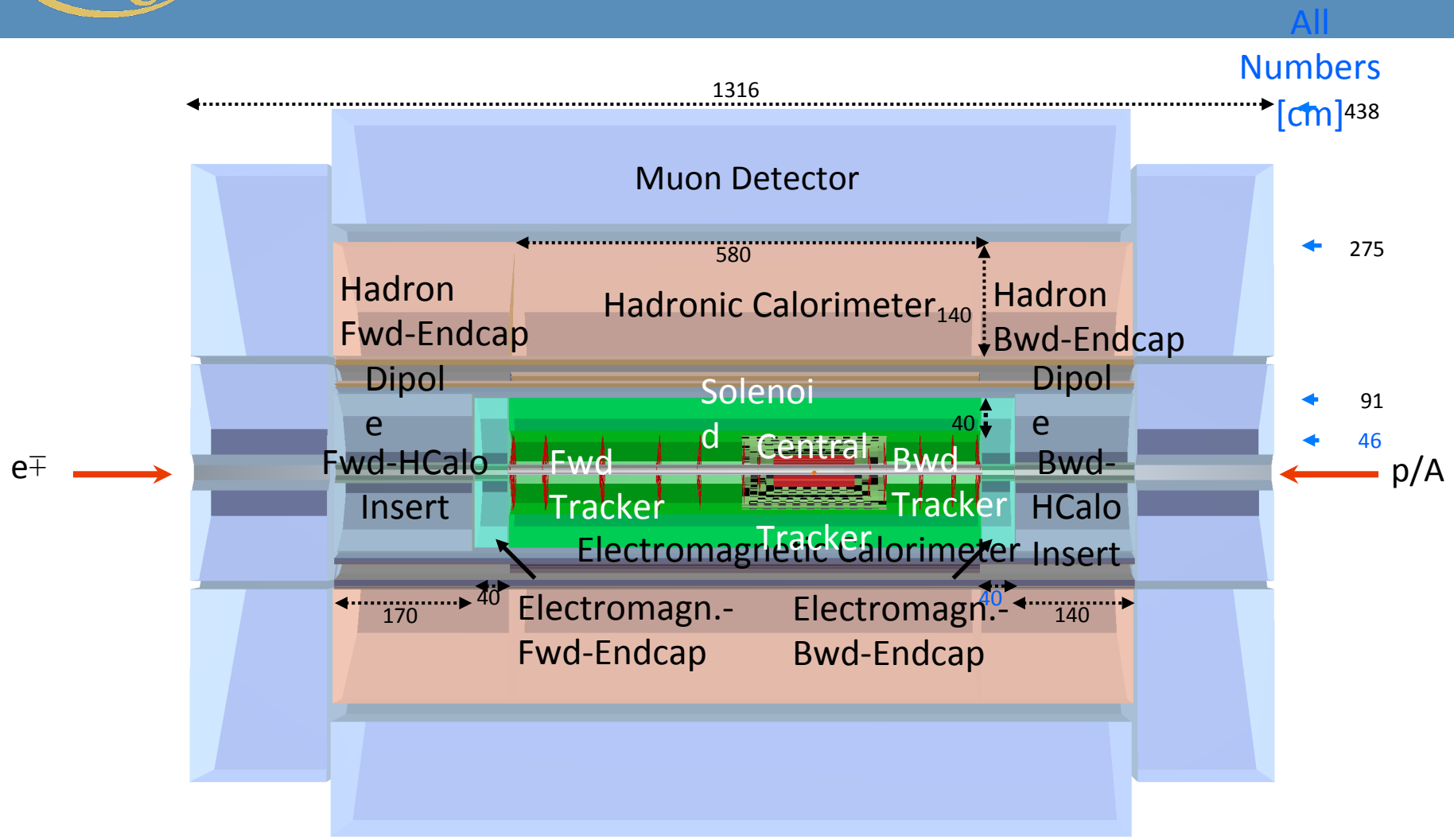
Physics and Detector

Brief remarks, for/with Peter and Stefano

Max Klein
University of Liverpool and CERN

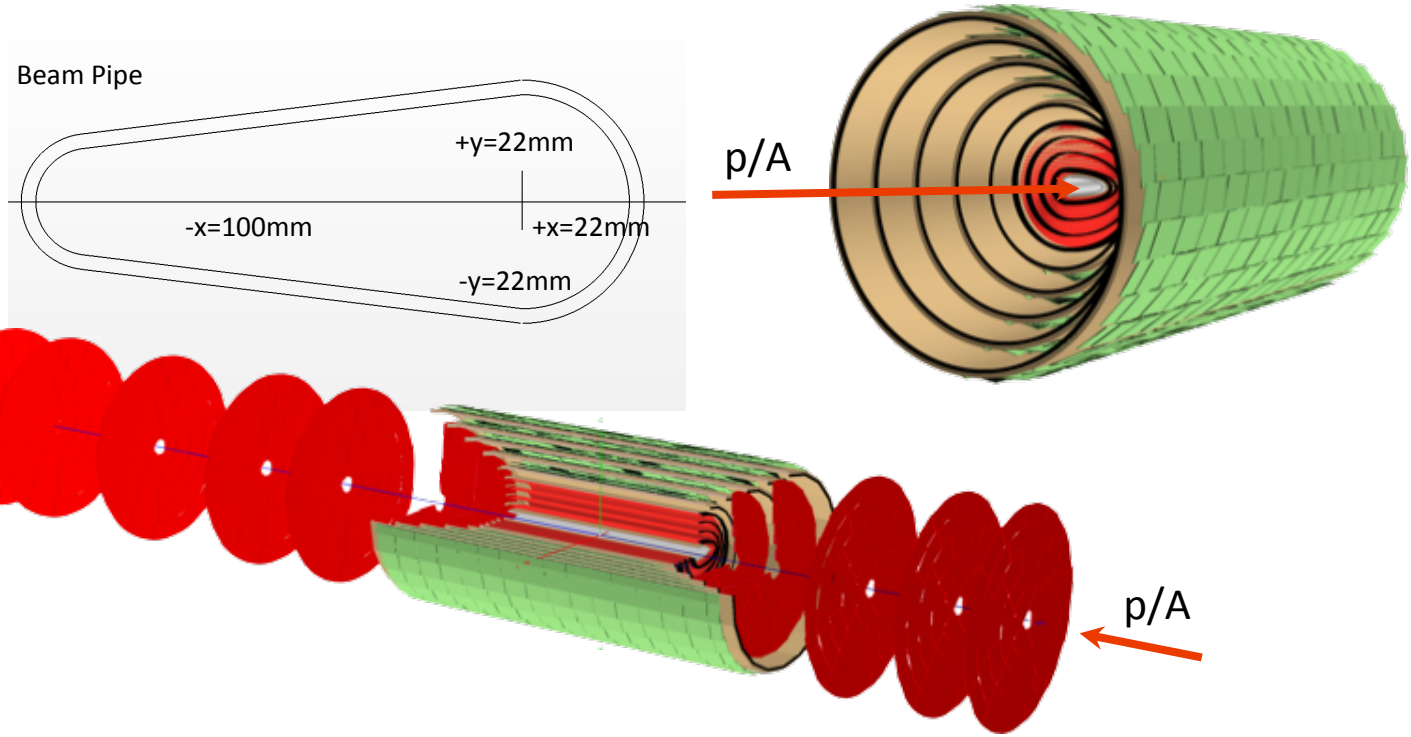
LHeC ep/A Detector



3 beams: e∓ + proton1 + proton2 (also heavy ions A)

Dipole magnets to guide the e-beam in and out, for making electrons to collide head-on with p-beam1; 0.3 T transverse field along 2 x 9 m

