Kinematical fit of $h \to bb$ with TKinFitter

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Intro

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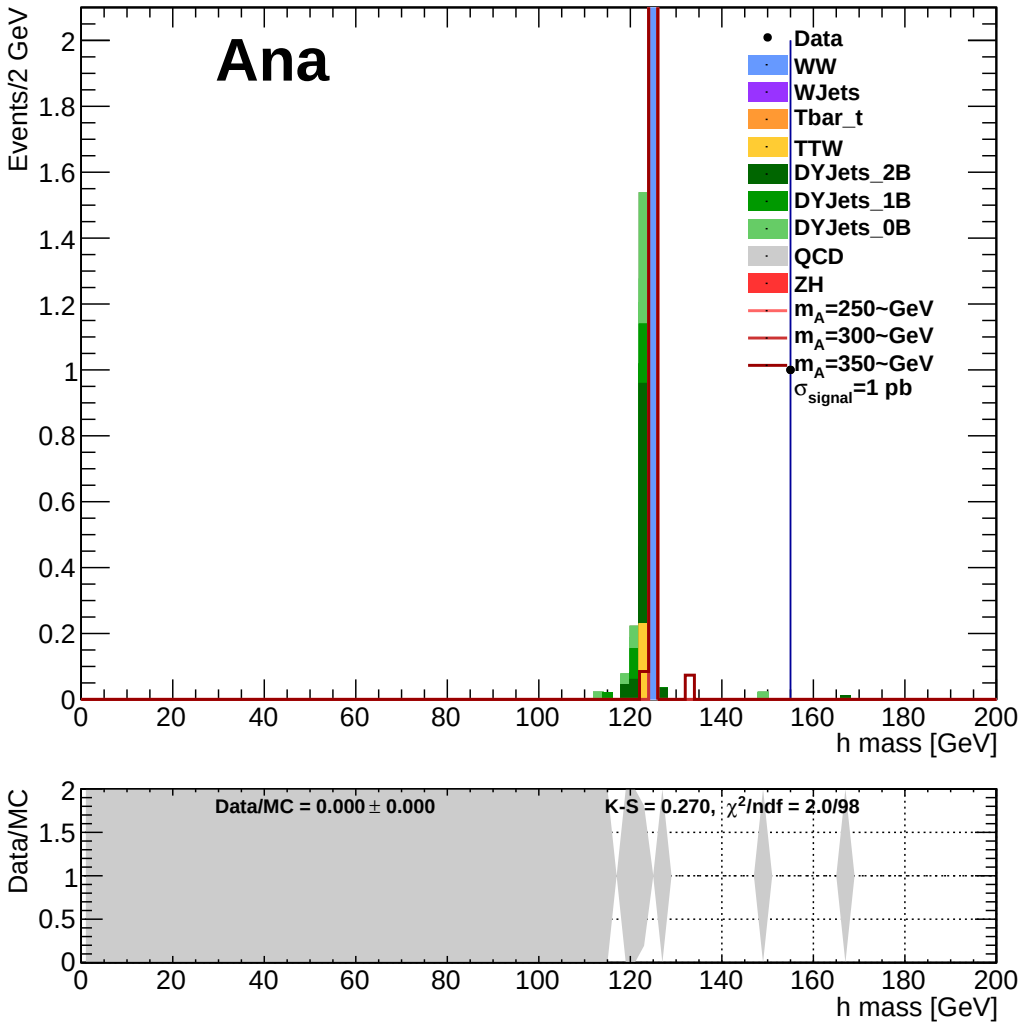
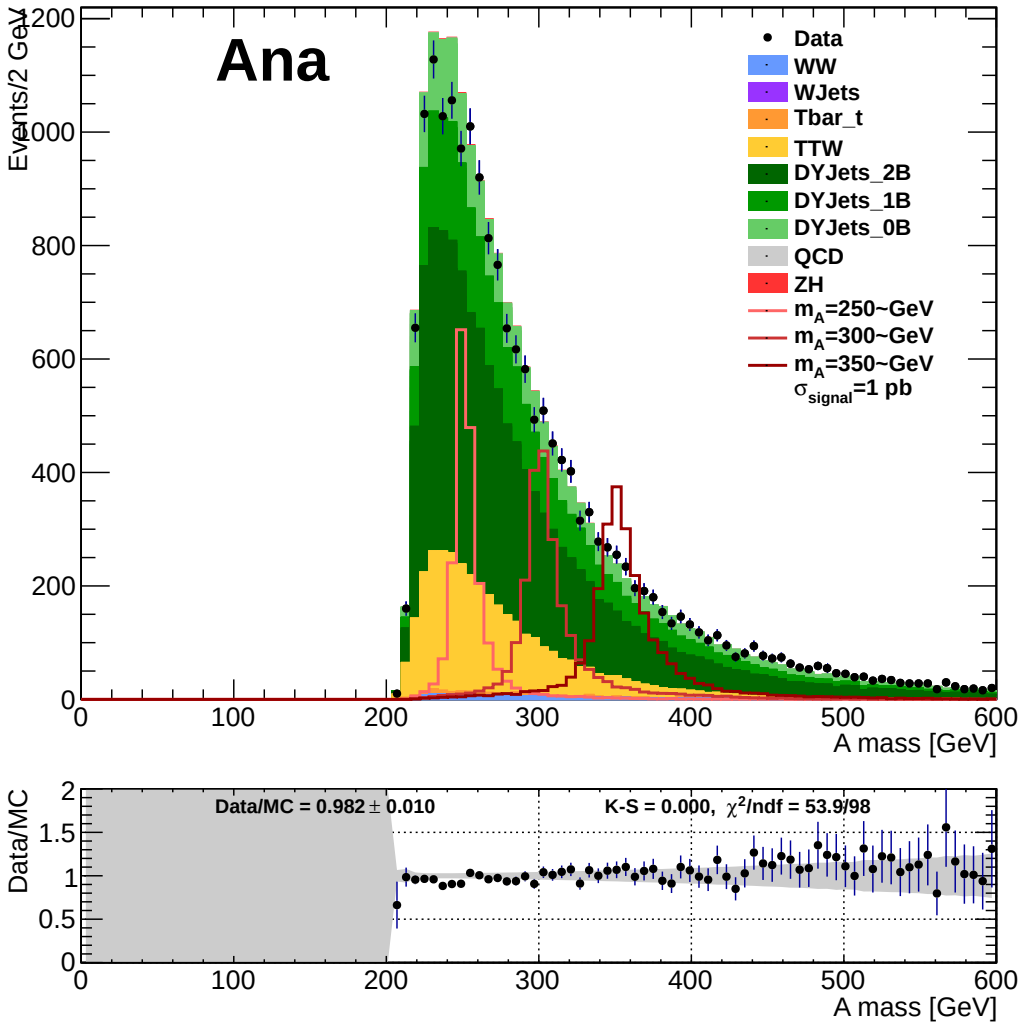
- Use `TKinFitter` tool to do a kinematical fit of M_{bb} to $M_h = 125.7\ GeV$;
- Make use of lagrangian multipliers to apply the constraint;
- Allow a zero-width mass constraint: not easy with previous χ^2 constraint;
- Let vary p_T, ϕ, and η;
- Some problem with χ^2: too small;
- look also at p_T, ϕ, and η pulls.

h mass

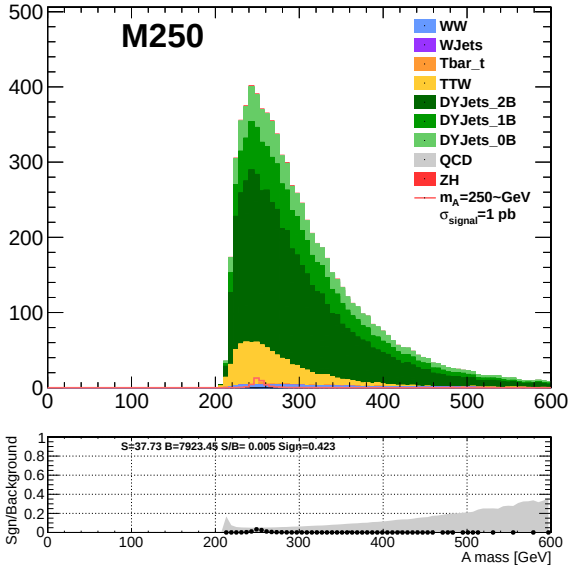

Ana
Data
WW
WJets
Tbar_t
TTW
DYJets_2B
DYJets_1B
DYJets_0B
QCD
ZH
m_A=250~GeV
m_A=300~GeV
m_A=350~GeV
σ_signal=1 pb
Events/2 GeV
h mass [GeV]
Data/MC = 0.000 ± 0.000
K-S = 0.270, χ²/ndf = 2.0/98
Data/MC
h mass [GeV]

