Update Of TTH/TTZ

Hua-Sheng Shao

CERN, PH-TH

2015.02.25

MSTW2008NLO, $\mu_0 = H_T/2$, FCC100

	ttH (pb)	ttZ (pb)	ttH/ttZ
NLO QCD	33.9 $[^{+7.06\%}_{-8.29\%}]$Scale $[^{+0.941\%}_{-1.26\%}]$PDF	57.9 $[^{+8.93\%}_{-9.46\%}]$Scale $[^{+0.901\%}_{-1.20\%}]$PDF	0.585 $[^{+1.29\%}_{-2.02\%}]$Scale $[^{+0.0526\%}_{-0.0758\%}]$PDF

1.The theoretical uncertainty in the ratio can be at percent level, which requires at least 10 K events to guarantee the statistical uncertainty.

2.Two promising decay channels can be measured at a 100 TeV machine:

$$H \to \gamma\gamma, Z \to \ell^+\ell^-$$
$$H \to b\bar{b}, Z \to b\bar{b}$$

where the second one might be the only channel to be accessible at HL-LHC. It requires at least one lepton to be a trigger.

$t\bar{t}(\to \ell^\pm + X)H(\to \gamma\gamma)$	$t\bar{t}(\to \ell^\pm + X)H(\to b\bar{b})$
100 K events (10 ab-1,no cuts)	**50 M events (10 ab-1,no cuts)**

$H \to \gamma\gamma$

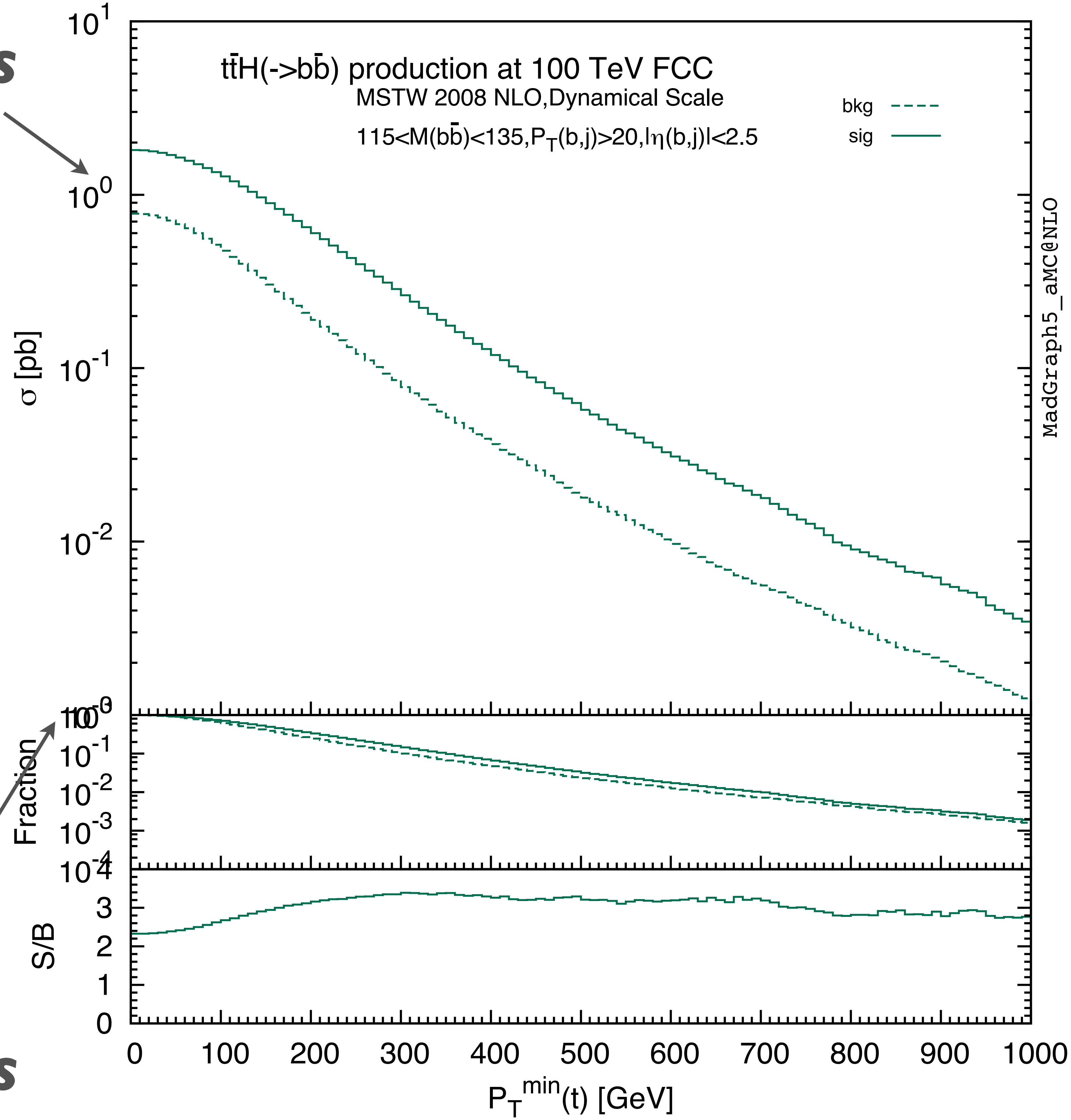
	$t\bar{t}H(\to \gamma\gamma)$	$t\bar{t}Z(\to \ell^+\ell^-)$	$t\bar{t}\gamma\gamma$
$t\bar{t} \to jjjjbb$	$2.546 \cdot 10^4$	$1.295 \cdot 10^6$	$3.315 \cdot 10^3$
$t\bar{t} \to \ell\nu jjbb$	$2.457 \cdot 10^4$	$1.239 \cdot 10^6$	$3.270 \cdot 10^3$
$t\bar{t} \to \ell\nu\ell\nu bb$	$7.013 \cdot 10^3$	$3.452 \cdot 10^5$	$1.030 \cdot 10^3$
$t\bar{t} \to \tau\nu jjbb$	$1.237 \cdot 10^4$	$6.152 \cdot 10^5$	$1.600 \cdot 10^3$
$t\bar{t} \to \ell\nu\tau\nu bb$	$6.967 \cdot 10^3$	$3.396 \cdot 10^5$	$9.640 \cdot 10^2$
$t\bar{t} \to \tau\nu\tau\nu bb$	$1.739 \cdot 10^3$	$8.605 \cdot 10^4$	$2.327 \cdot 10^2$
sum	$7.812 \cdot 10^4$	$3.921 \cdot 10^6$	$1.041 \cdot 10^4$

$$p_{T,j} > 25 \text{ GeV}, |\eta_j| < 2.5,$$
$$p_{T,b} > 25 \text{ GeV}, |\eta_b| < 2.5,$$
$$p_{T,\gamma} > 25 \text{ GeV}, |\eta_\gamma| < 2.5,$$
$$120 \text{ GeV} < m_{\gamma\gamma} < 130 \text{ GeV},$$
$$p_{T,\ell^\pm/\tau^\pm} > 20 \text{ GeV}, |\eta_{\ell^\pm/\tau^\pm}| < 2.5,$$
$$E_{T,\text{miss}} > 20 \text{ GeV},$$
$$\Delta R_{jj} > 0.4, \Delta R_{bj} > 0.4, \Delta R_{bb} > 0.4.$$

1.The rate (~100 K events) implies one needs at least O(10%) efficiency to reconstruct the signal events.
2. Good S/B. In the above cuts condition (without optimization), S/B ~ 7. One can still 2-3 times further loss of efficiency beyond the parton-level cuts.
3. ttZ has enough events because of large branching ratio.

