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Low Q^2 inclusive analysis

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DESY



on behalf of the H1 collaboration

Motivation

Study the transition from soft to hard interaction for low Q^2 and low x

Final inclusive cross
section measurement for
low Q^2 HERA-I

$$\frac{d\sigma}{dx dQ^2} = \frac{2\pi\alpha^2 Y_+}{Q^4 x} \left(F_2(x, Q^2) - \frac{y^2}{Y_+} F_L(x, Q^2) \right)$$

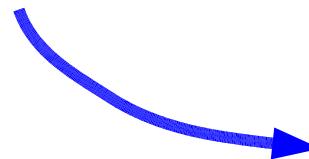


obtain information on F_2, F_L

Combination of low Q^2 data
according to its systematics

Considered Phase Space:

$$0.2 \text{ GeV}^2 \leq Q^2 \leq 12 \text{ GeV}^2$$



Data samples?

Data Samples

Data sets taken with special runs and minimum bias triggers at low Q^2 :

- MB'99
 $\mathcal{L}=2.1 \text{ pb}^{-1}$

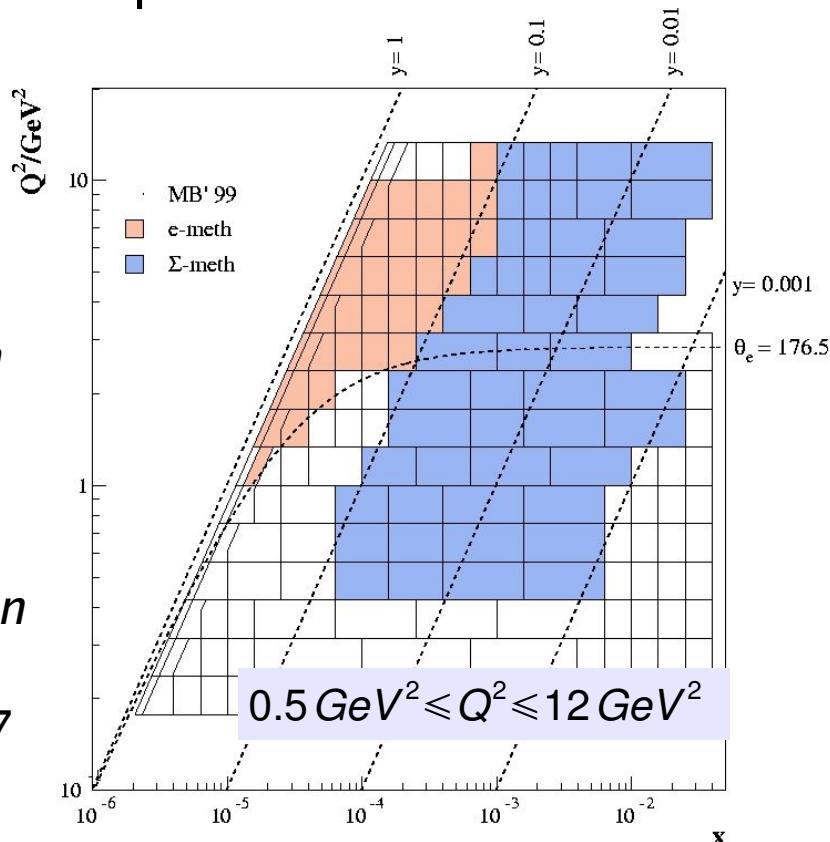
high y extension

- SVX'00
 $\mathcal{L}=504 \text{ nb}^{-1}$

low Q^2 extension

- Published MB'97
 $\mathcal{L}=1.8 \text{ pb}^{-1}$

$1.5 \text{ GeV}^2 \leq Q^2 \leq 12 \text{ GeV}^2$



