RECAST

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With Kyle Cranmer 1009.####

BSM Physics

Many new models of beyond the Standard Model physics have been suggested:

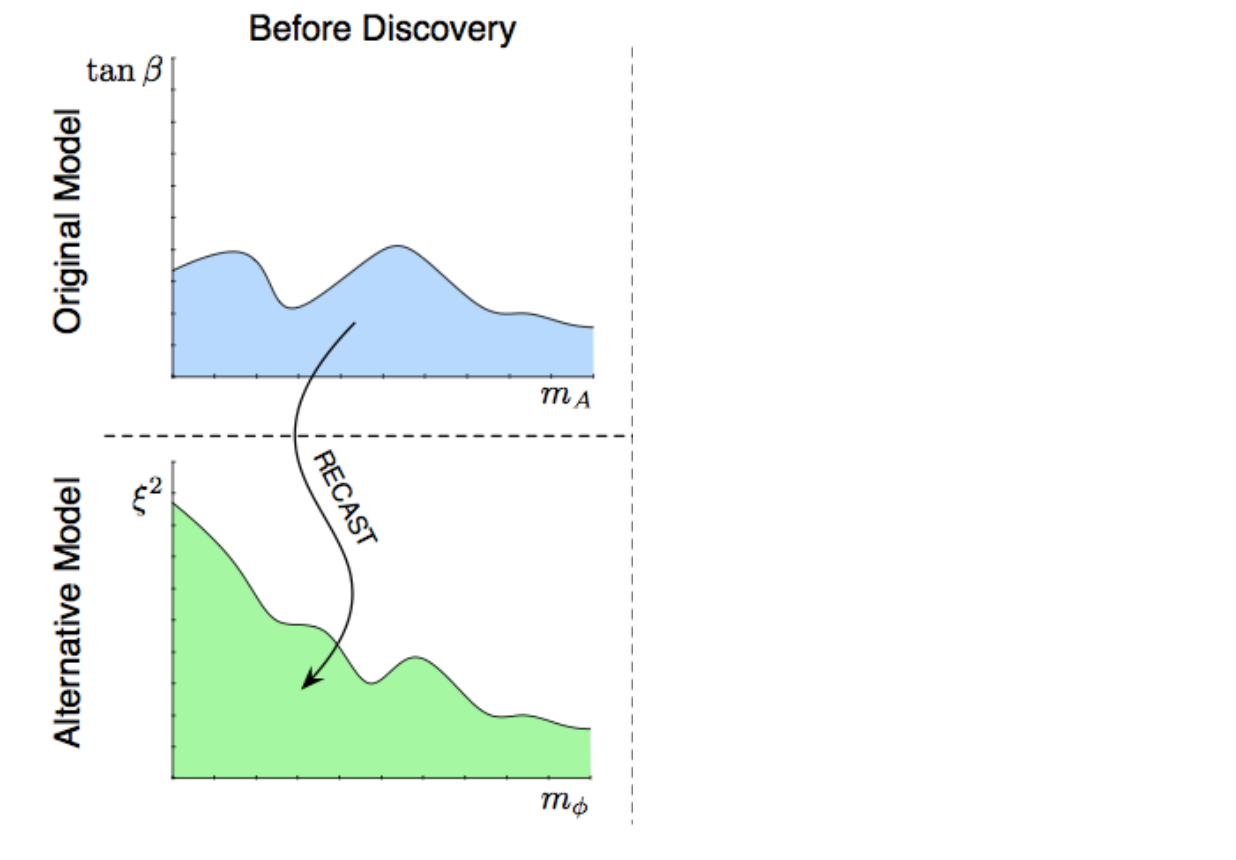
- SUSY – SUGRA,GMSB,AMSB,…
- RS
- UED
- Little Higgs

Many powerful tools were created to allow fast incorporation ***and*** simulation of new particle physics,

- Madgraph/Madevent
- Calchep/Comphep
- PYTHIA,HERWIG
- LHE format

Question

What impact does an *existing* analysis have on an alternative signal hypothesis?



