Hadronic Recoil Mass at 350 GeV and 420 GeV

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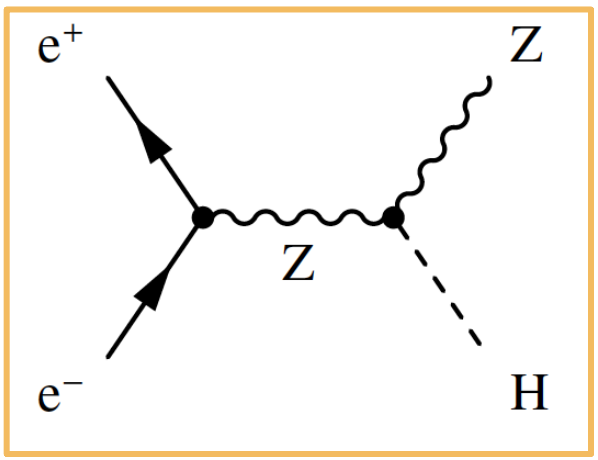

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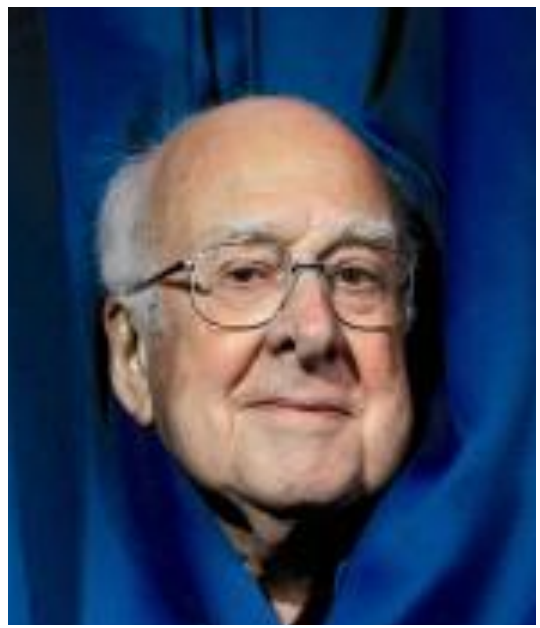

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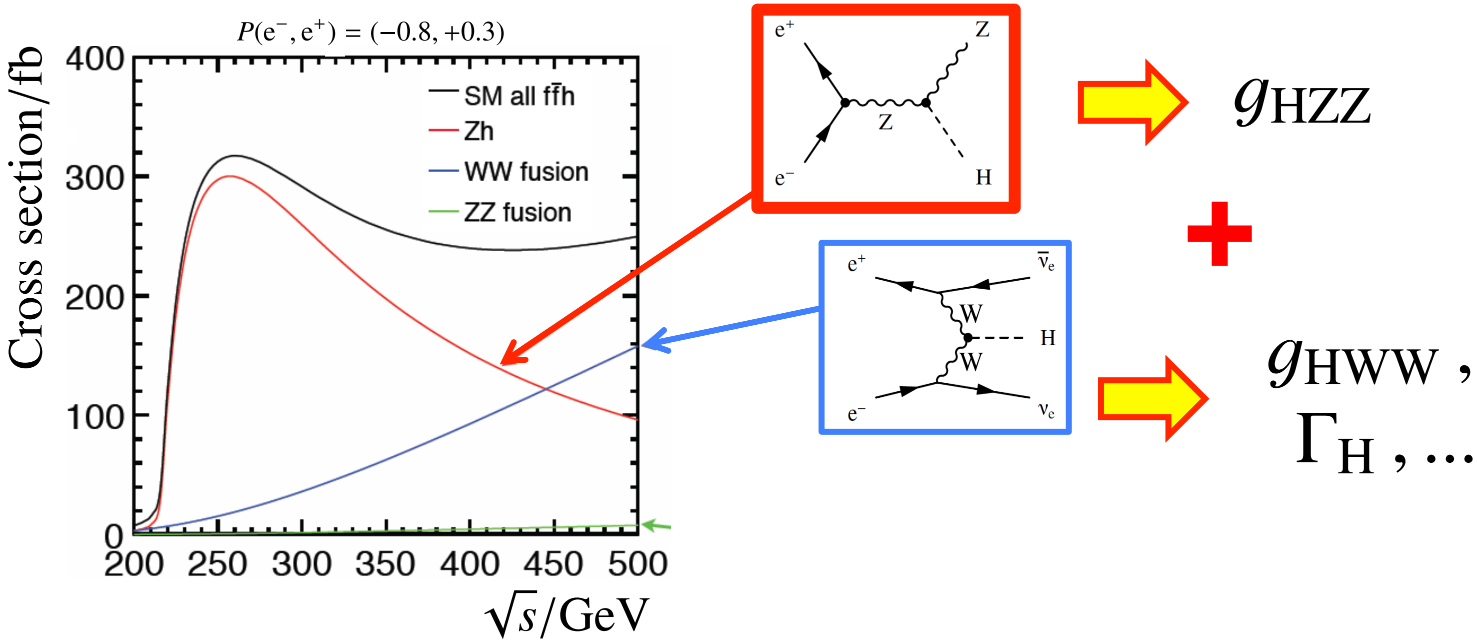
Motivation

