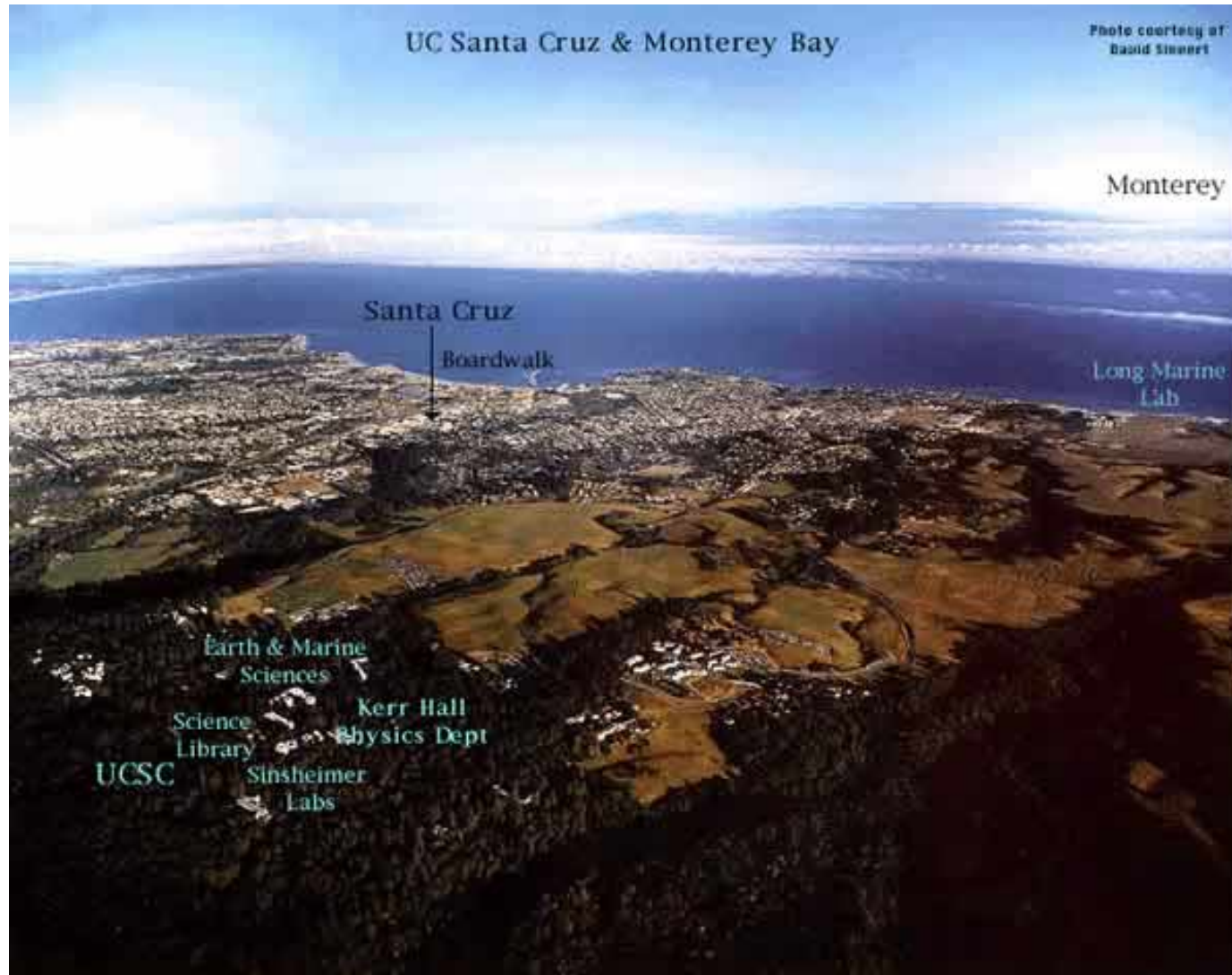


The Santa Cruz Node



1st RISE Collaboration Meeting
6—8 December 2015
University of Warsaw
Presented by Howard E. Haber



The Santa Cruz Institute for Particle Physics (SCIPP) Theory Group

Faculty members:

- Howard Haber
- Michael Dine
- Stefano Profumo

Post-doctoral research associates:

- Francesco D'Eramo
- Tim Stefaniak

Close connections to the Santa Cruz ATLAS Experimental group

- Jason Nielsen, Michael Hance, Bruce Schumm, Marco Battaglia, Alan Litke, Abe Seiden and Alex Grillo

Recent and Current Activities (Howard Haber)

- The alignment limit of the 2HDM
 - Theory of the alignment and decoupling limits
 - Phenomenological implications of the alignment limit for LHC Higgs searches (either h or H is SM-like)
- LHC benchmarks for the 2HDM
 - For Types-I and II 2HDMs
 - Including CP-violation and relaxing the \mathbf{Z}_2 symmetry
- Higgs sector alignment in supersymmetric models
 - Alignment in the MSSM due to radiative corrections
 - Alignment in the NMSSM at tree-level
- Theoretical aspects of the 2HDM
 - Vacuum stability and approximate flavor alignment
 - A partially natural 2HDM

2015 Publications

[Scrutinizing the Alignment Limit in Two-Higgs-Doublet Models. Part 2: \$m_H=125\$ GeV](#)

J. Bernon, J.F. Gunion, H.E. Haber, Y. Jiang and S. Kraml, arXiv:1511.03682 [hep-ph].

[On the Alignment Limit of the NMSSM Higgs Sector](#)

M. Carena, H. E. Haber, I. Low, N.R. Shah and C.E.M. Wagner, arXiv:1510.09137 [hep-ph].

[New LHC Benchmarks for the CP-conserving Two-Higgs-Doublet Model](#)

H.E. Haber and O. Stål, Eur. Phys. J. C **75**, 491 (2015) [arXiv:1507.04281 [hep-ph]].

[Scrutinizing the Alignment Limit in Two-Higgs-Doublet Models. Part 1: \$m_h = 125\$ GeV](#)

J. Bernon, J.F. Gunion, H.E. Haber, Y. Jiang and S. Kraml, Phys. Rev. D **92**, 075004 (2015) [arXiv:1507.00933 [hep-ph]].

[Preserving the validity of the Two-Higgs Doublet Model up to the Planck scale](#)

P. Ferreira, H.E. Haber and E. Santos, Phys. Rev. D **92**, 033003 (2015) [arXiv:1505.04001 [hep-ph]].

[Complementarity Between Non-Standard Higgs Boson Searches and Precision Higgs Boson Measurements in the MSSM](#)

M. Carena, H.E. Haber, I. Low, N.R. Shah and C.E.M. Wagner, Phys. Rev. D **91**, 035003 (2015) [arXiv:1410.4969 [hep-ph]].