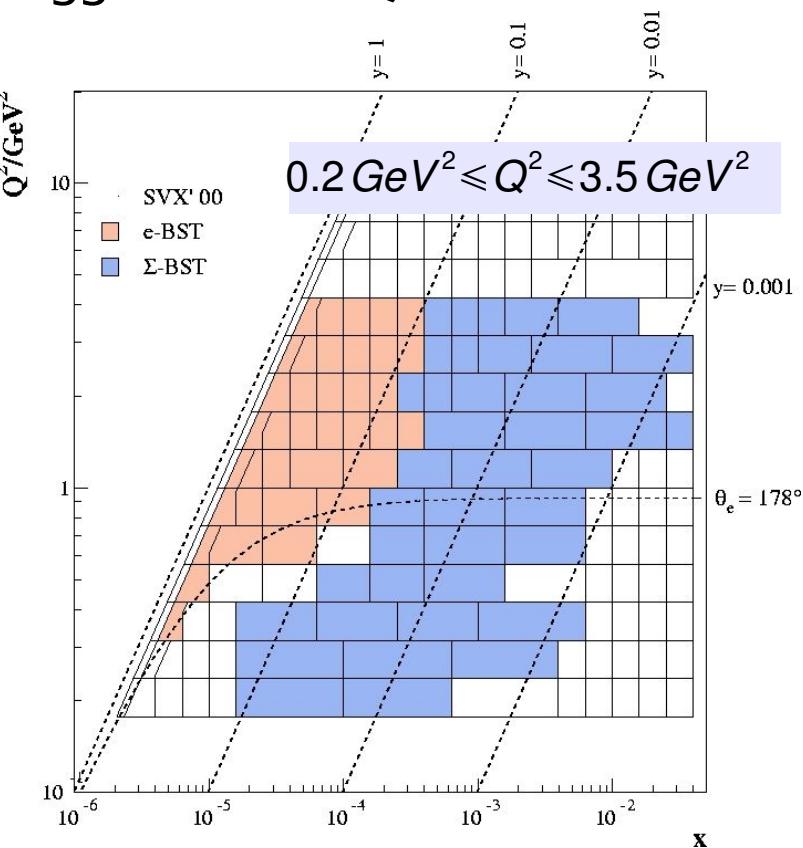
$$\sqrt{s} = 318 \text{ GeV}$$

$$\sqrt{s} = 300 \text{ GeV}$$

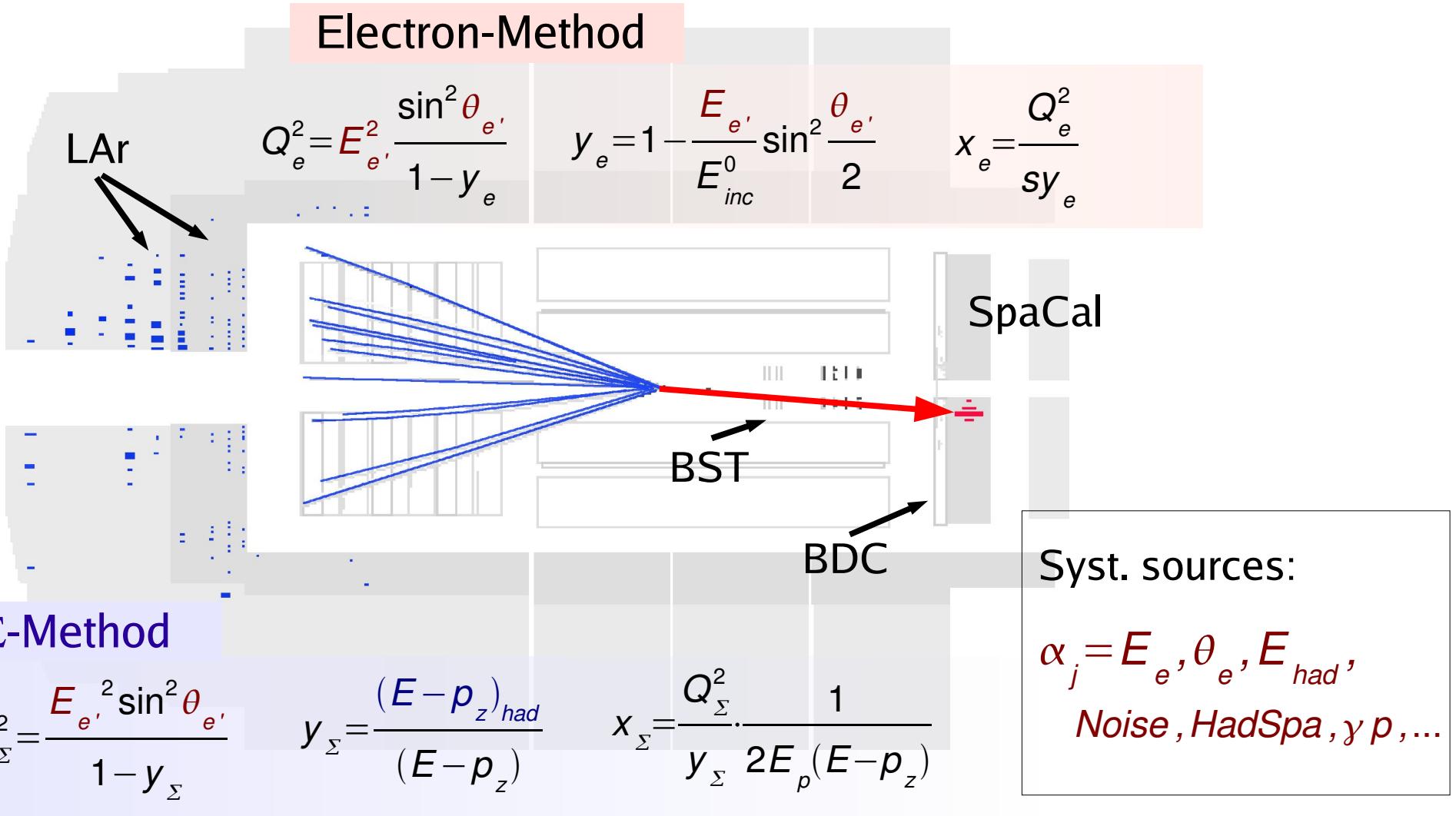
MB'99
SVX'00
MB'97

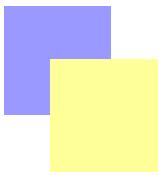
}

to be combined



Kinematic Reconstruction





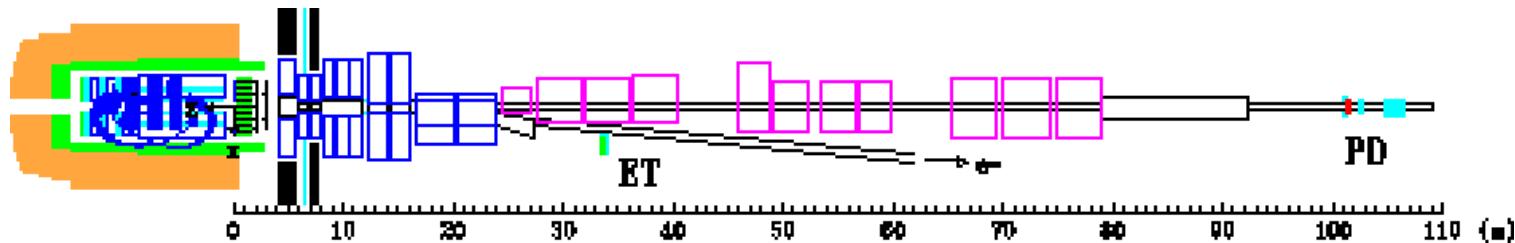
Systematics of the Data Samples

Systematic uncertainties

Correlated	MB'99	SVX'00	Published MB'97
E_e	0.2% - 1%		0.3%-2.7%
θ_e	0.2mrad	0.2-0.5mrad	0.3mrad
E_{had}		10%-2%	2%
Noise		10 %	25%
HSpaCal		500 MeV	-
γp		15 %	20%
Lumi	1.1%	3%	1.5%
Uncorrelated			
	2% vertex efficiency		
	0.5% Rad-corrections		

Luminosity Measurement

Luminosity measured with BH events: $ep \rightarrow ep\gamma$



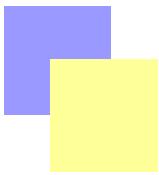
Improvement of understanding

- a) Photon detector (PD) acceptance
- b) Satellite contribution



Reanalysis of MB'97 sample

Luminosity of the MB'97 sample
modified by -3.4%



Combination Procedure



combination of data sets **requires** a proper handling of systematic & statistical errors.

