BSM summary

Mikael Berggren[1]

[1]DESY, Hamburg

LCWS, Whistler, BC, Nov. 2015

Outline

Introduction

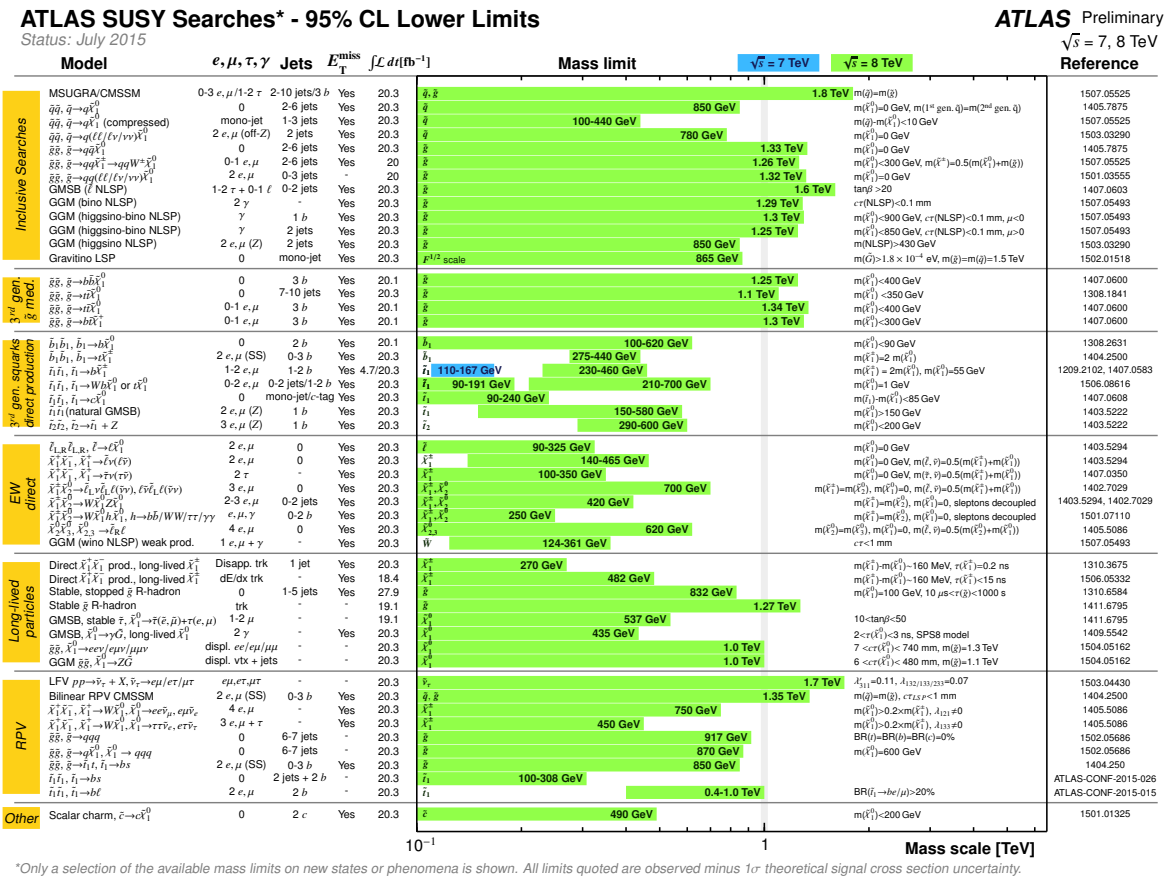
- Some stats:
  - 11 Talks
  - 8 SUSY, 3 non-SUSY
  - 6 experimental, 5 theory
- + a discussion session, with 2 presentations.
- + Session combined with Higgs, with 5 talks (not covered here)

SUSY

SUSY at LHC

Current LHC results from C. Potter:

ATLAS Summary



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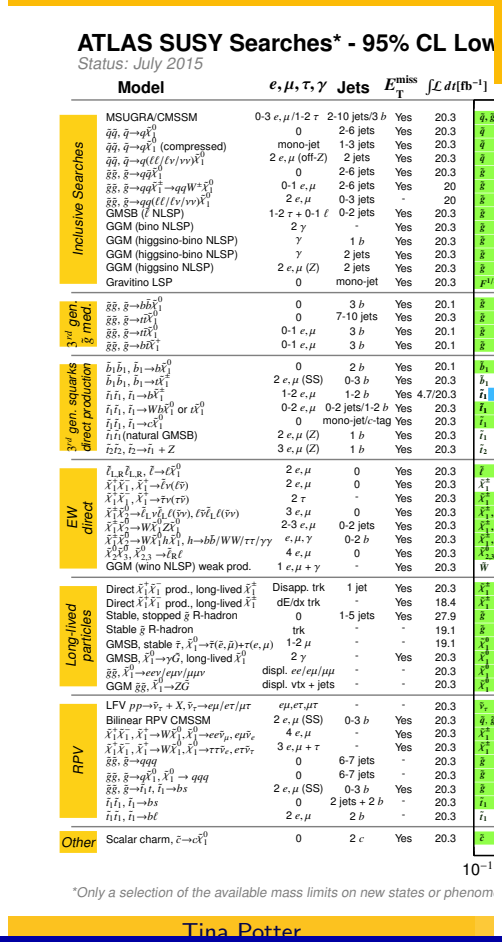
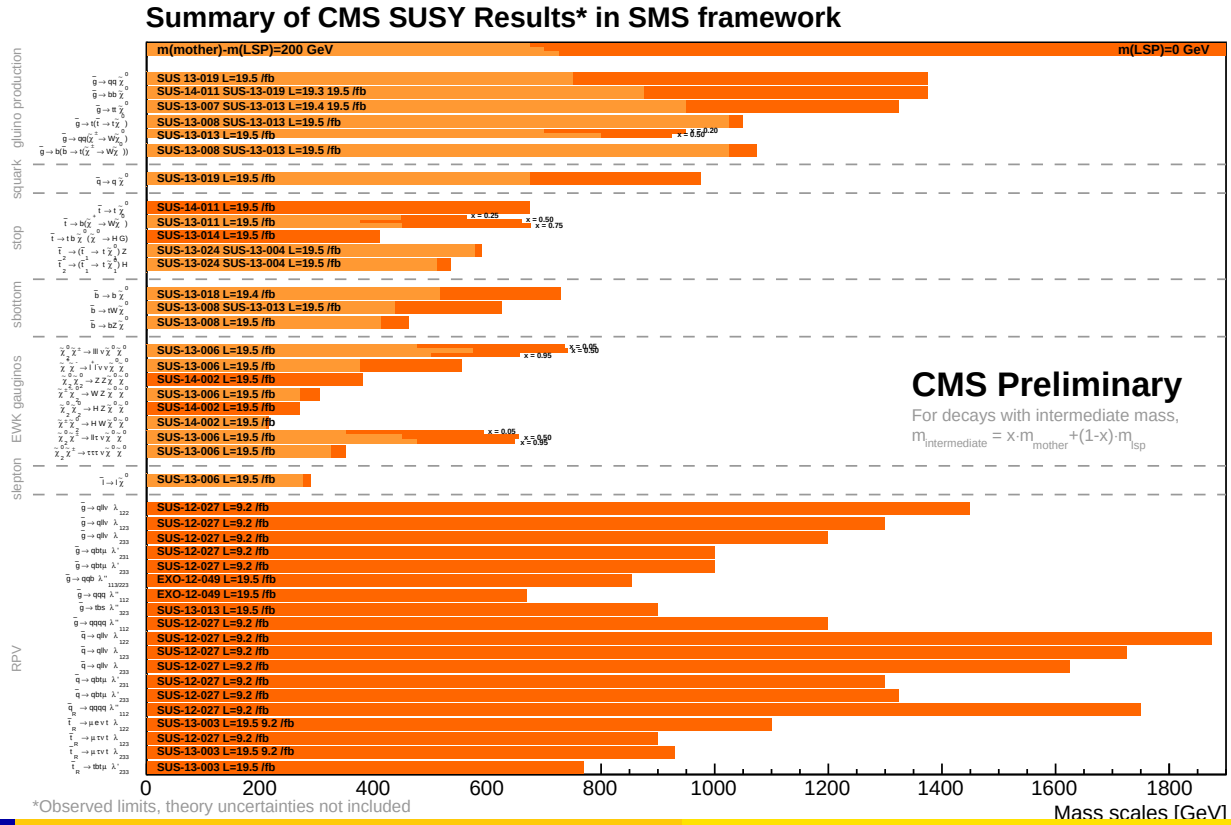


Tina Potter

CMS Summary



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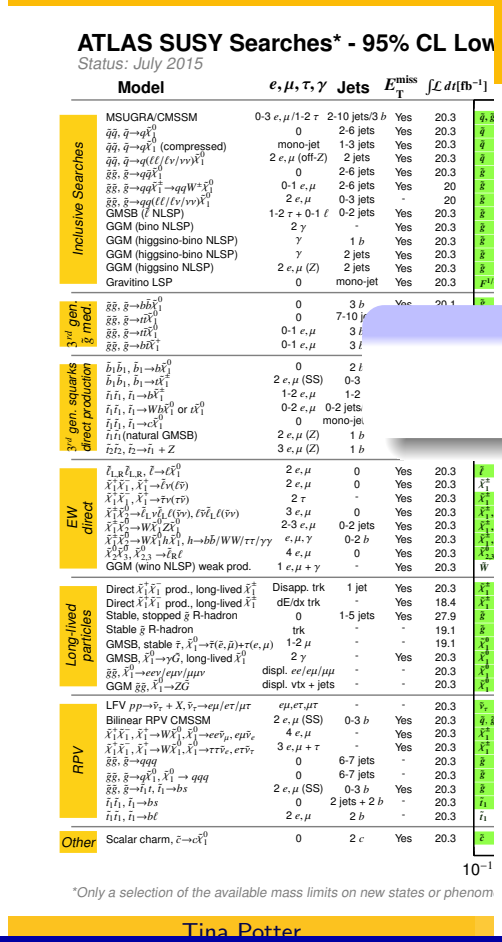