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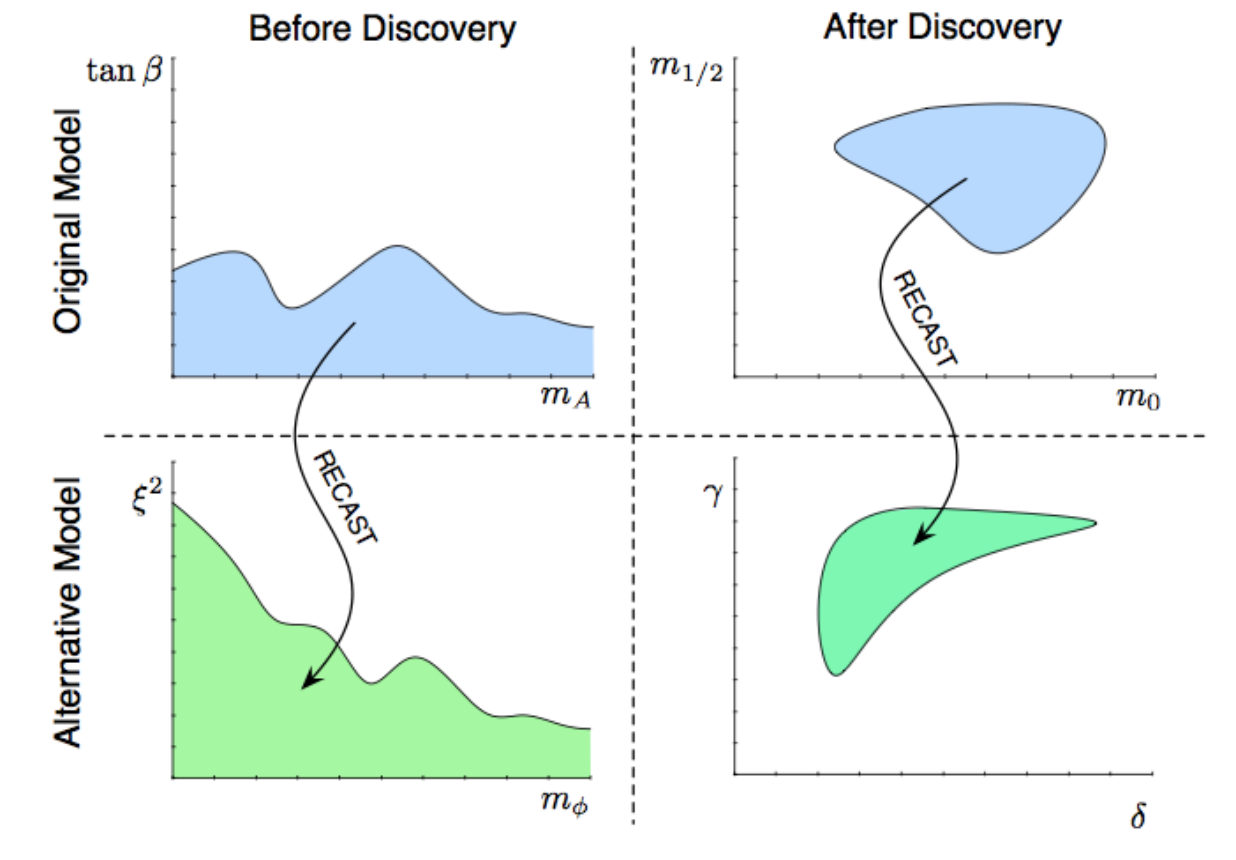
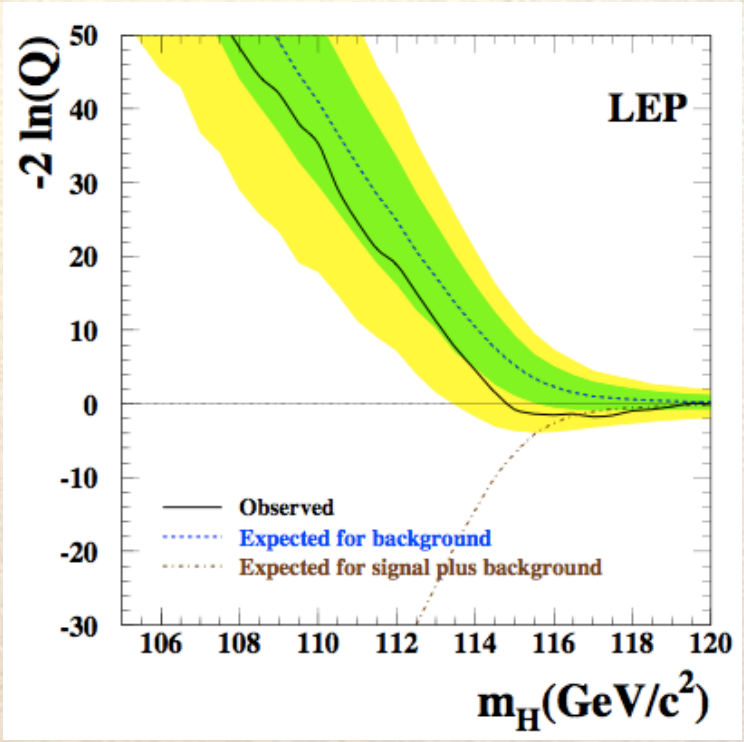


