Kierunek FAIR
Przystanek Mazury

Tomasz Matulewicz

WYDZIAŁ FIZYKI
UNIWERSYTET WARSZAWSKI

16 X 2009

Kierunek FAIR
Przystanek Mazury

1. FAIR-przypomnienie
2. XXXI Mazurian Lakes Conference *Nuclear Physics and the Road to FAIR*

a) QCD i materia hadronowa

b) Antyprotony

c) Egzotyka jądrowa i jej struktury

3. FAIR-aktualności

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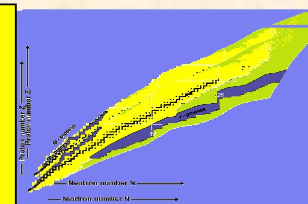
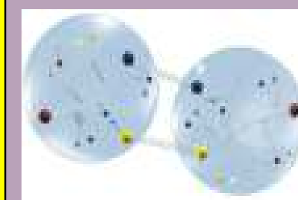
Summary of Research Areas at FAIR

PIASKI 09

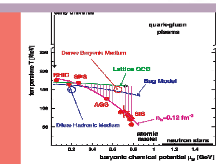
Structure and Dynamics of Nuclei - Radioactive Beams
Nucleonic matter
Nuclear astrophysics
Fundamental symmetries



Hadron Structure and Quark-Gluon Dynamics - Antiprotons
Non-pertubative QCD
Quark-gluon degrees of freedom
Confinement and chiral symmetry



Nuclear Matter and the Quark-Gluon Plasma - Relativistic HI - Beams
Nuclear phase diagram
Compressed nuclear/strange matter
Deconfinement and chiral symmetry



Physics of Dense Bulk Matter - Bunch Compression
Properties of high density plasmas
Phase transitions and equation of state
Laser - ion interaction with and in plasmas

Ultra High EM-Fields and Applications - Ions & Petawatt Laser
QED and critical fields
Ion - laser interaction
Ion - matter interaction

FLAIR – spectroscopy of antiprotonic atoms
Cooled antiproton beams of low energy (trapping)

The future Facility for Antiproton an Ion Research (FAIR)

FAIR ma zapewniać możliwość równoległej pracy zespołów badawczych (zderzenia AA, RIB, plazma, antyprotony)

100% duty cycle

Primary beams:

10^{12} /s $^{238}U^{28+}$ 1-2 AGeV

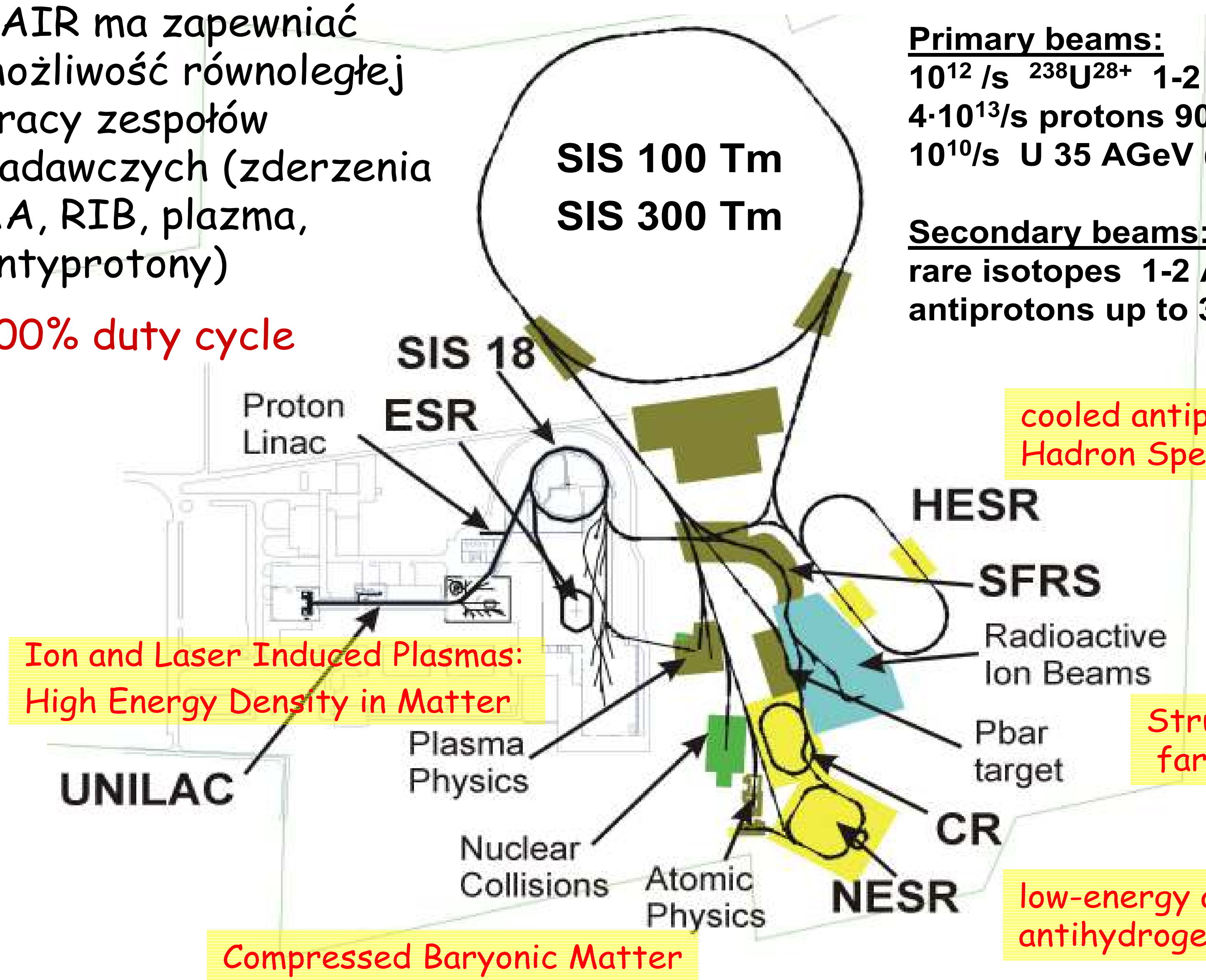
$4{\cdot}10^{13}$/s protons 90 GeV

10^{10}/s U 35 AGeV (Ni 45 AGeV)

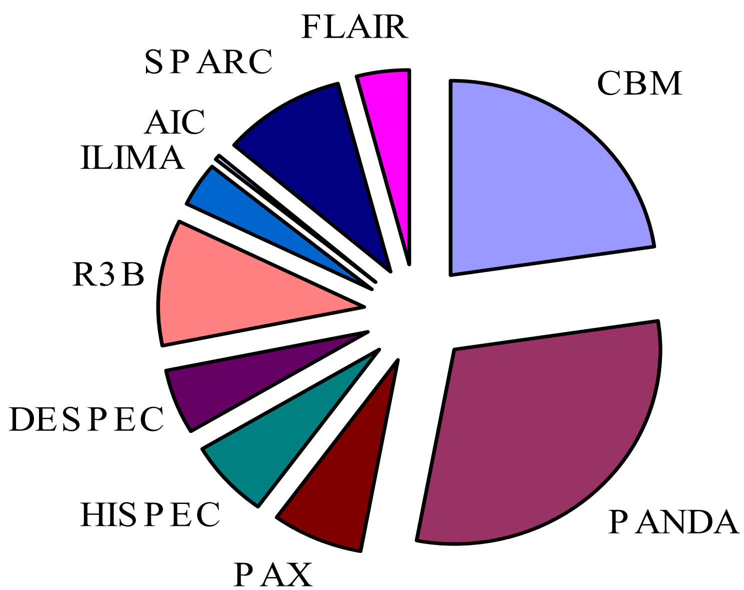
Secondary beams:

rare isotopes 1-2 AGeV

antiprotons up to 30 GeV



Polscy uczestnicy FAIR
(wg spisu początkowego)