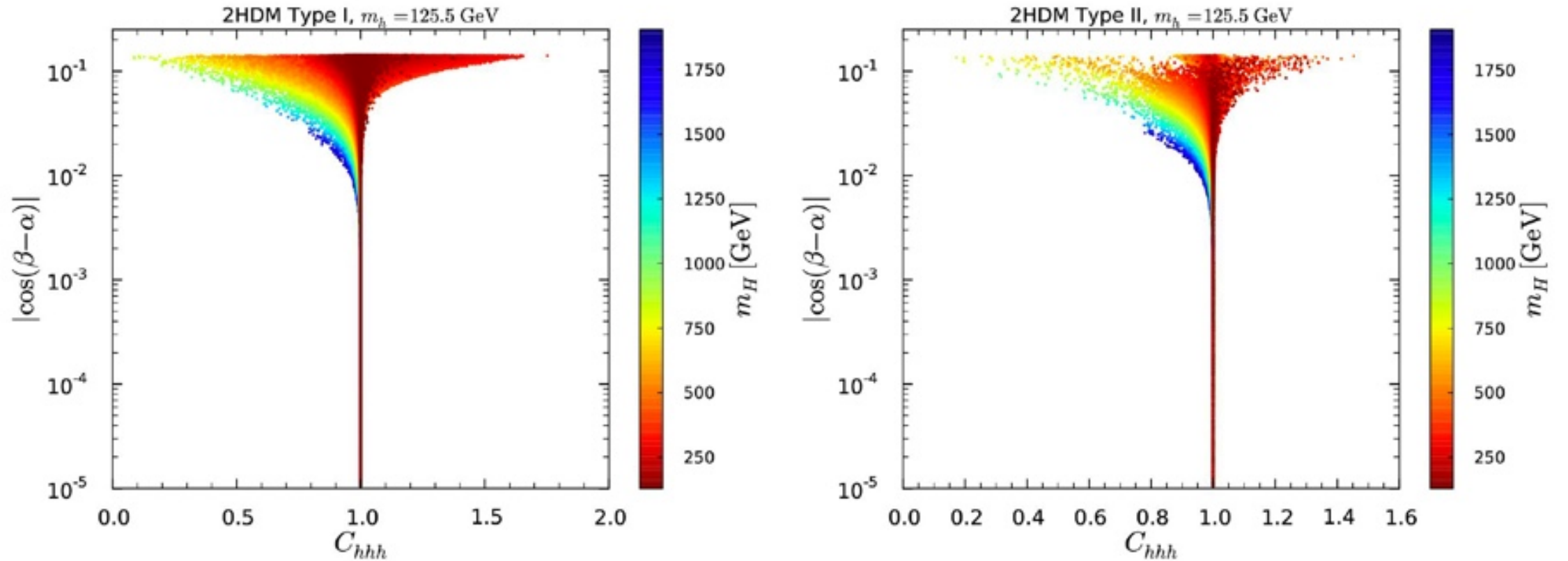


Figure 8: $|c_{\beta-\alpha}|$ versus the reduced triple Higgs coupling C_{hhh} in Type I (left) and Type II (right) with m_H color code. Points are ordered from high to low m_H values.

In the alignment limit, significant deviations from SM behavior can be seen in the triple Higgs coupling in certain regions of the 2HDM parameter space. Taken from J. Bernon et al., Phys. Rev. D **92**, 075004 (2015) .

Ongoing and Future Activities

- Partially Natural 2HDM (with P. Draper and J. Ruderman)
 - Implementing the second fine tuning of the 2HDM with a symmetry.
- Implications of 2HDM flavor alignment at a very high energies (with S. Gori and E. Santos)
 - Generating manageable flavor violation at the electroweak scale via renormalization group running.
- LHC Benchmarks for more general 2HDMs (with T. Stefaniak)
 - Putting in CP violation and Z_2 symmetry breaking effects in the 2HDM in the HiggsSignals program.
- Higgs alignment in the radiatively corrected 2HDM revisited (with T. Stefaniak)
 - A more comprehensive scan of the pMSSM parameter space.

Michael Dine

- M. Dine, N. Seiberg and S. Thomas, *Higgs physics as a window beyond the MSSM (BMSSM)*, Phys. Rev. D **76**, 095004 (2007) [arXiv:0707.0005 [hep-ph]].