Reporting an Experimental Search

Eve

Experimentalist



Eve is searching for some signal and reports an exclusion plot based on that signal. The cuts and procedure she employs leads to some signal efficiency which she quotes.

Reporting an Experimental Search

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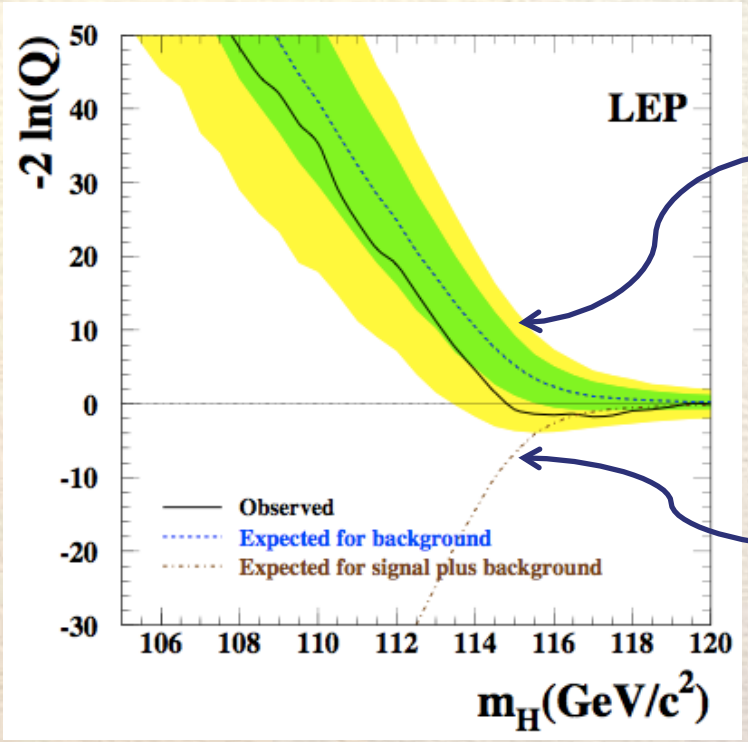
Experimentalist



Signal independent
(a lot of hard work: background estimation, acceptances, and etc.)

Signal dependent

Eve is searching for some signal and reports an exclusion plot based on that signal. The cuts and procedure she employs leads to some signal efficiency which she quotes.