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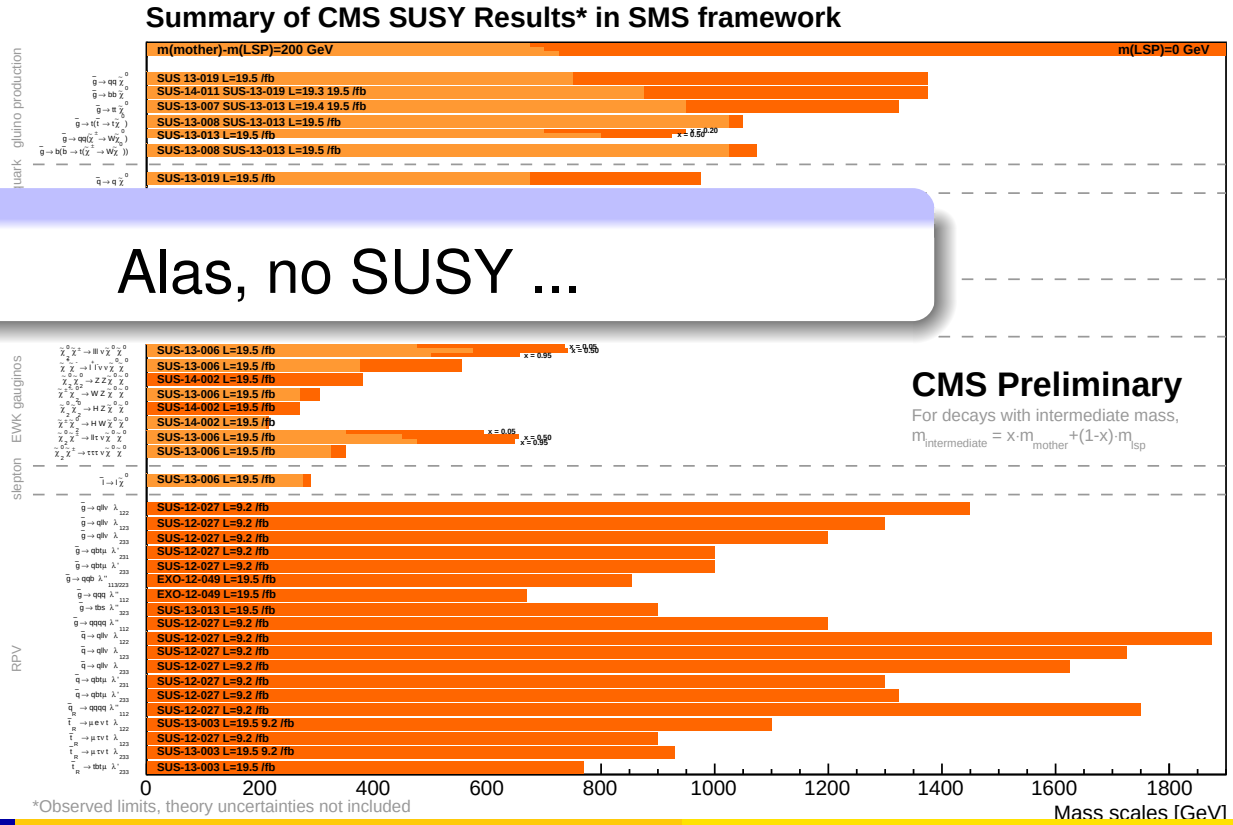
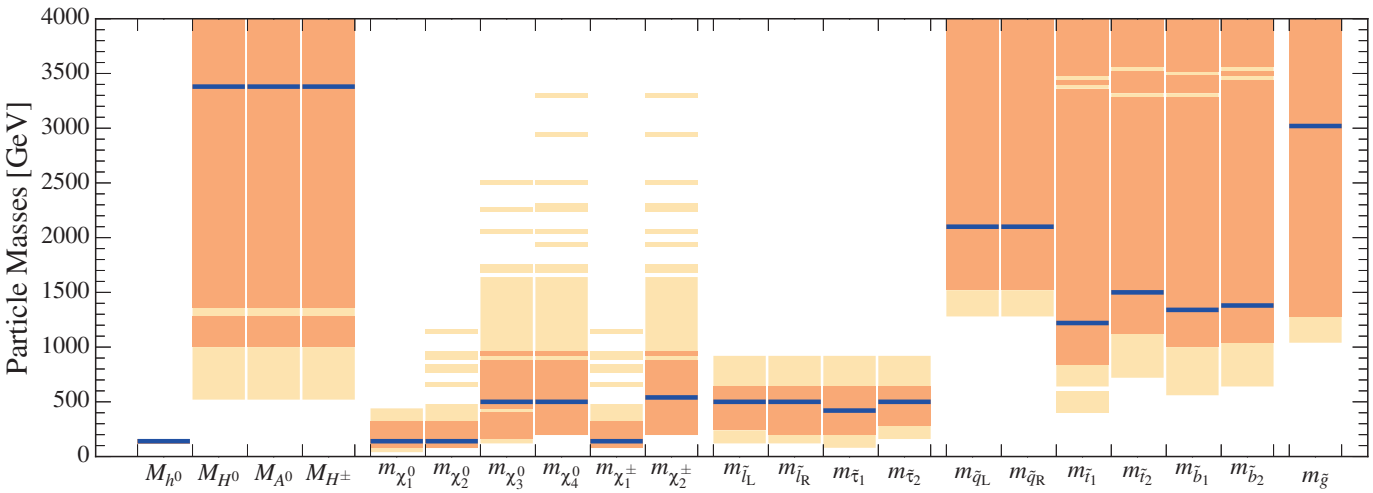


Alas, no SUSY ...

SUSY: Global fit (10 parameters)

pMSSM10 prediction: best-fit masses

[2015]



