50 let DESY HAMBURG

(ve fyzice elementárních částic)

Jan Hladký

FZÚ AV ČR, v. v. i.

Praha

Seminář v DESY (duben 2009)

The decade of 1969 - 1979:
How quarks and gluons became a reality

Paul Söding

formerly

DESY
and Humboldt University zu Berlin

Prof P. Soeding – člen dir. - pro vědu (1996-2002), první ředitel DESY II -Zeuthen

How we were incredibly stupid 40 years ago

Paul Söding

formerly

DESY
and Humboldt University zu Berlin

FYZIKA vysokých energií 60. let

QED – testy:

CEA, DESY, Novosibirsk, Orsay

Silné interakce:

SU(3) - Gell-Mann, Ne‘eman

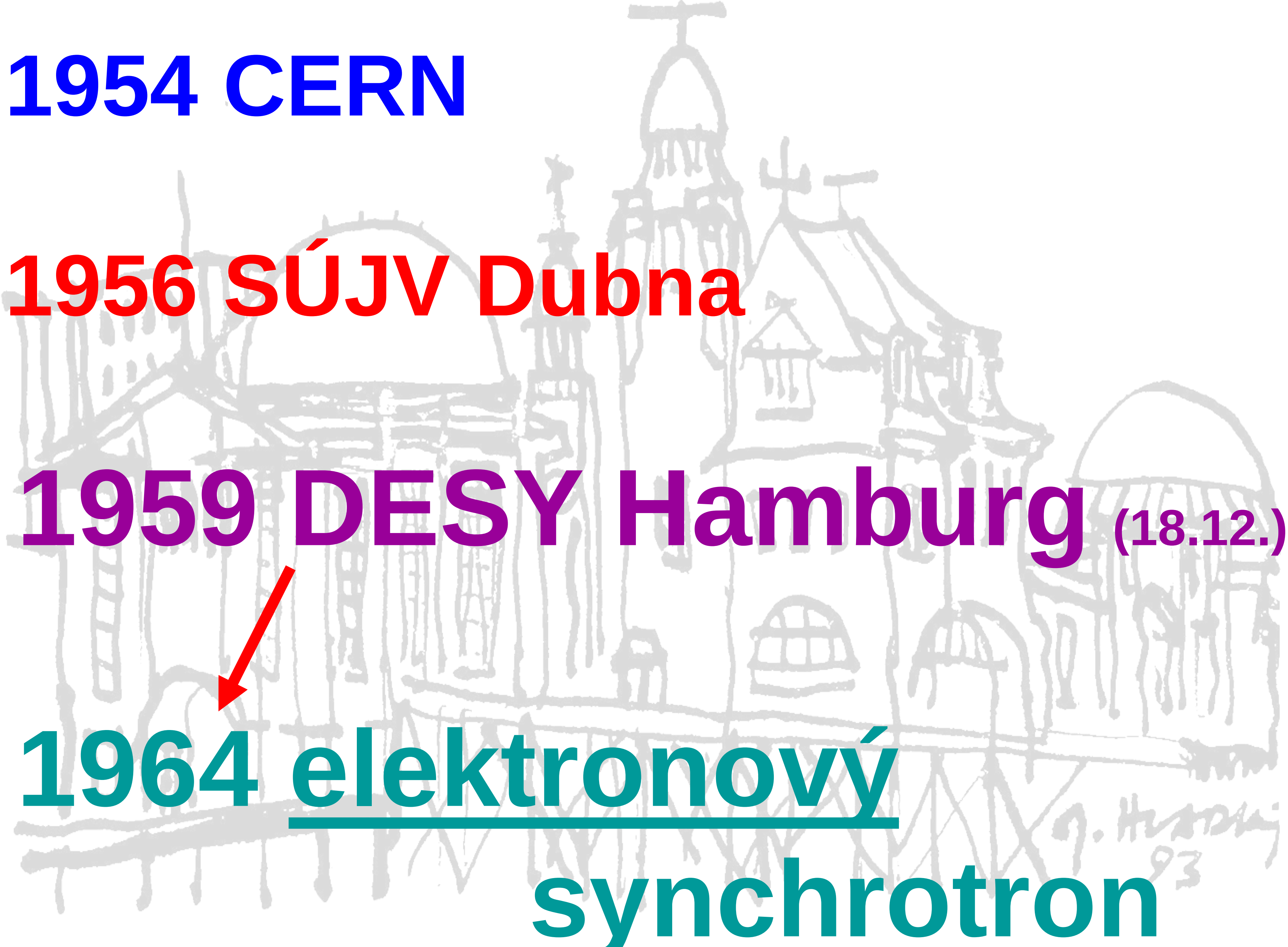
Quark model – Gell-Mann,Zweig

Vektorové mezony – VDM model

Slabé interakce:

Fermi model,

V – A model - Feynman Gell - Mann



1954 CERN

1956 SÚJV Dubna

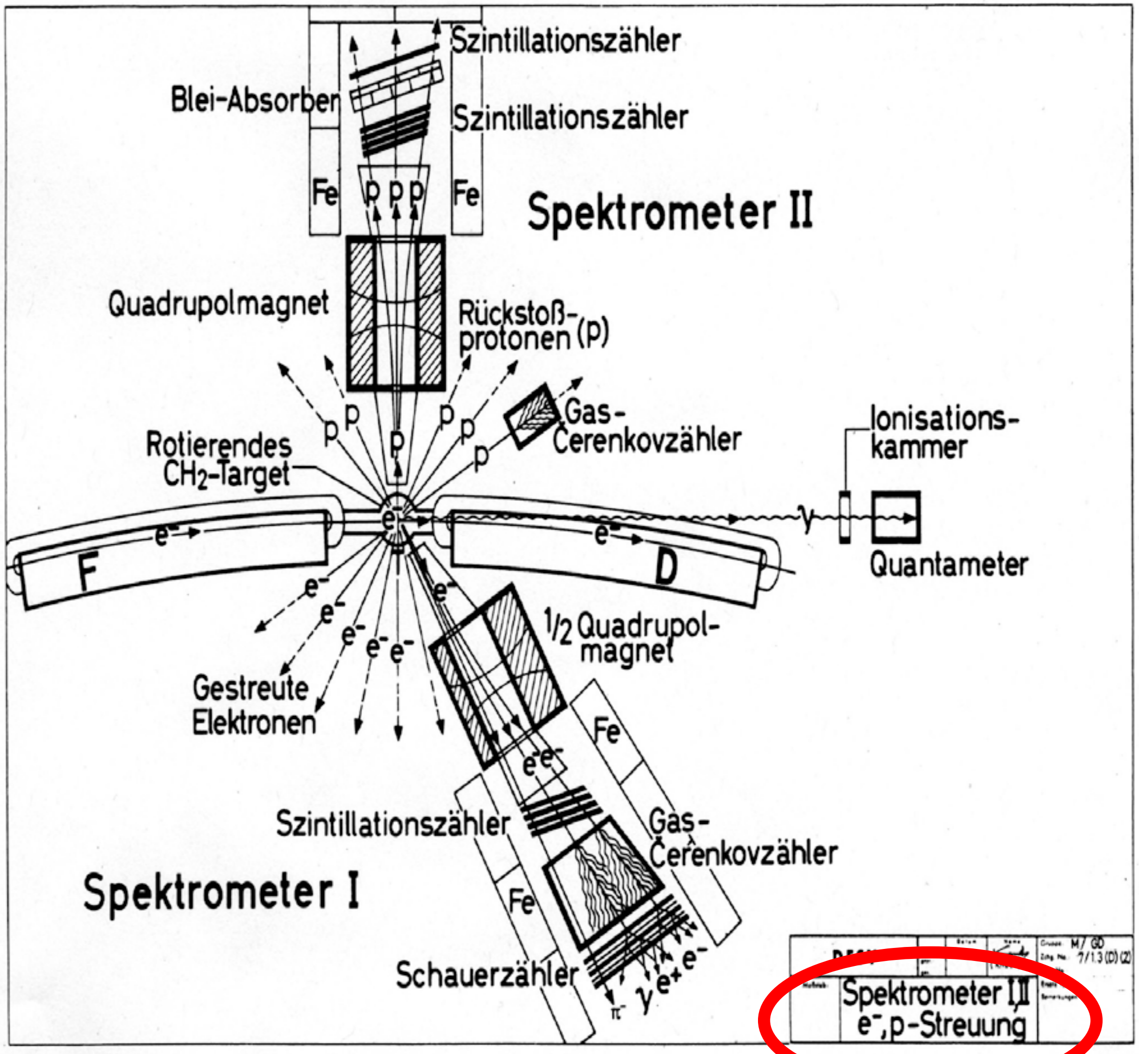
1959 DESY Hamburg (18.12.)

1964 <u>elektronový synchrotron</u>

První (1959 – 1970) a třetí (1974 – 1980) ředitelé DESY

Wilibald Jentschke ***Herwig Schopper***

(později generální ředitelé CERN)



Elektronový synchrotron:

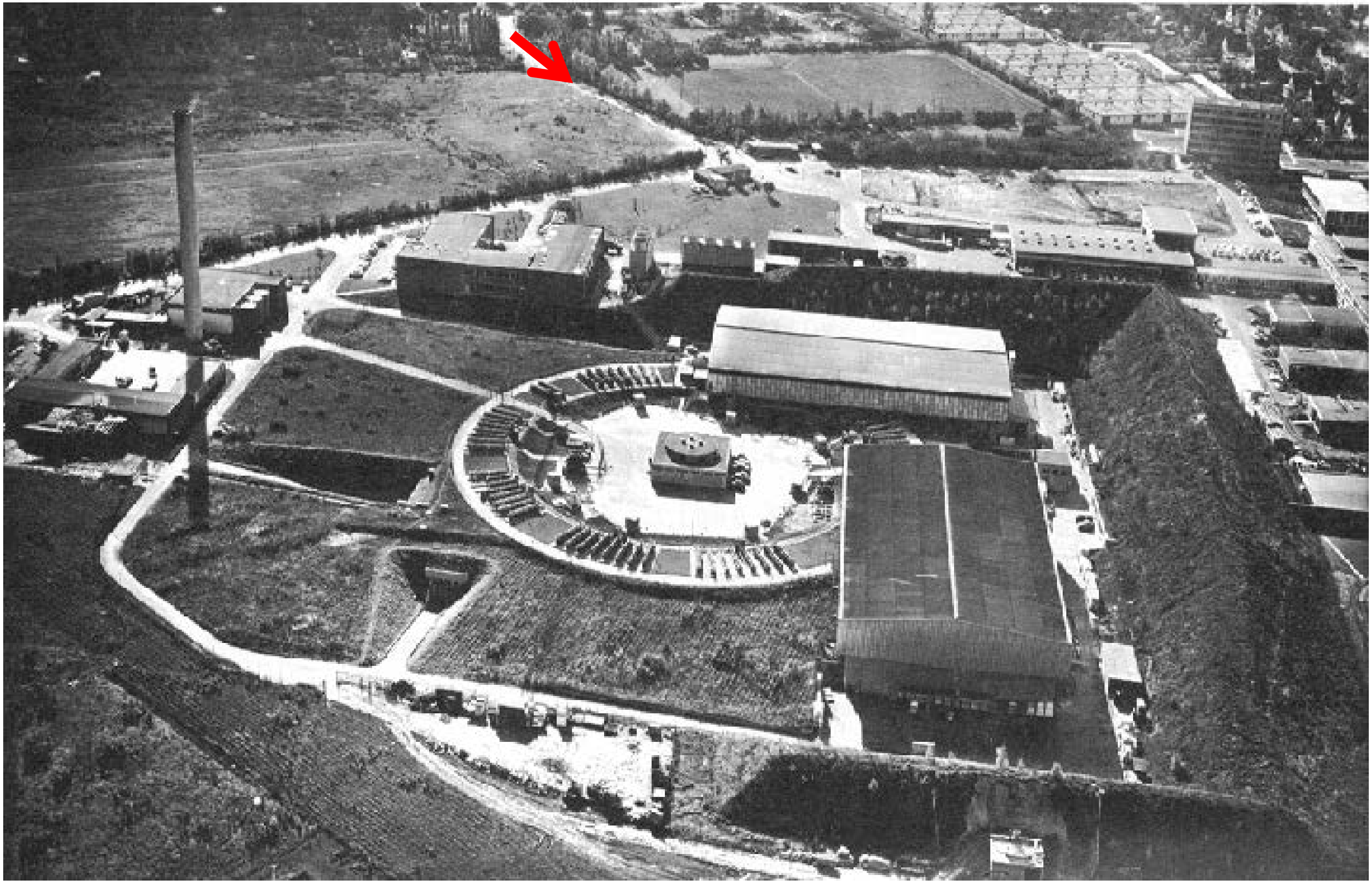
6 GeV brzdné záření,

pevné terče

Dvouramenný magnetický spektrometr

30. 8. 08. J. Hladký

DESY in 1965: 6 GeV electrons



Fyzika:

Testy platnosti QED

na př.

-produkce vektorových mezonů

-jejich leptonové rozpady

-protonové formfaktory

konkurence CEA 6 GeV (Harvard)

Experimenty:

elastický a neelastický rozptyl e^- a γ na protonu

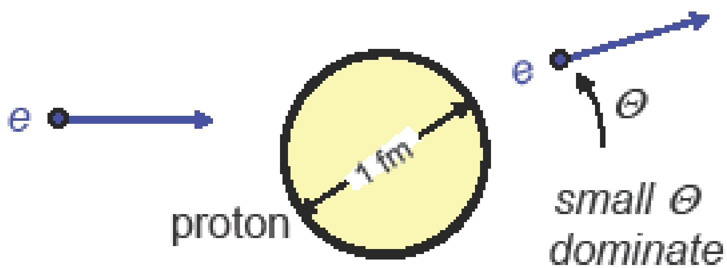
na příklad:

- -nepružný rozptyl → nové rezonance?
- -rozptyl e^- na malé úhly
- -produkce mezonu ρ polarizov. γ
- -fotoprodukce π mezonů
- -fotoprodukce neutrálních mezonů
- -experimenty s polariz. terčem

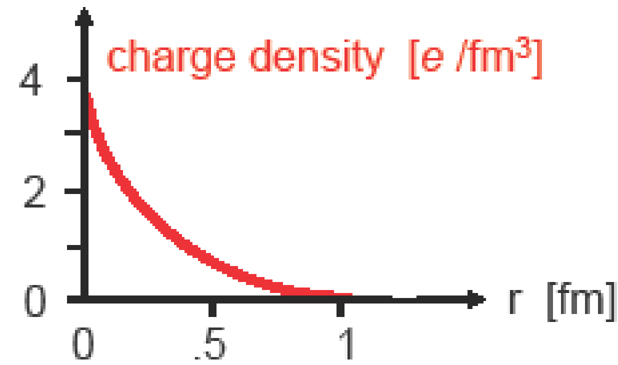
Electron scattering experiments:

DESY - 6 GeV
CEA (Cambridge Electron Accelerator) 6 GeV
SLAC (Stanford Linear Accelerator Center) - 20 GeV

Elastic scattering

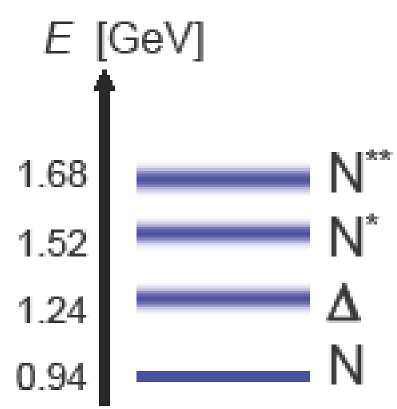


E_S = 4 ... 6 GeV
$\lambda\!\!\!^{-}$ = 0.05 fm

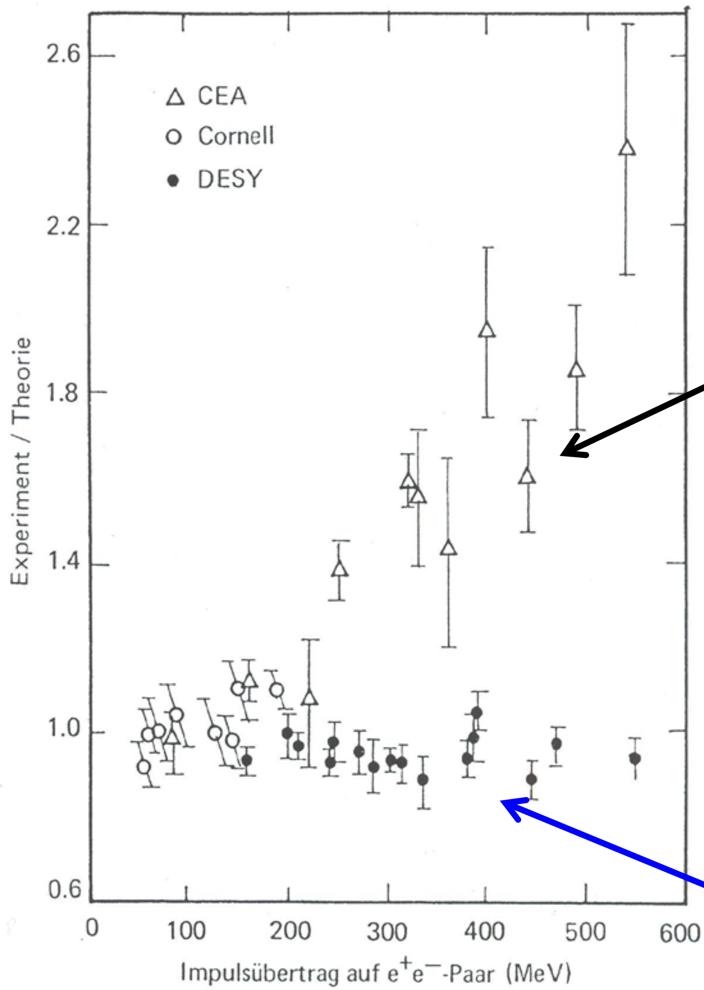


Inelastic scattering

excited states
of the nucleon



Platnost QED pro e+e⁻ produkci s velkými Q^2?



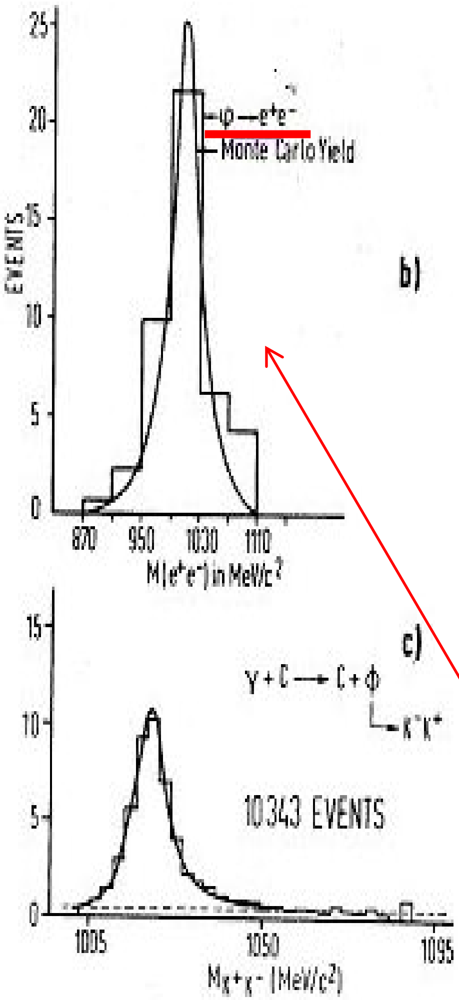
CEA: <u>neplatí !!!</u>

➡ **problém s univerzalitou**

e ⟷ μ

DESY-Columbia (Ting): <u>platí !!! (1966)</u>

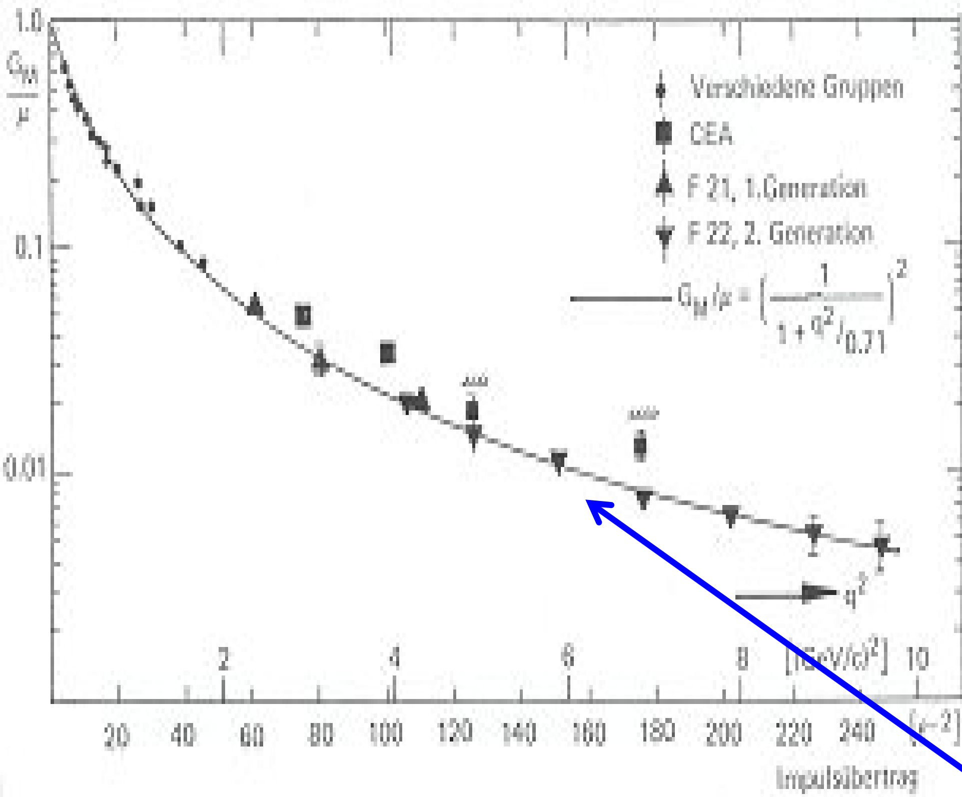
S.C.C. Ting *W. Sheel, prezident BRD*



S.C.C. Ting DESY-Columbia

Leptonové rozpady vektorových mezonů

$\varphi \longrightarrow e^{+} e^{-}$, BR≈$10^{-4}$

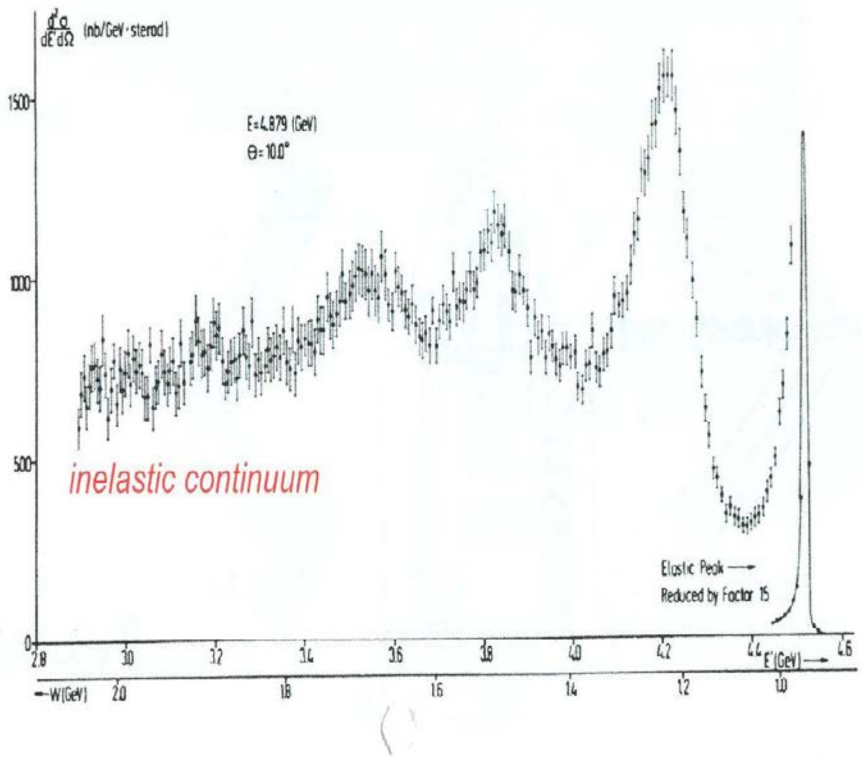


Magnetický formfaktor protonu

DESY opravuje

měření z CEA

Symetrie nábojů a proudů
<u>není</u> narušena!



