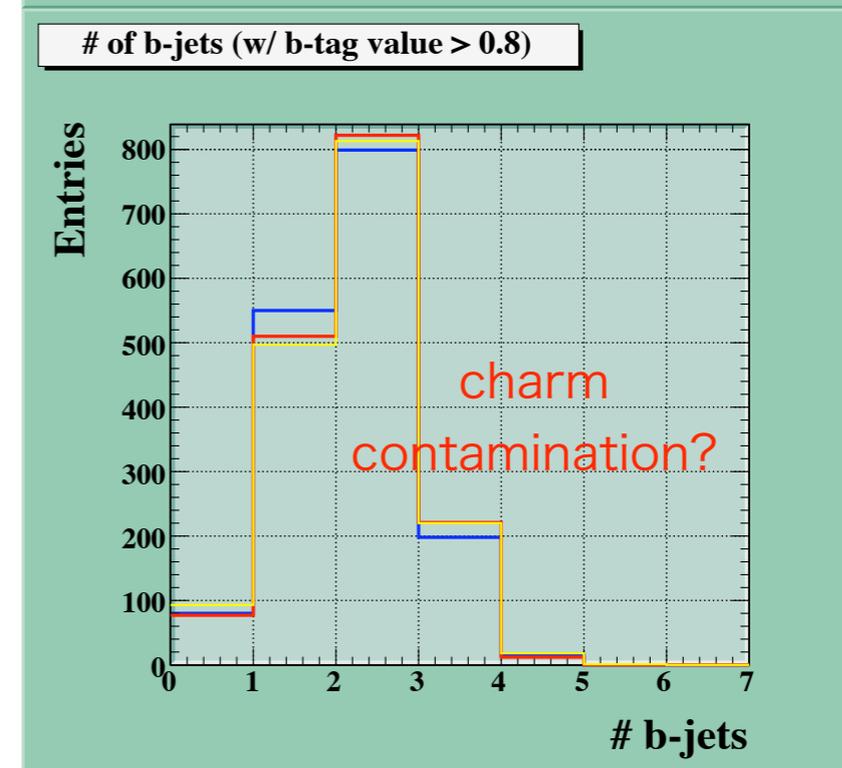
ttbar mediated
bbuddu samples

Blue: GLD
Red: GLDprim
Yellow: J4LDC

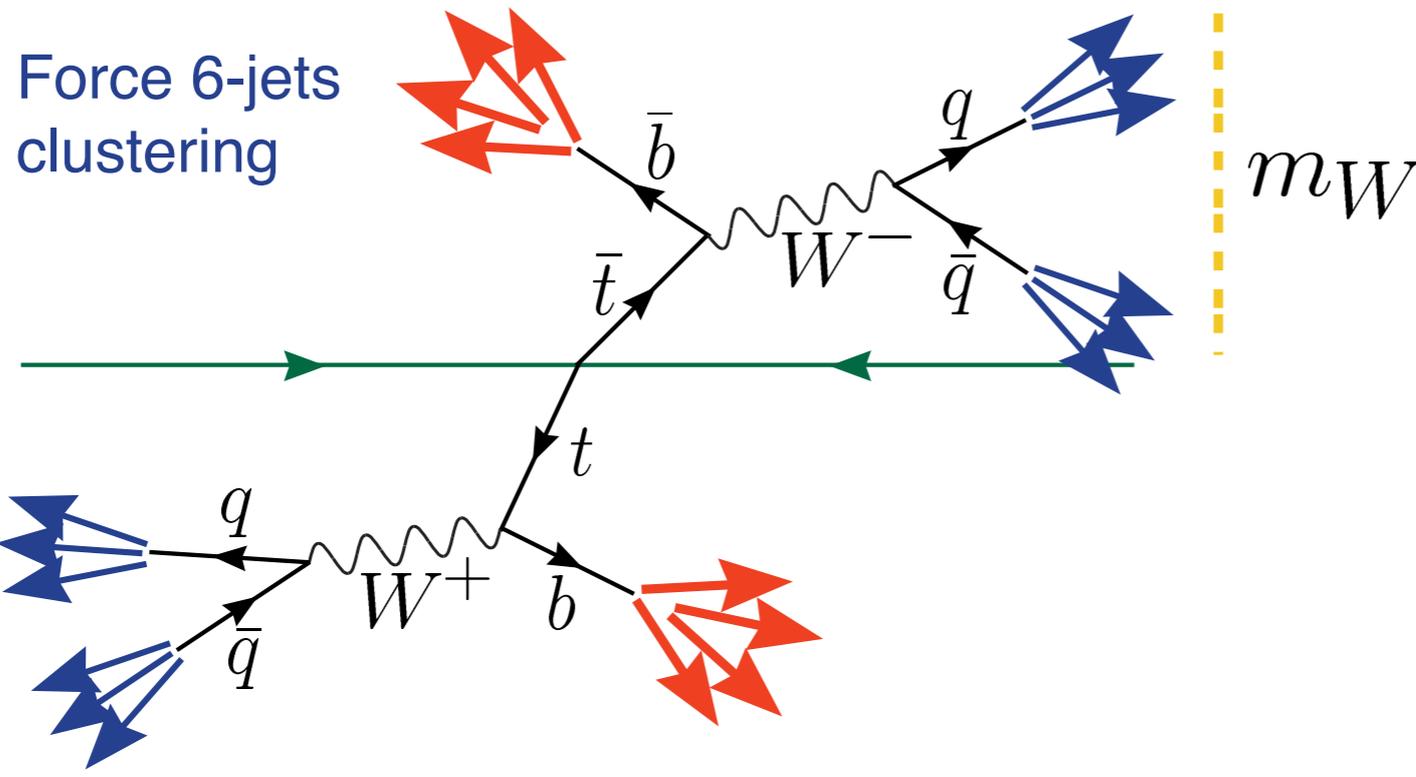


ttbar mediated
bbcsc samples

Blue: GLD
Red: GLDprim
Yellow: J4LDC

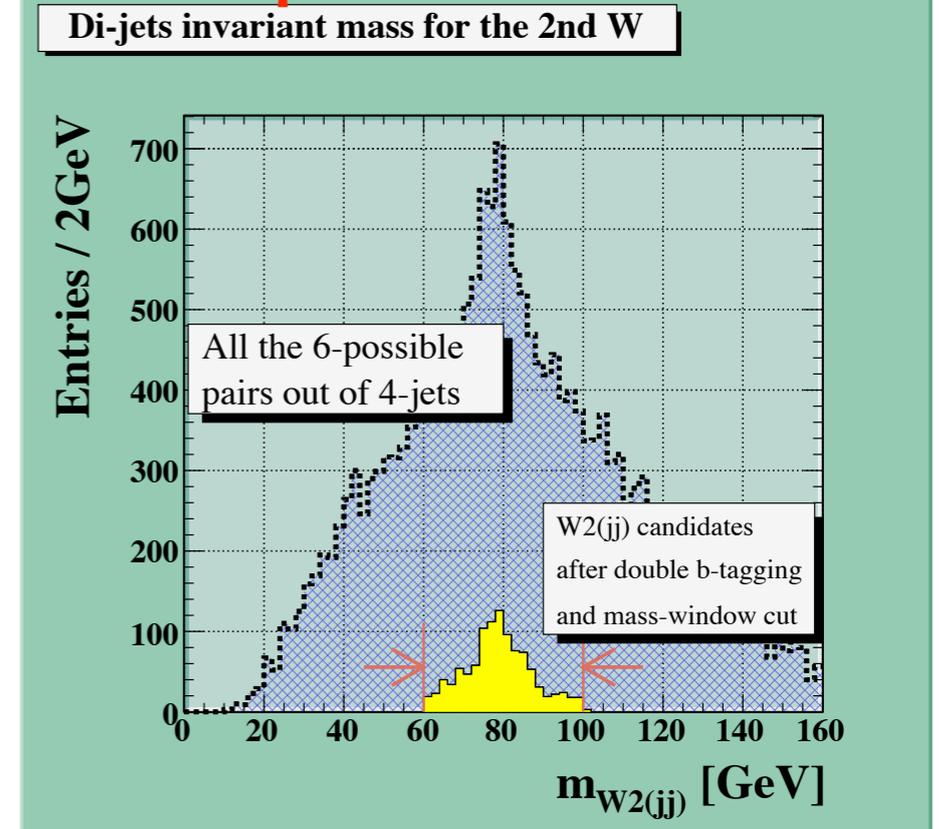
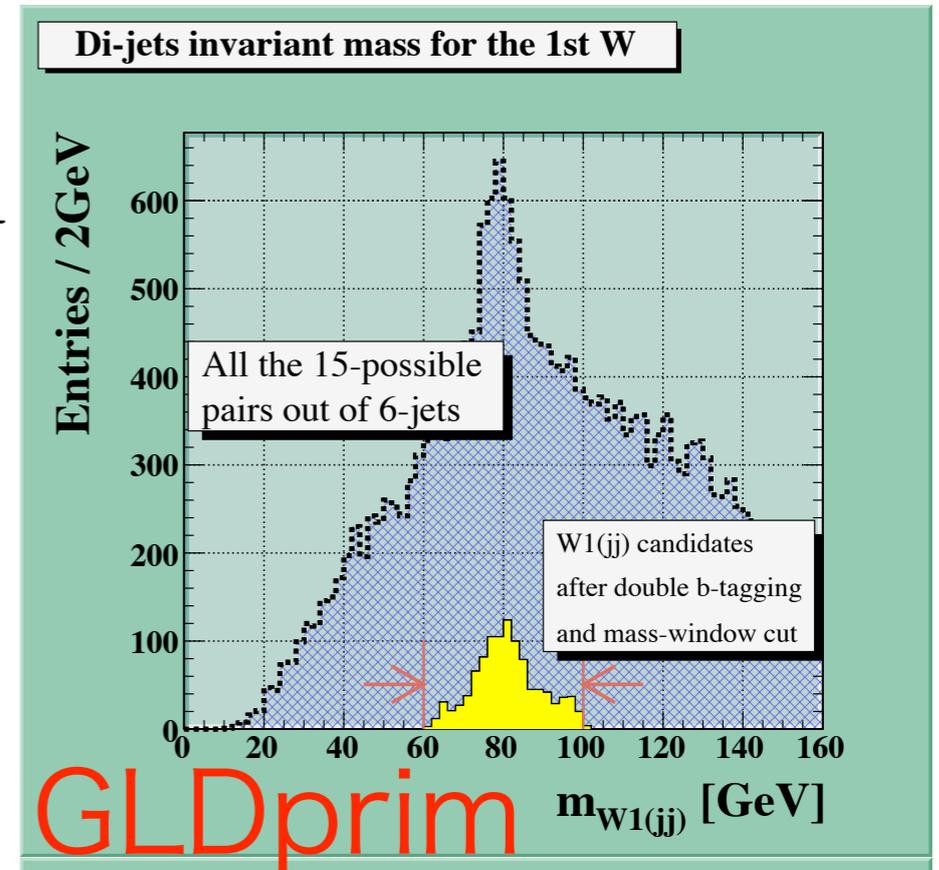


