

Momente Tiefinelastischer Streuung

QCD
Wurzeln
Trigger
Krisen
Erinnerungen
Aussicht
Leben

Für Christian Kiesling und seine Zukunft,

Max Klein
Liverpool, H1, ATLAS, LHeC

Max Planck Institut Werner Heisenberg, München, 14. Oktober 2014

Moments of Deep Inelastic Scattering

QCD
Roots
Trigger
Crises
Recollections
Prospects
Life

Dedicated to Christian Kiesling and his Future

Max Klein
Liverpool, H1, ATLAS, LHeC

Max Planck Institute Werner Heisenberg, Munich, 14. October 2014

Momente

$$\int_0^1 dx x^{n-2} F_k^{\text{NS}}(x, Q^2) = \delta_{\text{NS}}^k A_n^{\text{NS}} [\ln(Q^2/\Lambda^2)]^{-d_{\text{NS}}^n}, \quad k=1, 2, 3.$$

$$d_{\text{NS}}^n = \frac{\gamma_{\text{NS}}^{(0),n}}{2\beta_0} \quad \gamma_{\text{NS}}^{(0),n} = \frac{8}{3} \left[1 - \frac{2}{n(n+1)} + 4 \sum_{j=2}^n \frac{1}{j} \right]$$

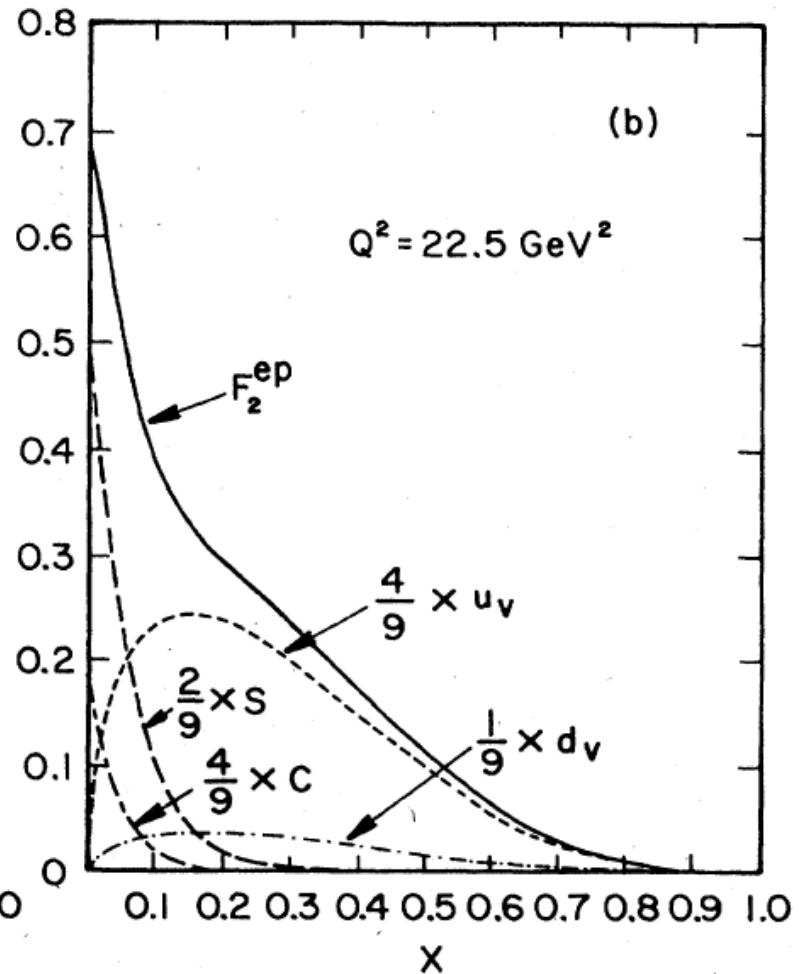
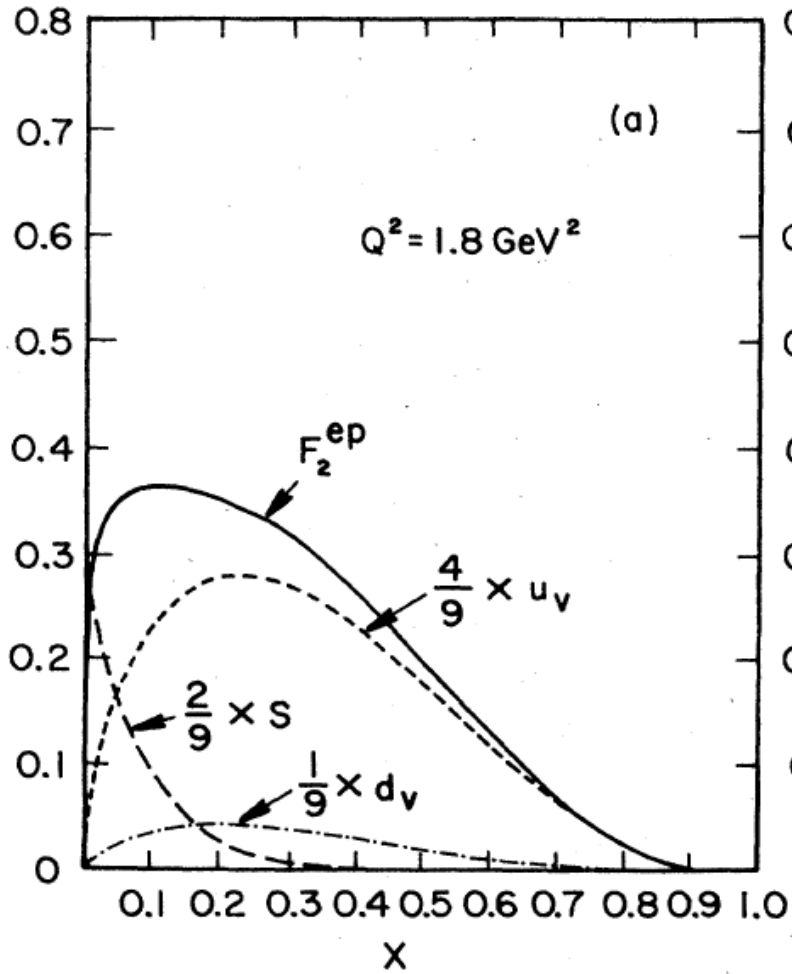
Asymptotic freedom in deep inelastic processes in the leading order and beyond^{*†}

Andrzej J. Buras

1980

Fermi National Accelerator Laboratory P.O. Box 500, Batavia, Illinois 60510 USA

“Herr Klein, gehen sie zurück zu den Momenten, und tun sie etwas für die Pflege der QCD..”
Otto Nachtmann (~2013)