A mass


Ana
Data
WW
WJets
Tbar_t
TTW
DYJets_2B
DYJets_1B
DYJets_0B
QCD
ZH
m_A=250~GeV
m_A=300~GeV
m_A=350~GeV
σ_signal=1 pb
Events/2 GeV
A mass [GeV]
Data/MC = 0.982 ± 0.010
K-S = 0.000, χ²/ndf = 53.9/98
Data/MC

A mass

Comparison of results of TKinFitter and χ^2 minimization



TKinFitter

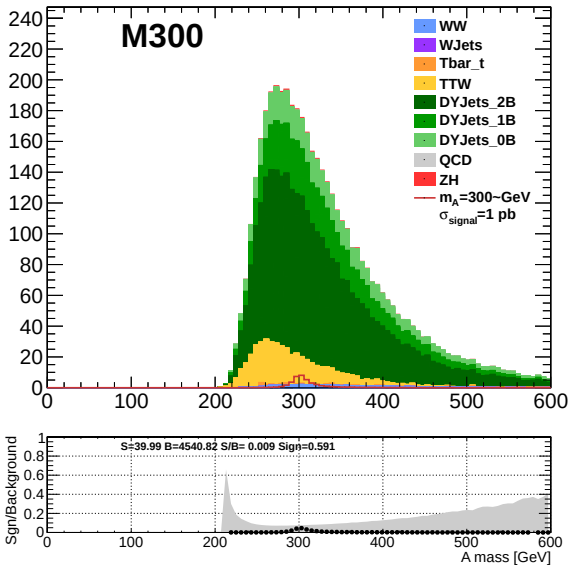
$M_A = 251.78 \pm 0.06\ GeV$

$\sigma_{M_A} = 7.29 \pm 0.06\ GeV$

χ^2

$M_A = 250.52 \pm 0.04\ GeV$

$\sigma_{M_A} = 5.47 \pm 0.04\ GeV$



TKinFitter

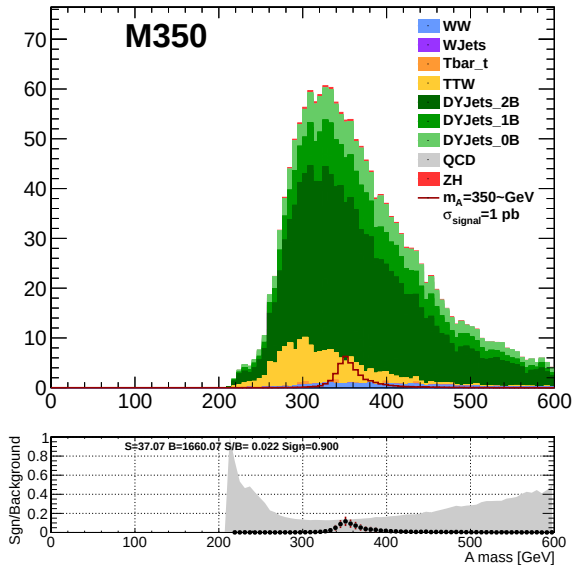
$M_A = 303.38 \pm 0.10\ GeV$

$\sigma_{M_A} = 12.68 \pm 0.12\ GeV$

χ^2

$M_A = 300.56 \pm 0.07\ GeV$

$\sigma_{M_A} = 8.94 \pm 0.08\ GeV$



TKinFitter

$M_A = 355.30 \pm 0.14\ GeV$

$\sigma_{M_A} = 16.60 \pm 0.16\ GeV$

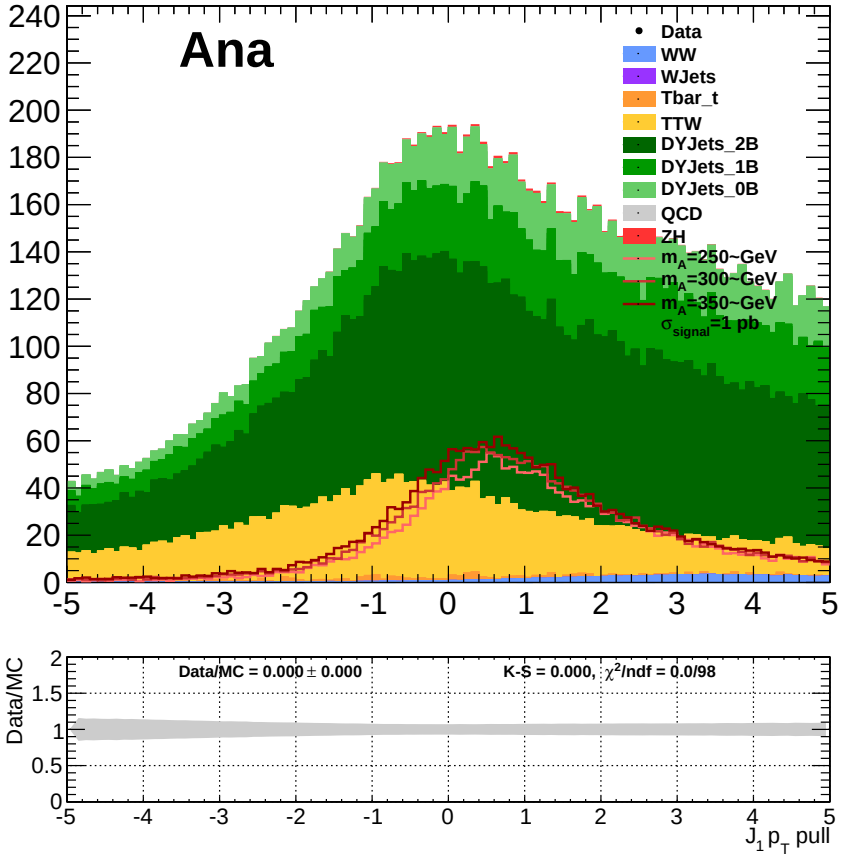
χ^2

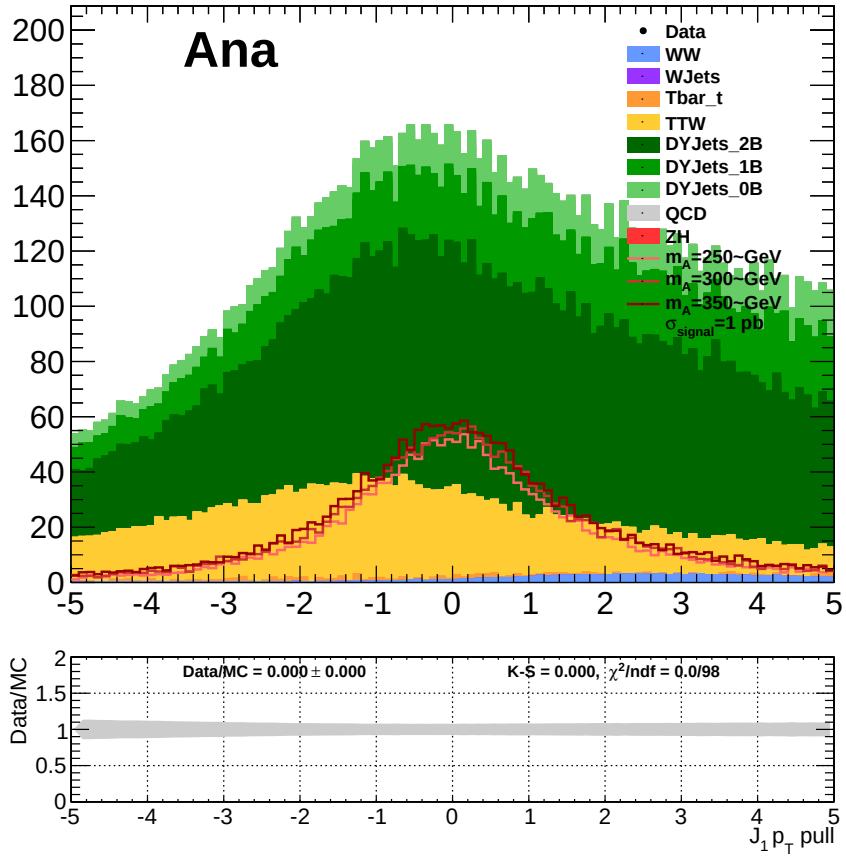
$M_A = 351.36 \pm 0.10\ GeV$

$\sigma_{M_A} = 11.78 \pm 0.10\ GeV$

Pull Pt (Jet1)