Kraków	29
Warszawa	30
Katowice	9
Kielce	2

Od 2006 też:
Politechnika Krakowska,
Politechnika Wrocławska

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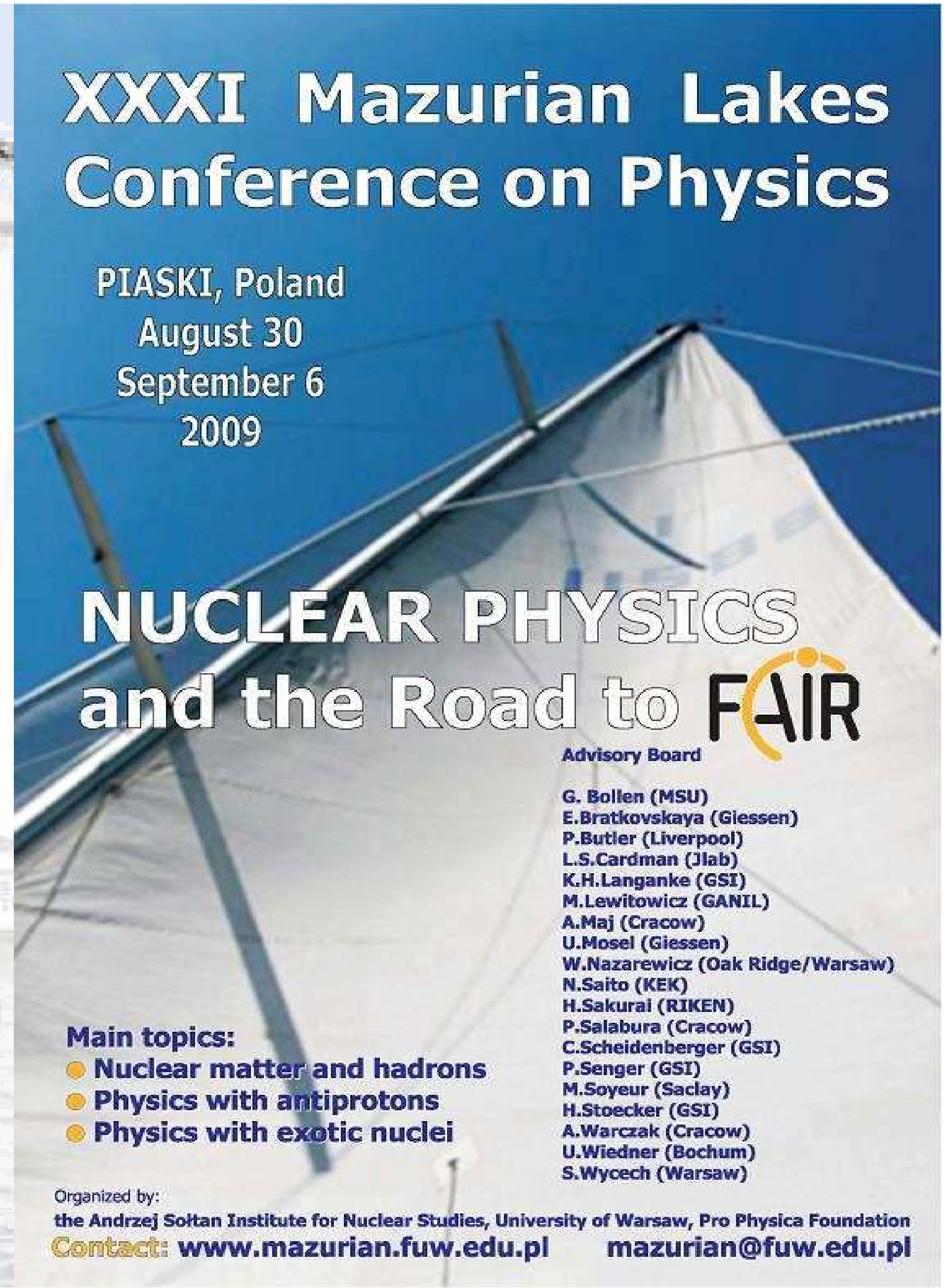
- Wykład inauguracyjny o Mazurach: Joanna Mariuk
- Koncert Camerata (+1)
- Wykład z historii fizyki: A.K.Wróblewski *Physics 1909*
- Regaty (5 biegów!): ponownie najlepszy sternik z zagranicy...



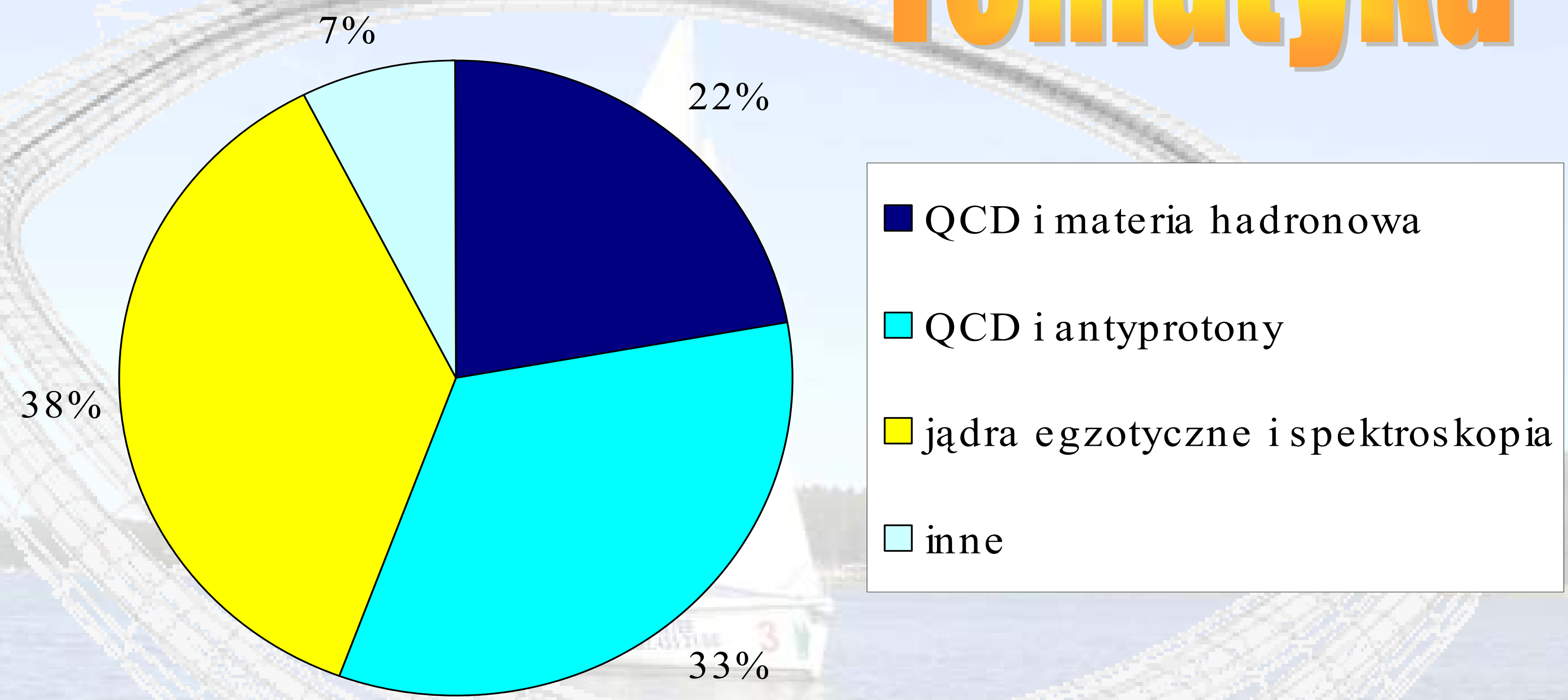
XXXI Mazurian Lakes Conference on Physics
NUCLEAR PHYSICS and the Road to Fair
August 30 – September 6, 2009 PIASKI Poland

Organizatorzy: TM & Marek Pfützner
Danka Chmielewska (sekretarz naukowy),
Kasia Delegacz (sekretariat),
Marek Karny (finanse),
Michał Godlewski (żagle i regaty),
Sebastian Małek (www.mazurian.fuw.edu.pl)

70 uczestników z 14 krajów; 30 z Polski


ŻYWIEC
ŻYWIEC

Tematyka



Podczas konferencji można było dowiedzieć się o postępie badań w <u>różnych</u> obszarach fizyki jądrowej

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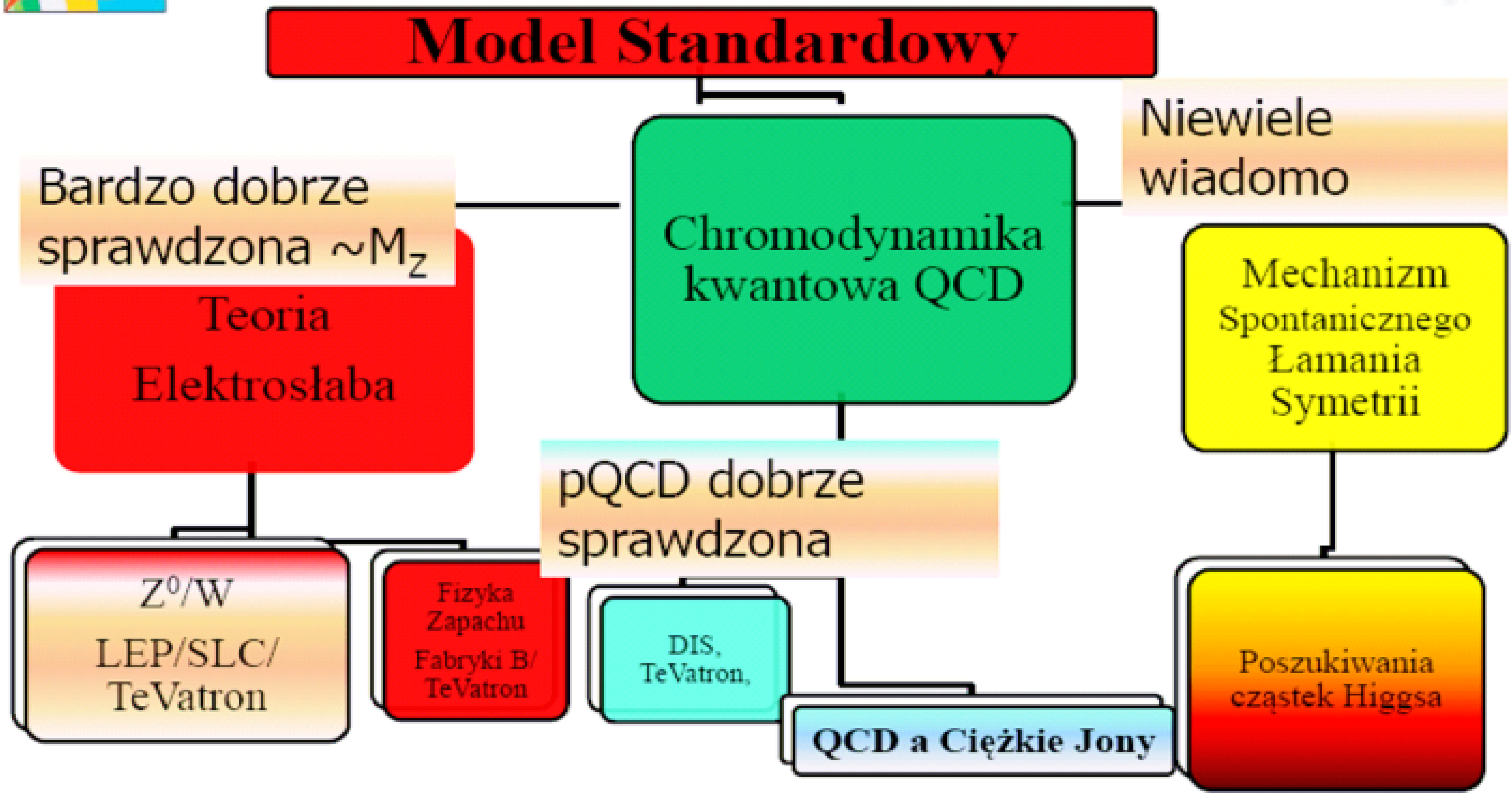
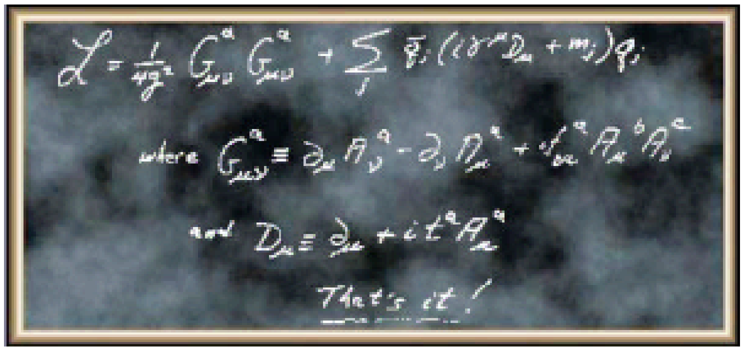
Model Standardowy

