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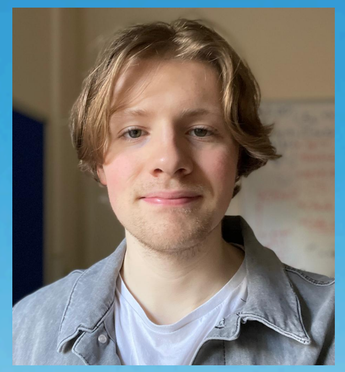
Andrea Banfi

Jonas Lindert

Matthew Lim

Gloria Bertolotti

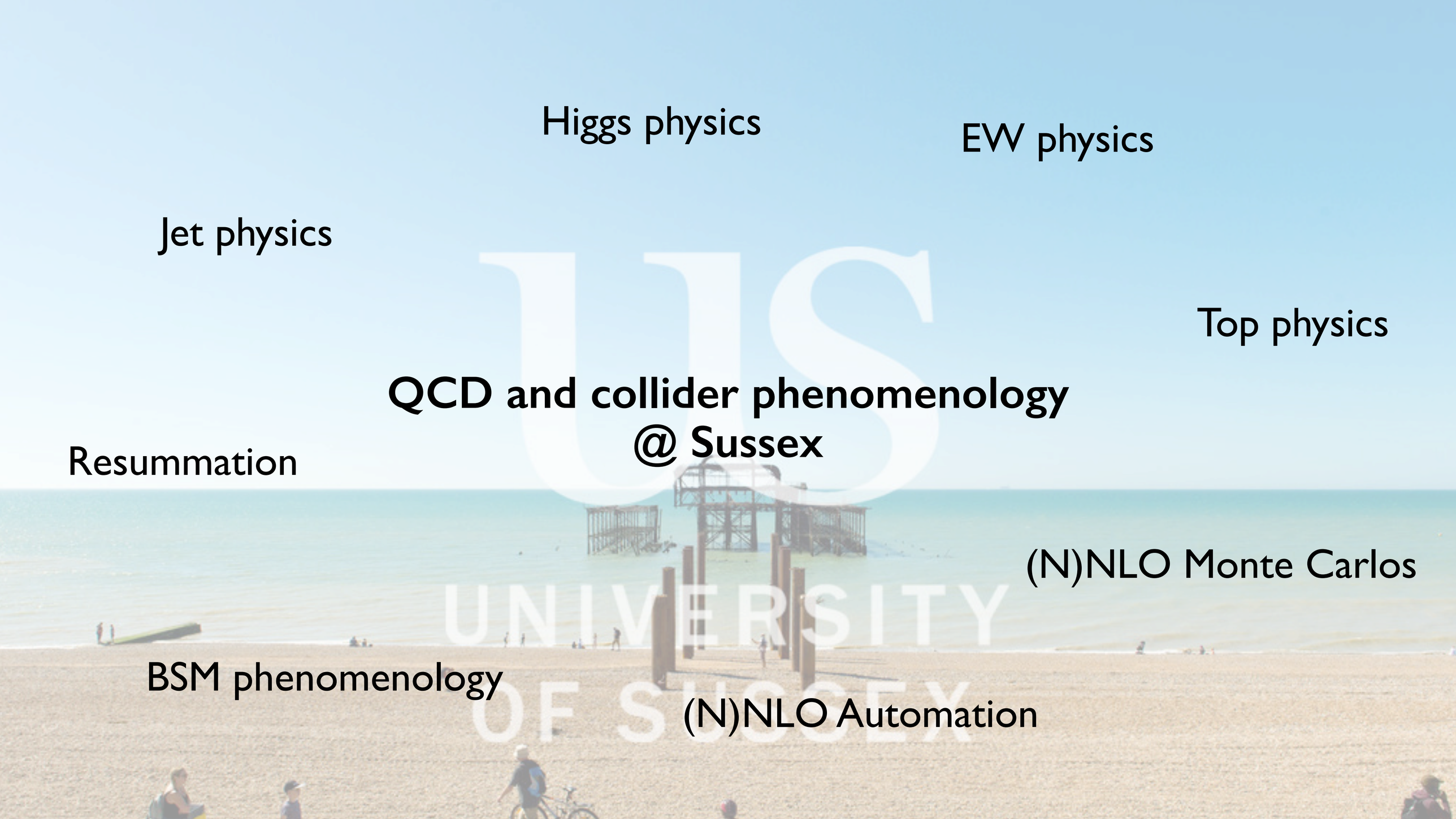
Lorenzo Mai



Daniel Gillies

Patrick Hurley

Darcy Peake


Higgs physics
EW physics
Jet physics
Top physics
QCD and collider phenomenology
@ Sussex
Resummation
(N)NLO Monte Carlos
BSM phenomenology
(N)NLO Automation

