QCD & backgrounds for the LHC

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Rencontres des Moriond EW 2009

LHC: unprecedented potential (energy, luminosity)
first data very soon

Do we master QCD well enough to guarantee a successful program?

The challenge: provide theoretical predictions that match or exceed the accuracy of LHC data

The aim: early success in understanding the energy frontier

I will try to address this question by giving a

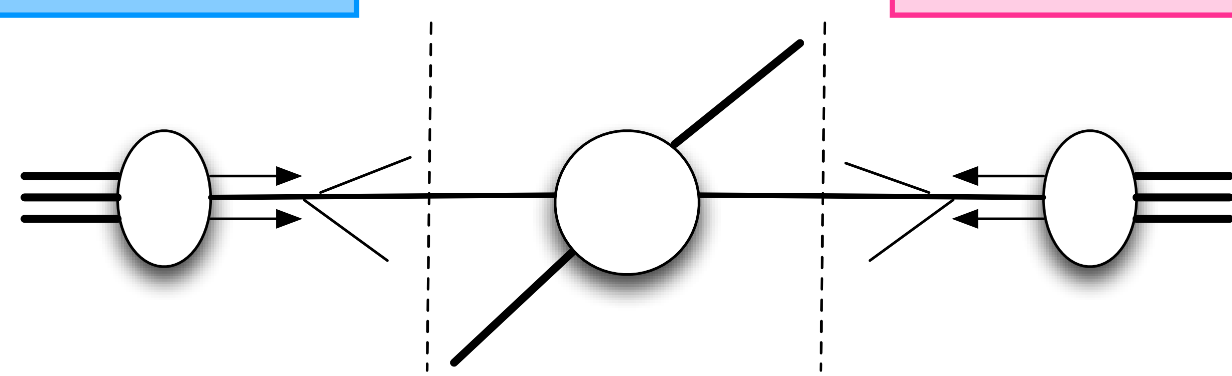
brief status report of technical progress
&
a short review of selected recent developments

Prerequisite: factorization

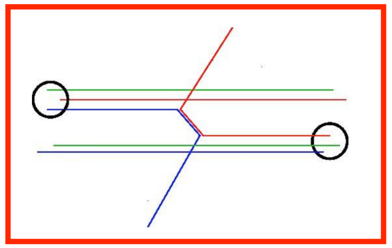
$$\frac{d\sigma_{\mathrm{pp}\to\mathrm{hadrons}}}{dX} = \sum_{a,b} \int dx_1 dx_2 f_a(x_1,\mu_F) f_b(x_2,\mu_F) \times \frac{d\hat{\sigma}_{\mathrm{ab}\to\mathrm{partons}}(\alpha_s(\mu_R),\mu_R,\mu_F)}{dX} + \mathcal{O}\left(\frac{\Lambda^n_{\mathrm{QCD}}}{Q^n}\right)$$

Extracted from data, but evolution is perturbative

Expansion in the coupling constant (LO, NLO, NNLO...)

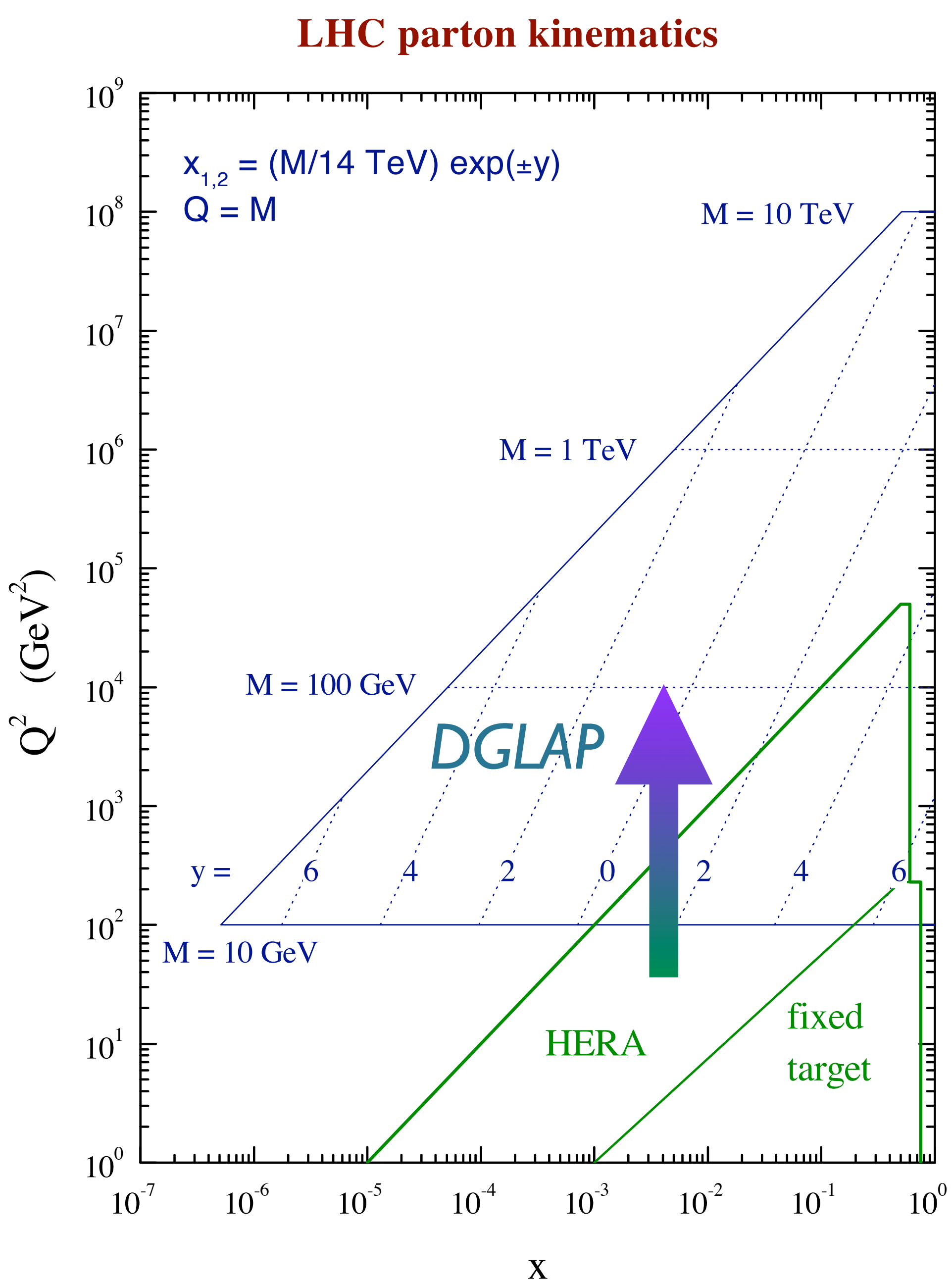


NB: factorization used in many contexts without proof



Parton densities coverage

- most of the LHC x-range covered by Hera
- need 2-3 orders of magnitude Q^2-evolution
- rapidity distributions probe extreme x-values
- 100 GeV physics at LHC: small-x, sea partons
- TeV physics: large x



PDF summary report, Hera-LHC '05

➠ *Hera: key and essential input to the LHC*

Parton densities: recent progress

Recent major progress:

- full NNLO evolution (previous only approximate NNLO)
- full treatment of heavy flavors near the quark mass

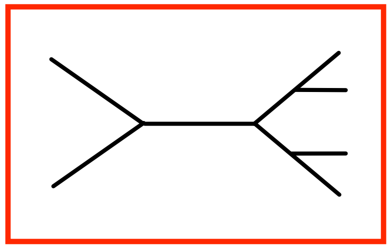
  [Numerically: e.g. (6-7)% effect on Drell-Yan at LHC]
- more systematic use of uncertainties/correlations
- Neural Network (NN) PDFs

splitting functions at NNLO: Moch, Vermaseren, A.Vogt '04
[+ much related theory progress '04 -'08]
Alekhin, CTEQ, MSTW (new MSTW '09), NN collaboration

Recently on the market: toolkits for NNLO DGLAP evolution of PDFs

PEGASUS A.Vogt '04; QCDNUM Botje '07
CANDIA Cafarella et al. '08; HOPPET Salam & Rojo '08

⇒ Description of PDFs reaching precision, but still some work ahead



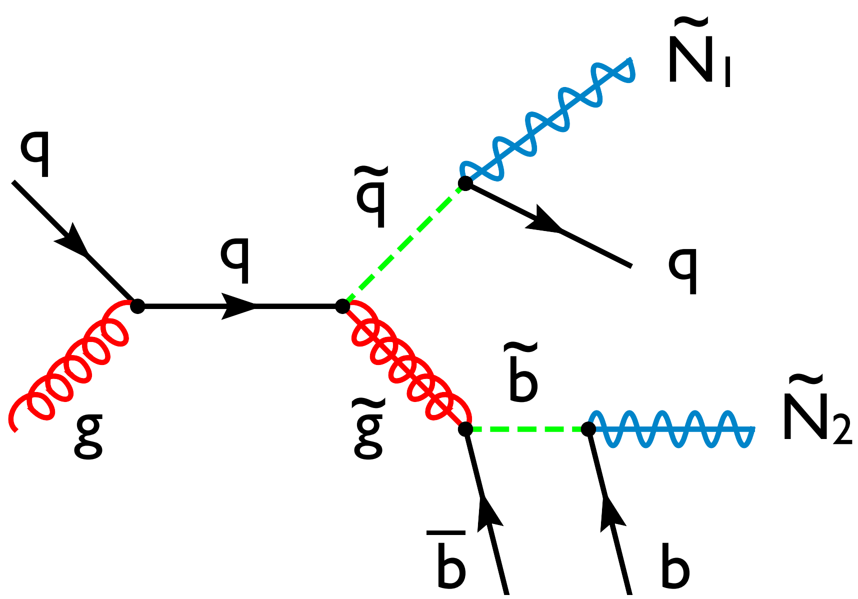
Multiparticle final states

The LHC will operate in a new regime: highest energy & luminosity

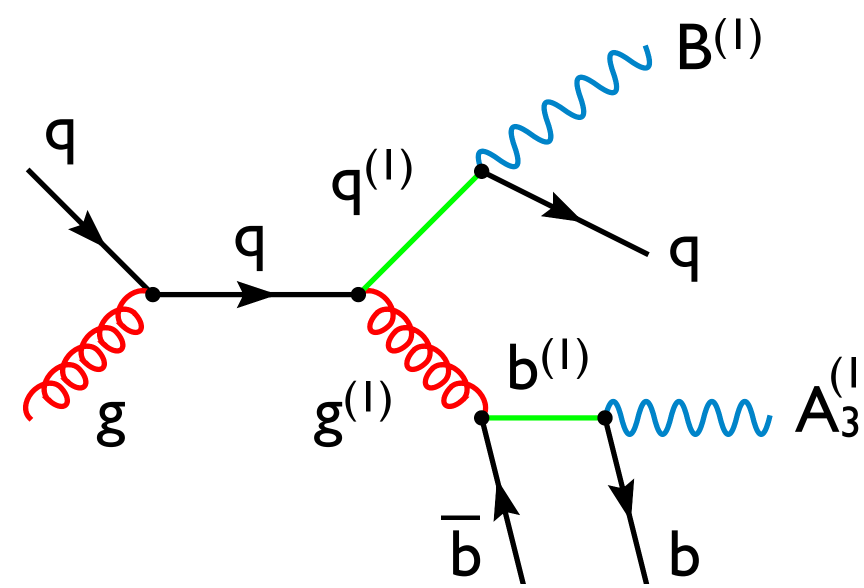
Very large number of high-multiplicity events

- typical SM process is accompanied by radiation multi-jet events
- most signals involve pair-production and subsequent chain decays

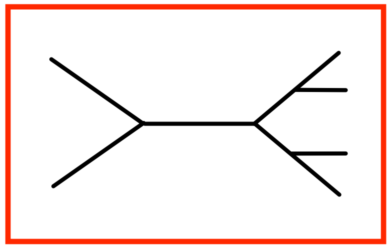
SUSY:



UED:



More important than ever to describe high-multiplicity final states



Leading order

Status: fully automated, at most 8 outgoing particles

Alpgen, CompHEP, CalcHEP, Helac, Madgraph, Helas, Sherpa, Whizard, ...

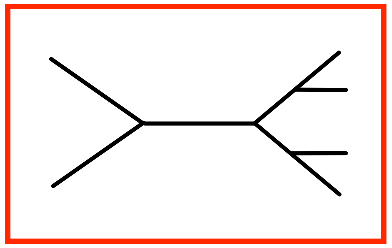
Drawbacks of LO: large scale dependences, sensitivity to cuts, poor modeling of jets, ...

Example: W+4 jet cross-section $\propto \alpha_s(Q)^4$

Vary $\alpha_s(Q)$ by ±10% via change of Q ⇒ cross-section varies by ±40%

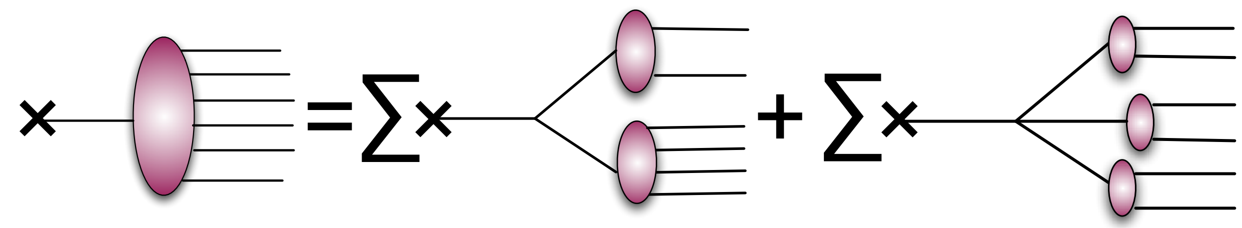
Why use LO at all?

- fastest option; often the only one
- test quickly new ideas with fully exclusive description
- many working, well-tested approaches
- highly automated, crucial to explore new ground, but no precision



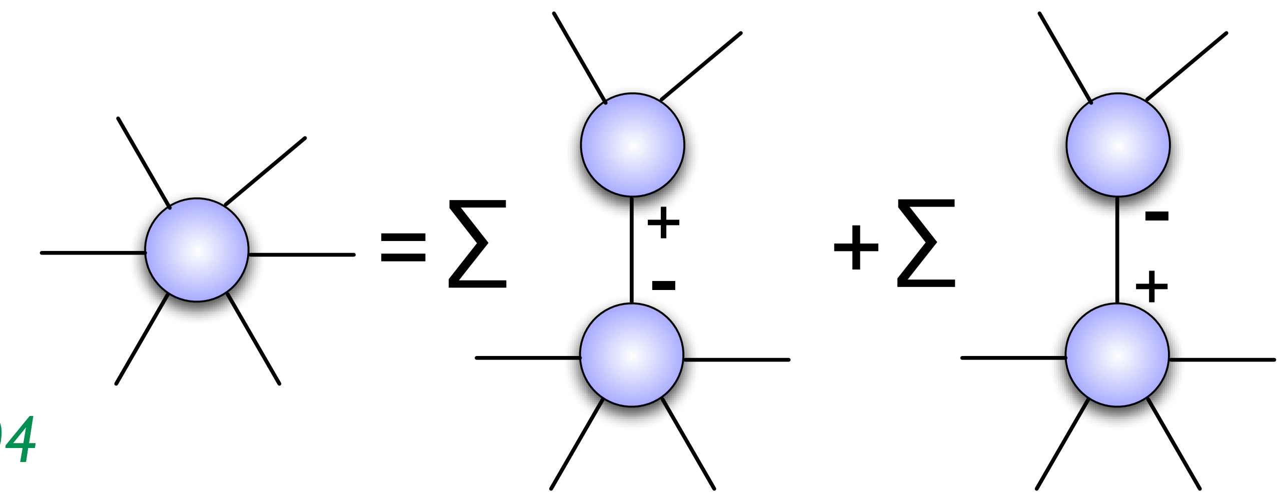
LO: 3 methods beyond Feynman

✓ Berends-Giele relations: compute helicity amplitudes recursively using off-shell currents



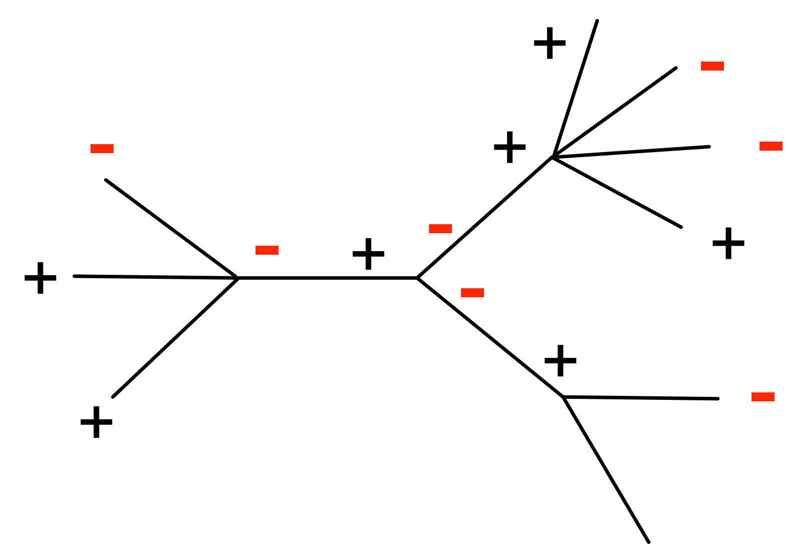
Berends, Giele '88

✓ BCF relations: compute helicity amplitudes via on-shell recursions (use complex momentum shifts)

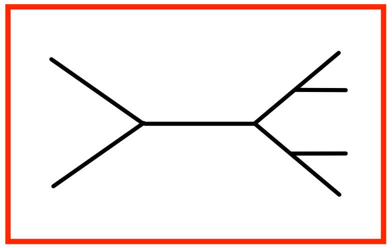


Britto, Cachazo, Feng '04

✓ CSW relations: compute helicity amplitudes by sewing together MHV amplitudes [- - + + ... +]



Cachazo, Svrcek, Witten '04



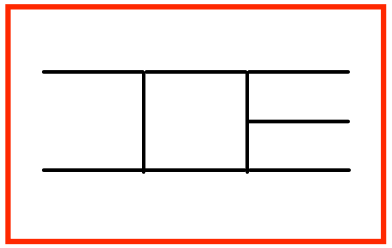
LO race: who is faster?

