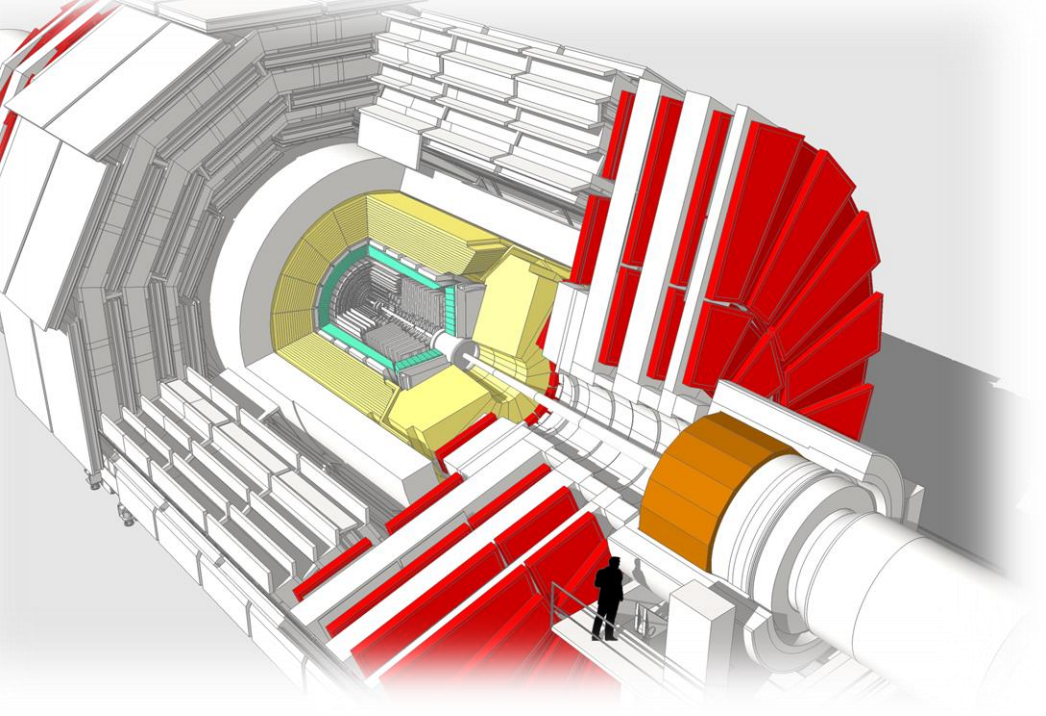
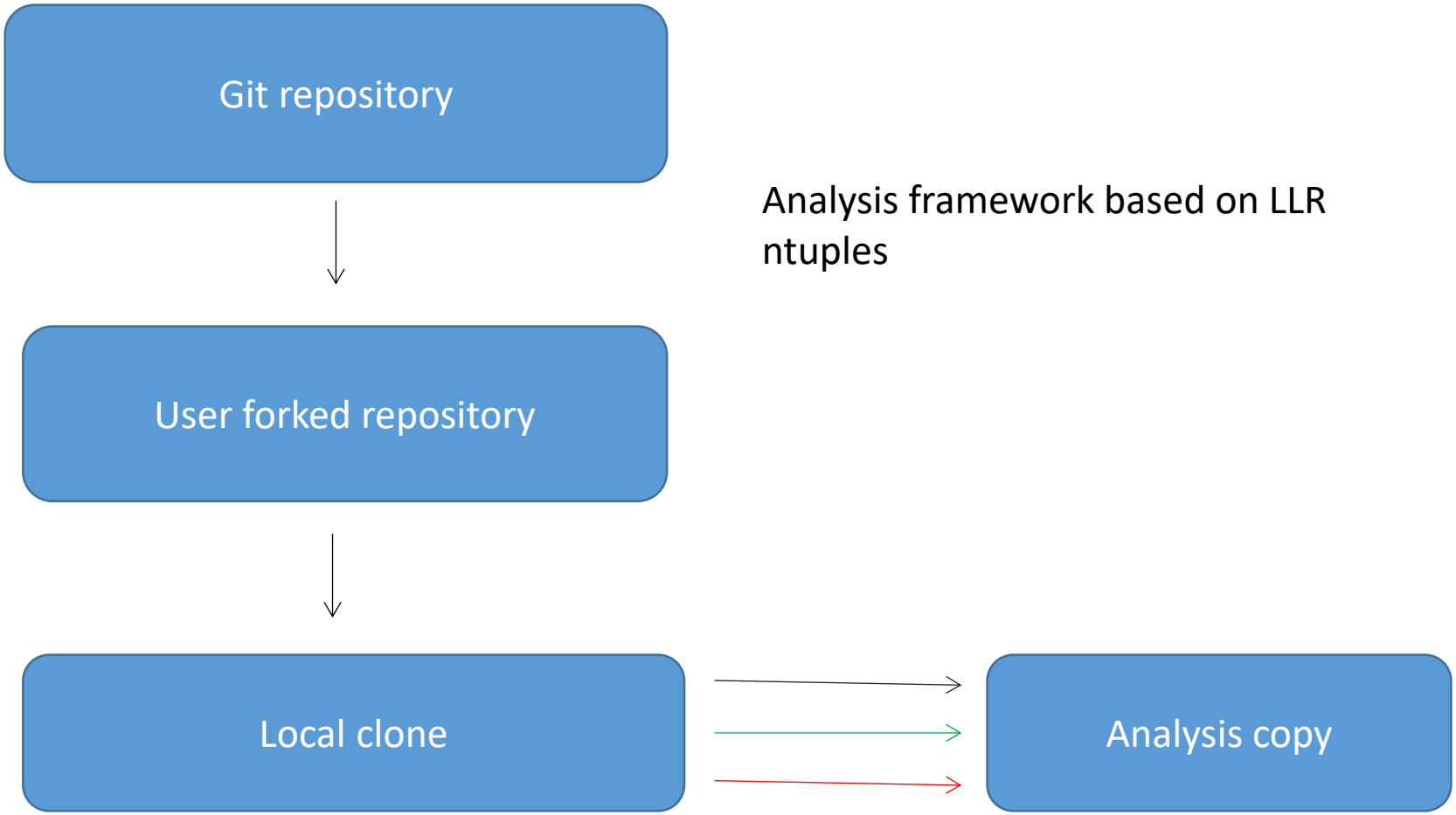


