Cascade group meeting

CASCADE news

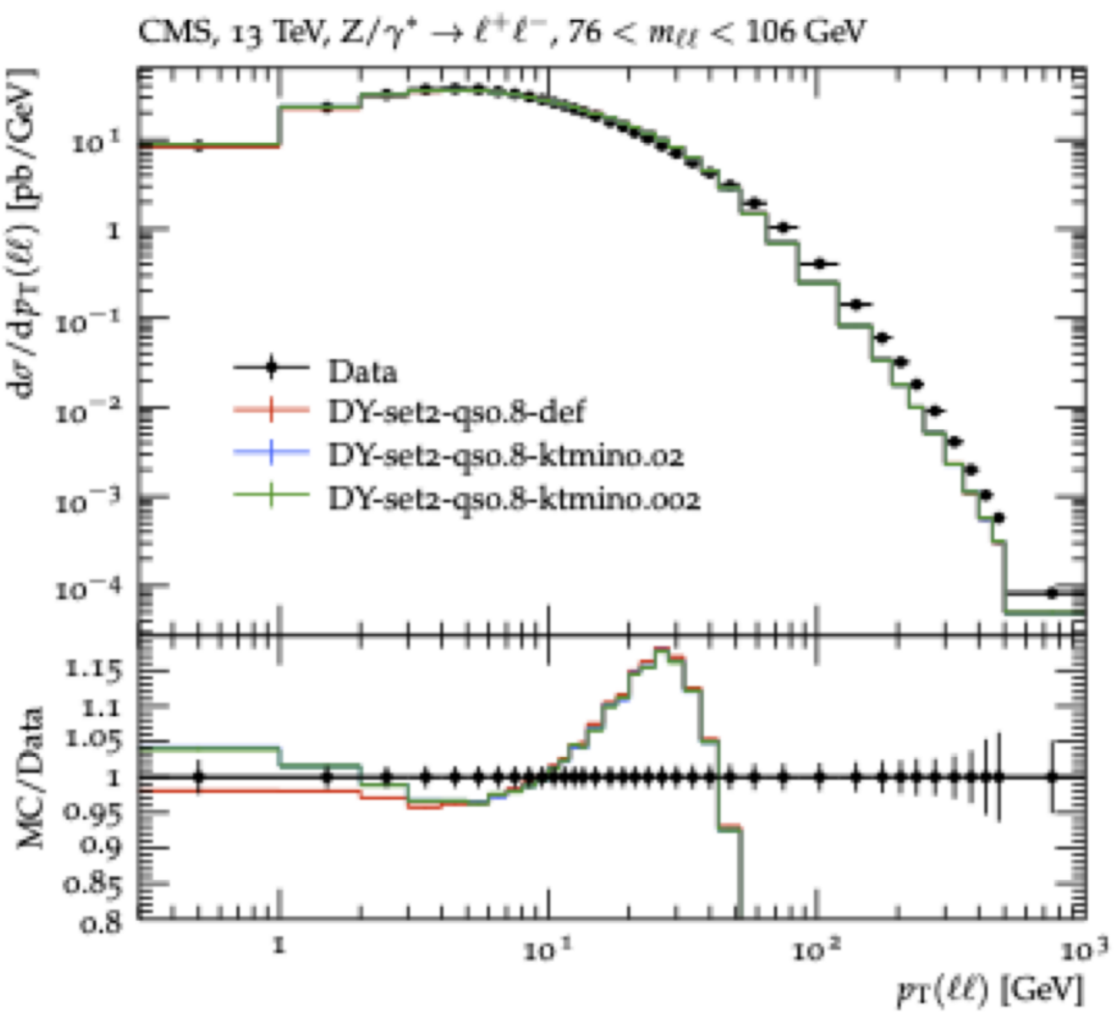
- New version ready: 3.3.1
  - timing and Maxfactor
    - tested: significant increase in speed (and simplicity)
  - new version released in git and hepforge