⇒ high colored masses

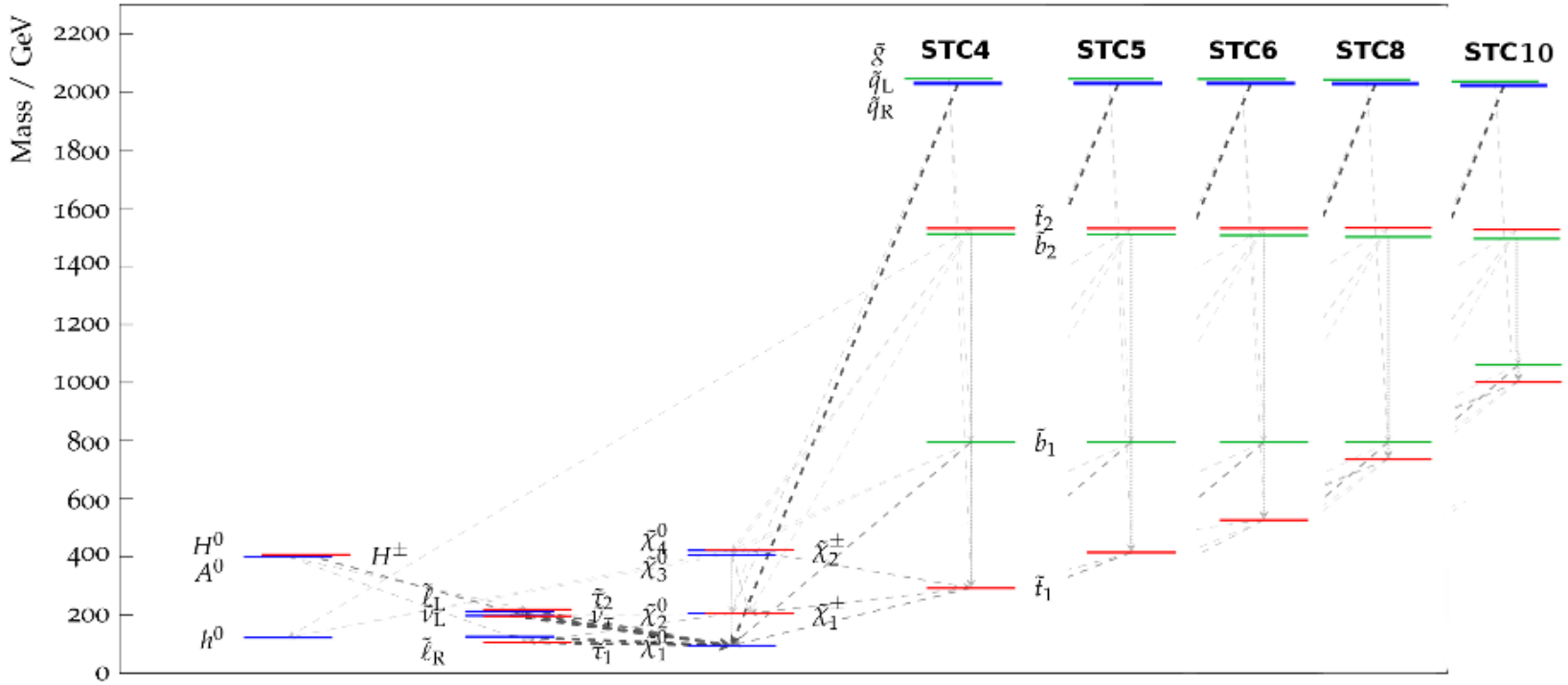
⇒ relatively low electroweak masses

partially with not too large ranges

⇒ clear prediction for ILC and CLIC

SUSY: A possible model

Berggren



Well-tempered higgs, bosino and slepton sector

Varying 3-gen squarks

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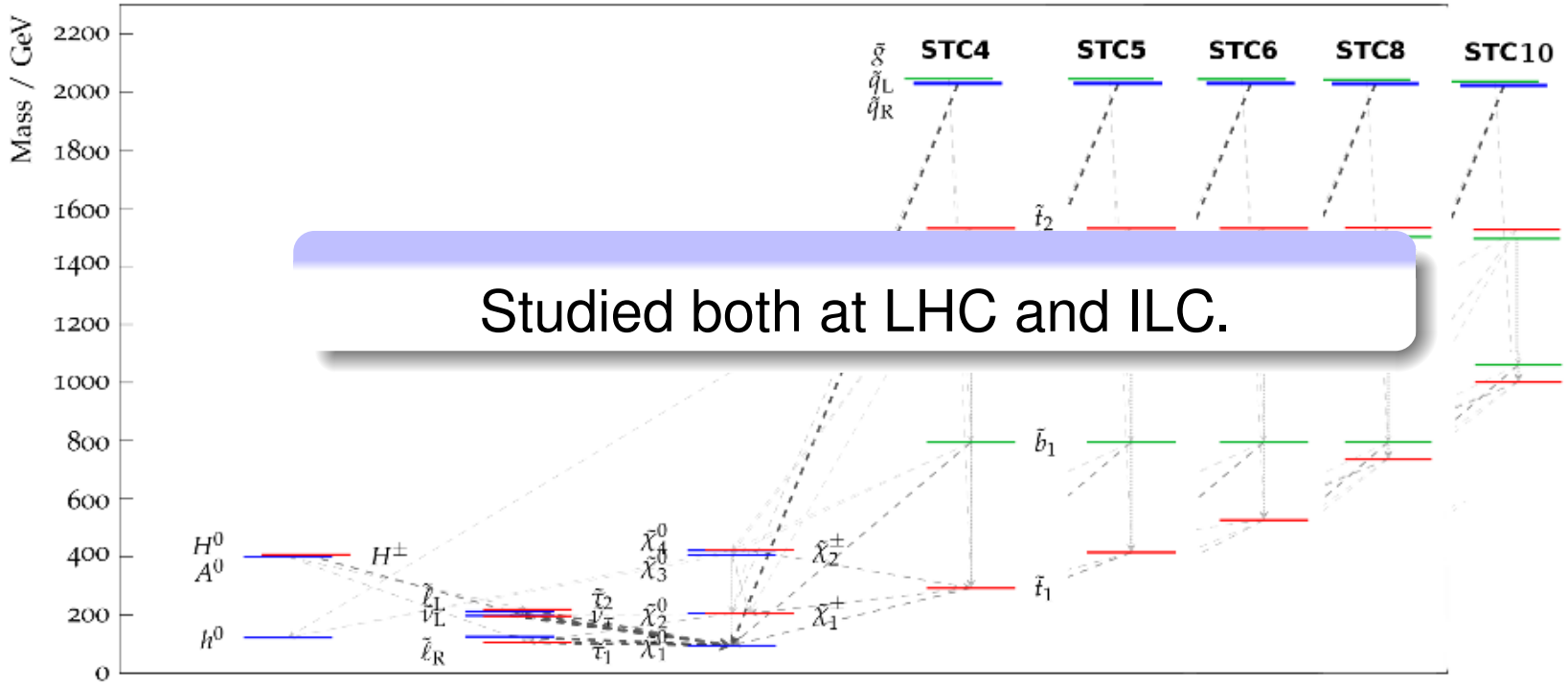

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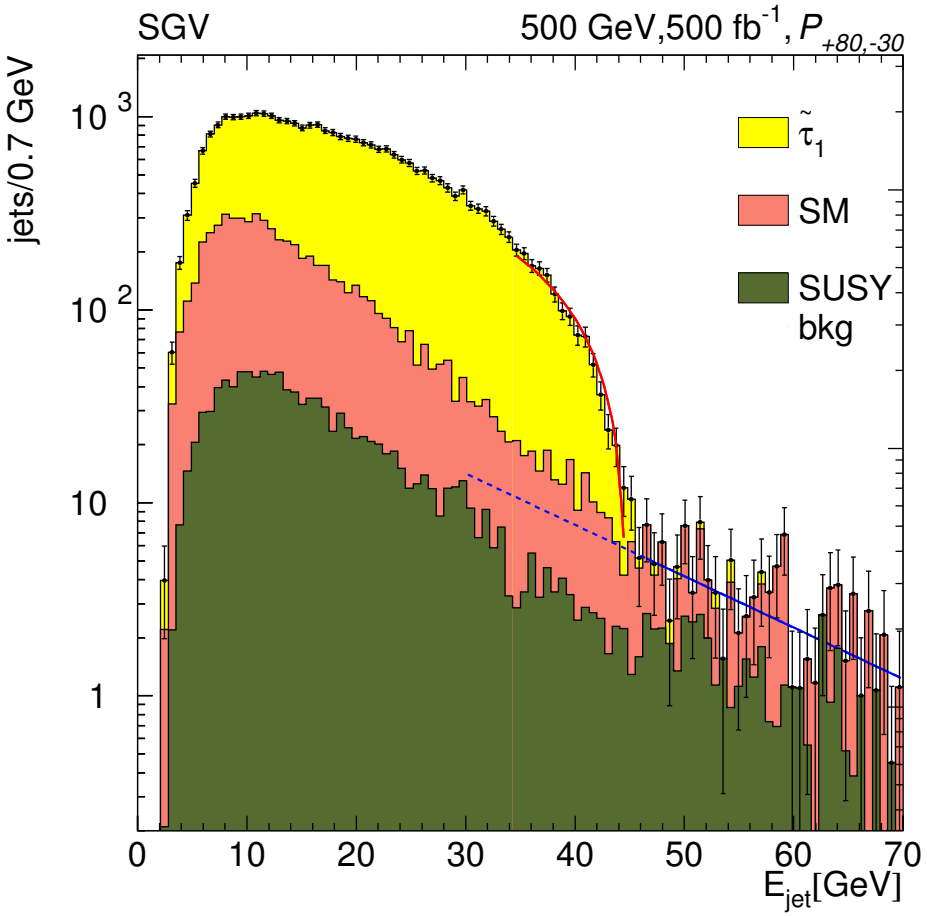
SUSY: A possible model

- The $\tilde{\tau}_1$ = The NLSP - M to 200 MeV
- $\tilde{e}_R$ = The big guy - $M_{\tilde{\chi}_1^0}$ to 200 MeV = the DM.
- Threshold scan = sleptons are scalars.



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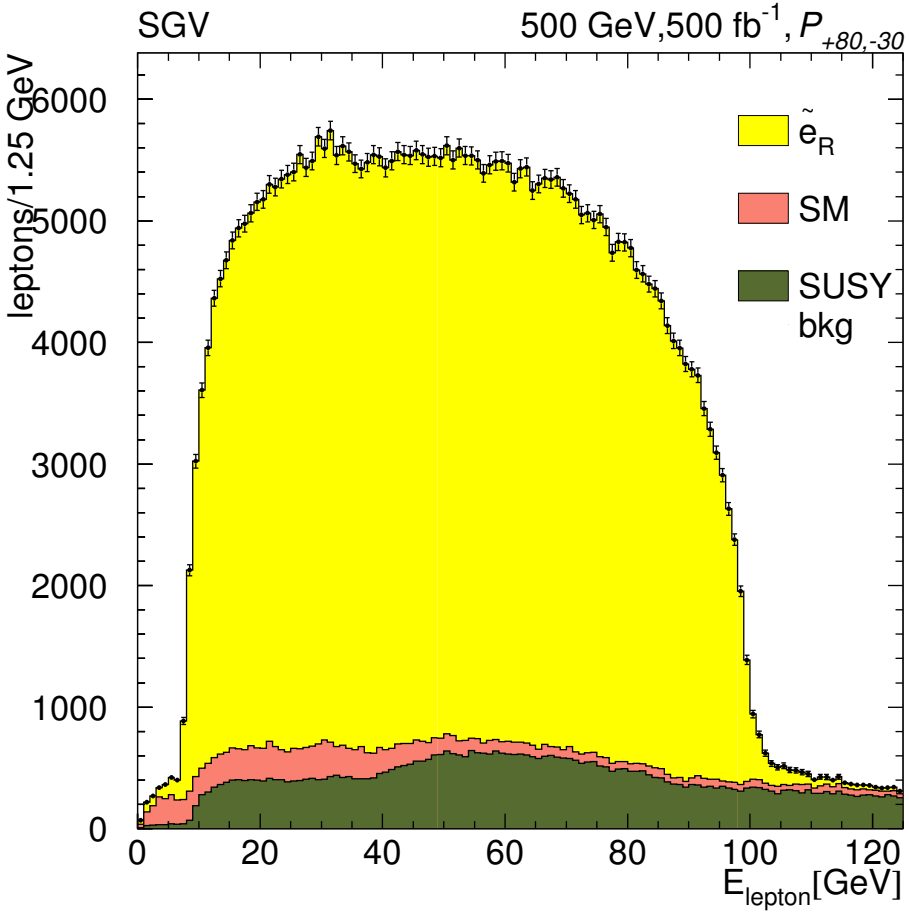