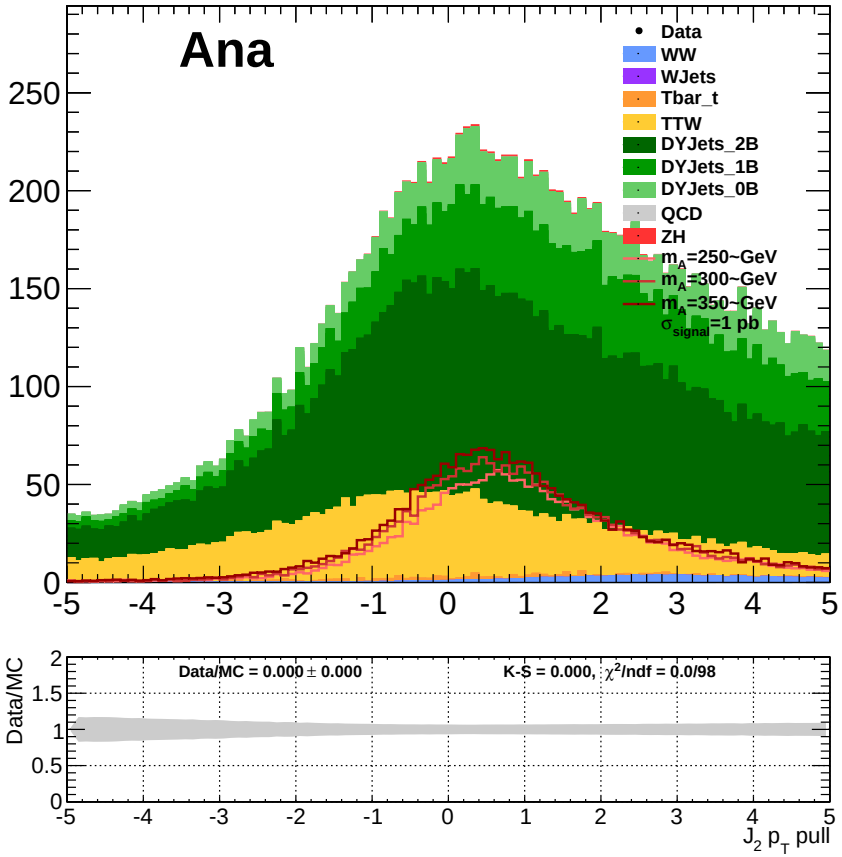
vs GenJet (left), vs GenParton (right)

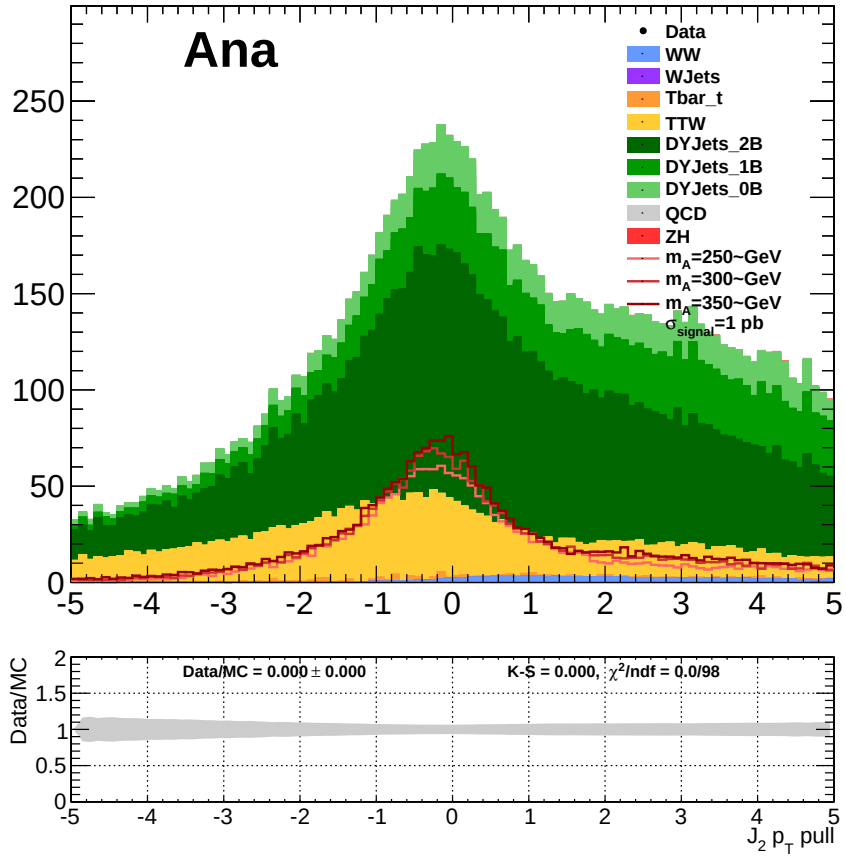




Pull Pt (Jet2)

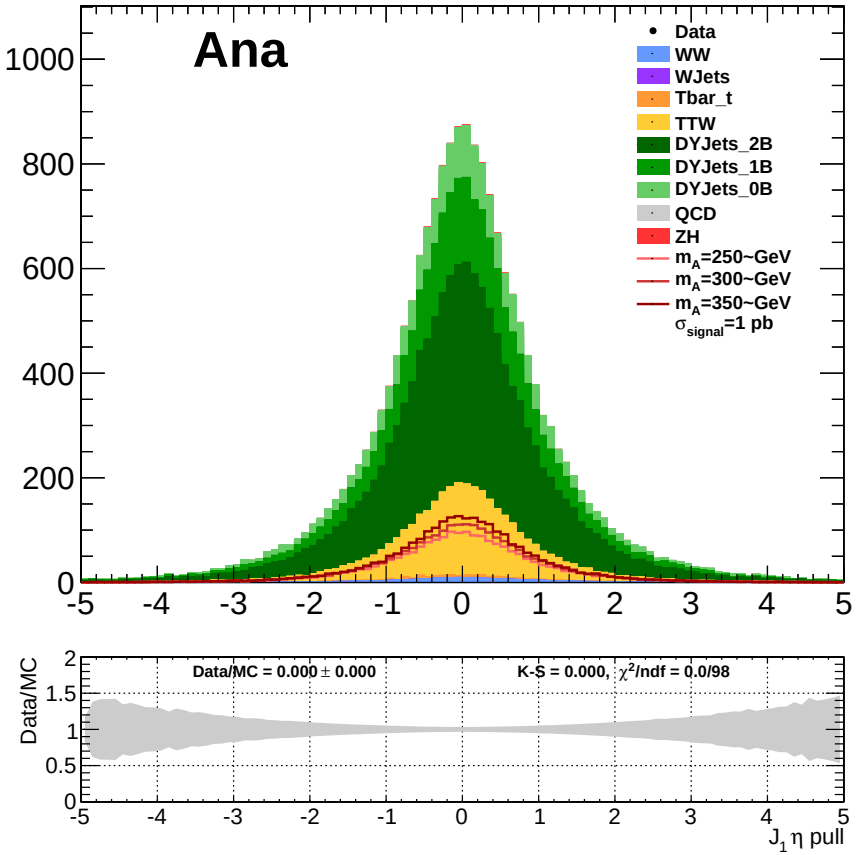
vs GenJet (left), vs GenParton (right)