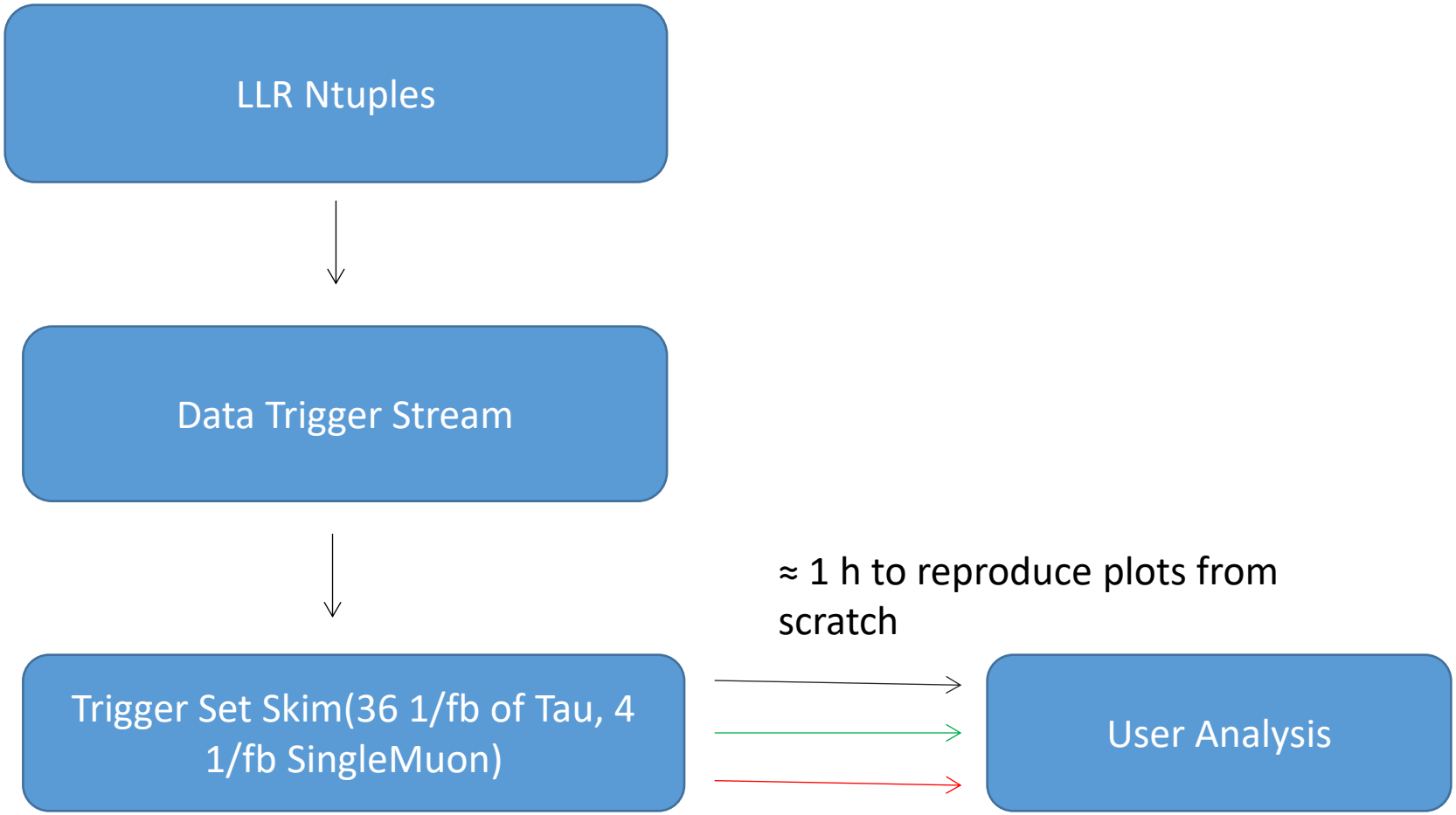
Vladimir Cherepanov

IPHC Analysis Tools https://github.com/cherepan/IPHCAnalysisTools



Analysis framework based on LLR ntuples

IPHC Analysis Tools https://github.com/cherepan/IPHCAnalysisTools



Summary tables

	$Data$	QCD	$W \to l\nu$	$W \to \tau\nu$	$WW \to 2l2\nu$	$ZZ \to 4l$
Before Skim	3.30575e + 08	7.52931e + 06	1.98146e + 07	9.8912e + 06	1.999e + 06	1.07098e + 07
Before Cuts	9.41445e+07	1.01139e+06	5370	2635	21765	150655
Trigger	9.41445e+07	1.01139e+06	5370	2635	21765	150655
NGoodPairs	1.50153e+07	1.01139e+06	302	546	2043	13854
Lepton Veto	1.50153e+07	1.01139e+06	302	546	2043	13854
First Tau Isolation	1.02219e+06	1.01139e+06	10	180	775	7012
Second Tau Isolation	105285	1.01139e+06	0	20	256	3536
Number of muons	105132	1.009e+06	0	20	251	2873
Pair Charge	67823	1.009e+06	0	15	243	2134
Pair Visible Mass	27723	291296	0	4	35	1322
Delta R btw taus	27412	288322	0	4	34	1322

	$ZZ \to 2l2\nu$	$ZZ \to 2l2q$	$ttbar$	$Z/\gamma \to \tau\tau$	$Z/\gamma \to \mu\mu$
Before Skim	8.84248e + 06	1.53456e + 07	7.70812e + 07	1.53719e + 07	3.37724e + 07
Before Cuts	118244	355592	1.06684e+06	37488	221315
Trigger	118244	355592	1.06684e+06	37488	221315
NGoodPairs	10128	45569	235755	8737	4113
Lepton Veto	10128	45569	235755	8737	4113
First Tau Isolation	5414	13528	23587	5006	1102
Second Tau Isolation	3078	4394	1995	2726	725
Number of muons	3071	4312	1881	2715	725
Pair Charge	3023	4106	1622	2657	711
Pair Visible Mass	2593	3532	485	2520	105
Delta R btw taus	2593	3532	483	2514	104

Table 3: Raw Event Selection

	$Data$	QCD	$W \to l\nu$	$W \to \tau\nu$	$WW \to 2l2\nu$	$ZZ \to 4l$
Trigger	1	1	1	1	1	1
NGoodPairs	0.159492	1	0.056174	0.207082	0.0940664	0.0903714
Lepton Veto	1	1	1	1	1	1
First Tau Isolation	0.0680765	1	0.0307887	0.33705	0.373864	0.503202
Second Tau Isolation	0.103	1	0	0.104406	0.323339	0.502535
Number of muons	0.998547	0.997644	-nan	1	0.979463	0.814515
Pair Charge	0.645122	1	-nan	0.7353	0.96494	0.742363
Pair Visible Mass	0.408755	0.288697	-nan	0.245302	0.147478	0.61849
Delta R btw taus	0.988782	0.98979	-nan	1	0.973388	1

	$ZZ \to 2l2\nu$	$ZZ \to 2l2q$	$ttbar$	$Z/\gamma \to \tau\tau$	$Z/\gamma \to \mu\mu$
Trigger	1	1	1	1	1
NGoodPairs	0.0843689	0.128337	0.224199	0.224369	0.0187272
Lepton Veto	1	1	1	1	1
First Tau Isolation	0.531657	0.290654	0.0984394	0.571216	0.258161
Second Tau Isolation	0.566895	0.320733	0.0832154	0.541618	0.658625
Number of muons	0.997506	0.981466	0.943497	0.995693	1
Pair Charge	0.984995	0.951417	0.862786	0.97782	0.982189
Pair Visible Mass	0.855393	0.861259	0.299036	0.947657	0.137417
Delta R btw taus	1	1	0.996009	0.997635	0.989645