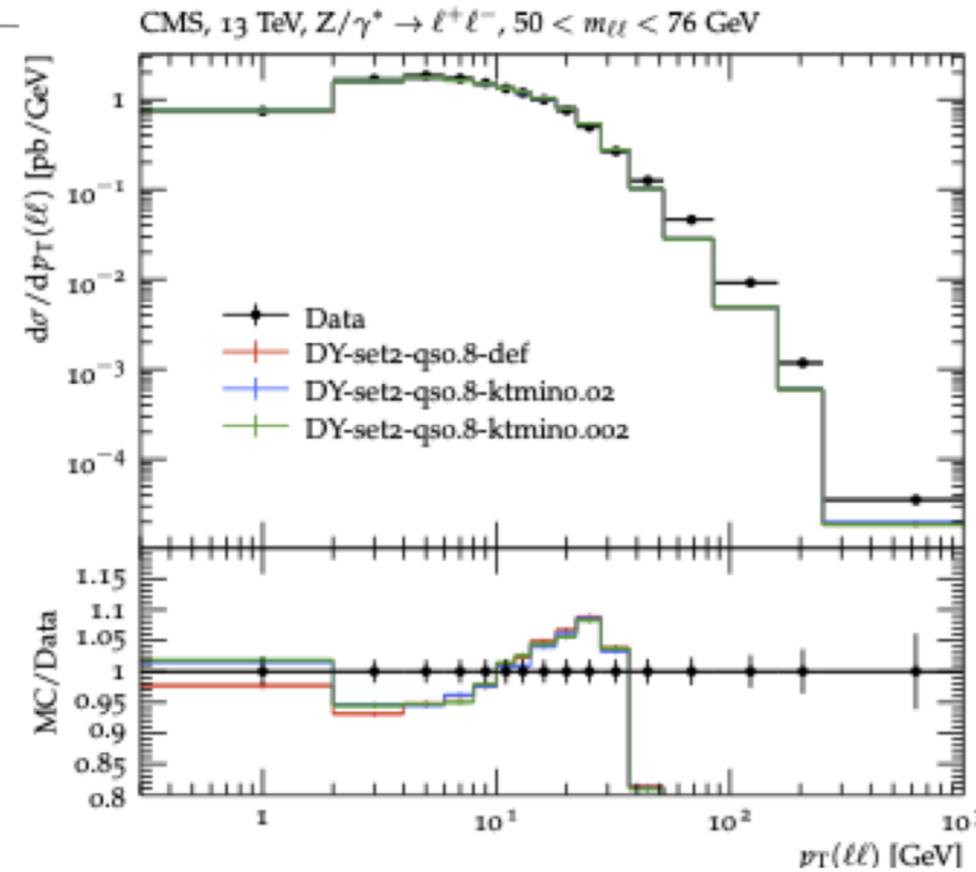
- Please note that rivet version 3.1.5 – 3.1.7 have issues with scale uncertainties, these versions should not be used

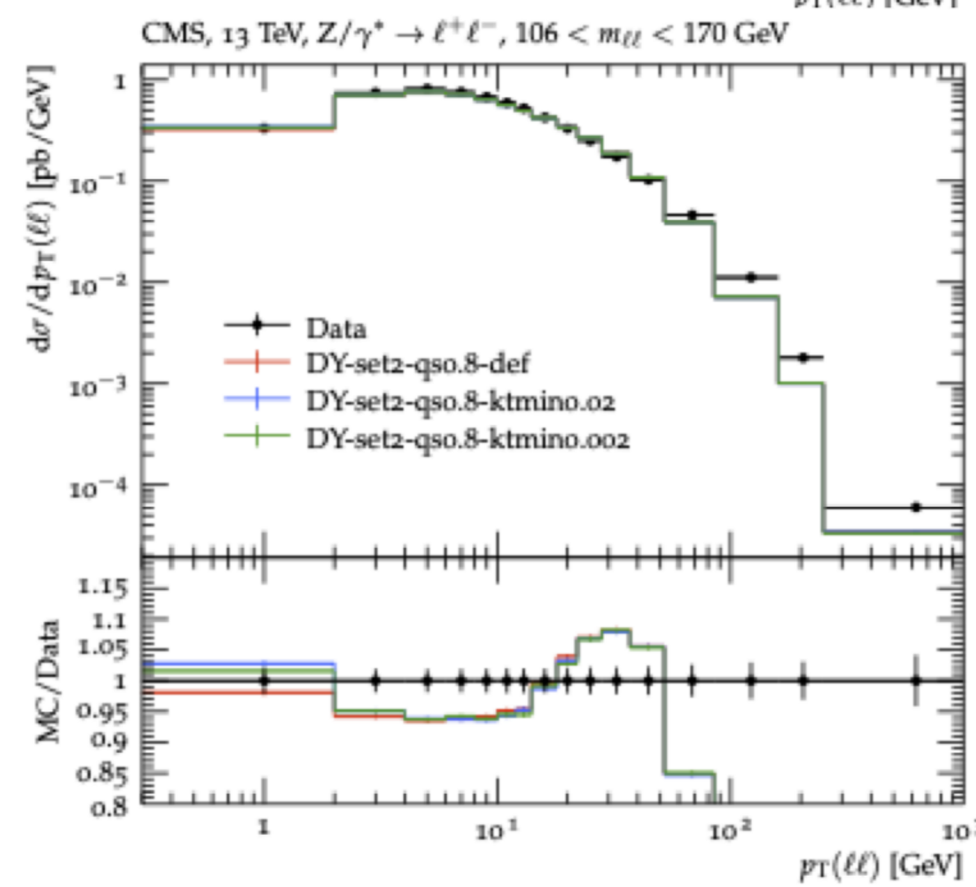
ktmin in CASCADE

- ktmin is lower limit of k_T to be generated in CASCADE
- check with TMD with very low limit