W_1 & W_2 reconst w/ double b-tagging

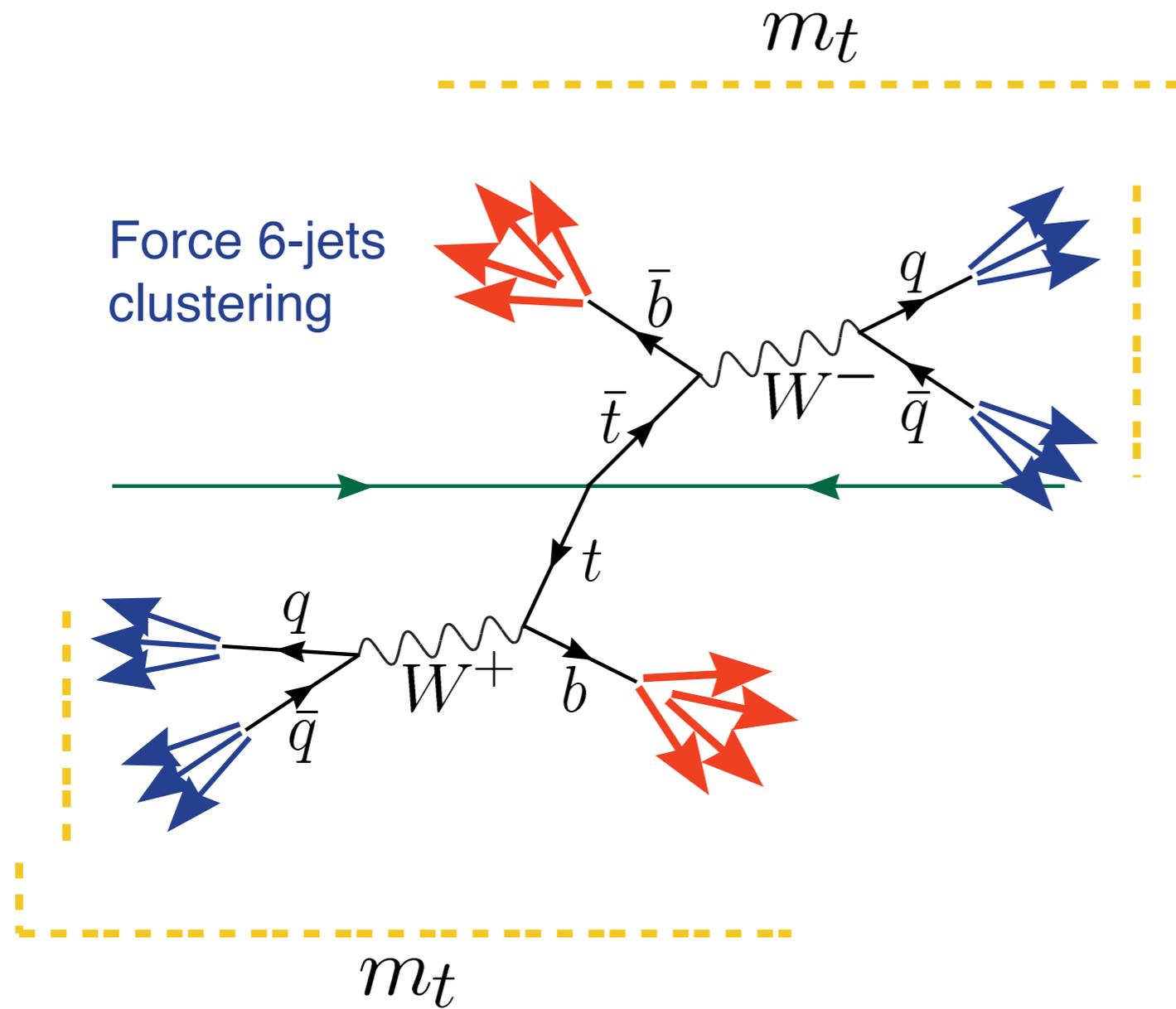


- I) Choose all the 15-possible pairs out of 6-jets $\Rightarrow W_1$ candidate
- II) Choose all the 6-possible pairs out of remaining 4-jets $\Rightarrow W_2$ candidate
- III) **Remaining 2-jets should be b-jets:** flavor tagging (charm/bottom tagging) is very important to eliminate both combinatorial and process BGs

- Loose di-jet mass window cut ($\pm 20\text{GeV}$)
- Double b-tagging (b-tag value > 0.8) \Rightarrow ~half of $t\bar{t}$ events were lost...

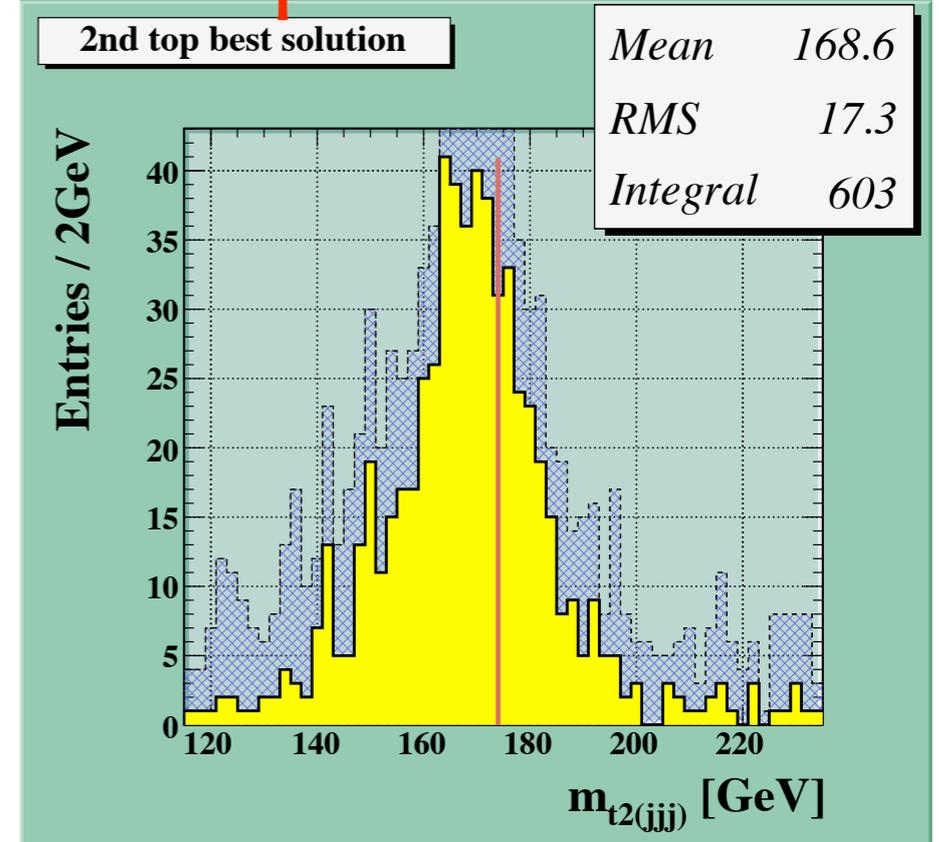
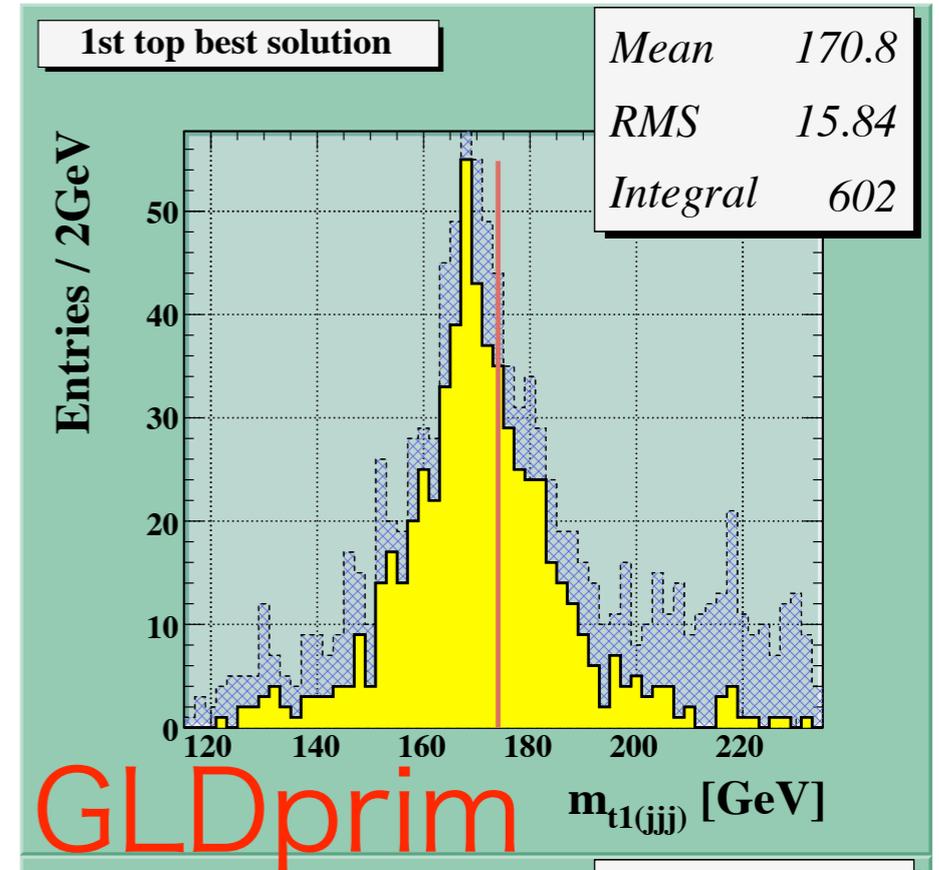