Sometimes in the Future…

Oscar

The Other Experimentalist

Oscar wants to search for a different signal. But, maybe Eve's search already covers his signal in certain regions of the parameter space. If that is true Oscar's job is made much simpler, he can concentrate on these regions which are not already excluded by Eve's analysis…

But how will Oscar know? He needs to know what is the sensitivity of Eve's search for his new signal!

Theodora just thought of a new particle that can explain all sorts of things. But, she realizes that this particle may result in a signal which, while not the same as Eve's, does have some overlap with it. Maybe it's already excluded by Eve's analysis. . .

How will Theodora know? She needs to know what is the sensitivity of Eve's search for her new signal!

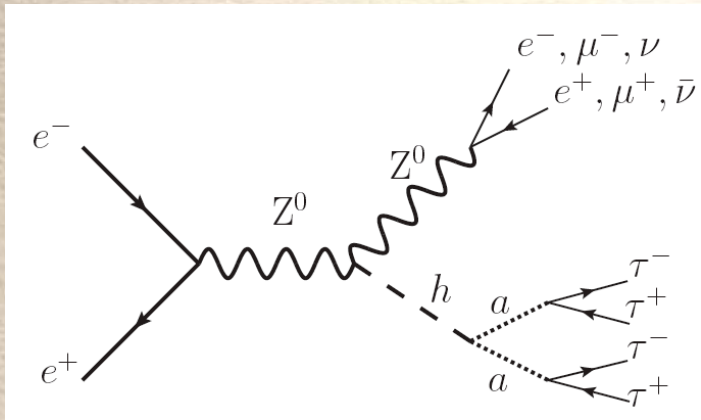
Theodora

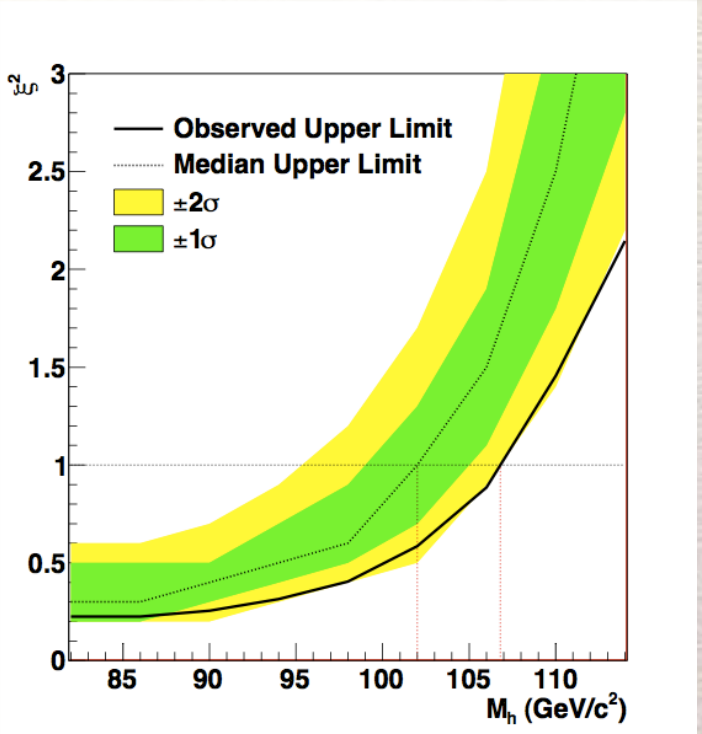
Theorist

Examples

Exotic Higgs Searches

In 0901.0283 we reported on a search for a Higgs boson decay into 4 taus at ALEPH and the associated exclusion plots.





$$\xi^2 = \frac{\sigma\,\mathrm{BR}(h \to aa)\,\mathrm{BR}(a \to \tau\tau)^2}{\sigma_{SM}}$$

RECAST – Other Leptons

We can recast that analysis to exclude other leptonic decays such as Higgs boson decay into 4 electrons or 4 muons.