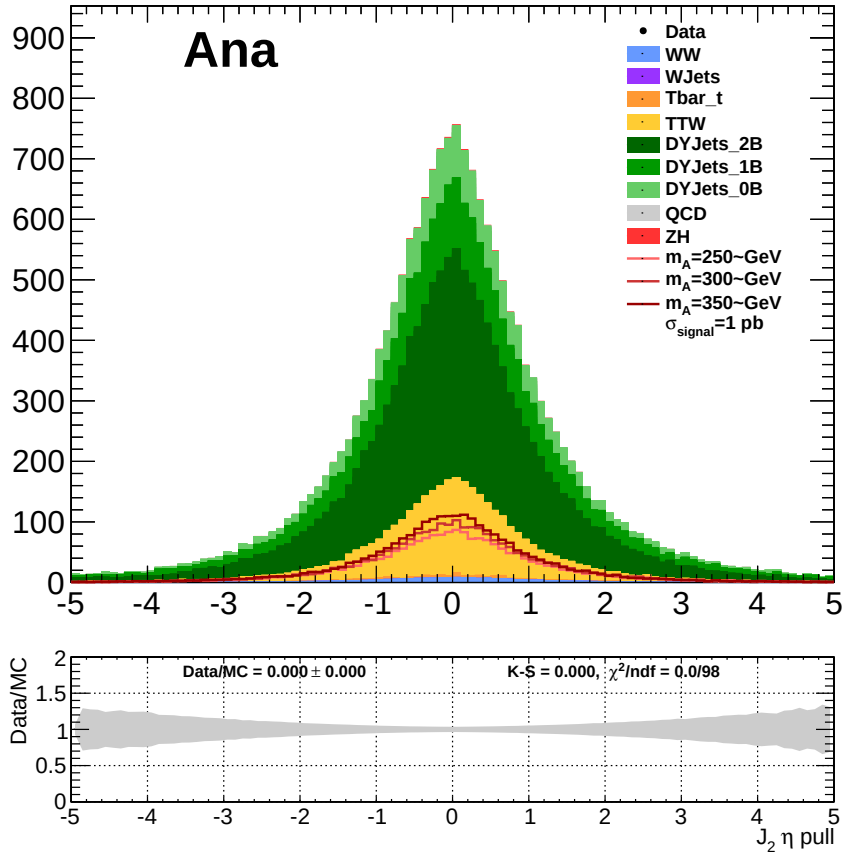




Pull Eta

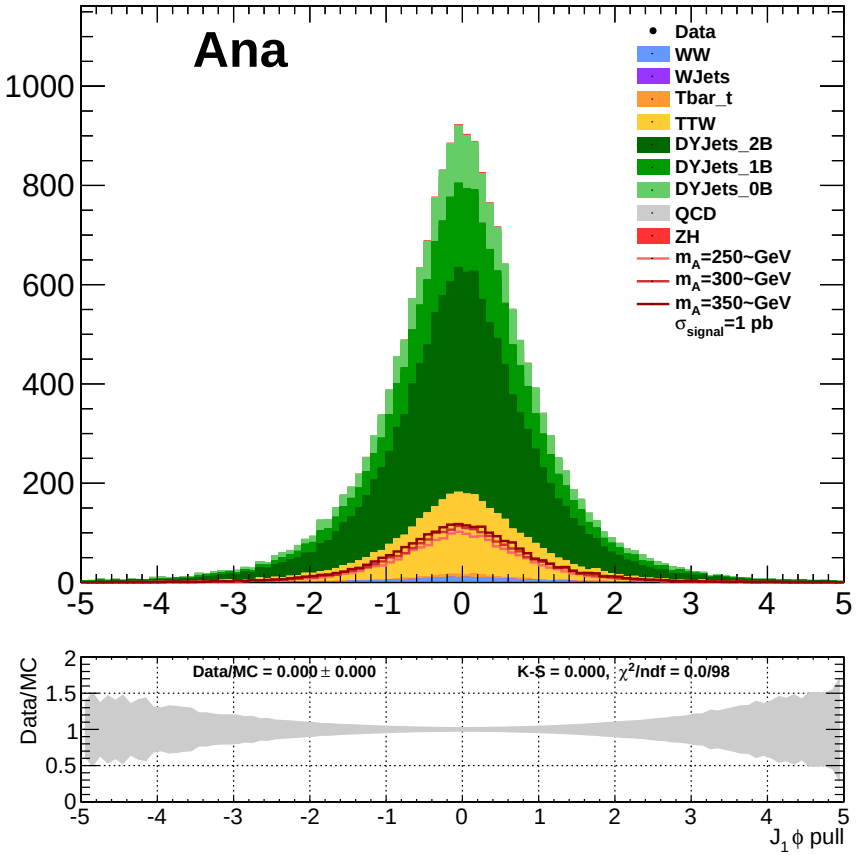
Jet1 (left), Jet2 (right)

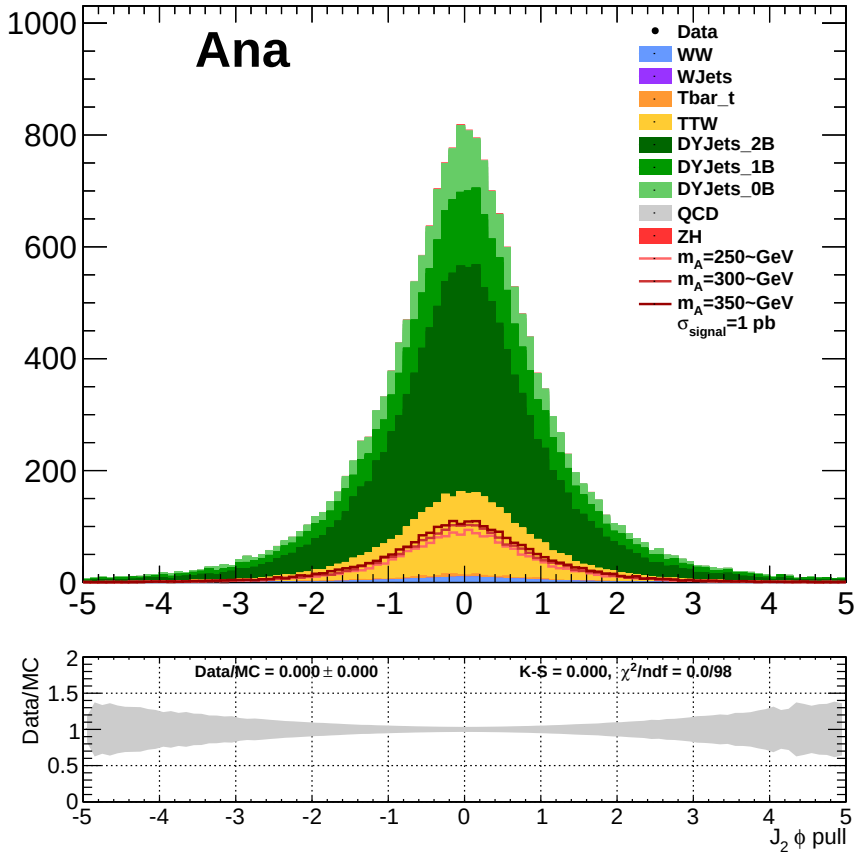




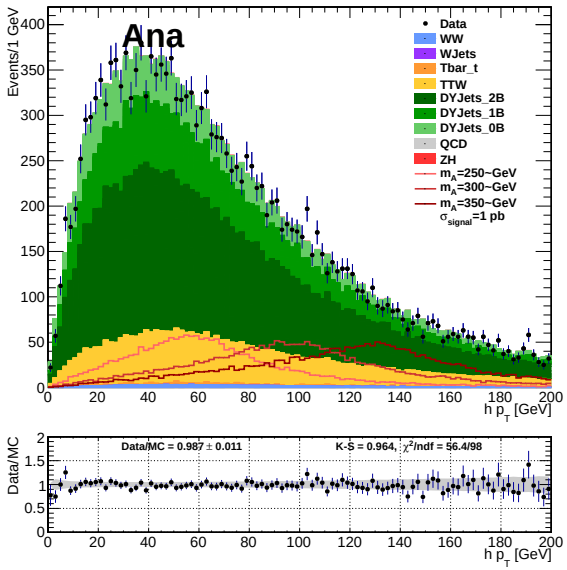
Pull phi

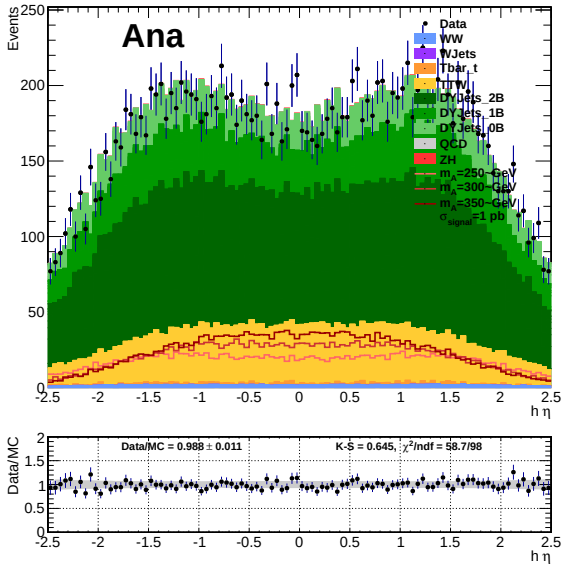
Jet1 (left), Jet2 (right)

