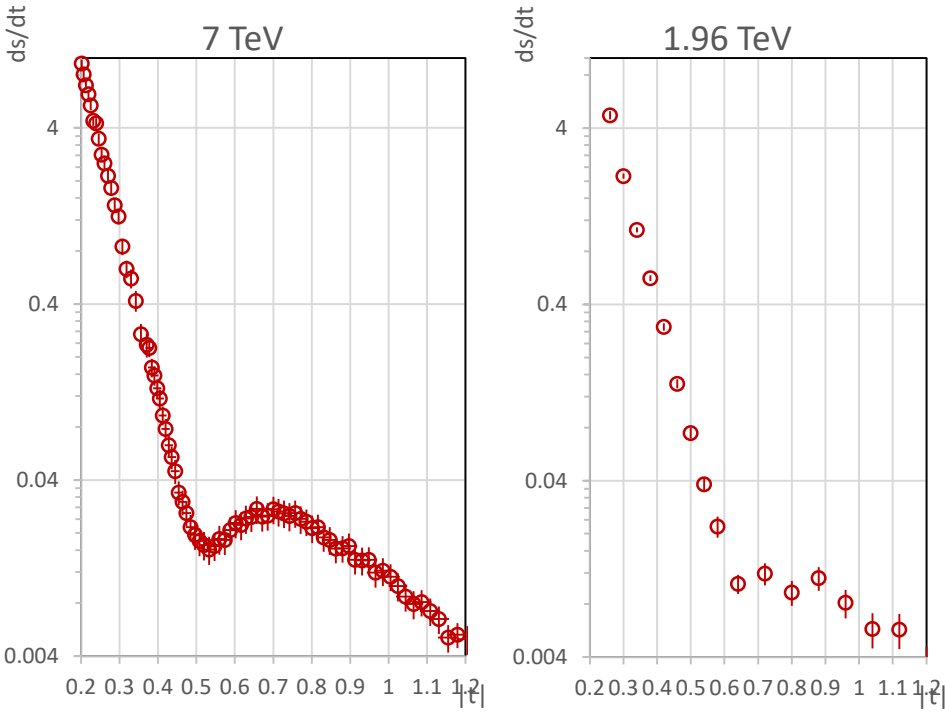
Detailing the Odderon-effect: numerical examples



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6th Day of Femtoscopy

Gyöngyös

29th October 2020

Outline

- Odderon-effect: $H(x)$ function
- Dataset: TOTEM – 2.76 TeV, 7 TeV

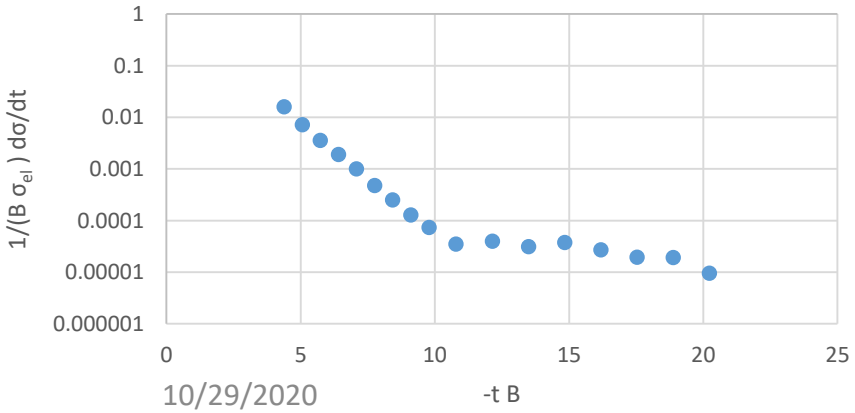
  D0 – 1.96 TeV
- Quantification: how to compare two different scaling function
- Extrapolation: how to interpolate between data points if measurements are missing
- Results