- ★ Previously **H(Z→qq)** analysis studied at √s = 350 GeV
- ★ Provides nearly model-independent cross section measurement with Δσ(HZ) = 1.7 %
- ★ But: is √s = 350 GeV optimal ?
- ★ There are arguments for starting CLIC at higher √s



- ★ Higher √s: **better for WW-fusion and top**

Cross sections

- ★ Compare cross sections at 350 GeV and 420 GeV
- ★ Most significant change is decrease in HZ
- ★ Assuming:
  - same luminosity: 28 % fewer HZ events at 420 GeV
  - lumi. scales with γ_e: 14 % fewer HZ events at 420 GeV
- ★ All other things being equal:
  - For same lumi: might expect ~14 % worse precision

Process	350 GeV	420 GeV
HZ	93 fb	67 fb
$H\nu\nu$	51 fb	60 fb
qq	25180 fb	18442 fb
qqqq	5847 fb	4664 fb
qqll	1704 fb	1823 fb
$qql\nu$	5914 fb	5291 fb
$qq\nu\nu$	325 fb	329 fb

Results

- ★ Re-run hadronic recoil analysis **on 420 GeV** samples
- ★ Modify recoil mass range for preselection (more phase space)
- ★ Results (500 fb^{-1}):

	350 GeV	420 GeV	
$\Delta\sigma(HZ)_{vis}$	1.7 %	2.4 %	x 1.4
$\Delta\sigma(HZ)_{invis}$	0.6 %	1.0 %	x 1.8
$\Delta\sigma(HZ)$	1.8 %	2.6 %	x 1.5

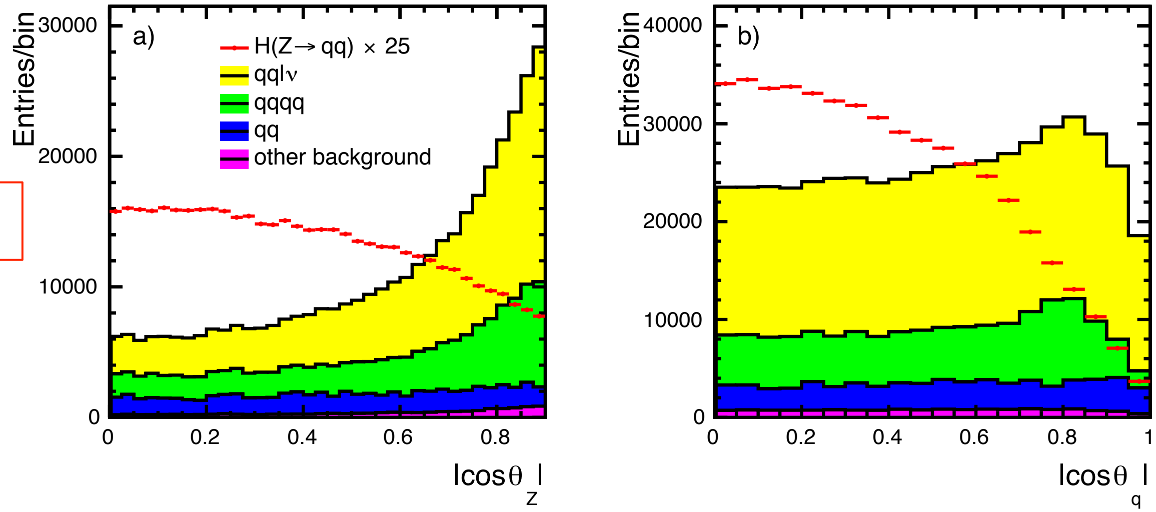
- ★ Significantly worse results at 420 GeV
  - Beyond what can be accounted for by HZ statistics

