

Working Group II: “MET Signatures”

- This meeting: focused on LHC results and new/improved analyses
- Future: will focus on Implications
 - Interpretation of discovery
 - Implications of discovery (or not) for future facilities

Some issues raised

- **Format of expt. results / tools for interpretation**
 - σ_{χ^2} ?
 - SMS limits ?
 - Likelihoods (workspaces) ?
 - Additional CL contours ?
- **Comment from one experimental colleague:**
 - “Experiments have provided many data types, little feedback from theory so far”
- **Comment from on theoretical colleague:**
 - “We keep requesting, but the experiments are not responding”
- **Reality:**
 - there is no common, experiment-wide rule for expressing results
 - very heterogeneous: depends on analysis, analysers, approval
- **Suggest common WG2/3 sub-group to study this topic**
 - form concrete proposals

Some issues raised

- **problem: $\sigma \times A = N \times L$**
 - Acceptance, A, is model and analysis dependent
 - arbitrary new physics model is not well defined
- **For exclusion limits,**
 - one could quote the acceptance for the SM (well defined)
 - must then evolve SM acceptance to NP acceptance
 - object efficiency driven (are these useful to provide?)
 - simulation driven (clearly useful, but how valid?)

Some issues raised

- **Fast Detector Simulation**
 - Can in principle make one's own (tune it to published results)
 - not as difficult as one might think
 - **Key: stay within the toy sim's region of validity!**
 - **Corollary: do not use outside region of validity!**
 - rare phase-space regions are difficult to model correctly
 - rare phase-space regions also tend to be the most interesting for most models!
- **Why prefer an experiment blessed Det Sim?**
 - “I want to make sure my results are realistic” (Good!)
 - “I want a reference for the tools I use” (Irrelevant!)
 - “I want my results to be credible” (Bad!)
 - precisely what the experimentalist fears: someone will use “ATLAS/CMS” blessed tools to study an invalid region of the tool and say: “it must be OK because I used ATLAS/CMS blessed tools!”
- **If 20% is good enough, then Delphes, should be OK...**
 - if more precision is needed, then it is becoming an “analysis”
 - nevertheless, the interest in a “blessed” fast toy det sim is clear!

Some issues raised

- **Prioritized list of analyses not covered**
 - **Not models! Analyses!**
 - different signatures
 - different regions of phase-space
 - **Interplay of difficult SUSY signatures vs searches for exotic signatures: MET vs non-MET searches**
 - what is the coverage of **all searches** on difficult to find SUSY searches?
 - **Put into categories (e.g. Low MET, soft jets....how low, how soft?)**
 - what is the model coverage in each category? what is the priority of each category?
- **Missing any critical analysis methods**
 - counting n-WIMPS, etc
- **Missing any critical analysis objects?**
 - kinematic variables (a la MT2, alpha_T, etc)
 - boosted objects (jet substructure, etc)
- **What are the efficiency/systematic limits of**
 - MET, jets, b-jets, taus, leptons, photons, charged pions, etc...

Some issues raised

- **Challenges to getting to difficult regions**
 - trigger
 - SM backgrounds
 - experimental apparatus
 - ignorance of existence
- **Aids to getting to difficult regions**
 - ISR! need common prescription for both ATLAS and CMS
- **How does the physics potential evolve with machine conditions (luminosity)? High p_T vs subtle signatures**
 - online (trigger),
 - offline (PU reconstruction),
 - analysis (NP sensitivity)

Some issues raised

- **Model independent searches**
 - Look-elsewhere-effect: Challenging, but understood
 - Systematics: Challenging, and sometimes not understood
- **Some Observations:**
 - Single top **discovered** as a sliver of excess on large bkg! **Predicted!**
 - **Wjj** excess observed! **Not Predicted!** Jury still out! (NP? not NP?)
 - One needs a plan before(!) observation.
 - how to handle this is a challenge when one does not necessarily have a prediction a priori.
- **LHC data analysis is all about compromises:**
 - **MET vs jet pT vs n-leptons/photons, etc (fact of reality)**
 - strongly dependent on experimental apparatus, LHC running conditions, etc
 - **inclusive vs exclusive (less model sensitive vs more model sensitive)**
 - inclusive: one can easily miss a subtle signature
 - exclusive: one can easily miss a gross signature
- **Model independent searches very useful!**
 - ...but not a silver bullet!