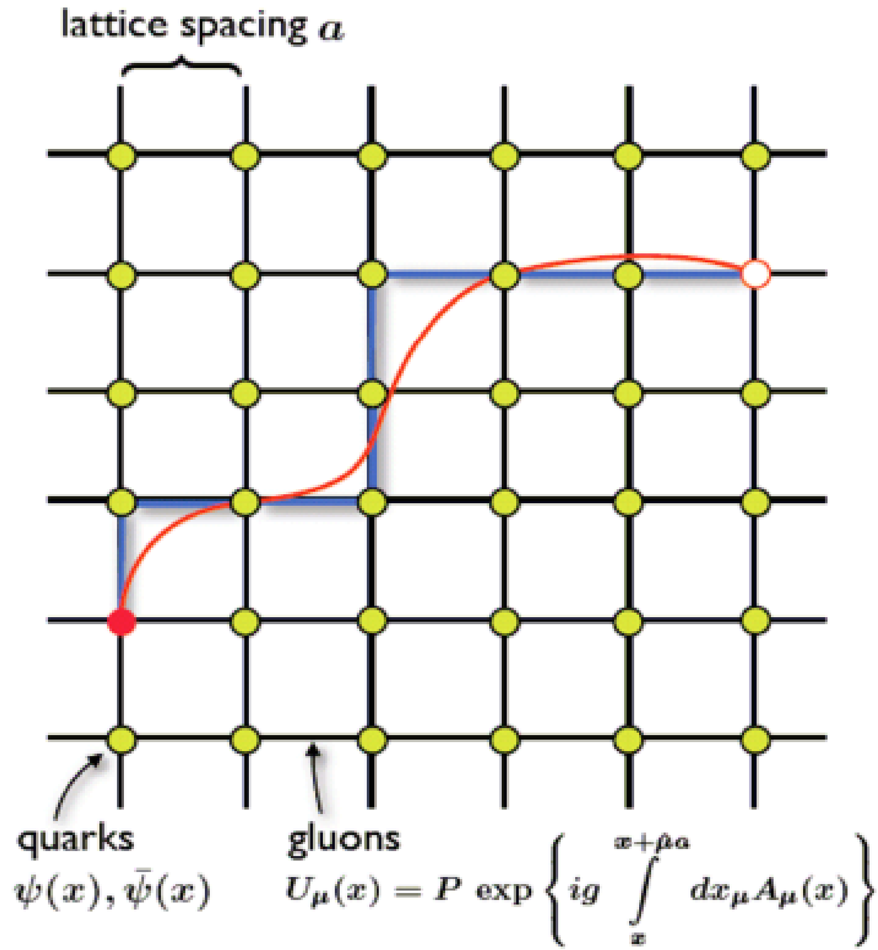


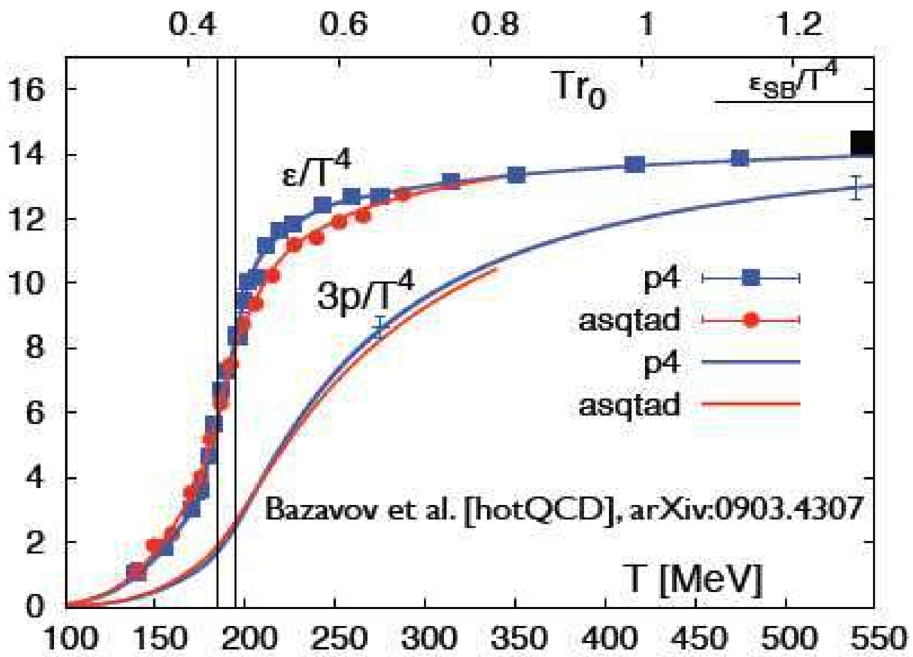
Lattice QCD results on bulk thermodynamics at zero and nonzero density

Christian Schmidt
Universität Bielefeld



Monte Carlo integration:
$\approx 10^6$ lattice points,
$\approx 10^8$ degrees of freedom



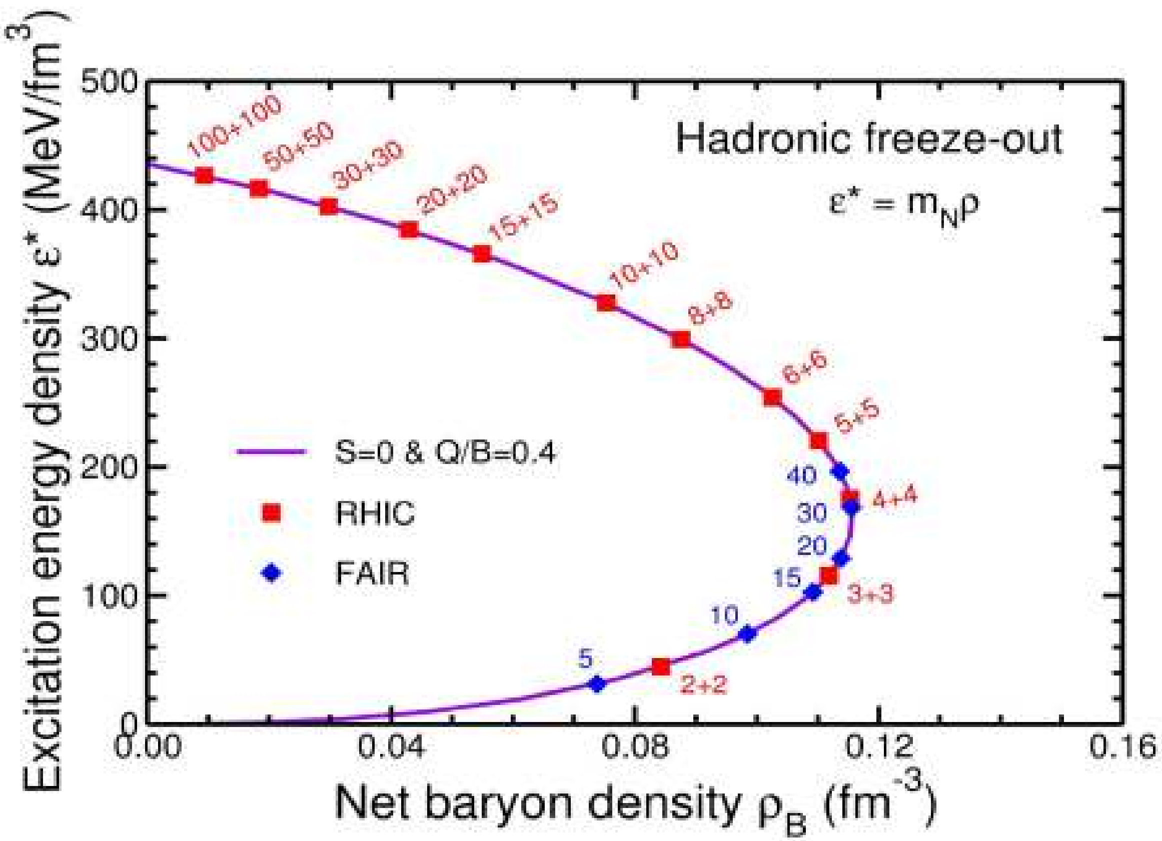


- lattice effects are small, different actions give consistent results
- steep increase in energy density and pressure in a narrow temperature interval
  $$T \approx (185 - 195)\ \mathrm{MeV}$$
- transition is smooth: „*crossover*“

Contact of Lattice QCD with perturbative QCD still to be worked out: actual agreement not yet satisfactory.

