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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 its systematic

Considered Phase Space:

$0.2\,GeV^2 \leqslant Q^2 \leqslant 12\,GeV^2$

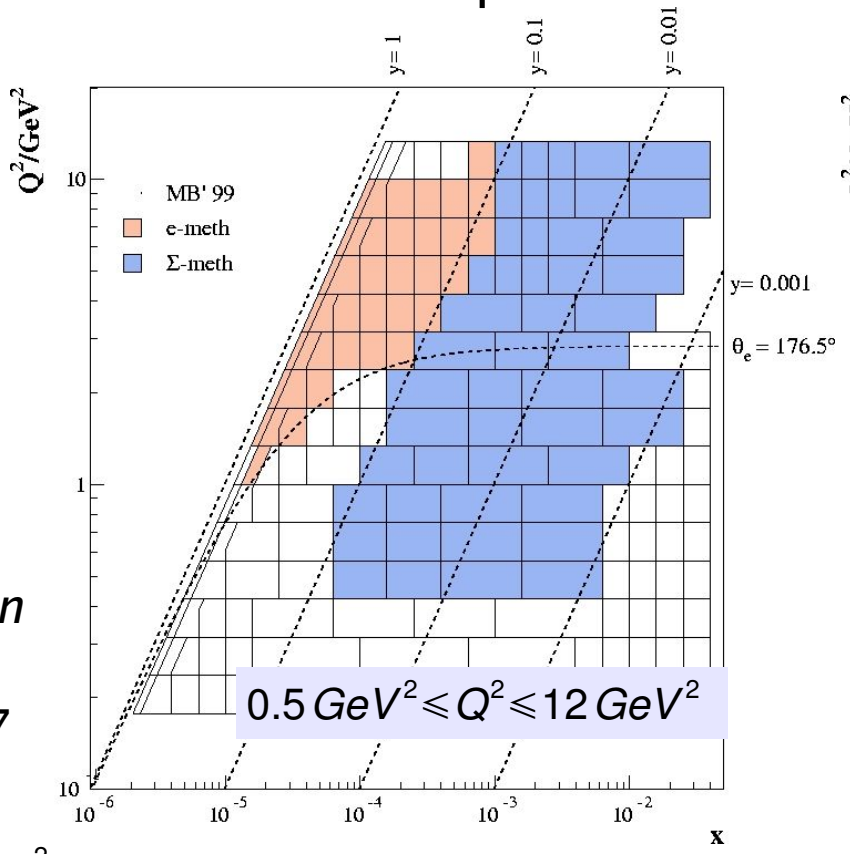
Data samples?

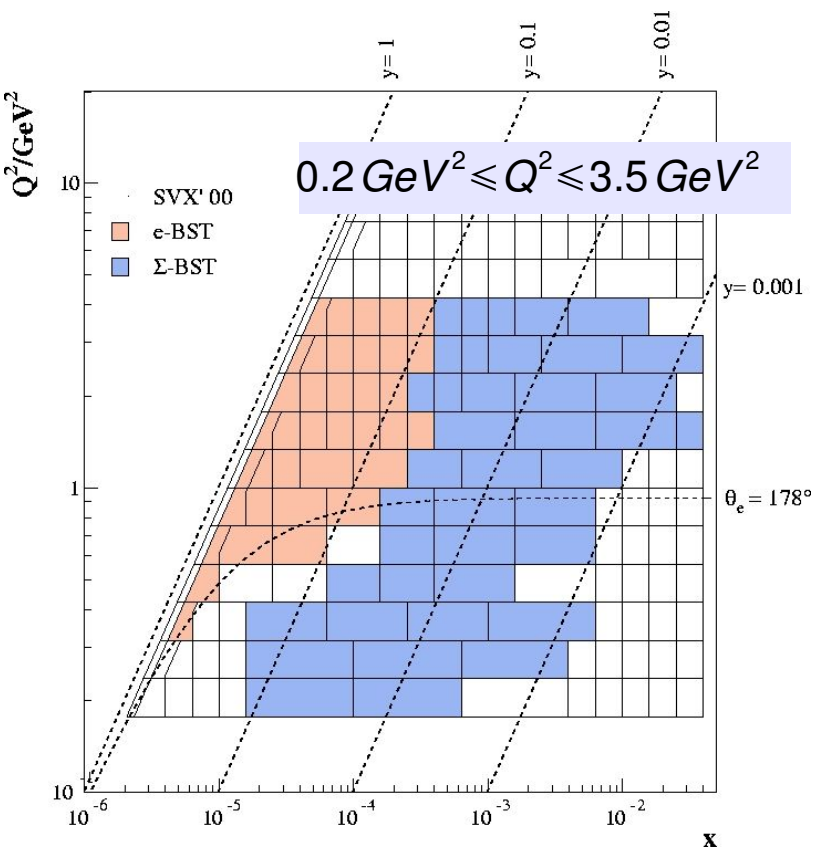
Data Samples

Data sets taken with minimum bias special runs:

- MB'99
  $\mathscr{L}=2.1\ pb^{-1}$
  high y extension
- SVX'00
  $\mathscr{L}=504\ nb^{-1}$
  low Q^2 extension
- Published MB'97
  $\mathscr{L}=1.8\ pb^{-1}$