$H \to b\bar{b}$

10 M events with 10 ab-1

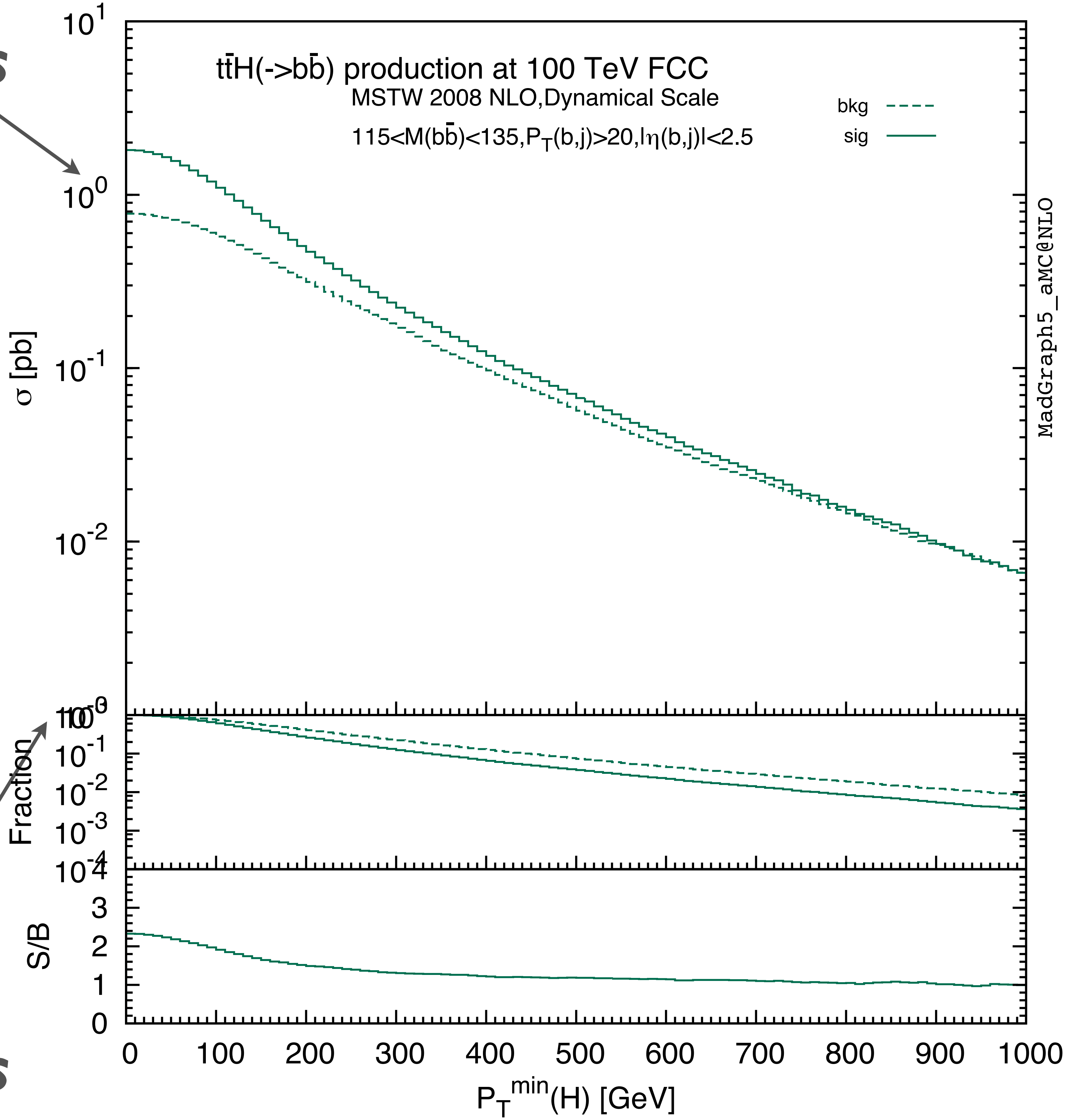


10 K events

1. The rate (~50 M events) is much larger than 10 K. However, the background is also large.
2. There is much room to optimize by using top tagging techniques.

$H \to b\bar{b}$

10 M events with 10 ab-1



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3. By boosting Higgs alone is not good for optimize S/B.

$H \to b\bar{b}$

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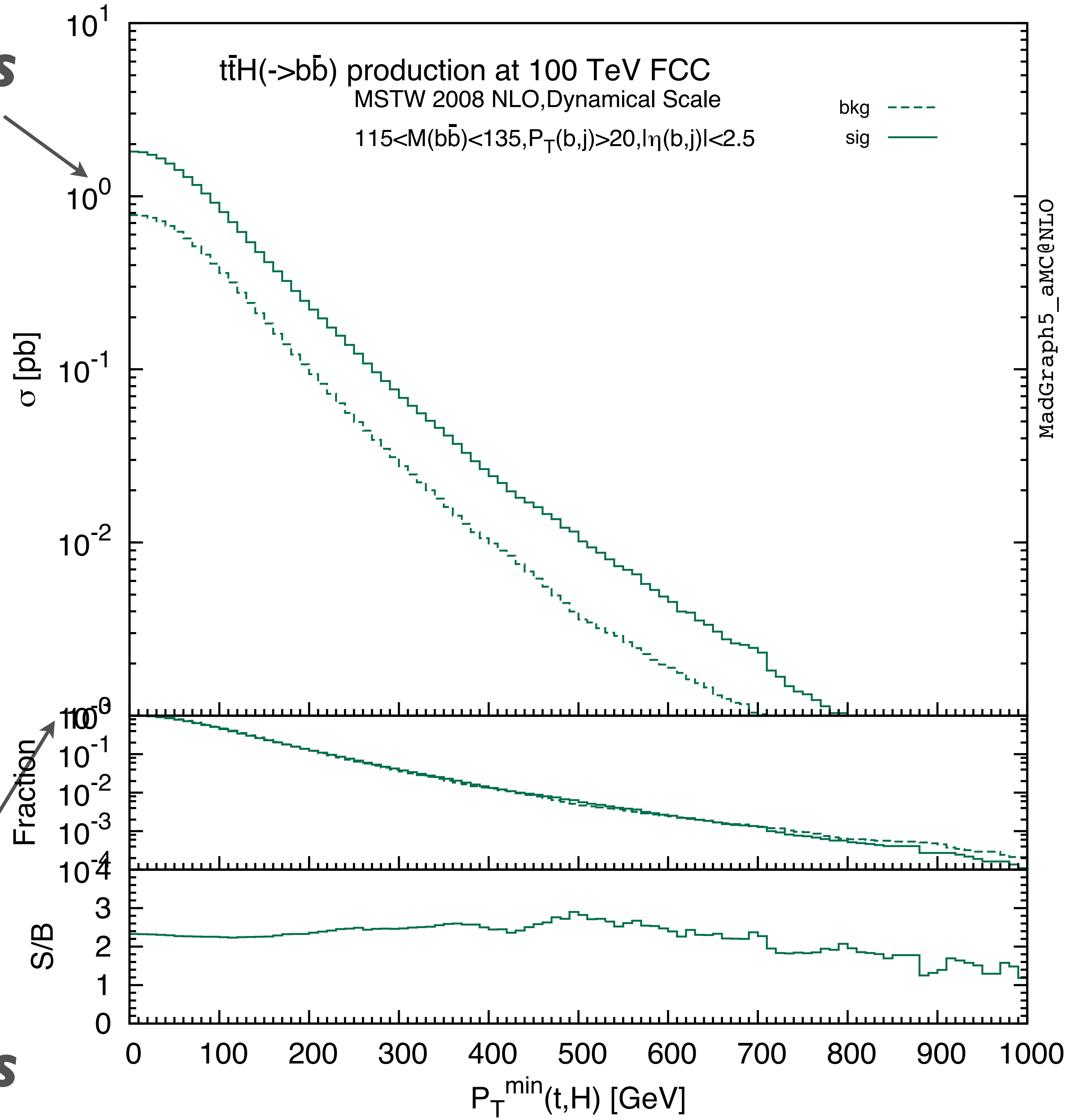

