

Future Collider – Theory Activities

DESY – University of Hamburg – Quantum Universe

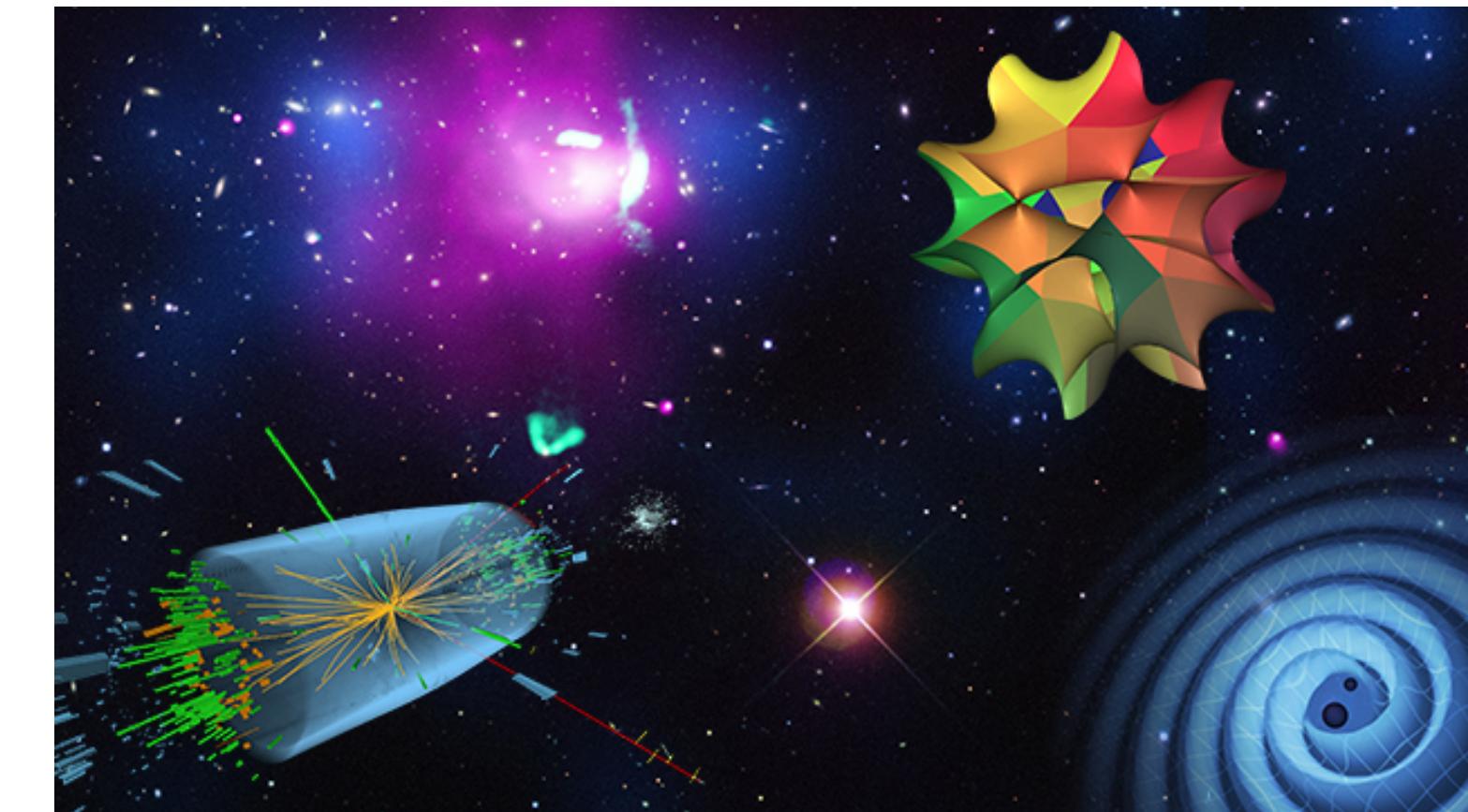


HELMHOLTZ
RESEARCH FOR GRAND CHALLENGES



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CLUSTER OF EXCELLENCE
QUANTUM UNIVERSE



