

# Reminiscences - 50 Years in Physics



Dedicated to **Paul**, Benjamin

Max Klein<sup>\*)</sup>

Education  
Papers + Detectors  
Various  
Future of PP  
And then?



Lino, **Lotta** and those grandkids who still may be born

<sup>\*)</sup> Born in Berlin, Diploma 72 Humboldt-University, PhD 76 IfH Zeuthen and HUB, Habilitation 1984, Professor Liverpool 2006

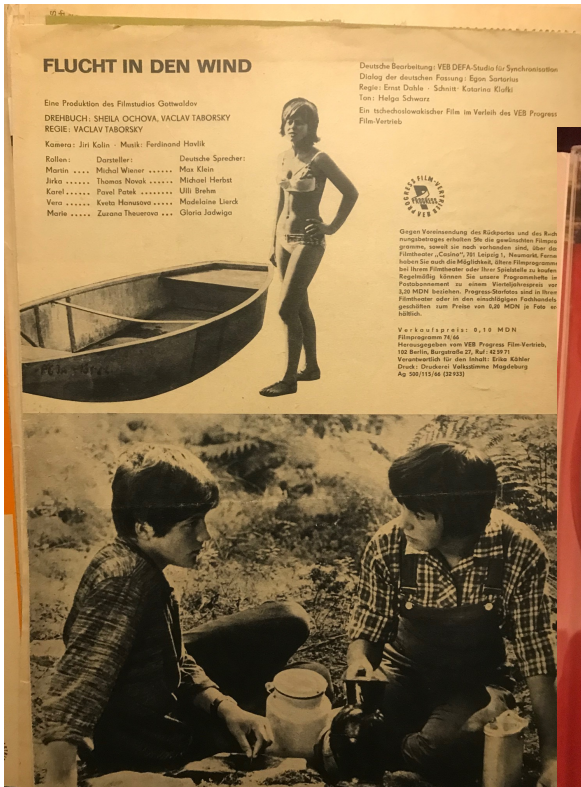
Long term stays at JINR Dubna, ETH Zurich, DESY Hamburg, CERN Geneva. Conferences, workshops at very many places.

Thank you to my family, numerous friends, encouraging colleagues, bosses and directors, speakers and listeners of today.

Things which may not have been said before today. Remarks presented at a Colloquium at Liverpool University, Friday December 9, 2022



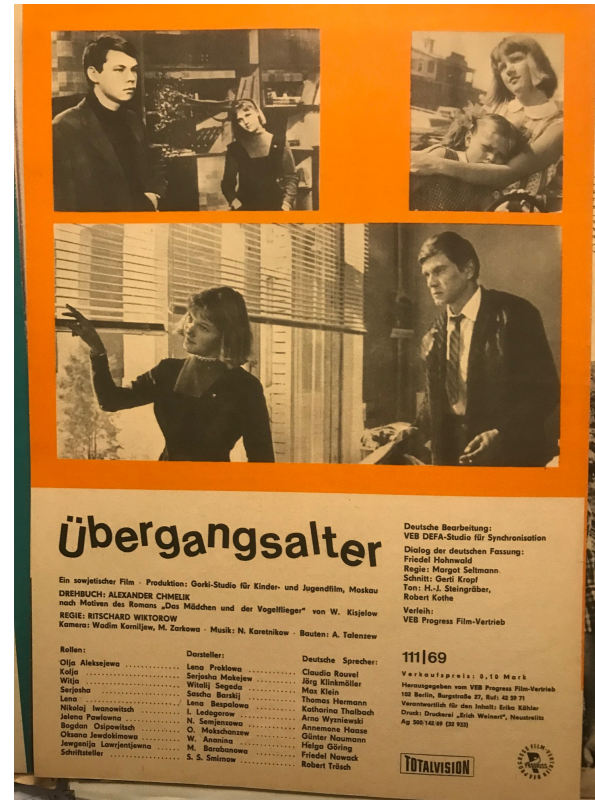
# Physics ?



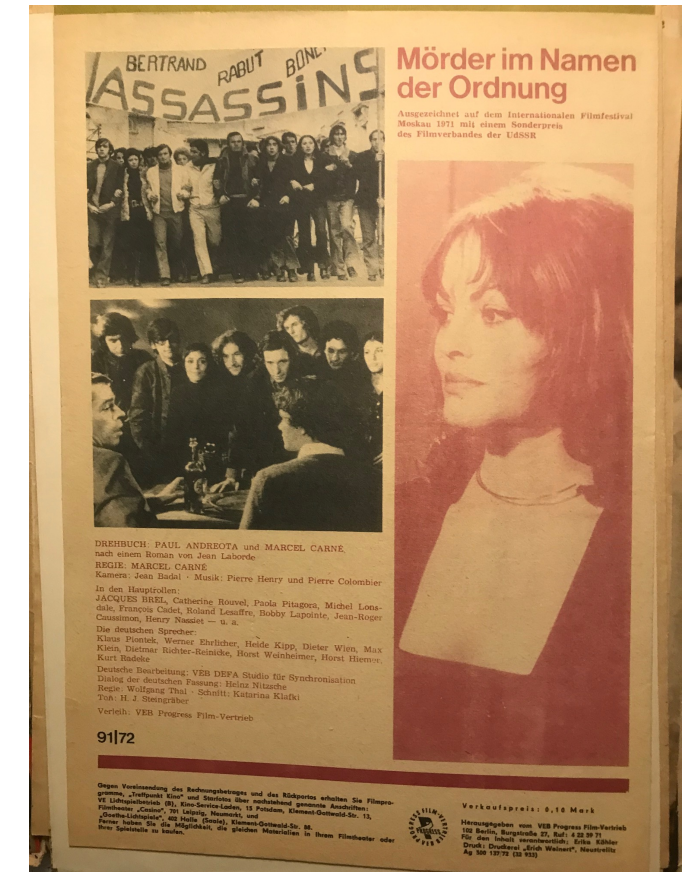
Martin in  
*Utek do Vetru* – 1965  
*Escape in the Wind*



Petja Rostov in  
*War and Peace*  
of Bondarchuk  
- 1967 (Oscar 69)



Witja in  
*Transitional Age* - 1969

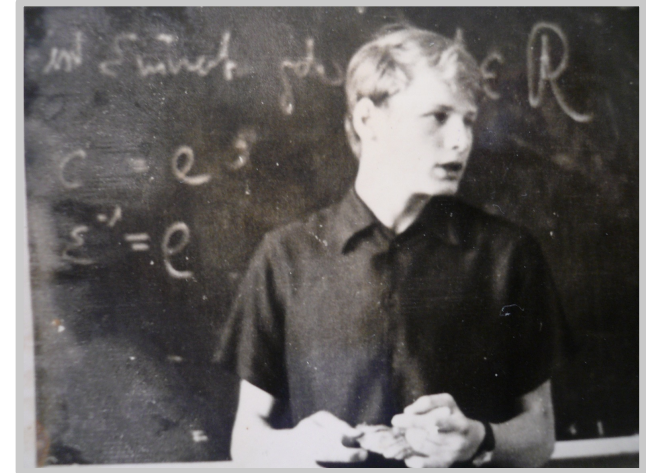


*Les Assassins de l'Ordre* - 1972  
*Law Breakers of Marcel Carne*

50 years ago, this was an offer to not follow physics  
An unforgettable experience with a different world.  
Wolfgang: Historian - Katharina: Painting Restorer



# Special Class for Mathematics 1967-1969, downtown Berlin



Eckehard Krauss (1951-199?)

To us, one of the most gifted mathematics talents that lived (for a while) in the DDR, and one of my best friends at the origin of my family ...

2/67: an advertisement in the ND Newspaper, ~200 applicants 6/67: 120 invited for written exam, 30 for oral, 17 accepted  
Lectures University Teachers. Never easy but friendly indeed: 2 left, 11 math, 2 physics (W Friebel +MK), 1 bio, 1 chemist

# Schools and Education

9. Oberschule Berlin-Johannisthal, 1957-1965, Barbara Stoot (95 since 7.11.22)

Gymnasium (EOS) Alexander von Humboldt, Berlin-Koepenick, 1965-1967,  
Gerhard Sack (1912-2006)

Special Class Humboldt-University Berlin, 1967-1969, Lecturers of the University,  
Ursula Heukenkamp, Fritz Homagk..