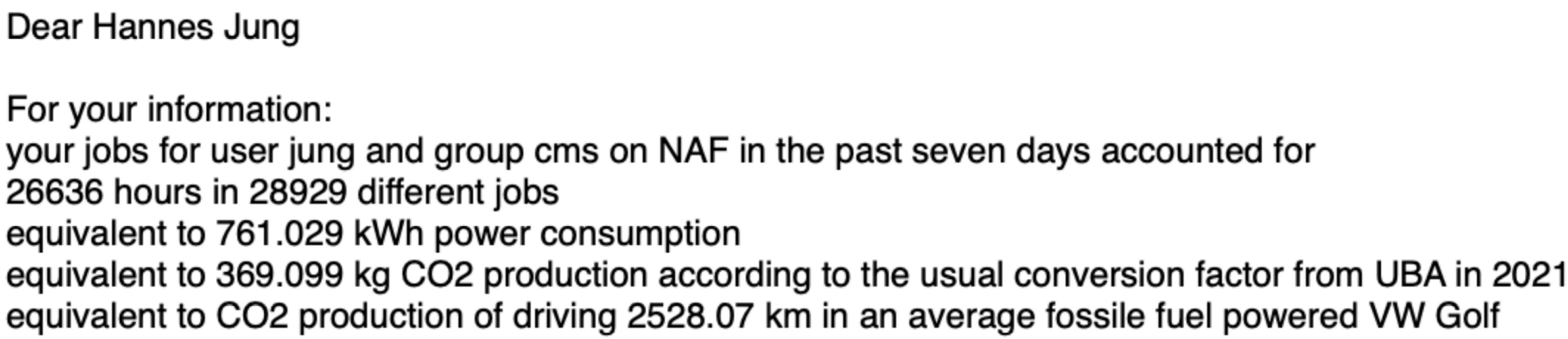
- ktmin=0.02 is safe for DY processes at LHC !