Andrea Banfi

Jet observables at all orders in QCD

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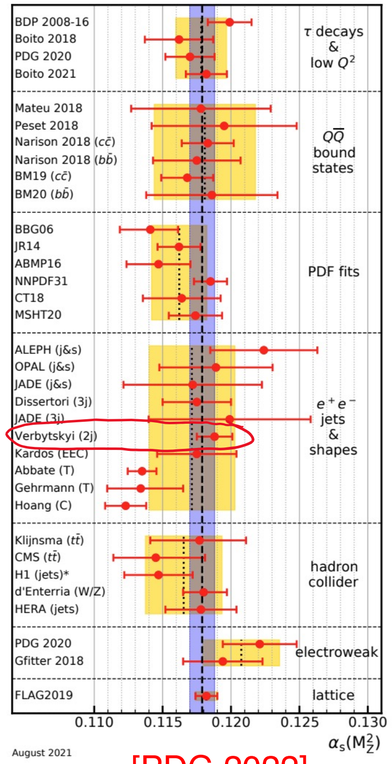
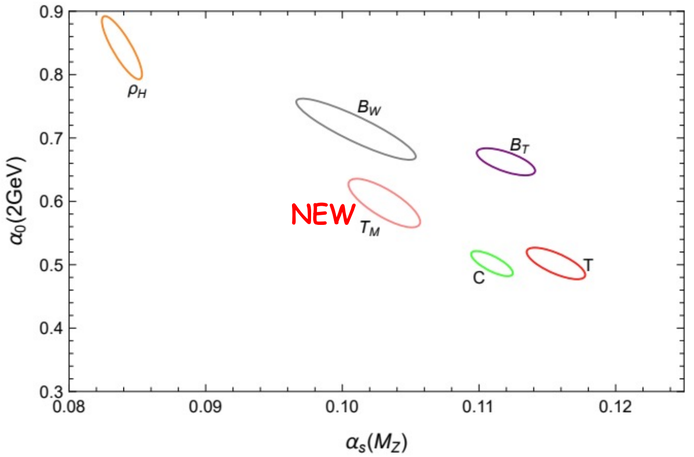
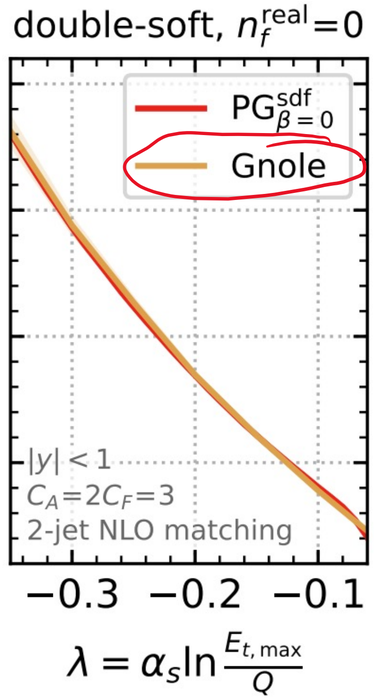
- Jet observables, such as event-shape distributions and jet rates, are powerful probes of strong interaction dynamics (e.g. measurement of the strong coupling)
- Develop novel theoretical frameworks for jet physics to
  - obtain predictions for jet observables at an unprecedented accuracy
  - build the theoretical foundations for the next generation of Monte-Carlo event generators



[PDG 2022]



[AB El-Menoufi **Wood*** 2303.01534]



[Panscales coll 2307.11142]

Andrea Banfi

Jet observables at all orders in QCD

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- Jet observables, such as event-shape distributions and jet rates, are powerful probes of strong interaction dynamics (e.g. measurement of the strong coupling)
- Develop novel theoretical frameworks for jet physics to
  - obtain predictions for jet observables at an unprecedented accuracy
  - build the theoretical foundations for the next generation of Monte-Carlo event generators
- Highlights and future developments
  - ARES framework for the general NNLL resummation of jet observables
    [**Arpino** AB El-Menoufi Monni **McAslan*** Zanderighi]
  - First-ever NNLL resummation of the two-jet rate, and measurement of α_s
    [AB Monni **McAslan*** Zanderighi, et many al for the measurement]
  - Leading hadronisation corrections to event shapes in ARES
    [AB El-Menoufi **Wood*** 2303.01534]
  - NLL resummation of non-global observables, 20 years after their discovery
    [AB Monni Dreyer]
  - Extension to hadron collisions, avenues for full automation (CAESAR@NNLL)
    [AB Lim **Peake*** in progress]
  - Applications to Monte-Carlo event generators, e.g. POWHEG, GENEVA (feat Matthew Lim)
    [POWHEG: AB Ferrario Ravasio Jäger Karlberg **Reichenbach*** Zanderighi 2309.02127]

***Phd student**

Andrea Banfi

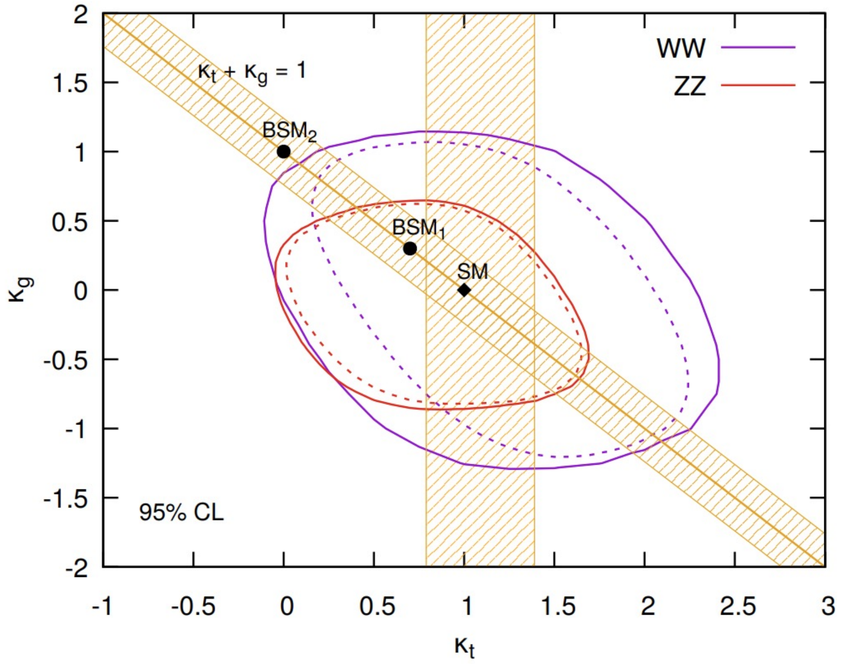
Jet physics for new physics

- Use jets to extract information on new physics beyond the Standard Model through
  - predictions of new physics effects on WW production with realistic experimental cuts (e.g. jet-veto in public code MCFM-RE)