Odderon-effect: *H(x,s)* scaling function

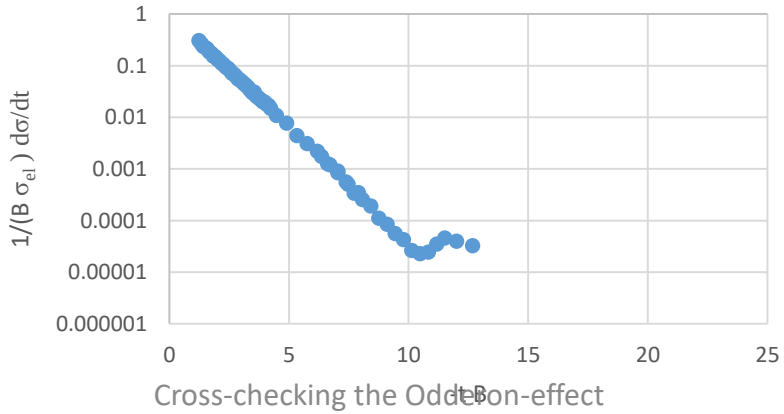
- The Mandelstam variables defined as $s = (p_1 + p_2)^2$ and $t = (p_1 - p_3)^2$, with incoming four momenta (p_1, p_2) and outgoing four-momenta (p_3, p_4).
- We investigate the scaling properties in s of

$$H(x,s) = \frac{1}{B(s)\sigma_{el}(s)}\frac{d\sigma}{dt}, \text{ where } x = -tB(s).$$

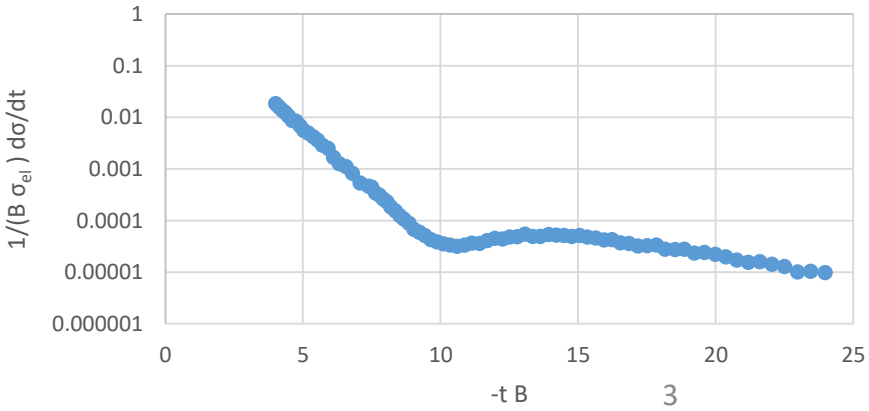
H(x,s|pbarp), 1.96 TeV



H(x,s|pp) - 2.76 TeV



H(x,s|pp) - 7 TeV



Quantification / Interpolation

- How to compare two different measured $H(x)$ scaling functions
- Determine if two different measurements correspond to significantly different $H(x)$ scaling functions, or not.
- Compare the data-sets D_1 and D_2 by creating a common domain X_{12} and linear interpolation between neighbouring data points.
- Using

$$\chi^2 = \sum \frac{(d_{12}(j) - d_{21}(j))^2}{e_{12}^2(j) + e_{21}^2(j)}.$$

- Evaluate the CL of the hypothesis that the two data sets represent the same $H(x)$ scaling function.

Generalizing the χ^2 definition

$$\chi^2_{2\to1}=\sum_{j=1}^{n_{21}}\frac{(d_1^j+\epsilon_{b,1}e^j_{B,1}-d_{21}^j-\epsilon_{b,21}e^j_{B,21})^2}{(\tilde{e}^j_{A,1})^2+(\tilde{e}^j_{A,21})^2}+\epsilon^2_{b,1}+\epsilon^2_{b,21},$$

