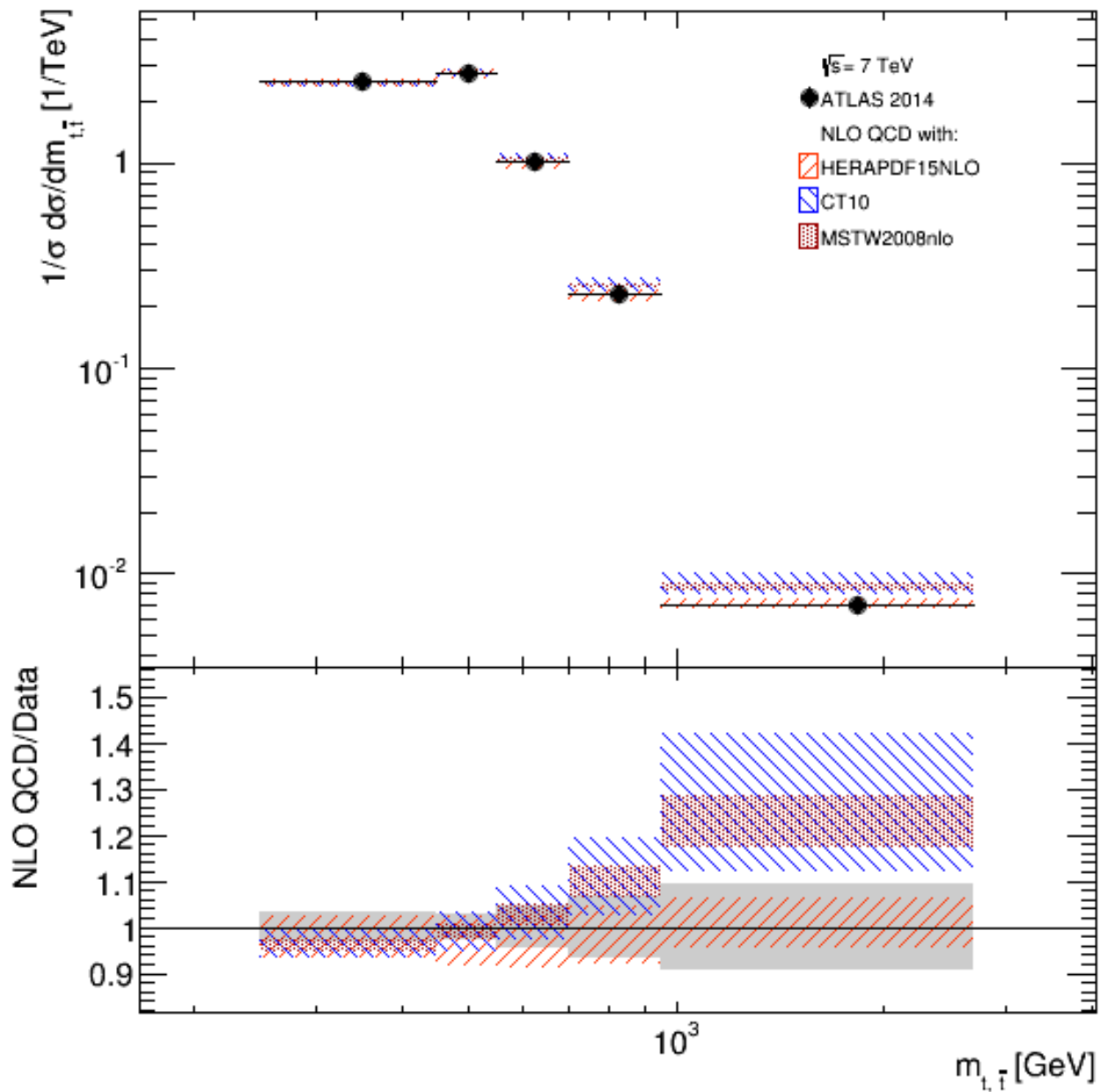


SPECTRUM

CERN – ATLAS Research Semester: Fall '14

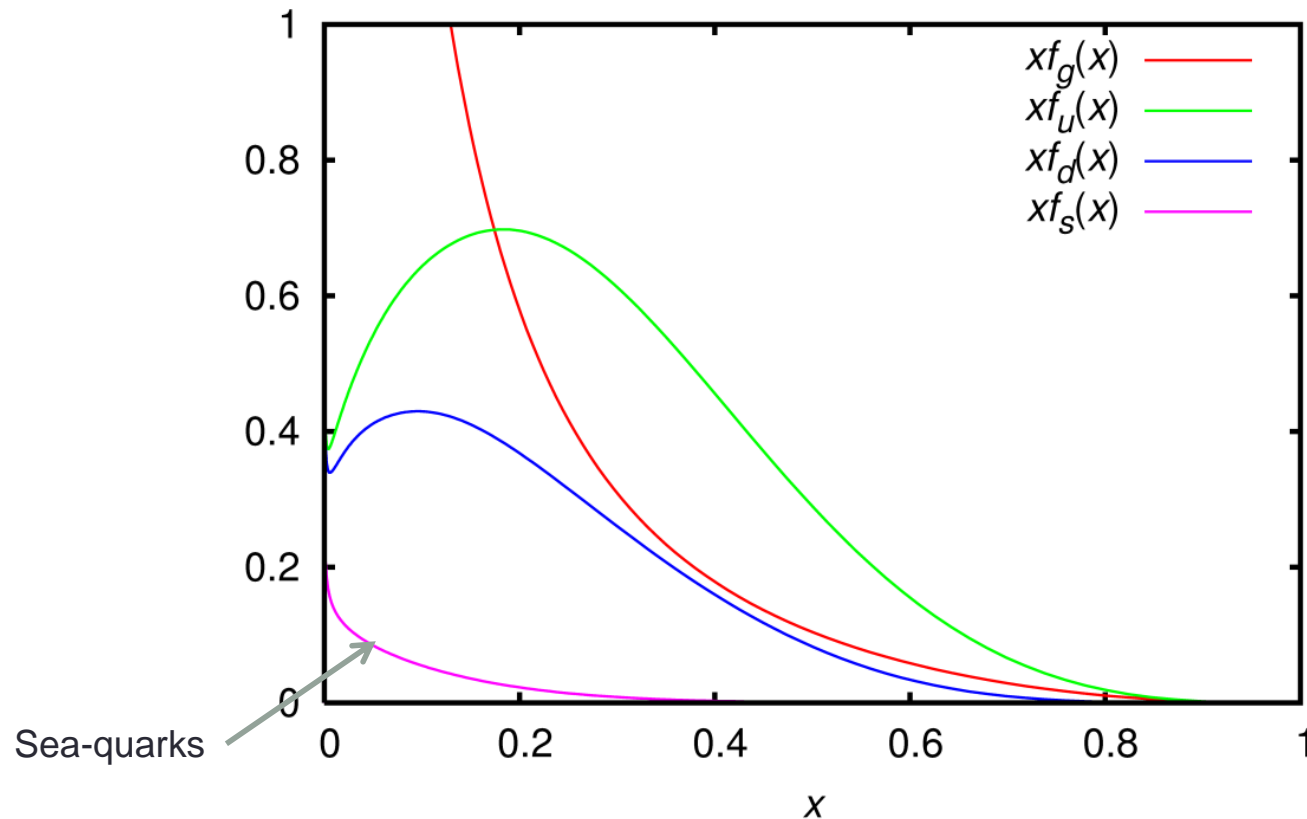
Joe Gibson, Computer Engineering

Grand Valley State University



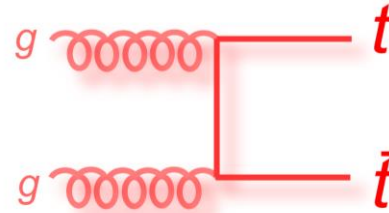
Parton Density Function

Defined as: probability density for finding a particle with a certain longitudinal momentum fraction x at resolution scale Q^2



