Scale/PDF choices/variation

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Outline

- Ntuples
- PDF uncertainty
- Scale variation

Ntuples

- For expensive calculations

Burn a lot of CPU power

...For a couple of plots

Ntuples

- Ntuple are a way to give you more for the CPU time you spend for expensive calculations
- While computing a complicated process write
  - Weight
  - Final state momenta
  - Optionally: All the information needed for the reconstruction of the weight for a different scale and different PDF

Ntuples: Advantages I

- Scale variation/ change of pdf cheap
- Pdf uncertainty
- Helps understanding results
- New plots, new analyses much easier
  - Can answer any question after the facts that could have been answered at generation time
  - “Have you checked that … ”
- Easier to reuse later (probably)

Ntuples advantages II

- Easier exchange of information
  - Between theorists
  - With experimenters
- One way of making result “public”
  - No need to have people
    - Compile code
    - Run the code

Ntuples: Disadvantge(s)

- Large files

  1 million events (either event or counter-event)

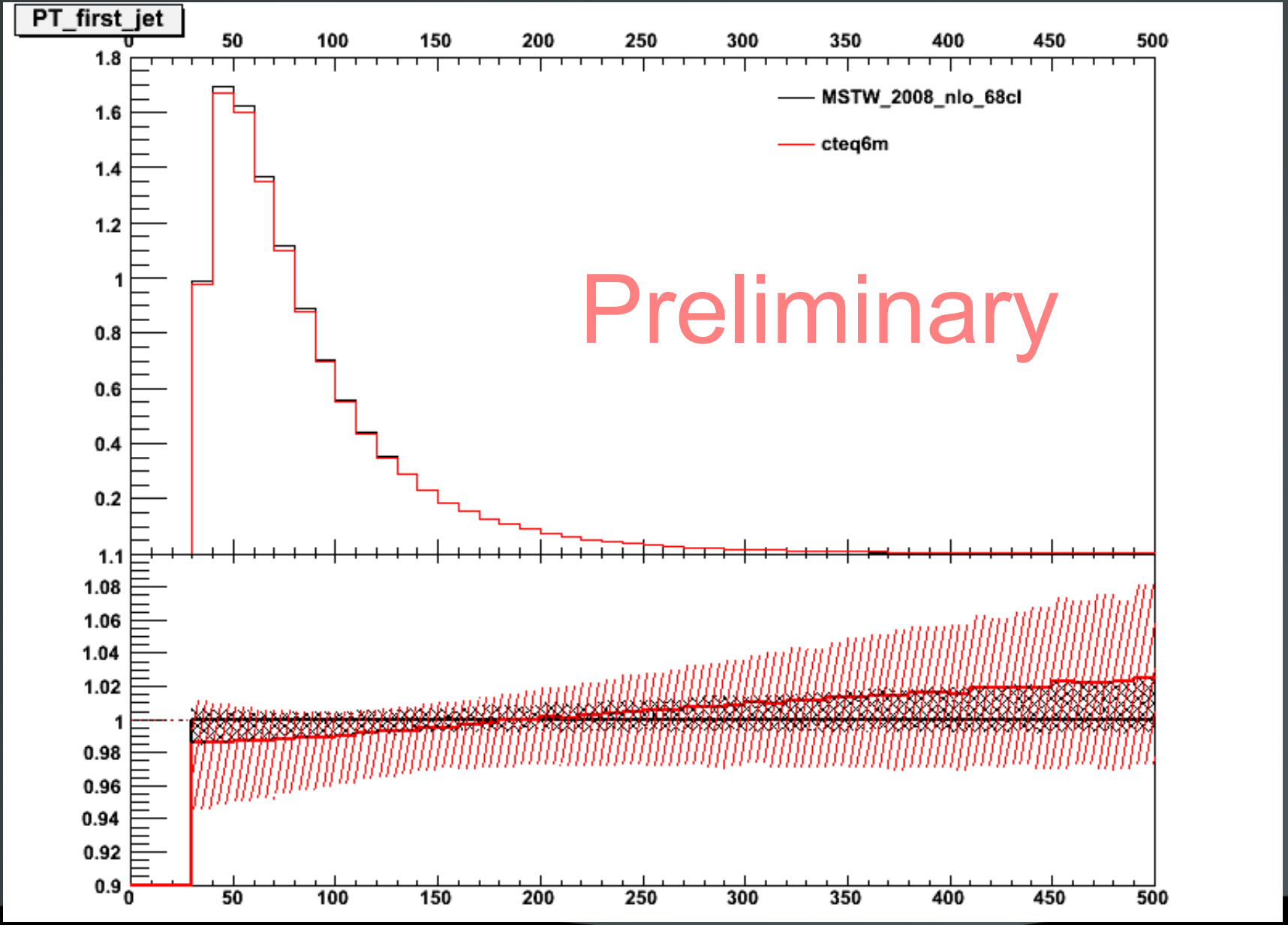
	W+2jets	W+4jets
Born	127MB (1.56)	170MB (1.5)
Virtual	172MB (1.35)	220MB (1.27)
Integrated subtraction	260MB (1.33)	300MB (1.33)
Real	100MB (1.99)	85MB (2.88)