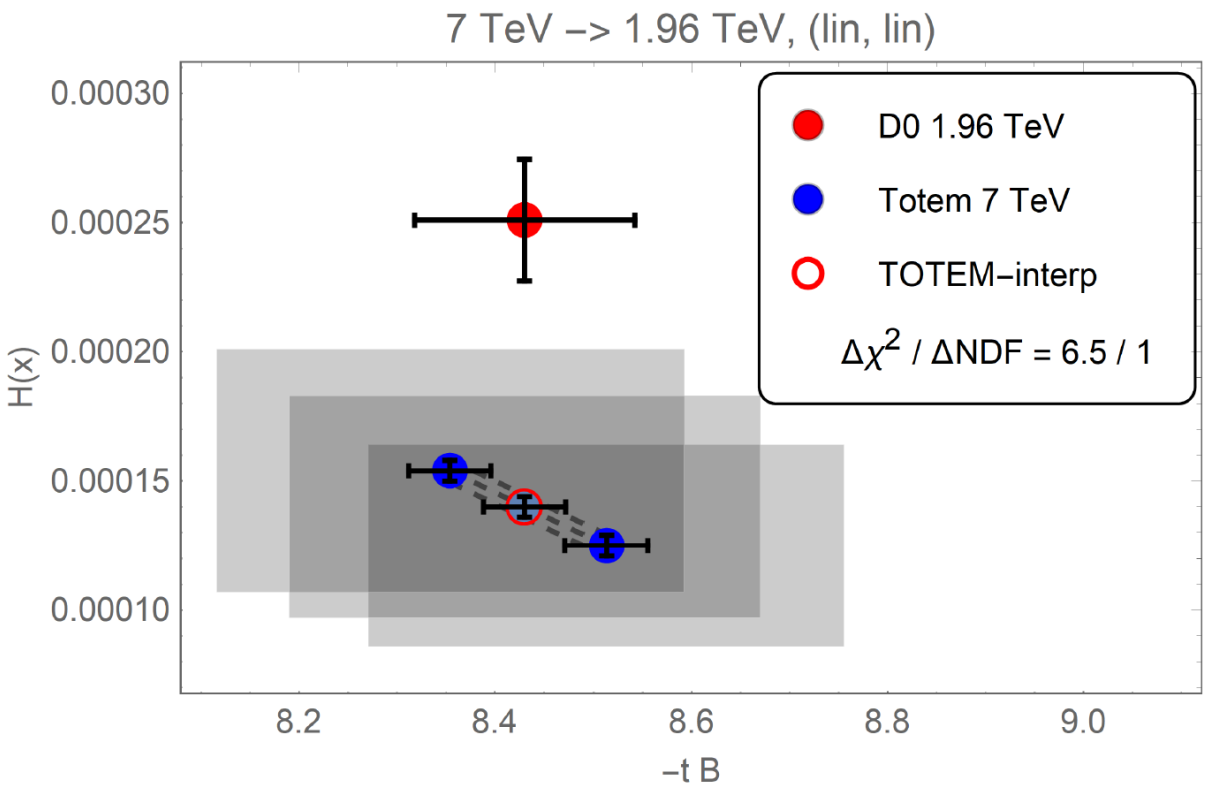
$$\tilde{e}^j_{A,k}=e^j_{A,k}\frac{d_k^j+\epsilon_{b,k}e^j_{B,k}}{d_k^j},$$