10 K events

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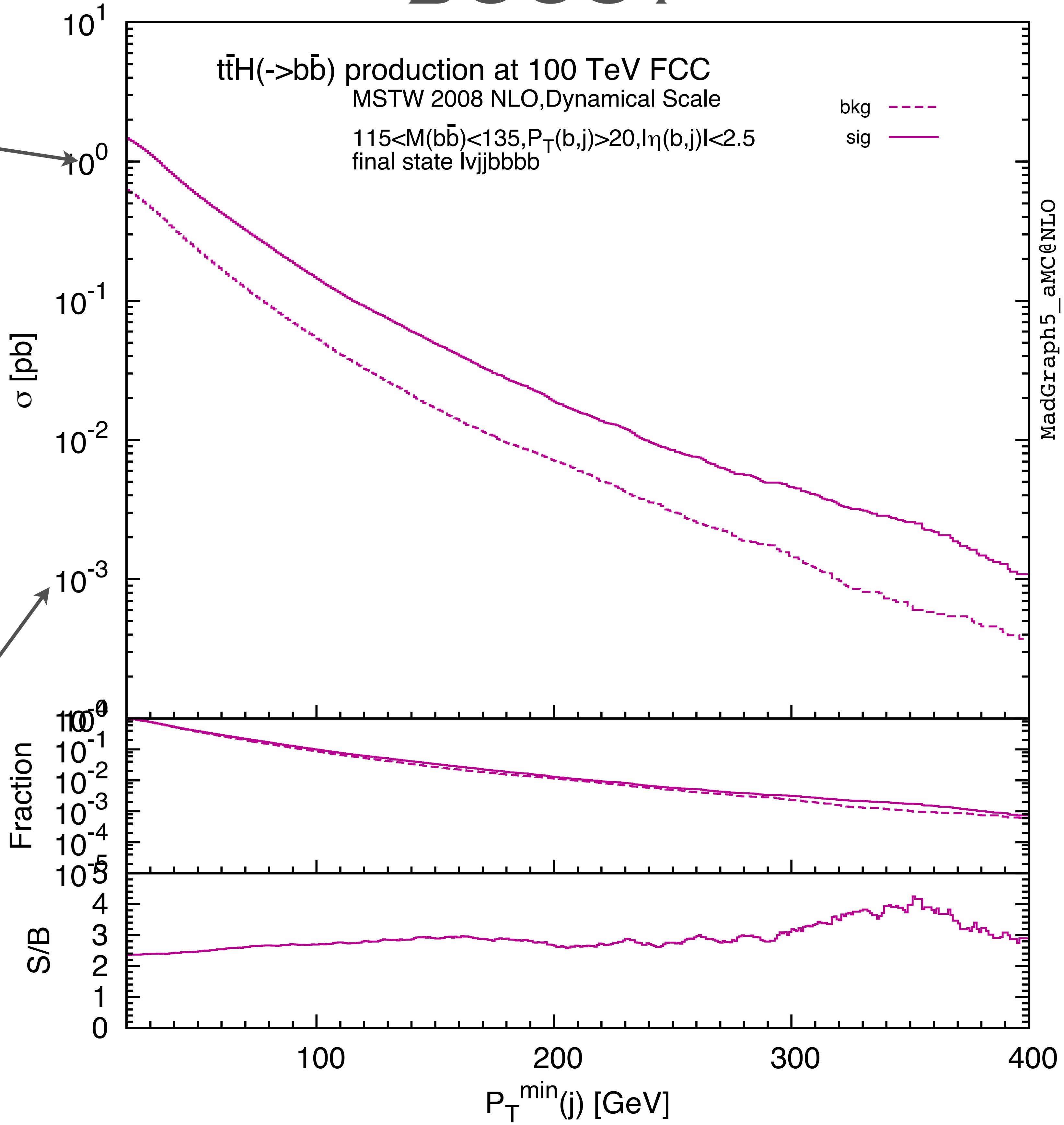
2. There is much room to optimize by using top tagging techniques.
3. By boosting Higgs alone is not good for optimize S/B.
4. Instead, by boosting Higgs and top together still maintains S/B ~ 2-3. One can also use boost techniques for H.

Back Up

BOOST

10 M events with 10 ab-1



10 K events

BOOST

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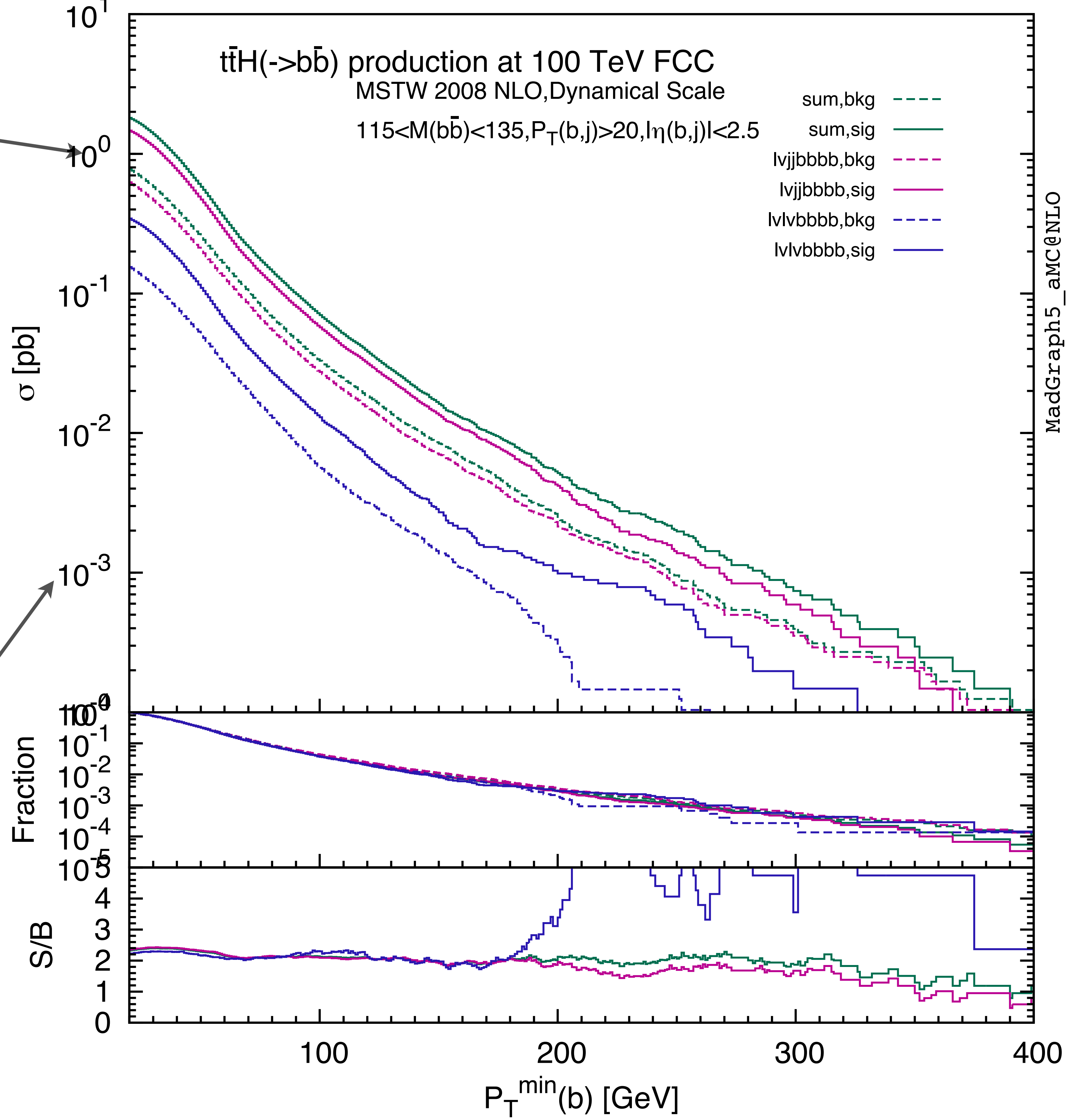
10 K events



