WP1: “New particles search”

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&

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Activities in 2013

- 1.1 SM Higgs discovery in the H→ZZ→4l:
  - Discovery via 4l invariant mass
  - measurement of the properties
    - mass, width, spin-parity
  - separation of ggF and VBF
  - Muon performance studies with/without GEM :
    - Muon efficiencies for ID, isolation and SIP
    - Muon HLT efficiency
    - Trigger efficiencies at high eta / upgrade high eta with GEM for LS1 and LS2
- 1.2 Search for Z'→ee and W'→μν
  - complete analysis on going
  - aspects related to calibration oe electrons involved
- 1.3 Setup of a CMS analysis center in AINSHAM

Deliverables and secondments

Goals:

- D 1.1: Mass spectrum of ZZ* in 4 leptons
- D 1.2: Mass spectrum of ee at high mass for Z'→ee
- D 1.3: Setup of a CMS data analysis center in Egypt

Secondments:

POLIBA: ER1 to AINSHAM for task 1.3 delivering D 1.3 at month 44

ECOLE: ER2 to AINSHAM for task 1.3 delivering D 1.3 at month 44

AINSHAM: ESR1 to ECOLE for task 1.1 delivering D 1.1 at month 16

AINSHAM: ESR2 to POLIBA for task 1.1 delivering D 1.1 at month 16

AINSHAM: ESR3 to ECOLE for task 1.1 delivering D 1.1 at month 36

AINSHAM: ESR4 to POLIBA for task 1.1 delivering D 1.1 at month 36

We got 2 people at POLIBA and 2 at ECOLE last year:

- Ahmed Ali Abdelalim / Reham Aly / Ahmed Sayed at Poliba
- Sherif Elgammal / Mostafa at Ecole Poly

Actions taken

- mailing list for WP1: WP1-EEPN2@cern.ch
- Twiki page: https://twiki.cern.ch/twiki/bin/view/CMSPublic/EEPN2WP1
- meetings every 2 weeks, sometimes post-poned for being too busy
- Current results about the analyses will be shown today at WP1 meeting

My personal view for future improvements:

- background about particle physics and particle detectors is generally low → specific courses need to be done at Egyptian universities
- some experience with basic tools before travelling to Europe could speed up the activity

Plans for 2014

- Effort to complete spin/parity studies for Higgs with 4l analysis
- Contribution for high mass paper to be finalized within 2 weeks
- Priority towards Z'→ee, μμ analyses that will be fundamental for Run II from the beginning
- New secondments for 2014 under discussion; the will be finalized this week
- Preparation of the contributions for the school in April: to be done

