US-ATLAS-PCAP Nov 2002

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Physics activities

- Project funded activities
- Current activities – mainly DC1
- RTAG # 9
- Physics activities in US.

Major Milestones and Achievements

- Physics support person hired
  Giorgos Stavropoulos hired by UC Berkeley on NSF funds in May 2002.
- DC0 completed March 2002
- All tools in place for DC1 phase 1. (May 2002)
- HepMC has appeared in CLHEP 1.8 (end of May 2002), 21 months after they agreed to take over this atlas product.
- DC1 Phase 1 Event Generation mostly completed (July 2002)
- Support for specialised Event Generators (Comphep $etc.$) (Started July 2002)
- Physics studies as part of DC1 Phase 2 starting up now.
- Prototype (python base) GUI for settting/querying parameters (Oct 2002)

Code status in atlas releases

- Provided support for current versions of Herwig (6.4) Isajet (7.63) and Pythia (6.203). All updated since November 2002
- Support for Tauola (initial work by Barcelona student). new since November 2001
- Support for special purpose MC's has begun (very late; lots of complaints from users about the delay). Needed for DC1 Phase 2 and some detailed studies *eg.* Pixel descoping release 4.3.0
- Rudimentary support for Phojet available Release 4.5.0
- Support for Hijing Heavy Ion Generator provided release 5.0.0
- Improved handling of Monte Carlo history release 4.6.0

Upcoming Deliverables

- DC1 Phase 2 is focussed on more physics studies (Phase 1 is aimed more at Trigger TDR
  More complex signals will be evaluated
- First release of C++ Generator (Herwig++) expected in 2003.
- Move to LHAPDF (see later)
- Integrate Isajet and Herwig with Tauola (should be default for DC1 phase 2)
- G4 Monte Carlo Truth (awaiting recommendations of Simulation RTAG)
- Physics workshop in June 2003 (last was Sept 2001)

LHC wide activities

An an hoc group (MC4LHC) has started up. Meetings in March and May 2002 and November . Approx 10 people from CMS, ATLAS, LHCb and CERN theory. Expect to bring in more people. Two separate but related goals.

- Physics modeling and tuning. Experimenters and theorists. Improve modeling of LHC physics and agree on common simulation issues (min bias etc) so physics studies can be compared. Some work has begun (Used in DC1). Workshop at CERN summer 2003
- Common support issues. Pool resources on support issues where possible. An RTAG on this has been approved by LCG.
- Will provide a forum and some support to theorists working in this area. (most of these are in europe)

Generator RTAG

RTAG# 8 set up by

Members N. Brook (LHC-b), A. De Roeck (CMS,chair), I. Hinchliffe (ATLAS), M. Mangano (Theory), A. Morsch (ALICE), S. Mrenna (Tevatron)

Guests & contacts during the RTAG: Representatives from CDF/D0, B. Webber (HERWIG), L. Loennblad (PYTHIA), E. Boos (COMPHEP), CLHEP/HepMC representatives

Report presented on 11 October 2002.

The mandate given by the SC2 to this RTAG is a study of how to best explore the common solutions needed for Monte Carlo (MC) generators and how to efficiently engage the HEP community external to the LCG to this effort. The items proposed to study and evaluate include: maintenance of common code repositories, development or adaptation of generator related tools for LHC needs, how to provide support for tuning, evaluation and maintenance of the generators, the integration of Monte Carlo generators into experimental software frameworks, and structure of possible forums to facilitate interaction with the distributed external groups who provide the Monte Carlo generators.

Recommendations

- Report is presented Oct 8
- Recommends LHAPDF be supported and used as replacement for PDFLIB
- Request that CERN provide 1FTE to maintain repository that should contain packages used by LHC experiments.
  Must have version control and platform support
  New versions available within 2 weeks of release
  Test packages to be run prior to release
  a. Absolute minimum: PYTHIA, HERWIG, ISAJET, HIJING
  b. Also needed: PHOJET, DPMJET, SFM, PHOTOS, TAUOLA, LHAPDF, EVTGEN, COMPHEP, ALPGEN, MADGRAPH, GRACE, nexus
- MC4LHC is expected to become a formal body with representatives from the experiments.

- MC4LHC will provide guidance/management
- Requests better support for HepMC/HepPDT from fnal/clhep group
- Expects that HepPDT will become standard for particle properties
- Report was accepted by SC2 and passed to LCG for action

LHAPDF

Proposed by RTAG as replacement for PDFLIB that is no longer maintained.

