

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

18 August – 15 September 2024

Welcome & Introductions – Week 3

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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 meant to be exclusive!

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

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

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

Classic credo is: PS produces LHC-like output - how close can FO calculations come?

Events from Fixed Order? Flavor definitions? Identified hadrons in FO?

Matching at NNLO

The need for resummation

How to integrate it systematically in FO computations not just for single 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 (Mon)

(Slack: #complexity)

& Focus Topic of the Week: Fabrizio Caola (Wed)

What is new on the PDF precision frontier?

(Slack: #pdfs)

Focus session mainly on (approximate) N3LO PDFs (Thu)

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?

How do we move towards NNLO for experimentalists?

FO ↔ MC, **uncertainties...**

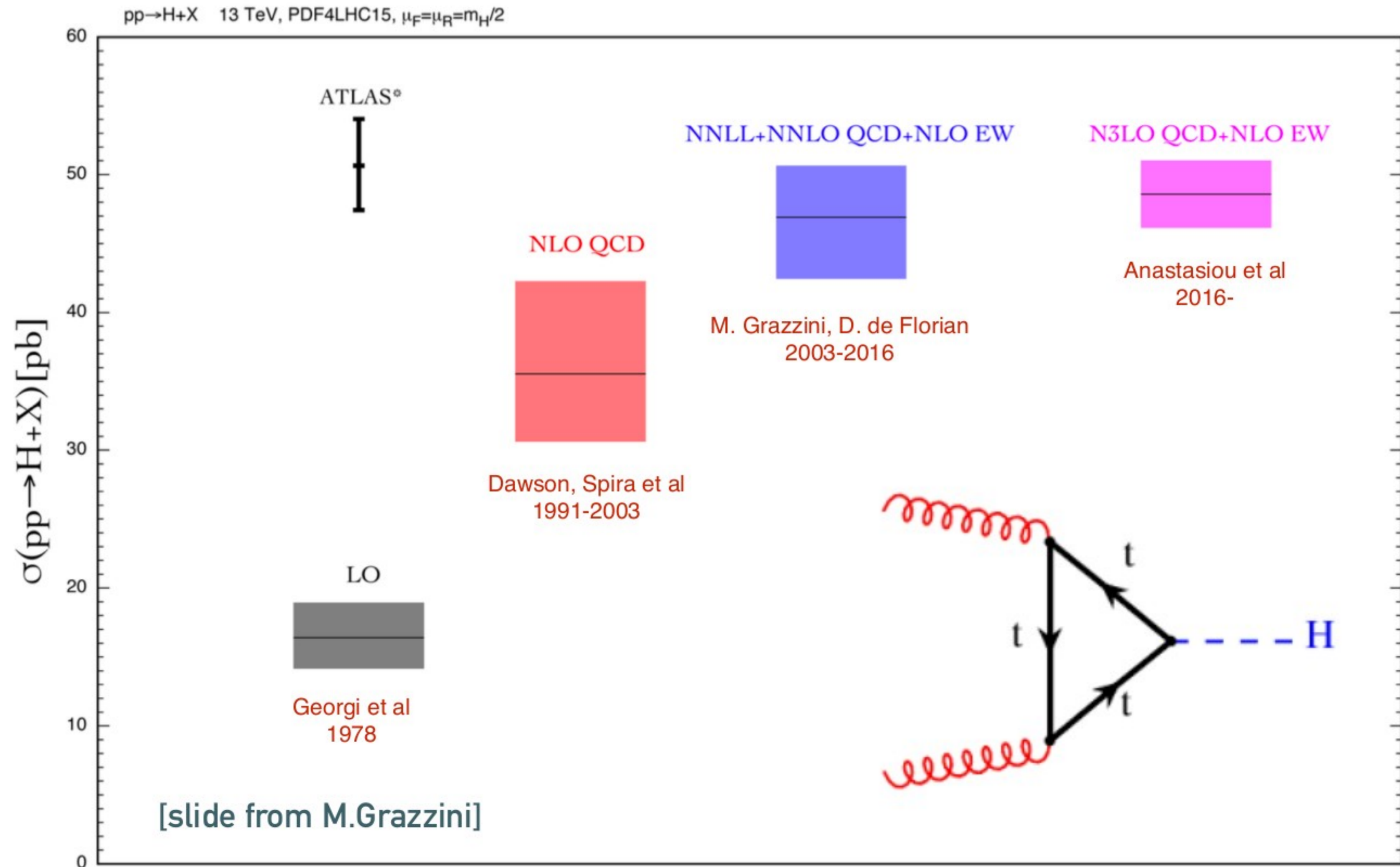
Constructive discussion of perturbative uncertainties (Tue)

(Slack: #uncertainties)