- Slightly longer production time
  - To make most useful loose cuts are better

Ntuples with BlackHat and Sherpa

- BlackHat+Sherpa can produce/use ntuples
  → For the processes for which we have ntuples
  - Different PDFs/ PDF uncertainty
  - Scale variation

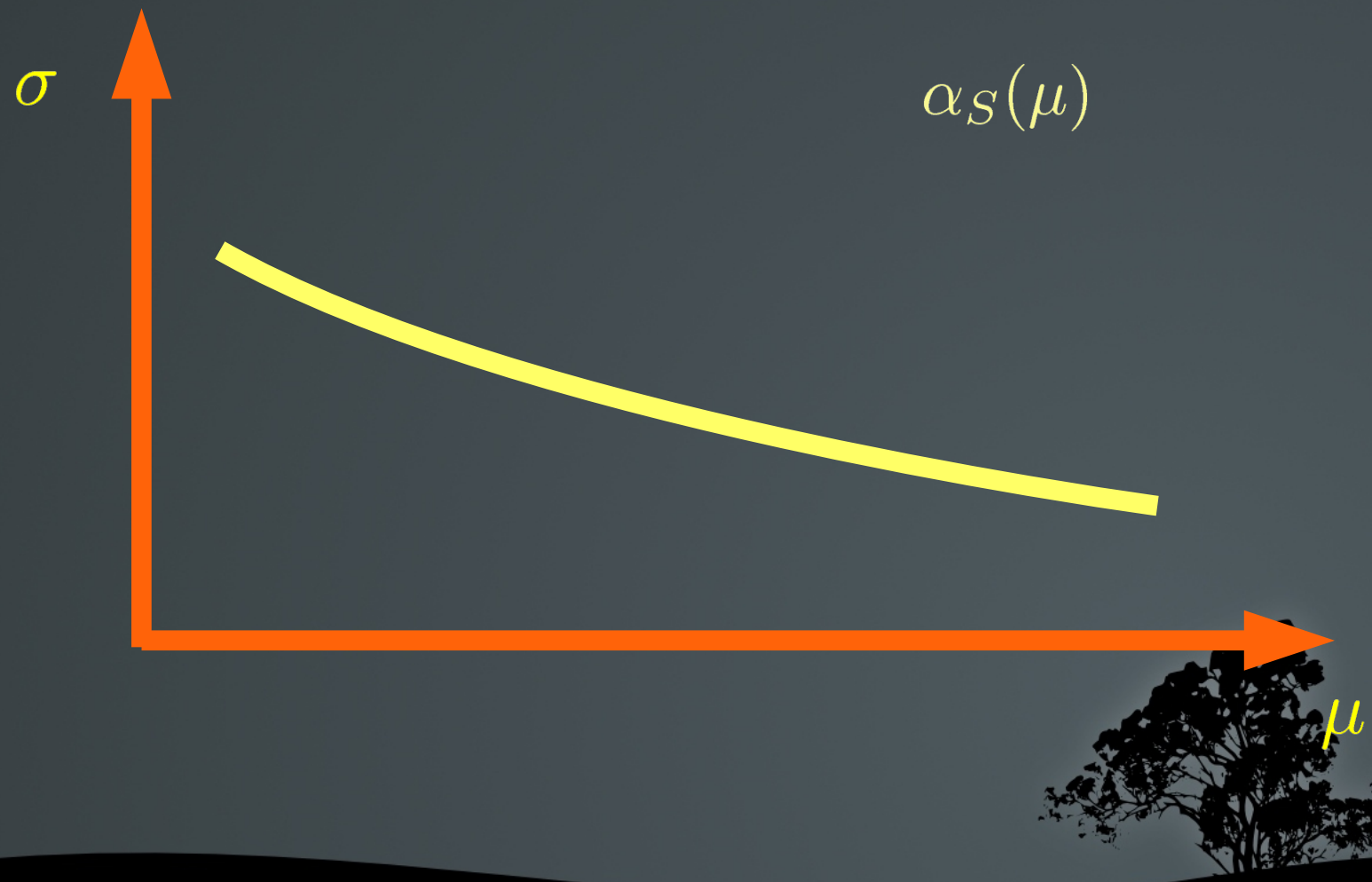
PDF uncertainties



Scale variation

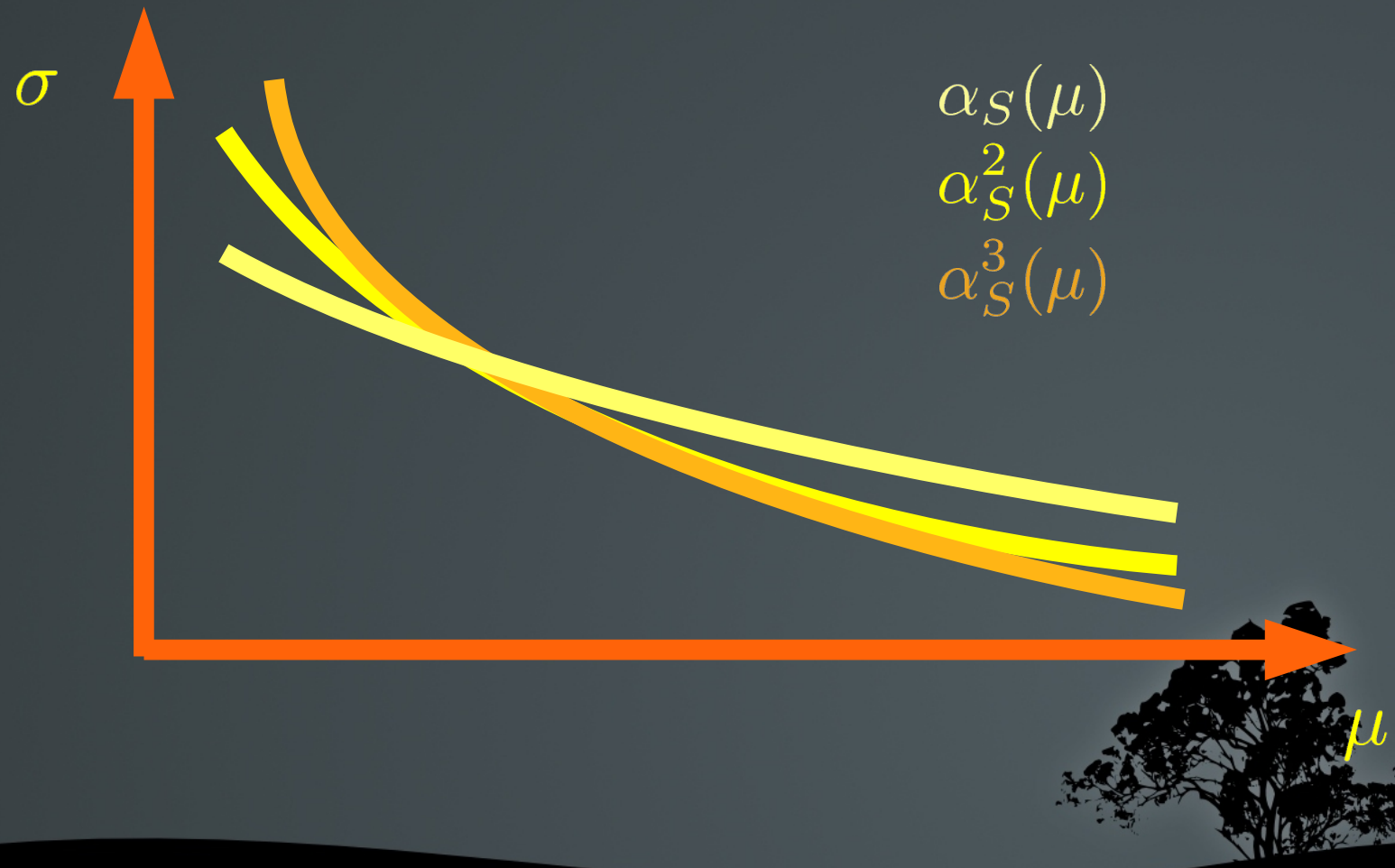
Typical shape

- Leading order



