

Search for Contact Interactions @ 8 TeV

Status Report

Suman Beri¹, Supriya Jain²,
Greg Myers³, Harrison B. Prosper³

¹Panjab University, ²SUNY Buffalo, ³Florida State University

Exotica-Multijets Meeting

27 June 2013

Outline

1. Overview
2. Analysis Overview
3. Status
4. Plans

Overview

Goal

- Using the full 8 TeV data set, compare measured inclusive jet p_T spectrum of central jets to QCD+CI models aiming for a preliminary result by this summer.

Experimental input

- Measured inclusive jet p_T spectrum above 500 GeV where trigger efficiency is flat
- Jet energy resolution (JER) σ vs. (true) jet p_T
- Jet energy scale uncertainty (JES) (2% – 4%)
- Jet energy resolution uncertainty (10%)

Overview

Theoretical input

- Program to calculate QCD @ NLO
fastNLO (v2.1.0-1360 + fnl3323y0.tab)
- Program to calculate CI @ NLO
CIJET (v1.0, Gao, arXiv:1301.7263v1)

Overview: Models

At next-to-leading order (NLO), the effective Lagrangian describing QCD-like interactions may be written as

$$L = L_{QCD} + 2\pi\lambda \sum_{i=1}^6 \kappa_i O_i$$

where $\lambda = 1/\Lambda^2$ and κ_i are free parameters*, and each O_i is a sum over dimension six operators:

$$O_{1,2} \sim \bar{u}_L \gamma_\mu u_L \bar{u}_L \gamma^\mu u_L$$

$$O_{3,4} \sim \bar{u}_L \gamma_\mu u_L \bar{u}_R \gamma^\mu u_R$$

$$O_{5,6} \sim \bar{u}_R \gamma_\mu u_R \bar{u}_R \gamma^\mu u_R$$

* In order to avoid confusion with $\lambda = 1/\Lambda^2$, we use κ_i instead of λ_i as in Gao et al.'s paper

Overview: Models

At NLO, the cross section per jet p_T bin is of the form

$$\sigma = \sigma_{\text{QCD}} + [b + b' - b'' \ln \lambda] \lambda + [a + a' - a'' \ln \lambda] \lambda^2$$

where σ_{QCD} is the SM cross section at NLO.

Notes:

1. The primed terms vanish at leading order.
2. The cross section is *linear* in the terms involving λ .

Analysis Overview

We are following the approach of the 7 TeV analysis, but with the following changes:

1. Compute all model spectra at NLO and smeared with the jet response function given in SMP-12-012
2. Compute (QCD+CI)/QCD bin-by-bin using fastNLO and CIJET. (Ansatz no longer needed.)
3. Assume a *constant* 4% uncertainty in JES
4. Compute limits using a Bayesian method *only*

As in the 7 TeV analysis, we are doing a pure *shape* analysis

Analysis Overview

Analysis Steps

1. Generate 100 MSTW2008 PDF sets using the procedure described at <http://mstwpdf.hepforge.org/random/>.
Do same for CT10.
NNPDF21 already available as a sample.
2. For each PDF set and renormalization and factorization scales, calculate σ_{QCD} and all coefficients required to calculate inclusive jet p_{T} spectrum for given values of λ and κ_i .

Analysis Overview

Analysis Steps

3. Convolve σ_{QCD} and these coefficients with the jet response function for randomly sampled pairs (x, z) of the JES and JER,

$$c_{\text{obs}}(p_T | x, z) = \int_0^\infty \text{Gaussian}(xp_T | p'_T, z\sigma(p'_T))c(p'_T)dp'_T$$

