

# **EF02: The Higgs Boson as a Portal to New Physics**

**Energy Frontier Kick Off Meeting  
May 21, 2020**

**Conveners: Patrick Meade and Isobel Ojalvo**

**Important to study Higgs properties as best as you  
can,  
in as many ways as you can (e.g. differential).**

**However it's also important to reflect on  
what this *means* for BSM  
and the interplay**

discussed organization last time

# The Big Picture

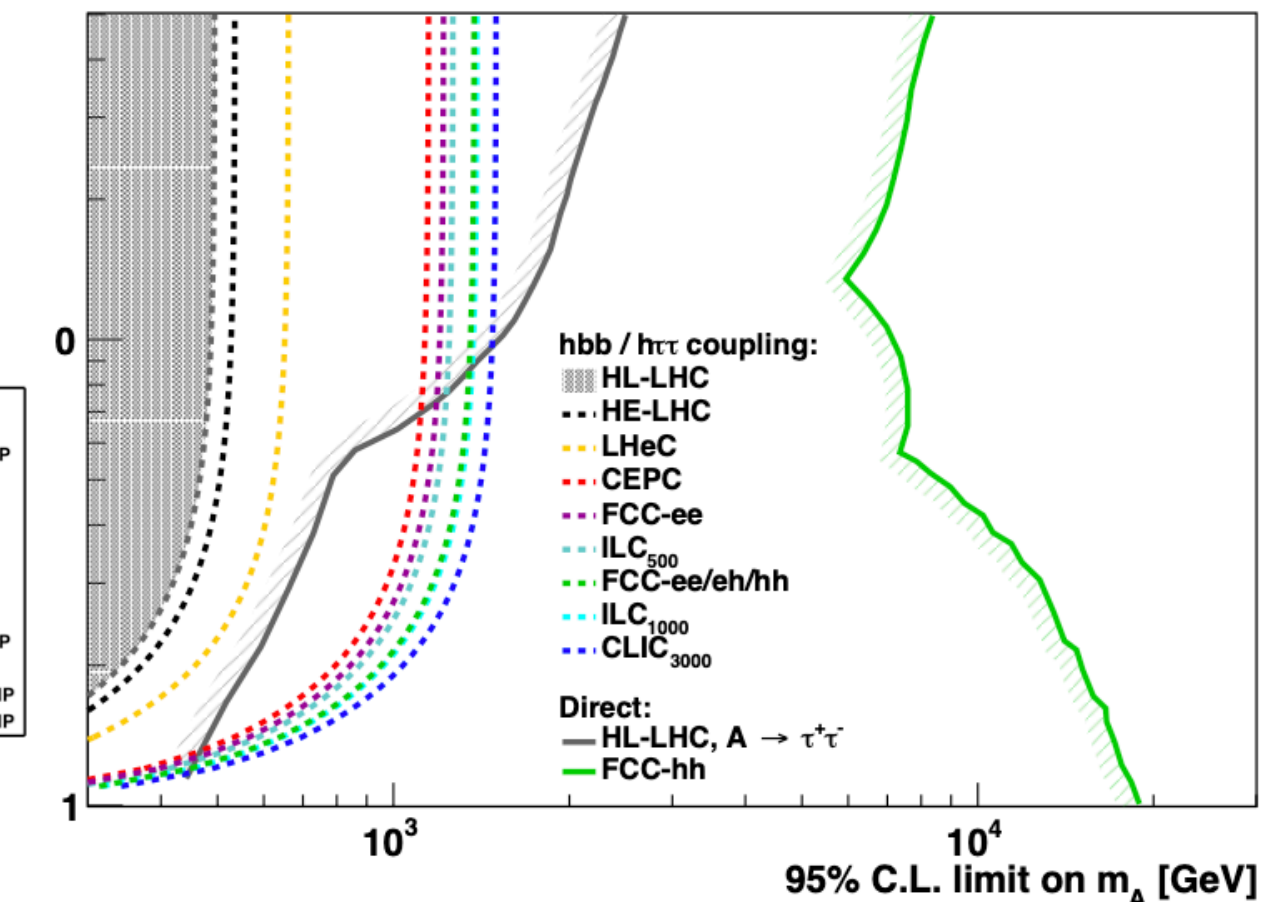
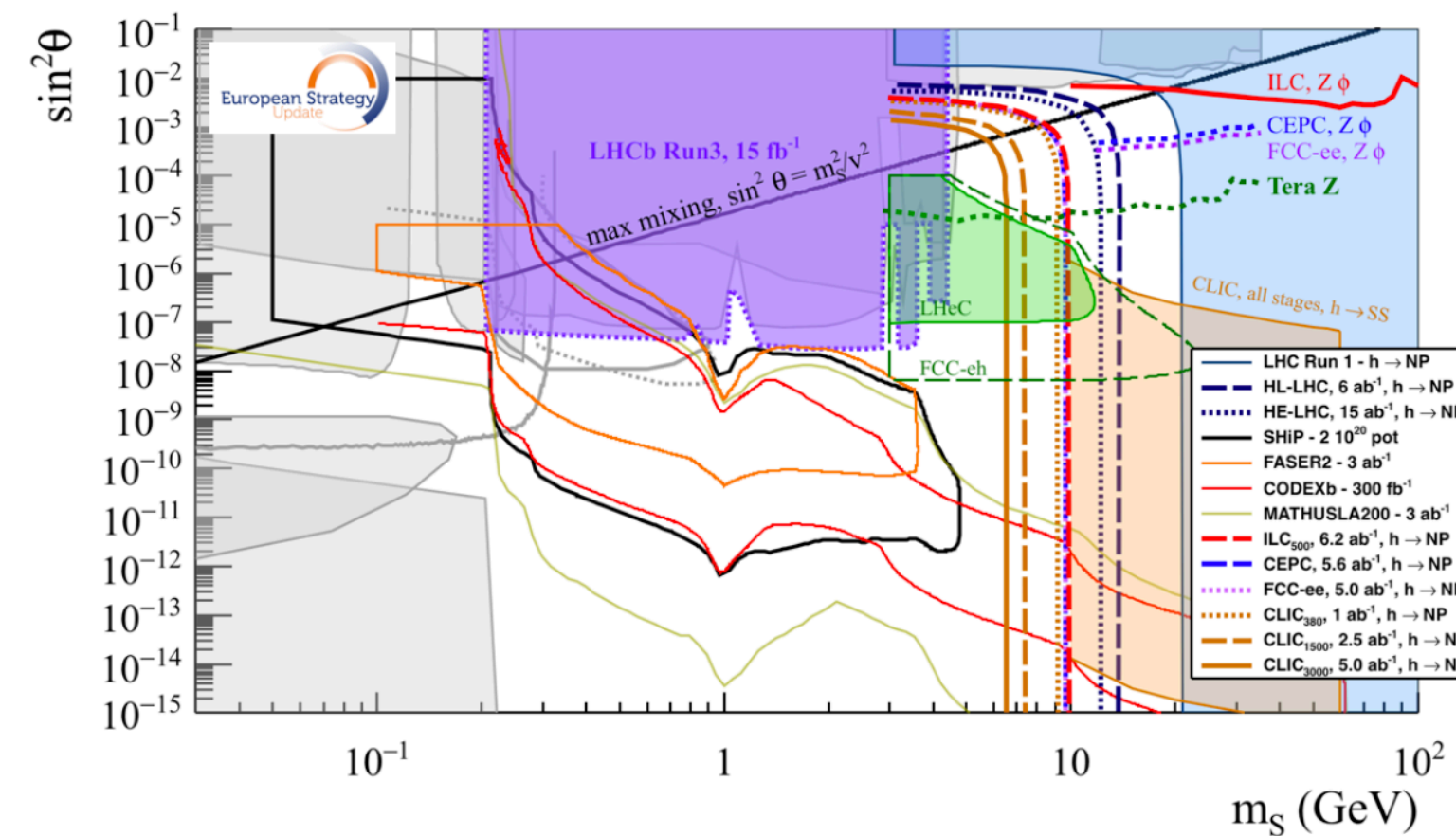
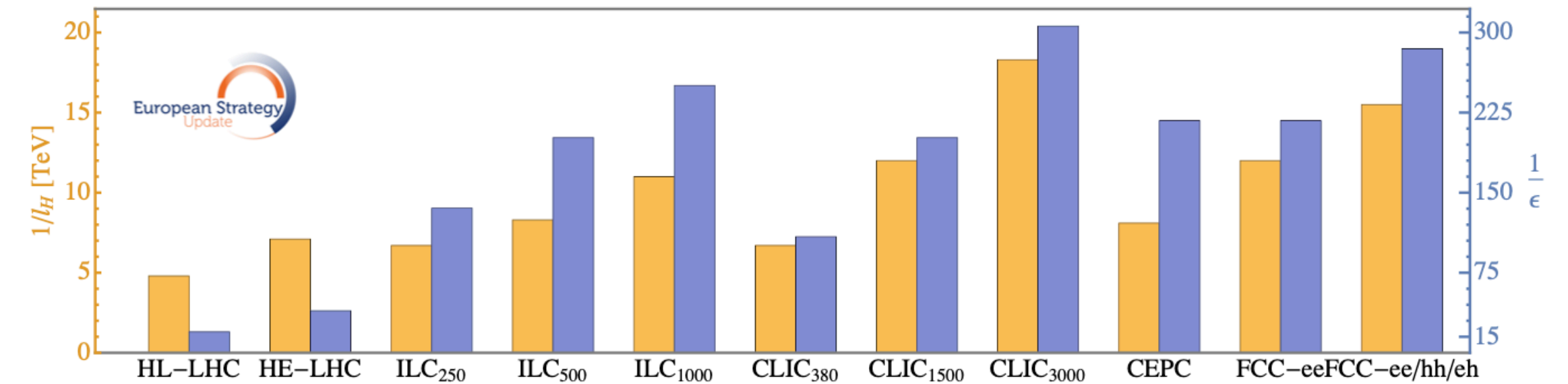
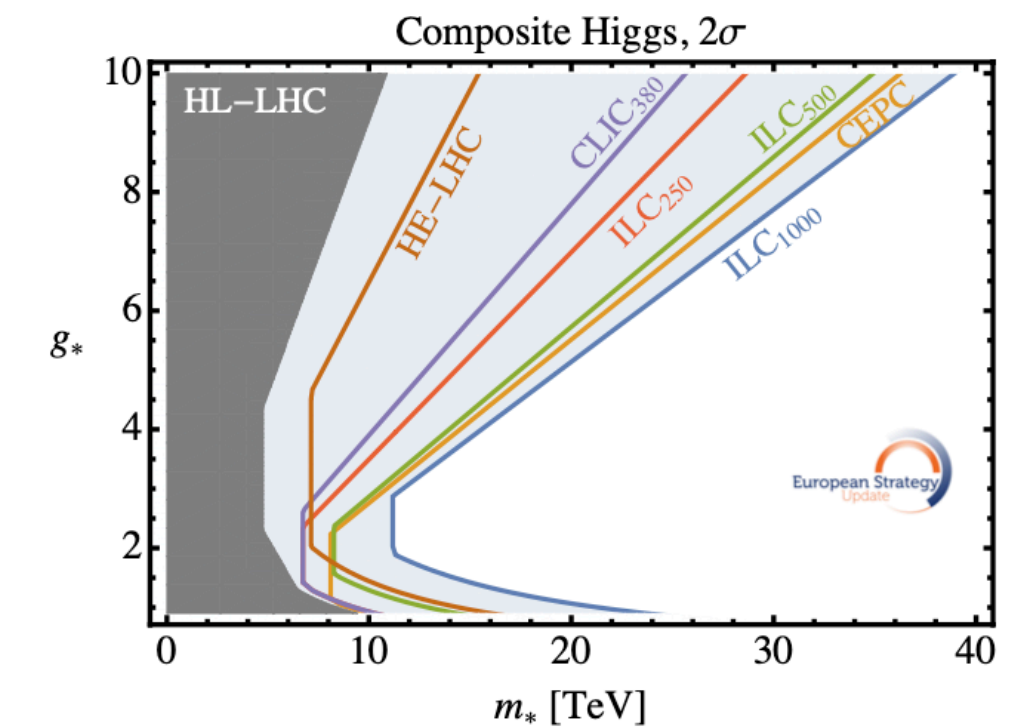
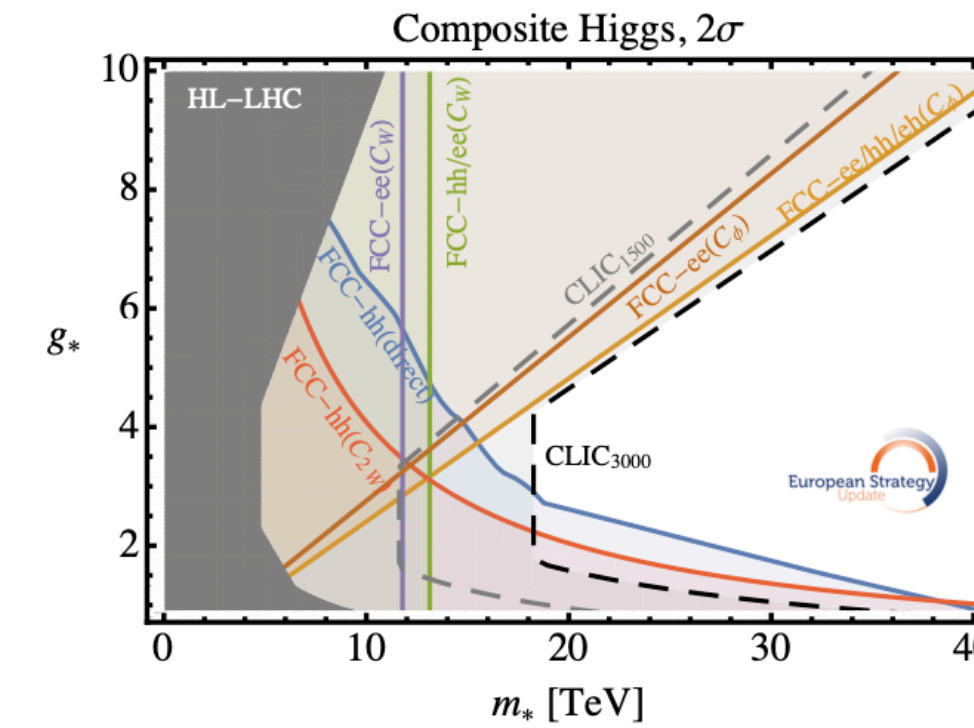
So far...