LHAPDF started at Les Houches 2001

http://vircol.fnal.gov/

Has "all sets available" and can handle PDF uncertainties

Need to have MC Generators support the interface.

RTAG expressed concerns about some "features"

Poor error trapping

Lot's of external files.

RAG asked CERN to maintain a central copy.

Will have this available in Release 6.0.0 of ATLAS (Feb 2003?).

Data Challenge Summary

Current round of Data Challenges began in October 2001.

DC0 Small physics samples (10^5) $Z + jet$ events passes through full chain. Event Generation complete March 8 2002 using all three primary physics generators.

DC1 Two phases.

Phase 1 uses G3 and is aimed at data needed for HLT TDR. Generation and simulation is complete with the biggest sample (10^7 jet events). Other samples will follow. Reconstruction is expected to begin shortly. Some Event Filtering tools incomplete.

Phase 2 (November 2002) will use both G3 and G4 and a large number of "Physics" samples will be made. Used to test distributed Analysis model and Grid tools. Real issue here is contributions of US Atlas physicists. There will be another atlas physics meeting to assess the results of DC1 phase 2.

Responsible for setting and validating of parameter sets and Q& A on Generation. (European is running the Q& A)

Note change in persistancy technology between DC0 and DC1.

SUSY Data Challenge

http://paige.home.cern.ch/paige/fullsusy/

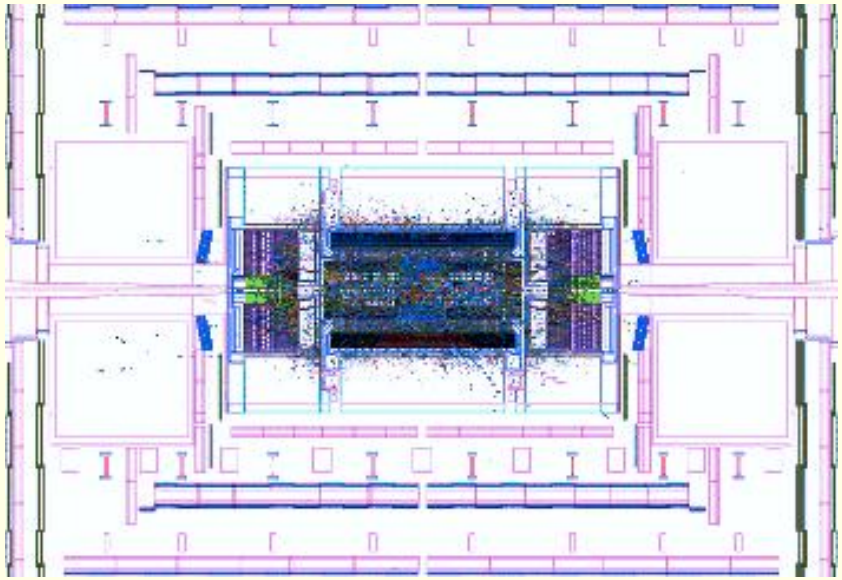
- First attempt in atlas to pass large sample of SUSY events through full simulation and reconstruction.
- Events are very complex
- Aim at 50K fully simulated (approx 400 CPU hrs)
- Collaborators from BNL, Cambridge, chicago, LBL, sheffield, Wiezmann..
- in valdiation phase now.
- Goal is results by next Physics workshop (June 2003)

Physics studies

US work on SUSY, Extra dimensions, Top quarks, W couplings

Physics Coordination now has 5 US members (Dobbs, Hinchliffe, Paige, Parsons, Shupe, out of 25 total)

Helio Takai (BNL) is leading task force on Heavy Ion physics in ATLAS. Letter of intent sent to DOE in March 2002: proposal next year. On agenda for LHCC June 28. Meeting on Sunday in Clarement-Ferrand. Work focused on Calorimetry and muons (Si occupancy is 35% in first layer)