Typical Shapes

- Leading order



Typical Shapes

- With NLO

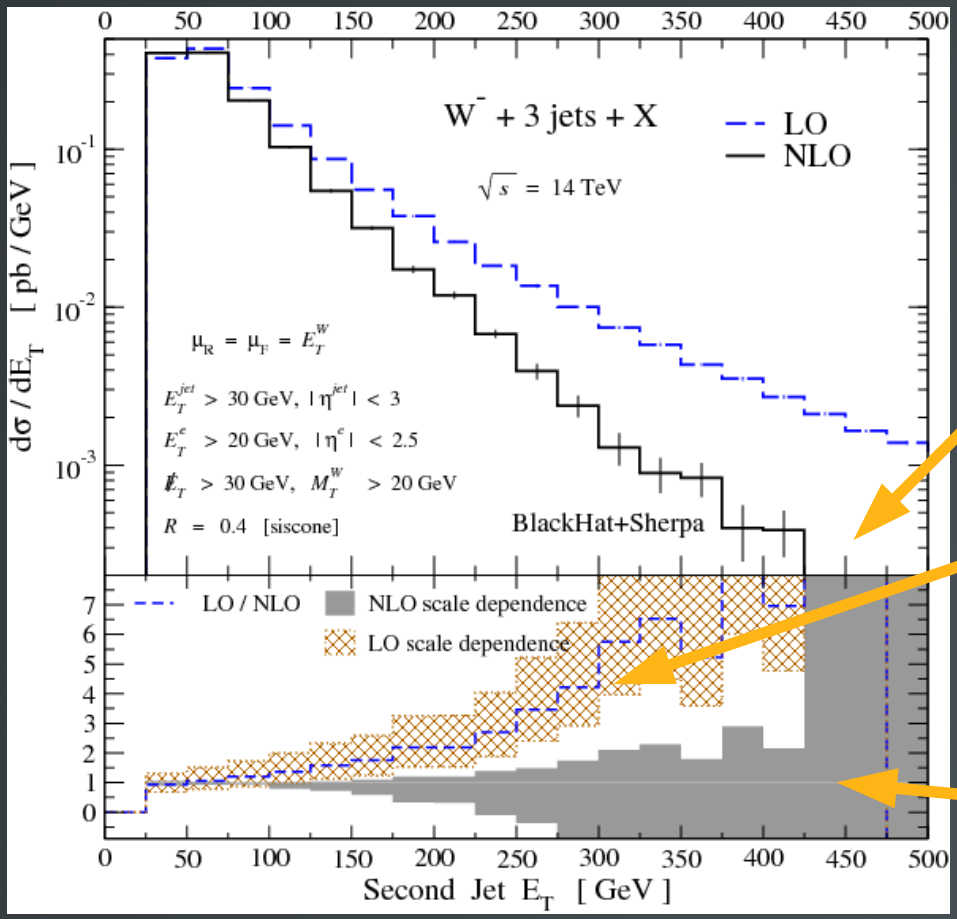
Why do we care about scale dependence?

- Scale dependence is unphysical, so the smaller the dependence, the better
- The scale dependence is compensated by higher orders.

Scale Dependence

Scale Choice

Poorly chosen scale has consequences



Differential cross section becomes negative