- Higgs as the origin of EWSB and a portal to Naturalness
- Higgs and Electroweak Phase Transition
- Higgs as the origin of all flavor in the SM
- Higgs as a portal to other sectors
- Composite Higgs

# Covering the Full Phase Space

## Previous Studies

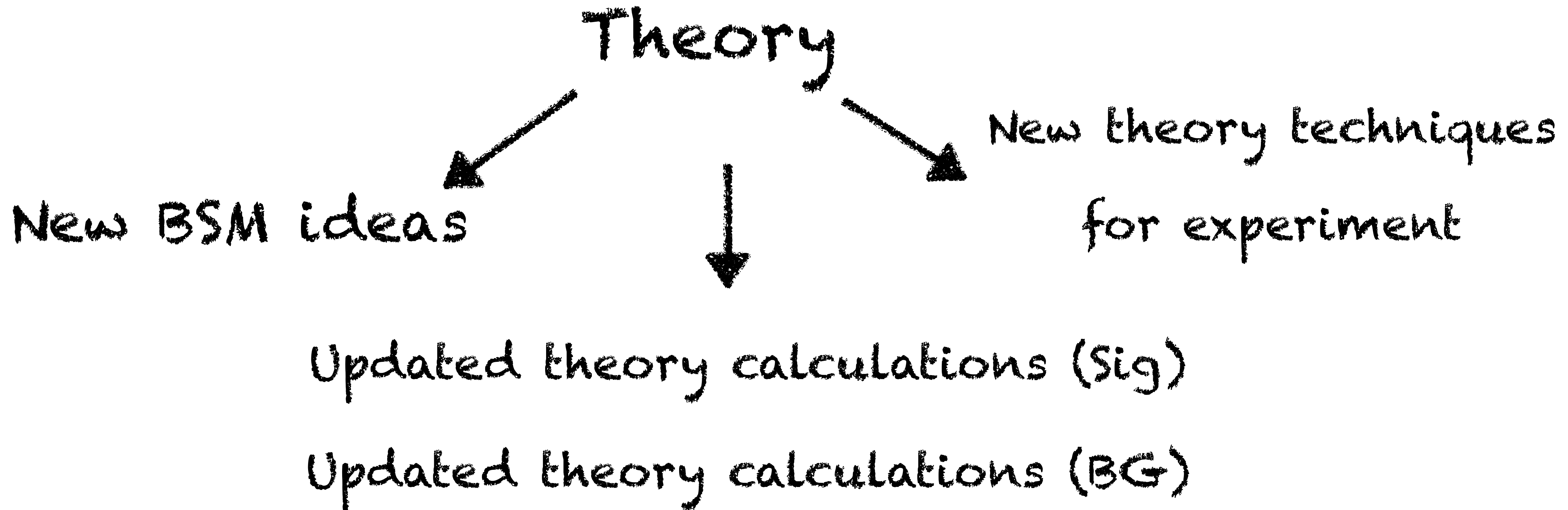
- Many projections from proposed experiments for a wide variety of Higgs Portal Topics
- HL/HE-LHC, ILC, CLIC, CEPC, FCCee/hh/eh
- Opportunity to insert new insights and ideas
- Encourage the community to evaluate and extend studies



