# Jets, Leptons,* and MET: Oh My!

- Who We Are
- What We Are Doing Now
- What We Are Planning For
- Why You Should Join Us

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For the LJMet Group.

* LJMet only deals with a single lepton, but the title sounded better with the **s**.

Who We Are

- We're a full-service group: we want to support and explore any work that will help us understand physics that manifests itself in LJMet final states:
    - Top pair production,
    - Single top,
    - Boosted top,
    - SUSY,
    - Etc.

- But we also want to have a clear impact in a particular analysis, to focus the strengths of US-based physicists, and we want to do it on early physics.

- Meanwhile, CMS is becoming very interested in "vertical integration"
    - What are the steps we must execute to pull together an entire analysis, beginning to end?

- So, we try to push for more focus on taking a solid early-physics topic all the way through while maintaining breadth....
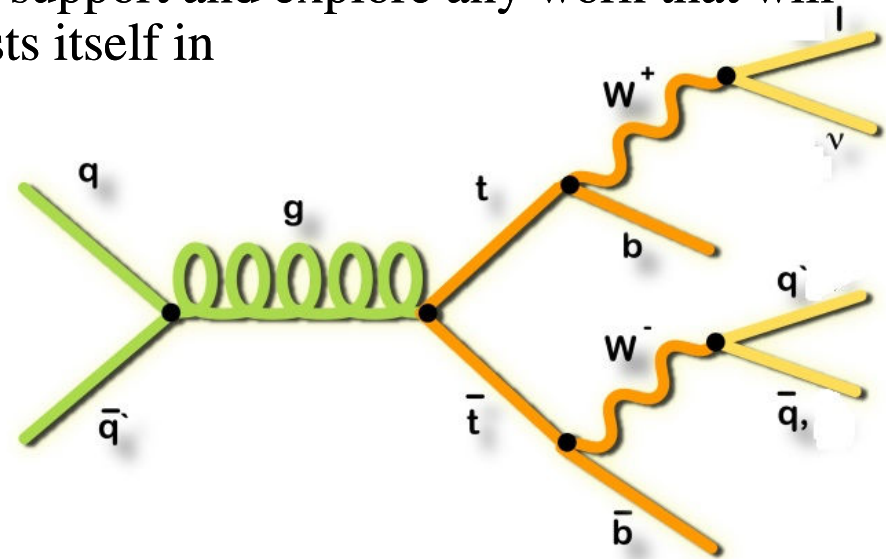
What We Are Doing Now

- We want to aim for understanding "W+jet" and "top quark" events in the LJMet final state.

- Where this goes depends on what you optimize for:
  - Measurement of a top-quark production property
    - Start with top pair production.
  - Understanding backgrounds for:
    - SUSY searches
    - Other exotic signals

- Keep in mind that we want to maintain our breadth while also having focus, because that is how we will find new physics!



- See Pratima's talk next for more!
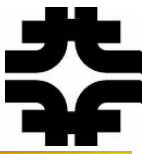
- When we start taking data, we will be
  - Running at an energy never explored before.
  - Using a detector that is not yet fully calibrated (although we have done an **amazing** job using cosmic events).

- While many cross sections increase from the Tevatron to the LHC energies, the top pair cross section grows by more than **two orders of magnitude**.
  - Will be very easy to have **very** pure samples of top quarks.

- Top quark physics (particularly in LJMet) gives us an unparallel opportunity to help us calibrate the detector:
  - $\not{E}_T$,
  - jet energy corrections,
 - b-tagging,
  - …