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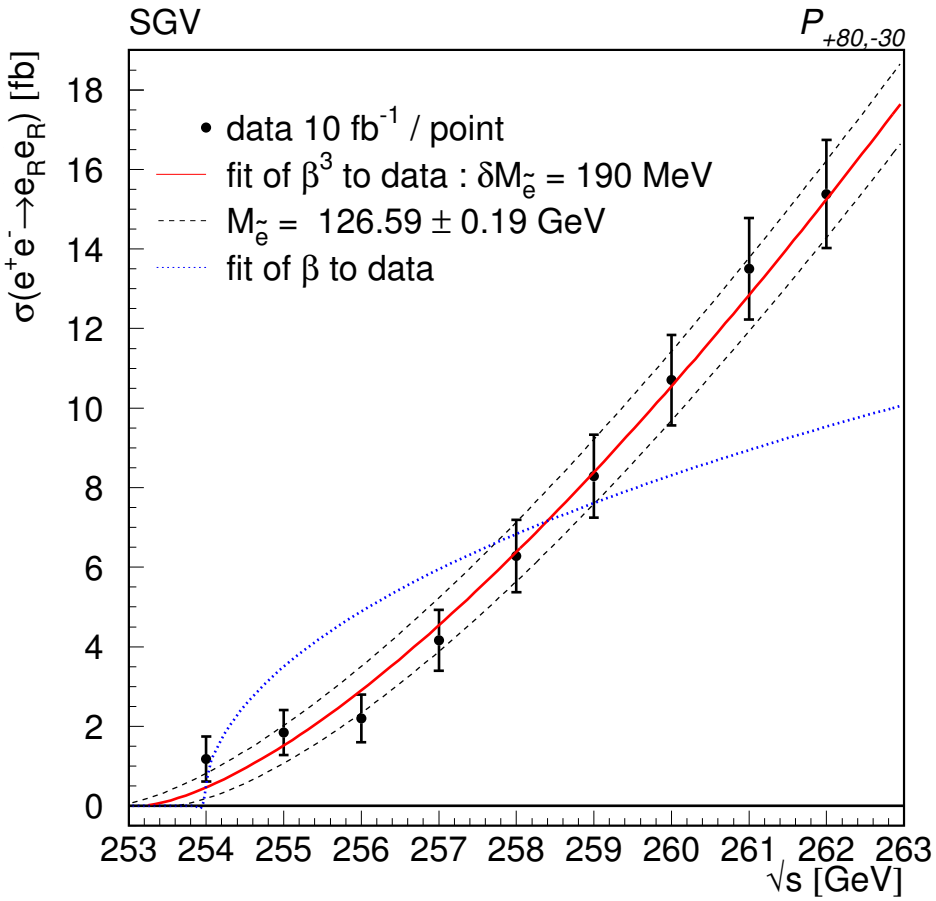

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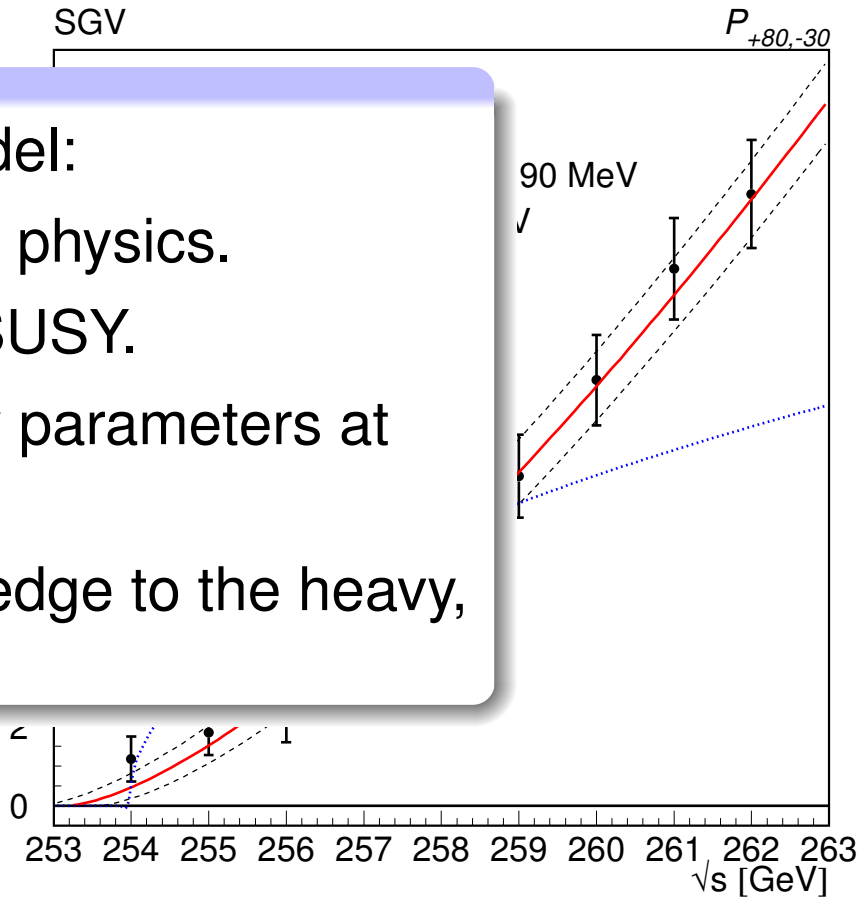
In this model:

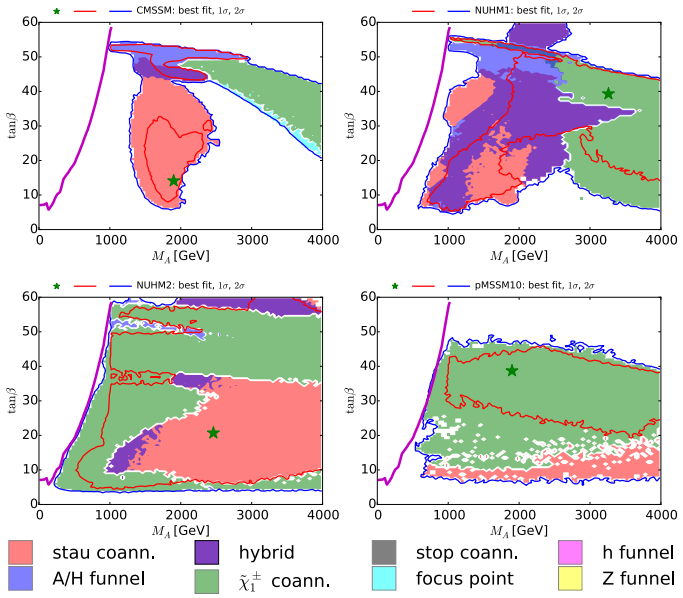
- LHC discovers BSM physics.
- ILC shows that it's SUSY.
- ILC measures many parameters at per mil level.
- LHC extends knowledge to the heavy, coloured sector.



SUSY: Implications for DM

Dark matter mechanisms in SUSY

- Stau coannihilation is one of the preferred mechanisms to explain dark matter in SUSY



Mastercode arXiv:1508.01173v1

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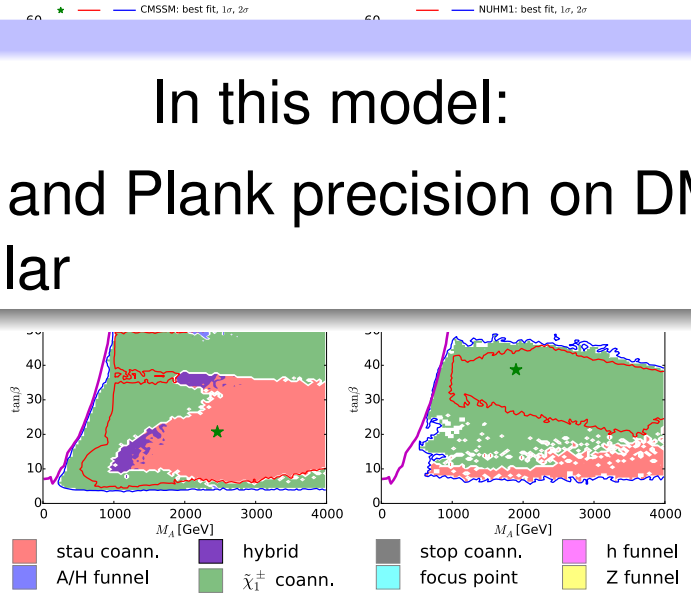

In this model:

- ILC and Plank precision on DM similar

Mastercode arXiv:1508.01173v1

SUSY: NMSSM

(Potter, Okumura)
The μ problem: Why should μ be at the EW scale ?

- In the NMSSM: add one singlet field to the MSSM. It's VEV generates a μ_{eff} at the EW scale.
- Benchmark h_{60}
- Add Mirage mediation: Very little fine-tuning.

