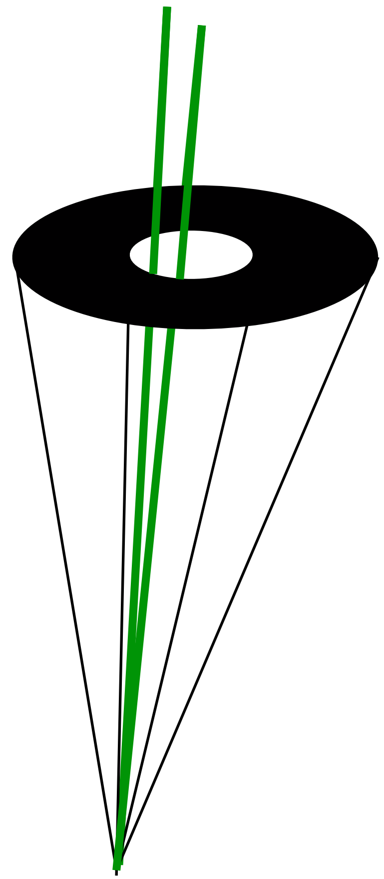
Lepton Jets Working Group Report



C. Hill, J. Wacker

Roll Call

- Jay W. (theory)
- Chris Hill (CMS)
- Chris Hays (CDF)
- Andy H. (D0/ATLAS)
- Eva H. (CDF/CMS)
- Lucas K. (CMS)
- James J. (CMS)
- Dave N. (CMS)
- Emanuel S. (ATLAS)

Small group,
almost all
experimentalists

From Boost 2009

Summary

Still making operative definitions of lepton Jets

New signals + tools appearing

Important searches to be done at Tevatron

Early searches possible at LHC

B-Physics & Fixed Targets Experiments

SLAC Workshop on Dark Forces: Sept 24-26, 2009

From Boost 2009

Advances to improve theoretical prediction

Showering & Hadronization
(Abelian & Non-Abelian)

Parameterization/Categorization of Lepton jets &
Production modes for benchmarks

Implementation of benchmarks into MCs

highlighting sensitivity differences between
Tevatron/LHC/B-factories/Fixed Target/LHCb