Tracker



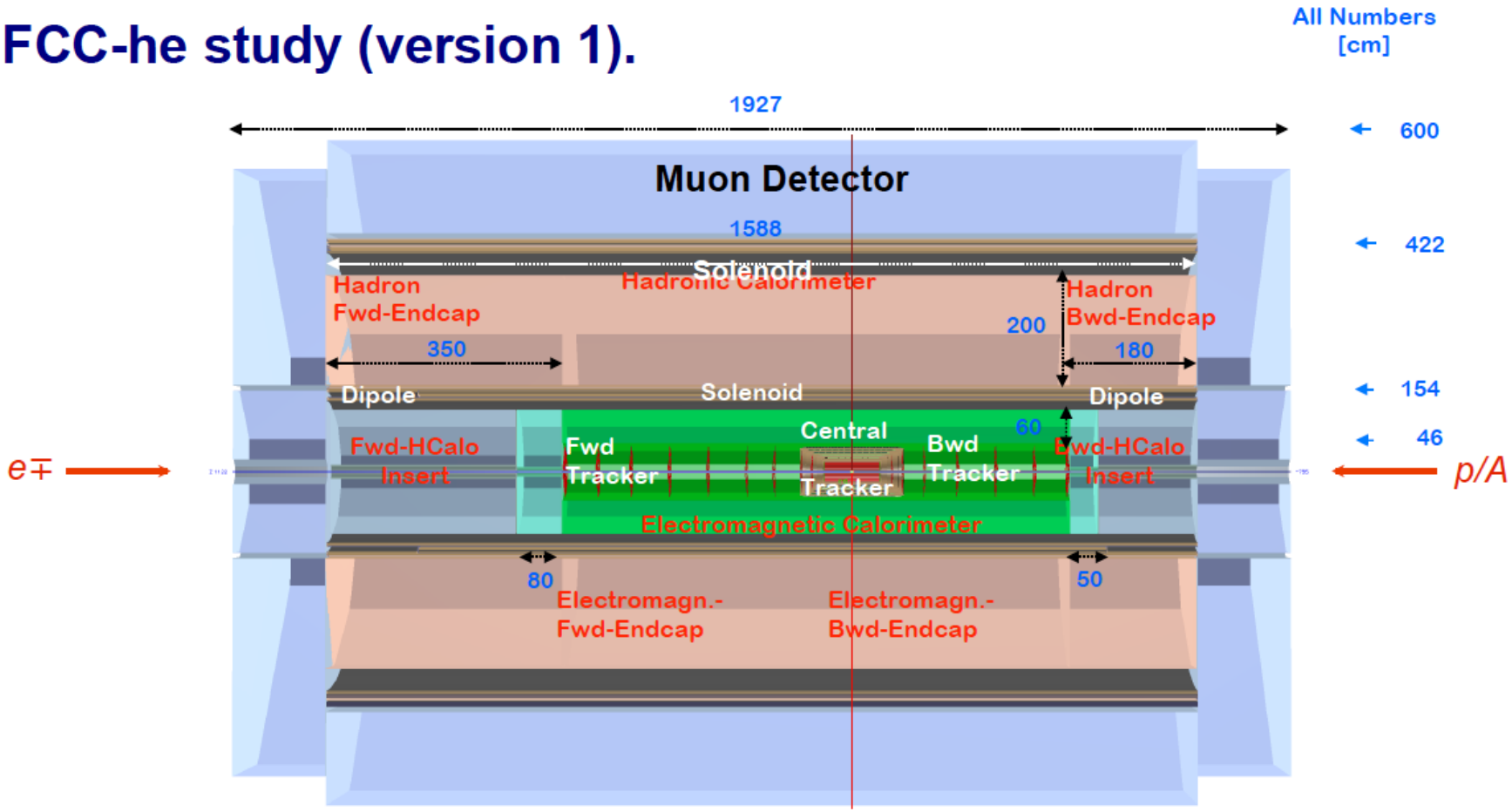
Interaction region design - Impact of Synchrotron Radiation

Elliptical Beam Pipe and Vertex Pixel Detector placement around

1st version describes sensitive / passive elements
(sensors / support structure / I-O elements)
Many details to be solved

LHeC/FCC-he design differ in fwd/bwd wheels placement only (currently)

FCC-he Detector



Solenoids 1 or 2, muons, fwd acceptance to enlarge, IR !