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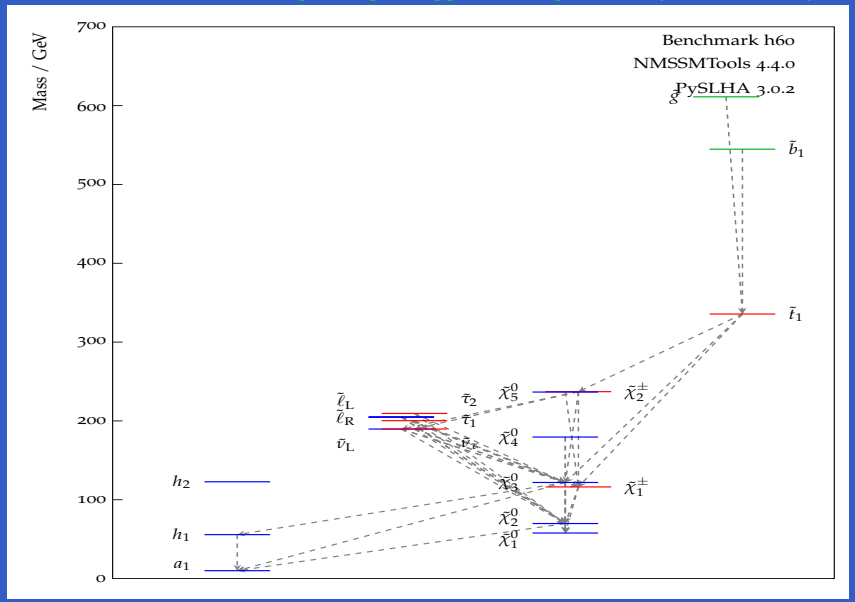
NMSSM Benchmark Point h_{60} (aka BP3)

Natural NMSSM with a Light Singlet Higgs and Singlino LSP (1505.05554v3)



Mass spectrum in benchmark point h_{60} (1505.05554v3). Also known as BP3 at https://twiki.cern.ch/twiki/bin/view/LHCPhysics/LHCHXSWGNMSSM

LCWS2015, 4 November 2015 – p.20/

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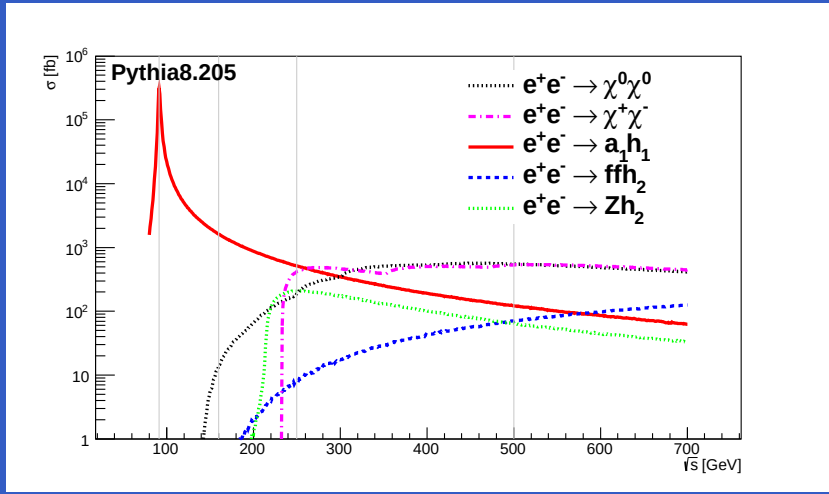
NMSSM h_{60} at e^+e^- Collider (LEP or ILC)



- Standard Higgstrahlung production channel $e^+e^- \to Zh_1$ is suppressed in the NMSSM due to the NMSSM coupling sum rule $\sum_{1=1}^{3} \xi^2_{ZZh_i} = 1$ and measured $h_{125} \to ZZ^\star$ signal strength.
- In h_{60} we have the possibility of resonant production $e^+e^- \to a_1h_1$, with cross section of several hundred picobarns at $\sqrt{s} = m_Z$.

LCWS2015, 4 November 2015 – p.23/

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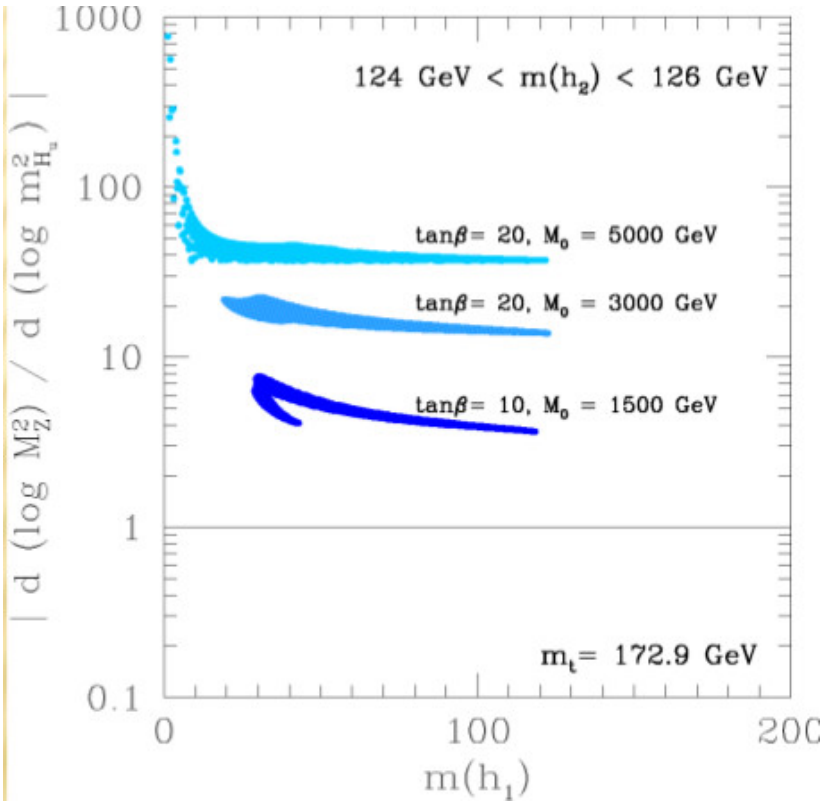

SUSY: and also...

- Chera: Study of an other valid model.
  - NLSP = degenerate $\tilde{\chi}_2^0$ and $\tilde{\chi}_1^{\pm}$.
  - $\Delta(M) > M_Z \Rightarrow$ final state is jets+missing.
- New technique for edge-determination in this case.
- Wang: Nothing-but-DM case, but in the multiple-LSP case.
- Ie. very close states, the slightly heavier one decays invisibly.
- Consequence: The produced particle might be charged.

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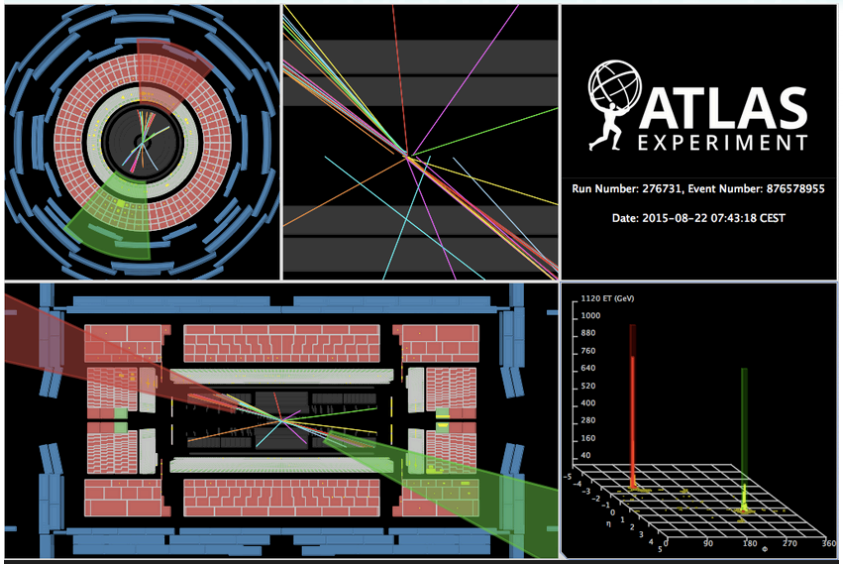
Non-SUSY BSM

Exotics @ LHC

13 TeV (!) LHC dijets from C. Biino:

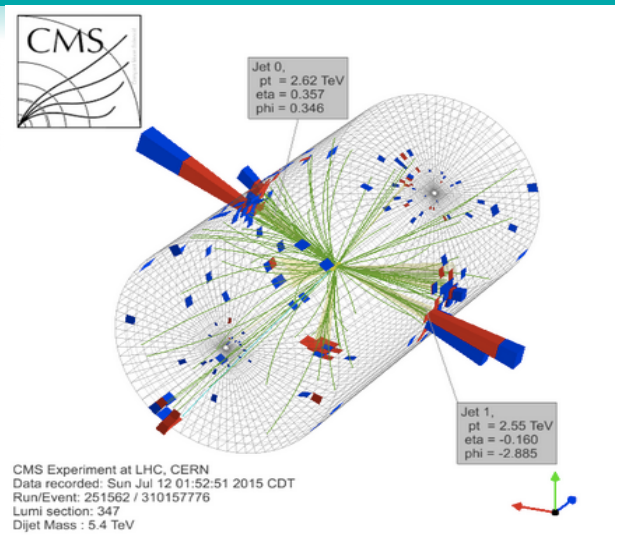
4

Di-jets events at 13 TeV



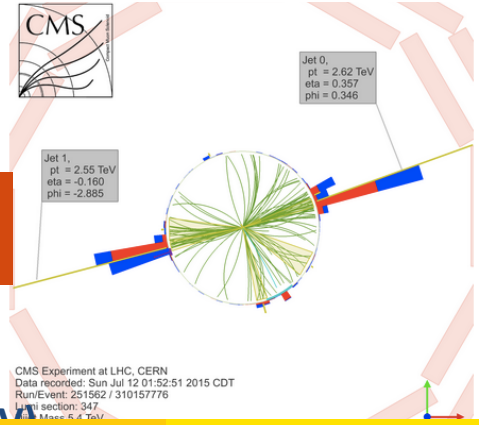
ATLAS-CONF-2015-042

The highest-mass, central dijet event. The invariant mass is 6.9 TeV



CMS-PhysicsResults EXO15001

Display of the event with the highest di-wide-jet mass (5.4 TeV)



