


# HL/HE-LHC Yellow Report: BSM WG3 meeting

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# Timeline

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- ◆ July 2017: creation of structure
  - ◆ Nov. 2017: Kick off meeting
  - ◆ March/April 2018: Draft table of contents, start writing
  - ◆ April/May 2018: WG3 Working meetings
    - ◆ Includes today
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- ◆ June 18-20 2018: Plenary Workshop  
<https://indico.cern.ch/event/686494>
    - ◆ ~ final table of contents, updates from contributors expected
  - ◆ Sept. 2018: Full draft of report
  - ◆ December 2018: Submission of report
  - ◆ May 2019: European Strategy for Particle Physics Open Symposium

Now

# Some details

- ◆ All contributions tracked in wiki  
<https://docs.google.com/spreadsheets/d/1iXV41m5inPbxFpoWMrt5vXVGva5F6GYO7XwxTMHc5hQ/edit#gid=0>
- ◆ Writing of BSM Chapter for Yellow Report has begun
  - ◆ Managed in overleaf:  
<https://www.overleaf.com/14722141bbfgfvqrrvbp#/56185127/>
  - ◆ All sections expected for the document should have a stub in overleaf now. If you are missing, let us know.
  - ◆ Have asked theory contributions for rough text (~2 pages) by the end of May, ie next week!
    - ◆ This is to give us time to organize potentially overlapping contributions into a coherent section
  - ◆ Depending on what we have we might decide to restructure some of the sub-chapters:
    - ◆ Merge resonances and VLQ
    - ◆ Separate section on characterization of new signals if NP evidence is found

# Status: Section 2 - SUSY

Experiment  
Theory – on going/today  
Theory – no report yet

- ◆ Generic searches for SUSY
  - ◆ **Probing SUSY at HL- and HE-LHC (T. Han et al.)**
  - ◆ **Prospects for realistic SUSY models at the HL-/HE-LHC (S. Heinemeyer et al.)**
  - ◆ **HE-LHC vs HL-LHC SUSY discovery reach (A. Aboubrahim et al.)**
- ◆ SUSY strong production
  - ◆ improved searches for squark/gluinos (ATLAS and CMS)
  - ◆ Prospects for 3rd gen squark production at the HL-LHC and HE-LHC (I. Vivarelli et al. ATLAS)
  - ◆ **T: Implications of a Stop Sector Signal at the LHC (A. Pierce et al.)**
- ◆ SUSY EWK production
  - ◆ Same-sign dilepton searches for EW SUSY (Zevi della Porta et al. CMS)
  - ◆ Prospects for C1N2 via WZ and Wh in multilepton at the HL/HE-LHC (A. de Santo et al. ATLAS)
  - ◆ Prospects for chargino pair production at HL- and HE-LHC (S. Carra' et al. ATLAS)
  - ◆ Search for chargino-neutral in Wh channel using 1Lbb final states (M. D'Onofrio et al. ATLAS)
  - ◆ Prospects for direct stau production at the HL-LHC (C. Zhung et al ATLAS)
  - ◆ Prospects for direct stau production at the HL-LHC (Colegrove et al., CMS)
  - ◆ Compressed electroweakinos at HL- and HE-LHC (S. Amoroso et al. ATLAS)
  - ◆ **Prospects for radiative natural SUSY at HL- and HE-LHC (H. Baer et al. @FNAL18, update today)**
  - ◆ **T: Constraining slepton and chargino through compressed top squark search (P. Konar et al.)**
  - ◆ light Higgsino - ISR + 2leptons (B. Schneider et al CMS)