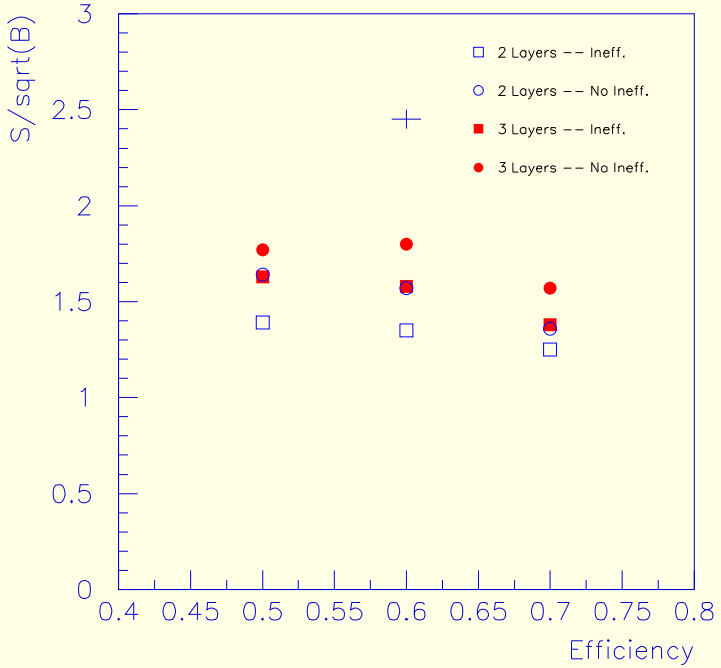


Detector Example –Pixel Staging

Middle layer of Pixel Barrel may be delayed/staged due to funding shortfall. Work to assess possible physics loss (D. Costanzo)

ttH final state may be useable to observe $H \longrightarrow b\bar{b}$ and measure couplings. Signal is marginal with baseline detecotor

May be hopeless with one missing layer



Upgrade Studies

Physics studies carried out in Summer 2000 and 2001 in response to request from CERN management.

Joint studies with CMS (plus theorists in 2001).

Completed and published as hep-ph/0204087 (Joint study) hep-ex/020319, J.Phys G (ATLAS only). 3 US-atlas authors.

Addressed physics impact of Luminosity and energy upgrades. $28\mathrm{TeV}$ and 10 times design luminosity.

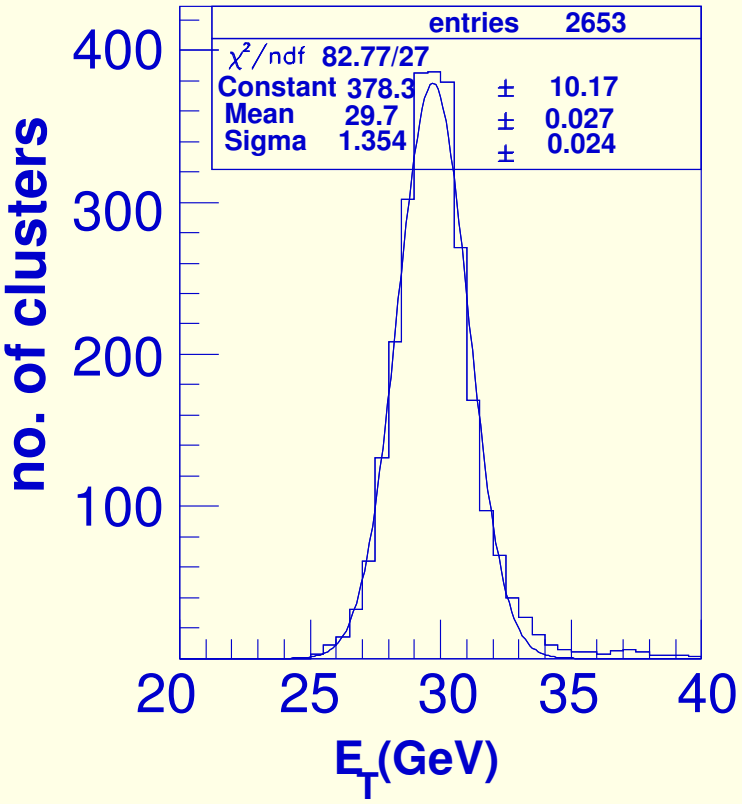
Most activity focused on luminosity upgrade as this is less demanding for the machine and less costly

Ultimate Luminosity of 2.3×10^{34} could be achieved by current design but only in two experiments (ATLAS+CMS)

