Universität Hamburg
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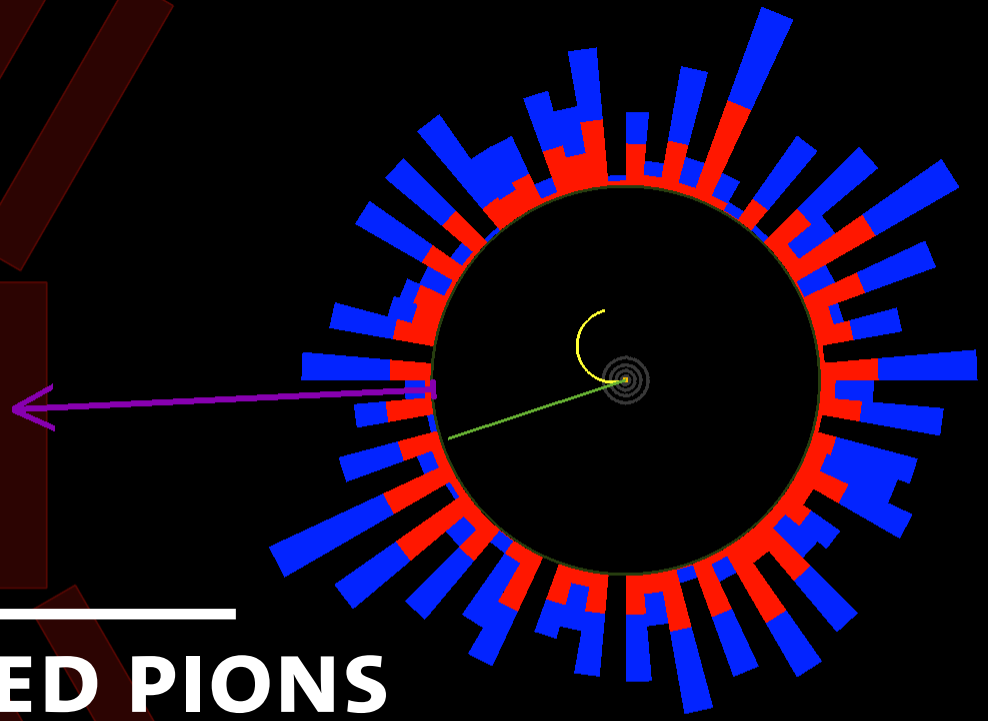
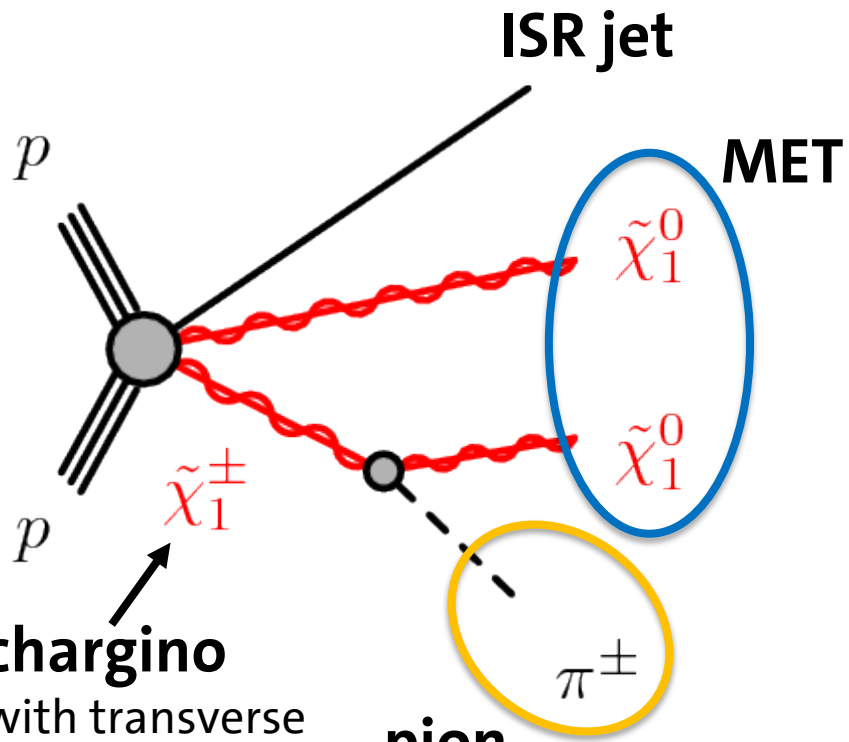


STATUS 19.05.2020

SOFT AND DISPLACED PIONS IN COMPRESSED HIGGSINO SEARCHES

SAM BEIN, PETER SCHLEPER, ALEXANDRA TEWS, MORITZ WOLF

ANALYSIS STRATEGY



chargino
with transverse decay length O(0,1 – 1 cm)

pion
with p_T = O(1 GeV) and displaced

Event selection:

- Trigger: HLT_PFMET120_PFMHT120_v*
- MET > 250 GeV
- ≥ 1 jet with p_T > 100 GeV
- Δphi(MET, $jet_{1,2,3,4}$) > 0.5
- m_T(MET, jet_1) > 300 GeV
- Veto on leptons, b-jets, isolated photons

Baseline monojet selection

\+ Require soft and displaced track (tagged with **BDT**)

Background processes:

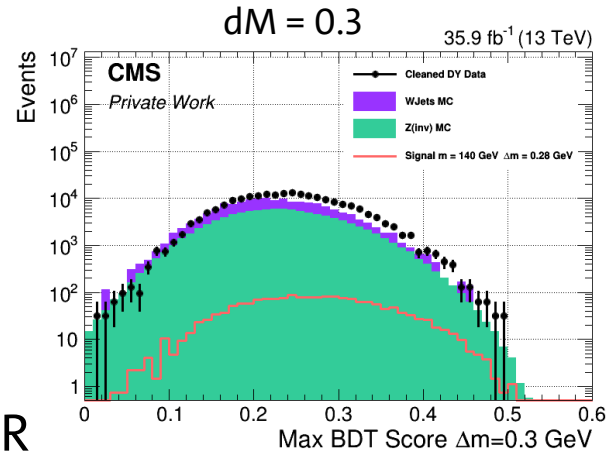
- Z(inv) ≈ 60%
- W+Jets ≈ 30%

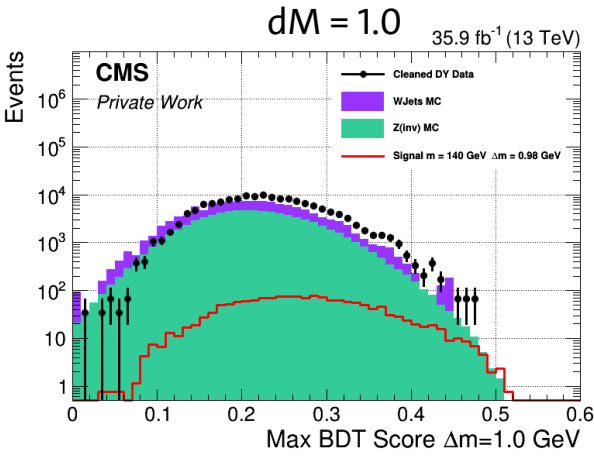
DEFINITION OF SIGNAL REGIONS

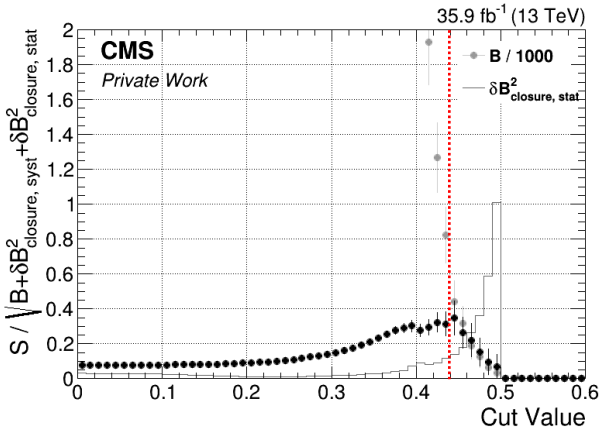
- Evaluation of $S/\sqrt{(B + dB_{syst}^2)}$
  $dB_{syst}^2 = dB_{closure,syst}^2 + dB_{closure,stat}^2$
  for different cuts
- **$dB_{closure,syst}$** = 0.1 * B (constant)
- **$dB_{closure,stat}$** from uncertainty in closure test for Z(inv) in SR
  (depends on SR cut)
- B: cleaned DY data
- MC Z(inv) and Wjets plotted for reference

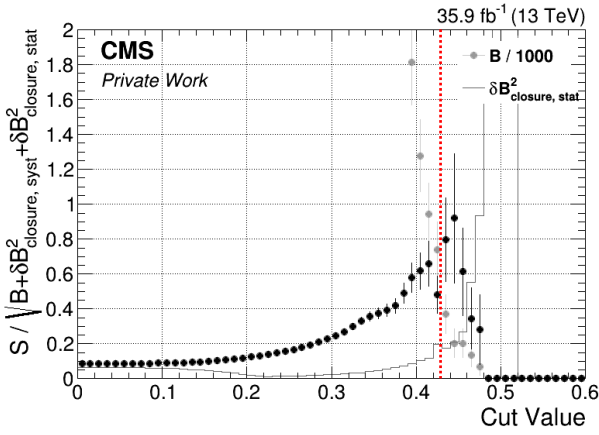
➢ SR cut dM = 0.3: **0.44**

➢ SR cut dM = 1.0: **0.43**





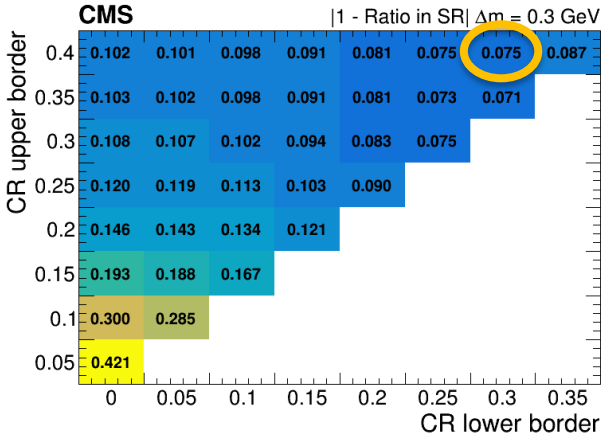


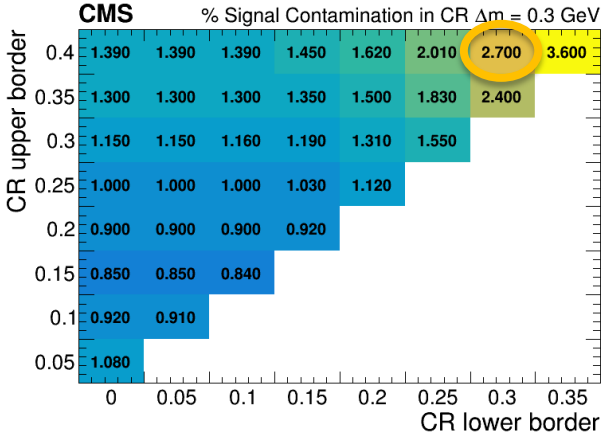


DEFINITION OF CONTROL REGION FOR DM = 0.3

- Evaluate for different definitions of control region (x-axis: lower bound, y-axis: upper bound)
  - upper plot: abs(1 – [Z(inv) MC event yield in SR / prediction from cleaned DY MC]) („goodness“ of CR)
  - lower plot: signal (m = 100 GeV) event yield in CR / MET data event yield in CR (signal contamination)
- Background prediction gets better for CR closer to SR (as expected)
- Stay below 3% signal contamination (high cross-section signal model point chosen)

➢ Choose CR from 0.3 to 0.4

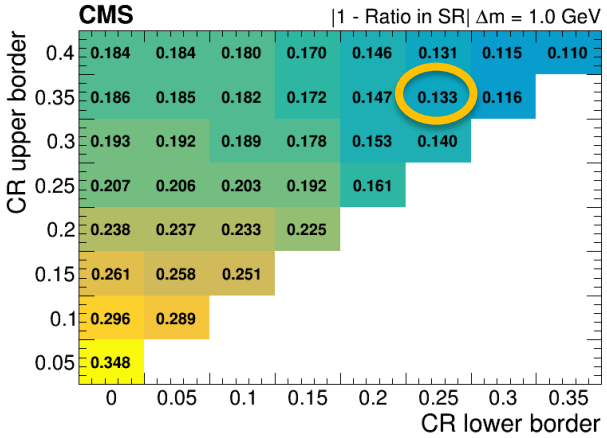


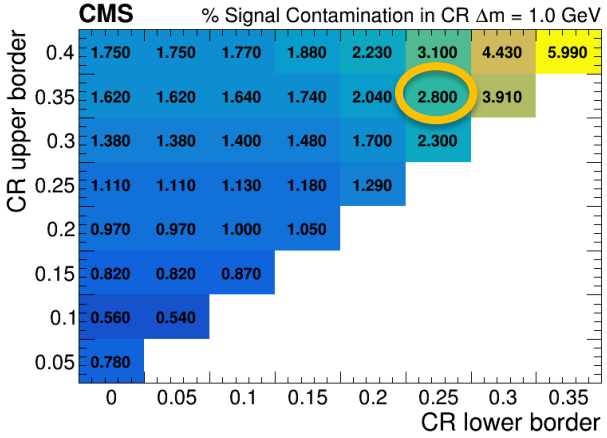


DEFINITION OF CONTROL REGION FOR DM = 1.0

- Evaluate for different definitions of control region (x-axis: lower bound, y-axis: upper bound)
  - upper plot: abs(1 – [Z(inv) MC event yield in SR / prediction from cleaned DY MC]) („goodness“ of CR)
  - lower plot: signal (m = 100 GeV) event yield in CR / MET data event yield in CR (signal contamination)
- Background prediction gets better for CR closer to SR (as expected)
- Stay below 3% signal contamination (high cross-section signal model point chosen)