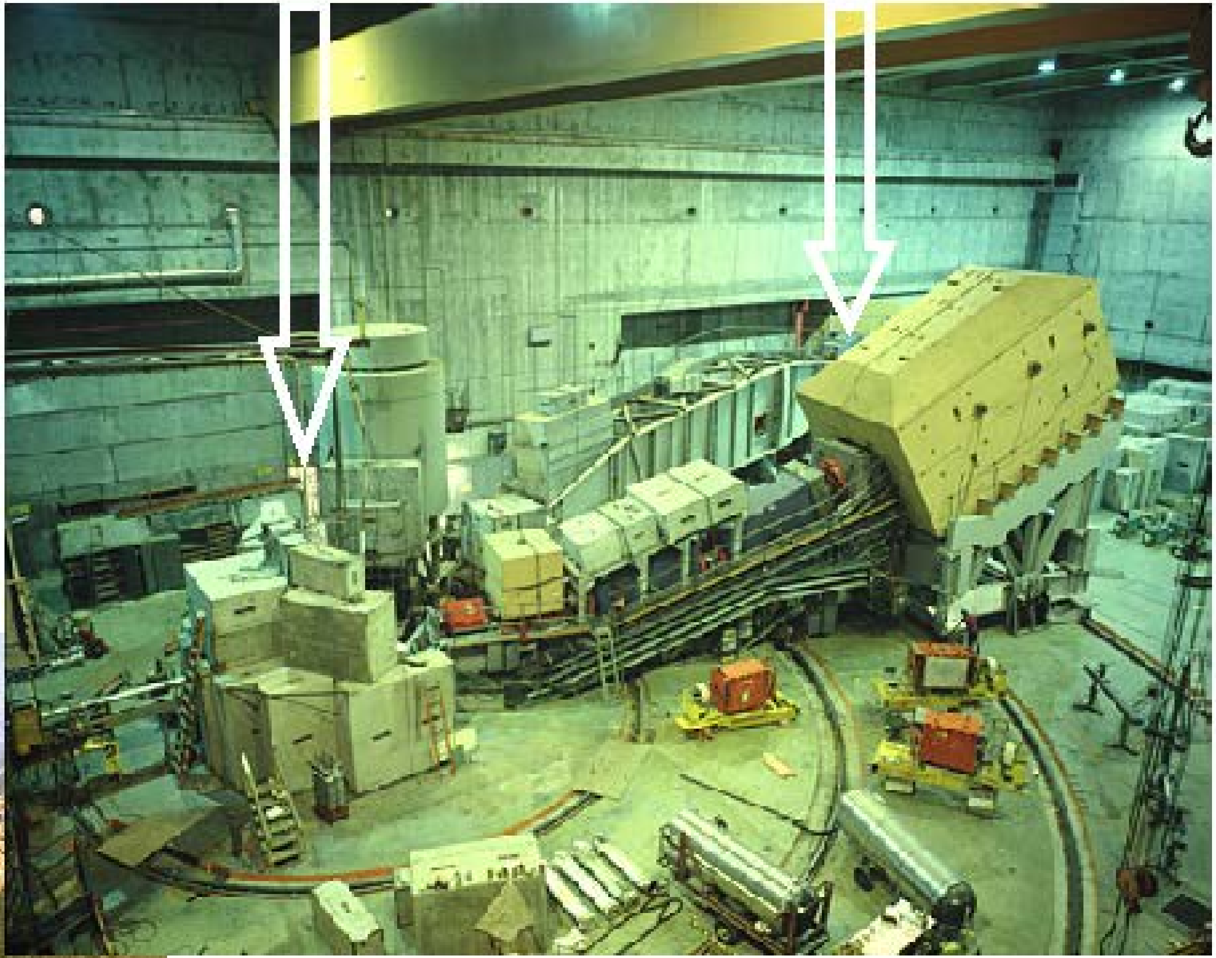
Studium nukleonových rezonancí velkých hmotností

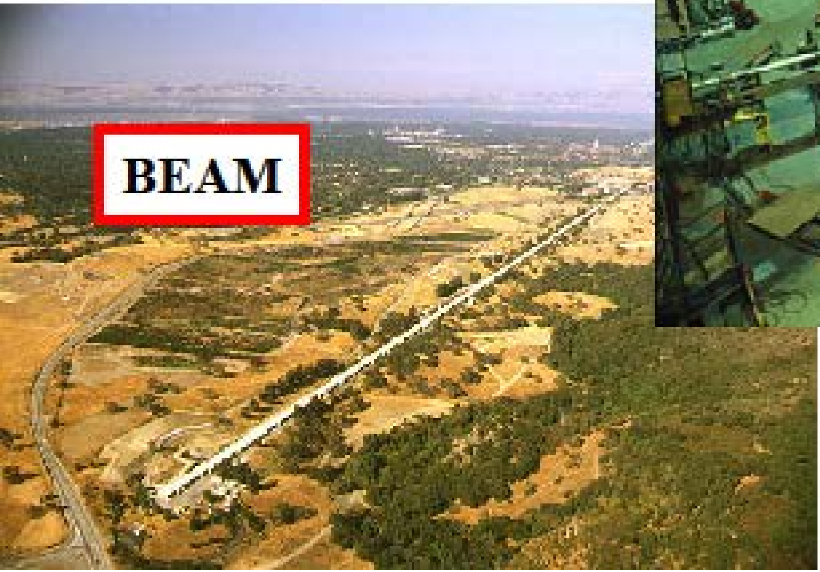
Přesné měření probíhalo

mimo oblast J/ψ!

SLAC

(Stanford Linear Accelerator Center)



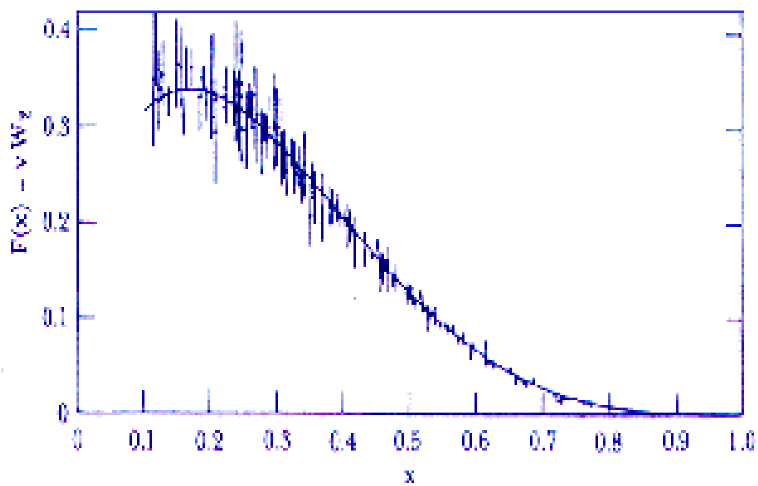


W.K.H. Panowsky	***H. Schopper***	***S.C.C. Ting***
ředitel SLAC	***ředitel DESY***	***DESY - MIT***

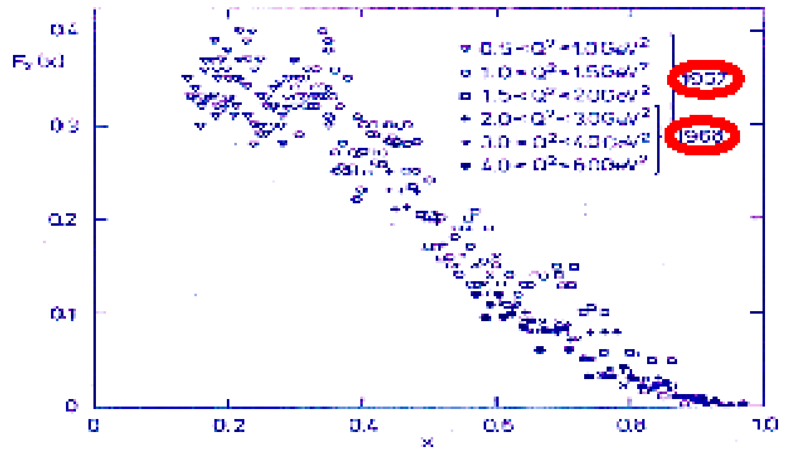
Could / should DESY have done it ?

The electron energy was much lower, but . . .

SLAC



DESY (reanalysis)



1969 SLAC - DIS

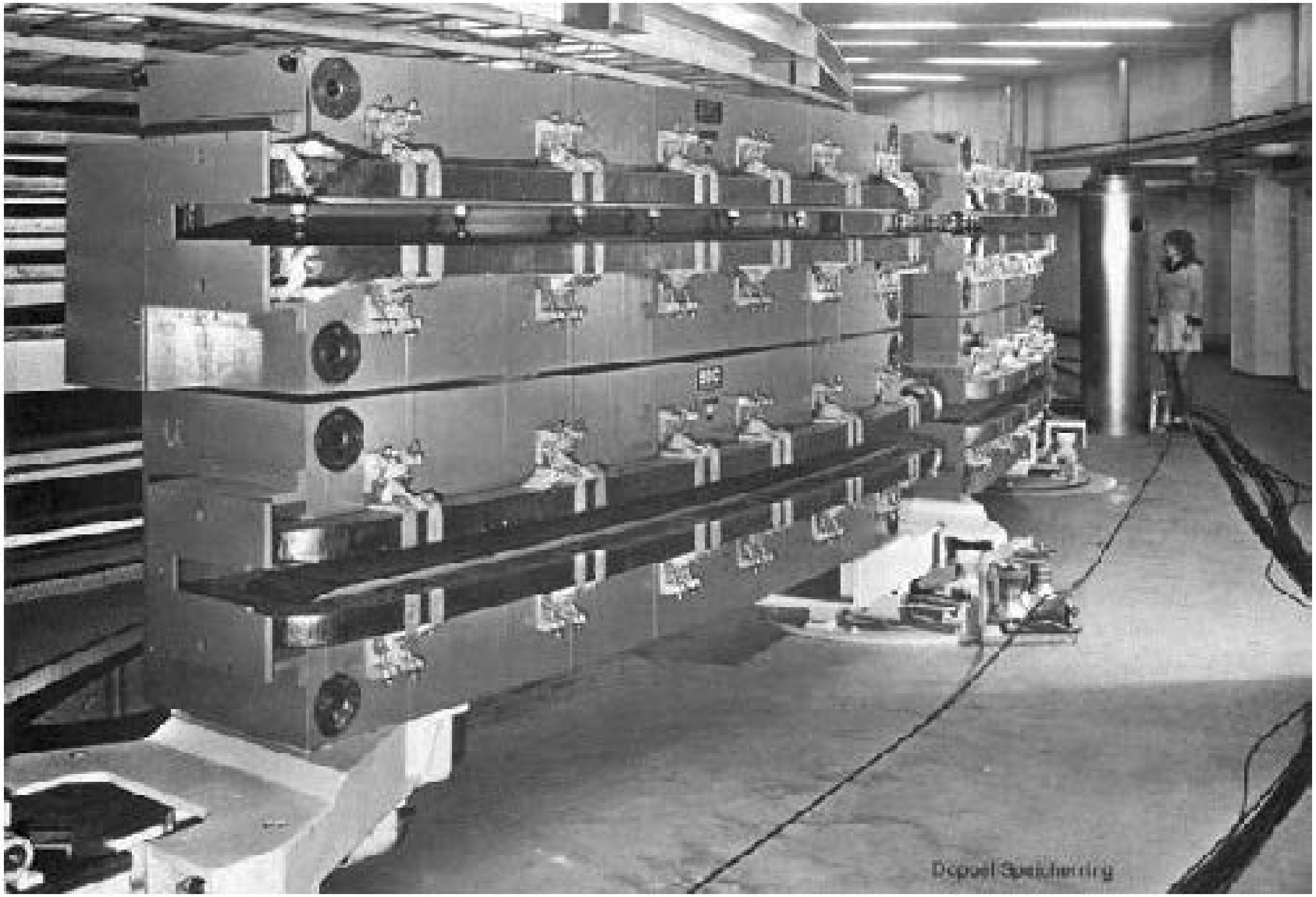
You may well call it stupidity . . .

R. Taylor - (Nobelovy cena)   G.- A. Voss

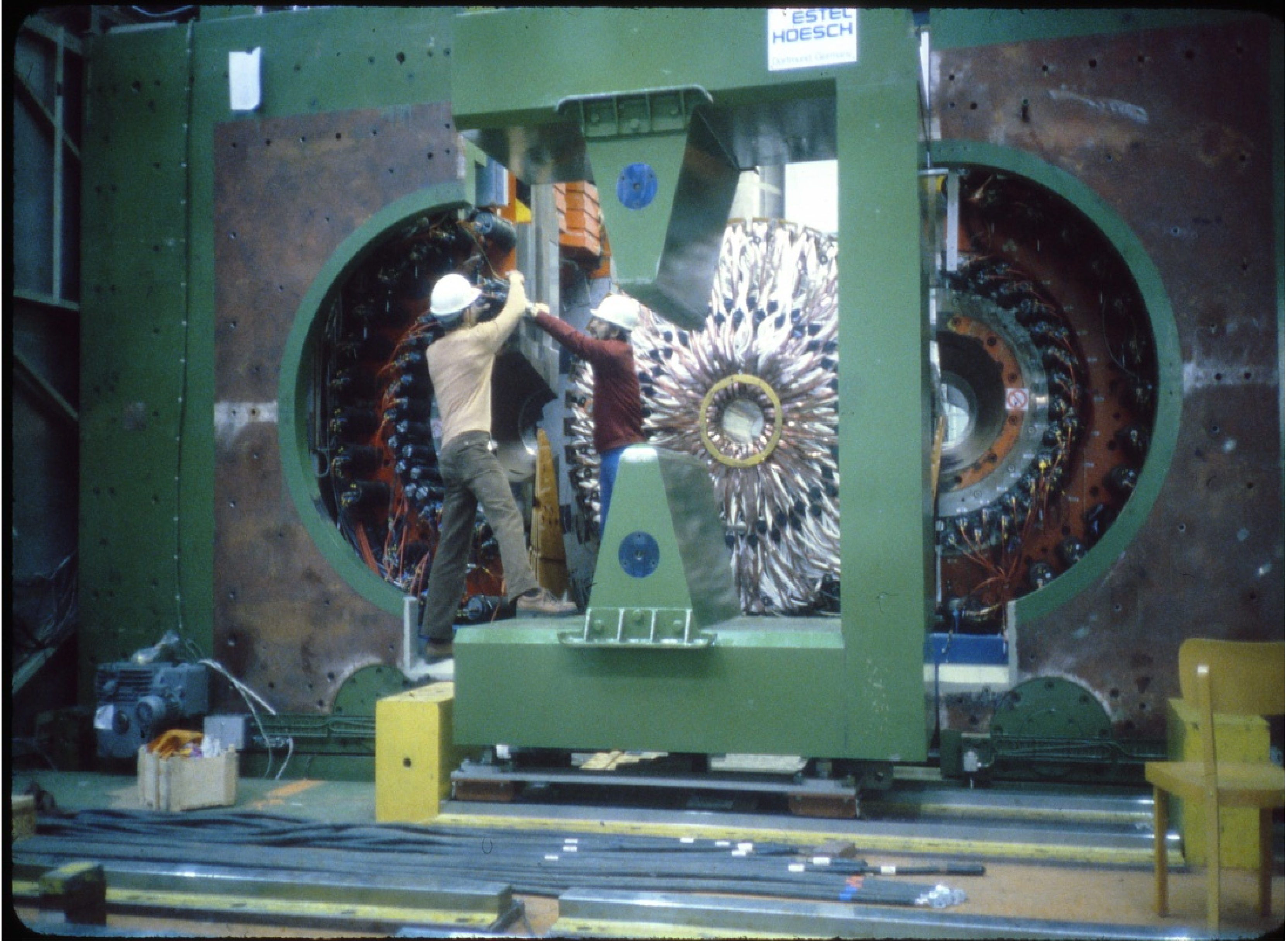
DESY Hamburg:
Doppelring "DORIS" 2 x 3 GeV