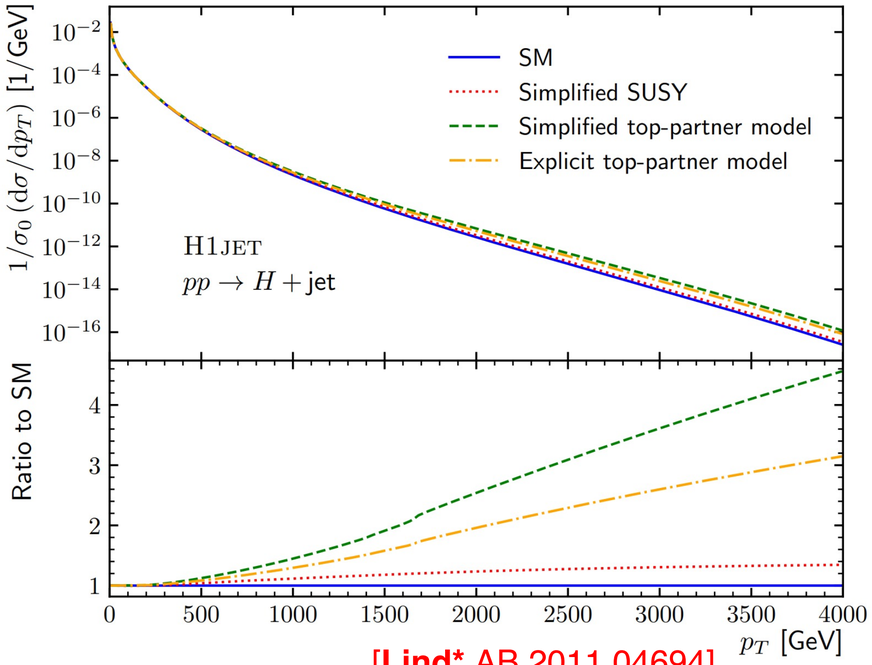
    [dim-6 operator: **Arpino*** AB Jäger Kauer 1905.06646]

    [dim-8 operators: AB **Gillies*** Lim Martin in progress]
  - indirect detection through deviations of tails of distribution from SM (public code H1jet)

    [AB **Bond*** Dillon **Kvedaraite*** **Lind*** Martin Sanz]



[**Arpino*** AB Jäger Kauer 1905.06646]



[**Lind*** AB 2011.04694]

***Phd student**

Jonas Lindert

Research Topics:

- Precision EW / Top / Higgs
- BSM backgrounds
- OpenLoops / (N)NLO Automation
- NLOPS for complex processes

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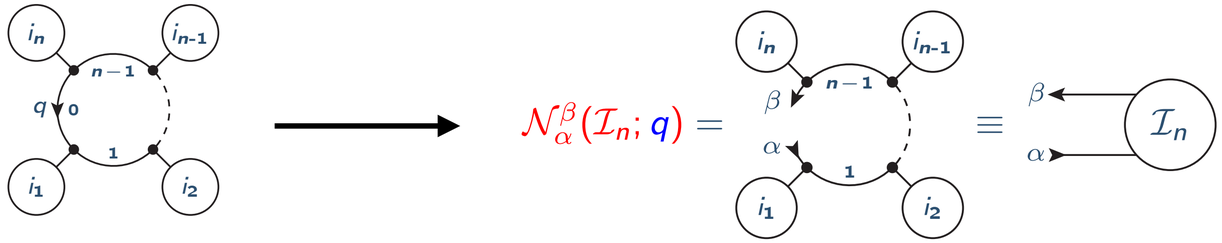
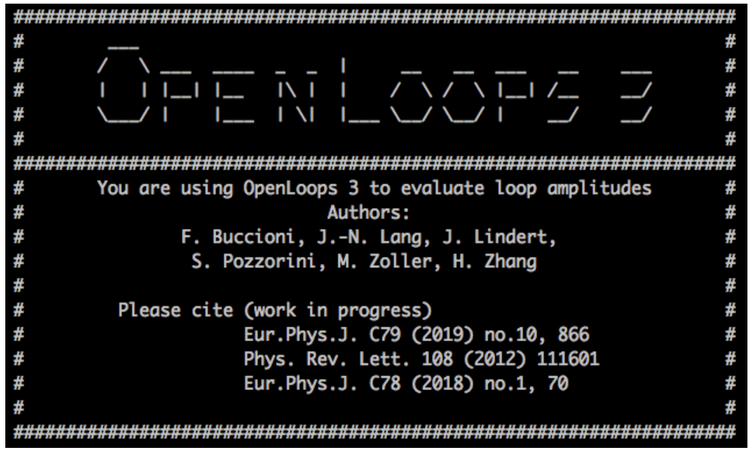
OpenLoops:

- Automated tree/one-loop amplitudes for any SM processes at NLO QCD + NLO EW
- one of the workhorses of LHC MC mass production (used in ~50% of all ATLAS publications)





New in upcoming OpenLoops3:

- In-house tensor-integral reduction library
- optimal combination of various reduction strategies (dAP, OPP, PV)
- sophisticated stability improvements
- hybrid precision rescue system
- speed: up to 10x faster wrt COLLIER

Current/future developments:

- BSM extensions
- Parallelisation (GPUs)
- Novel methods for (multi-)loop integrals, e.g. LTD