Let Λ' be a set of cross section measurement, then Λ^{Ave} is obtained:

$$\chi^2(\Lambda^{Ave}, \alpha) = \sum_{k=1}^{\text{exp}} \sum_i^{\text{bins}} \frac{\left[\Lambda^{i, \text{Ave}} - \left(\Lambda_i^k + \sum_{j=1}^{\text{syst}} \frac{\partial \Lambda_i^k}{\partial \alpha_j^k} \alpha_j^k \right) \right]^2}{\sigma_{\Lambda_i^k}^2} + \sum_{k=1}^{\text{exp}} \sum_{j=1}^{\text{syst}} \frac{(\alpha_j^k)^2}{\sigma_{\alpha_j^k}^2}$$

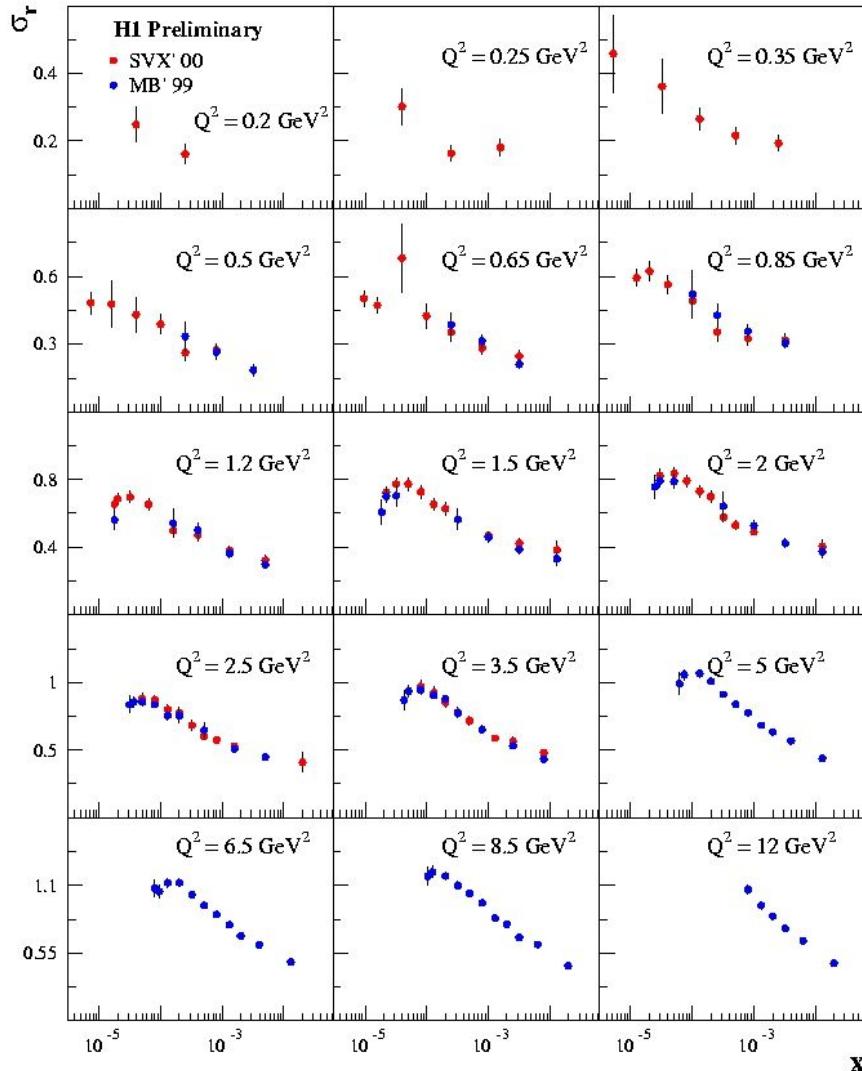
♦ Input:

$\Lambda^i, \frac{\partial \Lambda_i}{\partial \alpha_j}, \sigma_{\Lambda, i}^2, \sigma_{\alpha_j}$ uncertainty on the source
sensitivity to correlated syst stat+uncorr uncertainty

♦ Output:

Λ^{Ave}, α_j shift on the uncertainty of the source

σ_r Measurement: MB'99, SVX'00



Total error:

$$\delta_{tot} = \sqrt{\delta_{stat}^2 + \delta_{corr}^2 + \delta_{uncorr}^2}$$

- SVX'00

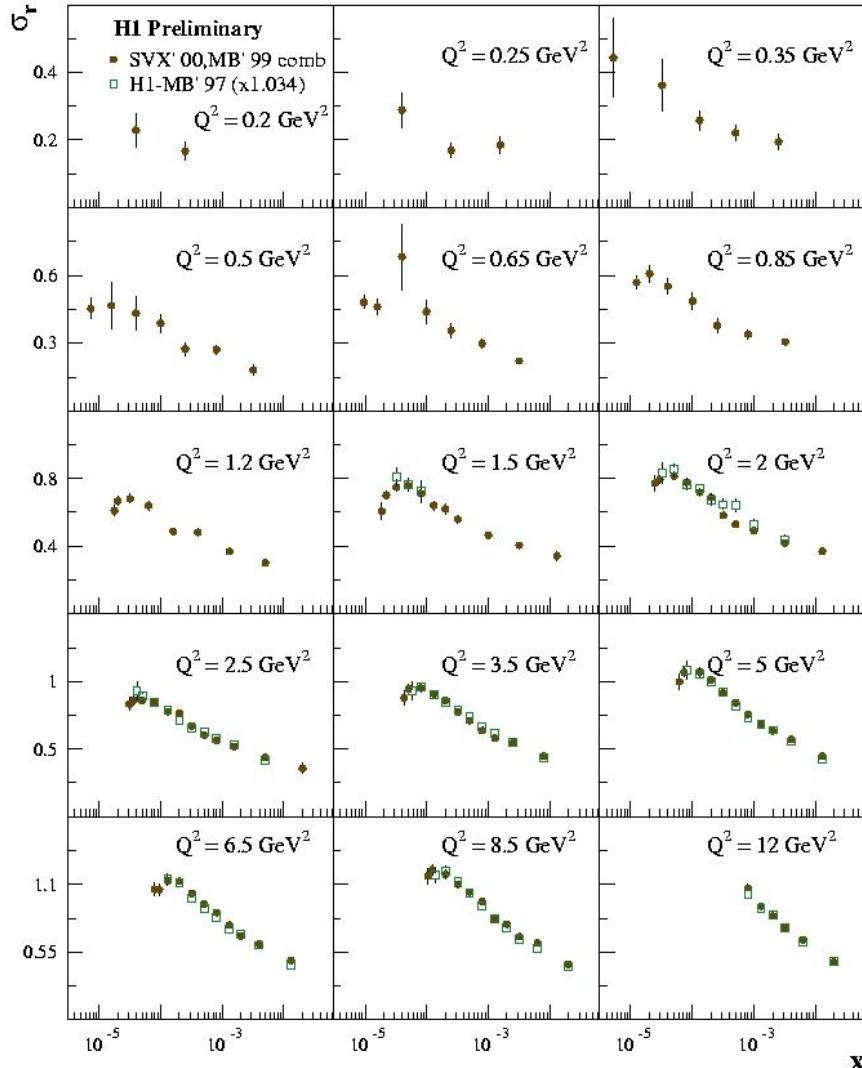
$7 < \delta_{tot} < 20\% \text{ for } Q^2 < 0.85 \text{ GeV}^2$
 $\delta_{tot} < 4\% \text{ for } Q^2 > 0.85 \text{ GeV}^2$

- MB'99

$7 < \delta_{tot} < 15\% \text{ for } Q^2 < 1.2 \text{ GeV}^2$
 $3 < \delta_{tot} < 12\% \text{ for } Q^2 > 1.2 \text{ GeV}^2$

large overlap & agreement between the two measurements ---> combine

Combination of MB'99 and SVX'00



- SVX'00, MB'99 comb

$4 < \delta_{tot} < 15\% \text{ for } Q^2 < 0.85 \text{ GeV}^2$
 $2.5 < \delta_{tot} < 6\% \text{ for } Q^2 > 0.85 \text{ GeV}^2$

- MB'97

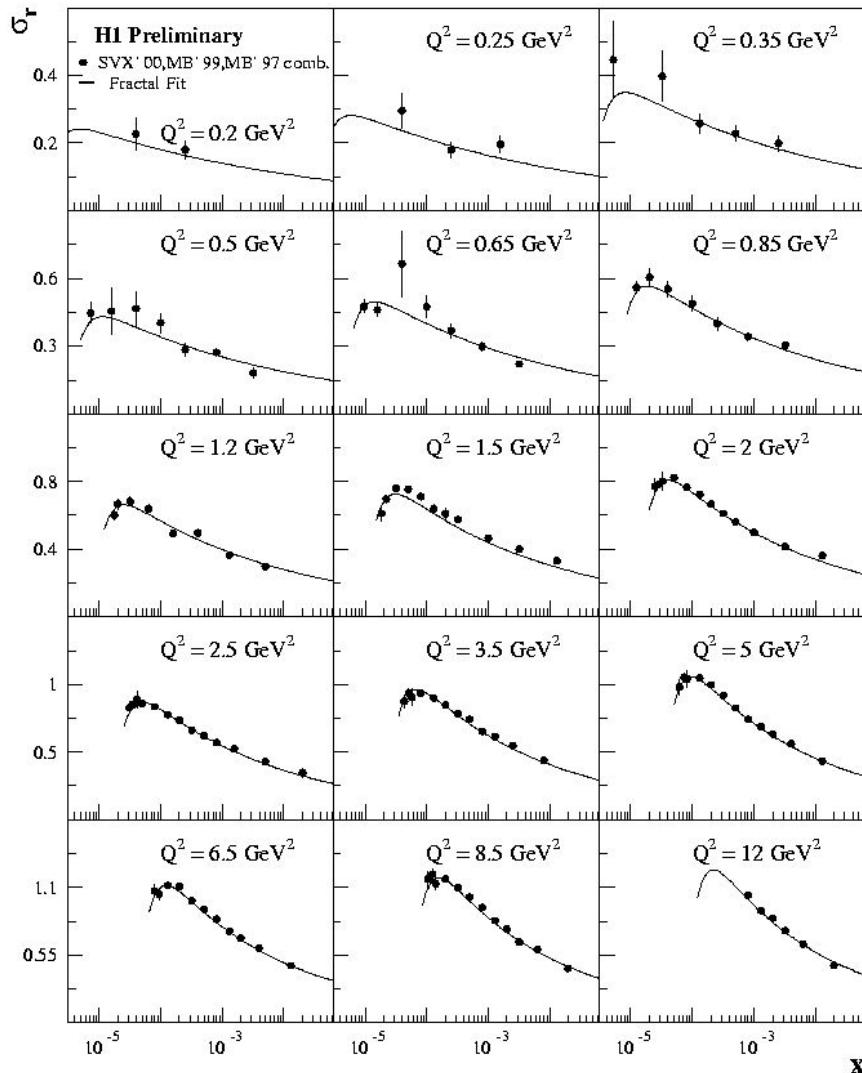
$2.5 < \delta_{tot} < 8\% \text{ for } 1.5 < Q^2 < 12 \text{ GeV}^2$