Gudrid Moortgat-Pick & Jürgen Reuter

DESY / UHH Future Collider Theory Activities

Beam dump experiments

Beam structure / PDFs

BSM sensitivity

Global Fits

Model building & Benchmarks

Monte Carlo development

Precision predictions & Calculational methods

Strategy Planning



DESY(HH/Z)/UHH staff involved:

Fadi Bishara
Johannes Blümlein
Markus Diehl
Christophe Grojean
Hyungjin Kim
Bernd Kniehl
Thomas Konstandin
Peter Marquard
Sven Moch
Gudrid Moortgat-Pick
Zoltan Nagy
Georgios Papathanasiou
Jürgen Reuter
Kai Schmidt-Hoberg
Andreas Ringwald
Geraldine Servant
Bibhushan Shakya
Frank Tackmann
Georg Weiglein
Alexander Westphal

and, of course, many postdocs and Phd/master students

in spiritu: Peter Zerwas

ILC International Development Team Members

Convenerships: CEPC, CLIC, EIC, ILC, HL-LHC, FCC-ee, FCC-hh

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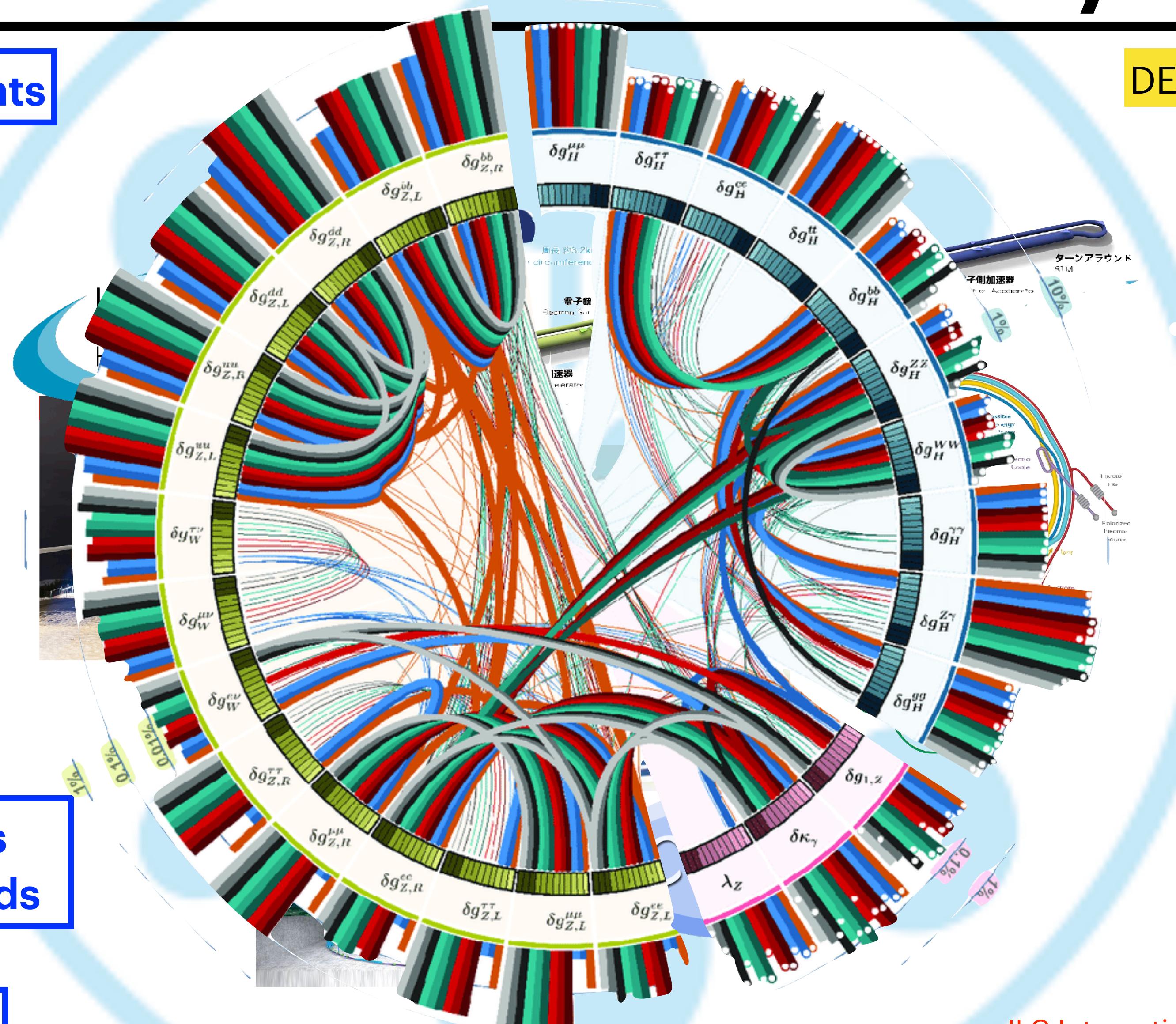