Willibald Jentschke

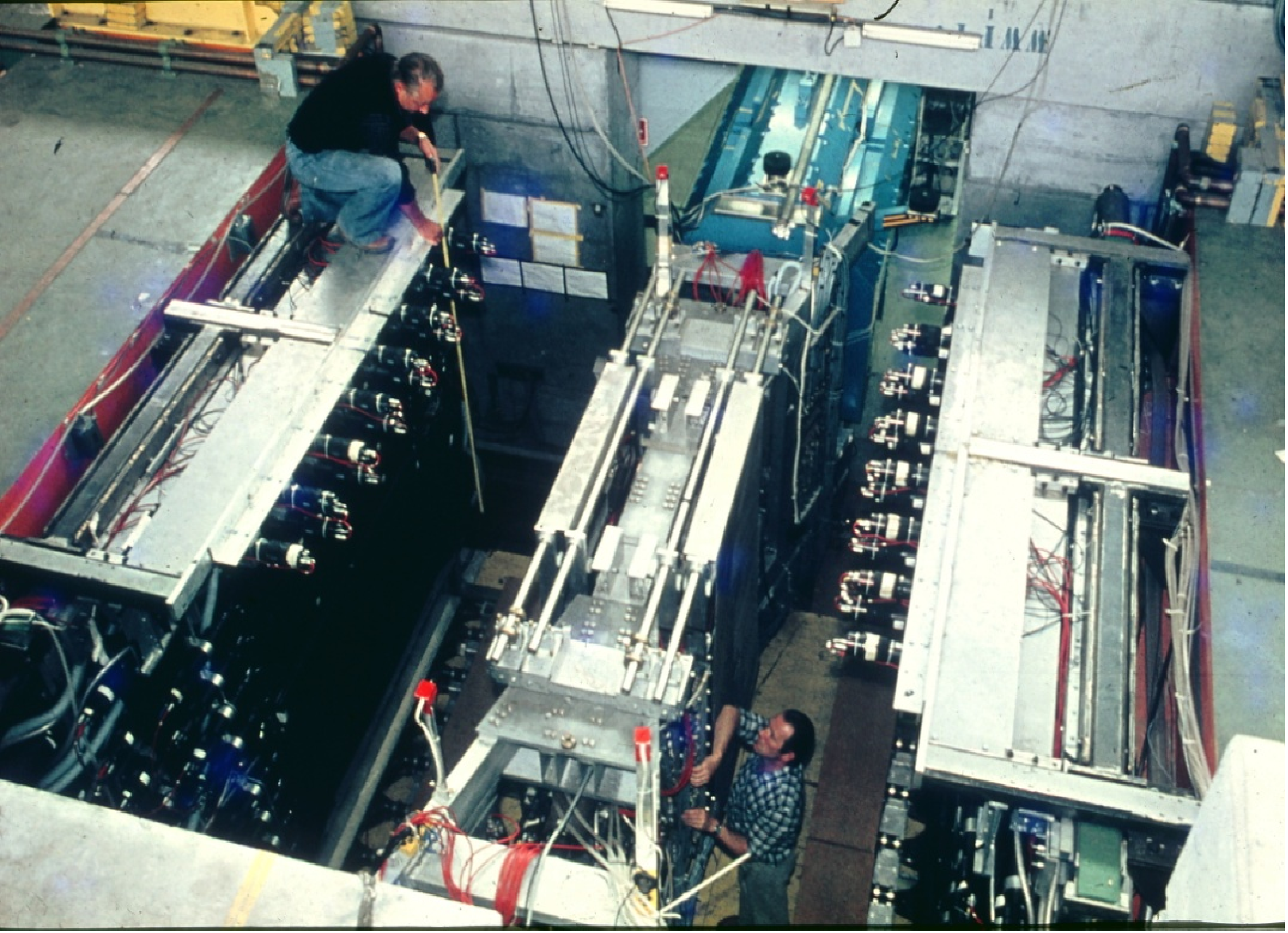

Erich Lohrmann



under construction 1969 - 1974



PLUTO na **DORIS** *(supravodivá cívka)*

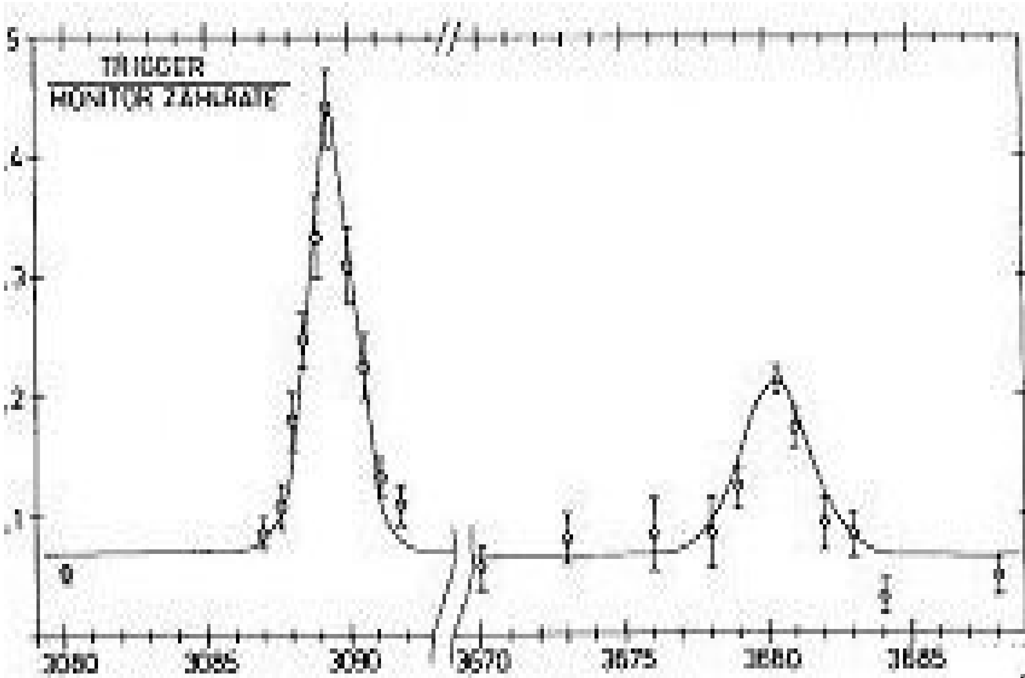


DASP na DORIS

J/ψ

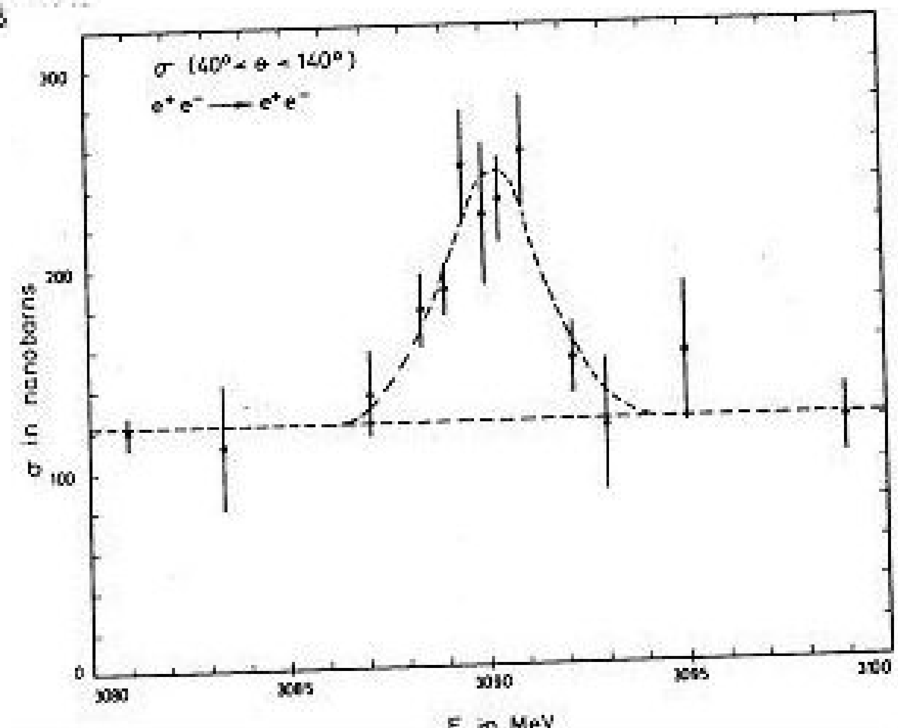
na experimentech **DESY**

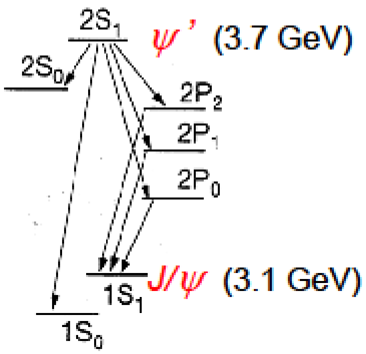
(1974) na DORIS



PLUTO

DASP

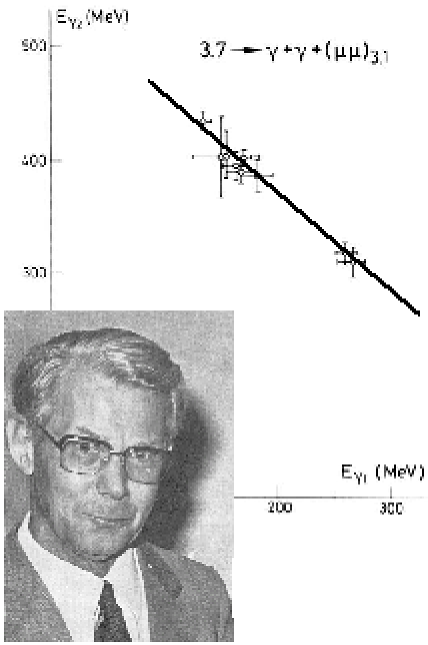




"Charmonium" = bound $c\bar{c}$ system

$$V(r) = -\frac{4}{3}\frac{\alpha_S}{r} + k\,r, \quad k \approx 1\,\mathrm{GeV/fm}$$

DESY in June 1975:
The DASP experiment at DORIS sets the final keystone:
Observing the photon transitions
$\Rightarrow$ $\boxed{\text{Discovery of the } P \text{ wave states of charmonium}}$



"From now on it is impossible not to believe in the quarks!"

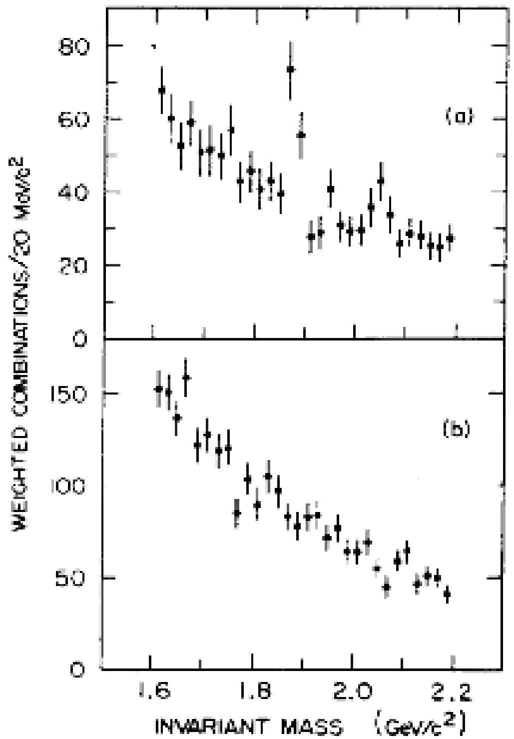
Gross, Wilczek, Politzer 1973
t'Hooft, Symanzik 1972

F mezon

Charmed particles (D mesons)

discovered 1976 by the SLAC-LBL collaboration @ SPEAR

$$D^+ \to K^- \pi^+ \pi^+$$

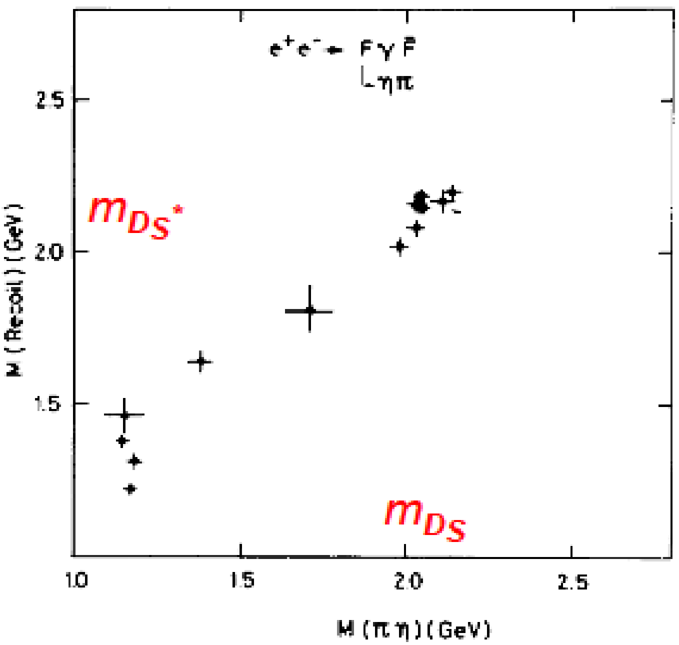


Charmed-strange (D_S) mesons

1977 first evidence by DASP @ DORIS

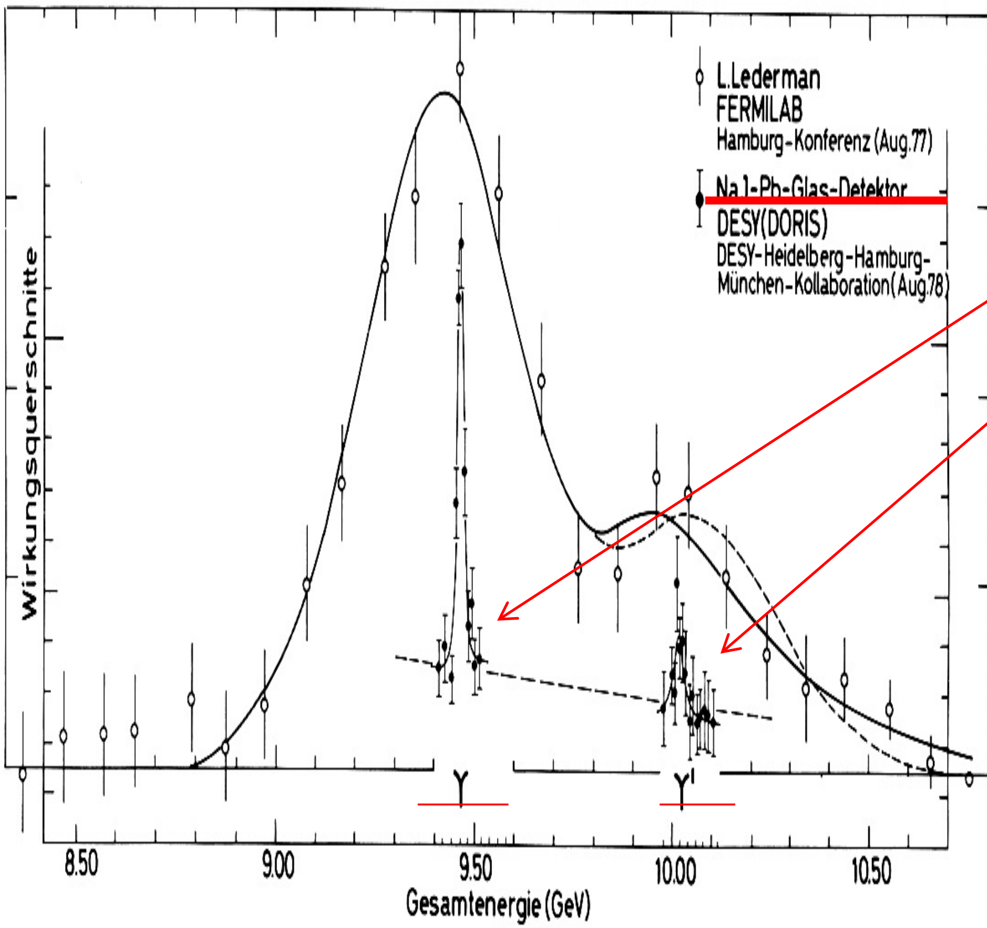
$$e^+e^- \to D_s \, \overline{D_s}^{*}$$

$D_s \to \eta\pi$, $\overline{D_s}^{*} \to \gamma \overline{D_s}$



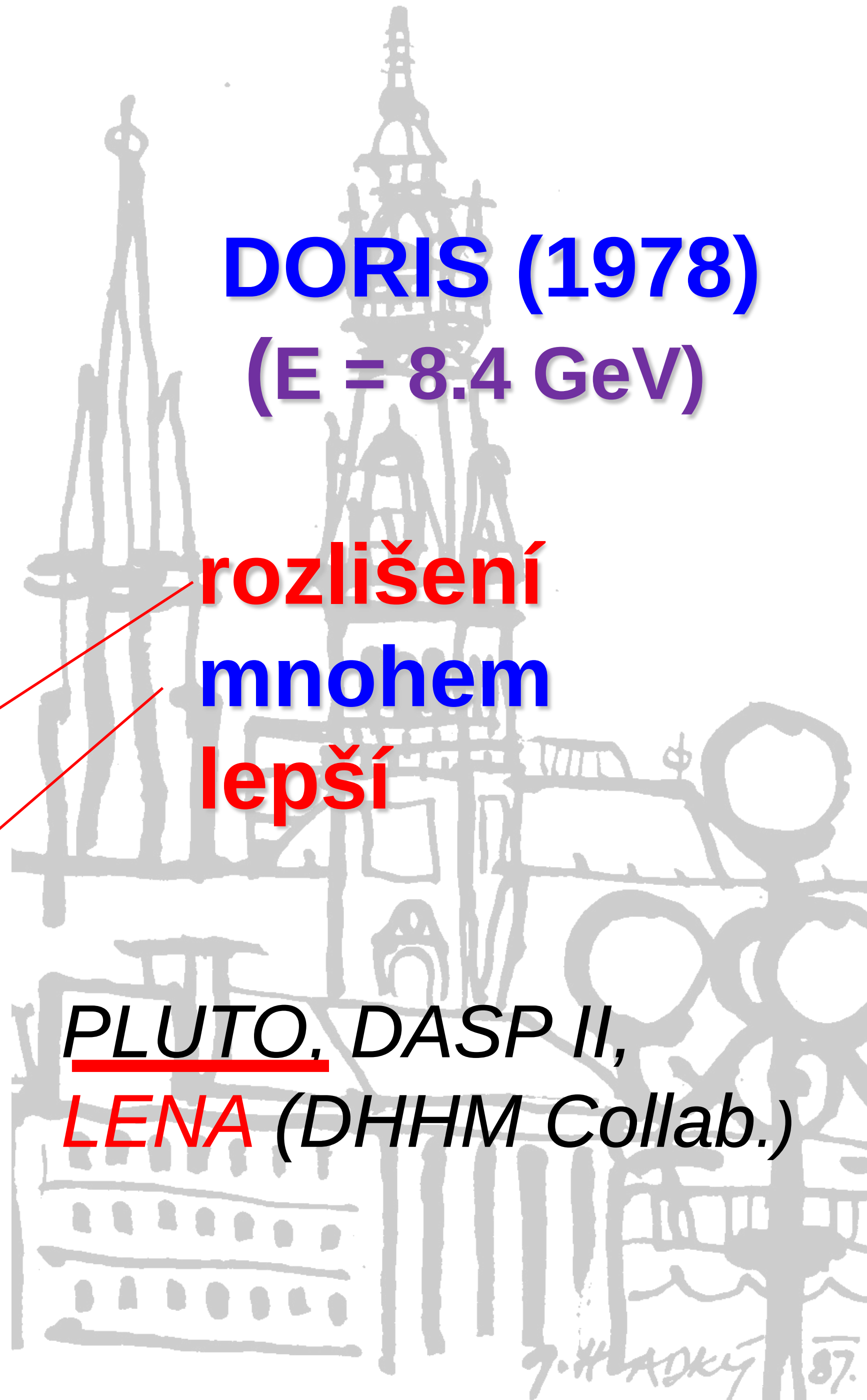
Υ - rezonance

Fermilab (1977)

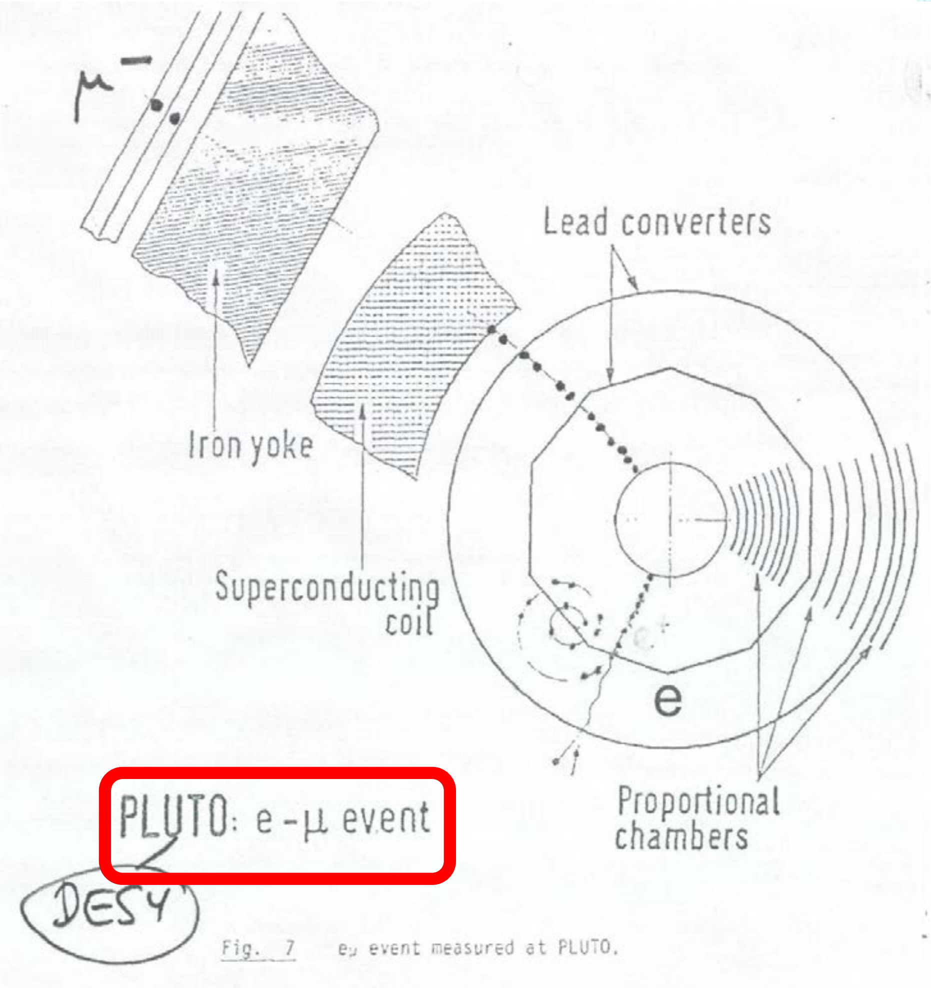


DORIS (1978)
(E = 8.4 GeV)

rozlišení mnohem lepší



PLUTO, DASP II,
LENA (DHHM Collab.)