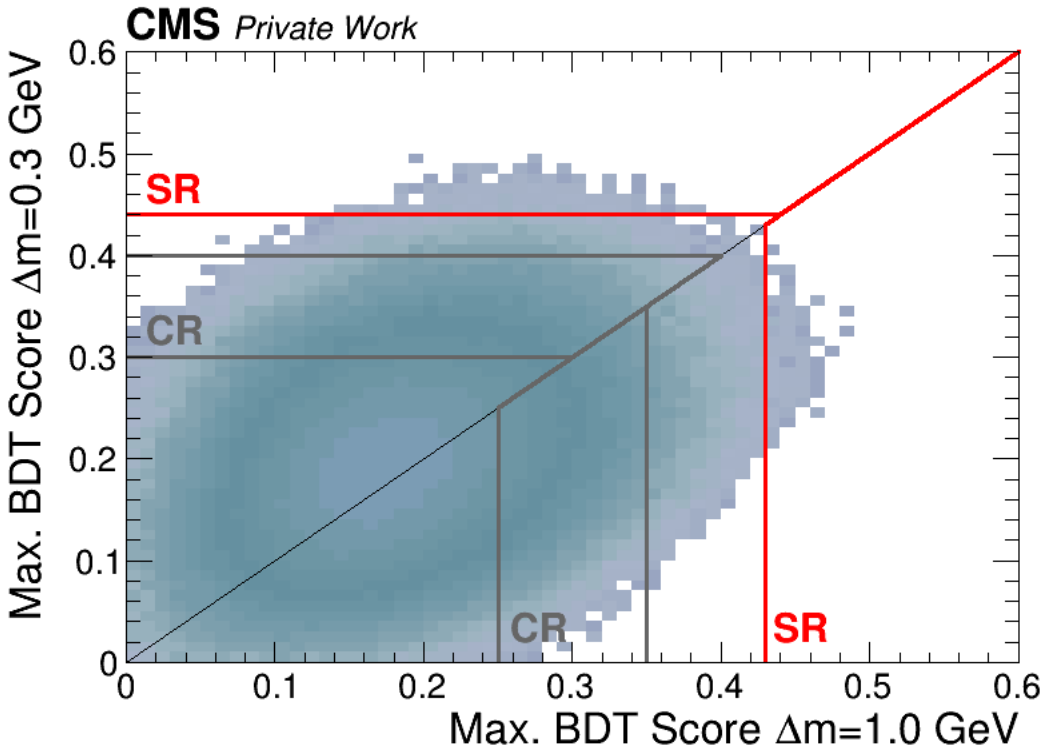
➢ Choose CR from 0.25 to 0.35





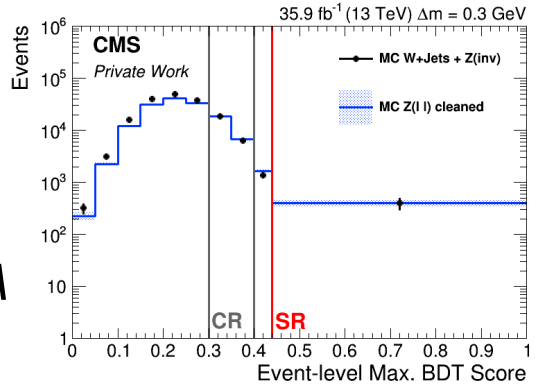
SIGNAL AND CONTROL REGIONS

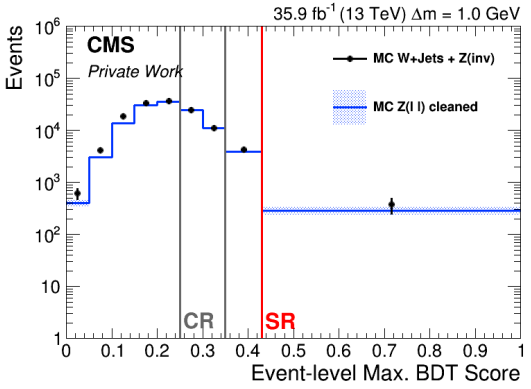
- SRs and CRs in 2D
- Gray/blue: distribution for Z(inv)

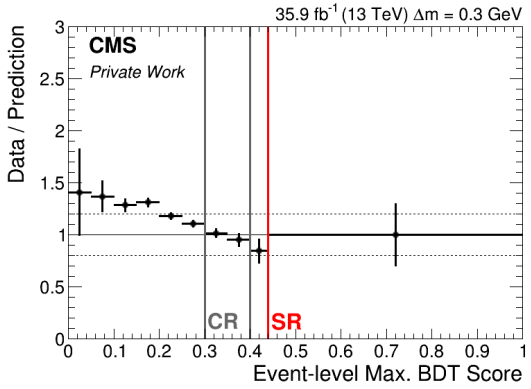


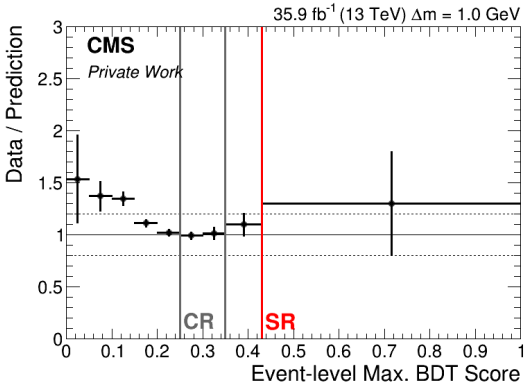
BACKGROUND ESTIMATION METHOD FOR Z(INV)+WJETS

- Z(inv) and W+Jets combined
- Define systematic uncertainty associated to background estimation method for each dM as max(deviation from 1, statistical uncertainty):
  - dM=0.3: **30%**
  - dM=1.0: **38%**