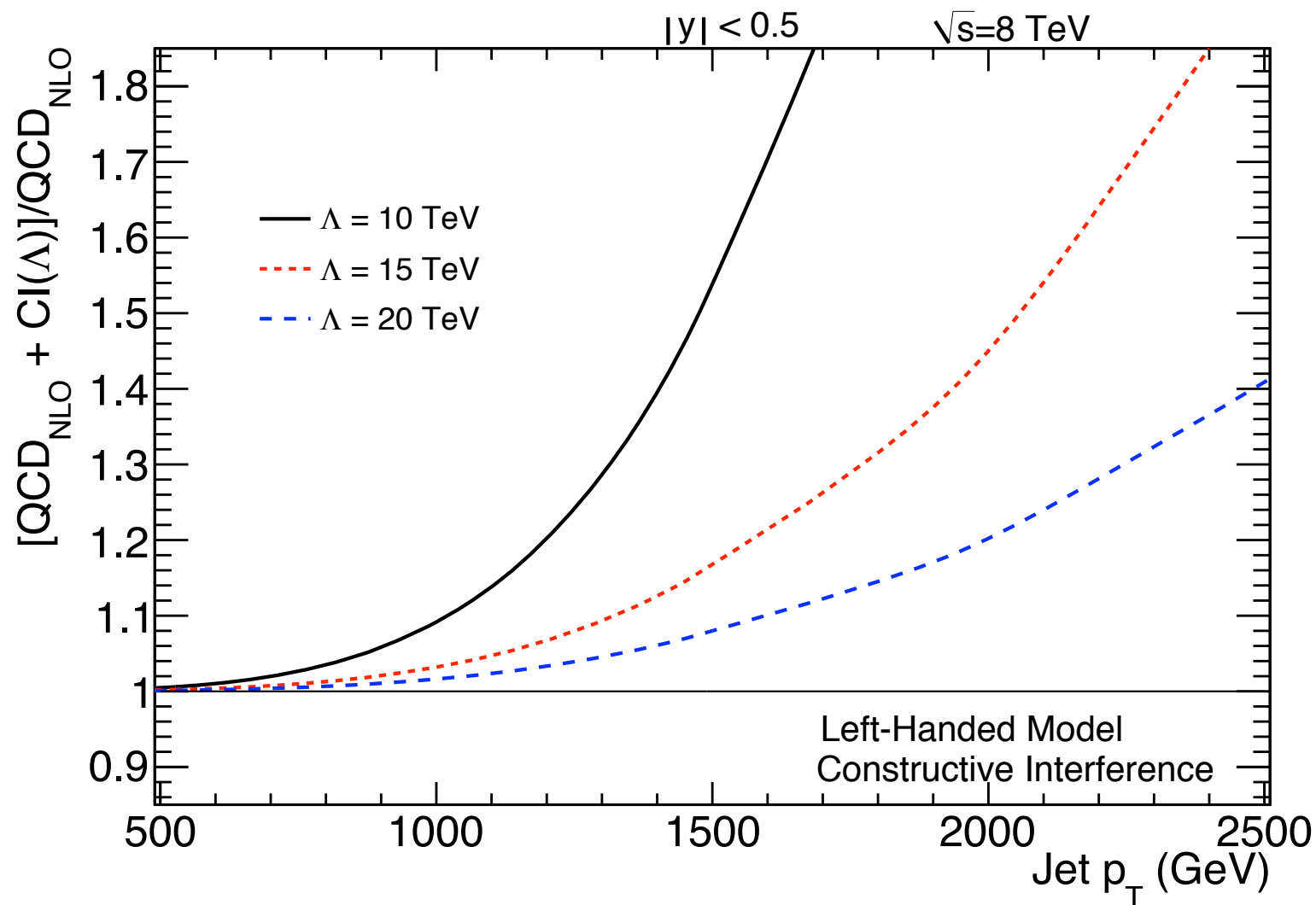
where c is a coefficient. Given the smeared coefficients, we can calculate the model spectra for any choice of λ and κ_i .

