Project Update:

F O A M

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Lightning Review: The First Three Weeks

Week 1

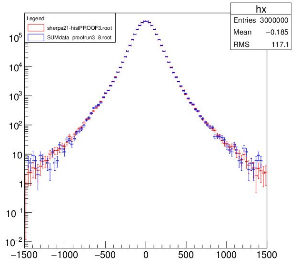
Project setup, getting used to ROOT, LXPLUS, and the wifi.

[1]

Began comparing MC MadGraph 5 with Sherpa.

Week 2

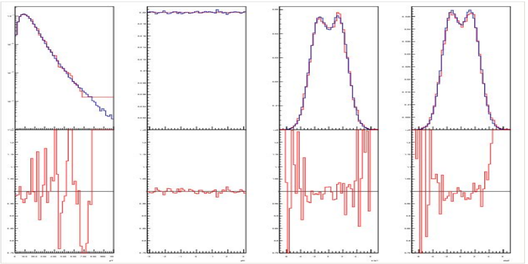
Verified MG5 against Sherpa, worked on visualizing histograms.



Began exploring FOAM.

Week 3

Successful FOAM implementation of gg>tt~ process, comparison with MG5.



“Cool beans, but what have you done recently?”

More processes

Expanded g g → t t~ to include one or both of the decays: t → b w+ and t~ → b~ w- .

High FOAM performance harder to achieve here, limited by computation time.

PS parameterization

MC generation over higher-dimensional phase space for these processes.

Some flexibility exists in which particle degrees of freedom are removed via conservation laws.

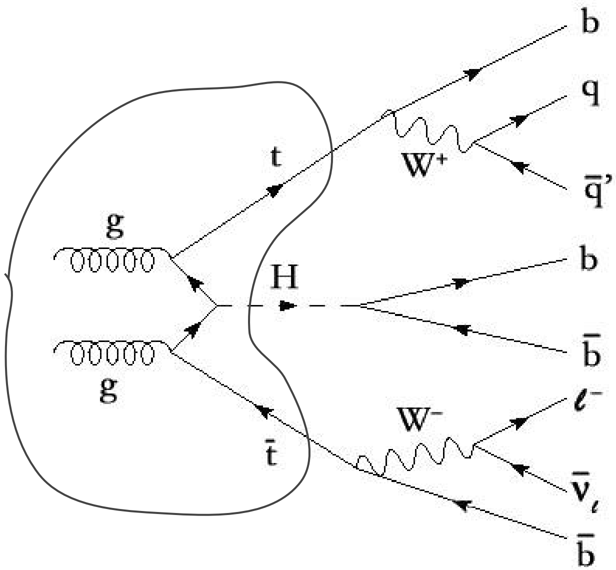
Var. transformations

Choosing nonlinear mappings between FOAM and physical variables.

‘Biasing’ the FOAM to perform more cell splits in PS regions where more precision is desired (e.g. dilating peaks).

More processes

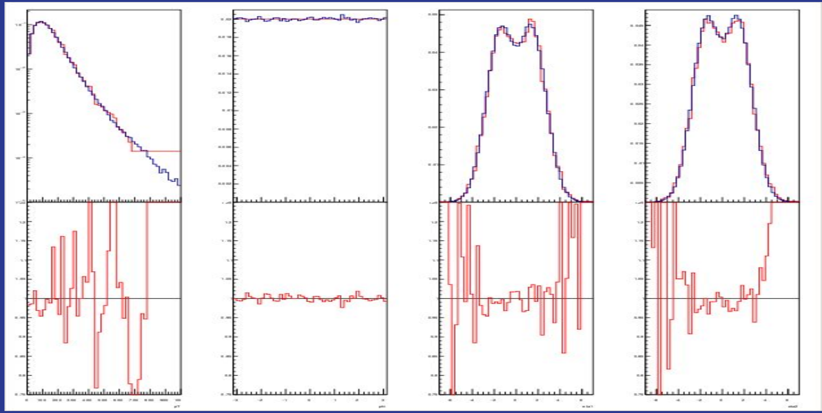
Long term goal is to apply FOAM to the full ttH diagram:



[2]

But we need to build up to this:

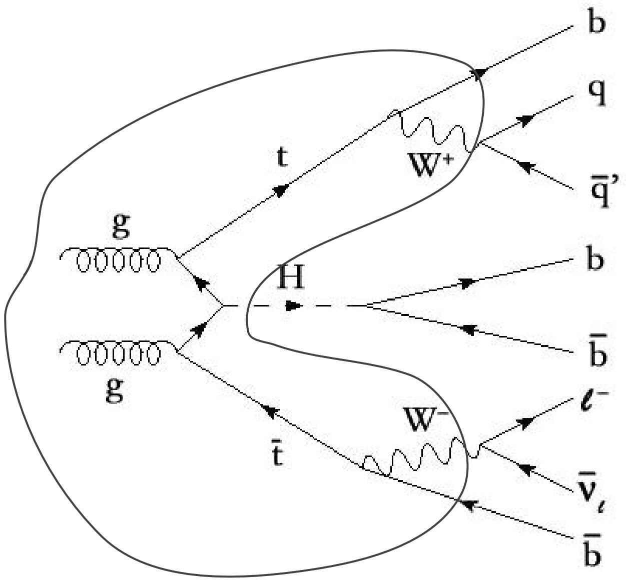
g g > t t~ [discussed in talk #1]



4-dimensional FOAM

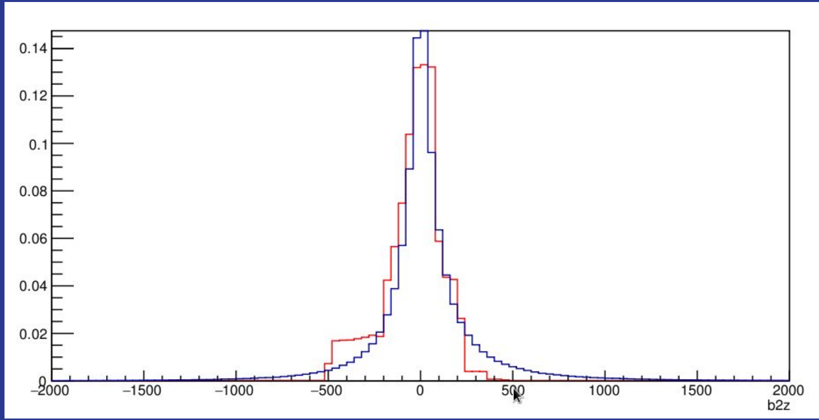
More processes

Long term goal is to apply FOAM to the full ttH diagram:



[2]

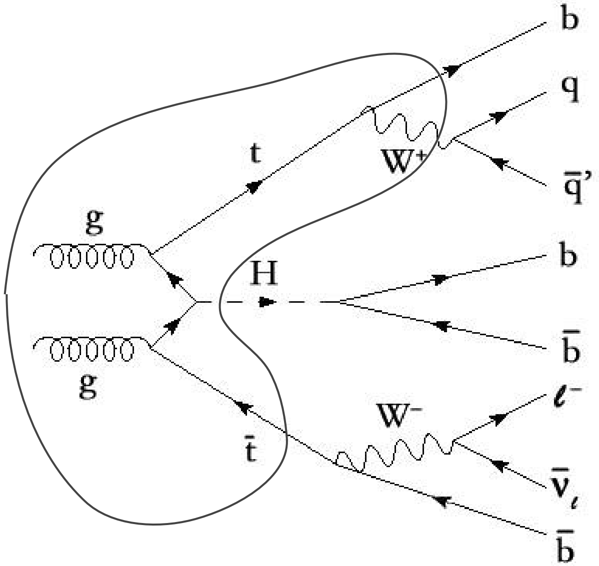
g g > t t~ with (t > b w+, t~ > b~ w-)