⇒ **The top quark is the new Z boson!**
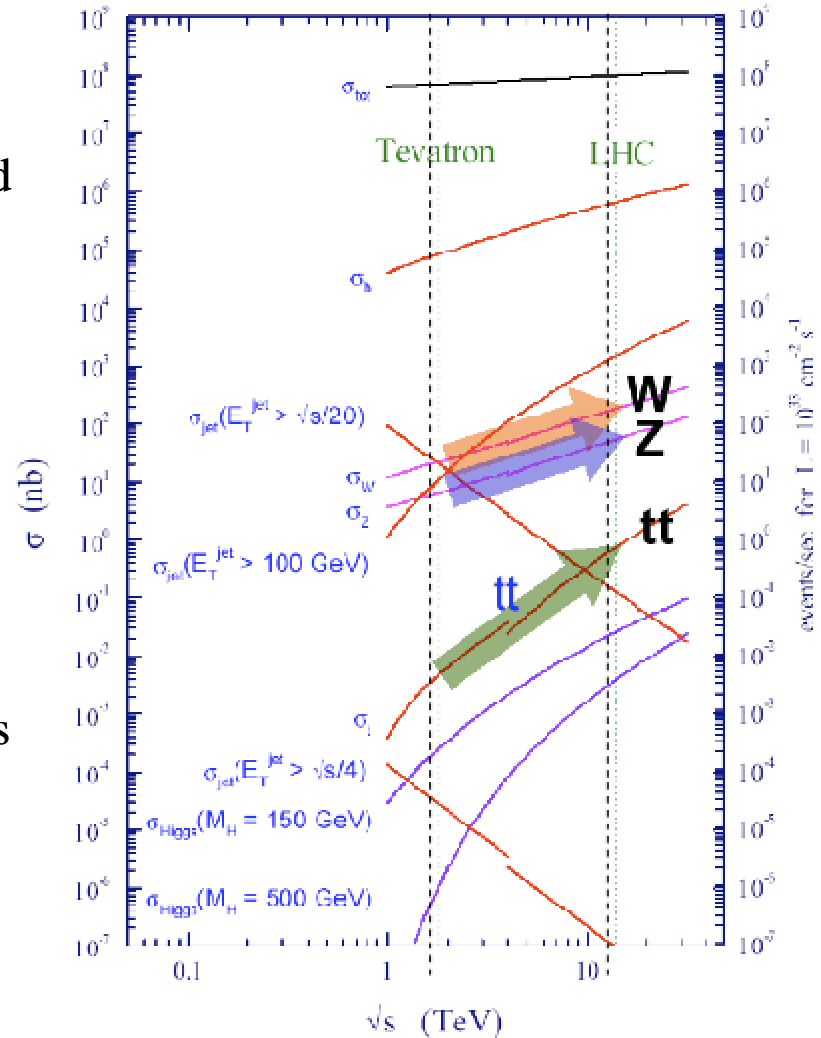
*"If top ain't your signal,
it'll be your background!"* **- Me**

Top Pair Phase Space - I

- Top pair events live in some complicated multidimensional space of event requirements.

- SM backgrounds to top (e.g. W+jets, Drell-Yan, QCD) populate a separate, but **not** completely disjointed region.

"core" tt region, e.g., eμ + MET + 2 b-tags

tt

other SM

event selection region
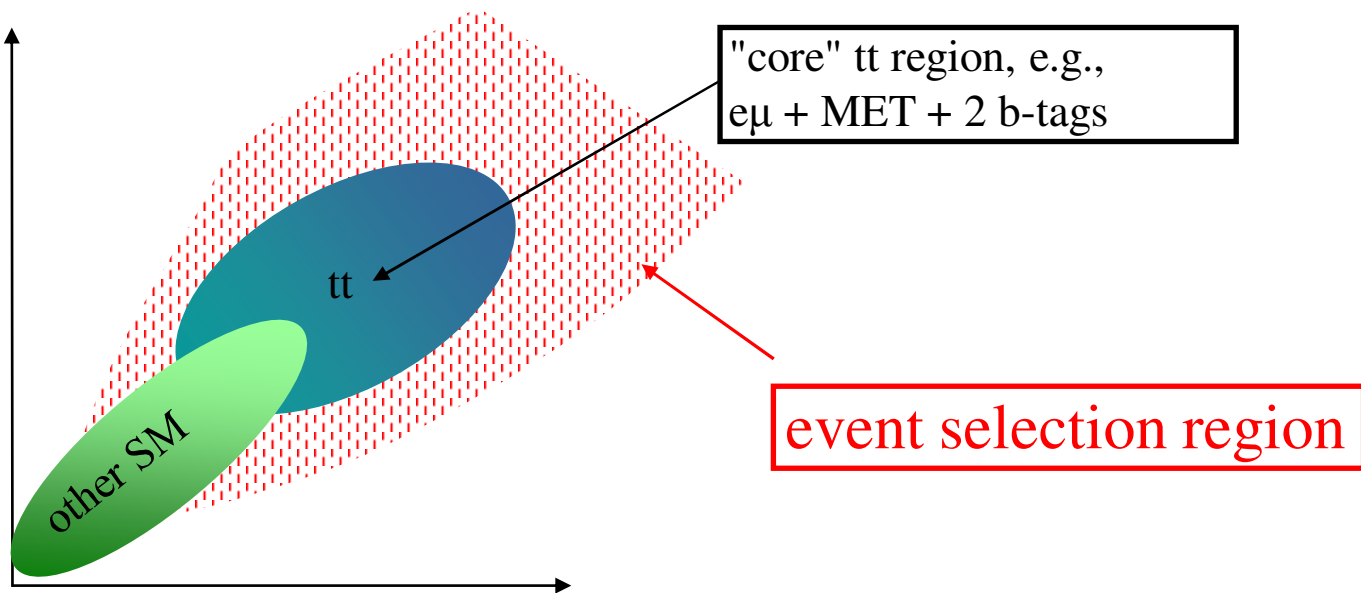
The basic event selection for tt cross-section-type analyses should encompass a SM control region and should not be limited to the core tt region