4. Compute limits using 7 TeV analysis procedure

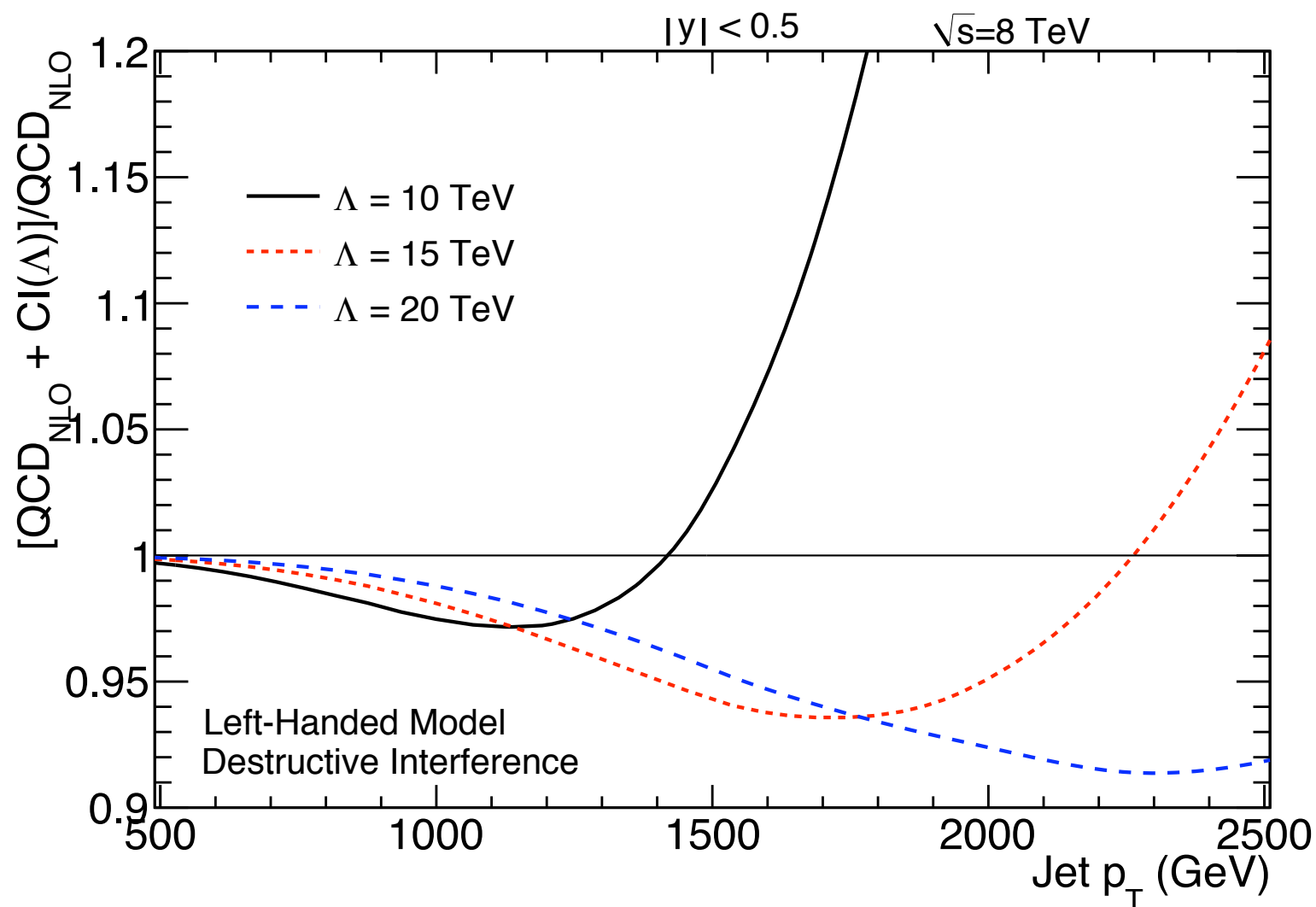
Status

- We have calculated the QCD and CI spectra for the nominal choices of renormalization and factorization scales, different values of Λ and two sets of values for the coefficients κ_i . (Myers, Beri, HP)
- The RooFit/RooStats implementation of the likelihood has been completed (Jain, HP)