- correction applied to MB'97 sample to cover different beam energy

$$\sigma_r^{920}(x, Q^2) = \sigma_r^{820}(x, Q^2) + F_L^{th}(x, Q^2) \mathbf{C}(y)$$

- 3% only at high y

Final Combination



- SVX'00, MB'99, MB'97 comb

$$1.7 < \delta_{tot} < 15 \%$$

- Systematic shifts $\delta(\alpha_j)$ inside 1σ
- Cross section parametrization

$F_2(x, Q^2) \longrightarrow$ Fractal fit (4 param)

$$F_L(x, Q^2) = F_2(x, Q^2) \frac{R}{1+R}$$

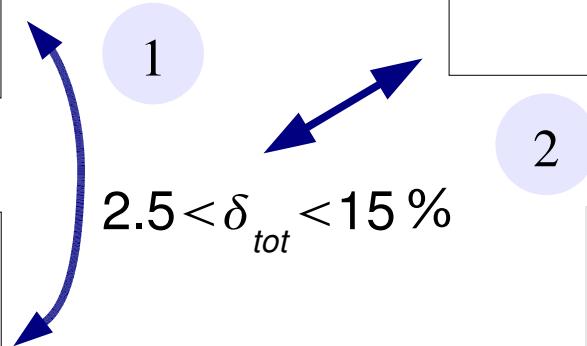
$$\chi^2/dof = 1.04$$

Combination improvement

SVX'00
 $0.2 \text{ GeV}^2 \leq Q^2 \leq 3.5 \text{ GeV}^2$
 $4 < \delta_{tot} < 20 \%$

MB'99
 $0.5 \text{ GeV}^2 \leq Q^2 \leq 12 \text{ GeV}^2$
 $3 < \delta_{tot} < 15 \%$

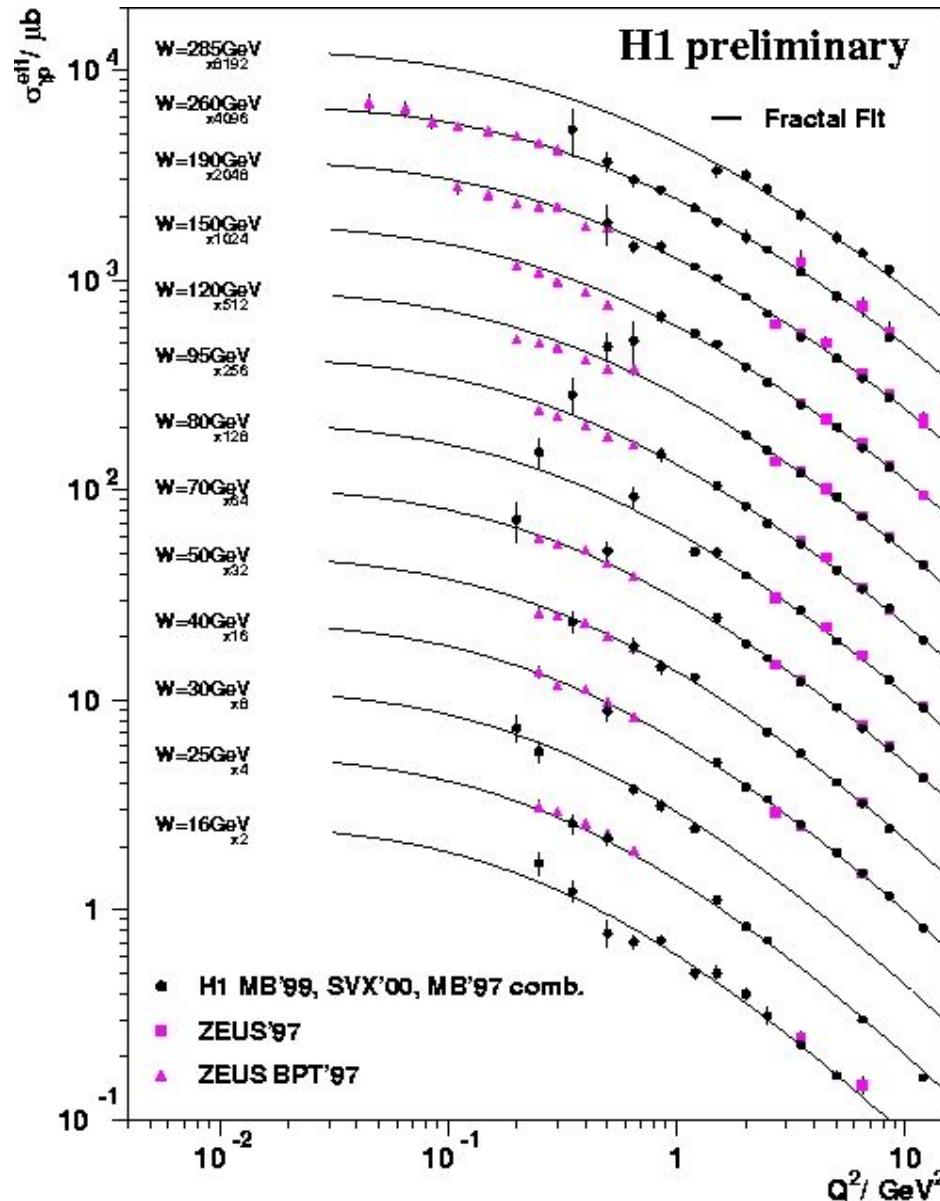
MB'97
 $1.5 \text{ GeV}^2 \leq Q^2 \leq 12 \text{ GeV}^2$
 $2.5 < \delta_{tot} < 10 \%$