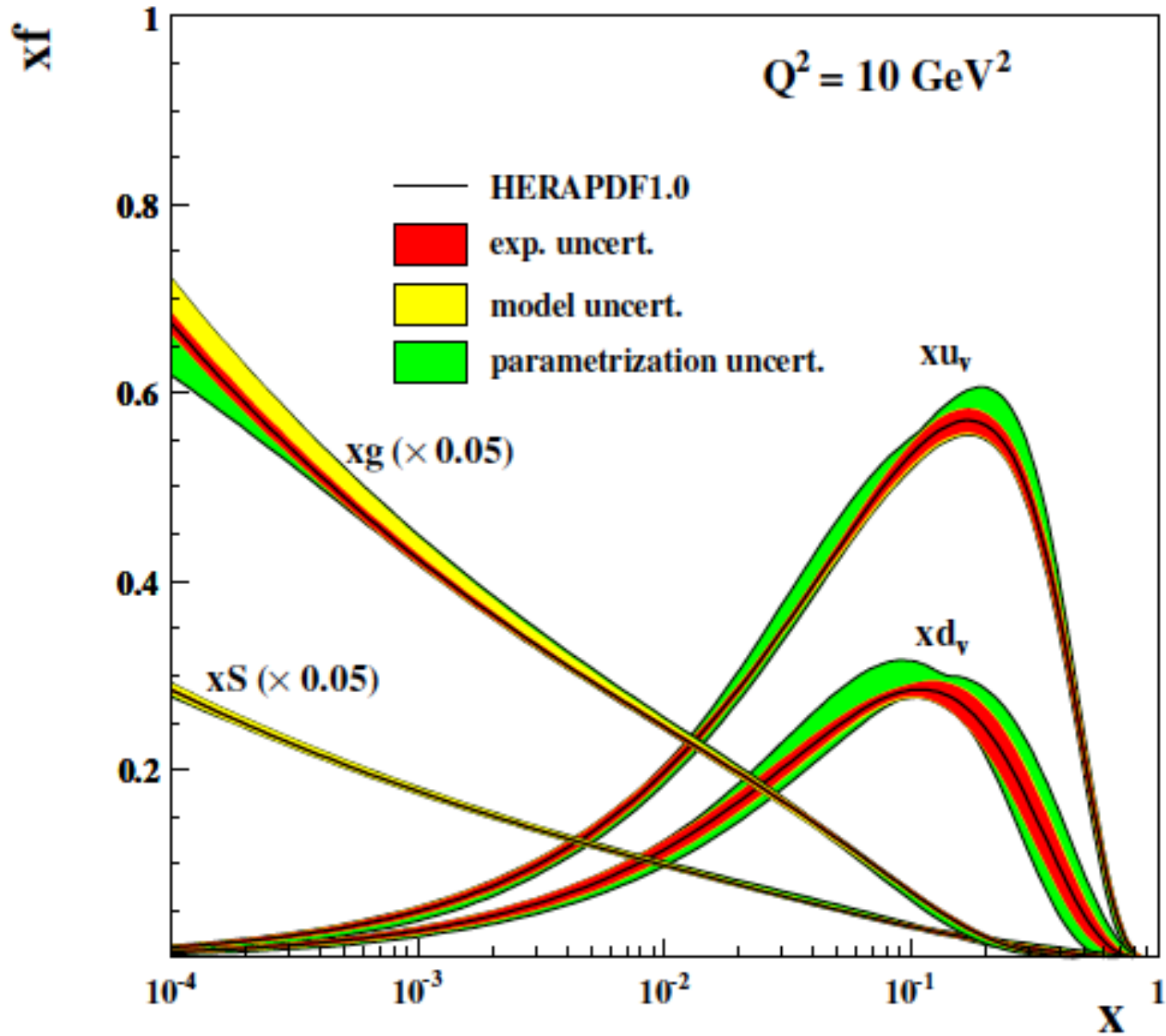


Rev. Mod. Phys., Vol. 52, No. 1, January 1980

$$xG(x, Q^2) = A_G(\bar{s})(1-x)^{n_G(\bar{s})}$$

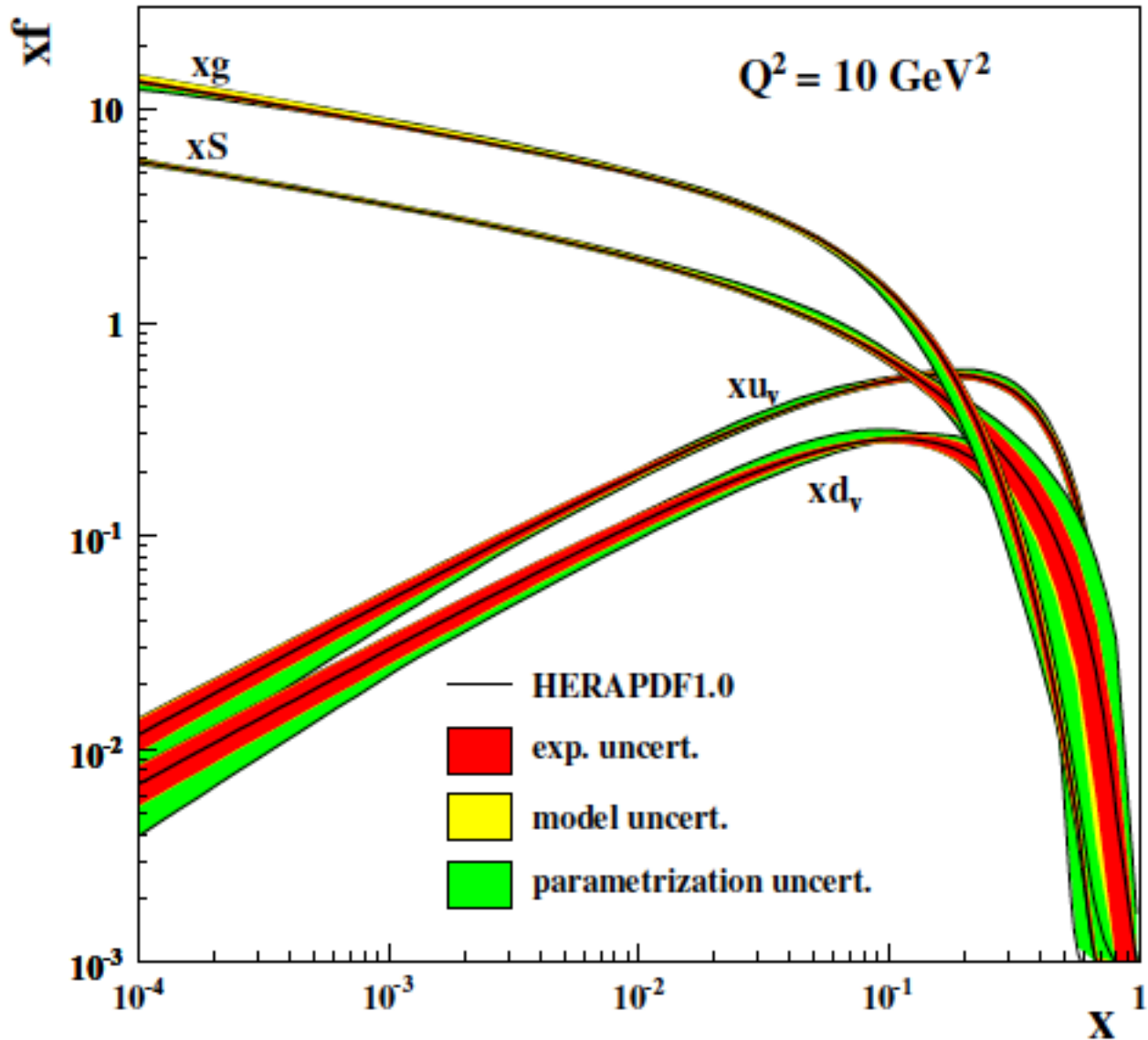
No low x term x^β

H1 and ZEUS



The rise of parton densities at low x

H1 and ZEUS

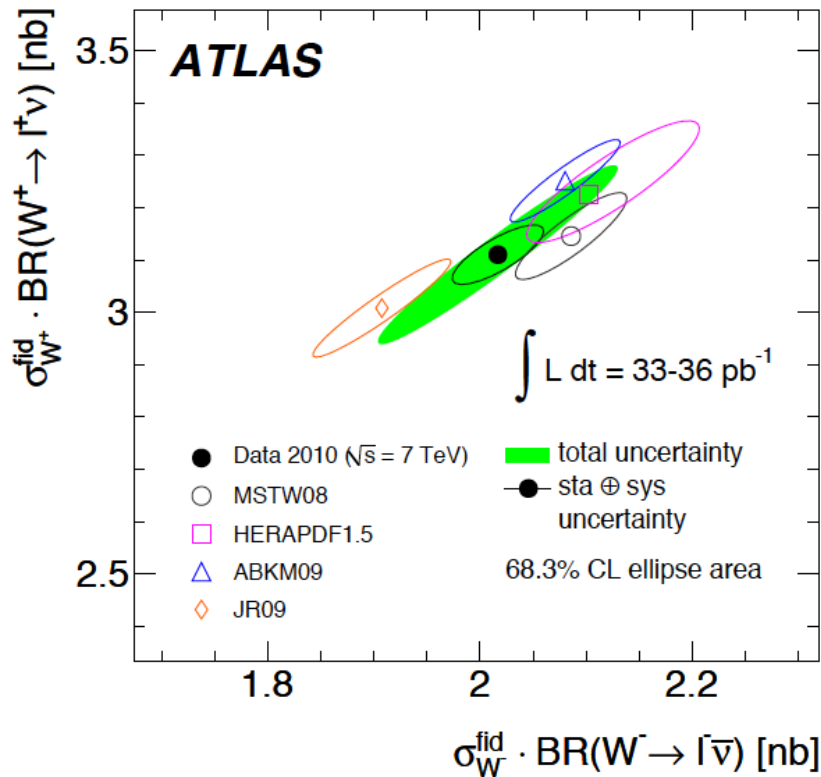


The proton mass is due to gg interactions [not the Higgs..]

HERA and the LHC

The LHC data require HERA's results for their interpretation.

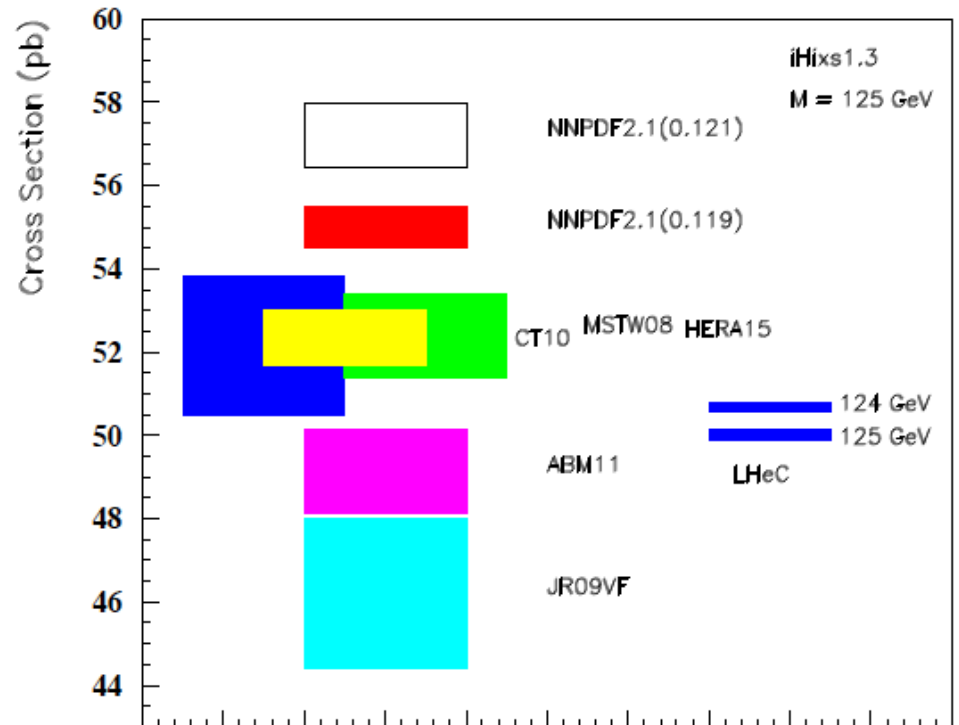
Prediction of W (and Z...) production (quarks)



arXiv:1109.5141 (ATLAS, PRD)

Prediction of Higgs production (gluon)

NNLO pp-Higgs Cross Sections at 14 TeV



arXiv:1305.2091 (OB, MK - MPLA)

INELASTIC ELECTRON-PROTON SCATTERING
AT LARGE MOMENTUM TRANSFERS

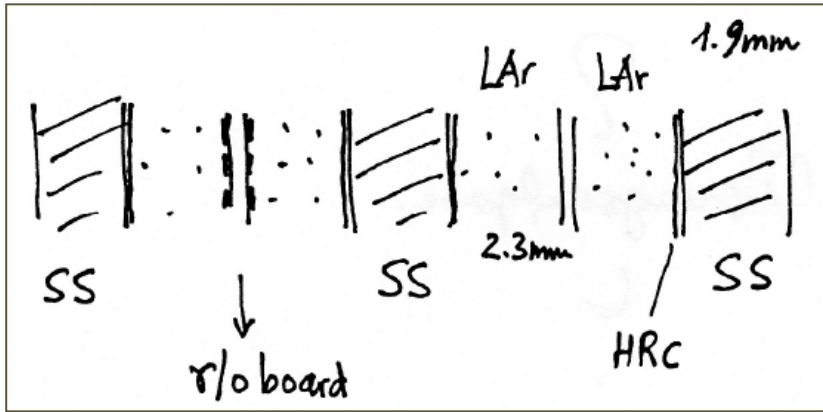
G. Miller, E. D. Bloom, G. Buschhorn,* D. H. Coward,
H. DeStaebler, J. Drees,** C. L. Jordan, L. W. Mo,*** R. E. Taylor
Stanford Linear Accelerator Center†
Stanford University, Stanford, California 94305

J. I. Friedman, G. C. Hartmann,†† H. W. Kendall, R. Verdier
Physics Department and Laboratory for Nuclear Science†††
Massachusetts Institute of Technology, Cambridge, Massachusetts 02139

On the assumption that R is a constant in this kinematic range, we find that
for this particular set of points the average value of $R = 0.18 \pm 0.10$, where the

Stanford: Important moments for DIS, the MPI, H1 and the Buschhorn family also...

*) DESY



Ergänzungen, Änderungen und die Aufhebung diese
 bedürfen der Schriftform.
 Bei Nichtzustandekommen eines Leistungsvertrage
 SKET ist die vorliegende Vereinbarung nichtig.

Akademie der Wissenschaften der DDR
 Direktor für Import und Export
 1086 Berlin, Otto-Nuschke-Straße 22/23

C. Buschmann

MPI 17. Dez. 1986

AdW

Vereinbarung

zwischen der Akademie der Wissenschaften der DDR
Otto-Nuschke-Str. 22-23
DDR-Berlin
1086

vertreten durch den
Direktor für Export-Import
Herrn Dipl.-oec. M. Fischer
(AdW)

und der Max-Planck-Gesellschaft zur Förderung
der Wissenschaften e. V.

vertreten durch den
Geschäftsführenden Direktor des
Werner-Heisenberg-Institutes für Physik
Herrn Prof. Dr. G. Buschhorn
Föhringer Ring 6
D-8000 München 40

(MPI)

über die gemeinsame Finanzierung der Konstruktion und des Baus
des Prototypen eines hadronischen Kalorimeters beim VEB Schwer-
maschinenbaukombinat "Ernst Thälmann" Magdeburg, DDR (SKET).

Prof. F. Eisele
H1 Kollaboration

Herrn
Prof. Dr. K. Lanius
Institut für Hochenergiephysik
der Akademie der Wissenschaften
der DDR
Platanenallee 6

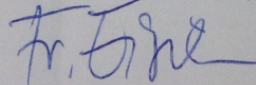
DDR - 1615 Zeuthen

Hamburg, 25. September 1986

Sehr geehrter Herr Prof. Lanius,
wie Ihnen bekannt ist, stehen die Verhandlungen zwischen dem Max-Planck-Institut, SKET und Ihrem Institut zur Fertigung eines Prototyps für das Hadronkalorimeter beim VEB SKET, Magdeburg, kurz vor dem Abschluß. Bedauerlicherweise konnte der für die letzten Vertragsverhandlungen am 26.9.86 vorgesehene Besuch von H1-Vertretern in Berlin nicht stattfinden, da uns von SKET als Vertragstermin September 1987 genannt wurde. Dieser Termin ist für die H1-Kollaboration nicht akzeptabel, da mit dem Prototyp im Sommer 1987 Strahltests in CERN durchgeführt werden müssen, die wegen der Zeitpläne sowohl des CERN als auch von H1 nicht verschoben werden können. Wegen der notwendigen Bestückung des Stacks mit Ausleseboards muß das MPI auf einer Lieferung im Zeitraum April/Mai 1987 bestehen. Aus unserer Sicht ist es erstrebenswert, einen späteren Großauftrag zur Kalorimeterfertigung an die Firma zu vergeben, die auch den Prototyp fertigt.

In der gegenwärtigen Situation ist daher die gesamte Kalorimeterfertigung bei SKET, die alle Beteiligten für sehr wahrscheinlich hielten, in Frage gestellt. In unserem gemeinsamen Interesse wäre ich Ihnen sehr verbunden, wenn Sie eine Änderung der Lage erwirken könnten.

Mit freundlichem Gruß



Eventually failed because SKET's bosses had not grasped the will of H1 to go ahead with the full Iron structure..

Verein der Bayern in Berlin (e. V.)



Diese Postkarte zeigt einen Dachauer Bauern beim Tanz mit einer Spreewälderin

Landesausstellung "Bayern und Preussen" Berlin 1999

Berlin in München



»Ich hatte nicht gedacht, daß man in den Straßen dieser Stadt doch so viele jebildet aussehende Leute treffen würde.«

»Janz einfach zu erklären: drei Ferien-Sonderzüge aus Berlin ankommen.«

Der Bayer in Berlin



»Jetz nimm di z'samm', Schorschl, daß d' koanen derschlagst von die Preuß'n.«

Why me today?