Time [s] for 2 → n gluon amplitudes for 10^4 points

Duhr et al. '06
also Dinsdale et al. '06

Final state	BG	BCF	CSW
2g	0.28	0.33	0.26
3g	0.48	0.51	0.55
4g	1.04	1.32	1.75
5g	2.69	7.26	5.96
6g	7.19	59.1	30.6
7g	23.7	646	195
8g	82.1	8690	1890
9g	270	127000	29700
10g	864	-	-

☛ undisputed numerical superiority of traditional Berends-Giele compared to twistor inspired methods



Next-to-leading order

For precision studies need next-to-leading-order

because the coupling is 'big-ish', to reduce dependence from unphysical scales, to model jets better, to predict the normalization, ...

Status of NLO:

☑ $2 \to 2$: all known or easy in SM and beyond

☑ $2 \to 3$: very few processes not yet computed

[but: often no decays, newest codes mostly private]

☐ $2 \to 4$: barely touched ground [$q\bar{q} \to t\bar{t}\, b\bar{b}$, $pp \to W$+3jets]

Bredenstein et al. '08; Berger et al. '09; Ellis et al. '09

Cancelation of divergences: automated subtraction

Gleisberg, Krauss '07; TeVJet [public] Seymour, Tevlin '08; Hasegawa et al. '08

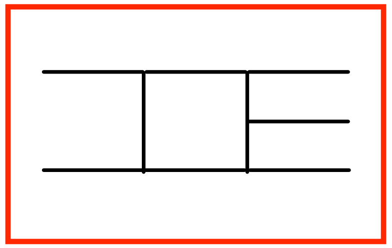
Bottleneck at NLO: virtual (loop) amplitudes

The 2005 Les Houches wishlist

[The QCD, EW & Higgs Working group report hep-ph/0604120]

Table 42: The LHC "priority" wishlist for which a NLO computation seems now feasible.

process ($V \in \{Z, W, \gamma\}$)	relevant for
1. $pp \to V\,V$ jet	$t\bar{t}H$, new physics
2. $pp \to t\bar{t}\,b\bar{b}$	$t\bar{t}H$
3. $pp \to t\bar{t} + 2$ jets	$t\bar{t}H$
4. $pp \to V\,V\,b\bar{b}$	VBF$\to H \to VV$, $t\bar{t}H$, new physics
5. $pp \to V\,V + 2$ jets	VBF$\to H \to VV$
6. $pp \to V + 3$ jets	various new physics signatures
7. $pp \to V\,V\,V$	SUSY trilepton



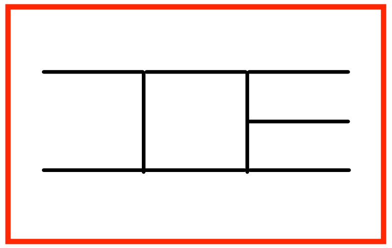
The 2007 update

[The NLO multi-leg Working group report 0803.0494]

Process ($V \in \{Z, W, \gamma\}$)	Comments
Calculations completed since Les Houches 2005	
1. $pp \to VV$jet 2. $pp \to$ Higgs+2jets 3. $pp \to V\,V\,V$	WWjet completed by Dittmaier/Kallweit/Uwer [3]; Campbell/Ellis/Zanderighi [4] and Binoth/Karg/Kauer/Sanguinetti (in progress) NLO QCD to the gg channel completed by Campbell/Ellis/Zanderighi [5]; NLO QCD+EW to the VBF channel completed by Ciccolini/Denner/Dittmaier [6, 7] ZZZ completed by Lazopoulos/Melnikov/Petriello [8] and WWZ by Hankele/Zeppenfeld [9]
Calculations remaining from Les Houches 2005	
4. $pp \to t\bar{t}\,b\bar{b}$ 5. $pp \to t\bar{t}$+2jets 6. $pp \to VV\,b\bar{b}$, 7. $pp \to VV$+2jets 8. $pp \to V$+3jets	relevant for $t\bar{t}H$ relevant for $t\bar{t}H$ relevant for VBF $\to H \to VV$, $t\bar{t}H$ relevant for VBF $\to H \to VV$ VBF contributions calculated by (Bozzi/)Jäger/Oleari/Zeppenfeld [10–12] various new physics signatures
NLO calculations added to list in 2007	
9. $pp \to b\bar{b}b\bar{b}$	Higgs and new physics signatures
Calculations beyond NLO added in 2007	
10. $gg \to W^*W^*$ $\mathcal{O}(\alpha^2\alpha_s^3)$ 11. NNLO $pp \to t\bar{t}$ 12. NNLO to VBF and Z/γ+jet	backgrounds to Higgs normalization of a benchmark process Higgs couplings and SM benchmark
Calculations including electroweak effects	
13. NNLO QCD+NLO EW for W/Z	precision calculation of a SM benchmark

Table 1: The updated experimenter's wishlist for LHC processes

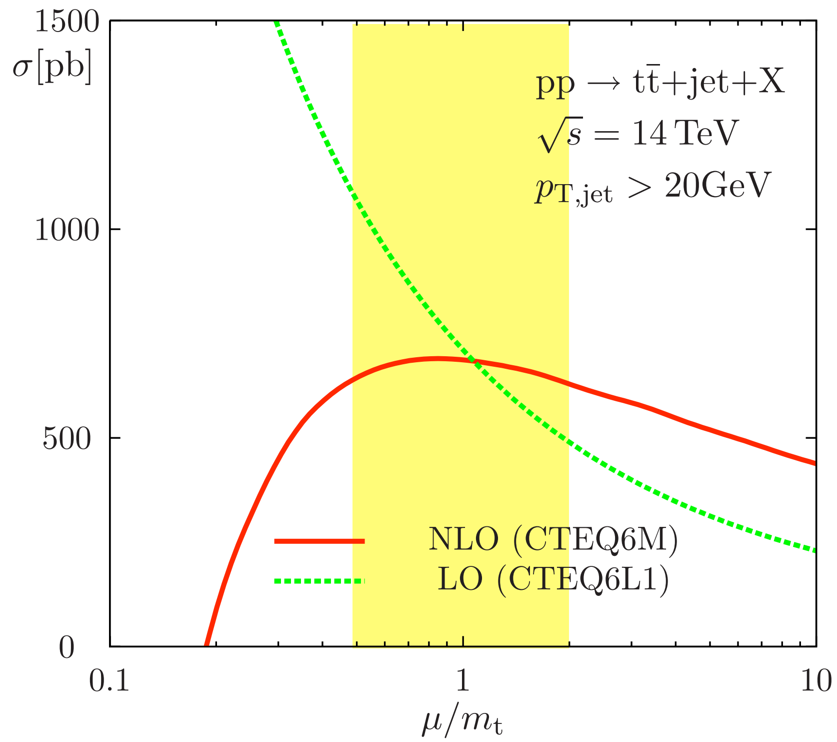
based on Feynman diagrams;
private codes only

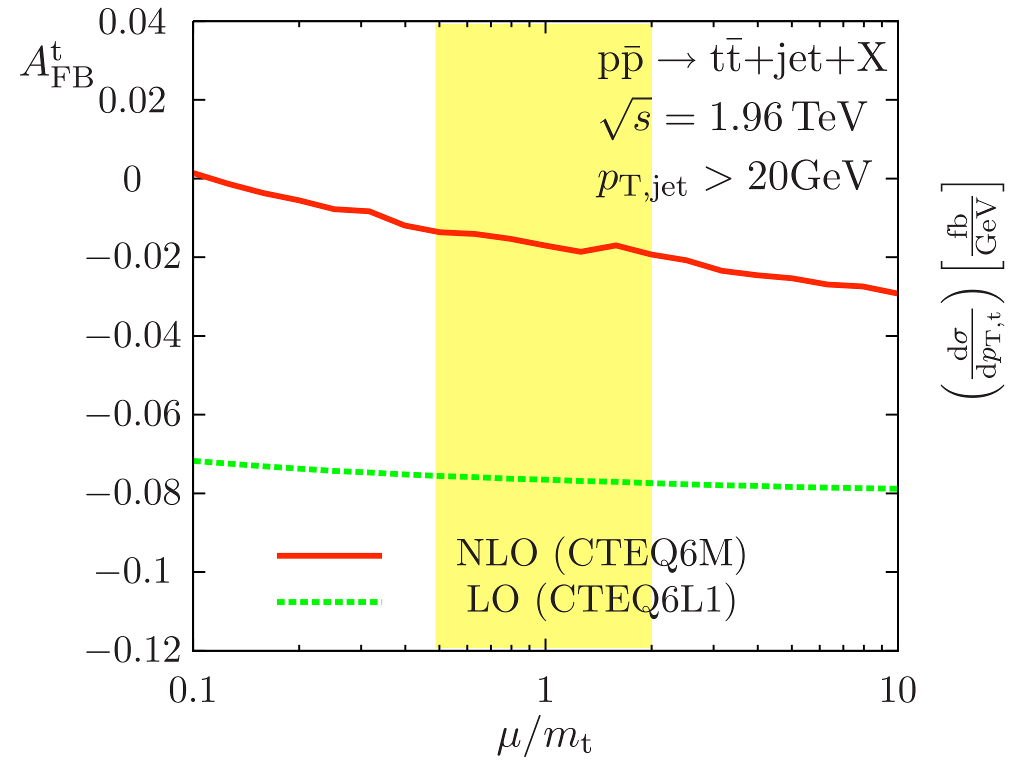


One NLO example: tt +1 jet

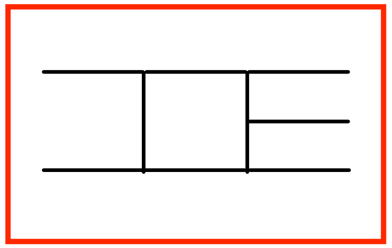
Calculation done with traditional methods

Dittmaier, Kallweit, Uwer '07, '08

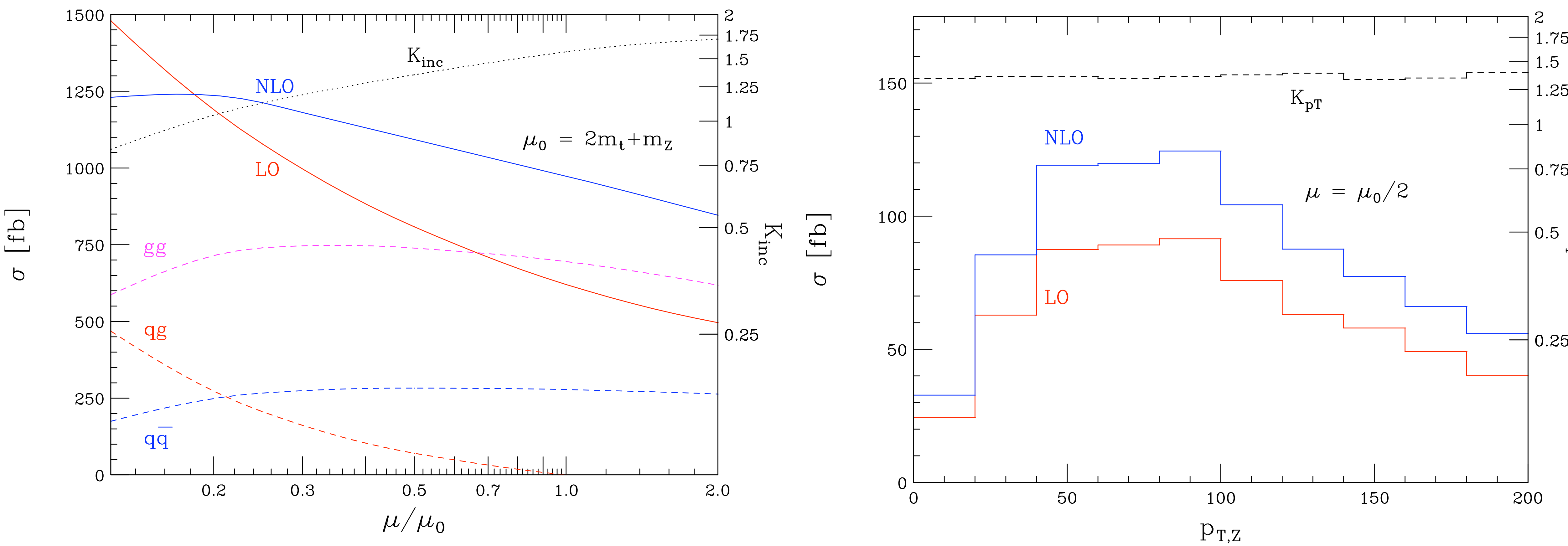




- improved stability of NLO result [differential, but no decays]
- large effect on A_{FB} at the Tevatron: now compatible with zero
- essential ingredient of NNLO tt production

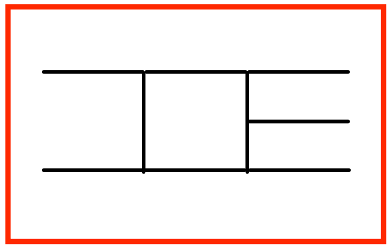


2nd NLO example: tt +Z



Lazopoulos, Melnikov, Petriello ’08

- NLO increase cross section by 35% (residual 10% uncertainty)
- factor of 1.5-2 improvement on ttZ measurement (probe BSM)
- no significant change in distributions



