ALEPH Results on F_2^γ and Comparison with Models and other Data

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- Quantities related to the measurement of F_2^γ
- Correlations between measured and true quantities
- The problem of unfolding
- ALEPH data on F_2^γ
- Comparison with models and other data
- Q^2-evolution of F_2^γ
- Conclusions

In leading order:

$$F_2^\gamma(x,Q^2) = x\sum_{i=1}^{n_f} e_i^2 \left[q_i^\gamma(x,Q^2) + \overline{q}_i^\gamma(x,Q^2)\right]$$

q_i^γ- quark-parton distribution functions for the different flavours i

$$x = \frac{Q^2}{Q^2 + P^2 + W_{\gamma\gamma}^2}$$

$$Q^2 = 2E_{\text{beam}}E_{\text{tag}}\left(1 - \cos\Theta_t\right)$$

Θ_t- scattering angle of the tagged electron

$$\frac{d^2\sigma_{e\gamma\to eX}}{dxdQ^2} \approx \frac{4\pi\alpha_{em}^2}{xQ^4}F_2^\gamma(x,Q^2)$$

"single-tag"

LEP I

	# of events	Q^2 range (GeV^2)	$\langle Q^2 \rangle$ (GeV^2)	E_{cms} (GeV)	$\mathcal{L}$ (pb^{-1})
ECAL	163	35 - 3000	284.0	91	162
LCAL	1647	13 - 44	20.7	91	155
LCAL	1543	6 - 13	9.9	91	155

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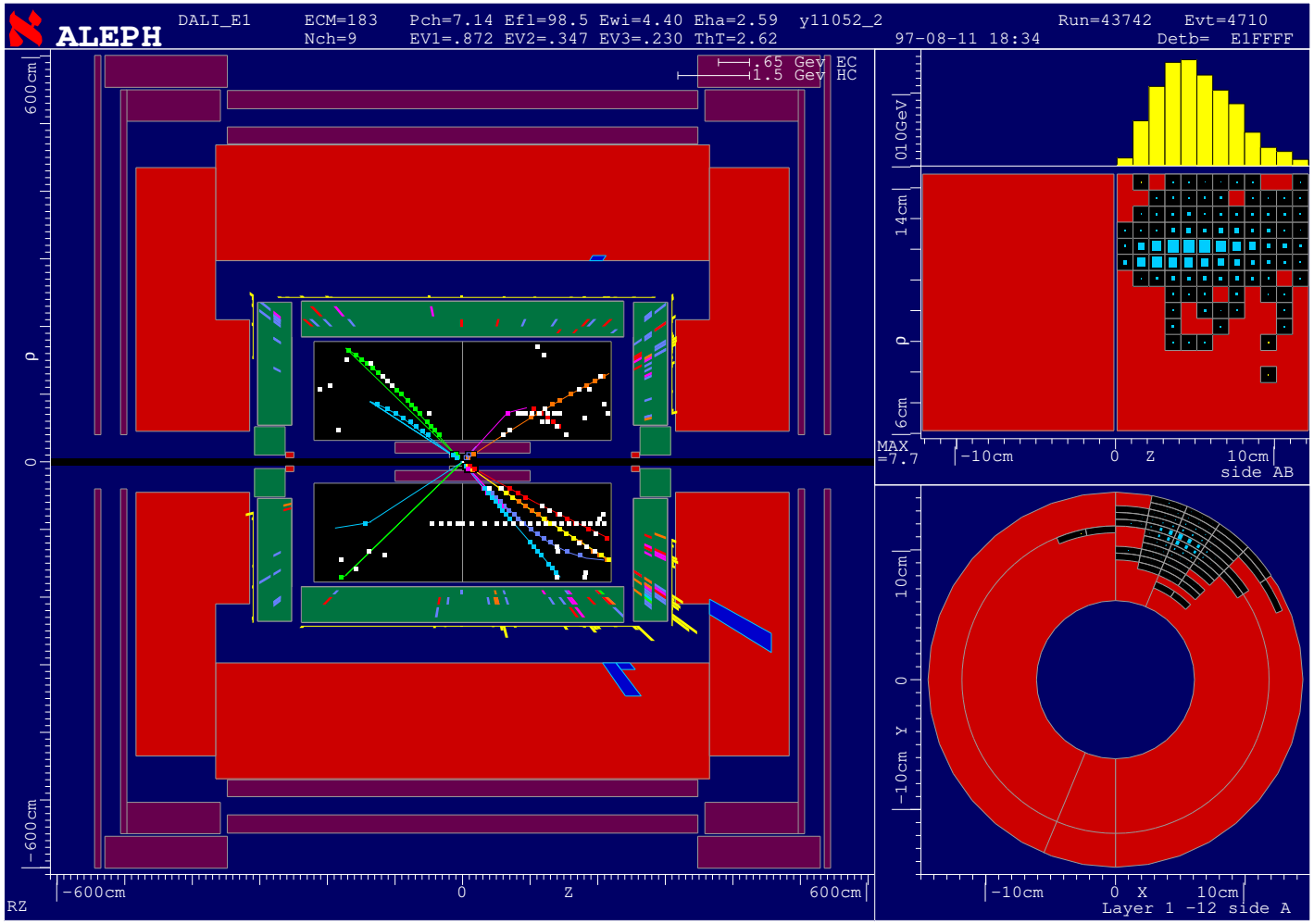
LEP II

	# of events	Q^2 range (GeV^2)	$\langle Q^2 \rangle$ (GeV^2)	E_{cms} (GeV)	$\mathcal{L}$ (pb^{-1})
SiCAL	1208	7 - 24	13.7	183	53
LCAL	861	17 - 200	56.5	183	53



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Filename: DC043742_004710_980629_1443.PS

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Q^2 measured: 18.1 GeV^2 ; W measured: 7.1 GeV