Jonas Lindert

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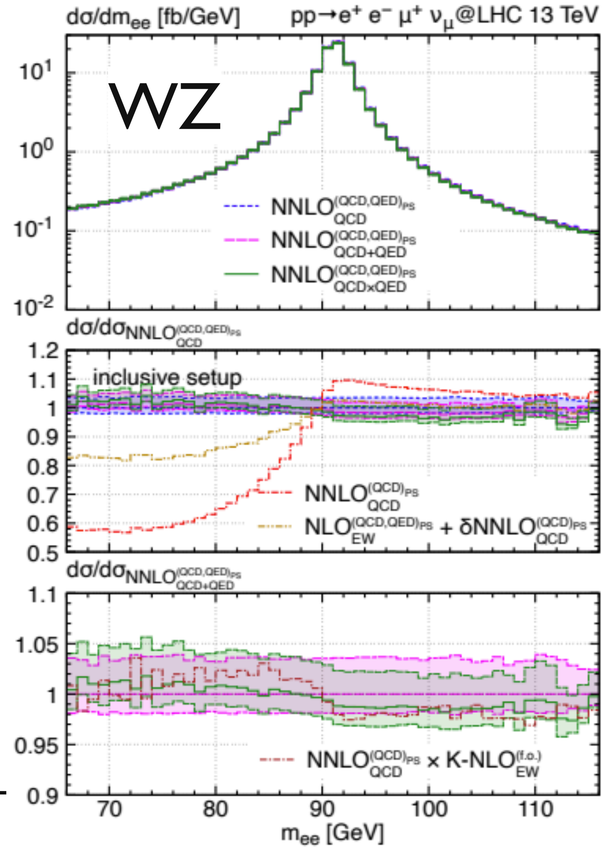
Precision EW

$$\mathrm{d}\sigma = \mathrm{d}\sigma_{\mathrm{LO}} + \alpha_S\,\mathrm{d}\sigma_{\mathrm{NLO}} + \alpha_{\mathrm{EW}}\,\mathrm{d}\sigma_{\mathrm{NLO\,EW}}$$
$$+\alpha_S^2\,\mathrm{d}\sigma_{\mathrm{NNLO}} + \alpha_{\mathrm{EW}}^2\,\mathrm{d}\sigma_{\mathrm{NNLO\,EW}}$$
$$+\,\alpha_S\alpha_{\mathrm{EW}}\,\mathrm{d}\sigma_{\mathrm{NNLO\,QCDxl}}$$
$$+\alpha_S^3\,\mathrm{d}\sigma_{\mathrm{N3LO}}$$

+

NNLO QCD + NLO EW PS

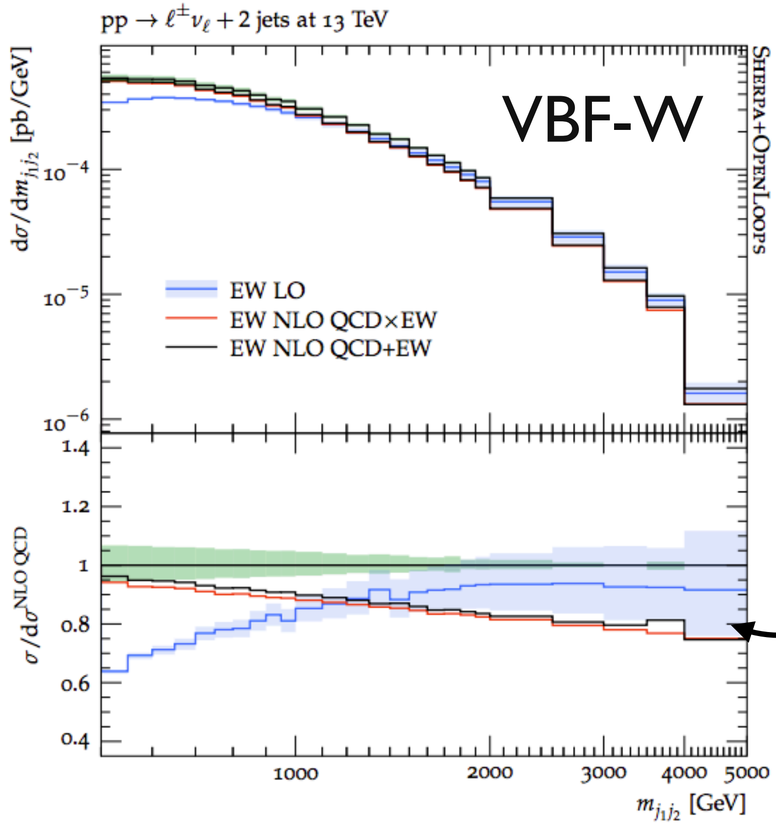
[JML, Lombardi, Wiesemann, Zanderighi, Zanoli, '22]

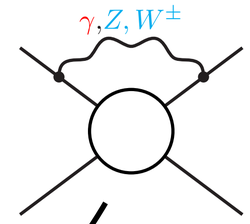


Silvia ←

NLO QCD + NLO EW

[JML, Pozzorini, Schönherr,, '22]





EW Sudakov logs → Lorenzo

Jonas Lindert

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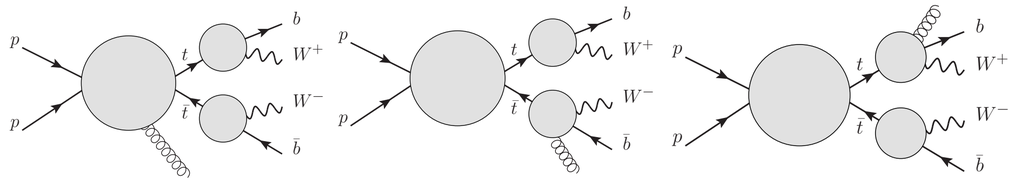
- BSM backgrounds