Study of Physics at the Humboldt-University Berlin, 1969-1973  
→ PhD (Aspirantur) at IHEP Zeuthen, south of Berlin

## Post Graduate Schools

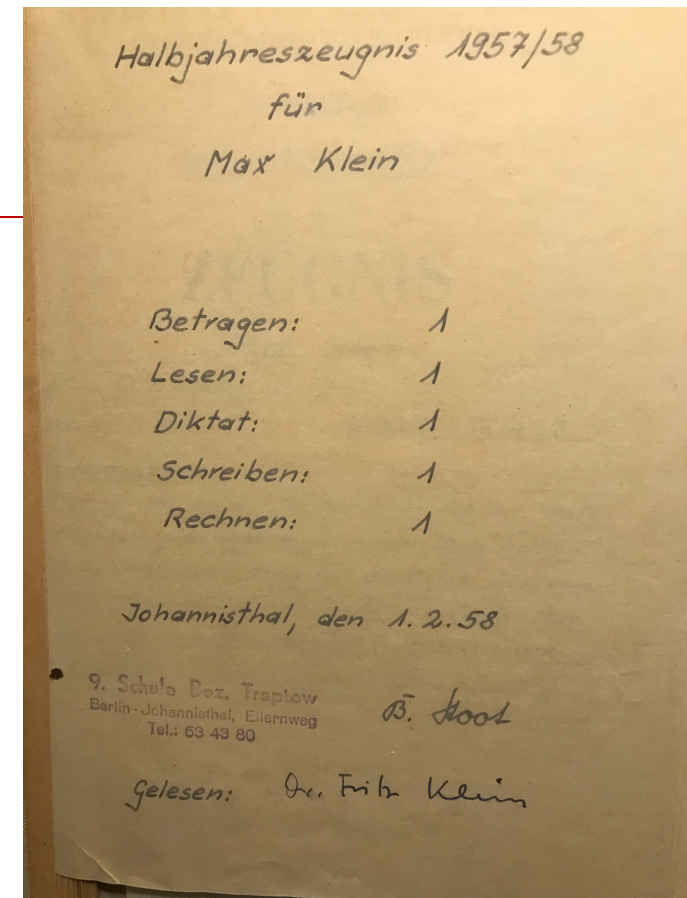
1974 CERN-Dubna School at Alushta, Crimea (Sovietunion..) - Wiik, Jenschke + Bogoljubov, wine tasting, Faustov DIS

1977 Dubna School at Gomel (Belorussia) – Rubbia, Al Mann HPWF, Quigg confinement, Misha Shifman, Guenter Wolf

1978 CERN School at Austerlitz Zeist near Utrecht – t’Hooft, Olga Botner, De Rujula, PV in Bi<sup>83</sup>, Bill Haynes

1979 Herceg Novy School at Kupari (Yugoslavia) Lecturer with Guido Altarelli, Hugh Montgomery, Aurore Savoy Navarro

1983 Pugwash School at Feldafing near Munich – Hartwig Spitzer, M Milzstain, Albrecht von Mueller, Frank von Hippel





# “Learning and Teaching” Syllabus of Physics in 4 years: Humboldt University Berlin (1969-1973)

Year 1

Year 2

Year 3

Year 4

Fall Semester

Analysis I  
Analytic Geometry  
Basics of Physics  
English

Mathematical Methods  
Electrodynamics  
Thermodynamics  
Electrodynamics in Media  
Lab Practice  
Theory of Translation (En)

Main Exams in Math and Physics after Year 2

Math for Theory  
Quantum II  
Electronshell  
Solid States  
Lab II  
English

Atomic Collisions  
Quantum Field Thy  
Group Theory  
Technology  
High Energy Physics

Spring Semester

Analysis II  
Theory of Functions  
Cristallography  
Mechanics of  
deformable Media  
Principle of Mechanics  
Electrodynamics  
English

Hilbert Space  
Quantum I  
Elder Quantum  
Electronics  
ALGOL 60  
Computing  
English

Quantum Field Thy  
Math for Theory  
Atomic Collisions  
Nuclear +Elem Particles

Quantum Field Thy  
High Energy Physics  
Gravitation  
Cosmology

only some of the Y3/Y4 courses were obligatory  
Spring in Y3: beginning of diploma work (1.5 years)

+ seminars/exercises to most of the lectures, and lectures around the theory supposedly underlying the society..

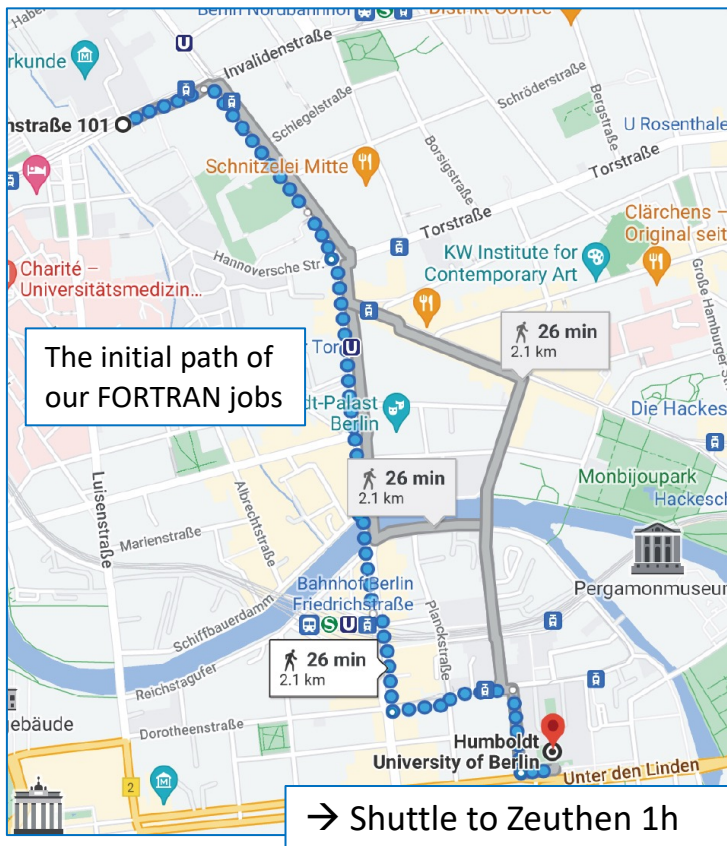
No info on previous exams, no hand outs, no copies: had to be present (Mo-Sat city of Berlin), take notes, study books



**Fritz Bernhard**, Patron of the Special Mathematics Classes - Eminent nuclear physicist and supervisor for our diploma



With Reiner Wedell, Berlin 2016



Sektion Physik der Humboldt-Universität zu Berlin,  
Bereich Atomstoßprozesse der Festkörperphysik

## The Energy-Angle Distribution of Heavy Particles Penetrating Solids

By  
L. MEYER<sup>1)</sup>, M. KLEIN<sup>2)</sup>, and R. WEDELL

Particles of definite initial energy and direction penetrating into a solid have, in a given depth, a certain distribution with respect to energy loss and scattering angle. This energy-angle distribution is calculated in small angle approximation for heavy low energy particles, taking scattering and nuclear stopping into account on the basis of a Thomas-Fermi potential and electronic stopping with a definite dependence on scattering angle. Introducing reduced values of energy loss, scattering angle, and thickness of the penetrated layer, it is found, that it is possible to get a general solution independent of particle and target type and of energy. The result is given by a combination of two functions which are tabulated. The most probable energy losses of the total energy distribution and of the distribution of the particles scattered in forward direction as well as the half-widths of these distributions are given. The results show, that stopping and scattering cannot be considered independently for heavy low energy particles. In particular the conception of 'stopping cross section' at low energies essentially loses its meaning.

## The energy-angle distribution of heavy particles penetrating solids: Experimental test of the Meyer-Klein-Wedell theory for Ne and Ar ions in carbon below 250 keV

By Gilles Beauchemin and Robert Drouon

[Nuclear Instruments and Methods](#)

[Volume 160, Issue 3,](#)