Review of Current Lepton Jet Analysis Activity

Boost 2010
Giving new physics a boost...
22 - 25 June
Oxford University, UK

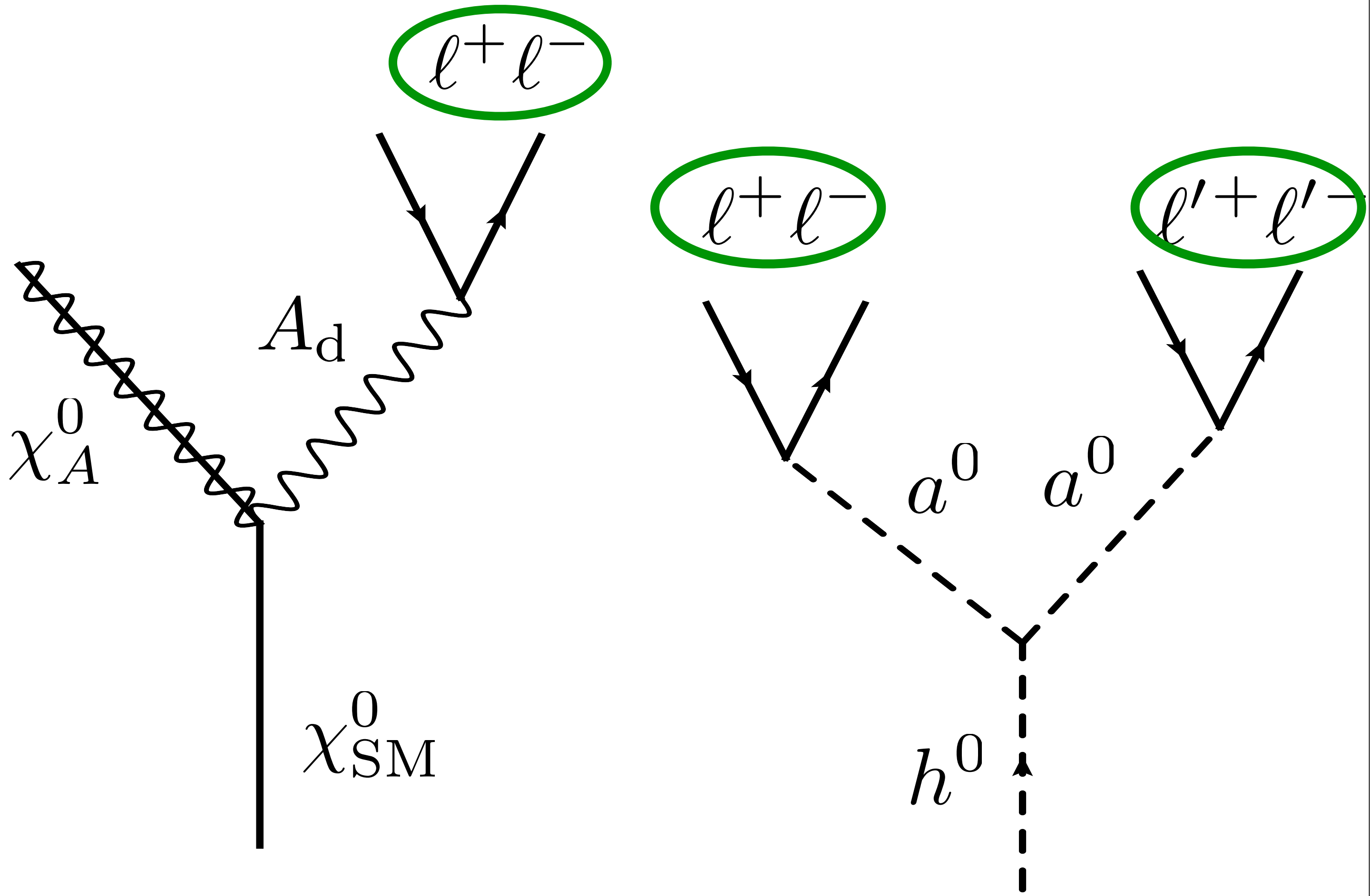
- Susy-like (D0)
  - 2 lepton jets + MET counting experiment (also w/o MET)
  - 2 lepton jets + MET bump hunt (also w/o MET)
- Photon + MET + lepton jet (D0)
- Double bump hunt (cascade, no MET)
- Lepton-jets with multi leptons (multiple)
  - Also including taus
- Inclusive search, interpret in several models (CDF)

Tevatron more advanced than LHC

Searches motivated by models w/ boosted final states; no analyses exploiting boosted leptons in difficult non-boosted searches

Models

- Mainly light dark matter inspired models with a dark sector
- Also light higgs models that evade LEP limits