$1.5\,GeV^2 \leqslant Q^2 \leqslant 12\,GeV^2$



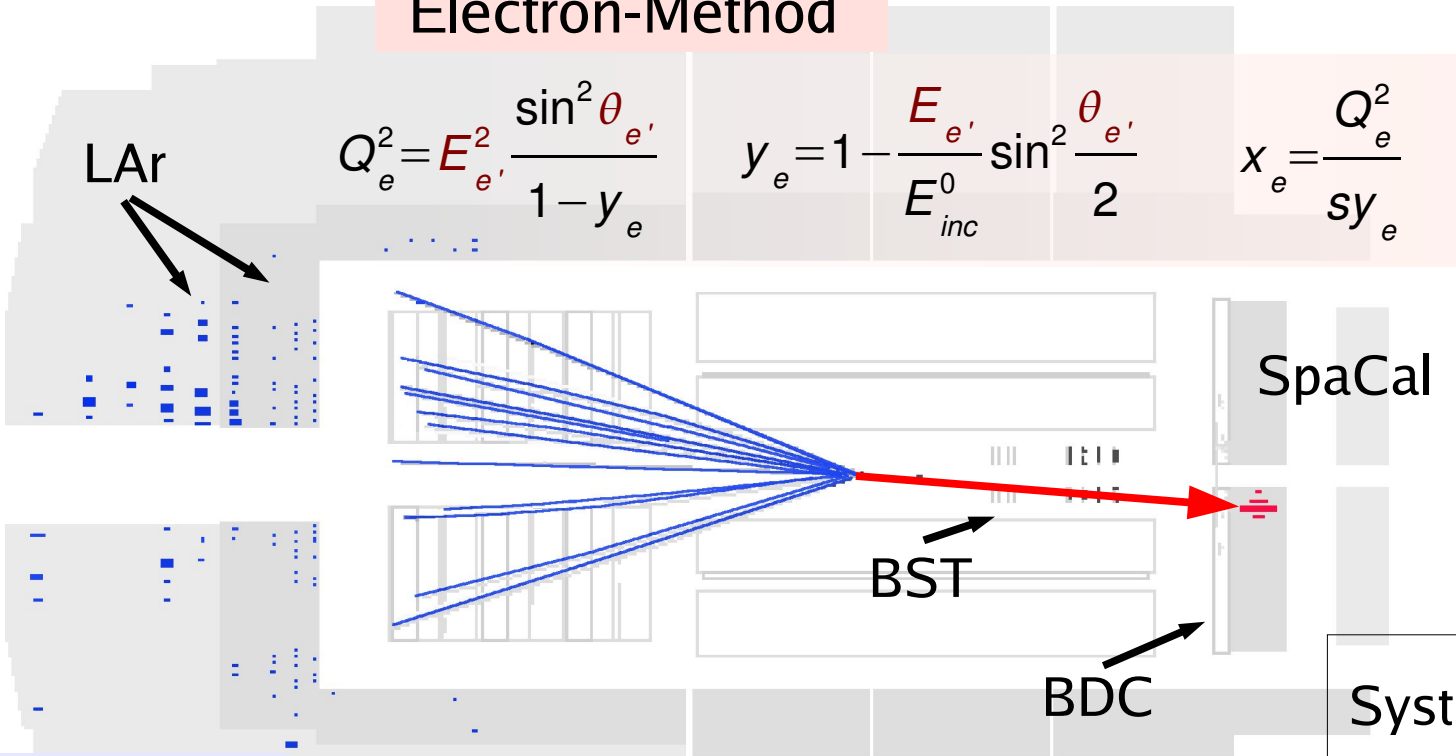


$\sqrt{s}=318\,GeV$ MB'99
SVX'00
$\sqrt{s}=300\,GeV$ MB'97
} to be combined

Kinematic Reconstruction

Electron-Method

$$Q_e^2 = E_{e'}^2 \frac{\sin^2\theta_{e'}}{1-y_e} \qquad y_e = 1 - \frac{E_{e'}}{E_{inc}^0}\sin^2\frac{\theta_{e'}}{2} \qquad x_e = \frac{Q_e^2}{s y_e}$$



Σ-Method

$$Q_\Sigma^2 = \frac{E_{e'}{}^2 \sin^2\theta_{e'}}{1-y_\Sigma} \qquad y_\Sigma = \frac{(E-p_z)_{had}}{(E-p_z)} \qquad x_\Sigma = \frac{Q_\Sigma^2}{\Sigma}\cdot\frac{1}{2E_p(E-p_z)}$$

Syst. sources:

$\alpha_j = E_e, \theta_e, E_{had},$

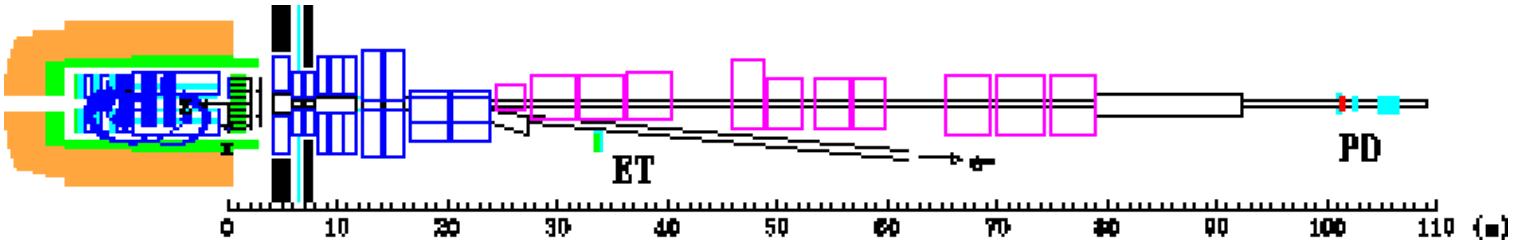
Noise , HadSpa , γ p ,...