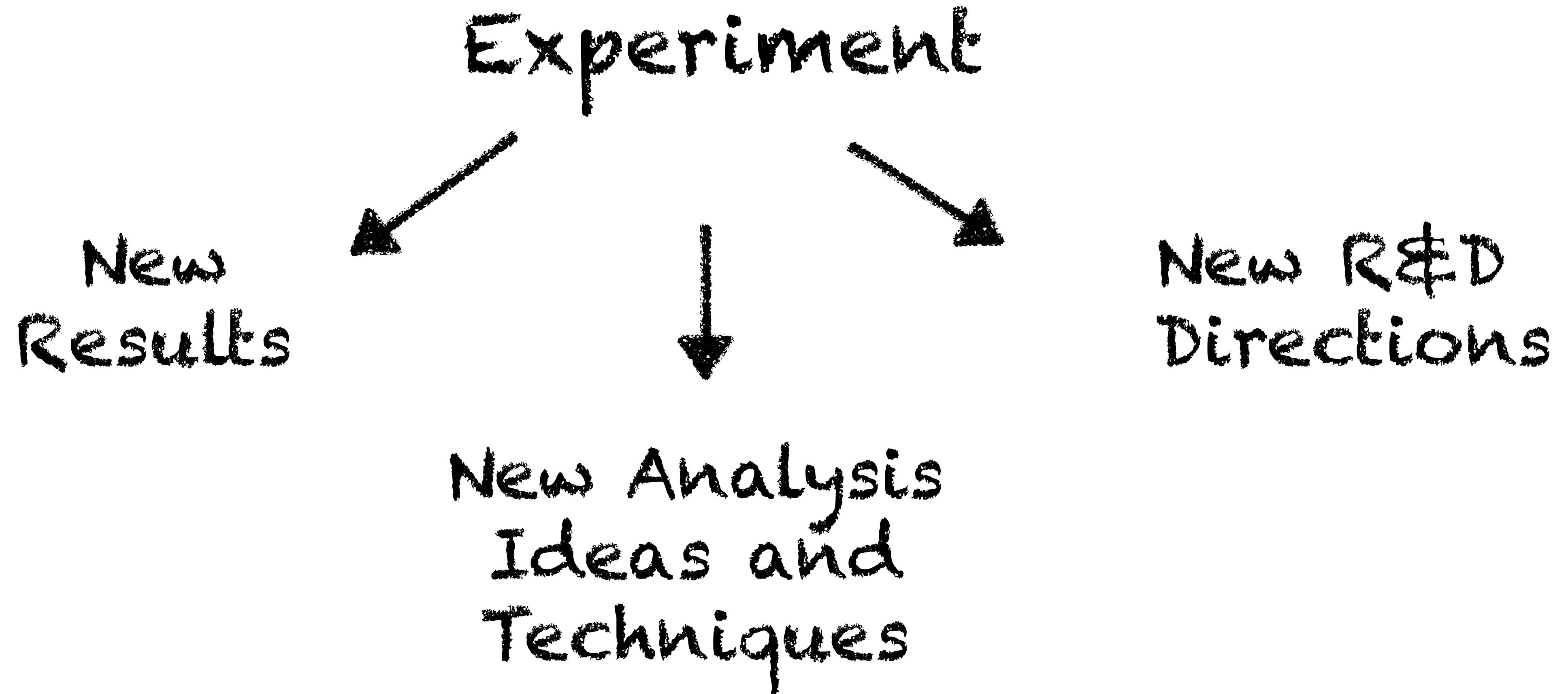
# Evaluating Current Proposals and Driving New Developments