1 April 1979, Pages 519-527

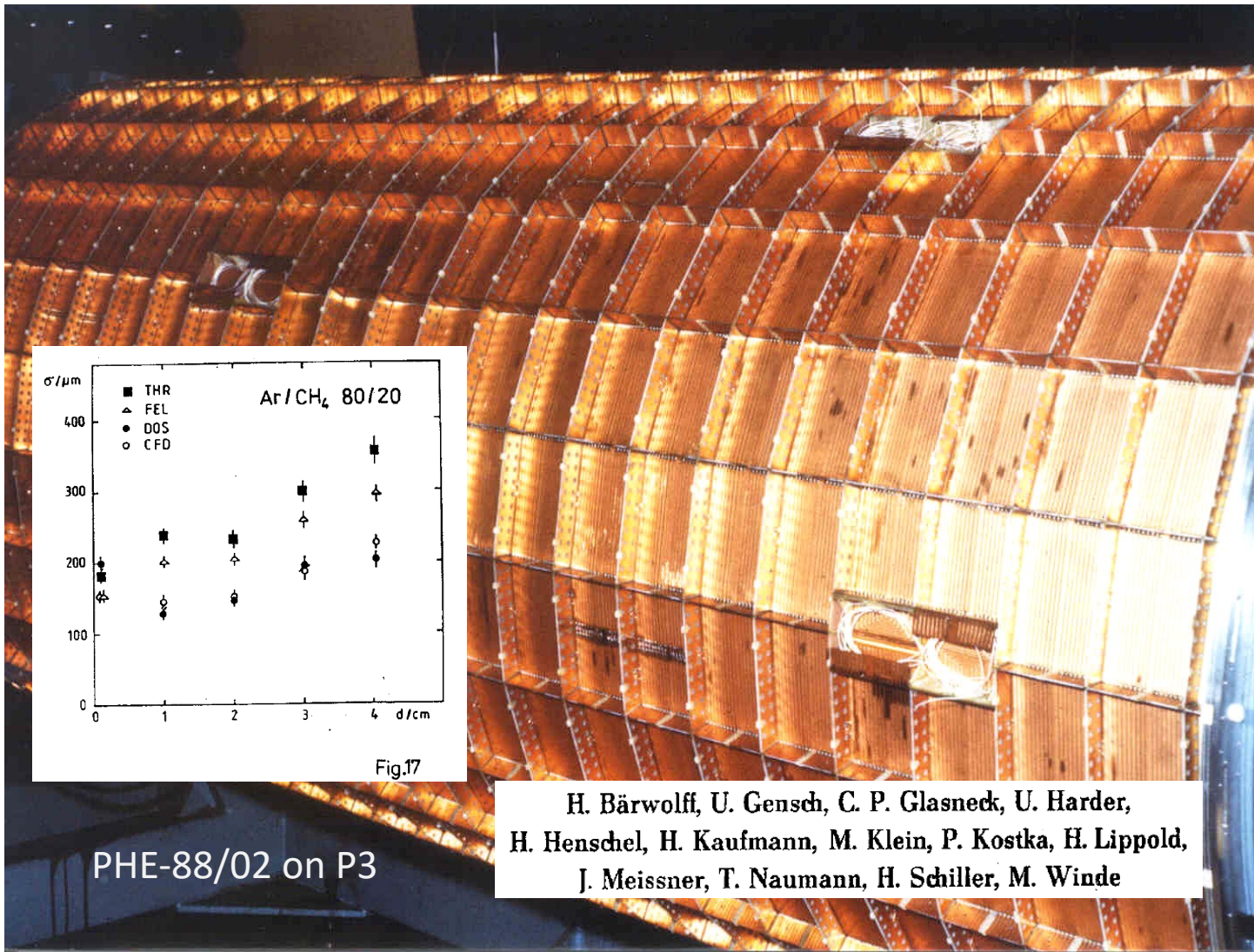
### Abstract

Meyer, Klein and Wedell have presented a theory of energy loss for heavy particles in solids. They assume that the *electronic* energy loss is, for one part, independent of the scattering angle (referring to term  $C_{e0}$ ) and, for another part, dependent of the scattering angle (referring to term  $C_{e2}$ ). In the present article we compare the MKW theory with experimental results obtained with neon ions (40–120 keV) and argon ions (40–240 keV) on thin carbon foils (4–15  $\mu\text{g}/\text{cm}^2$ ). Values of  $C_{e0}$  and  $C_{e2}$  were obtained in all cases. The MKW theory generally takes into account the principal phenomena observed during the study of the angular dependence of energy loss, i.e. a decreasing intensity with increasing emergence angle  $\theta$ , and an increasing energy loss as a function of  $\theta$ . In the energy distribution, the theory overestimates the number of ions having the highest energy losses; consequently it tends to overestimate half-widths, especially for energy spectra obtained at large angles. As far as the scattering angle dependence of the *electronic* energy loss is concerned, the validity of this basic hypothesis of the theory seems to be verified. The energy dependence of  $C_{e0}$  seems to be similar to the energy dependence of the electronic energy loss as defined by Lindhard, Nielsen and Scharff.

For the diploma we became guests at IfH Zeuthen's BESM6 (PK, WF) For the publication we used a table Hewlett Packard. In those times you had ample opportunity to read and think..



# Outer z Drift Chamber (COZ) of H1



PHE-88/02 on P3

H. Bärwolff, U. Gensch, C. P. Glasneck, U. Harder,  
H. Henschel, H. Kaufmann, M. Klein, P. Kostka, H. Lippold,  
J. Meissner, T. Naumann, H. Schiller, M. Winde

Many thanks for major support: by

Freedom to choose: H1 and Karl Lanius

Inner H1 tracker steering: Hartwig Spitzer

Mechanics, Cables .. : Jochen Buerger

Preamplifier: Walter Zimmermann

Prototype 1 + Test: Richard Hedgecock

Support Structure: Robin Marshall (5 DM)

Mac SE + VME interface: Bill Haynes

FADC DL101: Franz Eisele, Peter Steffen

Prototype 3 Test at PSI and CIZ: Peter Truoeel

Operation: Don Clarke and Steve McMahon

The Stabloh m Wire Battle: John Dainton

Cleaning: H1 Kosice (Dusan Brunsko group)

A lesson about collaboration and begging as a person from behind the wall



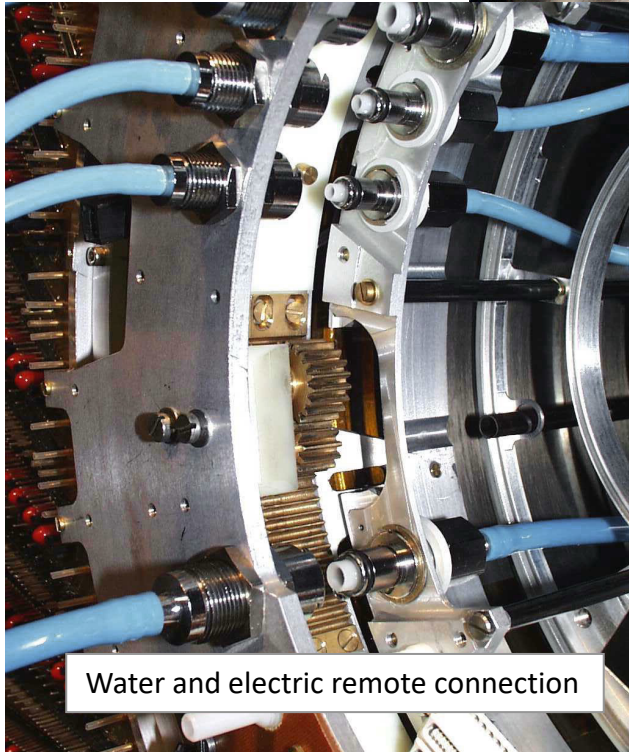
# H1 Backward and Forward Silicon Detectors

$$\tilde{\sigma}_{\text{NC}}(x, Q^2, y) \equiv F_2 - \frac{y^2}{Y_+} F_L - \frac{Y_-}{Y_+} x F_3$$

B/CST EOI 1992  
MK and Daniel Pitzl

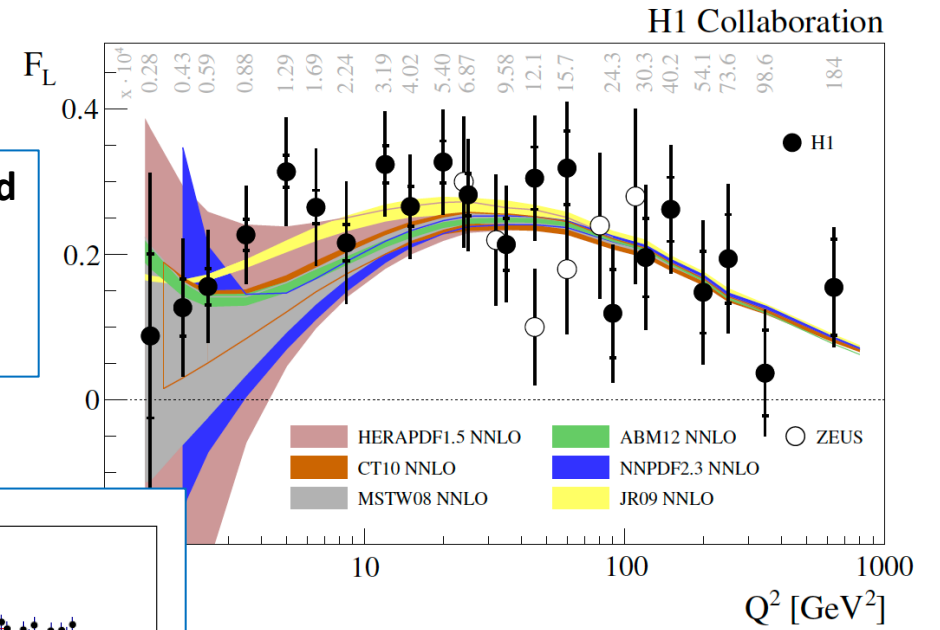


Zeuthen Silicon detector arrived at H1

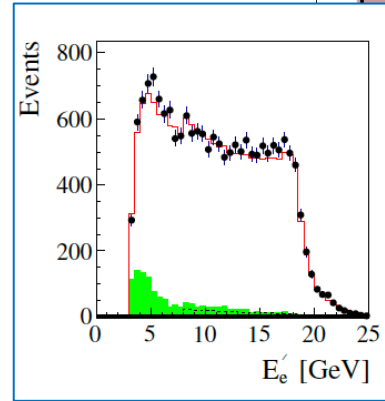


Water and electric remote connection

$F_L$  measured  
in the last  
months of  
HERA OP..