The determination of Q^2 requires to measure the

- tag electron energy
- scattering angle

$\Rightarrow$ good correlation between Q^2_{true} and Q^2_{vis}

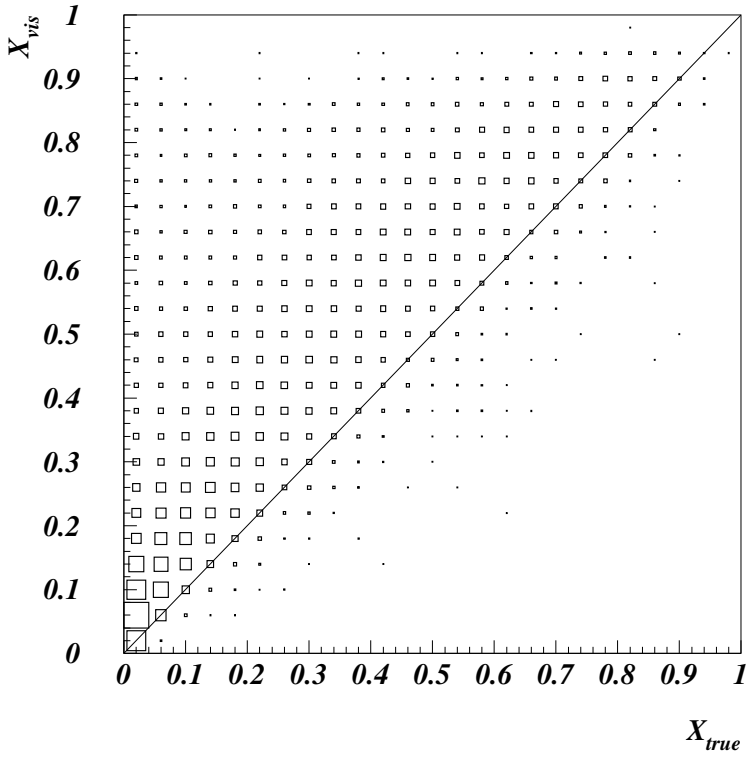
The determination of x requires to measure

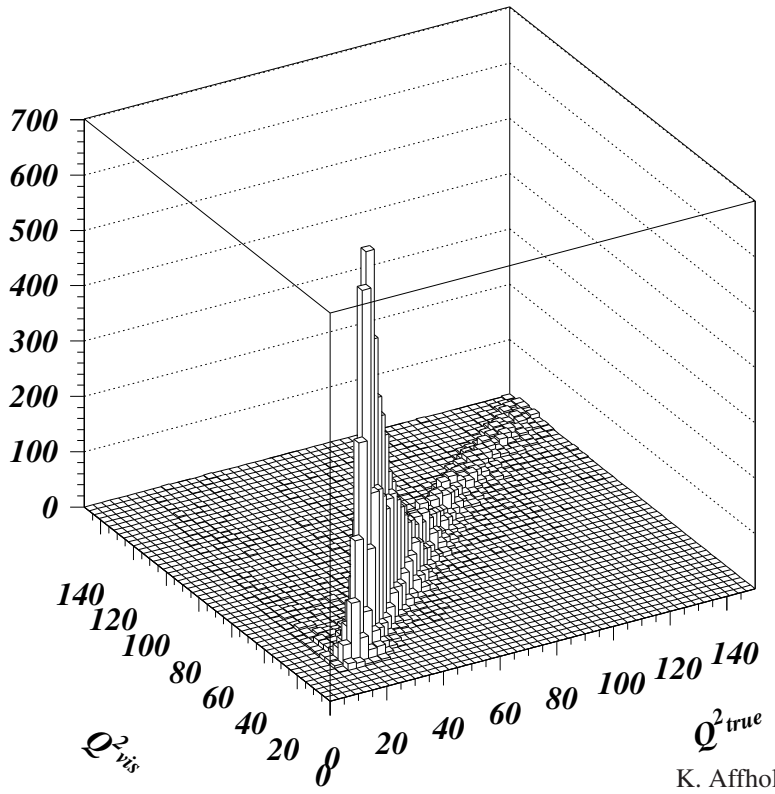
- Q^2
- $W_{\gamma\gamma}$

The resolution on $W_{\gamma\gamma}$ is poor because of acceptance losses !

Introduction of a "quality stamp" $\Rightarrow E_{\text{cut}} = E_{17^\circ}$

Comparison of x_{vis} versus x_{true} and Q^2_{vis} versus Q^2_{true} for LCAL–tag events





$\Rightarrow$ UNFOLDING NEEDED !

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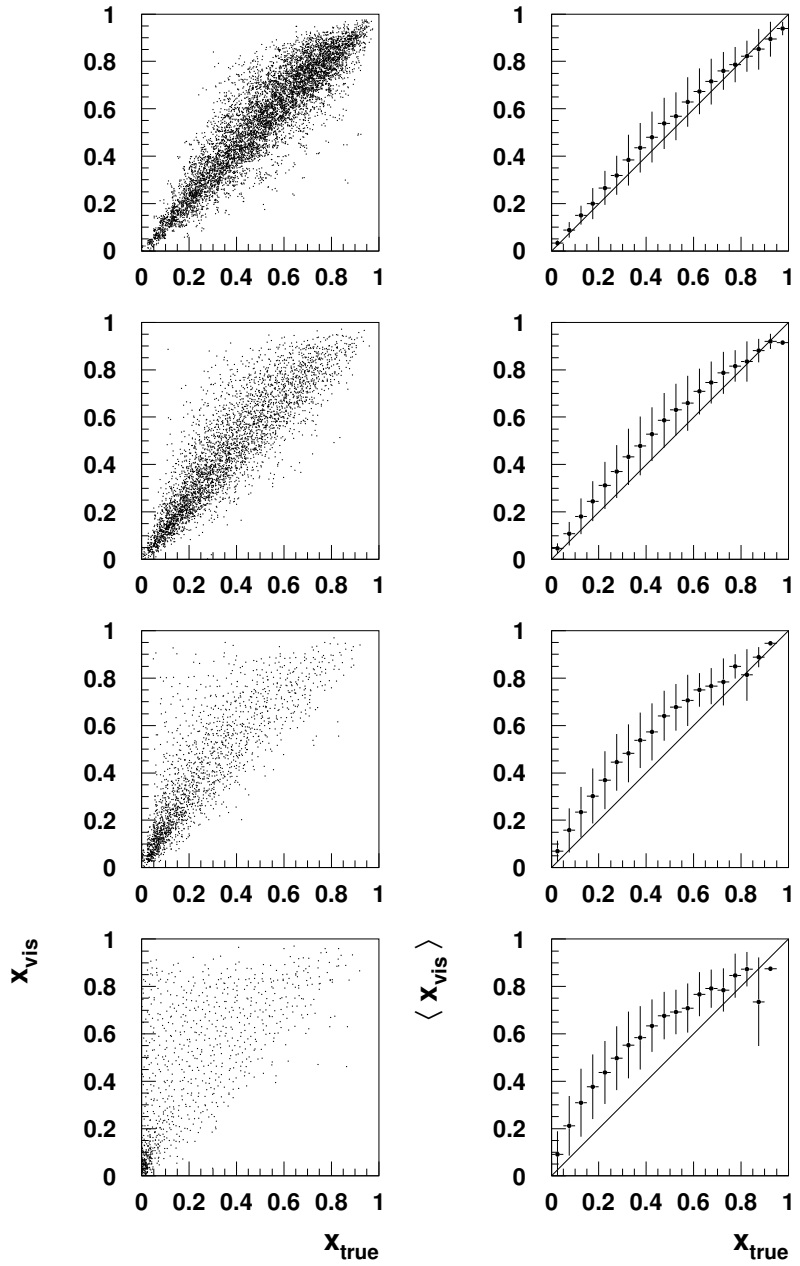

a)

$E_{17} < 50$ MeV

b)

$50 \text{ MeV} \leq E_{17} < 5 \text{ GeV}$

c)

$5 \text{ GeV} \leq E_{17} < 15 \text{ GeV}$

d)

$E_{17} \geq 15$ GeV.