# Status: Section 3 – Dark Matter

Experiment  
Theory – on going/today  
Theory – no report yet

- ◆ DM + jets
  - ◆ Prospects for DM interpretations in jet+MET analysis at HI/HE-LHC (*C. Gustavino et al. ATLAS*)
  - ◆ Mono-jet searches for DM (*CMS*)
- ◆ DM + ttbar / bbbar
  - ◆ Prospects for associated production of dark matter and top quark pairs at the HL-LHC (*F. Meloni et al. ATLAS*)
  - ◆ Prospects for associated production of dark matter and bottom quark pairs at the HL-LHC (*M. McDonald et al. ATLAS*)
  - ◆ **HL/HE-HLC prospect for determining the CP nature of spin-0 mediators in associated production of dark matter and top pairs (*U. Haisch et al.*)**
- ◆ DM + single top
  - ◆ **HL/HE-HLC prospect for DM and a single top-quark production in a 2HDM model with a pseudoscalar mediator (*P. Pani et al.*)**
  - ◆ Studies of DM production in single-top events (*Pinna et al. CMS*)
- ◆ More models expected to be targeted
  - ◆ Prospects for pure WIMP (pure triplet) Dark Matter at HL-LHC (*L. Carminati et al. ATLAS*)
  - ◆ **T: Search of Higgs portal dark matter models at HL/HE-LHC (*Y.G.Kim et al.*)**
  - ◆ DM in Z+MET channel (*Albert, Hoepfner CMS*)
  - ◆ *Electroweak dark matter at future hadron colliders (*T. Han et al*)*
  - ◆ *Discovery potential of light using boosted di-tau systems. (*G. Cacciapaglia et al.*)*

# Status: Section 4 – Long Lived

Experiment  
Theory – on going/today  
Theory – no report yet

- ◆ Disappearing tracks
  - ◆ Prospects for disappearing track analysis at HL-LHC (*J. Anders et al. ATLAS*)
  - ◆ Prospects for disappearing track analysis at HE-LHC (*M. Saito et al. – ATLAS authors*)
- ◆ Displaced vertex
  - ◆ **Displaced R-Parity Violation at the LHC (*H. Dreiner et al. - @CERN17*)**
  - ◆ Prospects for LLP→DV+MET (*L. Jeanty et al. ATLAS*)
  - ◆ displaced muons (*H. Keller et al. CMS*)
  - ◆ Prospects for LLP→mu+jets at the HL-LHC (*X. Cid Vidal et al. LHCb*)
  - ◆ Prospects for LLP→dijets at the HL-LHC (*X. Cid Vidal et al. LHCb*)
- ◆ long-lived stop/anti-stop with displaced muons (*Calderon et al, CMS*)
- ◆ heavy stable charged particles (dE/dx and TOF) (*Zobec et al., CMS*)
- ◆ fast timing signatures for long-lived particles (*L. Soffi et al. CMS*)
- ◆ Various interpretations
  - ◆ **Searching for Confining Hidden Valleys at the LHCb and ATLAS/CMS (*A. Pierce et al.*)**

# Status: Section 5 – Dark Sector

Experiment  
Theory – on going/today  
Theory – no report yet

- ◆ **dark photons**
  - ◆ Searching for dark photons via Higgs-boson production at the HL-LHC and HE-LHC (*S. Biswas et al.*)
  - ◆ Prospects for long-lived dark-photon decays (lepton-jets) at HL-LHC and HE-LHC (*C. Sebastiani et al. ATLAS*)
  - ◆ Dark photons interpretation of displaced muons analyses (*H Keller, K. Hoepfner CMS*)
- ◆ **Axions:**
  - ◆ Axion-like particles at the LHC (*A. Mariotti et al.*)

