Rikkert Frederix

My interests

✦ LHC phenomenology

✦ Perturbative QCD and higher order corrections applied to collider physics

✦ Matching of fixed order calculations to parton showers

✦ Apply improved predictions to look for interesting collider phenomenology

  ○ In particular:

    ◆ Top quark physics

    ◆ Higgs physics

✦ Mostly within the MadGraph5_aMC@NLO framework

MadGraph5_aMC@NLO

MadGraph5_aMC@NLO

MadGraph5

MadFKS

MadLoop

aMC@NLO

http://amcatnlo.cern.ch

✦ Automatic code that allows for simulation of collider events up to NLO accuracy in QCD

✦ Both for fixed order predictions, as well as the inclusion of the parton shower

✦ Widely used by CMS at ALTAS collaborations

✦ Modular structure:

  ○ Use MadGraph5 for LO and steering

  ○ MadFKS for factoring out Infrared singularities and performing phase-space integrals. I'm mostly involved in this part of the code

  ○ MadLoop for the virtual corrections

  ○ aMC@NLO for matching to the parton shower

✦ J.Alwall, RF, S.Frixione, V.Hirschi, F.Maltoni, O.Mattelaer, H-S.Shao, T.Stelzer, P.Torrielli, M.Zaro (2014)

Level of automation

✦ To make predictions easy in MadGraph5_aMC@NLO we have inherited the user-friendly interface from the MadGraph5 code

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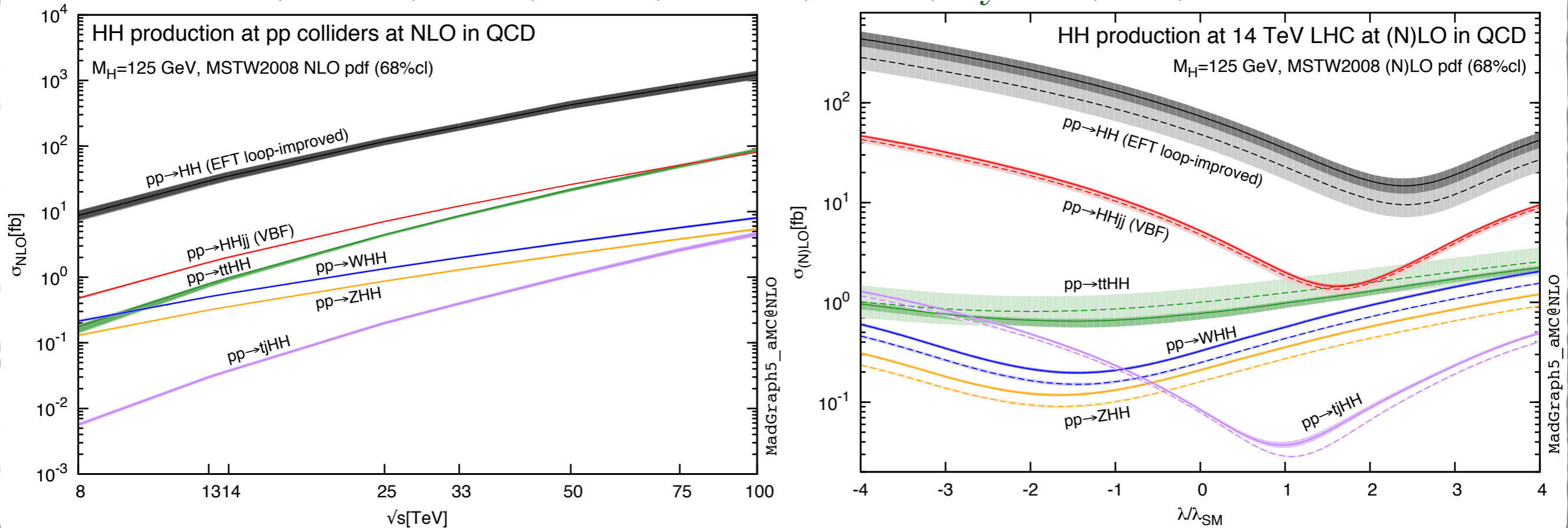✦ NLO predictions for collider processes are really as simple as:

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$ ./bin/mg5_aMC

MG5_aMC> generate p p > h h t t~ [QCD]