Table 9: Relative Efficiency

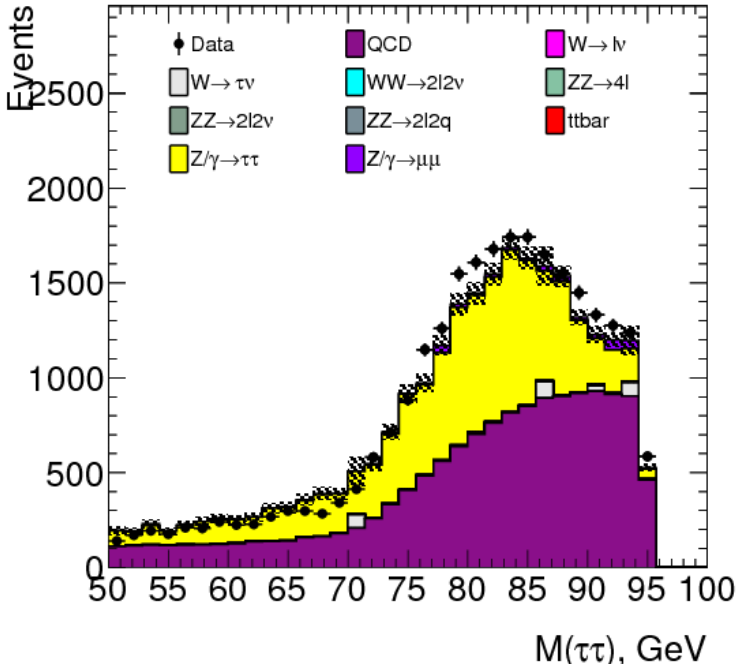
Z ->τ_h τ_h control sample

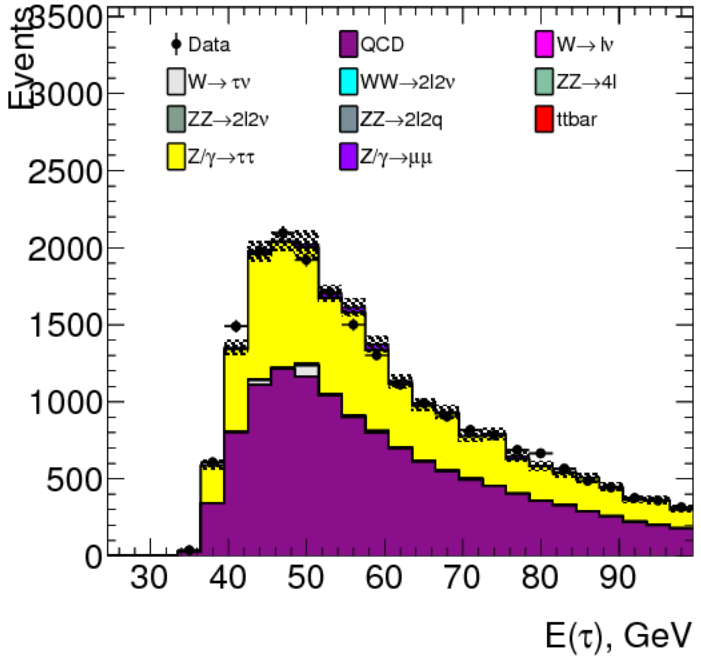
Data:
/Tau/Run2016*-23Sep2016-v1/MINIAOD

Following recipes from H2TauTau analysis

Not all necessary MC/Data corrections are applied: TauSpinner, TauES, MET…