Large K factor and large dependence of the K factor

Large growth of the scale dependence of the NLO

$$E_T^W = \sqrt{m_W^2 + p_T^2(W)}$$

Scale dependence

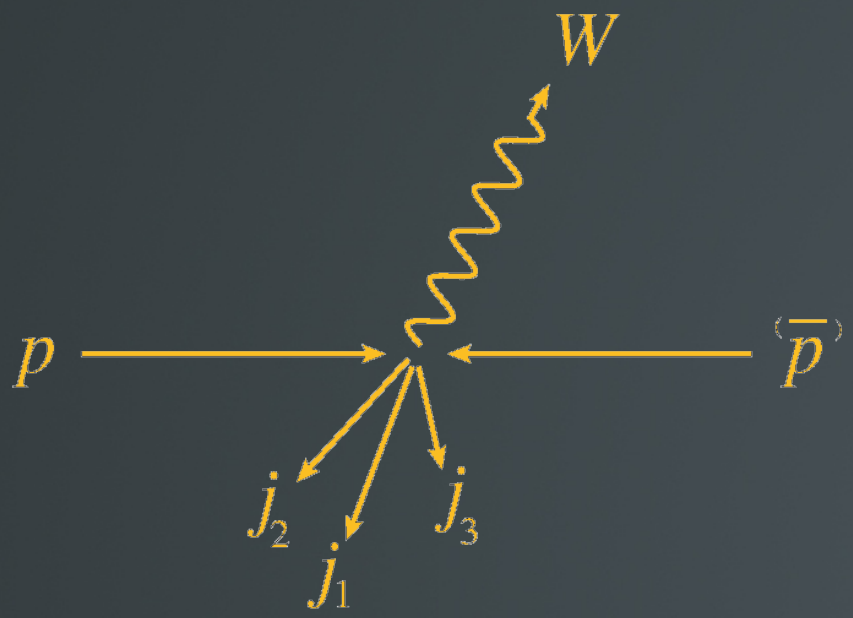
- How to choose a scale?
- Scale dependence shows up in the form of logarithms

$$\log\left(\frac{\mu^2}{s_{ij}}\right)$$

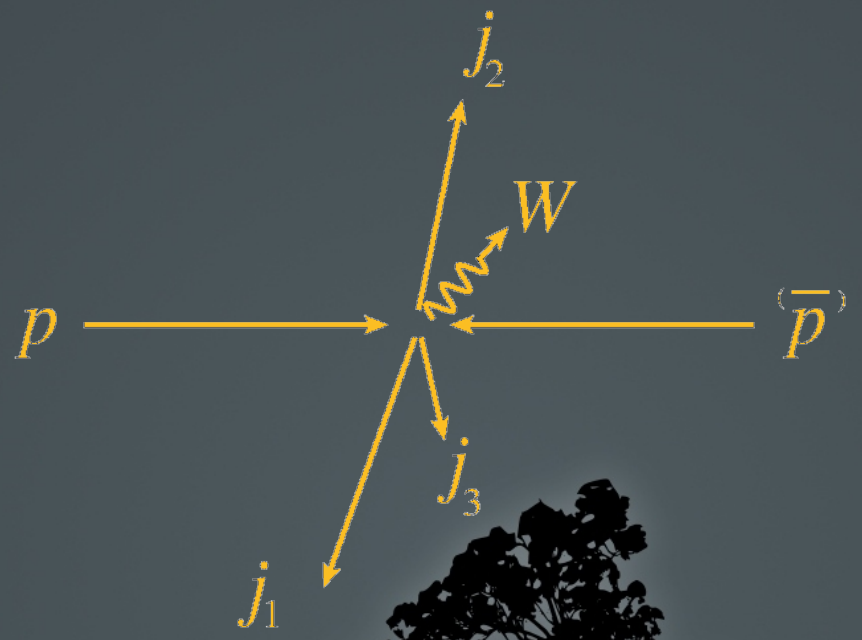
- If we can choose μ close to the invariants s_{ij} we can minimize their effect