m_H=100 GeV, m_a=10 GeV

Original analysis

Decay mode	Efficiency	ξ^2
$a \to \tau^+\tau^-$	0.37	0.46
$a \to \mu^+\mu^-$	0.35	0.14
$a \to e^+e^-$	0.27	0.20

1) Why is the electron channel efficiency lower? (Hint: GEANT)

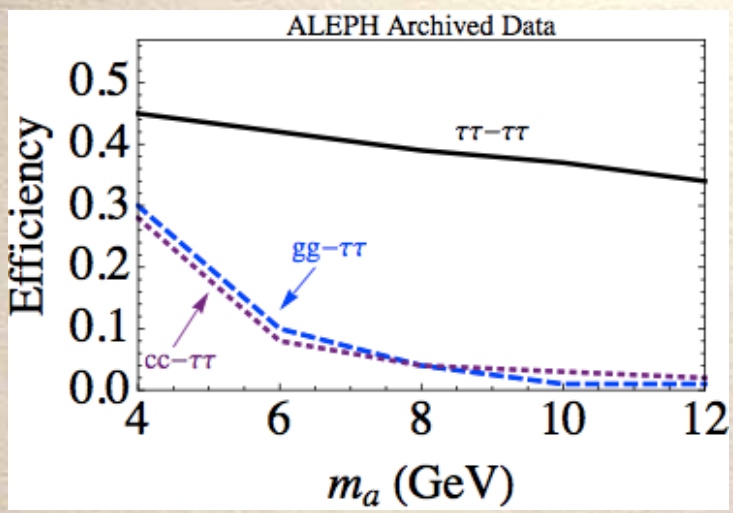
2) Why is the limit actually stronger? (Hint: Statistical analysis)

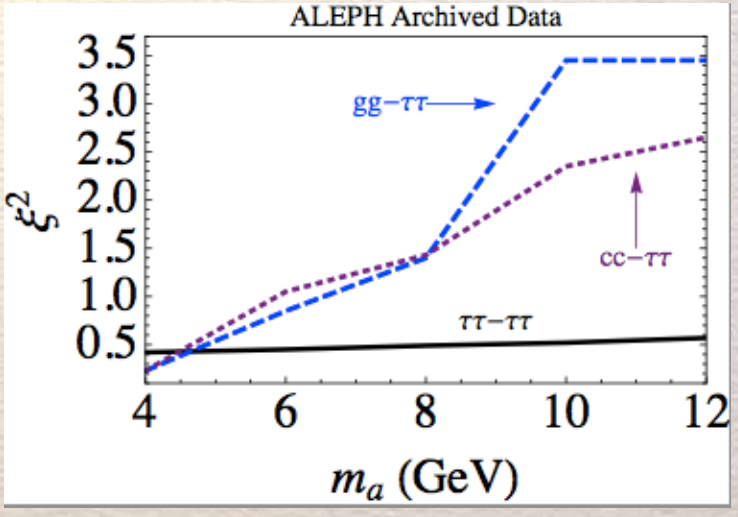
RECAST – Mixed Decays

The NMSSM with a light Higgs boson may still escape the previous search if the branching ratio into taus is reduced. But, in this case one would expect an enhancement in the decay into gluons or charm quarks

$$h \to aa \to 2\tau 2g$$

$$h \to aa \to 2\tau 2c$$





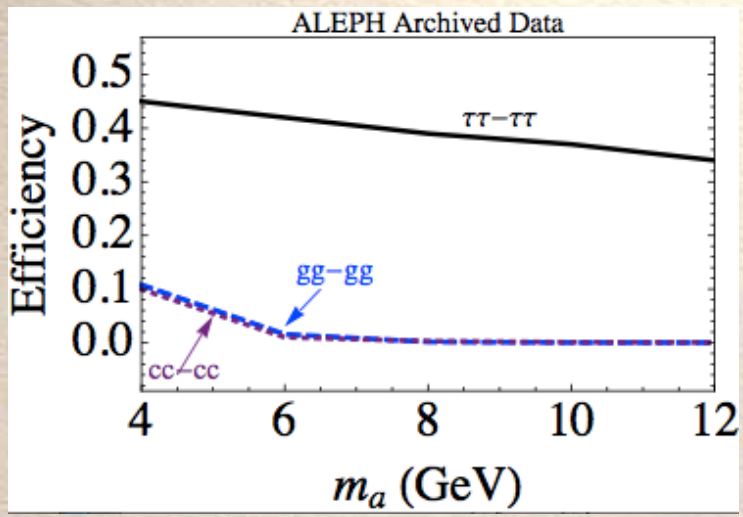
The lower efficiency is mainly due to the higher multiplicity in hadronic decays.