t₁ & t₂ reconst w/ double b-tagging



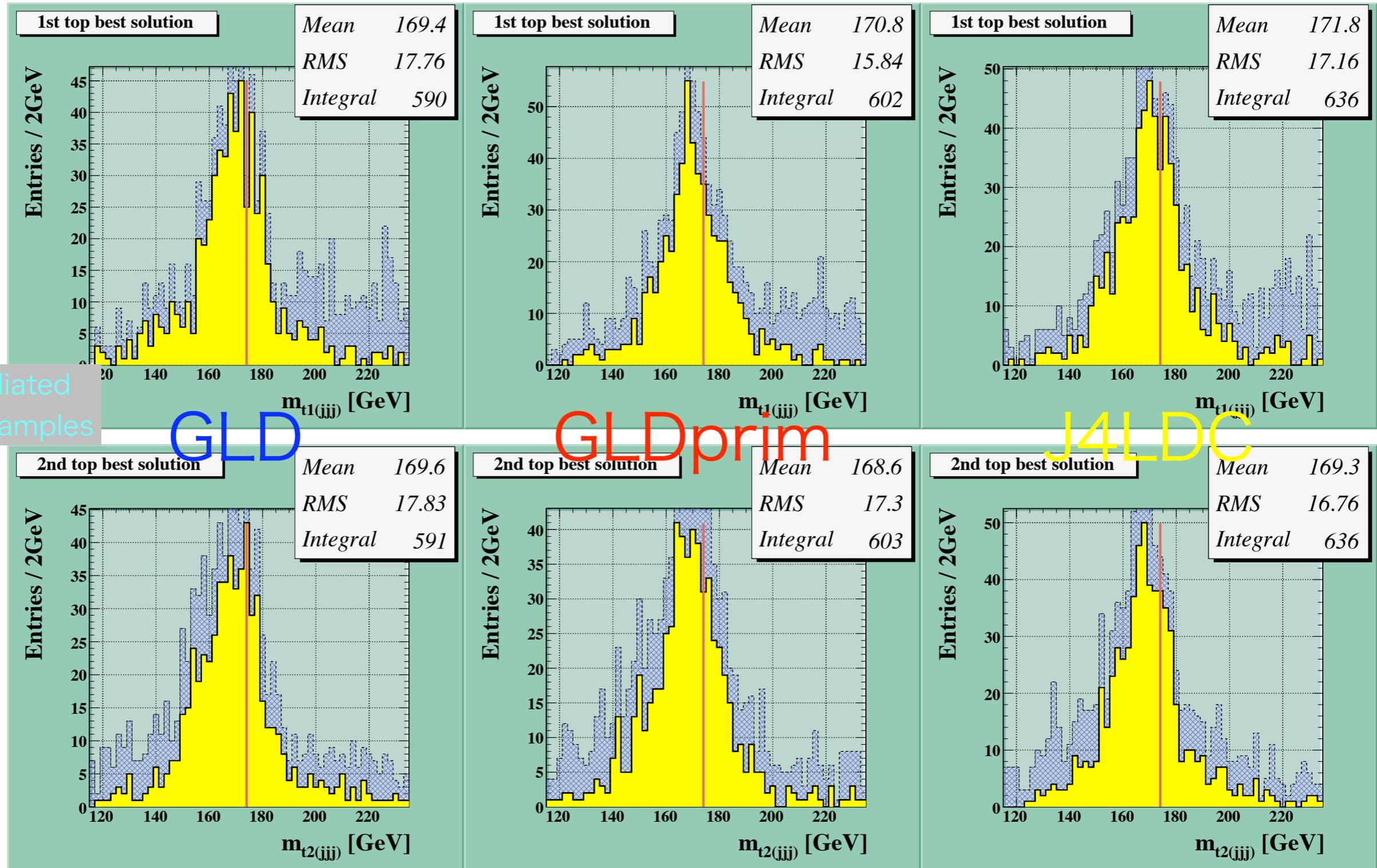
- I) After double b-tagging, there are 2 possibilities to attach a b-jet to W_1 and W_2 candidates
- II) Sort solutions according to χ^2 : choose the best solution

$$\chi^2 = (m_{w1} - m_w)^2 / \sigma_{mw}^2 + (m_{w2} - m_w)^2 / \sigma_{mw}^2 + (m_{t1} - m_t)^2 / \sigma_{mt}^2 + (m_{t2} - m_t)^2 / \sigma_{mt}^2$$



