Special Colloquium in memoriam Hans Joachim Specht

6.6.1936 - 20.5.2024

GSI, 14.10. 2025

Utku Asan

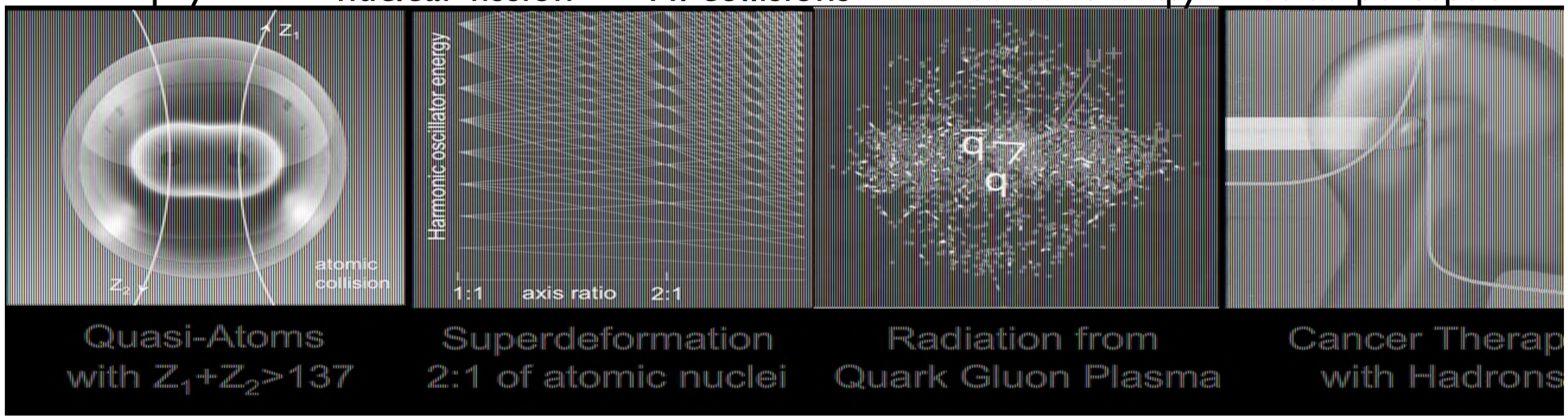
Chopin: Nocturne No. 20 in C-sharp minor Op. posth.

Hans Specht's research areas

broad range of interests

"do something new to see something new" (H. Maier-Leibniz)

atomic physics | nuclear fission | HI collisions | HI cancer therapy | musical perception



Axel Drees: *The Thermal Fingerprint of the Quark-Gluon Plasma*

Jürgen Debus: *Ion-Beam Therapy in Germany: HIT the target*

Dietrich v. Harrach: *Project and Promise: Remembering Hans Specht*

Volker Metag: *Program - Moderation*

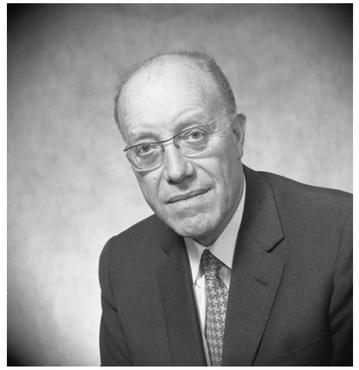
https://doi.org/10.1007/978-3-031-92353-1

open access

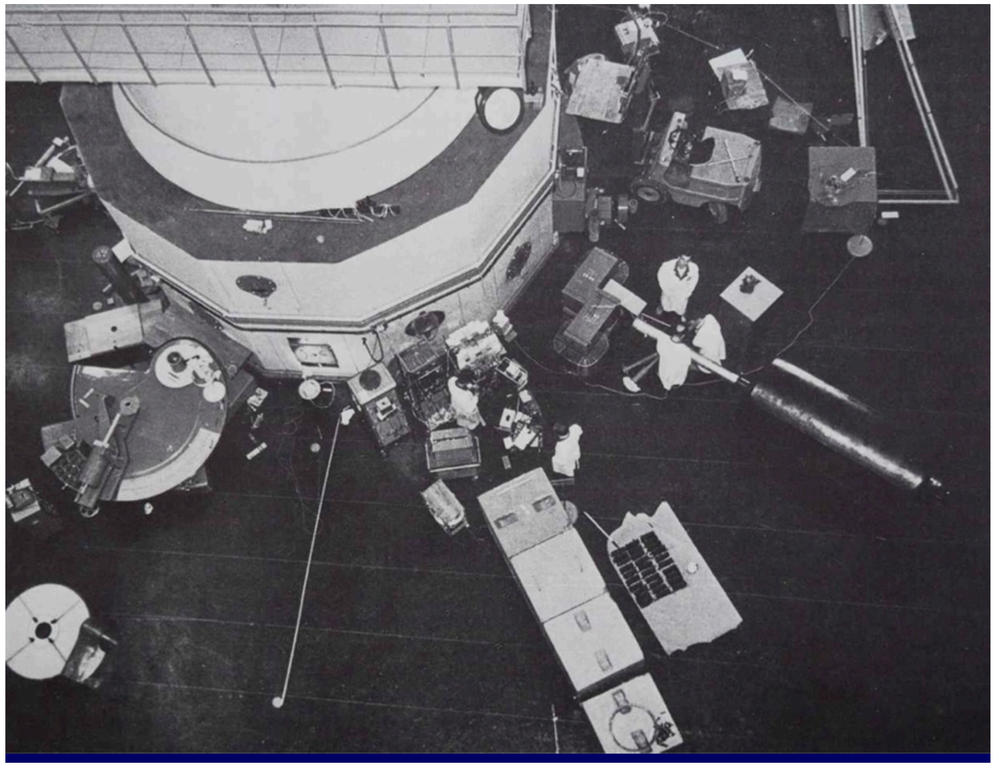
Hans Joachim Specht: Curriculum Vitae

6.6.1936	born in Unna, Westphalia, Germany
1942 -1956	school / Gymnasium in Kamen
1956 -1962	study of physics at LMU Munich, ETH Zürich and TU Munich
1964	PhD in atomic physics at FRM (adviser Maier-Leibnitz, TU Munich)
1965 - 1968	postdoc at Chalk River Nuclear Laboratories (Canada)
1969 - 1973	LMU Munich, habilitation (1970), HS2/3 professor (1971)
1973 - 2004	Full professor at University of Heidelberg
1992 - 1999	Scientific managing director of GSI Darmstadt
2000	member of the Heidelberg Academy of Sciences
research fields:	atomic physics, nuclear fission, ultra-relativistic HI-collisions, neuroscience (musical perception)
CERN collaborations:	R807/808 at the ISR, HELIOS/NA34 (spokesperson), NA45/CERES (founder and spokesperson), NA60 , ALICE
service to community:	member/chairman of numerous (inter)national advisory committees

the team at the **F**orschungs **R**eaktor **M**ünchen (FRM)



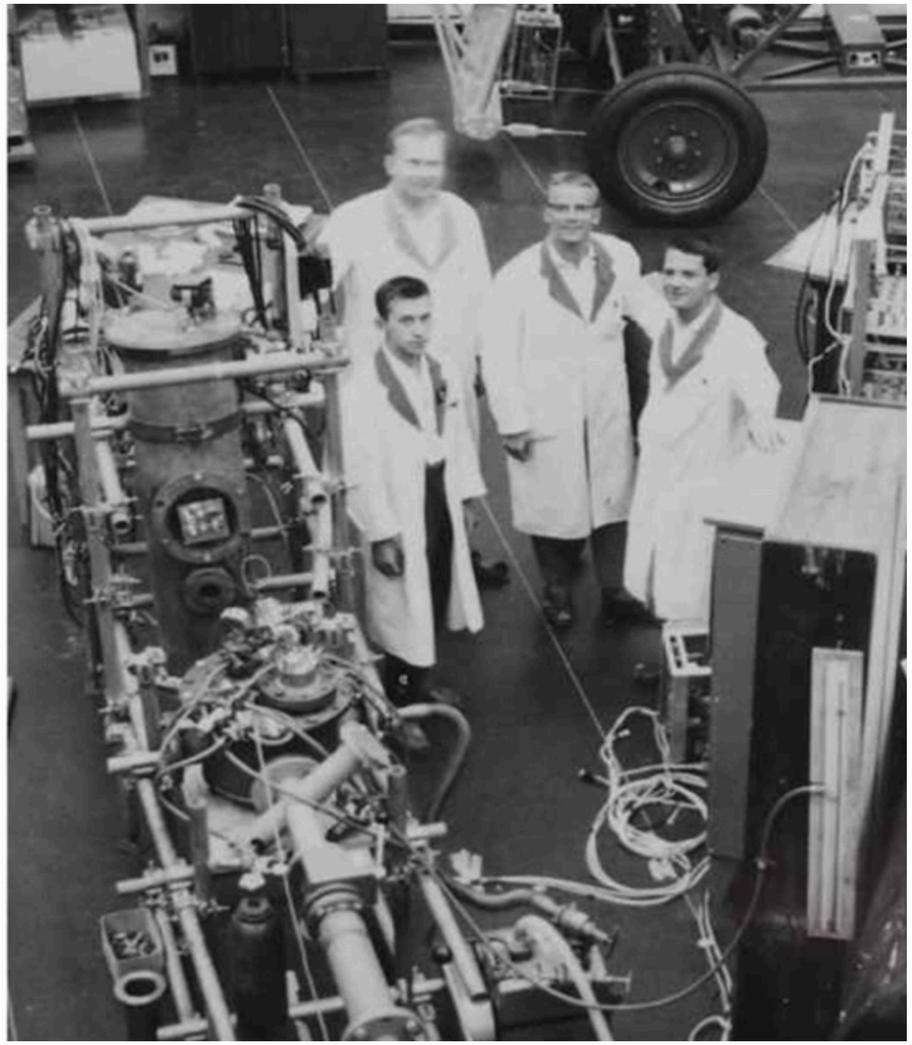
Heinz Maier-Leibniz



FRM Munich; start of operation 1957

heavy-ion (fission fragment) beam:

20 - 80 MeV; intensity: 300/s



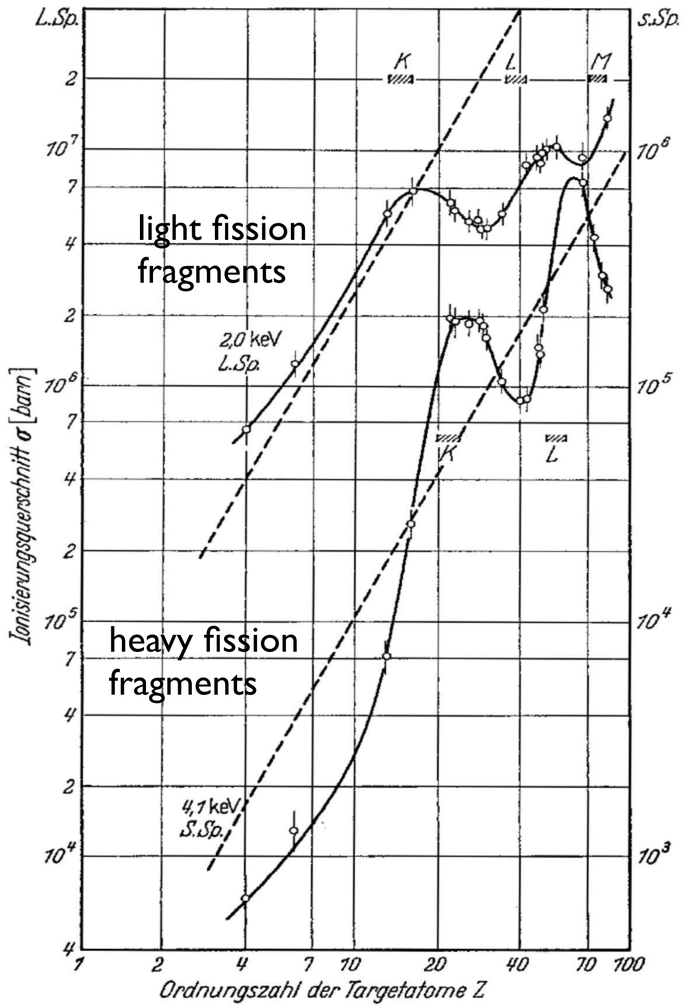
Hans Specht, Peter Armbruster et al.

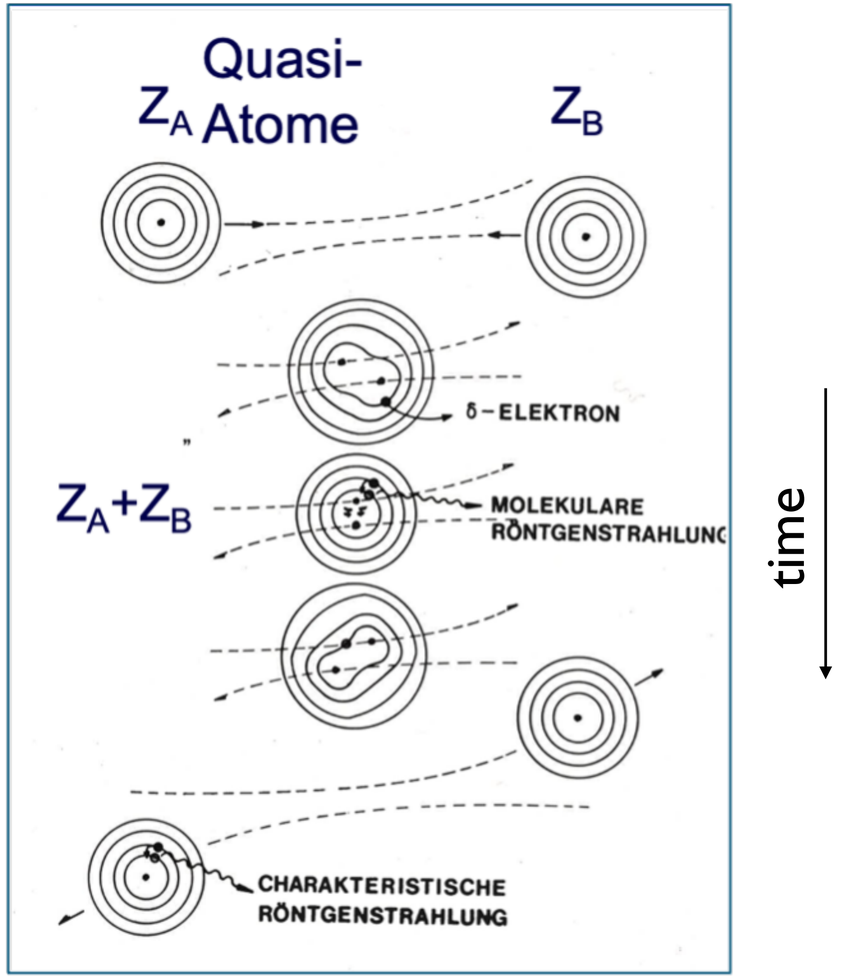
PhD: atomic physics (1964)

using the first heavy-ion beam: fission fragments from the Munich reactor

observation of quasi-atomic x-rays

H.J.Specht. Z.Phys.185 (1965) 8





later further pursued at MPI-HD MP-tandem together with R. Schuch et al. and H. Schmidt-Böcking et al.

the double humped fission barrier

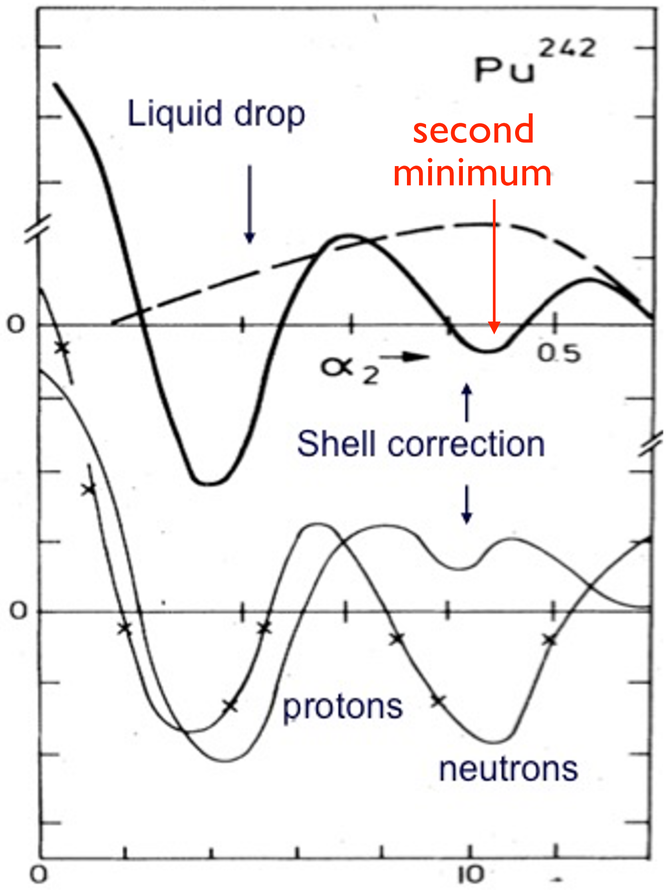
discovery of fission isomers by S. Polikanov et al.

spontaneously fissioning nuclear states with ns $\leq T_{1/2}^{sf} \leq$ ms

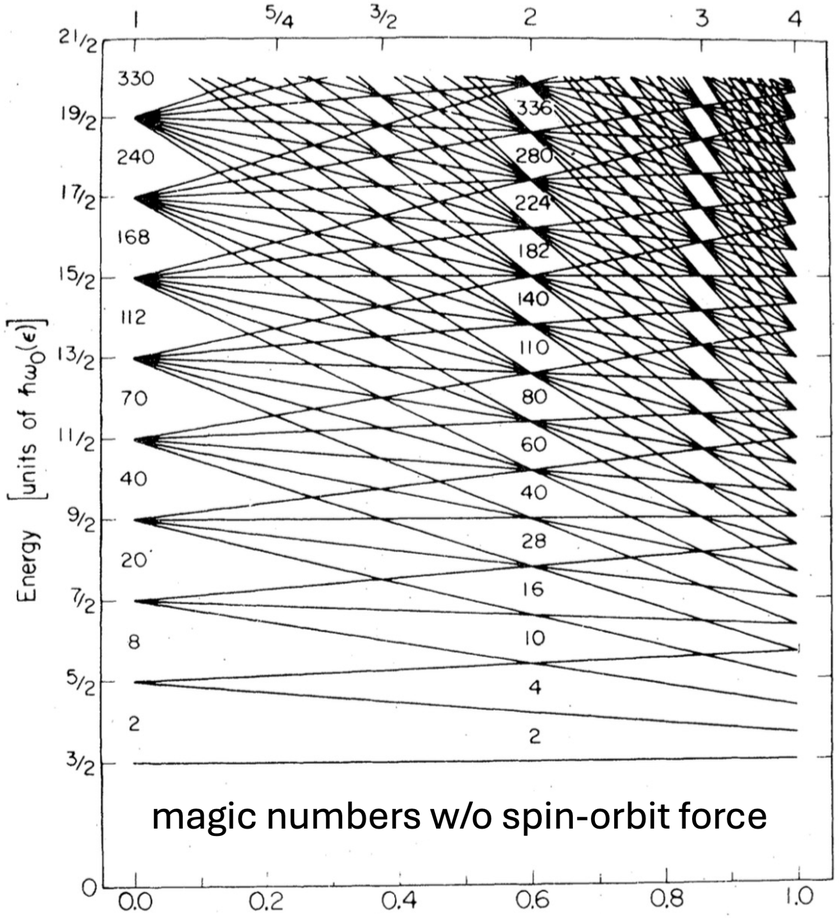
superposition of shell effects on the liquid drop model fusion barrier (V.M. Strutinsky)