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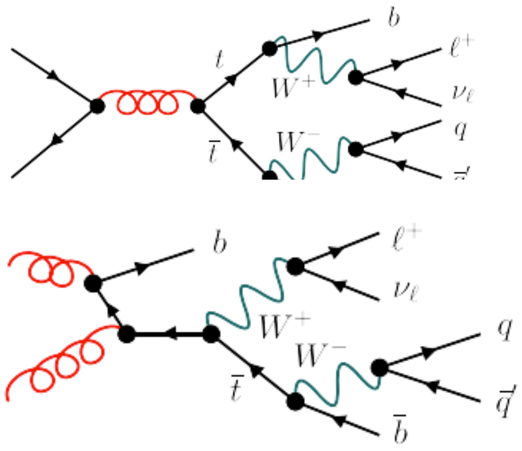
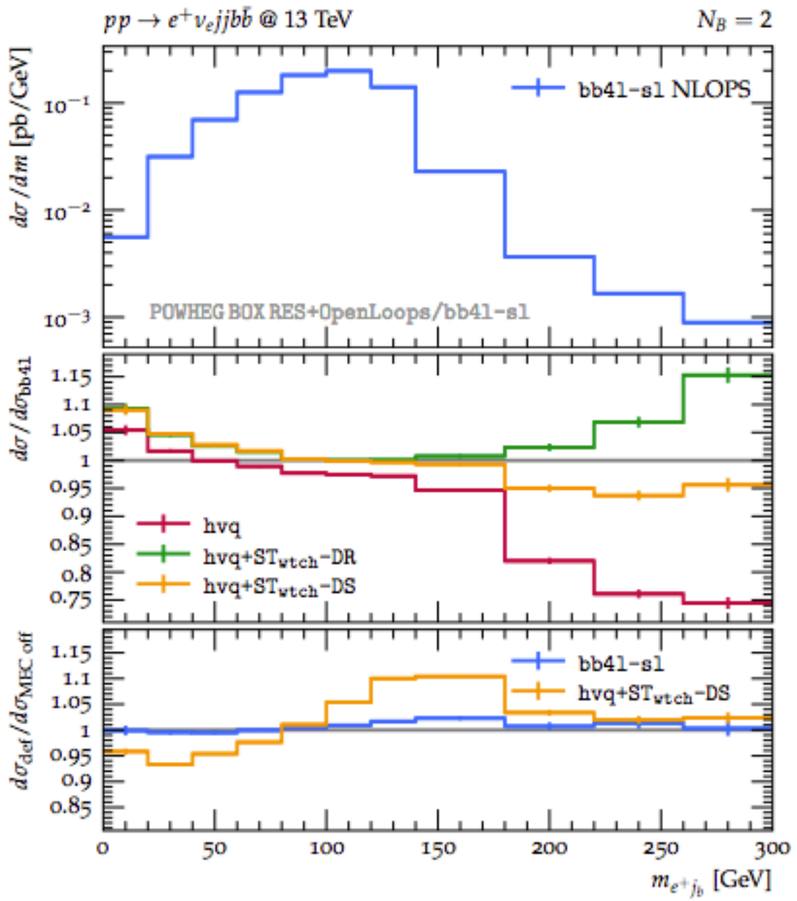
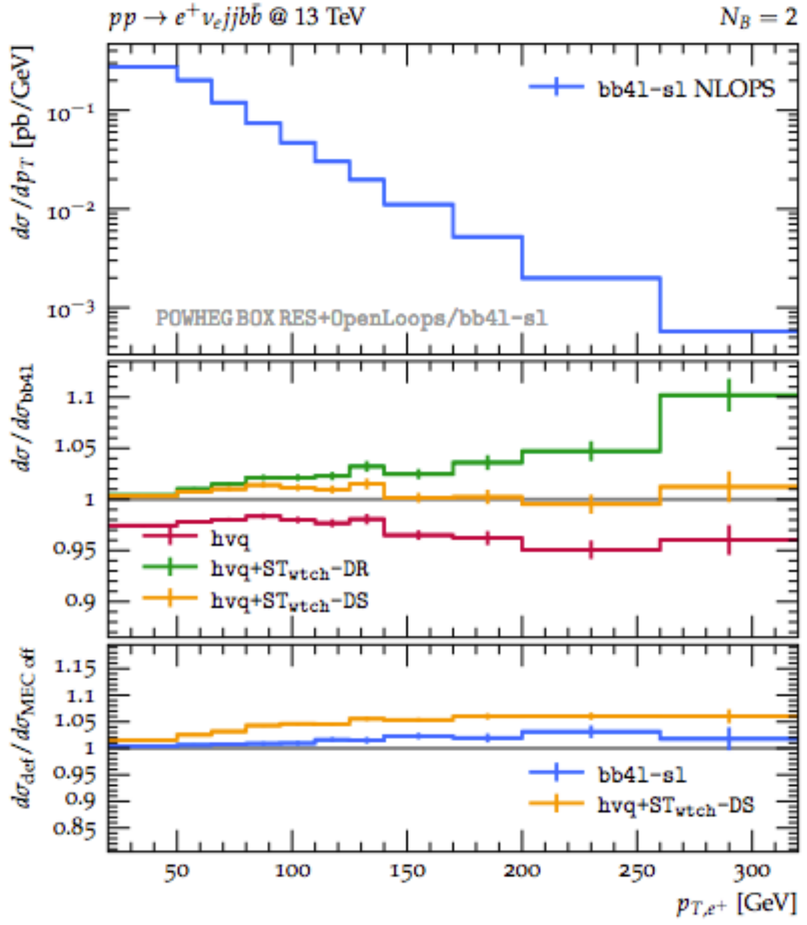
resonance-aware NLOPS