MG5_aMC> output my_NLO_hhtt_process

MG5_aMC> launch
```
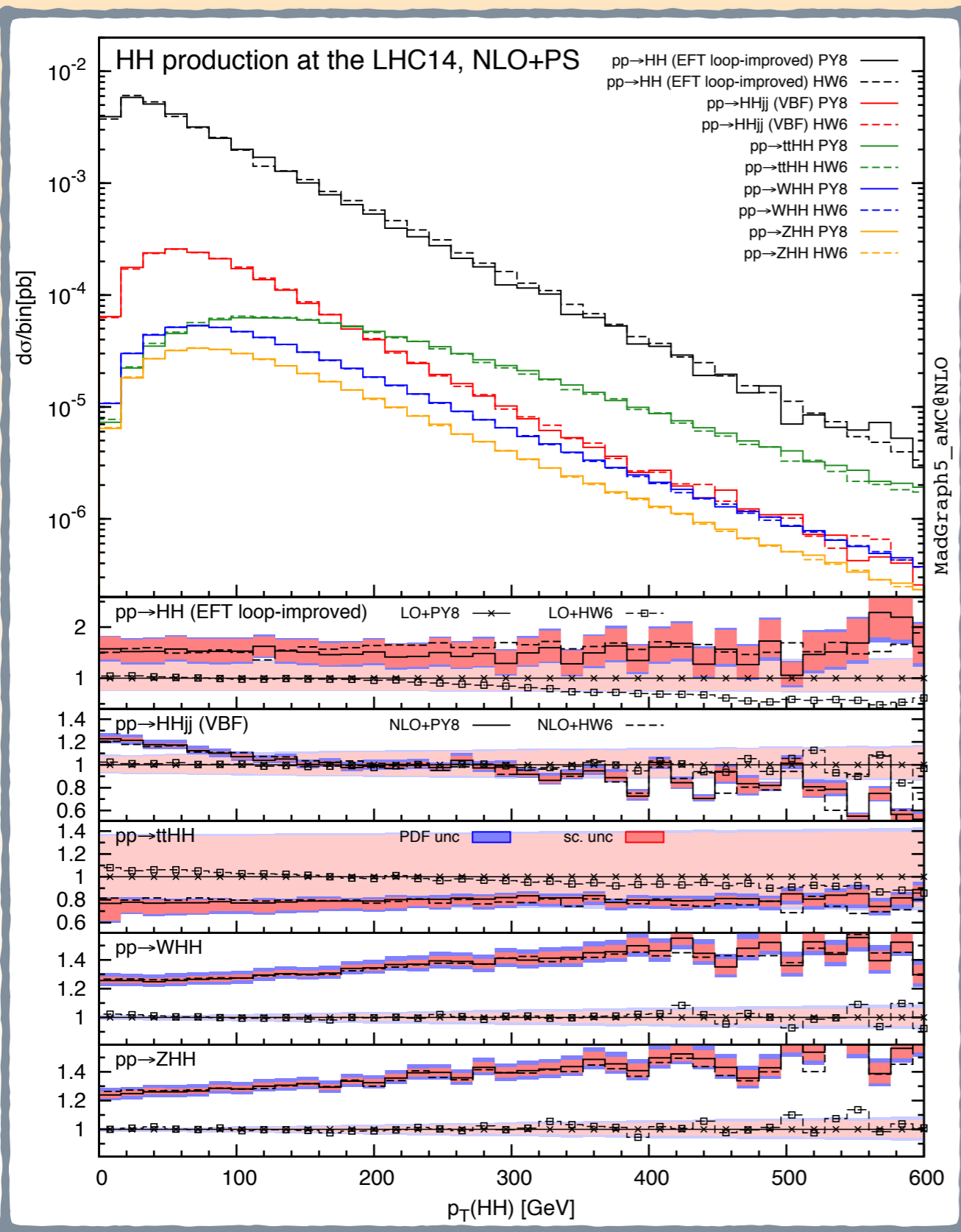
Higgs pair production

RF, Frixione, Hirschi, Maltoni, Mattelaer, Torrielli, Vryonidou, Zaro, arXiv:1401.7340

✦ Higgs pair production cross sections as a function of the collider energy (left) and Higgs triple coupling (right)

✦ Width of the bands are uncertainty estimates

P$_T$(HH)

* Transverse momentum of the Higgs pairs

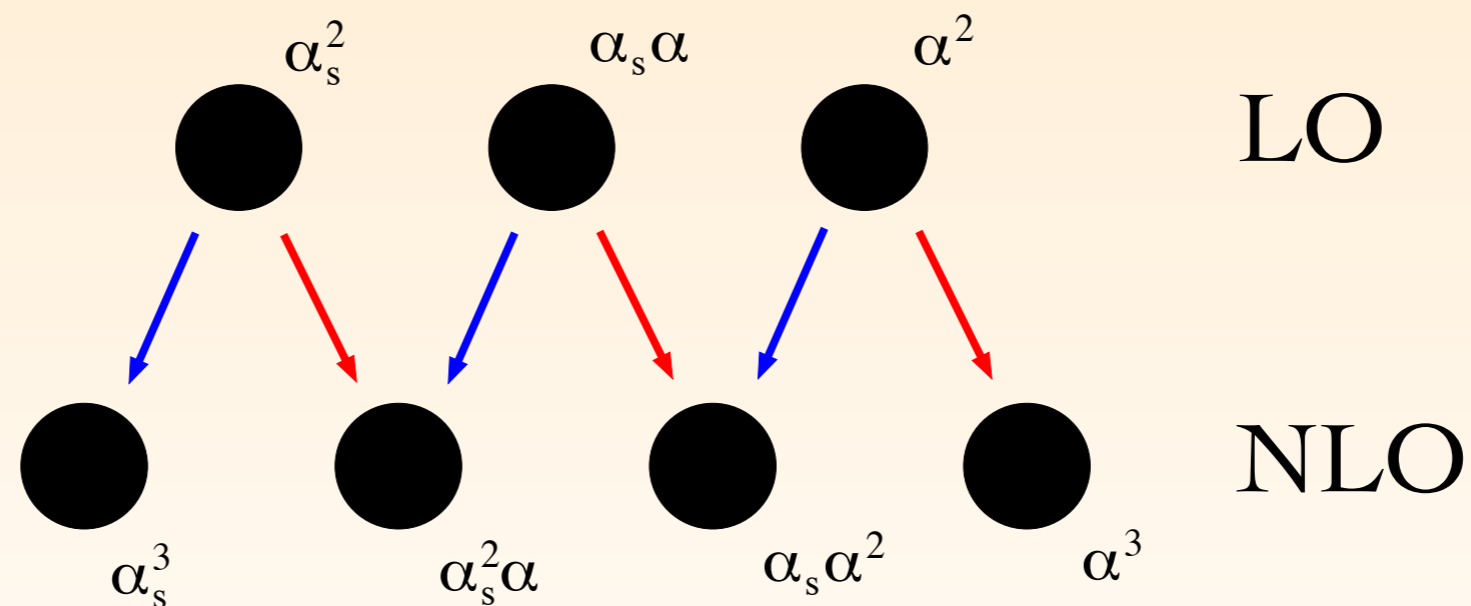* Shapes for the various production mechanisms completely different

RF, Frixione, Hirschi, Maltoni, Mattelaer, Torrielli, Vryonidou, Zaro, arXiv:1401.7340

Improvements

✦ Two types of improvements

  ○ technical

    ◆ faster code; more stable code; improve user-friendliness; "service work"

    ◆ Important for users, but time-consuming to implement. Not very visible to the community

  ○ physics

    ◆ improve the physics modelling

    ◆ Can be directly applied to pheno!
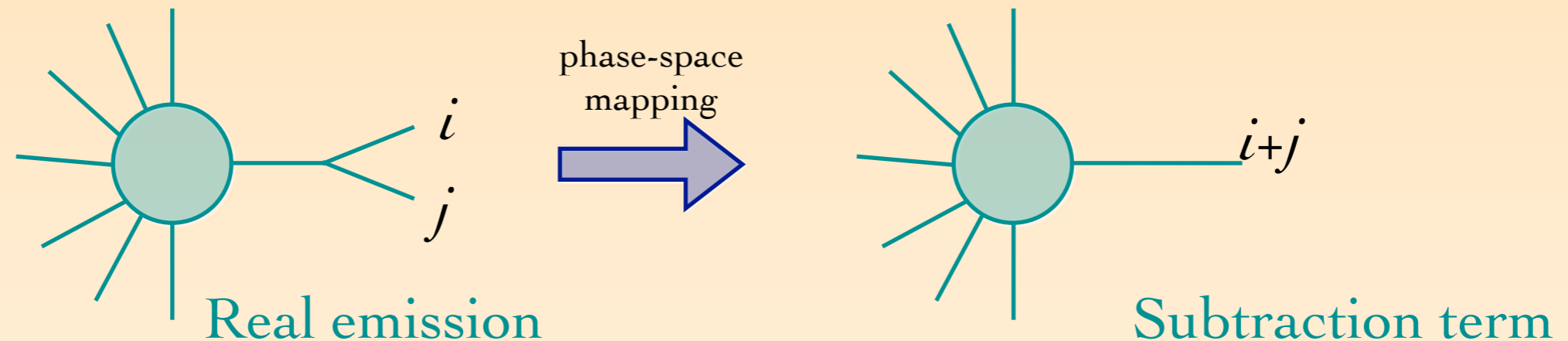
Improve physics modelling

✦ Currently, a lot of effort is put into also automating EW corrections within the MadGraph5_aMC@NLO framework

✦ What is meant by EW corrections?

○ Consider e.g. di-jet production. We have the following contributions in the Taylor expansion in the coupling constants

✦ Work is on-going and will take some more time to complete

EW CORRECTIONS ALSO NEED "HIDDEN" IMPROVEMENTS

phase-space mapping

i

j

$i+j$

Real emission

Subtraction term

✦ An example of one of those needed technical improvements in the code that I am working on is improving phase-space integration in the context of (charged) resonances

✦ Current mapping keeps no invariants fixed between any of the particles and particles i, j or $i+j$

  ○ In particular this means that the invariant mass of the resonance is not kept fixed. In principle not a problem, but reduces significantly the integration efficiency

  ○ For QCD corrections, only relevant for the top quark, e.g. NLO QCD corrections to pp > W$^+$bW$^-$b production which has resonant top quarks

  ○ For EW corrections, it applies to any particle and therefore much more important

✦ Can we improve the mapping to keep more (all?) masses of resonances fixed?

Collider Cross Talk

✦ The collider Cross talk is

   ○ very informal

   ○ blackboard based

   ○ joined theory and experiment

   ○ every week in the common room on Thursday at 11:00

✦ I'm one of the managers of the Collider X-talk, mainly responsible for Standard Model theory

   ○ If you think you have an interesting topic to discuss, please contact me and we can try to schedule it

   ○ Florian Goertz has agreed to take over from Nazila for the more BSM related topics