The Quest for the Highest Densities

Freeze-out configurations for X+X collisions
in the net-baryon density and energy density plane.



J. Randrup and J. Cleymans,
hep-ph/0607065

NA49 evidence for the Onset of Deconfinement

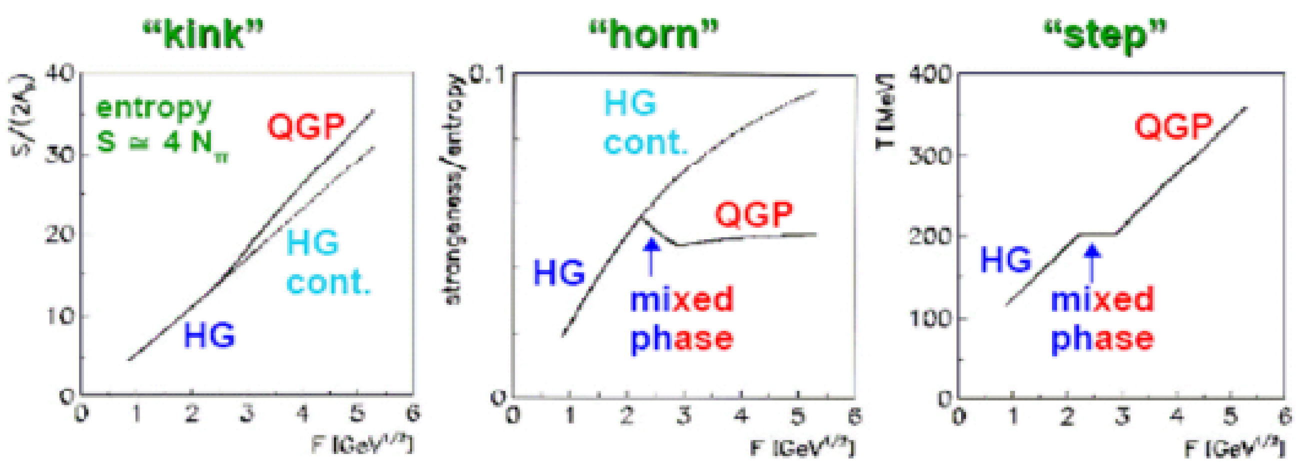
K. Grebieszkow

What is the energy threshold for deconfinement?

(the lowest energy sufficient to create a partonic system)

→ Motivation: **S**tatistical **M**odel of the **E**arly **S**tage (SMES)

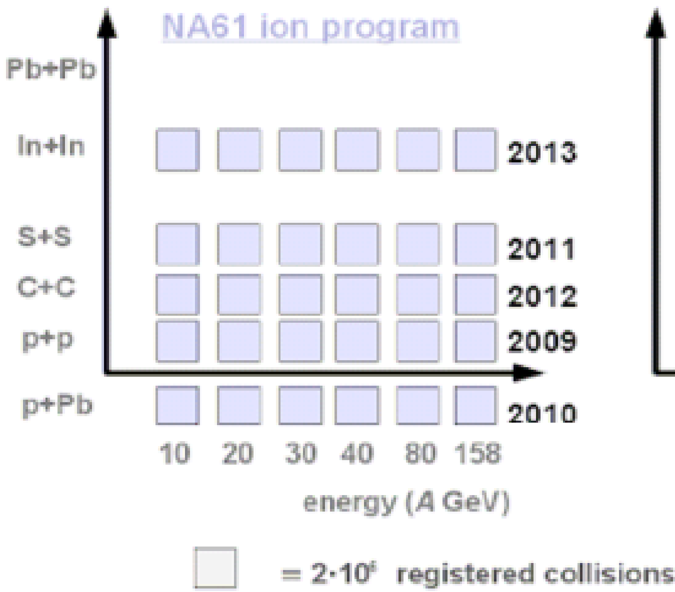
Gaździcki, Gorenstein, Acta Phys. Polon. **B30**, 2705 (1999)

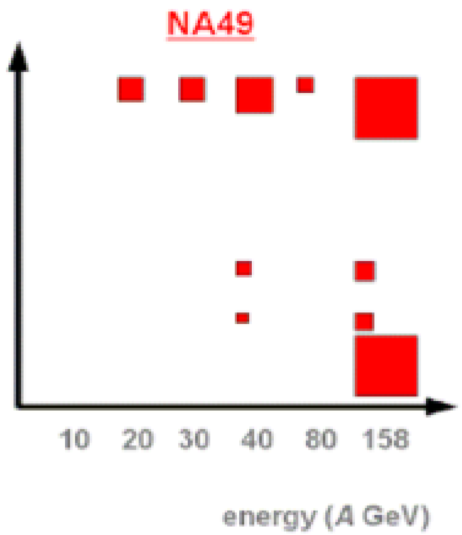


Fermi variable

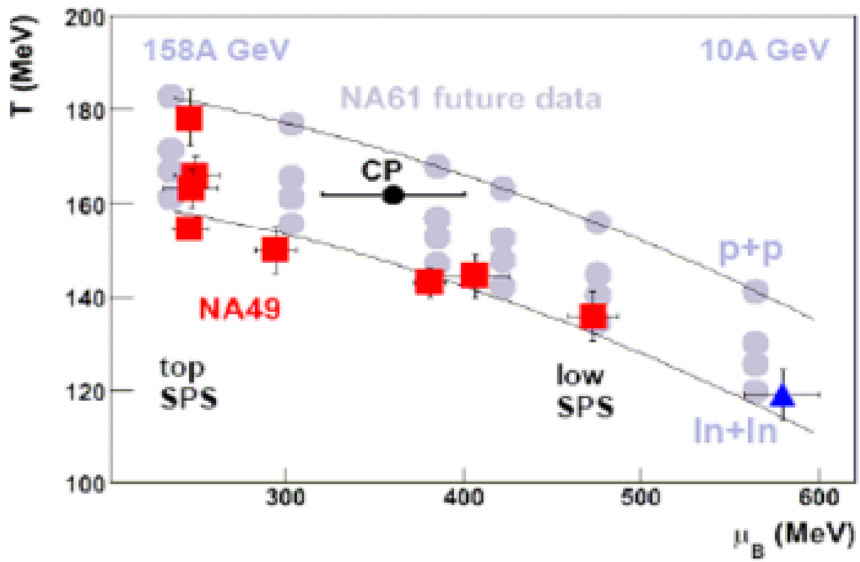
$$F \equiv \left[\frac{(\sqrt{s_{NN}} - 2m_N)^3}{\sqrt{s_{NN}}} \right]^{1/4}$$

$$F \simeq \sqrt{\sqrt{s_{NN}}}$$





Data sets planned to be recorded by SHINE within the **ion program** and those recorded by NA49



Comprehensive scan in the whole SPS energy range (10A-158A GeV) with **light and intermediate mass nuclei**

First time in history when such a 2D scan (energy, system size) will be performed

K. Grebieszkow

Własności CKM

Wyznaczany z rozpadów β $0^+ \to 0^+$

$$\begin{pmatrix} d' \\ s' \\ b' \end{pmatrix} = \begin{pmatrix} V_{ud} & V_{us} & V_{ub} \\ V_{cd} & V_{cs} & V_{cb} \\ V_{td} & V_{ts} & V_{tb} \end{pmatrix} \begin{pmatrix} d \\ s \\ b \end{pmatrix}$$

Macierz unitarną 3×3 można sparametryzować za pomocą 3 parametrów (kątów Eulera) i jednej fazy (łamanie CP).

(unitarność: $V^\dagger V=1$, $V^\dagger$ to macierz zespolona, sprzężona i transponowana względem V)

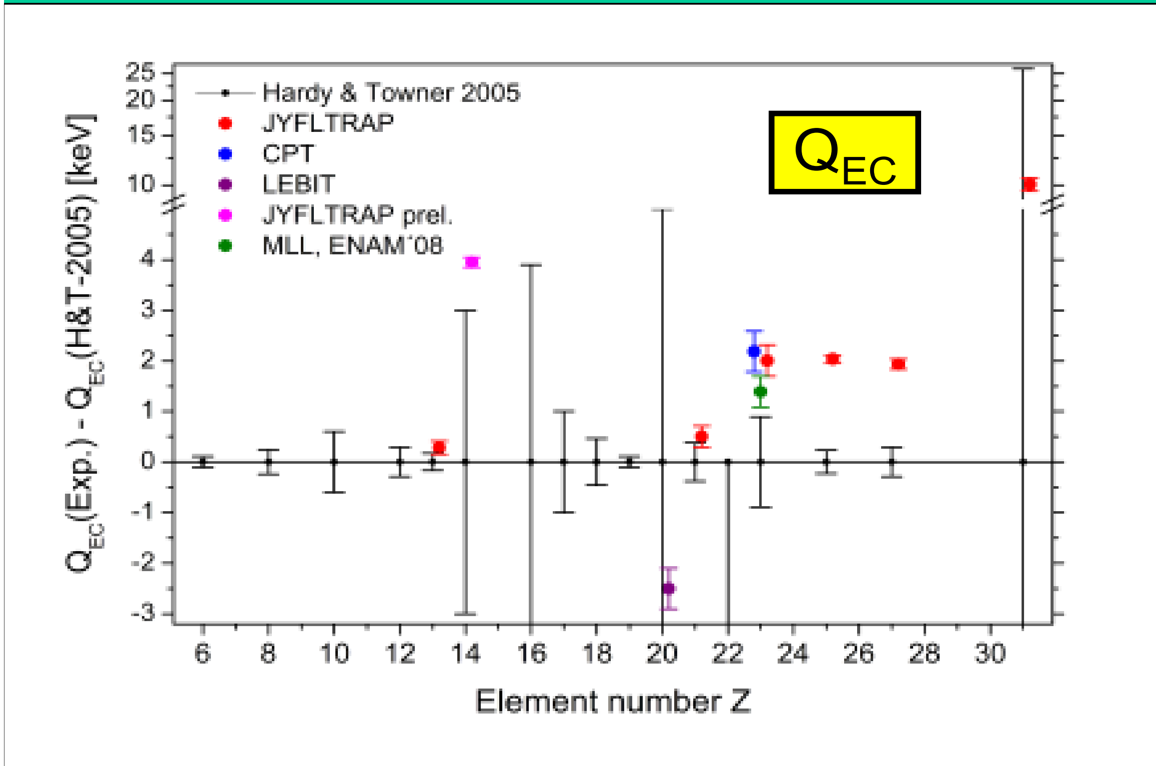
$$|V_{ud}|^2 + |V_{us}|^2 + |V_{ub}|^2 = 0{,}9992 \pm 0{,}0011$$