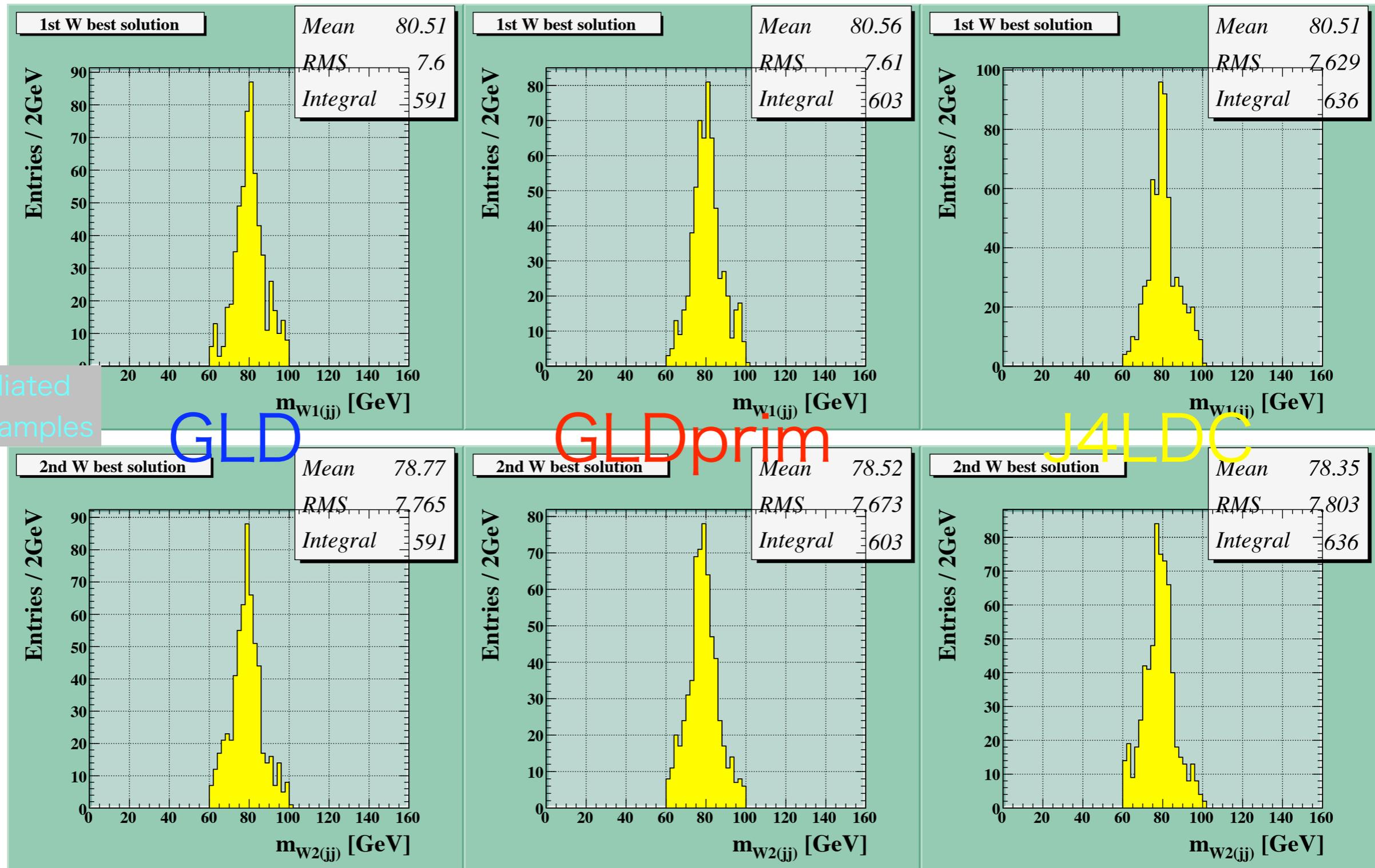
M_{t1} & M_{t2} for the best solution

- 3-jets mass resolution (t1 & t2 for the best solution)



M_{W1} & M_{W2} for the best solution

- Di-jets mass resolution (W1 & W2 for the best solution)



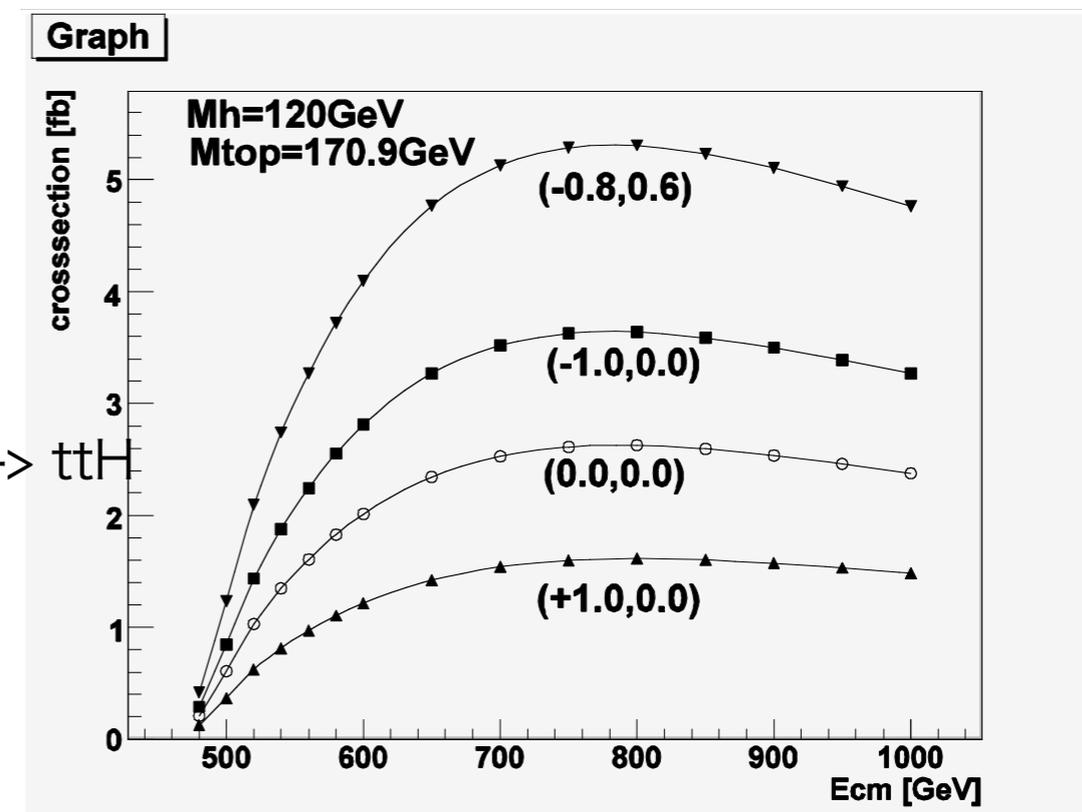
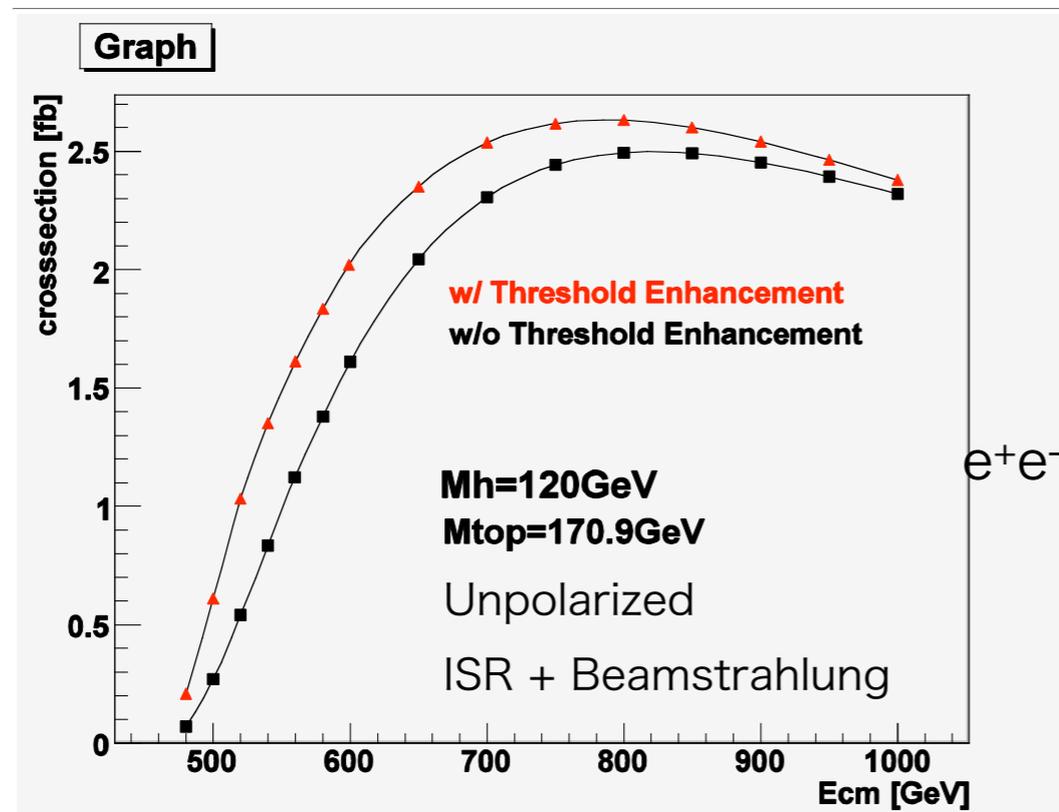
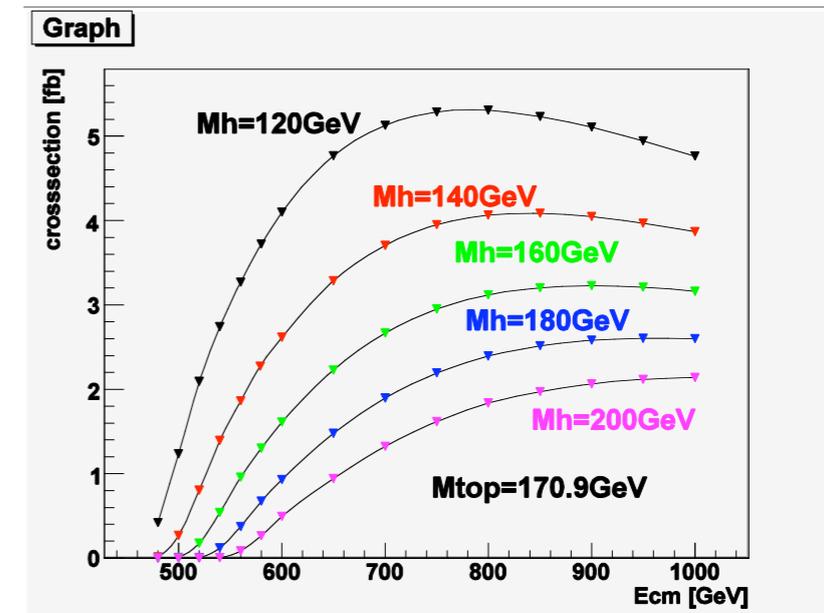
ttbar mediated
bbuddu samples

Summary / Plan

- Toward writing up the ILD-Lol:
 - $e^+e^- \rightarrow t\bar{t}$ @CMS 500GeV is one of the common Lol benchmarking process
 - ▶ 6-jets mode ($t \rightarrow bW$, $W \rightarrow qq'$) should be analyzed to test b-tagging and PFA in multi-jet events
 - $m_{\text{top}}(3\text{jet})$ measurement for 3 different detector geometries
 - No significant differences for fully reconstructed $t\bar{t}$ events (m_{t1} , m_{t2} , m_{W1} & m_{W2})
 - LCFIVertex performance under 6-jets environment is worse than expected
 - ▶ Problem on NN training and/or forced jet clustering??
- Next step:
 - Deeper understanding of LCFIVertex under multi-jet environment (also Vertex charge measurement)
 - Check jet-parton association to solve our problem

ttH: Effects of QCD corr. & beam pol.