Final combination:
 $0.2 \text{ GeV}^2 \leq Q^2 \leq 12 \text{ GeV}^2$
 $1.7 < \delta_{tot} < 15 \%$

- Cross sections
- Phenomenological fits

Cross Section

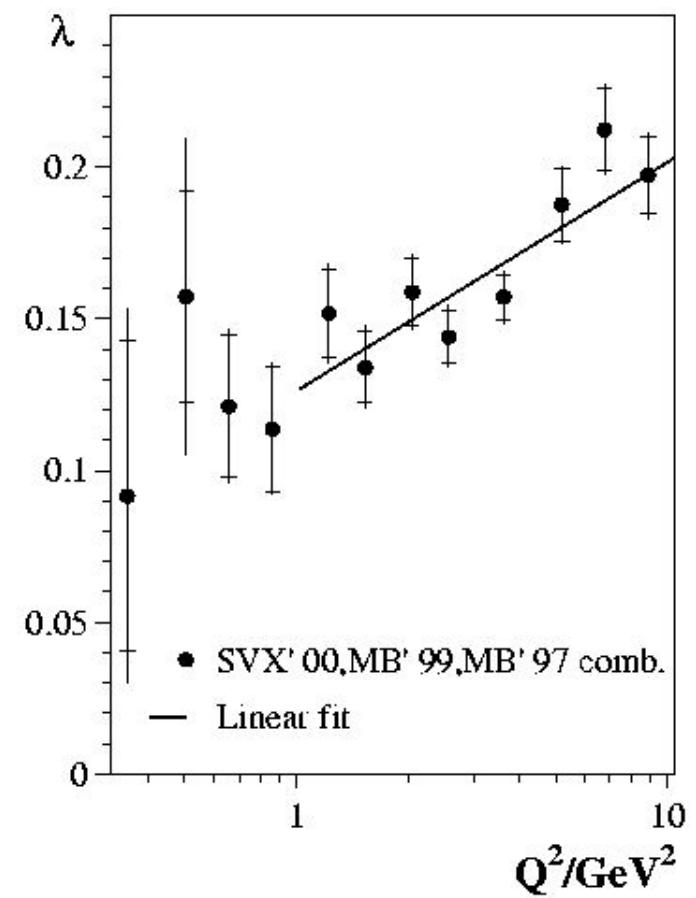
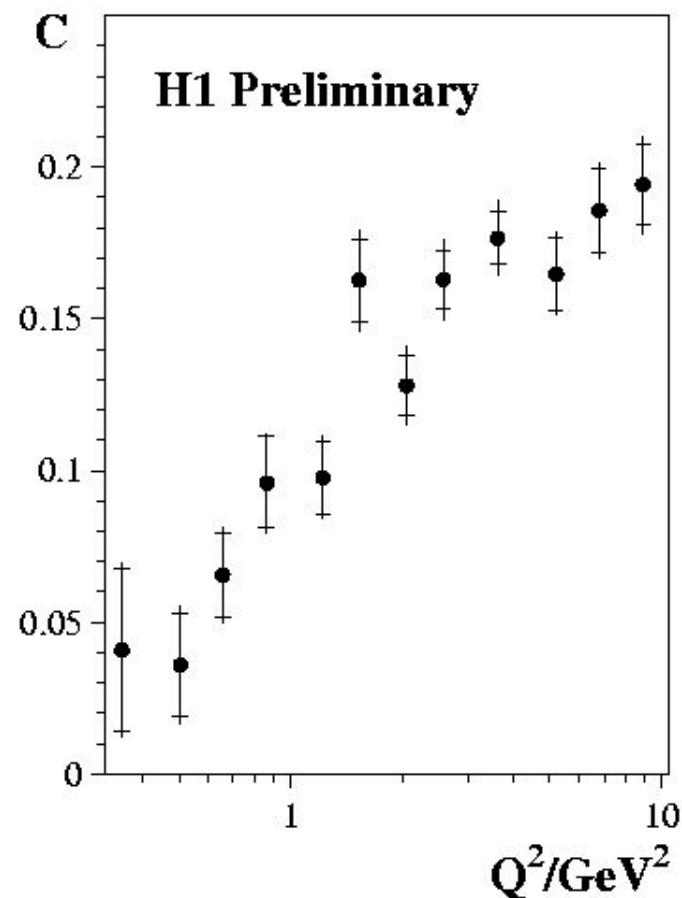


- ◆ Data fill the transition region at $Q^2 \sim 1 \text{ GeV}^2$
- ◆ Combined preliminary H1 data in agreement with ZEUS