So what's going on ?

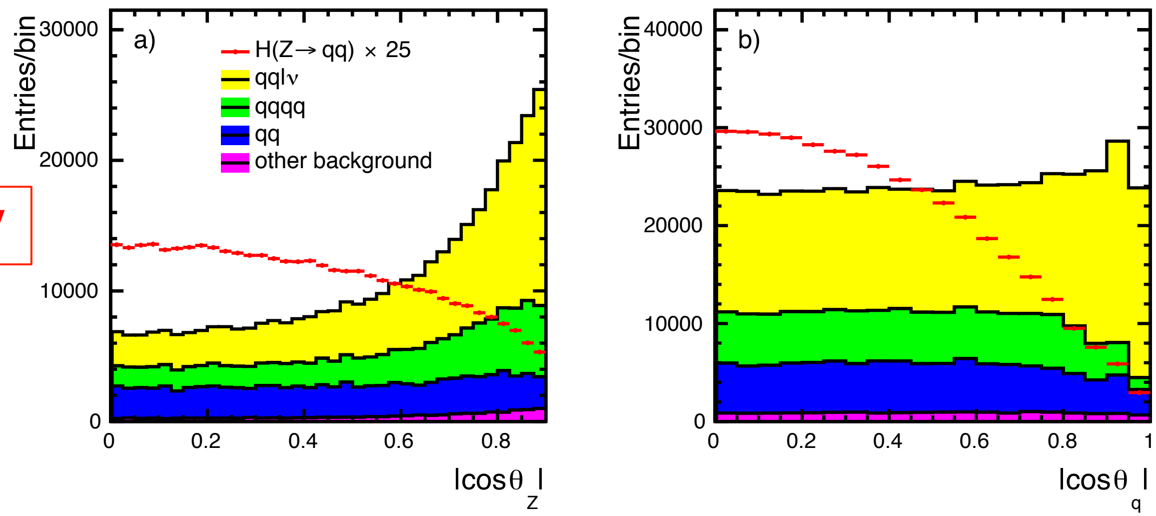
Likelihood Variables

★ e.g. visible hadronic recoil analysis variables (all based on Z→qq)