Identified topics that require further study or new approaches

Signal/model regions to further explore:

- Direct production of third generation squark, EW gauginos, and sleptons
- Stop production in gluino decays
- 4-body gluino decays
- Classify difficult models and develop possible new search strategies
- Can RPV searches be useful for multi-jet, low MET, low p_T final states
- Exp't limits in the pMSSM

Further Studies: Cont.

- Effectiveness of mono-jet searches for compressed spectra: optimization of ADD searches for SUSY/DM?
- Expand global fits to other SUSY breaking models
- Development of new techniques, such as boosted jets for NP searches
- Further work on effective DM theories and counting MET particles. New channels and/or observables?
- Examine validity of Simplified Model Approach: what are the limitations?
- How do we handle complex scenarios?

Much overlap with WGs 1&3!

- Interplay between non-susy and susy MET searches
- Interplay between non-susy and susy non-MET searches
- Invisible Higgs searches
- Higgs production in SUSY cascades (stop decays)

We need to coordinate!

Looking towards the final report

Discoveries @ 7 TeV:

- Identify observables to interpret discovery
- Identify future facilities needed to determine underlying theory

No Discoveries @ 7 TeV:

- Identify scenarios that are excluded (e.g., 4th gen)
- Identify scenarios with theoretical tension (e.g., mSUGRA)
- Identify scenarios that are untouched and still valid
- Implications for future facilities: what is impact of higher scale of NP?

7 TeV Results Linked to Many Future Facilities

Energy Frontier:

- LHC: 14 TeV, lumi upgrade, energy upgrade
- LC: ILC, CLIC, (e⁺e⁻ Higgs Factory?)

Intensity Frontier:

- Flavor Factories: Super-B, LFV exp'ts
- Neutrino Exp'ts

Cosmic Frontier:

- Direct and Indirect Detection of DM

The Road Ahead

Future Meetings:

- Propose Next WG2 Meeting: 7-8 November @ CERN
- Possible Joint WG2/3 Meeting?
- Possible topics:
 - Presentation Experimental Results (formats, etc)
 - Development of Report (start filling in outline)

WG2 Wiki:

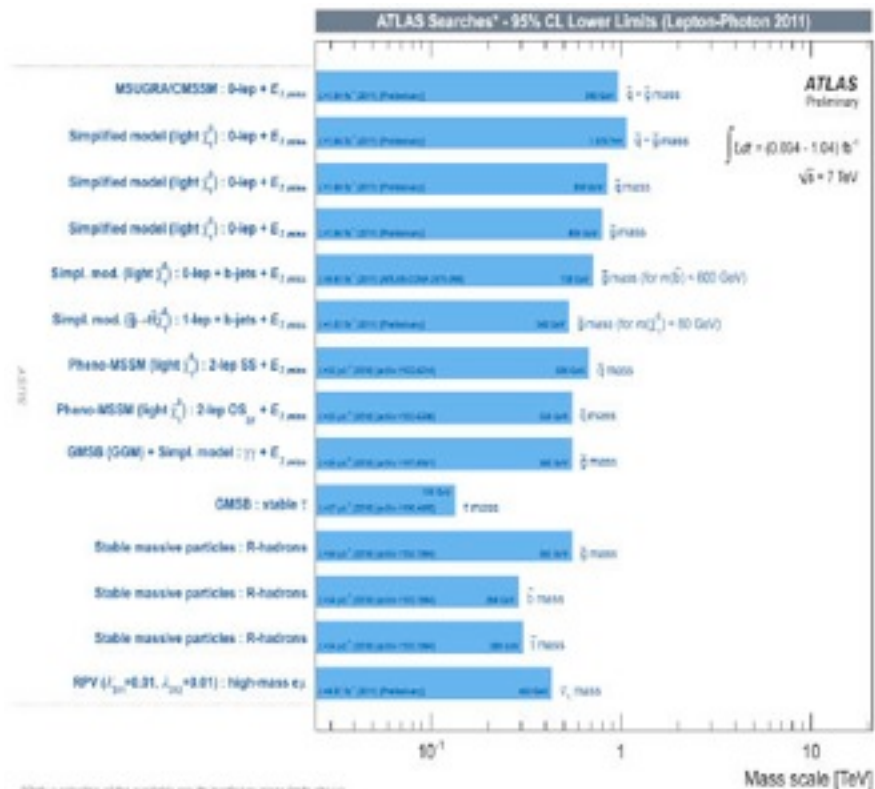
- Wiki page is set up – will go live soon
- Will be linked to workshop website
- Please sign up and contribute!!!