The rise of F_2

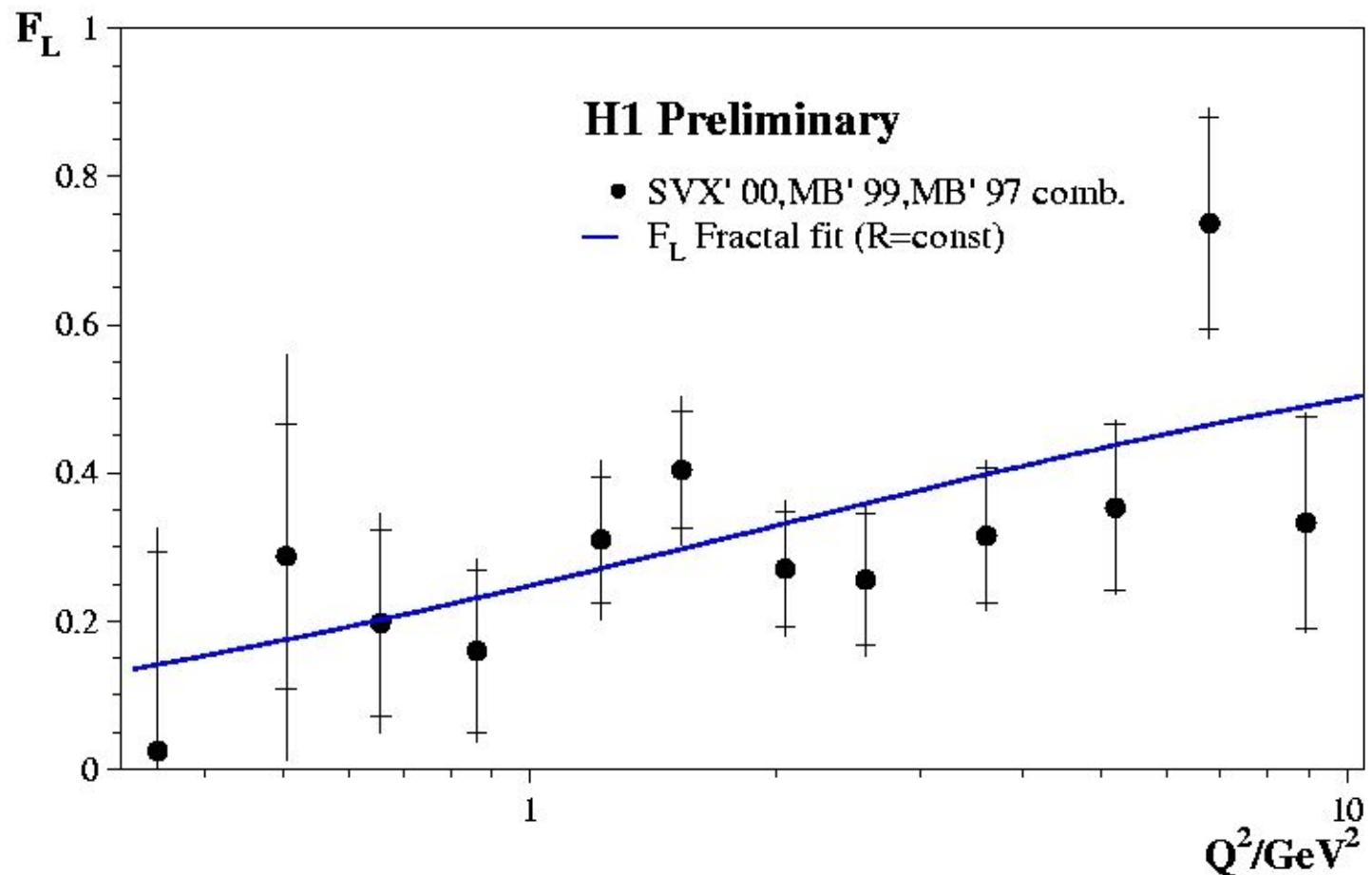
$$\sigma_r(Q^2, x) = c(Q^2) x^{-\lambda(Q^2)} - \frac{y^2}{(1 + (1 - y)^2)} F_L(x, Q^2)$$

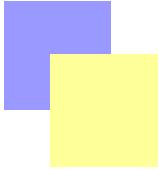
$F_2 \sim x^{-\lambda}$
at low x (< 0.01)