Computing and environment


Dear Hannes Jung

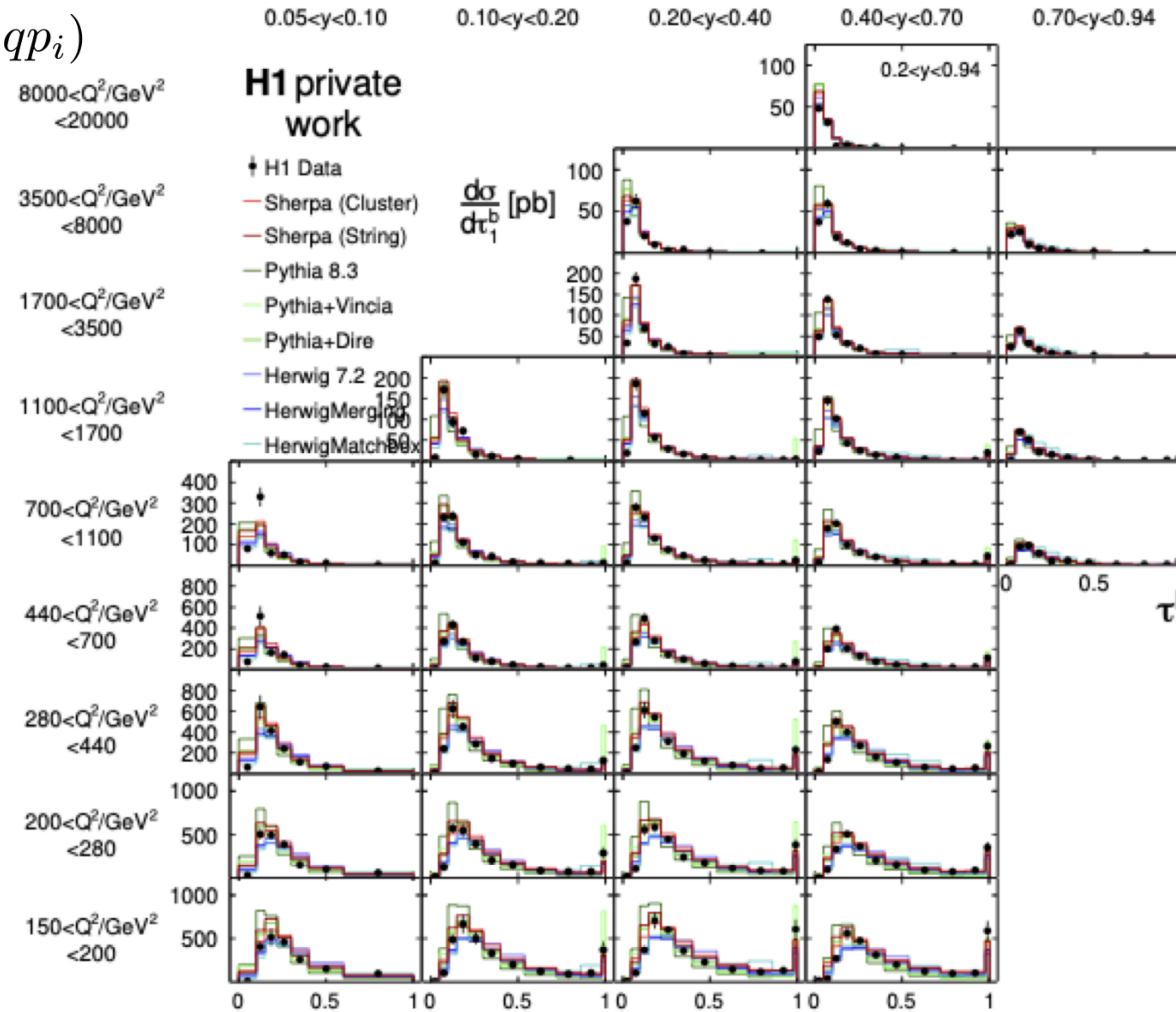
For your information:
your jobs for user jung and group cms on NAF in the past seven days accounted for
26636 hours in 28929 different jobs
equivalent to 761.029 kWh power consumption
equivalent to 369.099 kg CO2 production according to the usual conversion factor from UBA in 2021
equivalent to CO2 production of driving 2528.07 km in an average fossile fuel powered VW Golf

- Need to work on faster processing – CASCADE is too slow
  - help is needed !

Request of calculation for DIS: DIS - jetiness

- request from H1:

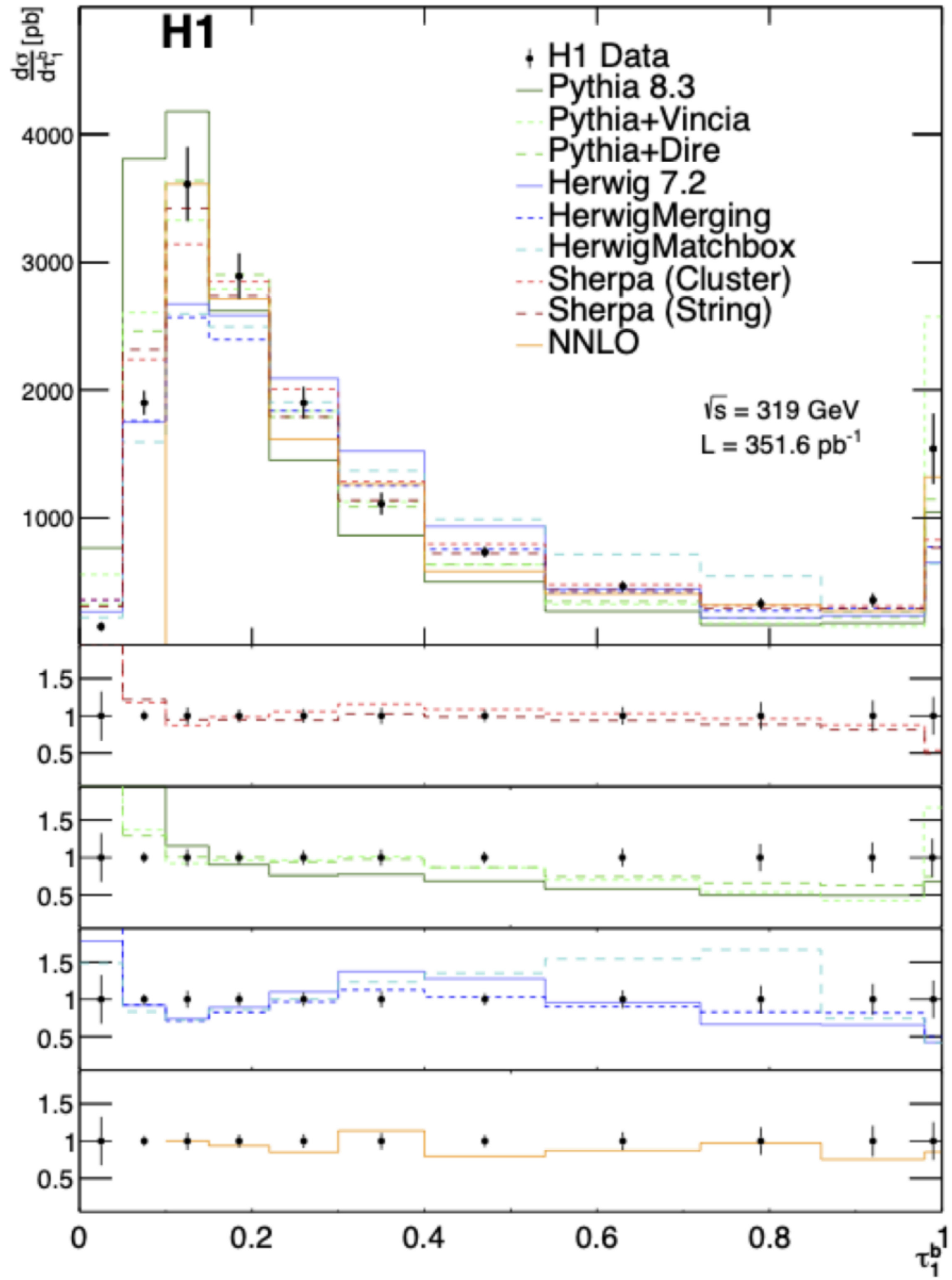
$$\tau_{1b} = 1 + \frac{2}{Q^2} \sum_i \min(0, qp_i)$$