10-dimensional FOAM

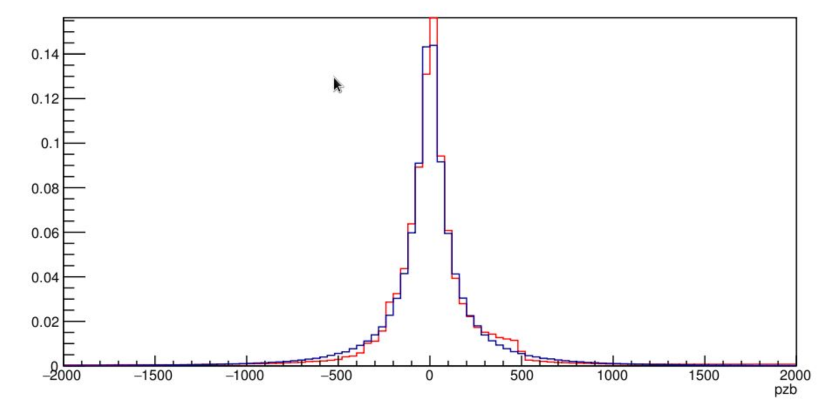
More processes

Long term goal is to apply FOAM to the full ttH diagram:



[2]

g g > t t~ with (t > b w+)



7-dimensional FOAM

PS Parameterization:

tt~ xs: $$\sigma^{t\bar{t}} = \int \frac{1}{F(x_1,x_2)} \int f(x_1,Q^2)\, f(x_2,Q^2) |M|^2 \delta^4(p_A + p_B - p_1 - p_2 - p_3 - p_4) \prod_{i=1}^{4} \left(\frac{d^3 p_i}{2E_i (2\pi)^3} \right) dx_1 dx_2$$

Integral over 14-dim, but can apply conservation laws to reduce to 10-dim.

Difficulty is choosing which variables to cancel from the integral.

Import property of dirac functions: $$\delta(f(x)) = \left| \frac{df}{dx} \right|_{x_0}^{-1} \delta(x - x_0)$$

Possible to decompose delta in integral as a product in desired variables.

Then reduces to form such as: $$\sigma^{t\bar{t}} = \frac{1}{2^{12}\pi^8} \int \frac{1}{F(x_1,x_2)} f(x_1,Q^2)\, f(x_2,Q^2) |M|^2 \prod_{i=2}^{4} \left(\frac{d^3 p_i}{E_i} \right) dx_2$$

Variable Transformations:

Simplest way to map physical variables to FOAM is a linear scaling.

This can work well usually, but FOAM struggles to resolve sharp features.

Will need fewer cells to accurately model a curve with less curvature.

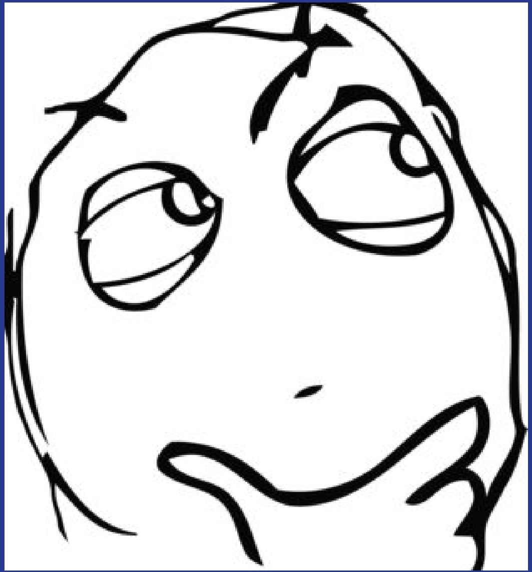
Solution: Nonlinear transformations between the FOAM and physical variables

Example! https://www.desmos.com/calculator/lv5hca7upt [3]

Works Cited:

- [1]: DepositPhotos
- [2]: WikiMedia Commons
- [3]: Desmos Graphing Calculator
- [4]: Pinterest

Questions?



[4]