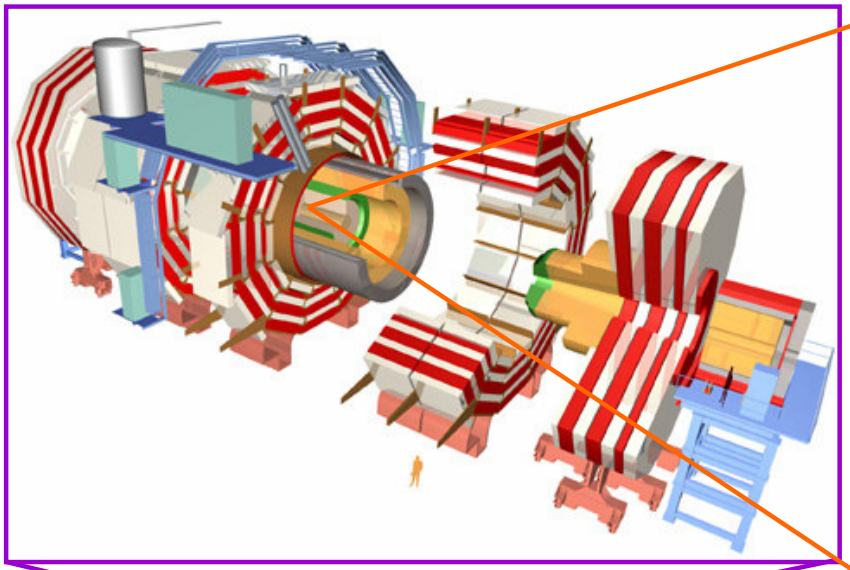
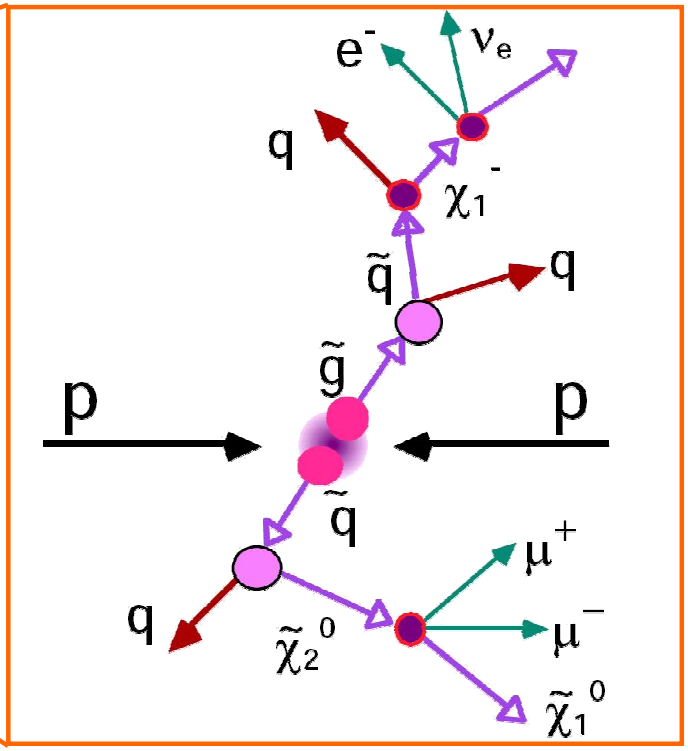
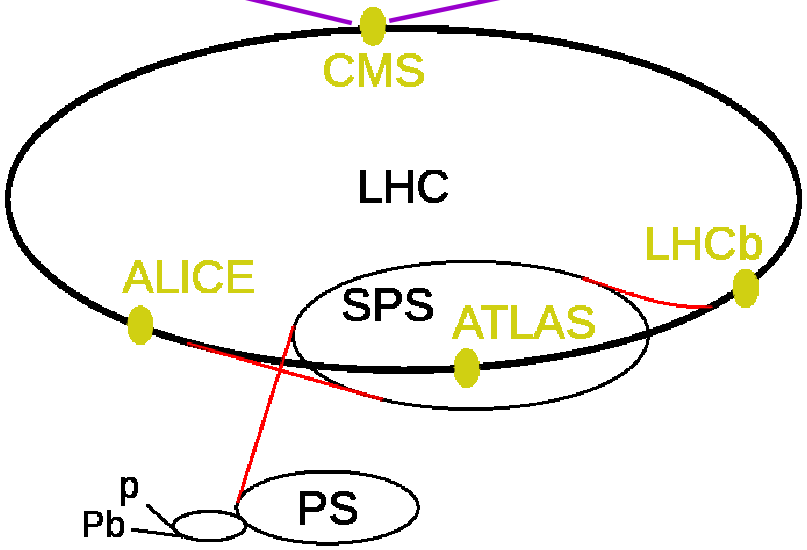
Study of Muon ID for RA4