Detector

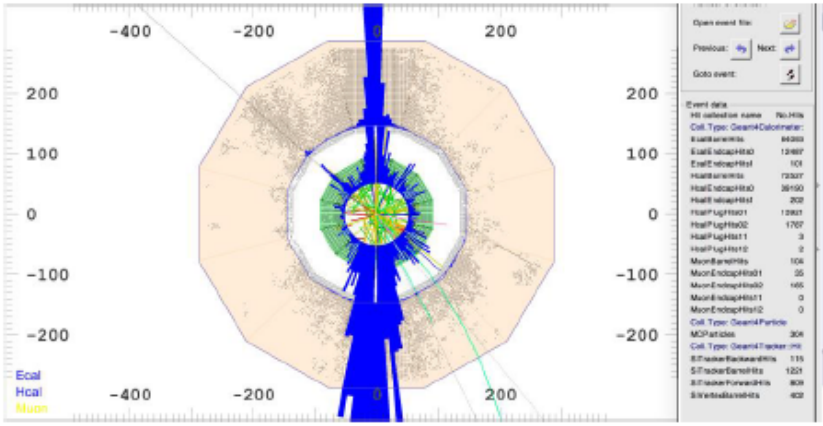
A great concept much owing to Peter! Alessandro Pollini (ATLAS run coord -2/16)

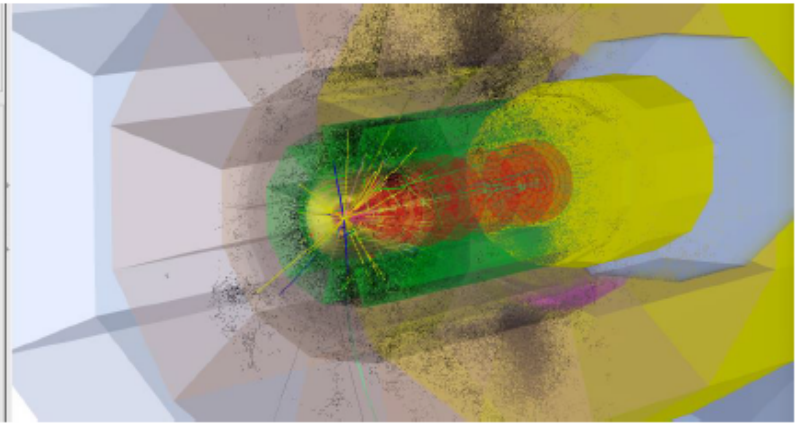
Most critical is the IR → priority for CDR update (backgrounds, lumi, acceptance)

Forward acceptance absolutely crucial for Higgs physics

No real study made for eA events

Software effort (together with FCC but we are weak – needs dedicated manpower
goal would be to link physics and detector with reconstruction)





Simulation of Higgs->bb from LHeC e-p

Physics Working Group

Physics Study Groups (Convenors)

PDFs, QCD	Fred Olness, Voica Radescu
Higgs	Uta Klein, Masahiro Khuze
BSM	Georges Azuelos, Monica D'Onofrio
Top	Olaf Behnke, Christian Schwanenberger
Nuclei	Nestor Armesto
Small x	Paul Newman, Anna Stasto

Progress

new PDF study
bb, cc, HH (FCC)
MSSM update
BSM overview
new nPDFs
UHE neutrinos

FCC physics coordination: Monica and Max

Great overviews (GA, SJB) and new studies at Chavannes

Had the goal of a yellow report on the LHeC/FCC-eh physics by 15 – 16 (Stefano Forte ed)
If we go for an updated CDR, then should it be integrated there ?

Motivation for a 100 TeV pp Collider

N. Arkani-Hamed
@SUSY2013

* It's the OBVIOUS FUTURE

* BIG physics ideas, BIG ambitions and BIG machines are the lifeblood of our field. It's how we've attracted the best minds on the planet to work on the hardest, most fundamental, most long-term problems in all of Science.

M. Mangano
@UKForum2014

'The "physics case" will emerge at the end, when confronting the potential against the explicit circumstances arising from the future 10 years of LHC running, DM searches, Belle2, etc., and in view of the overall synergy/complementarity with the other components of the project (ee and eh).'