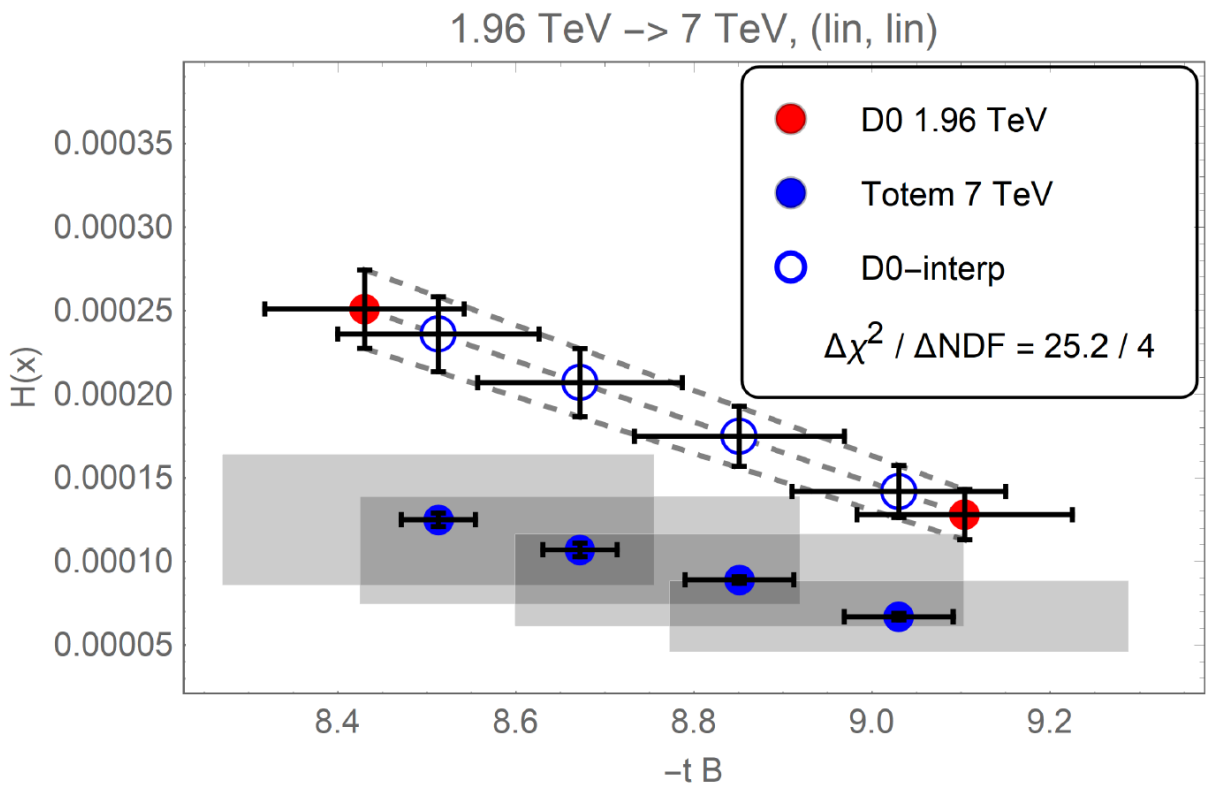
$$e^j_{M,k}=\sqrt{(\sigma^j_{M,k})^2+(d'^{,j}_k)^2(\delta^j_{M,k}x)^2},$$

where $k \in \{1, 21\}$ and $M \in \{A, B\}$ type error

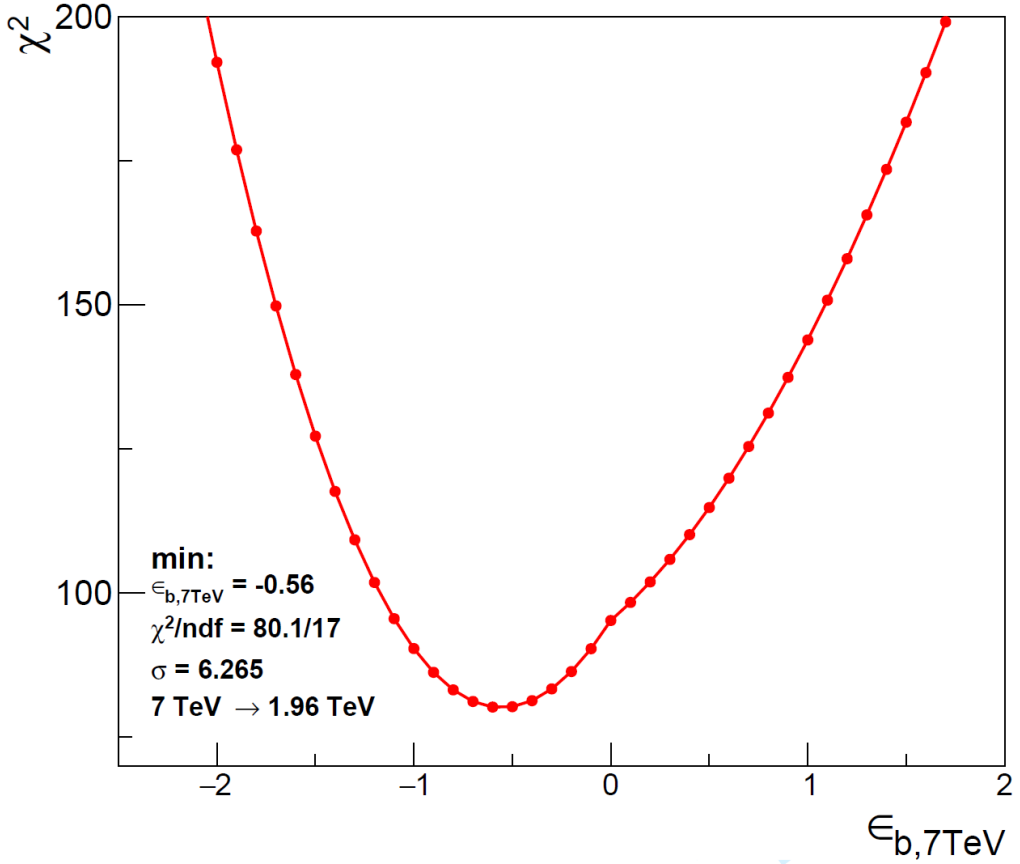
- Type A: point-to-point fluctuating (uncorrelated) systematic and statistical errors
- Type B: point-to-point dependent, but 100% correlated systematic errors