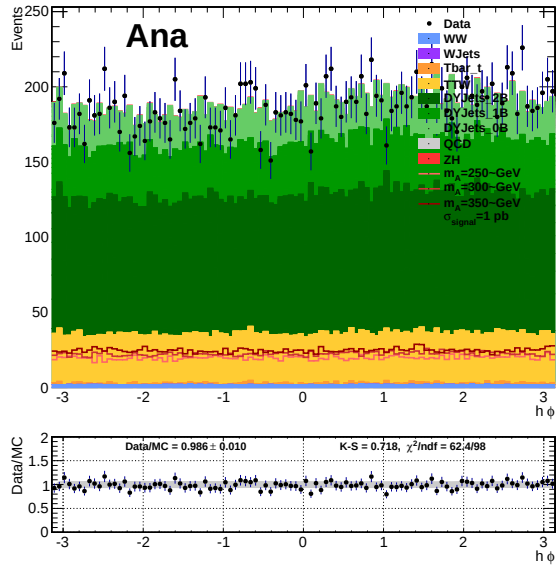




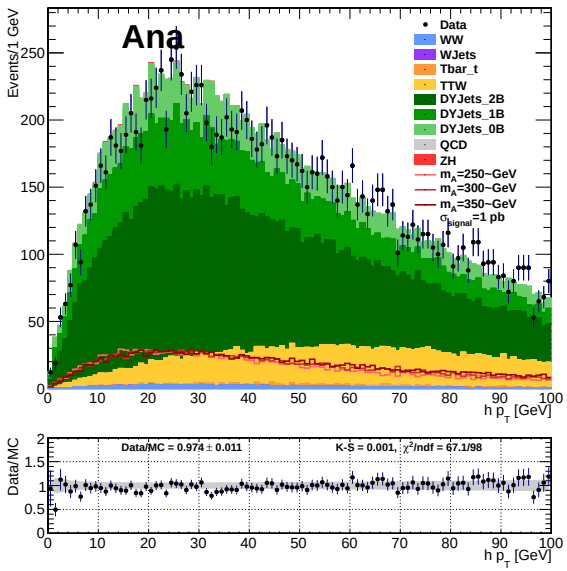
h p_T, η, ϕ after TKinFitter

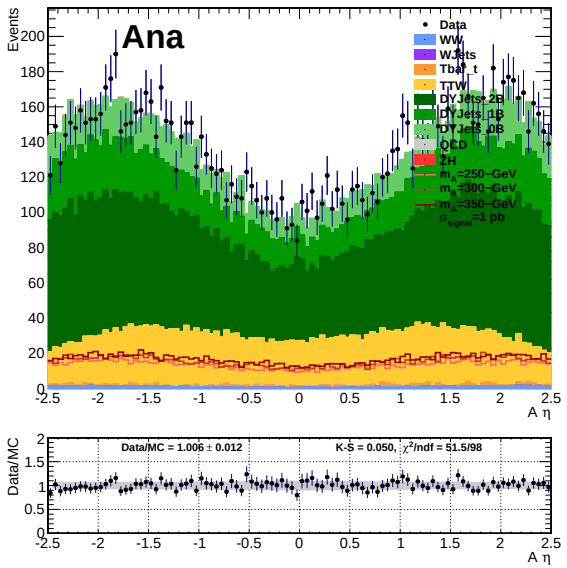


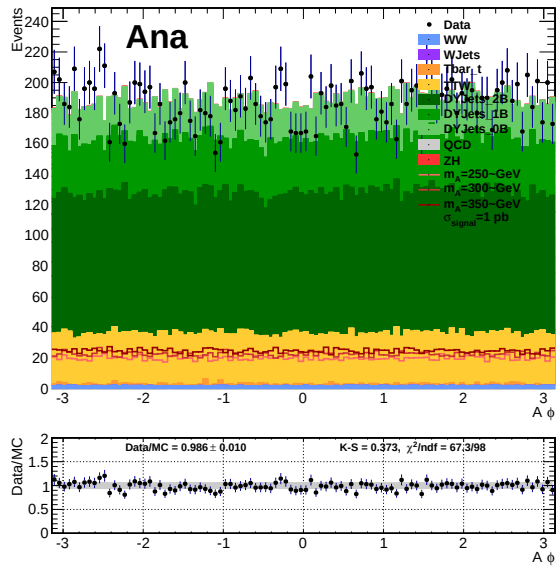




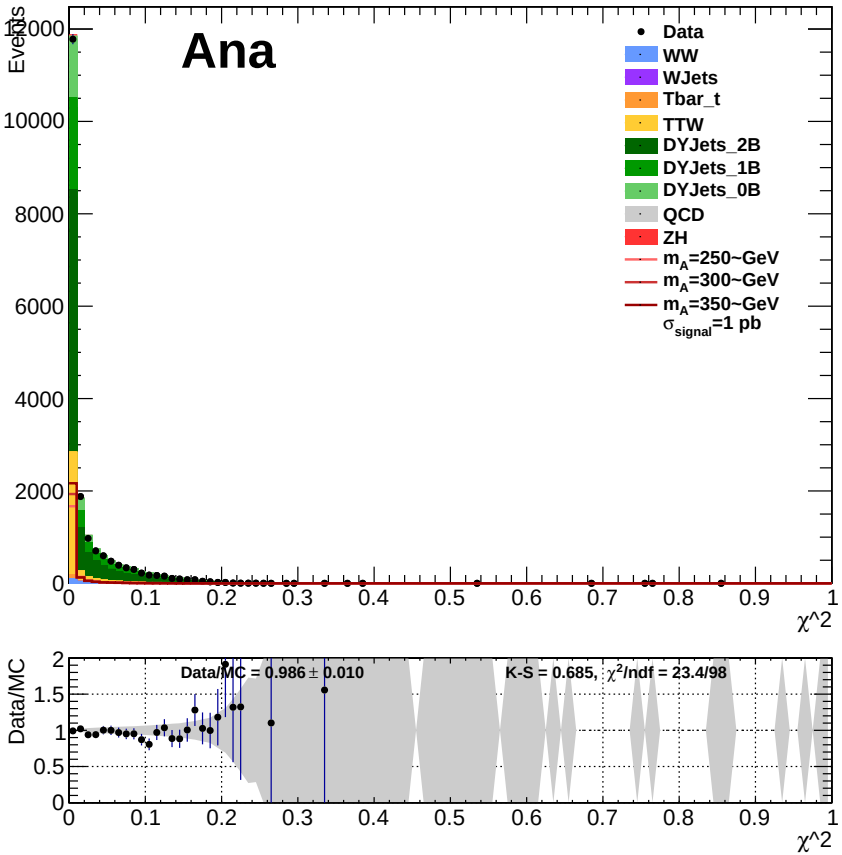
A p_T, η, ϕ after TKinFitter

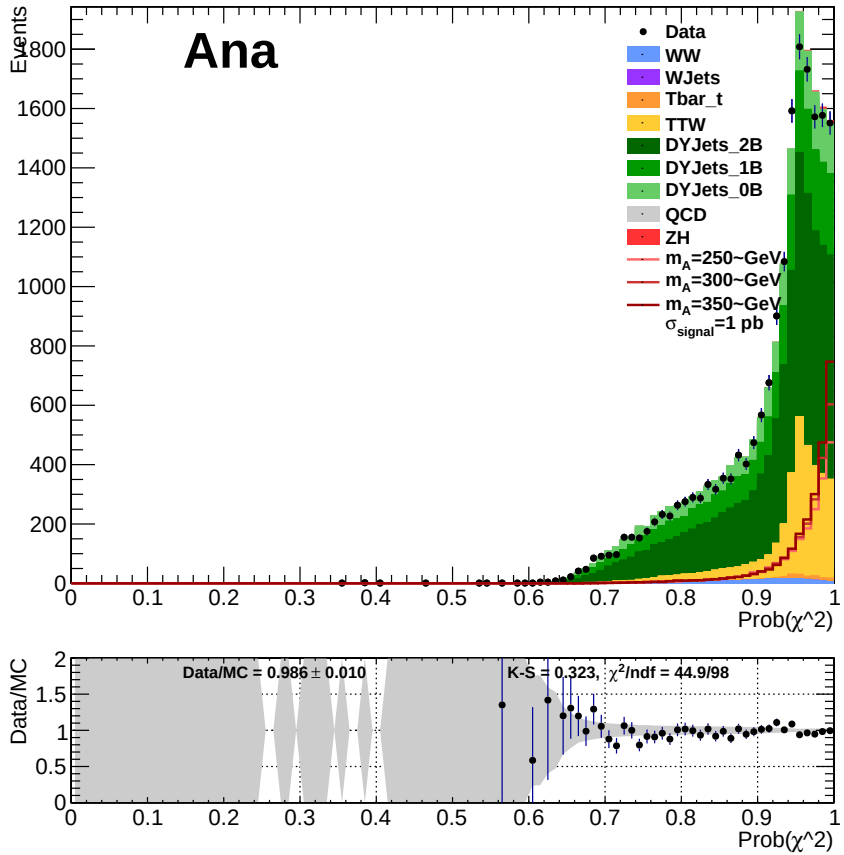




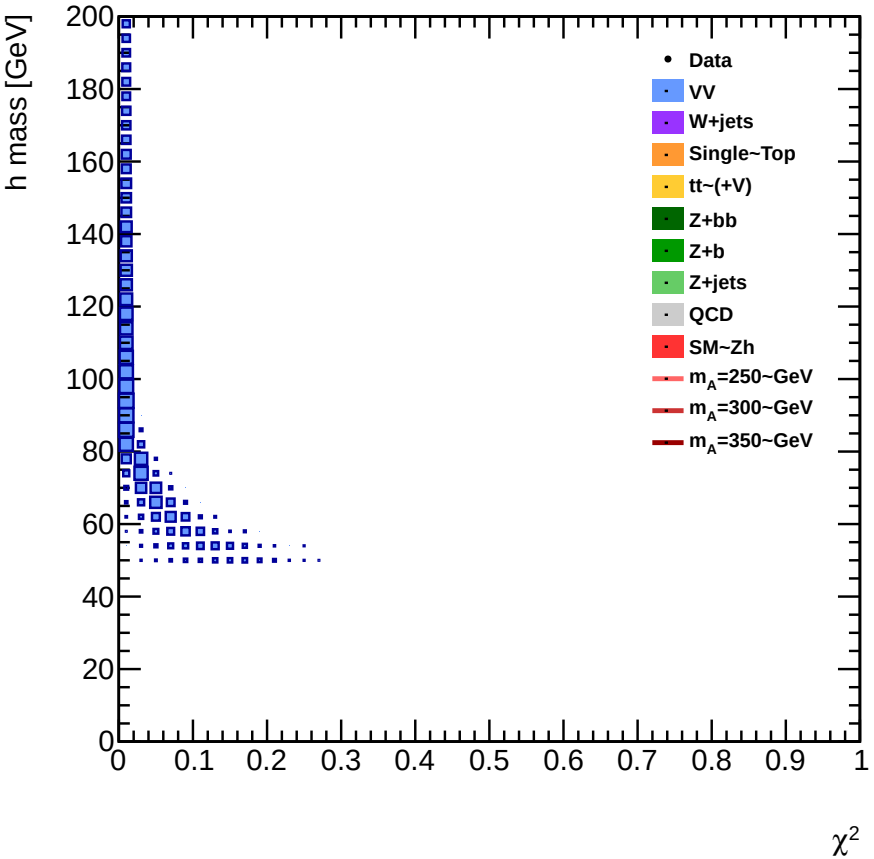