Stefano Profumo

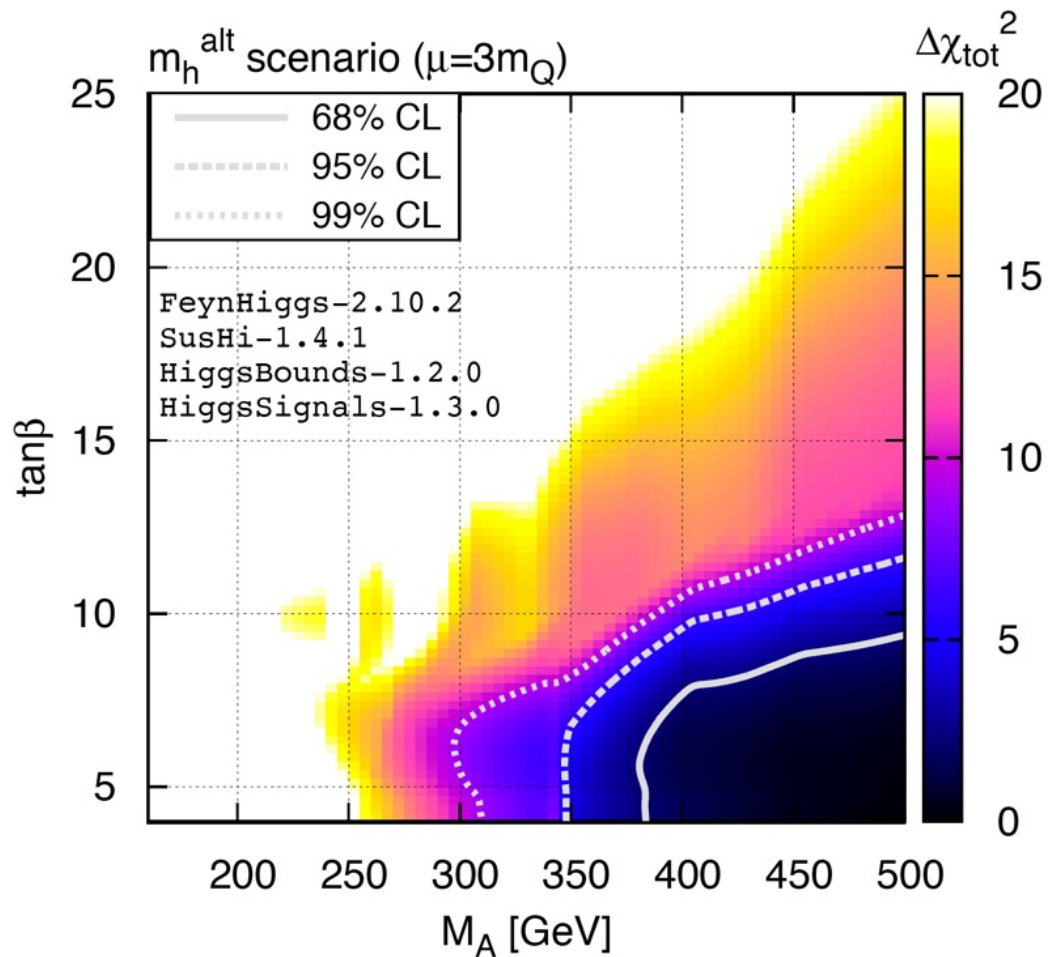
- N. Blinov, S. Profumo and T. Stefaniak, *The Electroweak Phase Transition in the Inert Doublet Model*, JCAP **1507**, 028 (2015) [arXiv:1504.05949 [hep-ph]].
- L. Feng, S. Profumo and L. Ubaldi, *Closing in on singlet scalar dark matter: LUX, invisible Higgs decays and gamma-ray lines*, JHEP **1503**, 045 (2015) [arXiv:1412.1105 [hep-ph]].
- S. Profumo, M.J. Ramsey-Musolf, C.L. Wainwright and P. Winslow, *Singlet-catalyzed electroweak phase transitions and precision Higgs boson studies*, Phys. Rev. D **91**, 035018 (2015) [arXiv:1407.5342 [hep-ph]].

Tim Stefaniak

- P. Bechtle, S. Heinemeyer, O. Stål, T. Stefaniak and G. Weiglein, *Applying Exclusion Likelihoods from LHC Searches to Extended Higgs Sectors*, Eur. Phys. J. C **75**, 421 (2015) [arXiv:1507.06706 [hep-ph]].
- N. Blinov, S. Profumo and T. Stefaniak, *The Electroweak Phase Transition in the Inert Doublet Model*, JCAP **1507**, 028 (2015) [arXiv:1504.05949 [hep-ph]].
- T. Robens and T. Stefaniak, *Status of the Higgs Singlet Extension of the Standard Model after LHC Run 1*, Eur. Phys. J. C **75**, 104 (2015) [arXiv:1501.02234 [hep-ph]].
- P. Bechtle, O. Brein, S. Heinemeyer, O. Stål, T. Stefaniak, G. Weiglein and K.E. Williams, *HiggsBounds-4: Improved Tests of Extended Higgs Sectors against Exclusion Bounds from LEP, the Tevatron and the LHC*, Eur. Phys. J. C **74**, 2693 (2014) [arXiv:1311.0055 [hep-ph]].