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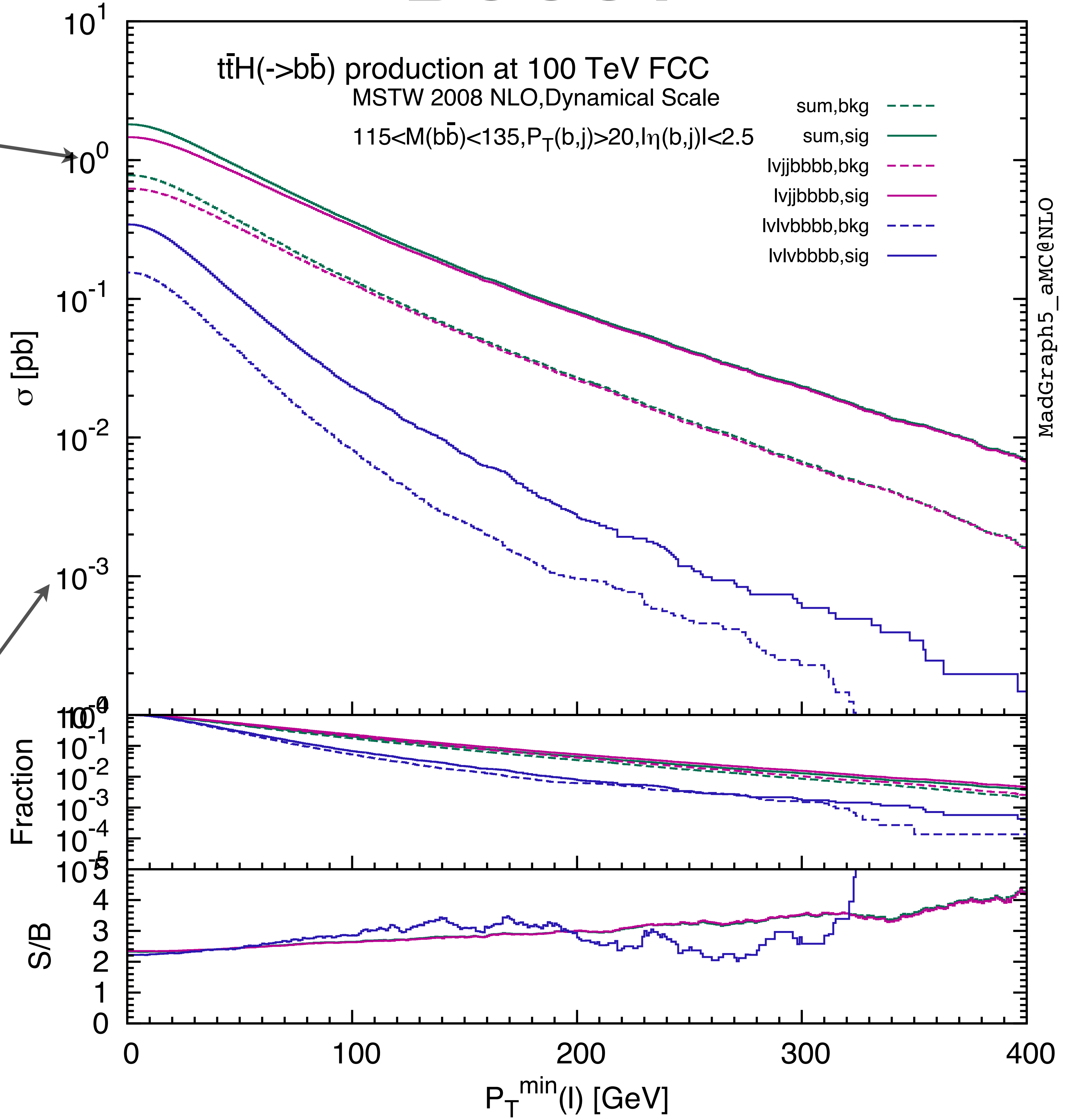
BOOST