Synchronization to legacy analysis in progress





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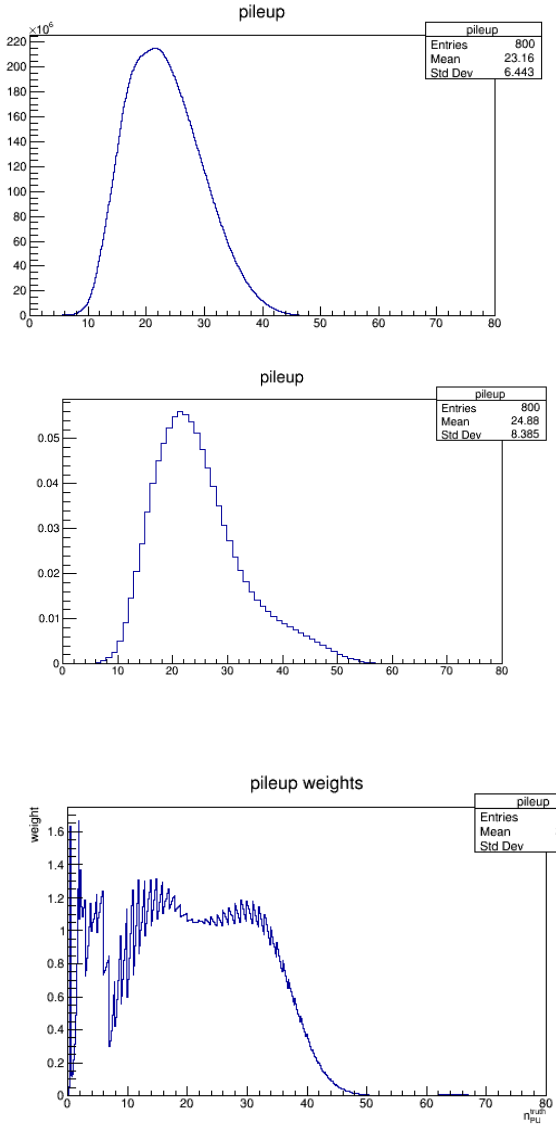
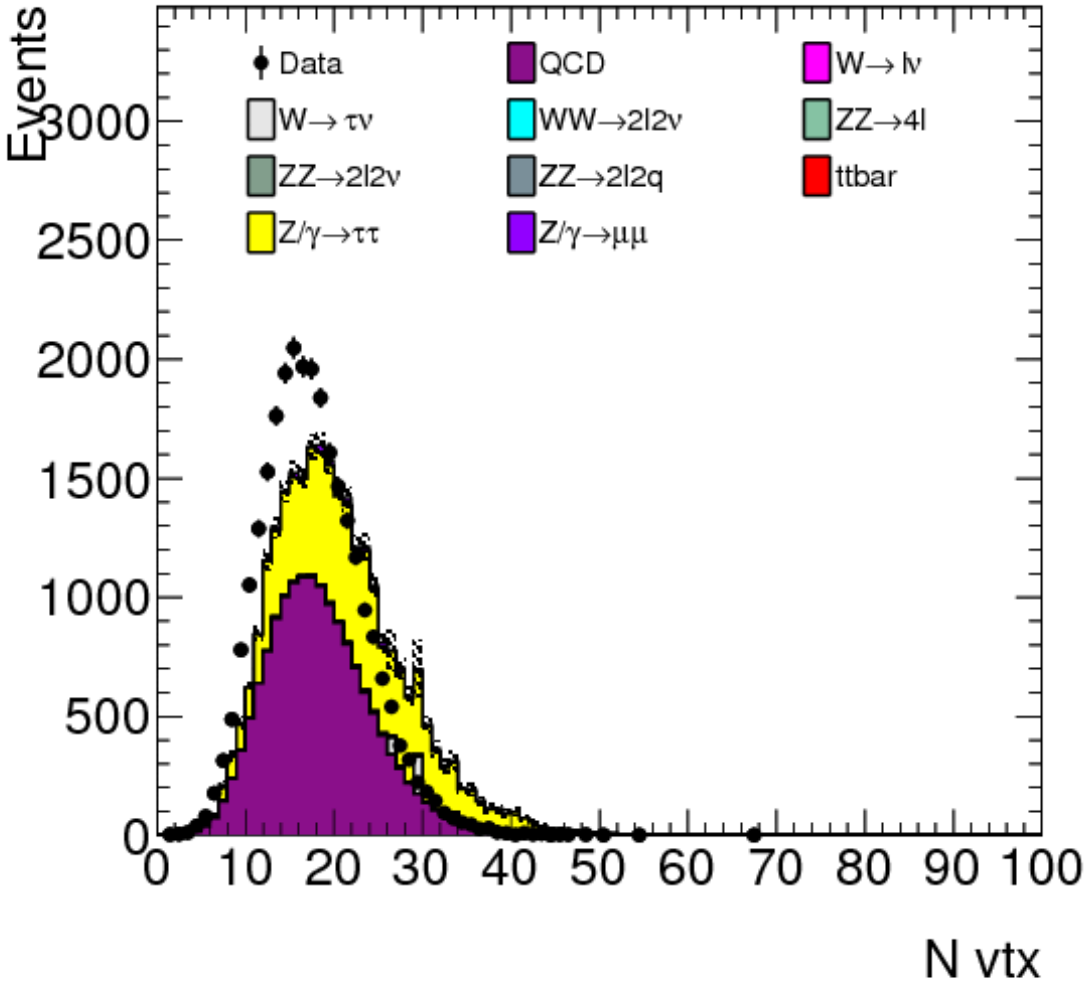
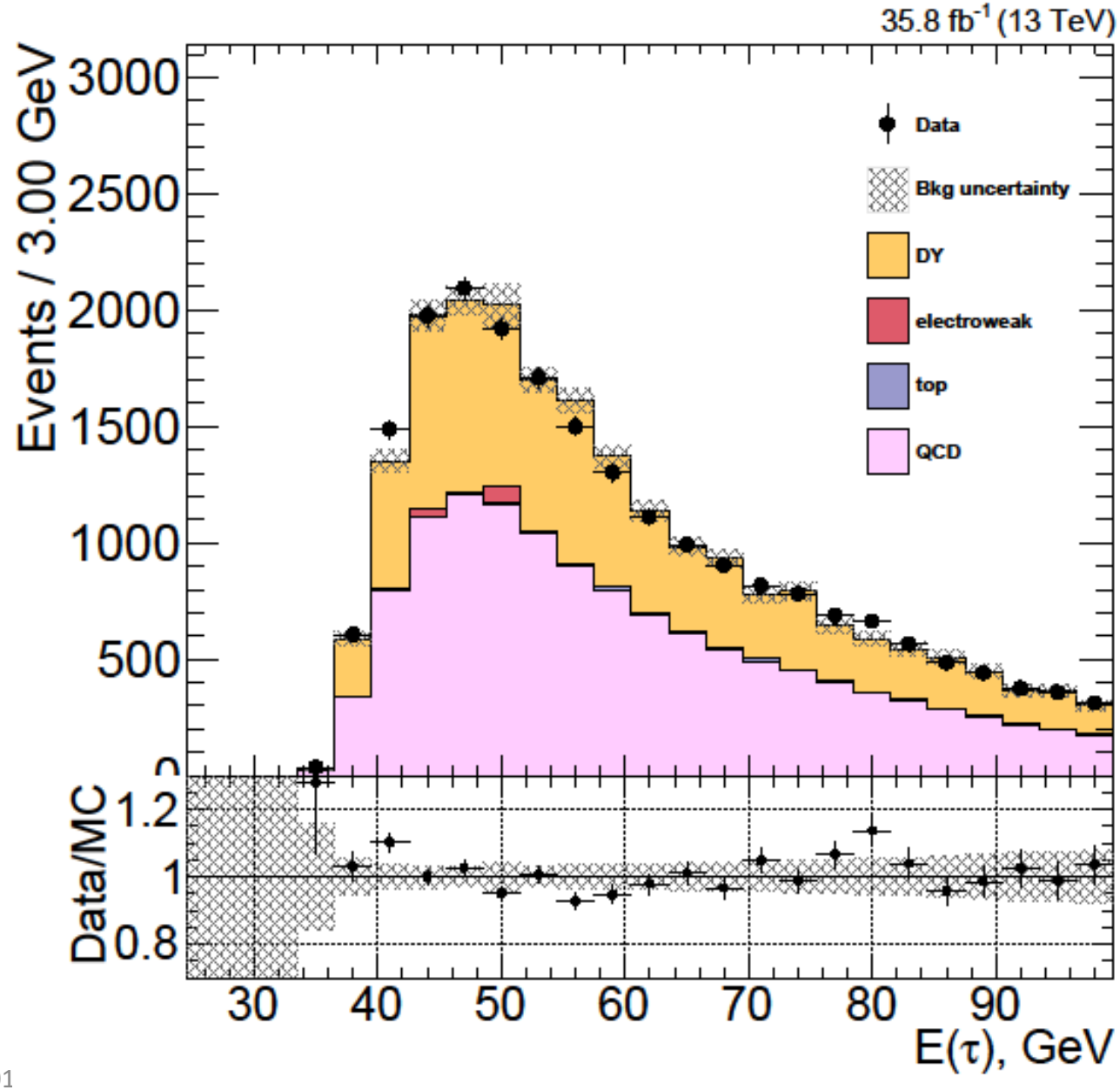
PU reweighting