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: $ep \to ep\gamma$



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

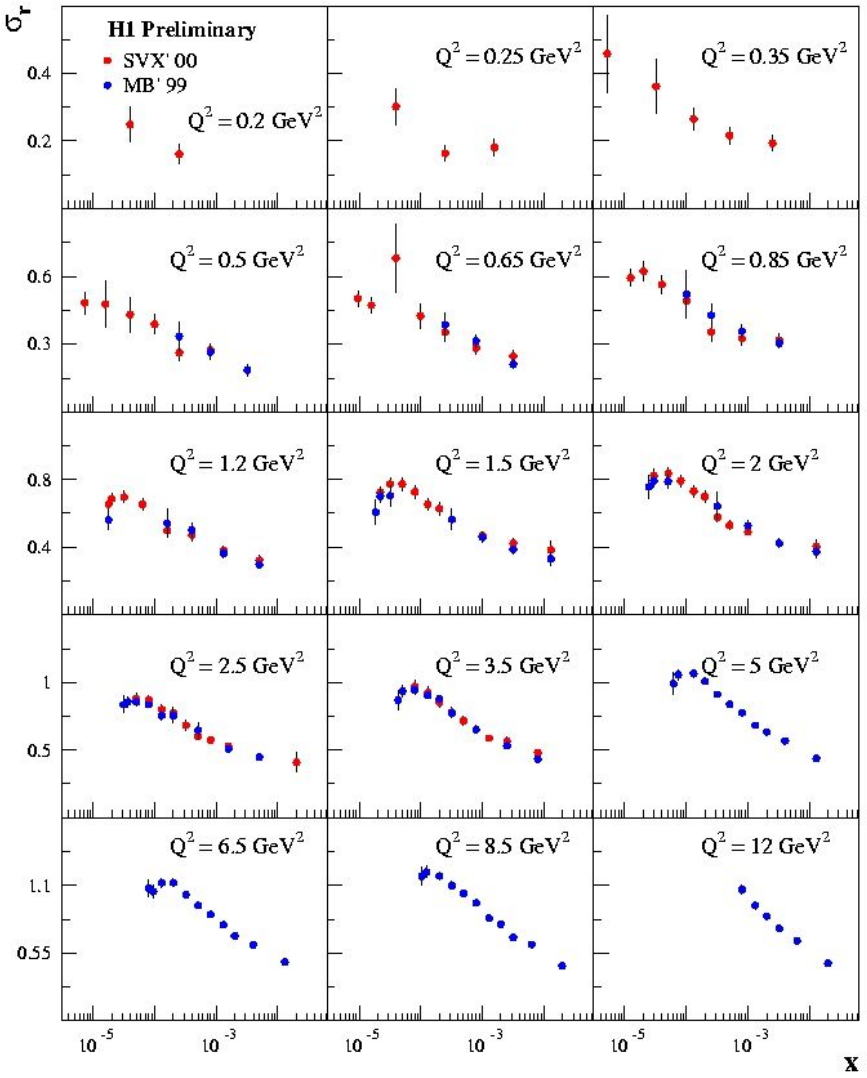
combination of data sets requires a proper handling of systematic & statistical errors.

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

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

- Input: $\Lambda^i, \frac{\partial\Lambda_i}{\partial\alpha_j}, \sigma^2_{\Lambda,i}, \sigma_{\alpha_j}$
  - $\frac{\partial\Lambda_i}{\partial\alpha_j}$: sensitivity to syst
  - $\sigma^2_{\Lambda,i}$: stat+uncorr uncertainty
  - σ_{α_j}: uncertainty on the source
- Output: Λ^{True}, α_j
  - α_j: shift on the uncertainty of the source

σ_r Measurement: MB'99,SVX'00



Total error:

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

- SVX'00

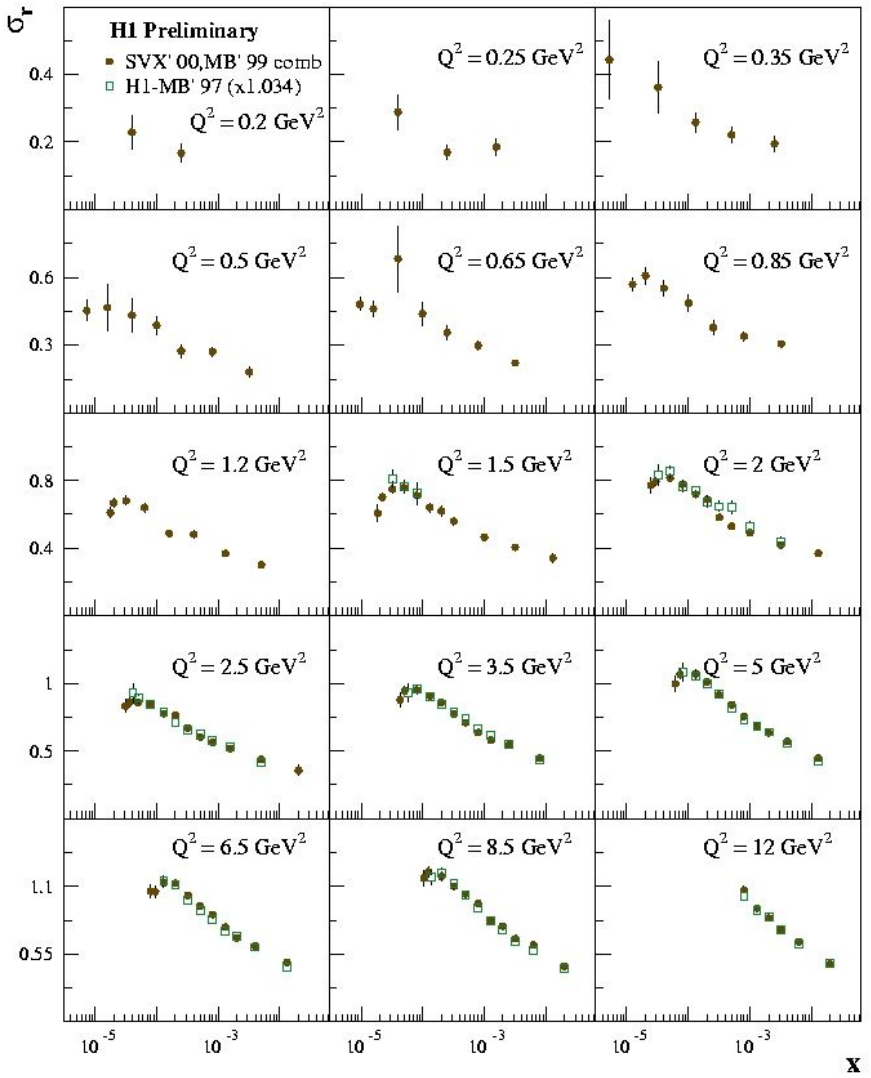
$$7 < \delta_{tot} < 20\,\% \quad \text{for} \quad Q^2 < 0.85\,GeV^2$$
$$\delta_{tot} < 4\,\% \quad \text{for} \quad Q^2 > 0.85\,GeV^2$$

- MB'99

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

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

Combination of MB'99 and SVX'00



- SVX'00, MB'99 comb

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

- MB'97

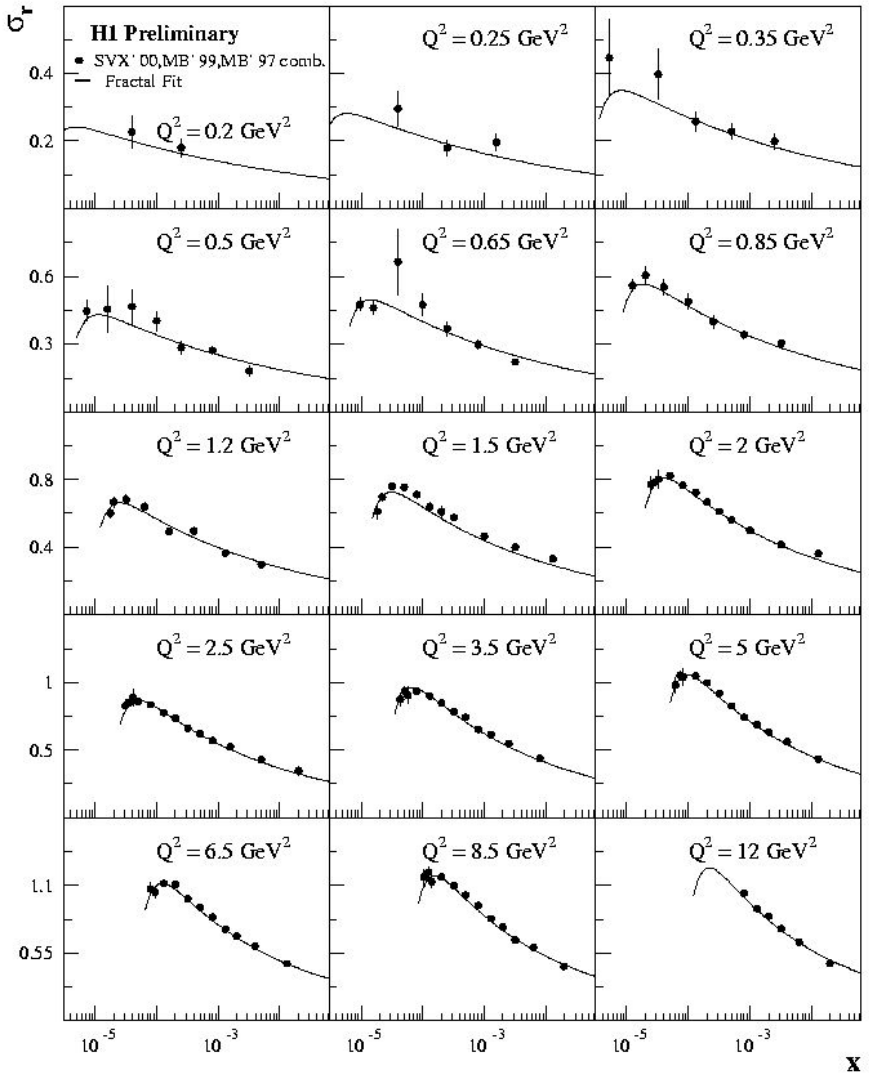
$$2.5 < \delta_{tot} < 8\% \quad \text{for } 1.5 < Q^2 < 12\, GeV^2$$