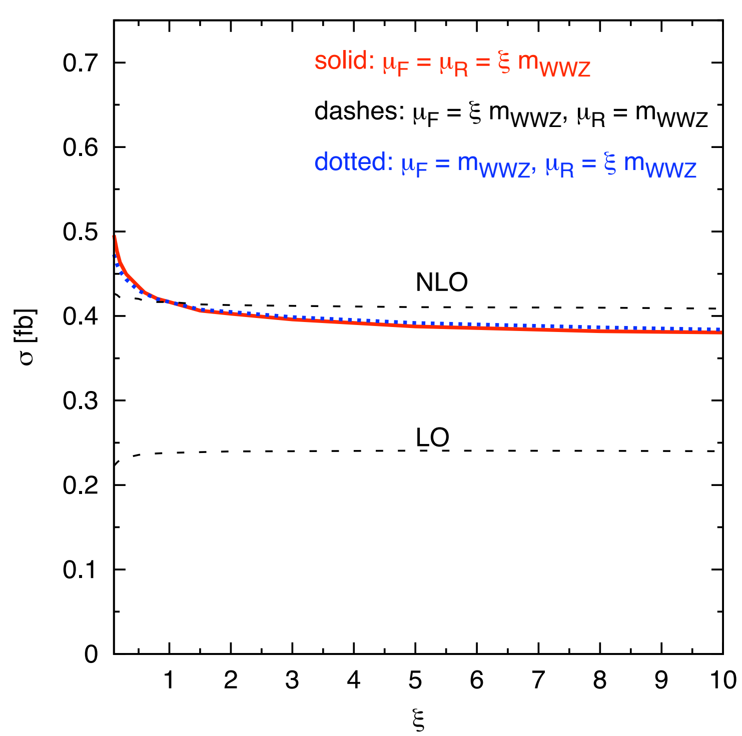
3rd NLO example: WW +Z

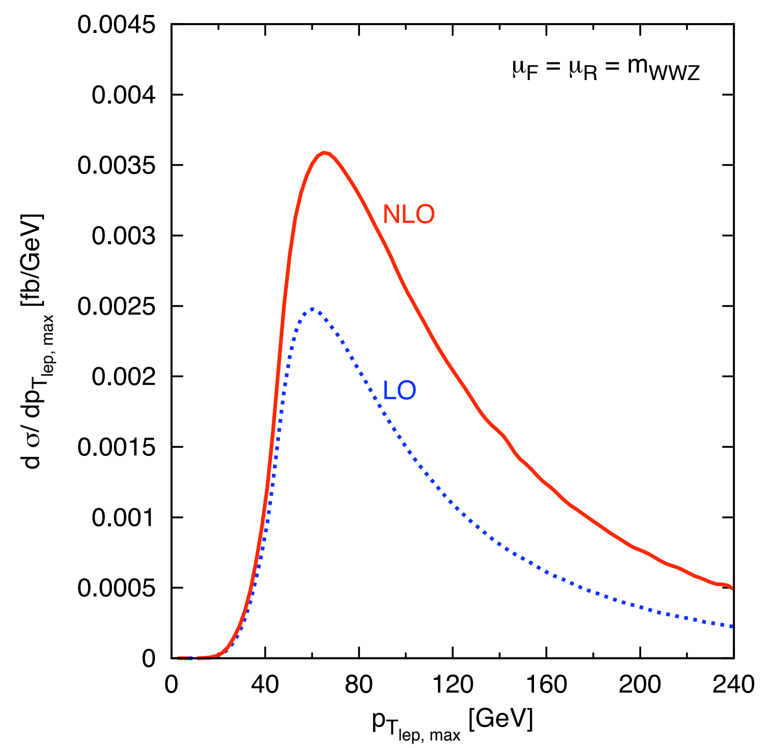
Motivation: probe EW gauge couplings and SUSY background

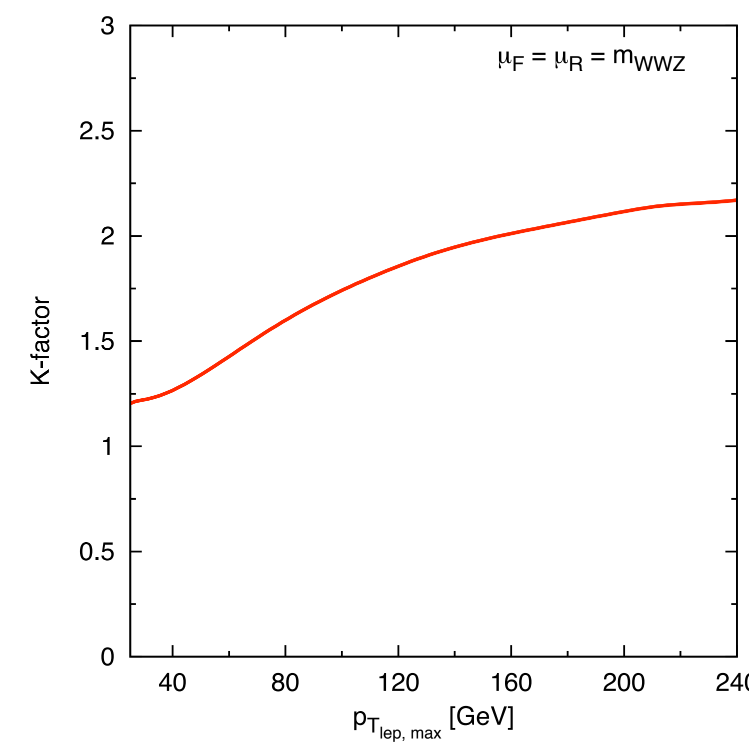
Lazoloupos, Melnikov, Petriello ’07

Binoth, Ossola, Papadoloulos, Pittau ’08

With decays and spin correlations: Hankele, Zeppenfeld ’07



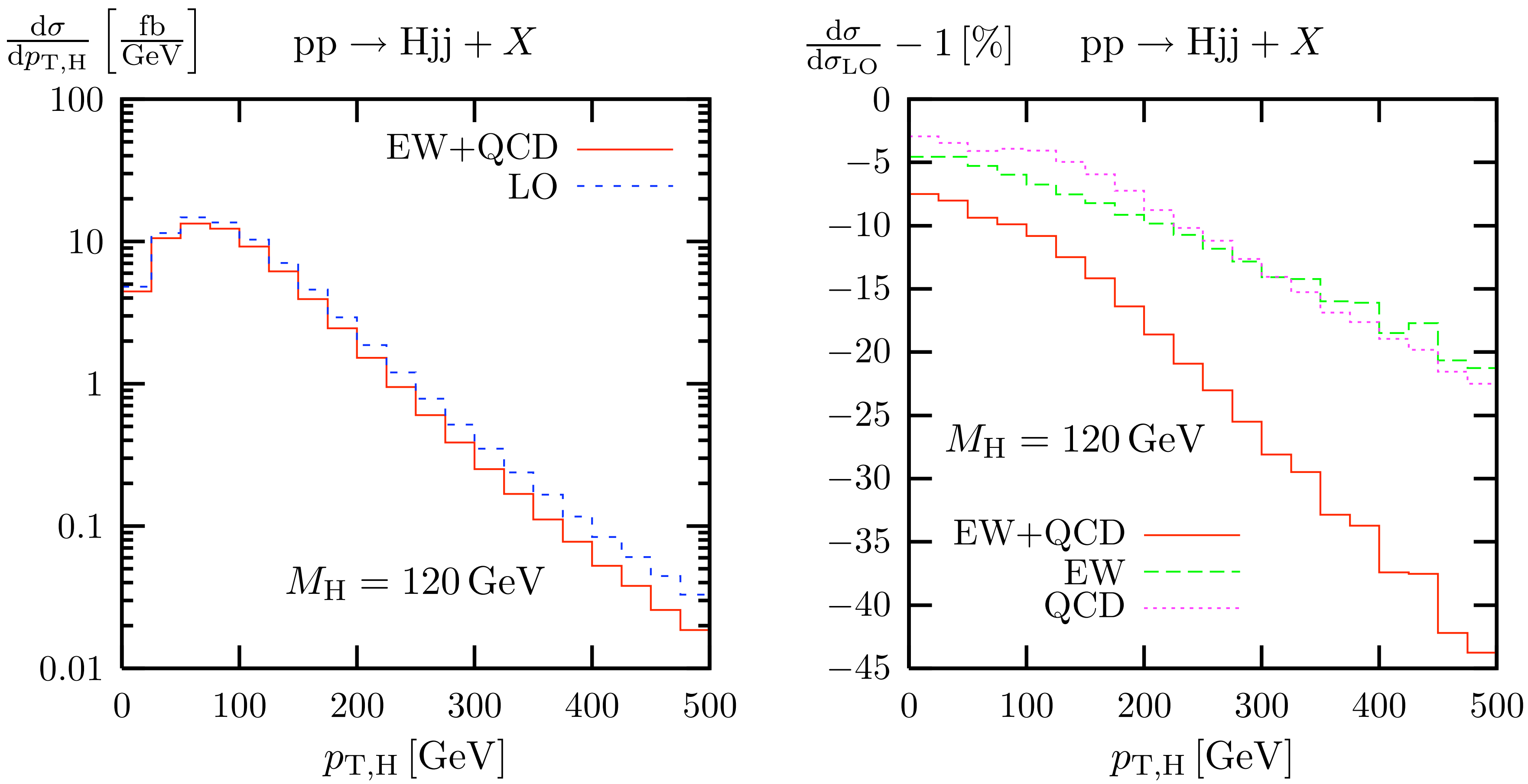




- NLO scale dependence larger than LO one (i.e. LO scale variation not indicative of the uncertainty)
- K-factors large and substantial shape change in distributions (simple multiplication of overall K-factor would distort shapes)

The “not so weak” EW :VBF Higgs

Ciccolini, Denner, Dittmaier ’07



- EW and QCD of the same size!

☛ be aware of EW corrections for precision studies (peaks) and in tails of distributions (large electro-weak logarithms)

General NLO features?

Process	Typical scales		Tevatron K-factor			LHC K-factor		
	μ_0	μ_1	$\mathcal{K}(\mu_0)$	$\mathcal{K}(\mu_1)$	$\mathcal{K}'(\mu_0)$	$\mathcal{K}(\mu_0)$	$\mathcal{K}(\mu_1)$	$\mathcal{K}'(\mu_0)$
W	m_W	$2m_W$	1.33	1.31	1.21	1.15	1.05	1.15
W+1jet	m_W	p_T^{jet}	1.42	1.20	1.43	1.21	1.32	1.42
W+2jets	m_W	p_T^{jet}	1.16	0.91	1.29	0.89	0.88	1.10
WW+jet	m_W	$2m_W$	1.19	1.37	1.26	1.33	1.40	1.42
$t\bar{t}$	m_t	$2m_t$	1.08	1.31	1.24	1.40	1.59	1.48
$t\bar{t}$+1jet	m_t	$2m_t$	1.13	1.43	1.37	0.97	1.29	1.10
$b\bar{b}$	m_b	$2m_b$	1.20	1.21	2.10	0.98	0.84	2.51
Higgs	m_H	p_T^{jet}	2.33	–	2.33	1.72	–	2.32
Higgs via VBF	m_H	p_T^{jet}	1.07	0.97	1.07	1.23	1.34	1.09
Higgs+1jet	m_H	p_T^{jet}	2.02	–	2.13	1.47	–	1.90
Higgs+2jets	m_H	p_T^{jet}	–	–	–	1.15	–	–

[NLO report 0803.0494]

<u>General features:</u>

- color annihilation, gluon dominated ⇒ large K factors
- extra legs in the final state ⇒ smaller K-factors

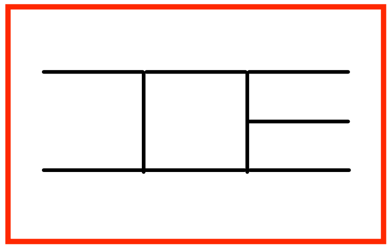
But be careful, only full calculations can really tell!

Recommendation

For the maximal exploitation of physics, there are also requirements on the experimental side. We suggest that cross sections at the LHC should be quoted at the hadron level, and where possible with the estimated parton-to-hadron corrections, so that any theoretical prediction (parton or hadron level) can easily be compared after the fact to the archived data [16]. Also, the experimental data needs to be quoted only for the range of measurement, rather than extrapolated to the full cross section; for example, measurements of $W \to e\nu$ should be quoted for the range of electron transverse momentum and rapidity and of missing transverse energy actually used in the triggering and analysis, rather than performing an extrapolation to the full W cross sections. Such recommendations were the exception (CDF W+jets) rather than the rule at the Tevatron and a clear model needs to be set for the LHC.

[Les Houches NLO report '08]

- ☛ this way your data will be useful for ever
- ☛ otherwise data will be obsolete sooner or later (typically rather soon)

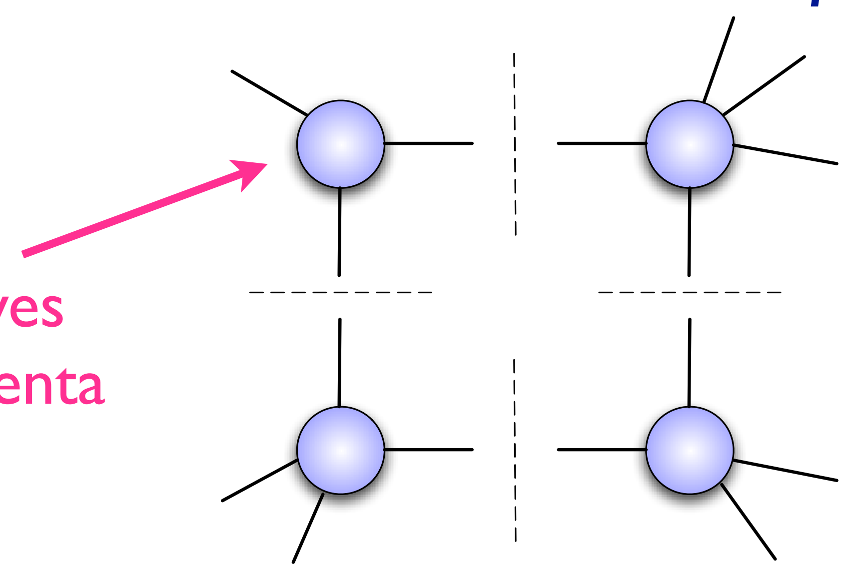


Two breakthrough ideas for NLO

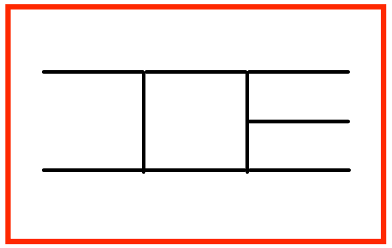
Aim: NLO loop integral without doing the integration

1) "... we show how to use generalized unitarity to read off the (box) coefficients. The generalized cuts we use are quadrupole cuts ..."

NB: non-zero because cut gives complex momenta



Britto, Cachazo, Feng '04

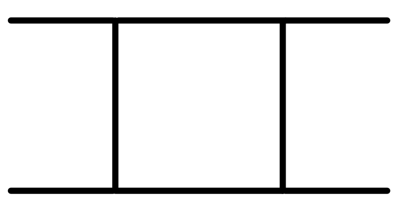


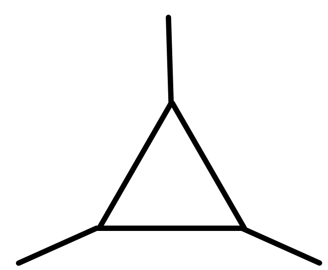
Two breakthrough ideas

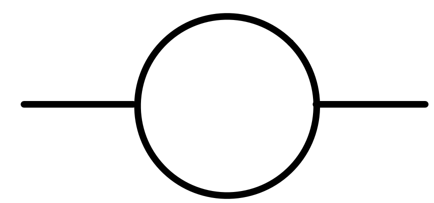
Aim: NLO loop integral without doing the integration

2) The OPP method: "We show how to extract the coefficients of 4-, 3-, 2- and 1-point one-loop scalar integrals...."

$$\mathcal{A}_N = \sum_{[i_1|i_4]} \left(d_{i_1 i_2 i_3 i_4} \; I^{(D)}_{i_1 i_2 i_3 i_4} \right) + \sum_{[i_1|i_3]} \left(c_{i_1 i_2 i_3} \; I^{(D)}_{i_1 i_2 i_3} \right) + \sum_{[i_1|i_2]} \left(b_{i_1 i_2} \; I^{(D)}_{i_1 i_2} \right) + \mathcal{R}$$

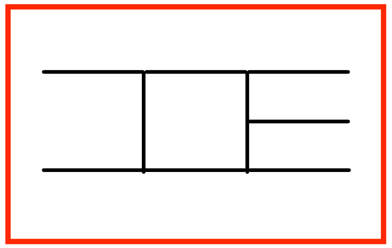






rational part treated separately

Ossola, Pittau, Papadopolous '06



A unified approach ?

Partial fractioning via OPP + BG recursion for tree amplitudes + unitarity in higher dimension
⇒ full one-loop from tree level

Two issues:

- Practicality? speed, stability

  Excellent performance of the method demonstrated for gluons

- Generality? what about realistic LHC processes?