→ second minimum in the fission barrier

Liquid drop + Shell correction



Ratio of axes c/a

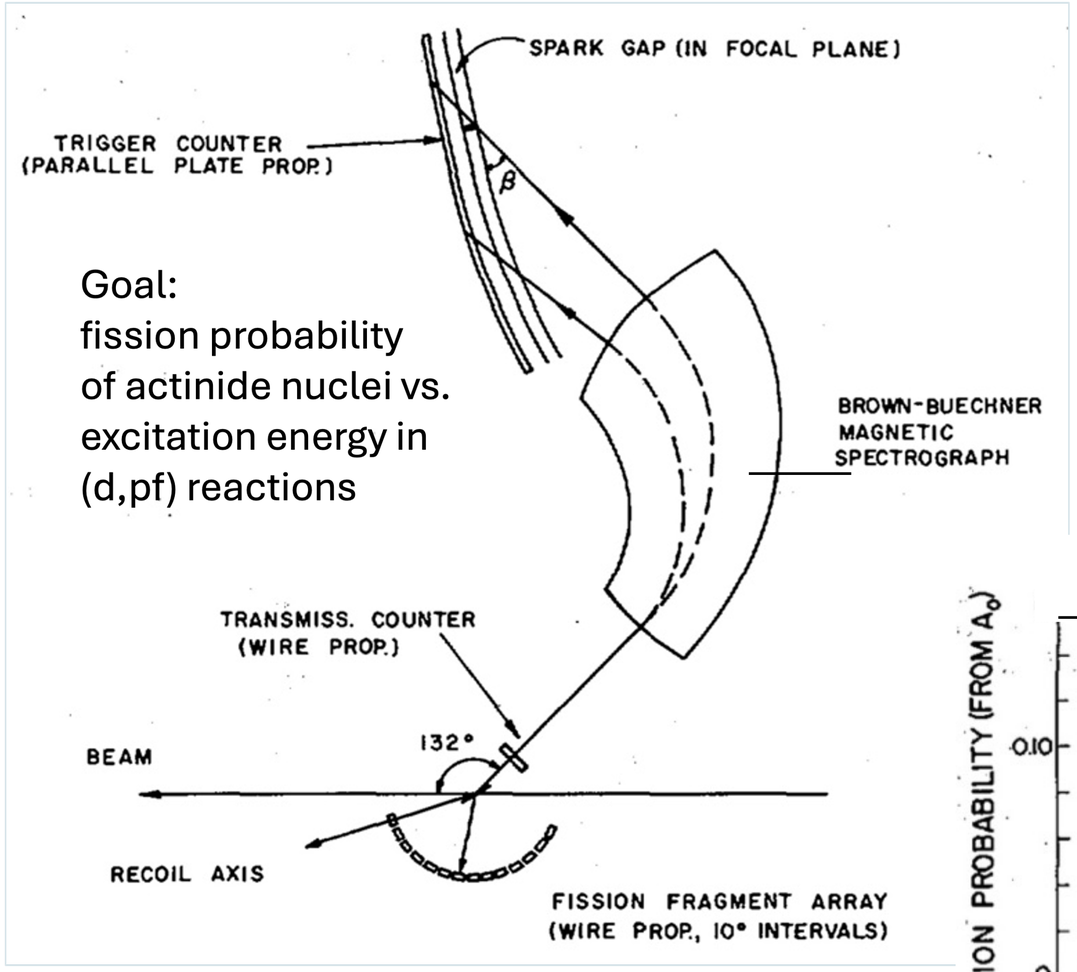


shell gaps occur not only for spherical shapes but also for deformations of c/a = 2/1 and 3/1

the double humped fission barrier: transmission resonances

postdoc at Chalk River Nuclear Laboratories (Canada) :1965-1968

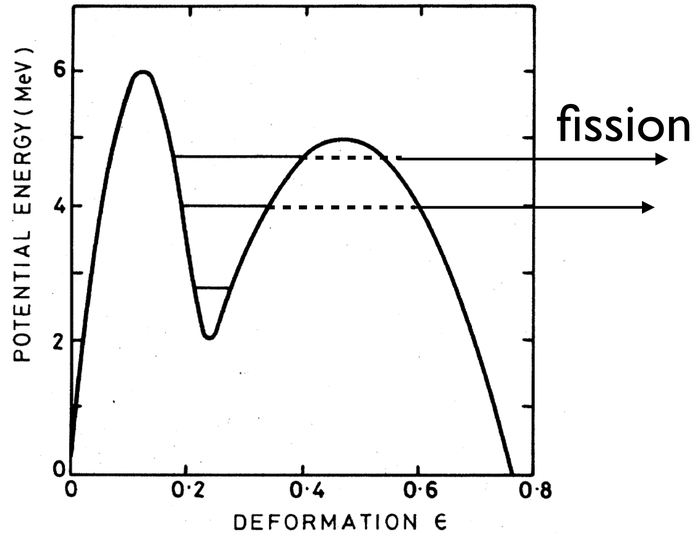
239 Pu (d,pf)

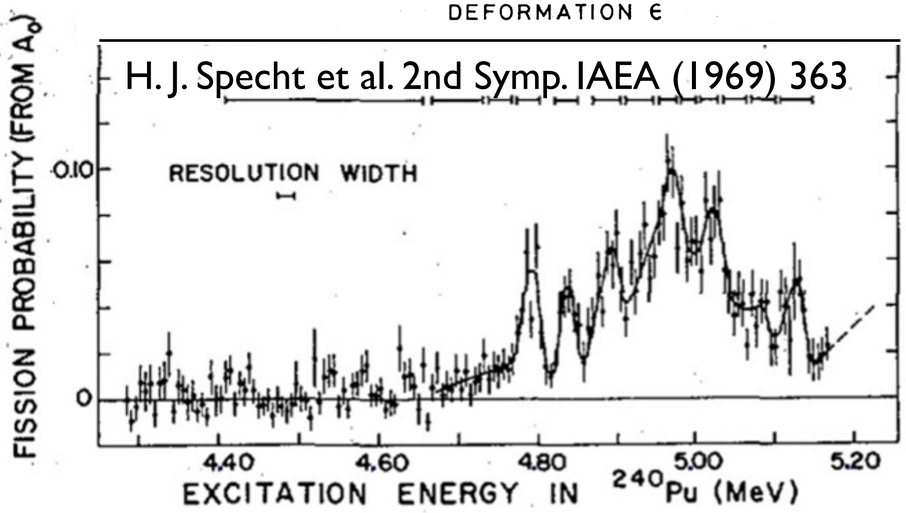


Goal:
fission probability
of actinide nuclei vs.
excitation energy in
(d,pf) reactions

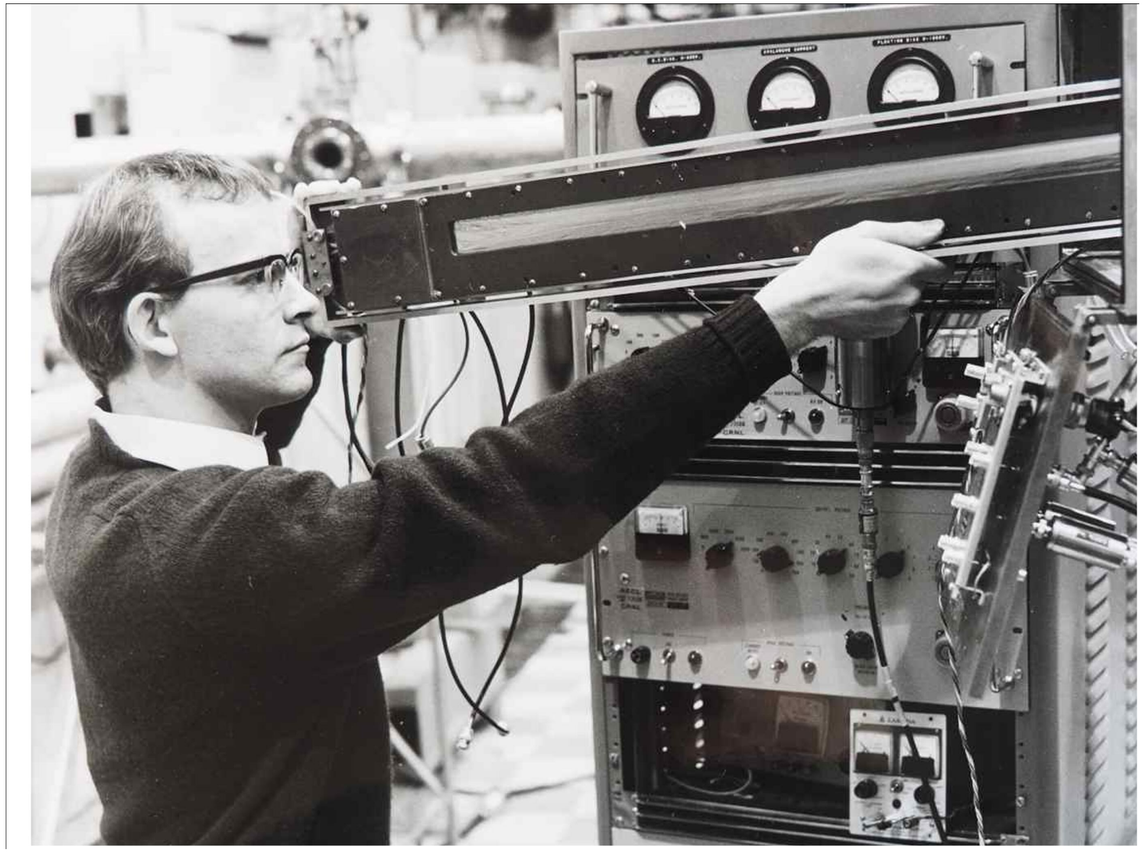
transmission resonance spectroscopy:

vibrational states in the second minimum
as doorway states to fission





the team at Chalk River

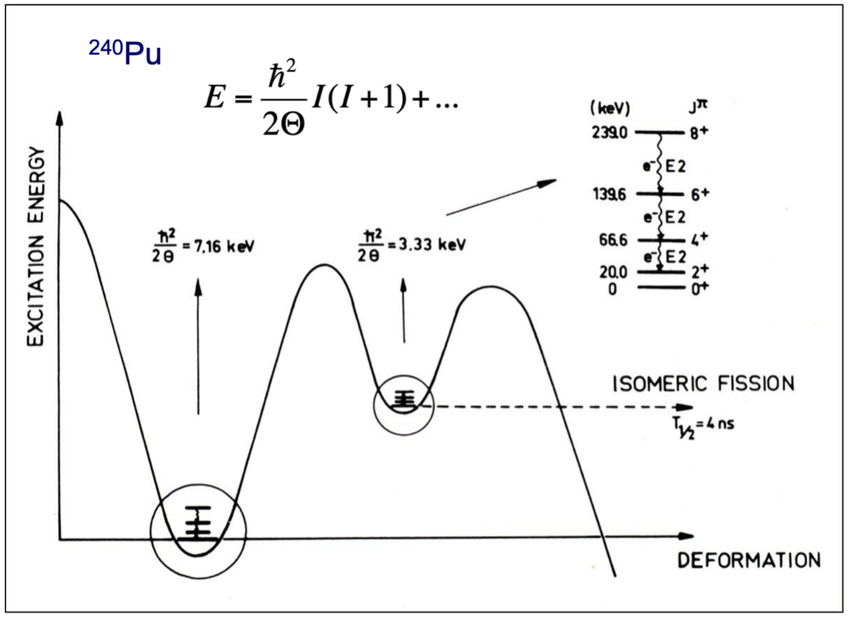


Hans Specht assembling his
position sensitive gas detector

Hans Specht awaiting experimental results
from the most modern computer (VAX)
together with J.C.D. Milton and J. S Fraser

the double humped fission barrier: fission isomers

measurement of conversion electrons in coincidence with delayed fission



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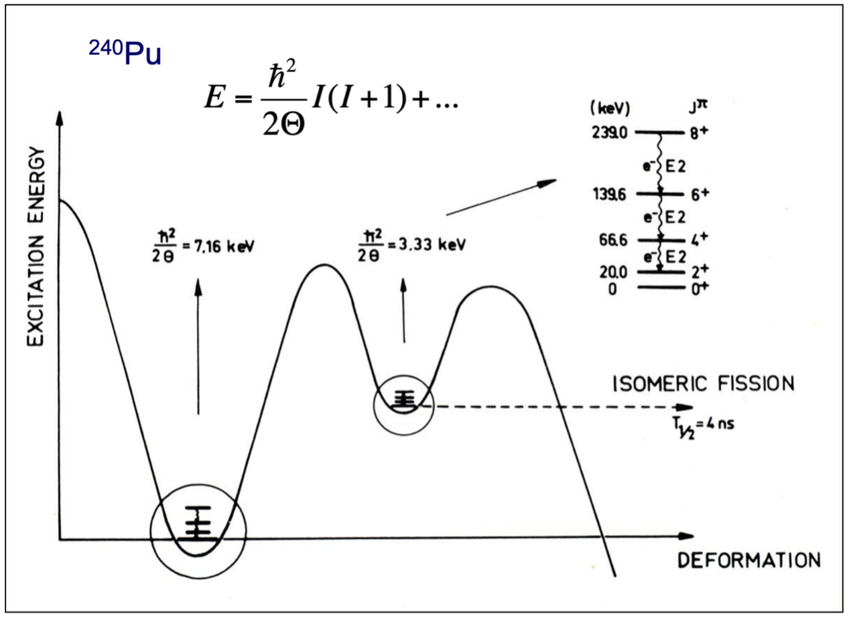
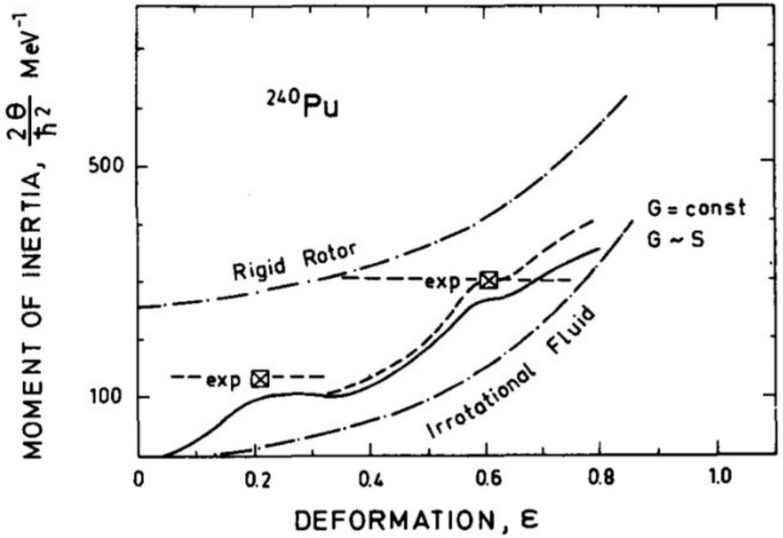




$\Theta_{fis} > \Theta_{rig.rot.}(gs)$

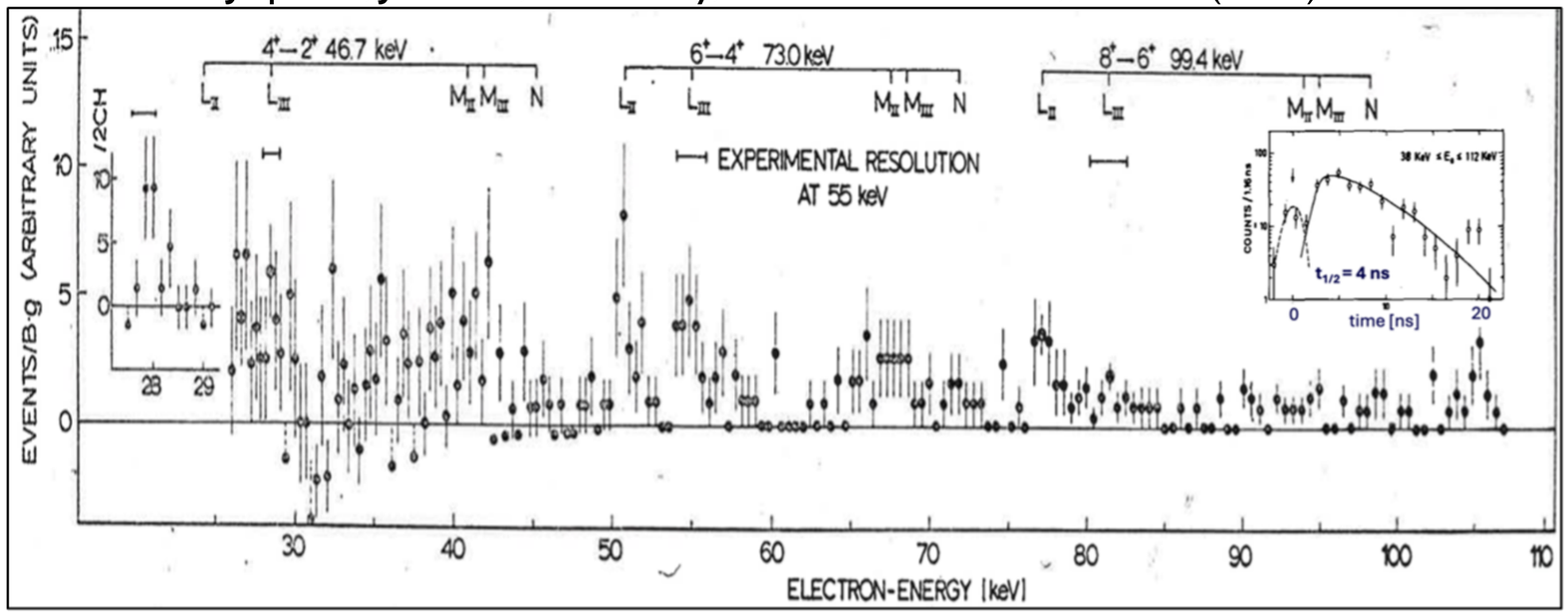
fission isomers = shape isomers !!

H.J.Specht, J.Weber, E.Konecny, and D. Heunemann, PLB 41 (1972) 43

Munich MP-Tandem

$^{238}U(\alpha,2n)^{240m}Pu$

$T_{1/2}^{sf}$=4ns



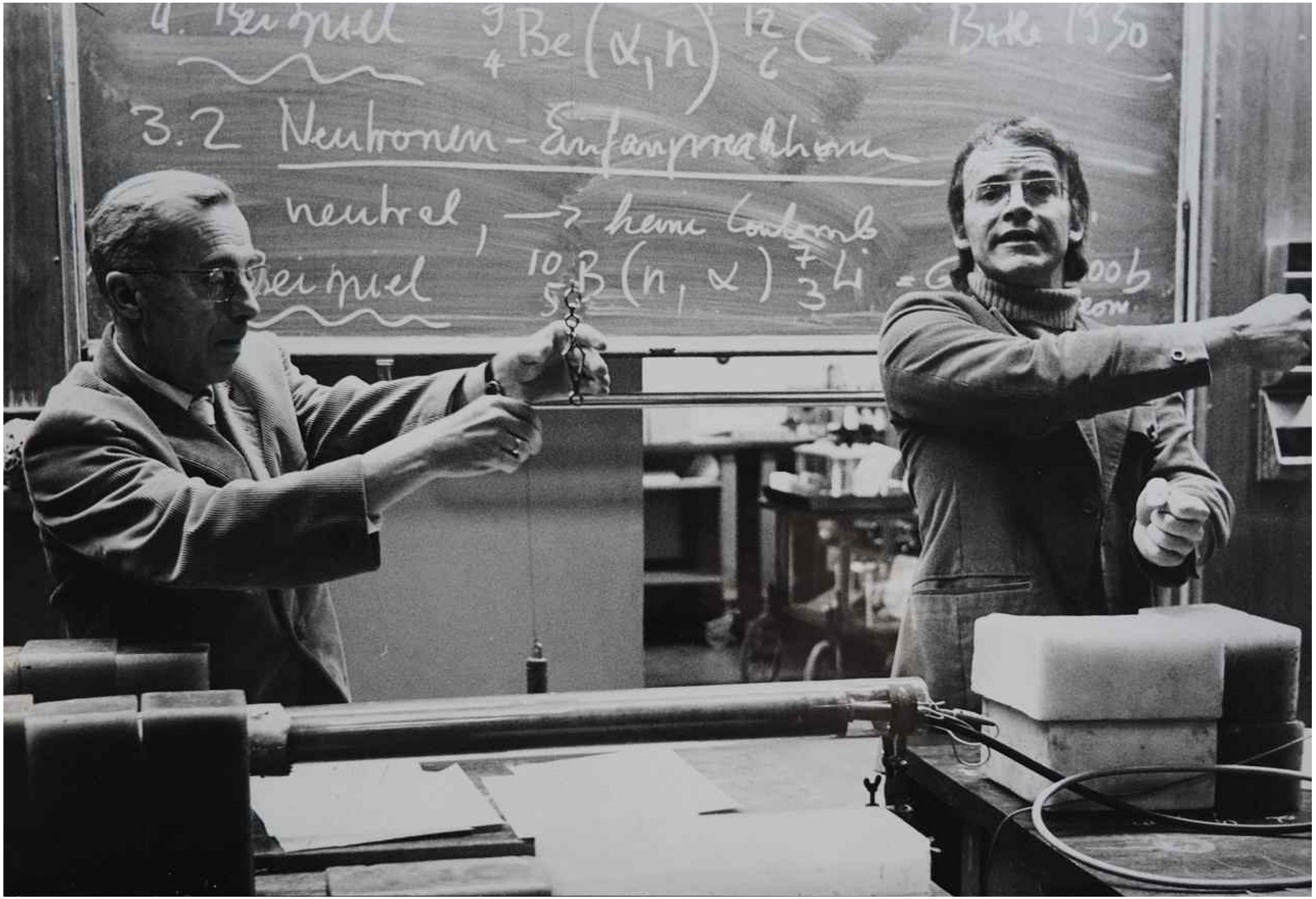
the team in Munich

the MP tandem in Munich

Hans Specht (LMU)

Ewald Konecny (TUM)

test lecture: Experimental Physics I in Heidelberg; winter semester 1972/73

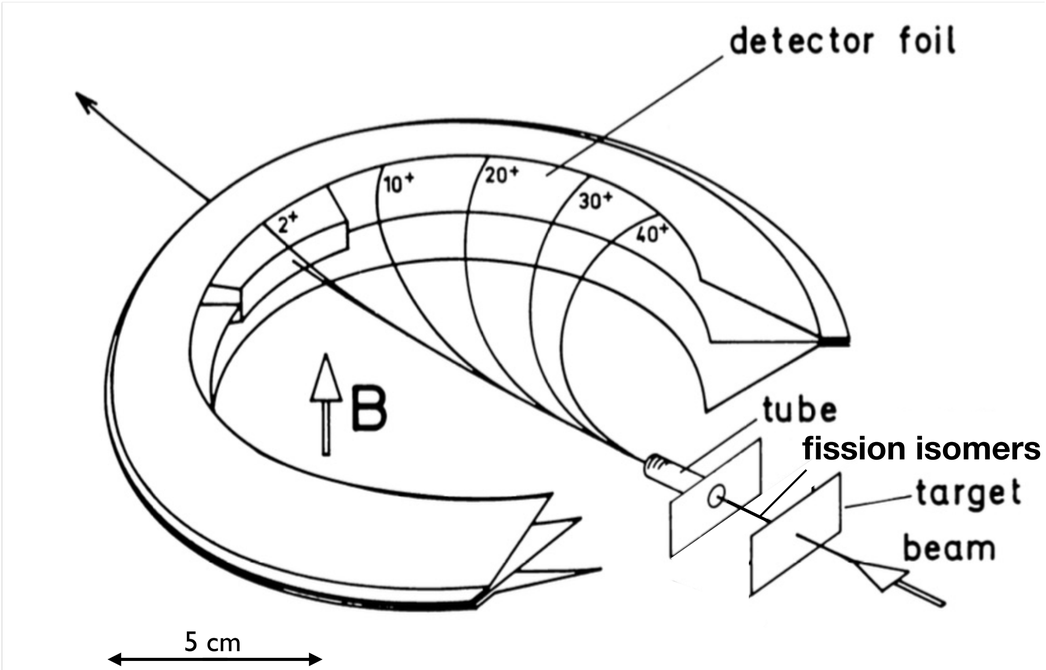


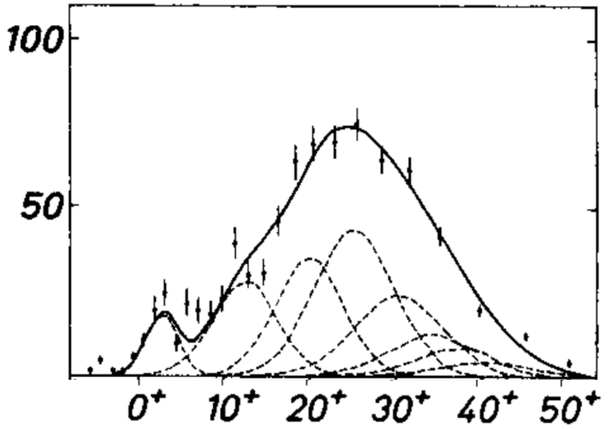
the charge plunger method

D. Habs, V. Metag, H.J. Specht and G. Ulfert PRL 38 (1977) 387

half-lives of rotational states in second minimum: $T_{1/2} \sim E^{-5} \cdot Q_0^{-2}$; →deformation

internal conversion of rotational transitions → high atomic charge states (Auger cascades)





atomic charge states

charge states measured by deflection in magnetic field and subsequent fission isomer decay