Request of calculation for DIS: DIS - jettiness

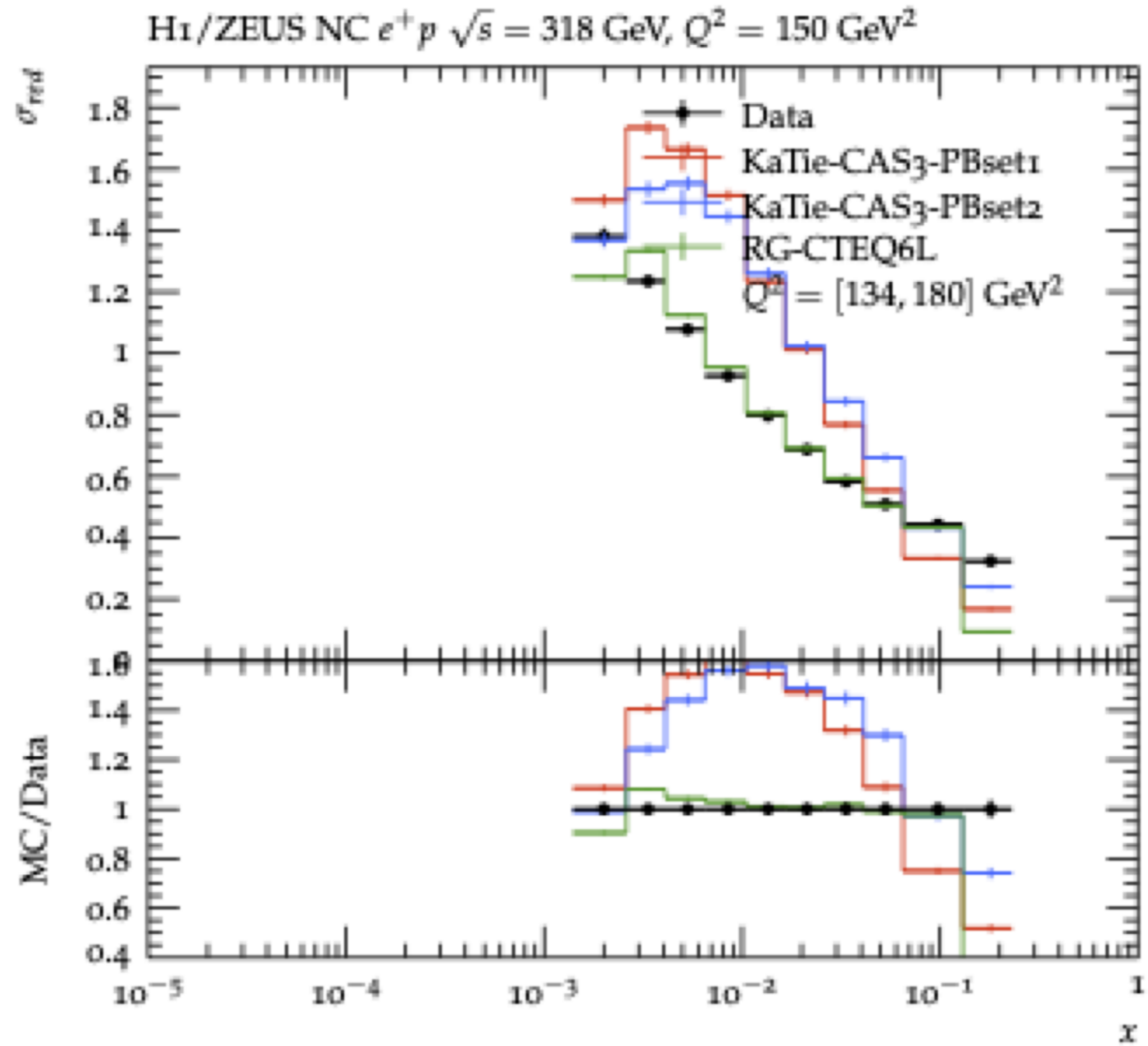
- request from H1:

$$\tau_{1b} = 1 + \frac{2}{Q^2} \sum_i \min(0, qp_i)$$



Request of calculation for DIS: DIS calculations

- Use TMDs with on-shell (or off-shell) ME
  - difficulties to describe F2
    - coming of finite kt
- Why is PB in DIS so bad ?



Request of calculation for DIS: DIS calculations

- We should provide calculations with CASCADE:
  - who is interested ?
    - Rivet plugin is existing !

New papers

- The small kt region in DY production at NLO with the parton branching method
  - pheno applications, determination of intrinsic kt
  - determine qs as fct of m_DY at 13 TeV
  - determine qs as fct of m_DY at 8 TeV ?
    determine qs as fct of m_DY at lower energies ?
- This paper is open and will stay open:
  - Please reply to me, if you want to be co-author, after reading and commenting

Treatment of systematic uncertainties

- χ^2 calculation with Covariance matrix representation C_{ik}

from HERAFITTER paper
Eur. Phys. J. C (2015) 75:304

$$\chi^2(\mathbf{m}) = \sum_{i,k}(m_i - \mu_i)C_{ik}^{-1}(m_k - \mu_k)$$

$$C_{ik} = C_{ik}^{stat} + C_{ik}^{uncorr} + C_{ik}^{sys}$$

  - this is the calculation used now: this is very new in data-MC comparison !

- χ^2calculation with nuisance parameter representation

$$\chi^2(\mathbf{m},\mathbf{b}) = \sum_i \frac{\left[\mu_i - m_i\left(1 - \sum_j \gamma_j^i b_j\right)\right]^2}{\delta_{i,unc}^2 m_i^2 + \delta_{i,stat}^2 \mu_i m_i \left(1 - \sum_j \gamma_j^i b_j\right)} + \sum_j b_j^2$$

  - with δ_i relative tat and uncorr syst uncertainty, $\gamma_j{}^i$, sensitivity of measurement to correlated sys source, and b_j , nuisance parameters, to be determined in fit

- both χ^2 definitions are not the same (?), but give a quantitative estimate of the deviation of the theory form the measurement

Calculation of χ^2

- issues with normalization, can be included with scale factor:

CMS_2022_I2079374

d01-x01-y01 (50 < m <76) (5 bins)

qs	norm					
	0.95	0.975	1.0	1.025	1.05	chi2/ndf
0	169,6,117.6	106.6,71.5	64.2,29.8	42.5,22.7		
0.1	173.4,121.6	106.5,73.1	60.1,39.0	34.2,19.2	28.6,13.8	
0.3	167.1,116.4	103.8,70.1	61.0,38.3	38.8,21.0	37.3,18.2	
0.6	161.5,113.3	96.1,66.1	51.1,33.2	26.7,14.9	22.8,11.0	
0.9	184.4,129.1	111.7,77.2	59.2,40.0	26.8,16.2	**14.6,7.0**	**2.9,1.4**
1.3	228.3,153.9	149.1,98.1	89.6,56.2	49.9,28.3	30.0,14.4	
1.6	327.4,204.9	244.1,146.2	180.2,101.3	135.9,70.2	111.0,52.8	
1.9	427.4,254.6	342.2,194.5	276.3,147.9	229.6,115.1	202.2,95.8	

d03-x01-y01 (75 < m <106) (10 bins)