- Deeper Look into the RA4 MuonID
- Some Thoughts and Plots

Reference Analysis - MuonID

Muon Selection

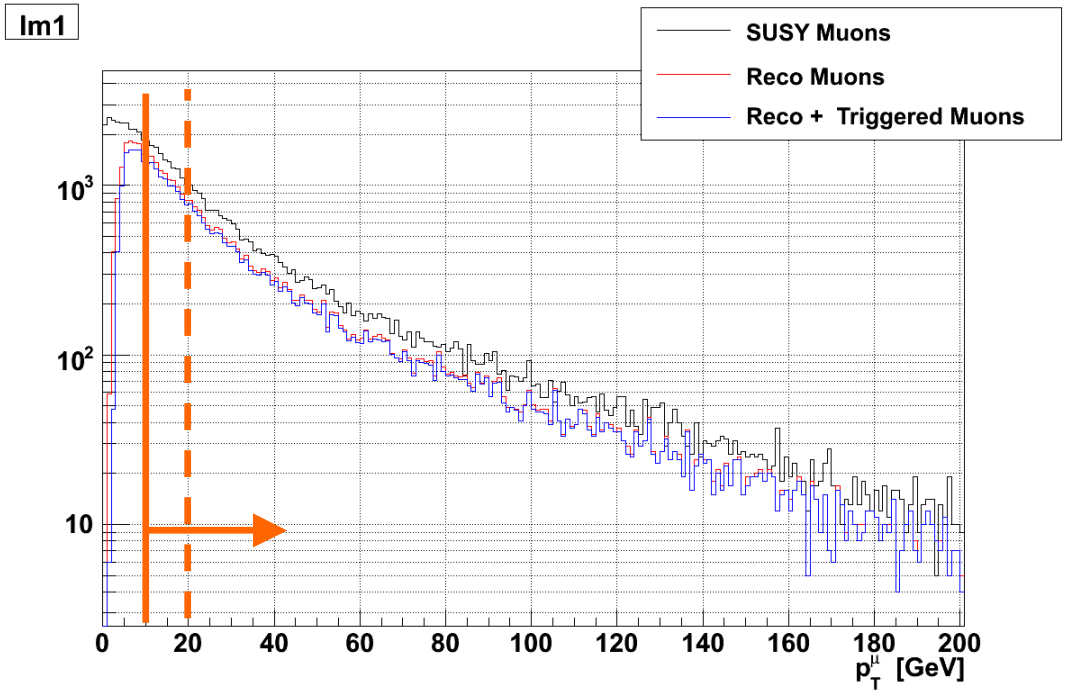
Not : „must be“

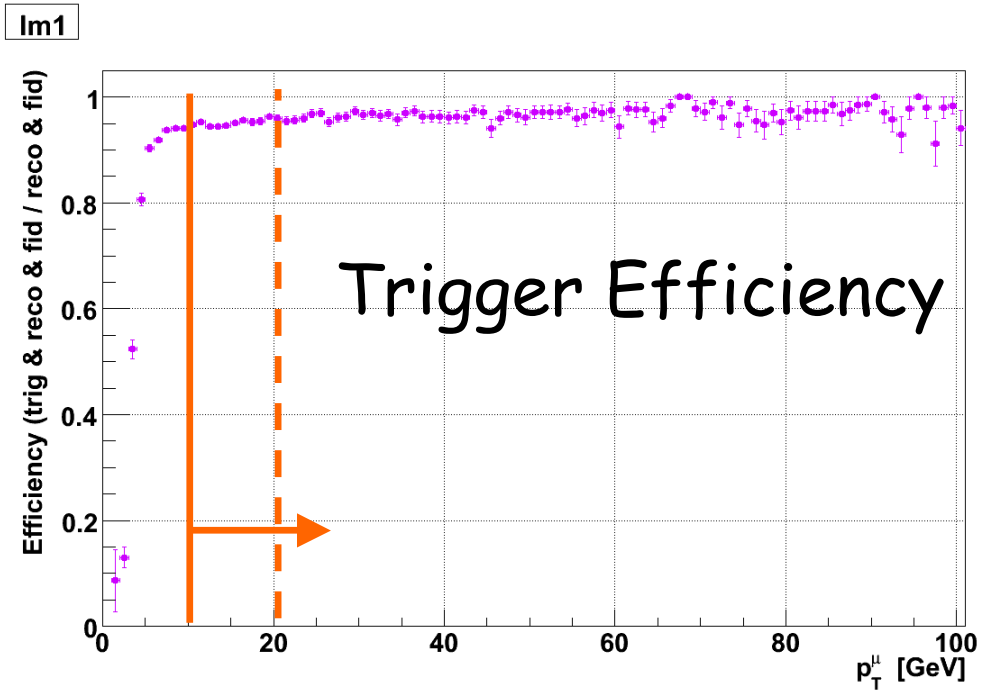
- Below are initial muon selection cuts that can be used as a reference for "Synchronization" of analysis codes.
- These cuts are taken from Finn's talk along with the V+jets baseline cuts.

Quantity	PAT Object and Member Function	Cut	Comment
Mu type	pat::Muon => isGood("GlobalMuonPromptTight")	GlobalMuonPromptTight	OK
p_T	pat::Muon => pt()	≥ 20 GeV	
abs(eta)	pat::Muon => eta()	≤ 2.1	OK
Rel. Isolation	pat::Muon => caloIso(), ecalIso(), trackIso(), pt()	< 0.1	
chi^2/dof	pat::Muon => combinedMuon()->chi2(), combinedMuon() ->ndof()	< 10	OK
abs(d_0)	pat::Muon => track()->d0 *	< 0.2 cm	OK
N hits	pat::Muon => track()->numValHits()	≥ 11	OK
HCal E	pat::Muon => hcalIsoDeposit->candEnergy()	< 6	
ECal E	pat::Muon => ecalIsoDeposit->candEnergy()	< 4	

Question : Is this MuonID really applicable to RA4/MU ?