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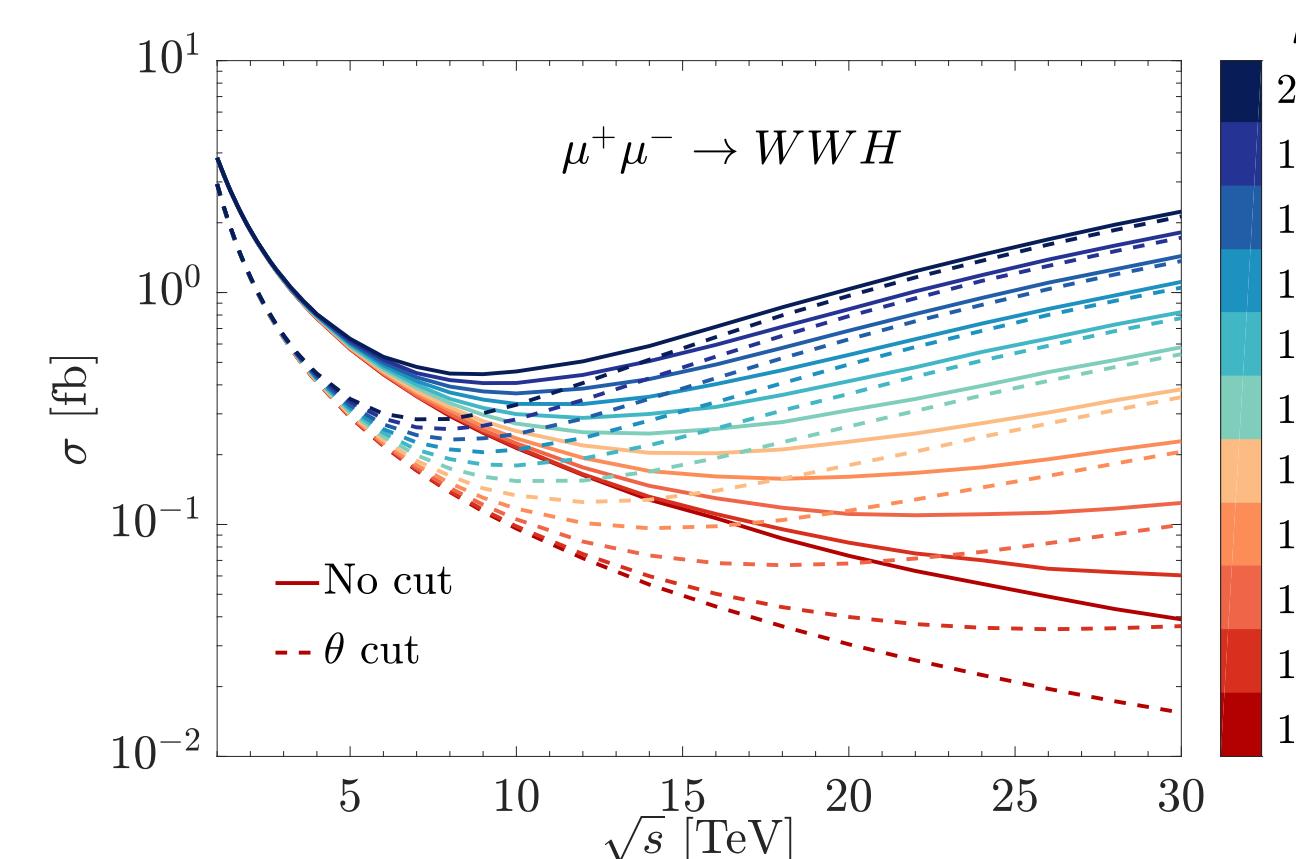
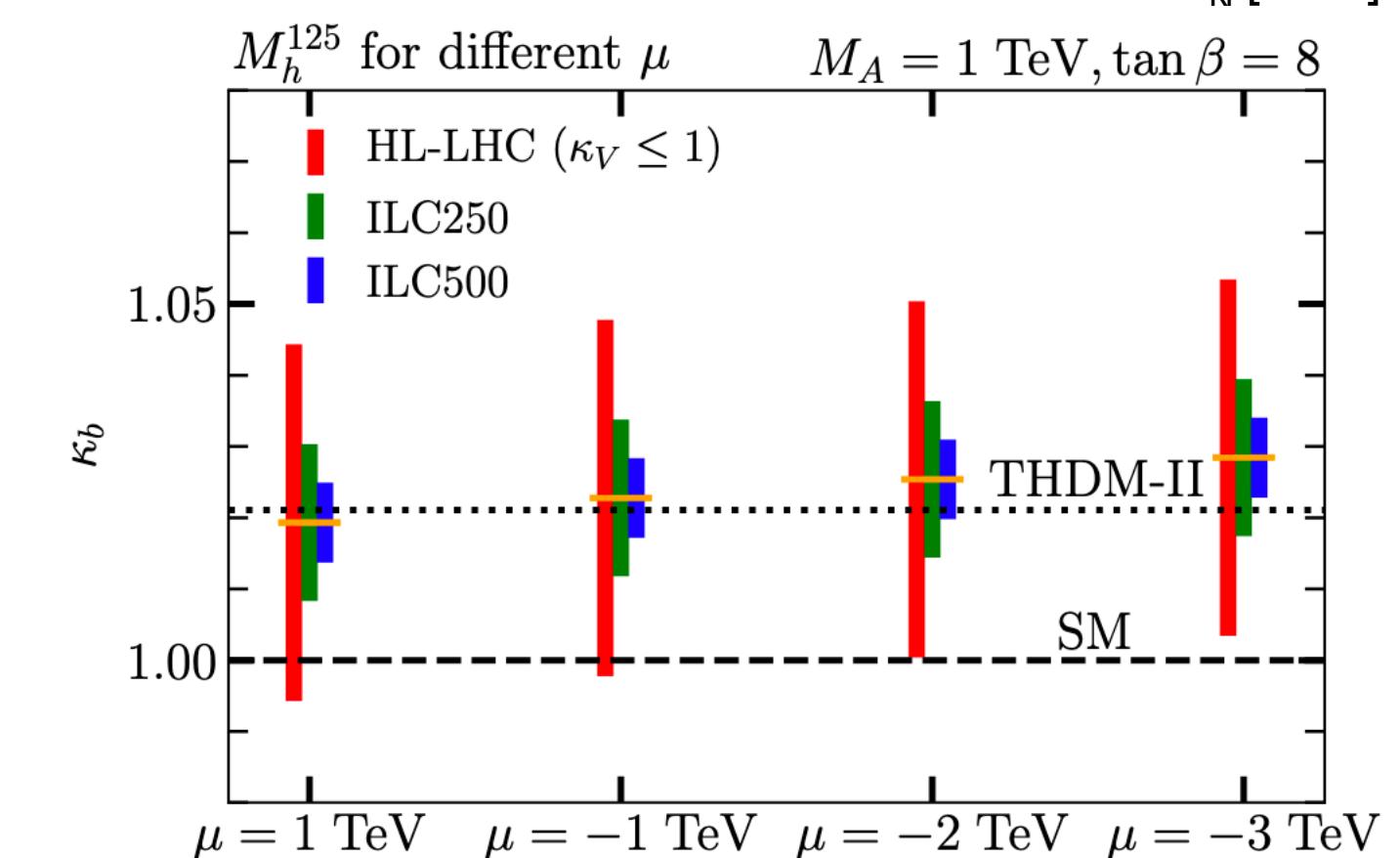
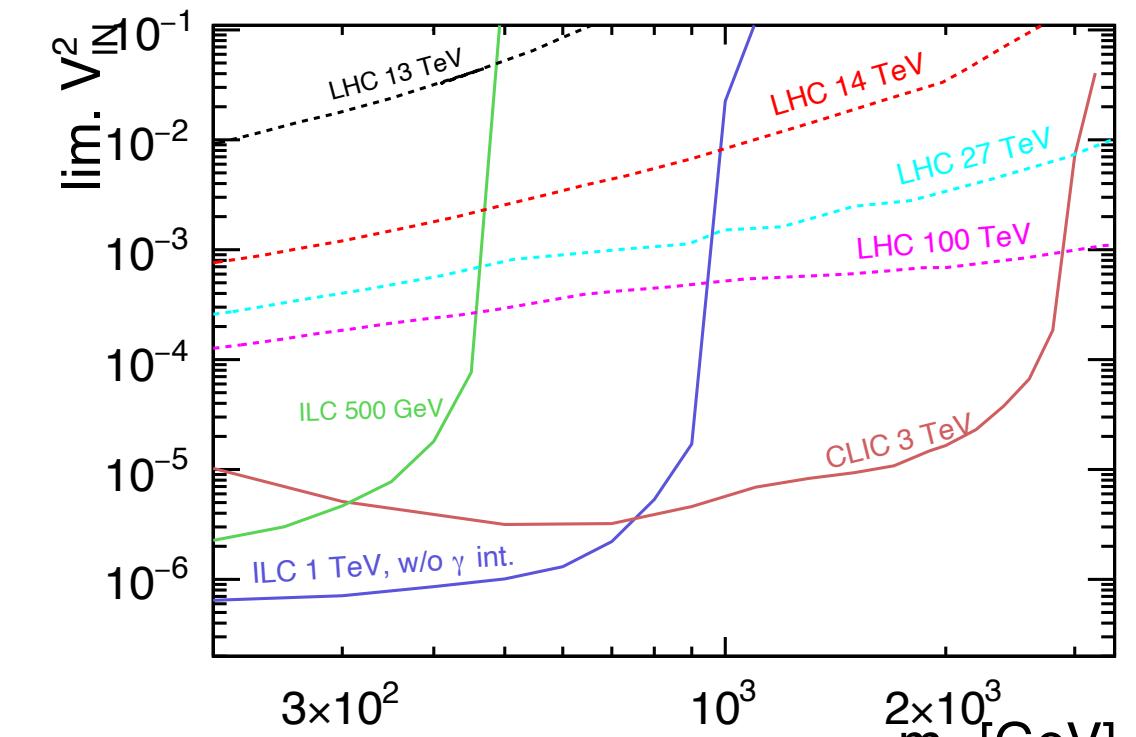
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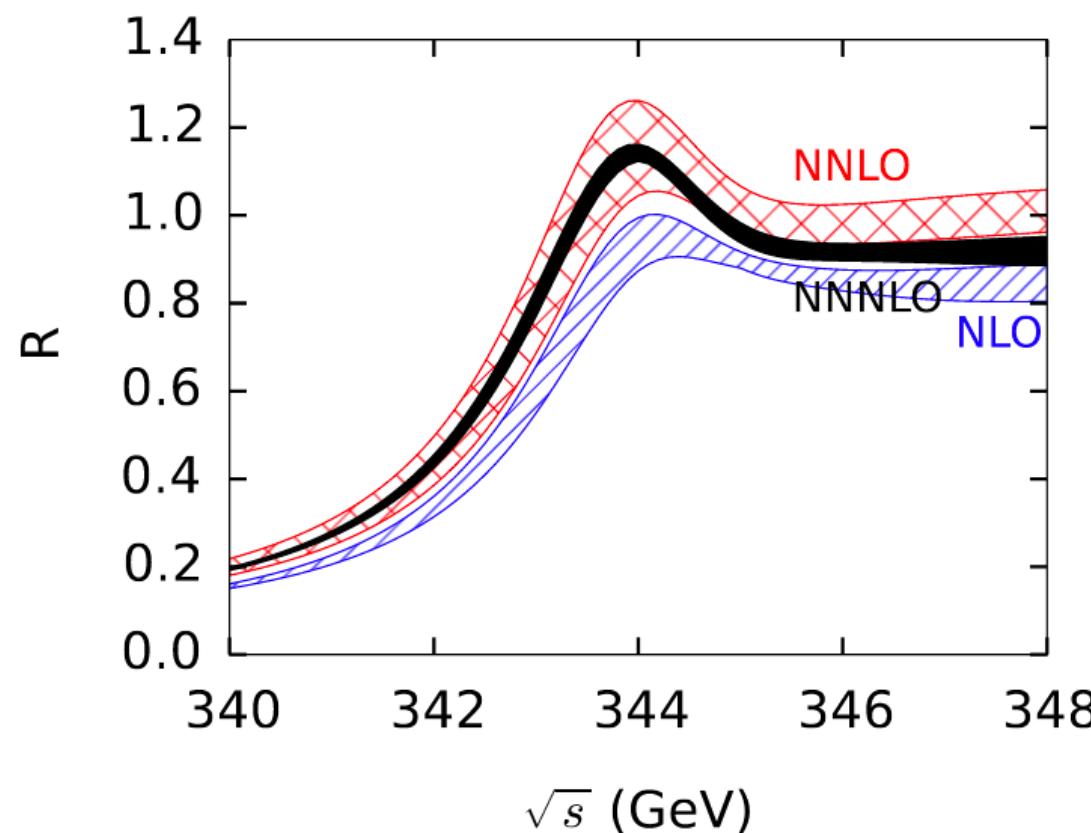
New Physics at Future Colliders