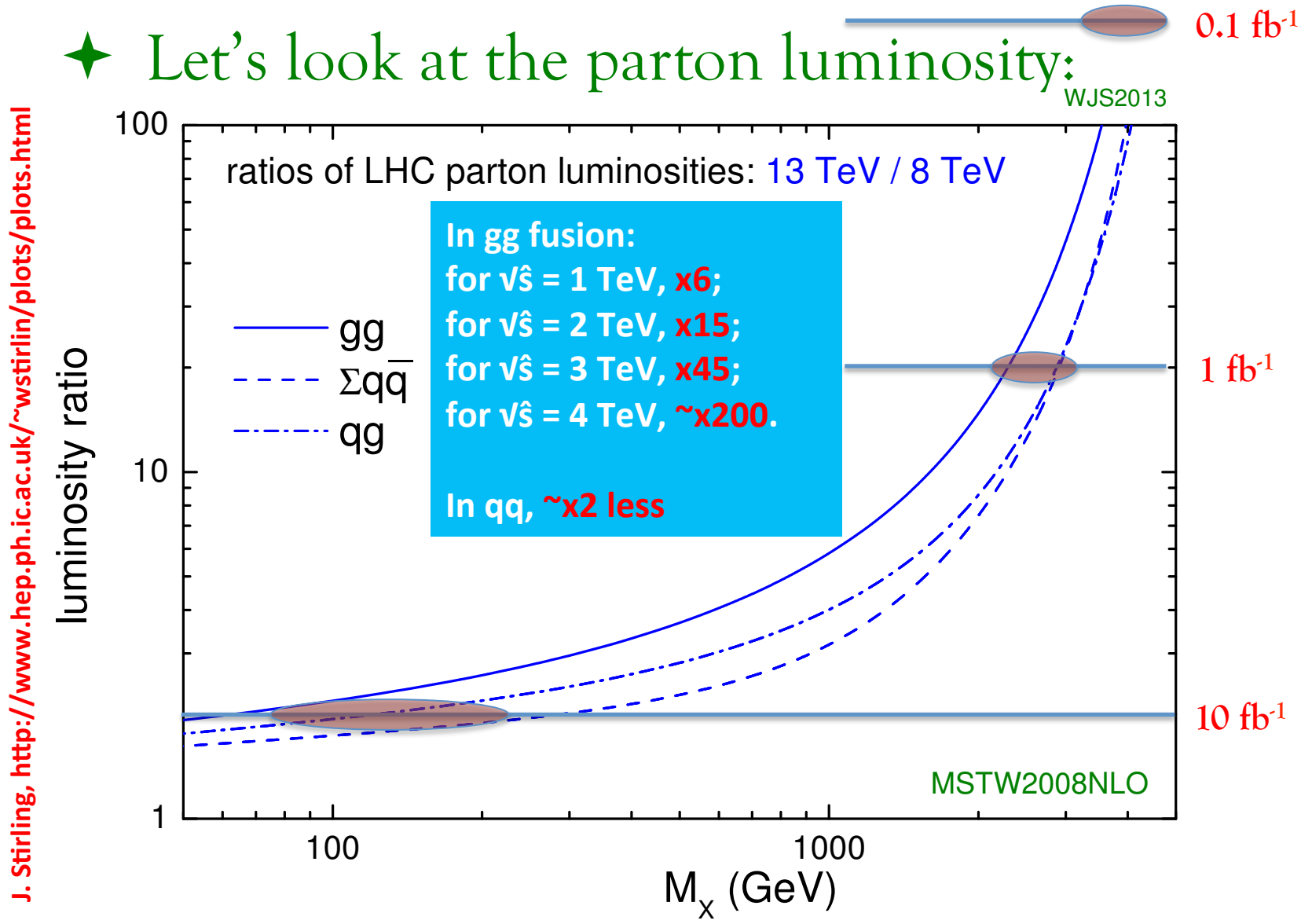
Run II challenge

- We know that the machine will start at 13 TeV and 50ns
- However, there are still many unknowns:
  - We don't know when the first collisions start
    - Nominally, as early as March-April, but delays are possible
  - We don't know how much data are going to be delivered at 50ns
    - Nominally, just a pilot run of 0.5-1.0/fb, but if there are challenges with 25ns running, we may end up getting significantly more 50ns data
  - We don't know how much data will be delivered altogether
    - Nominally, 20-30 fb^{-1}, but may end up with 5-10 fb^{-1}

Courtesy: G. Lansberg

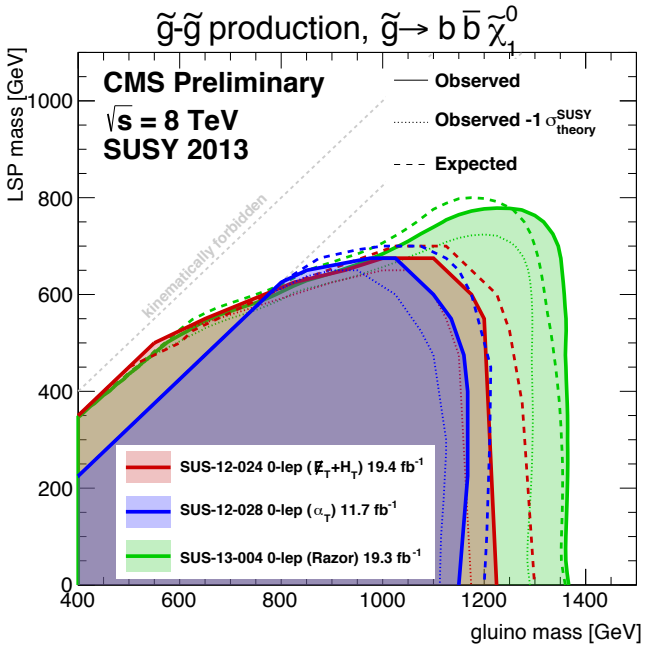
It's all about PDFs...