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$g(x_{\text{vis}})$ measured by the detector

$f(x_{\text{true}})$ required for the extraction of F_2^γ

$g(x_{\text{vis}}) = \int A(x_{\text{vis}}, x_{\text{true}}) f(x_{\text{true}})\, dx + B(x_{\text{true}}) \qquad (*)$

$A(x_{\text{vis}}, x_{\text{true}})$ response function of the detector, model dependent

$B(x_{\text{true}})$ background contribution

$g(x_{\text{vis}})$ has the form of a histogram

!! Simple inversion of $(*)$ leads to large fluctuations and oscillations !!
(Matrix inversion $\hat{=}$ Maximizing the *Likelihood function*)

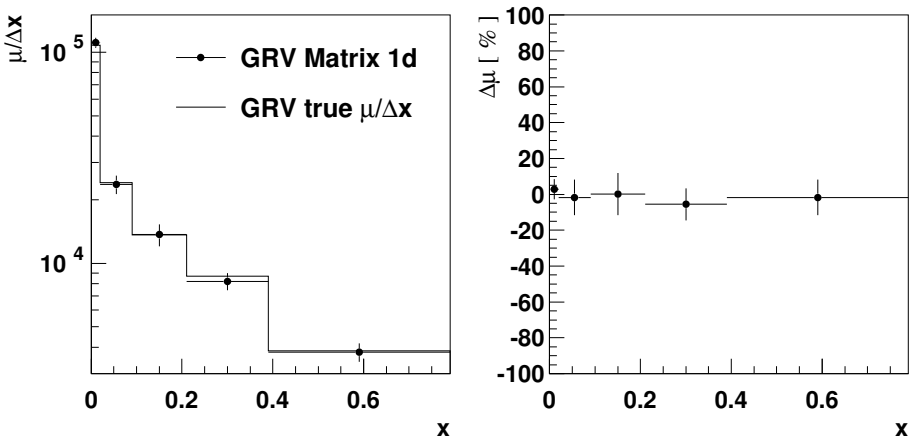
$\Rightarrow$ Introduce a smoothing function S

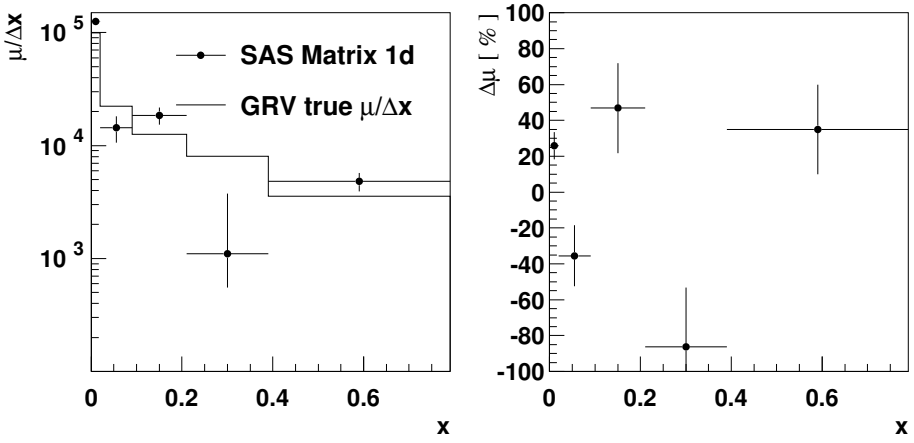
Unfolding with regularization:

$$\Phi(\vec{\mu}) = \alpha \cdot logL(\vec{\mu}) + S(\vec{\mu}) + \lambda \left(n_{tot} - \sum_{i=1}^{N} \nu_i \right)$$

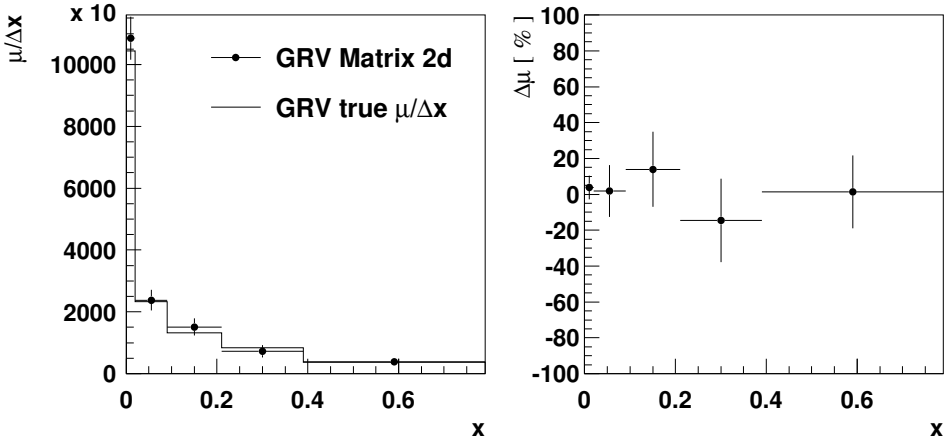
$$S_H(\vec{\mu}) = -\sum_{j=1}^{M} \frac{\mu_j}{\mu_{tot}} log \left(\frac{\mu_j}{\mu_{tot}} \right)$$