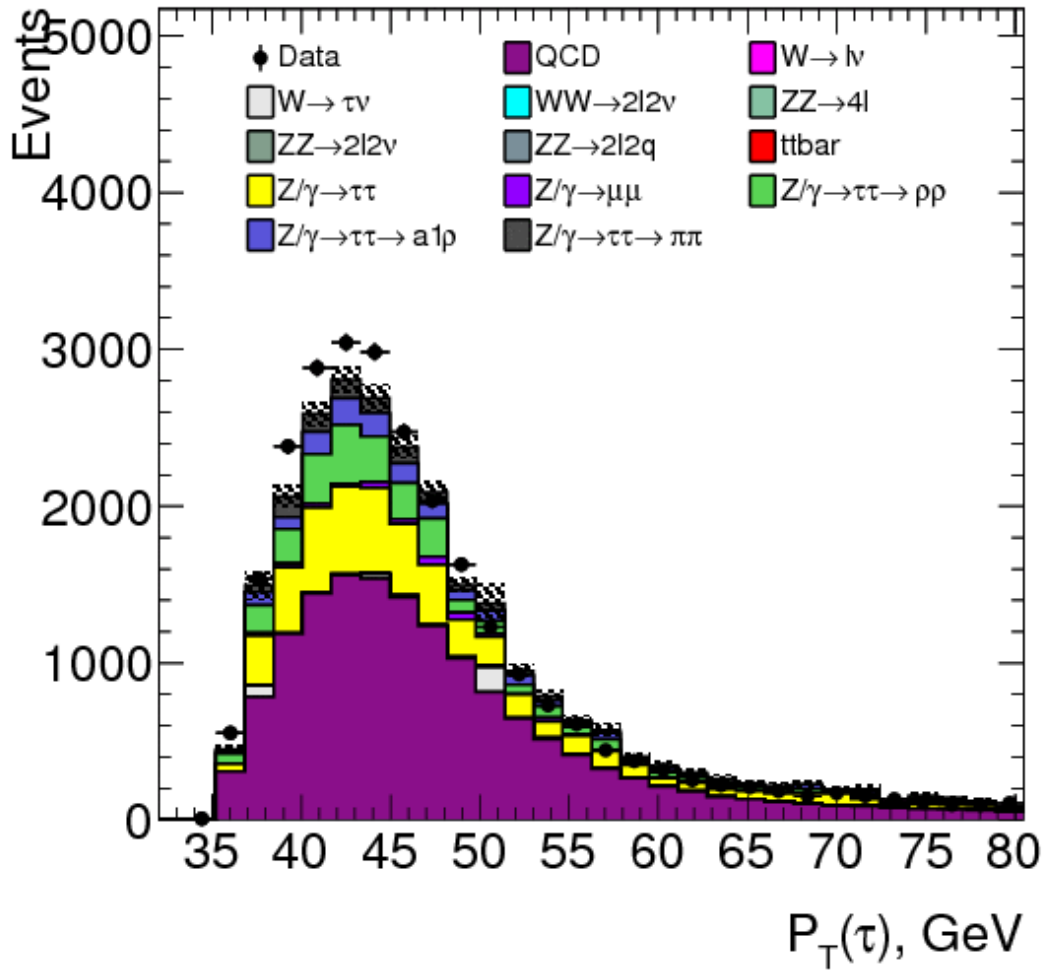




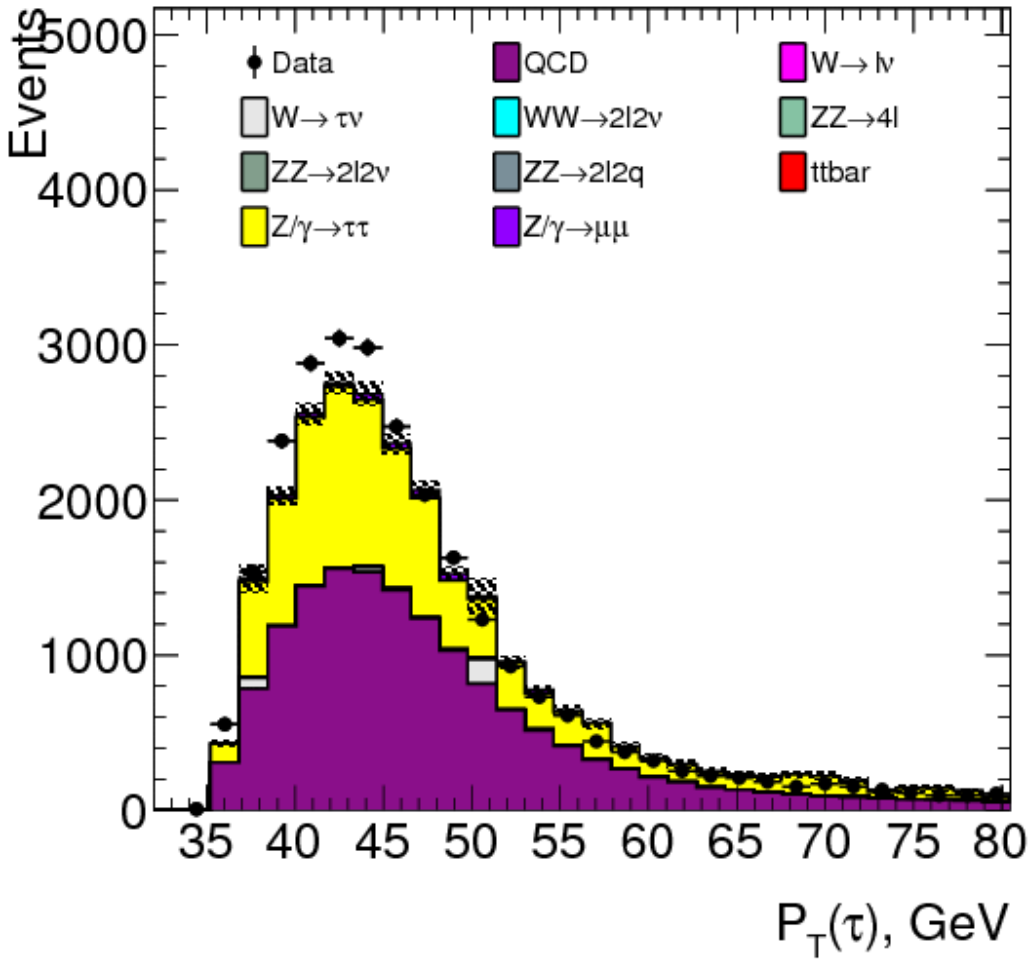
Plotting tool https://github.com/cherepan/Plotter