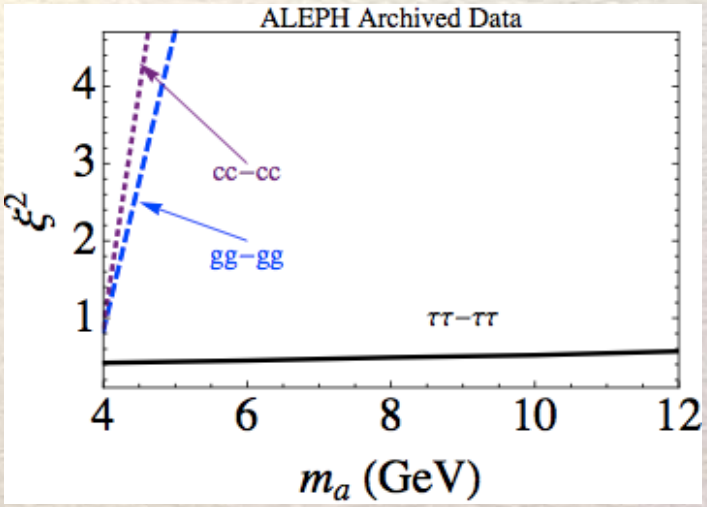
RECAST – Hadronic Decays

Other scenarios (Chang et al., Csaki et al.) contemplate fully hadronic decays of the Higgs boson which might have escaped the canonical searches.

$$h \to aa \to 4g$$

$$h \to aa \to 4c$$





The search is hardly sensitive to these decays except for very light pseudo-scalars.

RECAST

Request Efficiency Calculation for Alternative Signal Testing

and a little more. . .

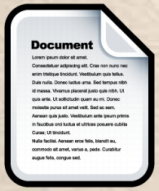
RECAST

Seen only by Eve

Eve's analysis code including all the cuts, detector effects and etc.

Can be submitted by everyone

Seen by everyone, no data, no code, only sensitivity



LHE

New signal

Efficiency for new signal

RECAST

Seen only by Eve

Eve's analysis code including all the cuts, detector effects and etc.

