

# Discussion on the plans for the study of pp physics at 100 TeV

- “Hadron collider physics” part of the FCC study: MLM (physics), F.Gianotti (detectors) and A.Ball (detector/machine interface)
- Kickoff mtg of the FCC Study: Febr 12-14 2014 (will cover all aspects, from civil engineering to magnet development, with little space for physics)
- pre-meeting focused on physics: Febr 10-11
- Until then, need to have an outline of the WG topics, conveners.
- Ideally a strong internal TH participation, particularly from the BSM model building side
- Strong efforts are starting already in China (led by Nima), and in the US (led by Michael Peskin)
- Some initial ideas, to trigger a preliminary discussion, follow ...

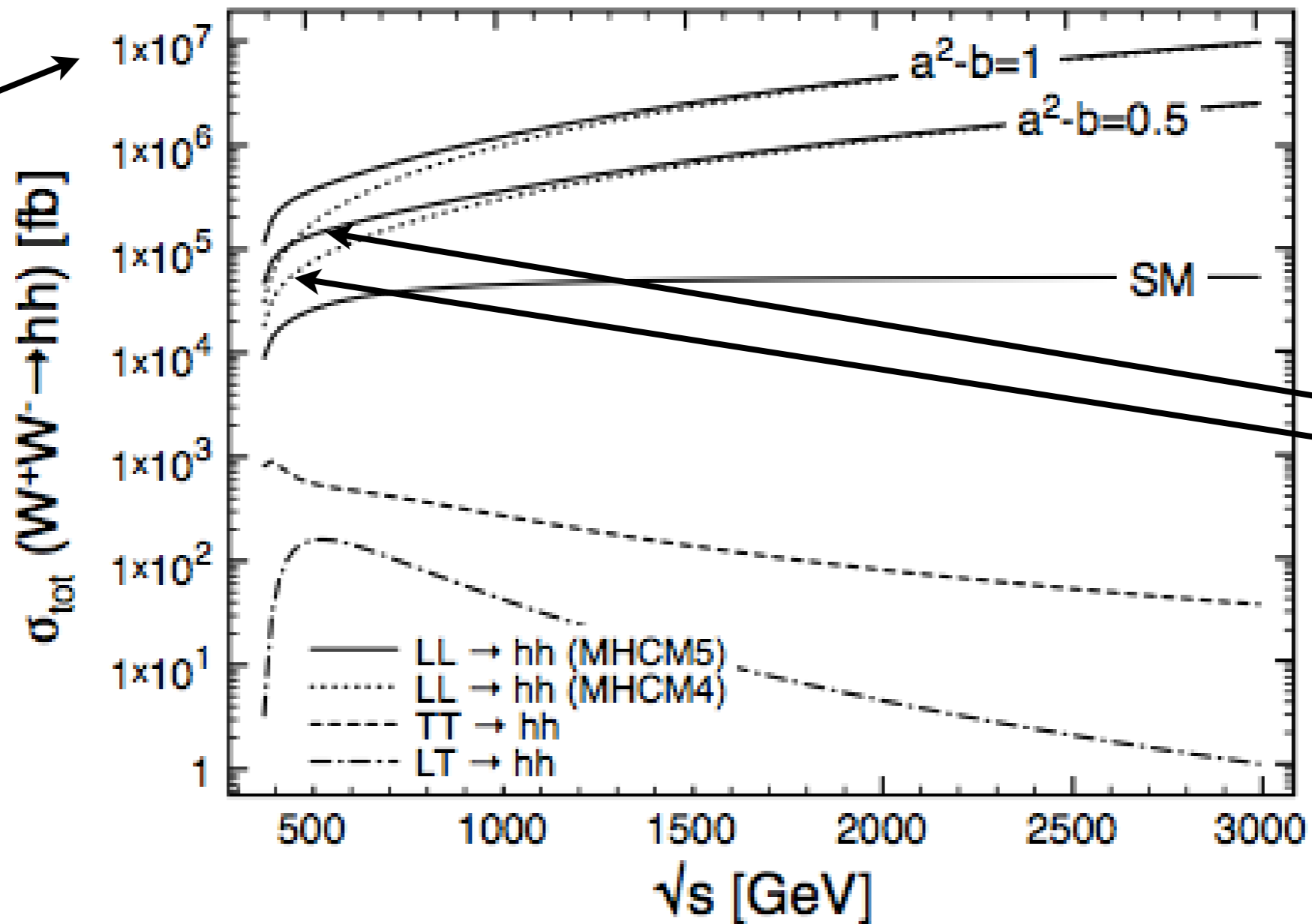
## **FHC.1.1 Exploration of EW Symmetry Breaking (EWSB)**

FHC.1.1.1 High-mass WW scattering, high mass HH production

# High-energy WW->HH scattering

Example: R.Contino et al, arXiv:1002.1011v2

partonic cross sections



different anomalous HHH couplings:

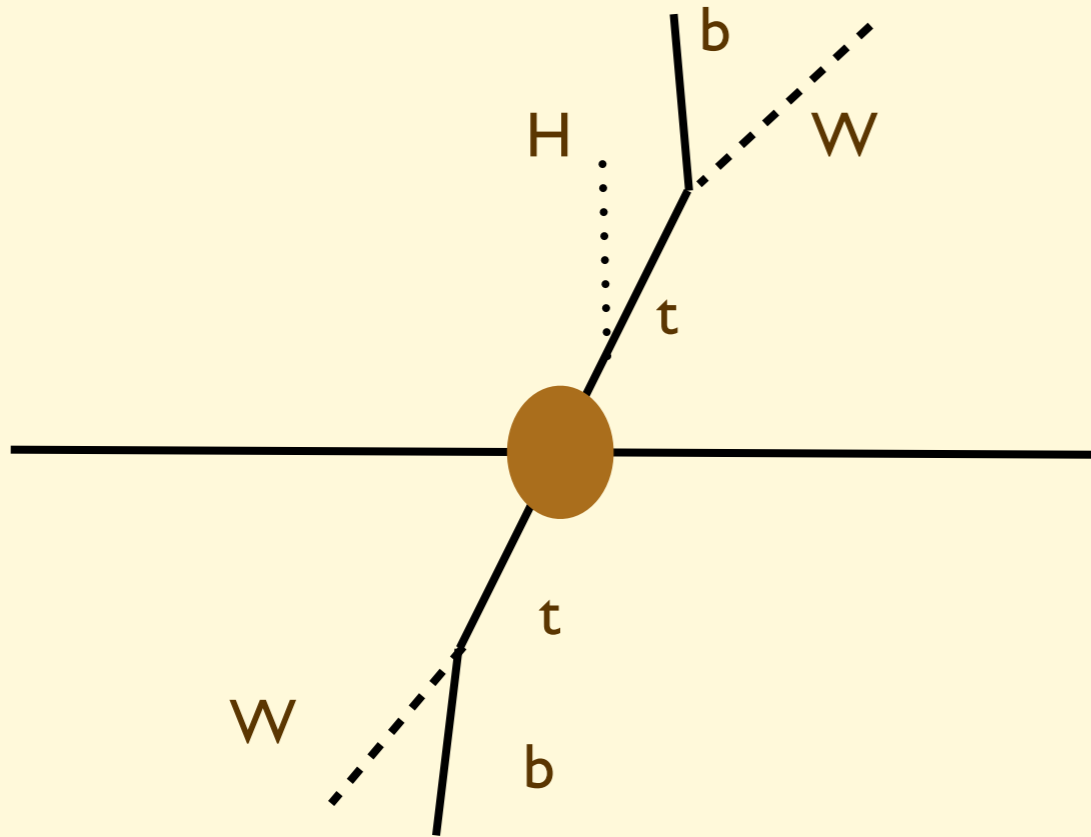
invariant mass spectrum of HH discriminates among BSM models

## **FHC.1.1 Exploration of EW Symmetry Breaking (EWSB)**

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FHC.1.1.2 Rare Higgs production/decays and precision studies of Higgs properties

# Example: $ttH$ at large $p_T(\text{top})$



- Reduced backgrounds
  - Reduced combinatorics
- ⇒ more reliable measurement of  $y_{\text{top}}$

$pp \rightarrow ttH$	<b>14 TeV</b>	<b>33 TeV</b> (33/14)	<b>60 TeV</b> (60/14)	<b>100 TeV</b> (100/14)
$\sigma_{\text{TOT}}$	0.4 pb	2.8 pb ( <b>x 7</b> )	9.7 pb ( <b>x 24</b> )	25 pb ( <b>x 60</b> )
$\sigma(p_T^{\text{top}} > 0.5 \text{ TeV})$	1.6 fb	26 fb ( <b>x 16</b> )	120 fb ( <b>x 75</b> )	400 fb ( <b>x 250</b> )