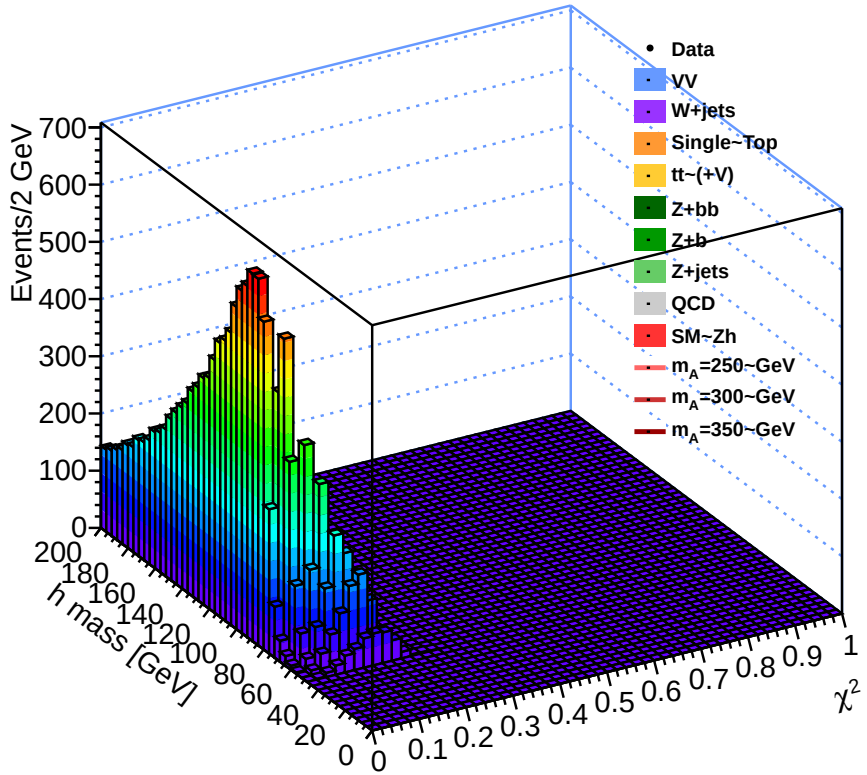
χ^2 and $P(\chi^2)$



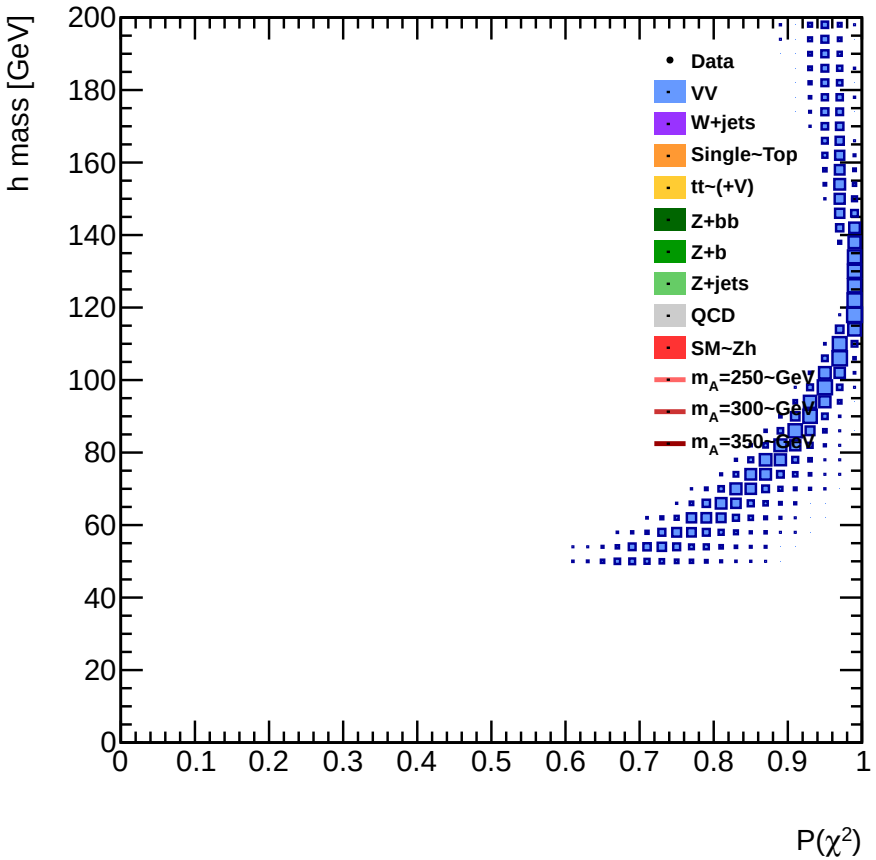


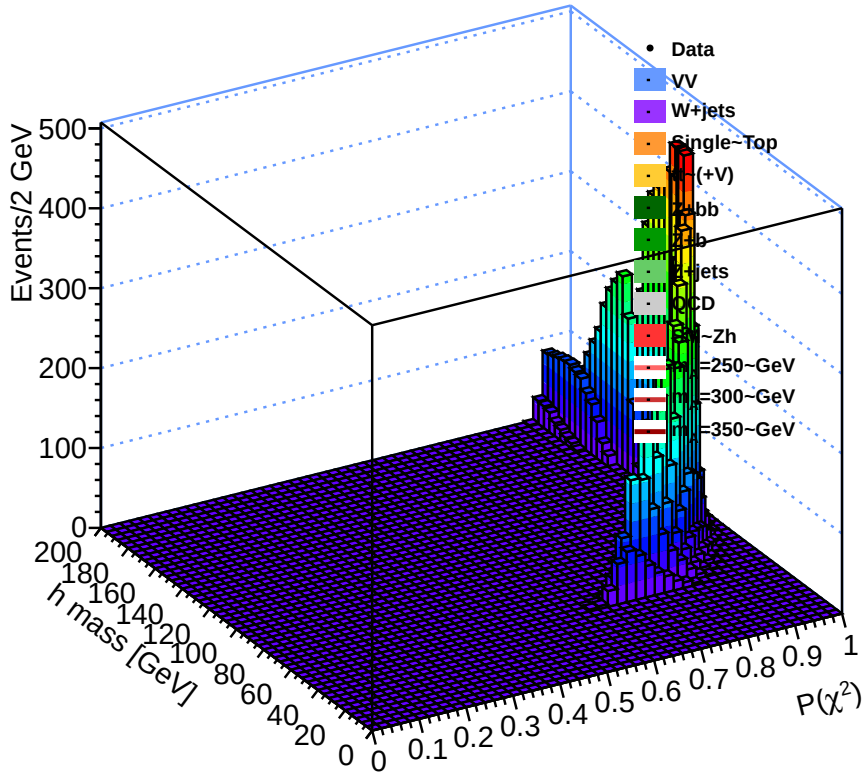
hMass vs χ^2





hMass vs $P(\chi^2)$





Addendum

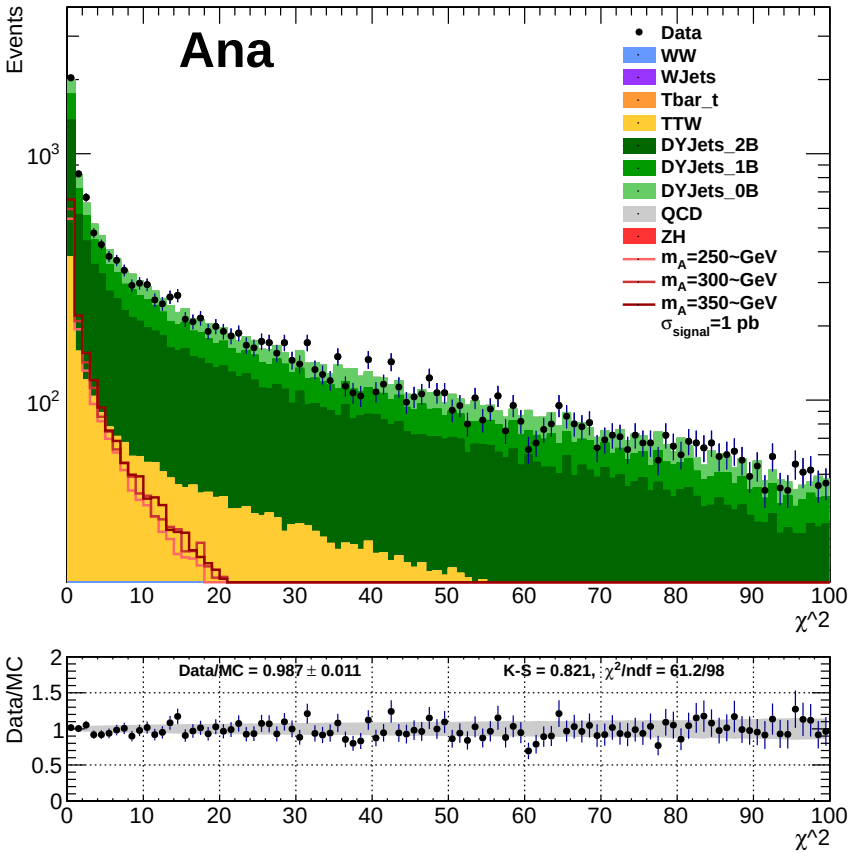
I'm computing by hand the χ^2 between the unconstrained and constrained Jets 4 momenta