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D. Habs, V. Metag, H.J. Specht and G. Ulfert PRL 38 (1977) 387

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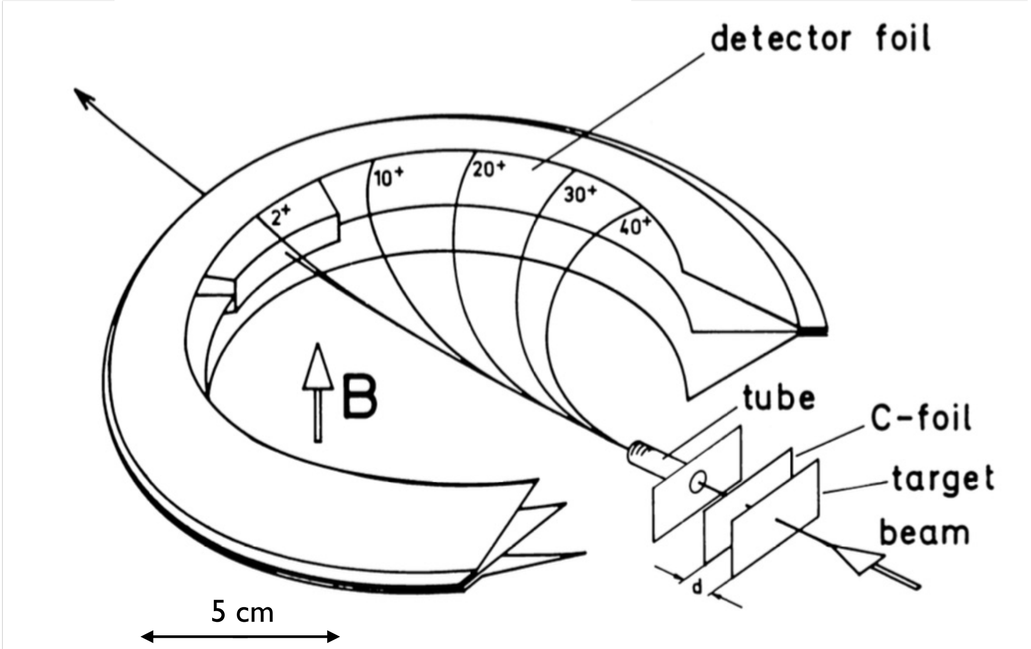
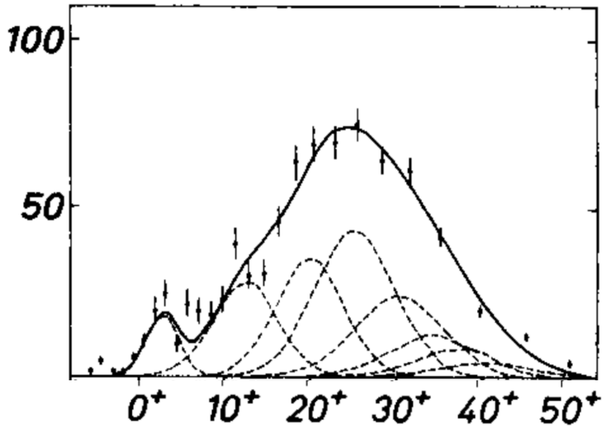
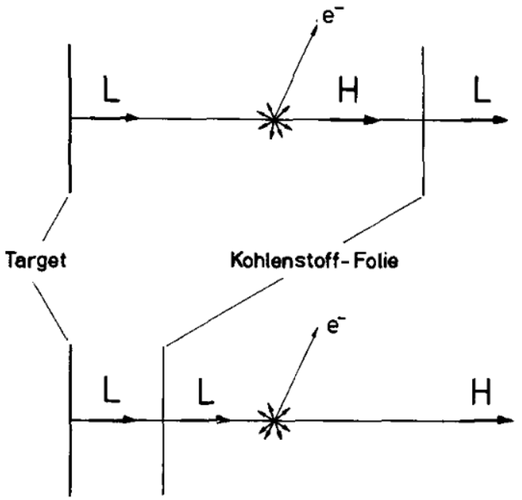


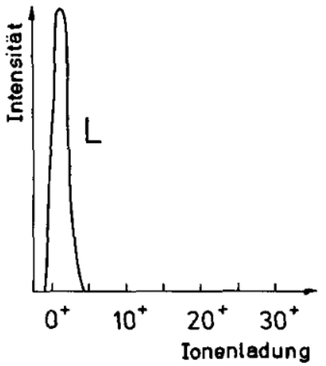
charge state measured by deflection in magnetic field and subsequent fission isomer decay

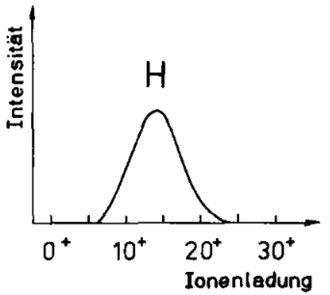
charge states reset in C-foil if rotational transition occurs before reaching the foil otherwise high charge state



atomic charge states

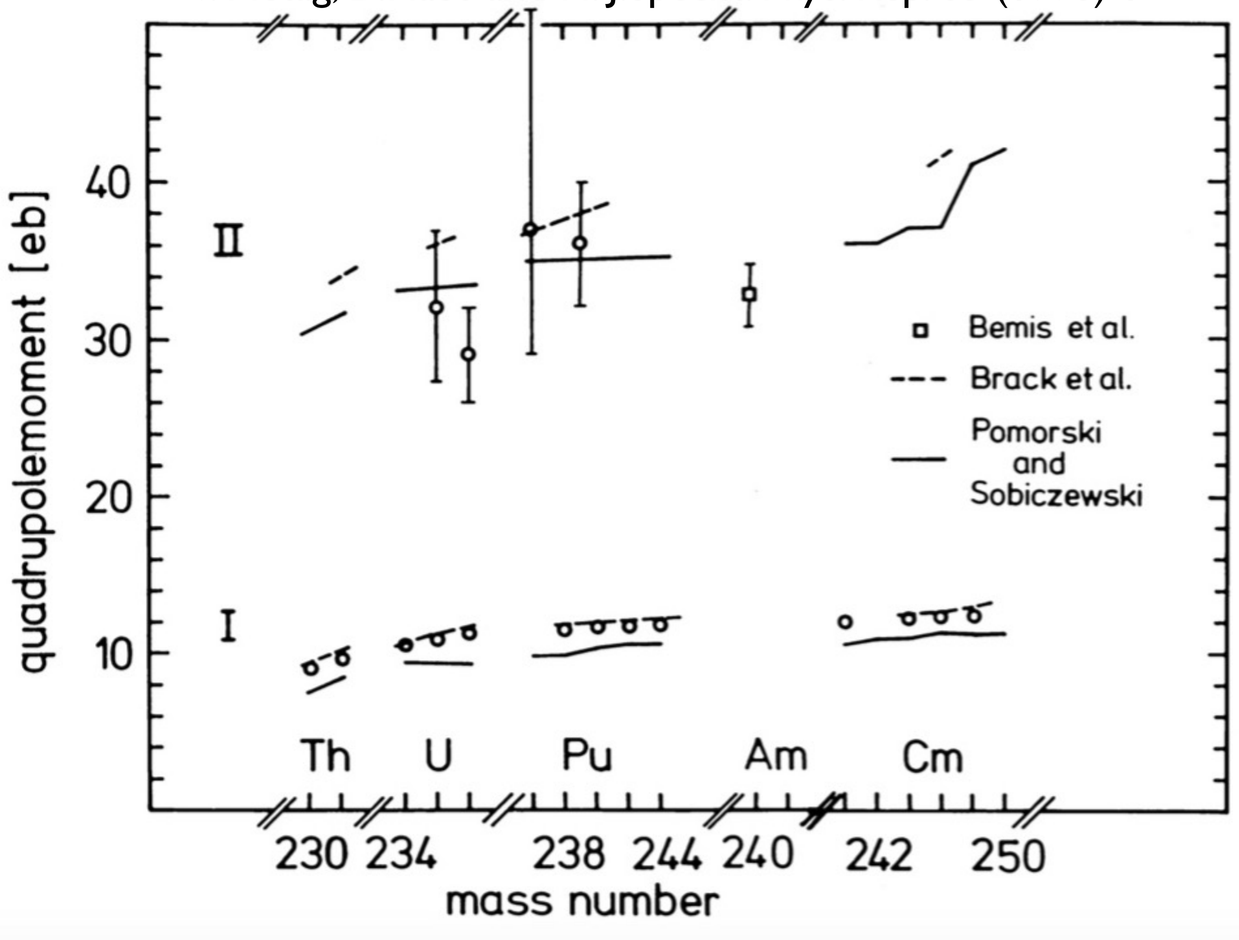


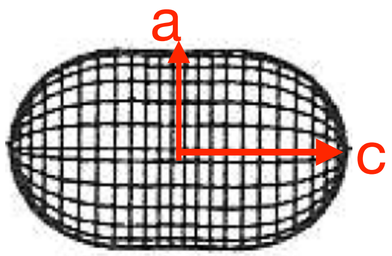




quadrupole moments and deformation of fission isomeric states

V. Metag, D.Habs and H. J.Specht. Phys. Rep. 65 (1998) 1





Q_{fis} = (36±4) b; c/a= 2.0±0.1

$Q_{gs} \approx$ 12 b; c/a ≈ 1.3

fission isomers are cigar-shaped nuclear states with an axis ratio of c/a = 2.0±0.1,

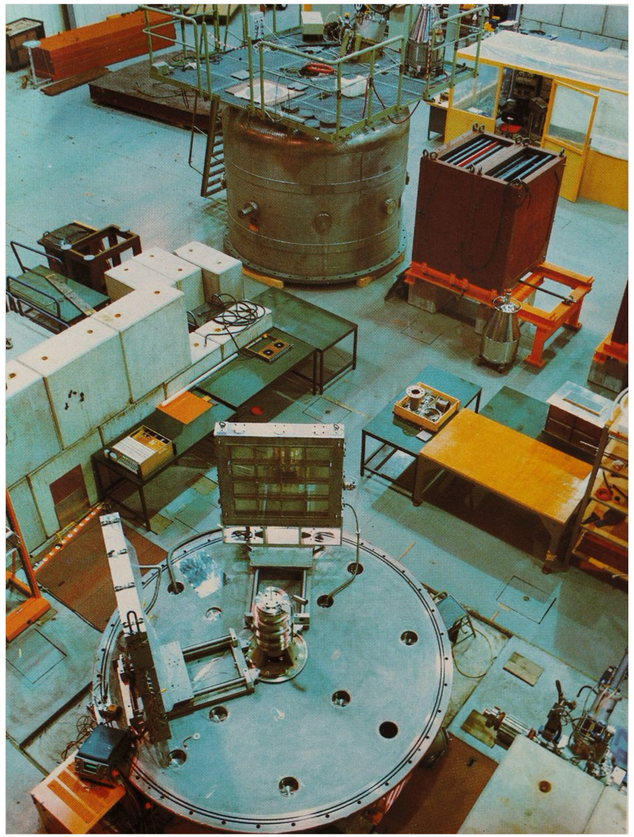
confirming quantitatively that the existence of fission isomers is due to shell effects at large deformation

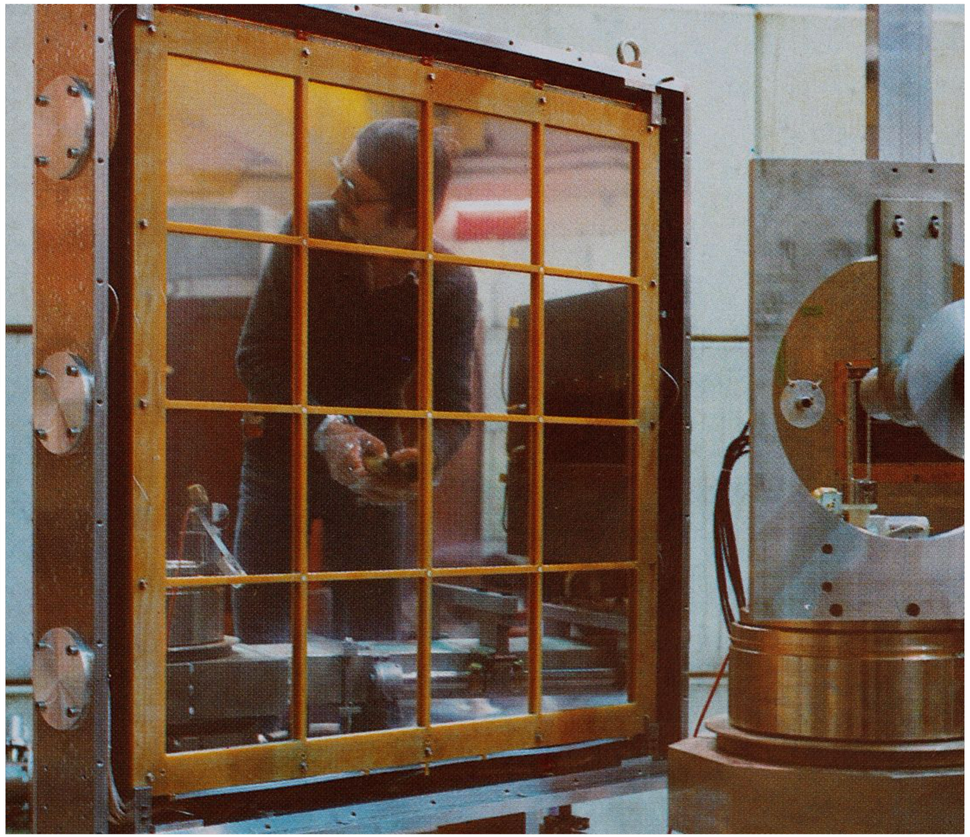
heavy-ion experiments at GSI: Heidelberger Fass

1 m^2 size position sensitive parallel plate gas detectors: TOF; dE/dx

(D. von Harrach, P. Glässel)

kinematically complete measurement of 3 or 4 particles in the final state





Angular momentum transfer in deeply inelastic heavy-ion collisions

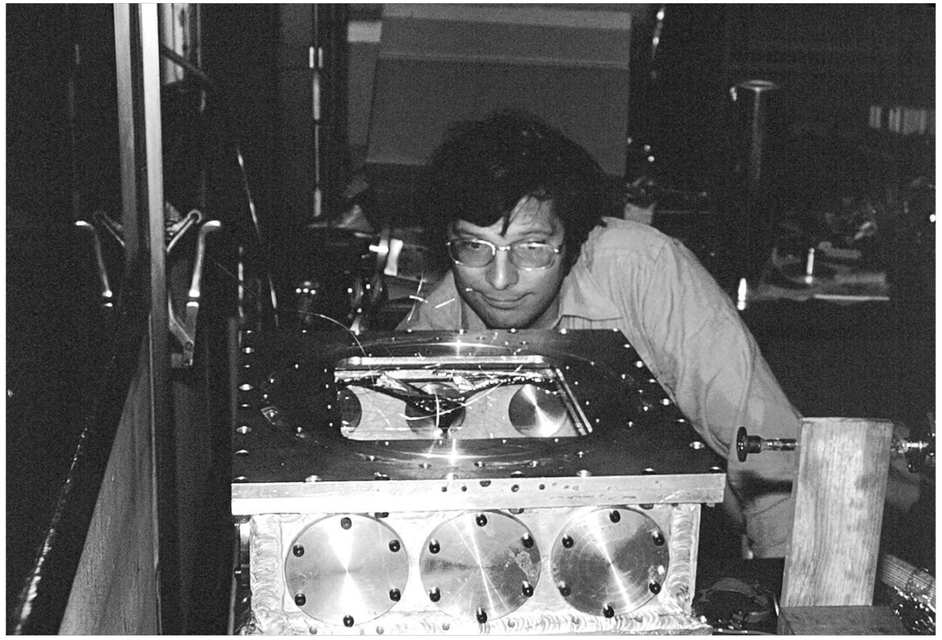
D. von Harrach, P. Glässel, Y. Civelekoglu, R. Männer and H.J. Specht, PRL 42 (1979)1728

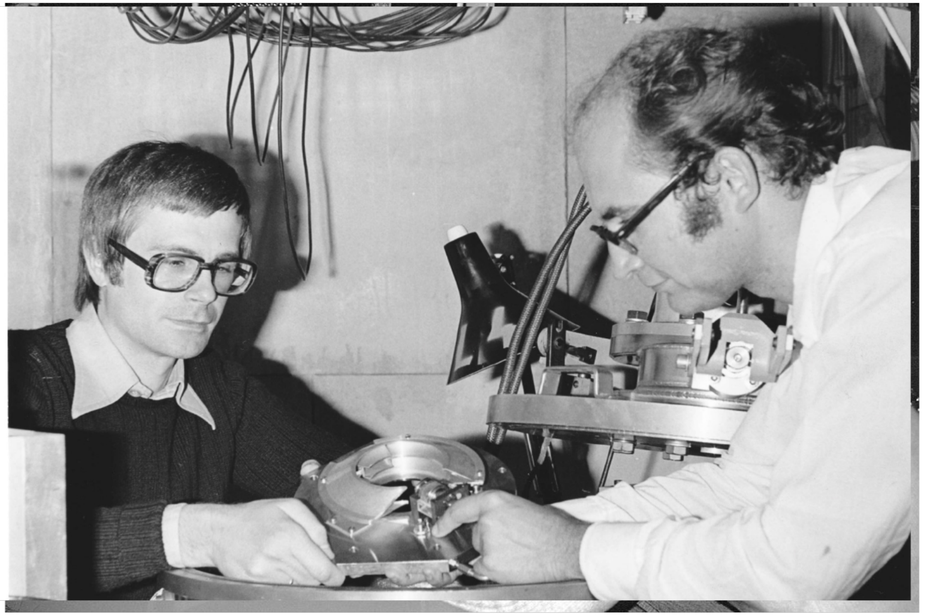
Direct observation of Coulomb fission of ^{238}U with ^{184}W projectiles