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

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

- 3% only at high y

Final Combination



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

$$1.5 < \delta_{tot} < 15\ \%$$

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

$F_2(x, Q^2)$ ⟶ 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

$0.2\,GeV^2 \leqslant Q^2 \leqslant 3.5\,GeV^2$

$4 < \delta_{tot} < 20\,\%$

MB'99

$0.5\,GeV^2 \leqslant Q^2 \leqslant 12\,GeV^2$

$3 < \delta_{tot} < 15\,\%$

1

$2.5 < \delta_{tot} < 15\,\%$

MB'97

$1.5\,GeV^2 \leqslant Q^2 \leqslant 12\,GeV^2$

$2.5 < \delta_{tot} < 10\,\%$

2

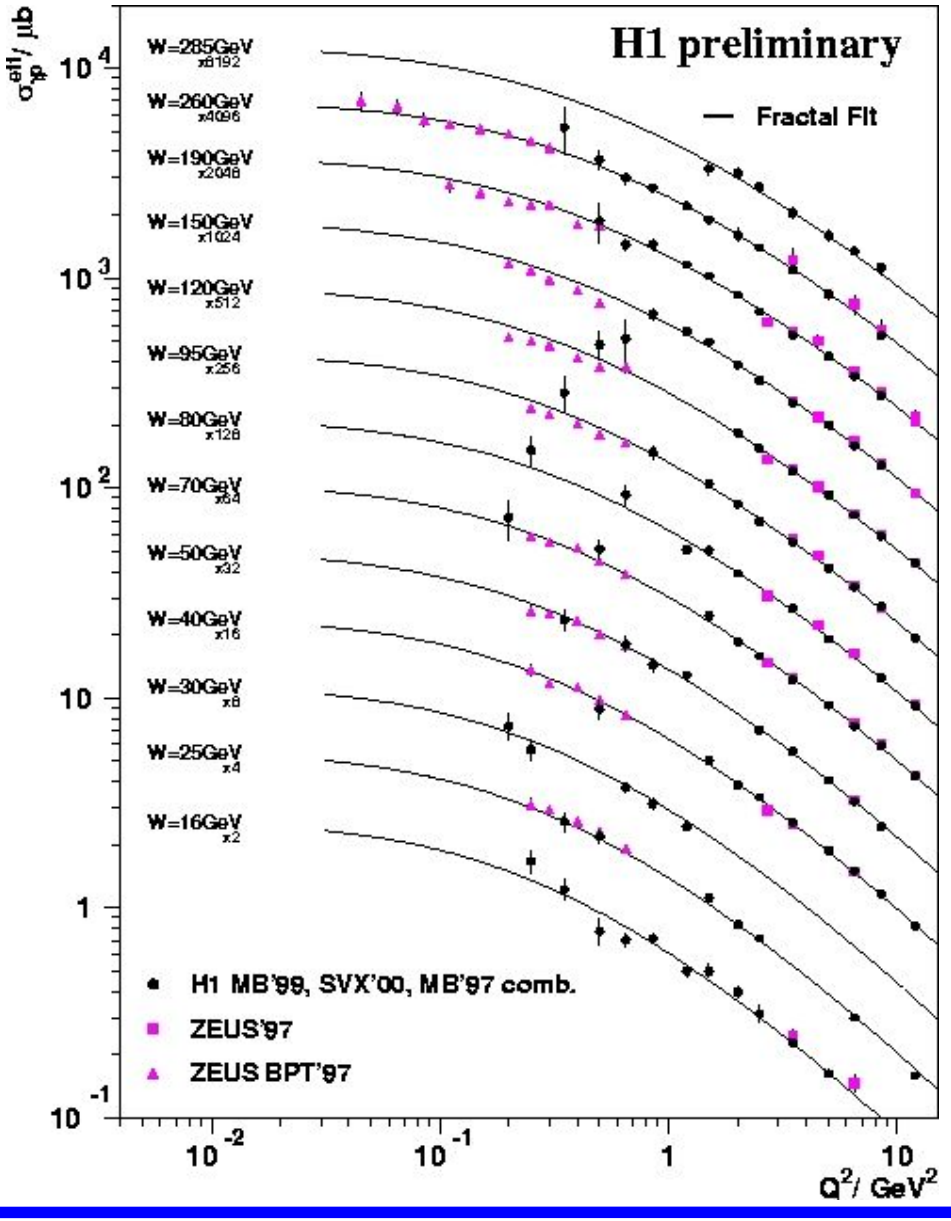
Final combination:

$0.2\,GeV^2 \leqslant Q^2 \leqslant 12\,GeV^2$

$1.5 < \delta_{tot} < 15\,\%$

- Cross sections
- Phenomenological fits

Cross Section



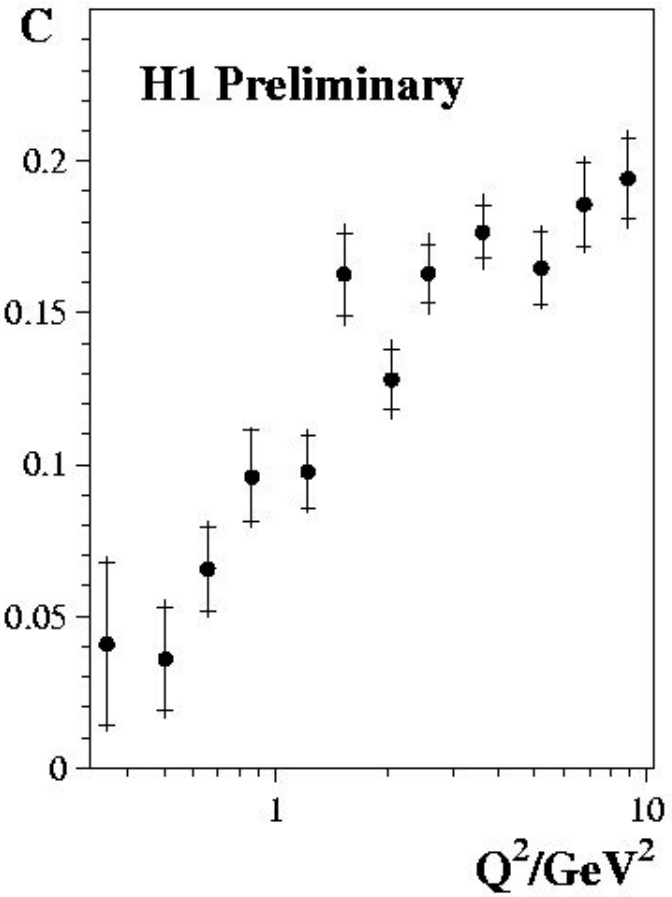
- Data fill the transition region at Q^2 ~1 GeV^2
- Combined preliminary H1 data in agreement with ZEUS