PLUTO 1977

DORIS

τ – lepton

reakce:

$e^+e^- \rightarrow \tau^+\tau^-$

Narušeny zákony zachování:

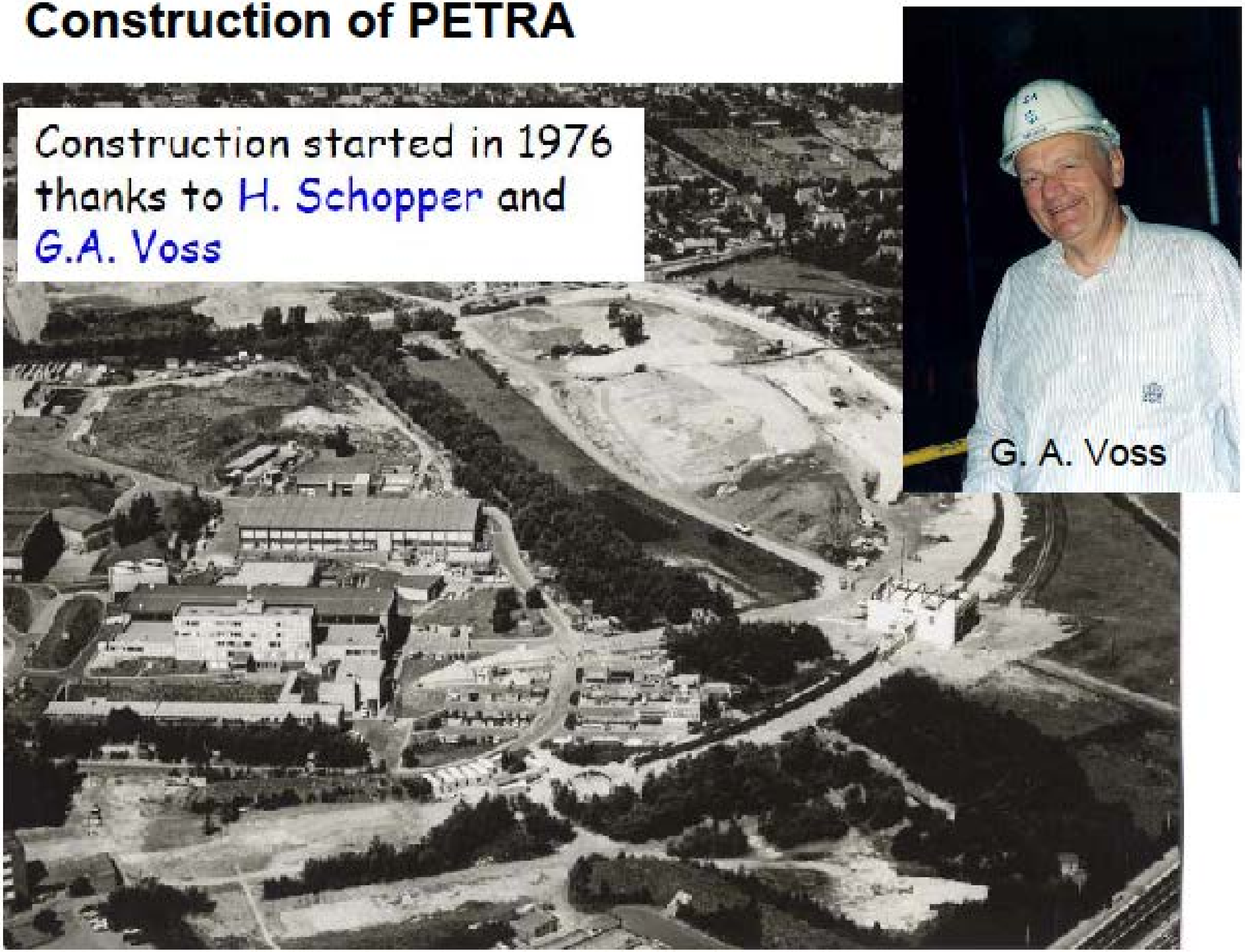
--energie,

--hybnosti,

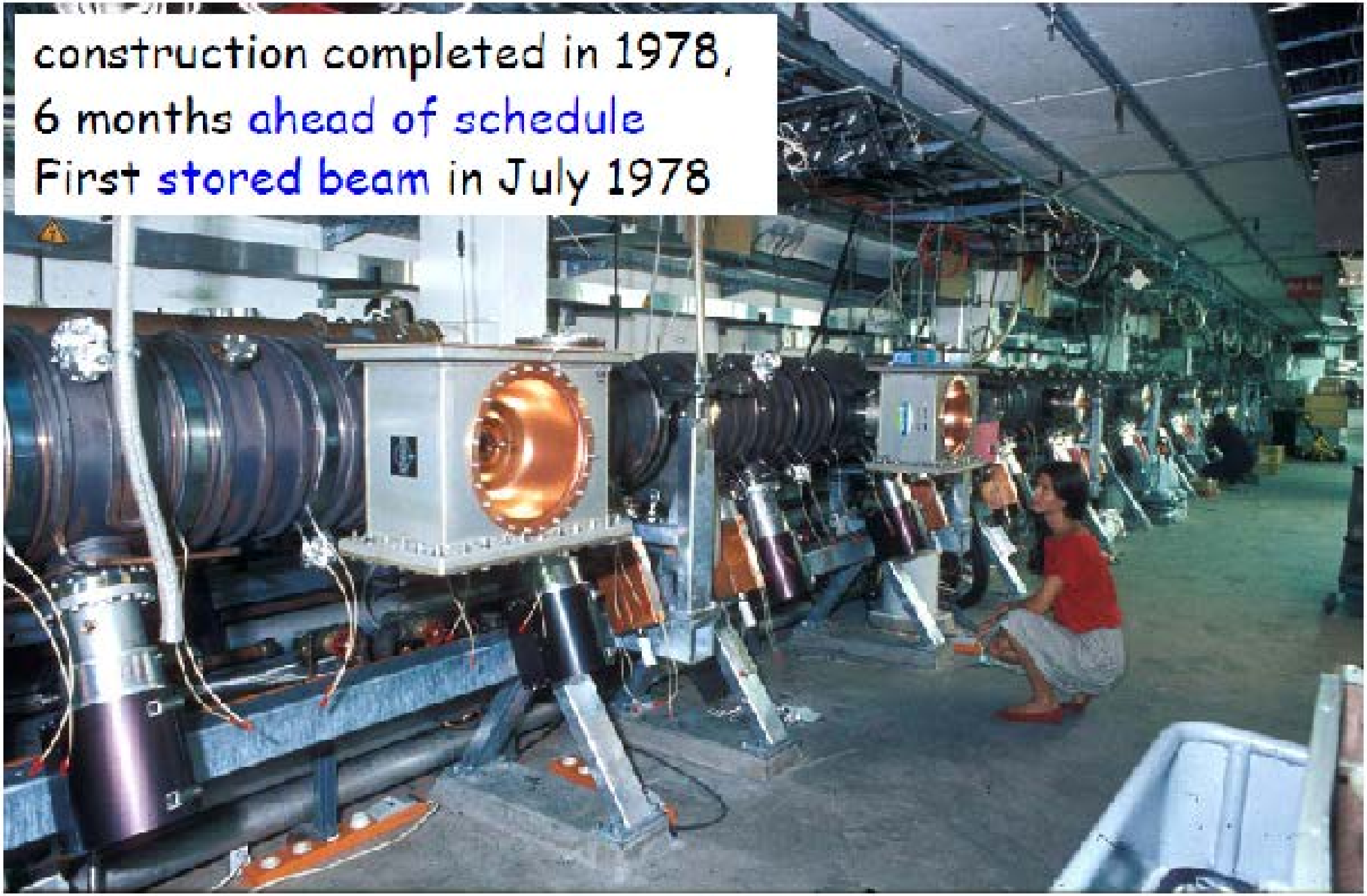
--leptonového čísla

Construction of PETRA

Construction started in 1976 thanks to H. Schopper and G.A. Voss

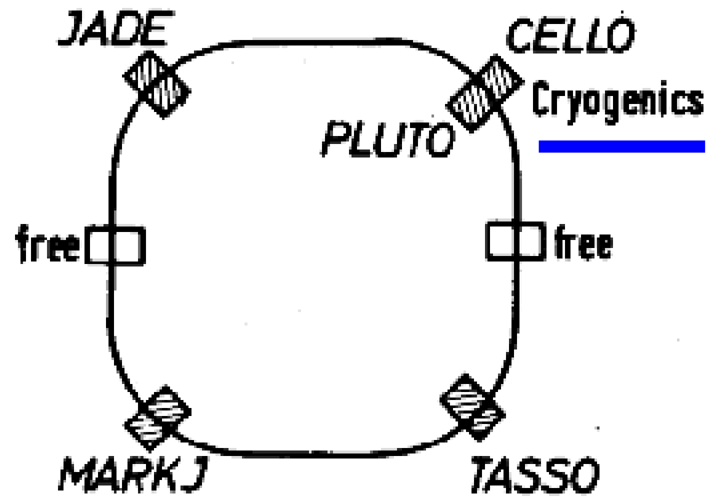


PETRA – e^+e^- 30 GeV

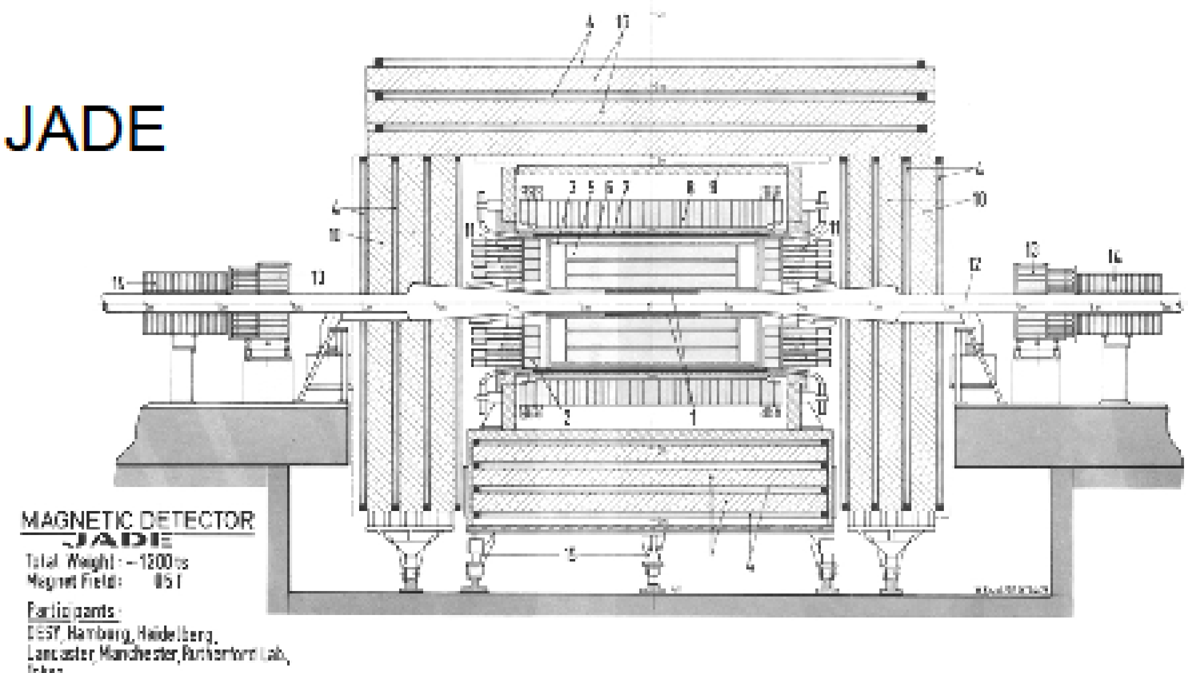


First collisions seen in November 1978

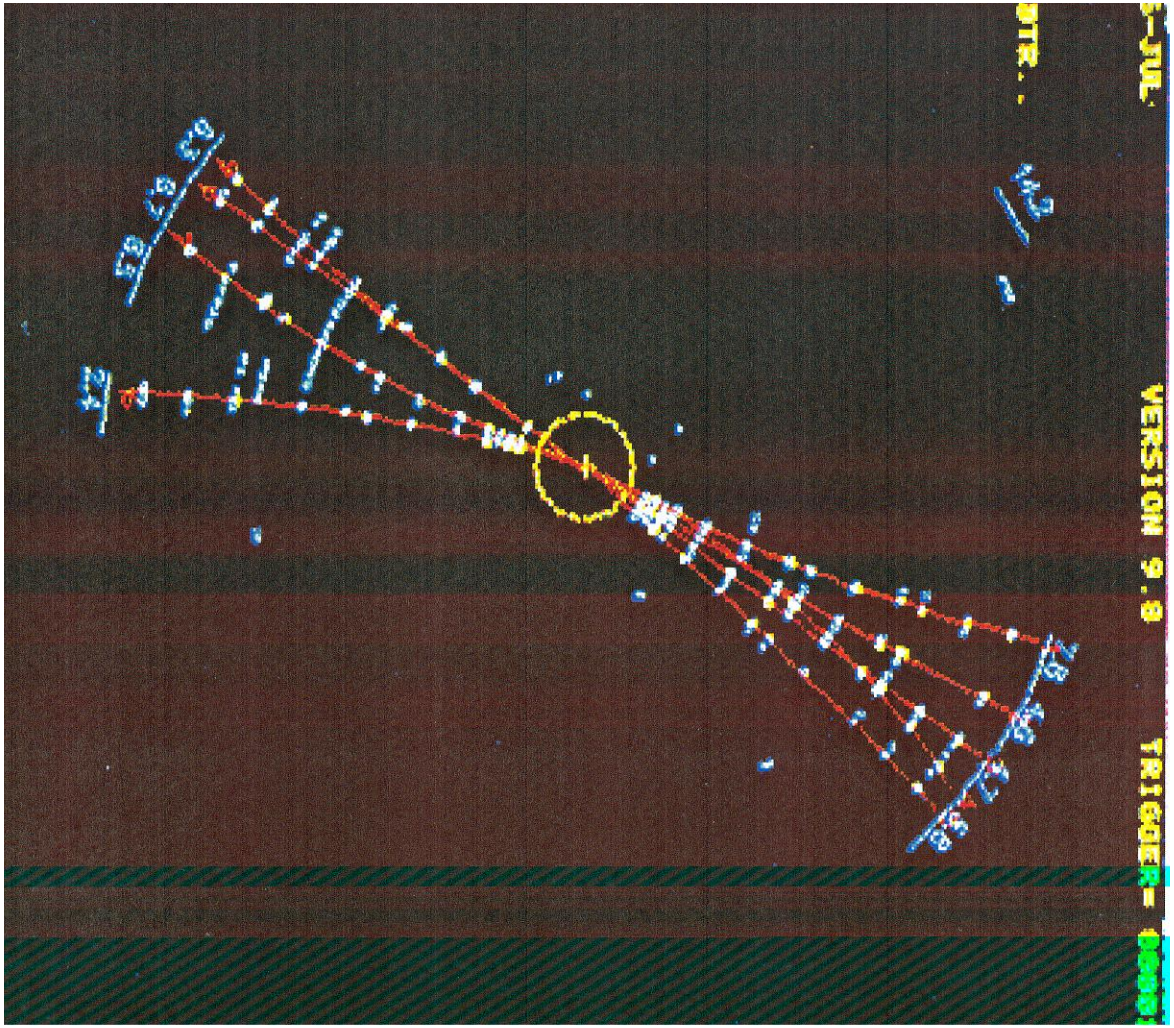
The detectors
at the PETRA e^+e^- ring



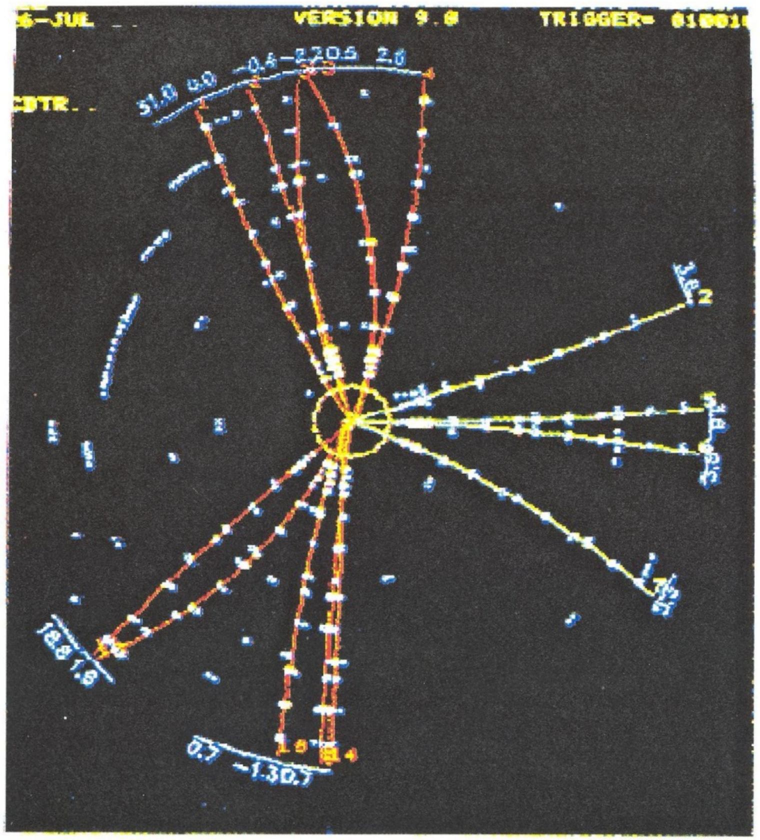
JADE



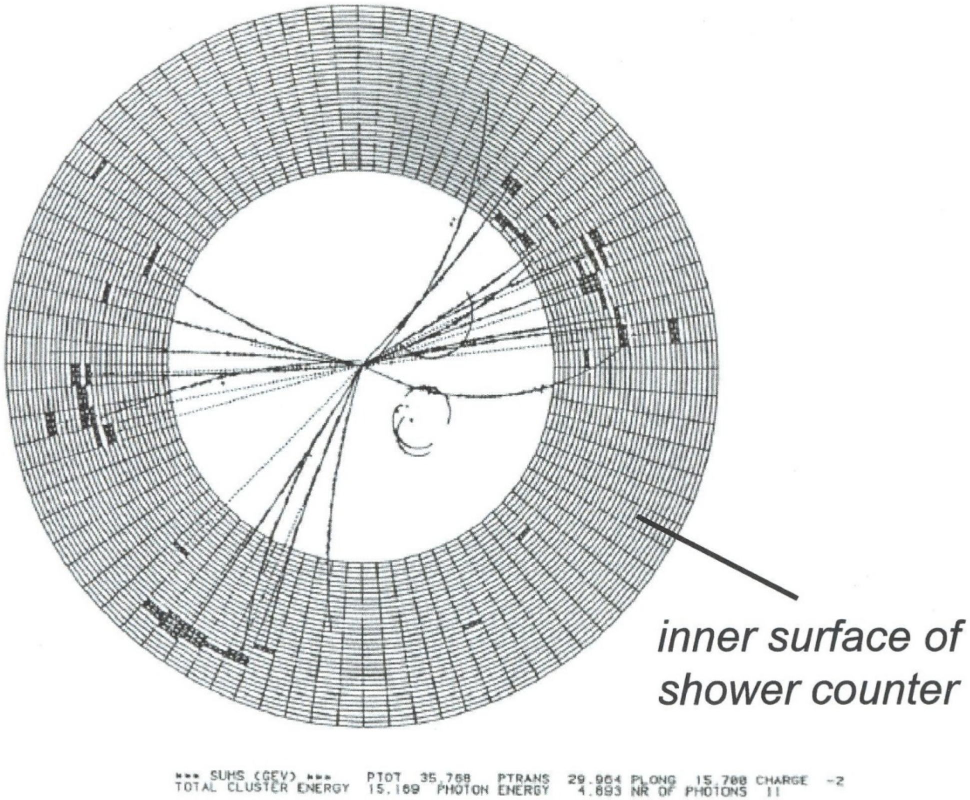
Jety (1975 SLAC-Berkeley)



Objev gluonu v DESY (1979)