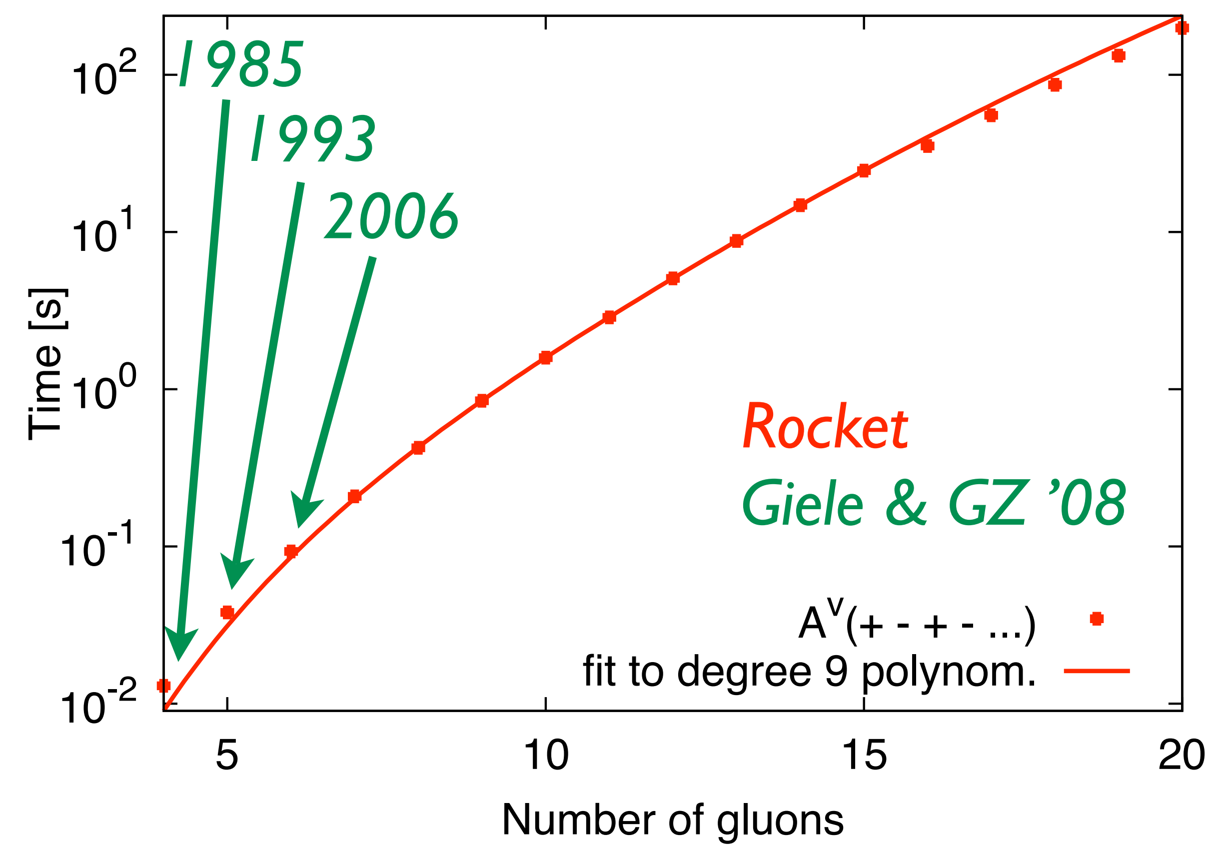
  Cases studied:

  $0 \to$ ttggg,

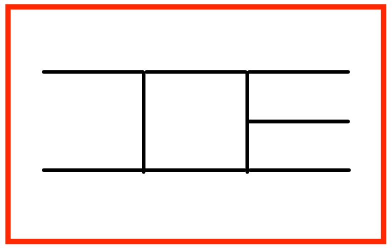
  $0 \to$ qq + (ng), $0 \to$ qqW + (ng),

  $0 \to$ qqQQW + 1g

Ellis, Giele, Kunszt, Melnikov '07, '08



Also: Blackhat up to N=6 [7,8 MHV],
Berger, Bern, Cordero, Dixon, Forde, Ita, Kosower, Maitre '08



1st physical application: W+3 jets

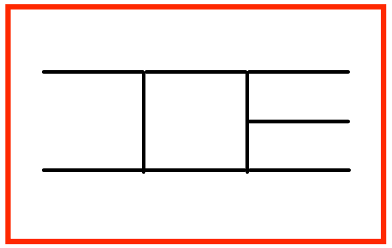
Why W+3 jets?

I. W+3 jets measured at the Tevaton, but LO varies by more than a factor of 2 under reasonable changes in scales ⇒ cannot use LO predictions for serious comparison of theory and data

II. measurements at the Tevaton for W+n jets with n=1,2 have shown that data is described well by NLO QCD
⇒ interesting to verify this for 3 and more jets

III. W+3 jets of interest at the LHC, as one of the backgrounds to model-independent new physics searches using jets + MET

IV. calculation highly non-trivial (more than 1000 Feyman diagrams) optimal testing ground



Approximations

In spite of all technical advances the calculation of one-loop W+5 parton amplitudes and tree-level W+6 partons integrated over phase space is still a very challenging task

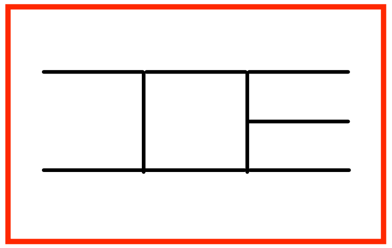
⇒ reasonable to look for reliable approximations as a first step

- the leading color approximation works up to 10% at leading order
- 4-quark processes only around 30% of the full result
- incoming gluon-gluon channel only 2%

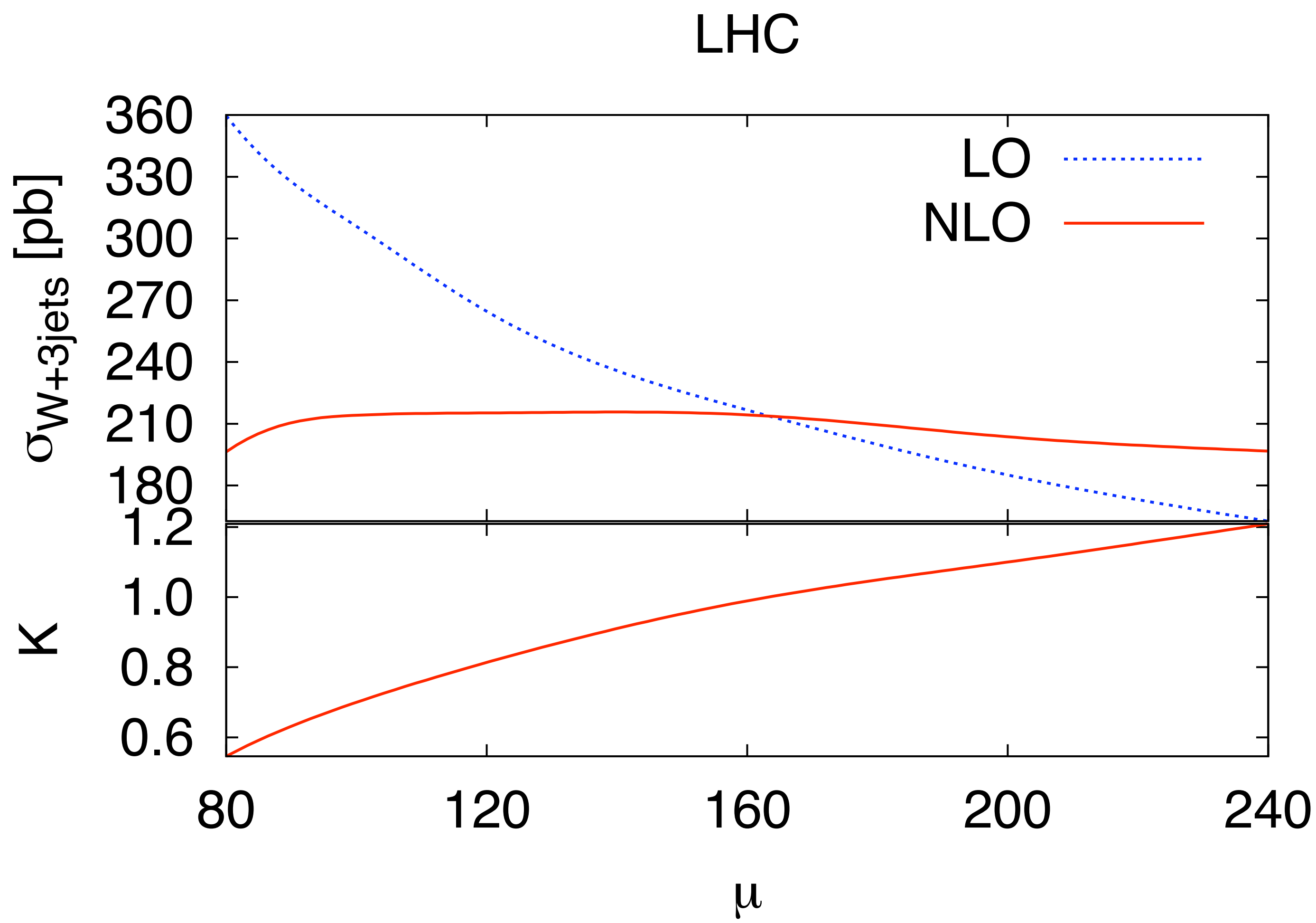
Since in the following

- leading color approximation is used
- 4-quark processes are dropped
- processes with two incoming gluons are omitted

Absolute results for cross-sections presented next should be taken with care, however ratio of NLO/LO should be less sensitive to these omissions



W+3 jets at the LHC

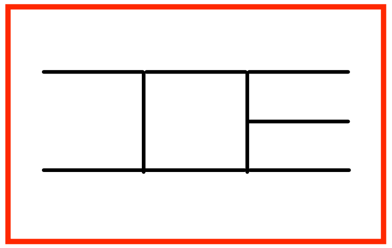


kt-alg. R=0.7
CTEQ6l1/ CTEQ6m

$p_{T,j} > 50\,\mathrm{GeV} \quad |\eta_j| < 3$

[Ellis, Melnikov, GZ '09]

- ☛ remarkable independence of cross-section on renormalization and factorization scale at NLO (unlike LO)
- ☛ LO = NLO at scales ~ 160 GeV
- ☛ gross features of W+3 jets are similar to W+2 jets, however the price one pays for an infelicitous choice of scales is higher now

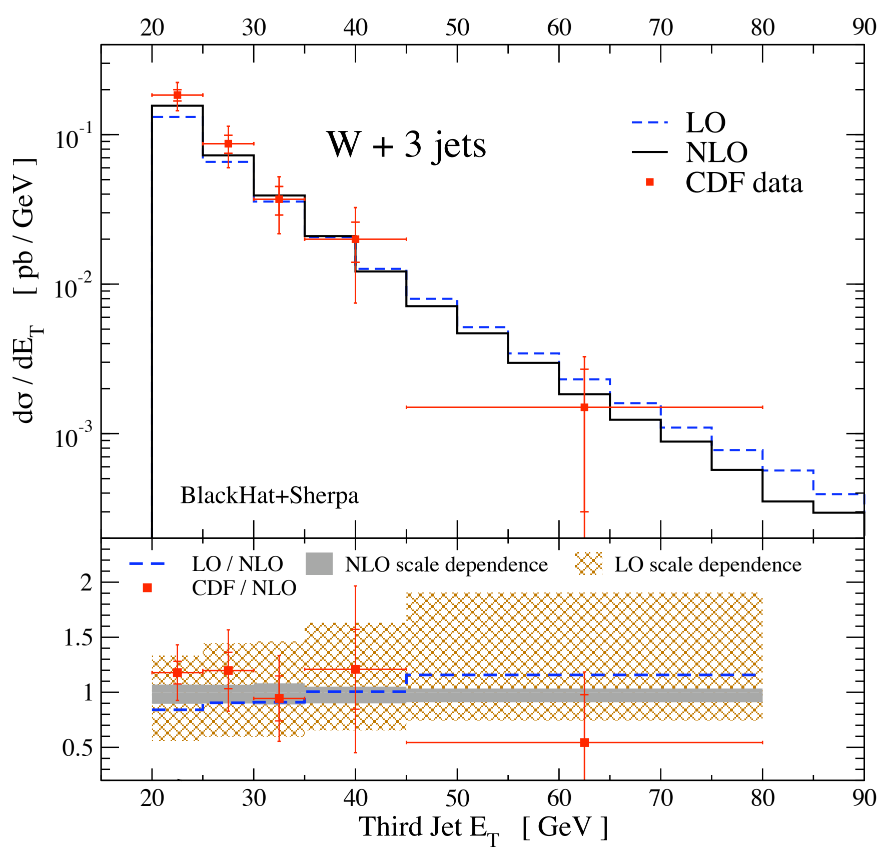


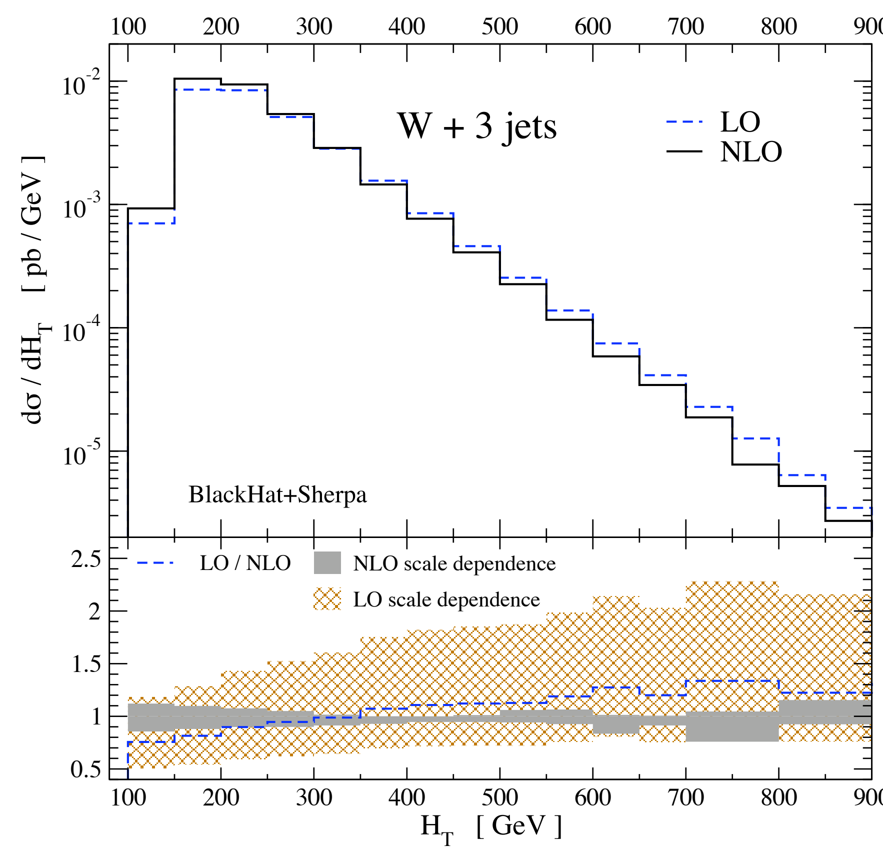
W+3 jets at the Tevatron

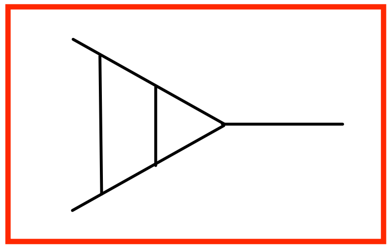
More recently, similar calculation for W+3 jets done in Blackhat+Sherpa

C.F. Berger, Z. Bern, L.J. Dixon, F. Febres Cordero, D. Forde, T. Gleisberg, H. Ita, D.A. Kosower, D. Maitre [0902.2760]

Still leading color approximation in virtual (not real), all subprocesses included (but no fermion loops)







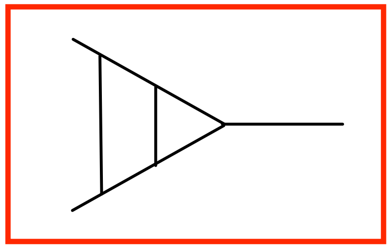
When is NLO not good enough?

- when NLO corrections are large (NLO correction ≈ LO)
  This may happen when
  - process involves very different scales → large logarithms
  - new channels open up (at NLO they are effectively LO)
  - gluon dominated processes

- when high precision is useful (occasionally the case)
  - Drell-Yan, heavy-quark production, 3 jets in e^+e^-, ...