- NLO + Threshold effect of tt system + e⁺ polarization enhance the $\sigma(e^+e^- \rightarrow ttH)$
- Signal generator w/ tt-system threshold enhancement was implemented (in our HELAS + BASES/SPRING framework)
- If $M_H > 140\text{GeV}$, it will be difficult to measure g_{ttH} around $E_{cm} \sim 500\text{GeV}$
- Cross section is calculated as a function of E_{cm} for different beam pol. combination w/ $M_H=120\text{GeV}$ and $M_t=170.9\text{GeV}$
- $\sigma = 1.2\text{ fb}$ for $P=(-0.8, 0.6)$ and $E_{cm}=500\text{GeV}$

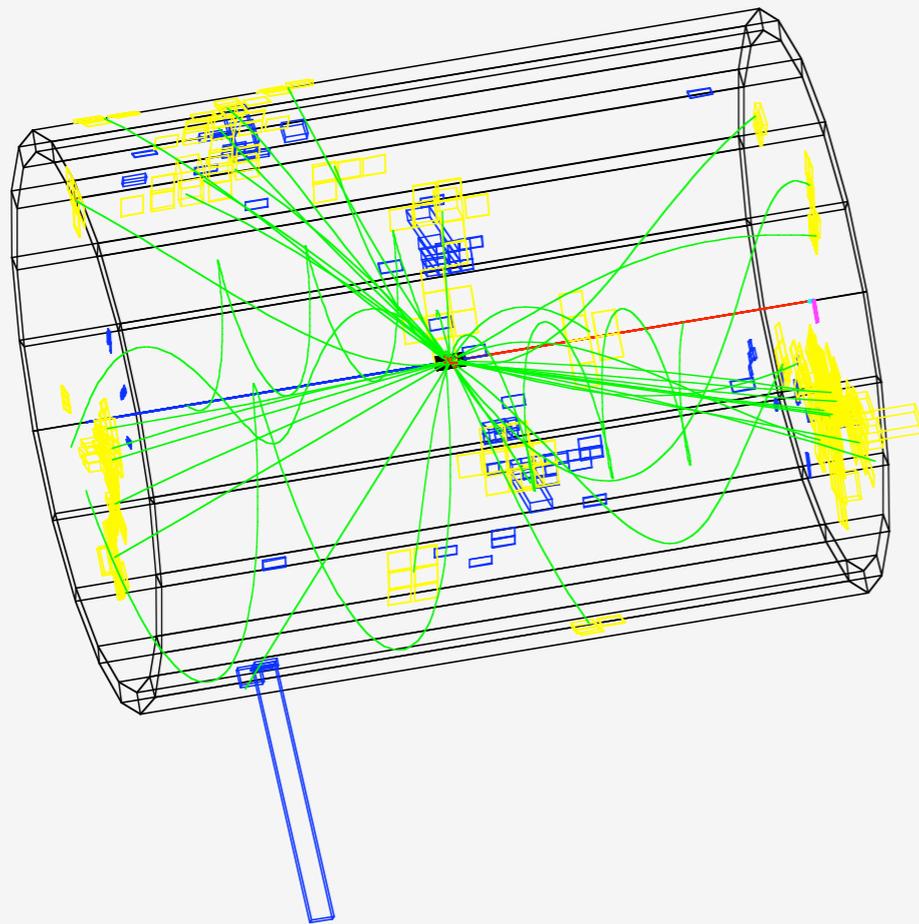


$e^+e^- \rightarrow ttH$

$e^+e^- \rightarrow ttH$ event display

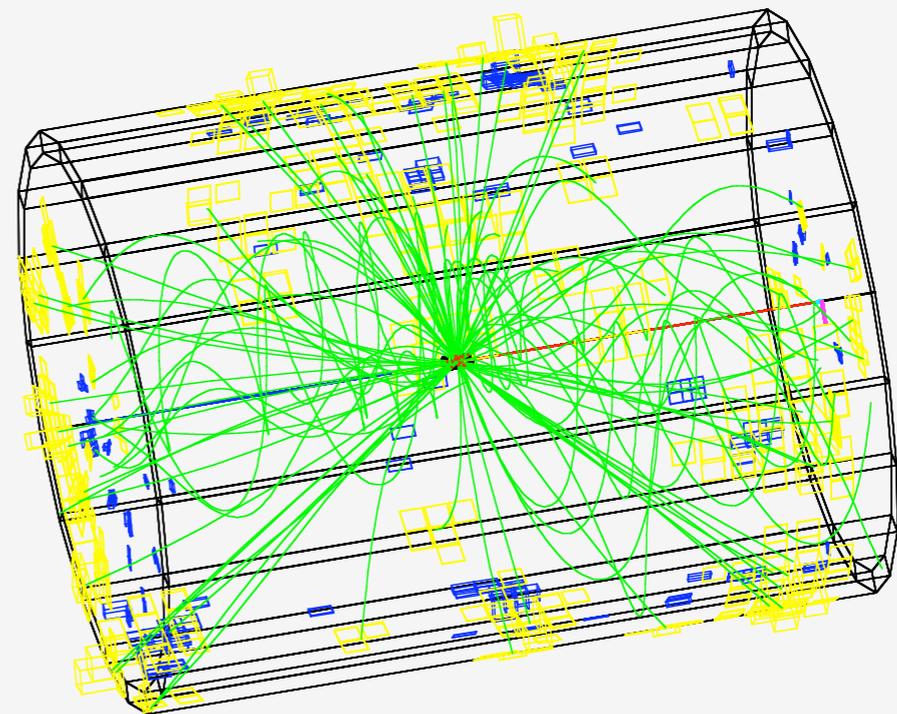
- Dense 8-fermion ($H \rightarrow bb$) & 10-fermion ($H \rightarrow WW^*$) events
- Challenging for correct reconstruction (jet-association)

Lepton + 6-jets mode



$ttH \rightarrow (bW)(bW)(bb) \rightarrow (bud)(bl\nu)(bb)$

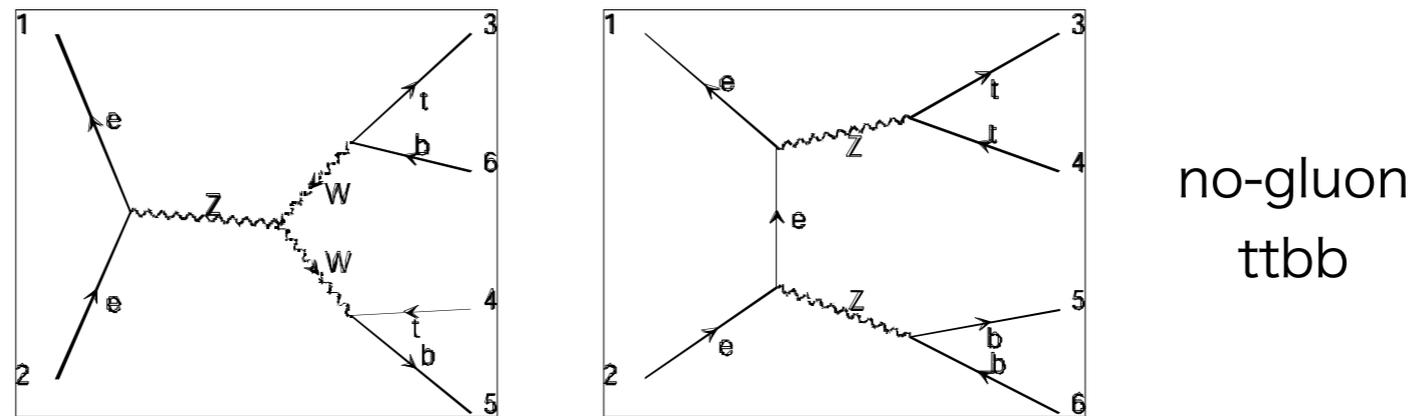
8-jets mode



$ttH \rightarrow (bW)(bW)(bb) \rightarrow (bcs)(bcs)(bb)$

Possible BGs for $ttH \rightarrow \text{Lepton} + 6\text{-jets}$

- Same final state w/ high jet multiplicity
 - ttZ ($Z \rightarrow bb$): $\sim 1.4\text{fb}$ (comparable to signal) need m_{2j} cut
 - $ttbb$ ($g \rightarrow bb$ dominant): need to evaluate cross section