10 M events with 10 ab-1



10 K events

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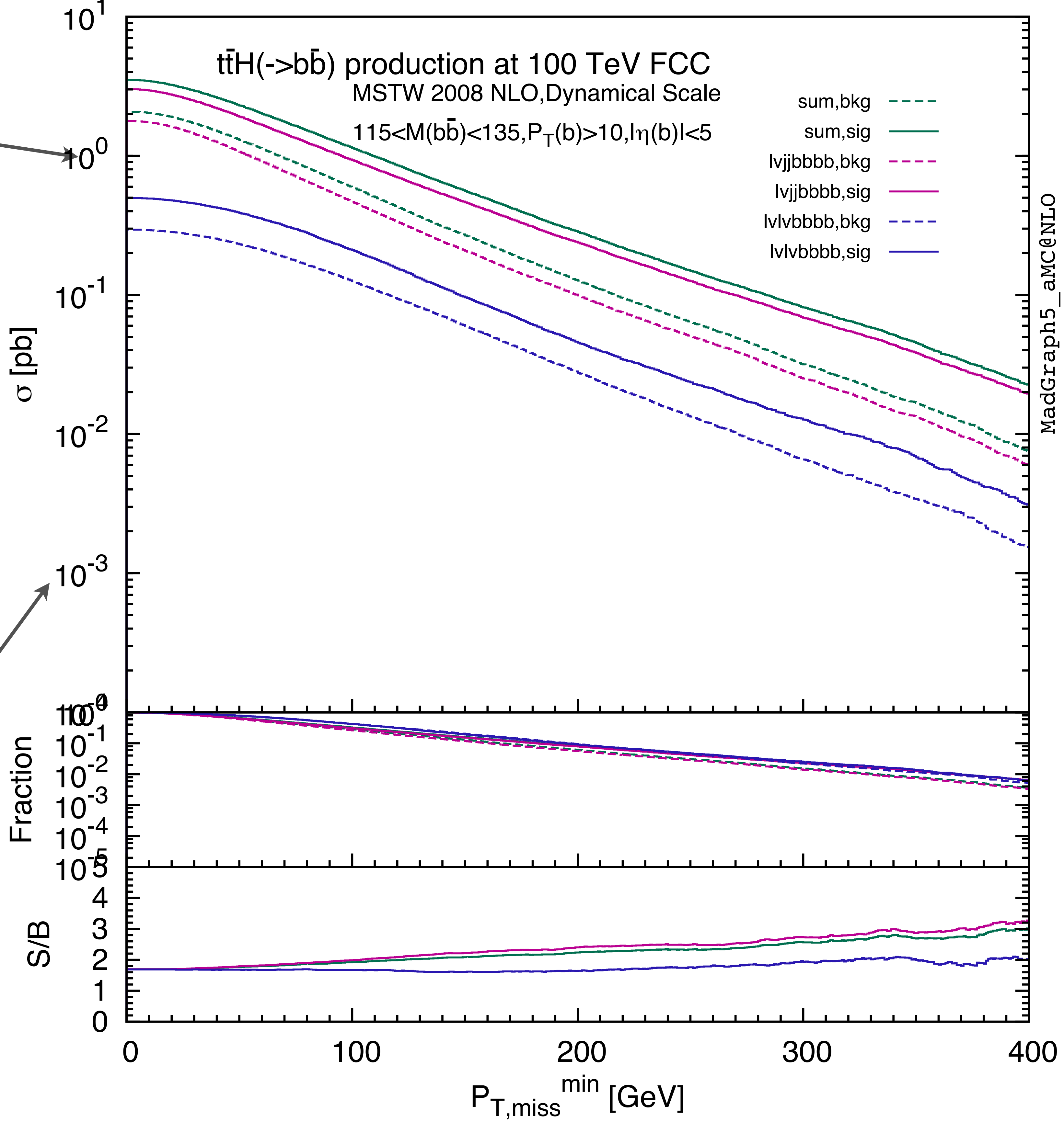
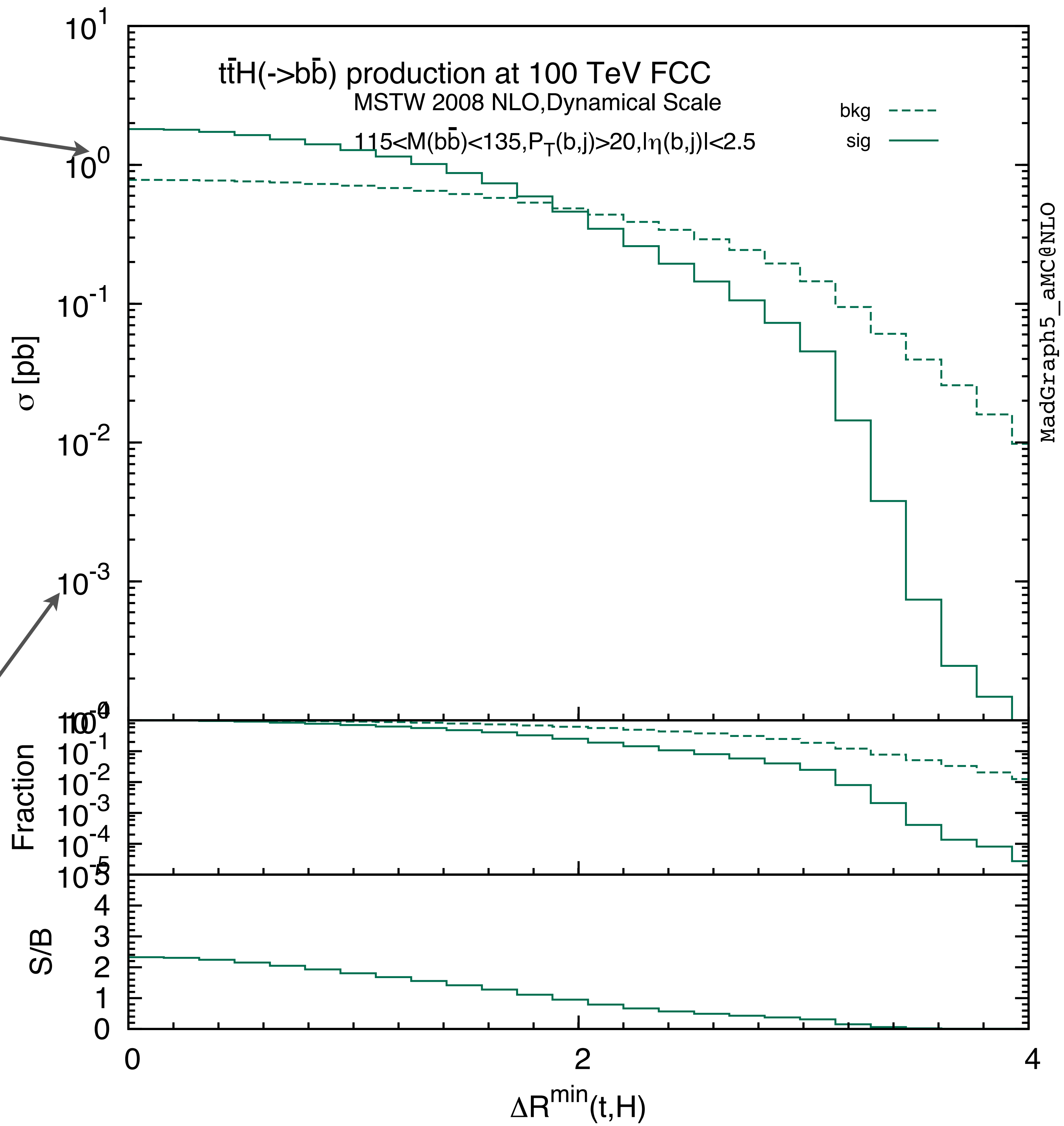