H. Backe et al., PRL 43 (1979) 1077

Hans Specht's team in Heidelberg

D. von Harrach, P. Glässel, J. Schukraft, V. Metag, D. Habs





Axel Drees

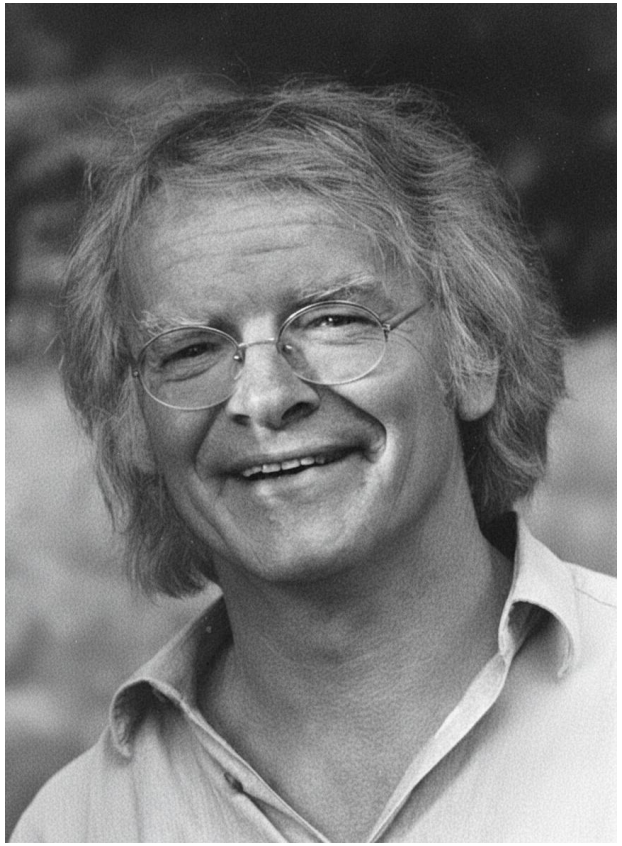
Stony Brook, USA

The Thermal Fingerprint of the Quark-Gluon-Plasma

The Thermal Fingerprint of the Quark Gluon Plasma

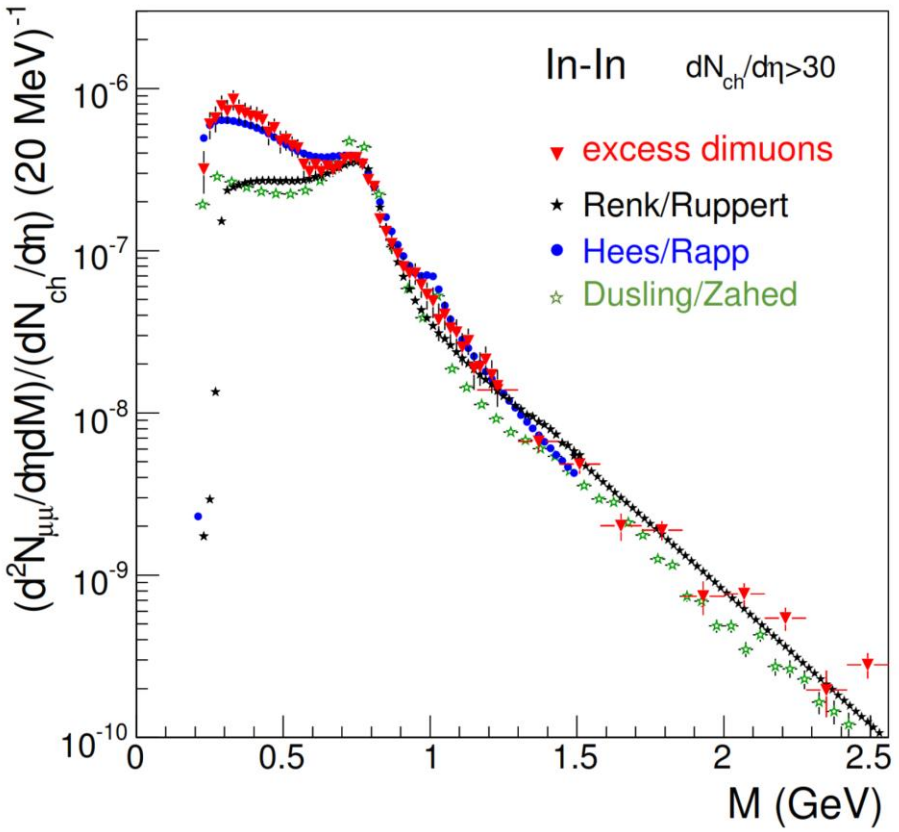
a tribute to Hans J. Specht

Axel Drees, GSI, October 2025



Max Planck Institute, July 1989

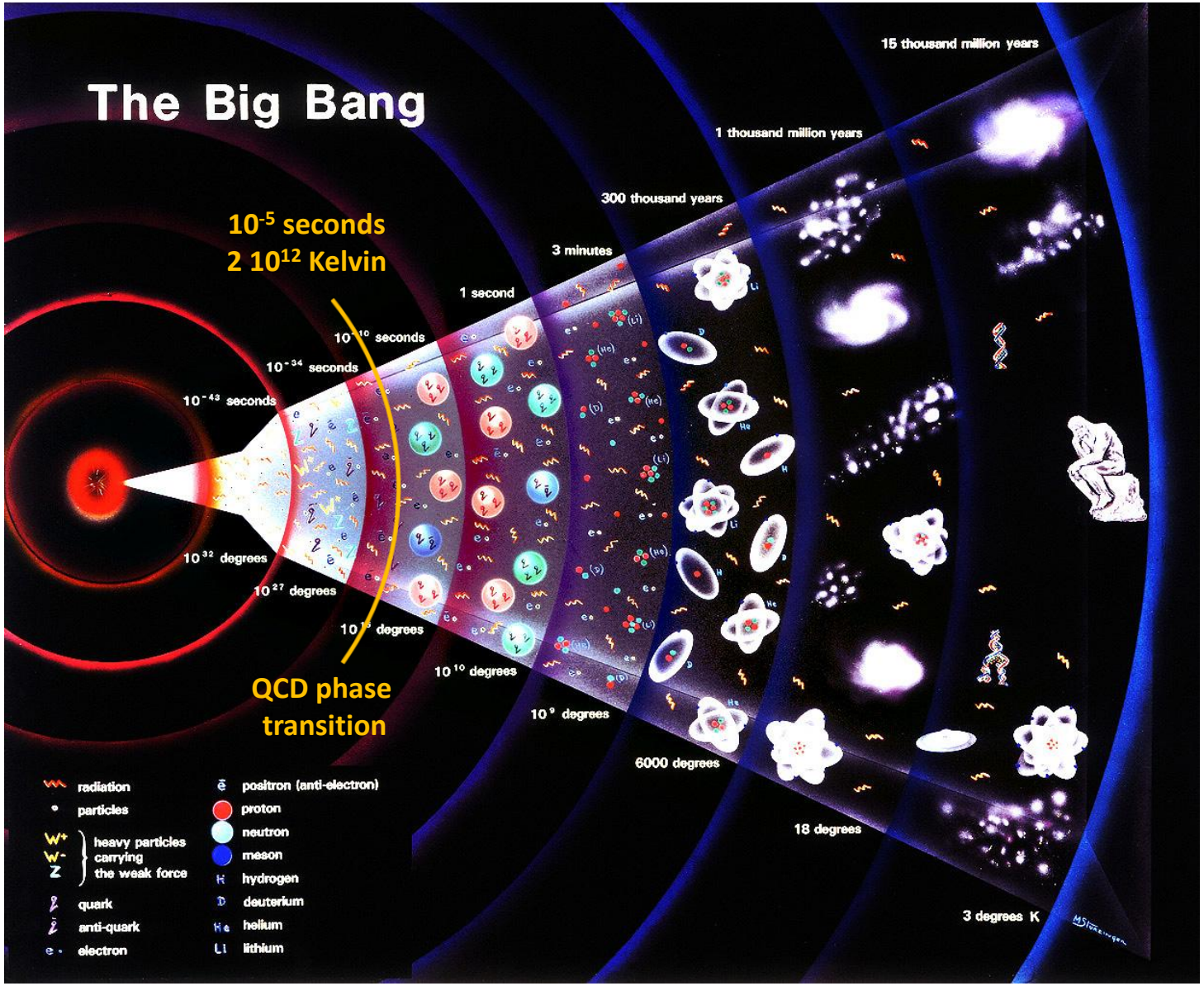
- **Brief Introduction**
- **Early years at CERN**
  - **Dawn of Heavy Ion Physics**
- **An Experimental Masterpiece**
  - **CERES and the perpetual run against time**
- **The State of the Art**
  - **NA60 and the thermal fingerprint of the QGP**
- **Perspectives for the Future**
  - **Status of the Field**
  - **NA60+/DICE the next generation experiment**

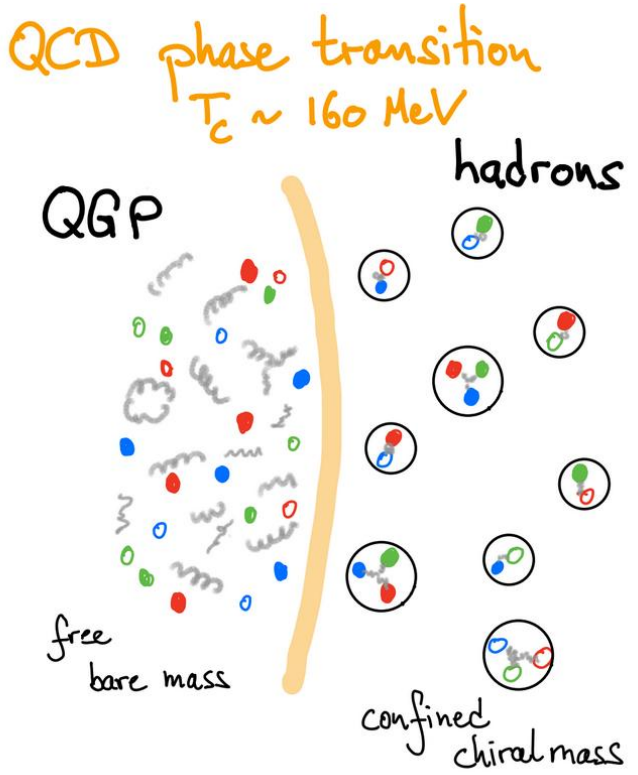


Center for Frontiers in Nuclear Science

Stony Brook University

Little Bang in the Laboratory

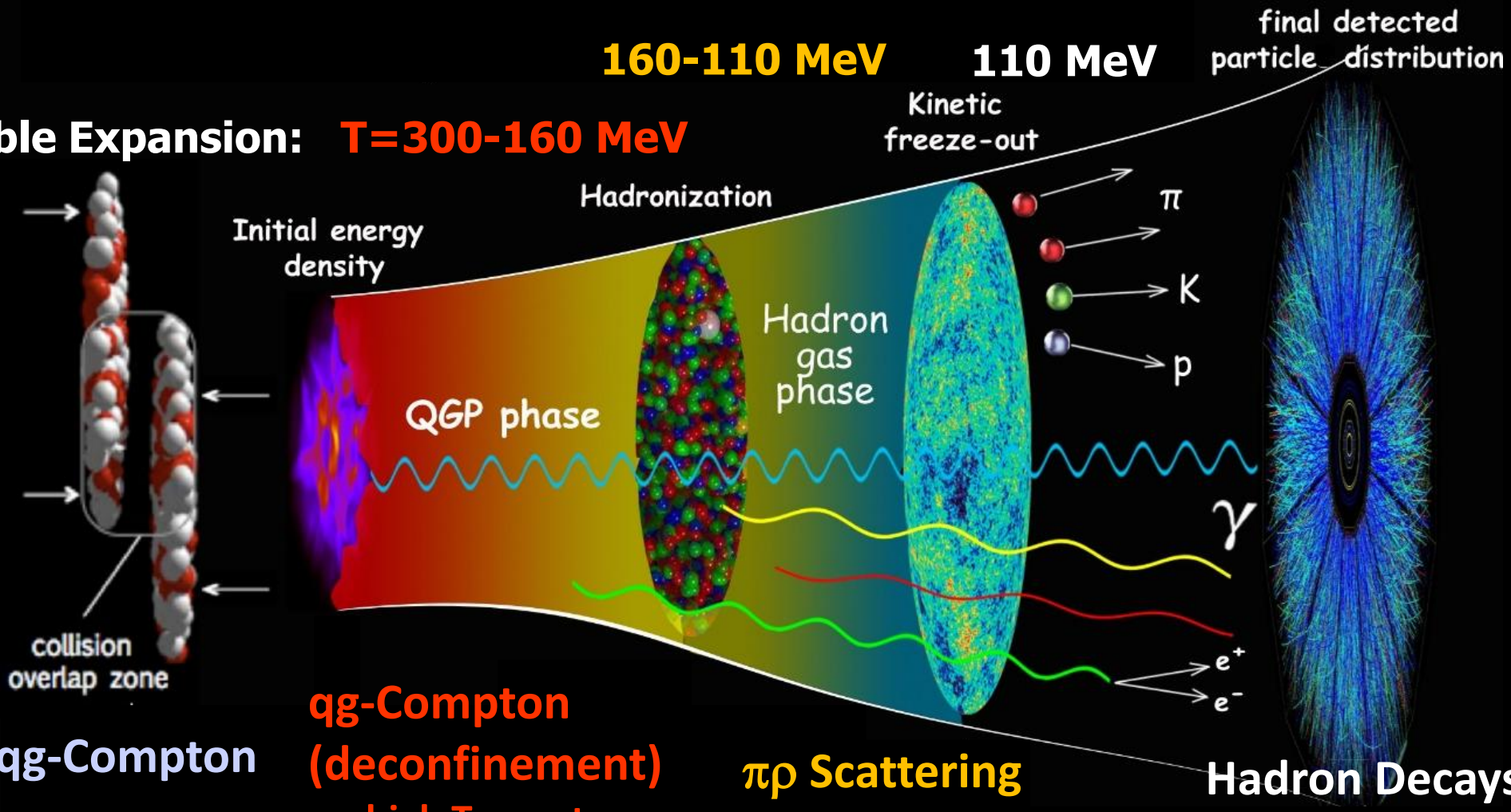




Recreate "little" big bang in Heavy Ion collisions

Study formation of hadrons

Heavy Ion Collisions and the Thermal Fingerprint



Initial qg-Compton

- power law spectrum
- $\propto N_{coll}$
- no collective motion

qg-Compton (deconfinement)

- high T spectrum
- little radial flow
- yield $\propto N_{ch}^{\alpha}$ $\alpha \leq 2$

πρ Scattering

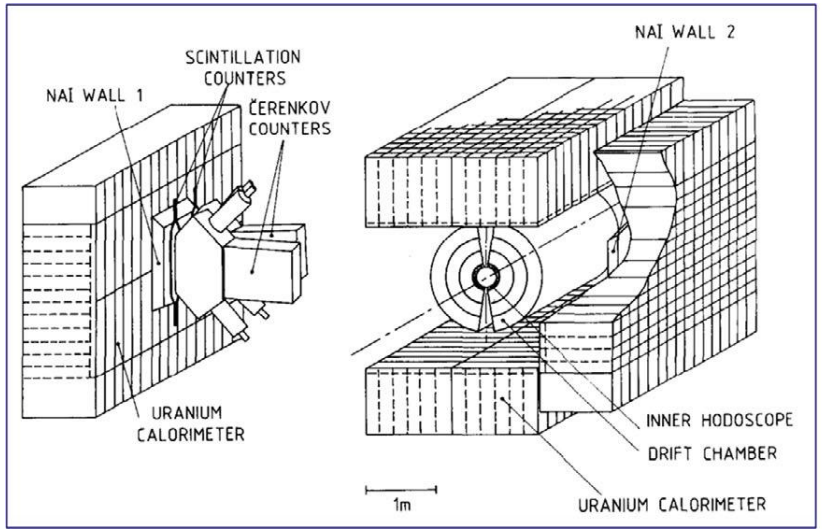
- Low T spectrum
- Large flow/ blue shift
- yield $\propto N_{ch}^{\alpha}$ $\alpha > 1$

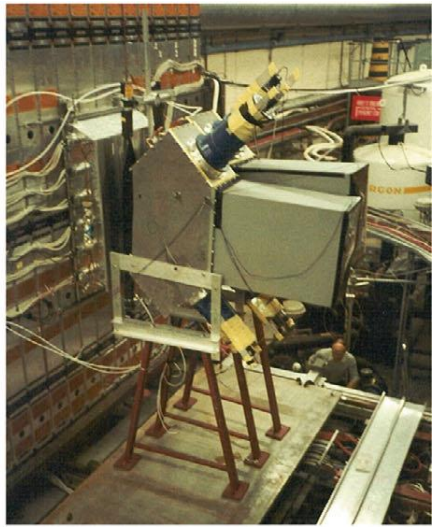
Hadron Decays

- yield $\propto N_{ch}$
- Spectra derived from parent particles

Early years at CERN: Axial Field Spectrometer

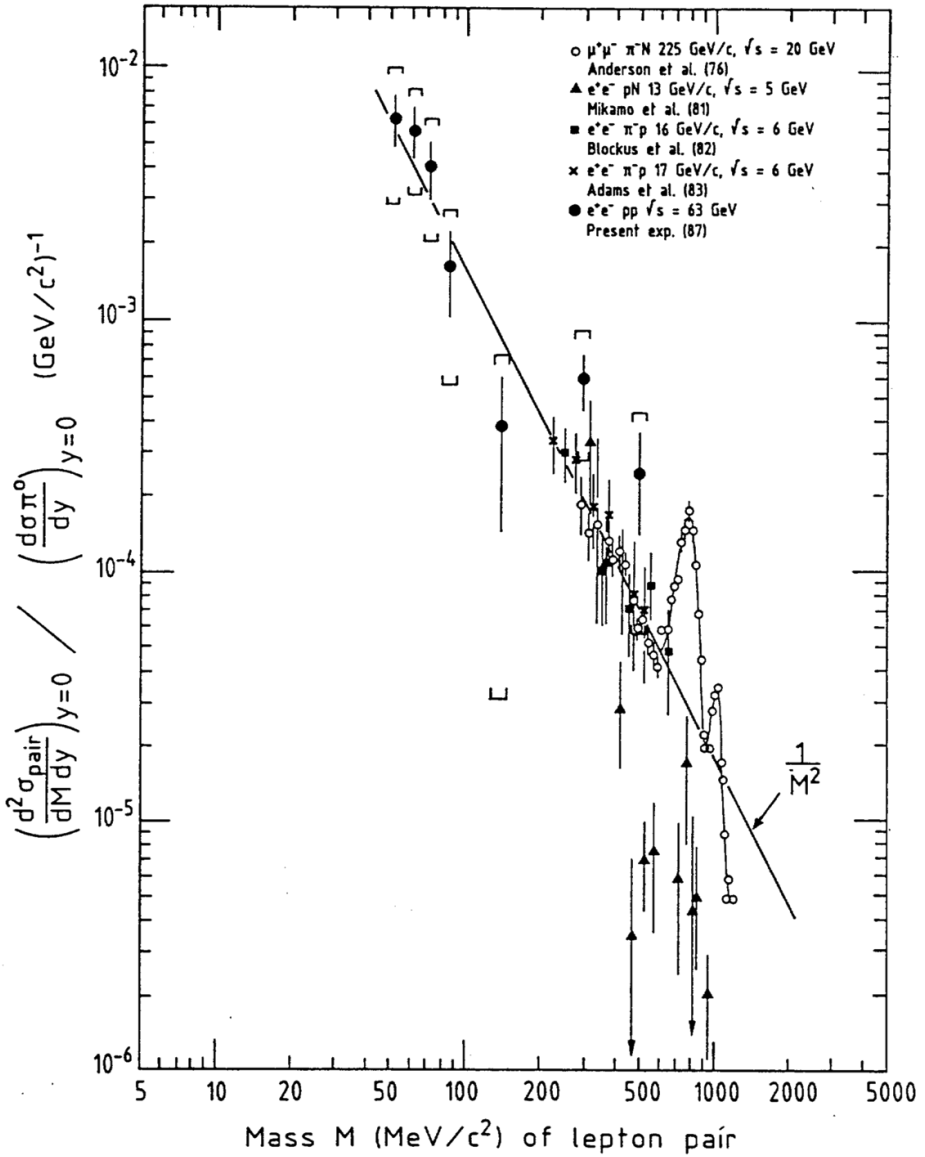
Axial Field Spectrometer (R807/808) at the ISR
1983 – 1985 lepton & dilepton measurements with pp collisions





Apparent enhancement in pp collisions low mass region

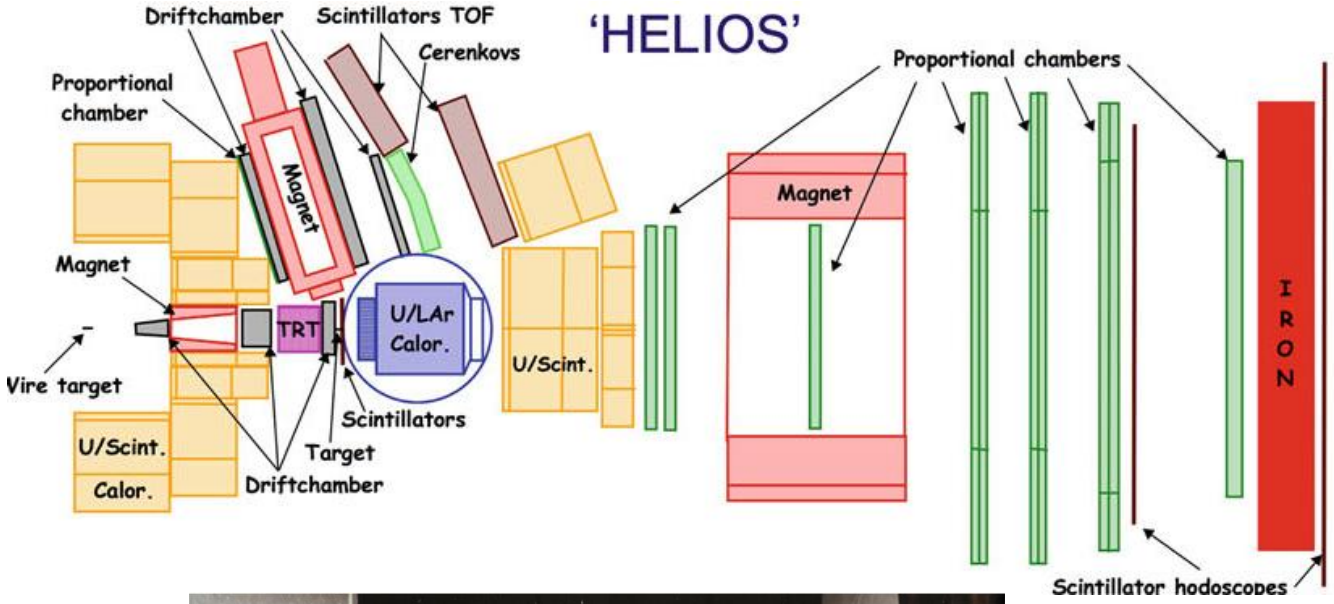
HELIOS-1: incomplete understanding of hadron decay sources

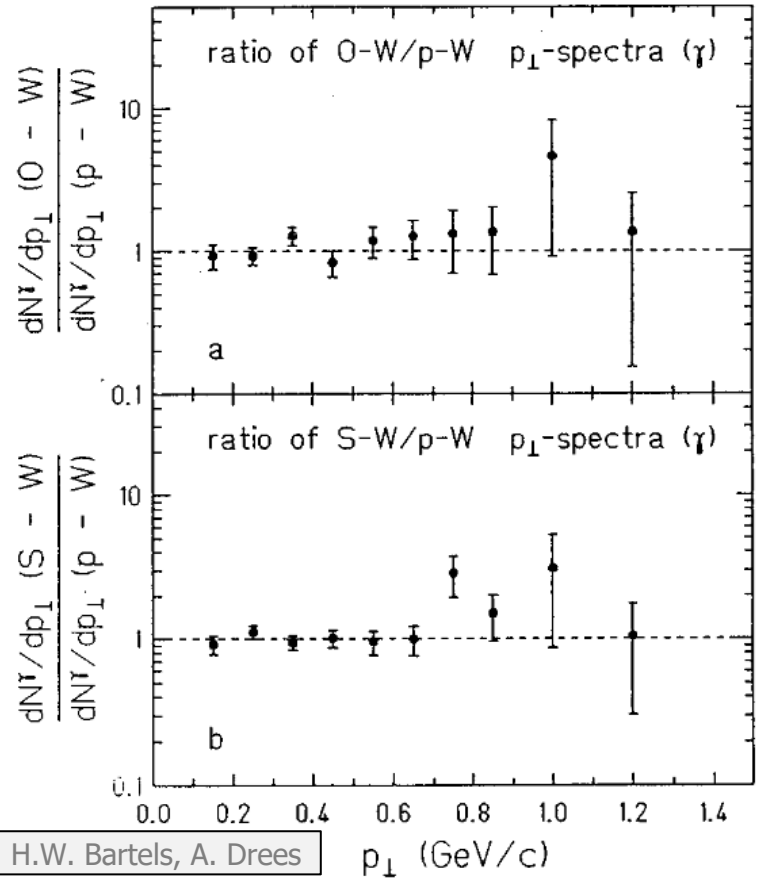


Early years at CERN: HELIOS-2

Spokesperson of HELIOS-2 1984 till 1988/89

HELIOS: Z.Phys. C46 (1990) 361
HELIOS: Z.Phys. C46 (1990) 369





Ph.D. H.W. Bartels, A. Drees

Hadron and photon spectra:
1st upper limit on "thermal photon" production from the QGP