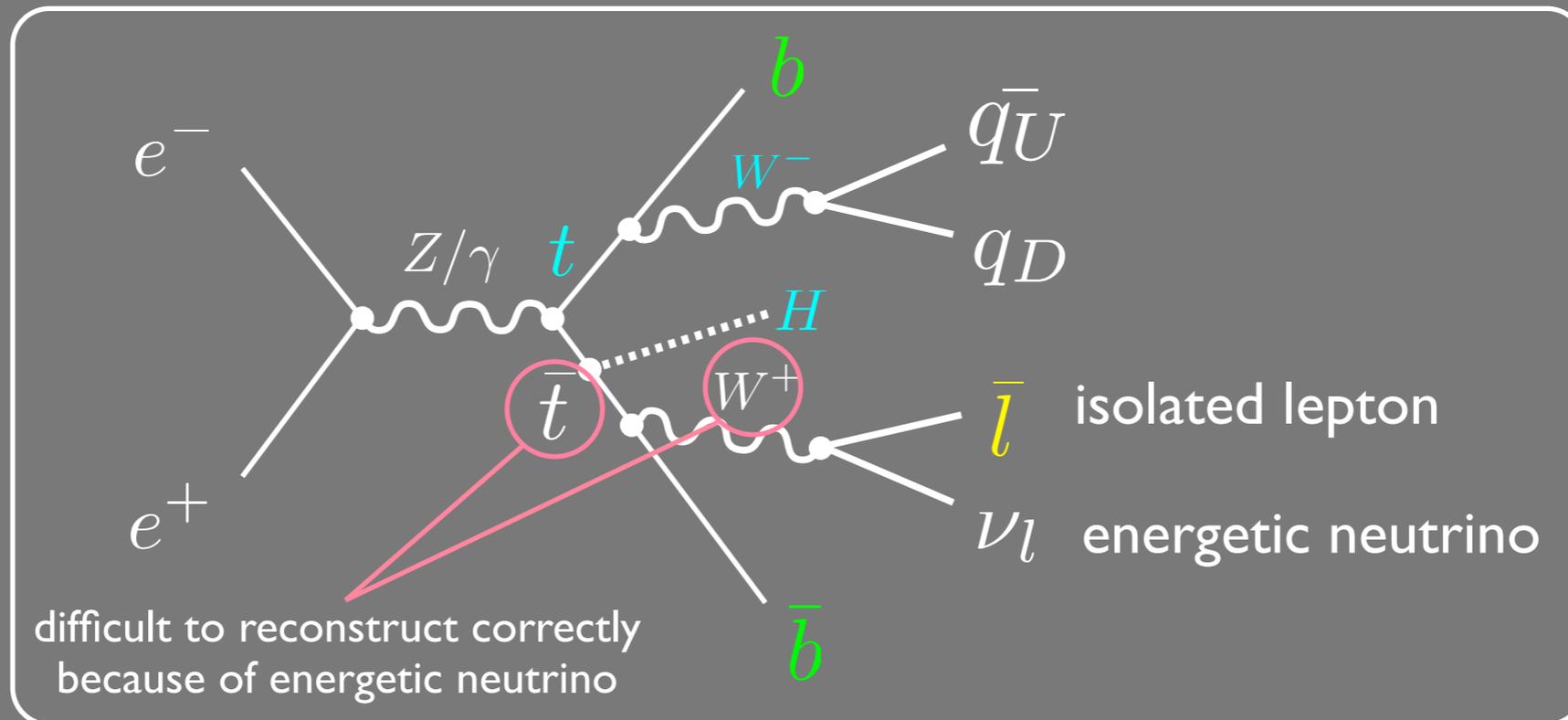


- $ttWW$ & $ttZZ$: less than 1fb (should be negligible)
- Large cross section mode
 - $tt \sim 700\text{fb}$: need realistic simulation
 - qq (5 flavors): negligible
 - WW: negligible w/ b-tagging

$e^+e^- \rightarrow ttH \rightarrow \text{lepton} + 6\text{-jets signature}$

The candidate event is expected to have ...

- ★ an **isolated lepton**
- ★ more than **2 b-jets (possibly 4 b-jets)**
- ★ jet pairs which can reconstruct **W-mass**, **H-mass** and **top-mass**
(from $q \bar{q}$) (from $b \bar{b}$)

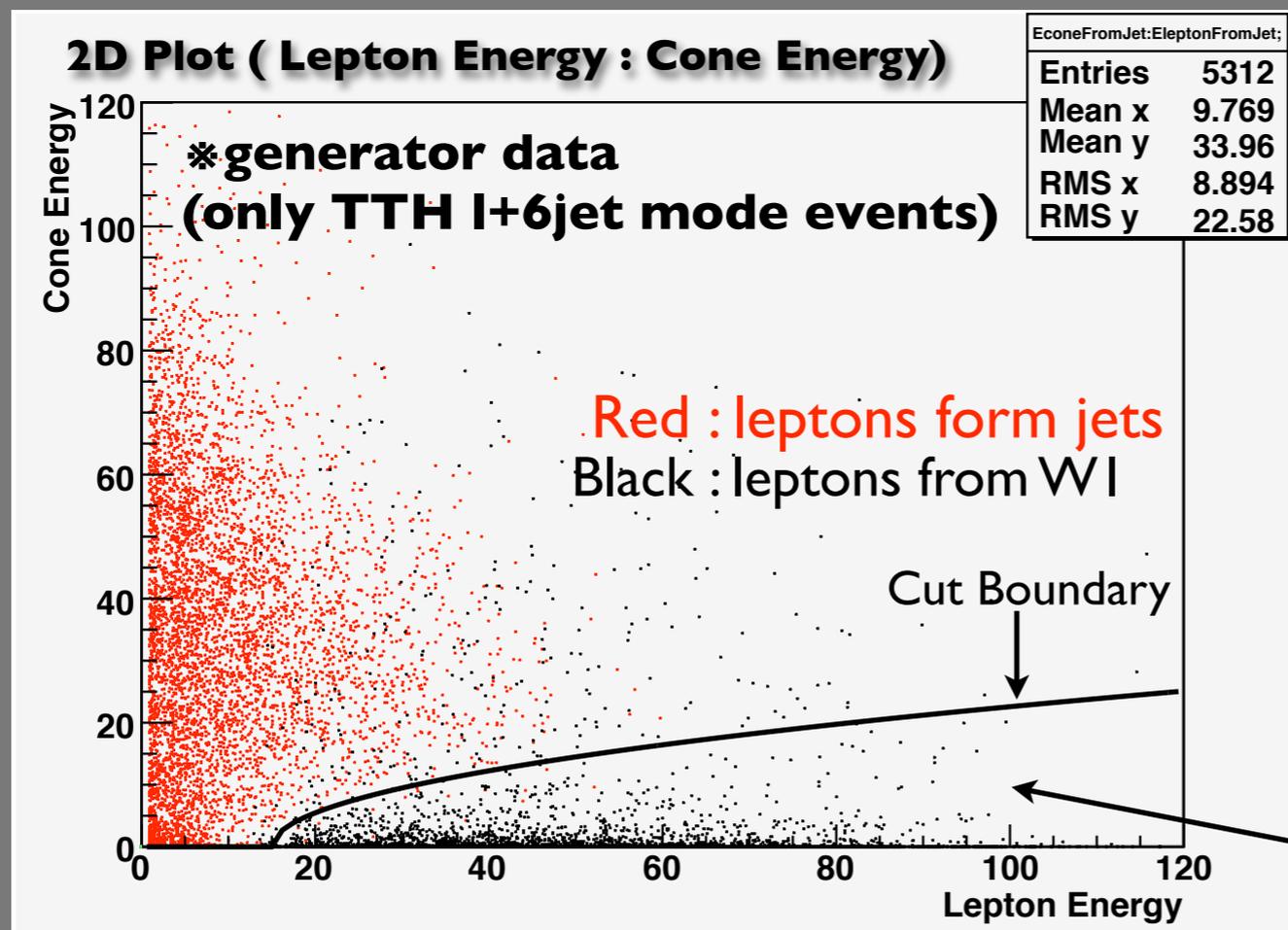


ttH (lepton + 6-jets) event selection (1)

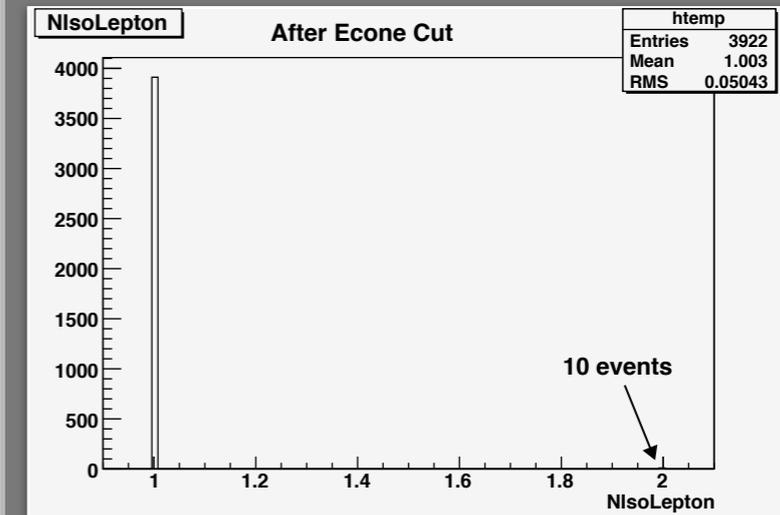
Study about finding isolated lepton

To get isolated leptons, I checked generator information.