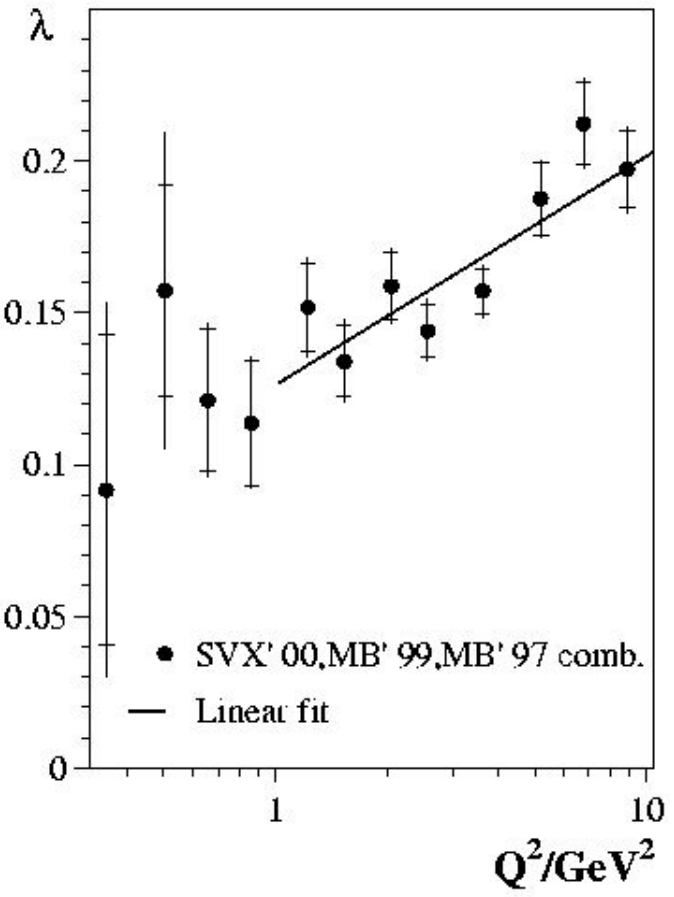
The rise of F_2

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

$F_2 \sim x^{-\lambda}$

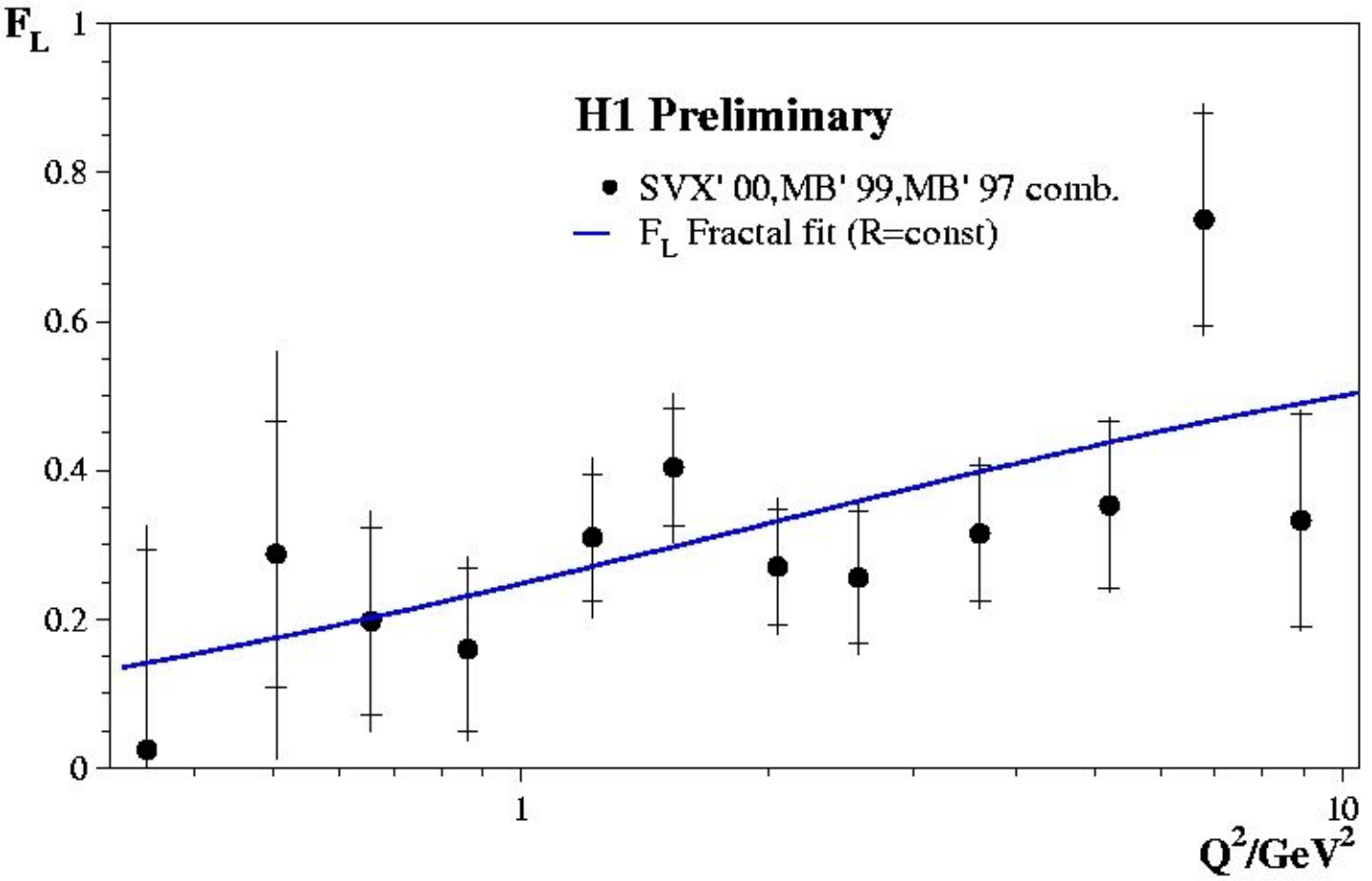
at low x (<0.01)