Scale choice

$$E_T^W = \sqrt{m_W^2 + p_T^2(W)} \qquad H_T = \sum_{j=1,2,3} E_{T,j}^{\text{jet}} + E_T^e + \not{E}_T$$

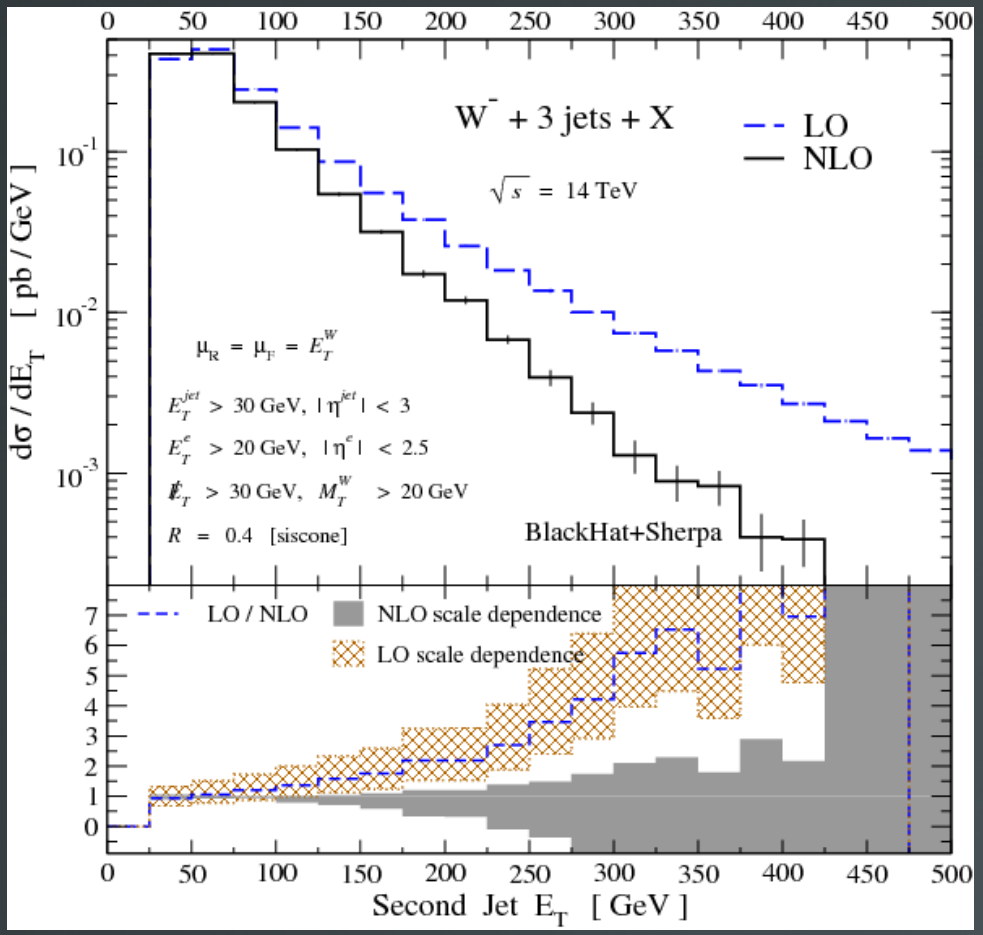


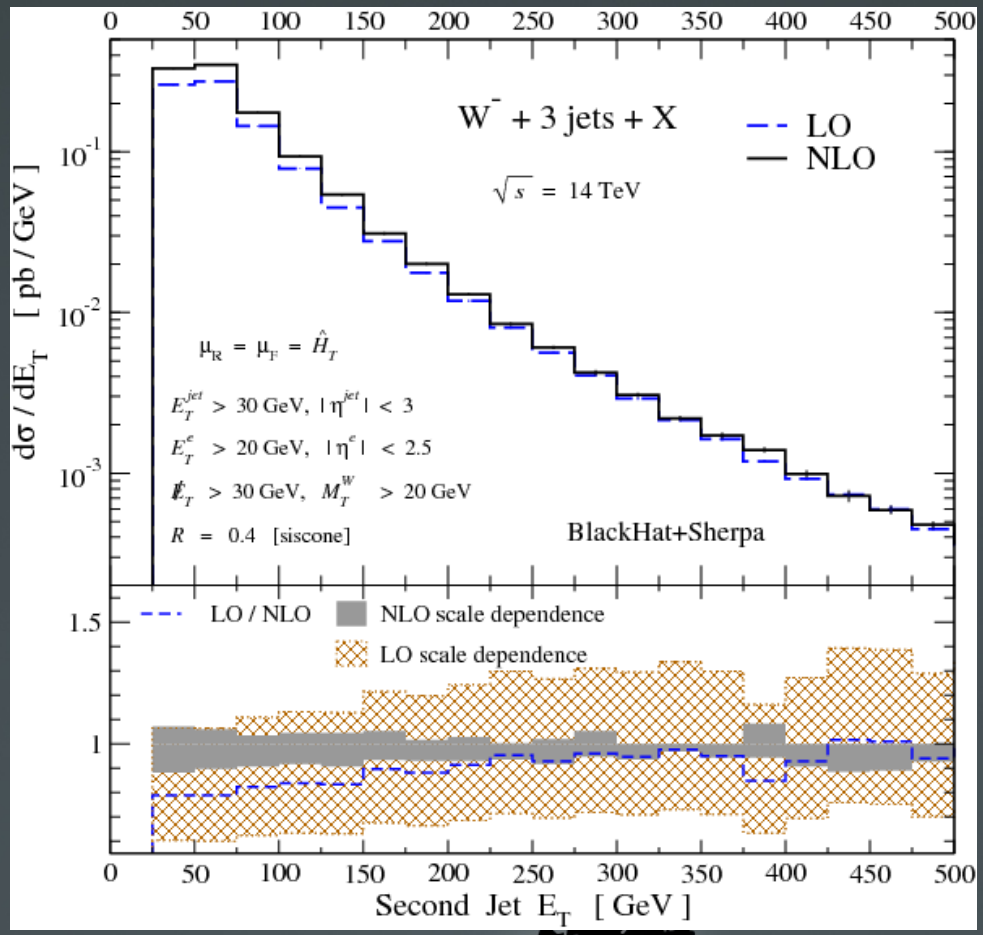