1. Select l+6jets mode from TTH events by using generator information
2. Make plot separately (from jets and from W_1)
3. Set Cut-Boundary for finding isolated lepton candidates



of isolated lepton / events



Isolated lepton candidates

*I rejected the events which include the leptons from H.

R. Yonamine

ttH (lepton + 6-jets) event selection (2)

Mass-Reconstruction Result

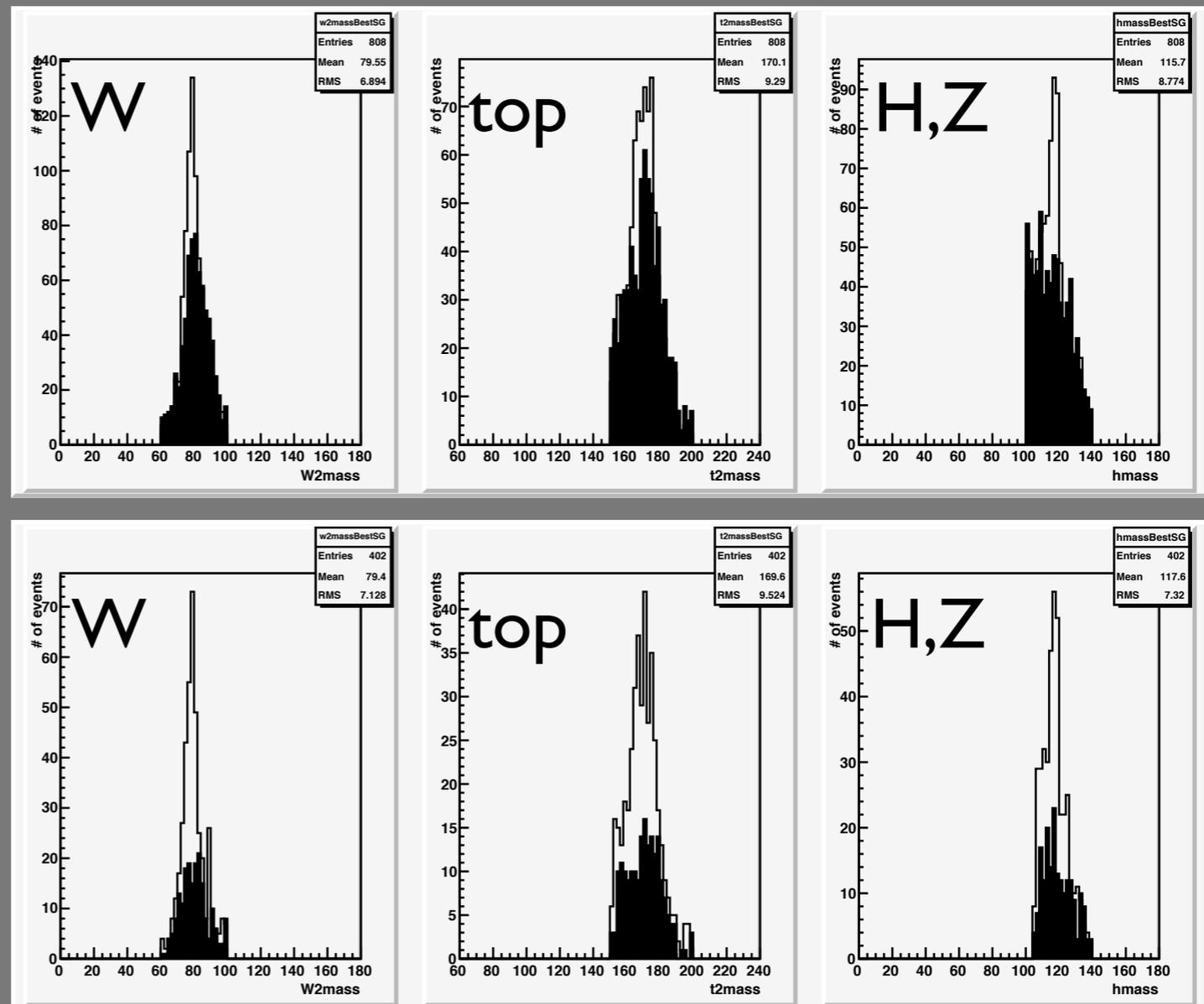
$$\chi^2 = \left(\frac{M_W - M_{W.ref}}{\sigma_{M_W}} \right)^2 + \left(\frac{M_t - M_{t.ref}}{\sigma_{M_t}} \right)^2 + \left(\frac{M_H - M_{H.ref}}{\sigma_{M_H}} \right)^2$$

Correct jet clustering
&
 χ^2 min jet association

$$|m_{jj} - m_{W,H}| \leq 20$$

$$|m_{3j} - m_t| \leq 25$$

Require $H_{cand}(2jets) \rightarrow bb$
(Double b-tagging)



R. Yonamine

Event selection: cut statistics

	TTH	TTZ	TT
No Cut	870	1360	726000
$N_{\text{isolated-lepton}} = 1$	306	443	247200
$N_{\text{jets}} \geq 6$ w/ $Y_{\text{cut}} = 0.0005$	306	441	237750
Mass cut & Double-b-tagging	39	8	15
Selection eff	4.5%	0.6%	0.002%

R. Yonamine

Very very preliminary

- Possible to eliminate ttZ & tt BGs
- **Need to improve signal selection** (max $\sim 30 \text{ eVt}$ @ 1 ab^{-1})

Summary / Plan

- To estimate sensitivity of the top quark Yukawa coupling with ttH channel at the ILC earlier phase:
 - Signal generator w/ tt-system threshold enhancement was implemented
 - ▶ NLO + Threshold effect of tt system + e⁺ polarization enhance the $\sigma(e^+e^- \rightarrow ttH)$
 - ▶ $\sigma = 1.2 \text{ fb}$ for $P=(-0.8, 0.6)$ and $E_{cm}=500\text{GeV}$
 - ttH (lepton + 6-jets) and BGs event analysis using Fast-simulator
 - ▶ Still tuning phase but reasonably expected to eliminate ttZ & tt BGs w/ jet-invariant-mass cut and b-tagging
- Next step:
 - Need to evaluate cross section of ttbb (g->bb dominant)
 - Need to improve signal selection (max ~30evt @1ab⁻¹)