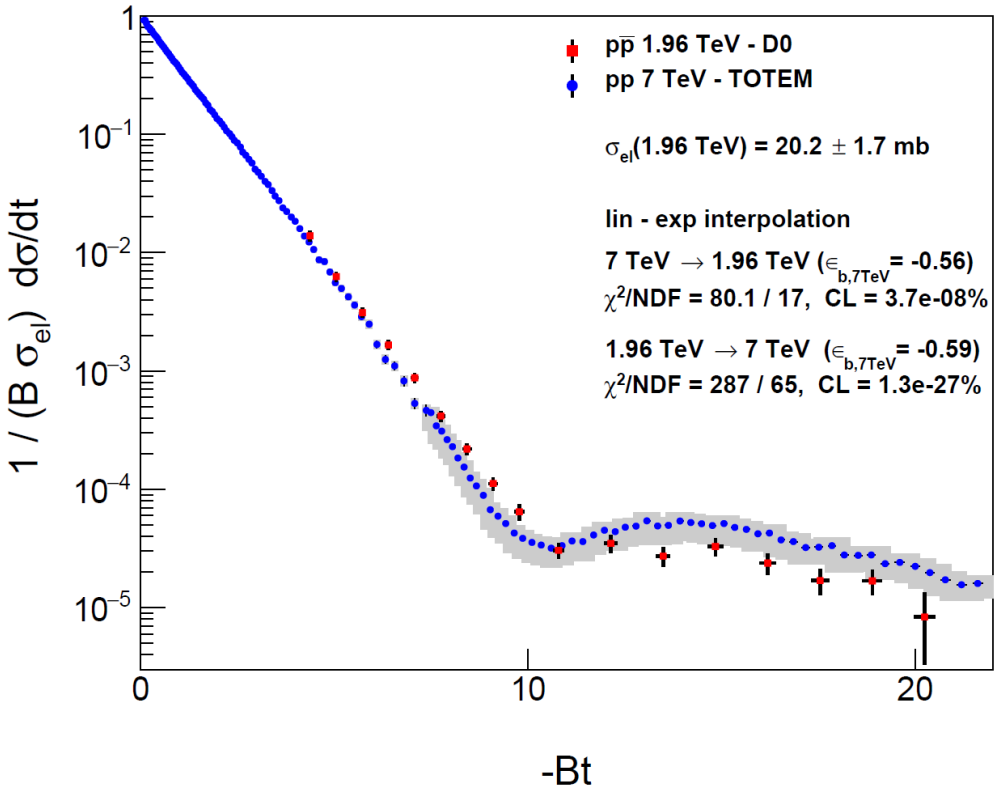
Examples for Projection 1--->2 and 2--->1





Significant Odderon signal





σ_{el} (mb)	interpolation	direction of projection	χ^2	NDF	CL (%)	Significance [σ]
20.2 ± 1.7	lin-exp	$7 \rightarrow 1.96$ TeV	80.1	17	3.7×10^{-8}	6.26

Cross-checking step by step

	A	B	C	D	E	F	G	H	I	J	K
1		Parameters				7 TeV - EPL 101, 21002 (2013)					
2		value	error_A	error_B		|t|	ds/dt	d_stat	d_syst+	d_syst-	d_tot
3	slope_totem (GeV^{-2})	19.89									
4	sigma_totem (mb)	25.43									
5											
6	slope_D0 (GeV^{-2})	16.86									
7	sigma_D0 (mb)	20.2									
8											
9	**Errors**										
10	BS_err_totem	505.80									
11	BS_err_D0	340.57									
12											
13	D0 values:	Phys. Rev. **D86**,									
14	TOTEM values:	EPL **101**, 21002									
15											
16	|t| [GeV^2]										