Muon pT Threshold





Most of the signal efficiency lost due to pT > 20 GeV
→ Go to pT > 10 GeV
- Trigger OK
- Reco (seems to be) OK
- Backgrounds → to be checked (reduce via MET & angular cuts,...)

Comparison

ACIIIA :	
RelIso	./.
TrkIso	< 6 GeV
ECalIso	< 6 GeV
HCalIso	< 6 GeV

RA4 :	
RelIso	< 0.1
TrkIso	./.
ECalIso	< 4 GeV
HCalIso	< 6 GeV

$$\text{RelIso} = \frac{\text{SumIso}}{p_T} = \frac{\text{TrkIso} + \text{ECalIso} + \text{HCalIso}}{p_T}$$

Usual argument : „RelIso better at high pt, say 200 GeV"

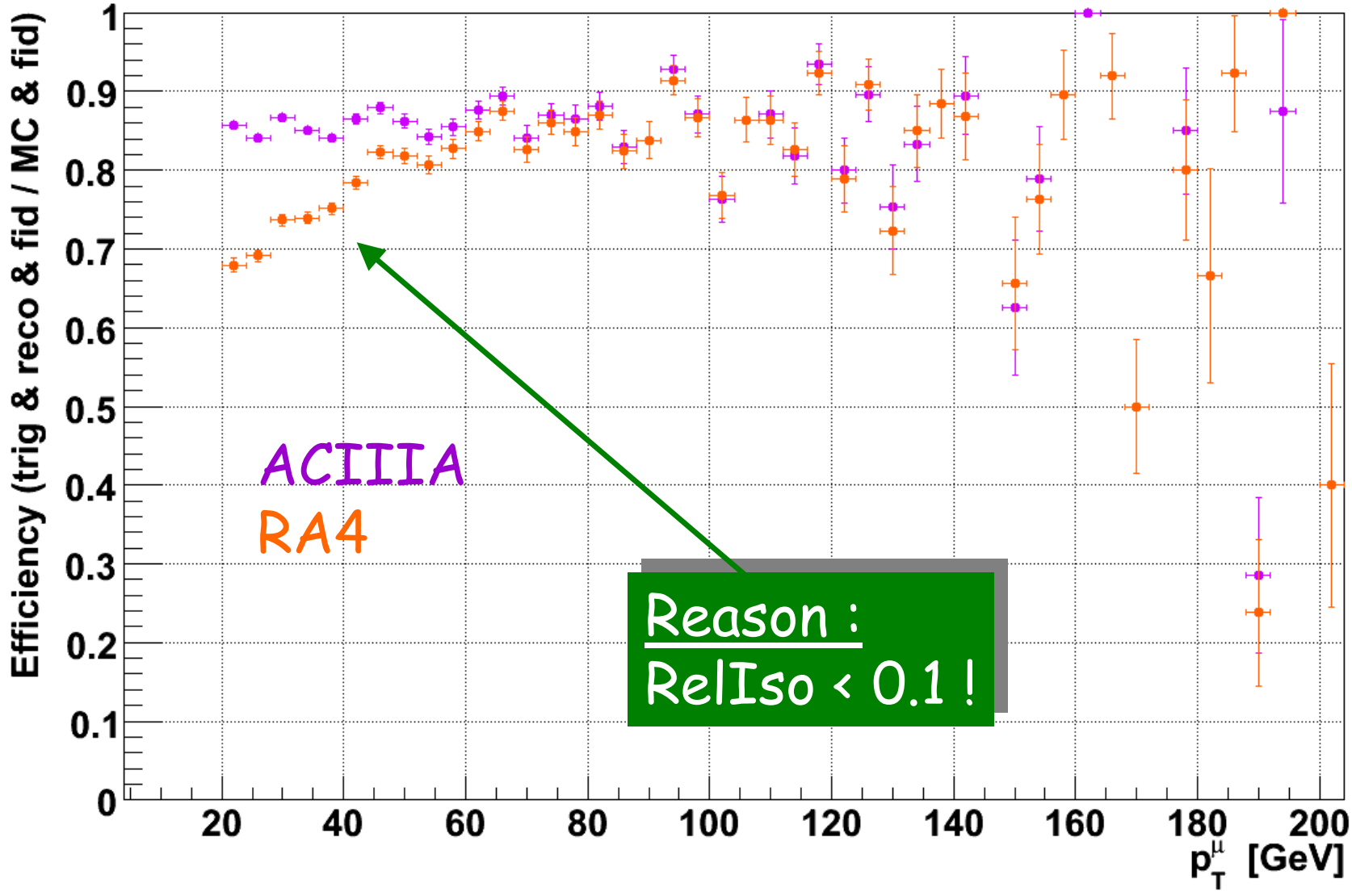
RelIso < 0.1 ➔ TrkIso + ECalIso + HCalIso < 20 GeV

Huh ?