350 GeV



420 GeV

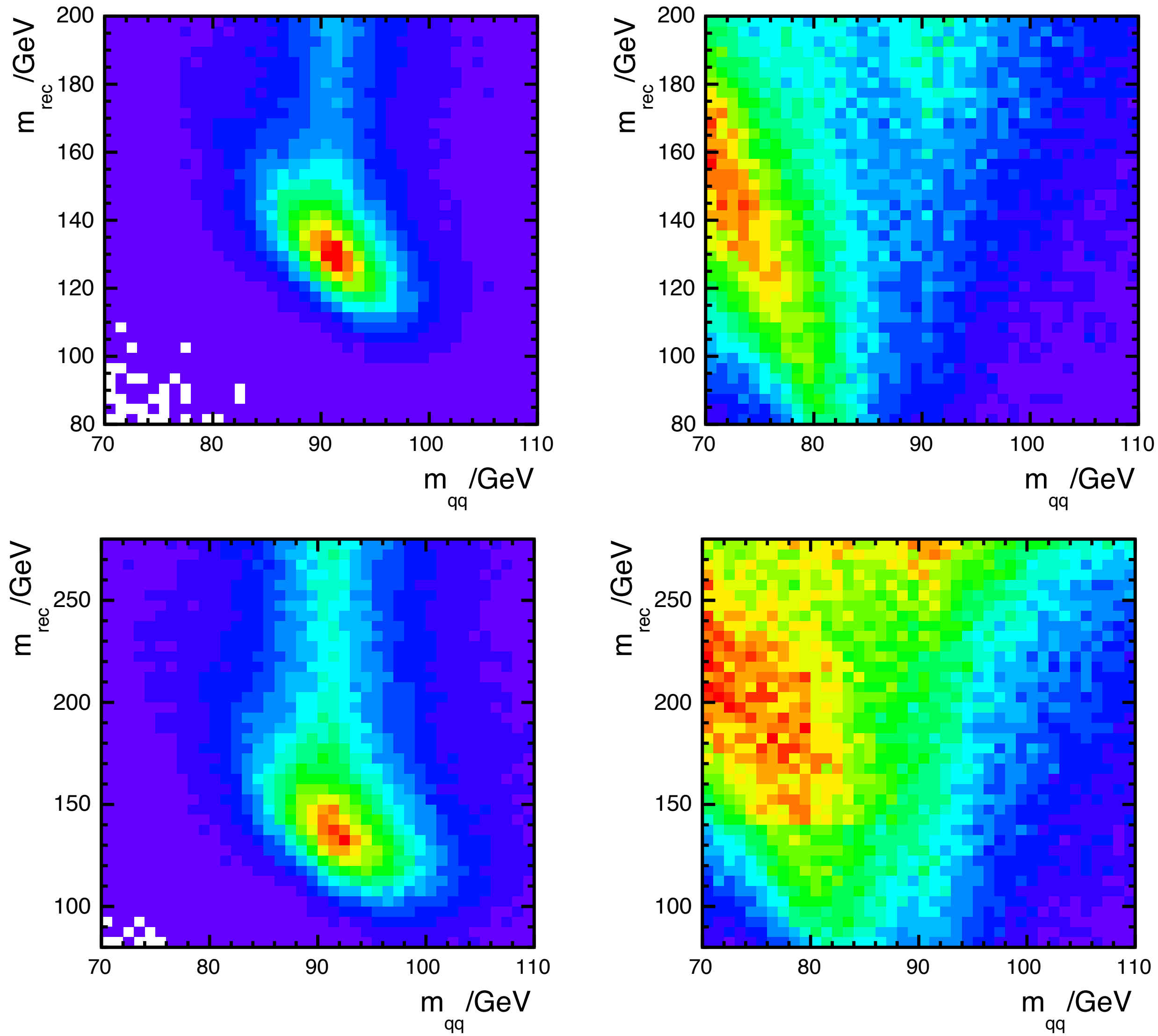


- fewer HZ events
- slightly lower background

Mass distributions

350 GeV

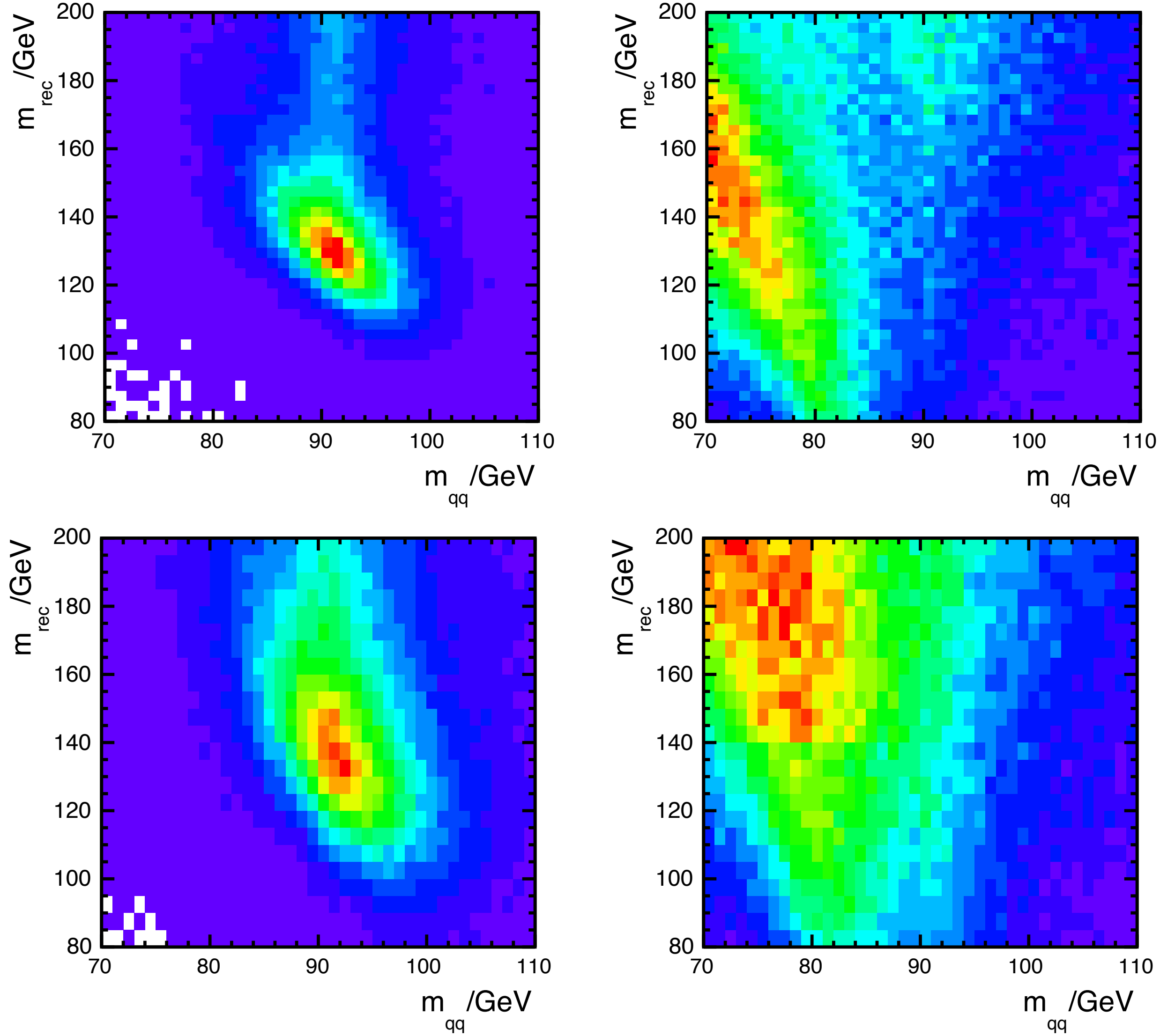
420 GeV



Mass distributions

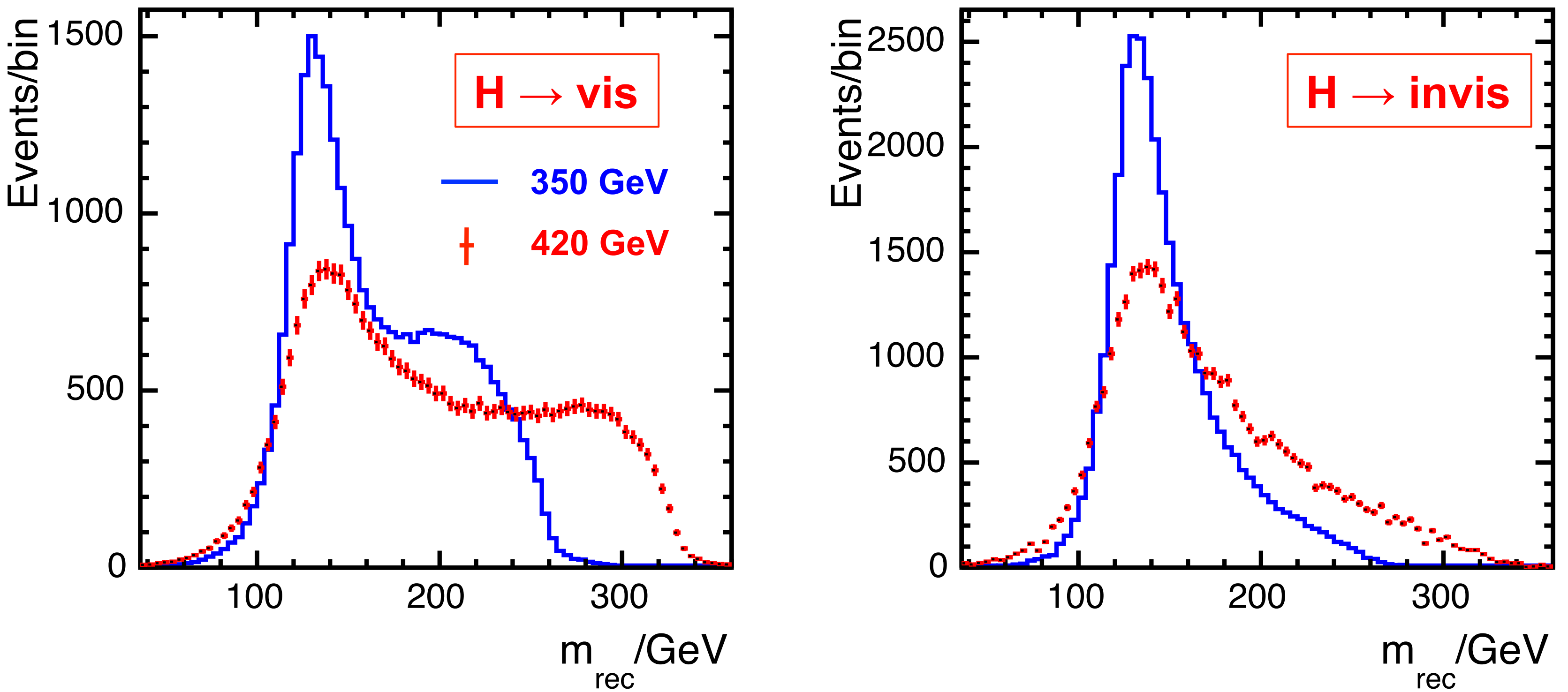
350 GeV

420 GeV



Recoil Mass

★ **Take a closer look at recoil mass distributions**
- **visible & invisible Higgs decay analyses**
- **for display scale 420 GeV distribution by: $\sigma(350)/\sigma(420)$**



★ **Recoil mass distributions at 420 GeV are much broader…**

Recoil Mass

★ **Easily understood…**

$$m_{\text{rec}}^2 = (\sqrt{s} - E_Z)^2 - (-\mathbf{p}_Z)^2$$