Detector Performance

Luminosity is much more demanding

LAr calorimeter performance degrades
30 GeV electrons $\frac{\sigma}{E} \sim 2.5\%$ at 10^{34}
$\rightarrow \frac{\sigma}{E} \sim 3.6\%$ at 10^{35}



b-tagging

Rejection factors against u-jets for 50% b-tagging efficiency

$P_T(\mathrm{GeV})$	10^{34}	10^{35}
25-40	33	3.7
45-60	140	23
60-100	190	27
100-200	300	113
200-350	90	42

e/jet separation: $40\mathrm{GeV}$ E_T

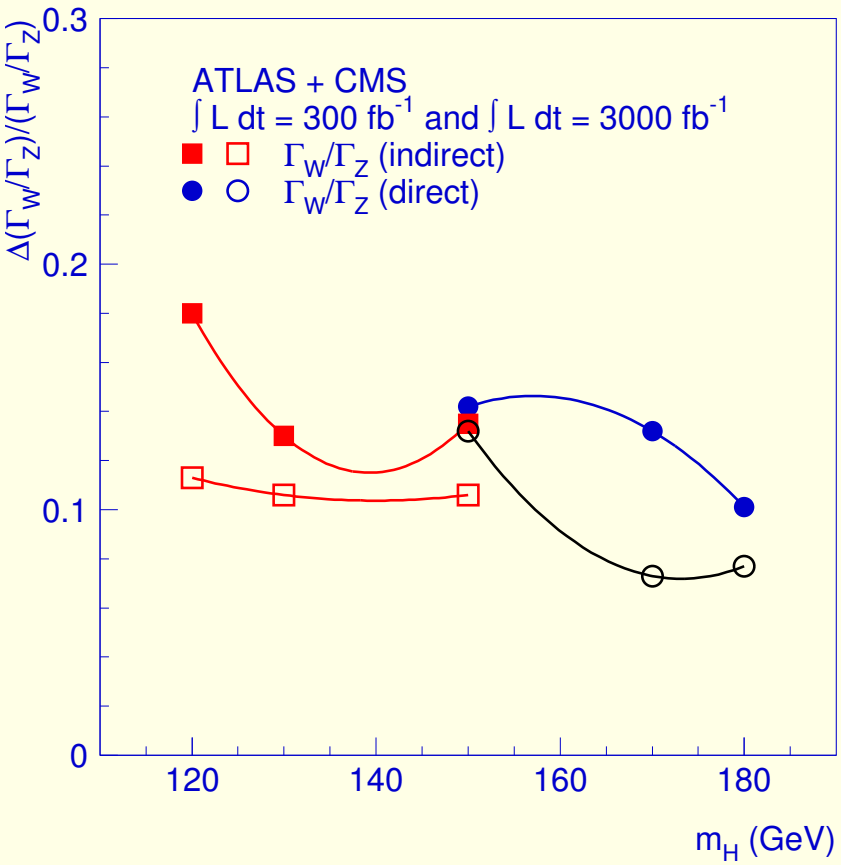
	Electron effic.	Jet Rejection
10^{34}	81%	10600 ± 2200
10^{35}	78%	6800 ± 1130