MC Tau Interface



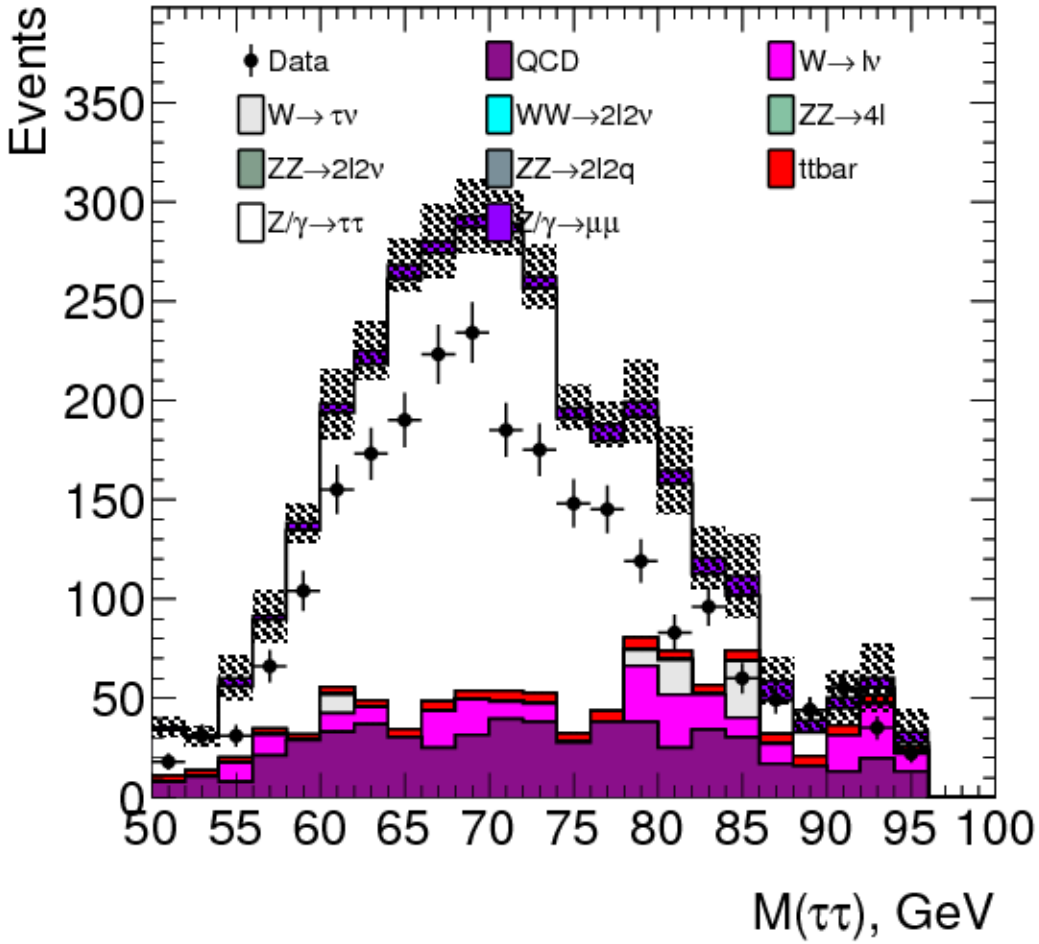
MC Tau Interface



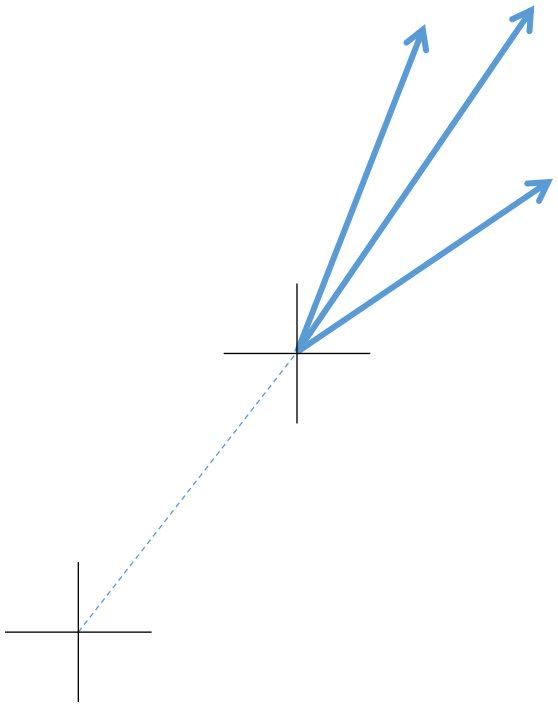
SingleMuon data

/SingleMuon/Run2016*-23Sep2016-v1/MINIAOD

4 1/fb is produced

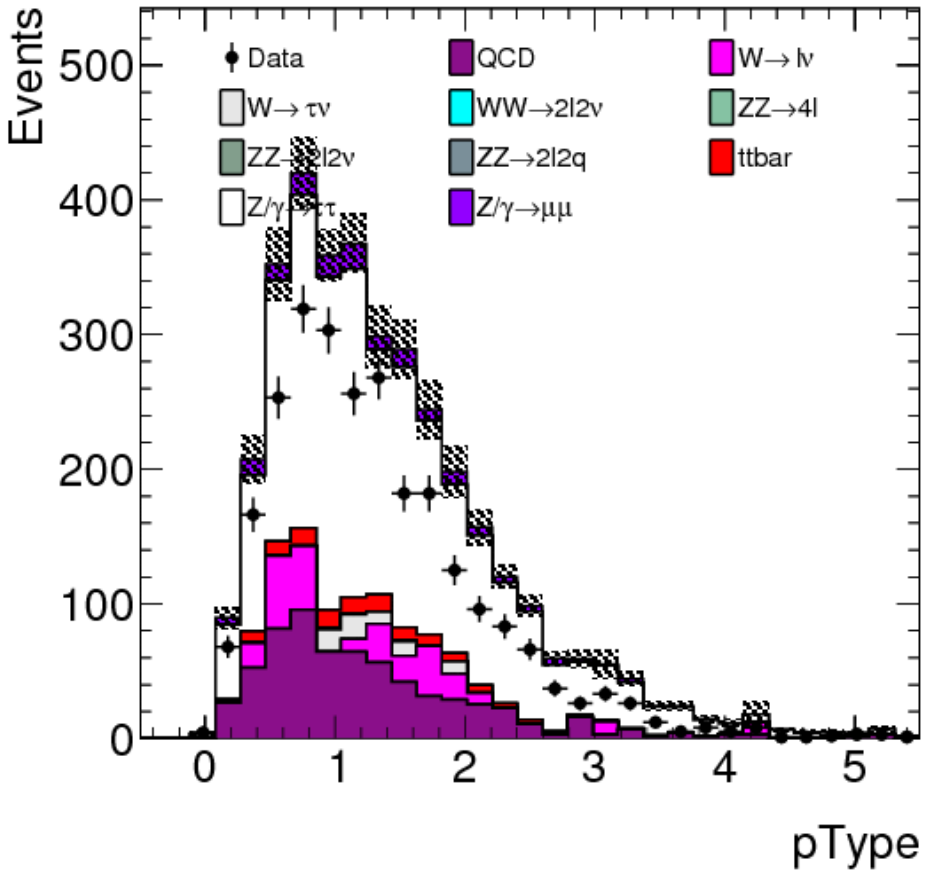


Secondary Vertex Reconstruction



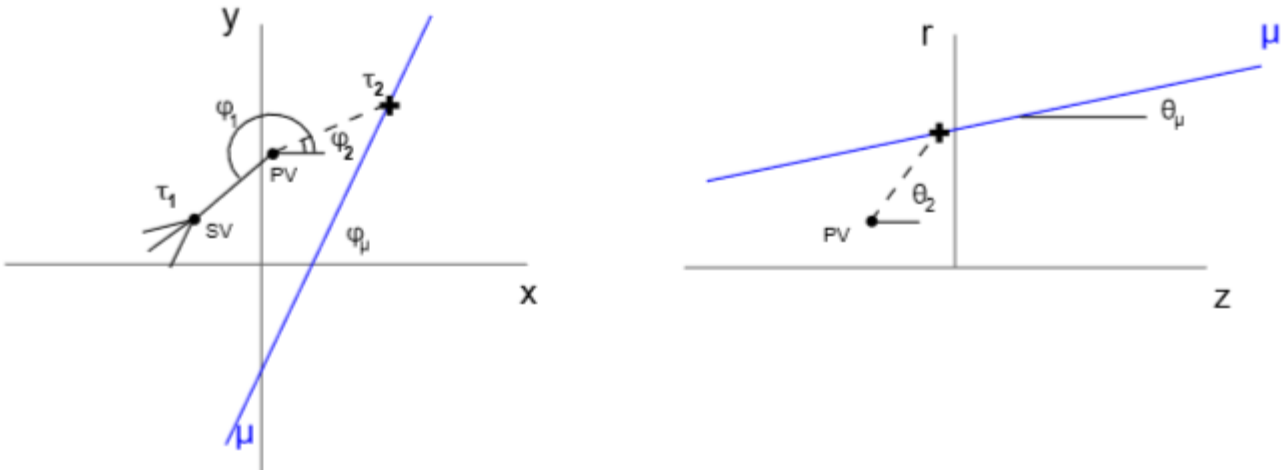
Adaptive vertex fitter to the general tracks matched to tau decay products

PV-SV significance



SimpleFits

Kinematic fit tool for tau reconstruction



Z->ττ -> μνν a1ν - moved to 13 TeV

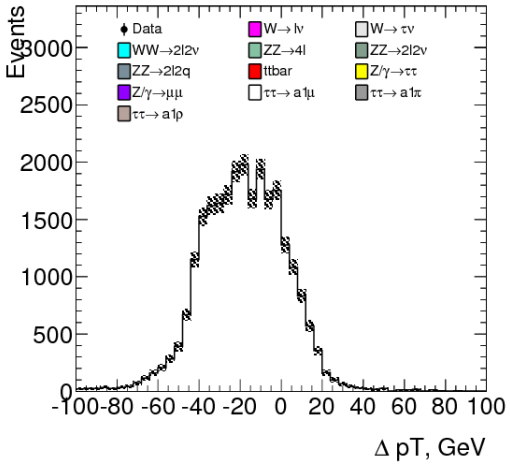
New:

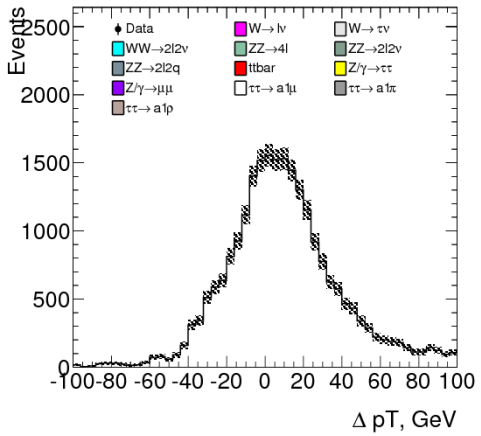
Z->ττ -> πν a1ν

Z->ττ -> ρν a1ν

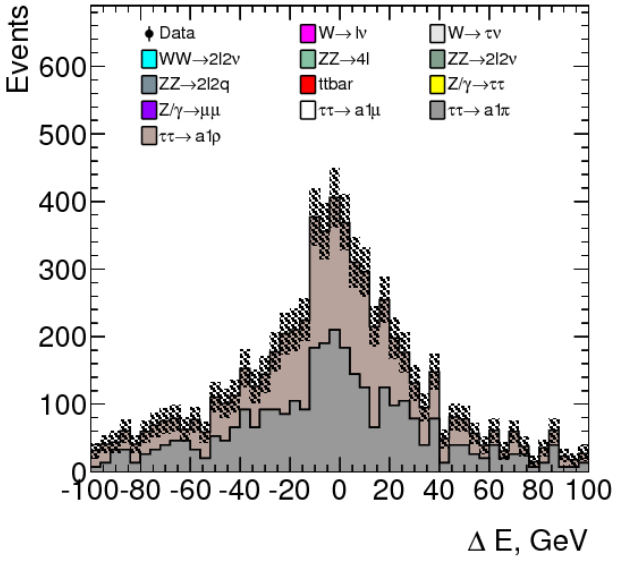
Z->ττ -> a1ν a1ν needs a spectial treatment