**(LO rates)**

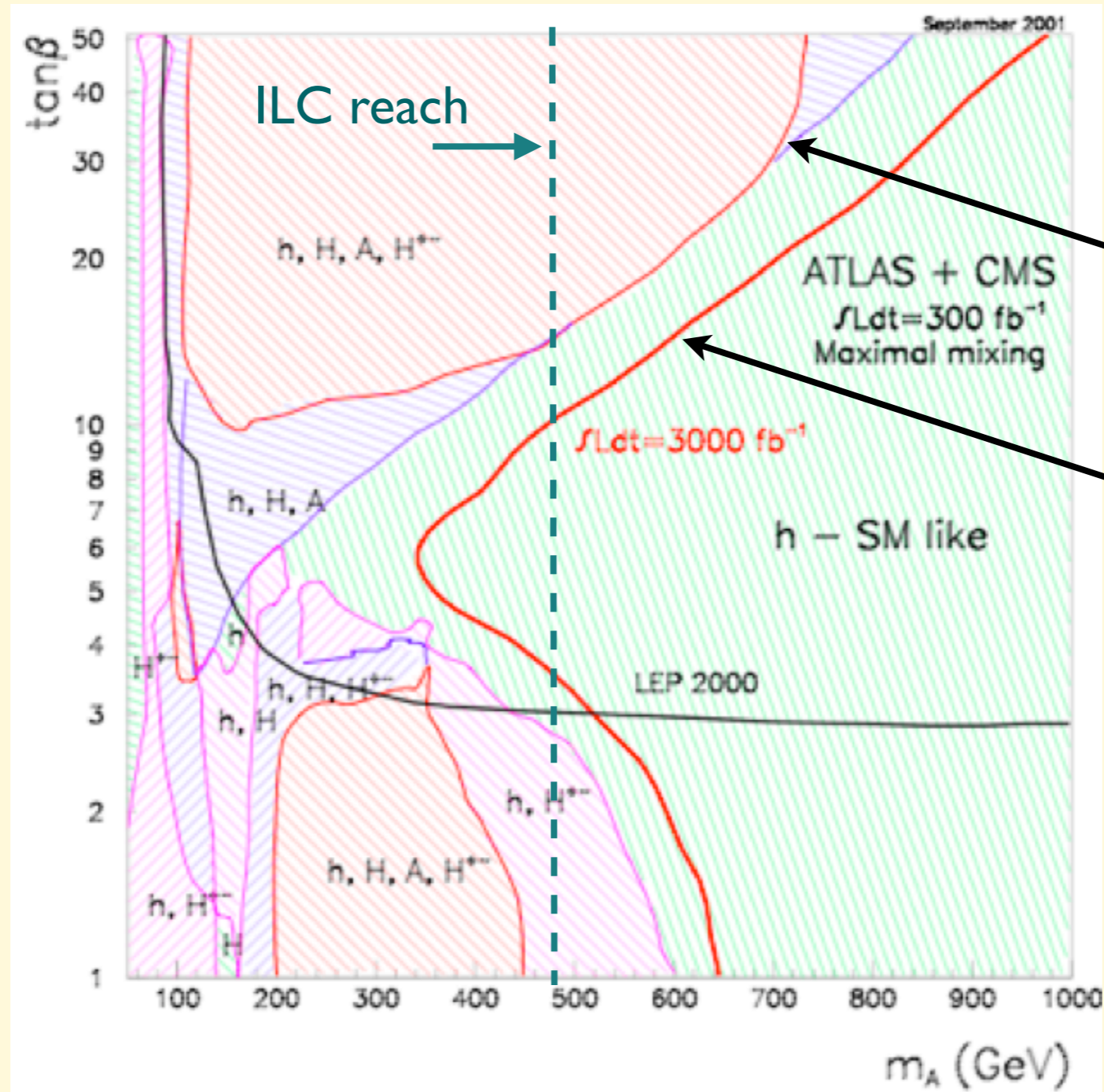
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FHC.1.1.3 Additional BSM Higgs bosons: discovery reach and precision physics programme (e.g., what is the potential of searches for additional Higgs bosons in constraining, in a model-independent way, supersymmetry? Is there a no-loose theorem for the observability, at 100 TeV, of additional susy Higgs bosons? )

# LHC reach for additional SUSY Higgs bosons (from 2001 study)



300 fb<sup>-1</sup>

3000 fb<sup>-1</sup>

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FHC.1.1.4 New handles on the study of non-SM EWSB dynamics (e.g. dynamical EWSB and composite H, etc)



## **FHC.1.2 Exploration of BSM phenomena**

FHC.1.2.1 discovery reach for various scenarios (SUSY, new gauge interactions, new quark and leptons, compositeness, etc.)

FHC.1.2.2 Theoretical implications of discovery/non-discovery of various BSM scenarios, e.g. address questions such as:

FHC.1.2.2.1 what remains of Supersymmetry if nothing is seen at the scales accessible at 100 TeV?

FHC.1.2.2.2 which new opportunities open up at 100 TeV for the detection and study of dark matter?

FHC.1.2.2.3 which new BSM frameworks, which are totally outside of the HL-LHC reach, become accessible/worth-discussing at 100 TeV ?

### **FHC.1.3 Continued exploration of SM particles**

FHC.1.3.1 Physics of the top quark (rare decays, FCNC, anomalous couplings, ...)

FHC.1.3.2 Physics of the bottom quark (rare decays, CPV, ...)

FHC.1.3.2 Physics of the tau lepton (e.g.  $\tau \rightarrow 3\mu$ ,  $\tau \rightarrow \mu\gamma$  and other LFV decays)

FHC.1.3.2 W/Z physics

FHC.1.3.3 QCD dynamics

### **FHC.1.4 Opportunities other than pp physics:**

FHC.1.4.1 Heavy Ion Collisions

FHC.1.4.2 Fixed target experiments:

FHC.1.4.2.1 "Intensity frontier": kaon physics,  $\mu 2e$  conversions, beam dump experiments and searches for heavy photons and other exotica...

FHC.1.4.2.2 Heavy Ion beams for fixed-target experiments

### **FHC.1.5 Theoretical tools for the study of 100 TeV collisions**

FHC.1.5.1 PDFs

FHC.1.5.2 MC generators

FHC.1.5.3  $N^n$ LO calculations

FHC.1.5.4 EW corrections