Measurements of Higgs Couplings

Luminosity upgrade improves precision by up to a factor of two

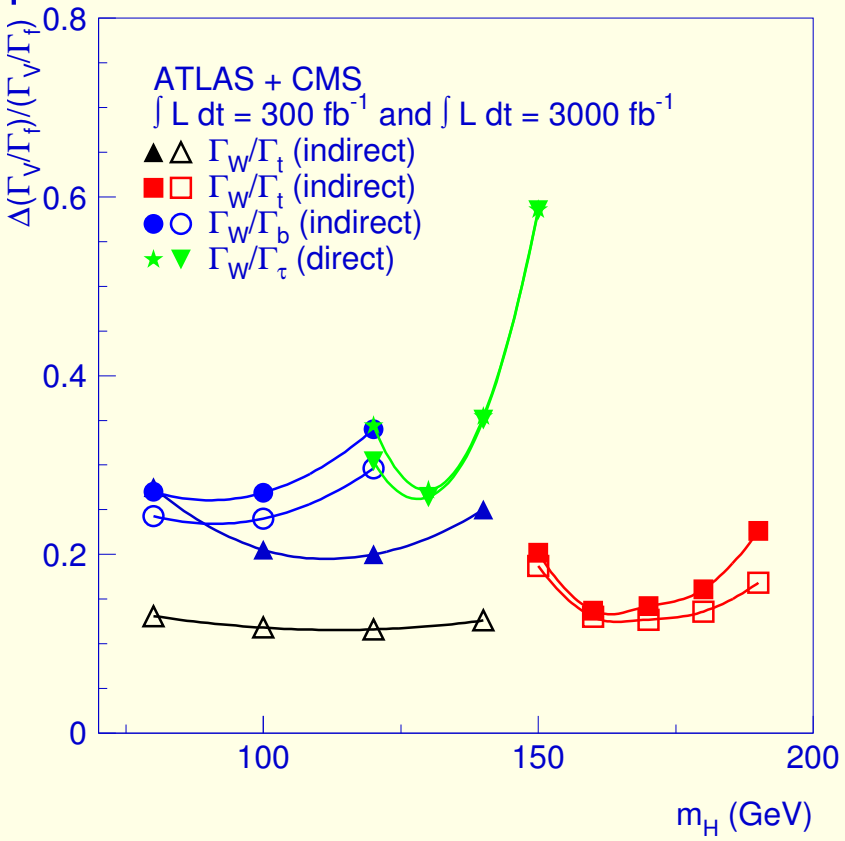
Boson couplings

Measured from $\gamma\gamma$ WW and ZZ decays



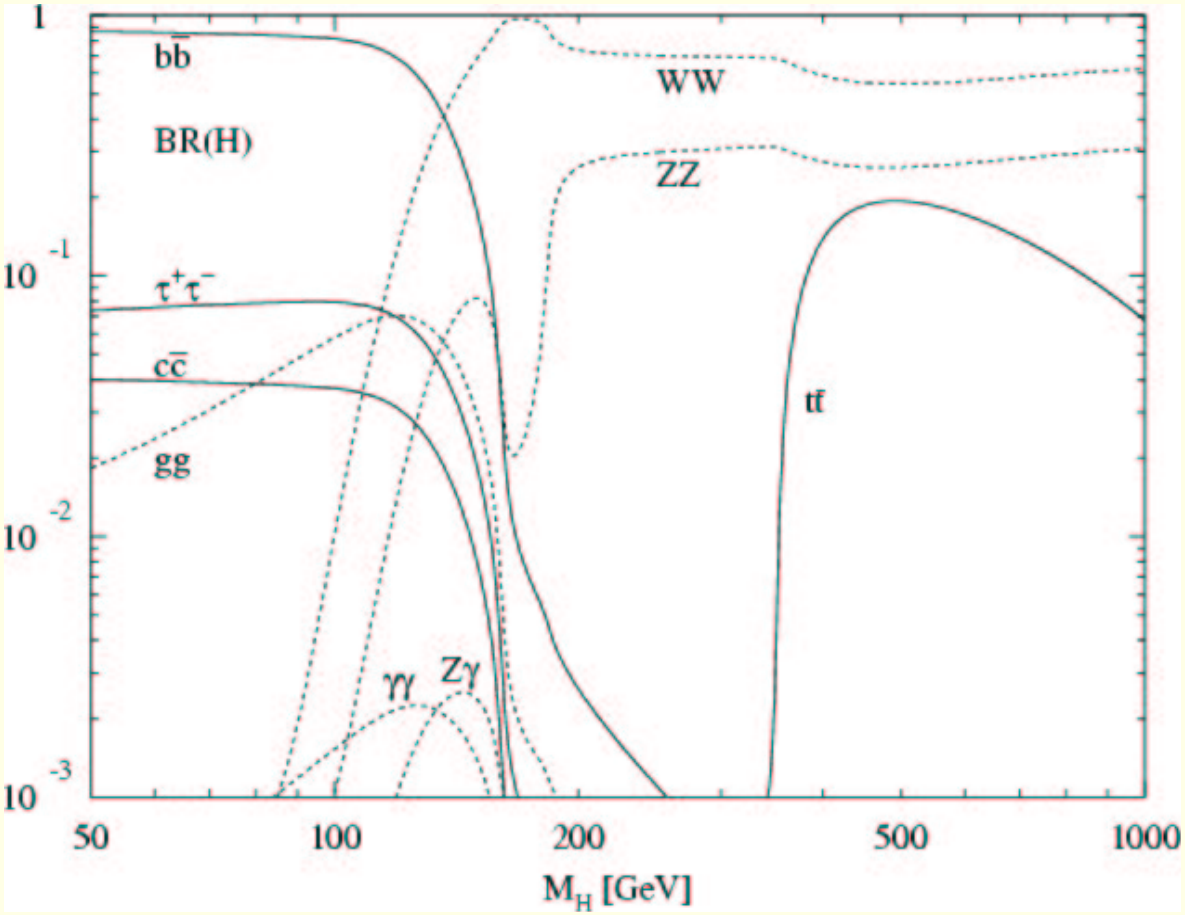
Fermion couplings

Inferred from $\gamma\gamma$ and WW final states and comparison of WH, $t\bar{t}H$ and H production



$H \to Z\gamma$ is with $Z \to \mu\mu$ or $Z \to e^+e^-$ is visible

BR



ATLAS+CMS 600fb^{-1} 3σ; 6000fb^{-1} 11σ

Higgs self coupling??

