

Tightening the Gap Between Scattering Amplitudes and Events at the LHC at Higher Orders

18 August – 15 September 2024

Welcome & Introductions – Week 2

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ASPEN CENTER
FOR PHYSICS

Wifi Network: ACP-physicists – Password: discovery

Scattering Amplitudes ➤ Events at the LHC

4 communities, each with own specialisations, techniques, & problems

**Scattering Amplitudes
& Fixed Orders**

**Phase-Space
Integrations**
Speed, Efficiency
Numerical Stability

**MC Event Generators
& Parton Showers**

**Resummation
& PDFs**

Accuracy
Codes/Interfaces
Combinations
Uncertainties

**LHC Experiments
(& Pheno Applications)**

...

Join the ACP Amplitudes to Events Slack Forum

Aspen = few formal sessions, few talks. Hopefully lots of discussions (and hiking)

We strive for blackboards over slides (when feasible). And we don't have an indico page.

You should have received an invitation to join the Slack forum

Workspace URL: acpamplitudestoevents.slack.com

Slack = main online forum for everything workshop related

#general: for announcing discussions, general questions, etc

Can also post slides there (e.g., [these slides](#) will be put there!)

Or under topics, such as #PDFs, #uncertainties, ... (+ feel free to create new ones)

Also useful for

#social: for organising hikes, dinners, **#photos** for sharing views, etc

...

Focus Weeks

Based on participants, we envision weekly “focus topics” (*not exclusive!*)

Week 1: FO Developments and how to make them available?

Week 2: (Experimental) Demand for Precision: Status, Problems and Outlook.

How well do current methods to assess uncertainties work in practice?

What sources of theory uncertainties are most problematic, for what observables?

PDFs, Hadronization Models, Shower Accuracy, Matching, MHOU, Parametrics (m_0), Statistical, ...?

For which (classes of) observables will current theoretical uncertainties be **too large**?

(Growth of) resources vs speed: efficiency, complexity, fit-for-purpose codes, interfaces, ...

Interplay between NⁿLO & MC/shower development, to highlight problematic areas

Week 3: Fixed Order as a proxy to realistic - LHC like observables

Week 4: The path to Higher Shower Accuracy

Week 1: FO Developments and how to make them available?

NNLO complexity and how much further can we push the limit?

Self-introductions → Discussion on complexity Monday
& Focus Topic of the Week: Wednesday (Fabrizio Caola)

(Slack: #complexity)

What is new on the PDF precision frontier?

Focus session Thursday, mainly on (approximate) N3LO PDFs

Genuine N3LO mainly DIS; Drell-Yan only total σ , not differential ⇒ weight up DIS data

Splitting kernels ~ known (at least moments important at moderate to large x)

Charm differs: derived vs fitted. Not sure we fully understood MSHT / NNPDF difference?

(Slack: #pdfs)

How do we move towards NNLO for experimentalists?