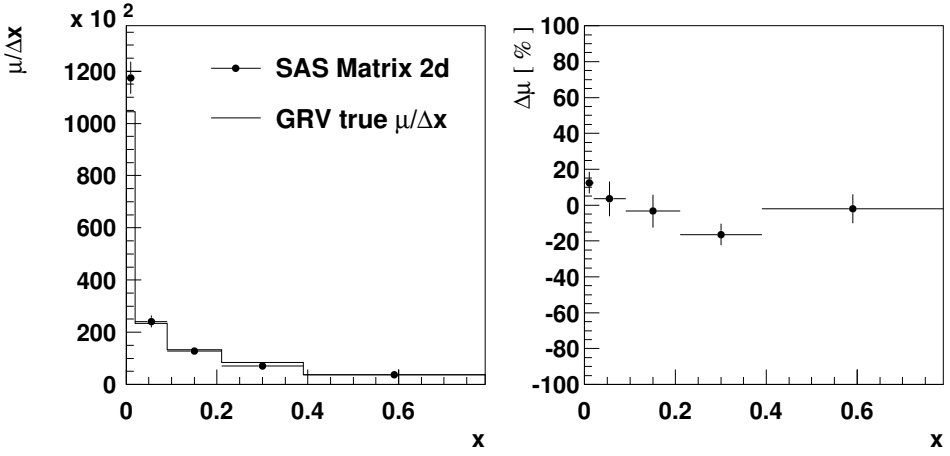
1-dim MaxEnt





2-dim MaxEnt





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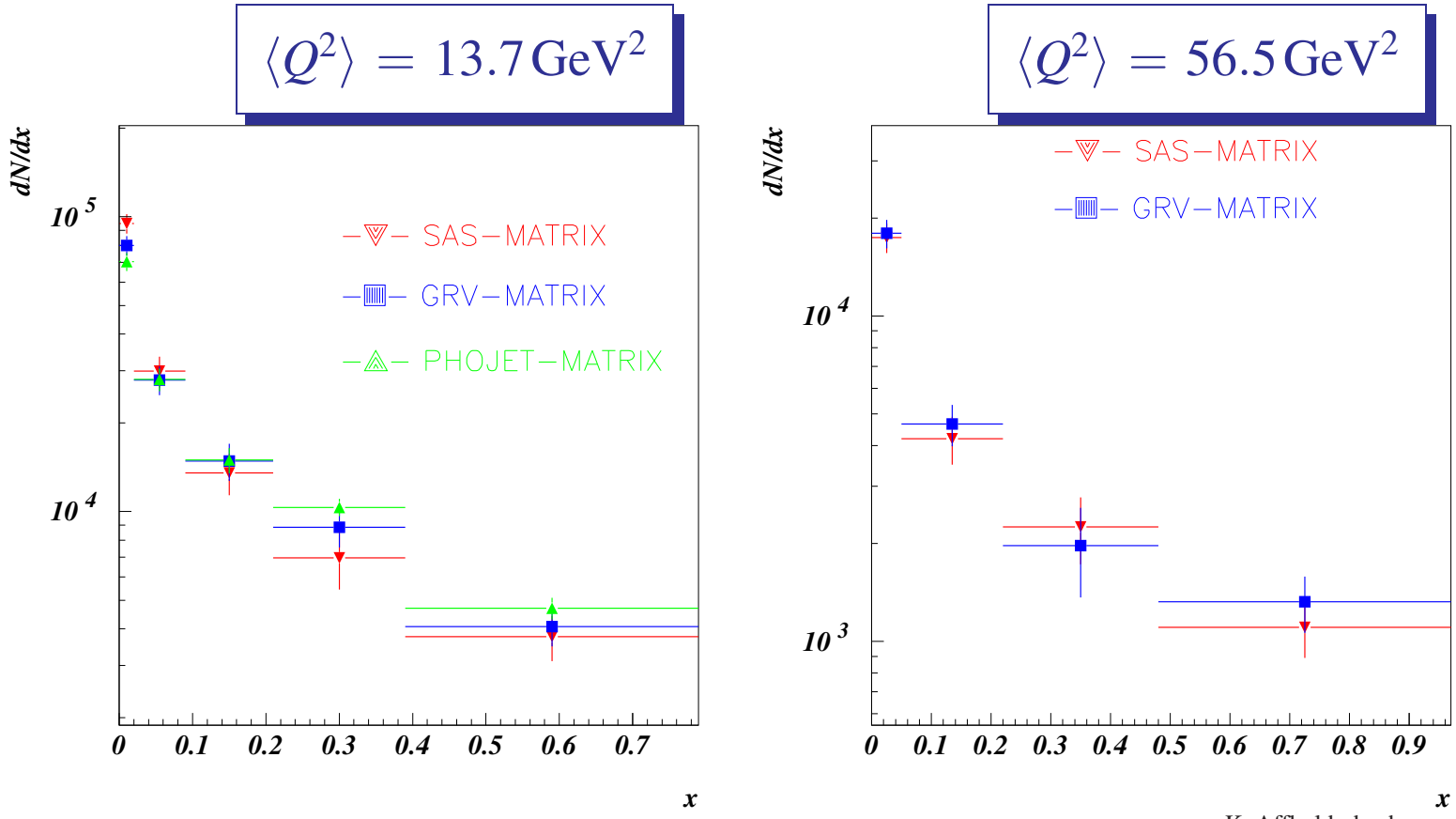

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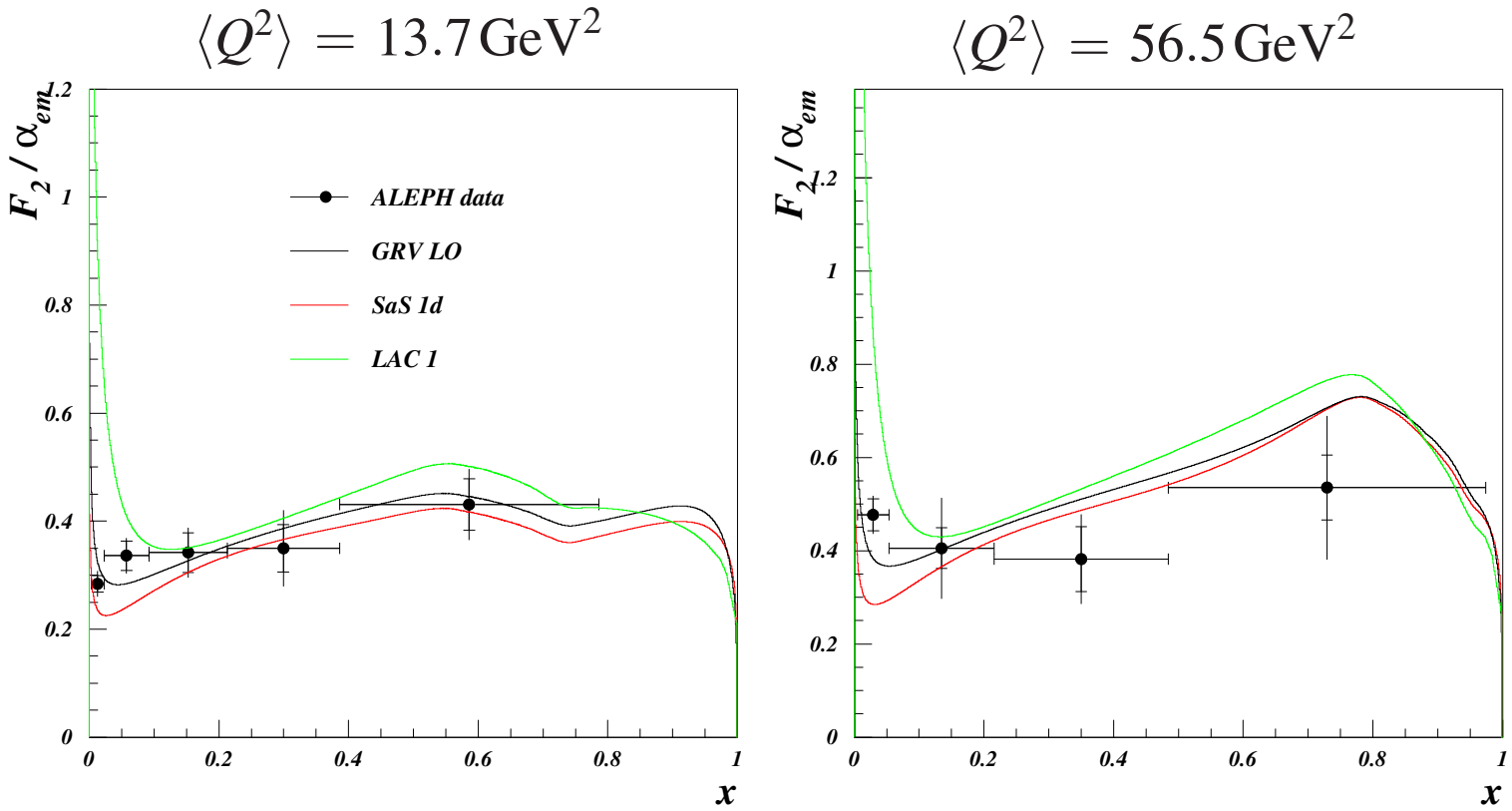
$$F_2^\gamma(x,\langle Q^2\rangle)_{\text{meas.}} = \frac{\left(\frac{dN}{dx}\right)_{\text{meas.}}}{\left(\frac{dN}{dx}\right)_{\text{ref.}}} \cdot F_2^\gamma(x,\langle Q^2\rangle)_{\text{ref.}}$$