rise above 1 GeV² as predicted by pQCD

Extraction of F_L

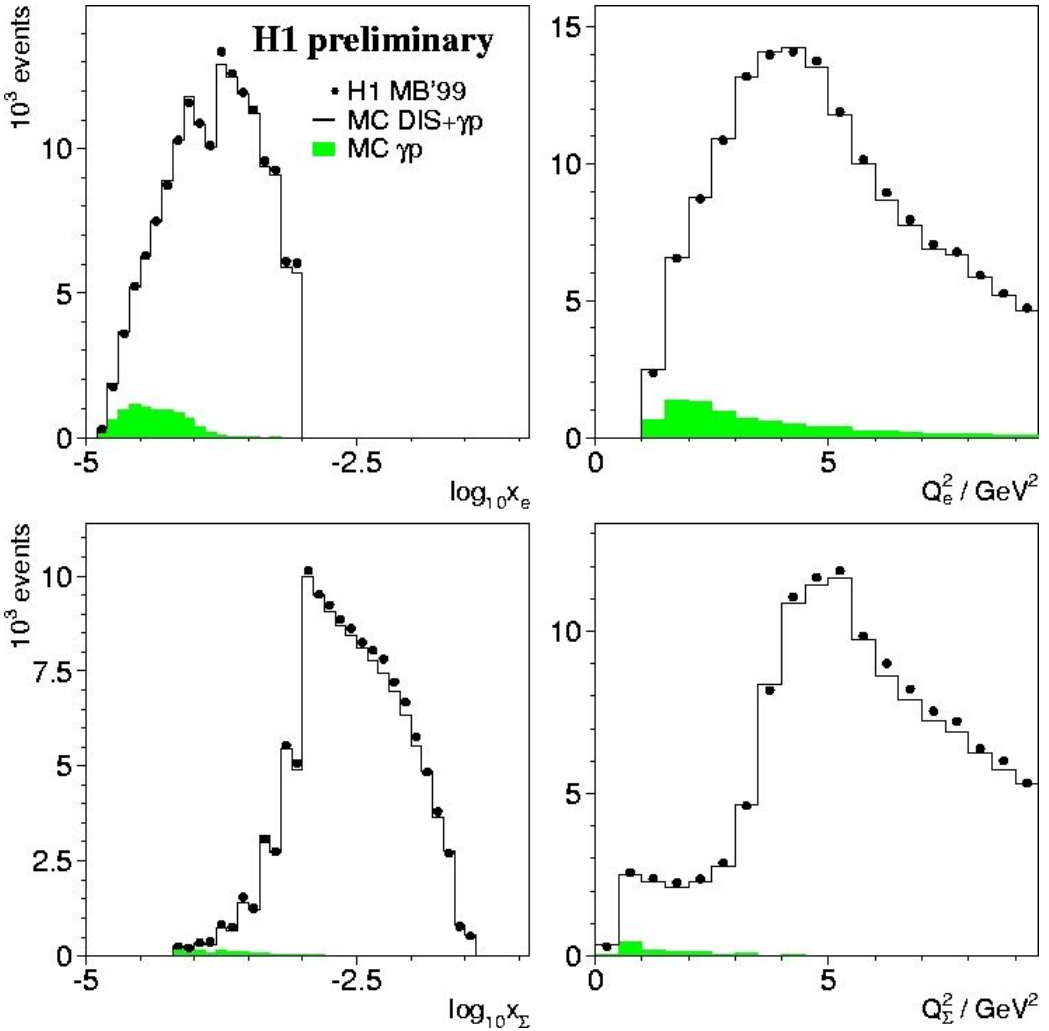


F_L extracted from λ fit

Summary & Outlook

- Final measurement at low Q^2 for HERA-I performed
  -improvement precision to 2-4% for high Q^2
- Combination with published MB'97
  -reanalisis of MB'97
- Ongoing Phenomenological analysis

Kinematic reconstruction



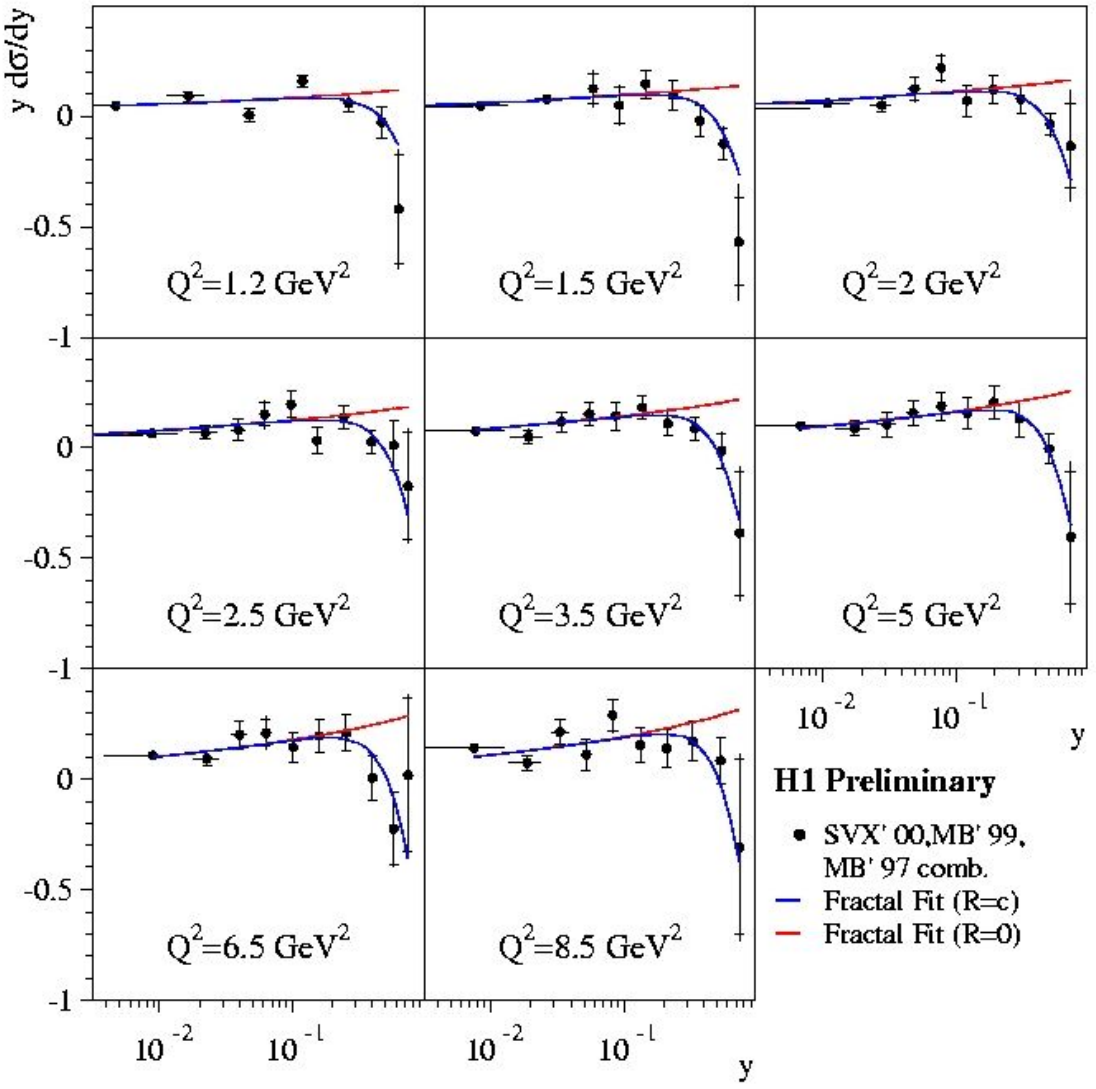
good agreement between measured data & simulation

Systematic shifts

	MB99	SVX00	MB97		
Energy	-0.01	0.48	1.14	Chi2/ndf=	62.6844/102
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