α_s Determination at the LHeC

2nd CERN-ECFA-NuPECC Workshop on the LHeC

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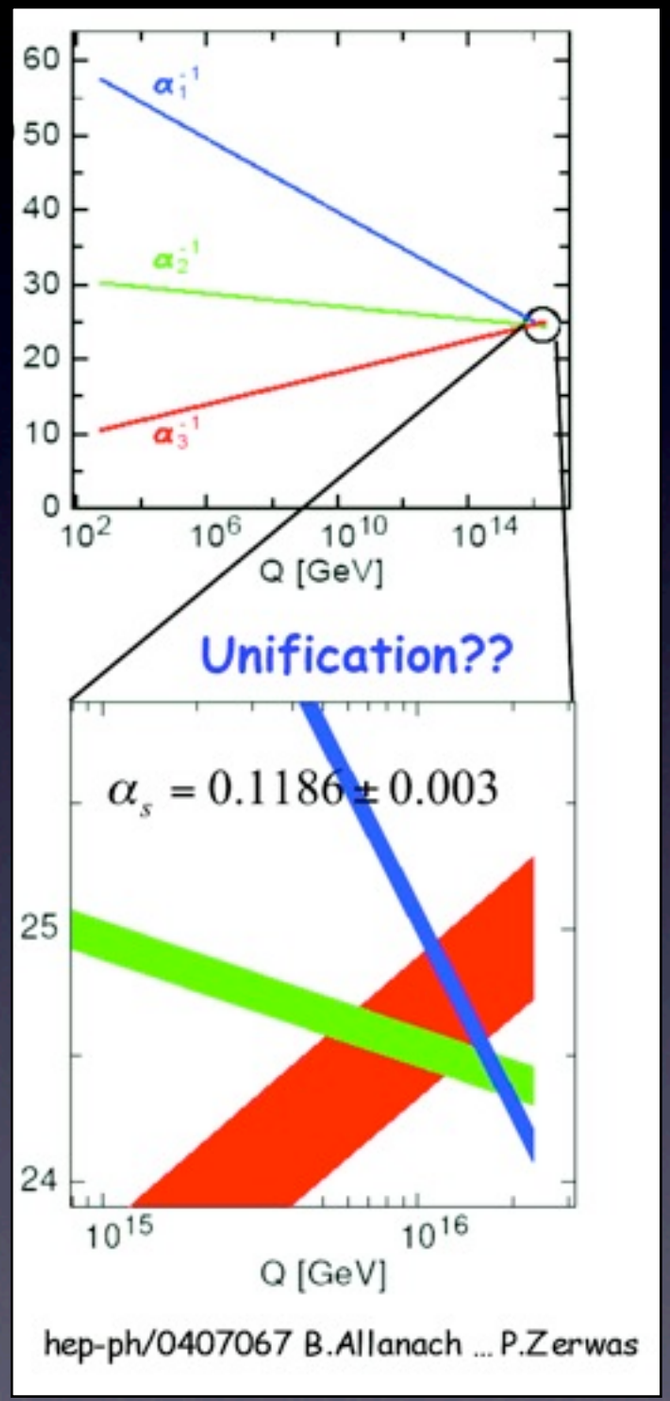
Introduction

- What is the potential for determining α_S with the LHeC?
- Motivation provided by Chris yesterday

- Fundamental parameter of QCD, need experimental input
- Precision: unification of forces?



α_s from DIS

- HERA inclusive: Eur.Phys.J.C21:33-61,2001
  - H1 and BCDMS data
  - $\alpha_s(M_Z)=0.1150\pm0.0017(exp)^{+0.0009}_{-0.0005}(mod)\pm0.005(NLO\ scale)$
  - 1.5% exp error (4.5% w/o BCDMS)
- HERA jets: DESY 09-032
  - H1 data
  - $\alpha_s(M_Z)=0.1168\pm0.0007(exp)+0.0046(th)\pm0.0016(PDF)$
  - 0.6% exp error