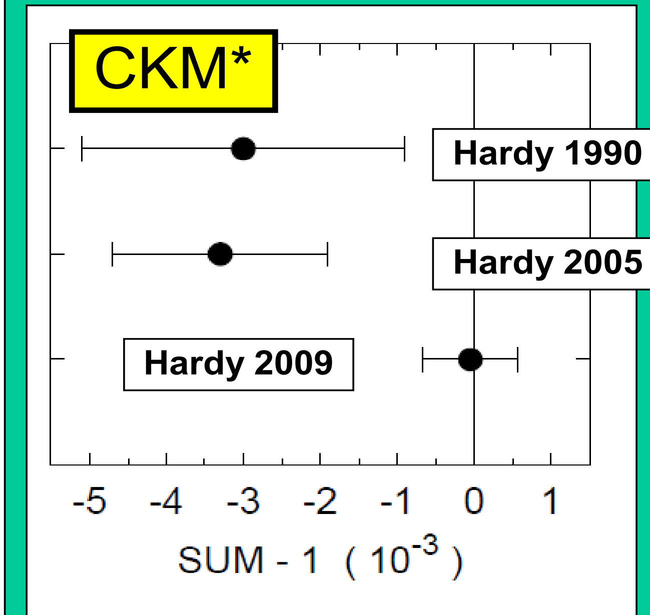
$$|V_{cd}|^2 + |V_{cs}|^2 + |V_{cb}|^2 = 0{,}968 \pm 0{,}181$$

$$|V_{ud}|^2 + |V_{cd}|^2 + |V_{td}|^2 = 1{,}001 \pm 0{,}005$$

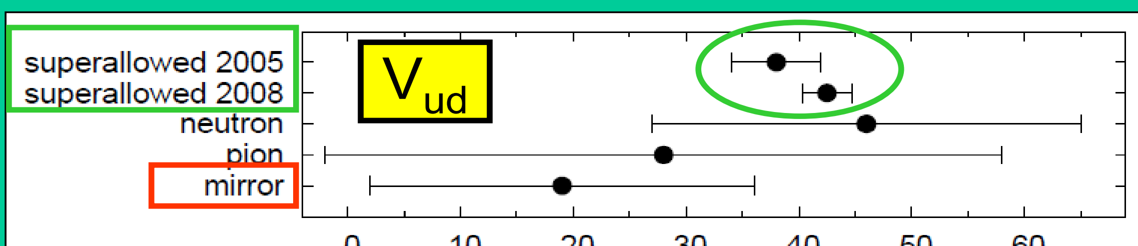
Ogromna rola fizyki jądrowej przy wyznaczaniu V_{ud}!

New Q_{EC}-values, V_{ud} and unitarity test





$SUM = V_{ud}^2 + V_{us}^2 + V_{ub}^2$



Naviliat &Severijns,
PRL 102 (2009) 142302

Most precise value for V_{ud} from nuclear beta decay !!!
Its^2 contribution > 95 %

J. Aysto, Piaski 2009

PHYSICAL REVIEW C **79**, 055502 (2009)

Superallowed $0^+ \rightarrow 0^+$ nuclear β decays: A new survey with precision tests of the conserved vector current hypothesis and the standard model

J. C. Hardy* and I. S. Towner
Cyclotron Institute, Texas A&M University, College Station, Texas 77843, USA
(Received 5 December 2008; published 26 May 2009)

Unitarity of CKM matrix

top-row: $|V_{ud}|^2 + |V_{us}|^2 + |V_{ub}|^2$

= 0.99995±0.00061

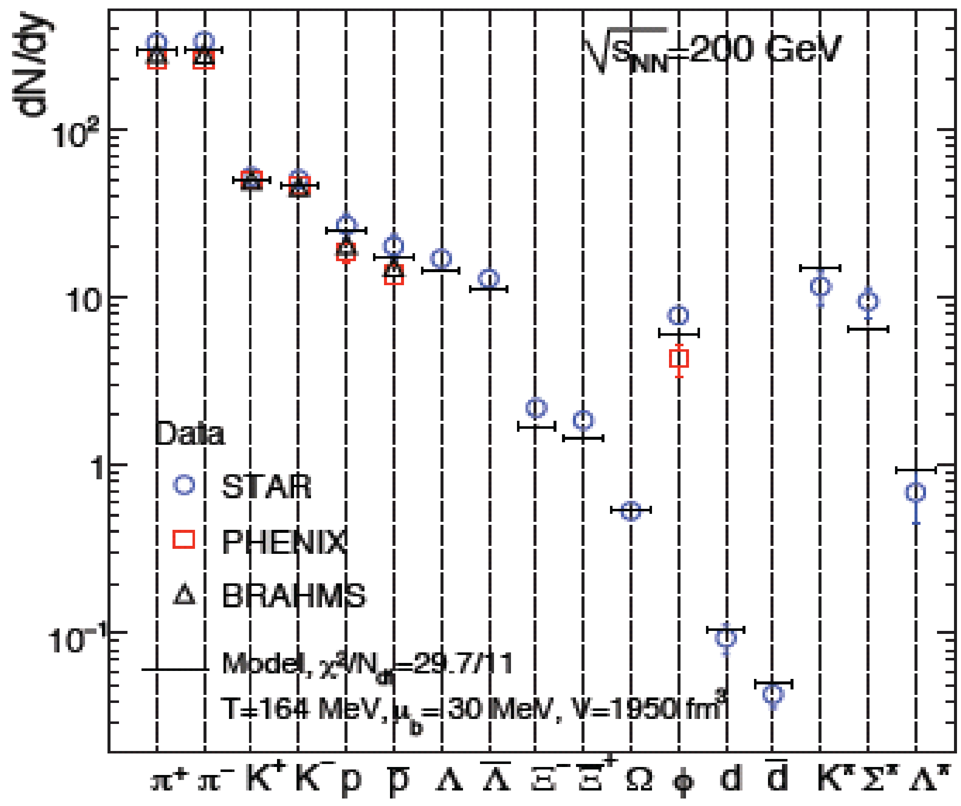
Current results—in agreement with the SM—place important constraints on candidates for the New Standard Model, including supersymmetry,

The next step is to work on theoretical corrections

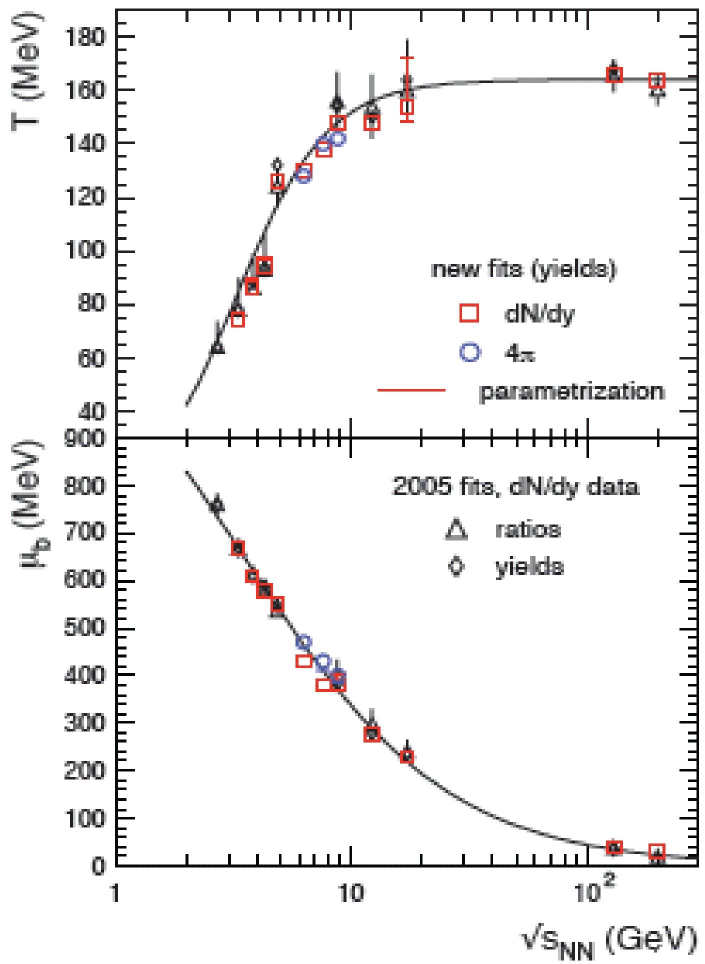
- more experiments on heavier nuclei for δ_c
- more theory on radiative corrections

J. Aysto, Piaski 2009

→ **produced matter is thermalized?**

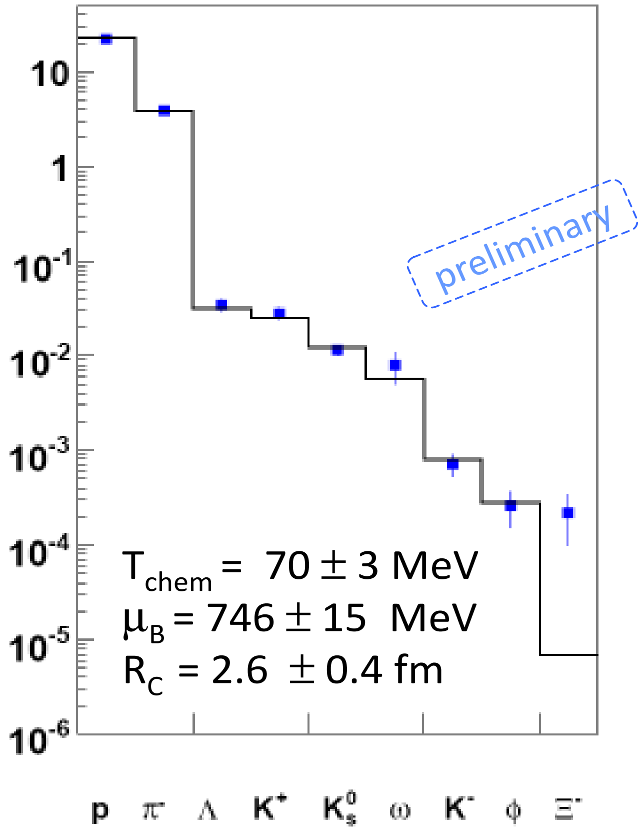


Andronic, Braun-Munzinger, Stachel,
PLB 673 (2009) 142.