BST enabled to reach very high  $y = 1 - E'/E$  and  $Q^2 < 10 \text{ GeV}^2$  where theory most uncertain



Nuclear Instruments and Methods in Physics Research A 386 (1997) 81-86

## Development of the H1 backward silicon strip detector

W. Eick<sup>a</sup>, H. Henschel<sup>a</sup>, H.H. Kaufmann<sup>a</sup>, M. Klein<sup>a</sup>, P. Kostka<sup>a</sup>, L. Kratzwald<sup>a</sup>,  
W. Lange<sup>a</sup>, H. Lippold<sup>a</sup>, J. Meißner<sup>a</sup>, Th. Naumann<sup>a</sup>, E. Peppel<sup>a,\*</sup>, U. Stöblein<sup>a</sup>,  
K. Stolze<sup>a</sup>, M. Winde<sup>a</sup>, J. Bürger<sup>b</sup>, K. Hansen<sup>b</sup>, W. Lange<sup>b</sup>, S. Prell<sup>b</sup>, W. Zimmermann<sup>b</sup>,  
M.A. Bullough<sup>c</sup>, N.M. Greenwood<sup>c</sup>, A.D. Lucas<sup>c</sup>, A.M. Newton<sup>c</sup>, C.D. Wilburn<sup>c</sup>,  
R. Horisberger<sup>d</sup>, D. Pitzl<sup>e</sup>, D. Clarke<sup>f</sup>, W.J. Haynes<sup>f</sup>, G. Noyes<sup>f</sup>

<sup>a</sup> Deutsches Elektronen-Synchrotron, Institut für Hochenergiephysik, Zeuthen, Germany

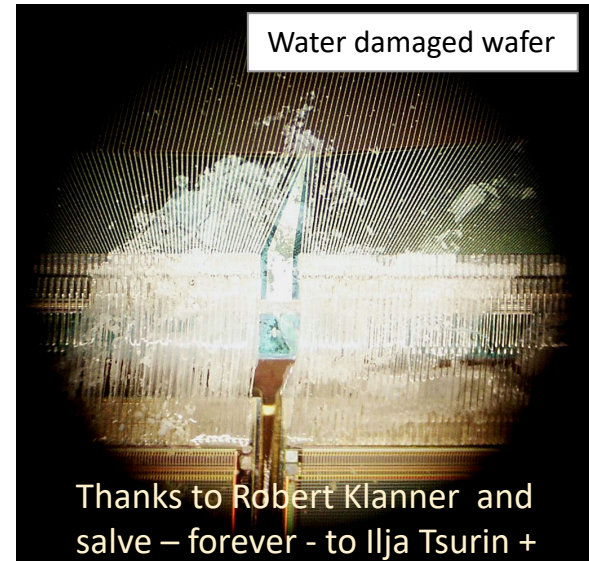
<sup>b</sup> Deutsches Elektronen-Synchrotron, Hamburg, Germany

<sup>c</sup> MICRON Semiconductor, Lancing, Sussex, UK

<sup>d</sup> Paul Scherrer Institute, Villigen, Switzerland

<sup>e</sup> Institut für Mittelenergiephysik, Eidgenössische Technische Hochschule, Zürich, Switzerland

<sup>f</sup> Rutherford Appleton Laboratory, Chilton, Didcot, UK



Water damaged wafer

Thanks to Robert Klanner and  
salve – forever - to Ilja Tsurin +



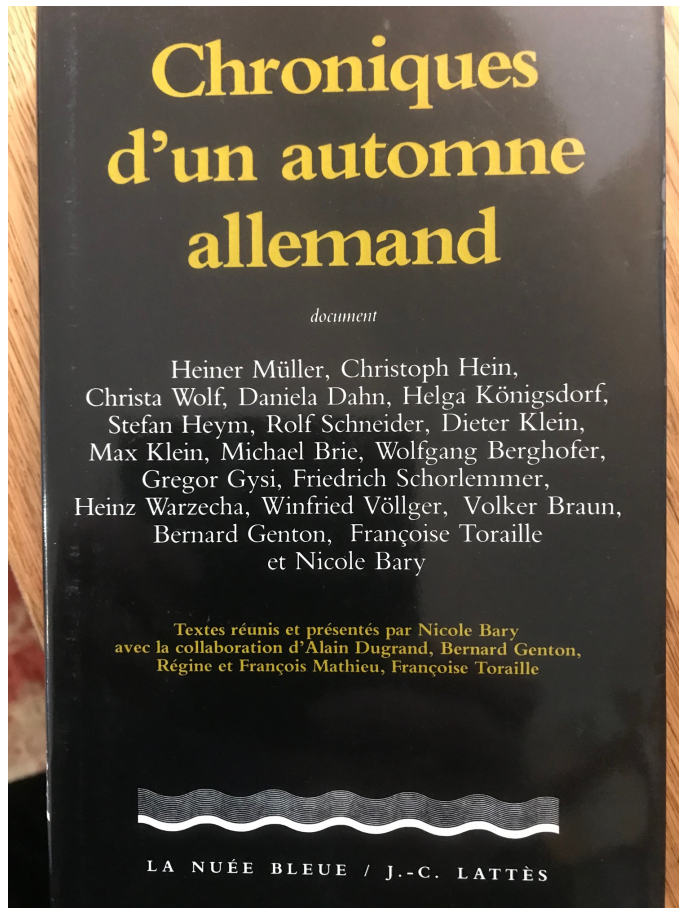
# When the times were changing

Max Klein

NATURE PHYSICS | VOL 5 | DECEMBER 2009 | www.nature.com/naturephysics

It has been 20 years since the fall of the Berlin Wall. In the wake of the upheaval, the East German society was radically remodelled. For physicists, it brought new opportunities — and fresh challenges.

1989/1990  
State vanished  
while H1 came  
together ..



Speech at **Manifestation for Democratic Science - Gendarmenmarkt, 10.11.89**  
Kapitza, Rutherford and further points

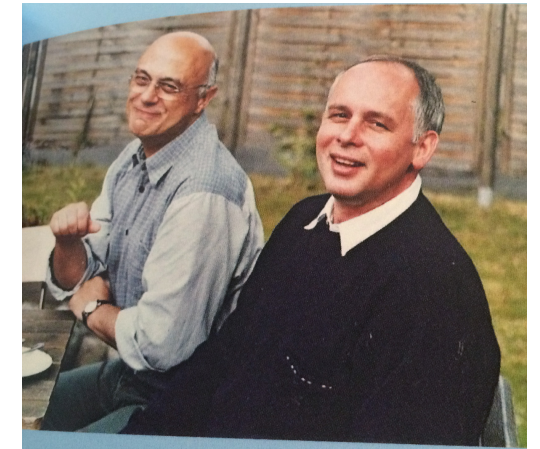
Chair Zeuthen Sc Council  
Theses of AdW Chairs 3/90  
H Schopper+ Visit at IfH  
... Foundation of DESY Zeuthen



Norbert Langhoff, **ZWG, H1, Adlershof**  
Chair of Academy Election Committee 6/1990  
Here with Reiner Wedell (co-diploma 1972)