„Data“sets

In the following using selection of data sets as provided by Max, from http://hep.ph.liv.ac.uk/~mklein/simdis09/

config.	E(e)	E(N)	N	∫L(e^+)	∫L(e^-)	|Pol|	L/10^{32}	P/MW years	type
A	20	7	p	1	1	-	1	10	1	SPL
B	50	7	p	50	50	0.4	25	30	2	RR hiQ^2
C	50	7	p	1	1	0.4	1	30	1	RR lo x
D	100	7	p	5	10	0.9	2.5	40	2	LR
E	150	7	p	3	6	0.9	1.8	40	2	LR
F	50	3.5	D	1	1	--	0.5	30	1	eD
G	50	2.7	Pb	0.1	0.1	0.4	0.1	30	1	ePb
H	50	1	p	--	1	--	25	30	1	lowEp

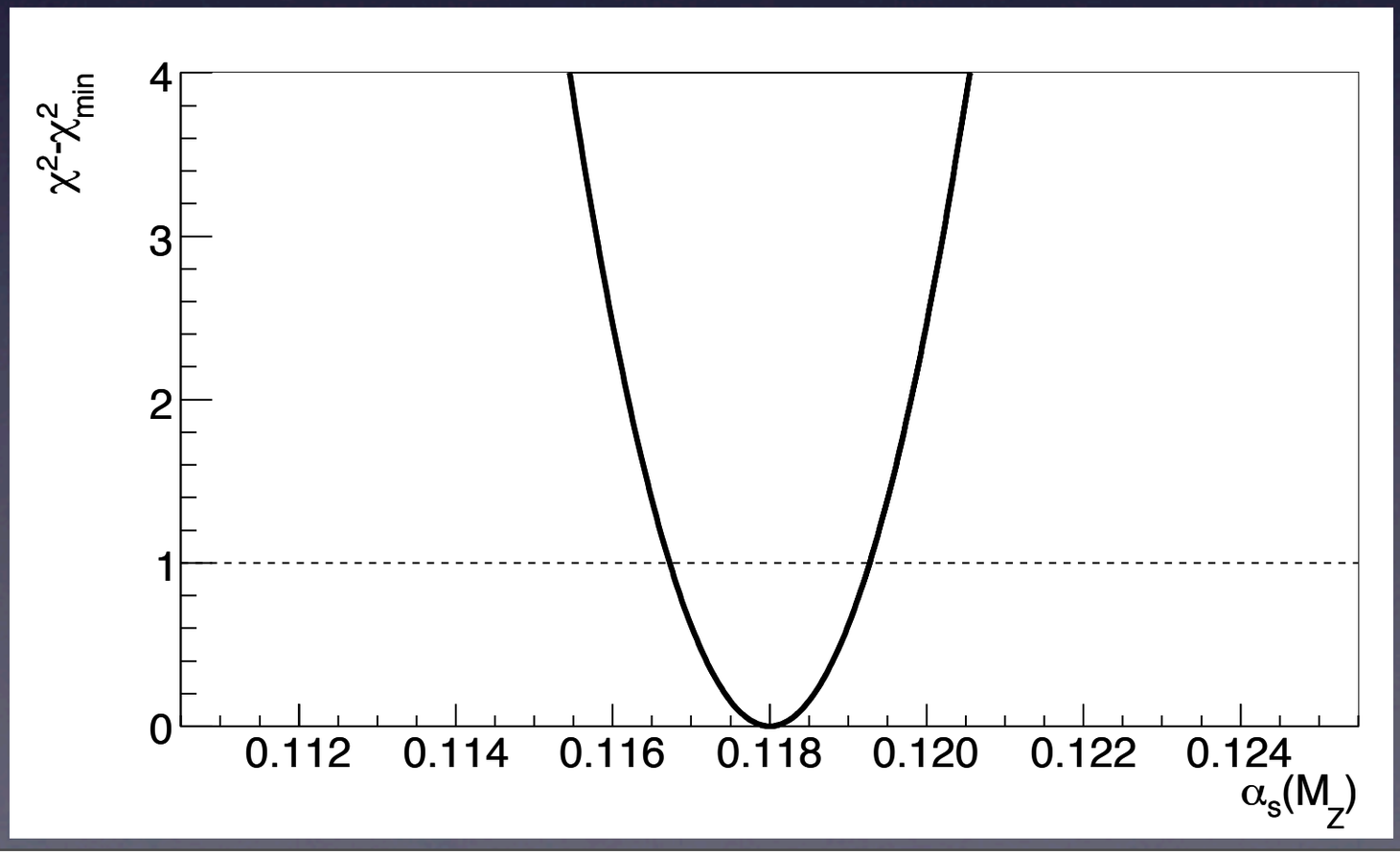
Fit Method

- Use H1 fit program (QCDNUM based)
- Simultaenous PDF and α_s fit
- Parameterisation and χ^2 like H12000 PDF
- Move data points to central PDF and $\alpha_s(m_Z)=0.118$
- Smear by statistical error, shift by correlated uncertainty, no cross correlation
- Luminosity 0.5%, half correlated btw datasets