An Experimental Masterpiece: CERES/NA45

CERES Proposal: SPSC P237 July 1988
Addendum October 1988

CERN/SPSC 88-40
SPSC/P237 Add 1
10 October 1988

ADDENDUM to PROPOSAL SPSC/P237

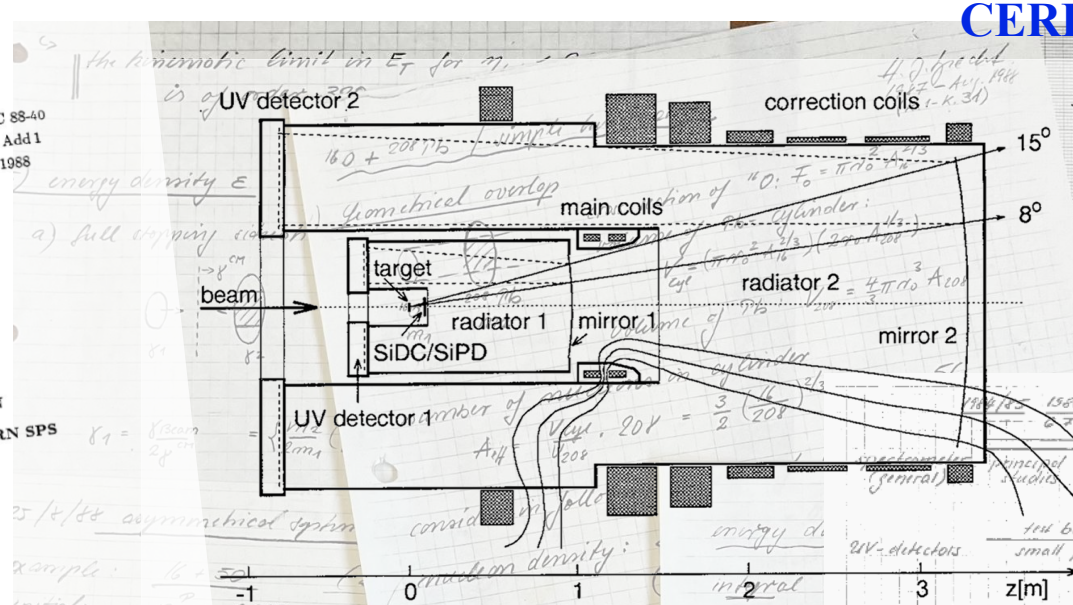
STUDY OF ELECTRON PAIR PRODUCTION IN HADRON AND NUCLEAR COLLISIONS AT THE CERN SPS

J. Schukraft
CERN, Geneva, Switzerland

U. Faschingbauer, M.G. Trauth, J.P. Wurm
Max-Planck-Institut für Kernphysik, Heidelberg, Germany

A. Drees, P. Fischer, P. Glässel, M. Guckes, D. Irmscher, R. Mosbach, L.H. Olsen,
A. Pfeiffer, H. Ries, A. Schön, H. Sickmüller, H.J. Specht (Spokesman), T.S. Ullrich
Physikalisches Institut, Universität Heidelberg, Germany

E. F. Barasch, A. Breskin, R. Chechik, Z. Fraenkel,
D. Sauvage, V. Steiner, I. Tserruya
Weizmann Institute of Science, Rehovot, Israel

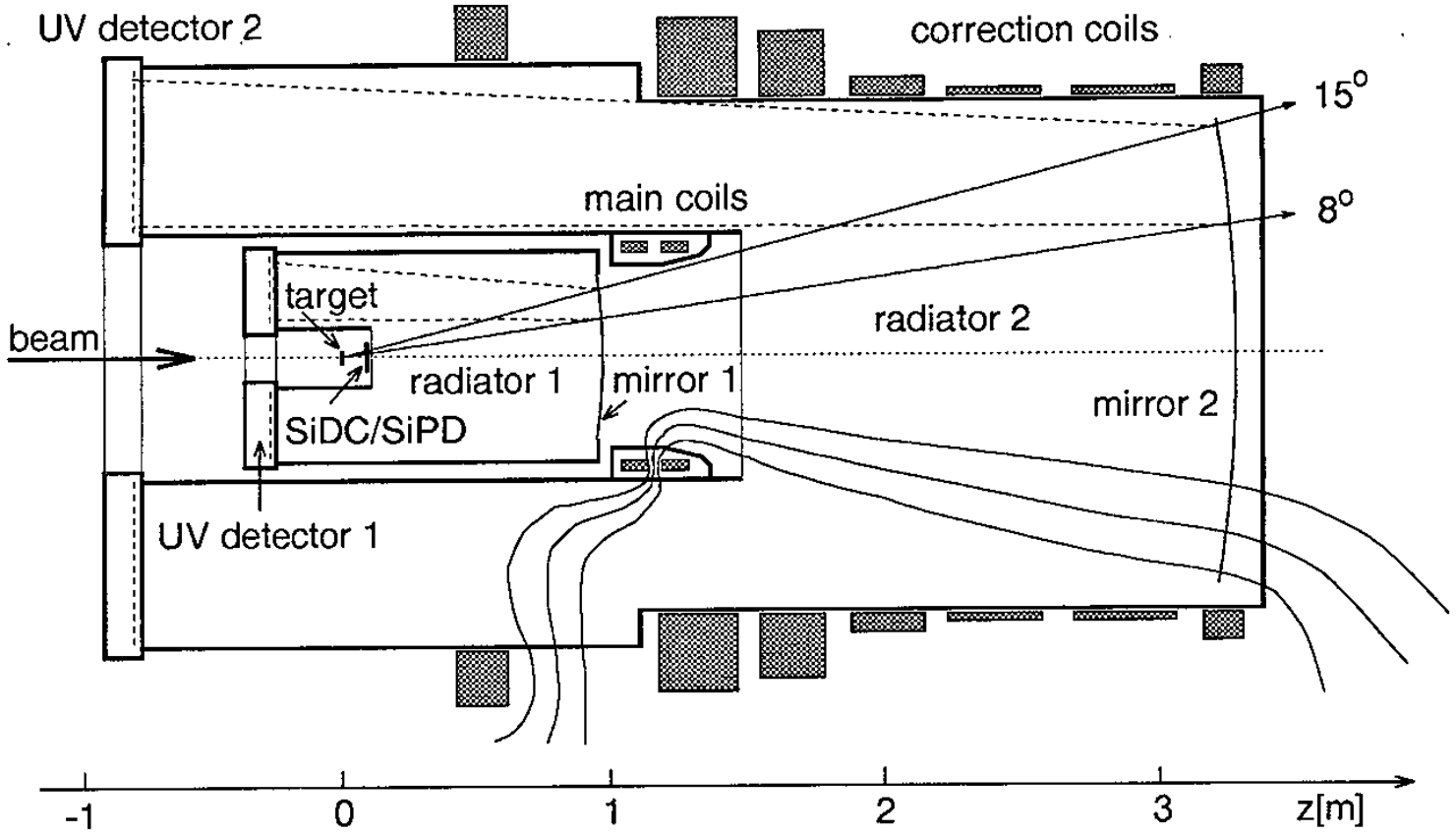


10/1988 2/1990
construction
physics

CERN (1)
MPI Heidelberg (3)
Universität Heidelberg (13)
Weizmann Institute, Rehovot (7)

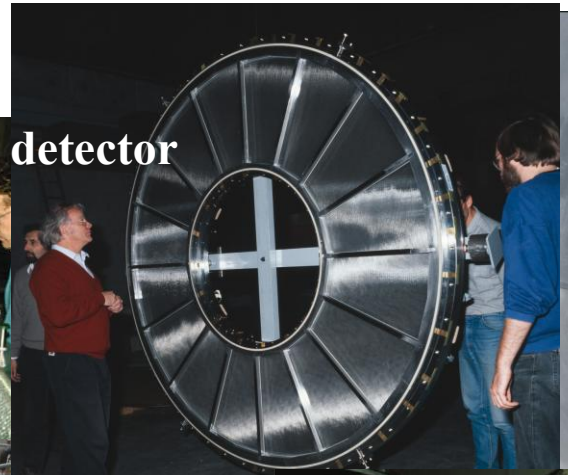
CERES: Hadron Blind e^+e^- Pair Spectrometer

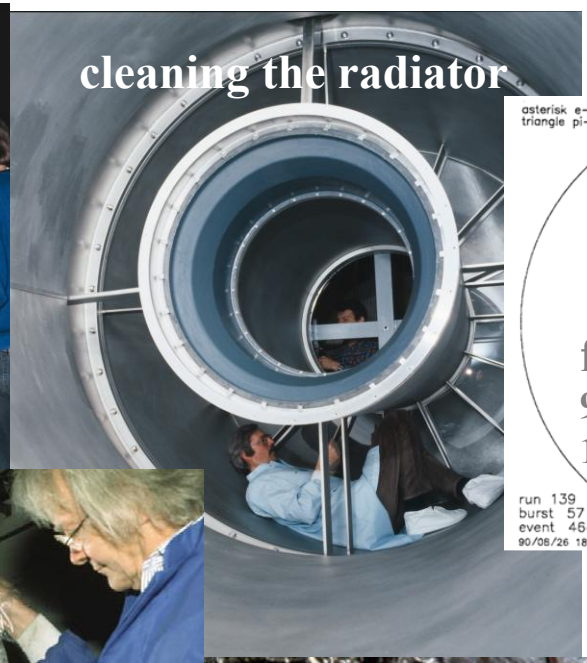
- **RICH detectors in the 1980's**
  - Concept proposed 1977
  - Feasibility not yet demonstrated
  - Only large-scale application DELPHI, would start operation in 1989
- **Other cutting-edge components**
  - Carbon fiber mirror 1
  - Superconducting main magnet
  - Sophisticated field shaping
  - Silicon Pad Detector
  - Multiprocessor 2nd level trigger
  - 120,000 readout channels
  - VME based data acquisition
  - …..
- **Silicon Drift detector (added 1990)**
  - Proposed in 1984
  - First use in CERES experiment

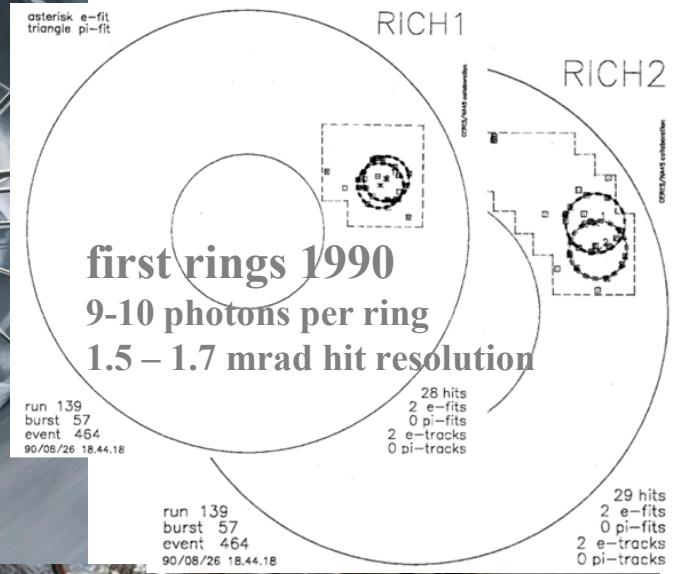


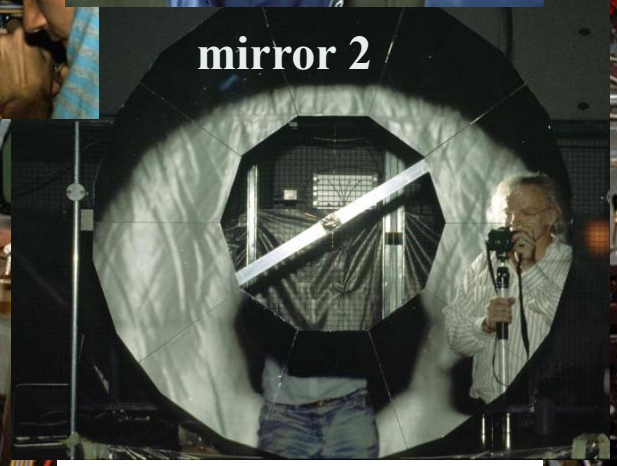
Cutting-edge technology and streamlined design

CERES: Construction 1989 and early 1990





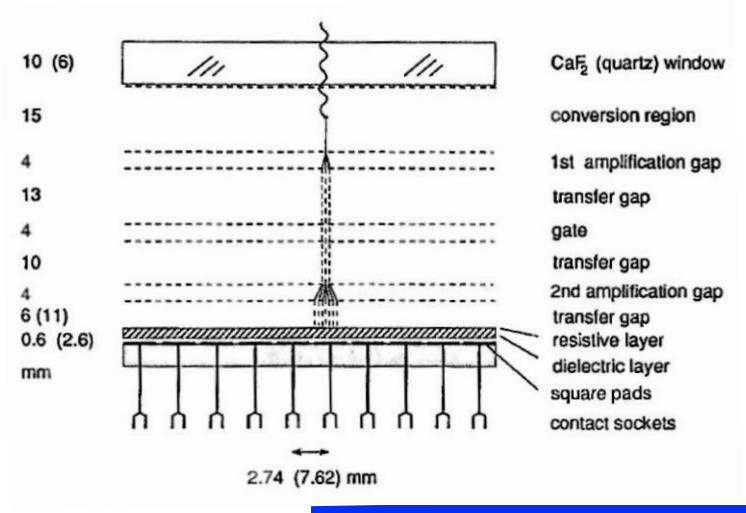




CERES: Catastrophic Sparking 1991

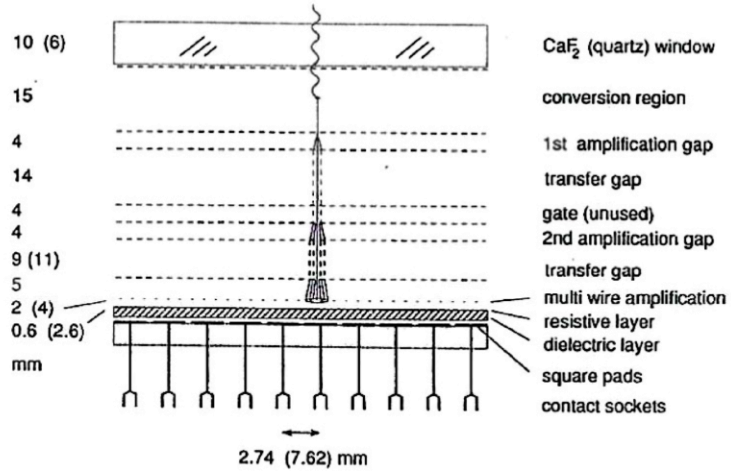
Gated parallel plate amplification

- UV detector operation
  - unstable at design gain ~ 2 10^5 despite gating
  - 100% spark probability from slow protons
  - >100 ms HV recovery time -> 1-2 Hz data rate
  - significant damage to electronics



MWPC amplification stage

- UV detector operation
  - self quenching amplification to < 10^8 charges
  - stable at design gain ~ 2 10^5 without gating
- Modification for 1992
  - replace PPAC with MWPC in UV1 and UV2
  - UV2: add diode protection to 60,000 channels
  - UV1: 2nd gen. modules replacing 60,000 channel



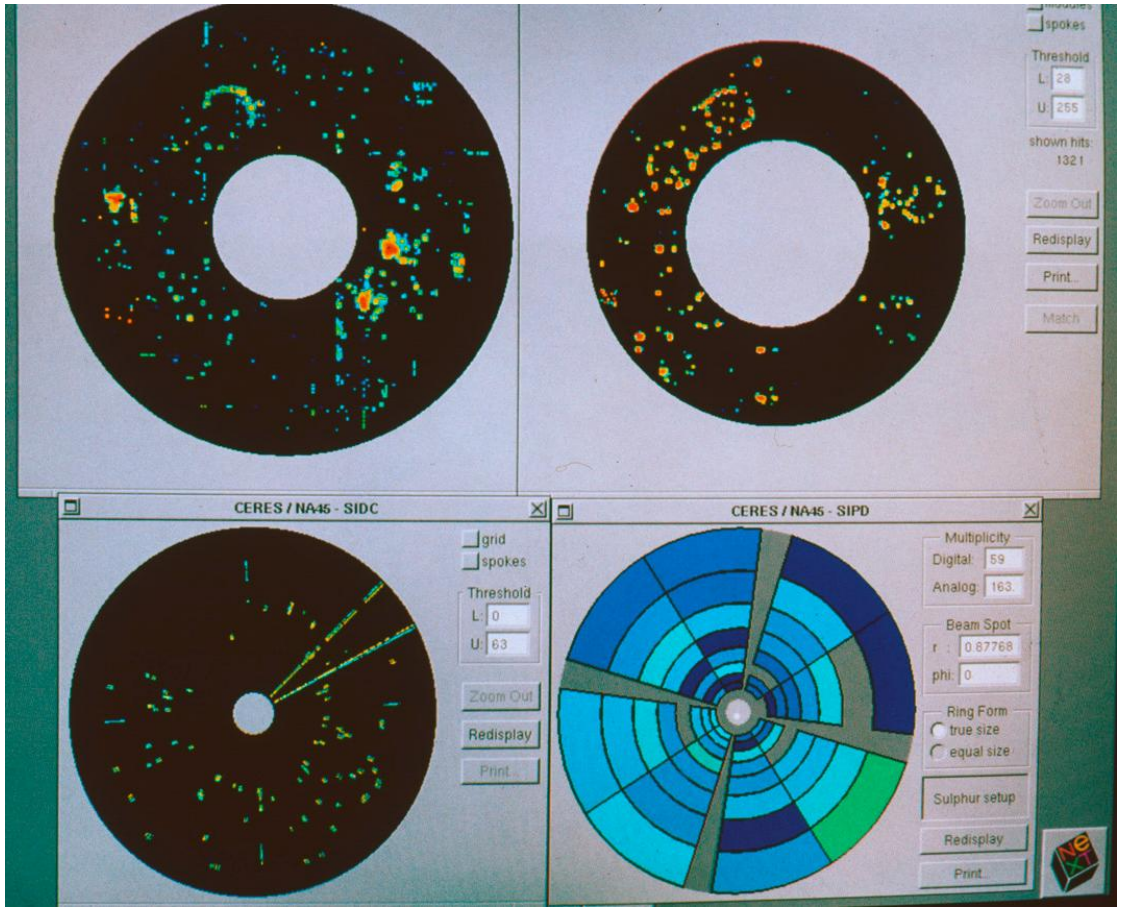
Hans J. Specht concludes NIM A343 (1994) 231: "We will in all future stick to the lovely tolerance of a MWPC"

CERES: Successful Data taking 1992/93

1992	S-Au physics run
1992-1992	CERES/TAPS addendum – use TAPS calorimeter downstream to measure hadron decays
1993	p-Be & p-Au physics run CERES/TAPS