Top Pair Phase Space - II

- Top pair events live in some complicated multidimensional space of event requirements.

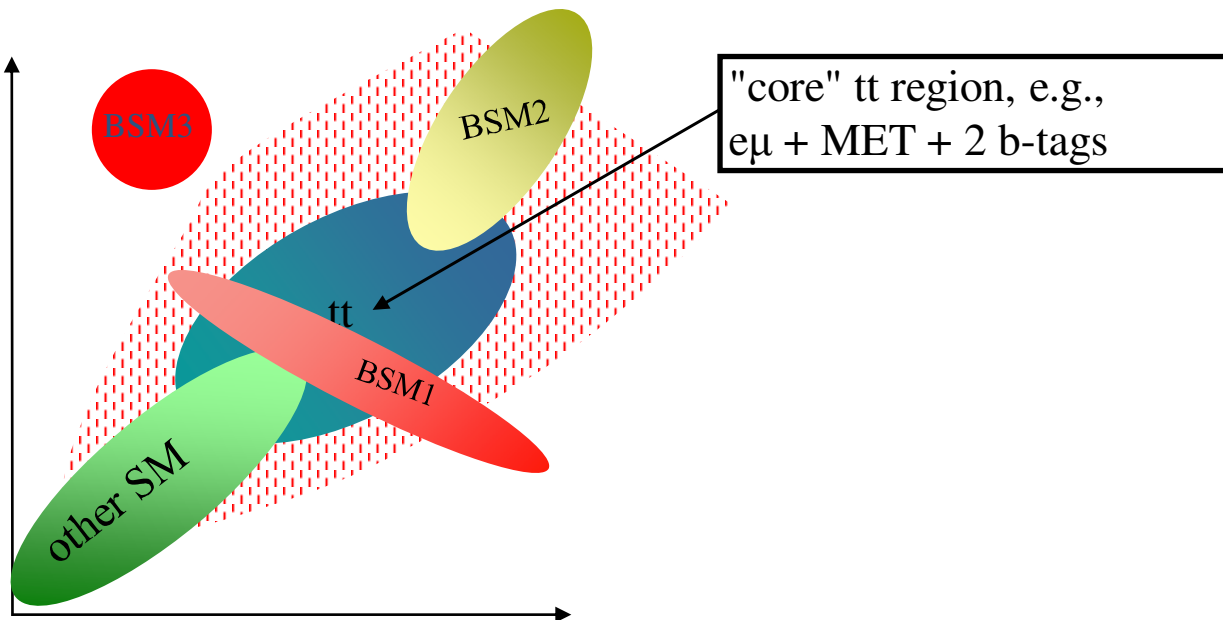- SM backgrounds to top (e.g. W+jets, Drell-Yan, QCD) populate a separate, but **not** completely disjointed region.

- Simplifying a lot, BSM could:
  - Be strongly overlap with the core tt region (BSM1).
  - Live only in the tails of ttbar (BSM2).
  - Be almost totally distinct (BSM3).