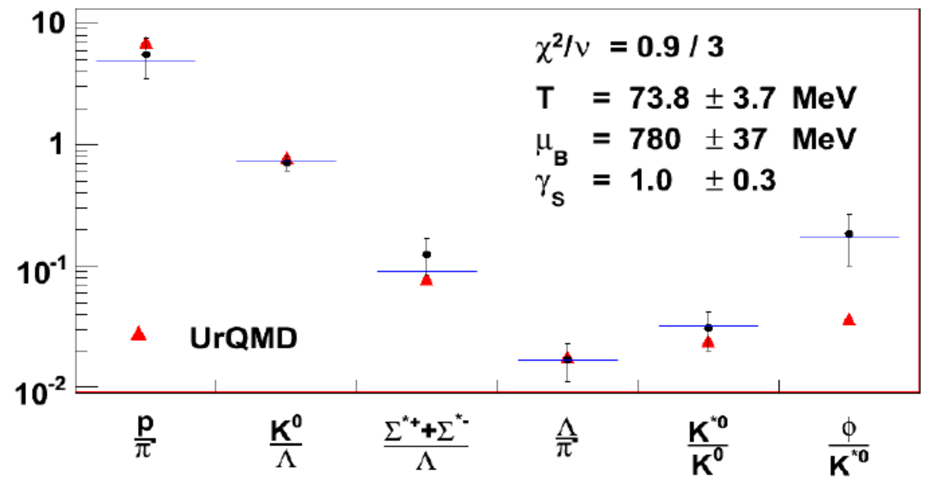
Strange Particle Production at SIS18

- HADES,
- Ar+KCl at 1.76 GeV/u



HADES collab.: arXiv:0907.3582
and arXiv:0902.3487

- FOPI (P. Gasik CPOD 2009),
- Al+Al at 2 GeV/u



Statistical Model:
THERMUS, S. Wheaton and J. Cleymans, hep-ph/0407174
Transport:
UrQMD, M. Bleicher, S. Vogel at al.

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Polarized Antiprotons: Motivation

Summary

Transversity: unknown piece of partonic structure of nucleon ⟷ Direct access to „transversity“ in Drell Yan

PRL **103,** 072002 (2009)

experimental difficulties have challenged the most promising ones. In particular, the measurement of double spin asymmetries in the Drell-Yan process will have to wait for a polarized antiproton facility [3].

PAX

Need beam of polarized antiprotons !!

H. Ströher

Polarized Antiprotons: PAX

In Search of a Method to Polarize Antiprotons

Eur. Phys. J. A 34, 447–461 (2007)
DOI 10.1140/epja/i2007-10462-x

THE EUROPEAN PHYSICAL JOURNAL A

Special Article – Tools for Experiment and Theory

A surprising method for polarising antiprotons

Th. Walcher[1,2,a], H. Arenhövel[1], K. Aulenbacher[1], R. Barday[1], and A. Jankowiak[1]

[1] Institut für Kernphysik, Johannes Gutenberg-Universität Mainz, D-55099 Mainz, Germany
[2] Laboratori Nazionali di Frascati, Istituto Nazionale di Fisica Nucleare, I-00044 Frascati (Rome), Italy

Received: 26 June 2007 / Revised: 11 January 2008
Published online: 6 February 2008 – © Società Italiana di Fisica / Springer-Verlag 2008
Communicated by E. De Sanctis

Abstract. We propose a method for polarising antiprotons in a storage ring by means of a polarised positron beam moving parallel to the antiprotons. If the relative velocity is adjusted to $v/c \approx 0.002$ the cross-section for spin-flip is as large as about $2 \cdot 10^{13}$ barn as shown by new QED calculations of the triple spin cross-

QED-calculation predicts $\sigma > 10^{13}$ b !!!

H. Ströher

Polarized Antiprotons: PAX

In Search of a Method to Polarize Antiprotons

V. Strakhovenko:

"Understanding the FILTEX Result"

Th. Walcher:

"A surprising Method to polarize Antiprotons"

EPJ A 34 (2007) 447

$\sigma \sim 10^{+13}$ b

NIM B 266 (2008) 1122

$\sigma < 10^{-3}$ b

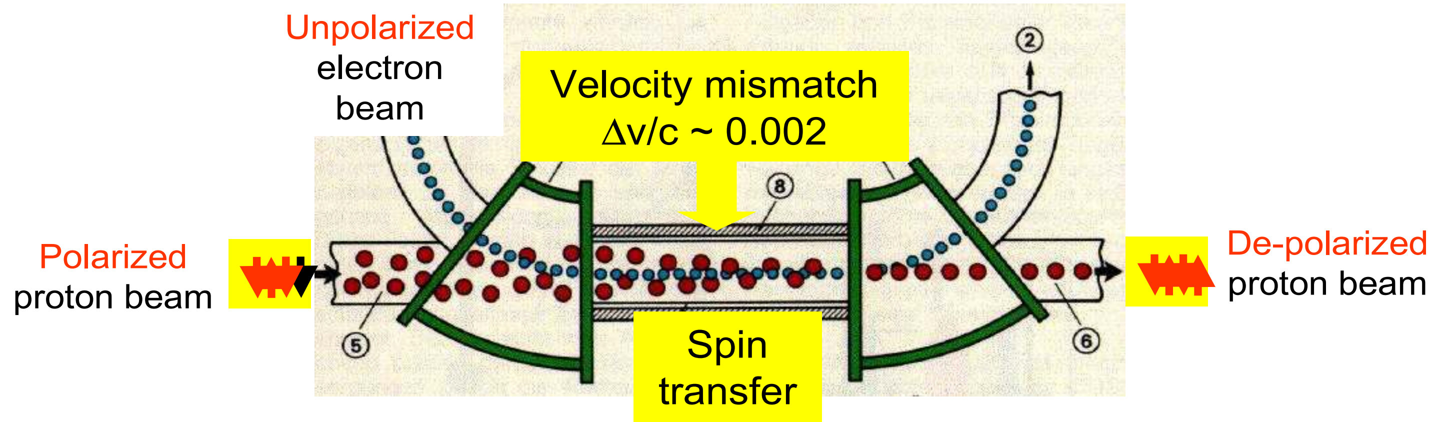
10^{16}

Experimental test necessary !

H. Ströher

Polarized Antiprotons: PAX

Spin flip – Test (at COSY)

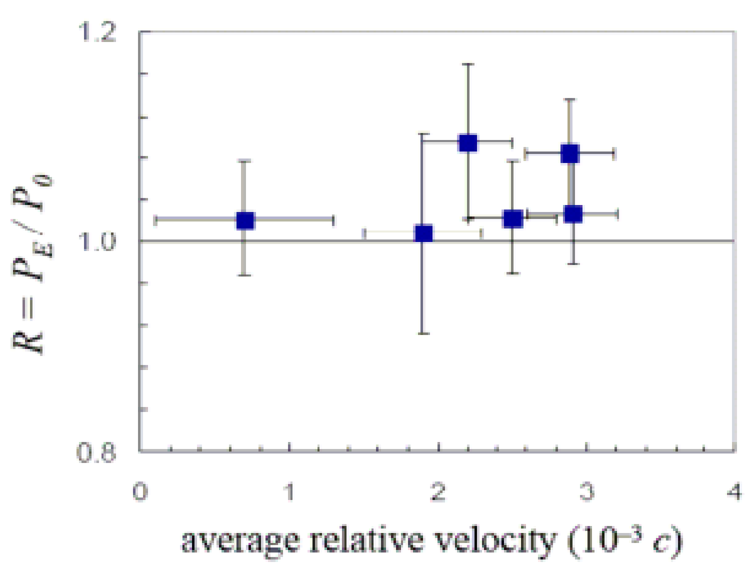


Are polarized protons depolarized by an electron beam ?