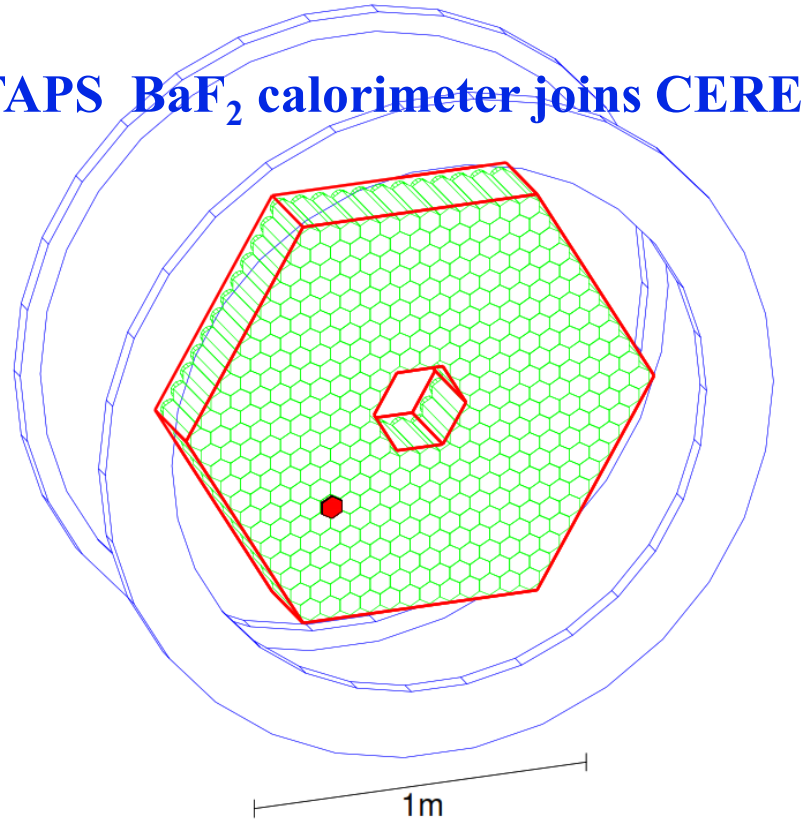
S-Au collision 1992

UV1 UV2



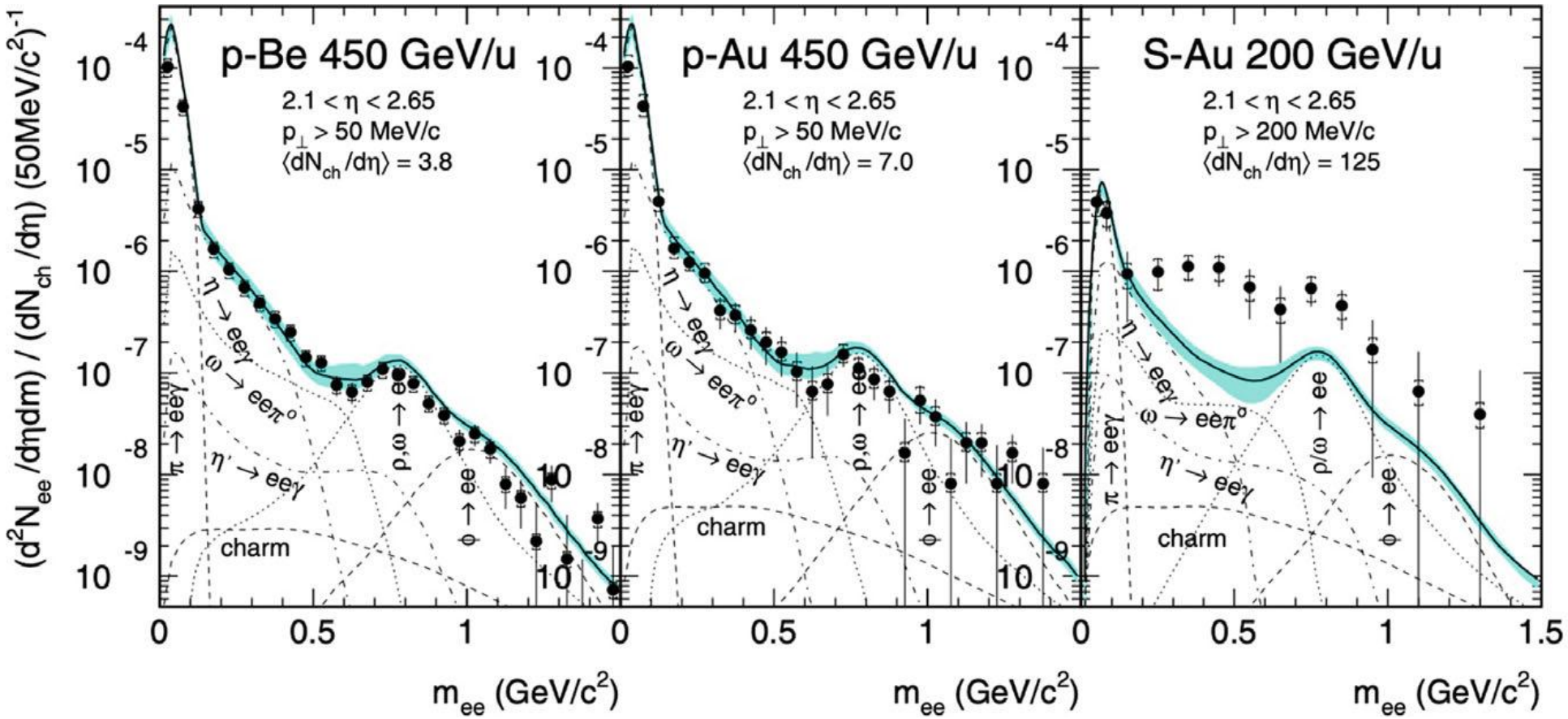
SiDC SiPD

TAPS BaF_2 calorimeter joins CERES



S-Au data and precision measurement of hadron decays in p-Be and p-Au

CERES: Scientific Breakthrough



Ph.D. T. Ullrich

Discovery of thermal dileptons

CERES: Phys. Rev. Lett. 75 (1995) 1271

647 citations –most cited experimental paper in heavy ion physics from SPS era; created a theoretical boost of hundreds of publications

CERES: Pb-Beam Era

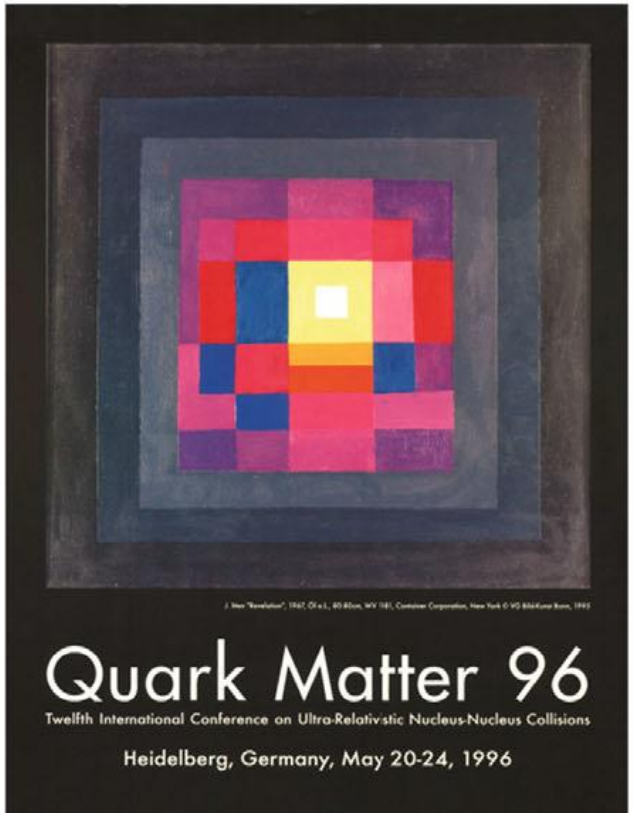
CERES – 2 proposal: SPSLC P280 January1994

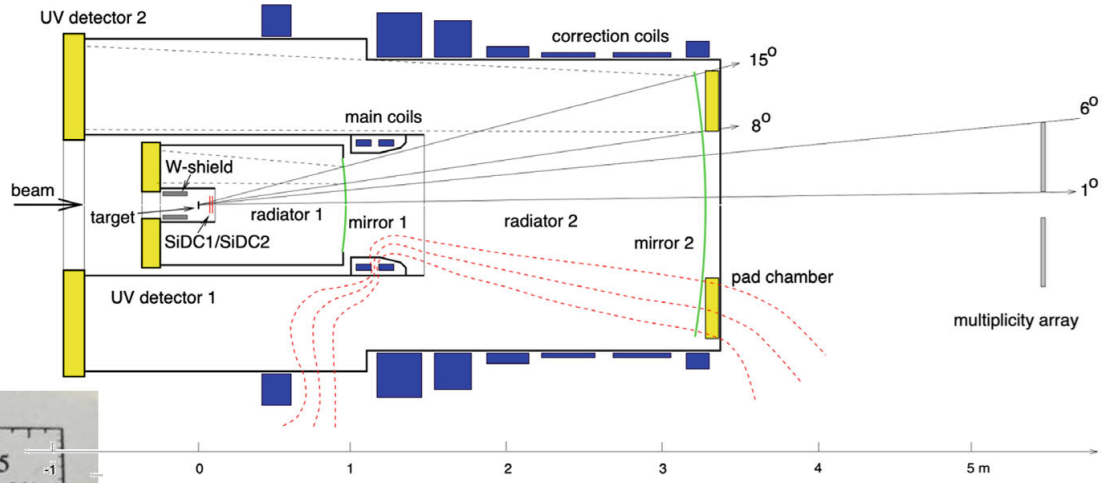
2 Si-drift chambers + pad chamber + interaction trigger

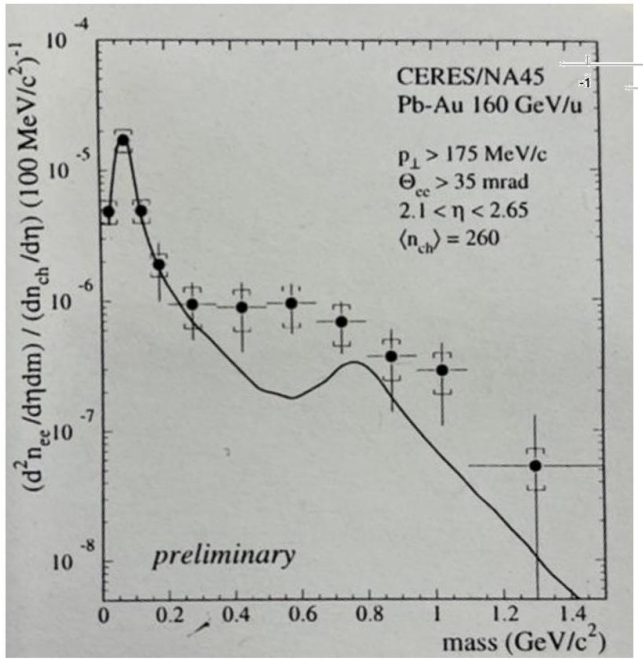
Main physics beam times 1995-1996

new analysis code: convert Fortran → C++

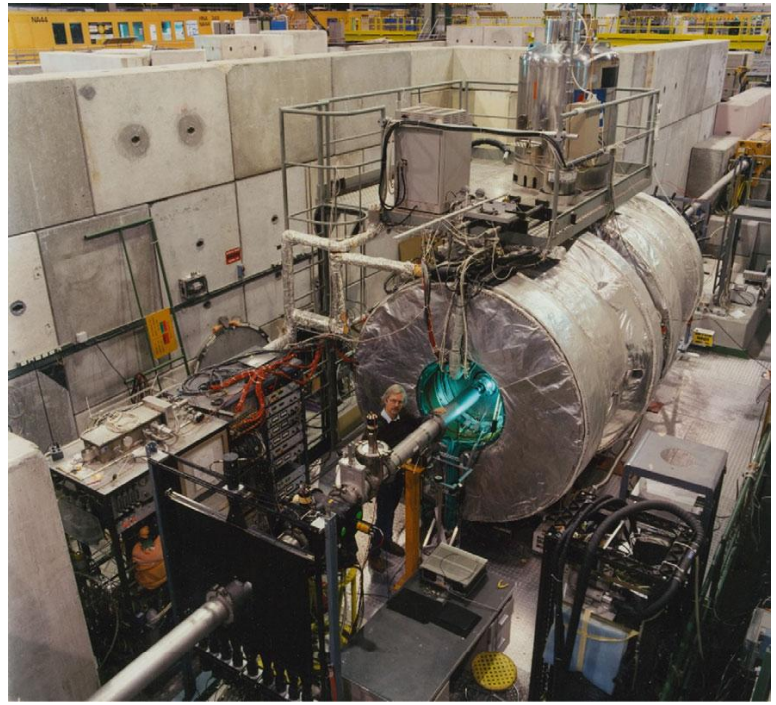
First results shown QM 1996 in Heidelberg







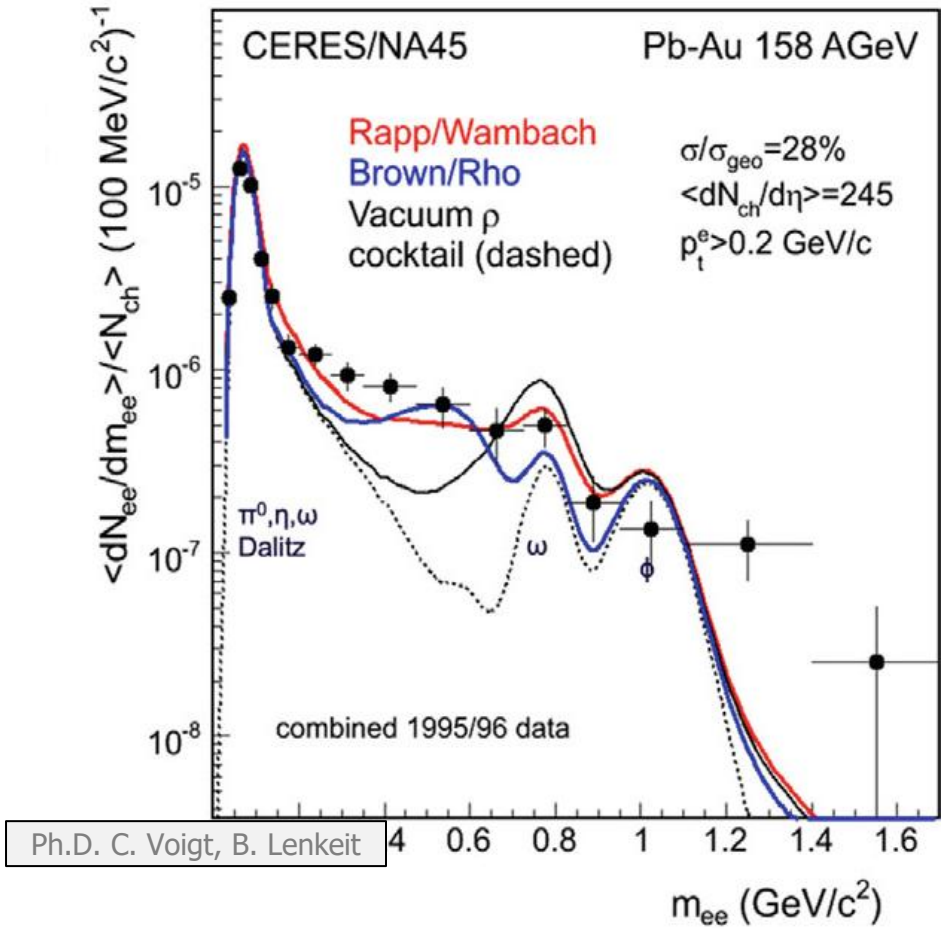
1st Pb beam results
5 days before QM96



Center for Frontiers in Nuclear Science

Stony Brook University

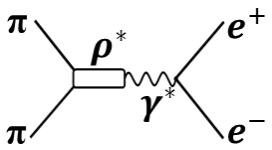
CERES: In Medium Effect



Ph.D. C. Voigt, B. Lenkeit

CERES: Phys.Lett. B442 (1998) 405; 329 citations
CERES: NPA 661 (1999) 23c, Eur.Phys.J. C41 (2005) 475; 342 citations

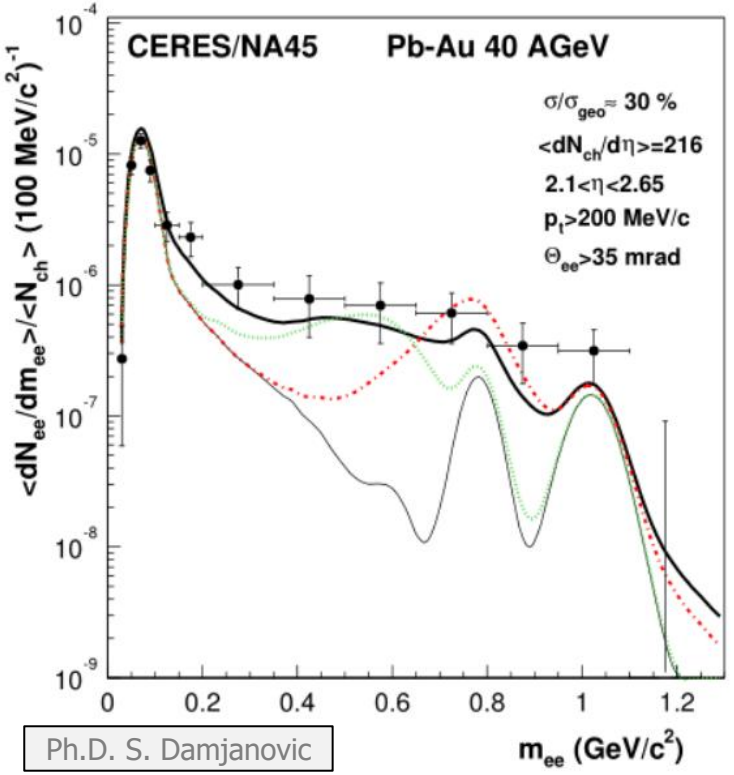
e^+e^- *pairs from hot hadron gas:*



CERES: ρ meson is modified!
but results do not distinguish:
dropping mass ↔ mass broadening

Final upgrade: CERES + TPC (lead by J.Stachel)

1996	**proposal to construct TPC downstream of CERES**
1999/2000	**data taking with Pb beam at 40 and 158 AGeV**
1999	**data for final Doctoral Thesis supervised by H.J.Specht**



Ph.D. S. Damjanovic

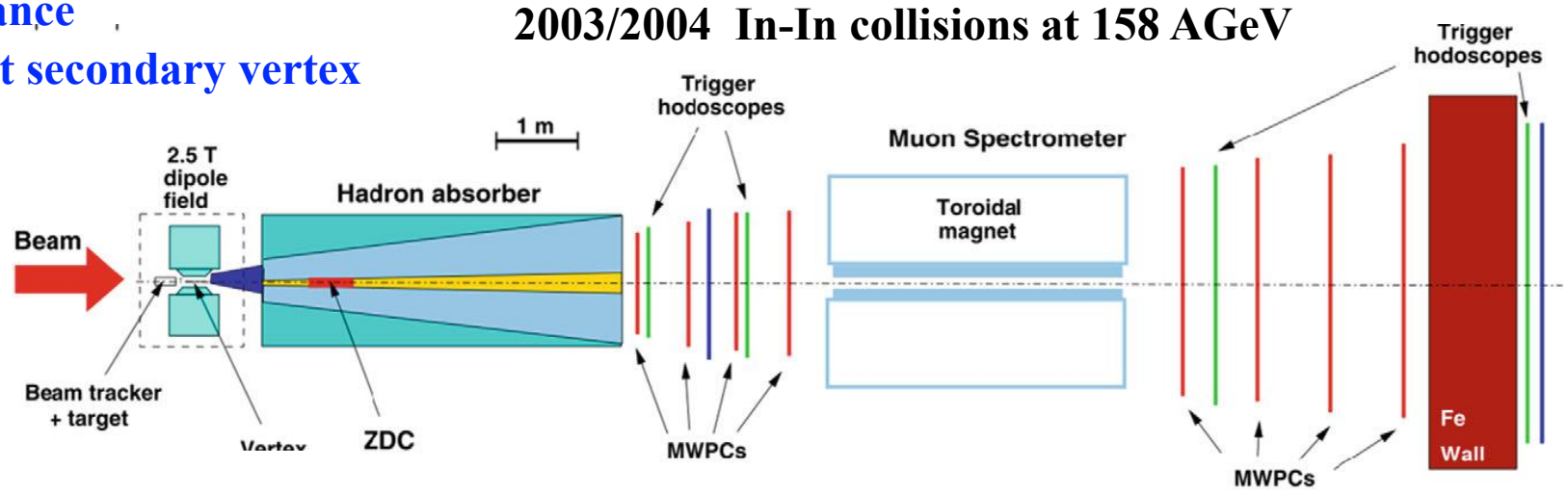
CERES: Phys.Rev.Lett. 91 (2003) 4230; 188 citations

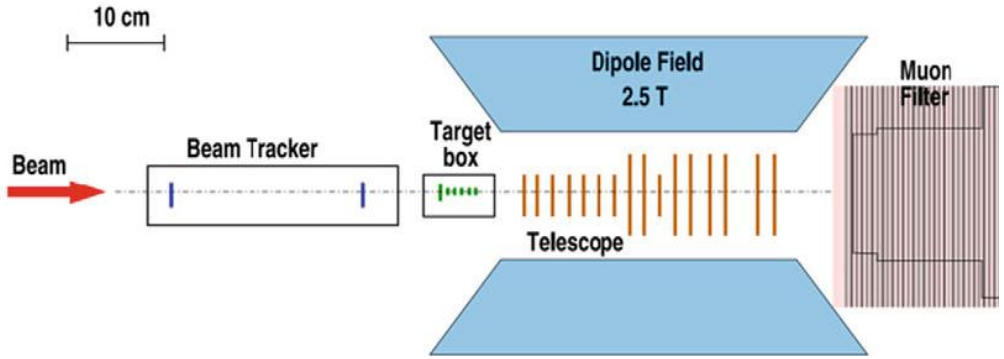
Importance of baryon density

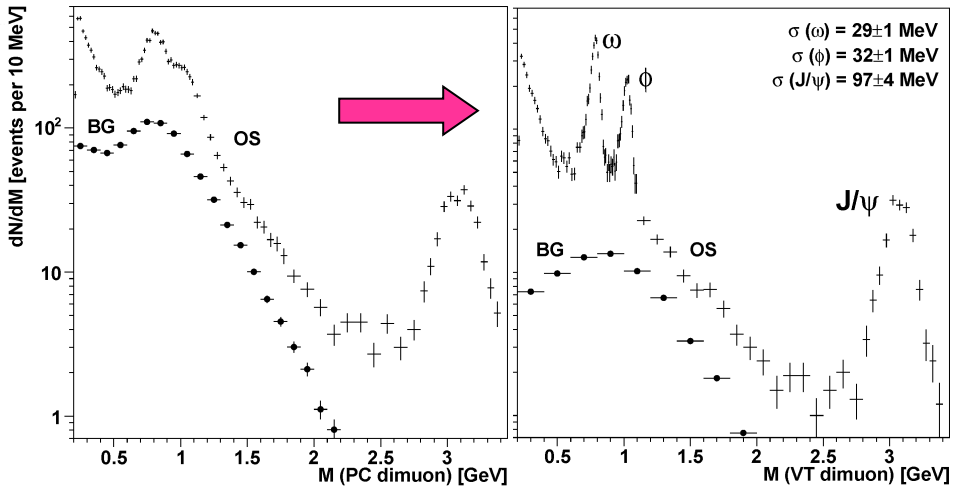
State of the Art Dilepton Experiment: NA60

- **Adding Silicon Pixel Telescope**
  - much better mass resolution
  - Reduce remaining π, K decay background
  - Larger low mass acceptance
  - Capability to reconstruct secondary vertex

2000	CERN approved proposal to add silicon pixel telescope to NA10/NA38/NA50 muon spectrometer
2003	H.J.Specht accepts invitation to join
2002	Proton beams on various tragets
2003/2004	In-In collisions at 158 AGeV