TASSO

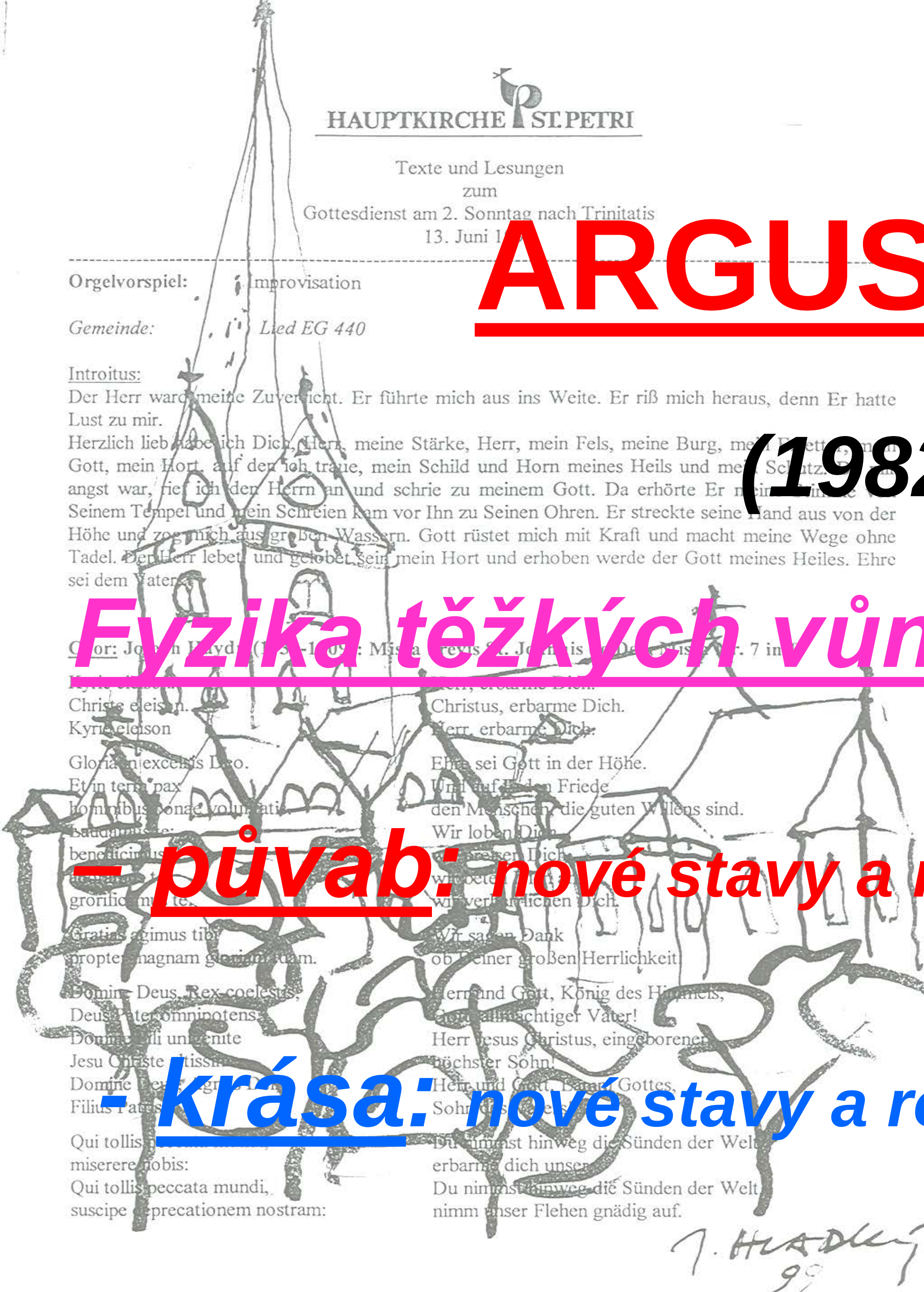


JADE

PETRA

Bjoern Wiik   *Paul Soeding*

Gustav Wolf   *Sau Lan WU*



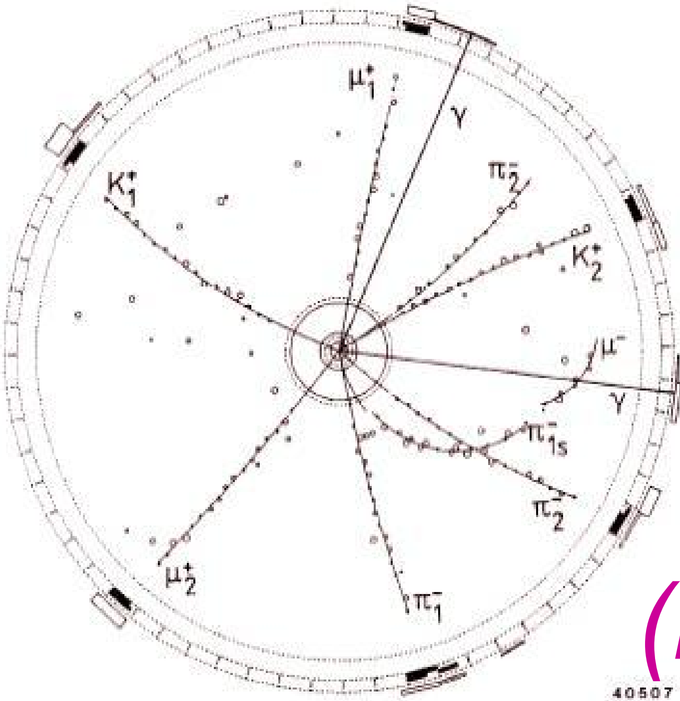
<u>ARGUS</u> na DORIS

(1982 – 1992)

<u>Fyzika těžkých vůní</u>

– <u>půvab:</u> nové stavy a rozpady D a Λ_c (D^{**}, Λ_c^{*+})

- <u>krása:</u> nové stavy a rozpady B, mixing atd.



Objev B^0 - $\bar{B}^0$ směšování

(nečekaně velké hodnoty)

ARGUS

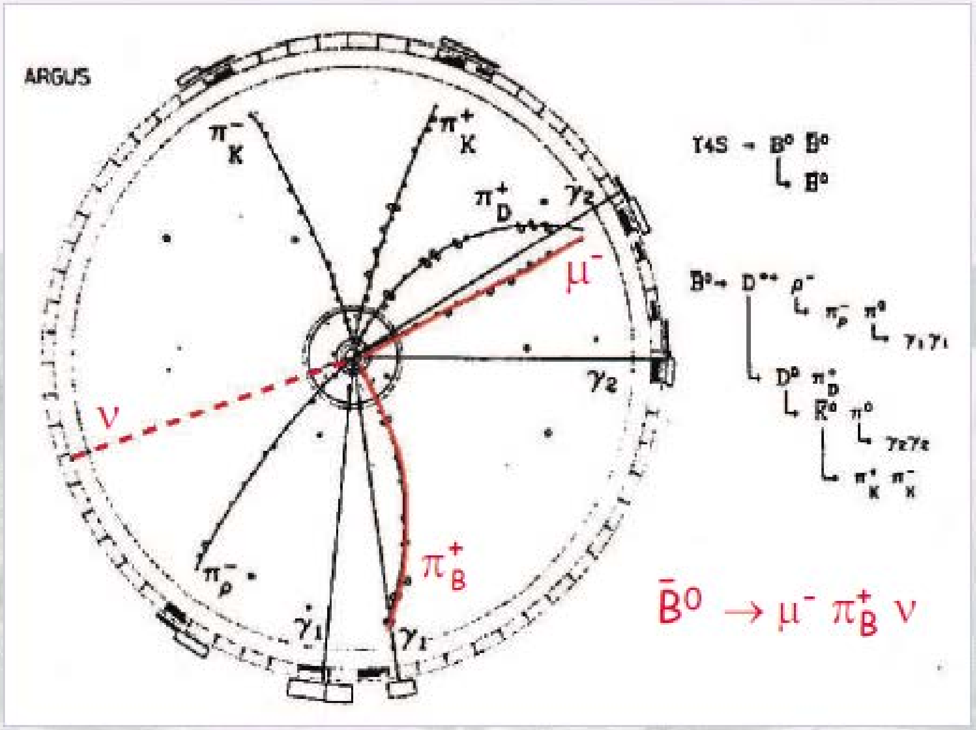
DORIS II

Úplná rekonstrukce případu

$$Y(4S) \rightarrow B^0 \bar{B}^0$$

Candidate event for $B^0 \bar{B}^0$ mixing and $b \rightarrow u$

ARGUS



ARGUS Observation of semileptonic charmless B-meson decays

Phys. Lett. B234 (1990) 409 (11.1.1990)

received 28.11.1989

CLEO Observation of B-meson semileptonic decays to noncharmed final states

Phys. Rev. Lett. 64 (1990) 16 (1.1.1990)

received 8.11.1989

HERA

Hadron-Elektron-Ring-Anlage

1984 -1992

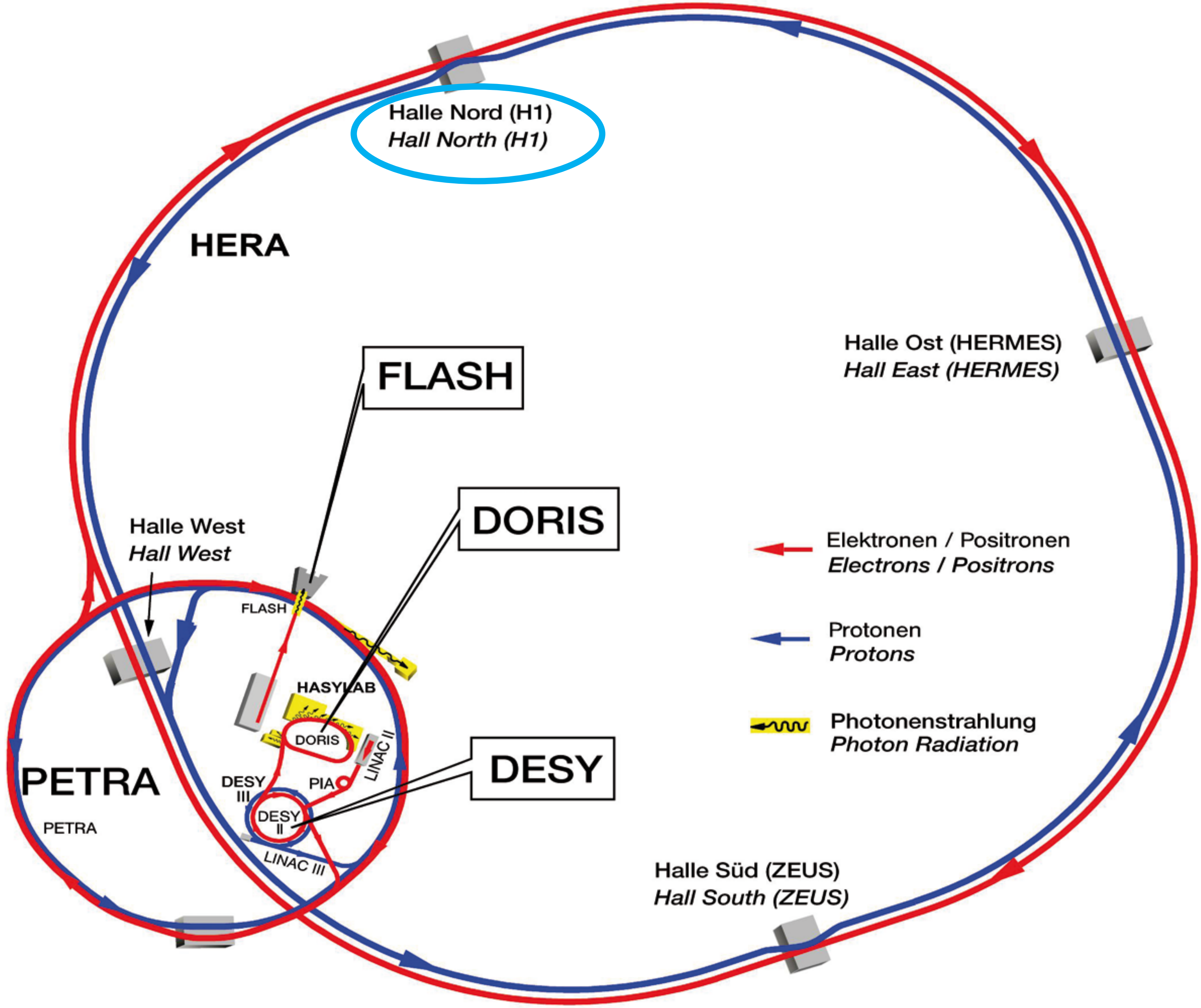
srážejí se:

820 GeV p, ~ 30 GeV e^+, e^-

projekty:

B. Wiik G.- A. Voss

1985-1992 HERA Electron-proton collider



Halle Nord (H1)
Hall North (H1)
HERA
Halle Ost (HERMES)
Hall East (HERMES)
FLASH
DORIS
Halle West
Hall West
Elektronen / Positronen
Electrons / Positrons
FLASH
HASYLAB
Protonen
Protons
DORIS
LINAC II
Photonenstrahlung
Photon Radiation
PETRA
DESY III
PIA
DESY
DESY II
PETRA
LINAC III
Halle Süd (ZEUS)
Hall South (ZEUS)

Prof . Bjoern Wiik

v tunelu HERA

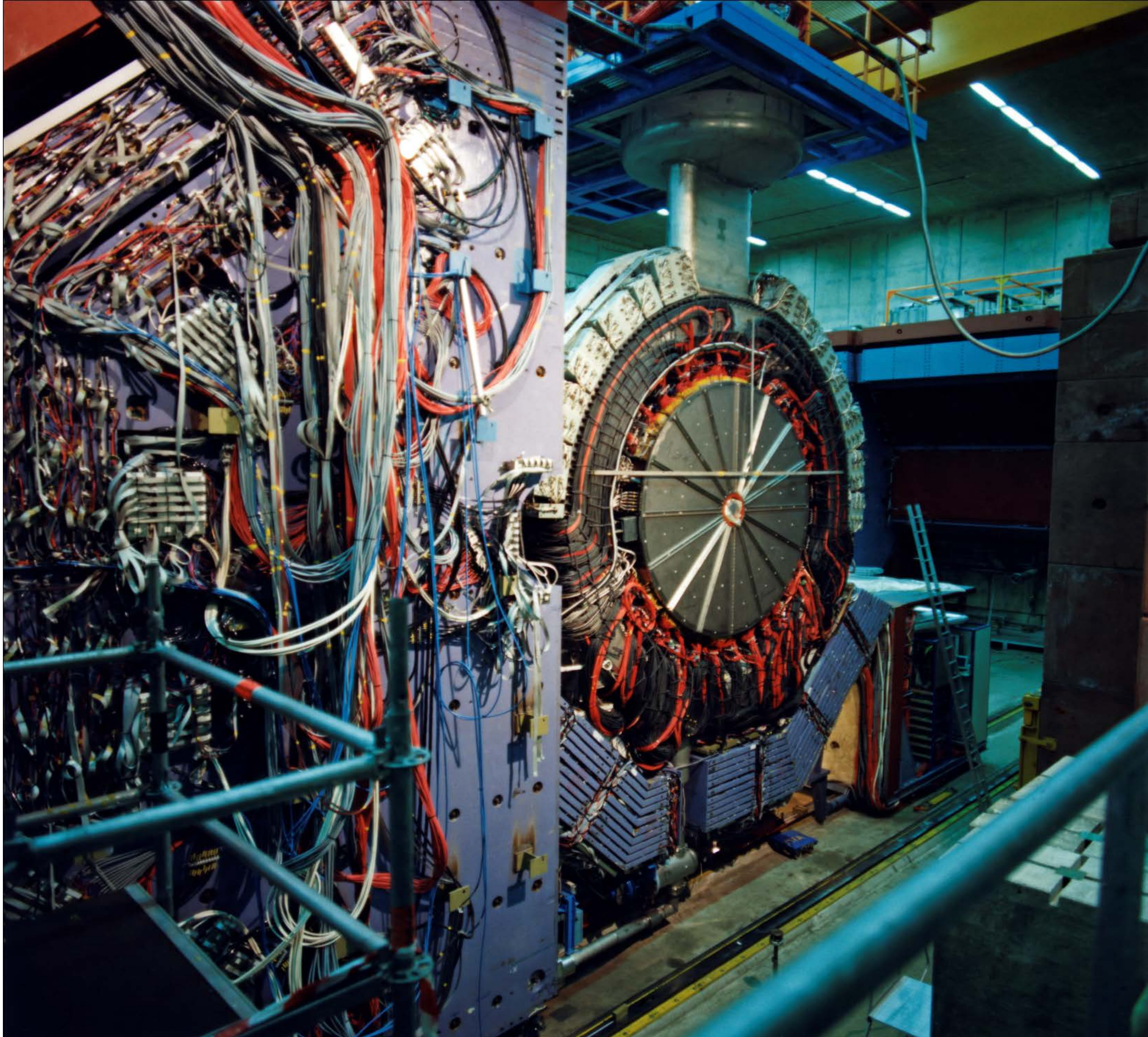
Protonový *okruh*

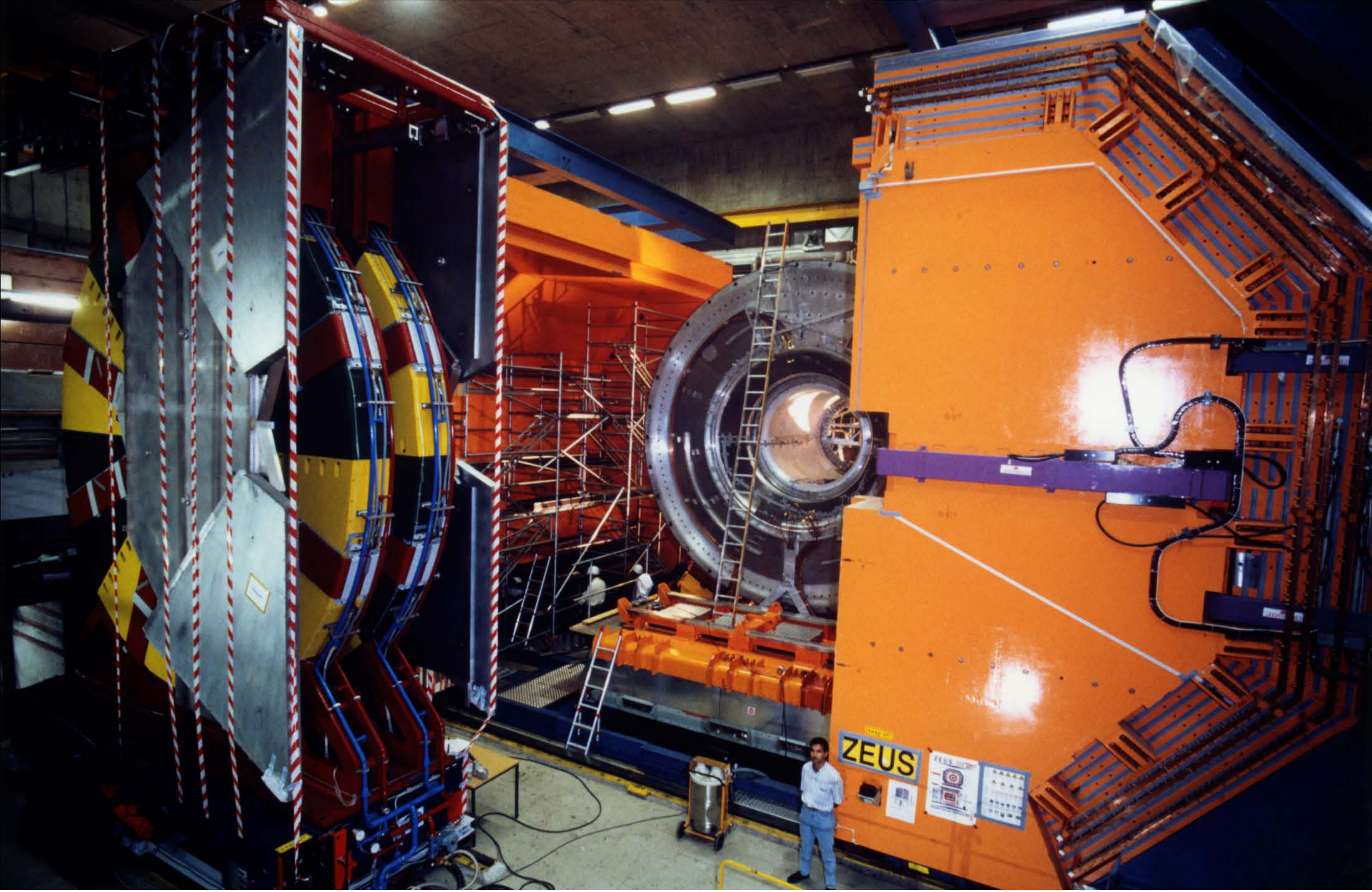
(supravodivý)