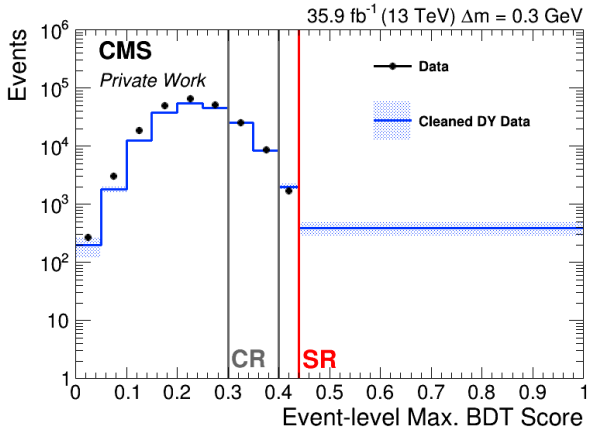


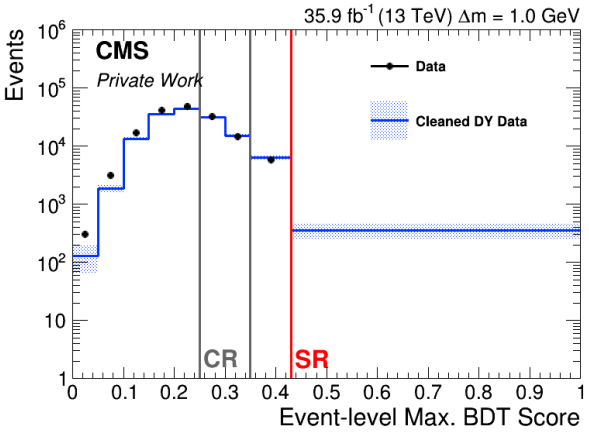


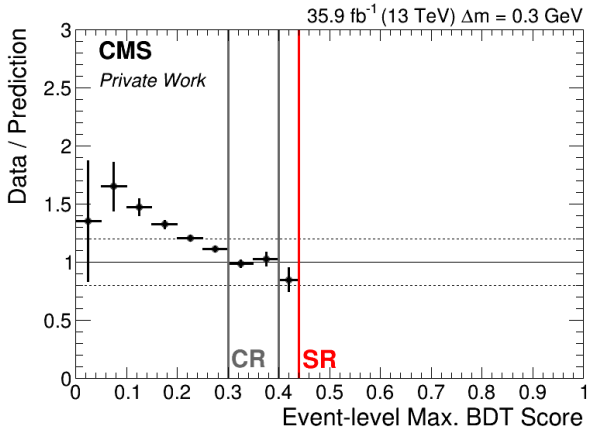


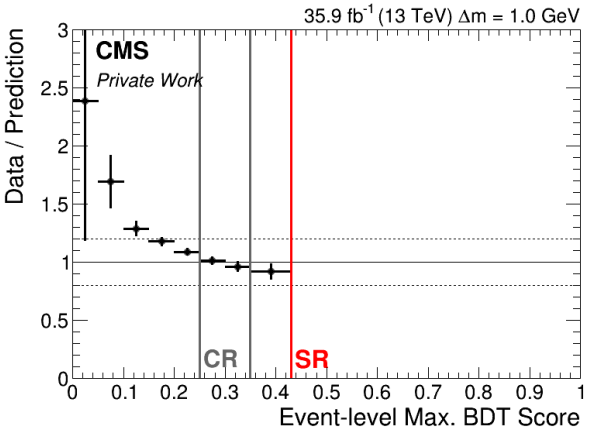
CLOSURE IN MAX BDT SCORE FOR DATA

- Blinded in SR
- Only statistical uncertainty shown for cleaned DY sample







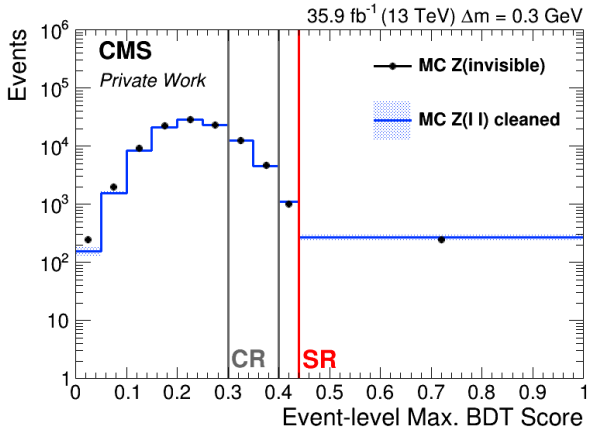


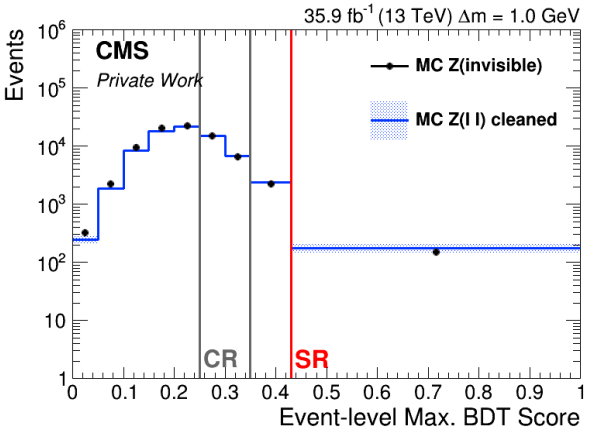
BACKUP

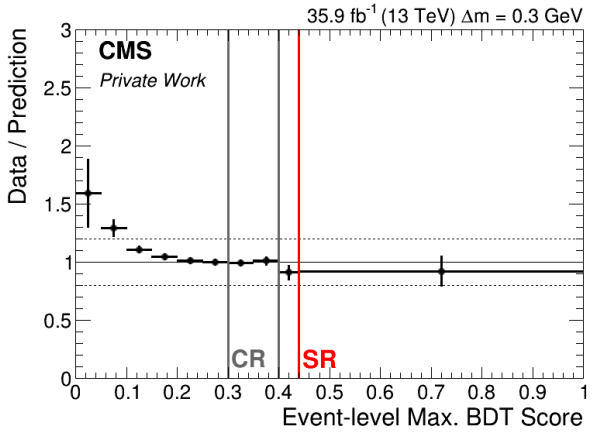
CLOSURE IN MAX BDT SCORE FOR Z(INV) MC

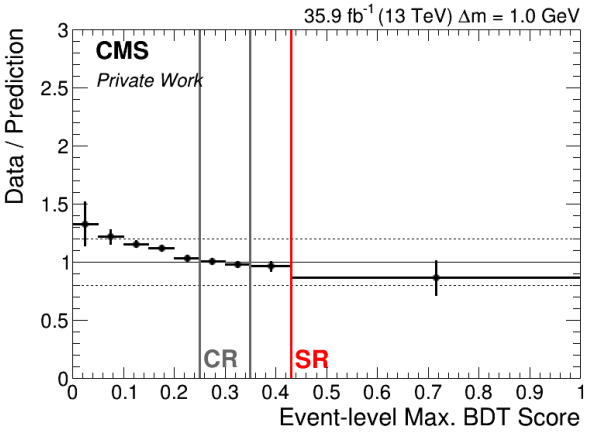
- Underprediction trend towards lower values