1.

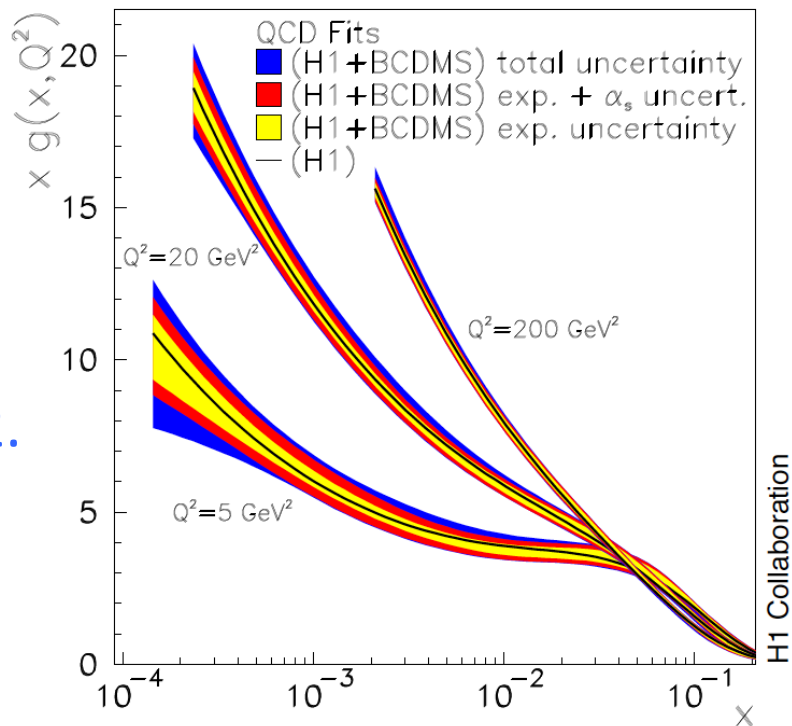
The success of this work I owe to Vladimir Chekelian. His interest and experience in all aspects of the analysis and his dedication to precision physics provided an guideline of invaluable importance. I am especially grateful that he, in spite of his overwhelming responsibilities as H1 physics coordinator, had time for very detailed proof-reading of ... Zhiqing Zhang for a successful teamwork. I am very grateful to Max Klein for many instructive and educative discussions.

Prof. Christian Kiesling I want to thank for continuous enlightening discussions about analysis and various physics topics. For a friendly atmosphere, very pleasant to work

Acknowledgement Thesis Ana Dubak

We admired the same people and got similar credit for this, and we like Montenegro

2.

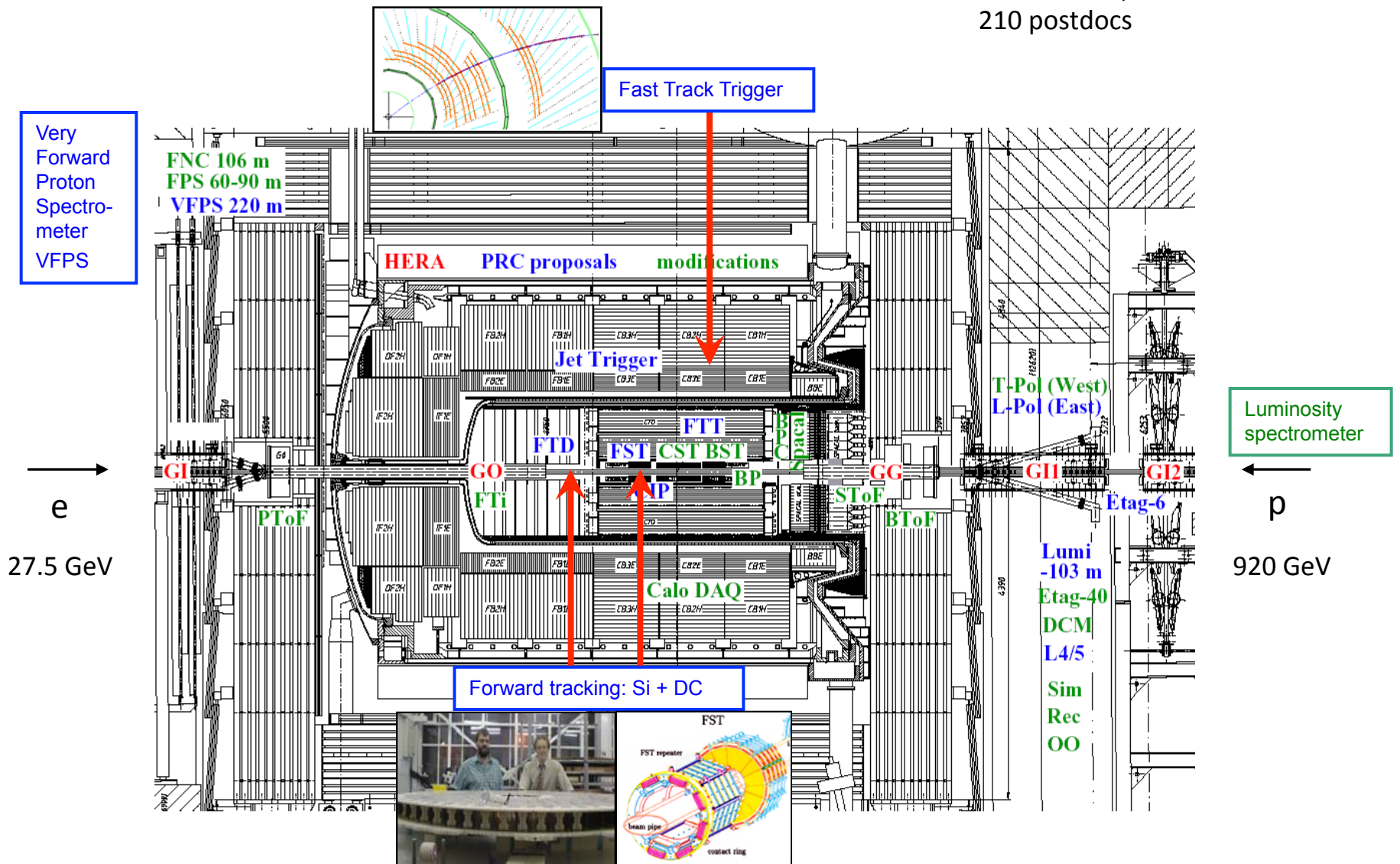


← DESY 00-181 (2000) 603 citations
The most cited HERA paper and the most cited paper of Christian Kiesling

I am your most successful ghostwriter

(Upgrades of) the H1 Detector for HERA II

36 institutes, 320 authors
210 postdocs



Status of the Jet Trigger

A. Aktas, A. Babaev, J. Bracinik, C. Braquet, A. Dubak,
M. Fras, W. Haberer, D. Hoffmann, C. Kiesling,
F. Krivan, Miriam Klug, A. Nikiforov, B. Olivier, A. Wassatsch

- Algorithm
- JetT Modules
- Installation/Readout/Tests
- Summary

LAr Jet Trigger

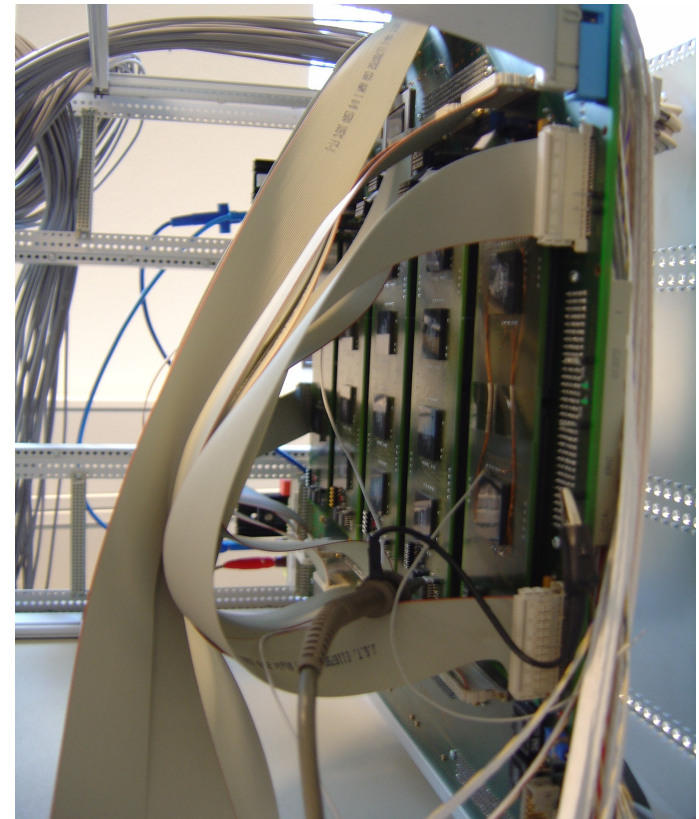


8 crates of 9 cards, 10 sub-boards, 1000 FADCs
software e/h weighting with lookup tables

Mass production of ACS boards imminent

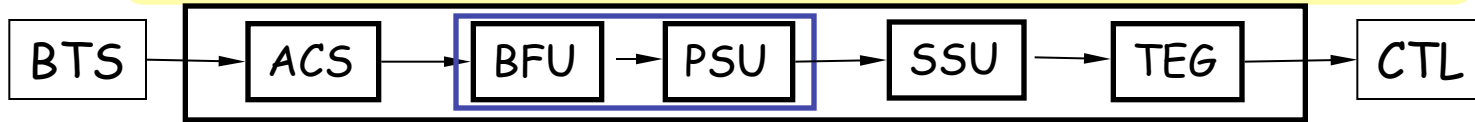
granularity (*4) on first trigger level
replace global sum by sorted list of clusters

„analog info transmitted with BTSU
via ACS to BFU and P/SSU and TEG“



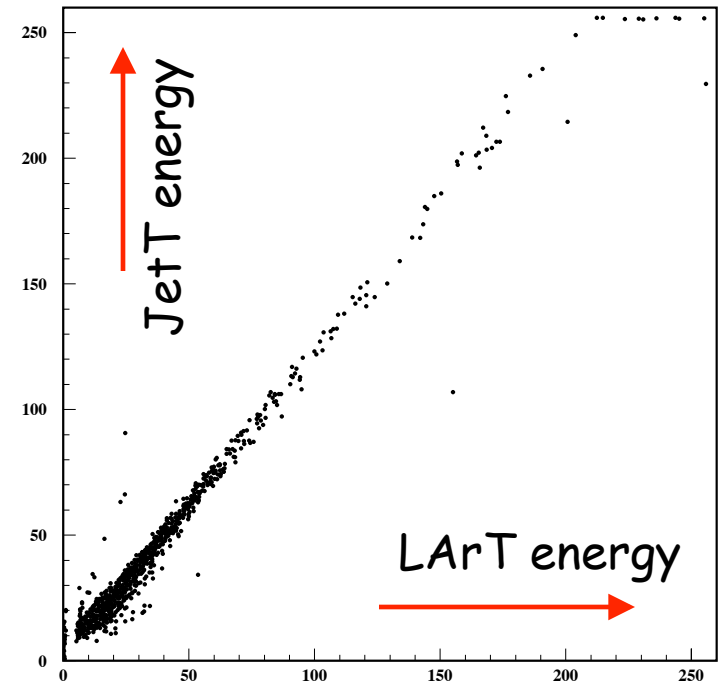
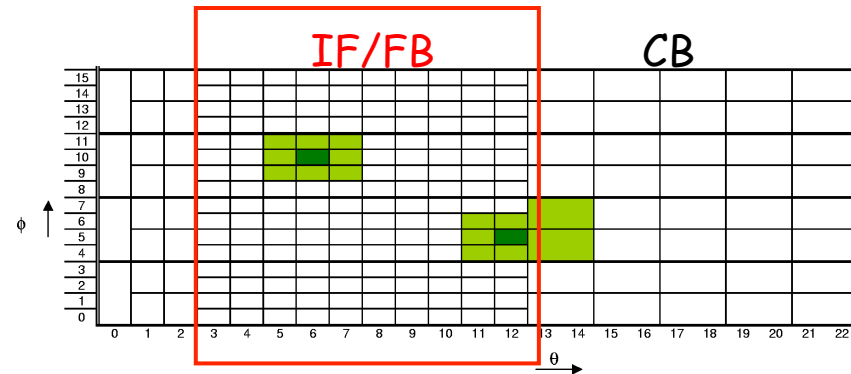
Front view of bumpfinder unit