[Jezo, JML, Pozzorini, 23]





Matthew Lim

MATTHEW LIM – BIOGRAPHY

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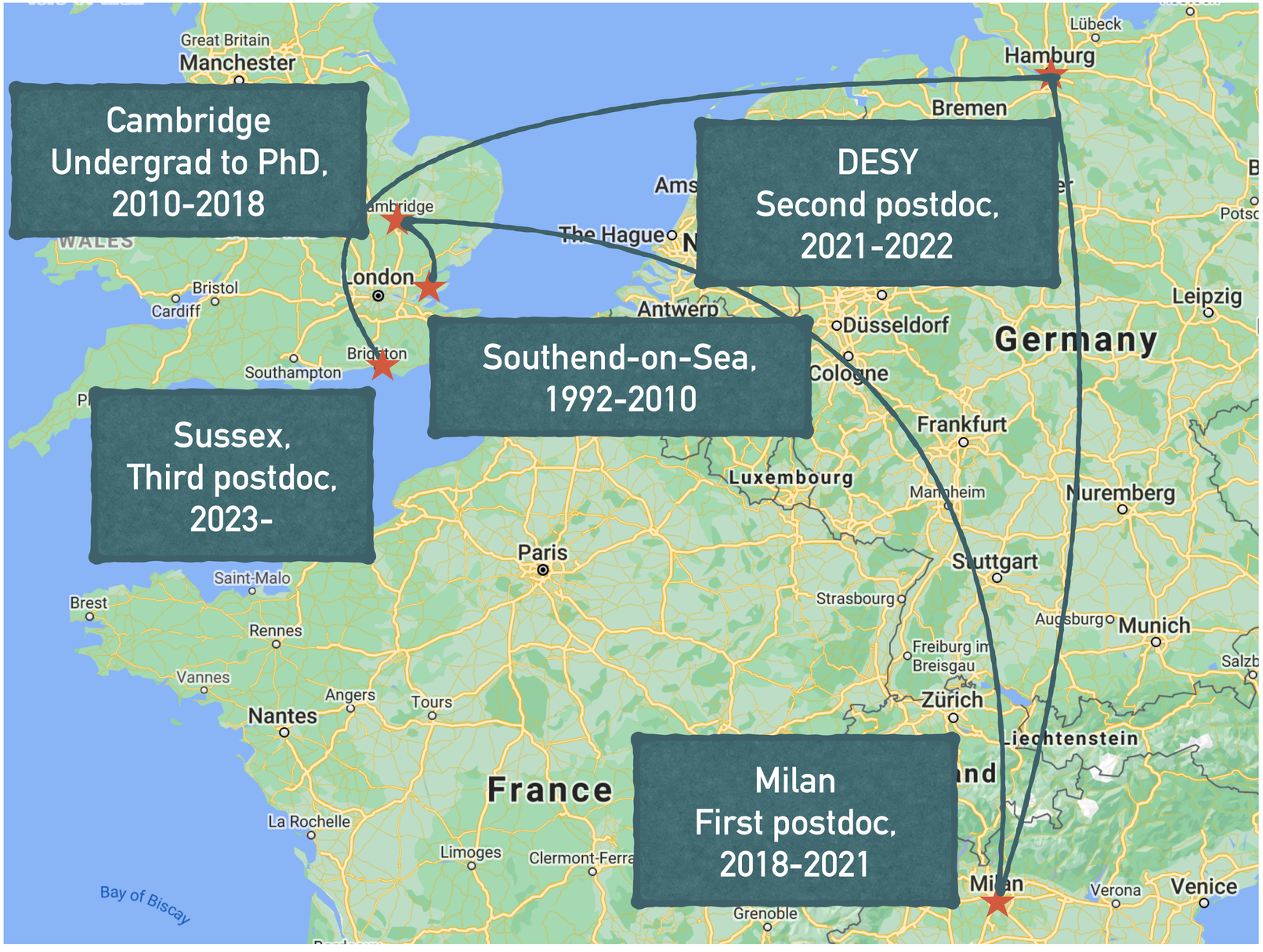

Matthew Lim

MATTHEW LIM – RESEARCH INTERESTS

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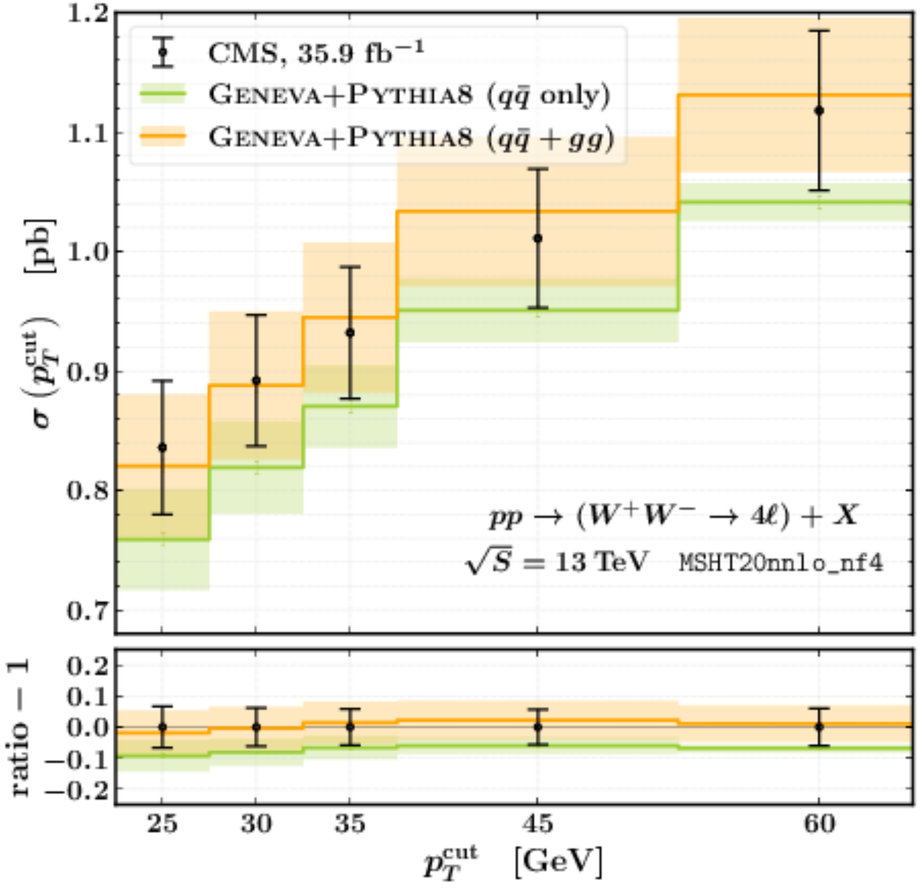