# Section 6,7 – Heavy Resonances and VLQ

Experiment  
Theory – on going/today  
Theory – no report yet

- ◆ **Precision searches in dijets at the HL-LHC and HE-LHC** (*S. Chekanov et al. @CERN17*)
- ◆ Prospects for diboson resonance at HL-LHC and HE-LHC (*R. Les et al. ATLAS*)
- ◆ **Improving sensitivity to heavy resonance decaying 4 leptons at the HL-/HE-LHC** (*D. Debnath et al.*)
- ◆ Search for heavy composite Majorana neutrino (*P. Azzi et al. CMS*)
- ◆ **Singlet-like scalars at HL and HE LHC** (*D. Buttazzo et al.*)
- ◆ **Dissecting Multiphoton Resonances at the LHC** (*Allanach et al. @CERN17*)
- ◆ LQ3- $\rightarrow$ tau,b projections of 13 TeV analyses (*Y. Takahashi CMS*)
- ◆ **Radiative Decays of Top-partners at the LHC** (*H. Alhazmi et al.*)
- ◆ **Vector-like quarks and leptons in extended Higgs sector** (*R. Dermisek et al.*)
- ◆ **VLQs at HL- and HE-LHC: discovery and characterization** (*D. Barducci, L. Panizzi, @CERN17*)
- ◆ Vector-like quark discovery reach (*S. Khalil, CMS*)
- ◆ VBF + new heavy resonance  $\rightarrow$  4b (*D. Majumder et al CMS*)
- ◆ *Prospects for  $ll$  ( $l=e, \mu, \tau$ ),  $WW$ ,  $tt$ ,  $qq$  resonances at HE-LHC* (*C. Helsens et al.*)
- ◆ *Neutrino Mass Models (flavor/lepton number violation)* (*T. Han et al. and S. Pascoli et al.*)
- ◆ **Fitting techniques using Gaussian Processes for resonance searches** (*Y. Ng et al.*)
- ◆ Resonance to  $tt$  (hadronic with substructure) (*S. Sagir et al. CMS*)
- ◆  $Z'$  measurements of properties (*K. Hoepfner, CMS*)
- ◆  $W' \rightarrow l, \nu$  discovery reach and weak couplings (*K. Hoepfner, CMS*)
- ◆  $W \rightarrow tb$  discovery reach (*CMS*)
- ◆ **Precision predictions for new di-lepton and t-tbar resonances** (*M. Altakach et al.*)
- ◆ **Model discrimination, at the HE-LHC, for  $Z'$  HL-LHC discoveries** (*T. Rizzo et al.*)



# Section 8 – Flavor-related and misc.

Experiment  
Theory – on going/today  
Theory – no report yet

- ◆ New Physics Prospects From  $B \rightarrow K^{(*)} \mu \mu$  (*Allanach et al*)
- ◆ Sphalerons in proton-proton collisions (*S. Amoroso @CERN17*)
- ◆ **Search for light composite objects at LHC (*A. Deandrea et al*)**
- ◆ **“composite 2HDM” (*S. Decurtis et al*)**
- ◆ Prospects for 4 top signatures at the HL/HE-LHC (*P. Pani, F. Meloni, ATLAS*)
- ◆ Same sign WW scattering at the LHC (*J. Kalinowski et al*)
  
- ◆ **BSM studies in complementary facility/experiments:**
  - ◆ electron-proton collider BSM topics review (*Oliver Fischer et al.*)
  - ◆ LLP in MATHUSLA and other experiments (feedback from LLP workshop last week) – *Xabier Vidal*

# miscellanea

- ◆ **Mini-groups** formed including ATLAS and CMS experimentalists to discuss common topics. E.g.:
  - ◆ SUSY: EWK higgsinos, stau pair production
  - ◆ DM + heavy flavor
  - ◆ Ttbar and other resonances (also at 27 TeV)
- ◆ Discussion on **systematic uncertainties** on-going
  - ◆ Talks at the June workshop foreseen
  - ◆ Involving SM group for theoretical uncertainties
- ◆ **DELPHES code** and MC samples for 27 TeV:
  - ◆ [https://twiki.cern.ch/twiki/bin/view/LHCPhysics/HLHEWG\\_MC](https://twiki.cern.ch/twiki/bin/view/LHCPhysics/HLHEWG_MC)
  - ◆ Code in GitHub, samples in <http://fcc-physics-events.web.cern.ch/fcc-physics-events/>