Hi Emily,
I've started the VBF-Higgs feasibility study for two decay channels: $H \to \gamma\gamma$ and $H \to \ell\ell\ell\ell$. I generated events with Pythia 8 for signal (including non-VBF Higgs production) and backgrounds and ran some published Rivet analyses over them. I assumed $\sqrt{s} = 13$ TeV for Run II.

Information by channel is given below. Cross sections are the values printed by Pythia 8 after generation. The generation phase space was restricted for some samples to get more relevant events.

Diphoton channel
Generated events (cross section in generated phase space in mb):

Sample	Phase space cuts	Cross section (mb)
VBF Higgs		8.283e-12
Non-VBF Higgs		6.856e-11
All Higgs		7.941e-11
Multijets	$\hat{p}_\perp > 20$ GeV	8.613e-01 ± 1.486e-02
Prompt $\gamma\gamma$	$\hat{m} > 20$ GeV	4.348e-06

$\hat{p}_\perp$ means the transverse momentum of each jet and $\hat{m}$ the invariant mass of the particles produced in the hard process. In this case, $\hat{m} = m_{\gamma\gamma}$.

Rivet analyses `MC_PHOTONJETS` and `MC_JETS`.

Tetralepton channel
Generated events (cross section in generated phase space in mb):

Sample	Phase space cuts	Cross section (mb)
VBF Higgs		4.378e-13
Non-VBF Higgs		3.418e-12
All Higgs		3.813e-12
ZZ		7.127e-11

Rivet analyses `MC_ZZJETS` and `MC_JETS`.

The signal cross section in the tetralepton channel is 20 times smaller than in the diphoton channel.

Analysis
I would like to write an analysis that

- reconstructs the diphoton/tetralepton mass, and
- reconstructs the mass of the additional jets (which ones → check VBF-Z paper) and allows a cut on it.

I think it's easiest to do this analysis in Rivet. I've never written Rivet code, now learning to.

There is a "Higgs + jets" analysis in Rivet (you or Keith mentioned this in our meeting), but it uses the $H \to \tau\tau$ channel. Could of course be modified.

In order to make the feasibility study more realistic (and thus worthwhile), I should probably apply Gaussian smearing to the photon, lepton, and jet momenta. I may also need to simulate pile-up.