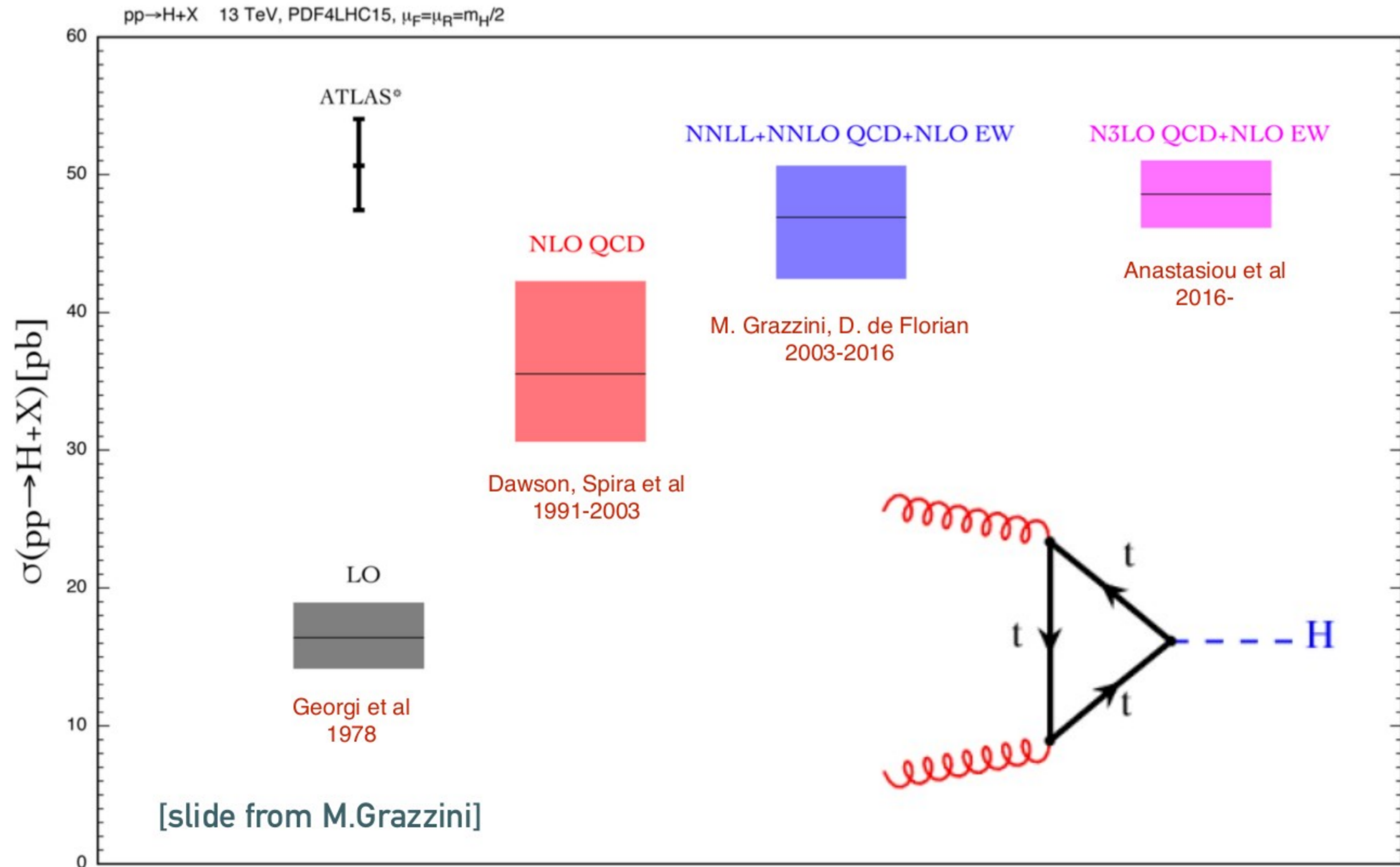
FO ↔ MC, **uncertainties...**

Constructive discussion of perturbative uncertainties Tuesday

Mainly focused on Fixed Order — more to come? (e.g., this week)