Backup slides

GLD / GLDPrim / J4LDC

Name of Sheet of Properties Name of Sheet	Properties gldec07_14m	gldapr08_14m	gldprim_v02	gldprim_v04	j4ldc_v02	j4ldc_v04						
BeamPipe												
OuterRadius1	1.525	1.55	1.525	1.450	1.525	1.35	HCAL Layer Thickness in cm	2.6	2.6	2.6	2.6	2.6
OuterRadius2	1.525	1.55	1.525	1.450	1.525	1.35	HCAL Total Thickness	119.6	119.6	106.6	109.2	96.2
BeamPipeThickness	0.025	0.050	0.025	0.050	0.025	0.05	HCAL Radius of Last Layer	349.4	349.4	311.4	314	276
InnerRadius	1.5	1.5	1.5	1.4	1.5	1.3	Segment Half Angle (degree)	15	15	15	15	15
Zmax J4.IR.ZEdges	5.0	8.0	5.0	8.0	5.0	8.0	HCAL Rmax of Last Layer	361.7254974	361.7254974	322.3850026	325.0767206	285.736226
Zmax J4.IR.BeamPipeP.HalfZLength	5.5	8.0	5.5	8.0	5.5	8						
Zmax J4.IR.BeamPipeMiddle.ZEdges	5.0	8.0	5.0	8.0	5.0	8.0	ECAL layer Nucl. Int. Length	0.031924195	0.031924195	0.031924195	0.031924195	0.03192419
							ECAL Total Nucl. Int. Length	1.053498424	1.053498424	1.053498424	1.053498424	1.05349842
							HCAL layer Nucl. Int. Length	0.124730859	0.124730859	0.124730859	0.124730859	0.12473086
							HCAL Total Nucl. Int. Length	5.73761952	5.73761952	5.113965224	5.238696083	4.61504179
							Total Nucl. Int. Length	6.791117943	6.791117943	6.167463648	6.292194507	5.66854021
Vertex Detectors												
Number of Layers	6	6	6	6	6	6	Barell CAL HalfZ	270	270	235	235	210
Inner Radius	2.0	1.75	1.8	1.6	1.6	1.5	Endcap ECAL Front Z	280	280	245	245	220
OuterRadius	5.0	6.0	4.8	6.0	4.6	6.0	Endcap ECAL LastZ	299.8	299.8	264.8	264.8	239.8
VTX Thickness/Layers	0.005	0.0094	0.005	0.0094	0.005	0.0094	Endcal HCAL LastZ	419.4	419.4	371.4	374	336
Silicon Radiation Length	9.36	9.36	9.36	9.36	9.36	9.36						
VTX Thickness/Layer in Rad. Length	0.000534188	0.001004274	0.000534188	0.001004274	0.00053419	0.0010043						
Total VTX Thickness in Rad. Length	0.003205128	0.006025641	0.003205128	0.006025641	0.00320513	0.0060256	Cryostat					
Half Z Length of 1st Layer	6.5	7.25	6.5	7.25	6.5	7.25	Cryostat Inner Radius	375	375	335	330	300
Outer Radius of 2nd Layer	2.205	1.9594	2.005	1.8094	1.805	1.7094	Coil-HCAL Distance of Barell	13.27450256	13.27450256	12.61499742	4.923279351	14.2637742
CosTheta Max of 2nd Layer	0.95	0.946994531	0.955572163	0.970240036	0.96353914	0.9733118	Cryostat Outer Radius	440	440	400	385	375
Half Z Length of 4th Layer	10	13.5	10	13.5	10	13.5	Cryostat Thickness	65	65	65	55	75
Outer Radius of 4th Layer	3.405	4.0094	3.205	3.9094	3.005	3.8594	Cryostat HalfZ	475	475	440	375	415
CosTheta Max of 4th Layer	0.95	0.946628398	0.958616106	0.952285837	0.960535654	0.95769439	Solenoid Bfield	3	3	3.5	3.5	4
Half Z Length of 6th Layer	10	13.5	10	13.5	10	13.5	Coil Center Radius	400	400	360	355	325
							Coil Thickness	5	5	5	30	5
							Coil HalfZ	430	430	395	370	370
Spacial Resolution												
Intermediate Tracker Barrel												
Number of Layers	4	4	4	4	4	4	Return Yoke and Muon Detector					
Inner Radius of 1st Layer	9.0	9.0	9.0	9.0	9.0	9.0	Barrel Minimum Radius	445	445	405	405	380
Inner Radius of Last Layer	30.0	30.0	30.0	30.0	29	29	Coil - Return Yoke Minimum Distance	15	15	10	35	10
Total Barrel IT Thickness (R.L.)	0.024	0.024	0.024	0.024	0.024	0.024	Barrel Outer Radius	765	765	690	690	700
MaxCosTheta	0.9	0.9	0.9	0.9	0.9	0.9	Barrel RY and MUD Total Thickness	315	315	280	280	280
HalfZ of 1st layer	18.58267444	18.58267444	18.58267444	18.58267444	18.5826744	18.582674	Barrel RY Outer Radius	760	760	685	685	660
HalfZ of 2nd layer	33.03586568	33.03586568	33.03586568	33.03586568	33.0358657	33.035866	Barrel RY Maximum Radius	786.8098971	786.8098971	709.1641836	709.1641836	683.282279
HalfZ of 3rd layer	47.48905691	47.48905691	47.48905691	47.48905691	47.4890569	47.489057	Endcap FrontEndcap FrontZ	425.1	425.1	390	375	365
HalfZ of 4th layer	61.94224815	61.94224815	61.94224815	61.94224815	59.8775065	59.877507	Endcap FrontEndcap LastZ	485	485	450	400	425
J4IT.Barrel.HalfZ	18.5 33.0 47.5 62.0	18.5 33.0 47.5 62.0	18.5 33.0 47.5 62.0	18.6 33.0 47.5 62.0	18.5 33.0 47.5 57	18.5 33.0 47.5 57	Endcap FrontEndcap Nsuler Layers	2	2	2	1	2
							Endcap LastZ	800	800	765	695	740
Intermediate Tracker Endcap												
Number of layers	7	7	7	7	7	7	IR-FCAL					
MinimumZ	15.5	15.5	15.5	15.5	15.5	15.5	FrontZ	230.0	230.0	230.0	230.0	230.0
Maximum Z	101.5	101.5	101.5	101.5	101.5	101.5	Front Rmin	8.2	8.2	8.2	8.2	8.2
							LastZ	284.99	284.99	284.99	284.99	284.99
							Rmax	39.79	39.0	39.0	39.0	29.0
TPC												
TPC Region Inner Radius	39.5	39.5	39.5	39.5	30	30	IR-BCAL					
Inner SupportTube Thickness	4.215	4.215	4	4	4	4	CH2Mask FirstZ	405	405	405	405	405
Drift Region Rmin	43.715	43.715	43.5	43.5	34	34	CH2Mask LastZ	430	430	430	430	430
TPC Region Outer radius	206	206	180	180	158	158	CH2Mask Outer Radius	20	20	20	20	20
Outer SupportTube Thickness	8.235	8.235	6	6	6	6	BCAL FirstZ	430	430	430	430	430
DriftRegion Rmax	197.765	197.765	174	174	152	152	BCAL LastZ	450	450	450	450	450
Inner Support Tube Rad. Length	0.013000993	0.020864271	0.012337835	0.01980002	0.01233783	0.0198	QC FirstZ	451.0	451.0	451.0	451.0	451.0
Outer SupportTube Rad. Length	0.01700115	0.027283841	0.012386994	0.019878937	0.01238699	0.0198789						
EndPlate and PadPlane Thickness	5	10	5	10	5	10						
TPC Region HalfZ	260	260	235	235	216	216						
TPC Drift Region HalfZ	255	250	230	225	211	206						
EndPlate and PadPlane Thickness R.L.	0.0999972	0.147795858	0.0999972	0.147795858	0.0999972	0.1477959						
# of Radial Sampling	200	256	170	217	150	196						
Pad Radial Height	0.77025	0.601757813	0.767647059	0.601382488	0.78666667	0.6020408						
Calorimeter												
ECAL Rmin	210	210	185	185	160	160						
ECAL # of layers	33	33	33	33	33	33						
ECAL Layer Thickness in cm	0.6	0.6	0.6	0.6	0.6	0.6						
ECAL Layer Thickness in Rad. Length	0.860794846	0.860794846	0.860794846	0.860794846	0.86079485	0.8607948						
ECAL Thickness	19.8	19.8	19.8	19.8	19.8	19.8						
ECAL Total Rad. Length	28.40622991	28.40622991	28.40622991	28.40622991	28.4062299	28.40623						
HCAL # of layers	46	46	41	42	37	37						

SLAC SM data samples: FAQ

- Whizard 1.40 has no gluon emission by default, leading to potentially incorrect multiplicity distributions.
- The WHIZARD version 1.40 that was used to generate this sample indeed did not include gluon emission. However gluon radiation was simulated using PYTHIA's parton showering algorithm. WHIZARD versions 1.50 and higher include gluon emission, and, starting with version 1.91, WHIZARD has its own parton showering code.
- Whizard 1.40 has an incorrect implementation of the CKM matrix. Only diagonal terms of the matrix are present (and = 1!), giving wrong W decays.
- Although true for the Whizard version 1.40 that was used to generate this data sample, it is extremely doubtful that this will have any effect on the current analyses. WHIZARD versions 1.51 and higher include the correct CKM matrix, and so future data samples will include the rarer W decays.
- This sample has generator level cuts a la SiD, providing a potential bias when used for ILD.
- There are, indeed, some kinematical cuts for processes with divergent cross-sections, which can be seen by looking at the whizard.in file as described above. However, the only kinematic cut that leads to a genuine loss of events is a 4 GeV minimum invariant mass cut on final state fermion-antifermion pairs.

SLAC SM data samples (cont'd)

- 6-fermion SM samples also contains no ttbar mediated events: ($e^+e^- \rightarrow bb$ with $\gamma \rightarrow WW$) and ($e^+e^- \rightarrow WW$ with $Z \rightarrow bb$)
=> same signature for the ttbar events
- This work: 50fb^{-1} MC samples focusing on pre-selected **bbuddu** (17766) & **bbcsc** (17790) => different flavour components and low Xsec (limitation for CPUs & disks)

IDRUPLH	Process	Pol(e ⁻)	Pol(e ⁺)	Xsec (fb)
17765	bbuddu	-1.0	1.0	166.3
17766	bbuddu	1.0	-1.0	66.0
17769	bbudsc	-1.0	1.0	164.7
17770	bbudsc	1.0	-1.0	65.7
17785	bbcscdu	-1.0	1.0	164.7
17786	bbcscdu	1.0	-1.0	66.0
17789	bbcsc	-1.0	1.0	165.1
17790	bbcsc	1.0	-1.0	66.0

Run condition for Marlin processors (2)

- Main difference between GLD and LDC comes from CaloDigiProcessors
 - ▶ LDC: **LDCCaloDigi + SimpleMuonDigi + SimpleLCalDigi**
 - ▶ GLD: **SimpleCaloDigi**

	ECALLayers	CalibrECAL	HCALLayers	CalibrHCAL
GLDapr08	33	24.56	46	27.44
GLDprim	33	24.33	42	27.09
J4LDC	33	23.954	37	28.196

- ▶ PandoraPFAProcessor

[Tuned calibration factors for 3 different detector geometries](#) (ECALMIPcalibration, HCALMIPcalibration, ECALThreshold, HCALThreshold, ECALEMMIPToGeV, ECALHadMIPToGeV, HCALEMMIPToGeV, HCALHadMIPToGeV)

```
<parameter name="ClusterFormationPadsECAL" type="float">2.5 </parameter>  
<parameter name="SameLayerPadCutECAL" type="float">2.8 </parameter>
```

- ▶ SatoruJetFinder (Only force 6-jets)

```
<parameter name="Mode" type="string" value="DurhamNJet" />  
<parameter name="NJetRequested" type="int" value="6" />
```

- ▶ Processors for LCFIVertex

follow LDC-DST steering