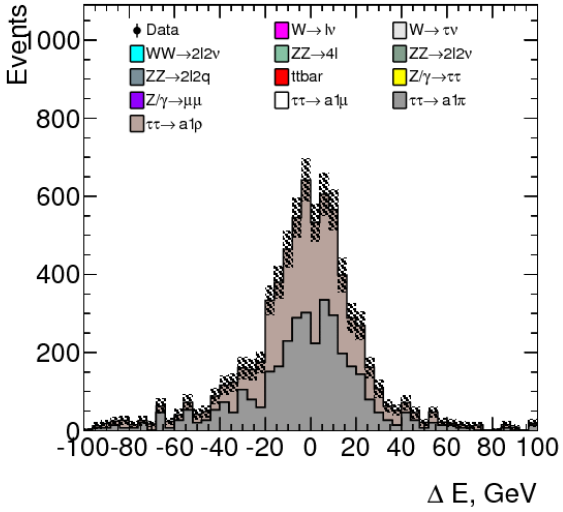
SimpleFits – basic resolution plots





Resolution of taus momentum including neutrino





Further tests are needed

Important post-fit corrections are missing for 13 TeV MC

Spin analysis of tau leptons

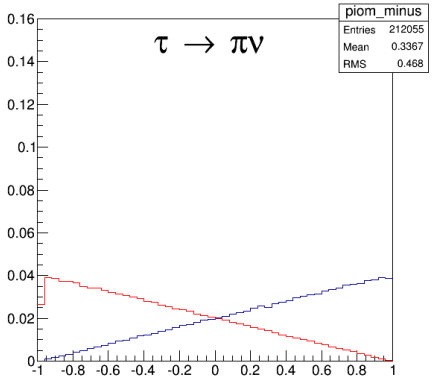
Angular analysis of the decay products

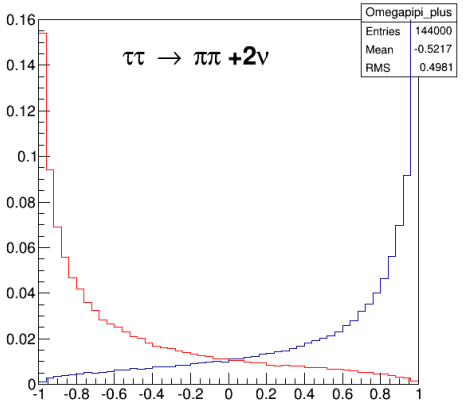
Some angles having only the “visible” information

More advanced angles are accessible only tau rest frame

The goal is to separate tau helicity states as good as possible

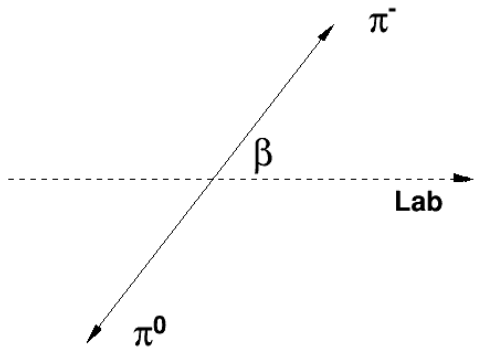
Combine both taus - helicities are ≈100% correlate

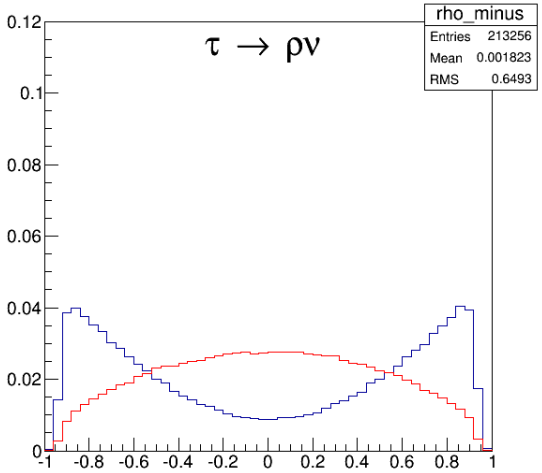




“Visible observables”

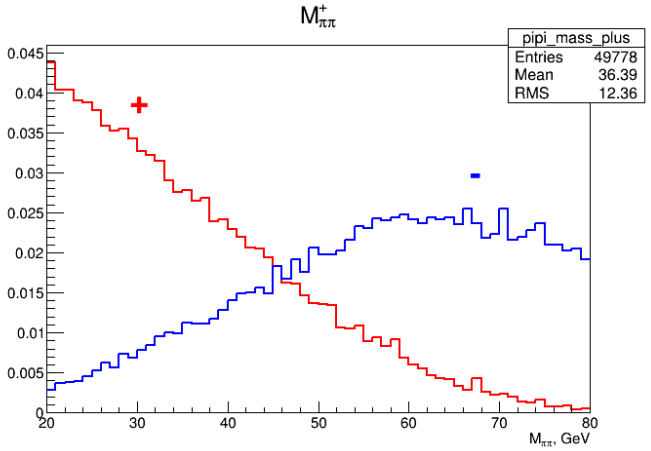
τ→ρν





τ→πν

Invariant mass of ππ

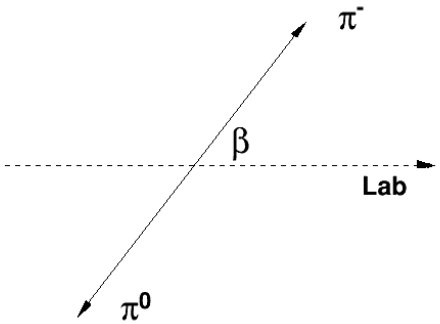


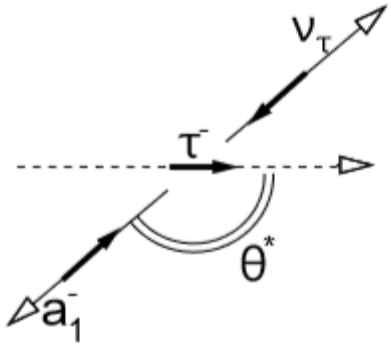
All angles (rho channel)

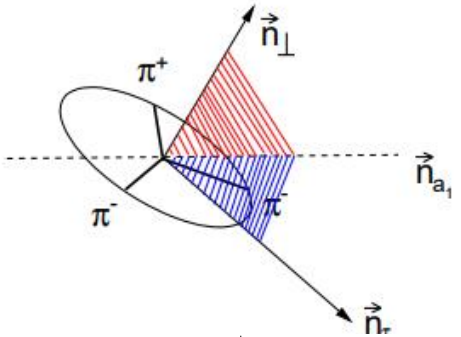
https://github.com/TauPolSoftware

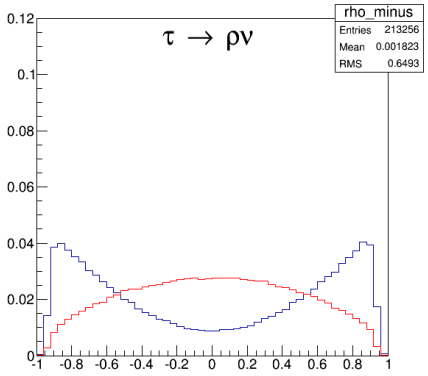
https://github.com/cherepan/Tau-Polar

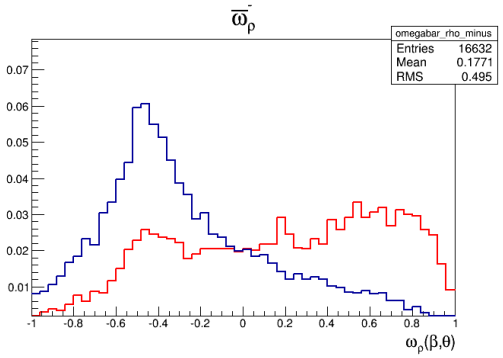
Tauola + pythia + TauSpinner packages to study anglular distributions at gen level