- Let's look at the parton luminosity:



Example: SUSY

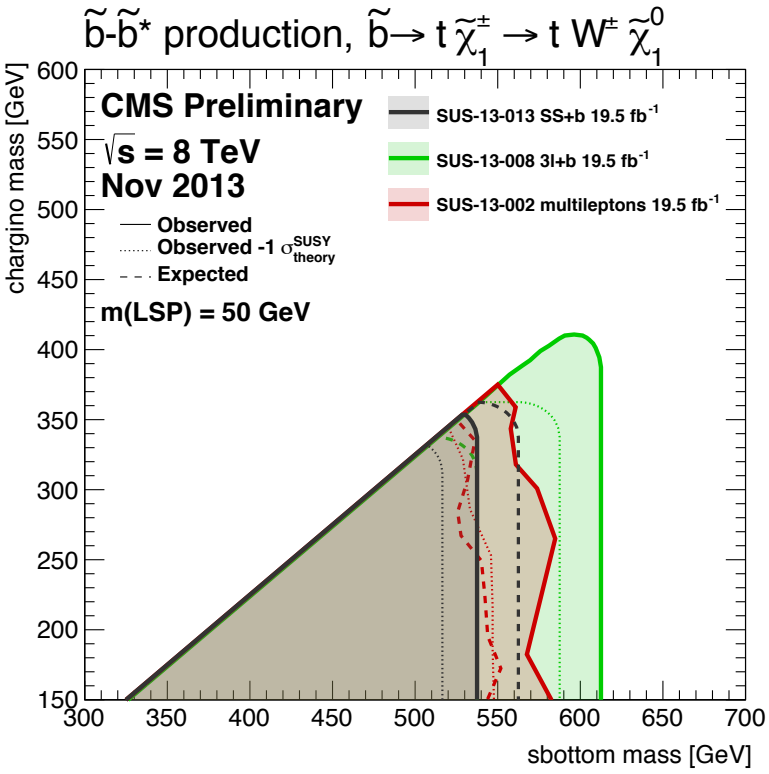
- Gluino pair production
  - Where we are now:
    - M_g > 1.4 TeV @ 95% CL
  - Let's take M_g = 1.5 TeV
    - This mass has not been probed yet
    - Moreover, relatively light gluino is required by in natural (i.e., non-fine-tuned) SUSY