  (due to lepton acceptance in Z(ll) sample depending on lepton-pT)



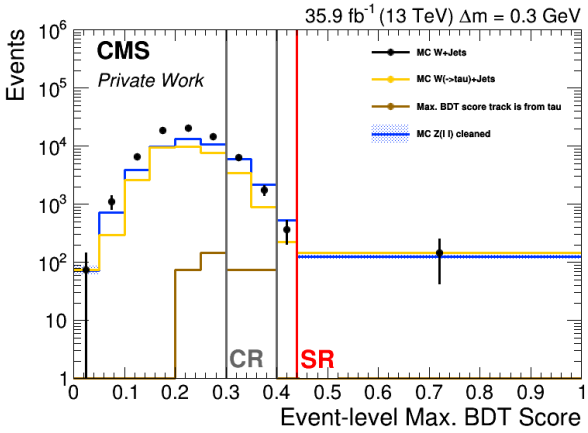


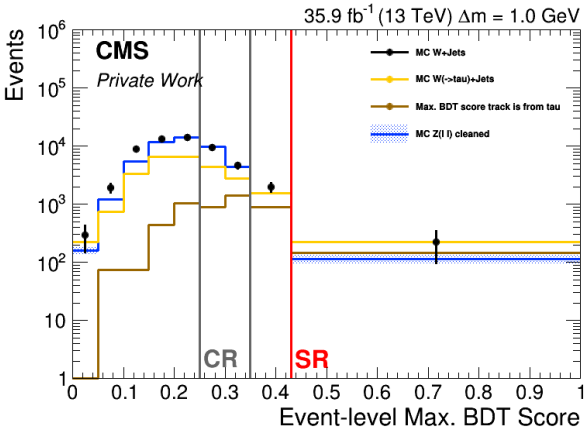


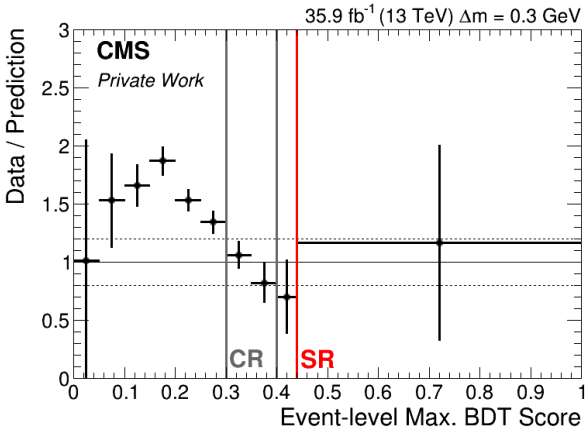


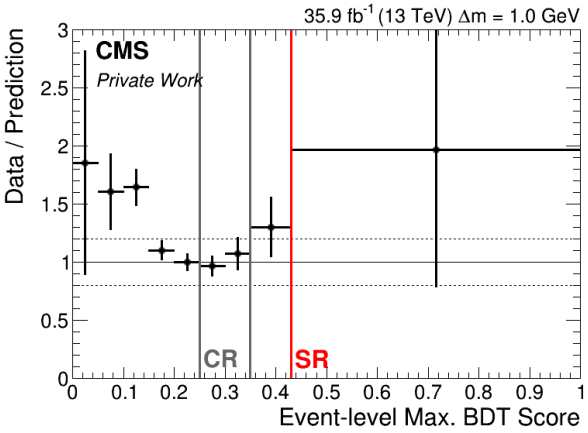
CLOSURE IN MAX BDT SCORE FOR WJETS MC

- General downward slope in ratio due to softer MET spectrum for W+Jets
- Enhanced tail due to W → tau decays