qs	norm					
	0.95	0.975	1.0	1.025	1.05	
0	623.2,231.1	369.6,123.7	210.7,63.9	146.1,51,7		
0.1	622.6,229.5	370.6,123.2	213.3,64.6	150.6,53.7	182.5,90.4	
0.3	590.3,225.1	338.4,116.2	182.1,54.7	118.6,40.8	150.7,74.4	
0.6	540.2,224.3	287.8,108.9	130.2,40.6	67.3,19.6	99.1,45.7	
0.9	508.0,241.0	255.1,116.8	97.0,39.4	**33.6,8.6**	64.9,24.6	**3.4,0.9**
1.3	603.7,320.6	348.4,183.9	187.7,93.3	121.4,48.6	149.6,49.8	
1.6	802.1,438.4	546.5,291.9	385.0,190.6	317.8,134.7	344.8,124.0	
1.9	1155,611.9	899.5,456.5	737.2,345.7	668.6,279.6	693.8,258.0	

d05-x01-y01 (106 < m <170) (5 bins)

qs	norm					
	0.95	0.975	1.0	1.025	1.05	
0	156.4,100.9	102.9,61.5	71.16,37.0	61.3,27.6		
0.1	154.0,100.9	98.6,60.3	64.9,34.7	53.0,24.1	62.8,28.4	
0.3	154.9,102.2	98.16,60.8	63.1,34.3	49.7,22.8	58.0,26.2	
0.6	152.6,104.3	89.9,59.5	48.5,29.4	28.6,14.0	30.0,13.42	
0.9	157.8,110.2	88.6,61.6	40.5,27.6	13.5,8.2	**7.5,3.3**	**1.5,0.7**
1.3	194.4,130.2	117.3,77.2	60.8,38.5	24.9,14.2	9.6,4.2	
1.6	258.3,165.5	174.3,108.1	110.4,63.8	66.7,34.5	43.3,19.2	
1.9	364.4,213.2	273.7,153.3	205.8,107.4	157.8,75.3	129.8,57.1	

Find a consistent minimum

Calculation of χ^2

- investigate factorization, renormalization scale uncertainty

Cut: 10 GeV

CMS_2022_I2079374

d01-x01-y01 (50 < m <76) (5 bins)

qs	R0.5_F0.5	R0.5_R1.0	R0.5_R2.0	R1.0_F0.5	R1.0_F1.0	R1.0_F2.0	R2.0_F0.5	R2.0_F1.0	R2.0_F2.0	**chi2/ndf**
0	151.7,104.4	230.6,160.6	309.3,216.0	59.2,36.2	64.2,39.8	70.8,44.4	71.8,45.9	46.9,26.5	40.6,20.8	
0.1	154.7,107.9	236.5,195.9	317.5,222.9	55.8,35.5	60.1,39.0	64.4,43.5	71.2,46.7	40.6,24.1	30.1,15.9	
0.3	149.1,102.7	226.8,158.0	304.3,212.6	56.2,34.9	61.0,38.3	67.3,42.6	68.3,44.9	41.0,24.0	34.0,17.7	
0.6	143.8,100.3	223.2,156.8	302.3,212.5	48.6,30.8	51.1,33.2	56.0,37.0	64.4,41.7	33.1,19.4	22.1,11.5	
0.9	166.0,115.6	240.5,174.9	331.8,232.7	54.2,37.7	59.2,39.6	63.1,43.1	76.7,50.5	36.2,22.4	**18.0,10.2**	**3.6,2.0**
1.3	202.6,135,9	290.1,197.6	375.6,257.3	91.3,55.6	89.6,56.2	91.5,58.8	119.6,74.6	68.0,39.7	40.5,22.0	
1.6	305.7,189.1	395.1,252.5	482.0,313.6	184.1,101.8	180.2,101.3	180.3,103.1	206.0,118.4	150.5,80.6	118.7,60.1	
1.9	407.0,238.4	498,3,303.0	586,9,365.0	279.7,148.3	276.3,147.9	276.5,149.8	298,8,165.1	241.5,125.4	20.7.9,103.2	

d03-x01-y01 (75 < m <106) (10 bins)