Elektronový *okruh*

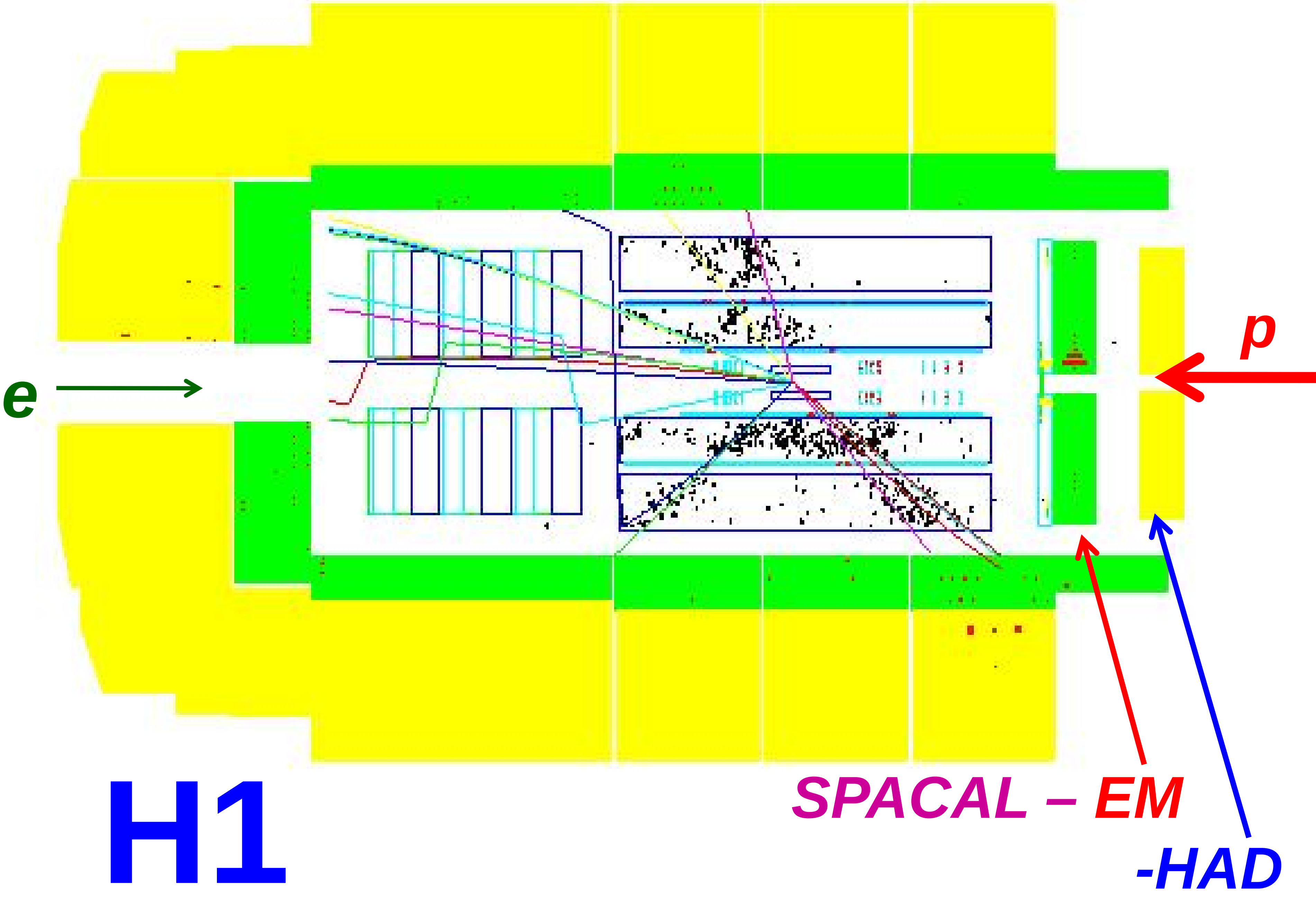
Detektor

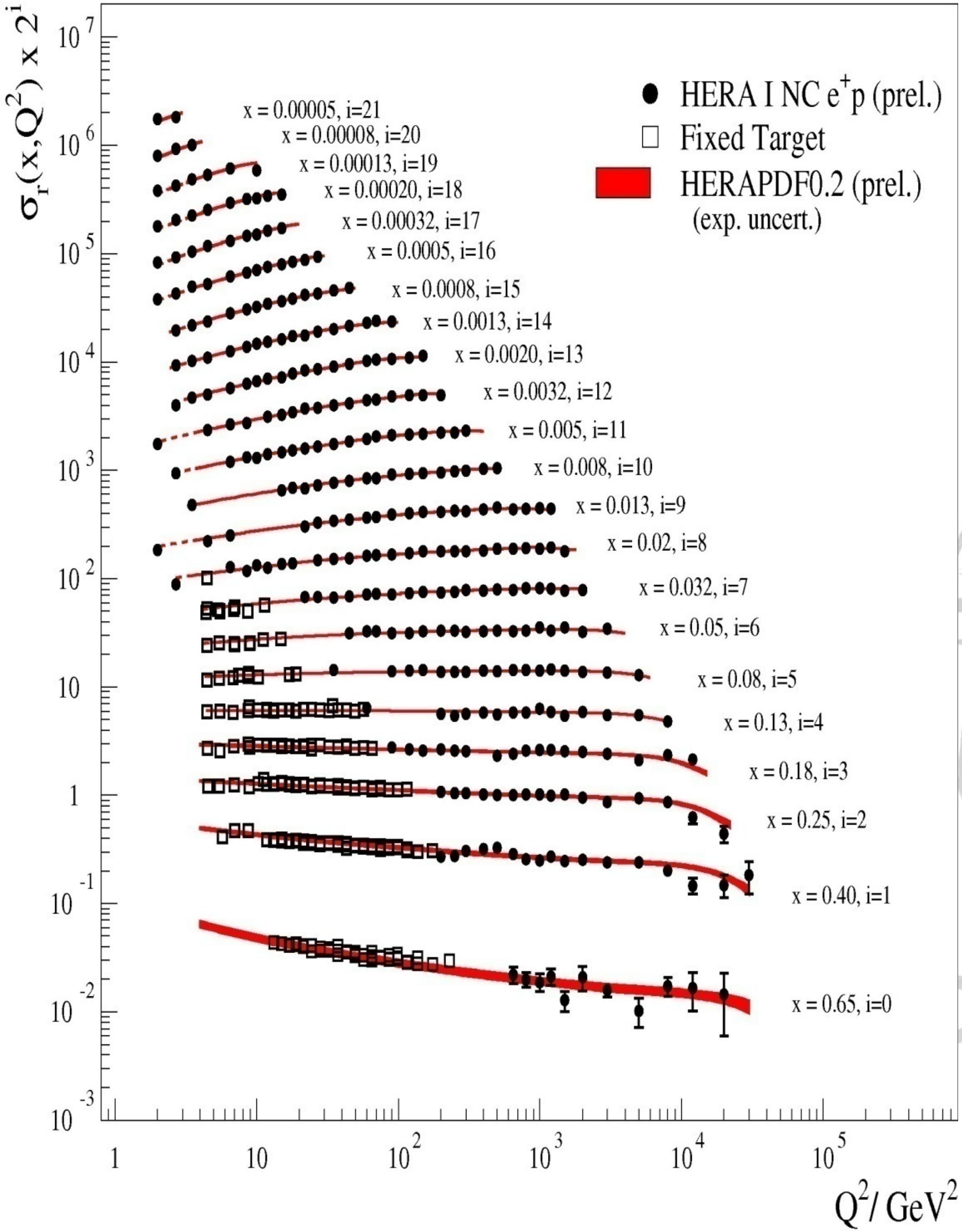
H1





Detektor **ZEUS**

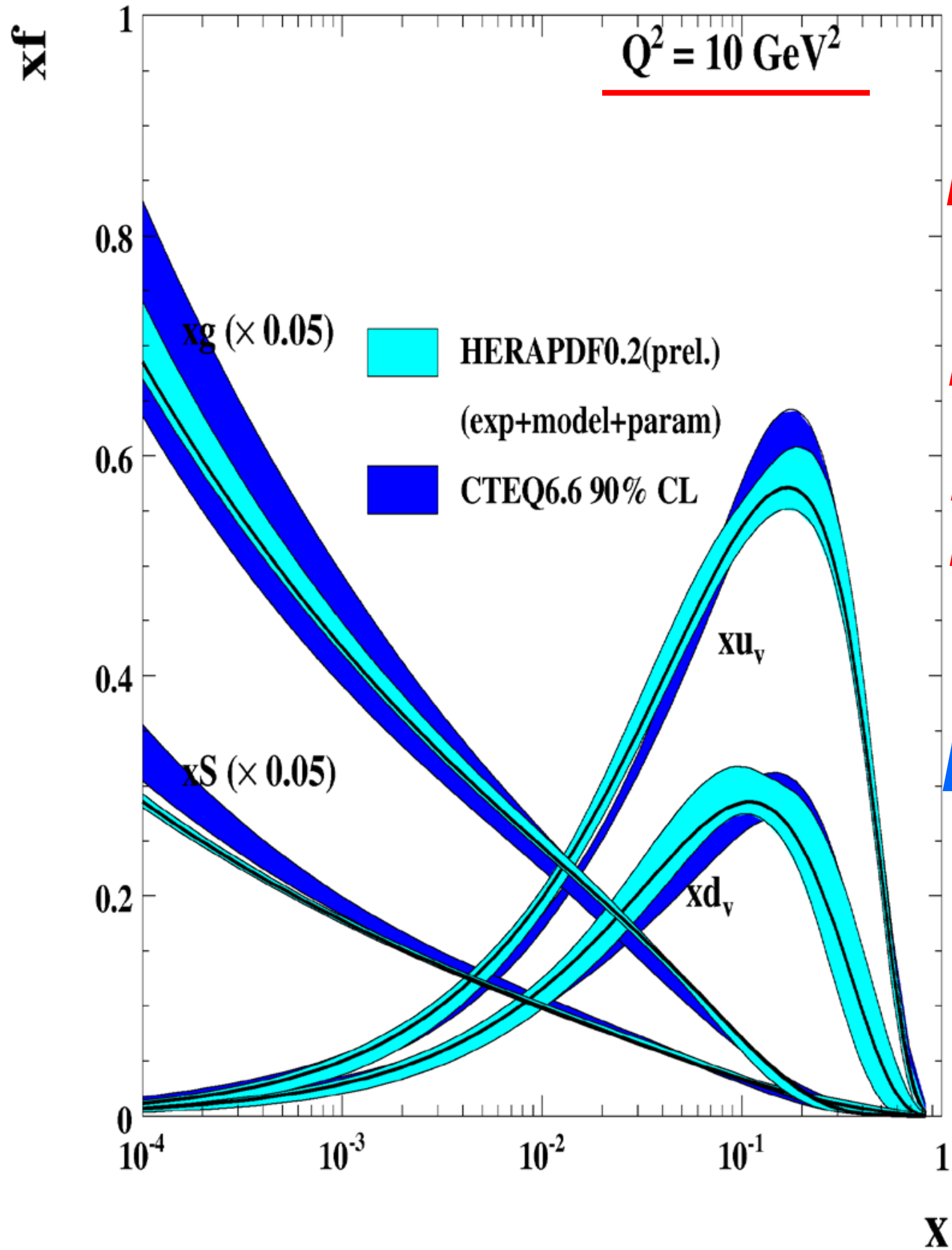

e
p
H1
SPACAL – EM
-HAD



Hloubkově nepružný rozptyl

H1 + ZEUS

Data jsou v rozsahu 10 pro σ_r a 4 řádů pro Q^2 a x



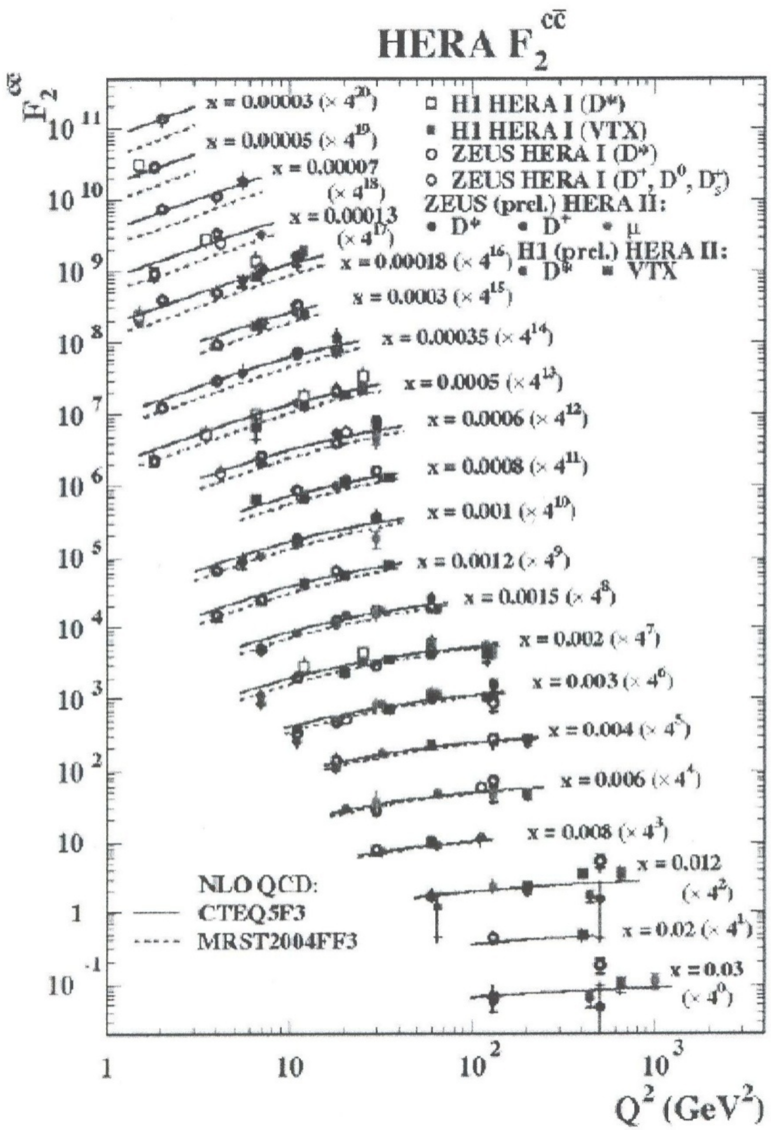
Partonové rozdělovací funkce

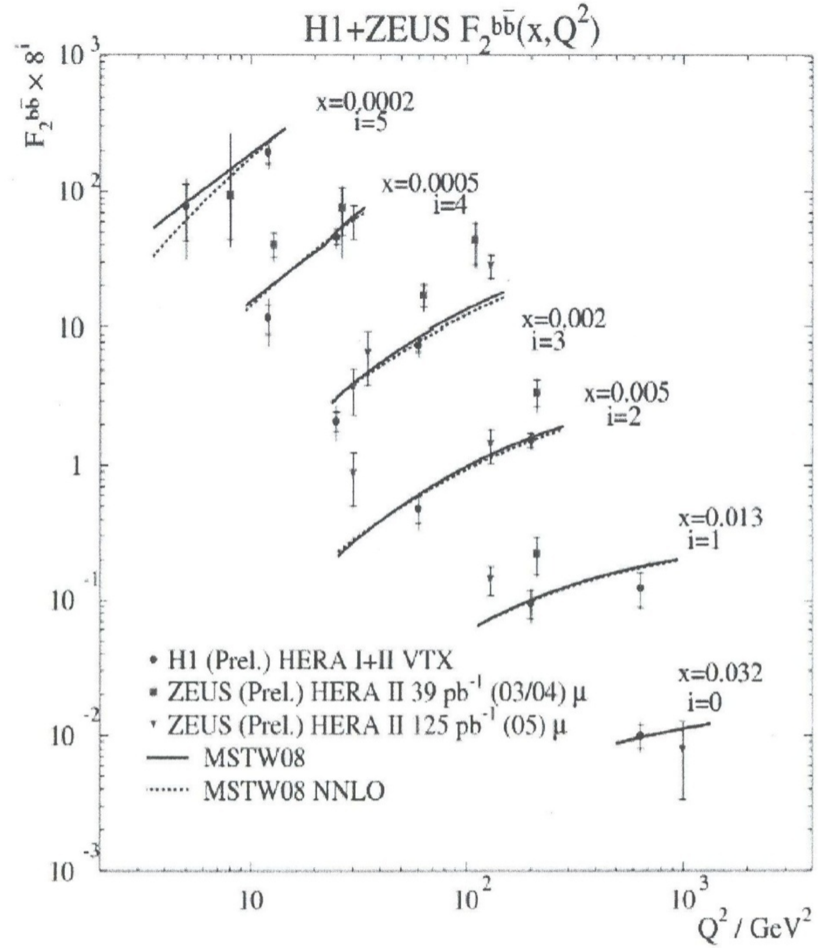
***pro kvarky** u,d,s a gluon*

H1 + ZEUS

→ ***<u>vliv gluonů při malých x</u>***

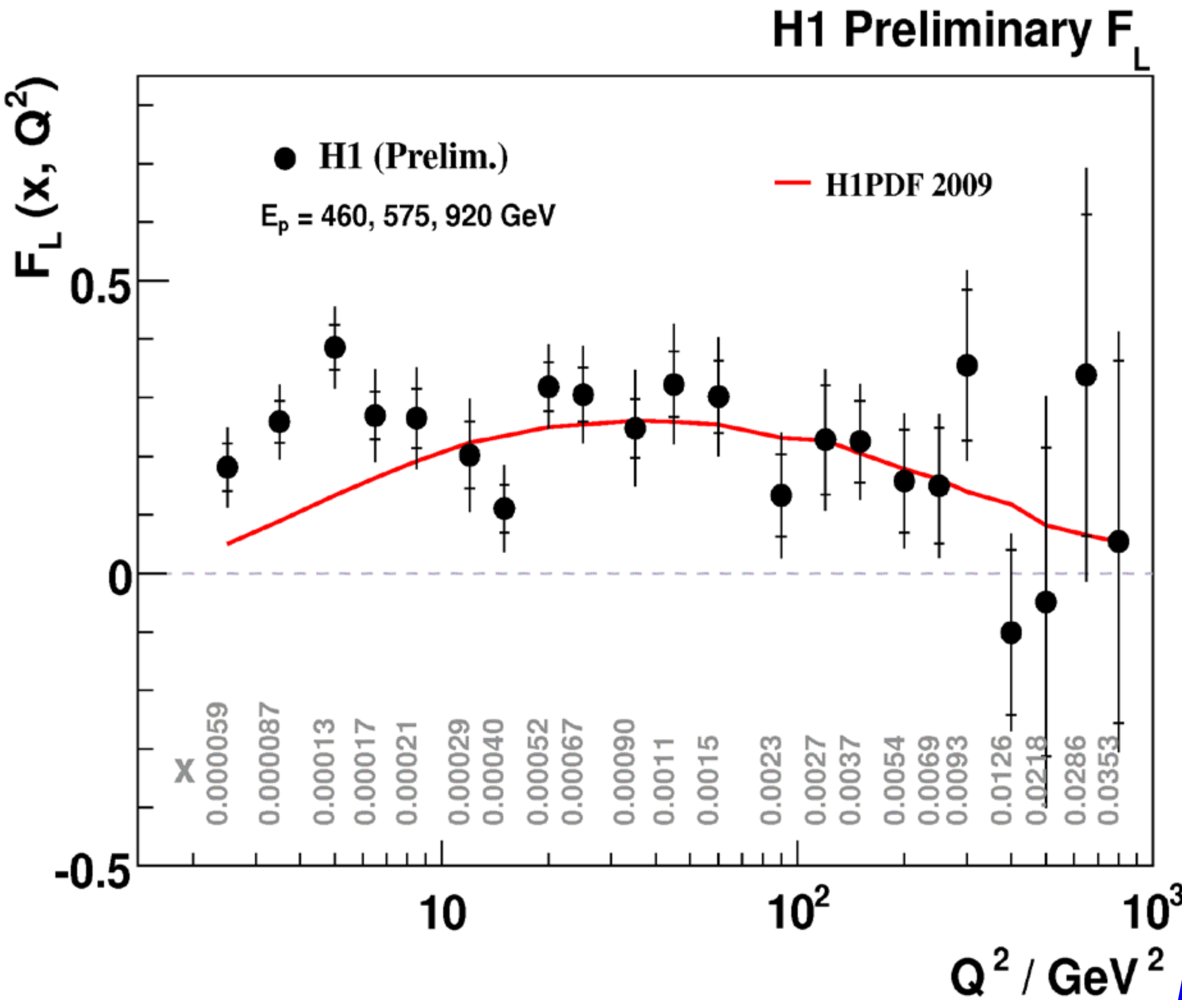
poprvé získány





Strukturní funkce

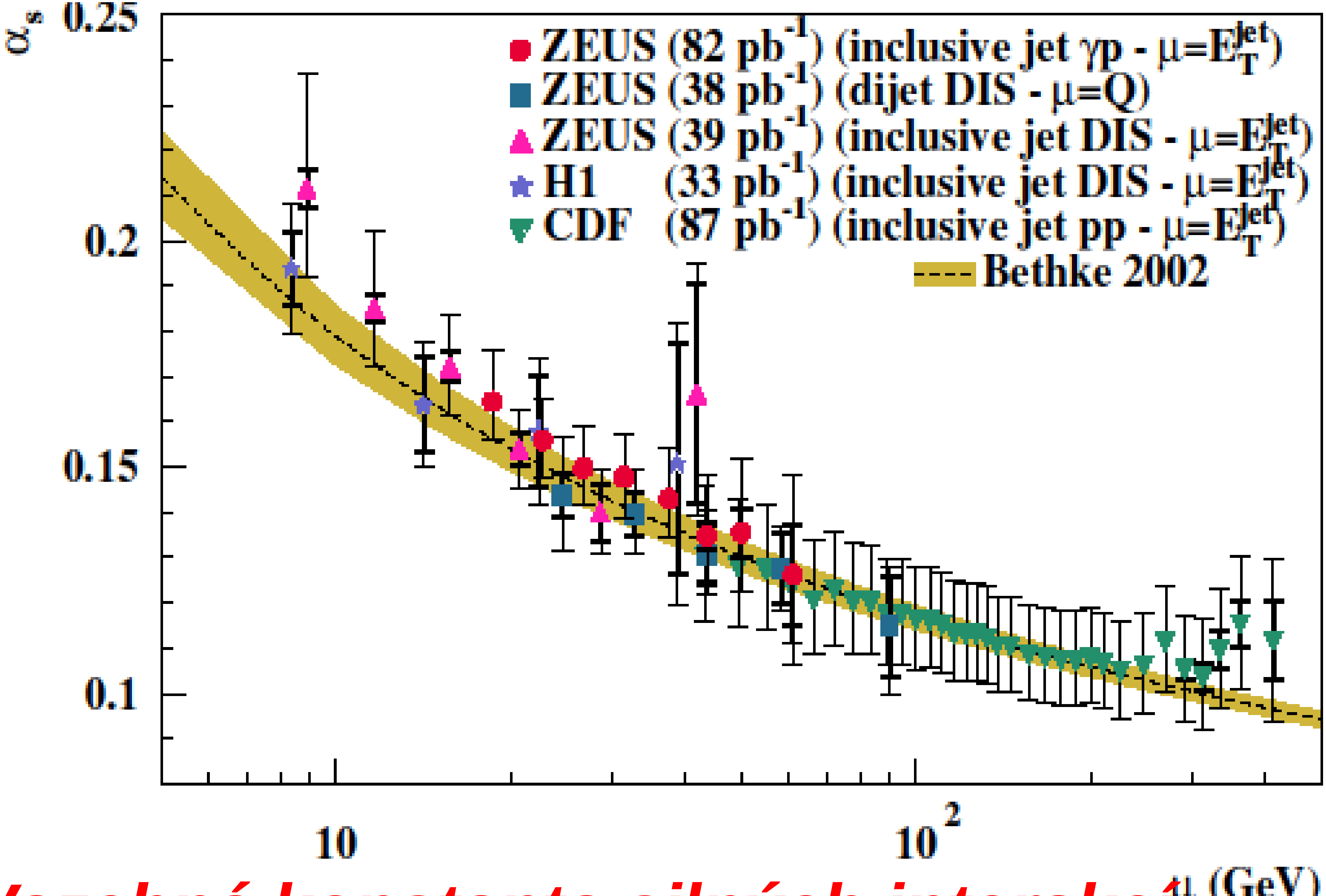
pro ***kvarky*** ***půvabné*** ***(13 řádů)*** ***a*** ***krásné*** ***(6 řádů)***