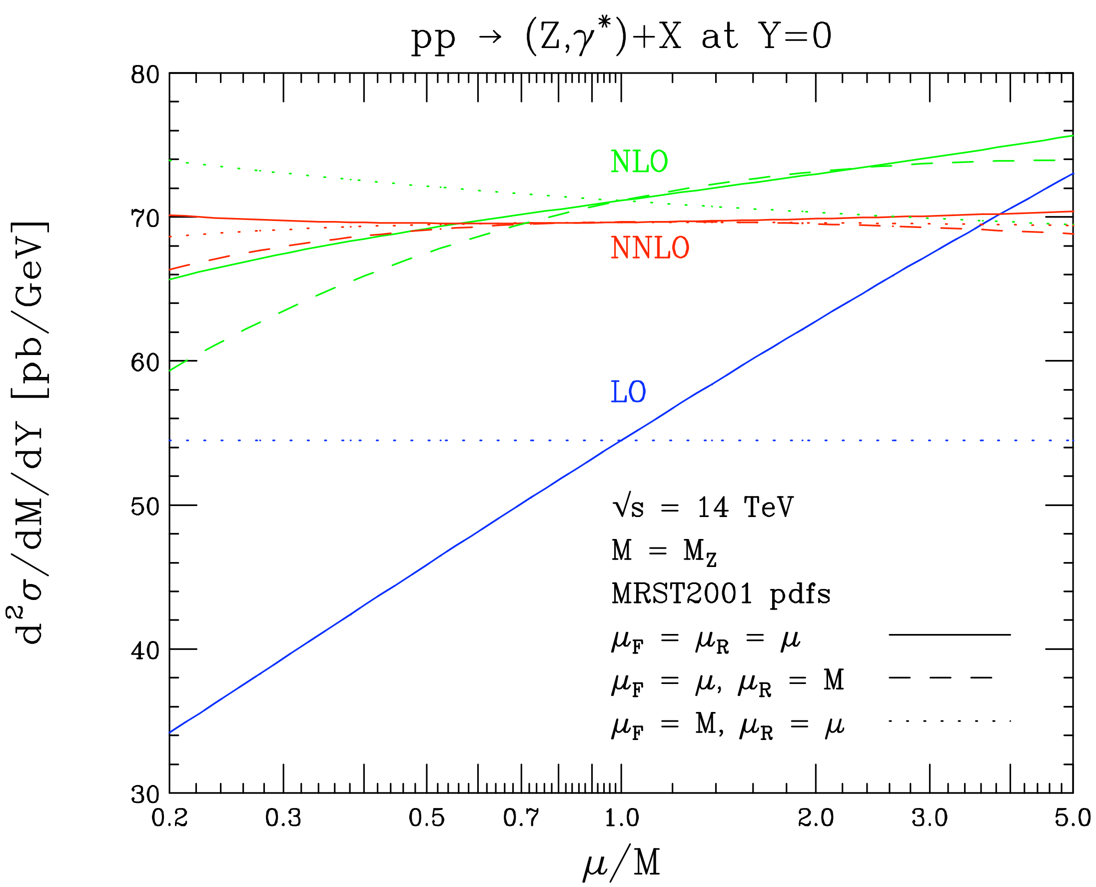
- when a reliable error estimate is wanted

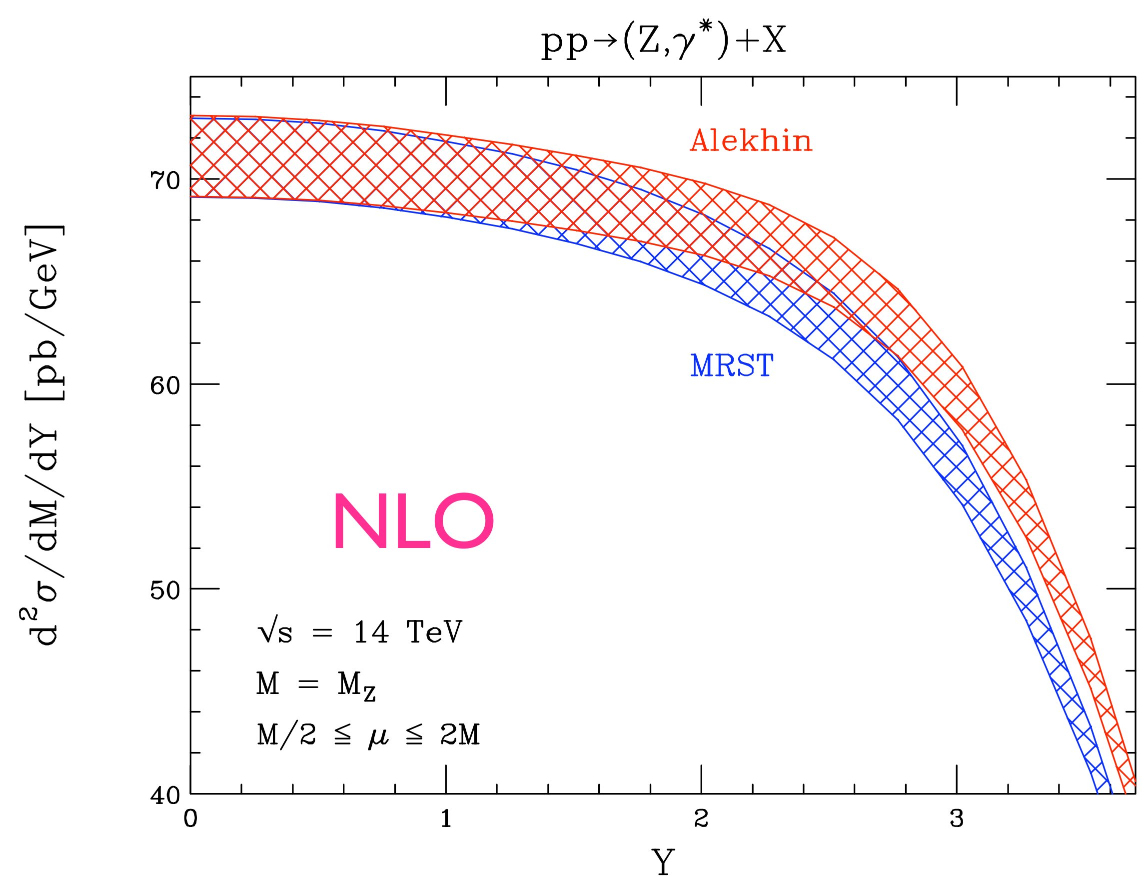
Bottleneck: cancel divergences before numerical evaluation



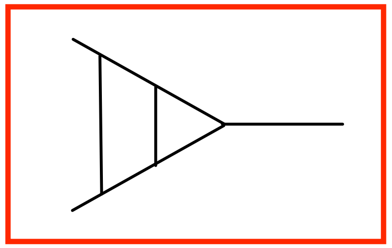
Best known at NNLO: Drell-Yan

- Most important and most precise test of the SM at the LHC
- Best known process at the LHC: spin-correlations, finite-width effects, γ-Z interference, fully differential in lepton momenta
- Sample NNLO results: scale stability & sensitivity to PDFs





Anastasiou, Dixon, Melnikov, Petriello ’03, ’05; Melnikov, Petriello ’06



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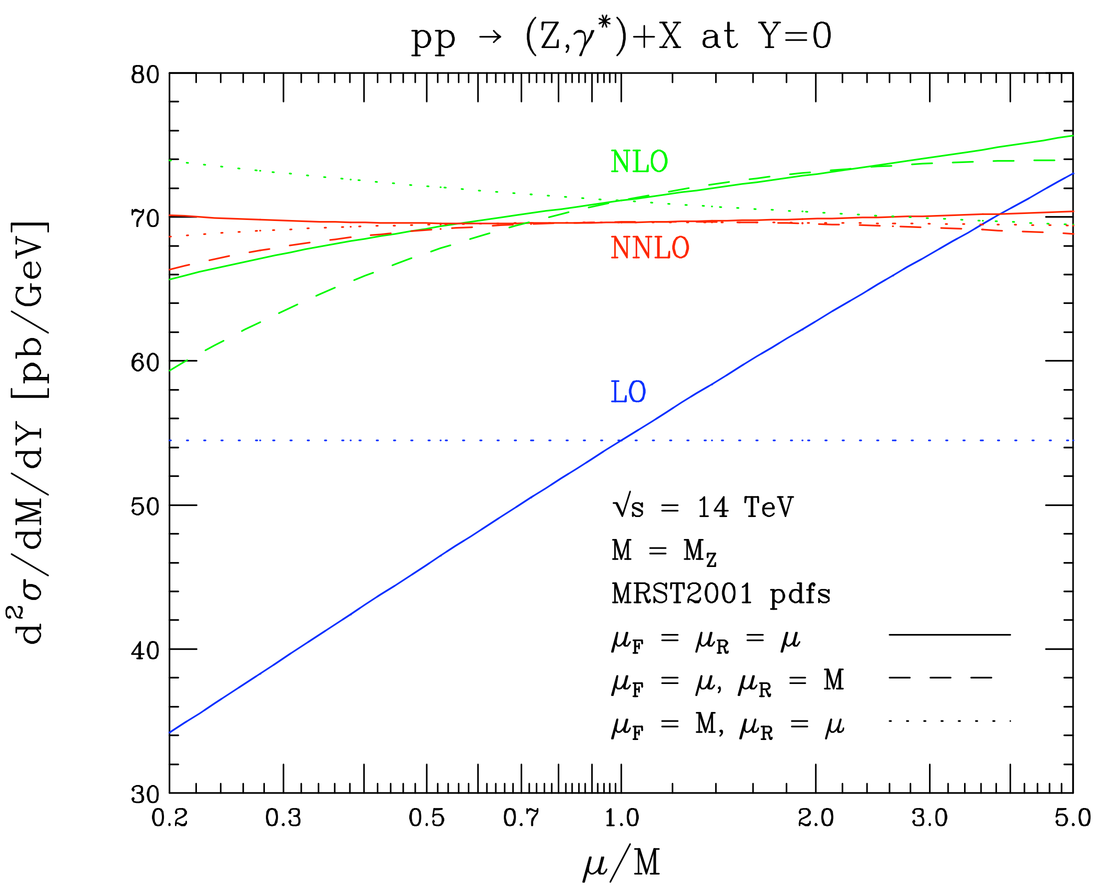

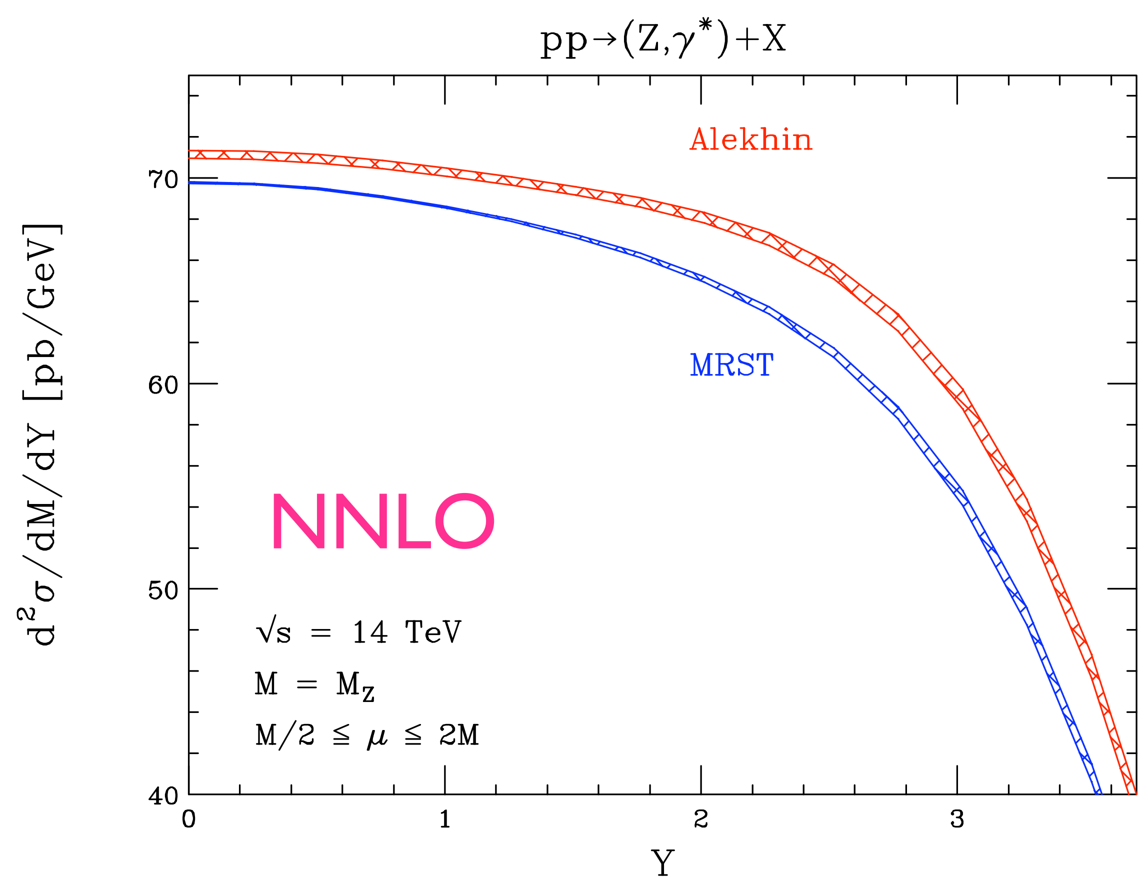

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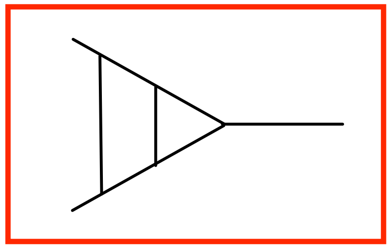
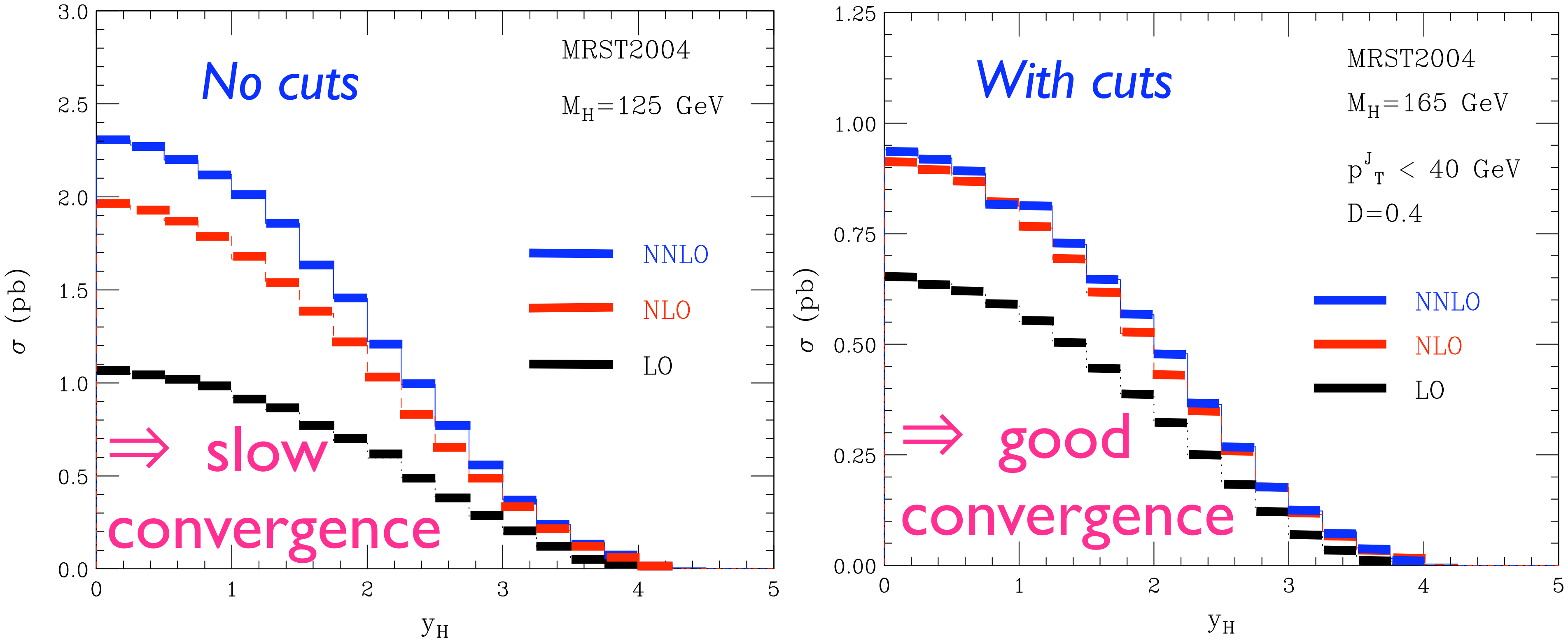


