Fermilab U.S. DEPARTMENT OF ENERGY Office of Science

Welcome to Fermilab

Double Higgs Production at Colliders Workshop

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The SM is Omnipresent

- The last seven particle colliders (three B factories, LEP, SLC,Tevatron, and LHC) have so far seen no conclusive evidence of Beyond the SM phenomena in the laboratory
- This is at least somewhat surprising for LHC, since strong arguments based on naturalness imply that the Higgs boson should be accompanied by BSM physics at a similar scale, ~ TeV
- The only BSM physics observed so far *in the lab* is neutrino mass (from neutrino flavor change)
- Some deviations in the flavor sector are intriguing, but not conclusive

Question:

Physics motivation for the next generation of Energy and Intensity Frontier machines?

Answer:

- **Higgs**
- **Neutrinos**
- **Dark matter**

} **BSM and Flavor**

Higgs

Its existence implies the Higgs mechanism, a very sophisticated property of the quantum vacuum

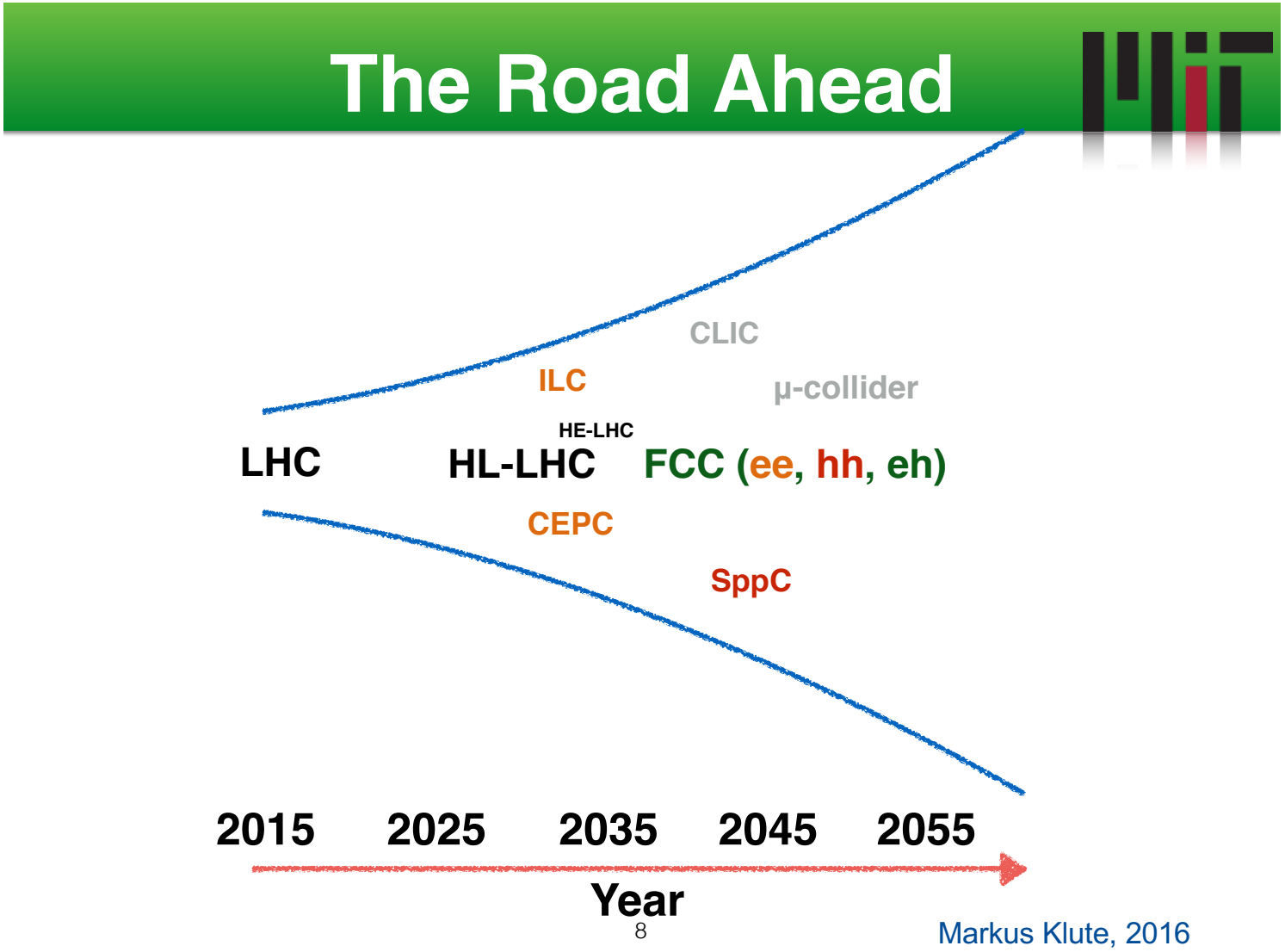
It implies a phase transition in the early universe of unknown origin