Franz Eisele, Master of H1,  
Here at LAL Orsay .., H1 Meeting



October 3, 1990 - Anna 14  
That day: I presented talk at Dubna

Happy to have stayed who we were

# Deep-inelastic inclusive $ep$ scattering at low $x$ and a determination of $\alpha_s$

Most cited (753) of all sole H1 papers

Data: 1997 Paper: 2001

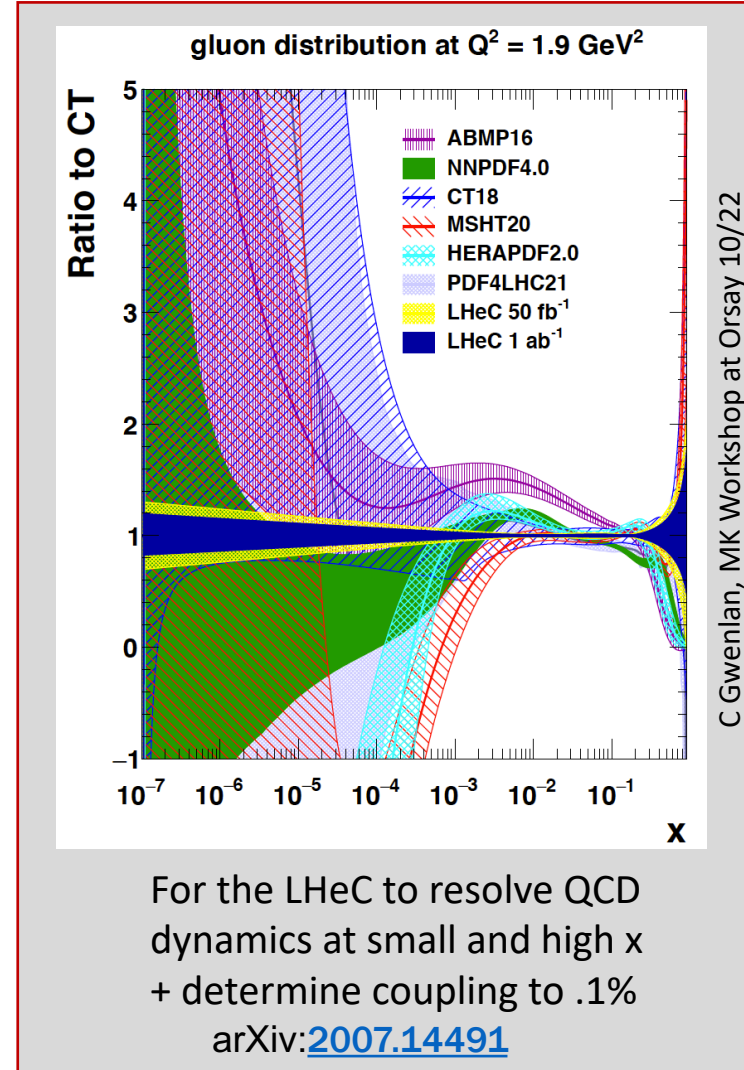
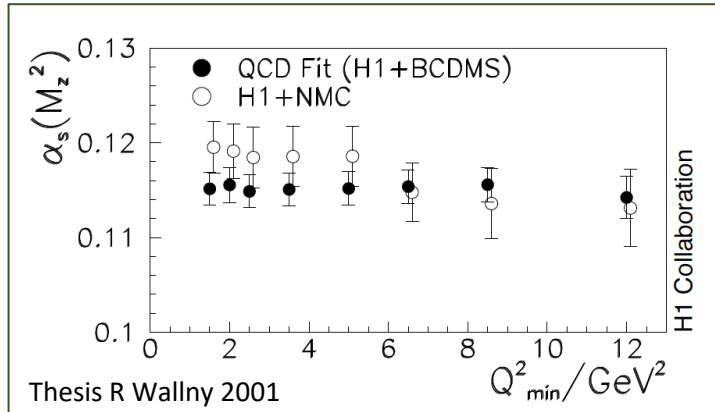
- Precise [ $\sim 3\%$ ] cross section measurement,  $20 \text{ pb}^{-1}$
- Extraction of  $F_2$ ,  $F_L$  and  $dF_2/d\ln Q_2^2 \sim xG$
- Dedicated QCD analysis in NLO for  $\alpha_s$  and  $xG$

## A Memorable Time + Paper

Series of papers before and after

$$\alpha_s(M_Z^2) = 0.1150 \pm 0.0017(\text{exp})_{-0.0005}^{+0.0009} (\text{model})$$

Below the canonical 0.118. Lattice? GUT?..

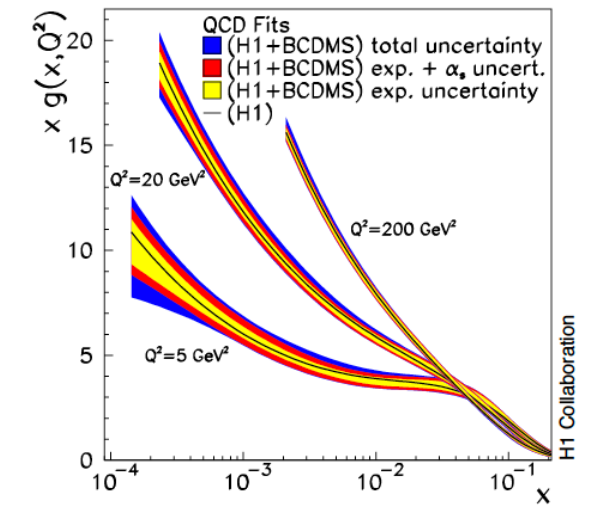


[hep-ex/0012053](https://arxiv.org/abs/hep-ex/0012053)

$$F_2 = \frac{2}{9} \cdot x\Sigma + \frac{1}{3} \cdot x\Delta = \frac{4}{9} \cdot xU + \frac{1}{9} \cdot xD$$

$$V = \frac{3}{4}(3U - 2D) \quad A = \frac{1}{4}(2D - U)$$

Novel decomposition of  $F_2$  to reduce number of QDFs to two  
→ emphasis on gluon + coupling



NMC pointed to very large coupling:  $Q^2$  cut at  $10 \text{ GeV}^2$  → removal of NMC from analysis as it had no effect  
BCDMS pointed to very low coupling:  $y$  cut at 0.3 → recuperation of bulk of BCDMS data and  $\Delta\chi^2$  of 1 → +2 years of analysis



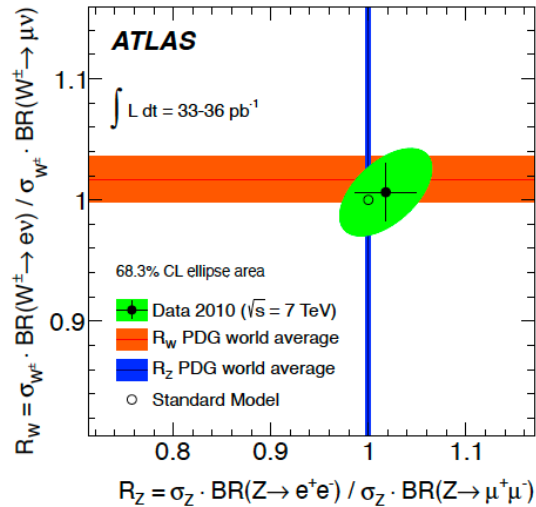
Measurement of the inclusive  $W^\pm$  and  $Z/\gamma^*$  cross sections in the  $e$  and  $\mu$  decay channels in  $pp$  collisions at  $\sqrt{s} = 7$  TeV with the ATLAS detector

CERN-PH-EP-2011-097  
Submitted to Phys. Rev. D

	sta	sys	lum	acc
$\sigma_W^{\text{fid}} \cdot \text{BR}(W \rightarrow \ell\nu)$ [nb]				
$ \eta_\ell  < 2.5, p_{T,\ell} > 20$ GeV,				
$p_{T,\nu} > 25$ GeV and $m_T > 40$ GeV				
$W^+$	$3.110 \pm 0.008$	$\pm 0.036$	$\pm 0.106$	$\pm 0.004$
$W^-$	$2.017 \pm 0.007$	$\pm 0.028$	$\pm 0.069$	$\pm 0.002$
$W^\pm$	$5.127 \pm 0.011$	$\pm 0.061$	$\pm 0.174$	$\pm 0.005$
$\sigma_{Z/\gamma^*}^{\text{fid}} \cdot \text{BR}(Z/\gamma^* \rightarrow \ell\ell)$ [nb]				
$ \eta_\ell  < 2.5, p_{T,\ell} > 20$ GeV				
and $66 < m_{\ell\ell} < 116$ GeV				
$Z/\gamma^*$	$0.479 \pm 0.003$	$\pm 0.005$	$\pm 0.016$	$\pm 0.001$

35 pb<sup>-1</sup>

W and Z/γ 1.2%  
Luminosity 3.3% ..