Can be submitted by everyone

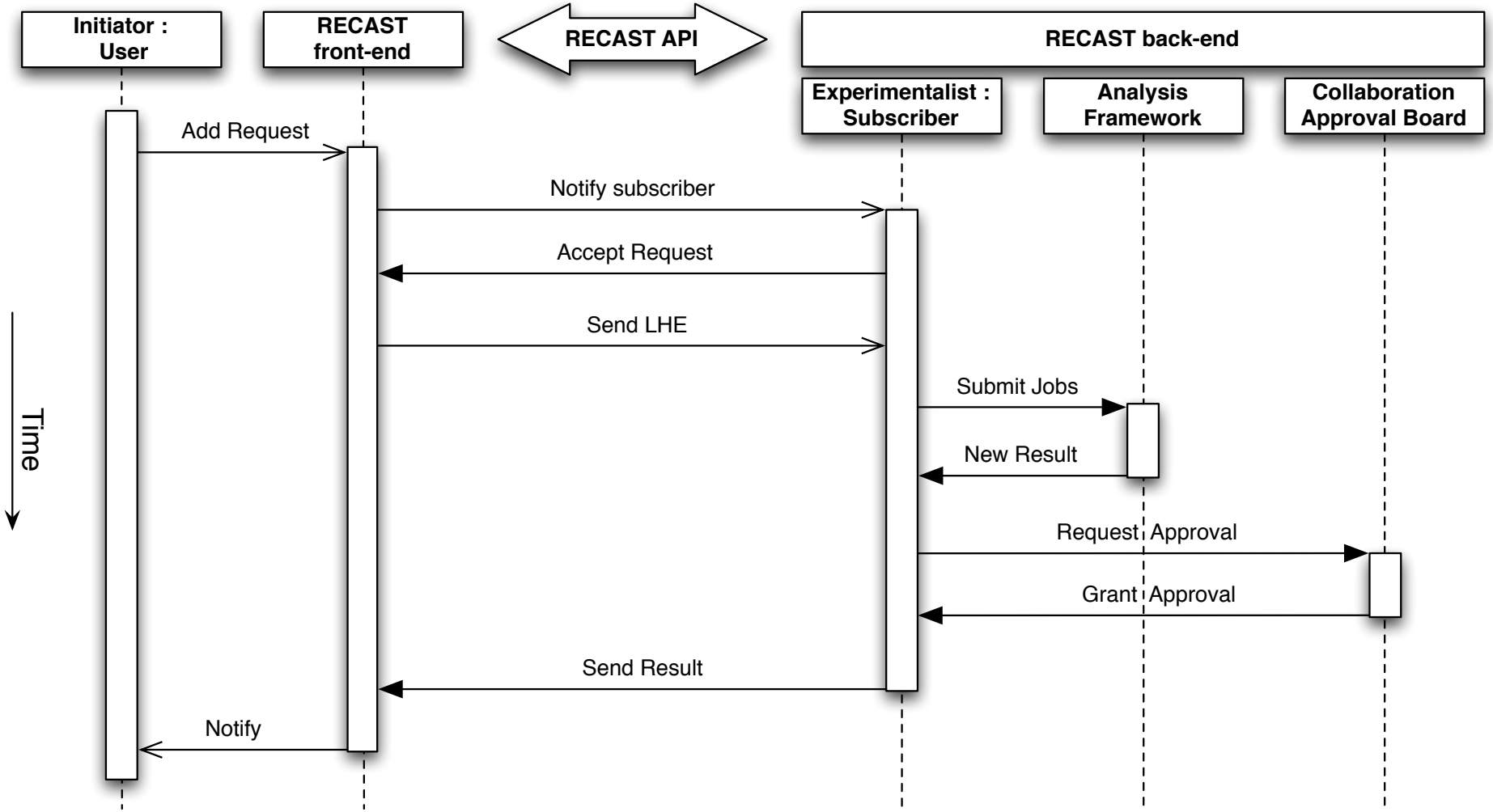
Seen by everyone, no data, no code, only sensitivity

LHE
New signal

Front-End
communication broker

Back-End
controlled by collaboration's protocol

Efficiency for new signal


Initiator : User
RECAST front-end
RECAST API
RECAST back-end
Experimentalist : Subscriber
Analysis Framework
Collaboration Approval Board
Add Request
Notify subscriber
Accept Request
Send LHE
Submit Jobs
New Result
Request Approval
Grant Approval
Send Result
Notify
Time

Everyone Benefits!!!

Eve

Experimentalist

- More impact for Eve's search!!!
- Eve does not have to worry about interpreting her results under many different signal assumptions.

Oscar

Other Experimentalist

- Oscar can use Eve's results to make sure the new signal he is planning to search for is not already excluded.
- Maybe some regions of his new signal are excluded, so concentrate and optimize his analysis to those which are not!

Theodora

Theorist

- Theodora can confidently estimate the coverage of Eve's analysis on her new model.
- Help to direct the theorist thinking into these regions not already excluded even when considering new models which have not been explicitly searched for.