Scenario B, NC

200 fb^{-1} data, ~144 data points,
1-2% uncertainty
detector acceptance 5°…175°

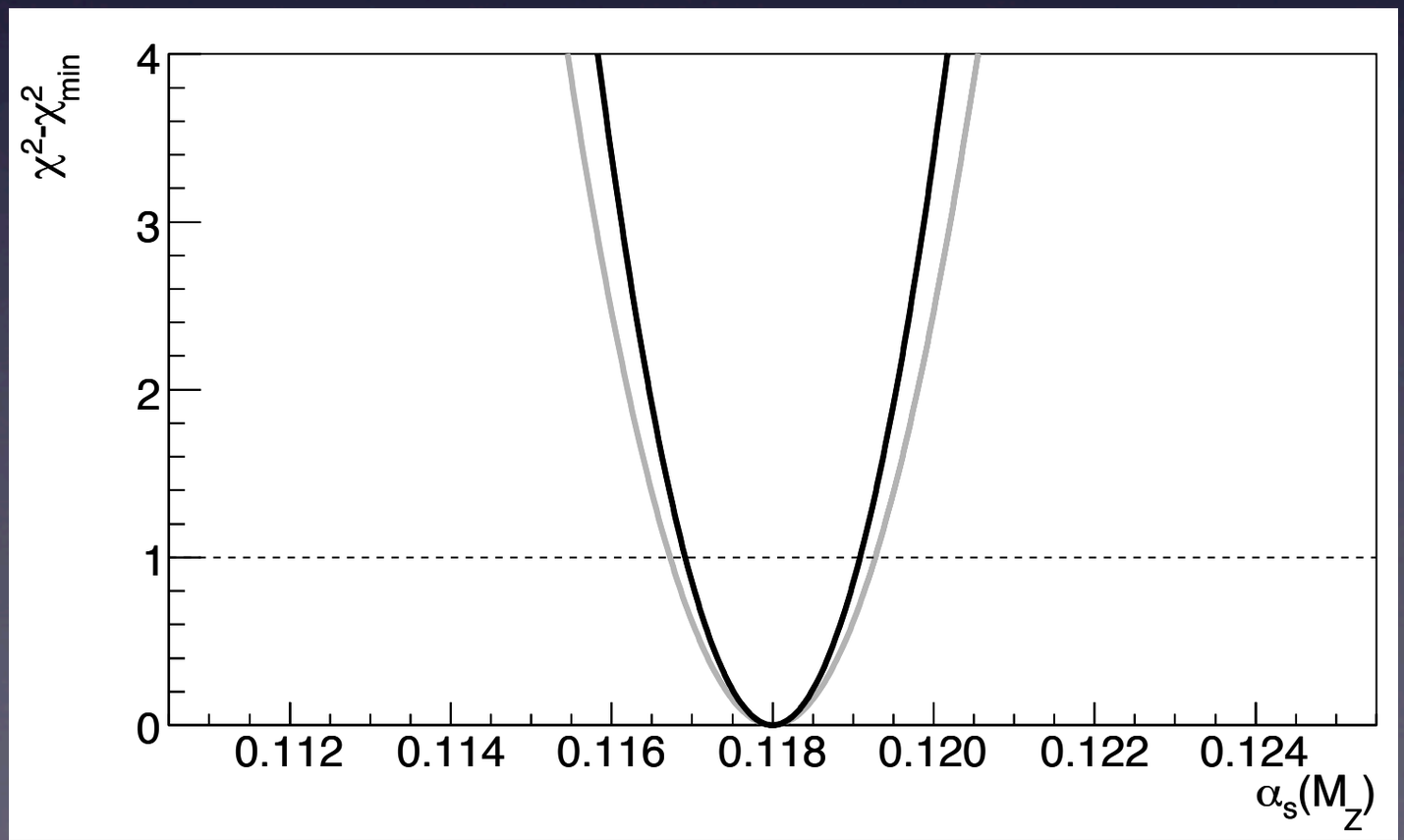
Uncertainty: 1.08%



Scenario B, NC+CC

adding CC, ~110 data points,
2-3%uncertainty

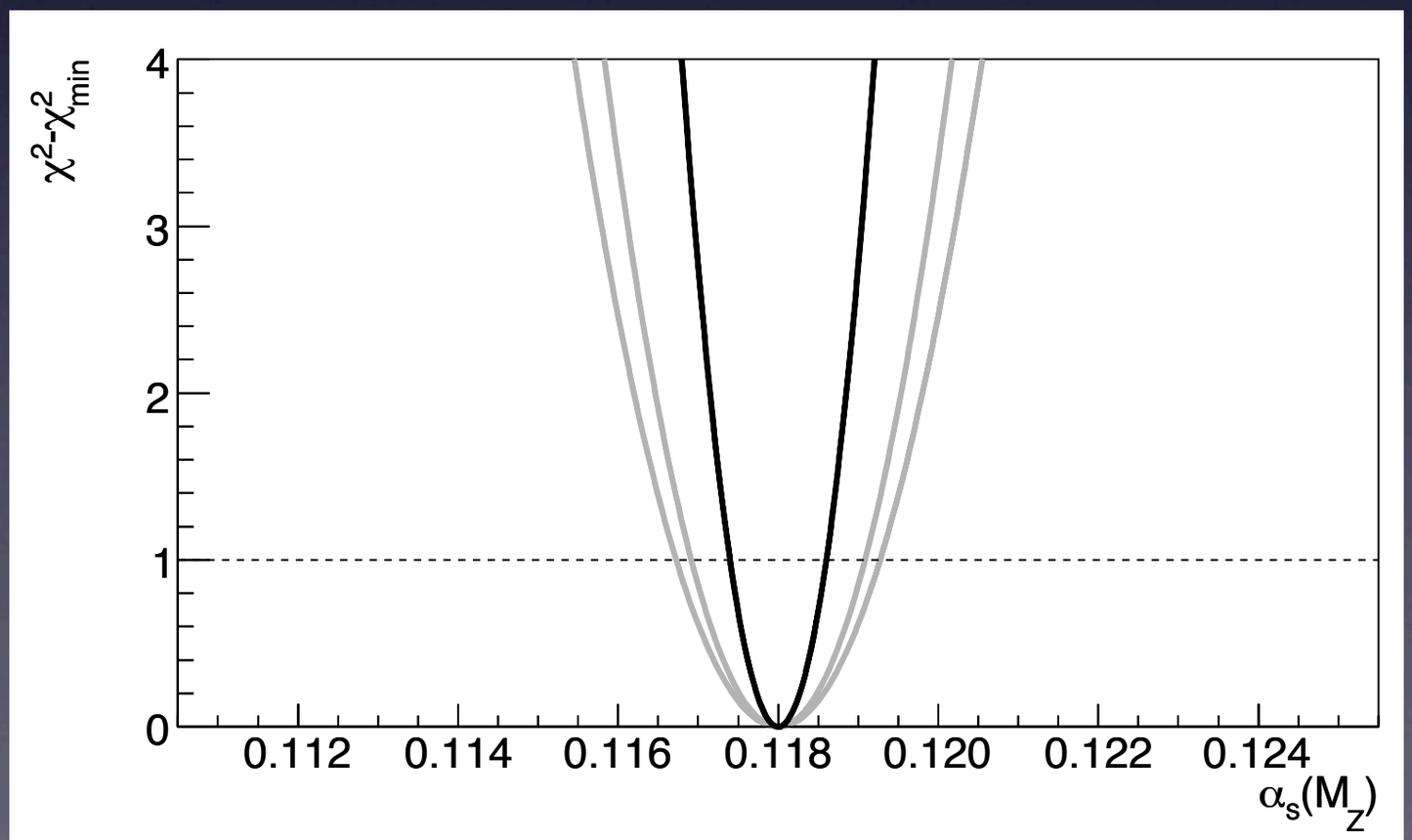
Uncertainty: 0.92%