PRELIMINARY



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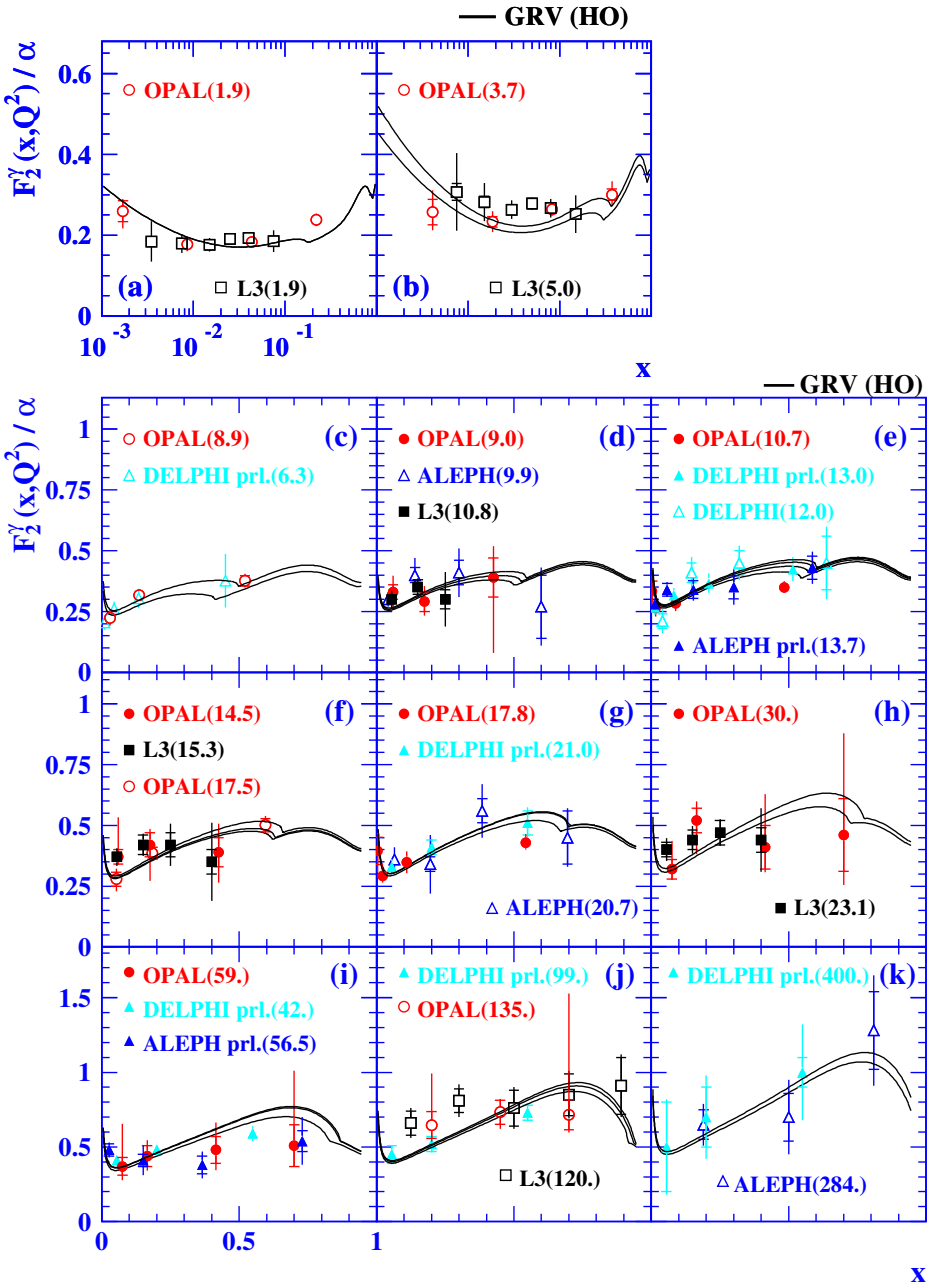
Errors on F_2^γ

- statistical errors
- sytematic errors
  - model dependence of the unfolding
  - variation of the cut parameters
  - choice of the regularisation parameter