Jet Trigger Status



JetT: searches for localised energy depositions / jets (E_T , η , ϕ)

- ⇒ less sensitive to the noise
- ⇒ possibility to explore correlations between jets
- ⇒ better granularity than old LArT



- Hardware fully installed
- Jet Trigger in commissioning phase
- Successfully in readout since 09.2005
- Successful tests of sorted jets
- Final design for ACS-A (CB) on-going

Summary

JetT commissioning phase:

- ACS: MB type B (IF + FB) fully installed
- BFU, SSU installed, tested
- TEG installed

- Full chain from FADC (ACS) to energy sorted jets (SSU) tested

Todo:

- ACS: loading - LUT, 0-suppression consts, determine pedestal
- TEG: loading - conditions to the hardware, testing

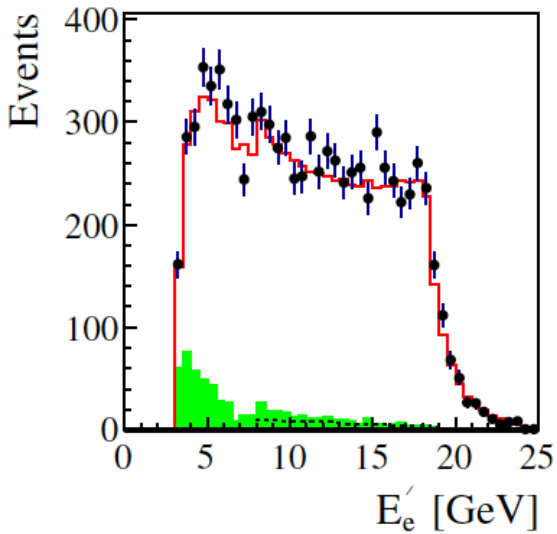
- Test full system ACS -> TEG

- Give signal to CTL

- Integrate the JetT readout into the standard H1 data stream

- Produce ACS type A

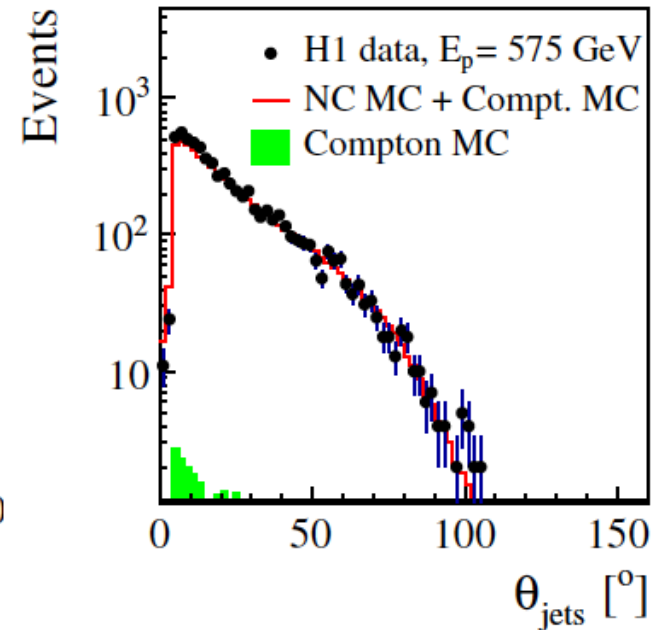
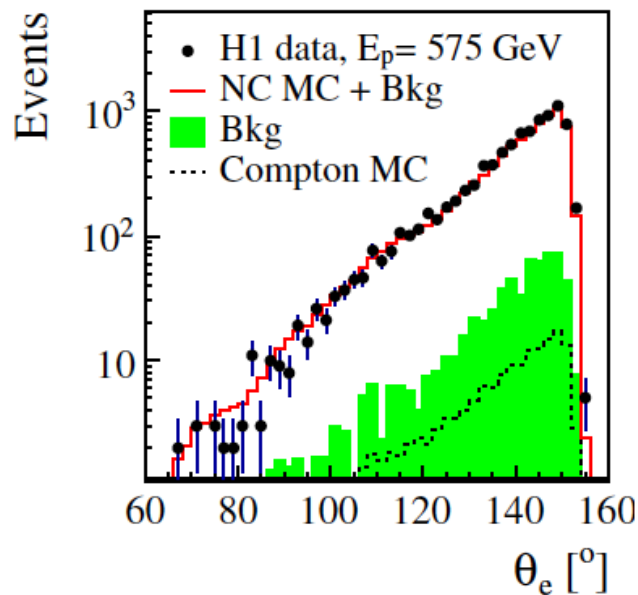
Kinematic Reconstruction



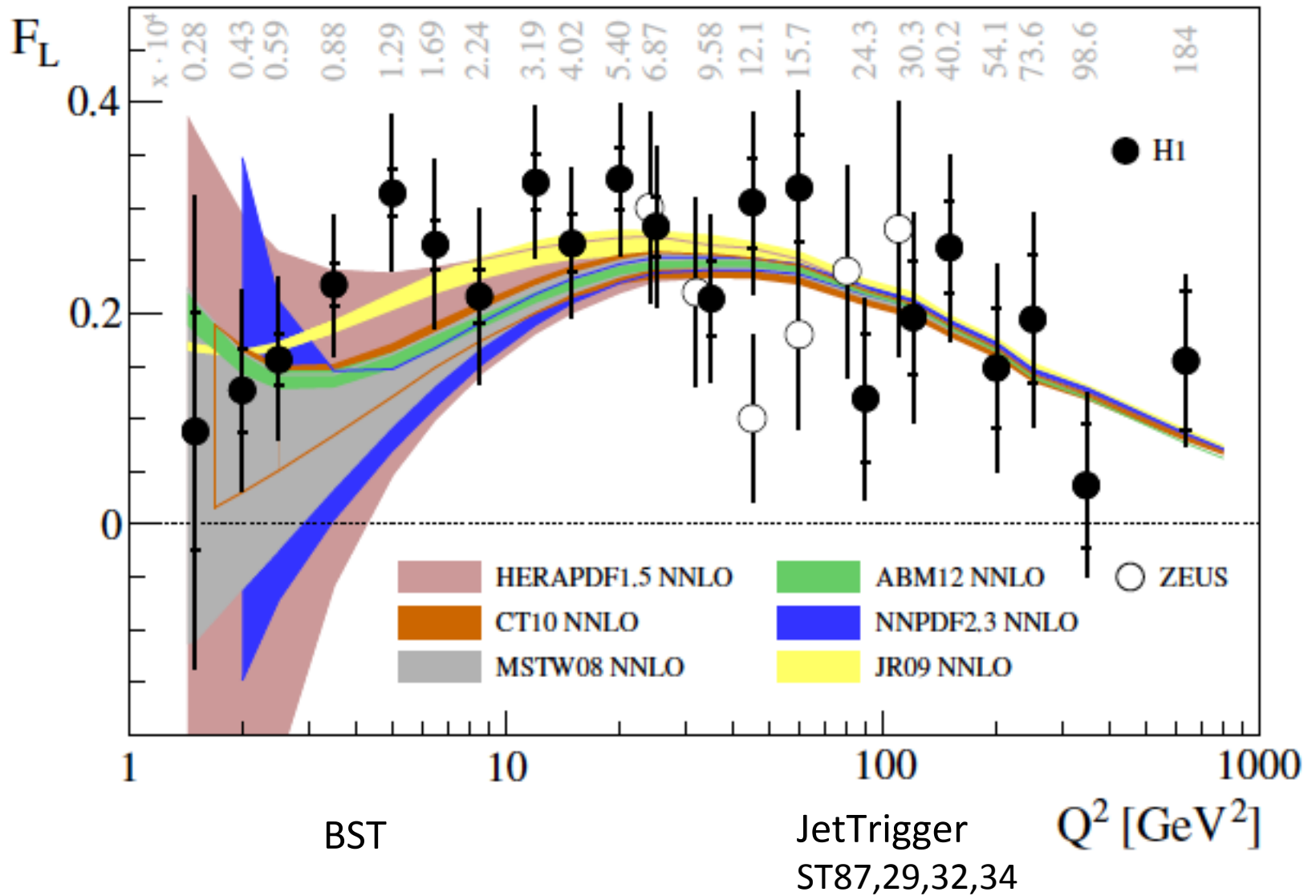
$$\frac{d^2\sigma_{\text{NC}}}{dx dQ^2} \frac{xQ^4}{2\pi\alpha^2} \frac{1}{Y_+} \equiv \left(F_2 - \frac{y^2}{Y_+} F_L - \frac{Y_-}{Y_+} x F_3 \right)$$

$y = 1 - E_e'/E_e \leftarrow$ need to safely reach smallest energy

Low energy run for measuring F_L
Data taking in 07
prior to shutdown
of the collider..