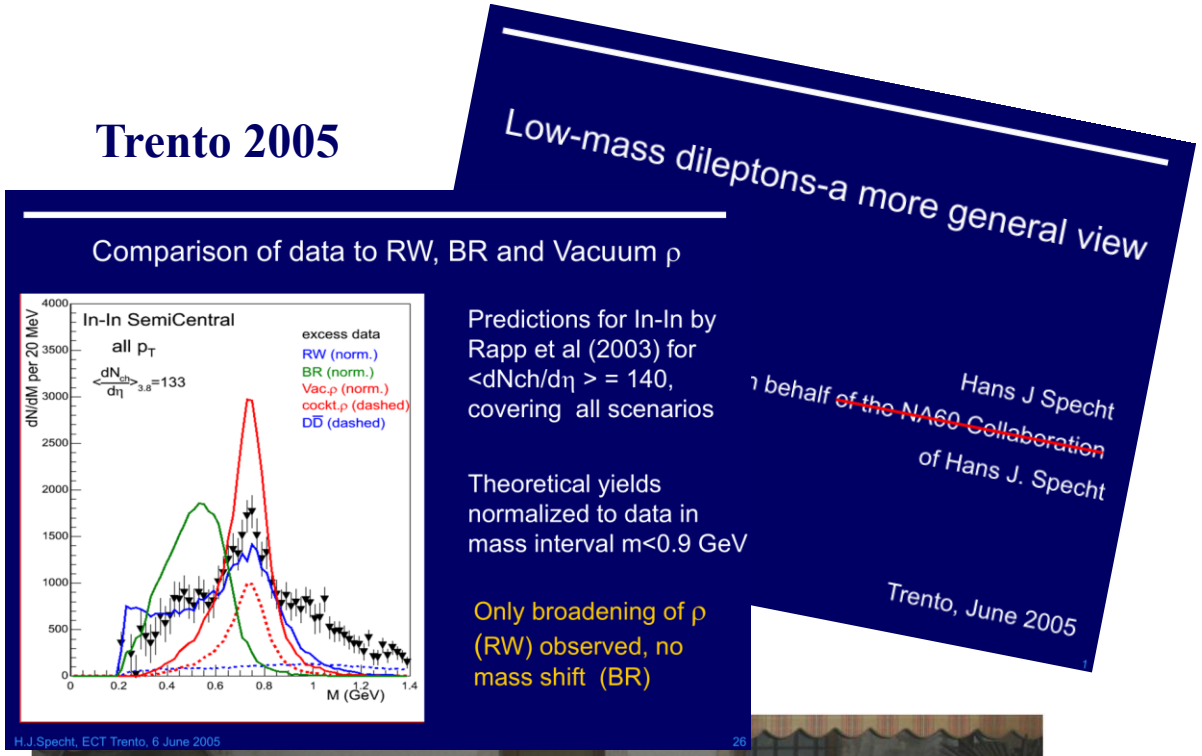




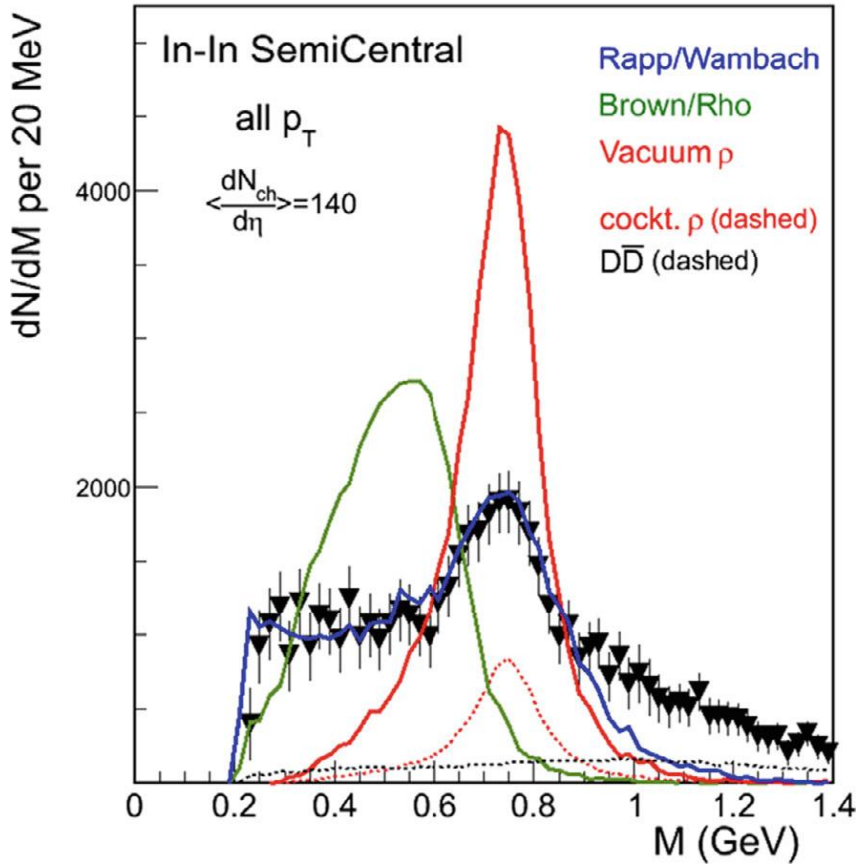
match vertex tracks with muon tracks in coordinate and momentum space

NA60: Medium Modifications of the ρ Meson

Trento 2005



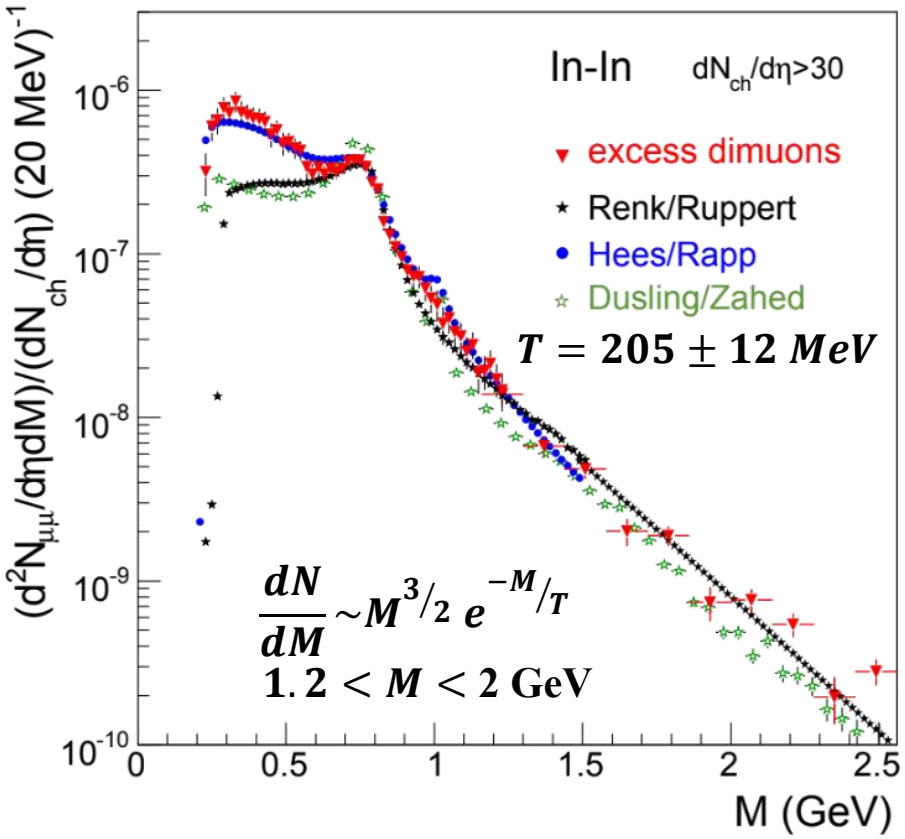
NA60: Phys.Rev.Lett. 96 (2006) 162302; 426 citations



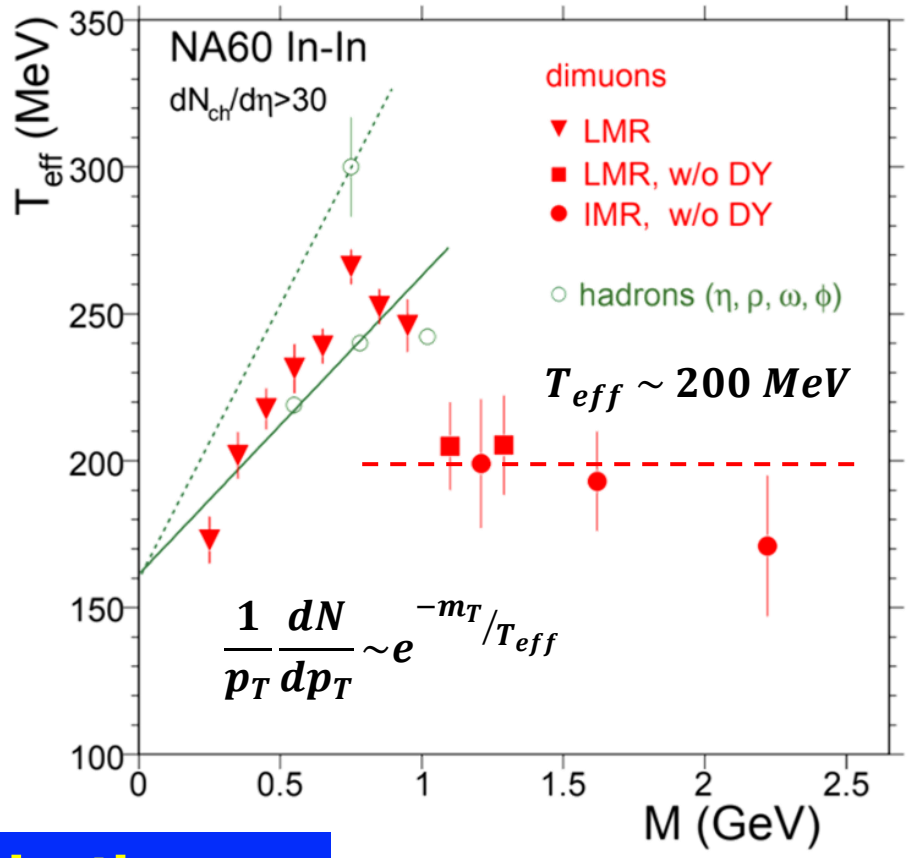
ρ meson spectral function broadens
No shift in mass!

NA60: Thermal Fingerprint of the QGP

- **Mass spectrum of thermal dileptons**
  - M < 1 GeV: ρ dominates and melts near T_C
  - M > 1 GeV: Planck-like thermal spectrum $T > T_C$



- **Momentum spectrum of thermal dileptons**
  - M < 1 GeV: rising T_{eff} →radial flow blue shifts
  - M > 1 GeV: const. $T_{eff} > T_C$



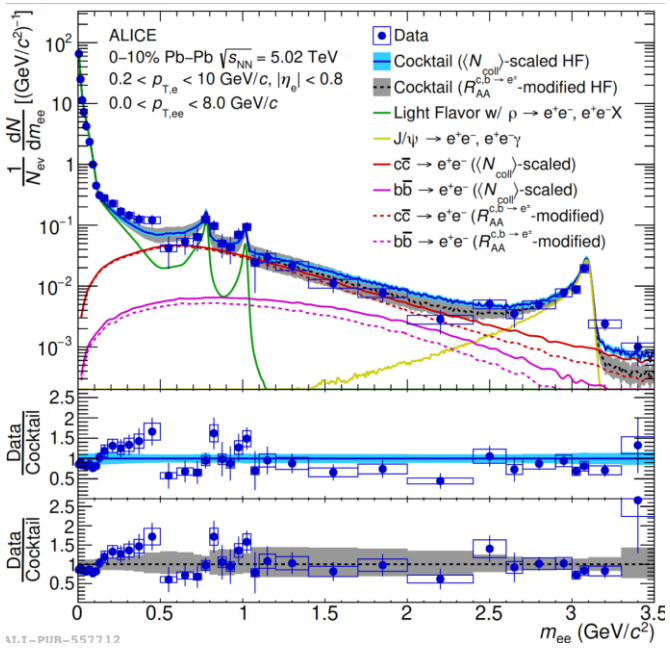
Model independent determination initial temperature T_i>200 MeV > T_C solid proof: QGP formed at SPS energies

NA60: Euro. Phys. J. C61 (2009) 711; 177 citation
NA60: Euro. Phys. J. C59 (2009) 607; 148 citations

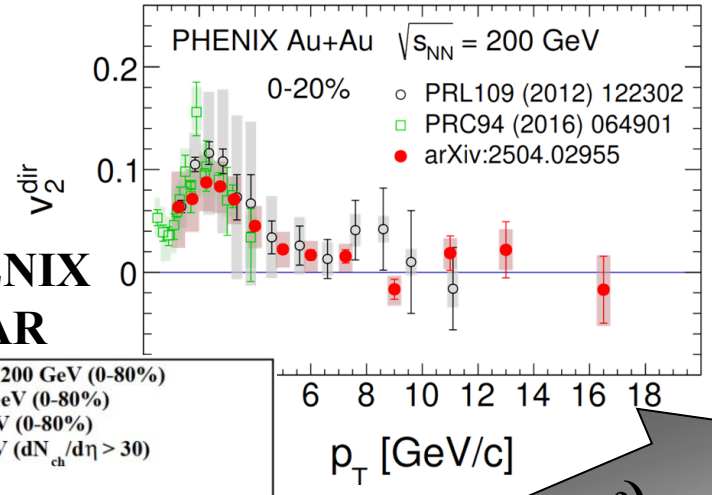
Thermal Radiation: QM2025

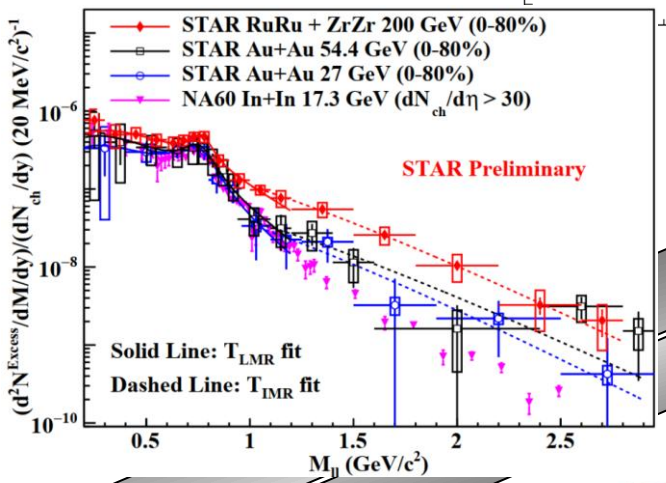
- **Status 2025**
  - New results at every major conference
  - Many experiments
  - Large range in temperature and density
  - NA60 precision unrivaled

LHC: ALICE

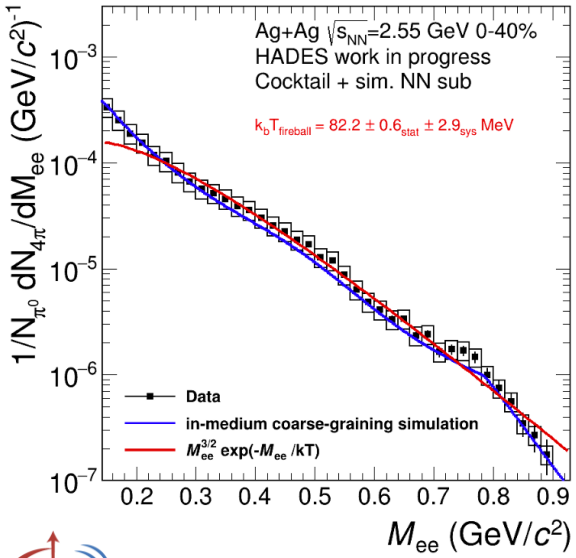


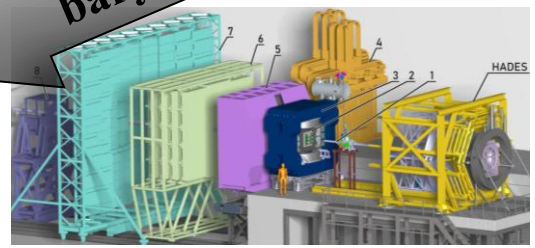
RHIC: PHENIX & STAR





GSI: HADES



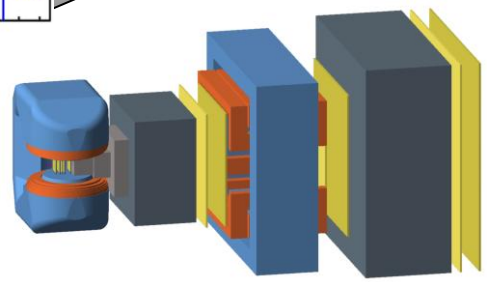


baryon density

$\sqrt{s}$ (temperature)

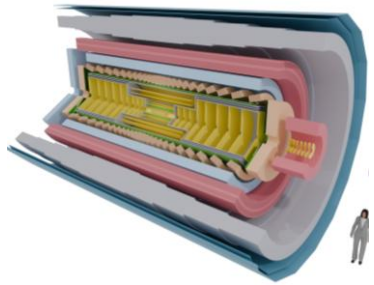
NA60+

$\sqrt{s_{NN}}$~ 6-17 GeV (SPS)



ALICE 3

$\sqrt{s_{NN}}$~ 5 TeV (LHC)



future experiments

CBM – HADES

$\sqrt{s_{NN}}$~ 3-5 GeV (SIS 100)

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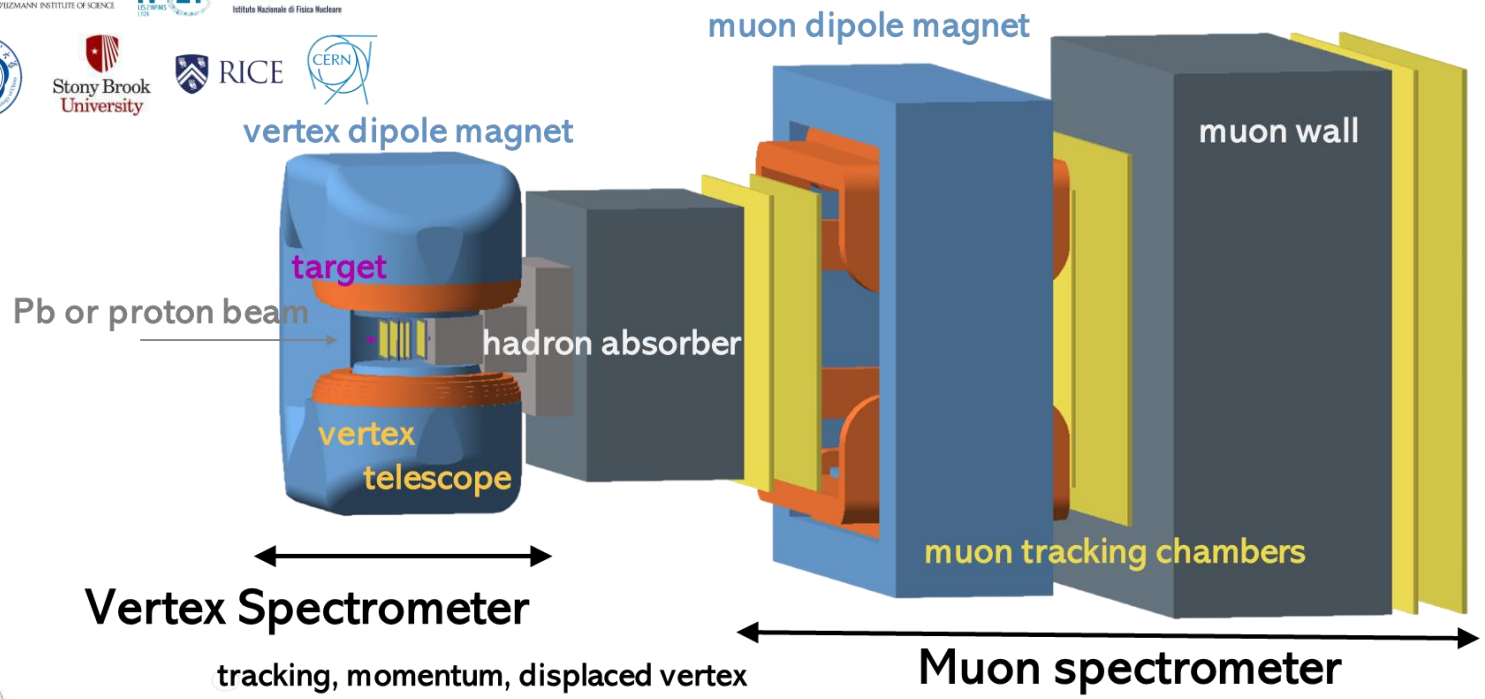
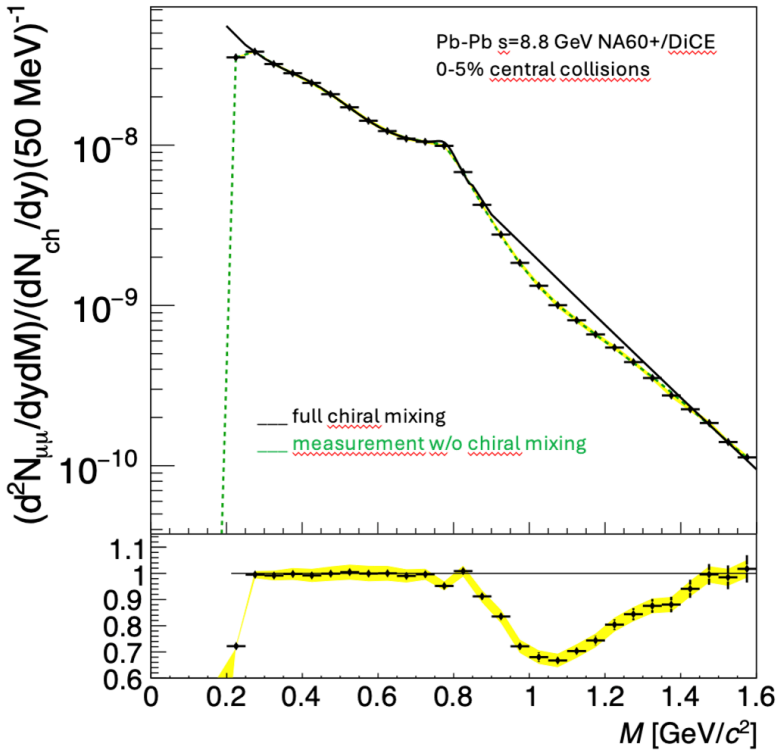
4th generation CERN-SPS Dimuon Experiment NA60+/DiCE

Dilepton and Charm Experiment



From NA60+/ DiCE proposal



DiCE

2022 LOI → 2025 Technical proposal → 2026-2028/29 Construction → 2029/30-2036/37 Data taking

10x statistics significant discovery potential

Proposal SPSC P373 – May 2025

Pb-Pb at $\sqrt{s_{NN}} = 6.3, 8.8, 17.3\ GeV$

Center for Frontiers in Nuclear Science

Stony Brook University

Encounters at the ECT* in Trento

ECT* EUROPEAN CENTRE FOR THEORETICAL STUDIES IN NUCLEAR PHYSICS AND RELATED AREAS
FONDAZIONE BRUNO KESSLER

Trento 1999 .. 2005 .. 2010 .. 2013 .. 2015 .. **2018** .. 2021 .. **2025** ..... **2030+**

1st Trento workshop on EM probes

Last workshop with Hans in person

Many talks dedicated to Hans

First results from NA60+??