rise above 1 GeV^2 linear with $\ln Q^2$

Extraction of F_L

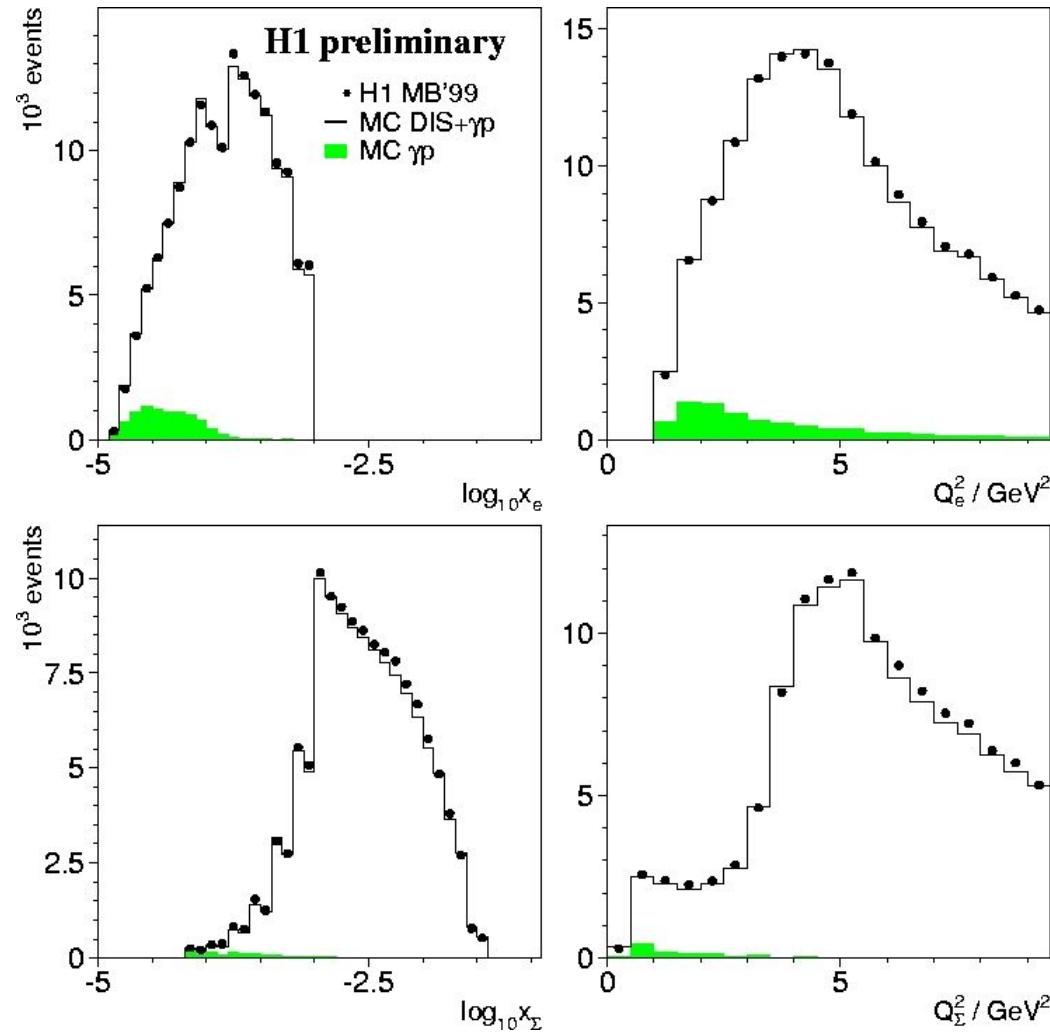




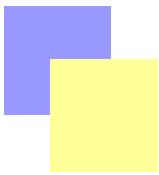
Summary

- ◆ Final measurement at low Q^2 for HERA-I performed
-improvement precision to 1.7-4% for higher Q^2 bins
- ◆ Combination with published MB'97
-reanalysis of MB'97

Kinematic reconstruction



good agreement between measured data & simulation

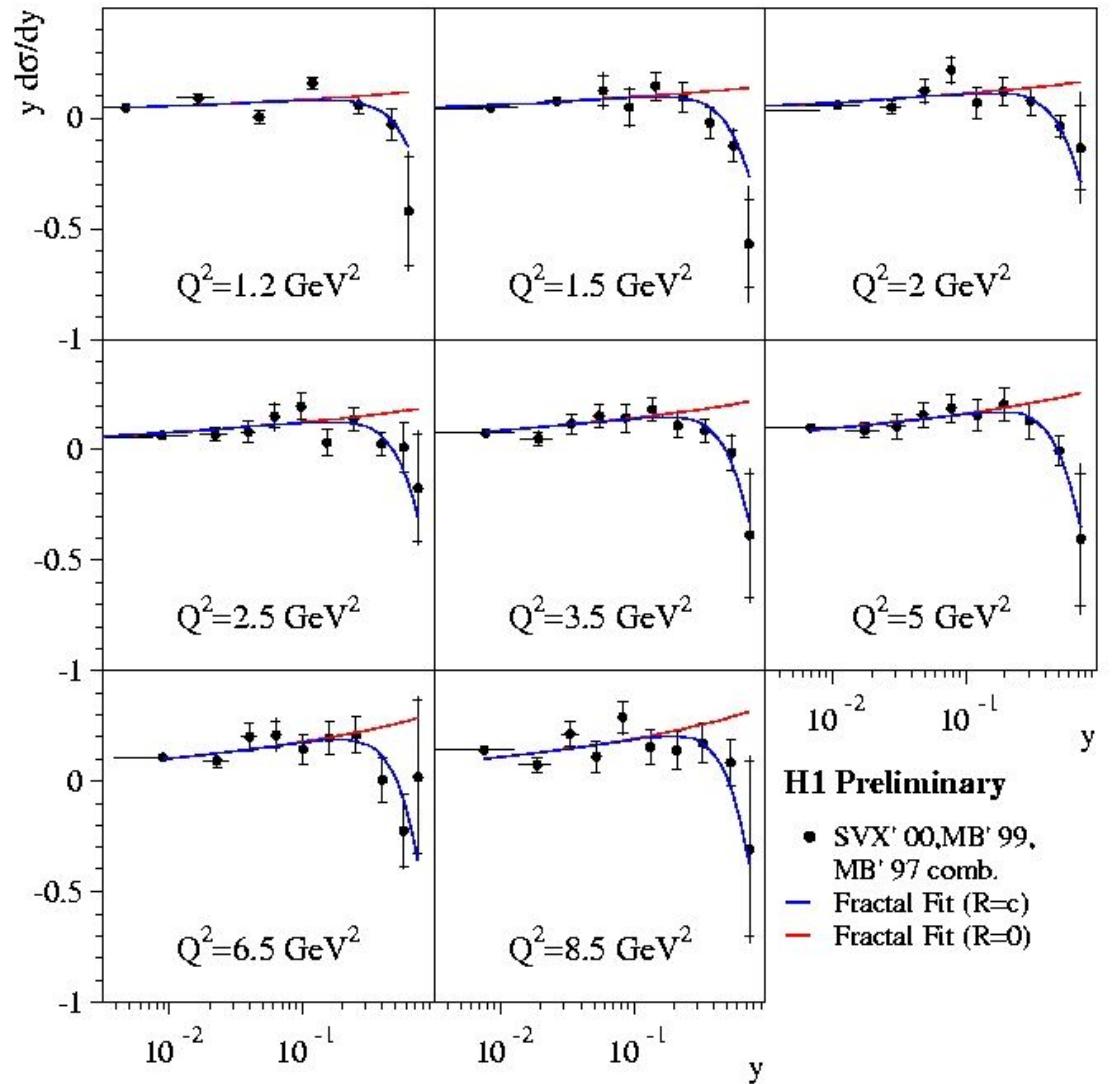


Systematic shifts

	MB99	SVX00	MB97	Chi2/ndf=	62.6844/102
Energy	-0.01	0.48	1.14		
Theta	1.01	0.4	-0.46		
Ehad	-0.29	-1.82	0.41		
Noise	0.21	-0.81	-0.96		
HadSpa	0.61	-1.34	-		
gammap	-0.01	0	0.66		
Lumi	-0.58	-0.19	-0.06		

Data: MB99-SVX00-MB97

Derivative method



Derivative method