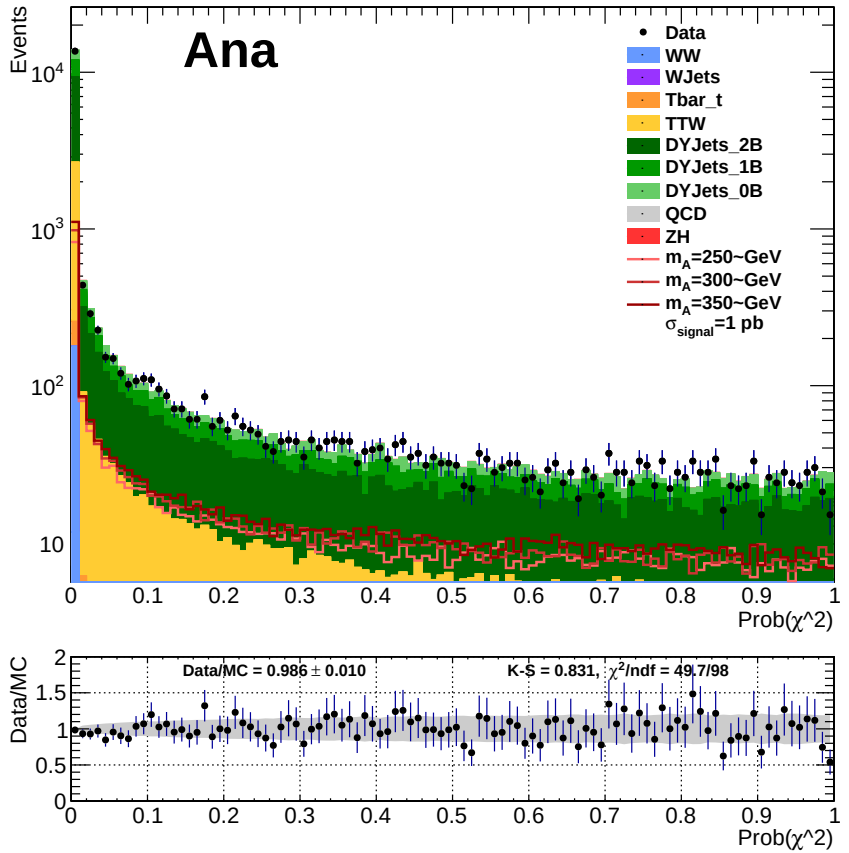
$$\chi^2 = \sum_{\substack{x=p_T,\eta,\phi \\ i=jet_1,jet_2}} \left(\frac{x_i^{\text{w/o KinFit}} - x_i^{\text{w/ KinFit}}}{\sigma_{x_i}} \right)^2$$

My understanding is that `TKinFitter` return the χ^2 between the actual and previous iteration of the minimization loop, which is small by definition, since otherwise other iteration would have take place.

χ^2 and $P(\chi^2)$

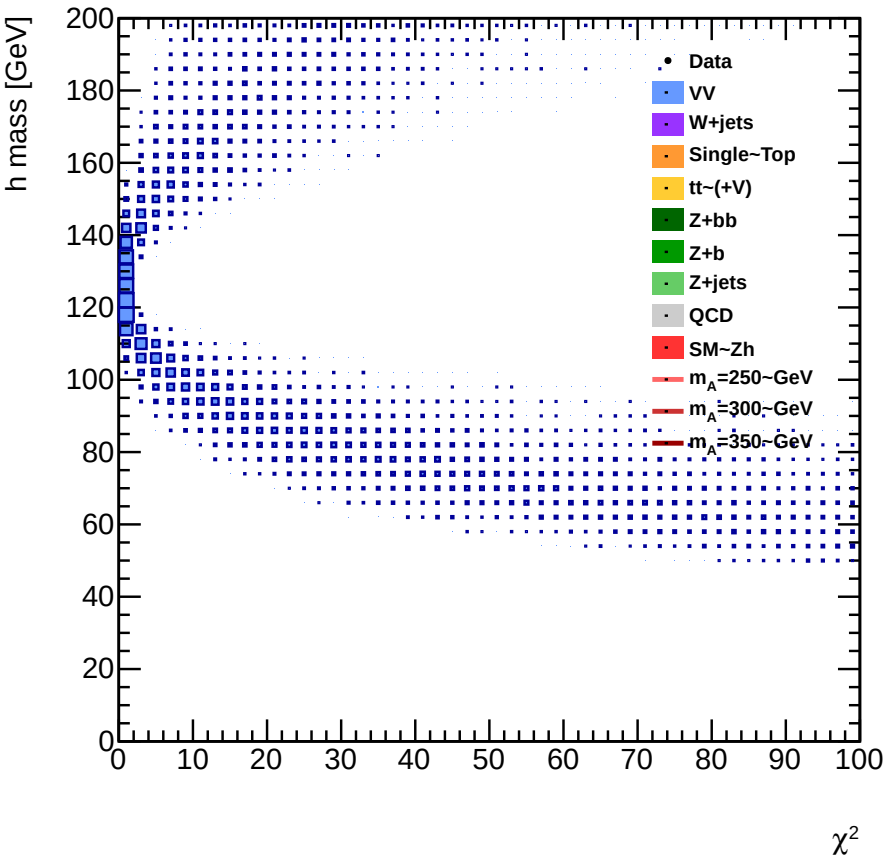
x-scale: [0,100] (was [0-1] in slide 12)

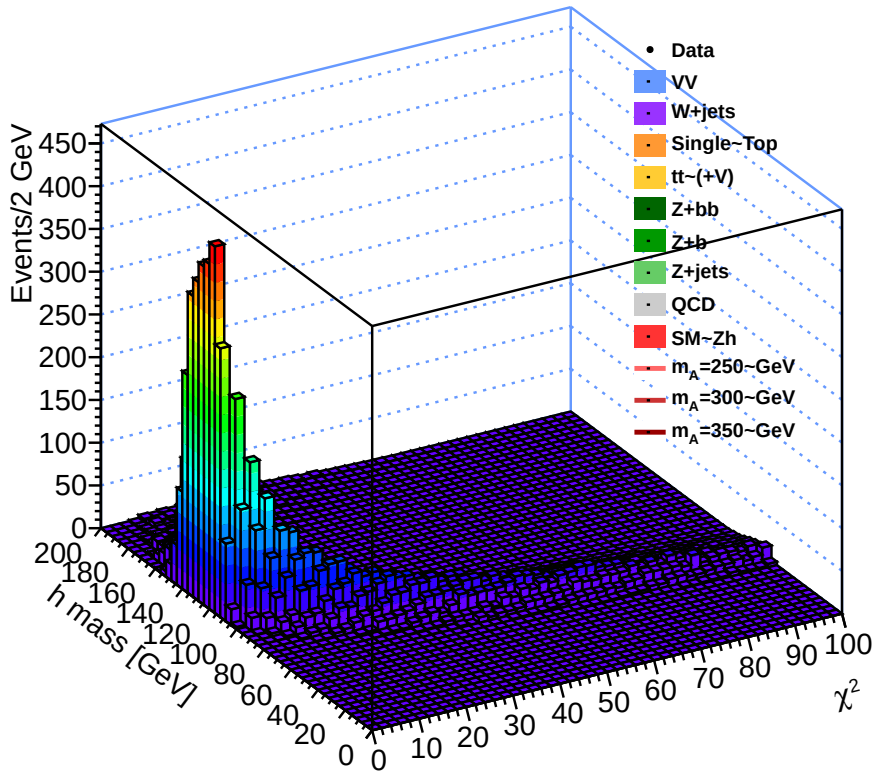




Cut at $\chi^2 < 10$: can be tuned. Not 100% sure about $P(\chi^2)$.