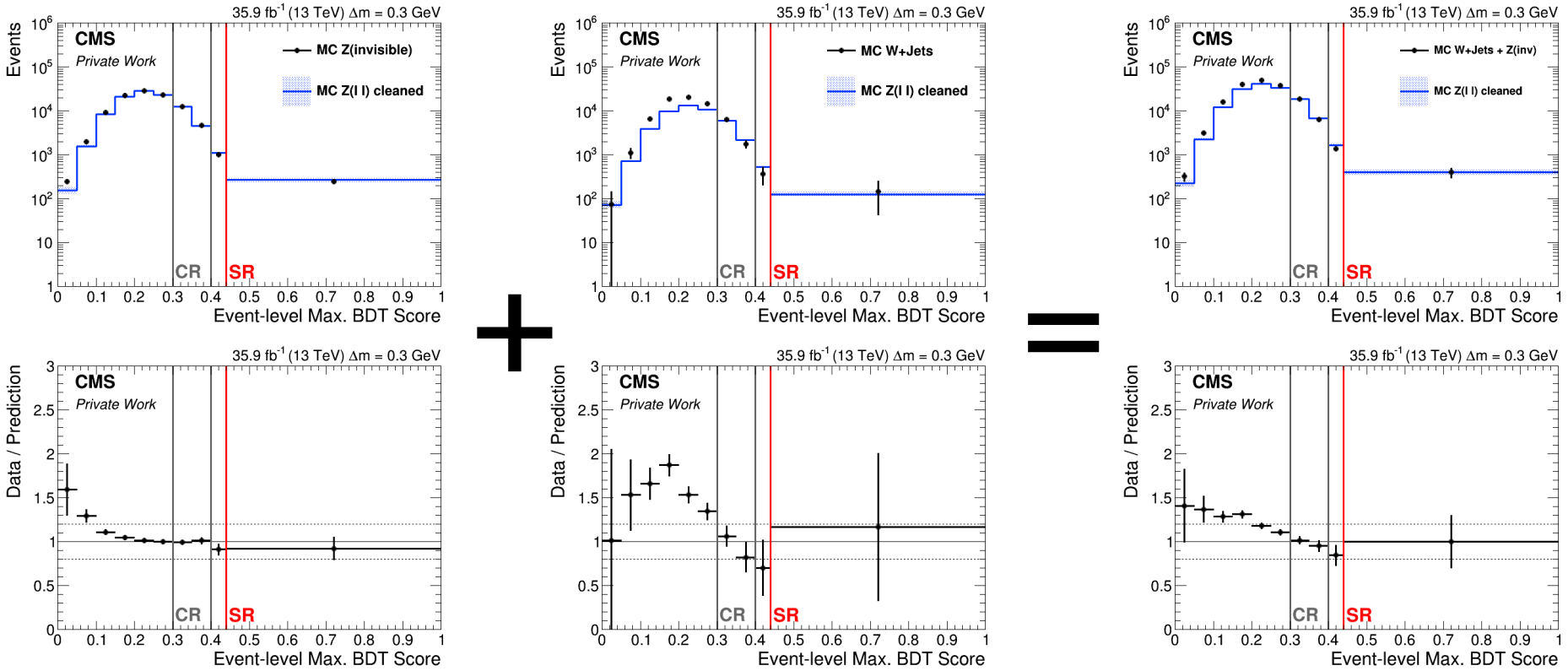






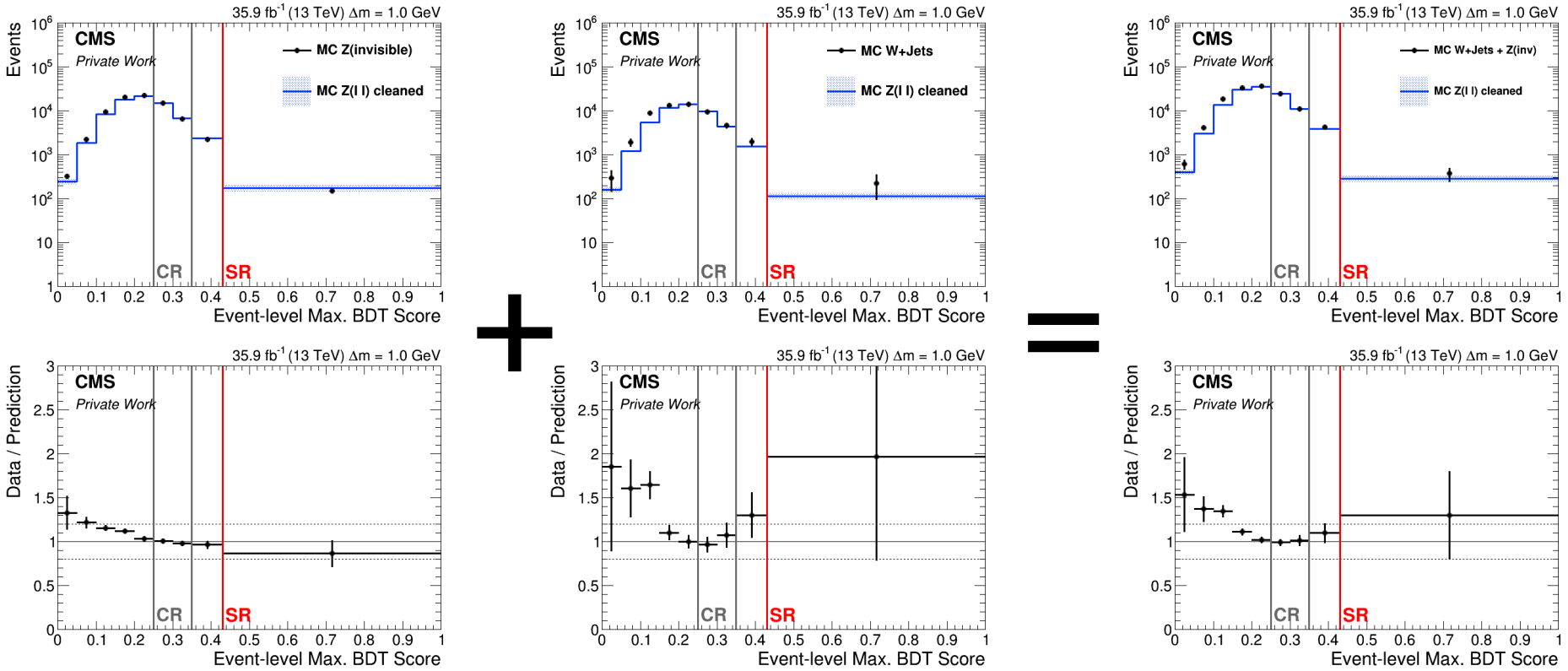
CLOSURE IN MAX BDT SCORE FOR Z(INV)+WJETS MC, DM=0.3

Z(inv) WJets



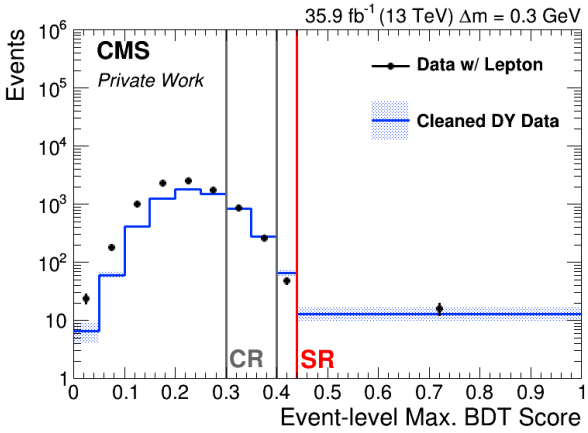
CLOSURE IN MAX BDT SCORE FOR Z(INV)+WJETS MC, DM=1.0