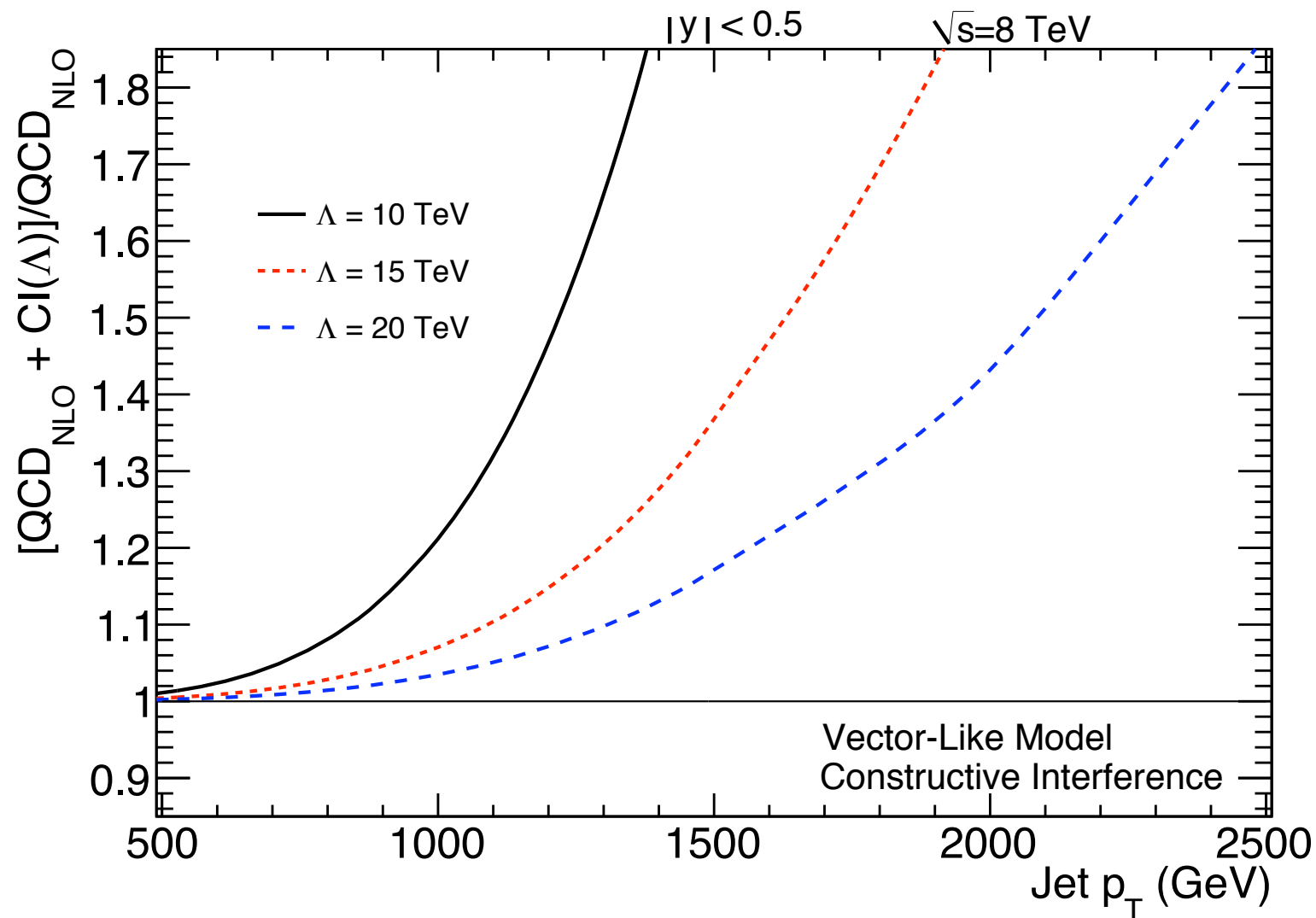
Left-Left Model



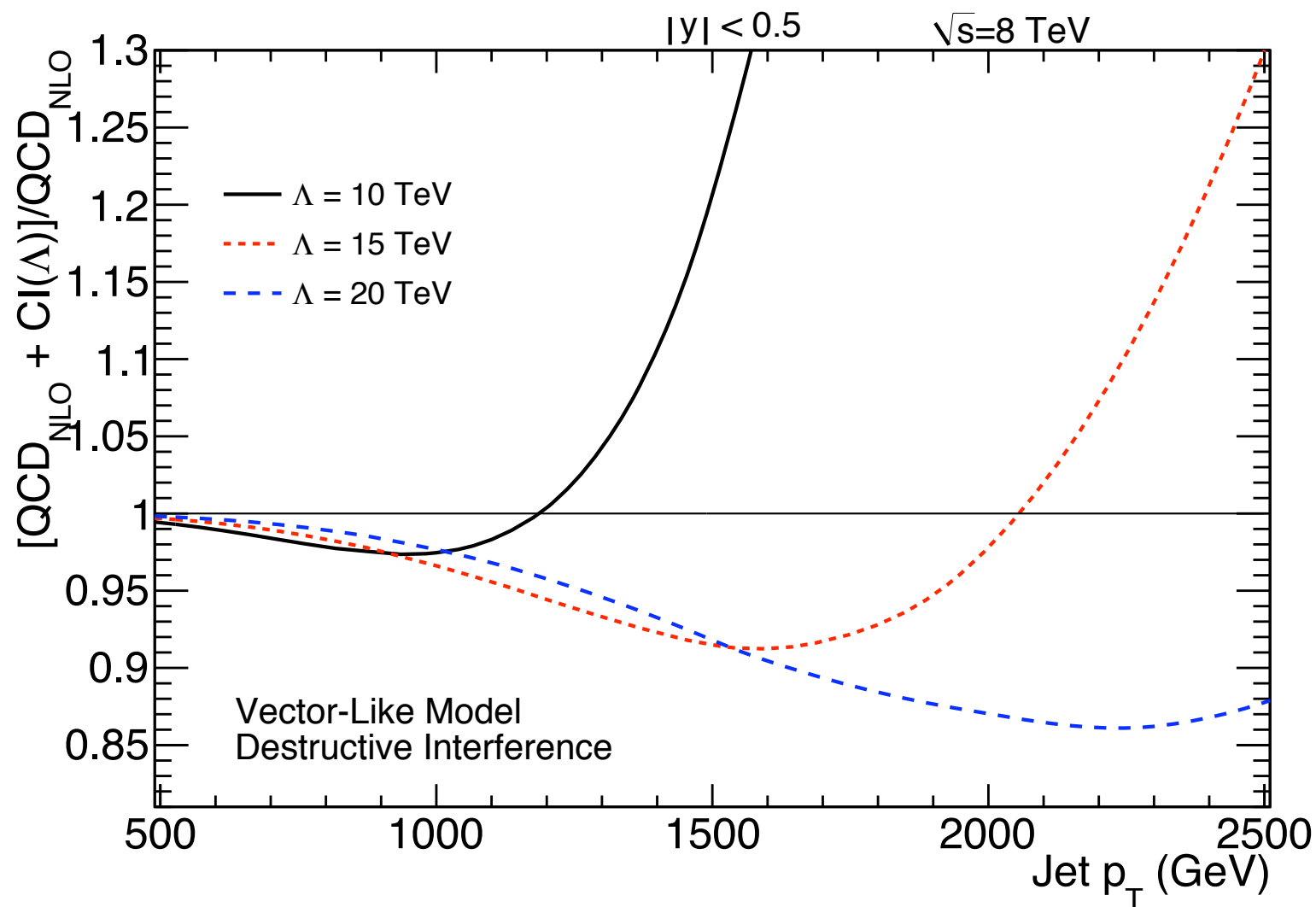
Left-Left Model



Vector-like Model



Vector-like Model



Plans

- Smear all models with jet response function for randomly sampled JES and JER
- Compute preliminary limit
 - Without and with JES and JER systematics
 - With JES, JER, PDF and renormalization and factorization scale variations
- Timescale
 - 1 to 2 months