H. Ströher

Polarized Antiprotons: PAX

Spin flip – Test (at COSY)



$$\sigma_{depol} = \frac{-\ln\left(\frac{P_{detuned}}{P_{nominal}}\right)}{\Delta t \cdot d_t \cdot f_{rev}}$$

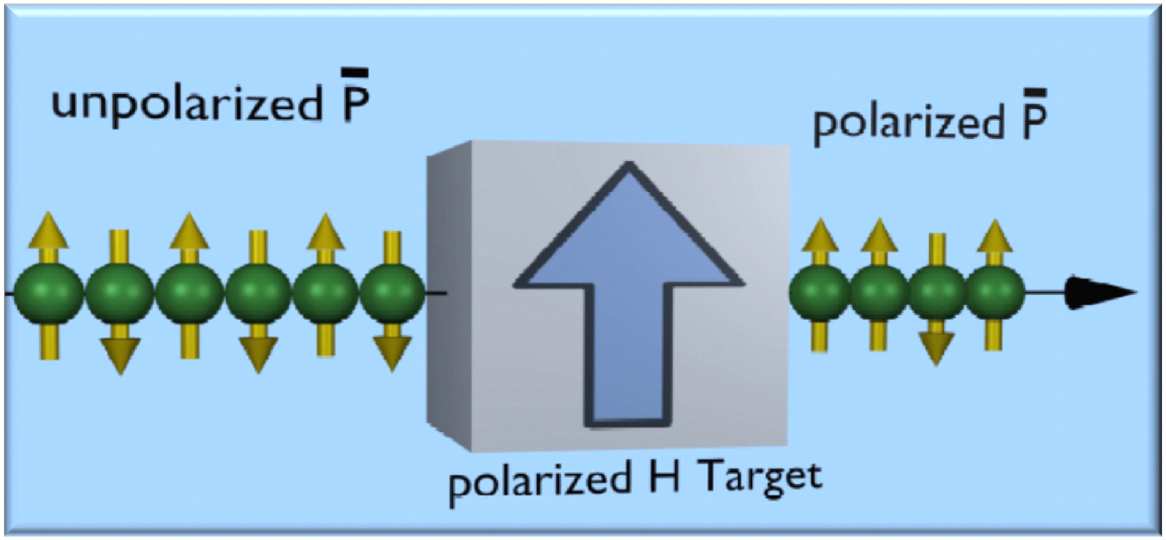
Result: NO effect observed

H. Ströher

Polarized Antiprotons: PAX

Spin filtering (SF)

Repeated interaction of the beam with a polarized target in a storage ring:

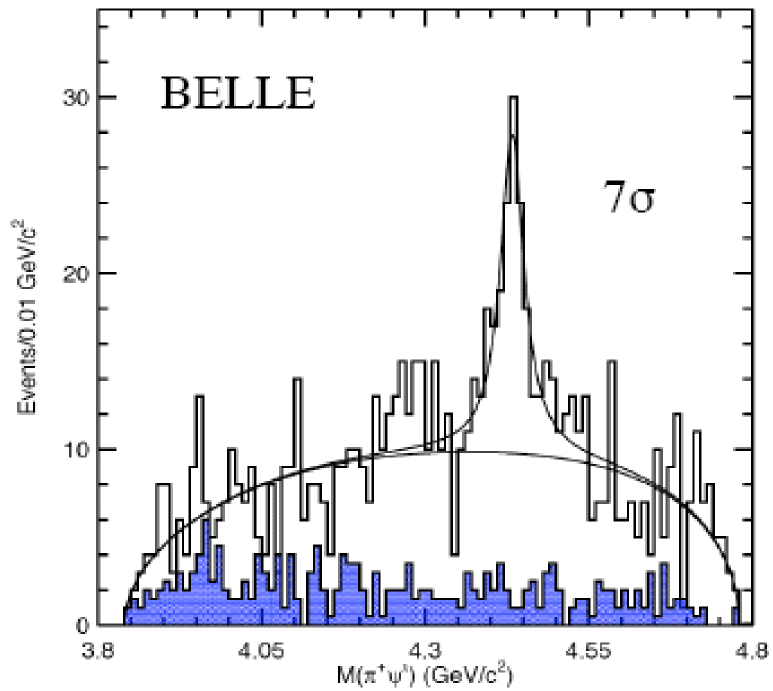


In-situ polarization build-up (at the expense of beam intensity)

H. Ströher

Now and here or never !

Z⁺ (4430) - a new state of matter (tetraquark?) decaying into $\pi^+\psi'$



Nie ma sprzeczności z wynikami BaBar.

Może zostać zmierzone w PANDA z dużą precyzją.

➡ Wait for PANDA

$$M = (4.433 \pm 0.004\ (\text{stat}) \pm 0.001\ (\text{syst}))\ \text{GeV}$$

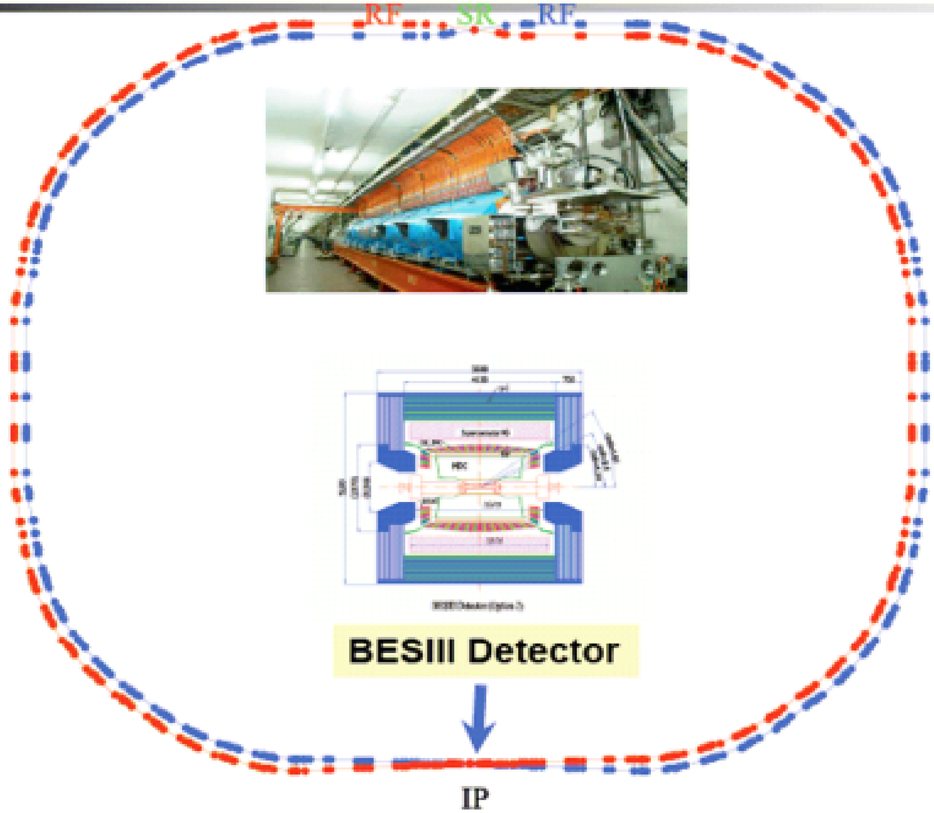
$$\Gamma = (0.044^{+0.017}_{-0.011}\ (\text{stat})^{+0.030}_{-0.011}\ (\text{syst}))\ \text{GeV}$$

$$\mathcal{B}(B \to KZ(4430)) \times \mathcal{B}(Z \to \pi^+\psi') = (4.1 \pm 1.0\ (stat) \pm 1.3\ (syst)) \times 10^{-5}$$

PRL 100, 142001 (2008)
arXiv:0708.1790 [hep-ex]

U. Wiedner

BEPC II Storage Ring: Large angle, double-ring



Beam energy:
1.0-2.3 GeV
Luminosity:
1×10^{33} cm^{-2}s^{-1}
Optimum energy:
1.89 GeV
Energy spread:
5×10^{-4}
No. of bunches:
93
Bunch length:
1.5 cm
Total current:
0.91 A

W. Kühn

Institute of High Energy Physics, Bejing

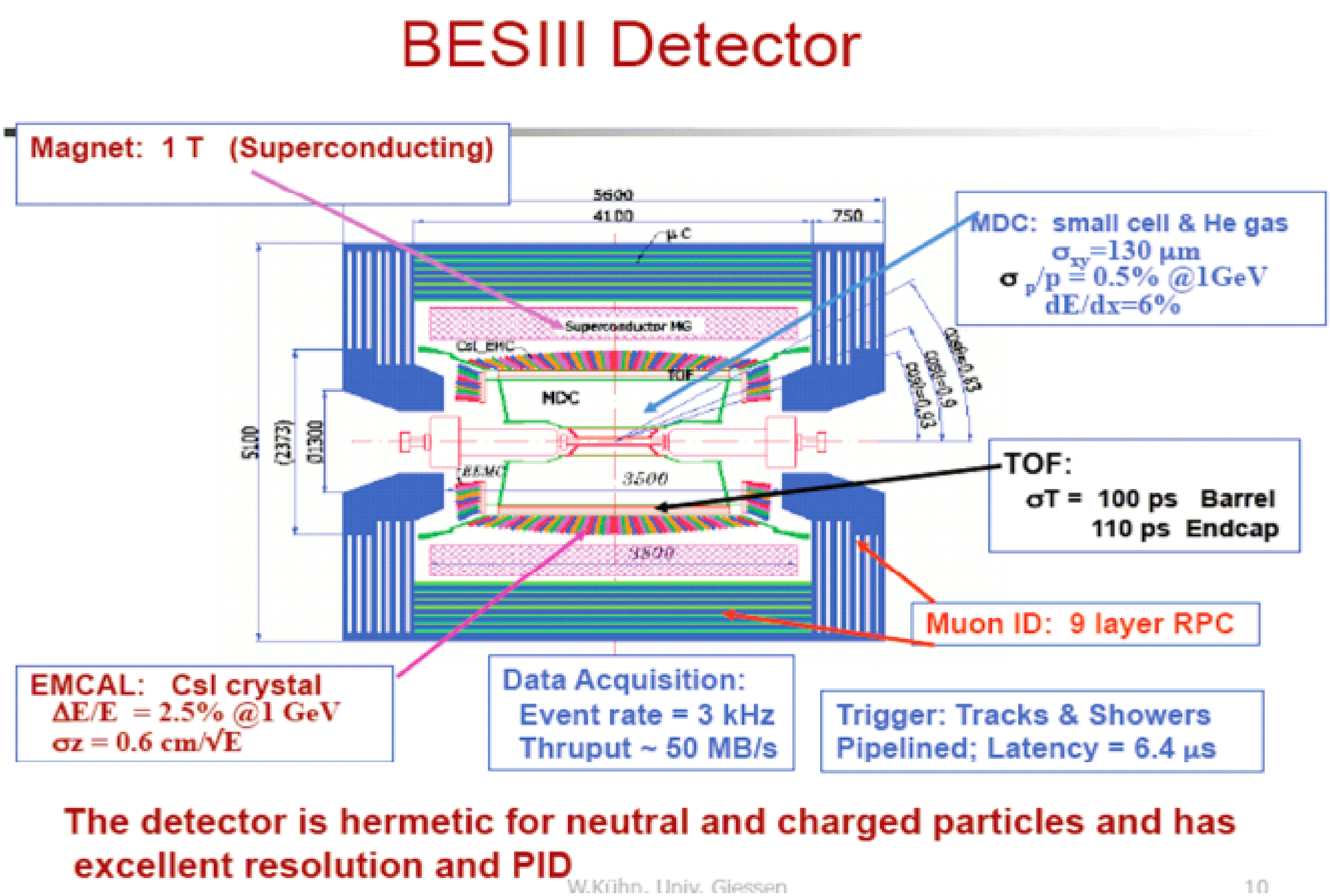
1000 pracowników (650 fizyków i inżynierów)