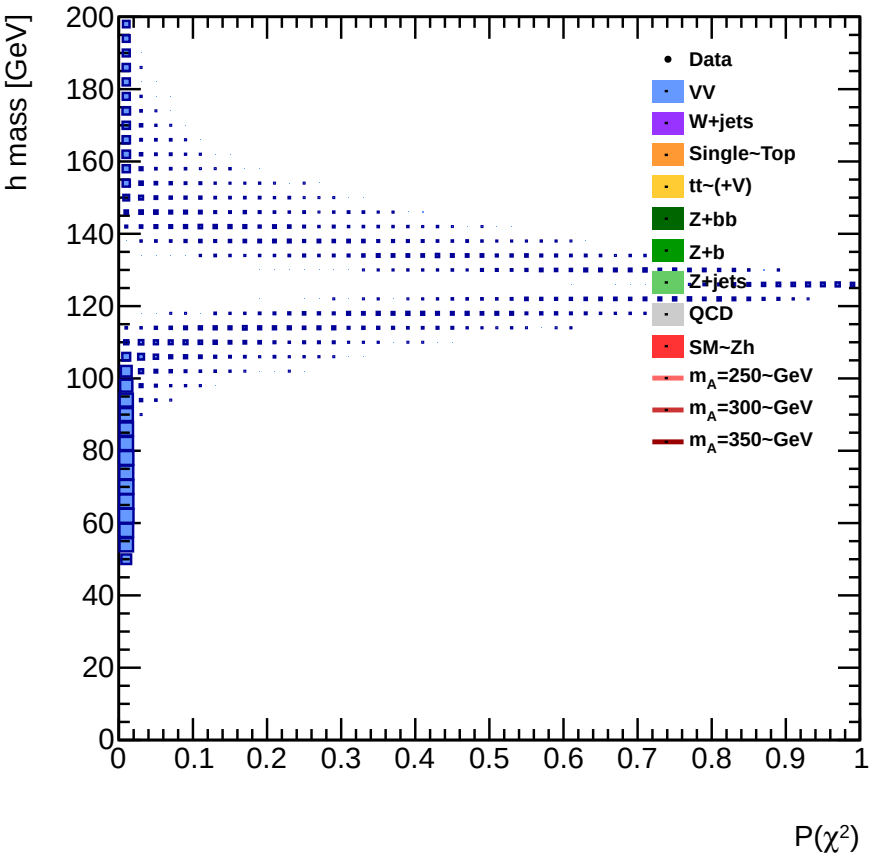
hMass vs χ^2

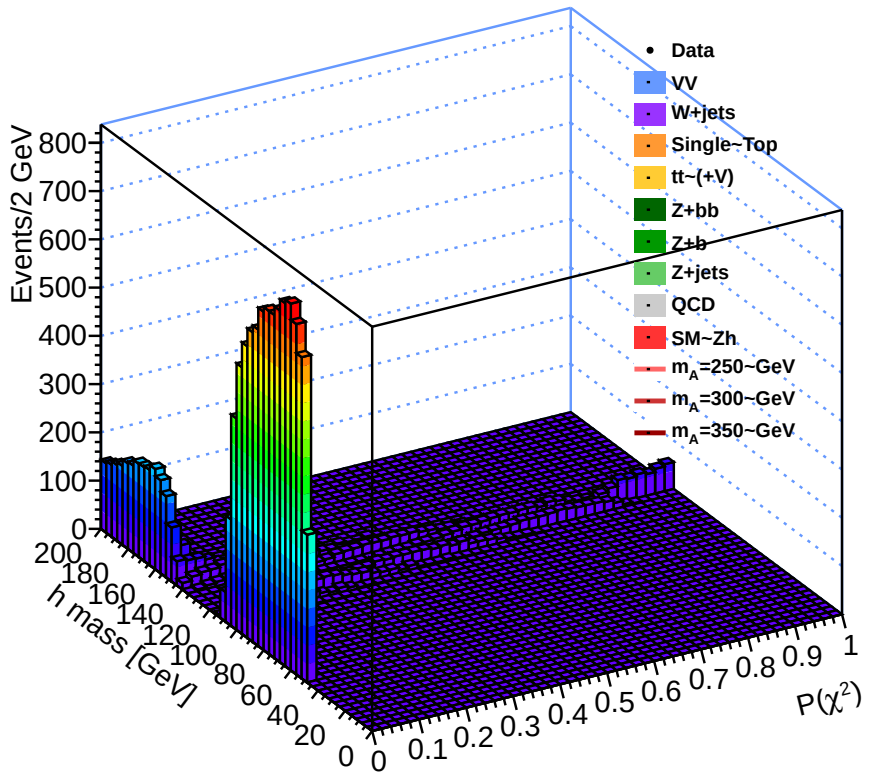




Cut at $\chi^2 < 10$: can be tuned.

hMass vs $P(\chi^2)$

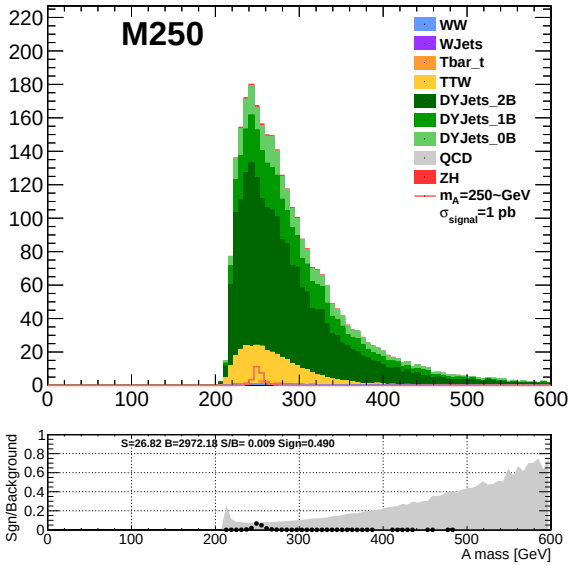




We could cut on $P(\chi^2)$ instead of χ^2

A mass: with hand-computed χ^2

Comparison of results of TKinFitter and χ^2 minimization



TKinFitter

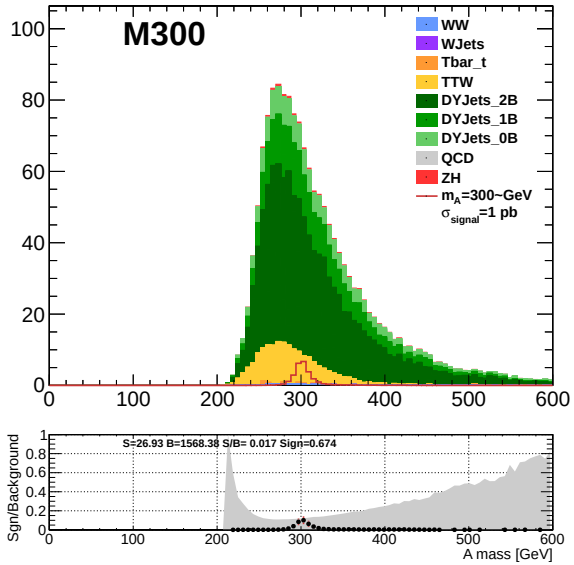
$M_A = 251.05 \pm 0.05\ GeV$

$\sigma_{M_A} = 5.90 \pm 0.05\ GeV$

χ^2

$M_A = 250.52 \pm 0.04\ GeV$

$\sigma_{M_A} = 5.47 \pm 0.04\ GeV$



TKinFitter

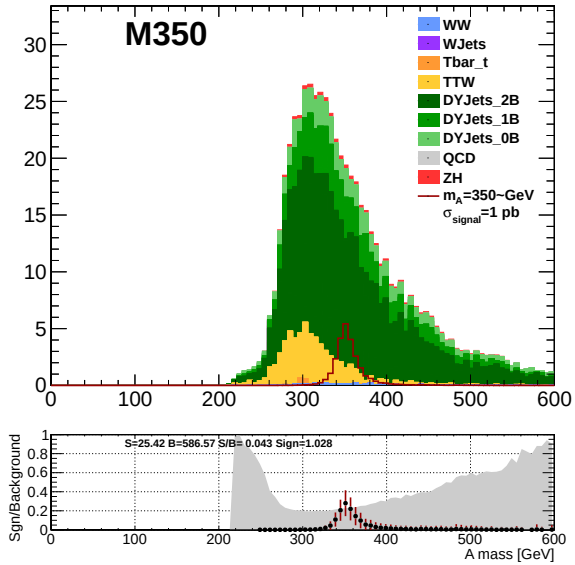
$M_A = 301.53 \pm 0.08\ GeV$

$\sigma_{M_A} = 9.64 \pm 0.09\ GeV$

χ^2

$M_A = 300.56 \pm 0.07\ GeV$

$\sigma_{M_A} = 8.94 \pm 0.08\ GeV$



TKinFitter

$M_A = 352.32 \pm 0.11\ GeV$

$\sigma_{M_A} = 12.61 \pm 0.12\ GeV$

χ^2

$M_A = 351.36 \pm 0.10\ GeV$

$\sigma_{M_A} = 11.78 \pm 0.10\ GeV$

TKinFitter slightly worse than χ^2 min, but closer: χ^2 cut can be tuned.