Recent (Aug/Sept) Publications

BSM Higgs with LHeC

Invisible Higgs Decay at the LHeC

Yi-Lei Tang,[1,*] Chen Zhang,[2,†] and Shou-hua Zhu[1,2,3,‡]

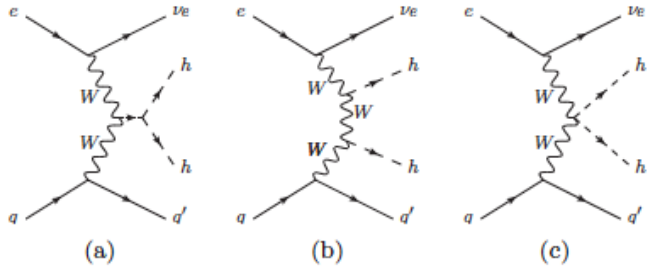
arXiv:1508.01095, 2015

Our study clearly justifies a luminosity upgrade to 1 ab^{-1} for the LHeC to become a Higgs boson factory [46] and demonstrates its huge potential on study of exotic Higgs decays. Besides the invisible Higgs decay, the LHeC is suited to the study of those exotic Higgs decays which suffer from large backgrounds, trigger or p_T threshold problem at the (HL-)LHC such as $h \to 4b$, $h \to 2b2\tau$, $h \to 4j$, $h \to b\bar{b} + \not{E}_T$ [73], $h \to \gamma + \not{E}_T$, $h \to Z + \not{E}_T$ [74]. Work on these directions is in progress [75]. The

H-HH with FCC-he ($\sqrt{s}$=3.5 TeV vs 0.3 at FCC-ee)

Probing anomalous couplings using di-Higgs production in electron-proton collisions

Mukesh Kumar,[1,*] Xifeng Ruan,[2,†] Rashidul Islam,[3,‡] Alan S. Cornell,[1,§] Max Klein,[4,¶] Uta Klein,[4,**] and Bruce Mellado[2,††]



arXiv:1509.04016, 2015.

Overview for Physics after (?) the Higgs

Deep Inelastic Scattering at the Energy Frontier

Max Klein (University of Liverpool and CERN)

To appear in a special edition "Particle Physics after the Higgs" of Annalen der Physik
mklein@hep.ph.liv.ac.uk, max.klein@cern.ch. submitted 15.9.2015

Next: ICFA Newsletter on ERL-LHeC
PERLE - Design Concept and Physics
Proceedings – worth writing + making known. LHeC Note submission changed ..

Neutrino-Nucleon Cross Section at UHE

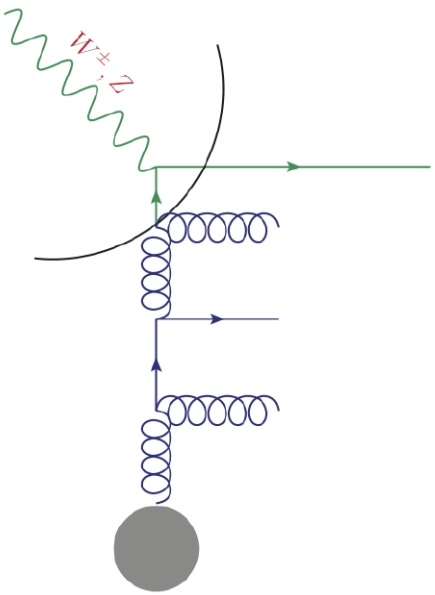
& its *astrophysical* Implications

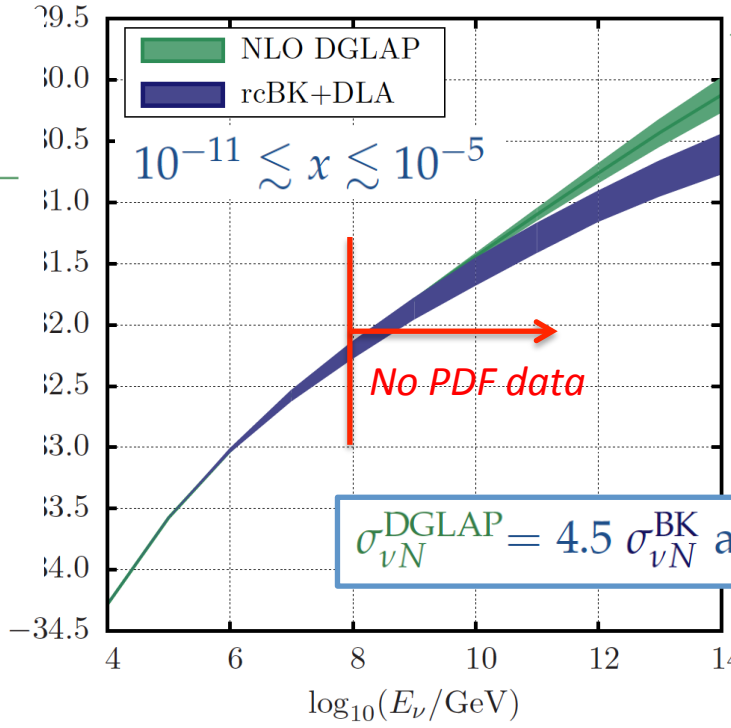
Alba SOTO ONTOSO,
@POETIC VI
PRD 92, 014027 (2015)