Outline of WG2 Report Chapter:

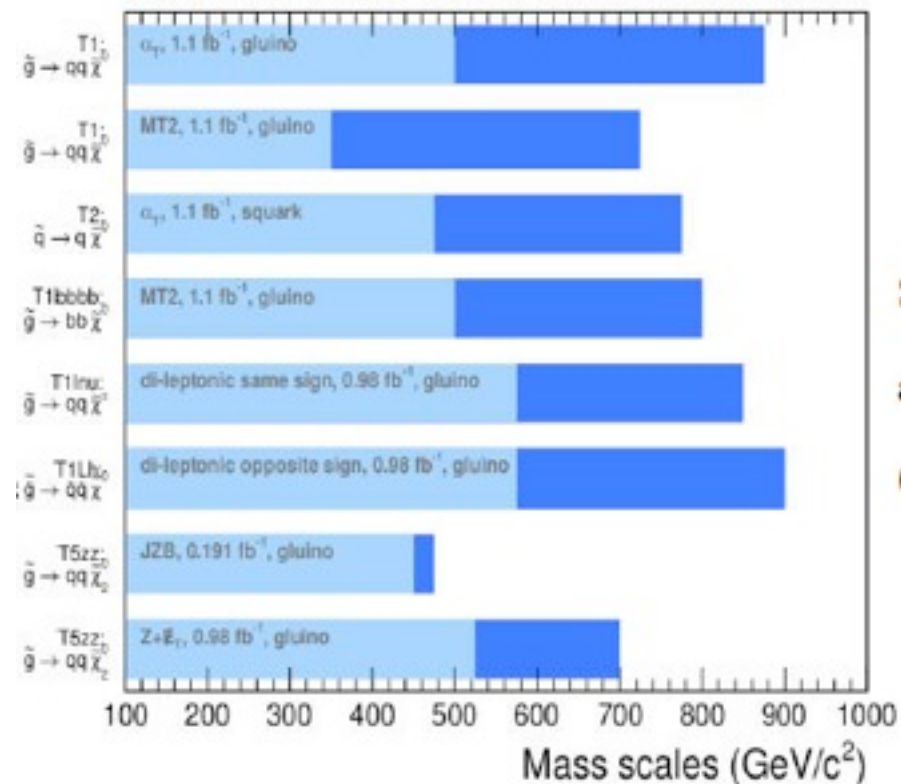
- Available for Nov WG2 meeting

No Obvious Signs of New Physics YET

ATLAS Search Summary



CMS Search Summary



- 1st 6 months of a 20 year program!
- NP could be at ~2 TeV or more complicated than the simplest scenarios



LHC puts supersymmetry in doubt

www.bbc.co.uk

Results from the Large Hadron Collider have all but killed the simplest version of a theory that physicists had hoped would update the current model of sub-atomic physics.



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The New York Times

Science

COLLECTIONS > SCIENTISTS

315 Physicists Report Failure In Search for Supersymmetry

By MALCOLM W. BROWNE
Published: January 05, 1993

Three hundred and fifteen physicists worked on the experiment.

Their apparatus included the Tevatron, the world's most powerful particle accelerator, as well as a \$65 million detector weighing as much as a warship, an advanced new computing system and a host of other innovative gadgets.

- If there are no discoveries by the end of the year, we need to coherently deliver a positive public message
- Hmwk: What is the best message to deliver !??!

Future Directions/Goals

- **Future:**
 - what do the 7 TeV results imply for 14 TeV?
 - where should we invest our resources?
 - what do the 7 TeV results imply for CLIC?
 - motivate specific R&D activity based on physics
- **Formulate a plan to identify and anticipate which analysis are not currently covered and are of high priority**
 - Such analyses should inform about physics at 7 TeV physics & where to look at 14 TeV
 - Such analyses should also provide possible insight for CLIC
 - light stops is one extremely good, well motivated example
- **Next steps: possible WG sub-groups**
 - Presentation of Experimental Results Group
 - Missed Analyses Categories Group
 - Phenomenology Interpretation Group
 - others?