BUT : ECalIso + HCalIso < 4 GeV + 6 GeV < 10 GeV

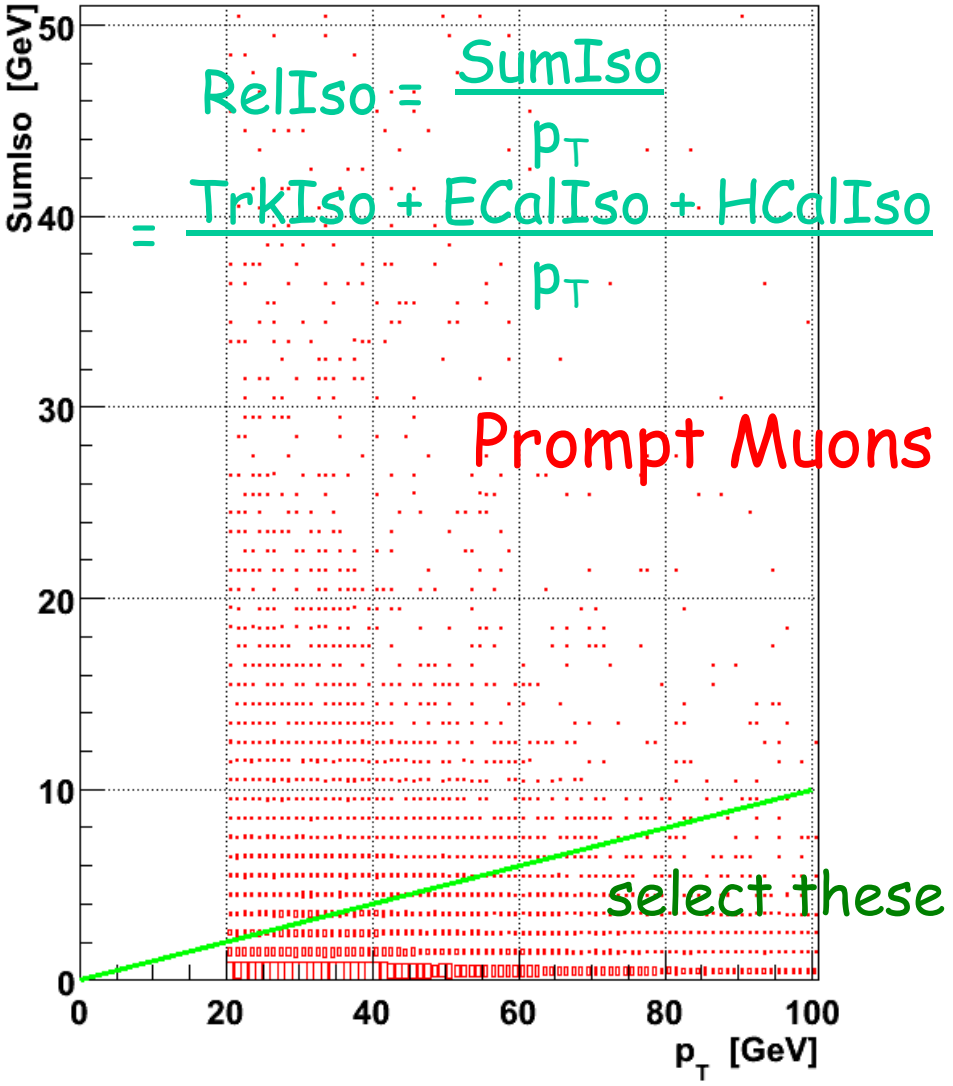
Clean W + Jets Muon (I) - Efficiency

wj



Clean W + Jets Muon (II) - Comparison

wj : Before Isolation Cuts

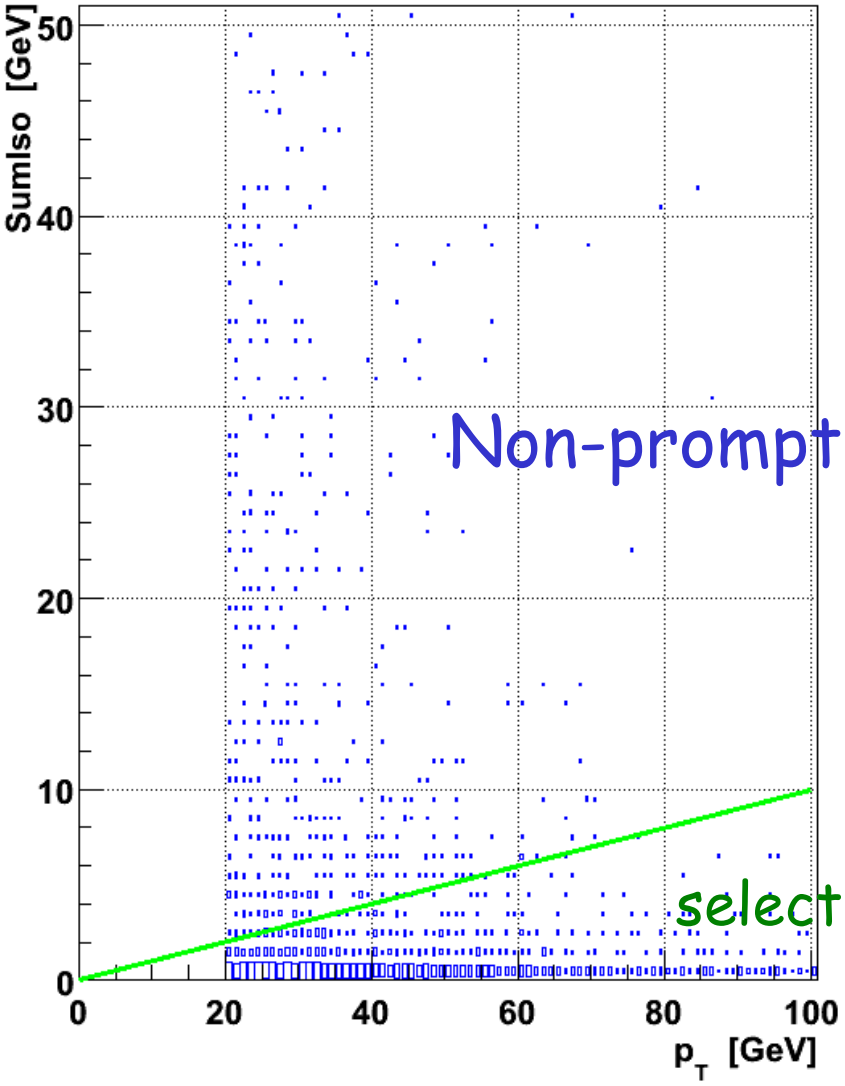


$$\text{RelIso} = \frac{\text{SumIso}}{p_T} = \frac{\text{TrkIso} + \text{ECalIso} + \text{HCalIso}}{p_T}$$