qs	R0.5_F0.5	R0.5_F1.0	R0.5_F2.0	R1.0_F0.5	R1.0_F1.0	R1.0_F2.0	R2.0_F0.5	R2.0_F1.0	R2.0_F2.0	
0	422.2,145.4	590.1,215.8	759.5,288.1	223.0,66.5	210.6,63.9	208.3,64.6	281.1,86.7	170.6,51.7	145.9,55.6	
0.1	425.1,145.3	592.4,215.2	761.6,287.3	225.4,66.9	213.3,64.7	211.0,65,4	279.6,85.7	172.5,52.5	149.5,57.4	
0.3	391.8,138.5	557.4,209.2	725.0,281.7	194.4,58.1	181.2,54.7	178.1,54.8	251.0,70.0	141.3,41.7	117.4,43.8	
0.6	340.6,132.9	501.9,205.6	666.3,280.0	148.6,47.1	130.2,40.6	123.0,38.5	209.3,72.0	94.1,25.9	65.5,21.0	
0.9	309.9,143.7	465.2,218.8	624.8,295.1	122.2,50.3	97.0,39.4	84.4,34.1	181.9,79.8	62.7,21.5	**29.1,7.2**	**2.9,0.72**
1.3	401.8,213.4	546.5,291.9	698.3,371.3	227.3,111.1	187.7,93.3	163.8,83.0	299.7,149.2	161.0,72.4	112.8,43.3	
1.6	602.7,325.6	740.3,407.2	886.5,489.3	433.0,213.2	385.0,190.6	354.2,176.9	506.0,255.1	360.2,165.3	305.11,125.6	
1.9	952.9,491.0	1080,575,4	1219,658.0	798.1,374.1	737.2,345.7	696.1,327.7	884.1,425.1	772.5,320.2	654.4,268.5	

d05-x01-y01 (106 < m <170) (5 bins)

qs	R0.5_F0.5	R0.5_R1.0	R0.5_R2.0	R1.0_F0.5	R1.0_F1.0	R1.0_F2.0	R2.0_F0.5	R2.0_F1.0	R2.0_F2.0	
0	99.1,58.7	120.0,72.9	140.0,86.7	72.4,39.6	71.2,37.0	71.9,36.2	74.4,42.6	60.7,29.8	61.6,27.8	
0.1	94.2,57.5	115.8,72.2	136.6,86.4	66.7,37.6	64.9,34.7	65.2,33.7	70.4,41.2	55.1,27.5	54.7,24.8	
0.3	94.8,58.1	115.7,72.4	135.7,86.3	66.1,37.8	63.1,34.3	62.5,32.8	65.1,41.4	51.3,26.2	49.1,22.4	
0.6	85.6,56.4	107.7,71.6	128.9,86.3	54.5,34.4	48.5,29.4	45.9,26.8	60.3,39.2	35.6,20.2	28.0,13.6	
0.9	83.5,57.9	106.8,74.1	129.2,89.5	49.2,34.0	40.5,27.6	35.9,24.1	56.9,40.0	25.1,17.0	**12.0,7.2**	**2.4,1.4**
1.3	113.1,73.8	137.2,90.8	160.5,107.2	74.1,47.0	60.8,38.5	52.5,33.4	82.4,53.3	41.9,25.9	21.1,12.1	
1.6	170.7,103.7	196.1,121.7	220.5,139.0	126.8,74.0	110.4,63.75	99.7,57.3	135.2,80.9	87.1,48.7	60.2,31.2	
1.9	268.1,149.3	293.2,167.5	317.4,184,.9	225.8,119.4	205.8,107.4	192.3,99.5	236,9,127.8	183.0,92.3	151.0,72.0	

d07-x01-y01 (170 < m <350) (5 bins)

Find a consistent minimum

Calculation of χ^2

- We now include the scale uncertainty as point-by-point uncertainty in χ^2 calculation:

Cut: 10 Bins
New calc treating only correlations between accepted bins.. (not between all)

optional including scale variation as point-by-point uncertainty on theory

CMS_2022_I2079374
d01-x01-y01 (50 < m <76)

qs	chi2((stat)	chi2(stat+scale)
0.5		6.5,6.2
0.6		5.5,5.2
0.7		5.5,5.2
0.8		**5.1,4.9**
0.9		6.0,5.8
1.0		6.2,6.0
1.1		1.0,6.8
1.2		7.1,6.9

d03-x01-y01 (75 < m <106)

qs	chi2((stat)	chi2(stat+scale)
0.5		9.6,8.5
0.6		7.7,7.0
0.7		7.7,7.0
0.8		3.7,4.5
0.9		**2.7,4.1**
1.0		3.1,5.4
1.1		4.7,7.8
1.2		7.9,12.1

Find a consistent minimum:
- same as with scale factor
- same as with ren/fact uncertainty

Intrinsic k_T paper

- With these developments, we have everything ready to proceed
  - determination of intrinsic k_T width as function of DY mass
    determination of intrinsic k_T width as function of $\sqrt{s}$

AOB

- Further news ?