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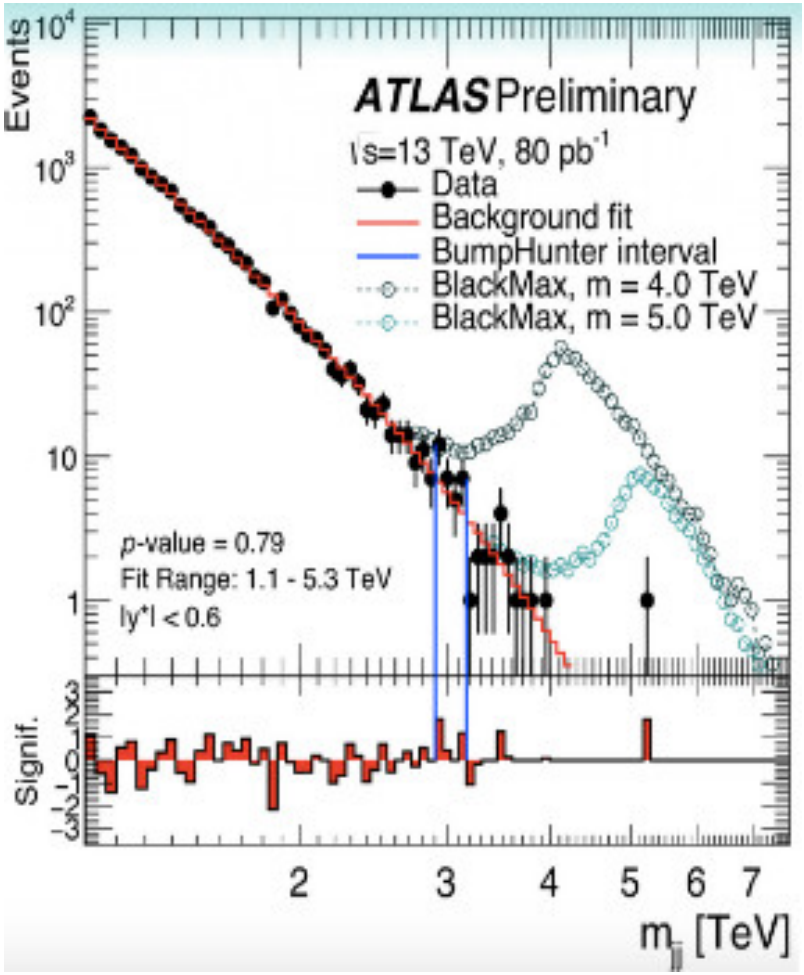

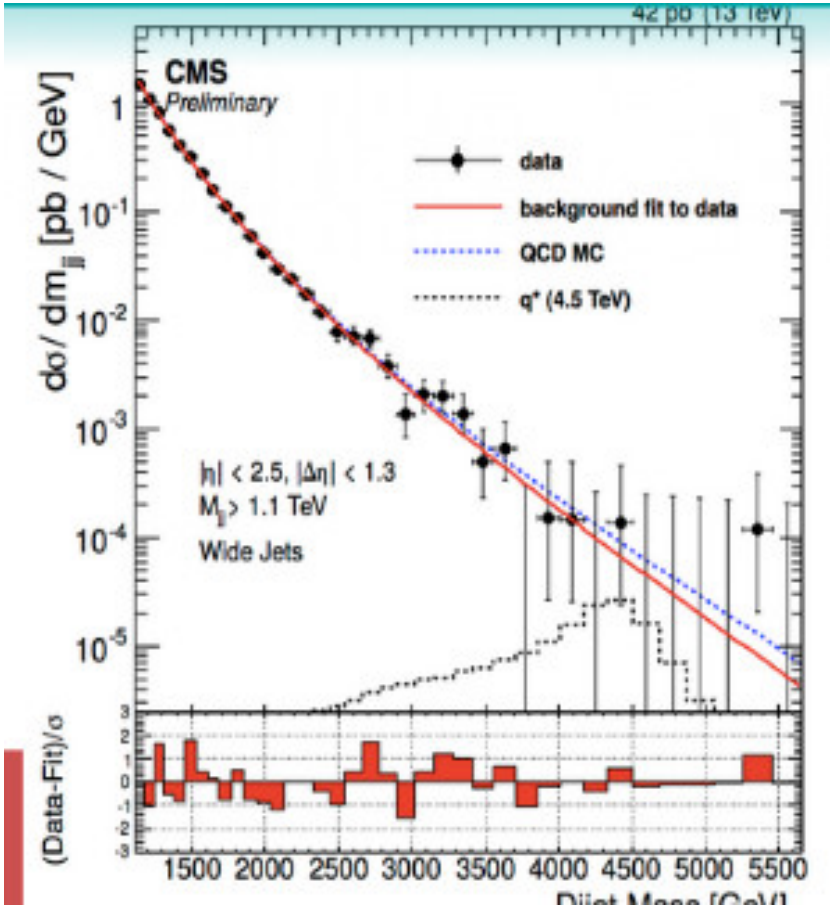

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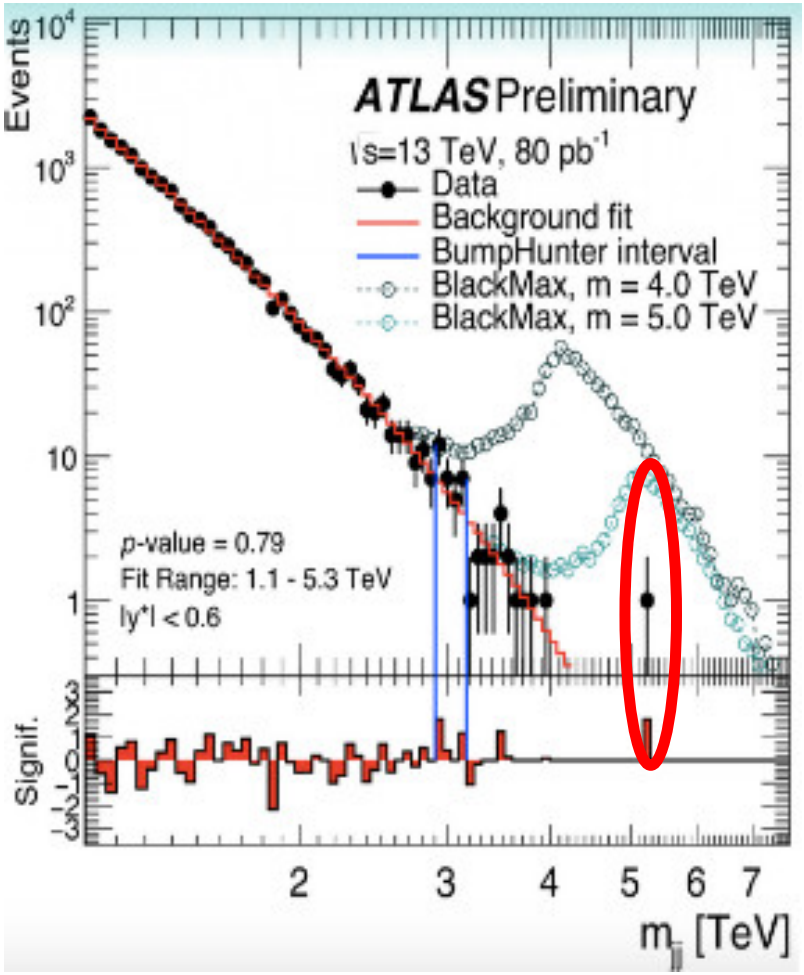