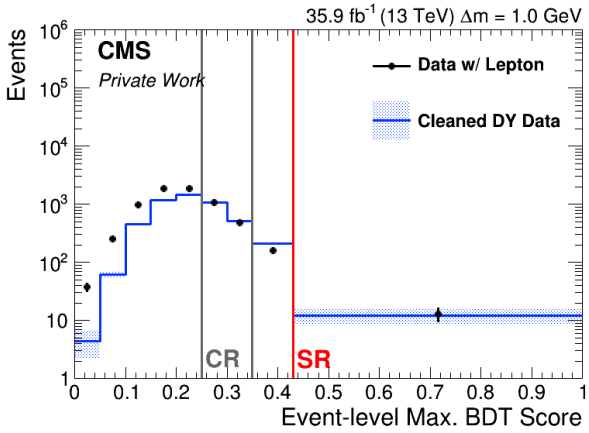
Z(inv) WJets

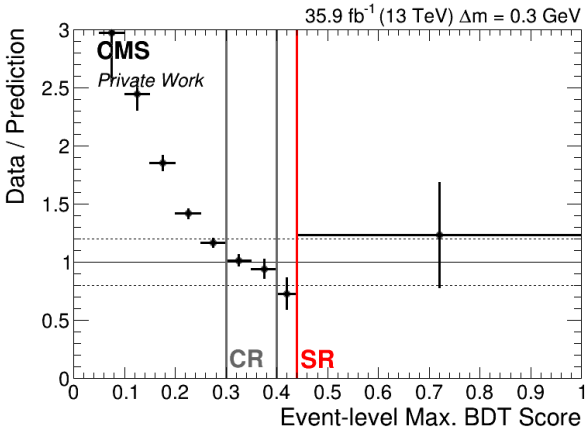


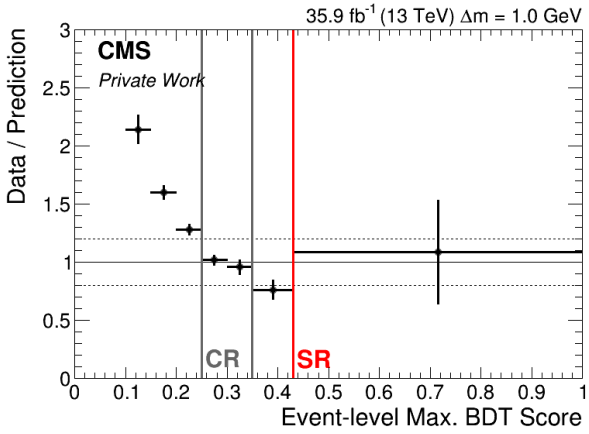
CLOSURE IN MAX BDT SCORE FOR DATA W/ LEPTON

- Control sample: MET data with exactly one „good“ lepton
  - p_T > 10 GeV
  - Iso < 0.02 (dR<0.2)



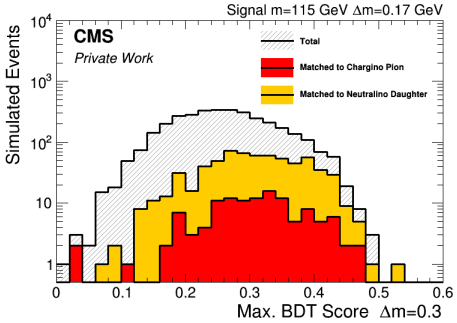


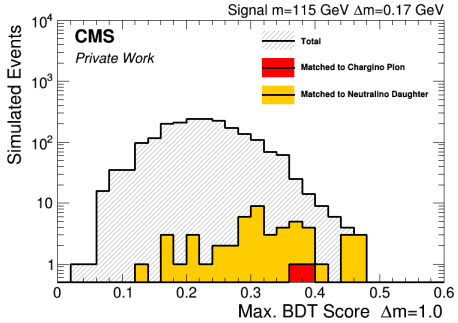




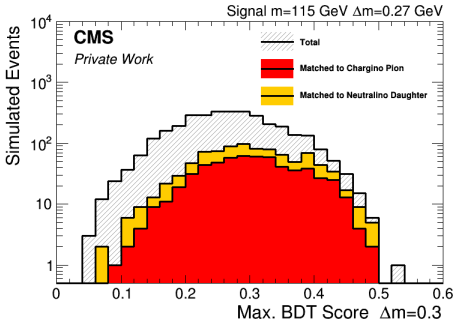
SIGNAL SAMPLES WITH GEN. INFO

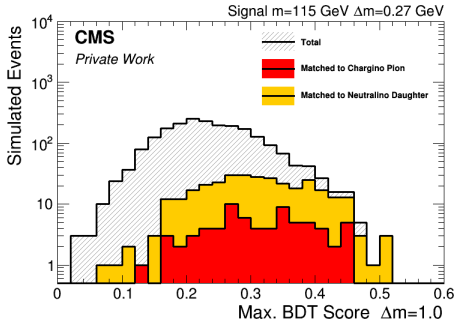
- signal model points with m = 115 GeV,
  top to bottom:
  ascending gen. dM
- left: BDT evaluated for dM=0.3
  right: dM=1.0
- red: chargino pion track
- orange: neutralino tracks