Scenario B+C, NC+CC

adding 4 fb^{-1} data, 38 data points
detector acceptance 1°…179°

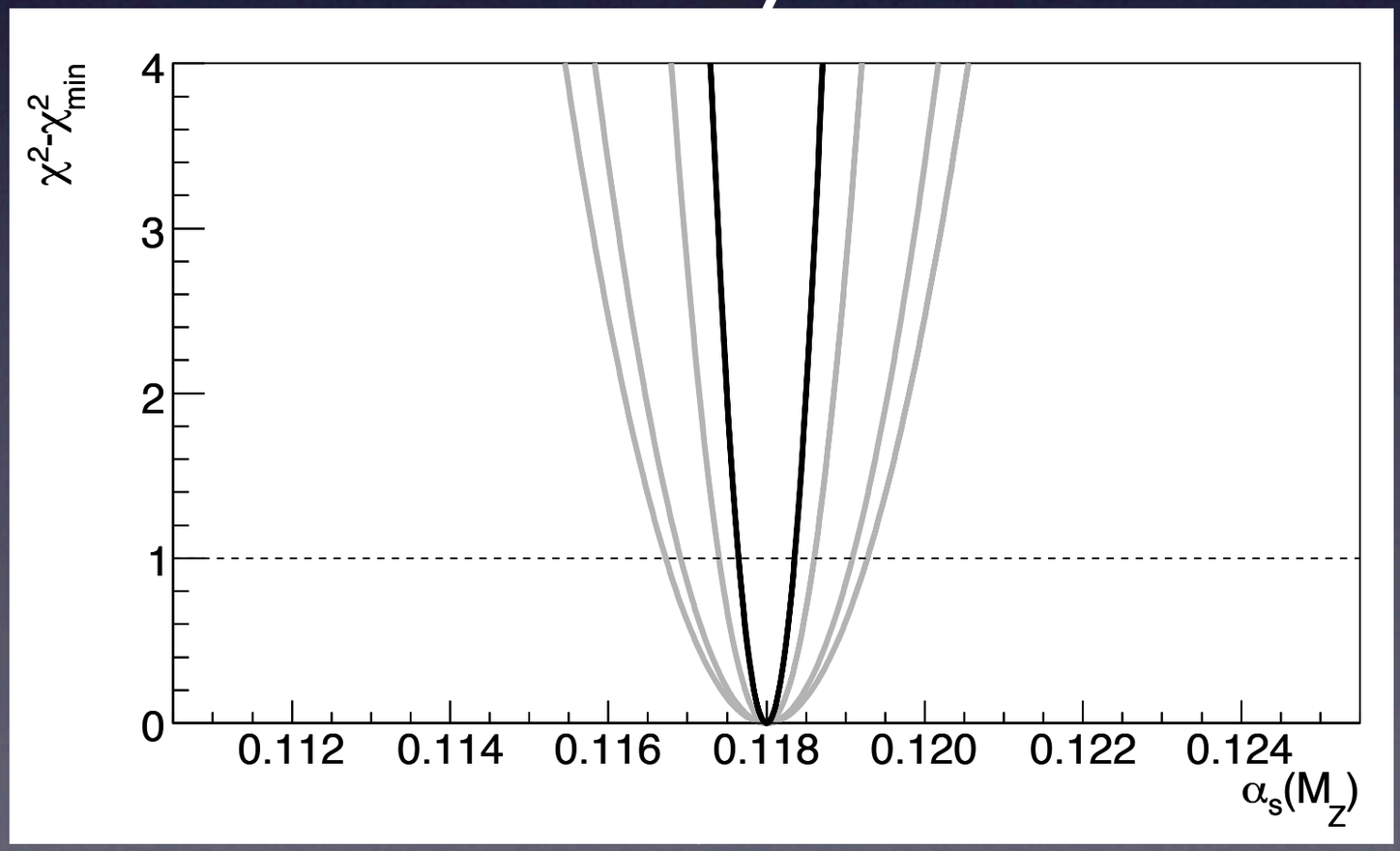
Uncertainty: 0.51%



B+C+H, NC+CC

adding 1 fb^{-1} data, 100 data points,
1-2% uncertainty
low E_p=1 TeV

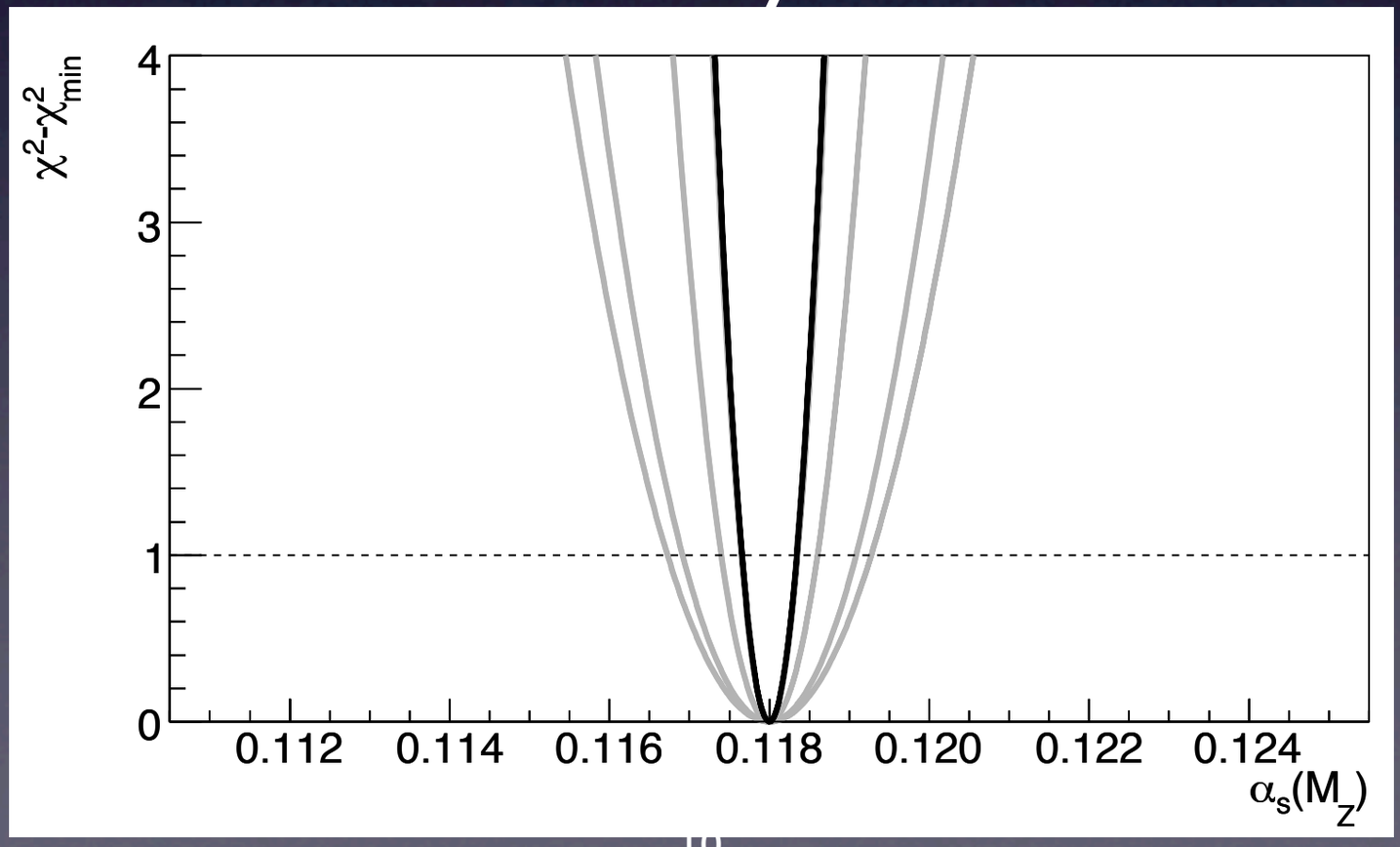
Uncertainty: 0.30%



B+C+H+F, NC+CC

adding 2 fb^{-1} data, 80 data points,
3-5% uncertainty
deuterium

Uncertainty: 0.29%



Summary

- LHeC has potential for O(1‰) experimental precision on $\alpha_s(m_Z)$ with inclusive data alone
- Challenge for theory to keep up
- Angular acceptance of the detector crucial, low E_p run also helps
- In progress: include jet production at LHeC in fits

Backup

From last year‘s workshop

LHeC Fits

DATA	exp. error on α_s
NC e^+ only	0.48%
NC	0.41%
NC & CC	**0.23% :=(1)**
(1) γ_h>5°	0.36% :=(2)
(1) +BCDMS	0.22%
(2) +BCDMS	0.22%
(1) stat. *= 2	0.35%