10 K events

ISOLATION

10 M events with 10 ab-1



10 K events

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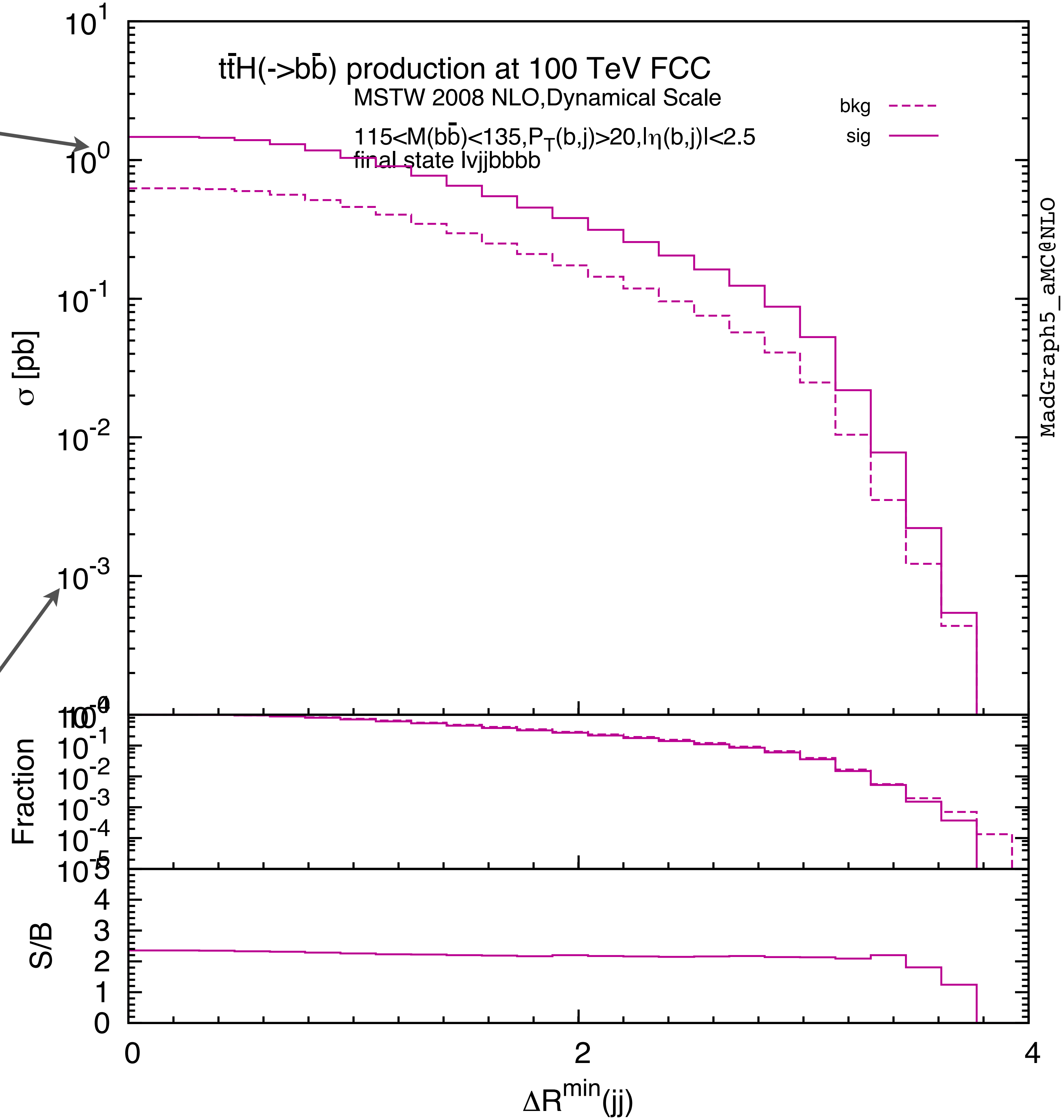

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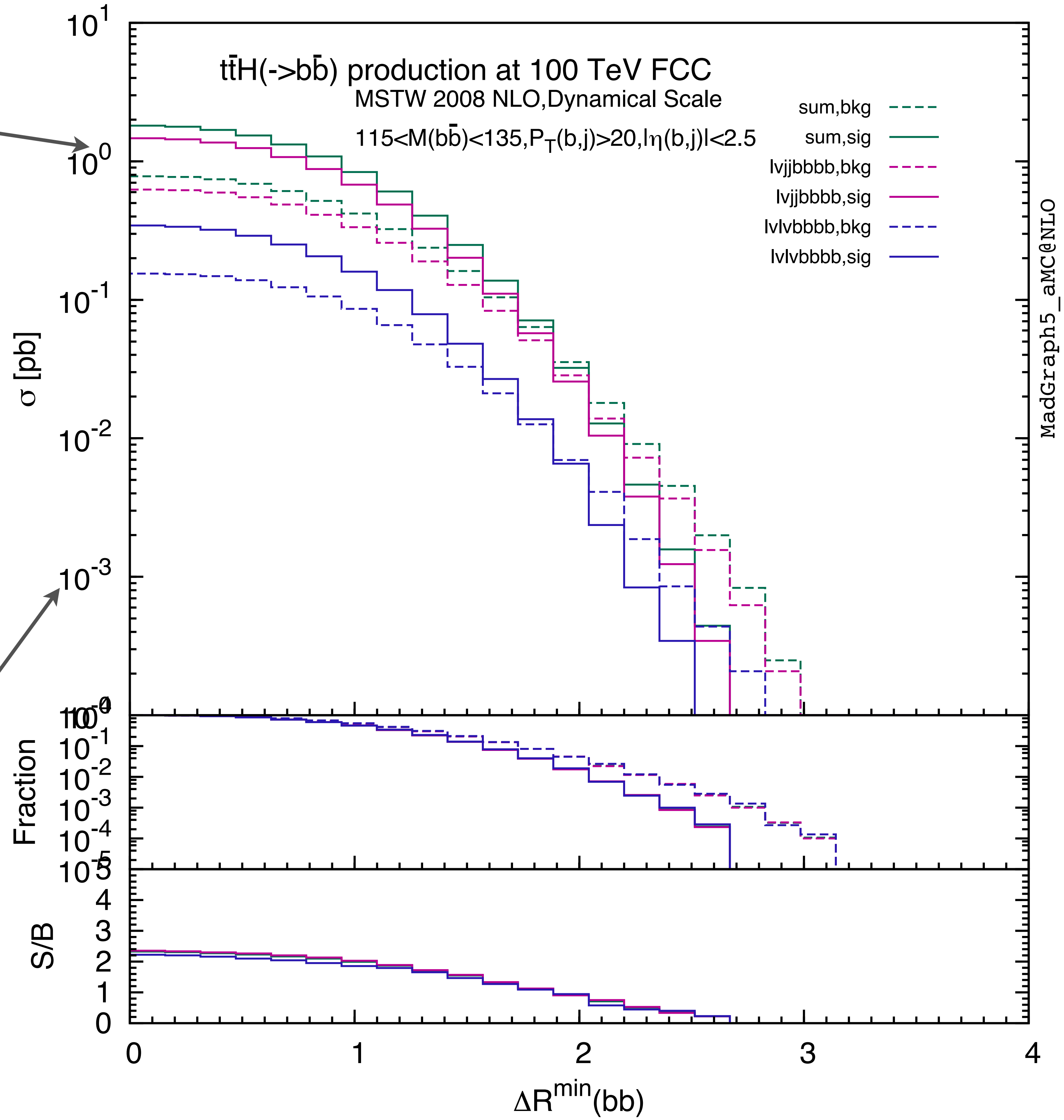