- Two considerations in the physics reach of an experimental program:
  - What Higgs BSM physics can be discovered?
    - **In case of discoveries**, how should we focus our next efforts as a community?
    - **In the absence of discoveries**, what information can be extracted from the measurements?
- Can the direction of experimental and theoretical R&D be further driven by the big picture goals?

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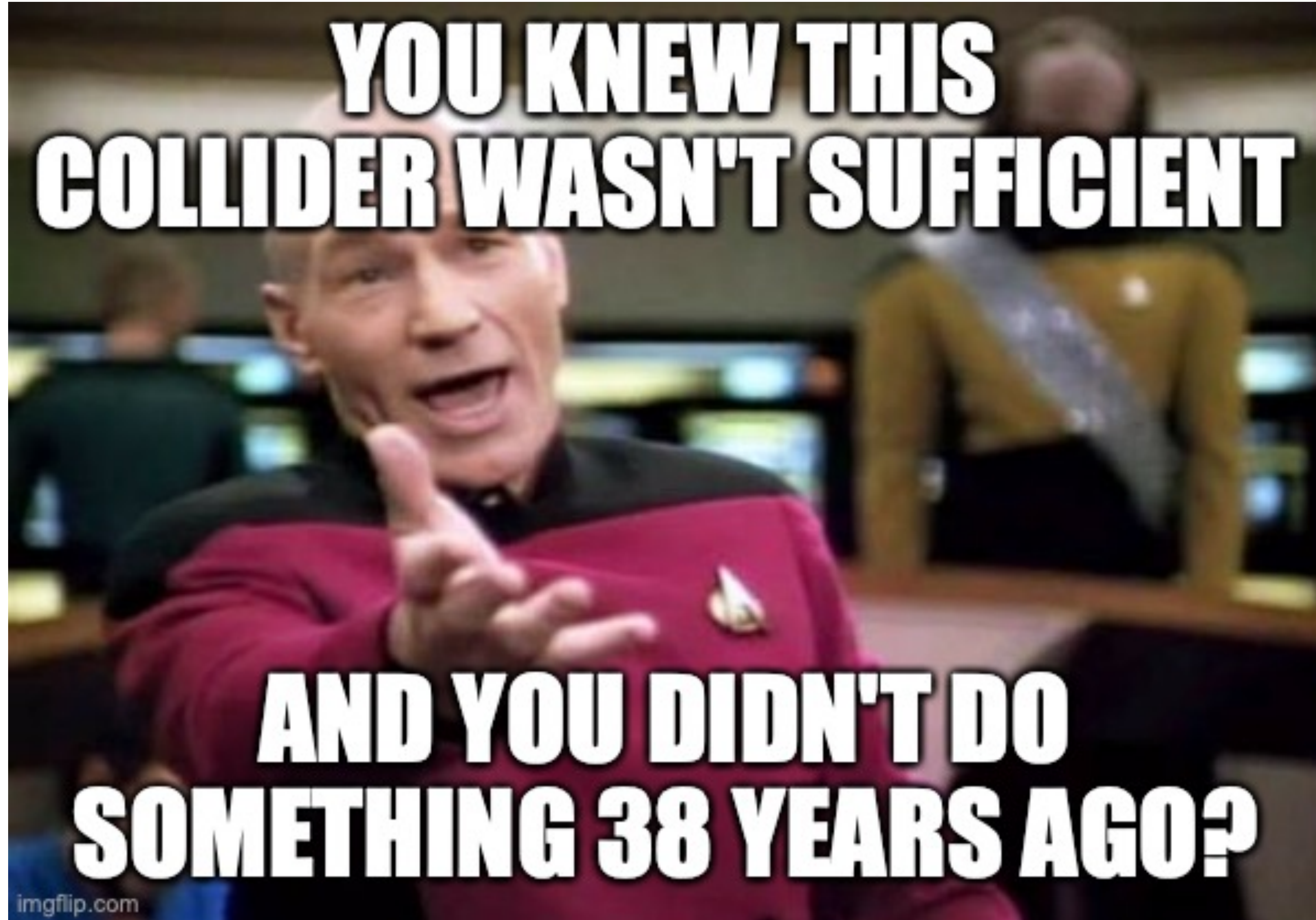
# Benchmarks