Prompt Muons

select these

wj : Before Isolation Cuts

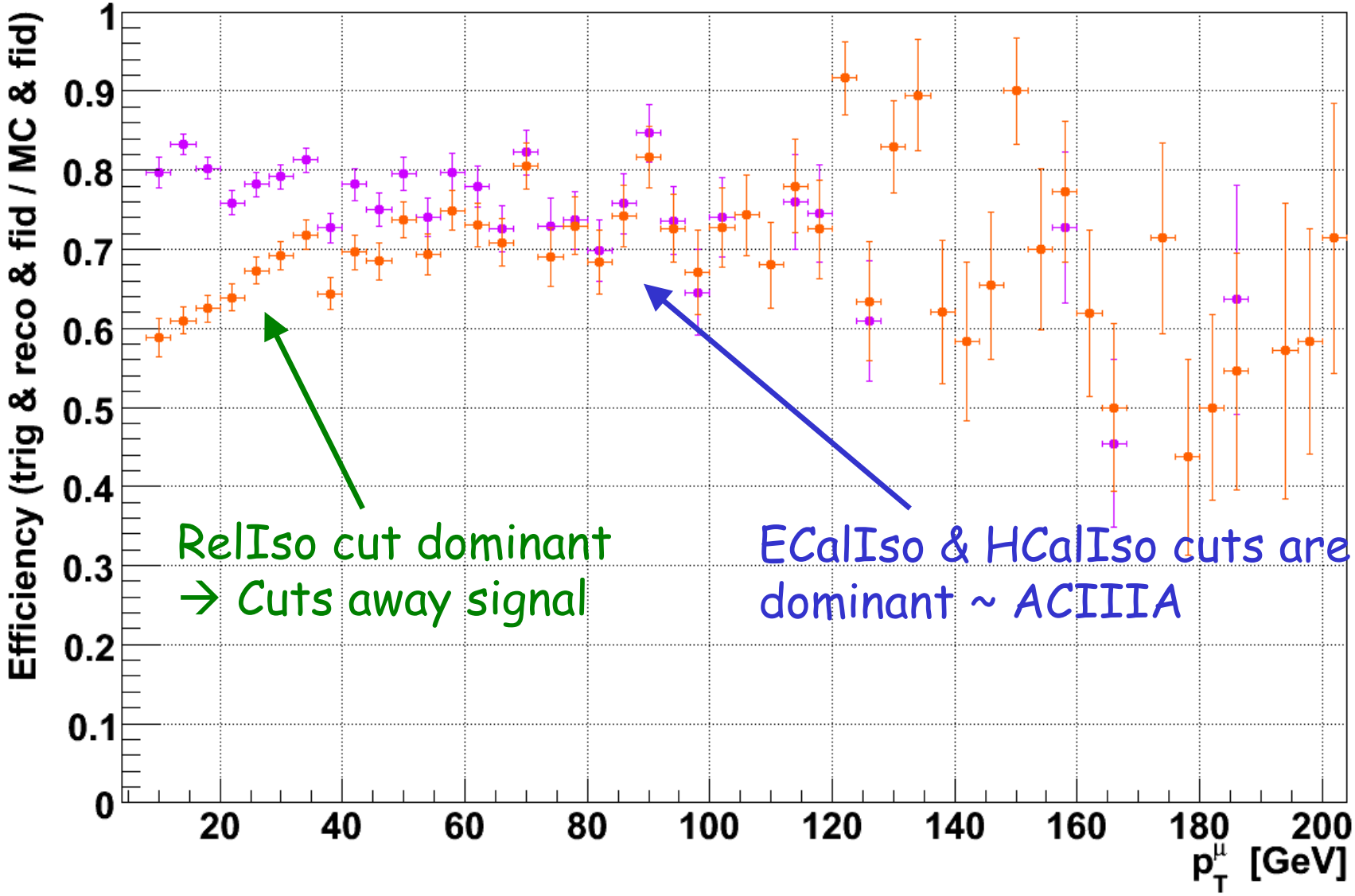


Non-prompt Muons

select these

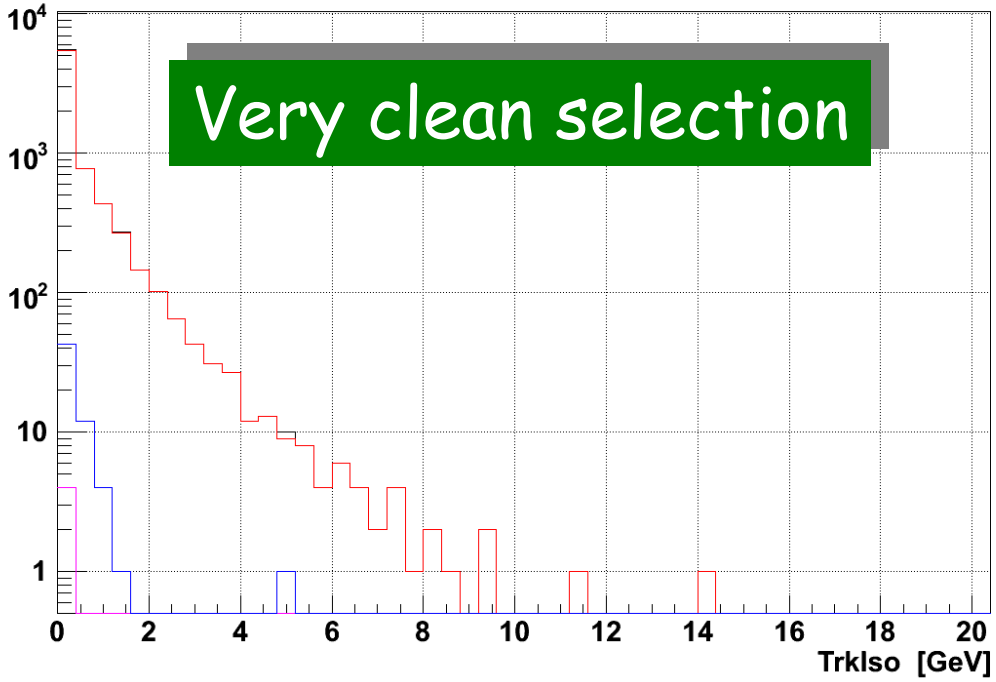
LM0 (I) - Efficiency

lm0



LM0 (II) - Comparison

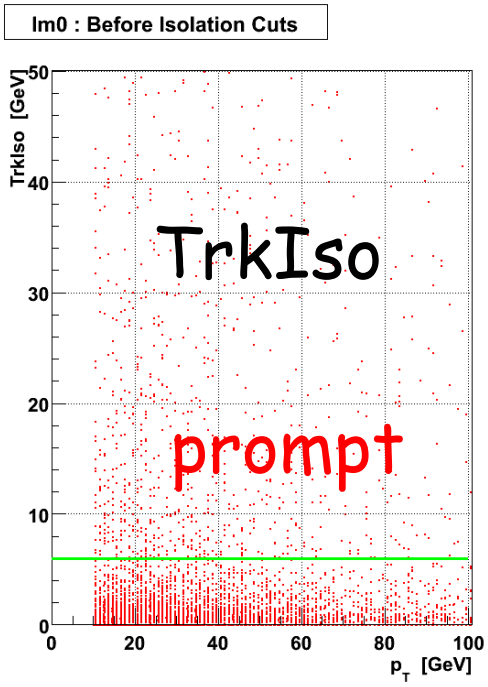
lm0 : After RA4 Rel. Isolation Cut