RECAST Framework

- Does not require access to or reprocessing of the data
- Does not involve design of new event selection criteria
- Does not require additional estimates of background rates or systematic uncertainties
- Extends the impact of existing experimental searches
- Targets physics scenarios of interest to the community
- Provides accurate interpretation of model-independent and signature-based searches in the context of a specific model
- Facilitates the consideration of new models even after the analysis is done
- Allows collaborations to control the approval of new results
- Complements data archival efforts

The End

Webpage under construction, should be available soon . . .

Examples

1. The buried/charmed Higgs scenarios of Csaki et al. (0906.3026, 0910.3210) could have been easily constrained by RECASTing existing Higgs to 2 jets flavor independent analyses.

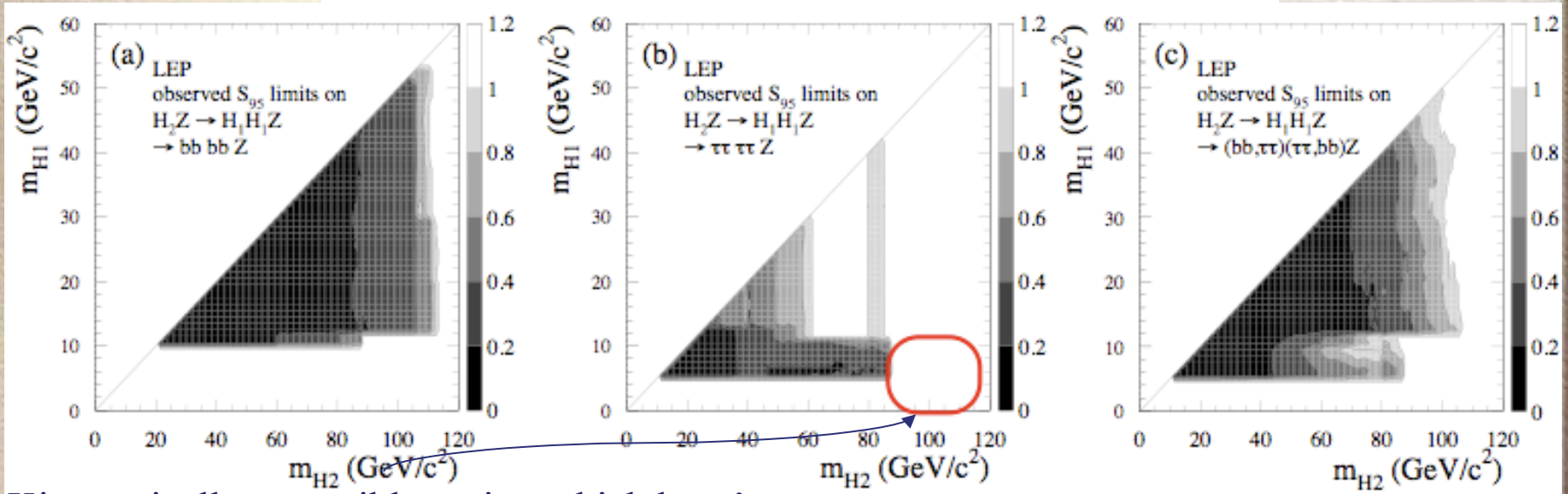
2. Meade, Reece, and Shih (0911.4130) derived limits on prompt decays of general neutralino NLSPs at Tevatron using the limited existing analysis available. Their efforts could have been greatly reduced with RECAST.

3. Falkwoski et al. suggested hiding the Higgs boson through Higgs to lepton-jets. Again, RECASTing existing analyses could have helped in placing better limits on this scenario.

4 Fermion Final State

Search for Neutral MSSM Higgs Bosons at LEP

ALEPH, DELPHI, L3 and OPAL Collaborations
The LEP Working Group for Higgs Boson Searches[1]



Kinematically accessible region which hasn't been searched

Also, A. Haas at Tevatron constrained decays into muons! [hep-ex] 0905.3381
(see Lisanti and Wacker for theory [hep-ph] 0903.1377