## High Precision in pp



← e/μ universality - W,Z

Habilitation in 1984 at HUB Berlin

INTERFERENCE OF ELECTROMAGNETIC AND WEAK INTERACTIONS  
AT HIGH ENERGIES AND NEUTRAL CURRENT  $\mu e$  UNIVERSALITY

M. Klein

Institut für Hochenergiephysik der AdW der DDR

Fortsch. Phys. 33 (1985) 375

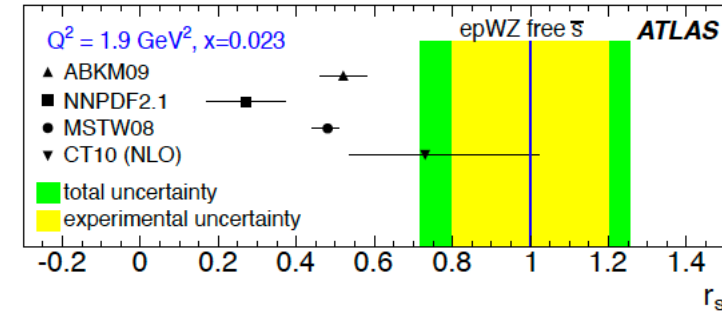
PHE 84-01

$$v_e = 0.02 \pm 0.06, \quad v_\mu = -0.05 \pm 0.16$$

$$a_e = -0.54 \pm 0.03, \quad a_\mu = -0.51 \pm 0.05$$

iv) the  $Q$  parameter is about equal to one pointing to the simplest realization of the Higgs mechanism. Though naturally

## Determination of the Strange-Quark Density of the Proton from ATLAS Measurements of the $W \rightarrow \ell\nu$ and $Z \rightarrow \ell\ell$ Cross Sections



Light flavour (u,d,s) democracy or is the strange suppressed?

## Double differential Z,W cross sections and their ratios in the electron channels

M. Aharrouche<sup>5</sup>, A. Arbuzov<sup>1</sup>, D. Bardin<sup>1</sup>, M. Bendel<sup>5</sup>, S. Bondarenko<sup>1</sup>, A. Cooper-Sarkar<sup>7</sup>, F. Ellinghaus<sup>5</sup>, M. Flowerdew<sup>4,8</sup>, S. Glazov<sup>2</sup>, C. Göringer<sup>5</sup>, J. Haller<sup>2,3</sup>, C. Handel<sup>5</sup>, G. Hörentrup<sup>2,3</sup>, L. Kalinovskaya<sup>1</sup>, M. Karnevskiy<sup>2</sup>, M. Klein<sup>4</sup>, U. Klein<sup>4</sup>, T. Kluge<sup>4</sup>, K. Köneke<sup>2,11</sup>, S. König<sup>5</sup>, V. Kolesnikov<sup>1</sup>, J. Kretzschmar<sup>4</sup>, S. Mahmoud<sup>4</sup>, S. Migas<sup>4</sup>, A. Nikiforov<sup>2,9</sup>, D. Petschull<sup>2</sup>, R. Placakyte<sup>2</sup>, V. Radescu<sup>2,10</sup>, R. Sadykov<sup>1</sup>, A. Saponov<sup>1</sup>, G. Siragusa<sup>5</sup>, S. Tapprogge<sup>5</sup>, J. Vosseveld<sup>4</sup>, S. Wollstadt<sup>5</sup>, and B. Wron<sup>1</sup>

<sup>1</sup>JINR Dubna  
<sup>2</sup>DESY Hamburg  
<sup>3</sup>University of Hamburg  
<sup>4</sup>University of Liverpool  
<sup>5</sup>University of Mainz  
<sup>6</sup>CERN  
<sup>7</sup>University of Oxford

Four years of training  
in a self organised  
analysis group prior  
to LHC operation

ATL-COM-PHYS-2010-335

187 pages, Appendices: Variations of PDFs,  
Propagation of Uncertainties  
Frozen Showers, SANC vs PYTHIA, software doc.



## PhD in Bubble Chamber Times

A CORRELATED JET MODEL DESCRIPTION OF THE REACTION  
 $\pi^+ p \rightarrow p 3\pi^+ 2\pi^-$  AT 8 AND 16 GeV/c

K.J. BIEBL, M. KLEIN, R. NAHNHAUER and H. SCHILLER  
*Institut für Hochenergiephysik, Akademie der Wissenschaften der DDR, Berlin-Zeuthen*

Received 30 June 1975  
(Revised 13 October 1975)

TATRA to Dubna for Rolf and M

Klaus-Jochen Biebl

Resonances instead of clusters..

ABCCCH Collaboration

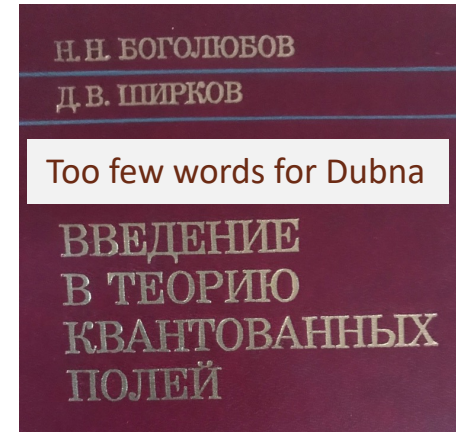
Reinhardtsbrunn

Morrison and Geneva City ..

Cocconis – a famous couple

Leipzig/Eisenach: Henri Lubatti

Ter Materiosjan and C.S' NO



Swjatoslav Richter  
Savin, Bardin +  
Golutvin, Smolin +  
international group  
with 1 terminal ..  
Bilenky, Tord Riemann

## ETH, MARK-J and L3

No more taus  
Learning about  
Drift chambers: TEC

Hans Hofer,  
Gert Viertel,  
Martin Pohl,  
Hans Anderhub,  
Min Chen,  
Joachim Mnich  
Franz Muheim.

DDR Cranes for L3  
with Leiste + Leistam

Sam Ting and Zeuthen

Review **H1 and ZEUS ...**  
**Collider physics at HERA**

M. Klein<sup>a</sup>, R. Yoshida<sup>b,\*</sup>

PPNP, 2008

## Into the LHC

ATLAS to DESY: AS,AG,PJ

An LHC Seminar at DESY

Liverpool: Neil, Phil, Barry +

Detector: SCT + Upgrade

Into the Experiment: FG



How to lead a group of  
that unique experience ?  
Now for Monica+ to answer

No PubCom-, no CB-Chair  
no spokesperson candidate  
w/o this outstanding group



## PhD in Bubble Chamber Times

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Cocconis – a famous couple

Leipzig/Eisenach: Henri Lubatti

Ter Materiosjan and C.S' NO

## A bit more on Dubna



Foundation of family

A huge country to visit

Outstanding social life

## ETH, MARK-J and L3

No more taus  
Learning about  
Drift chambers: TEC

Hans Hofer,  
Gert Viertel,  
Martin Pohl,  
Hans Anderhub,  
Min Chen,  
Joachim Mnich  
Franz Muheim.

DDR Cranes for L3  
with Leiste + Leistam

Sam Ting and Zeuthen

Review **H1 and ZEUS ...**  
**Collider physics at HERA**

M. Klein<sup>a</sup>, R. Yoshida<sup>b,\*</sup>

PPNP, 2008

## Into the LHC

ATLAS to DESY: AS,AG,PJ

An LHC Seminar at DESY

Liverpool: Neil, Phil, Barry +

Detector: SCT + Upgrade

Into the Experiment: FG



How to lead a group of  
that unique experience ?  
Now for Monica+ to answer

No PubCom-, no CB-Chair  
no spokesperson candidate  
w/o this outstanding group

Calin Alexa	- Bukarest
Ludovica Aperio Bella	- CERN
Shikma Bressler	- Rehovot
Alexander Cheplakov	- Dubna
Brian Cole	- New York
Claudia Glasman	- Madrid
Deepak Kar	- Witwatersrand
Marco Leite	- Sao Paulo
Fabienne Ledroit	- Grenoble
Jim Pilcher	- Chicago
Ian Shipsey	- Oxford
Jonas Strandberg	- Stockholm
Geoffrey Taylor	- Melbourne
Tamara V Schroeder	- Montreal
Haijun Yang	- Shanghai

**ATLAS**  
**Collaboration**  
Board Chair Advisory Group (2018-19)

The group which advised me while chairing the ATLAS Collaboration Board, and which greatly failed to change a simple rule - of a Collaboration which is yet strong through its traditions and the 1000s of enthusiasts working on it.

Victor Weisskopf on return from Mao Tse Tung (1974): Talk on the MIT Bag Model at the Leopoldina Academy Leipzig (East Germany, DDR):  
**Mao: High Energy Physics has two characteristics: It explores the secrets of nature and it empowers peaceful collaboration across borders.**  
 A view on this map and a look backwards and forward to our field lead to one sole conclusion: to decouple politics from science + papers..  
 Science enables contacts and mutual understanding, it is the enemy of and opposite to war, which has to be resisted with political means.

No first use of nuclear weapons appeal open for support: Science4peaceForum: contact Hannes Jung. 14 Nobel Prize winners + many others



# The Future is an old Problem

Think of the SSC which had Reagan's signature and the energy vs luminosity fight of US and CERN

Think of TESLA/ILC for which Snowmass 2001 claimed the existence of a "worldwide consensus"

Think of 15 years of investment in a ring fenced CLIC Development.