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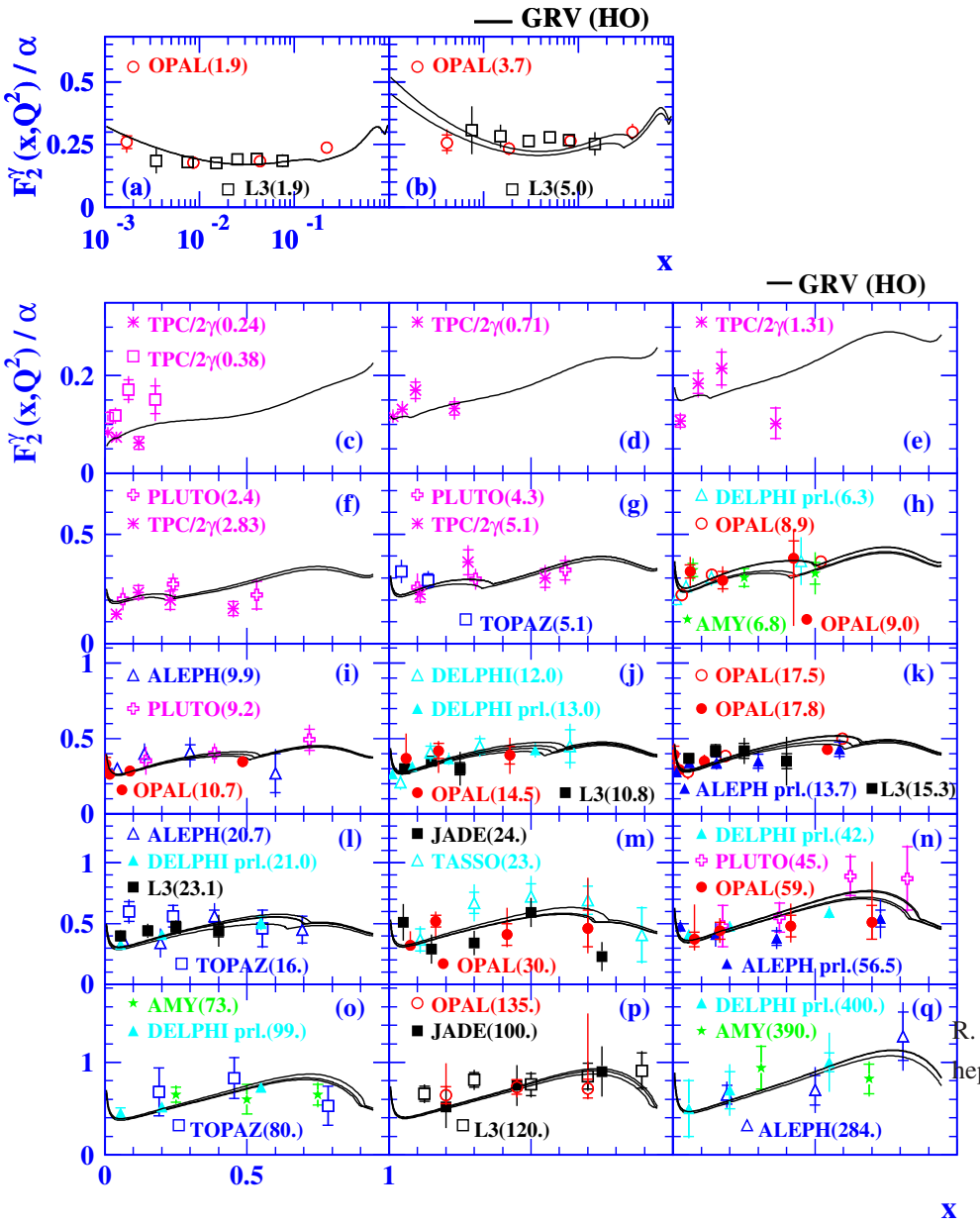

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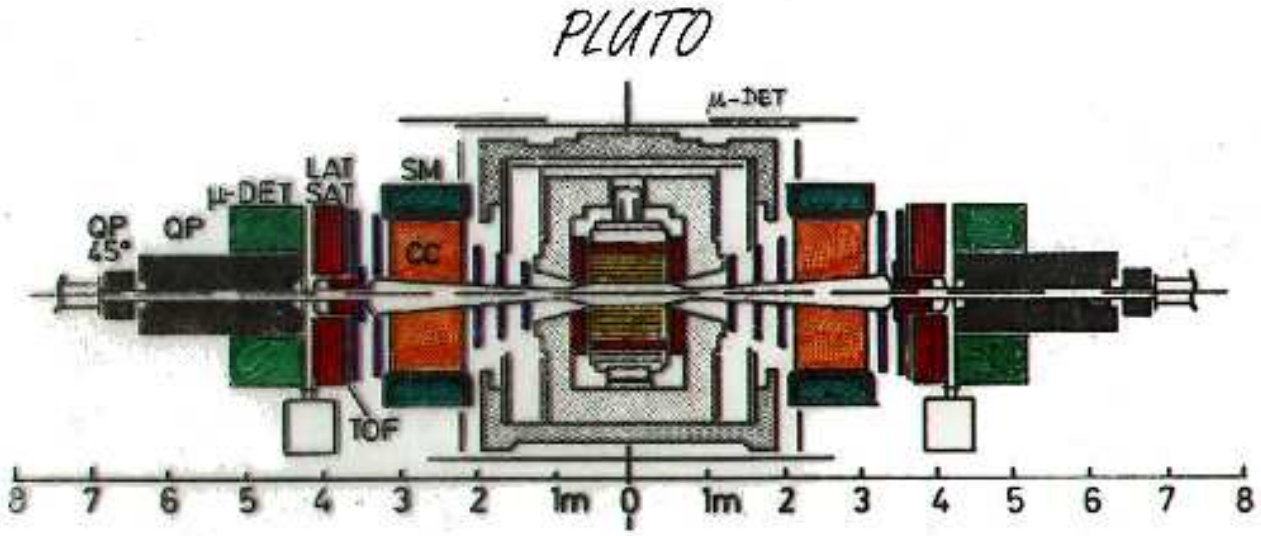
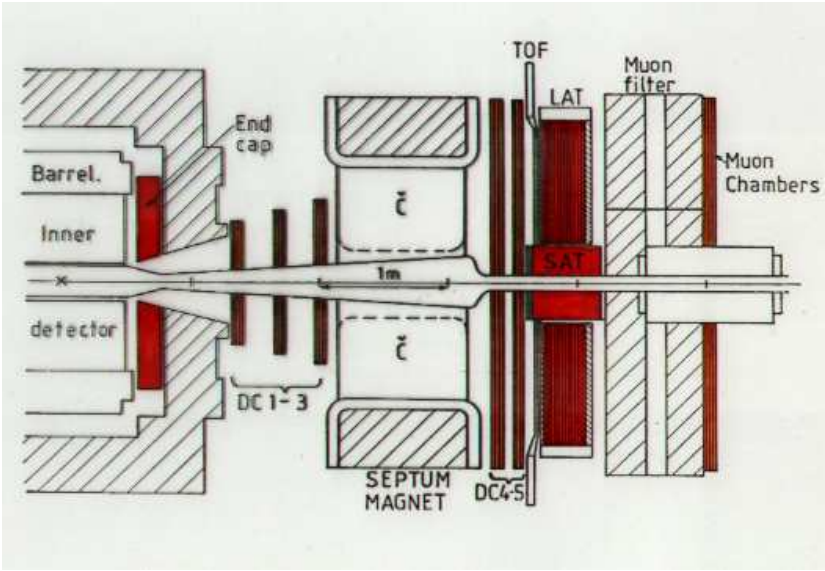