"core" tt region, e.g.,
eμ + MET + 2 b-tags

BSM3

BSM2

tt

BSM1

other SM

Beyond the SM Physics

- Lots of new physics can show up in this topology. Examples from PTDR:
  - Various mSUGRA points (up to $m_{1/2} \sim 700$ GeV) observable with significance ~ 30 in muon plus jets with 10 fb^{-1}.
  - H $\rightarrow$ WW $\rightarrow$ lvjj through vector boson fusion, 5σ significance for 140-200 GeV with 30 fb^{-1} (so a little beyond "first" physics?).
  - Charged Higgs in tt $\rightarrow$ HWbb with H $\rightarrow$ $\tau\nu$ has sensitivity to large range of tanβ at 30 fb^{-1}, gg $\rightarrow$ tbH similarly.
- So:
  - SM physics in LJMet comes very quickly.
  - Some beyond-SM physics in LJMet could come almost as quickly, other new stuff not far behind.
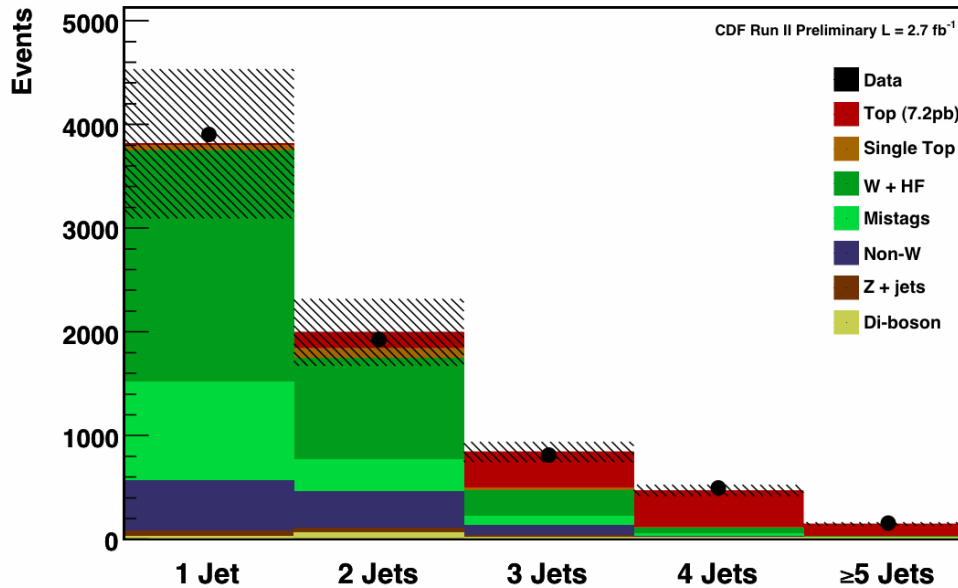 - We want to be ready to understand this topology quickly!

What We Need To Do

- We need to select a LJMet sample, and try to explain its physics content -- both in rate and in dynamics -- through SM processes:

- When SM processes can't do it, then we are on to something. But sample content is the first step -- we can do this as a joint effort, and then individuals can study particular old/new physics processes.

- Most thornier backgrounds are common to all physics of interest.

- We have Tevatron experience -- this isn't rocket surgery.

The To-Do List

- We've got lots to do:
  - Event selection -- understanding individual objects, global variables, isolation, trigger selection, optimization.
    - Working with V + jets group.
  - Backgrounds -- especially multijet, W+jets, can we use TeV-style techniques?, tagged vs. untagged analyses, samples needed?, systematics to worry about?
  - Acceptance/efficiency -- usual stuff, especially b-tagging, trigger, what tools do you need, systematic uncertainties of importance.
  - MC samples -- have what we need, know how to use, systematics?
 - Cross checks in control regions, systematic studies.