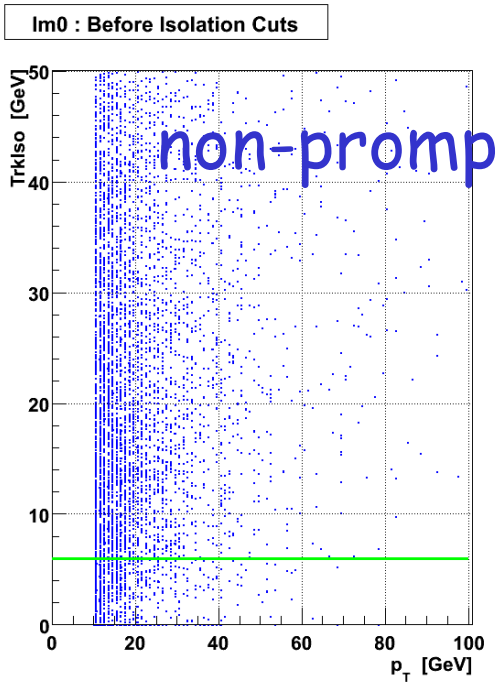


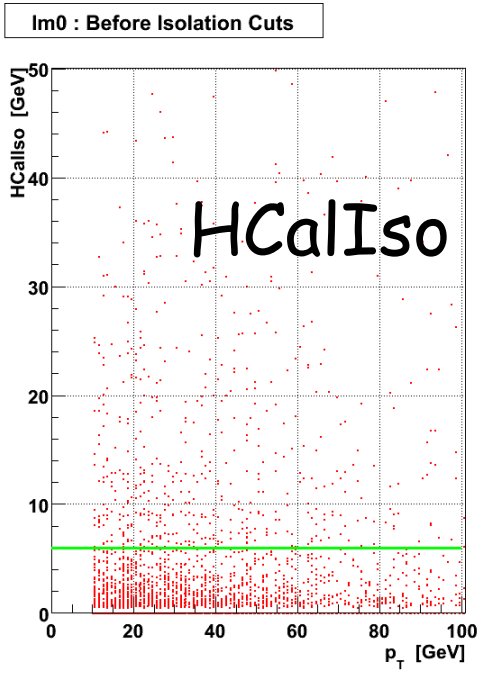
lm0 : After All Aachen Isolation Cuts

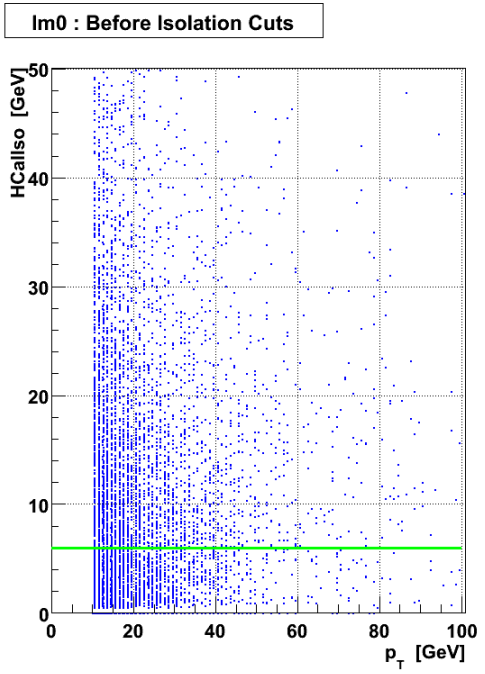
	AC (%)	RA4 (%)
Purity	LM1 : 98.3 ± 0.1 Wj : 94.1 ± 0.1	LM1 : 99.4 ± 0.1 Wj : 94.2 ± 0.1
Fakerate	LM1 : 1.7 ± 0.1 Wj : 5.8 ± 0.1	LM1 : 0.6 ± 0.1 Wj : 5.9 ± 0.1