NNLO Higgs with $H \to 2l\, 2\nu$, $H \to 4l$

FEHIP, Anastasiou, Dissertori, Stoeckli '07
also: HNNLO Catani, Grazzini '08



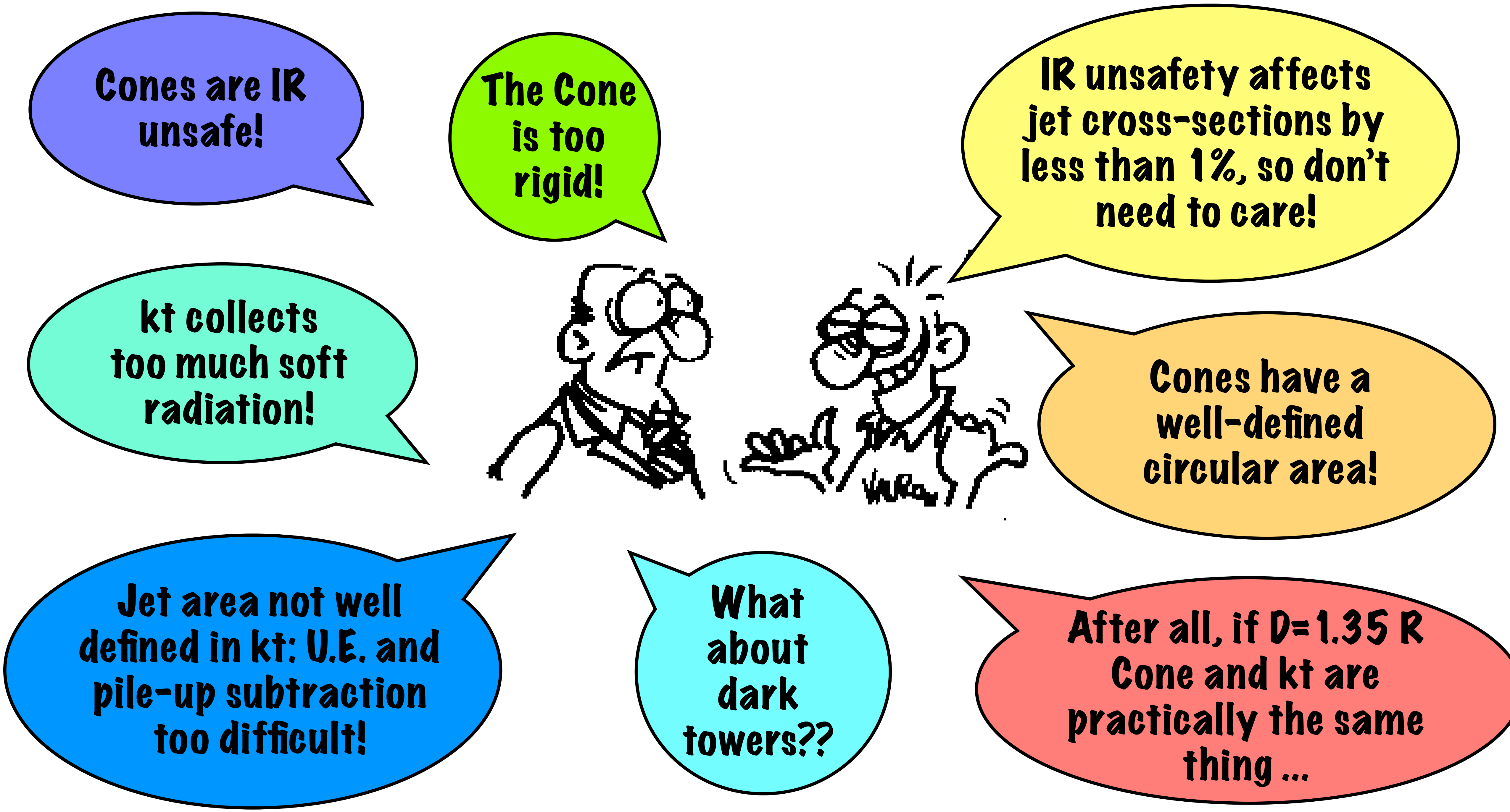
⇒ impact of NNLO dramatically reduced by cuts!

Very important to include cuts and decays in realistic studies!

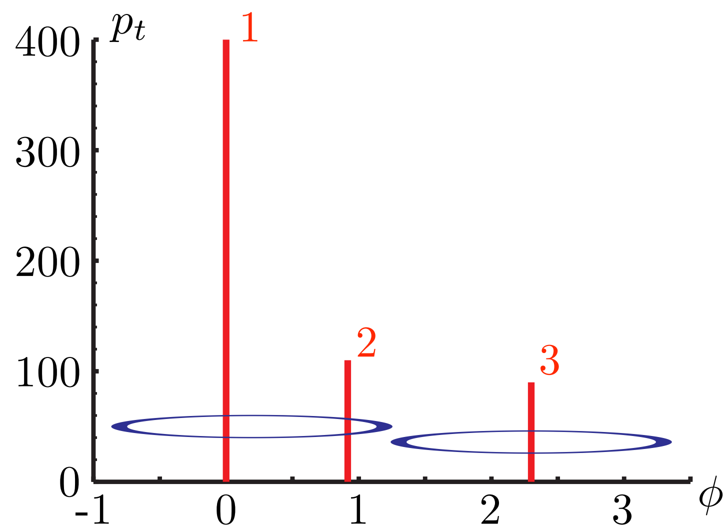
Also uncertainty reduced via resummation of soft gluons at N^{3}LO

Moch, Vermaseren '05

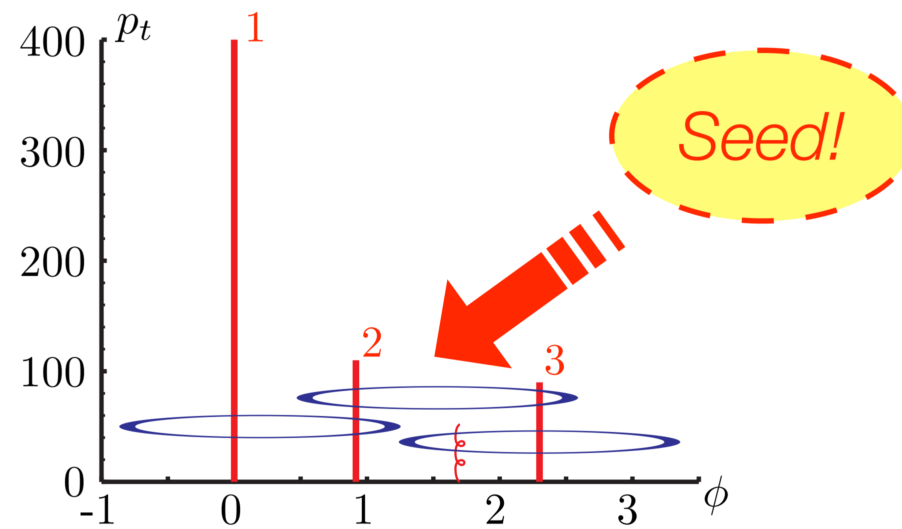
Jets: before 2006



Jets: infrared unsafety of midpoint



3 hard ⇒ 2 stable cones



3 hard + 1 soft ⇒ 3 stable cones

Soft emission changes the hard jets ⇒ algorithm is IR unsafe

Solution: use a seedless algorithm find all stable cones [⇒ jets]

SISCone: complexity $N^2 \log(N)$

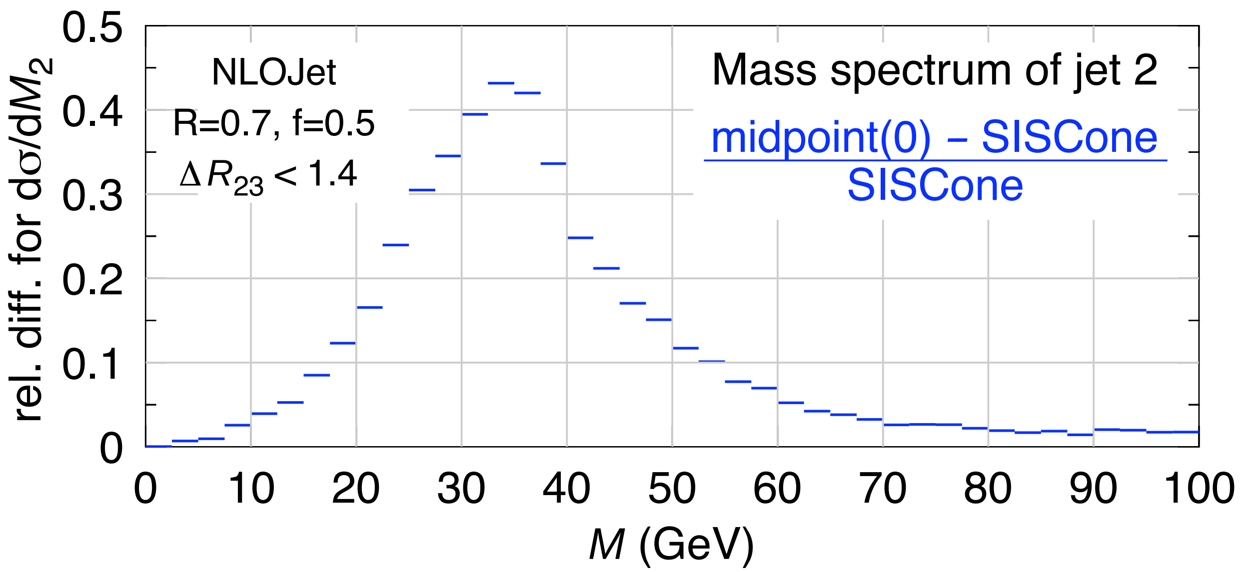
Salam, Soyez '07

Similarly: iterative cone is collinear unsafe

Solution: anti-kt algorithm

Cacciari, Salam, Soyez '08

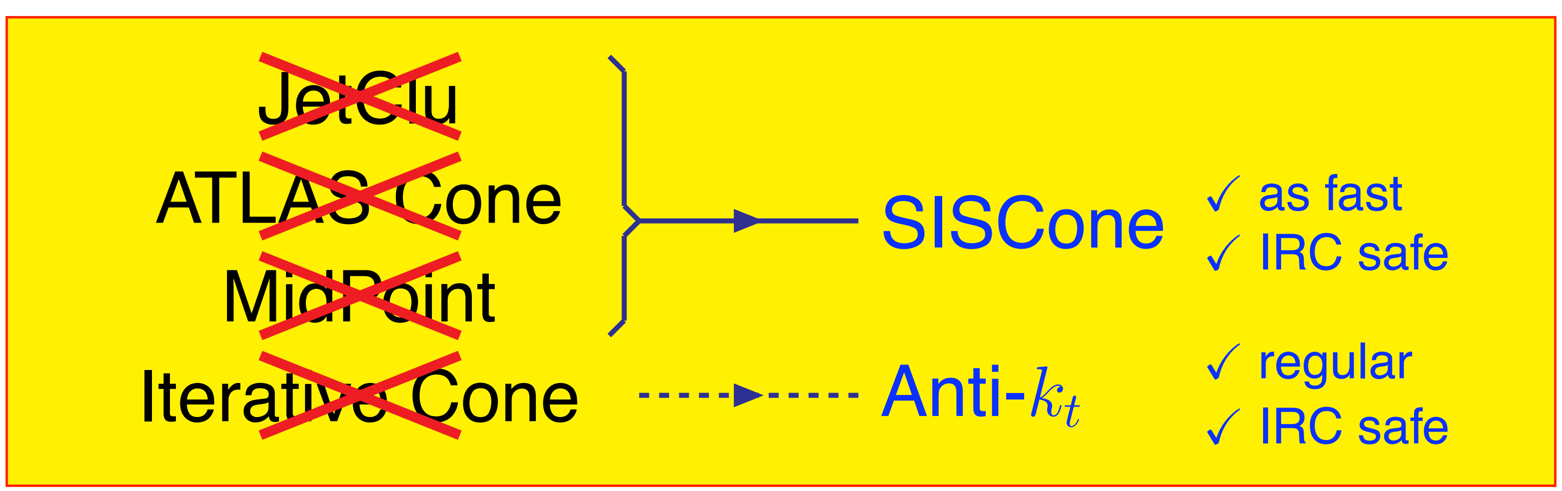
Physical impact of infrared unsafety



Up to 40% difference in mass spectrum

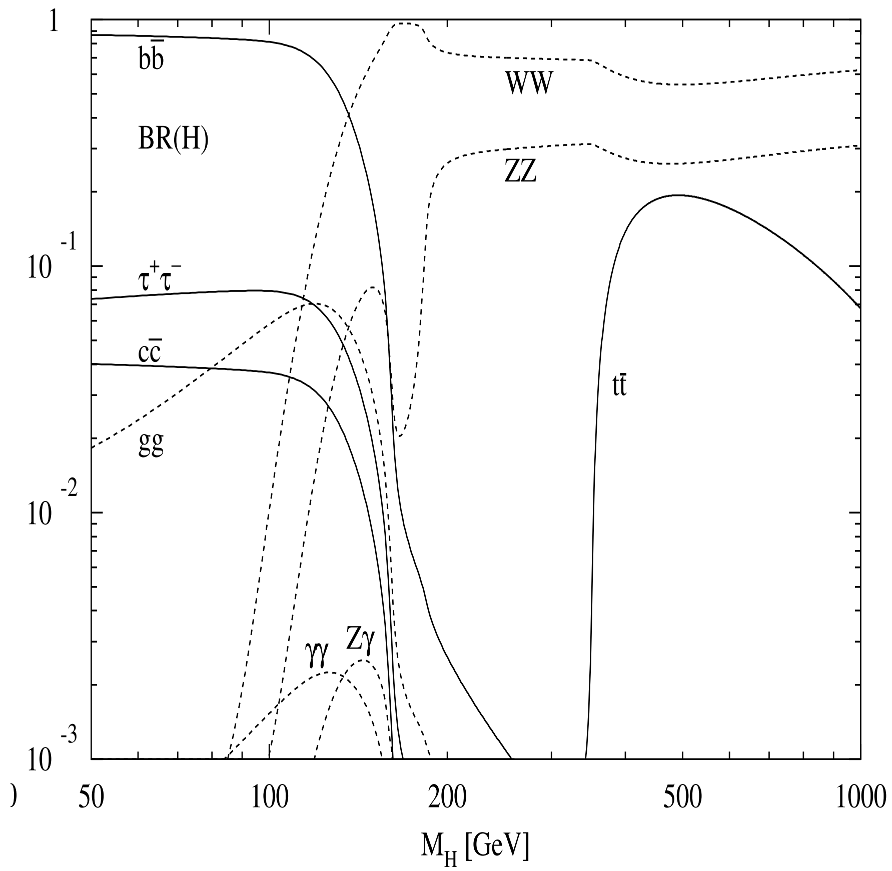
IR-unsafety is an issue at the LHC

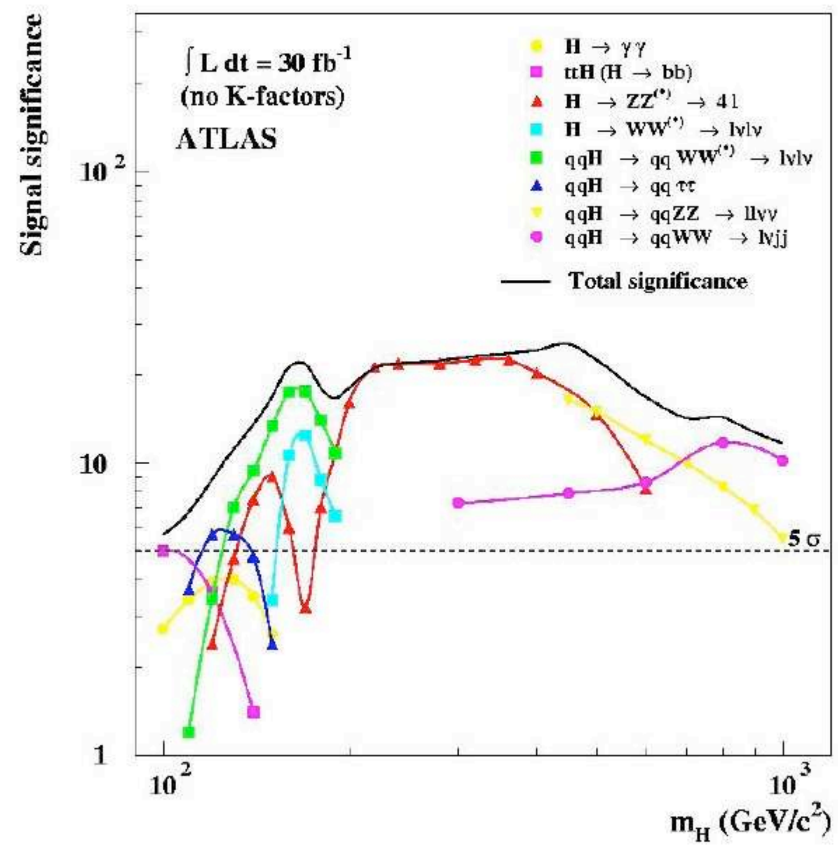
Observable	1st miss cones at	Last meaningful order
Inclusive jet cross section	NNLO	NLO
3 jet cross section	NLO	LO (NLO in NLOJet)
$W/Z/H$ + 2 jet cross sect.	NLO	LO (NLO in MCFM)
jet masses in 3 jets	LO	none (LO in NLOJet)



If you don't want theoretical efforts to be wasted!

Z/W+ H (→bb) rescued ?