**Experiment should lead theory...**

**But theory should inform experiment!**

**Especially when we already know there are models which go beyond what was planned for in current ESG, FCC, ILC, CLIC, CEPC docs...**

**We don't want our great-great-grad students saying...**



**#Snowmass1982 #Snowmass2058**

**BSM driven benchmarks, a work  
in progress...**

**I'M GONNA NEED SOME  
MORE ENERGY AND PRECISION**

**SO IF YOU COULD DO  
THAT, THAT'D BE GREAT**

# What's already needed or food for thought...

- $\ll O(1)\%$  precision on triple Higgs coupling
  - Needed to qualitatively understand EW phase transition
  - Solve part of ee/hh Higgs inverse problem
- Flavor
  - New models allow for deviations in Higgs couplings to light generations
  - Can we get to  $O(100)$  for up/down Yukawas,  $O(10)$  for strange,  $O(1)$  for charm?  
Can we eventually measure all Yukawa's to complete the picture for Higgs?
- What's needed to get beyond LHC for standard naturalness from Higgs precision?  
How complementary is BSM Higgs with direct searches?
- Can neutral naturalness and long lived decays be covered without requiring dedicated LLP detectors?
- Many more questions here's just a few to start but **we are planning meetings specifically for benchmarking BSM Higgs - we hope you join!**



# What's already needed or food for thought...

- Fold in R&D proposals from [recent conferences/workshops](#) (Basic Research Needs, etc. )
- Update previous studies with the latest results (LHC Run 2, CEPC, ILC, etc.)
- Integration of new technologies (Timing, ML, Computing) into expected performance metrics
- [What do we gain if we are more aggressive](#) in advancing Detector, Magnet and Accelerator technology?
- **Planning meetings with talks from Accelerator and R&D groups**

# Covering the Full Phase Space

- **Higgs Friends** - Exist in many models (synergy with EF1,8,9,10)
  - How to benchmark and set priorities?
- **Naturalness/Compositeness** - Mostly parameterizations, less “full models” complementarity with EF1,8,9
  - What is the synergy here with Higgs properties?
- **Naturalness/Symmetry** - SUSY is the canonical example, synergy with EF8,9
- **Neutral Naturalness** - partners of SM not charged under SU(3) - Exotics Higgs decays? EF8,9
- **Electroweak Phase Transition** - May need percent less than percent level precision on triple higgs coupling -synergy with EF1
- **Flavor** - Deviations in light generations possible! synergy with EF1

# Feedback from Kick-Off Meeting

[May 15 2020](#)

## New ideas encouraged!

- Higgs Inverse problem
  - In case of a discovery (or lack of discovery) are we prepared to modify the direction of the field to tackle the big questions?
- Synergies with Detector/Accelerator R&D... For Example:
  - What is needed from the Trigger/DAQ to collect all  $HH \rightarrow bbbb$  events at a future detector?
  - What is needed to better distinguish jet flavor?

# Summary

- We are collecting [expressions of interest](#) from the community to participate
- Topics are overlapping with EF01: Higgs Properties and EF08/09/10: BSM
  - Joint meeting with EF01 May 27th 12pm EST - **di-Higgs**
- Also work with accelerator and instrumentation groups to build an exciting array of meeting topics for the summer

Conveners	<a href="#">Patrick Meade, Isobel Ojalvo</a>
Mailing-list	<a href="mailto:SNOWMASS-EF-02-BSM_HIGGS@FNAL.GOV">SNOWMASS-EF-02-BSM_HIGGS@FNAL.GOV</a> (instructions)
Slack channel	<a href="#">ef02-higgs_bsm</a> (instructions)
Next Event May 27th	<a href="https://indico.fnal.gov/event/43223/">https://indico.fnal.gov/event/43223/</a>