Think of DESY and SLAC Once accelerator pp Flagship laboratories

Consider our inability to do realistic time projections →

## *Scientific activities*

*European Strategy 2006*

3. The LHC will be the energy frontier machine for the foreseeable future, maintaining European leadership in the field; *the highest priority is to fully exploit the physics potential of the LHC, resources for completion of the initial programme have to be secured such that machine and experiments can operate optimally at their design performance. A subsequent major luminosity upgrade (SLHC), motivated by physics results and operation experience, will be enabled by focussed R&D; to this end, R&D for machine and detectors has to be vigorously pursued now and centrally organized towards a luminosity upgrade by around 2015.*

Most likely, the LHC will have been the main base for HEP for ~50 years...

Apparently we are unable to deliver reliable time projections  
... and yet we need optimism in order to progress ...

# Future of Particle Physics

## What do you think?

Don't trust what you hear,  
Listen to what you see,  
This is what will be .. BS

- Despite the success of the Standard Model:  
**Major problems of Particle Physics remain not solved:**  
GUT,  $M_H$ , 26 parameters of the SM, Symmetries  
left-right?, lepton-quarks? particle-anti? fermion-boson  
confinement, free fractional charges, substructure,  $N_f = 3$  why?  
space time extra dimensions, unparticles, E8 ...
- you **don't need an astro problem like DM to justify the future of HEP**,  
and don't need biased people to loudly deny its fundamental role
- **Particle Physics is a global science, needs balance, peace and trust**
- the idea to work 100 years at CERN and nowhere else is inappropriate  
as it ignores the potential and capabilities of the world outside Meyrin  
and establishes inefficient, a-human timelines [FCCpp in 60 years, not for Lino]
- justification for new programs is oversold: SLAC MIT proposal:  
**whole field needs a reset**, less promises, less workshops, more courage on top,
- higher recognition of physics ability vs committee work. Talent in mass groups..
- **invest in theoretical physics**, EFT can't be the answer..
- **ECFA should be reinstated (cf E Amaldi) for timely decision when needed**,  
and the 5 year "socialist" planning/strategy habit be ended as a rather  
superfluous albeit big effort open for manipulation while ECFA and LDG have all
- **ICFA should regain its role as a global coordinator**, not an ILC lobby group
- indeed do **detector and accelerator R&D** – distinguish better blue sky from needs
- **jobs in particle physics and technology** for more than a few

## What then would **you** do ?

**Energy Frontier** requires global coordination, DESY, SLAC  
[hh/eh/ee energies are different, hh+eh is very precise]

- **LHC has still huge potential to be operated until 2050**  
with widened scope. We shall not throw away 5 BCHF ..  
Book in 23: **The Future of the LHC** (World Scientific,  
eds O Bruening, MK, L Rossi, P Spagnolo)
- **The next hadron collider at CERN** as energy upgrade  
to LHC (100 km tunnel by 2050, not now). Magnets  
as available by 2040ish, i.e. foresee an energy upgrade  
potentially with 20T HTS magnets.
- Integrate ep/eA into the hadron collider programs.
- No loose physics topic is the Higgs vacuum potential.
- **A next  $e^+e^-$  collider in Asia** for 6 abundant H channels  
Note that the Higgs "factory" is a "manufacture"
- The ERL Roadmap has the vision of a 500 GeV  
 $10^{36}$  luminosity 4K ERL  $e^+e^-$  collider (A Hutton ERL WS 22).
- Realistic check of neutrino radiation before  
embarking for the 3rd time on a muon collider.

**Specialised experiments**, including at high intensity.  
**Links to nuclear + astro physics and industry (crucial)**



# What is/maybe Next?

Happy birthday Mascha



Are there additional possibilities for further decades ahead?

“BFKL evolution and Saturation in DIS”



Circles in a circle  
V. Kandinsky, 1923  
Philadelphia Museum of Art

“Critical gravitational collapse”



5d tiny black holes and perturbative saturation  
Talk by A.S.Vera at LHeC Workshop 2008

We decided for the left vision following the idea that out of e and p you can form 3 not 2 combinations, **Jorgen - be welcome**



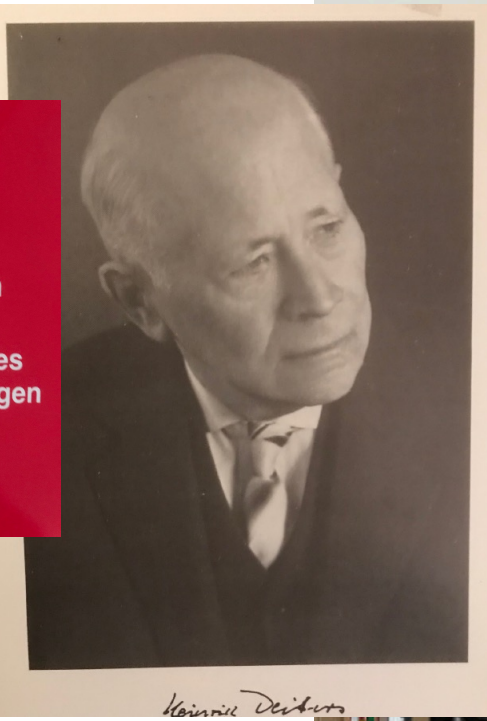
# “Stick to your Chromosoms”

Sergio Bertolucci

Heinrich Deiters

Bildung und Leben

Erinnerungen eines deutschen Pädagogen



Education and Life



Paul Loebe, ?, Fritz Klein ? - 1930

**Die Weltbühne**  
 Der Schaubühne XXVI. Jahr  
 Wochenschrift für Politik · Kunst · Wirtschaft  
 Begründet von Siegfried Jacobsohn  
 Unter Mitarbeit von Kurt Tucholsky  
 geleitet von Carl v. Ossietzky

Inhalt:

Carl v. Ossietzky	Sowjet-Justiz etc.
K. L. Gerstorff	Der Reformismus am Ende
Bruno Frei	Antwort an Arnold Zweig
Walter Mehring	Oustric
Erich Kästner	Brief an den Weihnachtsmann
Julie Blasius	Mädchenhandel
Rudolf Arnheim	Technische Improvisationen
Kaspar Hauser	Diese Häuser
Erich Mühsam	Nora 1930
Morus	Vorkriegszeit
S. J.	Ueber Theater und Kritiker

Bemerkungen — Antworten

Erscheint jeden Dienstag  
 XXVI. Jahrgang 2. Dezember 1930 Nummer 49  
 Versandort Potsdam

Verlag der Weltbühne  
 Charlottenburg · Kantstraße 152

Carl von Ossietzky  
Kurt Tucholsky ...

## Die Weltbühne

Wochenschrift für Politik · Kunst · Wirtschaft  
1905 gegründet von Siegfried Jacobsohn  
1926-1933 geleitet von Carl v. Ossietzky  
Nach 1933 herausgegeben von Hermann Budziszewski  
Wieder gegründet 1946 von Maud v. Ossietzky  
und Hans Leonard

Fritz Klein  
Frühe Schriften  
(1949 - 1968)



FK jun. author from  
1949 until 2010

## Die Weltbühne im Wirbel der Wende

Eine Zeitschrift im Umbruch  
Oktober 1989  
Dezember 1991

Ed Wolfgang Klein

Verlag der Weltbühne · Berlin

## Das Blättchen

Zweitschrift für Politik, Kunst und Wirtschaft

Monday, 5.12.2022

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 Erhard Crome ..... Deutsche Frage entschärft  
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25. Jahrgang (XXXV) N°25 5. Dezember 2022  
Erscheint jeden zweiten Montag  
www.das-blaetchen.de

Co-editor since 5.12  
Felix Klein a new author

“FK”: Deutsche Allgemeine Zeitung  
the FAZ of the Weimar Republik..