⇒ Light Higgs hard: H→bb dominant, but overwhelmed by background

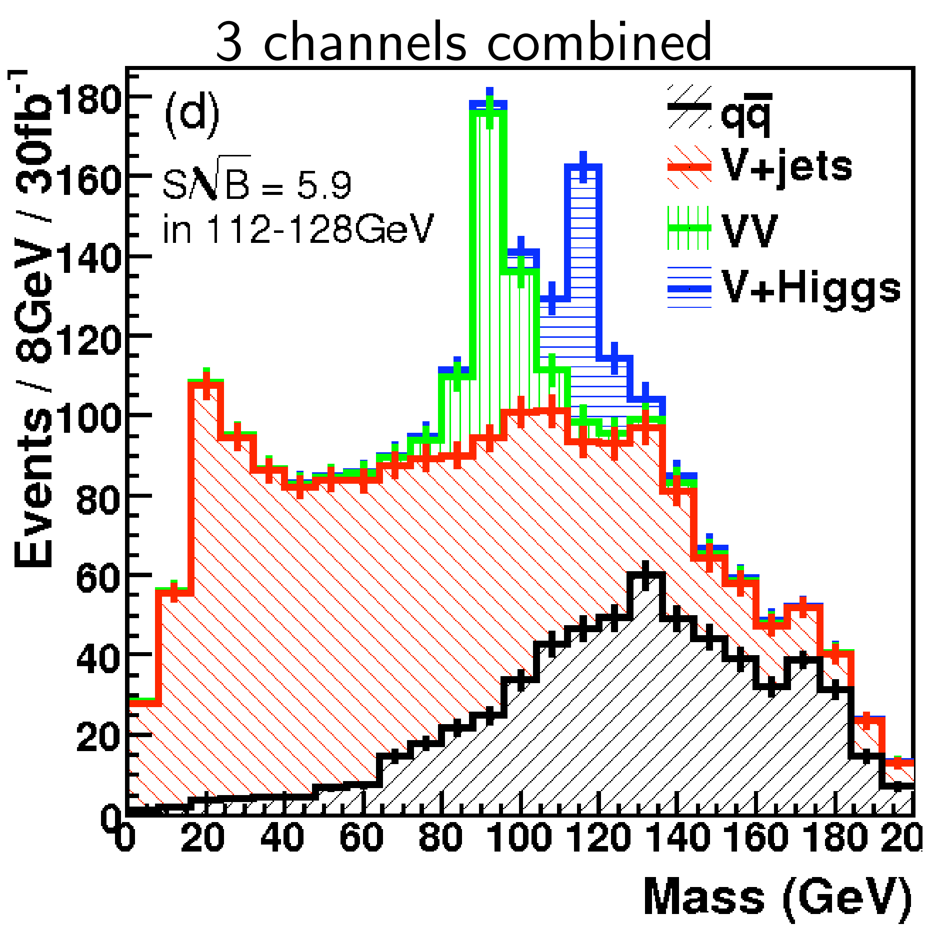
Conclusion [ATLAS TDR]:

The extraction of a signal from H → bb decays in the WH channel will be very difficult at the LHC even under the most optimistic assumptions [...]

Z/W + H (→bb) rescued ?

Boosted Higgs at high p_t: central decay products ⇒ single massive jet

Use jet-finding geared to identify the characteristic structure of fast-moving Higgs that decays into a bb-pair close in angle



- with common & channel specific cuts: p_{tV}, p_{tH} > 200GeV , ...
- real/fake b-tag rate: 0.7/0.01
- NB: very neat peak for WZ (Z →bb) Important for calibration

Butterworth, Davison, Rubin, Salam '08

5.9σ at 30 fb^{-1}: VH with H → bb recovered as one of the best discovery channels for light Higgs? More (exp) studies to come !

Conclusions

Impressive progress in the last years

- precision in parton densities
- higher orders (LO, NLO, NNLO & resummations)
- jets: many new ideas, impressive level of sophistication
- ... [much more, I did not have time to mention]

Progress driven by

- automation/flexibility/public codes
- good communication with experimentalists & common papers

Still many challenges ahead but QCD theory will provide solid basis for a successful physics program at the LHC

How often did you hear the statement that looking for BSM signals at the LHC might be like looking for a needle in a haystack?

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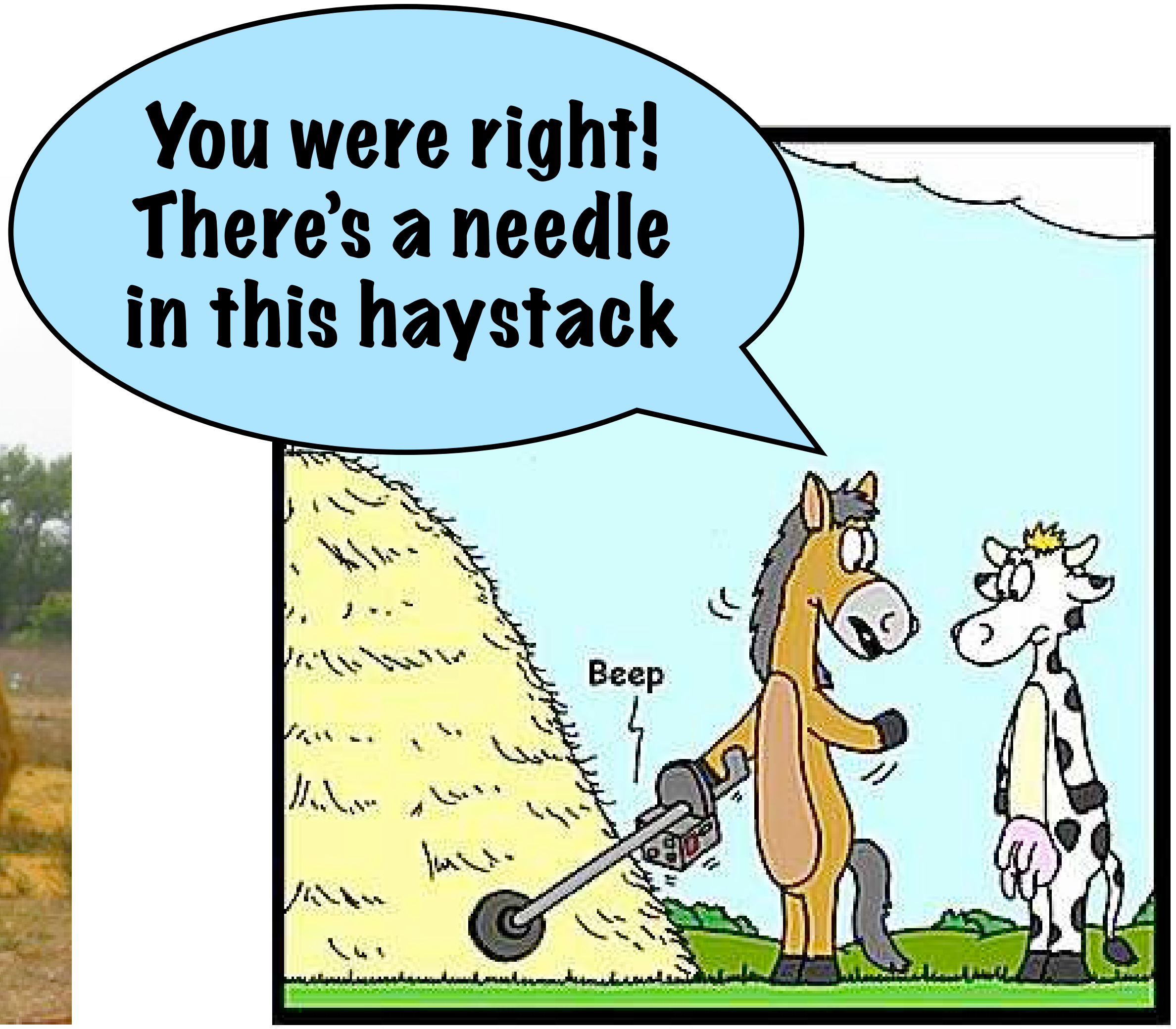
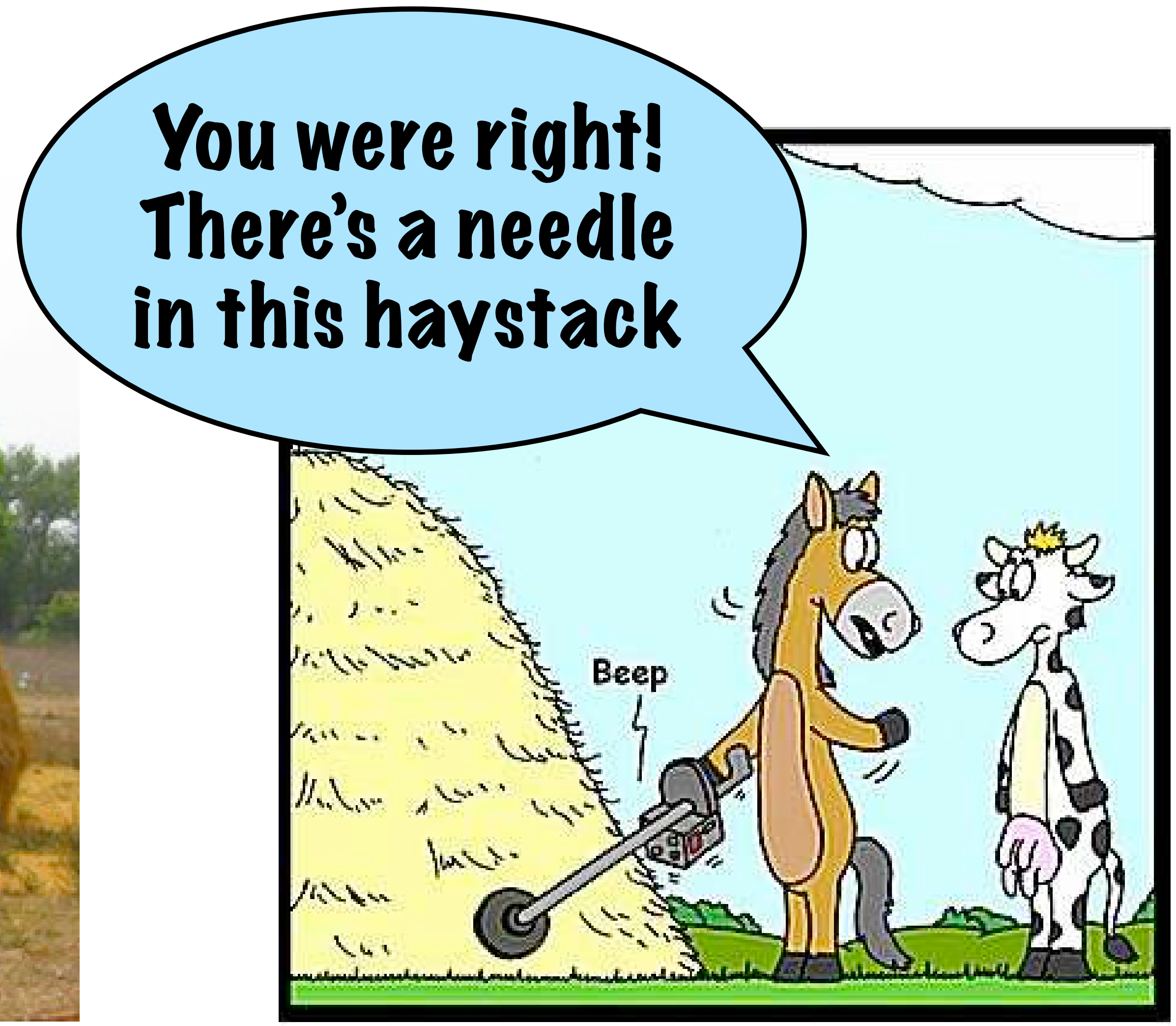


But at the end, it is all a matter of having the right tools.

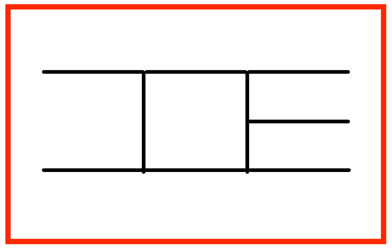
How often did you hear the statement that looking for BSM signals at the LHC might be like looking for a needle in a haystack?



But at the end, it is all a matter of having the right tools.

UNDERSTANDING QCD CRUCIAL TO DEVELOP THE RIGHT TOOLS!

Extra Slides



NLO + parton shower

<u>Combine best features:</u>

Get correct rates (NLO) and hadron-level description of events (PS)
Difficult because need exact NLO subtraction and remove it from PS

<u>Working LHC examples:</u>

- MC@NLO
  - W/Z boson production
  - WW, WZ, ZZ production
  - inclusive Higgs production
  - heavy quark production
  - single-top

Frixione&Webber '02 and later refs.

- POWHEG
  - ZZ production
  - heavy quark production
  - W/Z production
  - Higgs, single top ... in progress

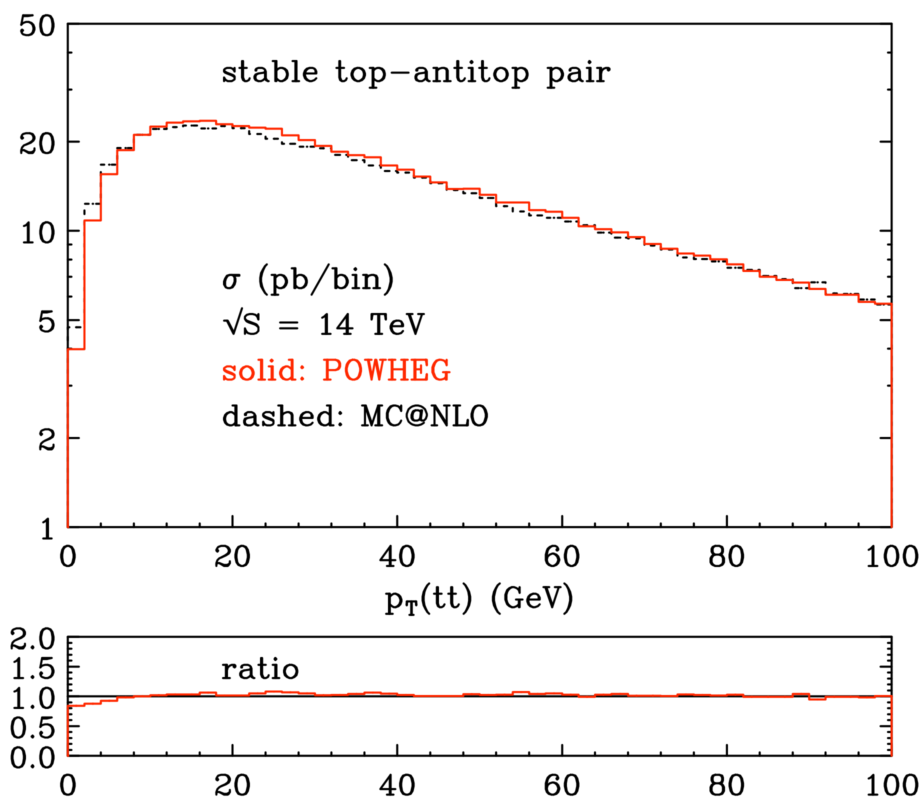
Nason '04 and later refs.