$$= s - 2\sqrt{s}\,E_Z + E_Z^2 - \mathbf{p}_Z^2$$
$$= s + m_Z^2 - 2\sqrt{s}(E_1 + E_2)$$

E_1 & E_2 are jet energies

$$\Rightarrow \quad \sigma_{m_{\text{rec}}} = \frac{\sqrt{s}}{m_{\text{rec}}}\left(\sigma_1^2 + \sigma_2^2\right)^{\frac{1}{2}}$$

for PFA: $\sigma_{E_{\text{jet}}} \sim \alpha E_{\text{jet}}$

$$\Rightarrow \quad \sigma_{m_{\text{rec}}} = \frac{\sqrt{s}}{m_{\text{rec}}}\alpha\left(E_1^2 + E_2^2\right)^{\frac{1}{2}}$$

Recoil Mass

★ Take case where both jets (in lab. frame) have same energy

$$E_1 = E_2 = \frac{s - m_H^2 + m_Z^2}{4\sqrt{s}}$$

$$\sigma_{m_{rec}} = \frac{1}{\sqrt{8}m_{rec}}\alpha\left(s - m_H^2 + m_Z^2\right)$$

⇨ $$\sigma_{m_{rec}} \sim s$$

★ Recoil mass resolution approximately scales with squared C.o.M. energy:

★ **Expect**

$$\sigma_{m_{rec}}(420\,\mathrm{GeV}) \sim 1.5 \times \sigma_{m_{rec}}(350\,\mathrm{GeV})$$

Conclusions

★ **For invisible Higgs:**

- **degraded resolution, background under recoil peak increases by x 1.5**
- **reduced HZ cross section x 0.72**

⇨ **Expect invisible cross section uncertainty to increase by**

$$\frac{\sqrt{B}}{S} = \frac{\sqrt{1.5}}{0.72} \sim 1.7$$

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★ **Degradation in performance largely understood…**