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

Perturbative Uncertainties

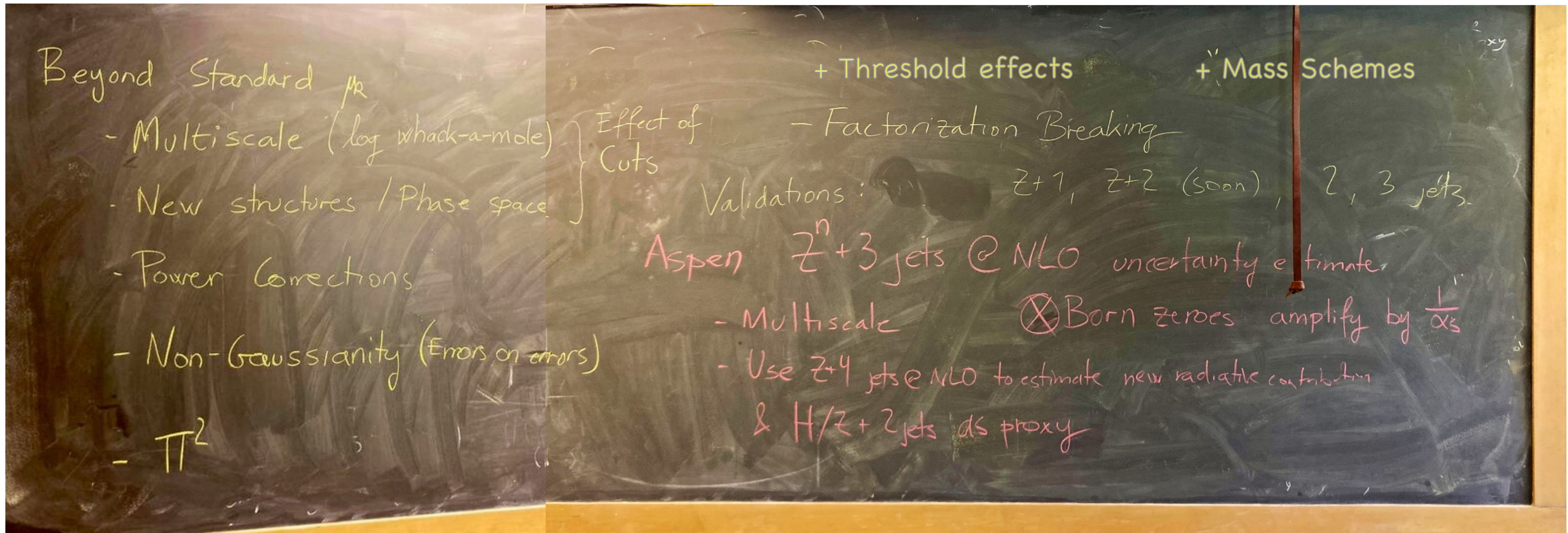
(Slack: #uncertainties)



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 contributions welcome)

Aspen Discussions on Beyond Standard 7-point Variations

Requirements: general (arbitrary processes, arbitrary orders), **comprehensive** — and not (much) more difficult to do from **amplitudes at hand** than scale variations

+ Should be accompanied by explicit prescriptions as **uncertainty weights in MC event generators** (incl with matching/merging)

Use existing theoretical insight on “approximate higher orders”

E.g., we know which logs we expect, which channels we expect, etc.

Overleaf Summary already includes a general and explicit prescription for MHO from universal $\ln^2(-1)$ terms from initial-initial “form factors” (not cast in stone! Peter based it on crude simplification of papers by Neubert et al. Continued discussion welcome!)

Bar is significantly lower since we are not aiming to get a believable **approximation** to the next order but **only estimate the MHO uncertainty!**

Week 2: **Experimental** Demand for Precision: Status, Problems and Outlook

Focus Topic led by Sinead Farrington (Wed). The very first things she wrote on the board:

Predictions

particle level final states

fiducial kinematic regions

quantified uncertainties

Good as starting points for discussions this week?

Continued: experimentalists' take on theory uncertainties

Parton shower - pythia / Herwig / hadronisation

Scale uncertainty $\text{scale} \times 2$
 $\times 0.5$

EW corrections

PDFs -

FSR colour reconnection
underlying event

ggF / VBF

HH: top quark mass scheme

(Slack: #uncertainties)

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 3 — Scheduled Activities

Monday

Tuesday

Wednesday

Thursday

Friday

10-12am (Flug)

Welcome
& Self-Introductions

10-12am (Patio)

Focus Topic: *Fixed Order*
as a proxy to realistic
LHC-like observables —
Rene Poncelet

10-12am (Bethe)

Focus Discussion
NNLOPS and
Applications —
Matthew Lim

|

3pm (Patio)

Lemonade
& Cookies
Meet & Greet

3:30pm (Patio)

Informal Discussion on
connecting FO,
Resummation and PS

3pm (Flug)

ACP Colloquium
(mandatory)

|

5.15pm (Snowmass)

Happy Hour at
Village Gatehouse
(BYOB)

5pm

Picnic Area
Picnic & BBQ
(Potluck/BYO)

|

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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