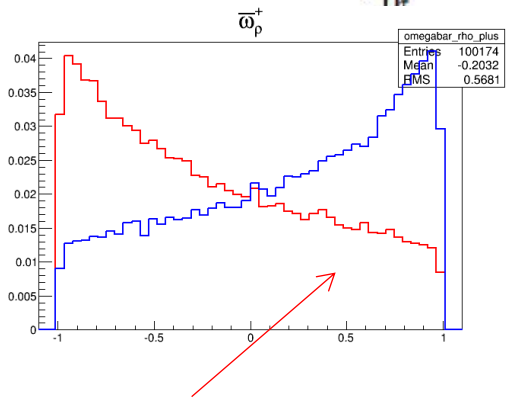








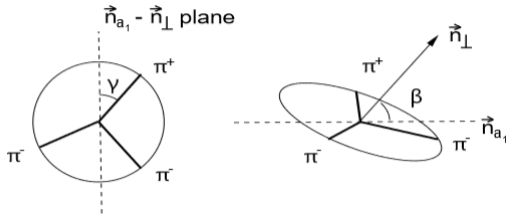


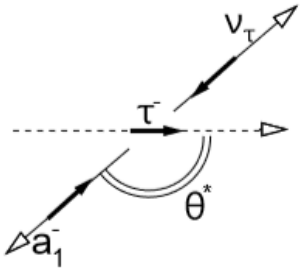


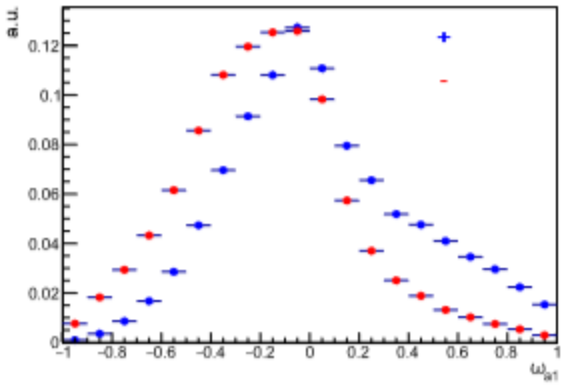
Not the right slope!

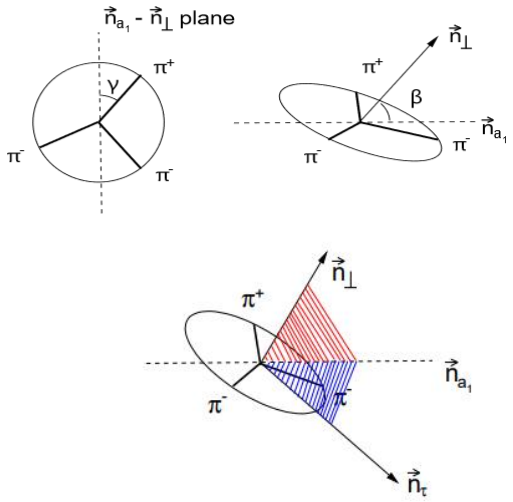
$$\omega = \frac{g(\vec{\xi})}{f(\vec{\xi})} = \frac{|M_+(\vec{\xi})|^2 - |M_-(\vec{\xi})|^2}{|M_+(\vec{\xi})|^2 + |M_-(\vec{\xi})|^2},$$

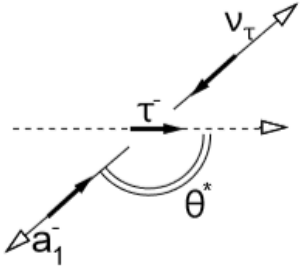
All angles (a1 channel)

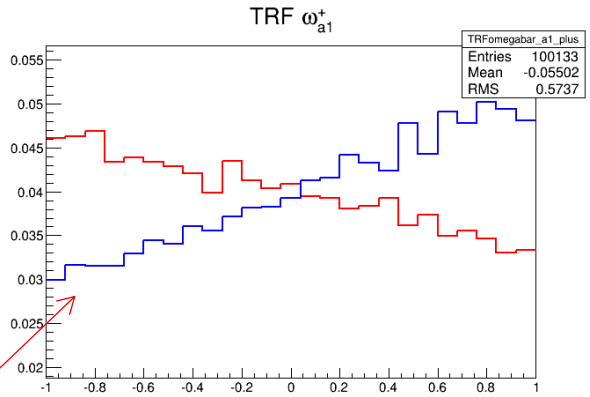






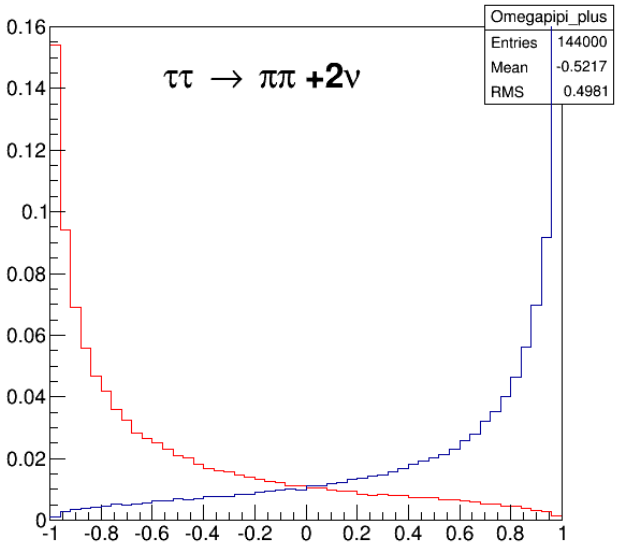




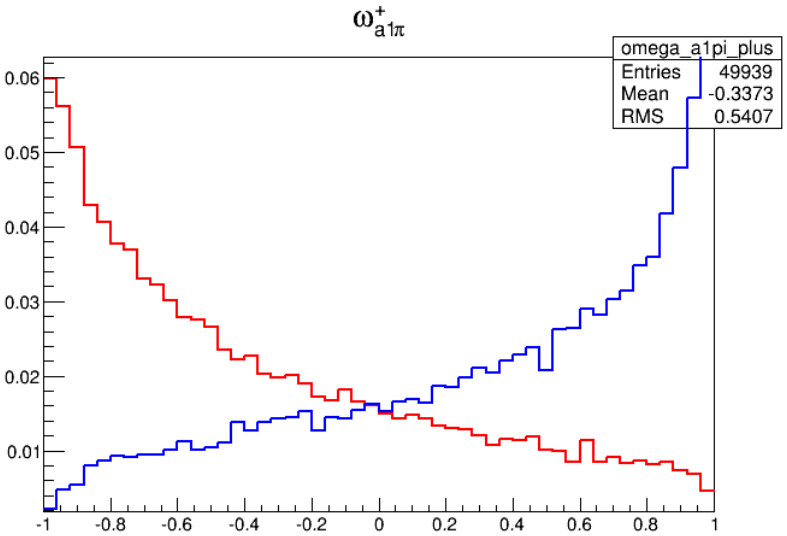


Not the right slope!

Combinations (some examples)



Accessible using MMC (to be implemented in the IPHCAnalysisTools)



Accessible using SimpleFits, MMC