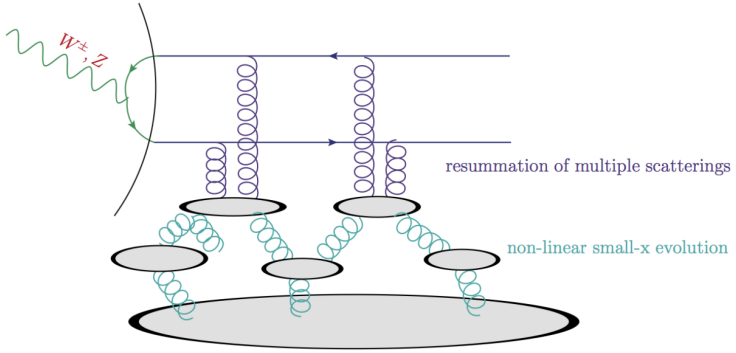
DGLAP approach $(\alpha_s \ln(Q^2/Q_0^2) \sim 1)$

$$\sigma_{\nu N} \sim \underbrace{\left(\begin{array}{c}\text{Probability of}\\ \text{finding a quark/gluon}\\ \text{in nucleon}\end{array}\right)}_{\text{Low energy QCD}} \otimes \underbrace{\sigma^{q/g-\nu}}_{\text{Perturbative}}$$

À la BK $(\alpha_s \ln(x_0/x) \sim 1)$







$\sigma_{\nu N}^{\text{DGLAP}} = 4.5\ \sigma_{\nu N}^{\text{BK}}$ at $E_\nu = 10^{14}$ GeV.

cf Anna Stasto at Chavannes

Limits on astrophysical ν fluxes

… have a **much larger uncertainties** than currently assumed :

factors 1.4 to 4.5 for $10^9 < E_\nu < 10^{14}$ GeV.

Physics and Detector

open for discussion

Thanks to many people, rising and persistent interest
in ep/A physics and new eh colliders (next slide)

ep colliders 11.2014 Max Klein	CEPC	MEIC	eRHIC	HERA 92-07	CepC	LHeC	SepC	FCC-he
√s/GeV	**13**	**35**	**122**	**319**	**1000**	**1300**	**3375**	**3464**
$L/10^{33}$ $cm^{-2}s^{-1}$	0.4	5.6	1.5	0.04	4.8	16	8.9	10
E_e /GeV	3	5	15.9	27.6	120	60	80	60
E_p /GeV	15	60	250	920	2100	7000	35600	50000
f /MHz	500	750	9.4	10.4	20	40	40	40
$N_{e/p}10^{10}$	3.7/0.54	2.5/0.42	3.3/3	3/7	1.3/16.7	0.4/22	3.3/5	0.5/10
$\varepsilon_{e/p}$ /μm	.03/.15	54/.35	32/.27	4.6/.09y	250/1	20/2.5	7.4/2.4	10/2
$\beta^*_{e/p}$/cm	10/2	10/2	5/5	28/18 y	4.2/10	10/5	9.3/75	9/40
comment	Lanzhou	full acc.	“Day1”	HERA II	Booster	ERL (H)	$E_e = M_W$	ERL (HH)
source	X.Chen July 14	McKoewn POETIC14	Litvinenko S.Brook 14	B.Holzer at CERN 2008	Y.Peng Oct. 2014	Frank Z. LHeC 2014	Y.Peng Oct. 2014	Frank Z. IPAC 2014