Hans J. Specht will be missed

Hans Specht

scientific managing director of GSI

1992 - 1999

Hans Specht: Scientific managing director of GSI: 1992 - 1999

Hans Specht and his predecessors: Ch. Schmelzer, G. zu Putlitz, P. Kienle

Changes introduced by Hans Specht

new management structure similar to CERN and DESY:

- six-member directory board:
  Chair and Scientific Director: Hans Specht
  Research Director: Volker Metag (Giessen); from 1999 Jürgen Kluge (Mainz);
  Accelerator Director: Norbert Angert
  Scientific and Technical Infrastructure: Wolfgang von Rüden (CERN)
  Administration and Commercial Director: Helmut Zeitträger
  Scientific secretary: Klaus-Dieter Gross

- involving leading scientists like Peter Armbruster, Rudolf Bock, Jürgen Kluge Eckart Grosse, Uli Lynen and later Peter Braun-Munzinger in regular meetings; round table discussions with senior and younger scientists on daily matters

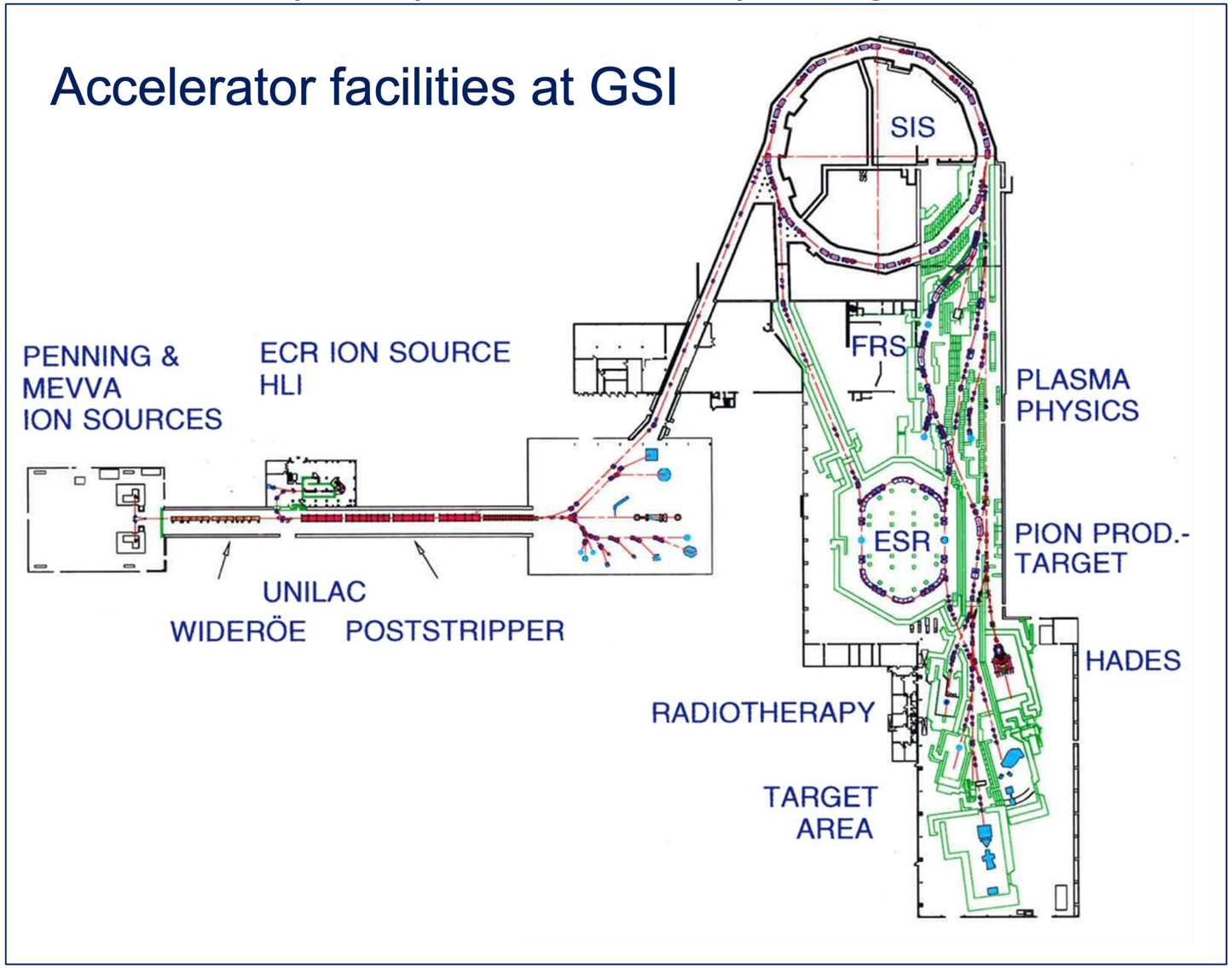
- internationalisation of scientific advisory boards: English as working language in the Scientific Council and Program Advisory Committees fostering a consistently international composition and broad level of outside advice

The extended GSI accelerator facility (1990)

synchrotron SIS18, storage ring ESR, and new detector systems:

FRS, ALADIN, FOPI, KAOS, TAPS

new research options pursued within a spirit of great enthusiasm



scientific highlights in 1992-1999

extremely euphoric and scientifically exciting time → numerous new results

- synthesis, identification and study of exotic doubly magic nuclei, e.g. ^{100}Sn, ^{132}Sn,^{48}Ni,^{78}Ni
- mass measurements of many exotic nuclei with Schottky or TOF at FRS/ESR
- first observation of bound state β-decay ^{187}Re → ^{187} Os at ESR
- first observation of low-lying (1s) pionic states in Pb atoms at FRS
- evidence for a liquid-gas phase transition in hadronic matter (ALADIN)
- observation of collective flow in Au+Au collisions (FOPI)
- evidence for in-medium modifications kaons in dense matter (KaoS)
- first detection of neutral mesons (π^0,η) in HI-collisions in the GeV range (TAPS)
- precision QED studies in strong electric and magnetic fields with U^{91+}, Bi^{82+} (ESR)

Synthesis of Superheavy elements at SHIP

1982-84: Z=107 Bohrium (Bh), 108 Hassium (Hs), 109 Meitnerium (Mt)

G. Münzenberg, P. Armbruster, F. P. Heßberger, S. Hofmann et al., Z. Physik. A (1982-84)

1994-96: Z=110 Darmstadtium (Ds), 111 Roentgenium (Rg), 112 Copernicium Cn)

S. Hofmann, F.P. Heßberger, P. Armbruster, G. Münzenberg, et al., Z. Physik. A (1995-96)

Peter Armbruster, Glenn T. Seaborg, Yuri Oganessian, Hans Specht

at farewell ceremony for Peter Armbruster Nov. 1996

1995: 25th. anniversary of GSI

Hans Specht

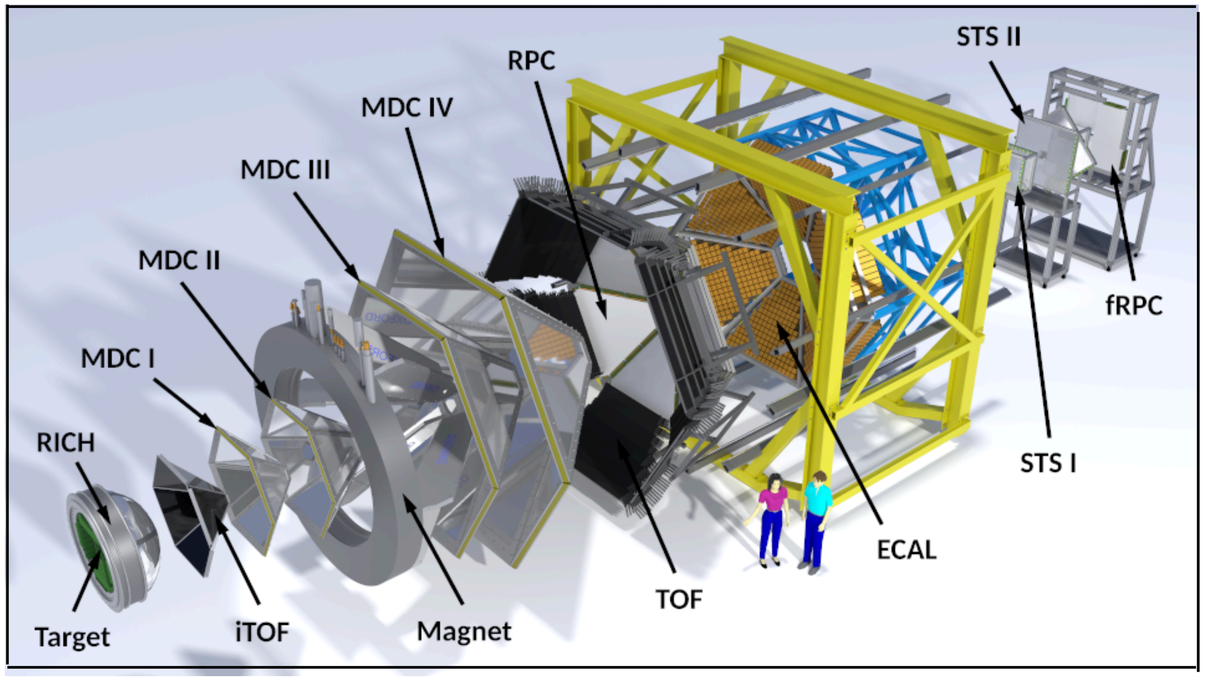
addressing a large audience of

politicians and internationally

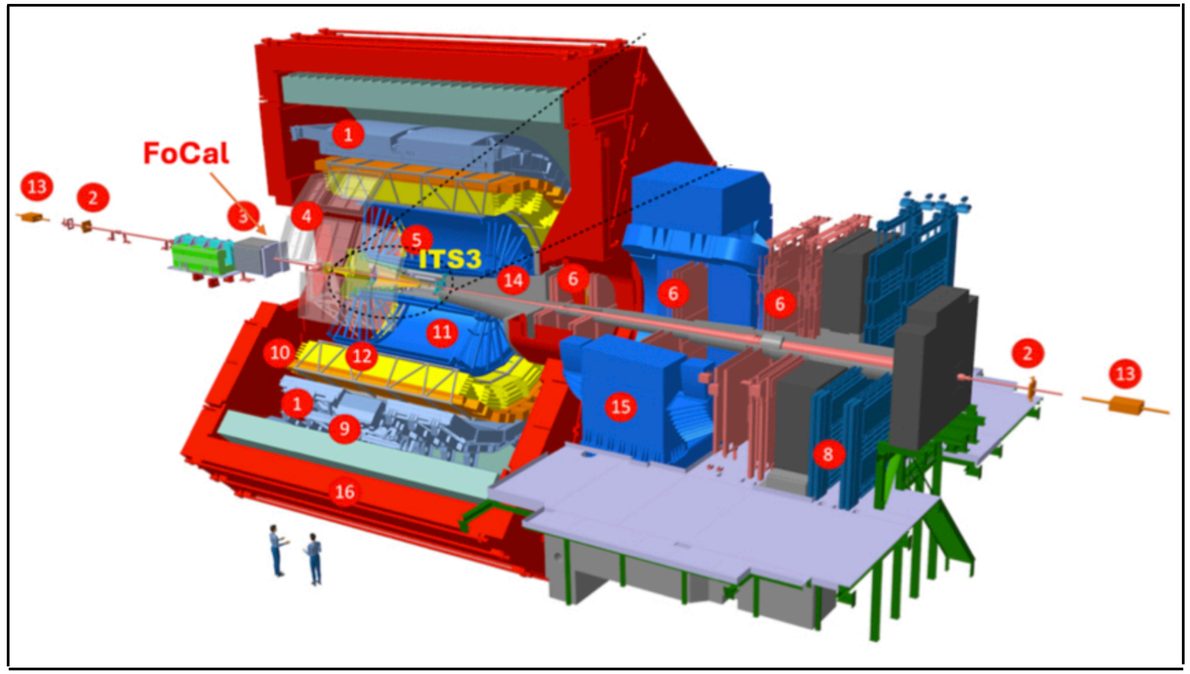
renowned scientists

medium-term future-oriented research projects (approved in 1994)

High **A**cceptance **D**i-**E**lectron **S**pectrometer (HADES)



A **L**arge **I**on **C**ollider **E**xperiment (ALICE)



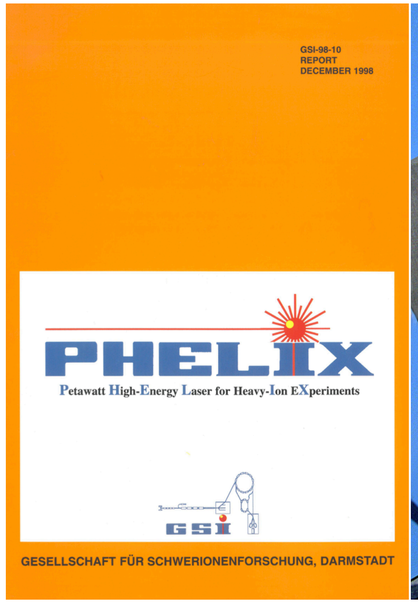
GSI participation in the CERN heavy-ion program:

- ALICE
- Pb injector

pioneering applied research at GSI

Petawatt **H**igh **E**nergy **L**aser for Heavy-**I**on E**X**periments:

PHELIX

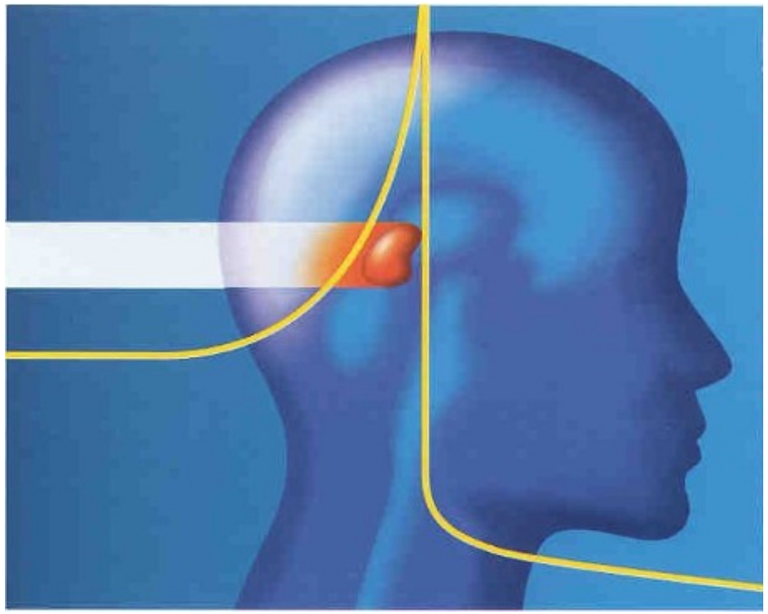


unique in its combination with high intensity heavy-ion beams for study of matter at extreme temperatures and pressures in plasma physics, astrophysics and energy research

project proposal 1998

groundbreaking ceremony in 2000

heavy-ion cancer therapy pilot project at GSI



(450 patients in1993 - 2008)

1998 project proposal for HIT; start 2009

Jürgen Debus

Jürgen Debus

Ion-beam therapy in Germany: HIT the target

long range perspectives of GSI

long-range perspectives of GSI (1995-97)

8 working groups with broad participation of the international scientific community :

1.) Deep-inelastic electron-nucleon and electron-nucleus scattering at $\sqrt{s}$=20-30 GeV

D. von Harrach ,V. Metag, A. Schäfer

2.) X-ray spectroscopy and radiation physics

H. Backe, J. Kluge, G. Soff

3.) Nuclear collisions at maximum baryon density

J.P. Blaizot, P. Braun-Munzinger, R. Stock

4.) Physics with secondary π^-, K^- and $\bar{p}$-beams

D. Frekers, U. Lynen, J. Wambach

5.) Nuclear structure with radioactive beams

D. Habs, H. Lenske, G. Münzenberg, P. Ring

6.) Plasma physics with intense heavy-ion beams

R. Bock, D.D.H.Hoffmann, J. Meyer-ter-Vehn

7.) Accelerator studies (e^- - N/A collider)

K. Blaschke, N. Dikansky, J. Maidment, B. Autin

8.) Accelerator studies (high intensity option)

D. Böhne

long-range perspectives of GSI (1997)

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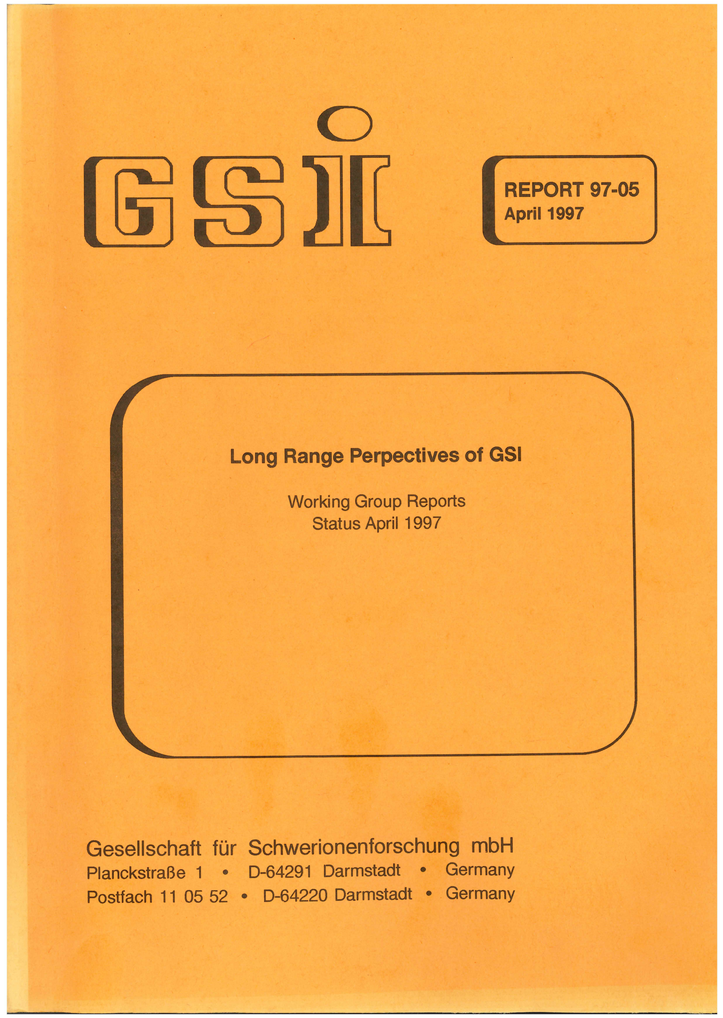
8.) Accelerator studies (high intensity option)

D. Böhne



basis for further discussions → FAIR

Dietrich von Harrach

Universität Mainz

“Project and Promise: Remembering Hans Specht”

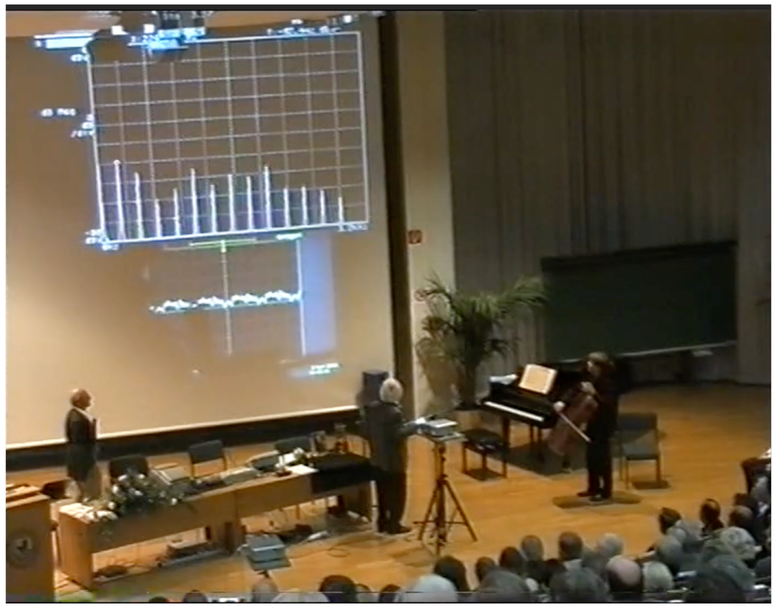
The link between music, physics, and neuroscience

Hans Specht: scientist and pianist

exploring the link between music, physics and neuroscience

lectures given together:
with Hans Günter Dosch

"Musical Perception -
Physics, Neurophysiology, Psychology"



Einstein Lecture, Berlin
Beethoven Festival, Bonn
Loeb Lecture, Harvard
Music Festival, Verbier
Academy Traunkirchen
GSI, DESY, CERN,
Munich, Wien, Giessen

P. Schneider, M. Scherg, H.G. Dosch, H. J.Specht et al. , Nature Neuroscience 5 (2002) 688

Hans Spechts most cited paper: 1024 citations

Utku Asan

Chopin: waltz in C-sharp minor, Op.64 no.2