10 K events

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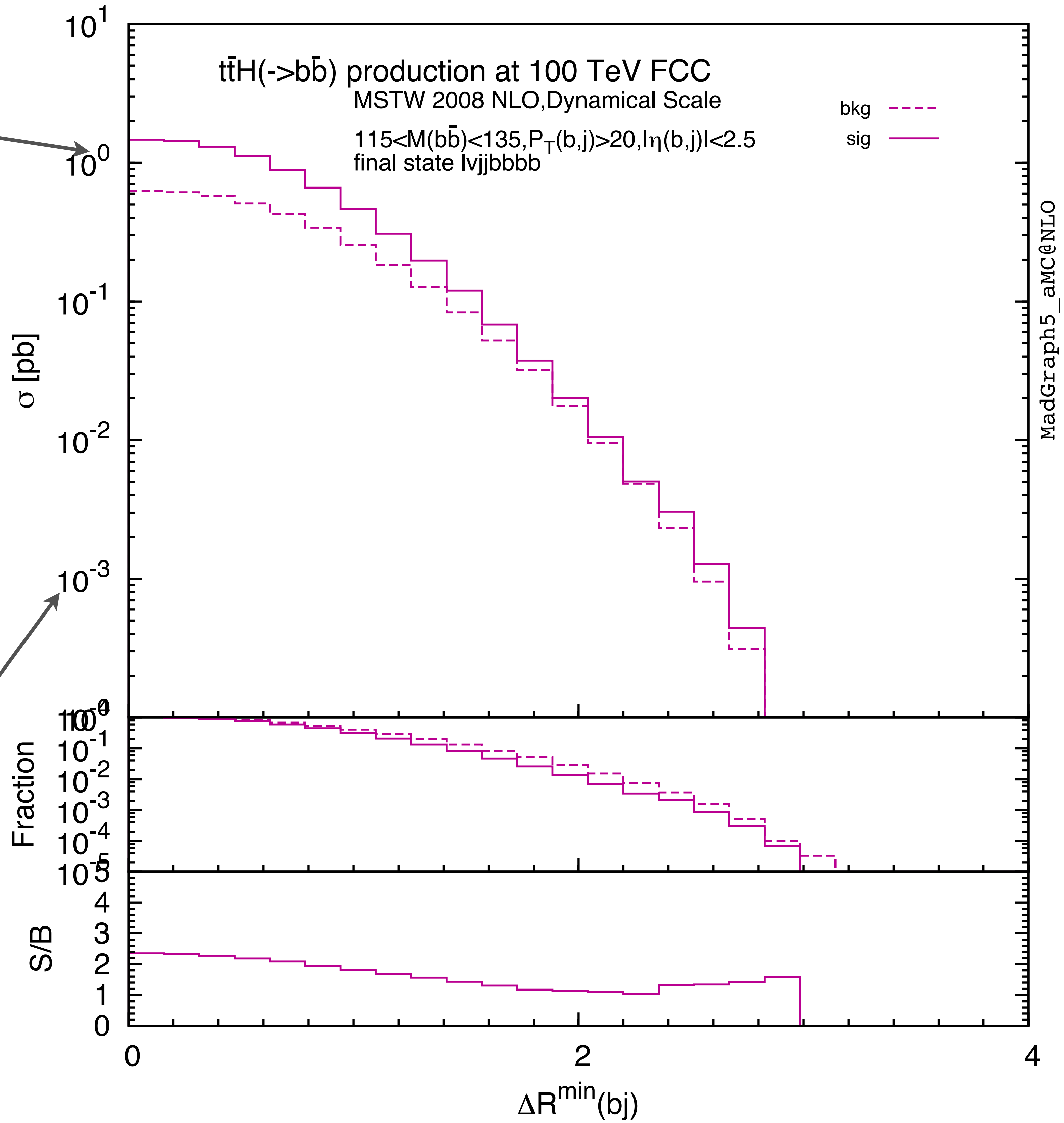

10 K events

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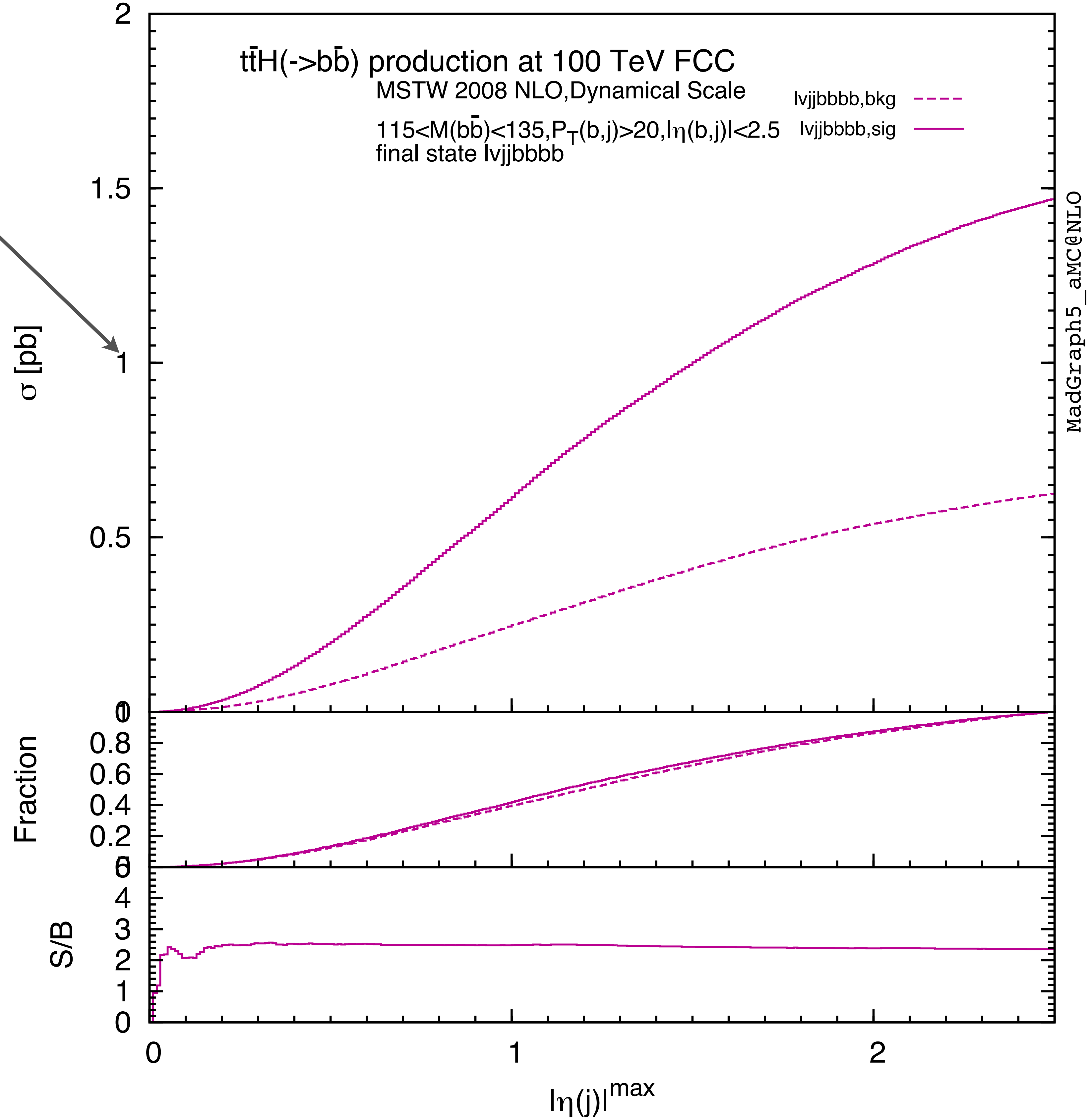
RAPIDITY