PLUTO
μ-DET
LAT
SAT
SM
μ-DET
QP
45°
QP
CC
TOF
8 7 6 5 4 3 2 1m 0 1m 2 3 4 5 6 7 8


TOF
Muon
filter
LAT
End
cap
Barrel.
Inner
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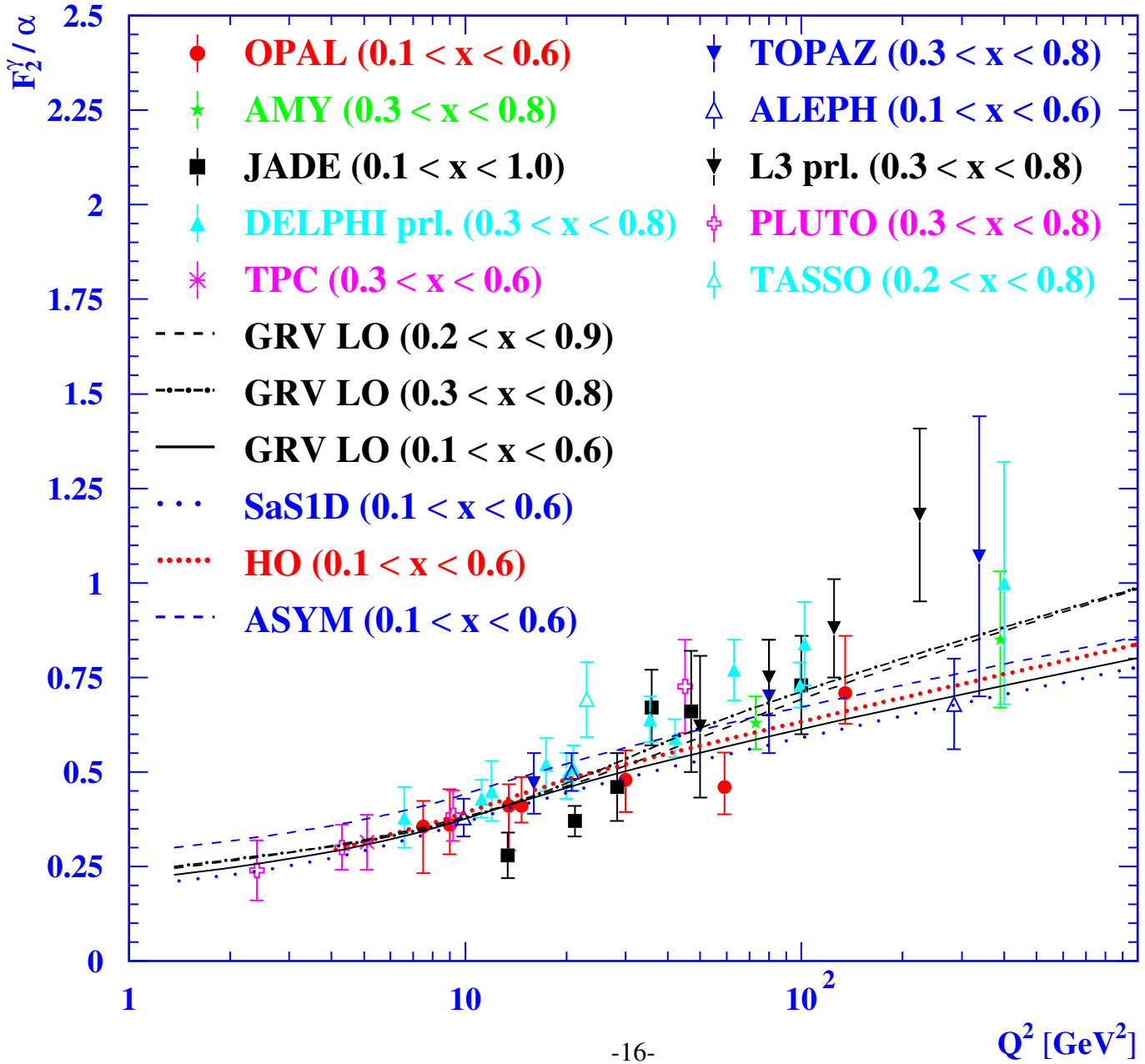
Muon
Chambers
SAT
1m
DC 1-3
SEPTUM
MAGNET
DC4-5



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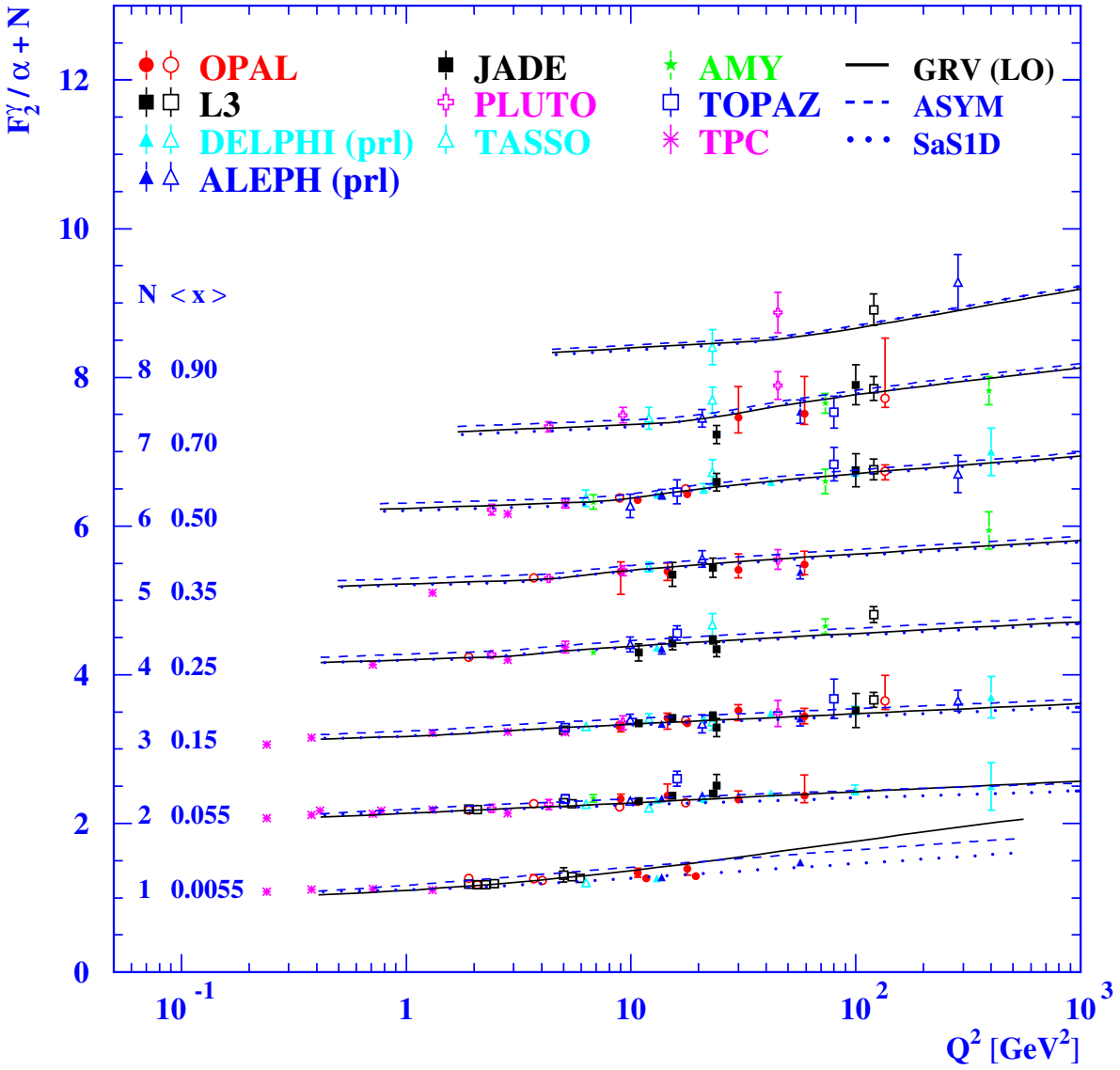