Cross Section for Specific Process

$$g + g \rightarrow t + \bar{t}$$



Cross section

Factorization
scale

Renormalization
scale

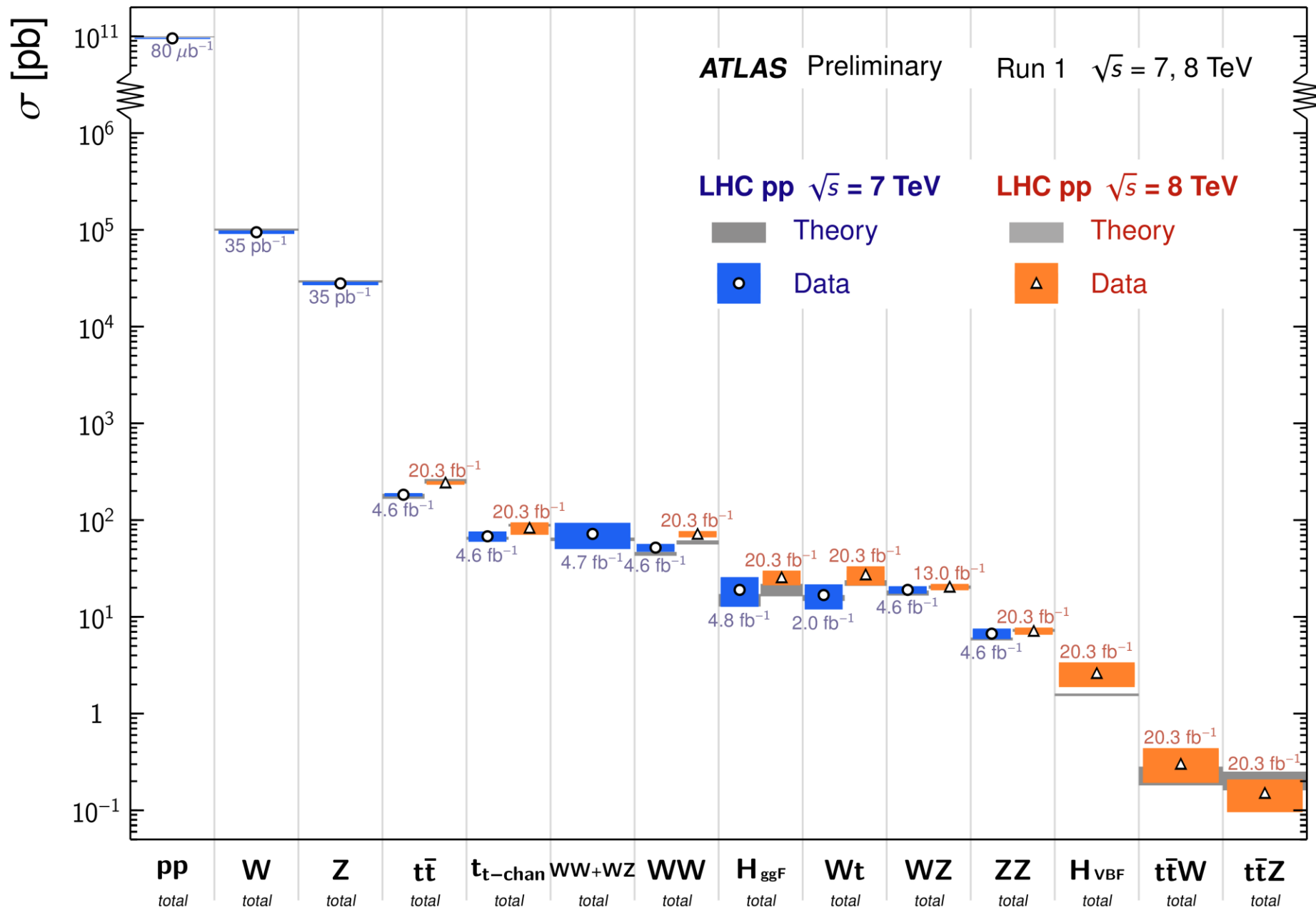
$$\sigma = \Sigma \alpha_s(\mu_R^2) \int f(x_1, x_2, \mu_F^2) \text{MI}(x_1, x_2, \mu_R^2, \mu_F^2) dx_1 dx_2$$

PDF
Obtained by
comparing experimental
cross section to calculations

Matrix element:
Calculated with
Feynman rules for
specific process

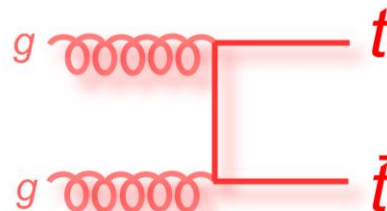
Standard Model Total Production Cross Section Measurements

Status: July 2014



Cross Section for Specific Process

$$g + g \rightarrow t + \bar{t}$$



Cross section

Factorization
scale

Renormalization
scale

$$\sigma = \sum \alpha_s(\mu_R^2) \int f(x_1, x_2, \mu_F^2) \text{MI}(x_1, x_2, \mu_R^2, \mu_F^2) dx_1 dx_2$$

PDF
Obtained by
comparing experimental
cross section to calculations

Matrix element:
Calculated with
Feynman rules for
specific process

Traditional NLO Programs

- Calculate cross section for specific processes
 - MCFM
 - NLOJet++
- Can take days or even weeks to perform calculation