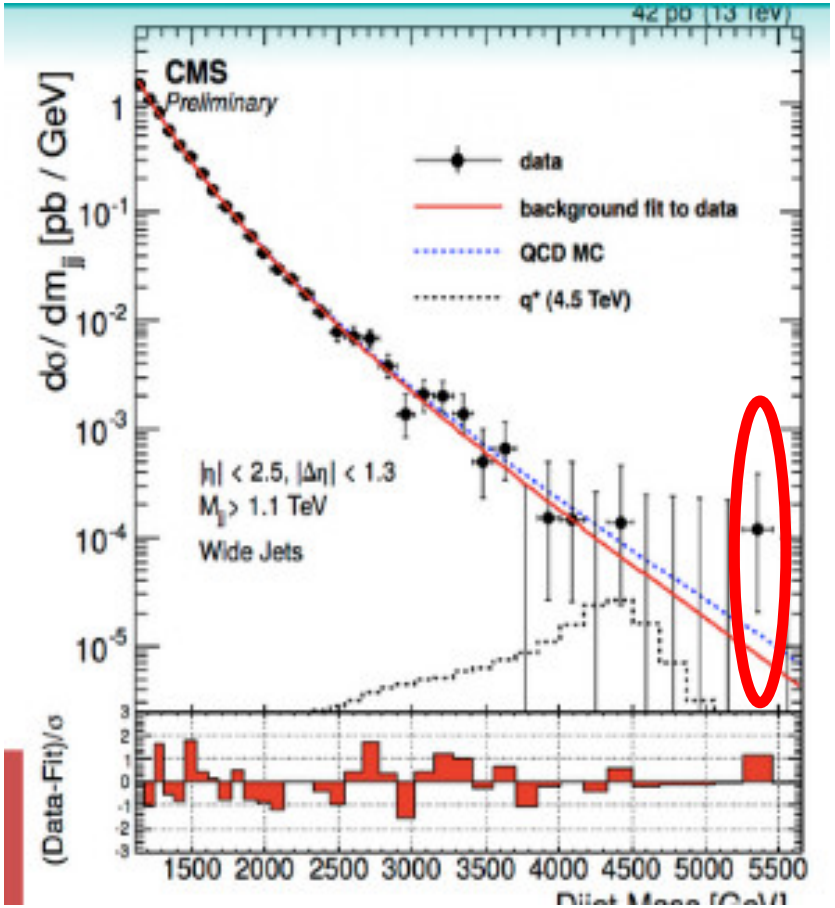

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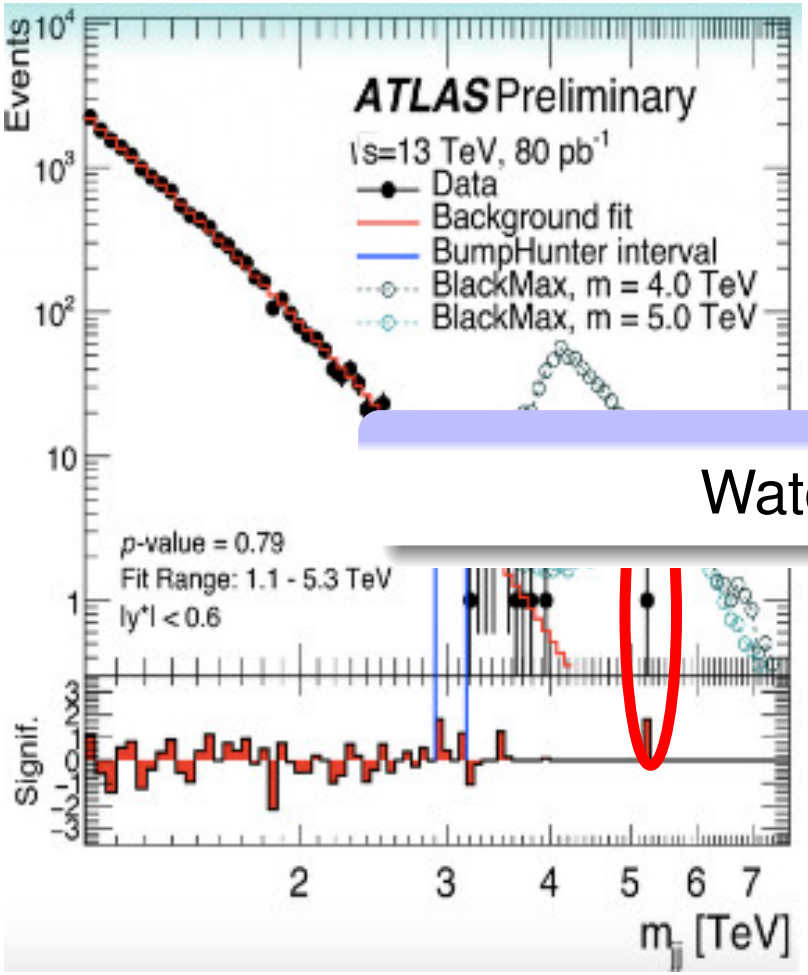
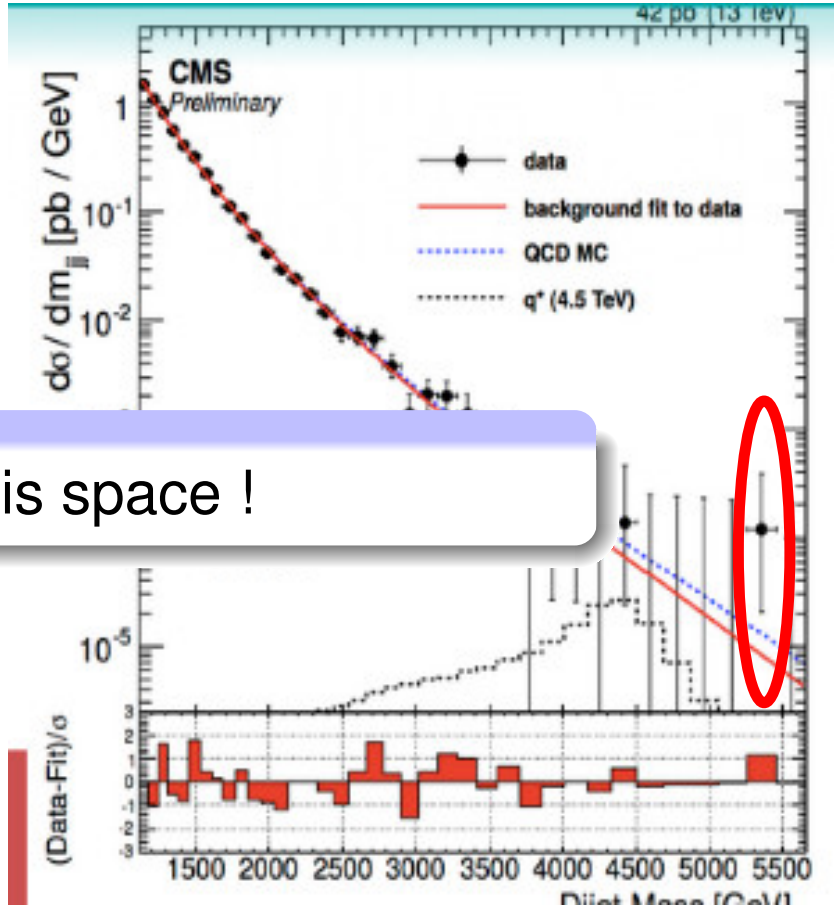
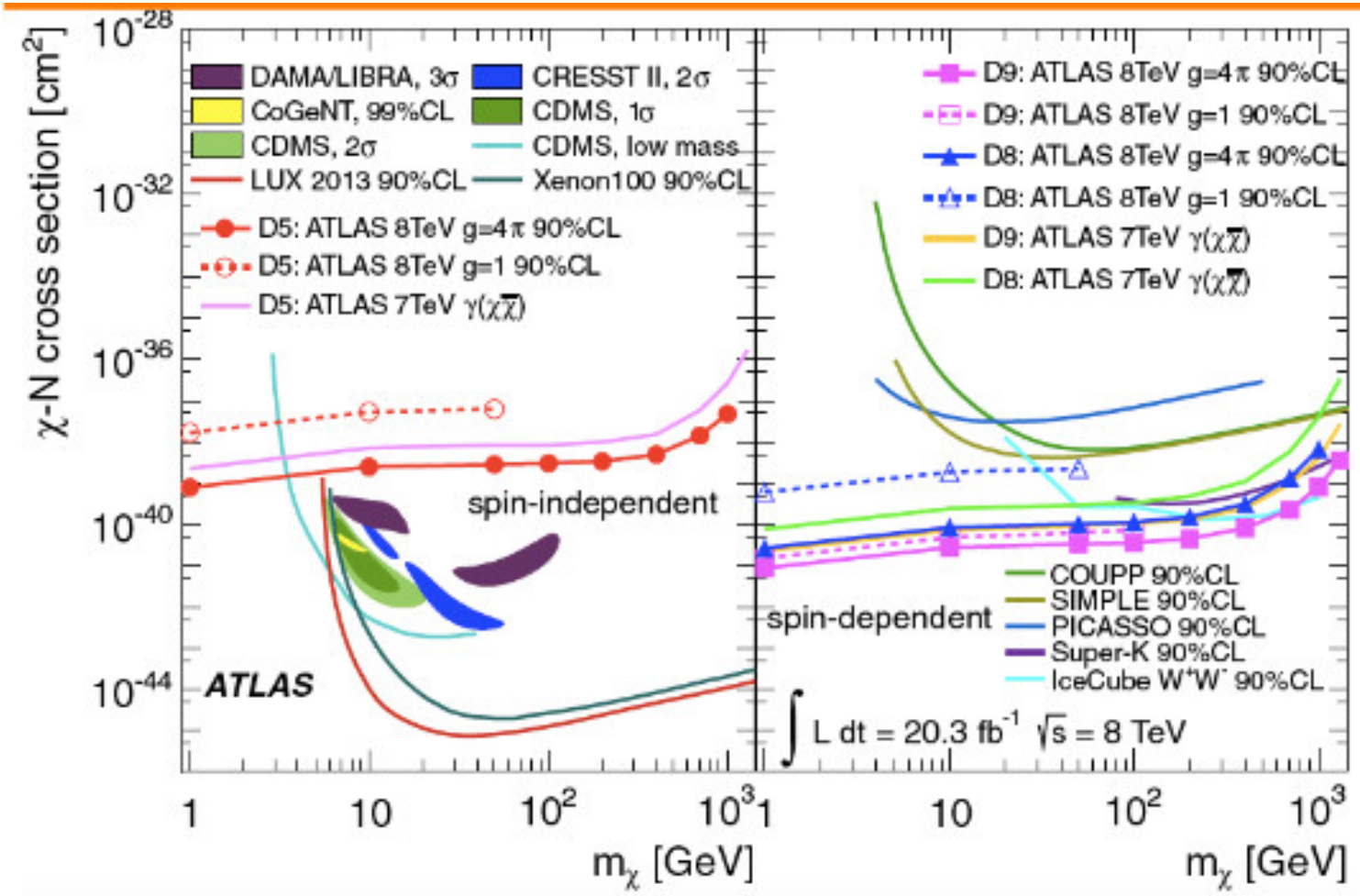




Watch this space !