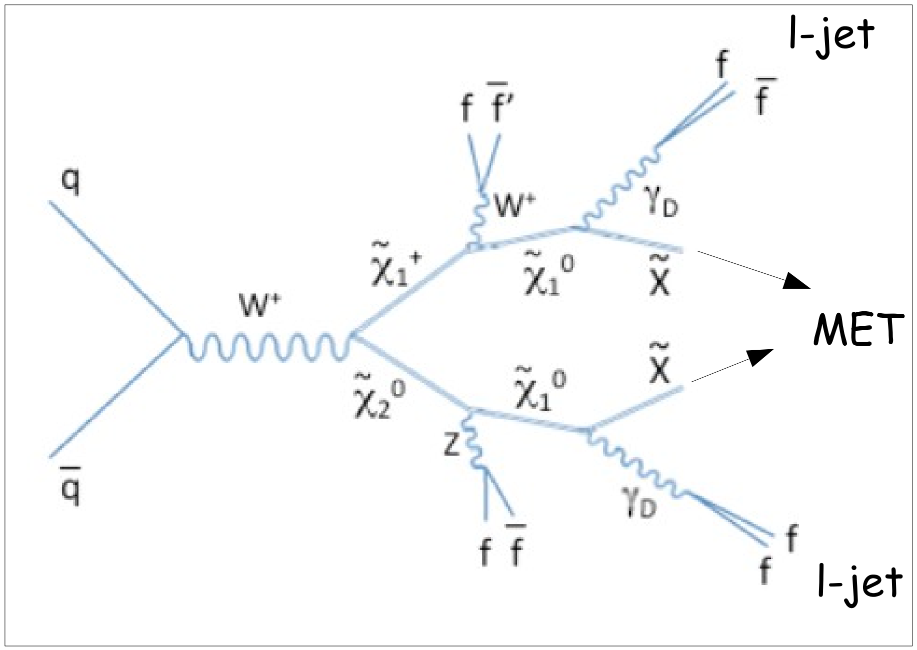


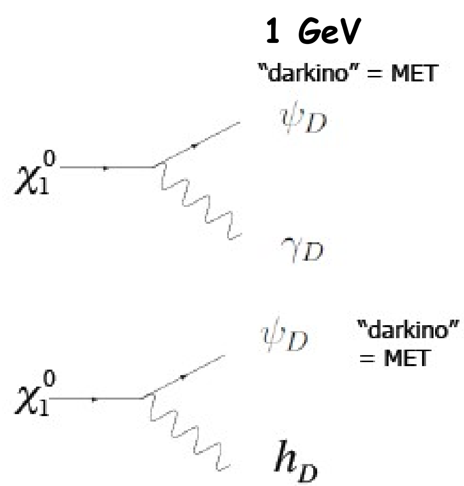
Susy-like

Higgs-like

Simple Lepton-Jets

- For a benchmark, use GMSB SPS8 point, σ =20fb
  - Kinematics do not change much for other similar SUSY points
- All SM LSPs decay to l-jet
- Focus on simpler case of dark photon + darkino (MET) first





Simplest case, 2 lepton lepton jets, counting experiment

Bump Hunt

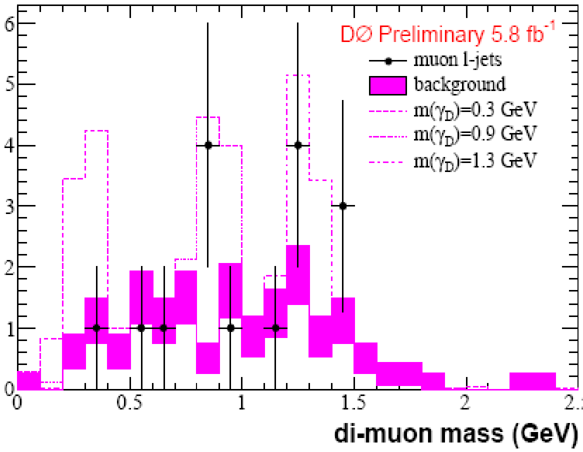
Resonance Search

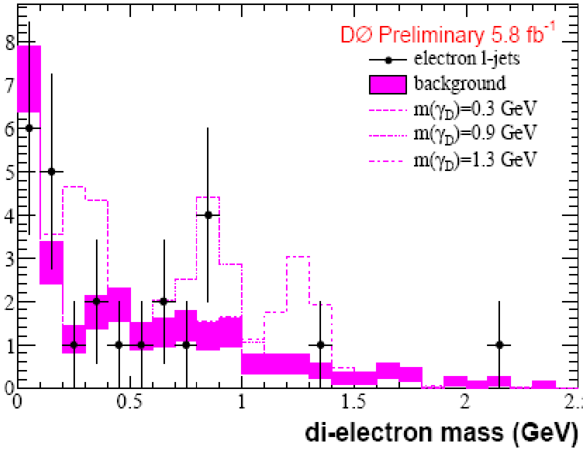
For events with 2 isolated l-jets and MET>30 GeV, look for resonance in track / companion track mass

Background estimated from isolated di-l-jet sample with MET<20 GeV

BR's, mass windows:

$m(\gamma_D)$ (GeV)	BR(ee)($\mu\mu$)	M^{low}_{reco}-M^{high}_{reco} (GeV)	Eff. e	Eff. μ
0.15	1 0	0.0 - 0.3	0.81	-
0.3	0.53 0.47	0.1 - 0.4	0.82	0.88
0.5	0.4 0.4	0.3 - 0.6	0.81	0.89
0.7	0.15 0.15	0.4 - 0.8	0.85	0.89
0.9	0.27 0.27	0.6 - 1.1	0.82	0.91
1.3	0.31 0.31	0.9 - 1.4	0.72	0.79
1.7	0.22 0.22	1.0 - 1.8	0.73	0.76
2.0	0.24 0.24	1.3 - 2.2	0.73	0.83





Next step, 2 lepton lepton jets, scan dilepton inv. mass

Multi-Lepton Lepton Jets

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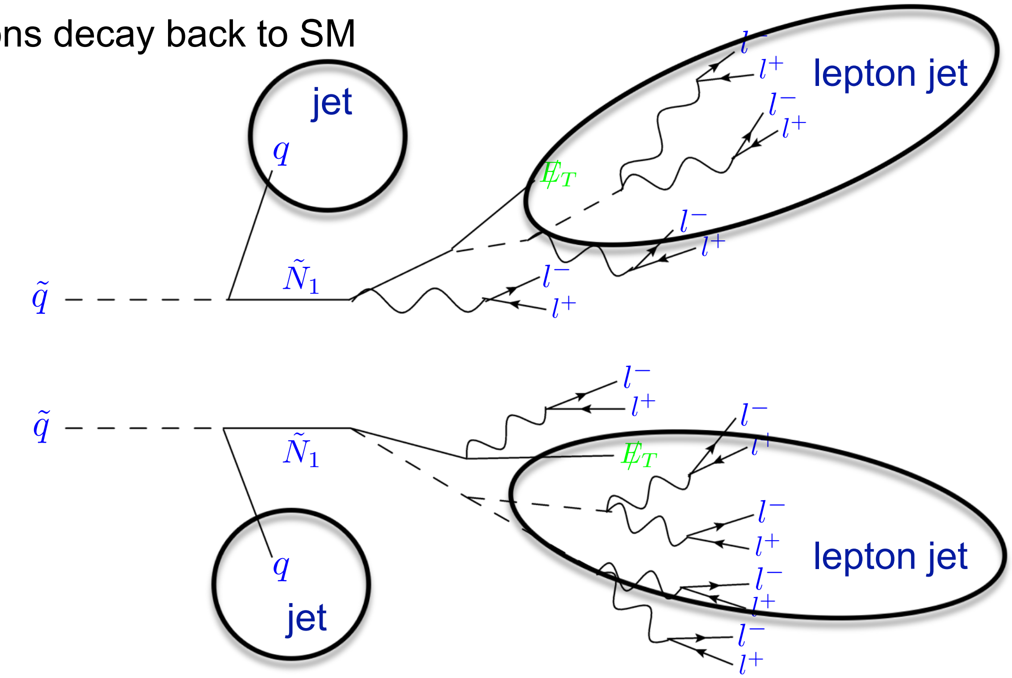
Lepton Jets Production Example

Hidden photons decay back to SM



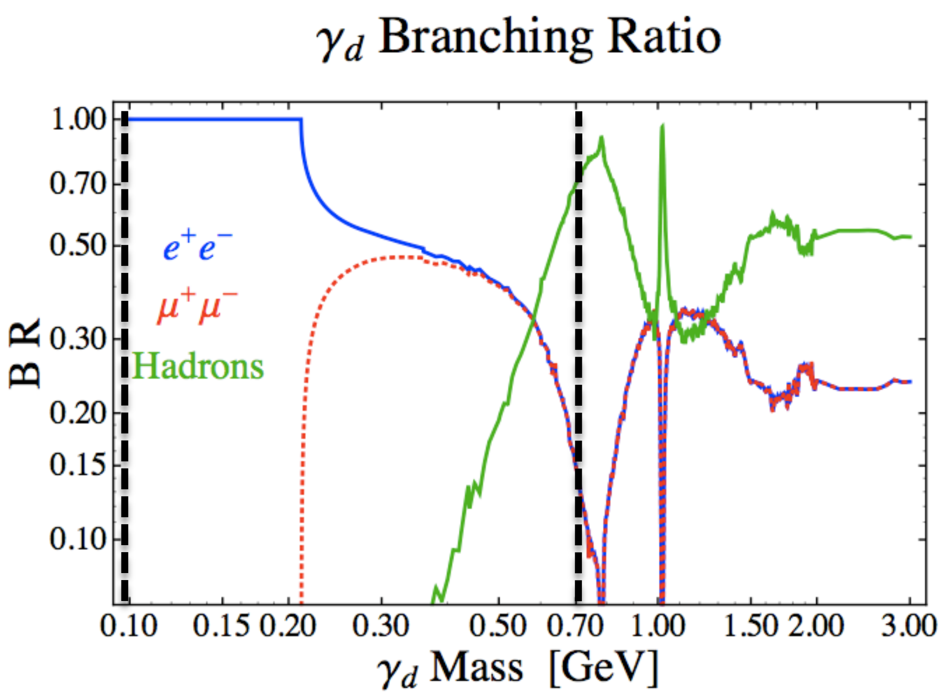
Slightly more complex is final states with many leptons in lepton-jet