- Phenomenology of BSM models: SUSY, extended Higgs sectors (THDM...), composite Higgs models, Little Higgs, Higgs portal, Twin Higgs,
- Precise calculations/predictions/parameters scans in different models
- Exploitation of collider-specific features, e.g. beam polarization, tunable energy, collider running scenarios, GigaZ etc., necessary collider energies (FCC-hh)
- Approaches for parameterizing SM deviations, e.g., SMEFT, validity and tests
- Special particles: WIMPs/axions/neutrinos....:
- Dump Experiments at ILC (ILC+, DM@positron dump), non-collider experiments
- Impact of gravitational waves, inflation, phase transitions at colliders
- Global fits: Higgs couplings, SUSY Parameter fits,...
- Application of new methods, e.g. ML, BDT, MCMC, ...
- Physics potential of future machines, e.g. FCC-hh, μ -collider, etc.



Precision Predictions and Tools for Future Colliders

- Many LHC calculations transferable to FCC-hh: NLO, NNLO, Resummation, Parton Showers, ...
- Parton structure predictions (HL-LHC/EIC/FCC-eh/hh): PDF fits, Parton correlations, Double Parton Scattering
- Development of new calculational techniques: Amplitudes methods, ML, bootstrap, ...
- Precision observables for future colliders: Top, Higgs, W/Z properties, EWPO, ...
- Strong development of tools: Deductor, HiggsBounds, MasterCode, SCETlib, Whizard, ...
- Precision predictions for e^+e^- colliders: full SM studies, higher order QED/EW, beam/polarization studies
- High energy lepton (e/μ) colliders: EW showers, EW PDFs, exclusive radiation patterns



	$\sigma_{\text{LO}}[\text{fb}]$	$\sigma_{\text{NLO}}[\text{fb}]$	K	$\sigma_{\text{std NLO}}$
$e^+e^- \rightarrow jj$	622.737(8)	639.39(5)	1.027	0.69
$e^+e^- \rightarrow jjj$	340.6(5)	317.8(5)	0.933	0.53
$e^+e^- \rightarrow jjjj$	105.0(3)	104.2(4)	0.992	1.11
$e^+e^- \rightarrow jjjjj$	22.33(5)	24.57(7)	1.100	0.99
$e^+e^- \rightarrow jjjjjj$	3.583(17)	4.46(4)	1.245	-

Organizational involvement

- **Intense T/EXP collaboration:** for many of the future colliders, particularly HL-LHC, FCC-hh, ILC
- **DESY Theory Workshop:** every 3rd year focus on collider phenomenology
- **Linear (ILC) Collider Activities :** Linear Collider School, Linear Collider Forum → [Future Collider Forum](#)
- **DESY Summer School:** strong theory involvement, world-wide participation, many FC projects
- **Monte Carlo School:** ~ annual event, techniques and tools,
- **Cluster 'Quantum Universe':** regular lectures, colloquia, workshops with FC context

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