Longitudální strukturní funkce

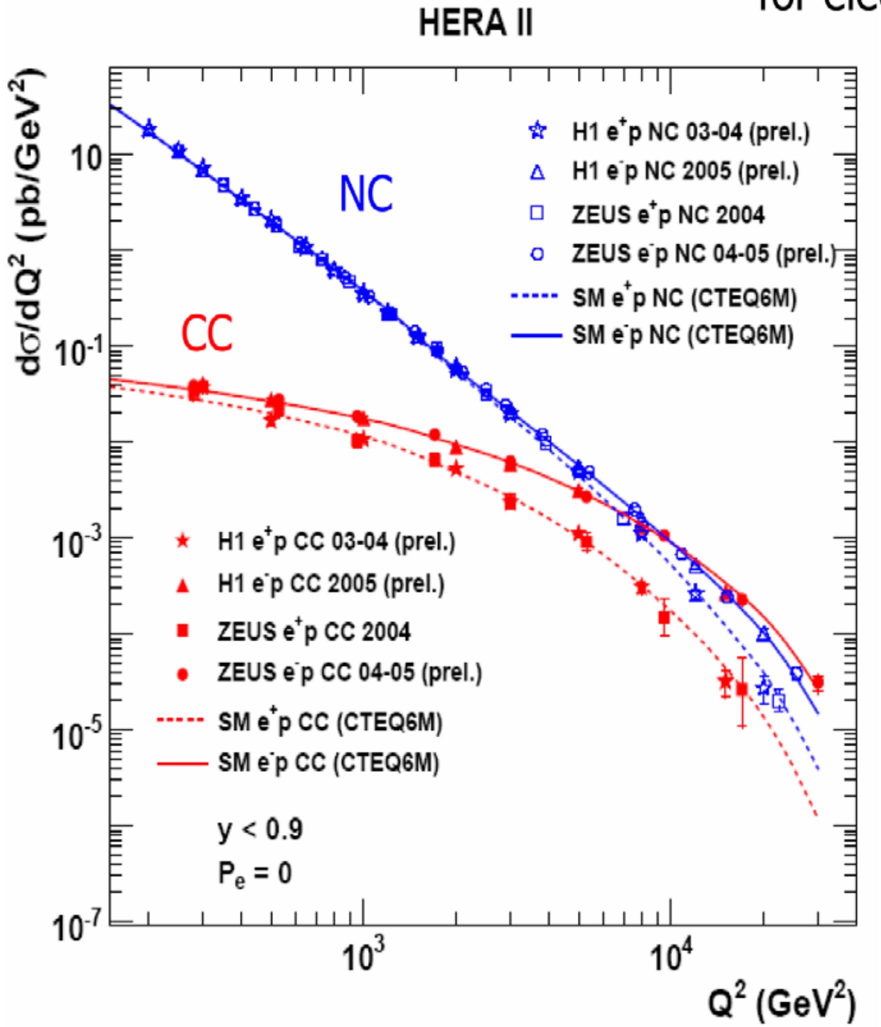
pro tři energie protonů

H1 první měření !!



Vazebná konstanta silných interakcí

Measurement of NC & CC cross sections



Unpolarised cross sections

for electron & positron scattering

Cross sections measured over 6 orders of magnitude

NC cross section dominated by photon exchange

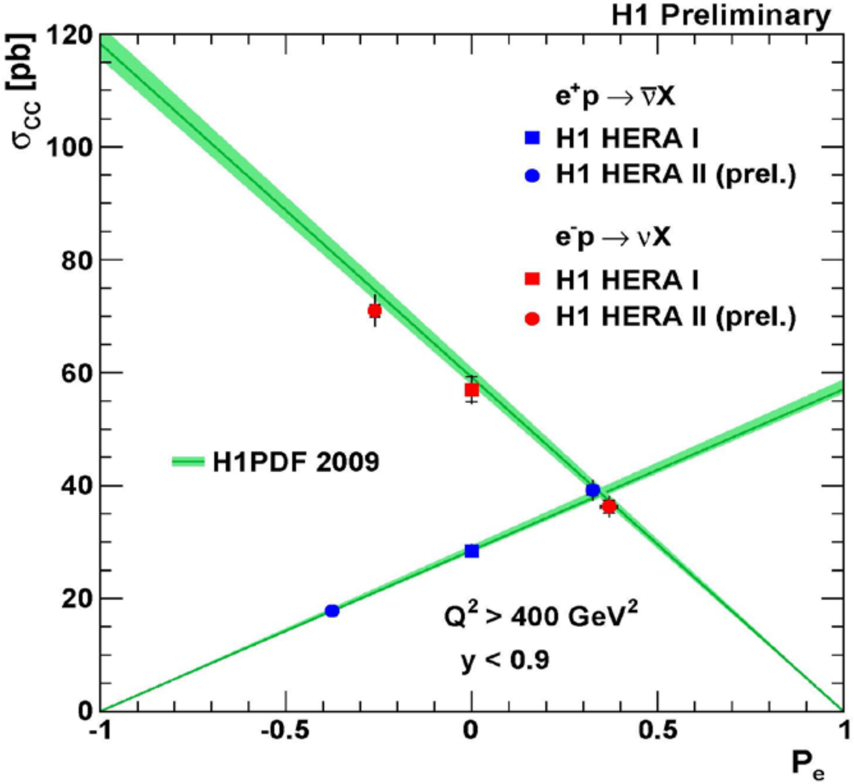
NC e^+/e^- difference due to Z^0 exchange

CC cross section similar to NC cross section at high Q^2 → EW unification

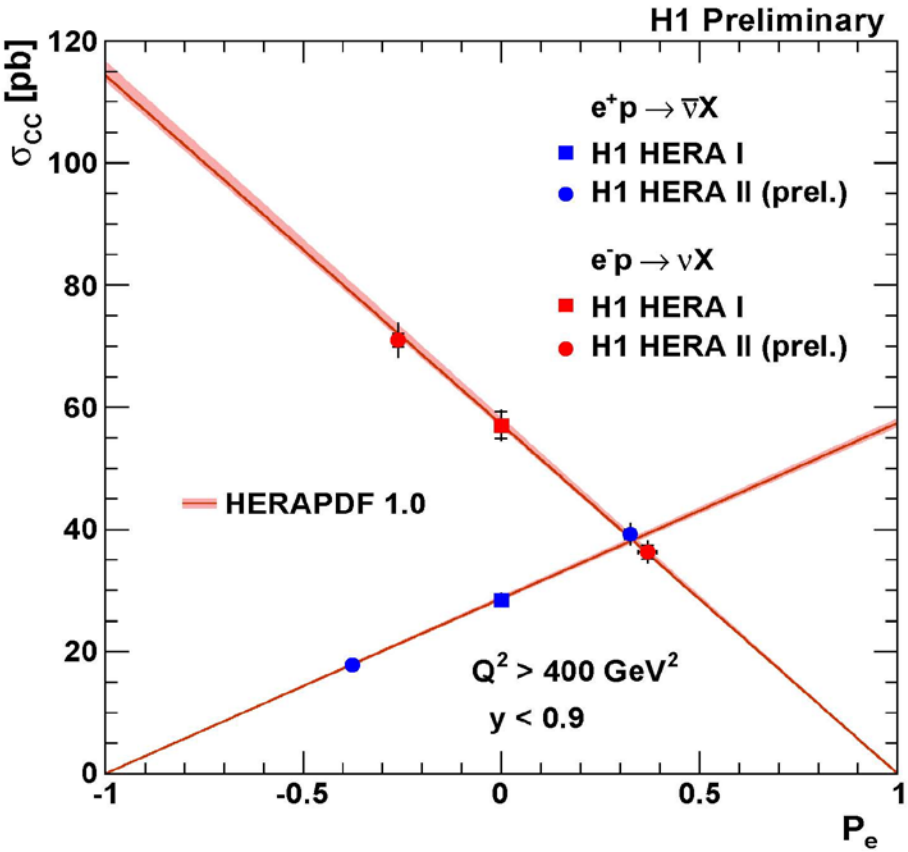
Remaining difference due to PDFs

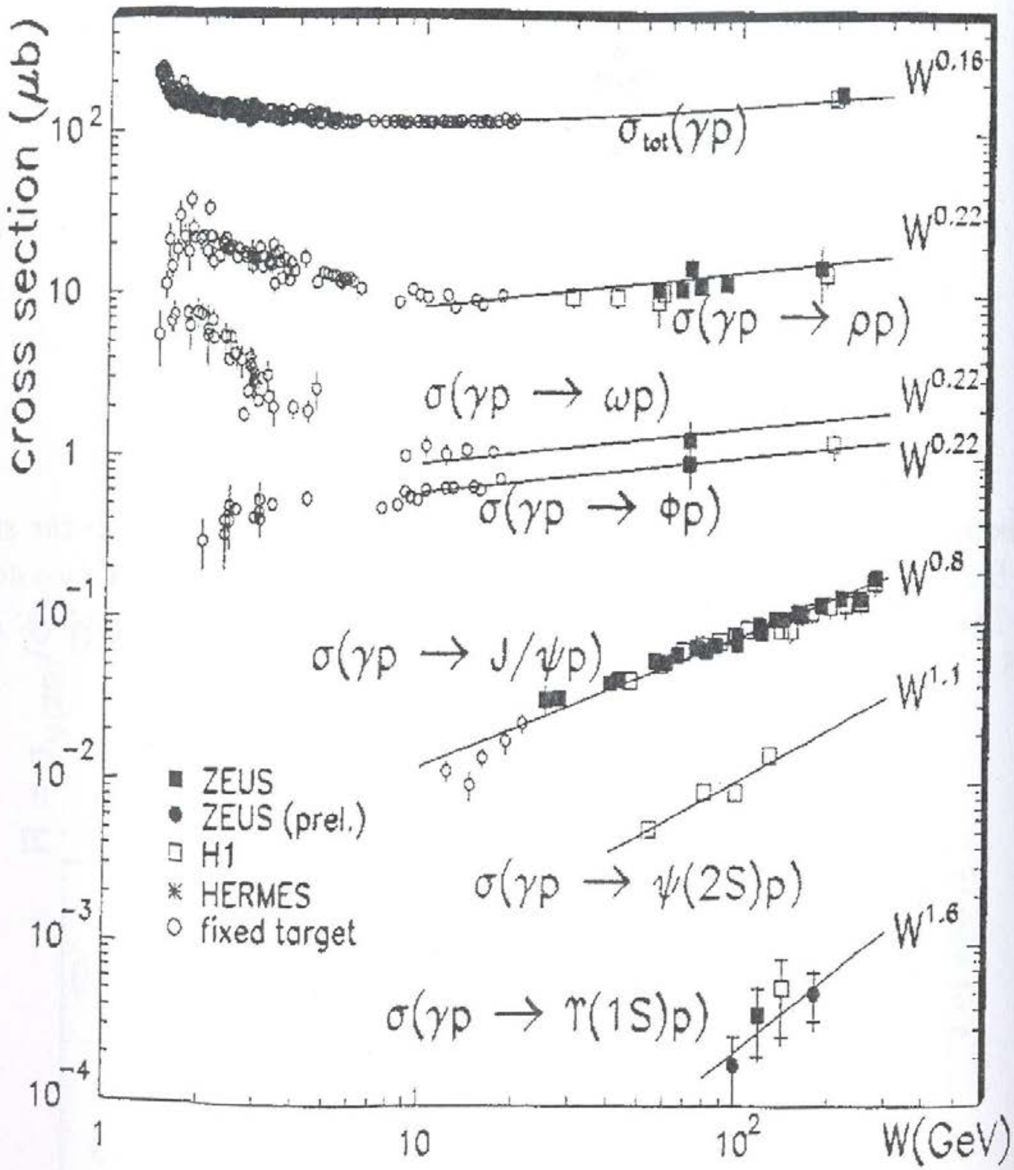
Slabé interakce

HERA II – polarizace elektronů



Nabité proudy (velké Q^2)





Difrakční procesy

H1+ZEUS+HERMES

Fotoprodukce vektorových mezonů

ρ, ω, φ, J/ψ, ψ´, Υ

Spinové vlastnosti nukleonu

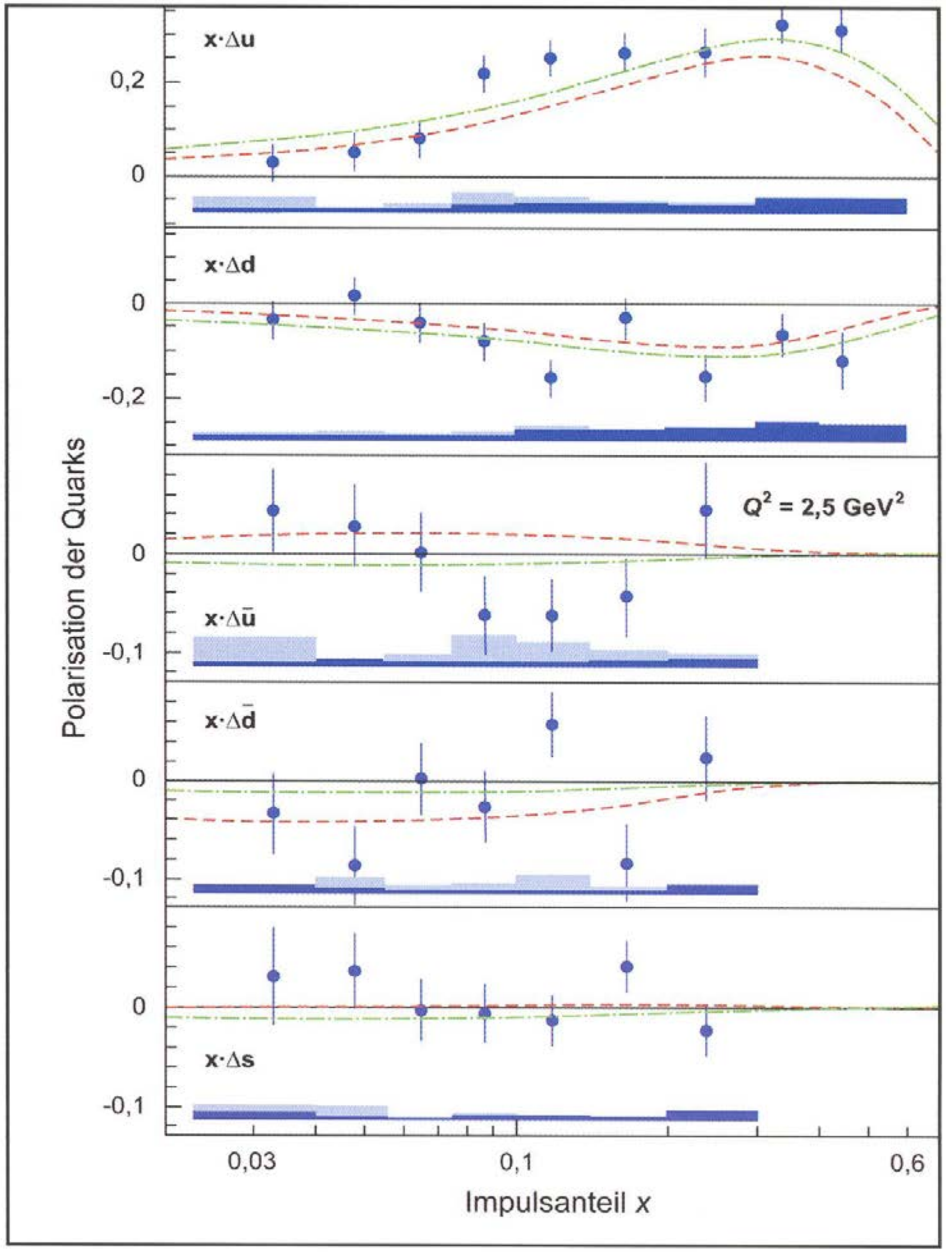
HERMES

(srážky e + p pevný terč)

Polarizace

kvarků a antikvarků

v protonu



HERA-B

studium krásných kvarků :

produkce,oscilace, narušení CP atd.

srážky p (920 GeV) s terčem

experiment skončil předčasně

TESLA

TeV-Energy-Superconducting-Linear-Accelerator

Projekt DESY 1977,

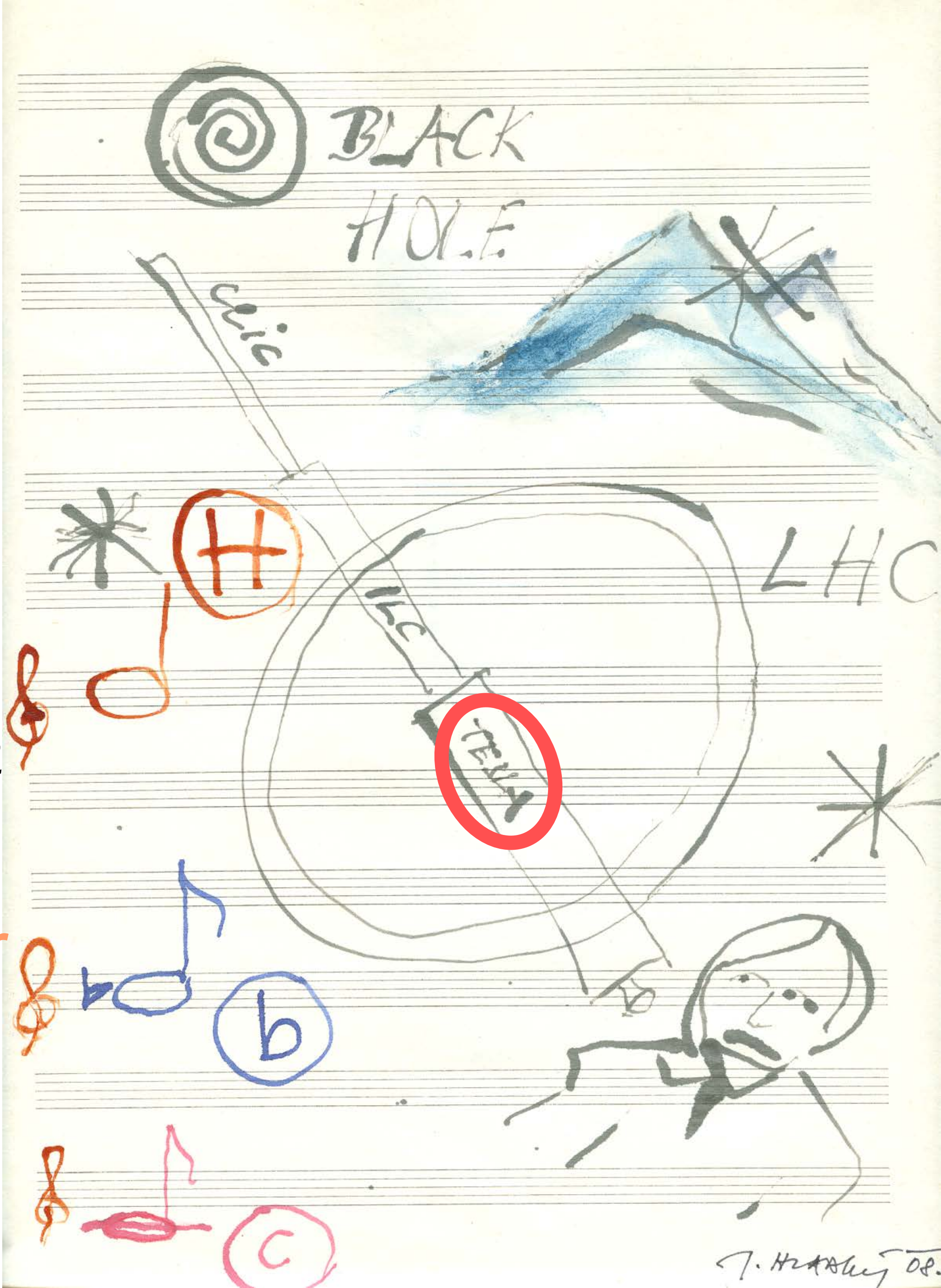
kombinace srážek

elektron-pozitron a

FEL-

Free-Electron-Laser

kromě vědy i pro technologii, biologii, lékařství atd.