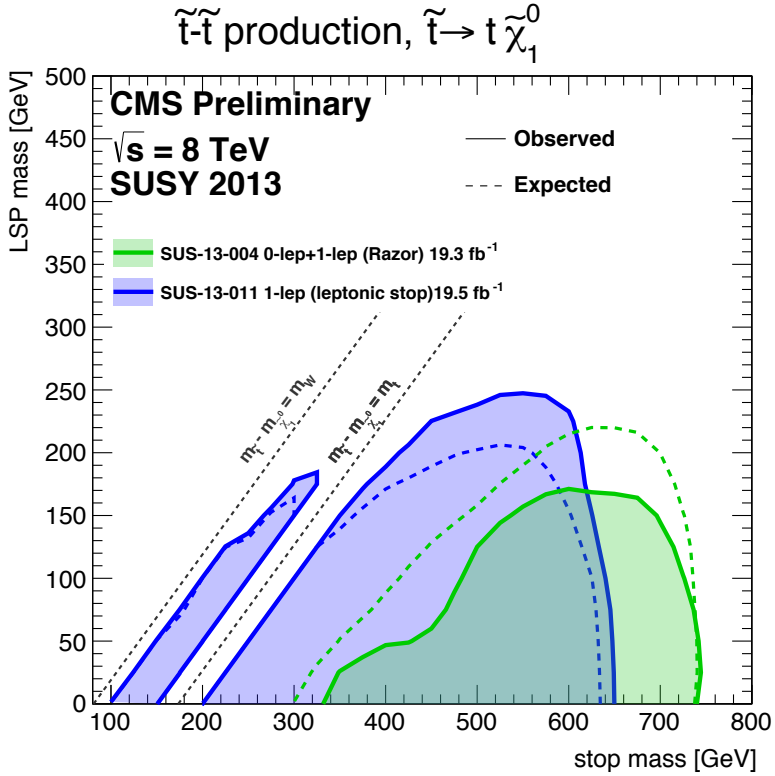


  - M_g = 1.5 TeV corresponds to $\sqrt{\hat{s}}$ = 3 TeV; production mechanism is gg
  - Sensitivity can be achieved with little over ~0.5/fb @ 13 TeV
    - 1/fb pilot 50 ns sample is a discovery sample!
  - Gluino-mediated searches will have the highest priority in early 2015!

More on SUSY

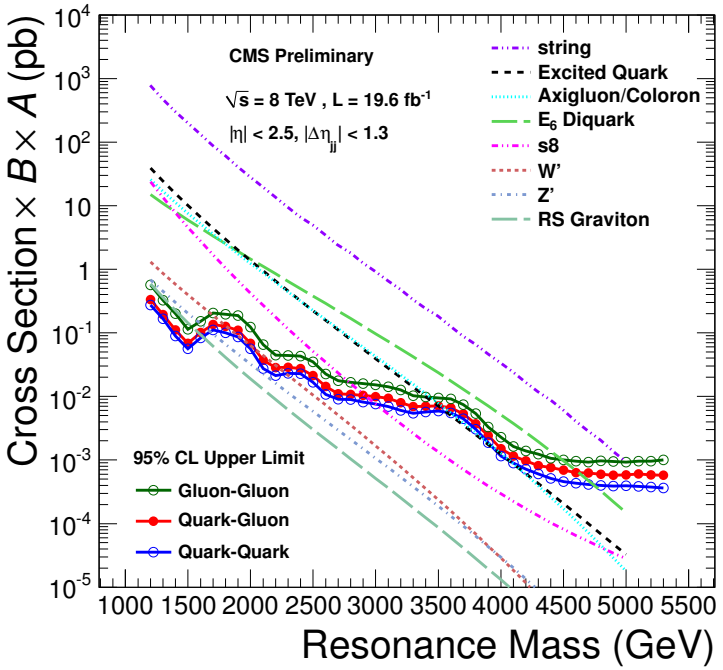
- What about direct third-generation squark searches?
  - Current lower limits on sbottom/stop mass es ~600 GeV, corresponds to $\sqrt{\hat{s}}$ ~ 1.2 TeV
  - Cross section boost in gluon fusion ~6; need ~4-5 fb^{-1} to go beyond the current limits – end of 2015 or 2016





Example: Dijet Resonances

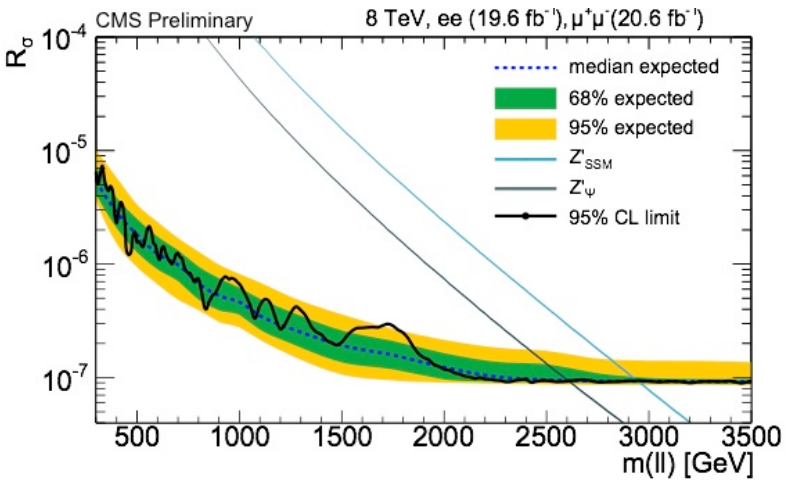
- Search for strongly produced resonances decaying into dijets or quantum gravity effects, such as black holes
- Very large cross sections; current limits in 4-5 TeV range