10 M events with 10 ab-1



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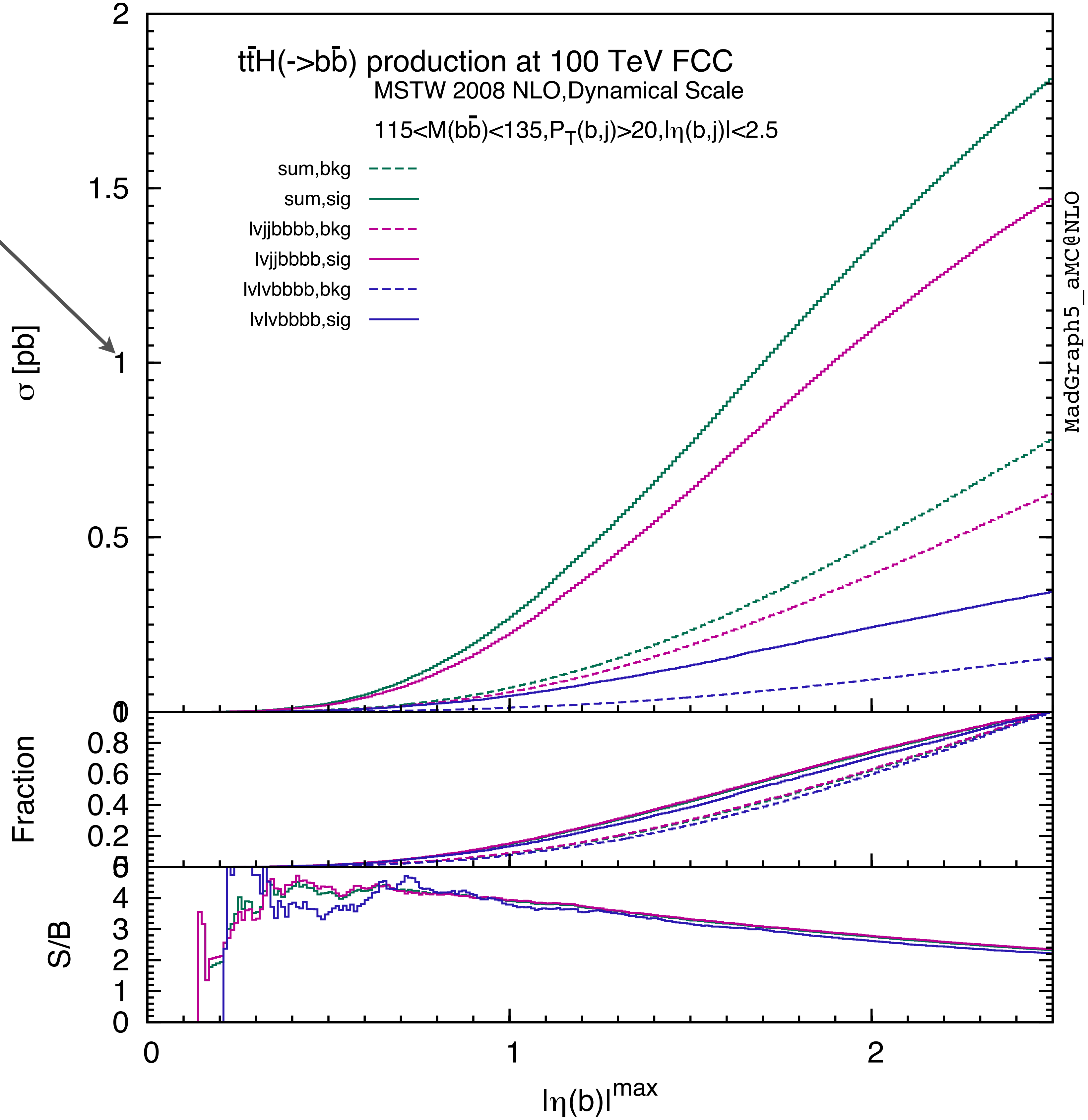

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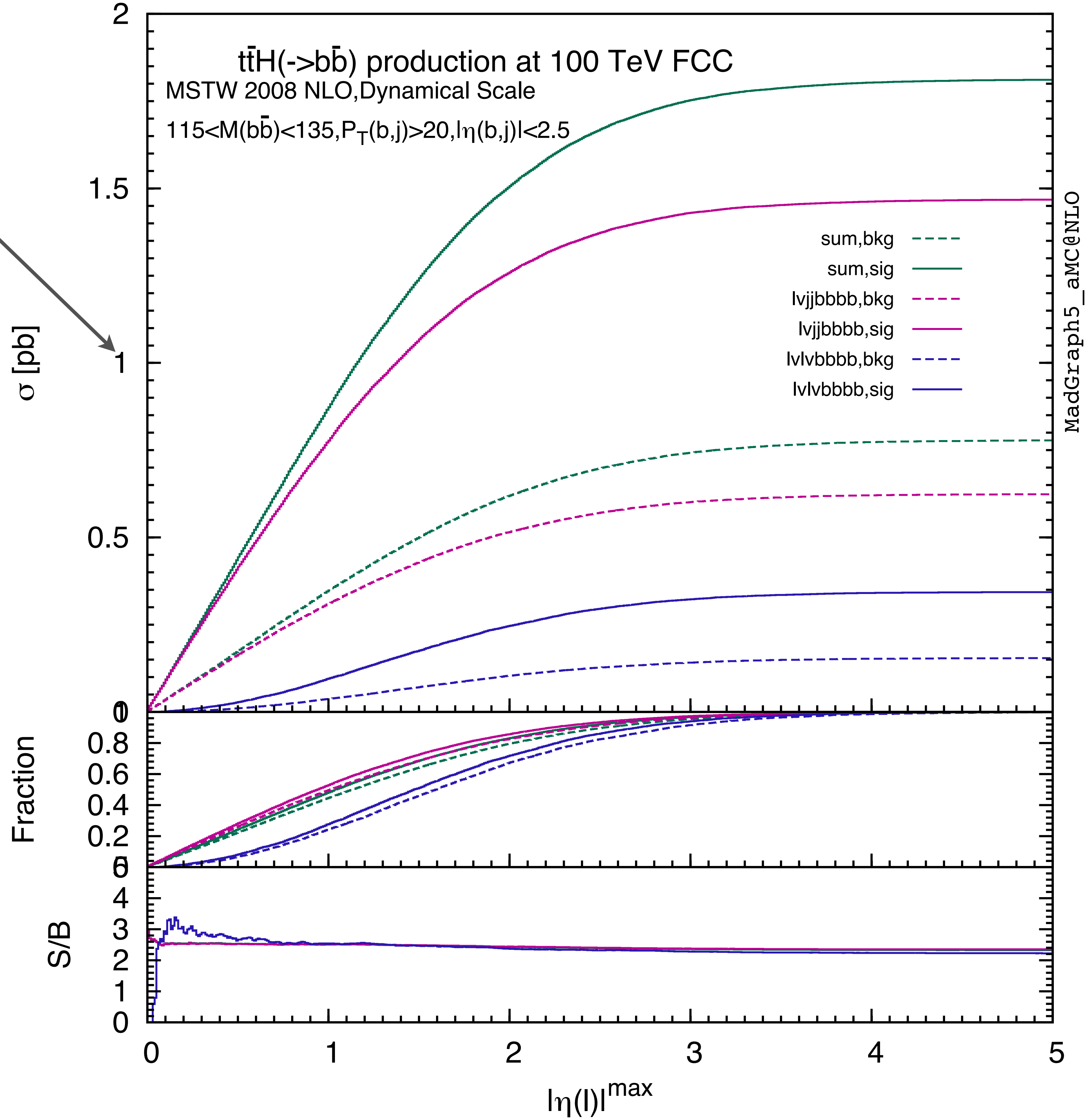

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