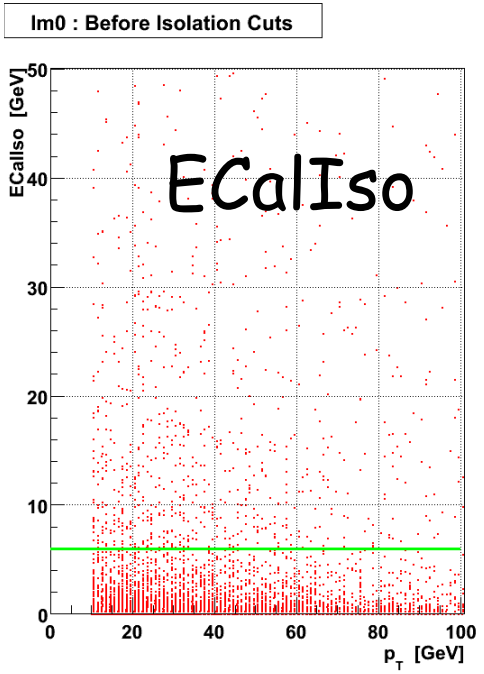
LM0 (III) - Comparison

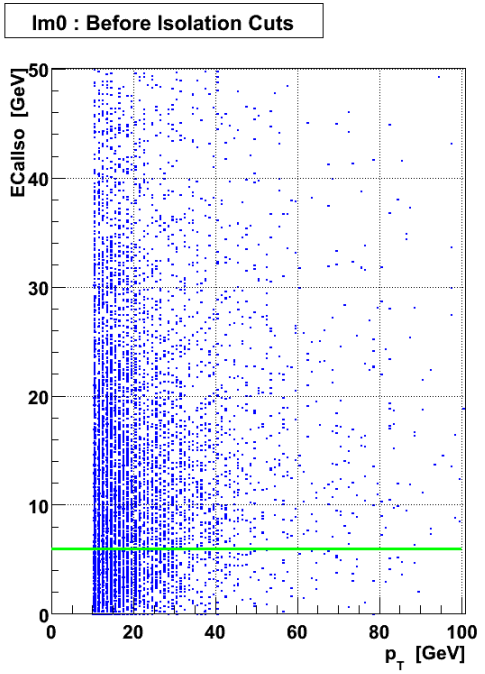








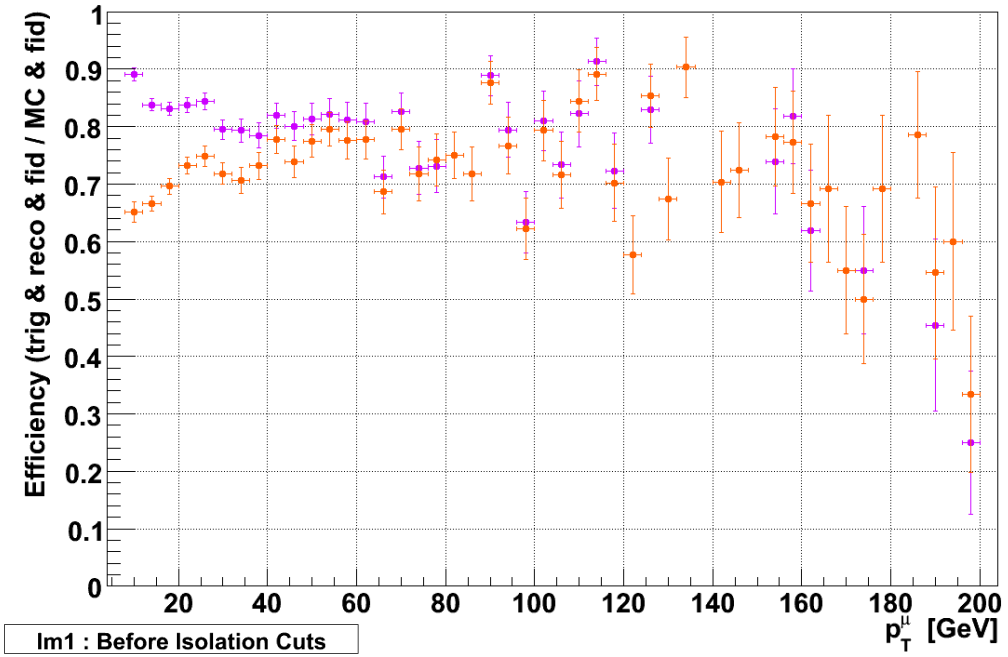




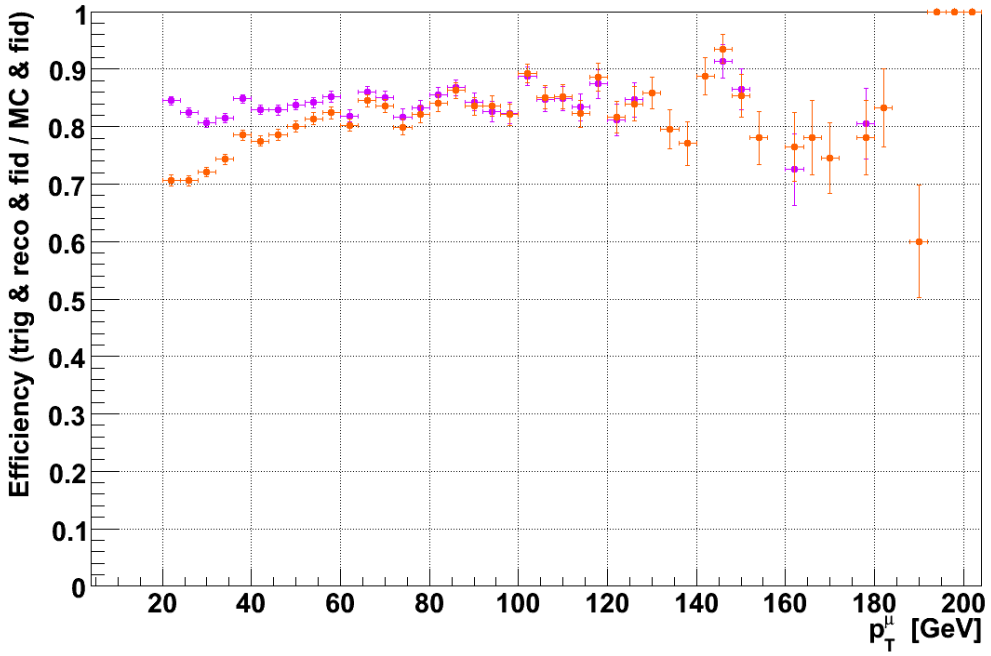
ACIIIA :
no p_T dependency

Other Samples

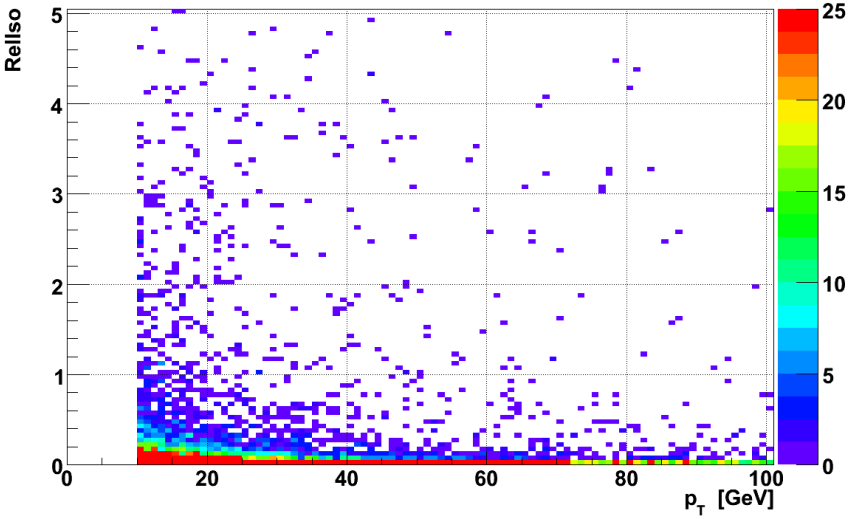
lm1



ttbar



lm1 : Before Isolation Cuts



Other signal & background samples exhibit the same behavior

Summary

RA4 Cuts are **not optimal** for RA4/MU analysis

→ efficiency not flat, small where signal sits

→ difficult to invert cut, since many real muons (small pt) have rather high values of RelIso

→ additional ECalIso/HCalIso cuts destroy the advantage of RelIso at high pt

ACIIIA Cuts have same efficiency & fake rate

→ flat in pt, significantly higher where signal sits

→ allows individual treatment of 3 types of isolation

→ no problems with QCD estimation/cut inversion