Signature we are considering here: 2 regular jets, plus 2 lepton jets, plus MET

Hadron/lepton Mix

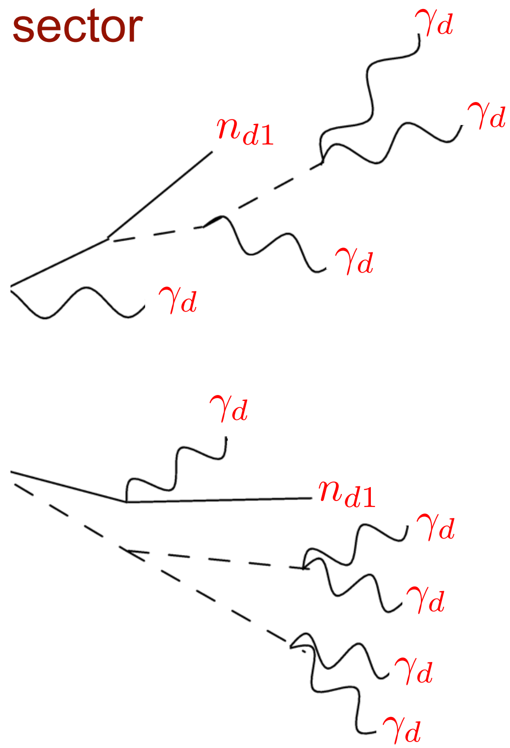
Cascade into hidden sector

Blue = visible sector Red = hidden sector



http://arxiv.org/abs/1002.2952

Falkowski, Ruderman, Volansky, Zupan



Still more complex is if γ_d can decay to hadrons

Lepton-jet normal jet boundary blurred

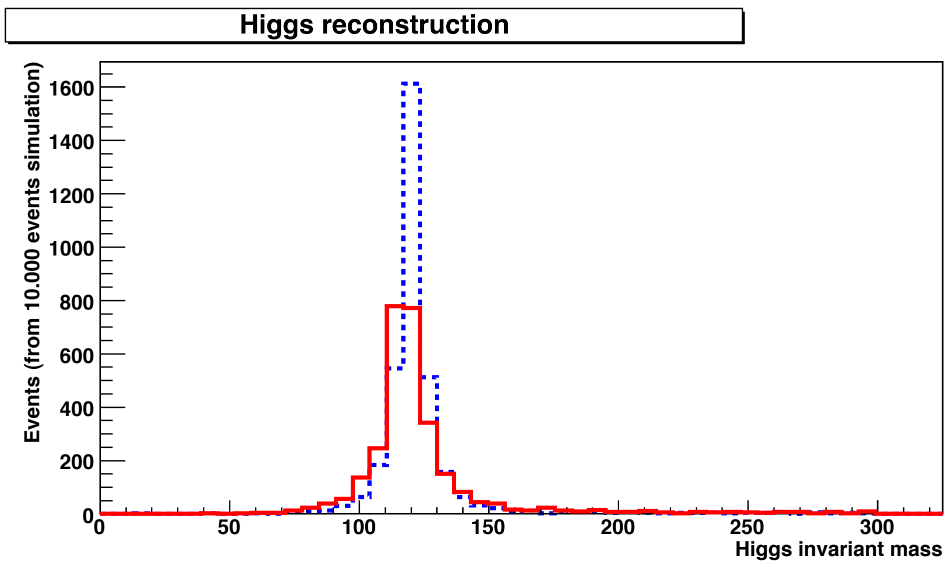
Open Questions & Wishlist

- How can we compare results between experiments (e.g. Tevatron vs. B-factories)?
  - Want (minimal) parameterisation of signals
    - Classification & benchmarks
- What do we know about SM backgrounds and how to deal with them (from Tevatron)? how do they translate to the LHC?
  - Conversions
  - Punch-through
  - Instrumental effects
  - Rare SM processes (dimuons from hadronic interactions with material)

Example of exploiting boost in difficult search

Boosted light Higgs from TeV scale resonance: $h \to \tau\tau$

BOOST 2010, Oxford

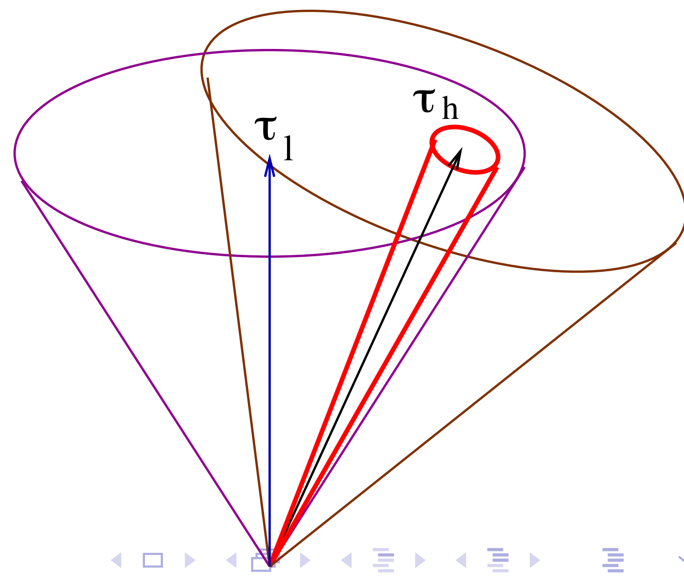


Andrey Katz

Work in progress with Minho Son and Brock Tweedie

University of Maryland

Define new objects: mutually isolated lepton and τ.



How well do we reconstruct these events?

- 85% of all leptonic Zs are reconstructed
- out of these events we properly reconstruct almost all dileptonic Higgses (above 95%).
- around 65% of the semileptonic events are reconstructed properly

Open Questions & Wishlist (continued)