Perturbative Uncertainties

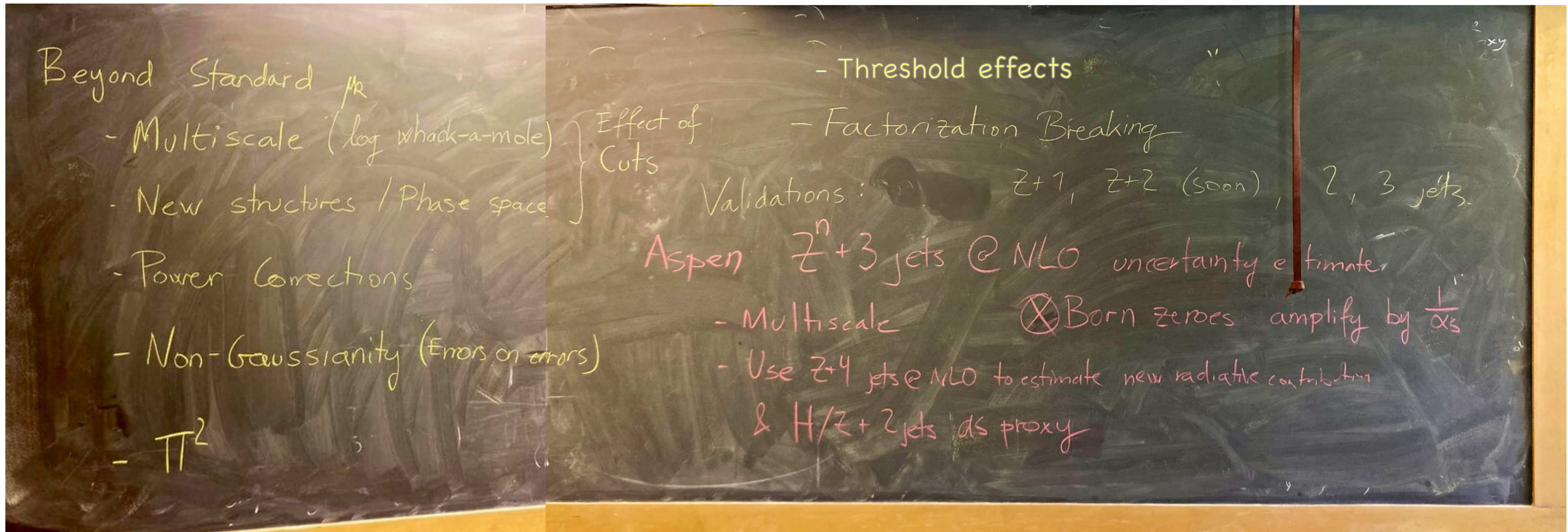
(Slack: #uncertainties)



Perturbative Uncertainties

(Slack: #uncertainties)

Week 1 Discussion: Mainly Fixed Order



Expect continued discussions along chain:

FO \rightarrow Matching & Merging \rightarrow Showers \rightarrow MPI & Hadronization \rightarrow Tuning
(+ preparing an Overleaf Summary — though not clear yet what will come of it ...)

Proposed Topics from Questionnaire

- Reliable estimation of theory uncertainties
- Resummation of super-leading logarithms
- Efficiency of NNLO calculations
- Non-perturbative and power corrections
- Parton shower matching at NNLO
- Accuracy of Parton distribution functions
- Event Generators
- Automation of two-loop amplitudes
-

Week 2 – Scheduled Activities

Monday	Tuesday	Wednesday	Thursday	Friday
<p>10-12am (Flug) Welcome & Self-Introductions</p>	<p>10am (Bethe) Informal Discussion on Amplitudes and Showers</p>	<p>10-12am (Flug) Focus Topic <i>Experimental viewpoint on theory uncertainties</i> — Sinead Farrington</p>	<p>10-12am (Bethe) Discussions on: 10: Multiscale Problems & Cuts 11:15: AI Uncertainties</p>	
<p>1.30pm (Bethe)</p>  <p>3pm (Patio) Lemonade & Cookies Meet & Greet</p>		<p>3:30pm (Patio) Informal Discussion on Complexity and Resources</p>	<p>3pm (Flug) ACP Colloquium (mandatory)</p>	
<p>5.15pm (Snowmass) Happy Hour at Village Gatehouse (BYOB)</p>	<p>5pm Picnic Area Picnic & BBQ (Potluck/BYO)</p>	<p>5.30pm Public Lecture: <i>10,000 Einsteins: AI and the Future of Theoretical Physics</i> — Matt Schwarz</p>		

Tuesday BBQ & Picnic

Tuesday 5-7pm @ ACP Picnic Area

Physicist's BYO Picnic for participants & their families.

You should bring food to grill and beverages.

ACP supplies plates, utensils, grills, condiments, chips, and watermelon.



First time in Aspen?

Beautiful place to hike and explore

But be aware of the **altitude**

Aspen town is at **8,000 feet ~ 2.5km**

(1.5km higher than Les Houches/Chamonix)

Mountains reach 14,000 feet > 4km

Bring and wear **sunscreen** (& appropriate shoes, clothes)

+ First few days until you acclimate:

Stay hydrated: **Drink plenty of water** (& limit alcohol intake)

Take it slow: Limit physical exercise



THE BEARS
ARE
HUNGRY

Acknowledging the Aspen Physics Center

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