DM from mom-jets @ LHC

LHC DM searches using mono-jets compared to direct detection searches, also from C. Biino:



Exotics at ILC

Moroi

- A secret asset of the ILC: The beam-dumps !
- Look if something rare is produced by the 10^{21}/year $e^{\pm}$:s hitting the beam-dump.
- Sensitivity, following the sHips TDR for detector design.

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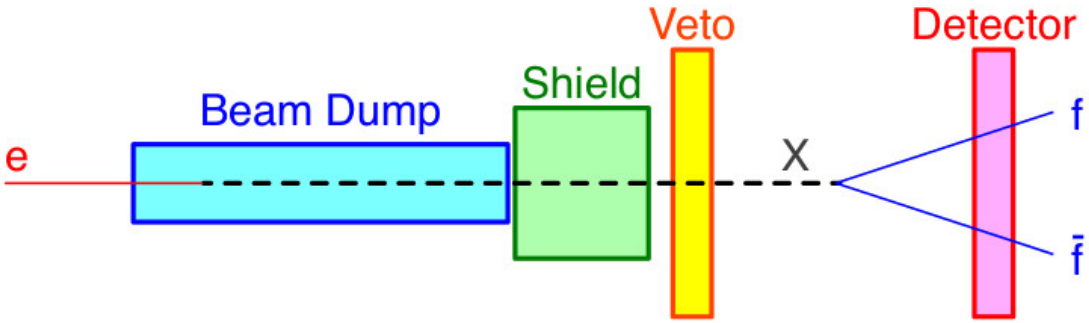

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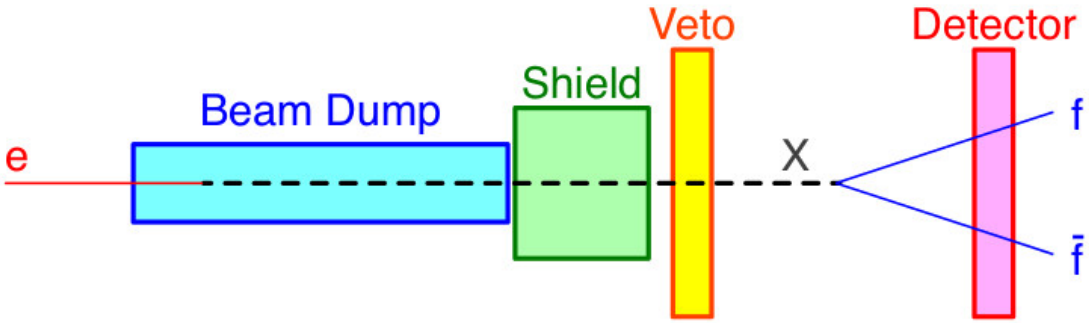
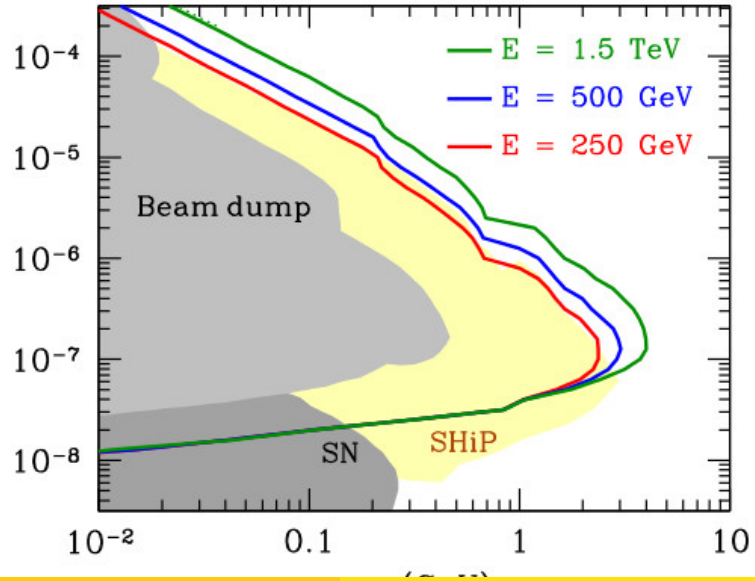
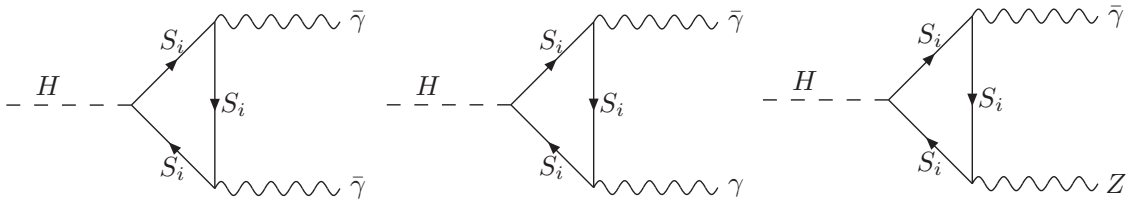




Exotics at ILC: Dark photons and the Higgs

Coupling to the SM

Couplings to the Higgs can be generated via messenger particles charged under $U(1)' \times U(1)$.



Similar diagrams will also contribute to the $H \to \gamma\gamma,\ H \to ZZ$ decay widths.
Effective Lagrangian:

$$\mathcal{L}_{\mathrm{DP_H}} = \frac{\alpha}{\pi}\left(\frac{C_{\gamma\bar{\gamma}}}{v}\gamma^{\mu\nu}\bar{\gamma}_{\mu\nu}H + \frac{C_{Z\bar{\gamma}}}{v}Z^{\mu\nu}\bar{\gamma}_{\mu\nu}H + \frac{C_{\bar{\gamma}\bar{\gamma}}}{v}\bar{\gamma}^{\mu\nu}\bar{\gamma}_{\mu\nu}H\right)$$

Exotics at ILC: Dark photons and the Higgs

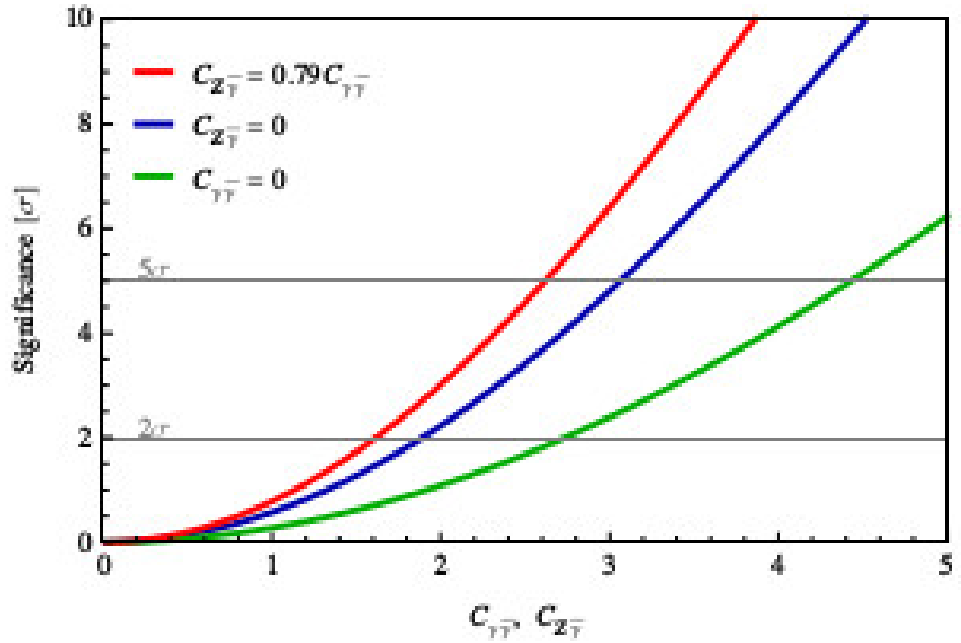
Coup

Co
pa

Si
H
Ef

$\mathcal{L}$

Discovery-reach at a circular collider



Conclusions and outlook

- Fruitful sessions.
- Somewhat SUSY-heavy: Studies of non-SUSY, also in discovery channels (ie. not only in precision measurements) are highly welcome !
- In the discussion session, it was proposed by K. Fujii to plan for a summary paper/note/flyer on the BSM capabilities of the ILC.
- The prime target audience is the MEXT advisory panel members.
- It was agreed to go on in that direction.
- Time-goal: next summer.
- Also, please check out Jürgen Reuter's State-of-Union talk in that session !

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Suggested contents

Plan

Report to be based on a ILC-LHC comparison table of discovery potential

Structure of the table

Typical discovery scenarios in Y-axis

- SUSY (subdivision such as Bino-, Wino-, Higgsino-LSP, as needed)
- Minimal Composite Higgs Models (subdivision as needed)
- Dark matter particles

Discovery channel/method in X-axis

- Precision Higgs measurements
- Precision top measurements
- Indirect searches (other than H and t)
- Direct searches

Each cell

Prospects at ILC (depending on 13TeV LHC results)

Key message to deliver

There are other important kinds of discovery than new particle discovery!

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