Obviously, it should be a top priority of HEP to detect, measure, and understand the detailed physics tied to the Higgs

- **Detect and measure with precision the various decay modes of the Higgs boson, including "invisible" decays.**
- **Detect the Higgs self-coupling; constrain directly the Higgs potential**
- **Detect evidence of Higgs compositeness ?**
- **Find heavier (or lighter?) additional Higgs bosons**

LHC and HL-LHC **can tell us a lot**,
but will **not** be definitive for any of these challenges

Many Colliders in the Horizon



Markus Klute, 2016

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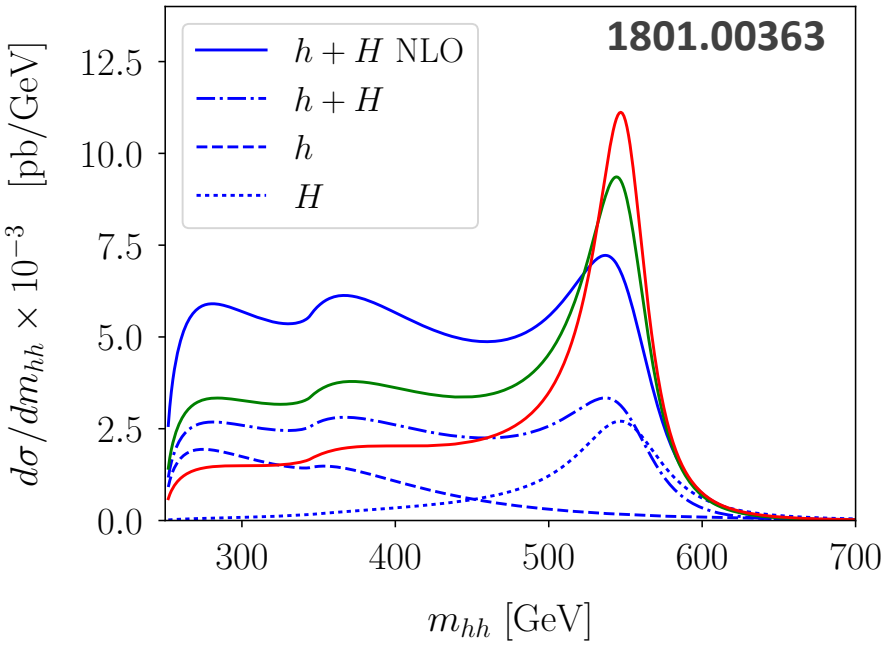
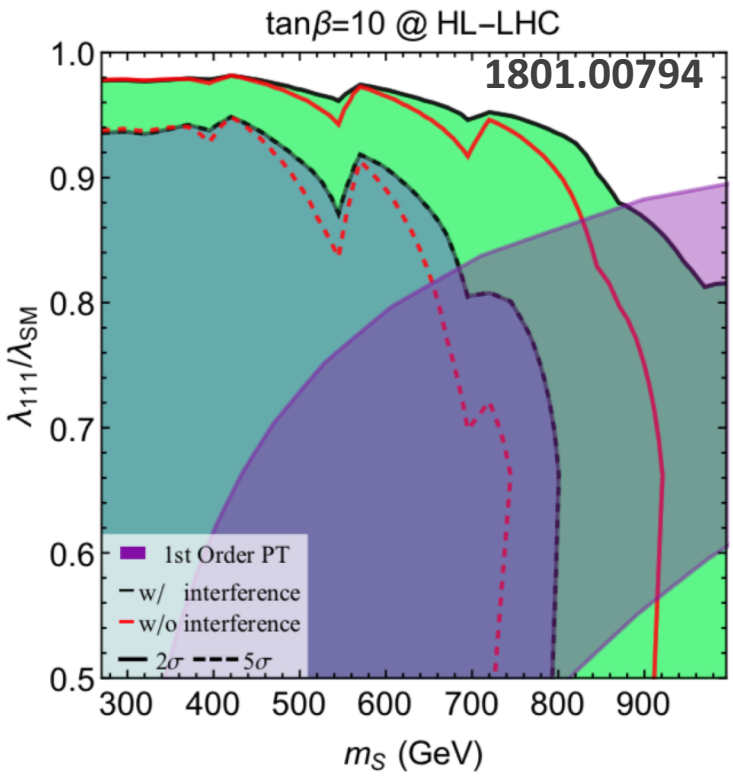
Di-Higgs