(a)



(b)

Different choices at NLO





$$E_T^W = \sqrt{m_W^2 + p_T^2(W)}$$

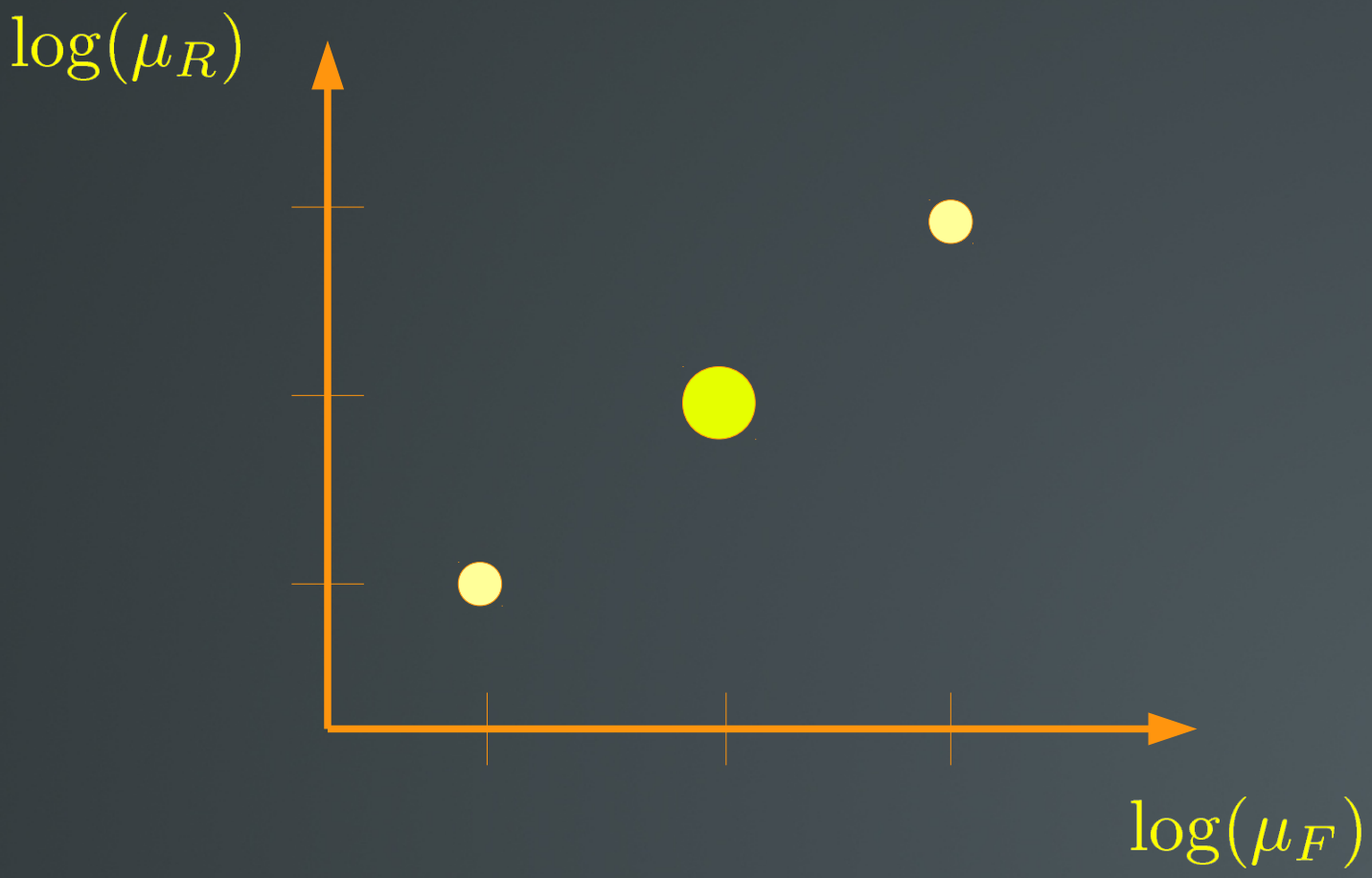
$$H_T = \sum_{j=1,2,3} E_{T,j}^{\text{jet}} + E_T^e + \not{E}_T$$