AG	AH	AI	AJ	AK	AL	AM	AN	AO	AP	AQ	AR	AS
joined				joined errors - type A				syst errors - type B			7	1.96
-t B	H1(x)	H2(x)		-t B	e1(x)	e2(x)		-t B	syst+	syst-	systematic	syst
4.35591	0.01229729			4.35591	0.00034			4.35591	6.75E-04	6.75E-04	6.75E-04	
4.3836	0.01189022	0.0138884		4.3836	0.00033	0.00141		4.3836	0.00065788422	0.00066	6.58E-04	0.00E+00
4.47525	0.0106366	0.01246931		4.47525	0.00032	0.00130		4.47525	6.003388E-04	6.00339E-04	6.00E-04	0.00E+00
4.61448	0.00869904	0.01058598		4.61448	0.00028	0.00112		4.61448	5.087030E-04	5.08703E-04	5.09E-04	0.00E+00
4.75371	0.00840249	0.00898711		4.75371	0.00028	0.00095		4.75371	5.163430E-04	5.16343E-04	5.16E-04	0.00E+00
4.89294	0.00686038	0.00762972		4.89294	0.00026	0.00078		4.89294	4.376707E-04	4.38E-04	4.38E-04	0.00E+00
5.03217	0.0055753	0.00647735		5.03217	0.00022	0.00061		5.03217	3.76E-04	3.76E-04	3.76E-04	0.00E+00
5.058	0.00547442	0.00628355		5.058	0.00021	0.00058		5.058	0.00037	0.00037	3.71E-04	0.00E+00
5.19129	0.00498218	0.00546893		5.19129	0.00020	0.00051847		5.19129	3.44E-04	3.44E-04	3.44E-04	0.00E+00
5.3703	0.00423485	0.00453854		5.3703	0.00019	0.000441753		5.3703	3.10E-04	3.10E-04	3.10E-04	0.00E+00
												0.00E+00
												0.00E+00
												0.00E+00
												0.00E+00
												0.00E+00

BD	BE	BF	BG	BH	BI	BJ	BK
e1_A	e1_B	etilde1_A	e21_A	e21_B	etilde21_A	khi2	
0.001699379	0	0.001699379	0.00034577	0.0010829	0.00032813	2.264680502	
0.000333513	1.11E-03	3.13E-04	0.00156121	0.00E+00	1.56E-03	2.440467	
0.000277698	5.27E-04	2.68E-04	0.00135795	0.00E+00	1.36E-03	2.520882	
0.000290806	9.43E-04	2.72E-04	0.0011621	0.00E+00	1.16E-03	0.914532	
0.000268178	8.08E-04	2.50E-04	0.00097348	0.00E+00	9.73E-04	1.536940	
0.000219783	4.62E-04	2.09E-04	0.00079272	0.00E+00	7.93E-04	2.053388	
0.000724426	0	0.000724426	0.00021655	0.00045594	0.00020645	1.996869902	
0.000201079	4.69E-04	1.90E-04	0.00065054	0.00E+00	6.51E-04	1.268406	
0.000195047	4.40E-04	1.83E-04	0.00055582	0.00E+00	5.56E-04	0.925993	
0.000174353	4.39E-04	1.62E-04	0.00047555	0.00E+00	4.76E-04	0.984346	

BL	BM	BN	BO	BP
Projection 1--->2				
eps_b12_7tev	-0.59			
eps_b12_1.96tev	0			
chi2 1--->2	286.600	CL (%)	1.3E-27	
ndf 1--->2	65	Significance	#SZÁM!	*too large*
Projection 2--->1				
eps_b21_7tev	-0.56			
eps_b21_1.96tev	0			
chi2 2--->1	80.074	CL (%)	3.7E-08	
ndf 2--->1	17	Significance	6.2653	

Results

- Different data-set ⟹ use the published
- Different parameters ⟹ use the published
- Same χ^2 ⟹ two independent codes, same results

Thank you for your attention!