Preliminary particle level study of HH final states which contains a contribution from λ_{HHH} Very hard to measure anywhere: linear collider folks claim 20% precision.

Event rates for $6000\mathrm{fb}^{-1}$, both total rates and rates from WW fusion studied

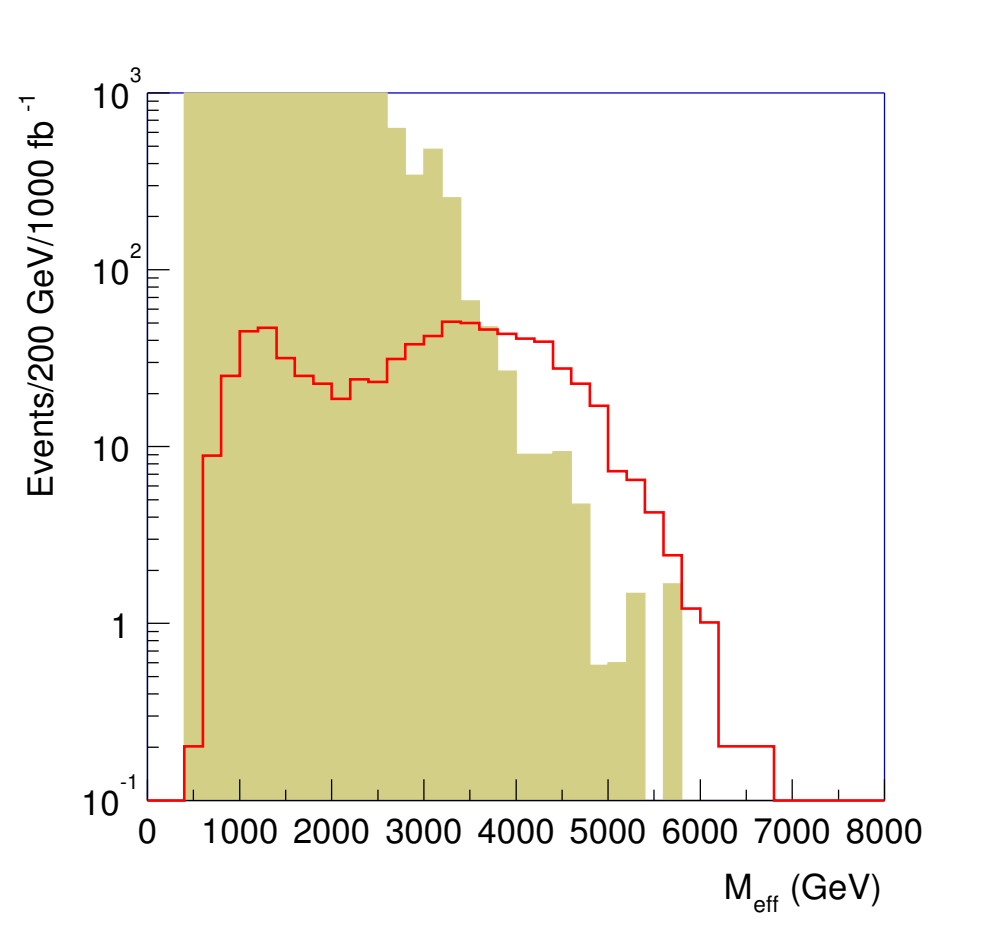
Process	$M_H = 120$	$M_H = 140$	$M_H = 170$
$HH \to 4b$	6000	1000	0.5
$HH \to 2b\ell\nu\ell\nu$	500	650	5
$HH \to 4\ell 4\nu$	10	90	235
$qqHH \to qq4b$	380	70	0
$qqHH \to qq4b$	30	40	1
$qqHH \to qq4b$	0.5	6	15
$t\bar{t}H \to 6b\ell\nu jj$	15	2	0

b-tagging efficiency is vital (50% assumed)

Only a few backgrounds estimated: jet rejection at least 40 is needed

SUSY

$M_{\tilde{g}} = 2.4TeV$
SM is shaded



Mass reach extends by 30% to $3.5\mathrm{TeV}$ for gluinos in case of luminosity upgrade More detailed measurements become possible Note that energy upgrade is more powerful

Conclusions

Just about managed to "stay above water"

Manpower shortage for DC.

Hired support person supported by project

Need to negotiate software agreement.

Hope that LHC wide coordination will yield long term savings.