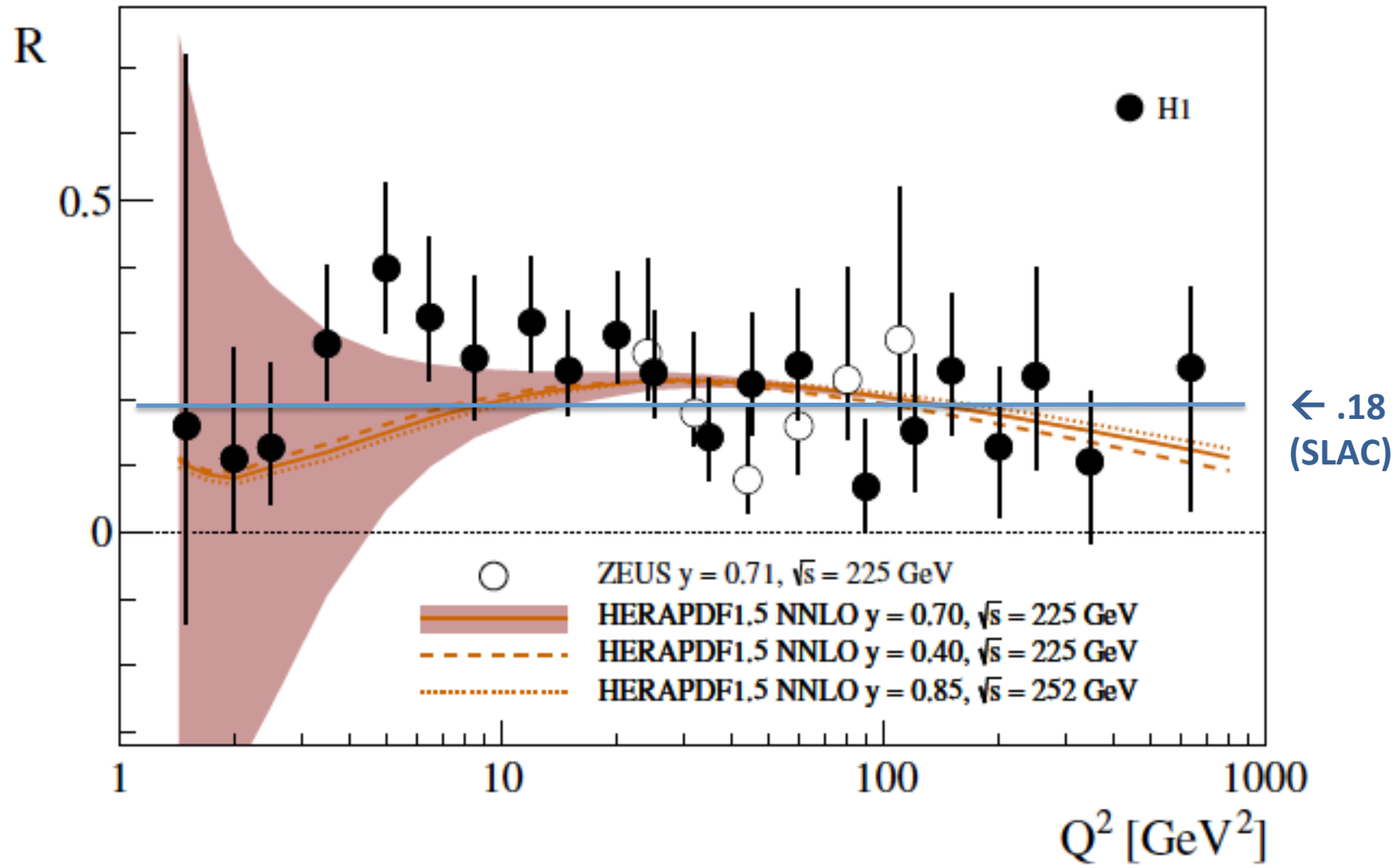


H1 Collaboration

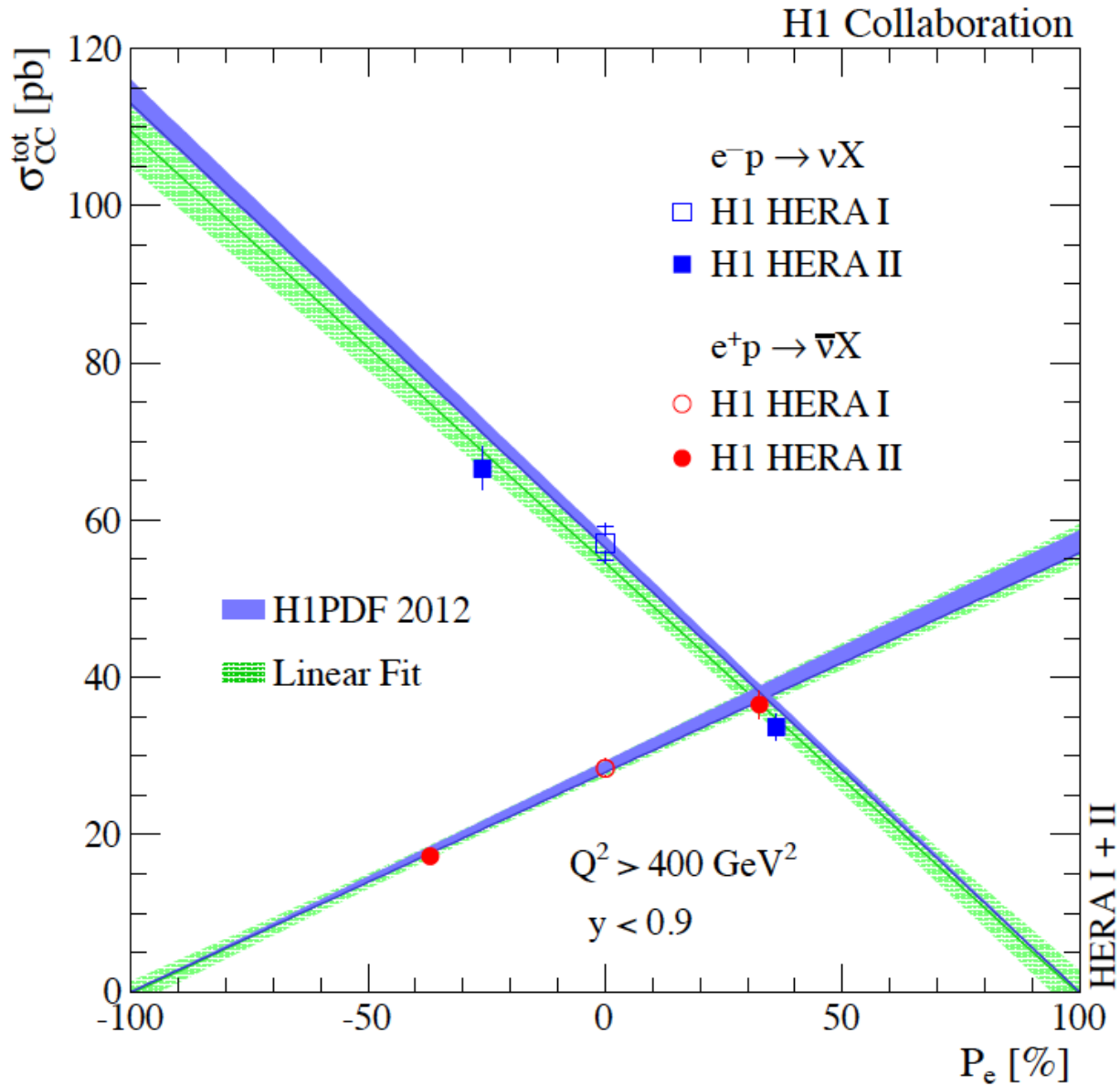


$$R = \sigma_L / \sigma_T = F_L / (F_2 - F_L)$$

H1 Collaboration

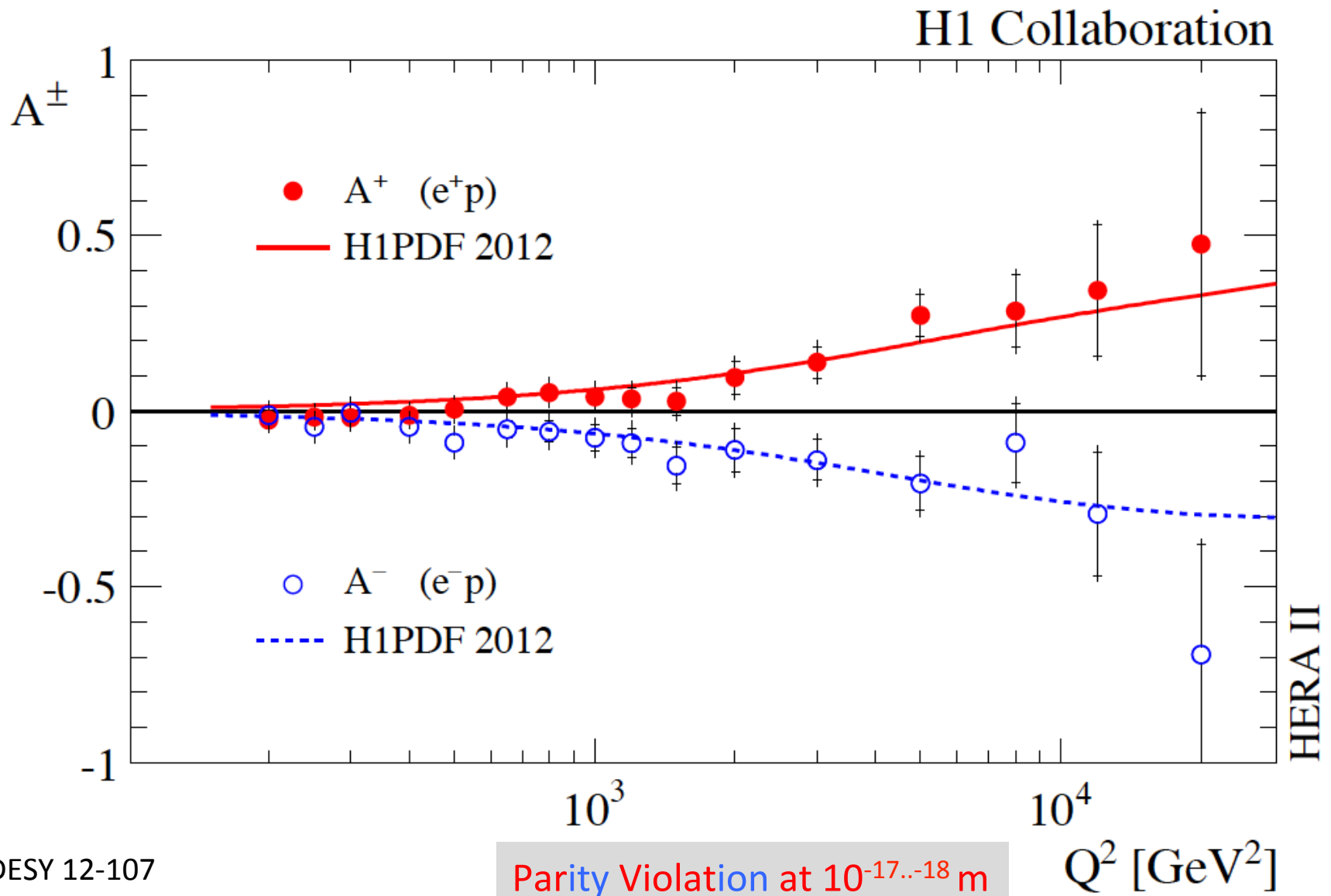


Charged Current Cross Section



No r.h.
currents

Neutral Current Cross Section Asymmetry



Crises

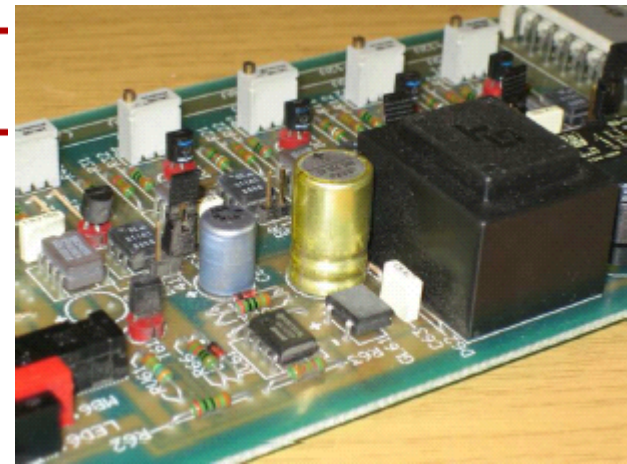
Power supplies for ANBX's II.



More than 2000 capacitors exchanged

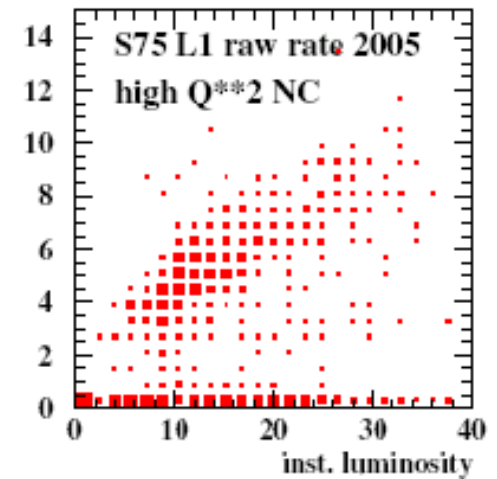
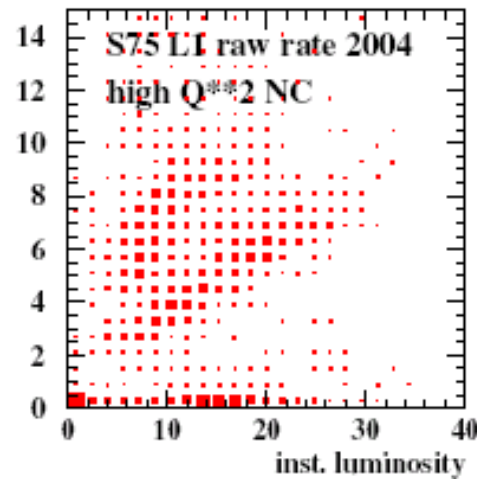
A. Babaev, J. Spalek (2 months work!)

J. Bracinik LArT 14.2.05 (e1, emiss)



All yellow electrolytical capacitors
at ANBX PS exchanged

Subtrigger S75



Alexey Ivanovitch Babaev

(25.5.1935 – 27.11.2005)

Ramenskoe, Lidoshka+Ladoshka

... In the 80th with the ARGUS experiment, about which Yuri Zaitsev will speak, Alexey began a more intimate collaboration with German physicists and moved to DESY for his last 15 years, sometimes via Dortmund or via Munich. Joffe already had worked at Munich, with Roentgen. **When I asked Alexey what I could do, 3 years ago, to keep him working in H1, knowing H1 was him to a large extent, he told me that he liked Christian so much and how motivating it was to work with him. Alexey did not just like the technical challenges, he liked the people and for both reasons we admired him. Meanwhile I helped to keep Christian Kiesling happy in H1...**

..Alexey's responsibility was so well known, that his word "sdelaem" was already considered to be equivalent to the problem being understood and solved. “

FST: water damage

strips

strip adapter

Microscopic view on part of a damaged FST module

bonds

APC → rad hard



Max-Planck-Institut für Physik

(Werner-Heisenberg-Institut)



MAX-PLANCK-GESELLSCHAFT

Prof. A. Caldwell • MPI für Physik • Postfach 401212 • 80712 München

Prof. Dr. Allen Caldwell
Director
Tel.: 0 89 / 3 23 54 – 5 29
Email: caldwell@mppmu.mpg.de

Secretary: Kristiane Preuss
Tel.: 0 89 / 3 23 54 – 2 07
Fax: 0 89 / 3 23 54 – 4 36
Email: preuss@mppmu.mpg.de
<http://www.mppmu.mpg.de>

25 September 2014

Dear

The Scientific Council meeting on May 21 and 22 will discuss, amongst other items, the possibility of a further program of research with the HERA accelerator. We send you this letter to sketch some of our arguments in favor of such a program; more detail is included in the Letters of Intent. This program was worked out in a sequence of large international workshops starting in

We therefore ask the Scientific Council to consider future DESY projects in a broad way, with a view to balancing the activities in the areas of high energy physics and synchrotron light research. The HERA accelerator is a unique facility, constructed at substantial cost. Its physics potential is far from being fully exploited, and moderate investments will yield disproportionate returns in physics results. The measurements would be of fundamental importance for our understanding of the strong interaction, and would provide invaluable input for a wide range of other research areas such as the LHC program, heavy ion collisions, or very high energy particle astrophysics. A highly motivated community of physicists is anxious to carry out this program.