- Longest Spectrum Plot takes ~20 seconds

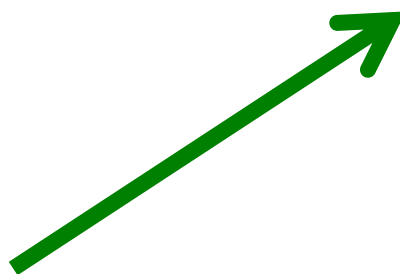
Spectrum Changes (v0.7.1)

- <https://github.com/gibsjose/Spectrum/blob/master/RELEASE.md>
- Major Changes
 - Single data format
 - Data/Grid Metadata (author, journal, year, arXiv, etc.)
 - Re-design of Cross Section Normalization
 - Issues with 'divided by bin width' and 'normalize to total sigma'
 - Convolute/Reference and Convolute/Nominal ratios
 - Overriding plot bounds for overlay/ratio
 - Bin matching
 - Grid electroweak and hadronization corrections

Data Format Consolidation

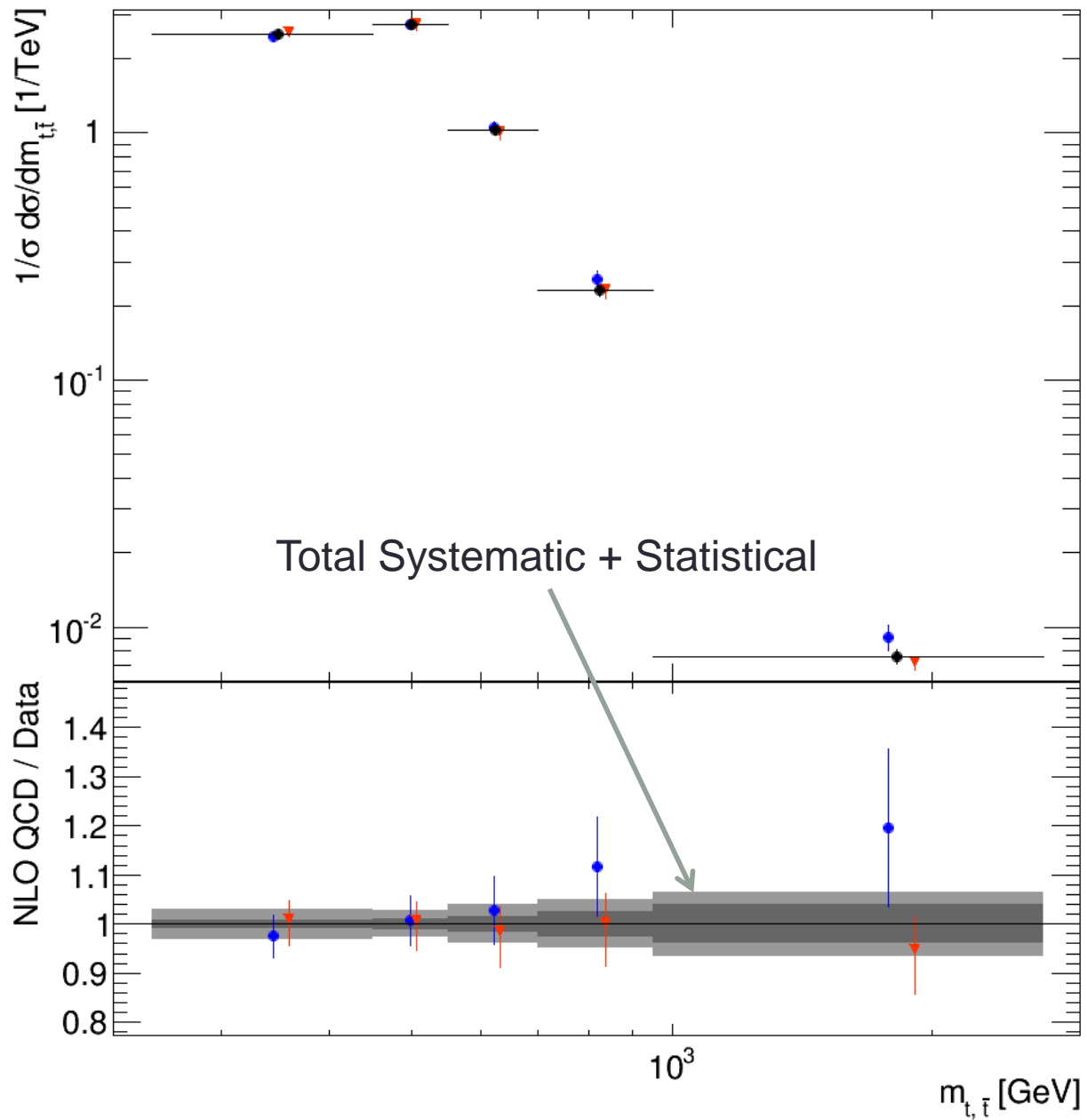
- ~~Data formats~~
 - ~~Spectrum T1S~~
 - ~~Spectrum T1A~~
 - ~~Spectrum T2S~~
 - ~~Spectrum T2A~~
 - **Spectrum T3S**
 - **Spectrum T3A**
 - ~~HERAFitter~~
- ~~Systematic Errors~~
 - ~~Symmetric or Asymmetric (S/A)~~
 - ~~Total or Total + Individual (T1/T2)~~
 - **Individual Systematic Errors (T3)**
 - ~~Explicit (HERAFitter)~~