# PERLE at Orsay

## Mission

1. Demonstration of high current (20mA) multi (3) turn ERL operation and low energy nuclear/particle physics

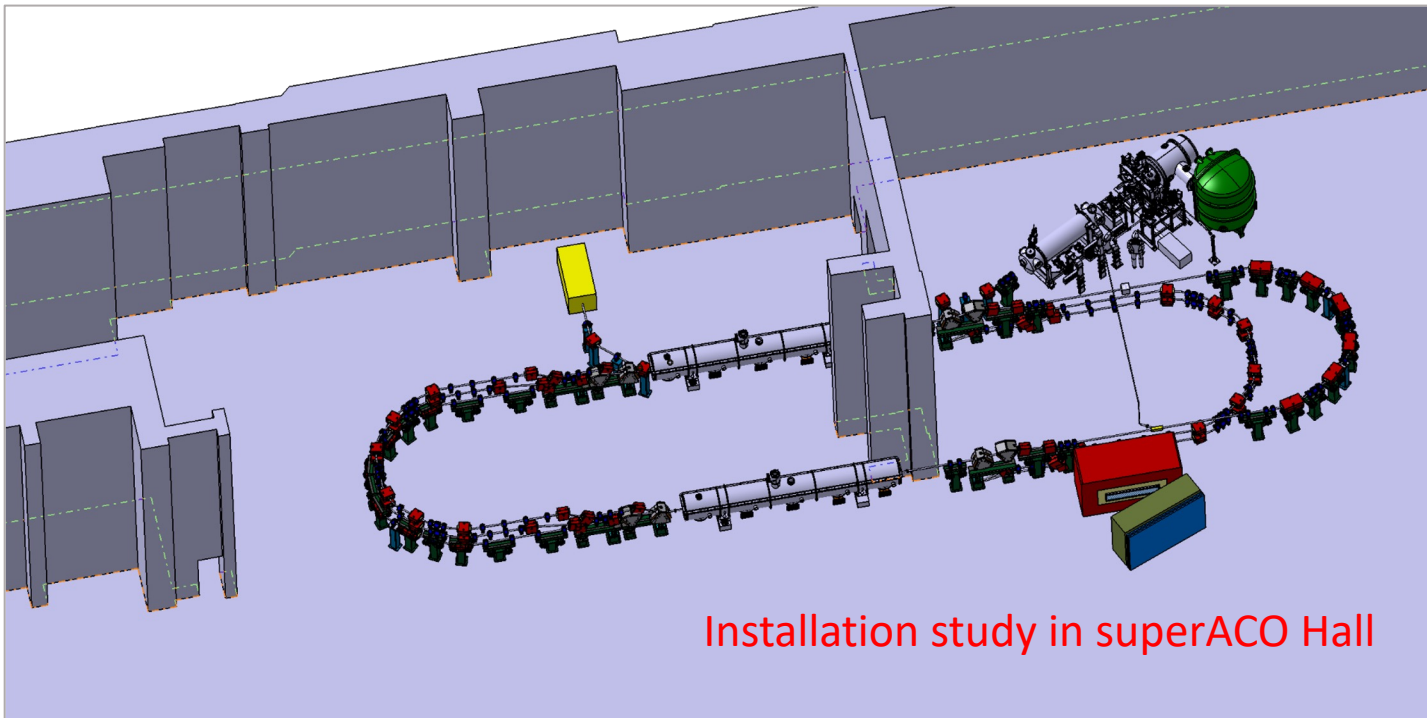
CDR in 2017 (*J.Phys.G* 45 (2018) 6, 065003 and arXiv:1705.08783)

current **Composition of PERLE Collaboration:**

IJCLab (host), AsTEC, BINP (on hold), CERN, Cockcroft, U Cornell, Grenoble, Jlab, U Liverpool, U Nablus, open to further partners

2. Technology (802 MHz, high  $Q_0$ , 20MV/m, ESS cryomodule, 4K..)

Synergy with FCC-ee: cavity development, racetrack as injector (Yannis)



Slide shown at Orsay – October 26, 2022



HV vessel tightness test 9/22



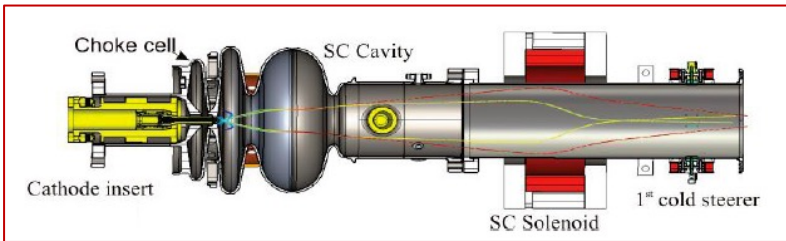
## 5.6 R&D objectives - Key technologies - ERL Roadmap Part B

### 5.6.2 SRF Technology and the 4.4 K Perspective

#### Near-Term 2 K Developments

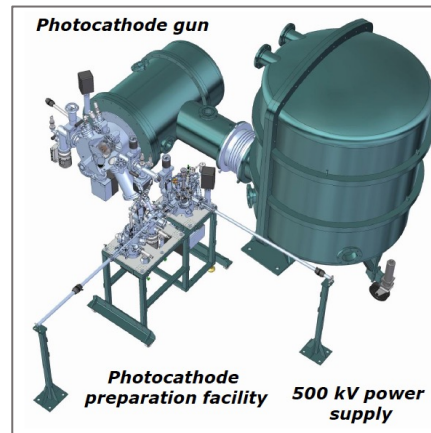
- Operation at 20 MV/m with  $Q_0 > 3 \cdot 10^{10}$
- Extraction of HOM power from Helium bath
- Damping of HOMs to prevent beam break up
- Reduction of RF power via Fast Reactive Tuners (FRT)
- 100mA sources (SRF and DC photocathode)

### 5.6.1 High-Current Electron Sources



SRF elliptical cavity gun at bERLinPro: new 100mA module

ALICE (20mA) PERLE:



**Roadmap integrates high current current source and 2K developments into the two facilities (part C):**

bERLinPRO: 1.3 GHz, 100mA, 1-pass & PERLE: 802 MHz, 20mA, 3 passes

Slide shown to LDG last year. Roadmap Panel arXiv:[2201.07895](https://arxiv.org/abs/2201.07895)

### Towards 4.4 K

A significant part of the power consumption of ERLs is related to the dynamic cavity load in CW operation, which can be estimated by

$$P = \frac{V_{\text{acc}}^2}{(R/Q) \cdot Q_0} \cdot N_{\text{cav}} \cdot \eta_T \quad (5.1)$$

where  $V_{\text{acc}}$  is the acceleration of a cavity,  $R/Q$  the shunt impedance,  $Q_0$  the cavity quality factor,  $N_{\text{cav}}$  the number of cavities and  $\eta_T$  the heat transfer, i.e. combined technical and Carnot, efficiency, which is proportional to the ratio of the cryo temperature,  $T$ , and its difference to room temperature,  $300 \text{ K} - T$ .

**Boost cryogenic efficiency and chill cavities with cryocoolers, no IHe**

- Nb<sub>3</sub>SN coating via vapour infusion, sputtering or ALD
- Evaluation of other superconductors as NbN, NbTiN, V3S
- Cavity tuners to avoid detachment of coating

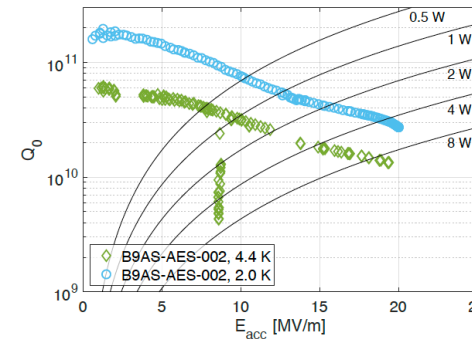


Fig. 13: Performance of 650 MHz single cell cavity B9AS-AES-002. The multipacting at 9 MV/m was processed during the test.

arXiv:2008.00599

In parallel:  
nitrogen  
diffusion  
and doping  
to reach  $10^{11}$

**Roadmap: long term cavity R&D towards 4.4K: SRF Panel  
ERL: full module in beam test (2030?) PERLE or bERLinPRO**





End of 15 years of HERA and H1 operation, June 2007, the last 9 o'clock meeting

**Thank you to all smaller or bigger groups that I had the privilege to work in, much more learning than teaching**

Apologies to the many great colleagues I have not mentioned: Johannes Bluemlein, Dima Ozerov, Volker Korbel ... and Sebastien Bousson



# Thank you to the family



A lady in the right age (Herwig S)



Ich bin überzeugt, daß es  
mit zum Erdenleben gehört,  
daß jeder in dem gekränkt werde,  
was ihm das Empfindlichste,  
das Unleidlichste ist:  
Wie er da herauskommt,  
ist das Wesentliche.

*Rabel Varnhagen*

1771-1833 (Berlin)

Cited in  
**Unter den Linden**  
By **Christa Wolf**  
1929-2011  
with Guenter Grass :



I am convinced that it's a normal part of life that everyone is sometimes upset about the things about which they care most. What's important is how they get over it. (TG-2)

## Tomorrow Never Knows

Bruce Springsteen

...

Well he who waits for the day's riches  
Will be lost  
In the whispering tide

Where the river flows  
Tomorrow never knows

**Best of personal and professional luck to everyone  
and a merry Christmas, Happy Holidays 2022**

**Thank you!**