- Boostedness of lepton-jet depends on masses in models (e.g. near degenerate states can give rise to hardly boosted dark sector particles)
  - What are the constraints (from theory side) on these masses?
  - What is the transition region where (on experimental side) the lepton-jet concept disappears (signal reverts to plain SUSY-like)
- Are jet clustering algorithms helpful in identifying lepton jets?
  - What about sub-jet algorithms (e.g. for electron jets)?
- How feasible experimentally are photon-jets signatures?
  - Would conversion of the photons help or hurt?
- Do false boost lepton-jet systems (e.g. H->WW) benefit from being boosted?

Plans for Proceedings

- Short write-up summarising:
  - Presentations given during Boost 2010
  - Gather contributions on open questions (tasks have been assigned) by August 15th
  - Add review of current limits
    - maybe discussion of long-lived issues too
  - Try to have first draft by September

Closing Remarks

- Good progress from last year
- Some of the same issues remain
  - Classification/parameterisation/comparison
  - Tools
- Small sessions conducive to discussion, but perhaps this one was too small? More theorists? More active experimentalists?
  - LHC experiments will have analyses this coming year to add to the experiences
  - Some lepton-jets are almost as much normal jets as lepton jets, could benefit from cross-pollination with hadronic working group

Thanks to Muge & Boost 2010 team for organising a productive workshop ...

Looking forward to Boost 2011!