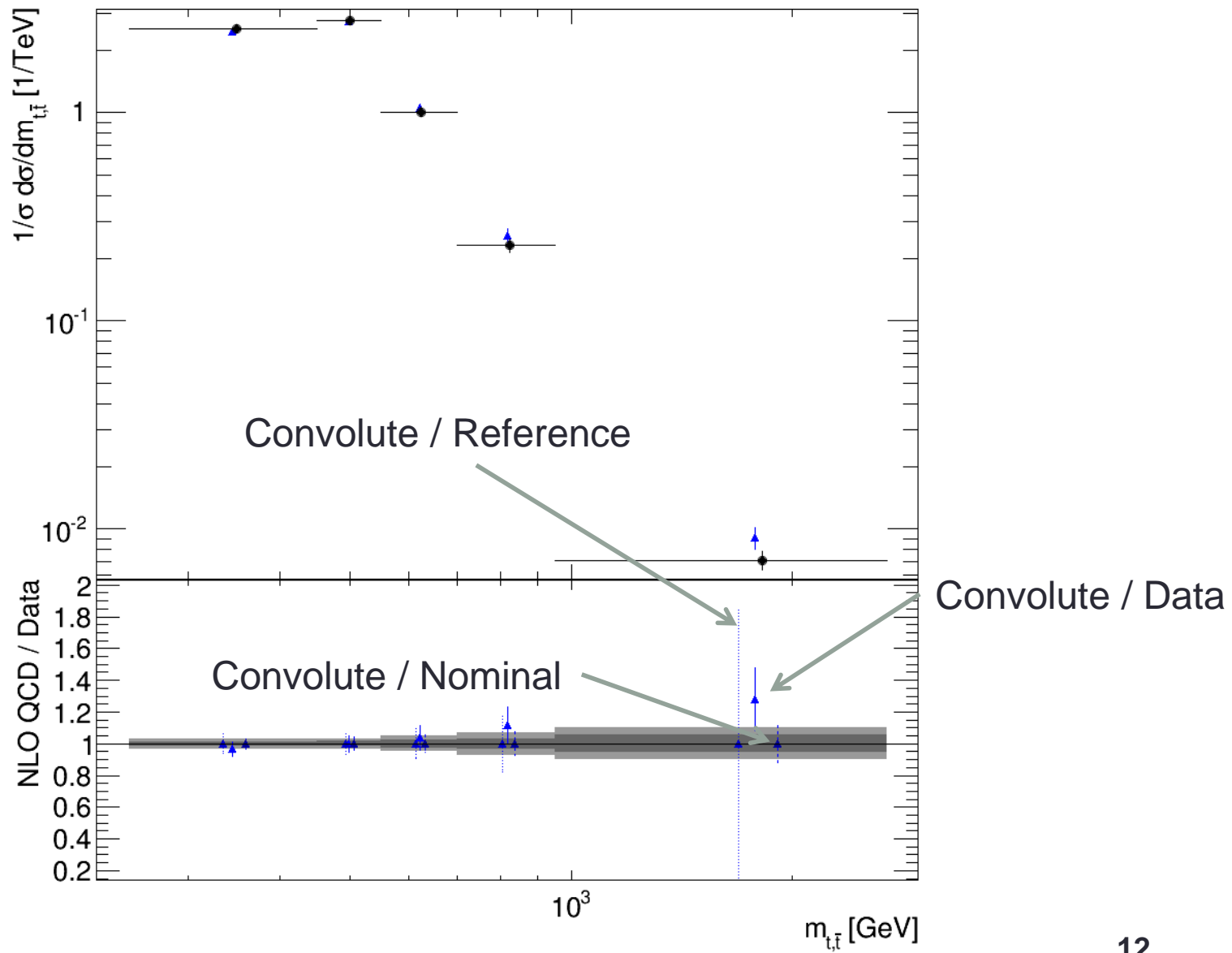
Single Spectrum
Format

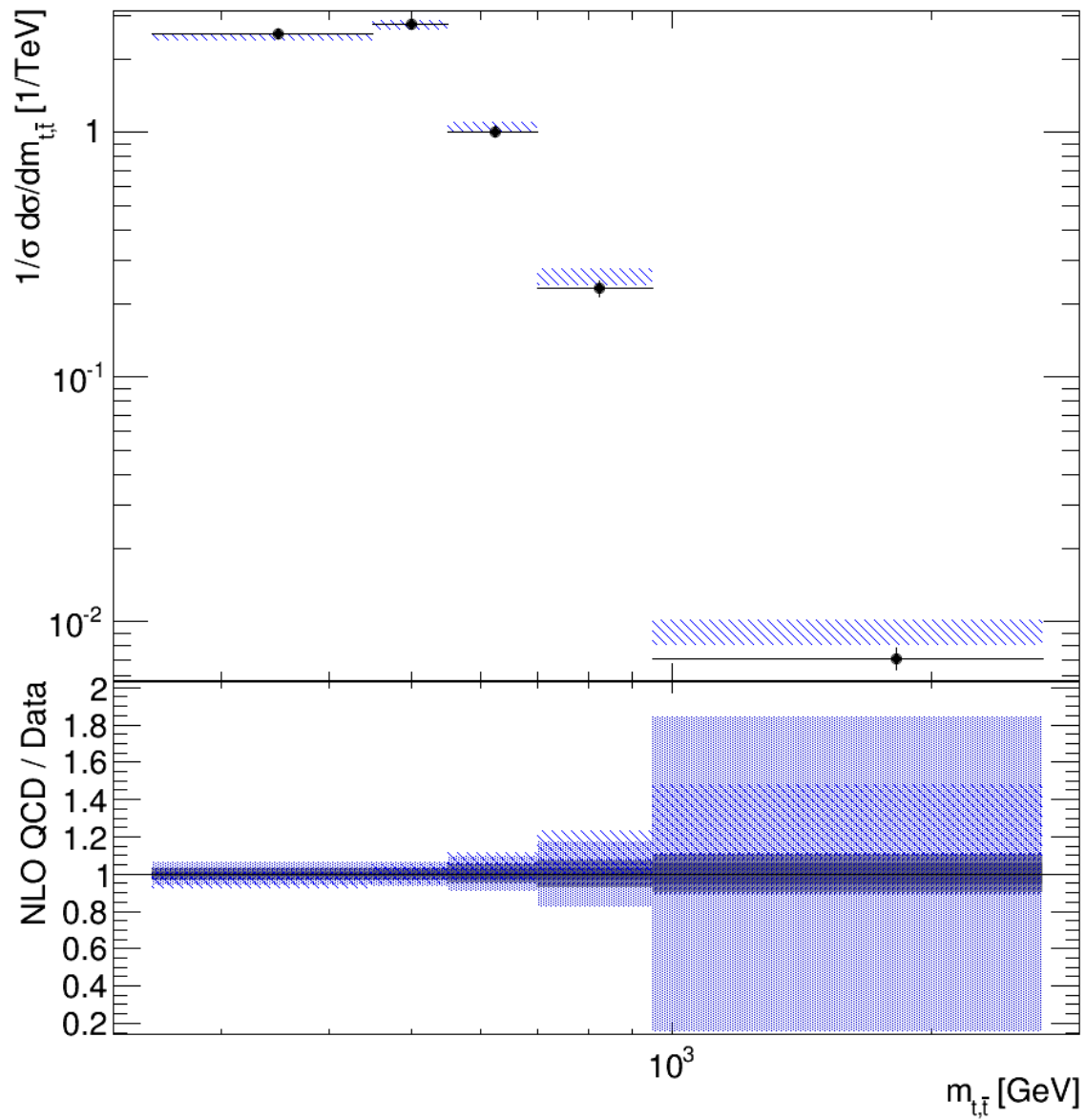


Ratios

- Data Total Error
- Data Statistical Error
- Convolute / Data
- Data / Convolute
- Convolute / Reference
- Convolute / Nominal
- Data / Data