Applying Our Tevatron Experience
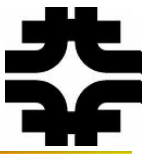
- We have experience in doing this work with real data:
  - Estimating multijet/fake lepton backgrounds from data -- both D0 and CDF have worked hard on this and have a lot of techniques that could be applicable.
    - This would be a *great* place for the LJMet group.
  - Setting normalization of W+jets backgrounds from data.
  - Our intuitive feeling for the trigger and working with complementary samples for studies of efficiency etc.
  - b-tagging efficiencies and systematic uncertainties.
  - What to do in the face of increasing interactions/crossing?
  - What to do in the face of an imperfect early detector?
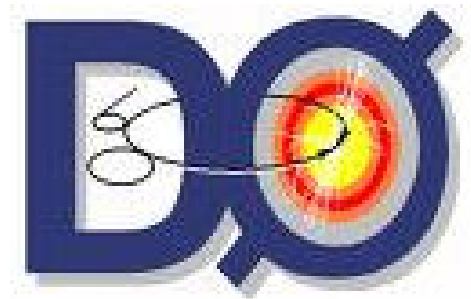
LJMet Goals

- Our goals:
  - Develop the analysis techniques that will get physics done.
  - Share knowledge, come to agreements on best practices.
  - Share infrastructure/tools, e.g. code for the common good.
  - Documents the above in a form other than slides from talks.
  - Provide supportive environment for people learning.
- We want to be able to funnel both
  - particular physics measurements and
  - tools/techniques of use to many measurements
- Into the relevant CMS PAG's

  (e.g., Top, V + jets, SUSY, Exotica, …)

  $\Rightarrow$ We expect to get the first analyses out with

  the first tens of pb^{-1}s (**including** using b-tagging).

Relation with other LPC groups

- Many other LPC working groups are single-object. LJMet is a multi-object group. So, start from work of single-object groups and extend to our particular environment:
  - Lepton ID and isolation when there are more jets around?
  - Is that thing an electron or a jet?
  - How useful is missing ET as a kinematic variable given pileup etc.?
  - What missing ET corrections are needed for this particular final state?
  - What are good discriminators made from multiple objects?
  - How well do we have to know any of this to quickly establish SM physics and move on to the new stuff?

People and physics in progress

- We know of a number of institutions that are going to be involved (or at least have expressed some interest):
  - Brown, UCLA, UCR, Cornell, FNAL, Florida, UIC, Johns Hopkins, Kansas, Nebraska, Notre Dame, Northwestern, Purdue Calumet, Rutgers, Virginia, and more coming soon.
  - Lots of friendly people.

- Some analyses that people have been working on:
  - tt cross section measurements
  - Jet-energy scale calibrations using tt events
  - Tagging efficiencies for different jet flavors using tt events
  - Heavy Z'→tt searches
  - General SUSY searches in l+jets events
  - …

- A number of these topics will benefit from more people working on them -- especially students. And for sure we could use help developing tools and techniques that will be helpful to all of these topics.

UNIVERSITY OF
CMS
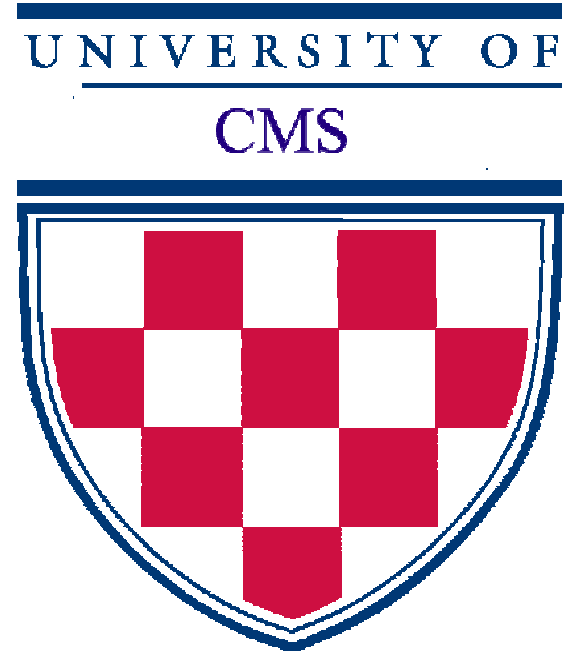
Please Come Join Us!

- Introduce yourself to the conveners:
  - kenbloom@unl.edu
  - narain@hep.brown.edu
- Come to our first meeting next week!
- Join our mailing list:
  - lpc_lepton_j_met@fnal.gov

- It's OK if you are just starting out -- LJMet is a place to learn and get friendly feedback.
- Want something to do to get your feet wet? We can come up with some ideas, and who knows what physics you might discover with it.

- The LHC is a once in a lifetime opportunity. This channel provides access to a wide range of possible new physics.

I WANT YOU TO JOIN LJMET!