- Monte Carlo event generator development - matching NNLO calculations to parton shower
- Higher order resummation in soft-collinear effective theory/ QCD
- Developer of GENEVA and SCETlib codes
- Recent papers on WW production with jet veto resummation, top-quark mass/PDF extraction

Gloria Bertolotti

Introduction slide: Gloria Bertolotti

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- Research interests: collider phenomenology, higher-order QCD corrections

- **Ph.D. Student** at the University of Turin (2020 - 2023)

  Supervisor: Prof. Sandro Uccirati

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- **Postdoctoral Researcher** at the University of Sussex (2023 - present)

  Advisor: Jonas Lindert

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Gloria Bertolotti

On-going projects...

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Local Analytic Sector Subtraction [2209.09123, 2212.11190]

- ***Strategy***: Sectors *à la* FKS + Catani-Seymour mappings

$$\frac{d\sigma}{dX} = \frac{d\sigma_{\rm LO}}{dX} + \frac{d\sigma_{\rm NLO}}{dX} + \frac{d\sigma_{\rm NNLO}}{dX} + \dots$$

σ = partonic cross section
X = generic IRC-safe observable

Gloria Bertolotti

On-going projects...

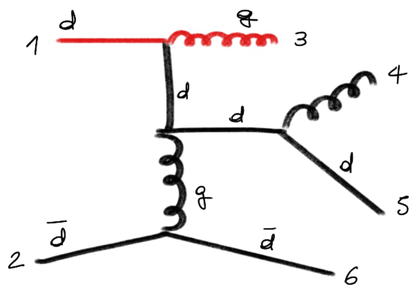
Local Analytic Sector Subtraction [2209.09123, 2212.11190]

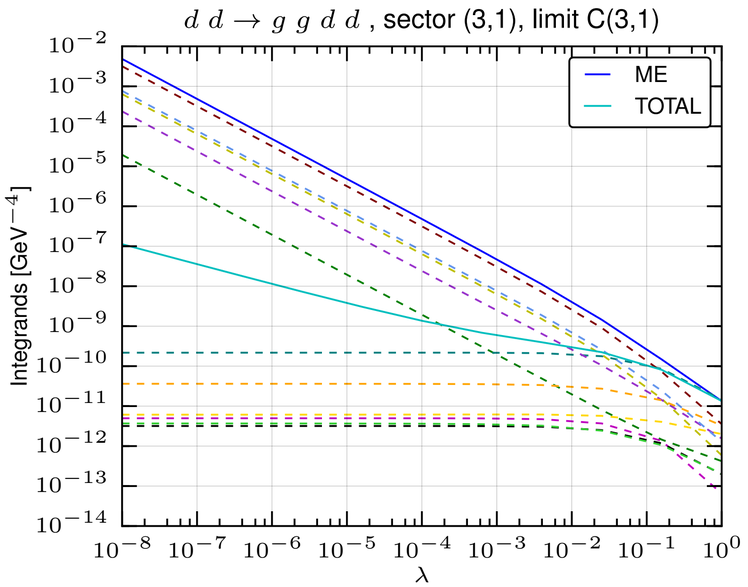
- ***Strategy***: Sectors *à la* FKS + Catani-Seymour mappings
- Subtraction at **NLO**
  - ☑ Extension to initial-state radiation in massless QCD
  - ☑ Complete numerical validation in MadNkLO [Hirschi, et al.]

$$\frac{d\sigma}{dX} = \frac{d\sigma_{\rm LO}}{dX} + \frac{d\sigma_{\rm NLO}}{dX} + \frac{d\sigma_{\rm NNLO}}{dX} + \dots$$

σ = *partonic cross section*
X = *generic IRC-safe observable*

Collinear limit : $\lambda \sim \theta_{ij}^2$





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On-going projects...

Local Analytic Sector Subtraction [2209.09123, 2212.11190]

- ***Strategy***: Sectors *à la* FKS + Catani-Seymour mappings
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- Subtraction at **NNLO**

$$\frac{d\sigma}{dX} = \frac{d\sigma_{\rm LO}}{dX} + \frac{d\sigma_{\rm NLO}}{dX} + \frac{d\sigma_{\rm NNLO}}{dX} + \dots$$

σ = *partonic cross section*
X = *generic IRC-safe observable*

$$\begin{aligned}\frac{d\sigma_{NNLO}}{dX} = &\int d\Phi_n \left(VV + I^{(2)} + I^{(\rm RV)}\right)\delta_{X_n} \\ &+ \int d\Phi_{n+1}\left[\left(RV + I^{(1)}\right)\delta_{X_{n+1}} - \left(K^{(\rm RV)} + I^{(12)}\right)\delta_{X_n}\right] \\ &+ \int d\Phi_{n+2}\left[RR\,\delta_{X_{n+2}} - K^{(1)}\delta_{X_{n+1}} - \left(K^{(2)} - K^{(12)}\right)\delta_{X_n}\right]\end{aligned}$$

- **General analytic formula** for final-state radiation in massless QCD
- All counterterms analytically integrated by means of **standard techniques**
- **Analytic finite remainder** retaining mostly ***simple logarithmic dependence*** on kinematic invariants
- Ready to be implemented in a numerical framework equipped with the relevant matrix elements

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On-going projects...