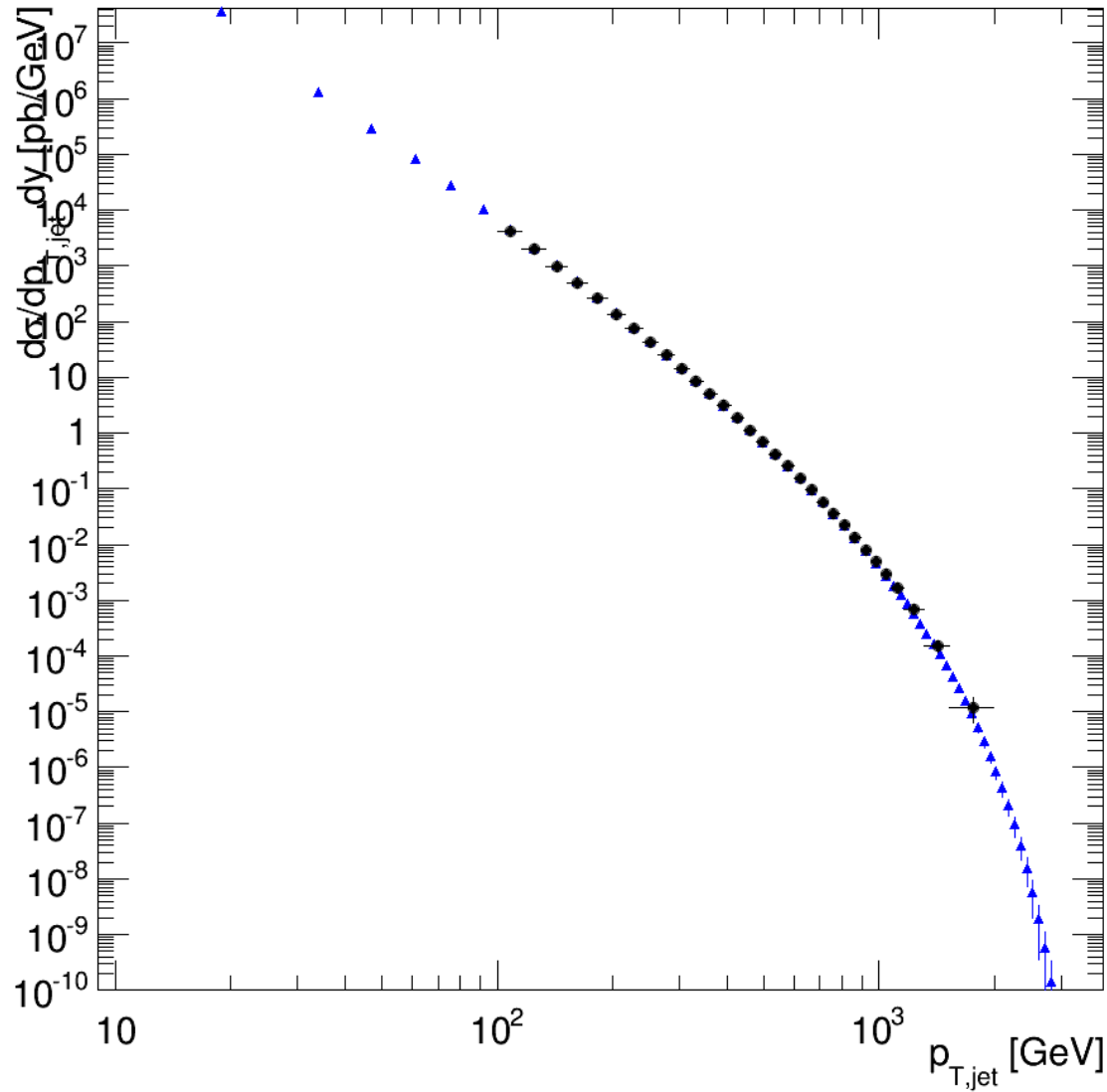




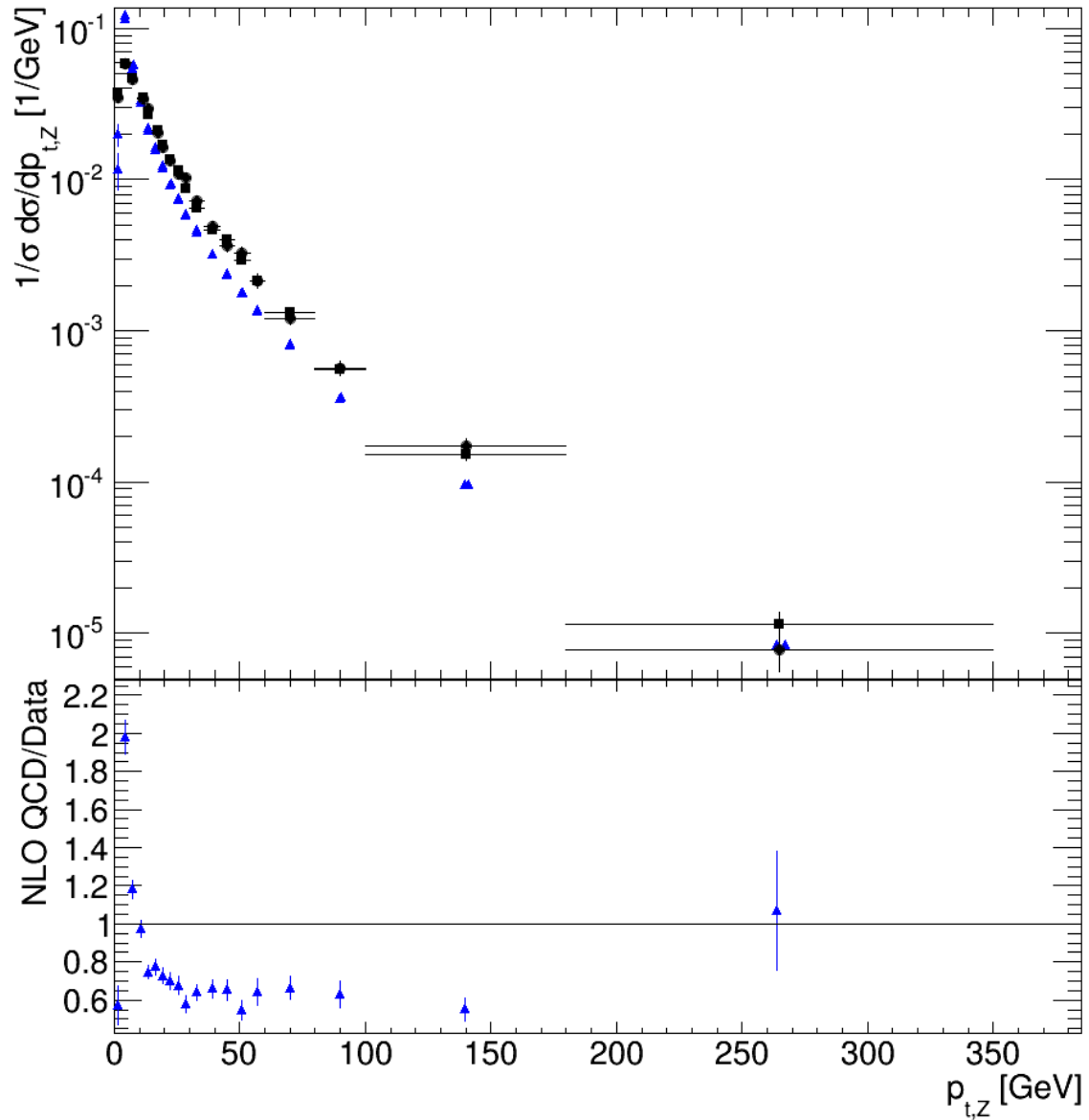
Bin Matching

- Overlay
 - Matches grid bins to data bins
- Ratio
 - MUST match bins for ratio
 - SPXGraphUtilities::Divide will throw SPXGraphException

No bin matching



Bin matching



Spectrum Website

- <http://spectrum.web.cern.ch/spectrum/>

Spectrum Technologies

- C++
- Python
- JavaScript
- HTML
- CSS
- PHP
- ~~CGI~~
- AJAX
- ~~CherryPy~~
- jQuery
- ~~REST~~
- Pure
- ~~Bootstrap~~
- ~~Node.js~~

Remaining Work

- Spectrum
 - Alpha S and Scale Uncertainty cross section bands
 - Legends
 - PDF-only overlay plot
 - Bug fixes
- Spectrum Website
 - Refine UI
 - Display data/grid metadata
 - Allow user to download grids and data files
 - Bug fixes



Spectrum