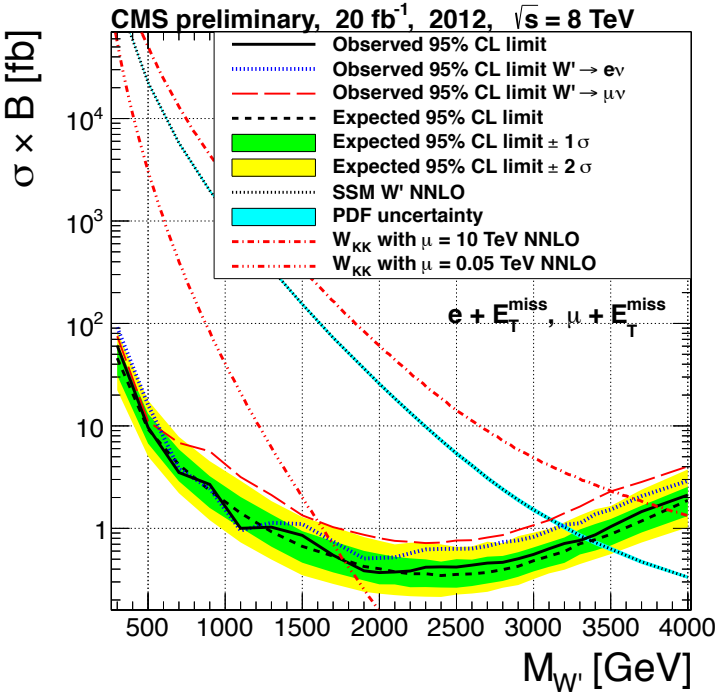


- Effective integrated luminosity at 13 TeV: <100/pb
- Discovery *literally* is possible on Day 1 of the LHC operations at 13 TeV!
  - Don't underestimate the power of high energy!

Example: Heavy Resonances

- Current limits on Z'/W':
  - M(Z') > 2.6-3.0 TeV (depending on the model)
  - M(W') > 3.2 TeV (SSM W')
- Produced in qq fusion; equivalent 13 TeV luminosity: 1/fb
- Can improve on the present limits with the pilot run
- Discovery in 2015 with >2/fb at 25ns or with additional 50ns running





Example: Higgs

- Higgs is light, so cross section doesn't get that much boost (x2, 19.1 → 43.6 pb)
  - Also, note that Higgs *has* been discovered already!
- Yet, it's very important to repeat the discovery at 13 TeV as a part of physics commissioning
  - Should be possible with <10/fb of 13 TeV data even with simpler techniques than we used in 2012
  - An important exception: ttH production, which gets a boost by a factor of 4 (0.13 → 0.50 pb)
  - Can potentially see it for the first time with 10/fb @ 13 TeV
    - But, this is a fairly challenging analysis!
    - Multileptons are going to play leading role (and they are good for other things, too!)

Run II – Early 2015

- 100/pb-1/fb program:
  - Dijet resonances
  - Black holes
  - Excited leptons
  - Leptoquarks
  - Heavy neutrino
  - W', Z'
  - Gluino-mediated SUSY searches
  - W/Z, tt, VV, Y, inclusive jet, direct photon cross sections
  - UE, particle multiplicity
- 1-10/fb program:
  - Direct third generation searches
  - Full program of Higgs physics
  - Possible observation of ttH production
  - Single top quark cross section
  - Searches with top quarks (tt resonances, top partners, etc.)
  - EWK SUSY production