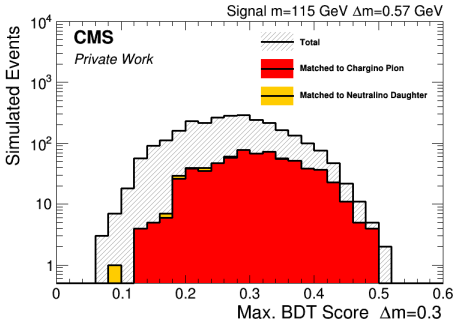


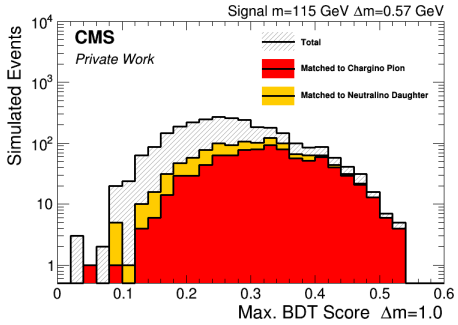
gen. dM = 0.17



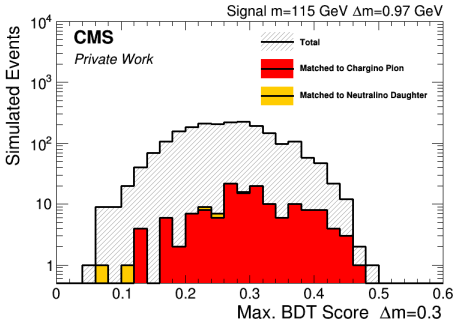


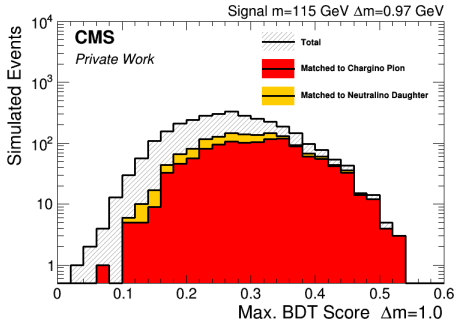
gen. dM = 0.27





gen. dM = 0.57

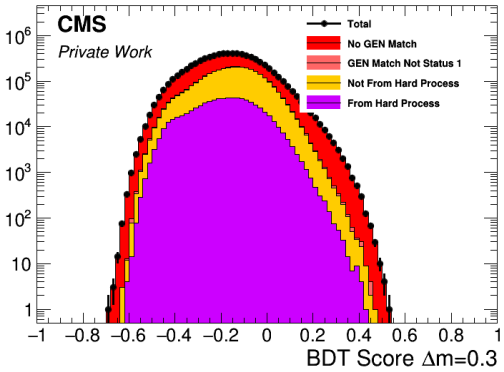


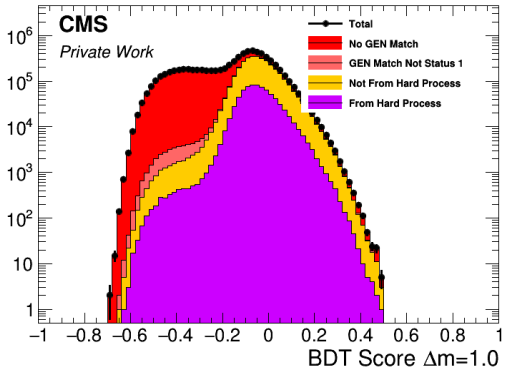


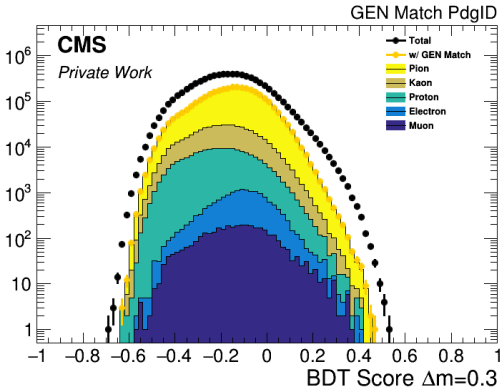
gen. dM = 0.97

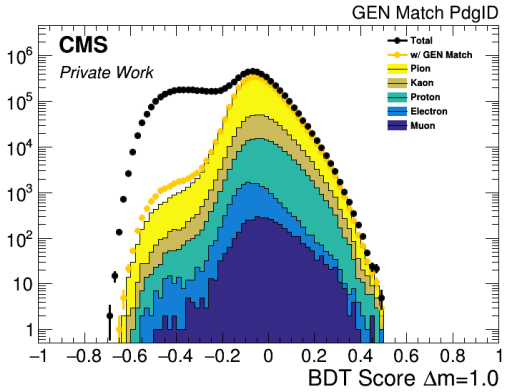
BACKGROUND SAMPLES WITH GEN. INFO

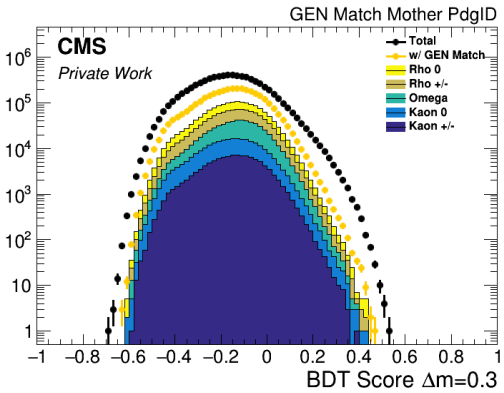
- Z(inv) sample
- Track-level BDT output not event-level quantity
- left: dM=0.3, right: dM=1.0

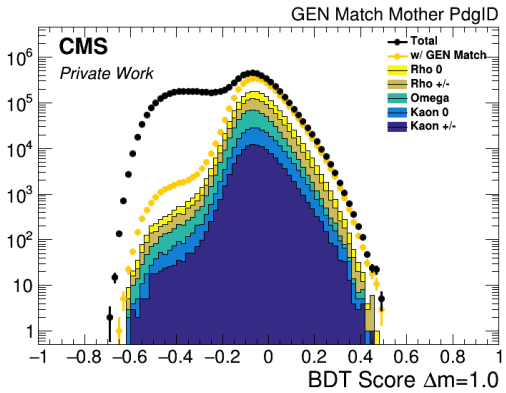




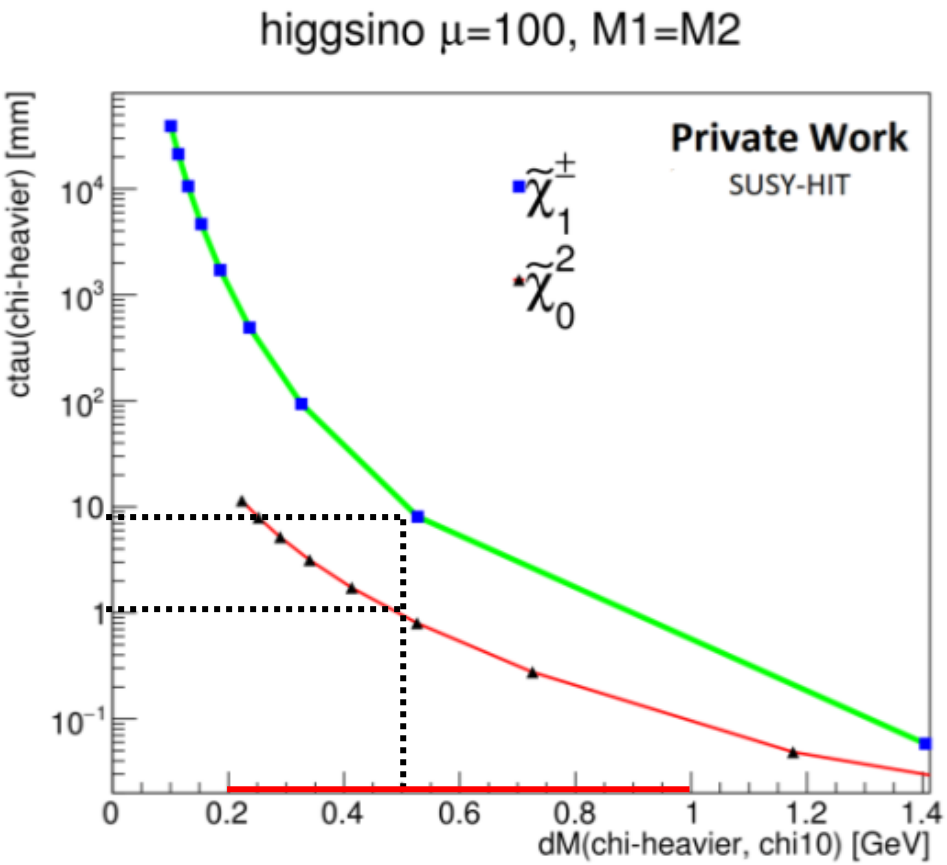








CTAU VS. DM


higgsino μ=100, M1=M2
Private Work
SUSY-HIT
$\tilde{\chi}_1^{\pm}$
$\tilde{\chi}_0^2$
ctau(chi-heavier) [mm]
10^4
10^3
10^2
10
1
10^{-1}
0
0.2
0.4
0.6
0.8
1
1.2
1.4
dM(chi-heavier, chi10) [GeV]

TRIGGER EFFICIENCY