DESY II - Zeuthen

od roku 1991**, **z IfH DAW v NDR** ,**vzniklé

v 1946 z Pruské Akademie věd

Institut fuer Hochenergiephysik
Zeuthen/Berlin

Spolupráce s CERN a DESY od ~ 1962
(kolaborace ABBHHM z ABBBHLM)

Volume 27B, number 1 PHYSICS LETTERS 27 May 1968

PHOTOPRODUCTION OF VECTOR MESONS ON PROTONS AT ENERGIES UP TO 5.8 GeV

Aachen-Berlin-Bonn-Hamburg-Heidelberg-München-Collaboration

R. ERBE, H. G. HILPERT, E. SCHÜTTLER, W. STRUCZINSKI
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Max-Planck-Institut für Physik und Astrophysik, München, Germany

Received 18 April 1968

Berlin

DESY II - Zeuthen

DESY - II Zeuthen

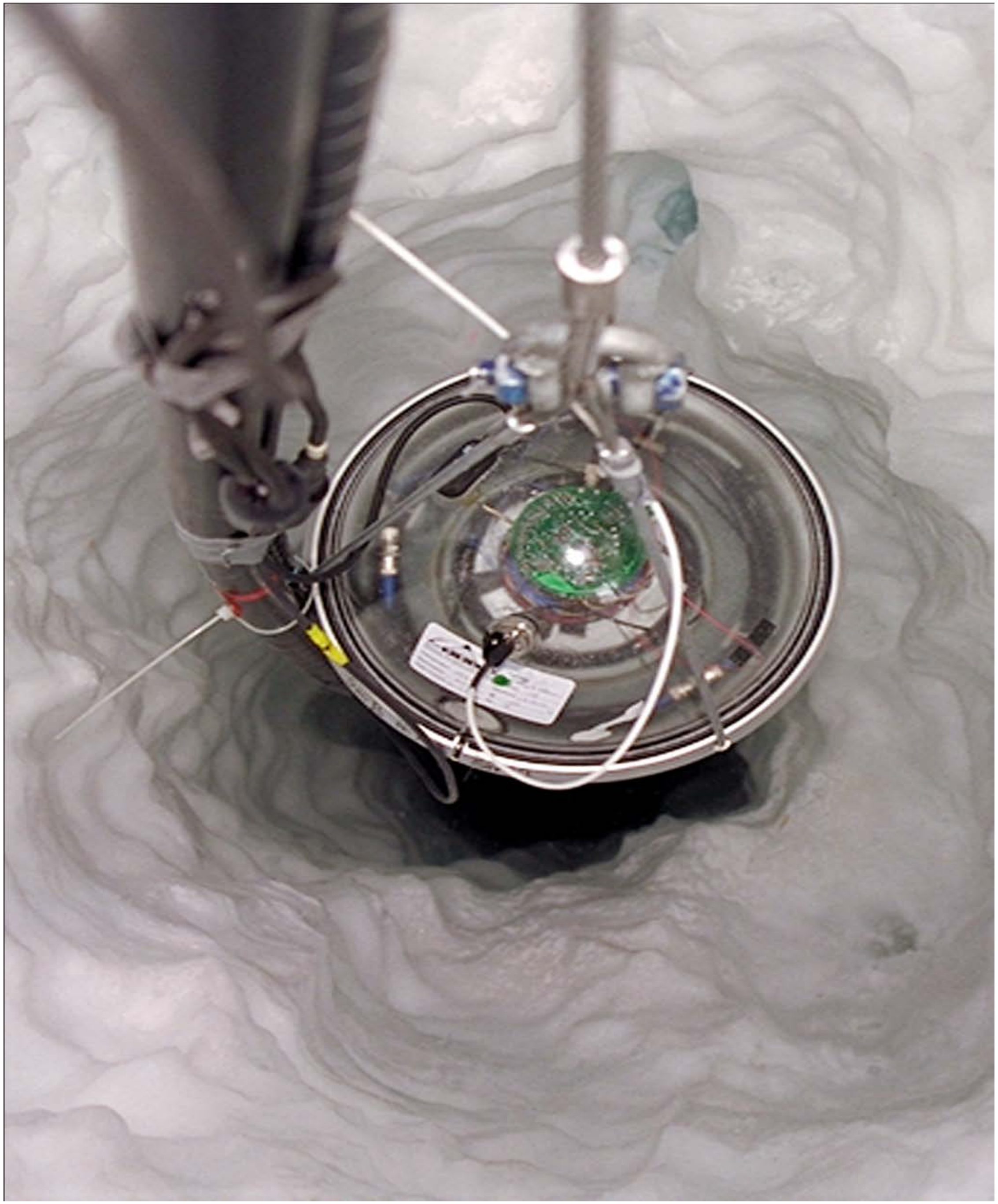
BAIKAL *(od 1988)*

AMANDA

Antarctic-Muon-
And-Neutrino-
Detection-Array

IceCube

Detektory do 2450 m
v ledu



Zkouška optických modulů v Zeuthen

pro experiment AMANDA → IceCube

2001 DESY → HGF

Helmholtz-Gemeindschaft Deutscher Forschungszentren

Sdružení 16 vědeckých institucí do 6 skupin

skupina „Struktura hmoty“

2007 HERA srážky končí

***DESY** výsledky a skupiny jdou do experimentů*

LHC –CERN

Ženeva

Předsedové direktoria DESY (1955 - 1999)

3. H. Schopper, 2. W. Paul, 1. W. Jentschke, 4. V. Soergel, 5. Bjoern Wiik

Předsedové direktoria DESY

Albrecht Wagner (1999-2009)

Helmut Dosch (2009-)

Od r. 1987 (Jaro Antoš a Jos. Žáček)→

„NAŠI v DESY“ účast

H1

- **budování kalorimetrů**

  LArgon, SPACAL (hardware a software)

- **inovace**

  lumimetr, BToF, VLQ, FST-BST

- **analyza dat**

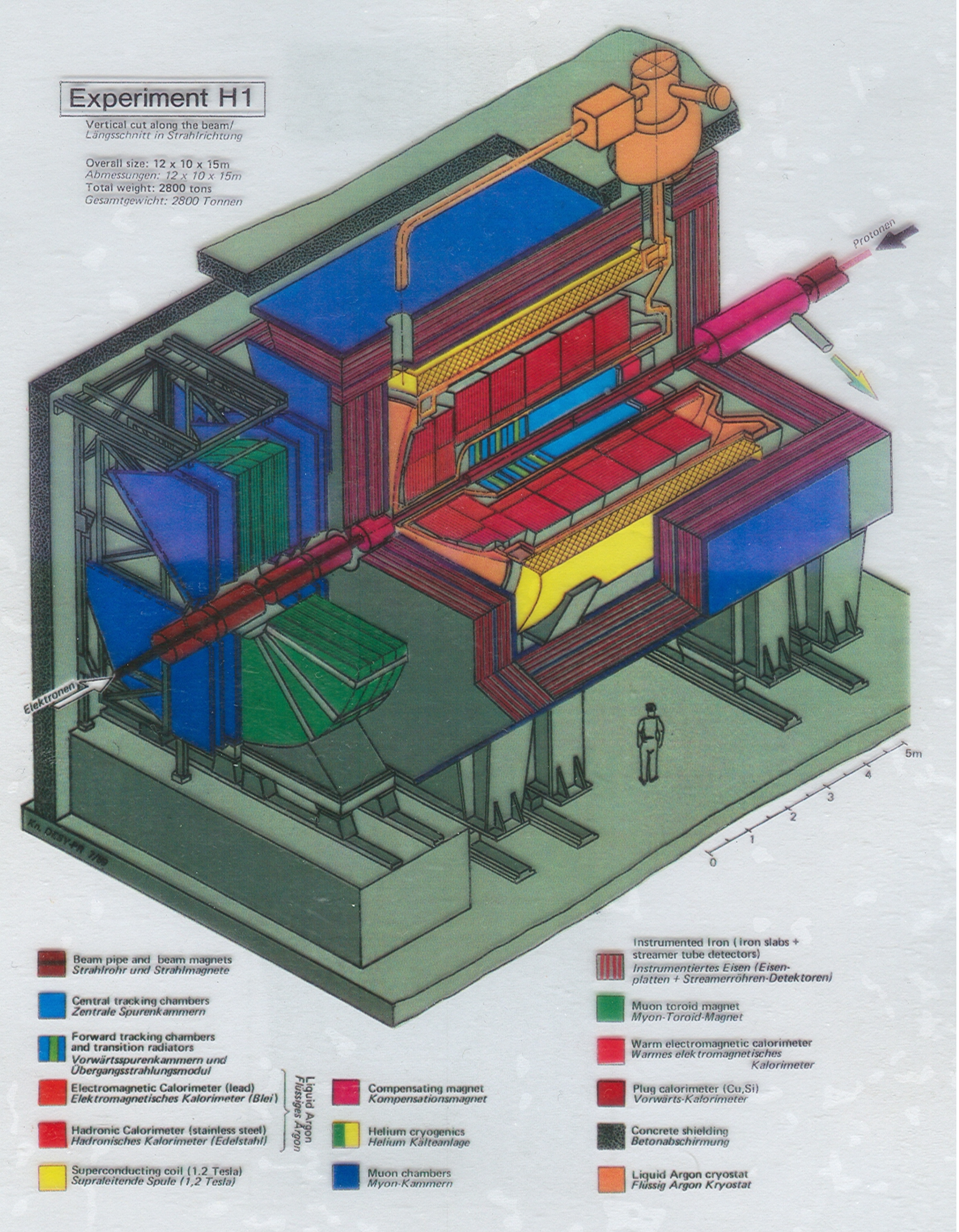
  DIS, struktura virtuálního fotonu, difrakční jevy

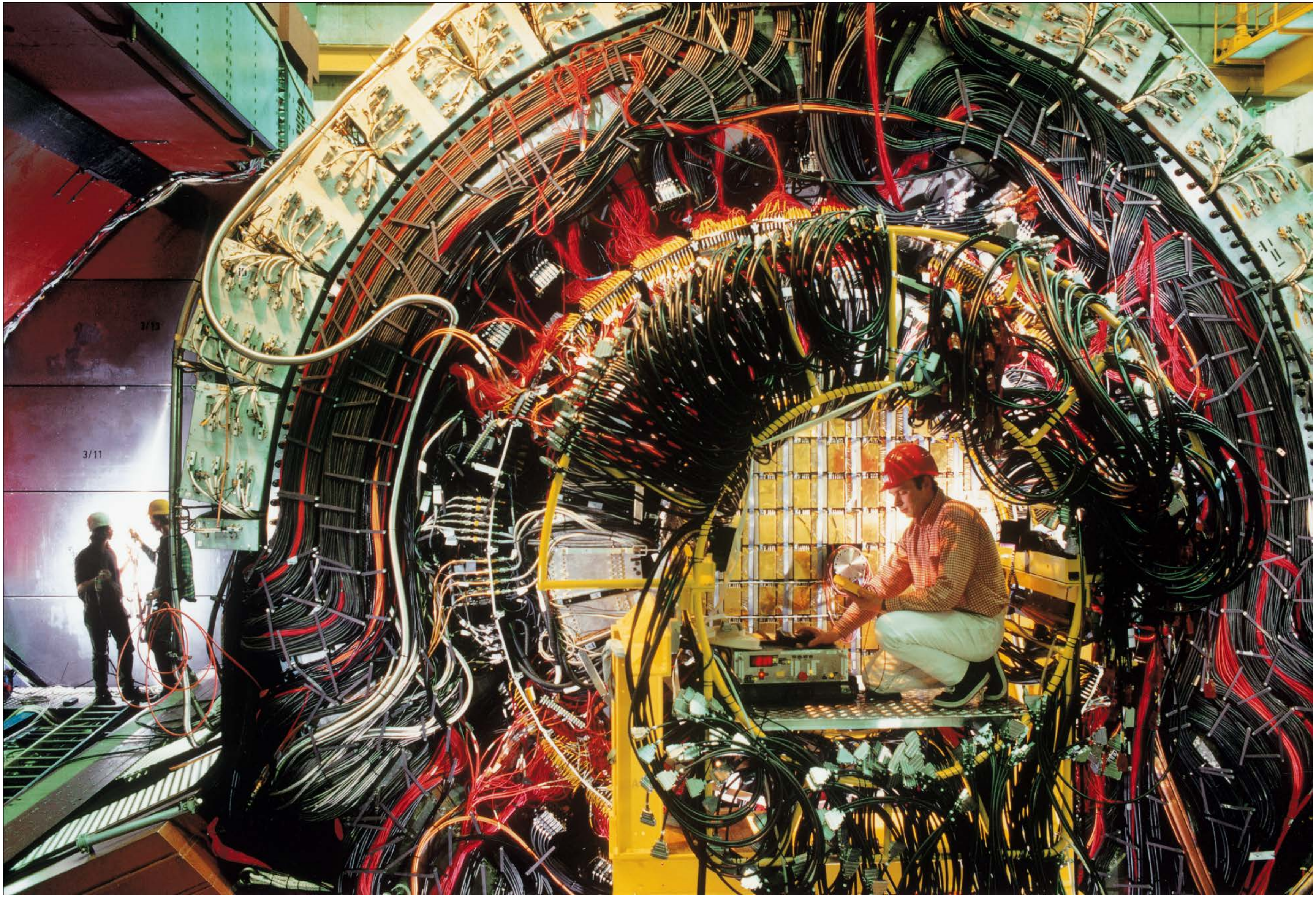
1989 – prof. Volker SOERGEL (vlevo)
v Praze na prezidiu ČSAV
podpis smlouvy o spolupráci DESY-ČSAV-SAV


A.Valkárová
Franz Eisele
1. mluvčí H1
J.Strachota
1. mluvčí
čs.skupin v H1

A
P
A
R
A
T
U
R
A

H1

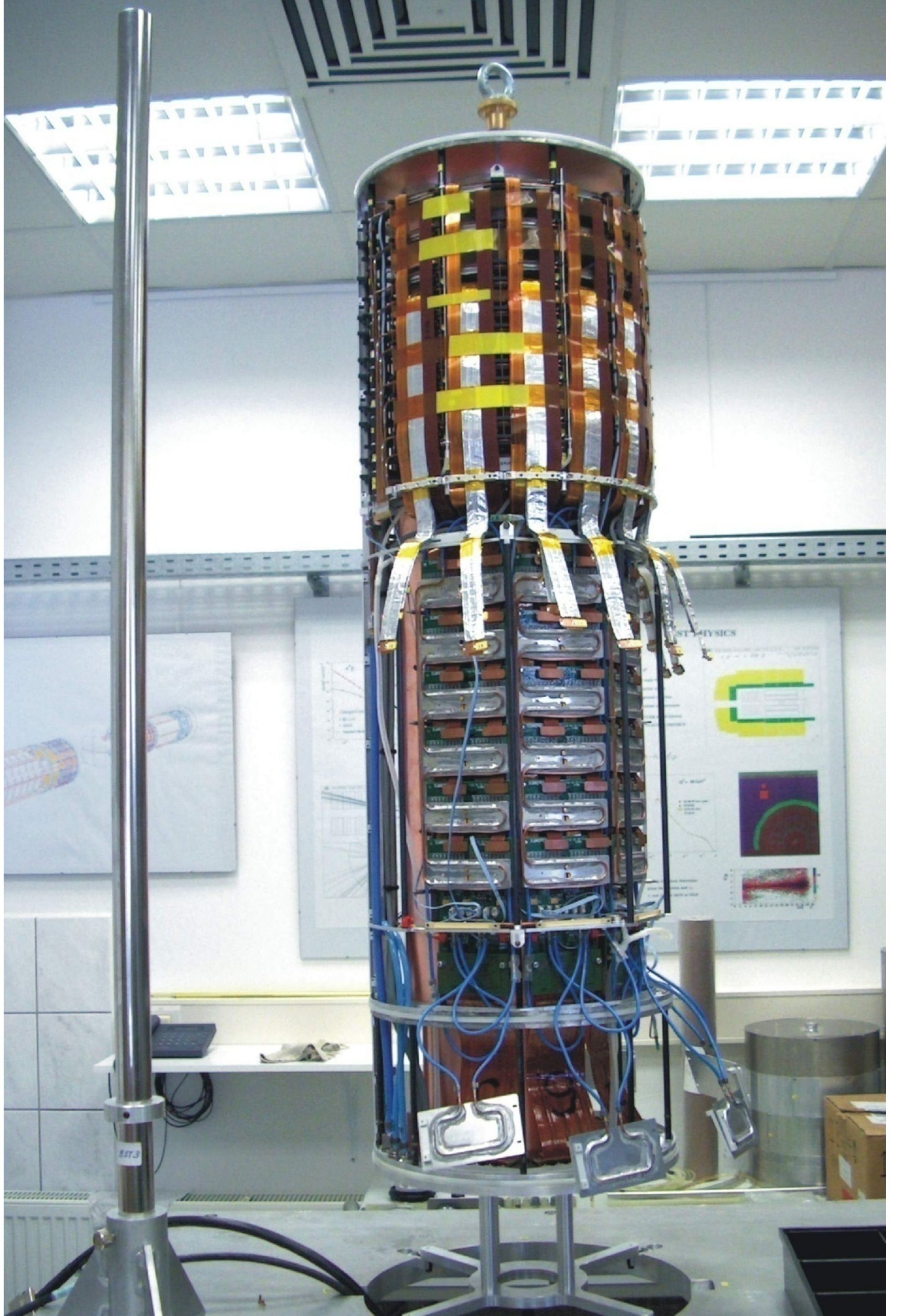




SPACAL – vláknový kalorimetr

BST

(backward silicon tracker)



DESY BEST RESULTS

Construction and building of the original big colliders

Deutsches Electron Synchrotron

-Proton form factors.
-Validity of QED.
-Inelastic scattering up to (nearly) deep inelastic region.

DORIS

-Charmonium excitations and semileptonic decays.
- Y resonance narrow (b quark c.: -1/3).
- Y-> 3 gluons → GLUON
-B-Bbar MIXING → CKM matrix.
- No top quark, new mass limit.

PETRA

-GLUON BREMSSTRAHLUNG
-Electroweak interference (Z0) in μ &τ pairs.
-Measurement of α_s.

HERA (international)

HERA I (1992-2000):
-MEASUREMENT OF PROTON STRUCTURE (F_2, F_3, F_L).
-Determine precise quark, sea and gluon PDF's.
HERA II (2002-2007, polarization):
-Measure the helicity distribution of separate quark flavors.
-Measure α_s running in a single experiment.
-Charge currents, electroweak unification,
-CC helicity structure, couplings.
-No leptoquark, SM good up to NLO (NNLO) of PQCD.
-- Diffractive DIS.

- HERMES: spin physics (helicity structure, orbital angular momentum, transversity).

prof. Wilibald Jentschke

prof. Albrecht Wagner

prof. Gustav Weber (emer. věd.řed. DESY), prof. Carlo Rubia, (emer. gen.řed. CERN)

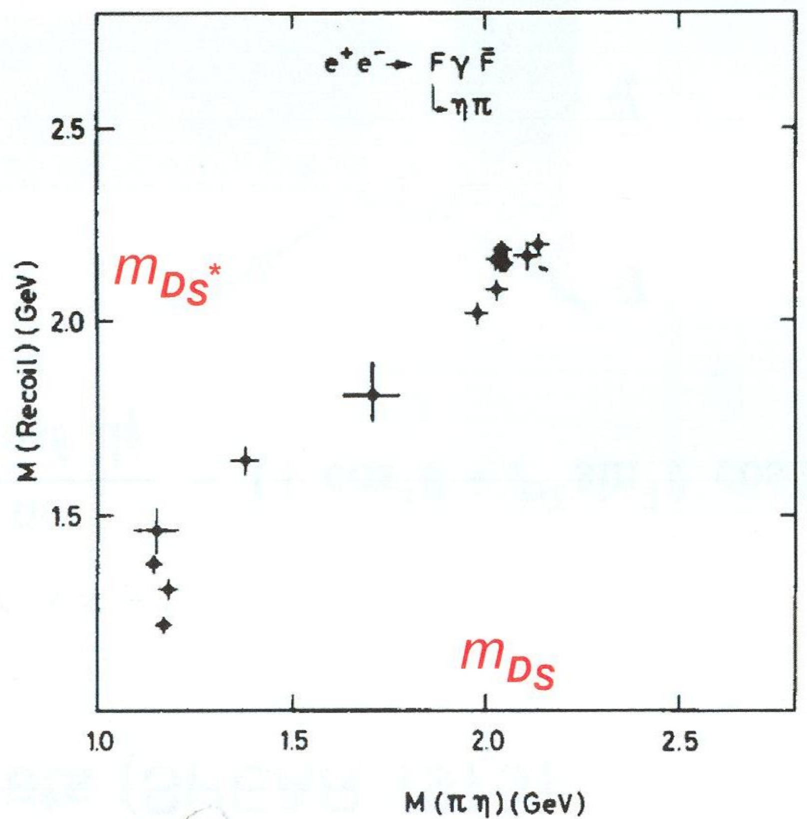
prof. Volker Soergel, *akademik P.A. Čerenkov*

prof. H.Schopper, emer.řed. DESY a CERN, prof. P.Soeding, emer.řed. DESY II-Zeuthen

První předsedové direktoria DESY Hamburg

První pozorování půvabně-podivného mezonu F (tj. D_S) - 1977

$$e^+e^- \to D_S \, \overline{D}_S^{\,*}$$
$$D_S \to \eta\pi, \quad \overline{D}_S^{\,*} \to \gamma \overline{D}_S$$



1985-1992 HERA Electron-proton collider

Hauptkirche St. Nikolai am Klosterstern

Haydn-Messe

im Gottesdienst

27. Juni 1999, 10.00 Uhr

(4. Sonntag nach Trinitatis)

Joseph Haydn: Missa Sancti Nicolai (Nicolai-Messe) für Soli, Chor und Orchester

Begrüßung

Eingangslied: EG 443,1.2.6

Kantorei: Kyrie, Gloria

Salutatio, Kollektengebet

Evangelium: Lukas 6,36-42

Lied: EG 495,1-5: O Gott, du frommer Gott

Lesung aus dem Alten Testament (=Predigttext):

1. Mose 50,15-21

Kantorei: Credo

Predigt: »Bin ich denn an Gottes Statt?«

Friedensgruß

Lied: EG 302,1.2 Du, meine Seele, singe ...

Fürbitten/Präfation

Kantorei: Sanctus

Vaterunser

Einsetzungsworte

Kantorei: Agnus Dei

Austeilung des Abendmahls (Benedictus)

Dankgebet

Entlassung/Segen

Kantorei: Dona nobis pacem