The HERA-III Steering Committee: H. Abramowicz (Tel Aviv University, Israel), A. Caldwell (Max-Planck-Institut für Physik (Werner-Heisenberg-Institut), Germany/Columbia University, USA), T. Greenshaw (University of Liverpool, UK), E. Kinney (University of Colorado, USA), M. Klein (DESY-Zeuthen, Germany), S. Levonian (DESY, Germany), G. Mallot (CERN, Switzerland), R. Milner (MIT, USA), D. Ryckbosch (University of Gent, Netherlands), T. Sloan (Lancaster University, UK), R. Yoshida (Argonne National Lab, USA)

Executive Committee proposed

C. Grab

J. Feltesse

E. Rizvi

A. Bunyatian all 4 to serve for 2 years

J. Ferencei

C. Kiesling

P. Newman

Spokesman

Deputy Spokesman (C. Diaconu)

Technical Coordinator

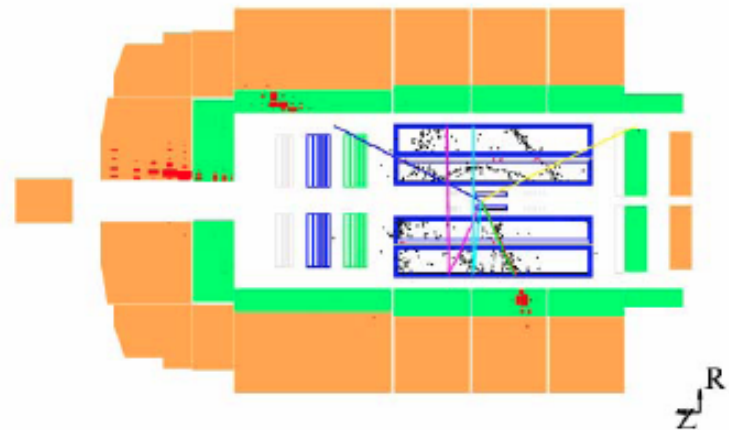
Physics Coordinators (E.P., O. Behnke)

Software Coordinator

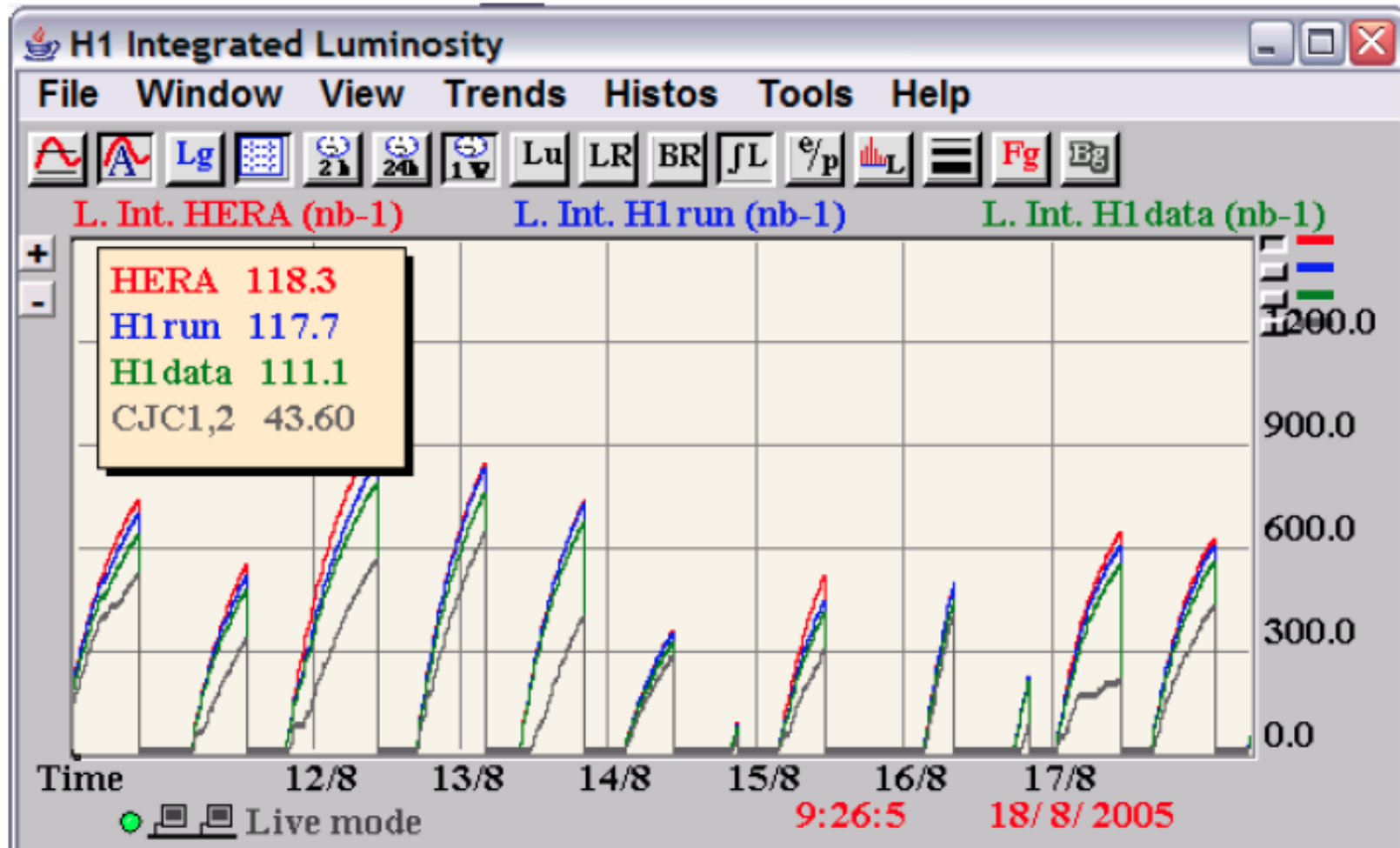
Scientific Secretary

Run Report, Aug. 12 – 18, 2005

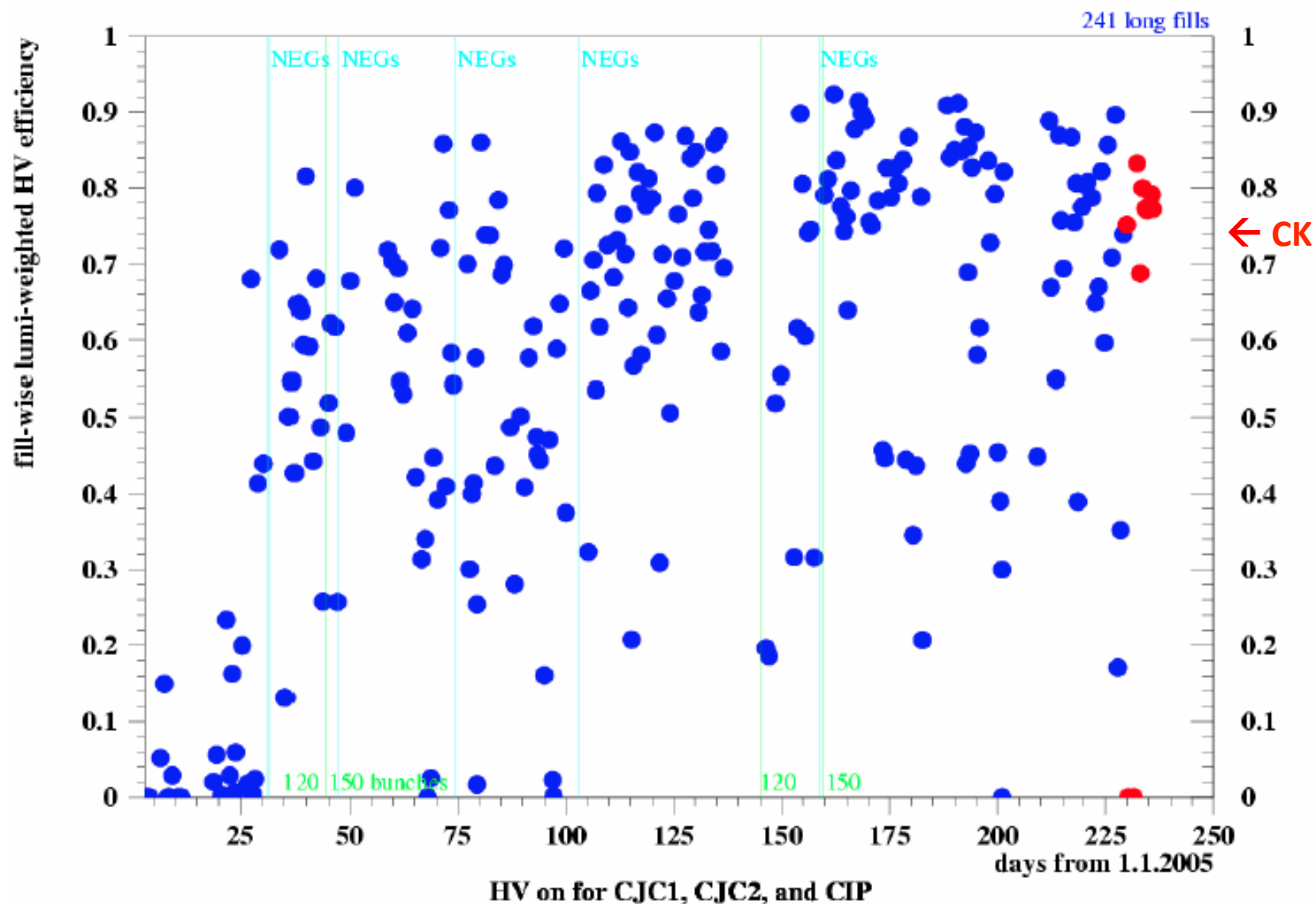
- Luminosity Operation
- Status of HERA
- Summary of the HERA Tuesday meeting
- Status of H1
- Summary



... we are accumulating data ...



H1 HV efficiency for long lumi fills



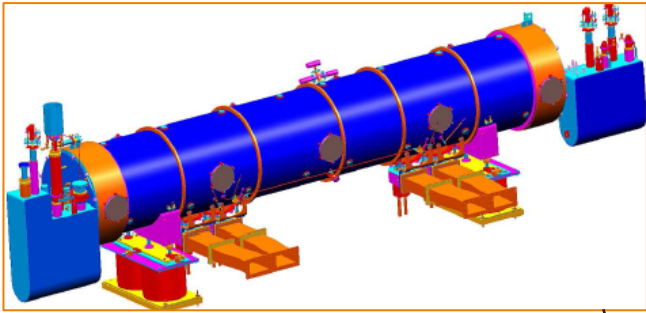
DP 15/08/2005 10:27:11

A Future Moment

When Christian had enough beauty and returns to his roots...