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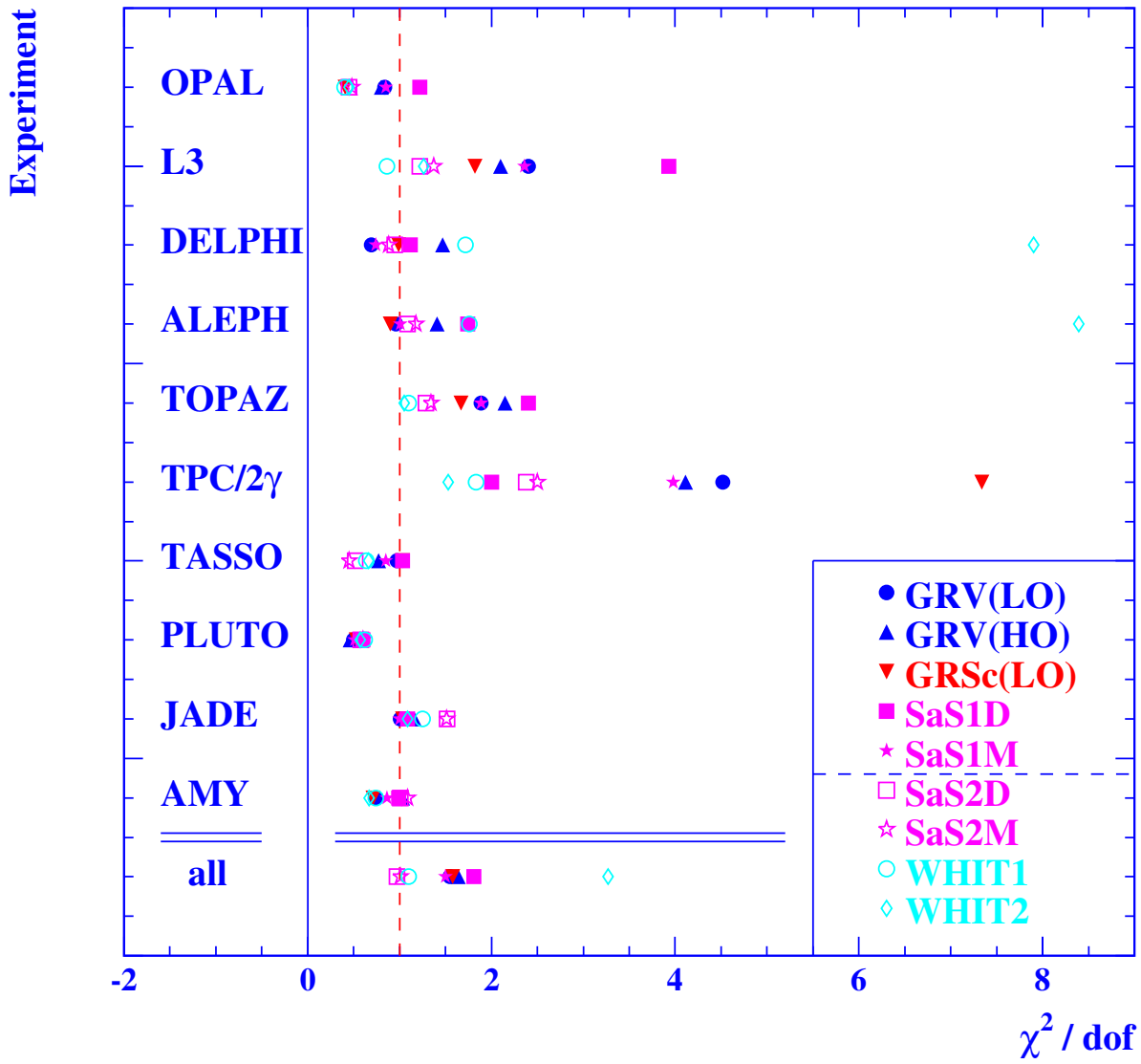
$$F_2^\gamma = a + b \ln \frac{Q^2}{\Lambda^2} \qquad (**)$$

expectation : an increasing slope as a function of Q^2 for increasing values of x

Λ = 0.2 GeV used in the fits

$(**)$ describes the data rather well



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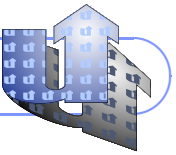
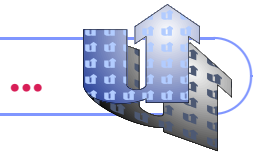
Physics Seminar CERN, 04/2000



Conclusions

- the GRV parametrization of the parton distribution function describes the data of nearly all experiments reasonably well.
- the TPC/2γ results show an unexpected behaviour at low x;
  they are in conflict with other experimental data;
  one cannot expect any model to describe them
- there is some scatter in the experimental data taken under similar conditions. Are they inconsistent? Or are the systematical errors underestimated?

- models predicting a fast rise at low x driven by
  large gluon distribution functions can be discarded



Einstein 1951

All these fifty years of conscious brooding have brought me no nearer to the answer of the question

"What are light quanta?"

Nowadays everyone thinks he knows it, but he is mistaken !