Many ways of choosing the scales

- One scale for all alphas
- Fix the scale so that different emission scales are taken into account ("blended scales")
  - To ensure cancellation of divergences, the choices must coincide in the collinear and soft limit

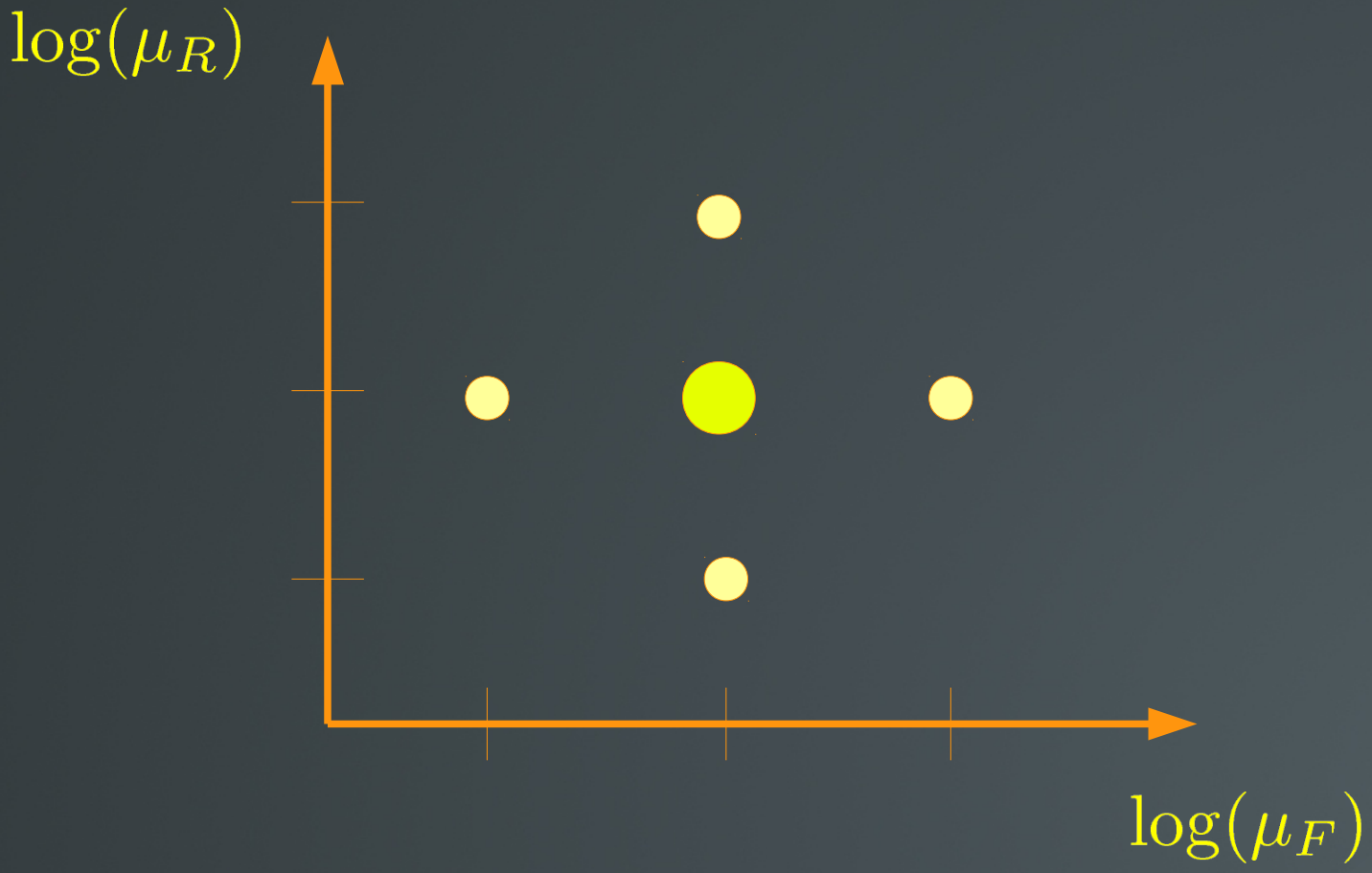