SCRF and LTFC

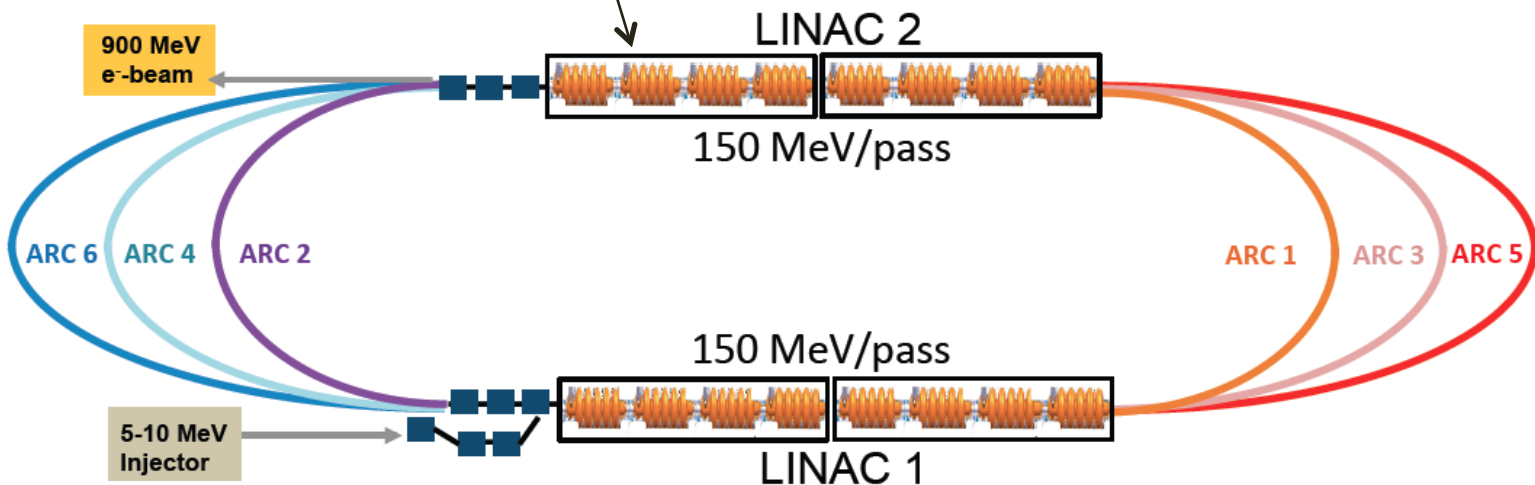
superconducting RF and ERL Test Facility at CERN



A.Hutton, B. Rimmer, E.Jensen et al.
MoU between CERN and Jlab - signed

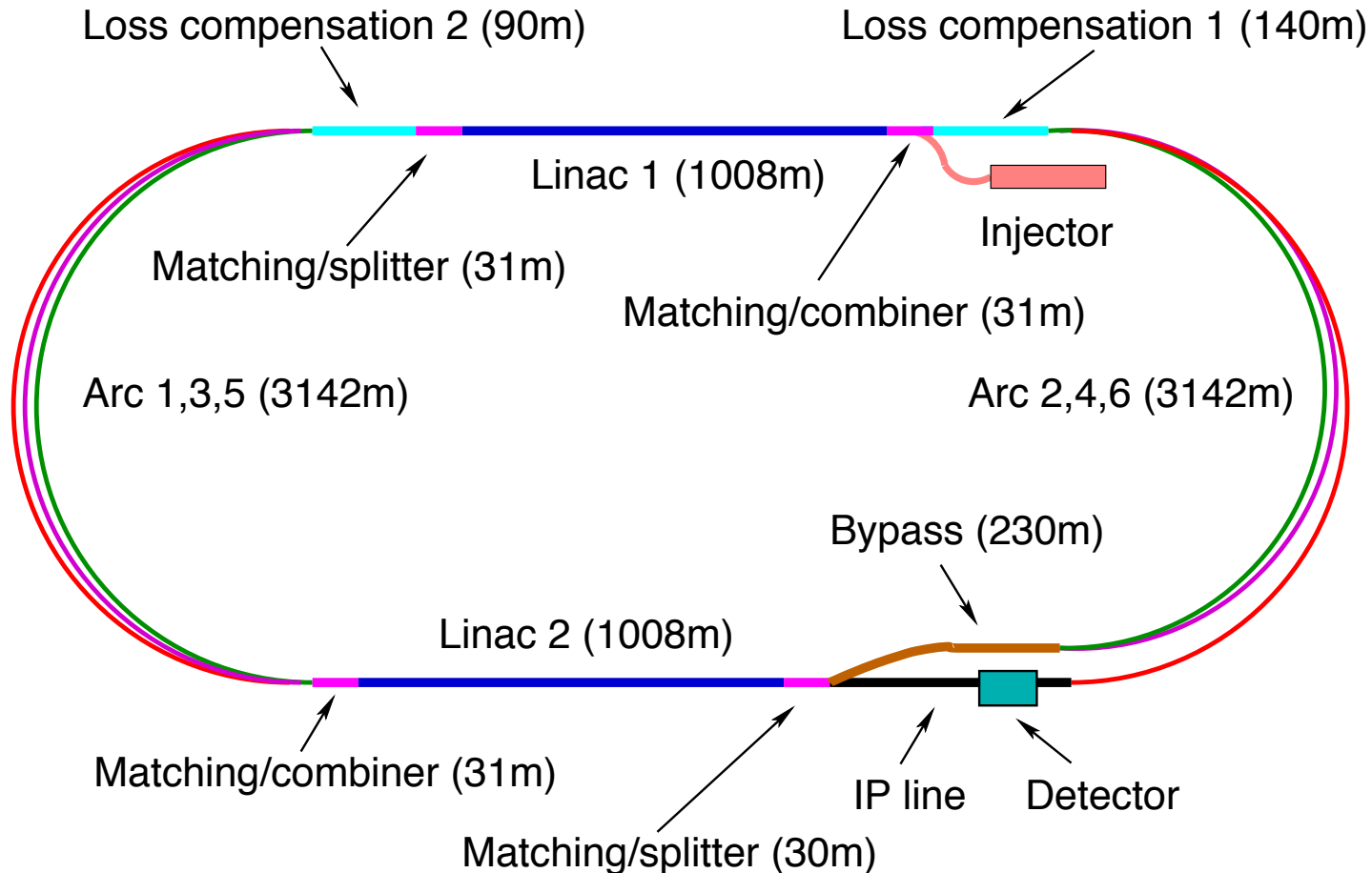
Frequency 802 MHz
Design and built of 2 Modules (CERN+Jlab+?)
Tentative Design of the LTFC – end of 2014:

Collaborations being established on
Source, Magnets, Operation, Applications

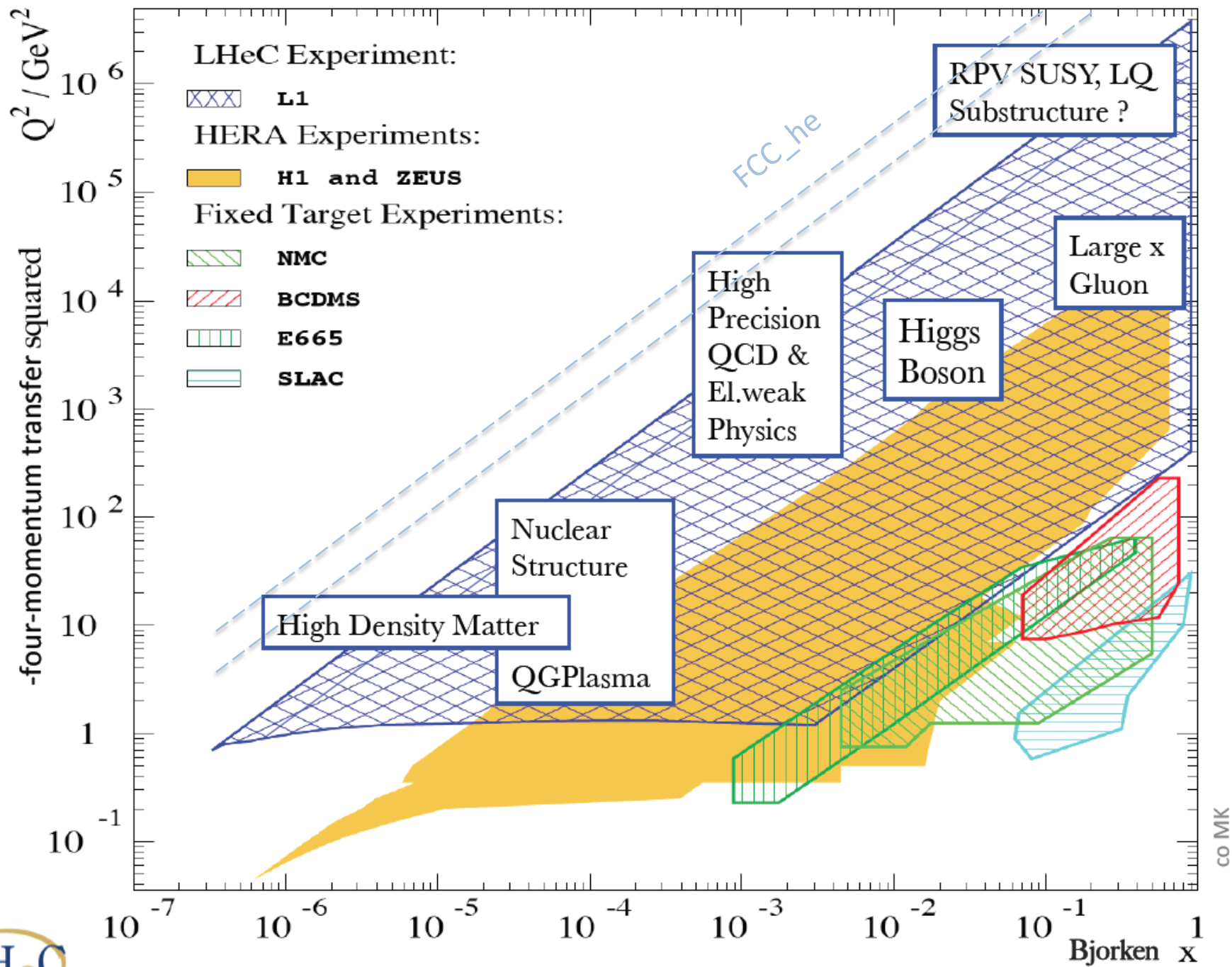


A. Bogazc, A.Valloni et al. presented at IPAC14 at Dresden by Erk Jensen

CDR Footprint of the LHeC ERL Electron Beam for synchronous ep and pp OP @ LHC



60 GeV electron beam energy, $L = 10^{33} \text{ cm}^{-2}\text{s}^{-1}$, $\sqrt{s} = 1.3 \text{ TeV}$: $Q^2_{\text{max}} = 10^6 \text{ GeV}^2$, $10^{-6} < x < 1$
 Recirculating linac (2 * 1km, 2*60 cavity cryo modules, 3 passes, energy recovery)
 Ring-ring as fall back. "SAPHIRE" 4 pass 80 GeV option to do mainly: $\gamma\gamma \rightarrow \text{H}$. CDR



co MK



Finally



Verband der Kleingärtner, Siedler und Kleintierzüchter (VKSK)

No Joy of Life



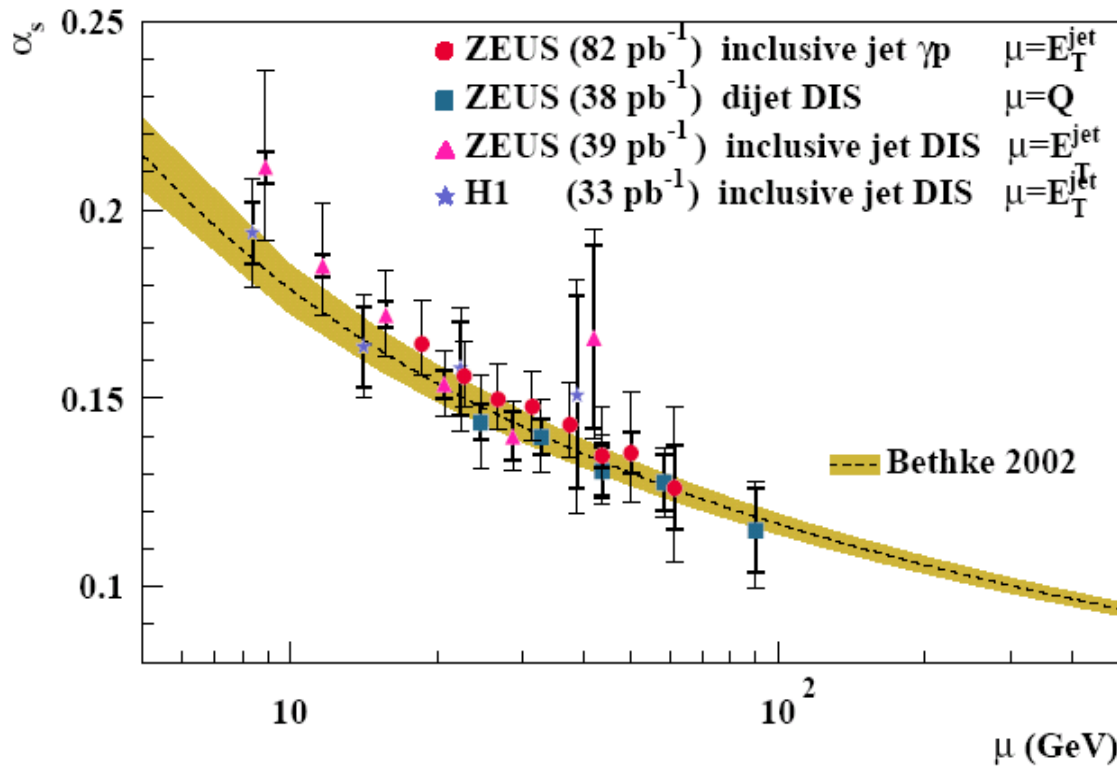
Without Science

$$W = 2,8 + 41,5 \times (UT)^3 + 3,72 \times (UH)^3$$

One of the joys of our subject is the continuing
of our culture that bridges continents and generations..
[Frank Wilczek]



Running of the strong coupling measured at HERA



Christian, you have built many bridges and always attracted people to our field,
you and to us. Fortunately there are still many to build and to cross:

Congratulations + Thank You + See You



Foto by Mascha Soerensen (Klein)
12.10.2014 Bolivia

Trigger

Possible QCD Developments and Discoveries

AdS/CFT

Instantons

Odderons

Non pQCD

QGP

N^k LO

Resummation

Saturation and BFKL

Non-conventional PDFs ...