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- Subtraction at **NLO**
- Subtraction at **NNLO**

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... and future avenues

- Implementation of the NNLO formula in a numerical framework
- Extension to initial-state coloured particles for LHC applications (expected integrals of complexity similar to massless FSR)
- Exploration of local singularity cancellation in LTD formalism

Lorenzo Mai

Lorenzo Mai

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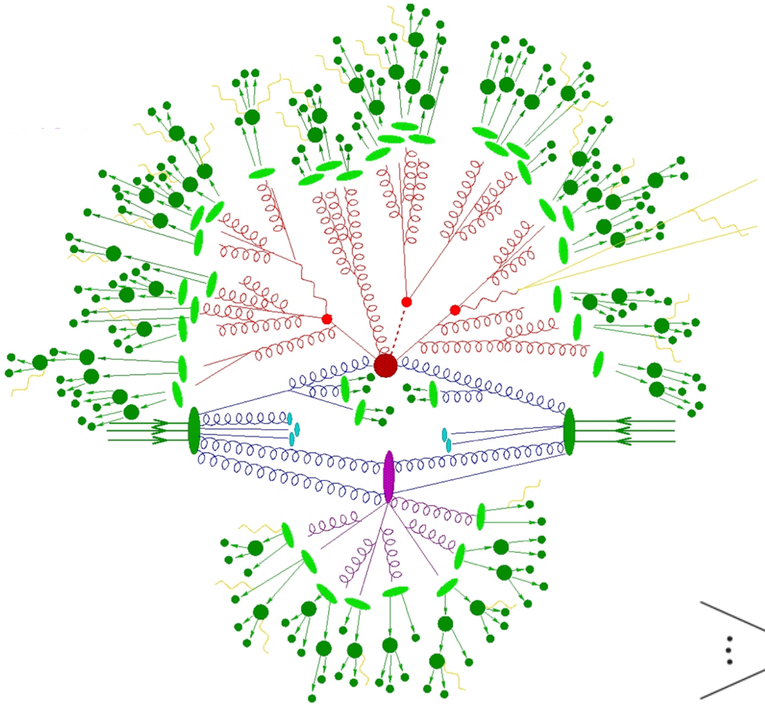
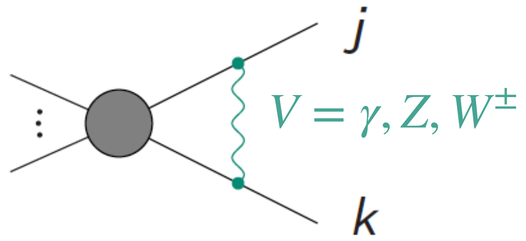
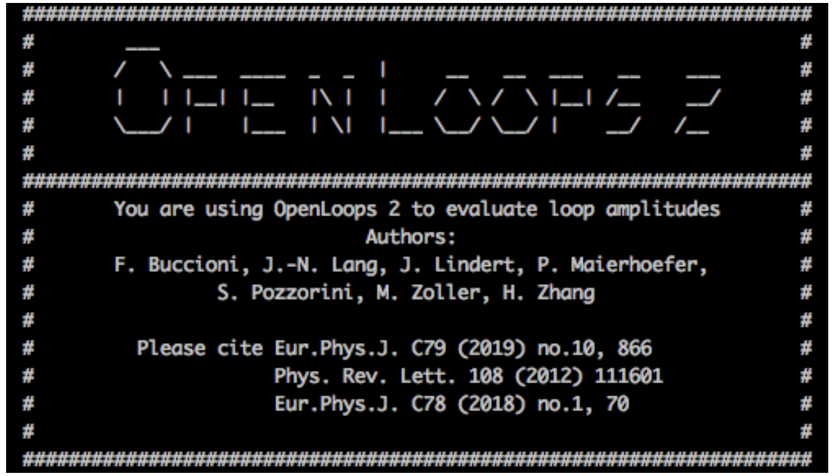




- Affiliation: University of Sussex
- Position: Ph.D. student (2020-present)
- Advisor: Jonas Lindert
- Research interests: collider phenomenology, higher orders EW corrections, MC event generators



Lorenzo Mai

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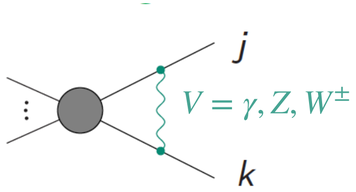
Research interests



- Implementation of one-loop EW Sudakov logarithms in OpenLoops (to appear soon):
  - ▶ Model independent (applicable to SM and BSM scenarios)
  - ▶ Direct employment in PS Event Generators with interface to OL
  - ▶ Can be used together with differential QED radiation at NLO (both MR and DR)
  - ▶ Support EW corrections for resonant processes (novelty)
- Future extensions to include:
  - ▶ Mixed QCD-EW corrections (dressing NLL EW Sudakov logs with QCD loops)
  - ▶ Two-loop EW Sudakov logs
- Exploration of numerical methods for the evaluation of loop integrals in the Loop-Tree duality representation