Bauer, MC, Carmona (1801.00363)
MC, Liu, Riembau (1801.00794)

Di-Higgs production in extended Higgs sectors

- Correlation between enhanced Higgs-fermion couplings and di-Higgs production in 2HDM w/ flavour symmetry
- Visible in resonant & non-resonant, dedicated LHC searches
- Interference effects in SM + Singlet extends sensitivity of di-higgs in first order phase transition region, at HL-LHC





Based on
pp → HH → bbγγ,
[1502.00539]

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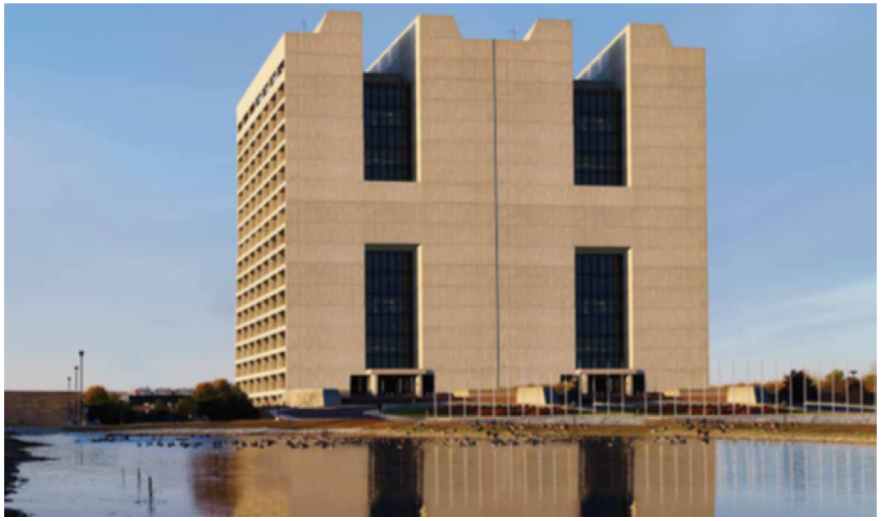
This Workshop:

- Discuss recent results, analysis techniques and theoretical calculations of HH production.



Local organization committee:

Luca Cadamuro (Florida U)
Marcela Carena (U Chicago/Fermilab)
Jacobo Konigsberg (Florida U)
Zhen Liu (Fermilab/U Maryland-chair)
Caterina Vernieri (Fermilab-chair)

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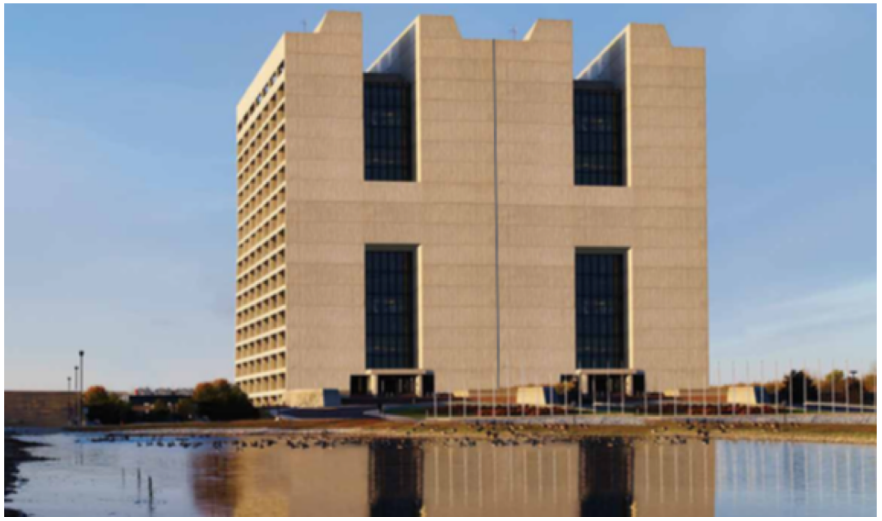

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Thanks for being at Fermilab