Breaking of Factorisation

Free Quarks

Unconfined Color

New kind of coloured matter

Quark substructure

New symmetry embedding QCD

QCD may break .. (Quigg DIS13)

QCD is the richest part of the Standard Model Gauge Field Theory and will (have to) be developed much further, on its own and as background

DEUTSCHES ELEKTRONEN - SYNCHROTRON DESY

NOTKESTR. 85 · 2000 HAMBURG 52 · TEL. 040/89 98-0 · TELEX 2 15 124 desy d · TELEGR.-ADR. DESY HAMBURG

Prof. F. Eisele
H1 Kollaboration

Herrn
Prof. Dr. K. Lanius
Institut für Hochenergiephysik
der Akademie der Wissenschaften
der DDR
Platanenallee 6

DDR - 1615 Zeuthen

Hamburg, 25. September 1986

Sehr geehrter Herr Prof. Lanius,
wie Ihnen bekannt ist, stehen die Verhandlungen zwischen dem Max-Planck-Institut, SKET und Ihrem Institut zur Fertigung eines Prototyps für das Hadronkalorimeter beim VEB SKET, Magdeburg, kurz vor dem Abschluß. Bedauerlicherweise konnte der für die letzten Vertragsverhandlungen am 26.9.86 vorgesehene Besuch von H1-Vertretern in Berlin nicht stattfinden,

In der gegenwärtigen Situation ist daher die gesamte Kalorimeterfertigung bei SKET, die alle Beteiligten für sehr wahrscheinlich hielten, in Frage gestellt. In unserem gemeinsamen Interesse wäre ich Ihnen sehr verbunden, wenn Sie eine Änderung der Lage erwirken könnten.

Mit freundlichem Gruß

F. Eisele

$ep \rightarrow \nu H(bb)X$

charged currents

$\sigma BR \sim 120 \text{ fb}$

$S/B \sim 1-2 \rightarrow$ crucial for QCD of H

$\mu = 0.1$

1% coupling precision at 1 ab^{-1}

$H \rightarrow b\bar{b}$

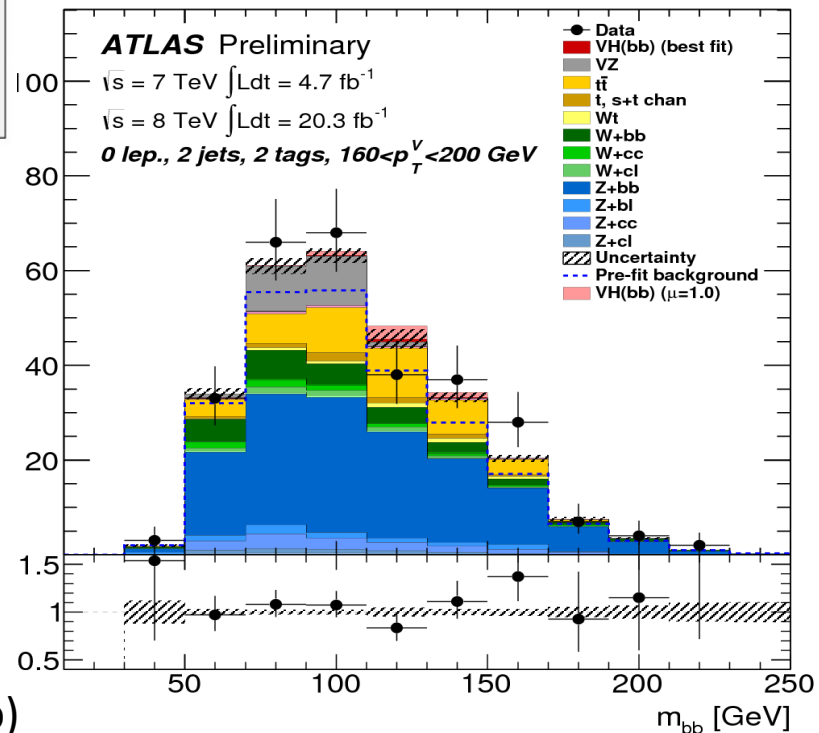
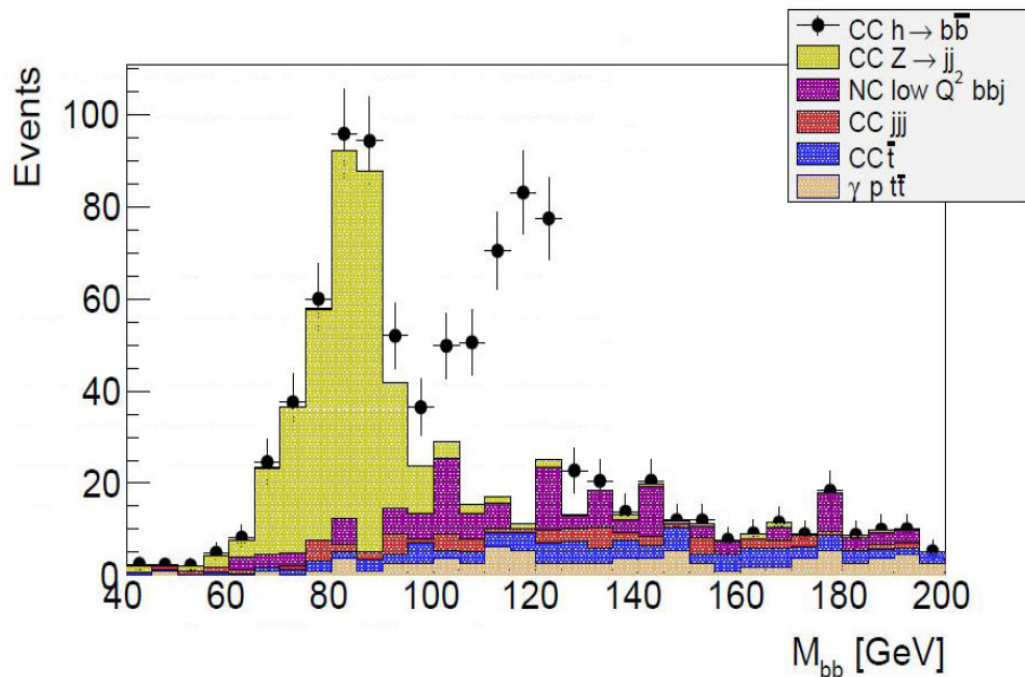
$pp \rightarrow X_1 W(l\nu) H(bb) X_2$

associated VH

$\sigma BR \sim 130 \text{ fb}$

$S/B < \sim 0.01$

$\mu \sim 40$



ep (new) Simulation 100 fb^{-1}

Ellis Kay (U Liverpool) ~ ok with M.Tanaka (Tokyo)

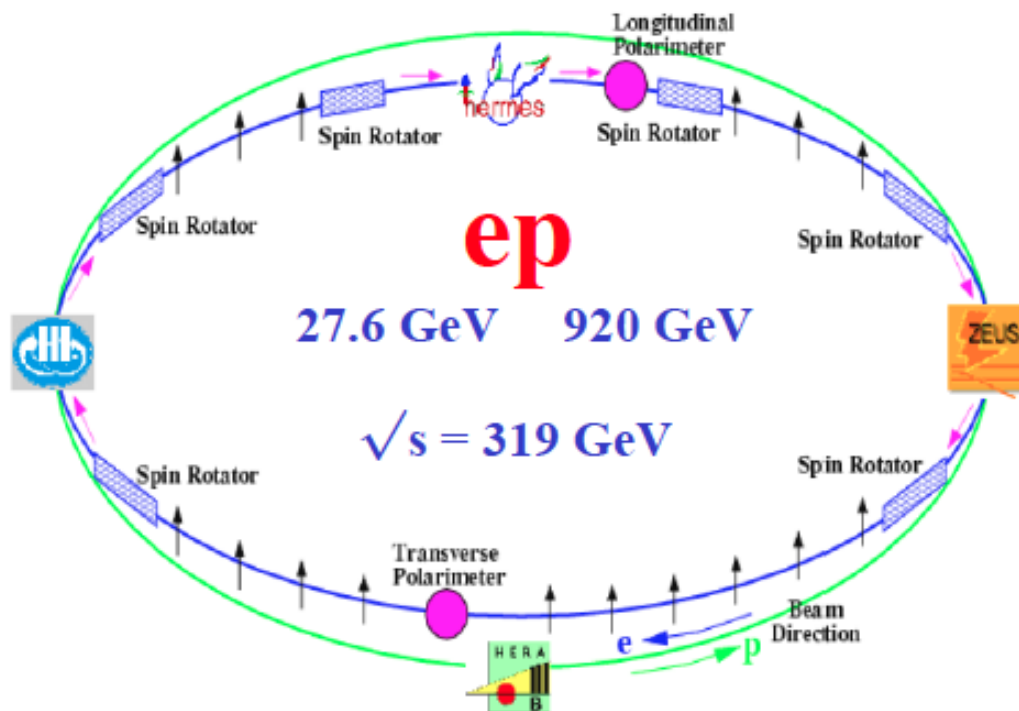
Master Thesis 5/14 with U.Klein

See Poster U. Klein Higgs in ep – this conference

pp 2013: Measurement
ATLAS CONF-2013-079

Highlights from HERA

Vladimir Chekelian (MPI for Physics, Munich)



- HERA performance
- Structure functions/PDFs
- Strong coupling α_s , jets
- Heavy flavour production
- Diffr. & QCD factorisation
- J/Ψ / DVCS / GPDs
- Searches for new physics
- Summary & Outlook

Jets = localised energy depositions in the cone of radius

$$r = \sqrt{\Delta\phi^2 + \Delta\eta^2} \approx 0.7-1.0$$

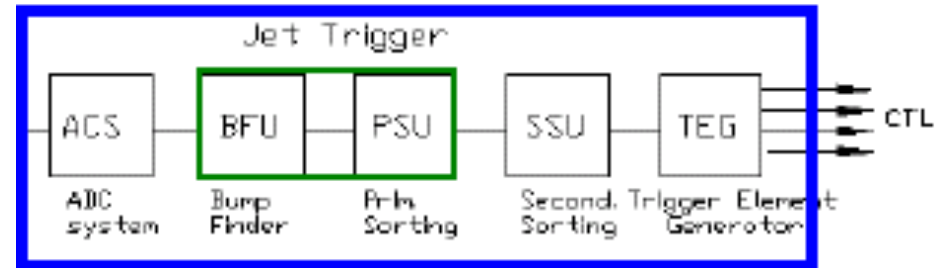
Jets defined by E_T , θ , ϕ

Input to the jet algorithm: ITs (digital sum of TTs)

Jet algorithm:

- Search for local maxima
- Sum energies of immediate neighbours
- Sort jets by transverse energy
- Build TE from ordered list of jets

BTS (summing TT to BT) provides analog outputs of the individual em and had TT's (1200 signals, finest granularity)



Tests progressing well
ACS, r/o software,
TEG/SSU VME access...

First triggers in 2004

- BTS → ACS → BFU cables with all mechanical support
- 4 ACS crates powered
- all ACS boards manufactured and assembled partially tested and installed
- BFU installed and tested
- SSU - 1 TEG board being adjusted for SSU
- TEG - 2 boards installed have VME access problem
- Timing measurement: JetT will be able to provide signal within 8 BCs
- standard readout banks defined, readout software

Jet Trigger ready for use for the 2005 data taking period