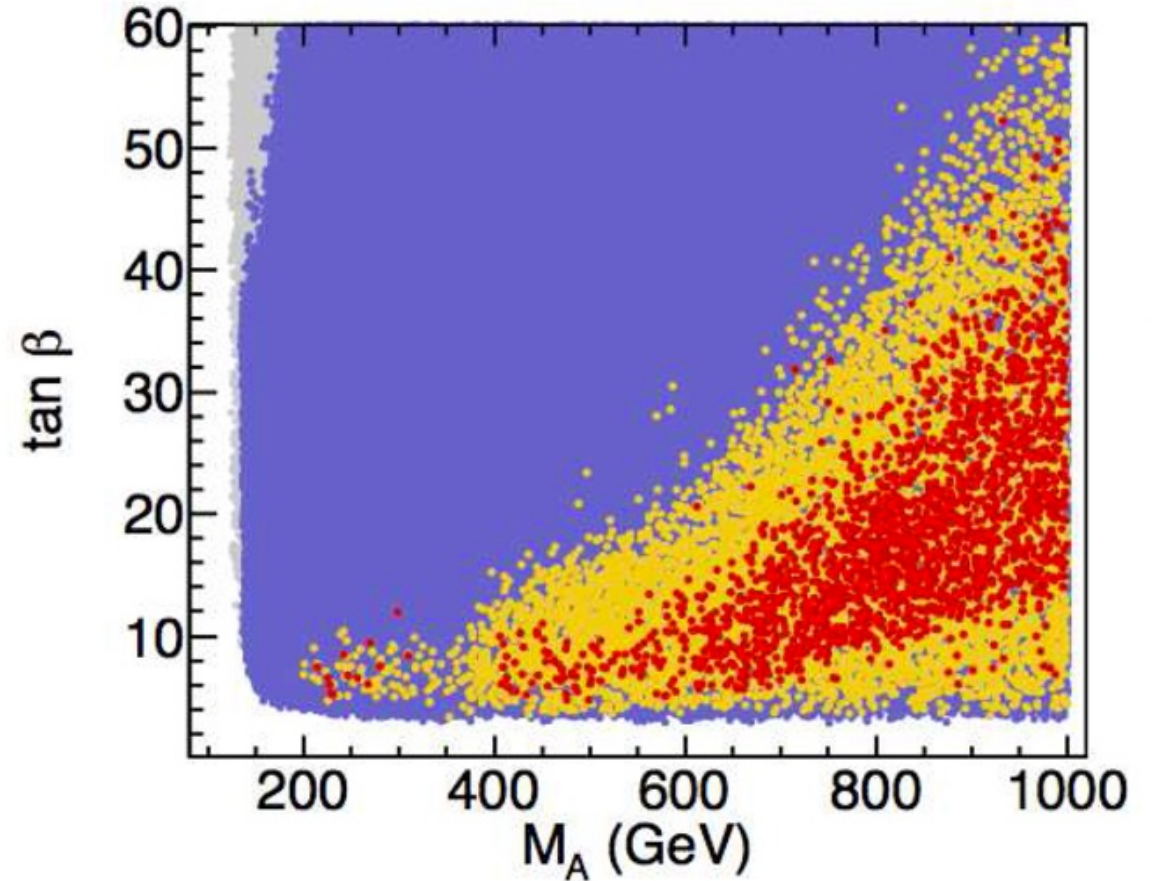
Francesco D'Eramo

- N. Craig, F. D'Eramo, P. Draper, S. Thomas and H. Zhang, *The Hunt for the Rest of the Higgs Bosons*, JHEP **1506**, 137 (2015) [arXiv:1504.04630 [hep-ph]].
- F. D'Eramo, L.J. Hall and D. Pappadopulo, *Radiative PQ Breaking and the Higgs Boson Mass*, JHEP **1506**, 117 (2015) [arXiv:1502.06963 [hep-ph]].



Allowed region of MSSM Higgs parameter space in the m_h^{alt} scenario where 2HDM alignment without decoupling is achieved for $\tan\beta \sim 10$ due to one-loop radiative corrections.

[T. Stefaniak and collaborators, after revisiting the results obtained by M. Carena et al.]



A 7 parameter pMSSM scan to generalize the constraints on the m_h^{alt} scenario. Red points are with 1σ of the best fit point and yellow points are within 2σ of the best fit point.

Incoming secondments in 2016

- Venus Keus will be visiting the SCIPP Theory group from 13 January—13 February 2016. Details of the visit are now fixed.
- Pedro Ferreira will be visiting the SCIPP Theory group in February, 2016. The precise dates are yet to be determined, although we expect some overlap with the visit of Venus Keus.
- A possible visit by Rui Santos is currently under consideration.