Scale dependence

- "Convention"



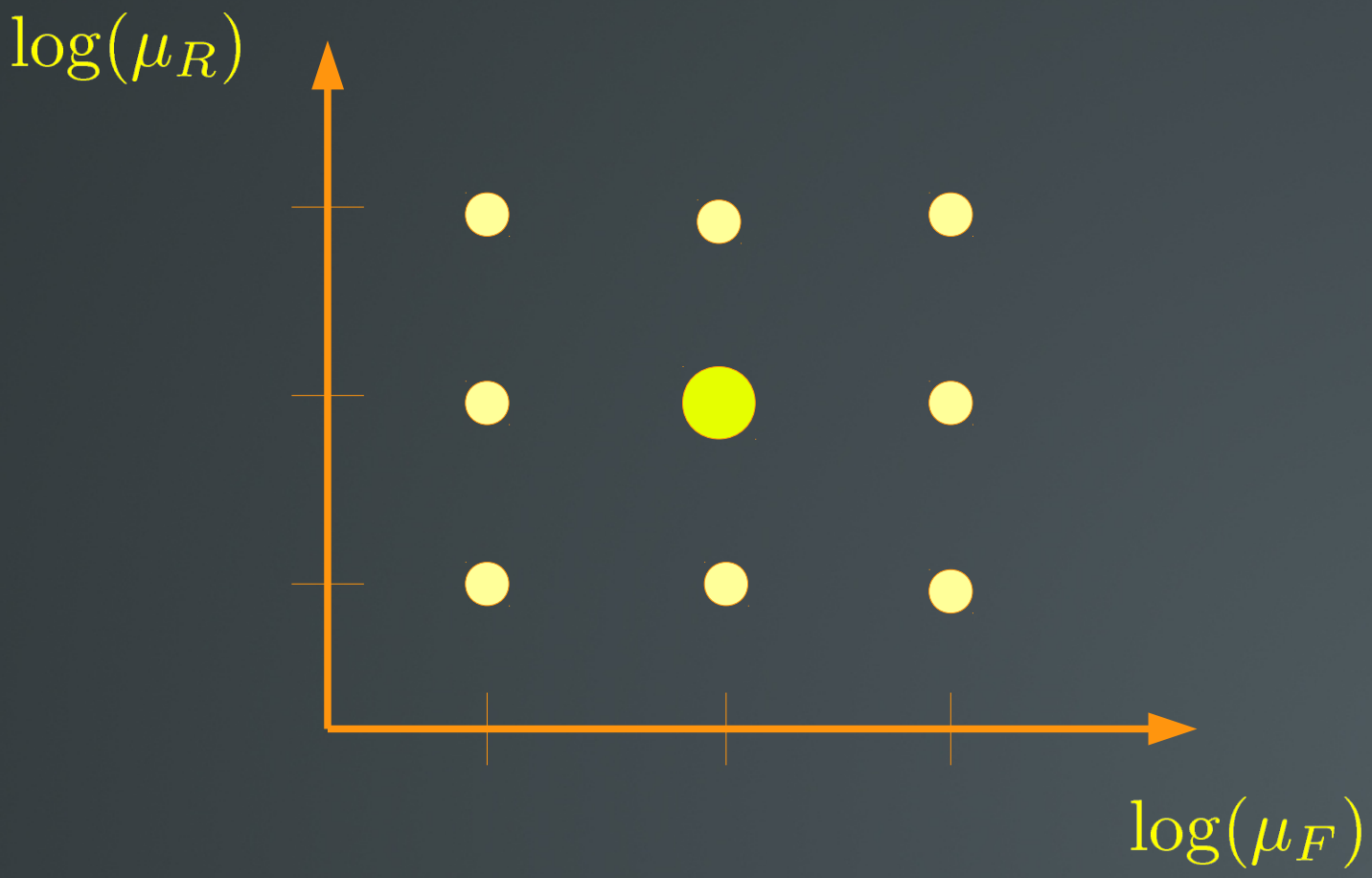
Scale dependence

- Fix one, vary the other



Scale dependence

- "Full"



Conclusion

- Using Ntuples allows for more flexibility for complicated calculations
- Thanks to ntuples, many scale choices can be compared and studied