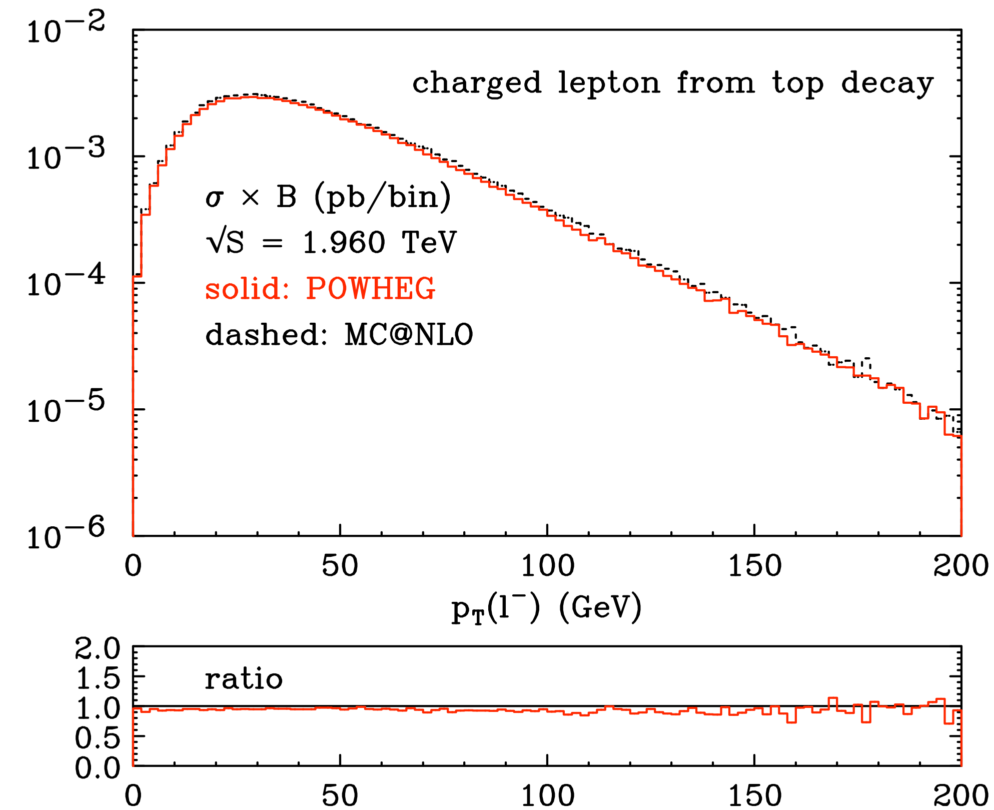
<u>Other recent progress:</u>

Shower with quantum inteference [Nagy, Soper], Geneve (SCET) [Bauer, Schwartz, Tackmann], Vincia (antenna factorization) [Giele et al.], Dipole factorization [Schumann]

MC@NLO vs PowHeg

Top pair production:

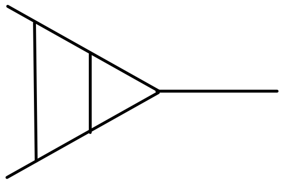




Frixione, Nason, Ridolfi '07

⇒ excellent agreement for all observables considered

(difference = different treatment of higher order terms)



tt cross-section at the LHC

- ☑ tt cross-section at NLO
  - scale uncertainty O(11%)
  - PDF & m_t uncertainty O(2-3%)

    Dawson, Ellis, Nason ’88; Beenakker ‘89

- ☐ experimental goal O(5%)

  Need NNLO!

  Similar aim:
  WW cross section at NNLO

- ☐ Pinning down the tt cross-section
  - ✓ NLO + NLL resummed threshold corrections

    Cacciari, Frixione, Mangano, Nason, Ridolfi ’08
  - ✓ two-loop virtual qq → tt and gg → tt at O(m_t^2/s)

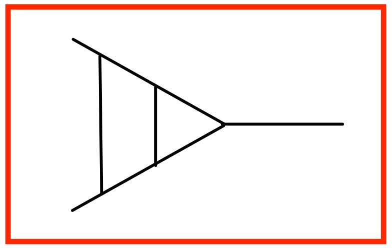
    Czakon, Mitov, Moch ’07, ’08
  - ✓ full mass dependence at two-loops for qq → tt

    Czakon ’08
  - ✓ $\mathrm{NNLO}_{\mathrm{approx}}$ (threshold logs + Coulomb + scale variation)

    Moch, Uwer ’08; also Kidonakis, R.Vogt ’08
  - ✓ analytic two-loop fermionic corrections for qq → tt

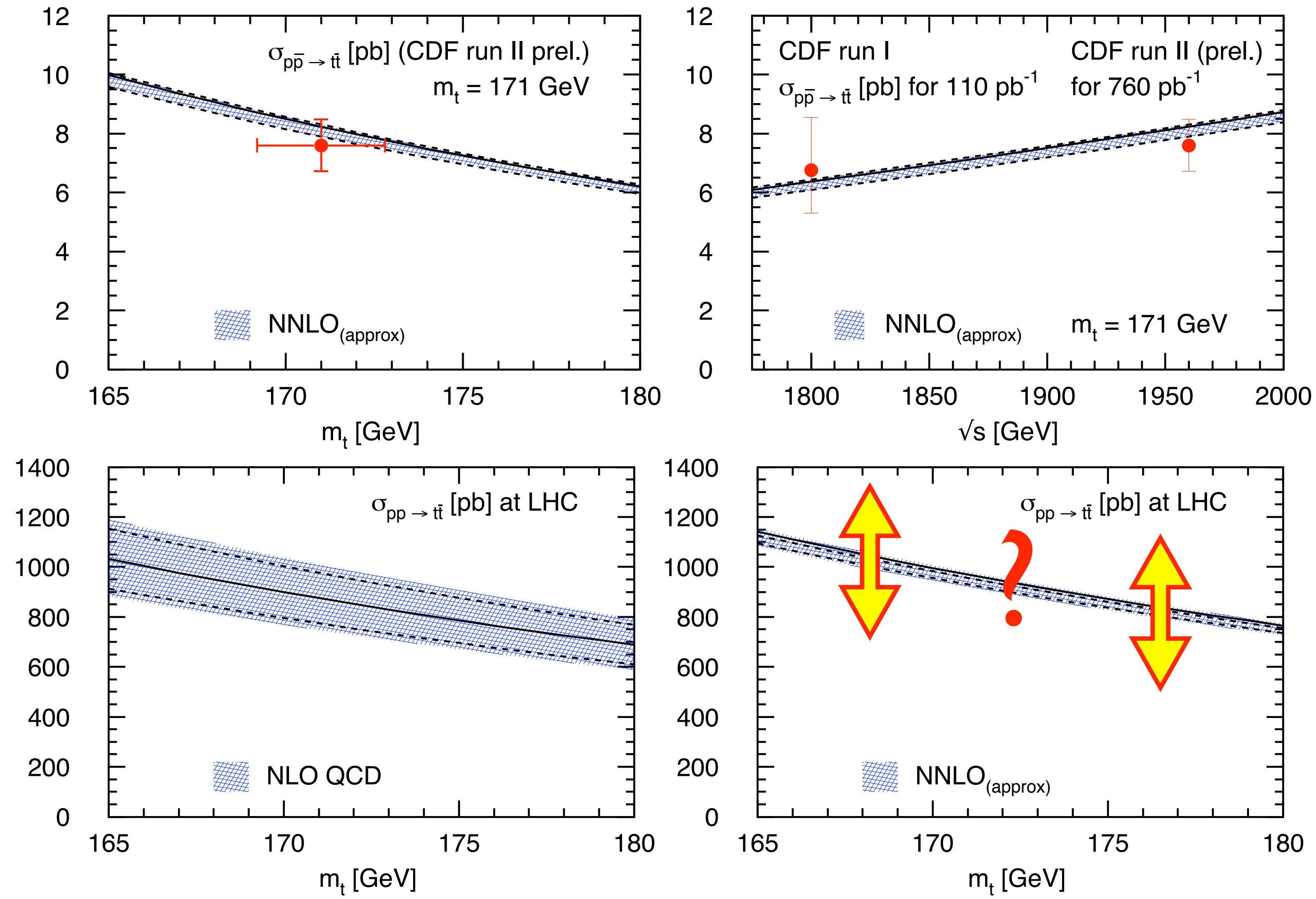
    Bonciani, Ferroglia, Gehrmann, Maitre, Studerus ’08
  - ✓ one-loop squared

    Koerner, Merebashvili, Rogal ’08



Towards NNLO tt

Moch, Uwer '08

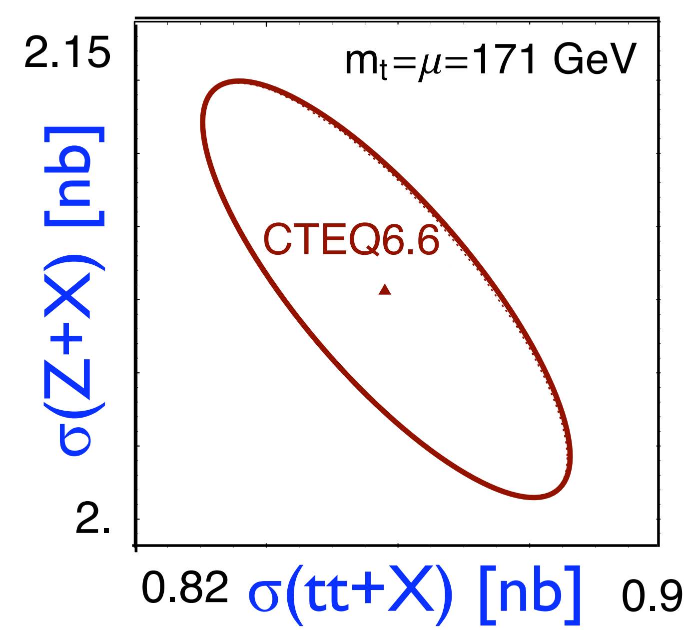


NB: band = simultaneous variation of μ_F and μ_R

- m_t from tt cross-section?
- tt promoted to luminosity monitor?

NB: PDFs in tt anti-correlated to W/Z

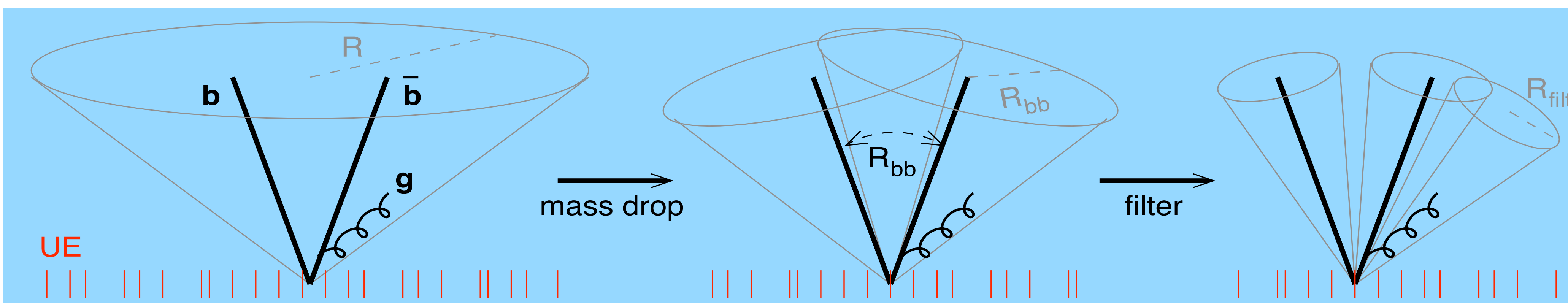
Nadolsky et al. '08



Z/W + H (→bb) rescued ?

Boosted Higgs at high p_t: central decay products ⇒ single massive jet

Use jet-finding geared to identify the characteristic structure of fast-moving Higgs that decays into a bb-pair close in angle



1. cluster the event with e.g. CA algo and large-ish R
2. undo last recomb: large mass drop + symmetric + b tags
3. filter away the UE: take only the 3 hardest sub-jets

Related ideas for 2- and 3-body decays (boosted tops): Butterworth, Cox & Forshaw; Butterworth, Ellis & Raklev; Skiba & Tucker-Smith; Hodom; Baur; Agashe et al; Lille, Randall & Wang; Contino & Servant; Brooijmans; Thaler & Wang; Kaplan et al.; Almeida et al. [...]

Quality measures of jets

Suppose you are searching for a heavy state (H→gg, Z'→qq, ...)

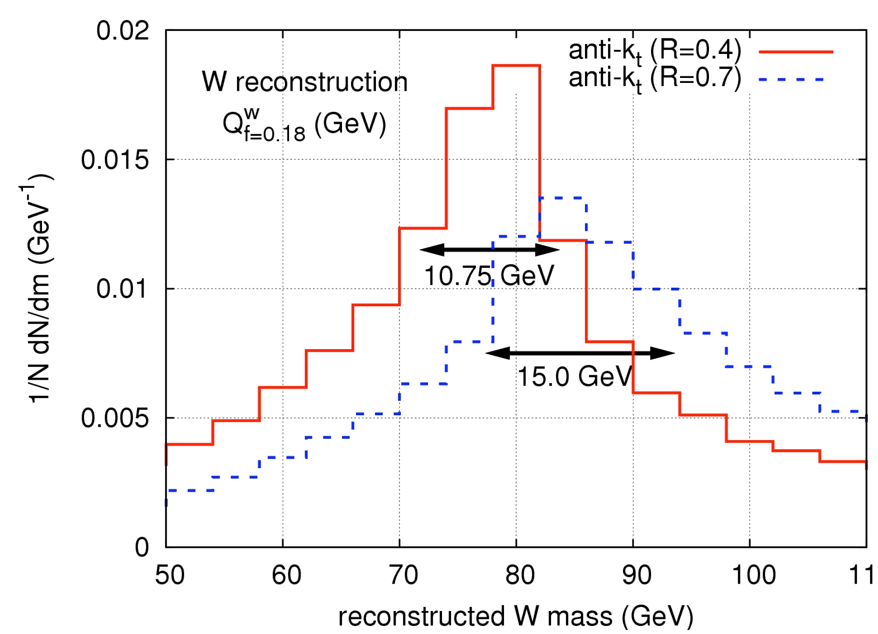
The object is reconstructed through its decay products

⇒ *Which jet algorithm (JA) is best ? Does the choice of R matter?*

Define: Q^w_f(JA, R) ≡ width of the smallest mass window that contains a fraction f of the generated massive objects

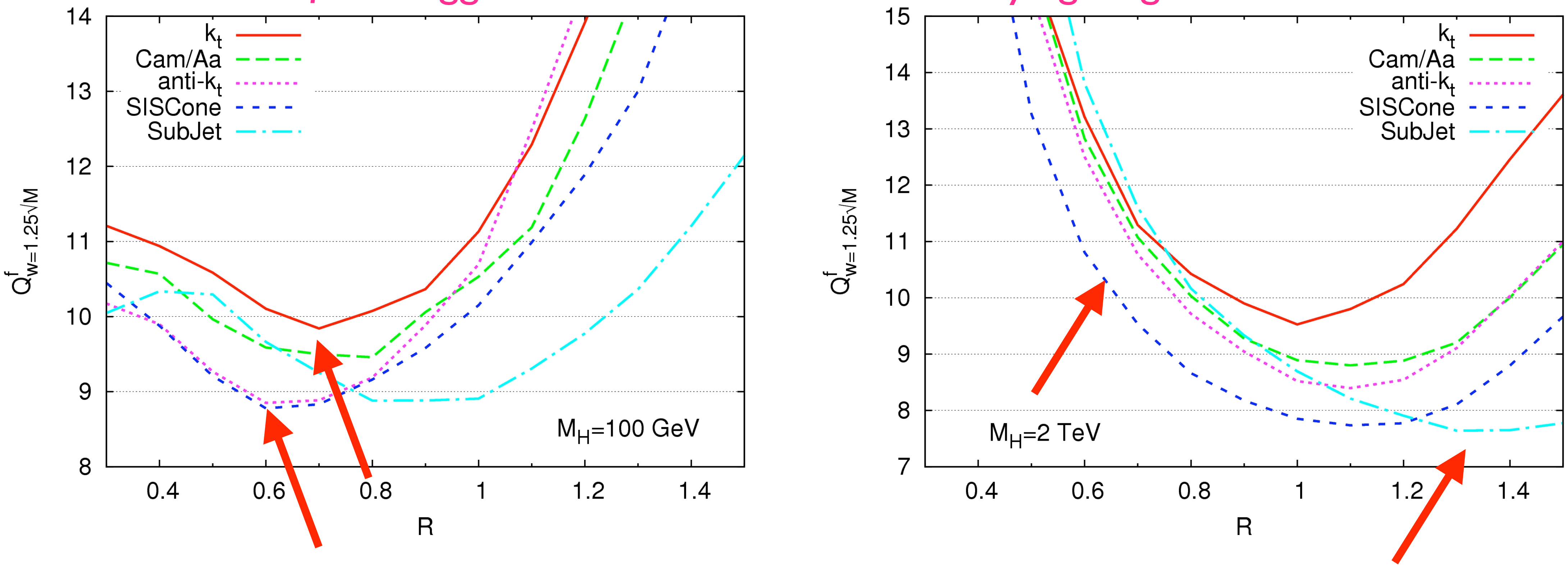
- good algo ⇔ small Q^w_f(JA, R)
- ratios of Q^w_f(JA,R): mapped to ratios of effective luminosity (with same $S/\sqrt{B}$)

$$\mathcal{L}_2 = \rho_{\mathcal{L}} \mathcal{L}_1 \qquad \rho_{\mathcal{L}} = \frac{Q_z^f(JA_2, R_2)}{Q_z^f(JA_1, R_1)}$$



Quality measures: sample results

NB: Here "fake Higgs" = narrow resonance decaying to gluons



- At 100GeV: use a Tevatron standard algo (k_t, R=0.7) instead of best choice (SISCone, R=0.6 $\Rightarrow$ lose $\rho_{\mathcal{L}} = 0.8$ in effective luminosity
- At 2 TeV: use $M_{Z'}$=100GeV best choice (or k_t) instead CAfilt, R=0.9 $\Rightarrow$ lose $\rho_{\mathcal{L}} = 0.6$ in effective luminosity

A good choice of jet-algorithm does matter!
Bad choice of algo $\Leftrightarrow$ lost in discrimination power!