400 doktorantów i postdoc-ów

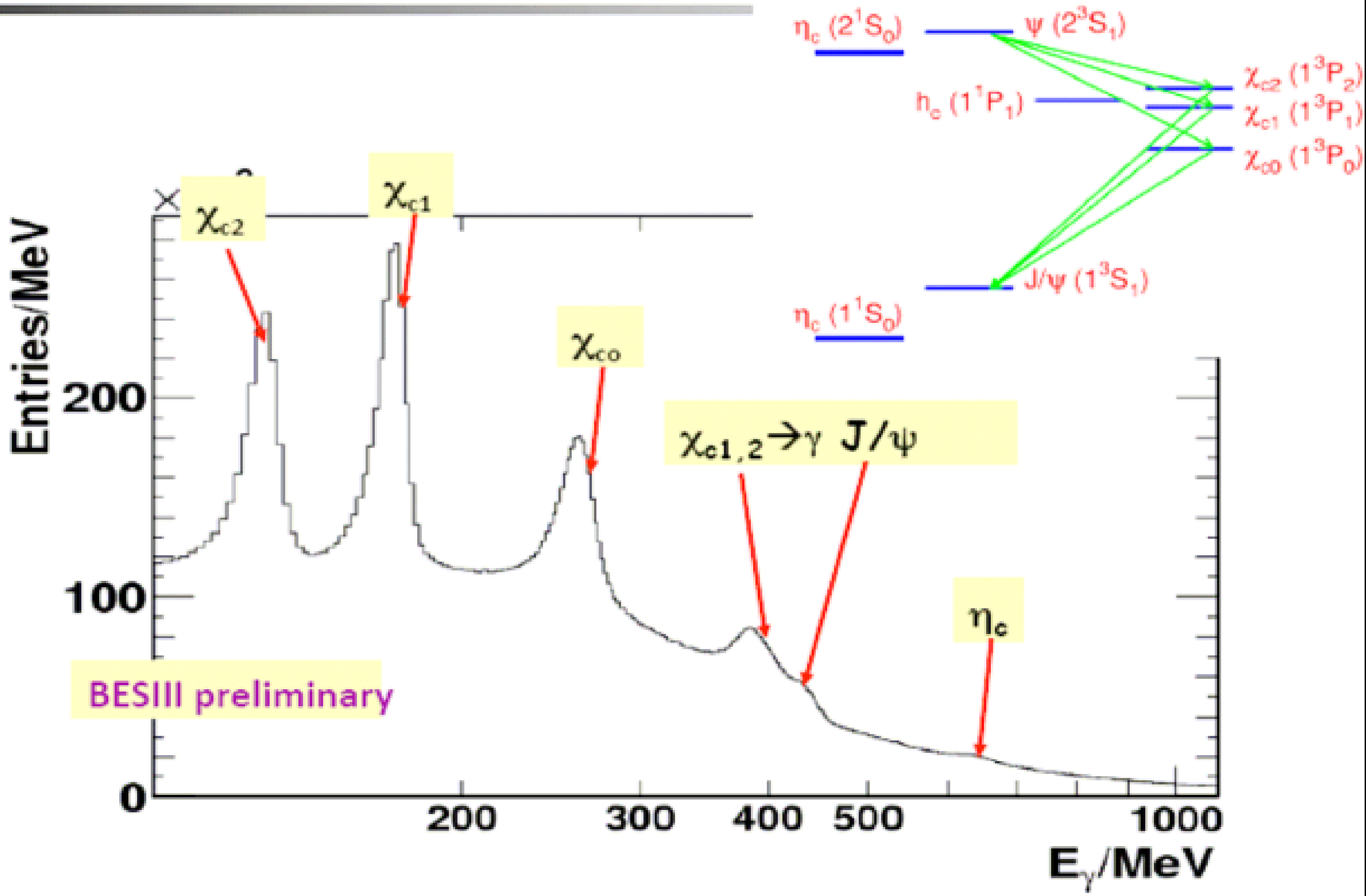
The Milestones

January 2004	Construction started
May. 4, 2004	Dismount of 8 linac sections started
Dec. 1, 2004	Linac delivered e^- beams for BEPC
July 4, 2005	BEPC ring dismount started
Mar. 2, 2006	BEPCII ring installation started
Nov. 13, 2006	Phase 1 commissioning started
Aug. 3, 2007	Shutdown for installation of IR-SCQ's
Oct. 24, 2007	Phase 2 commissioning started
Mar.28, 2008	Shutdown for installation of detector
June 22, 2008	Phase 3 commissioning started

W. Kühn


BESIII Detector
Magnet: 1 T (Superconducting)
MDC: small cell & He gas
σxy=130 μm
σ p/p = 0.5% @1GeV
dE/dx=6%
TOF:
σT = 100 ps Barrel
110 ps Endcap
Muon ID: 9 layer RPC
EMCAL: CsI crystal
ΔE/E = 2.5% @1 GeV
σz = 0.6 cm/√E
Data Acquisition:
Event rate = 3 kHz
Thruput ~ 50 MB/s
Trigger: Tracks & Showers
Pipelined; Latency = 6.4 μs
Superconductor MG
CsI_EMC
TOF
MDC
5600
4100
750
3500
3800
5100
(2373)
Ø1300
The detector is hermetic for neutral and charged particles and has excellent resolution and PID
W.Kühn, Univ. Giessen
10

E1 transitions: inclusive photon spectrum



W. Kühn

W. Kühn

Summary

- A new facility for Charm/Tau physics went successfully into operation
- Huge amounts of J/Psi and J/Psi(2s) and D mesons can be produced
  - Precision physics with the potential for standard model tests
  - Light meson spectroscopy, search for exotica in charmonium decays (glue-rich environment)
  - Charmonium spectroscopy
    - Ideal experiment for those who cannot wait and want to do physics now while they are building PANDA
  - **New members welcome !**

U. Wiedner

Mass of composed object larger than sum of constituents.

Hadron physics

$m_{hadron} >> \Sigma\, m_{quarks}$

extra mass due to large binding energy

gluon-gluon interaction

outside hadrons no strong force due to gluons, except residual effects

Cosmology

$m_{galaxy} >> \Sigma\, m_{stars}$

or alternatively

gravity might be stronger than we think for these systems

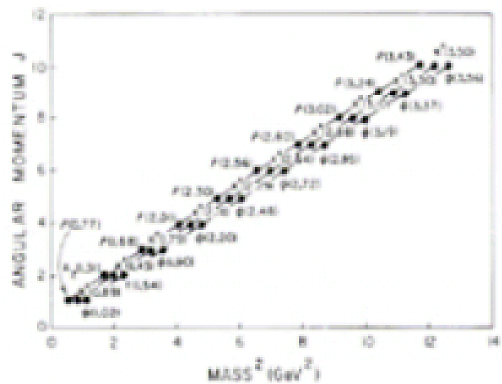
graviton-graviton interaction

Dark energy pushes galaxies away from each other

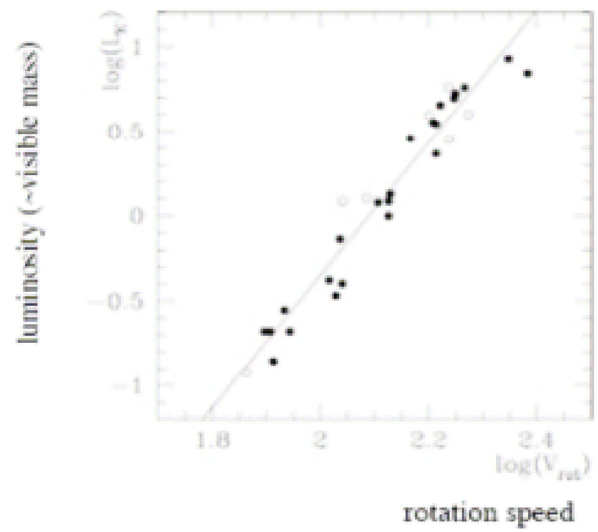
or alternatively

at very large distances the total force is smaller than we think

Regge trajectories



Tully-Fisher relation



log(M)=c log(J)+b (c=0.5)
(M, hadron mass, J angular momentum)

log(M)=γ log(v)+ε (γ=3.9±0.2, ε~1.5)
(M galaxy visible mass, v rotation speed)

(not explained by dark matter models)

U. Wiedner

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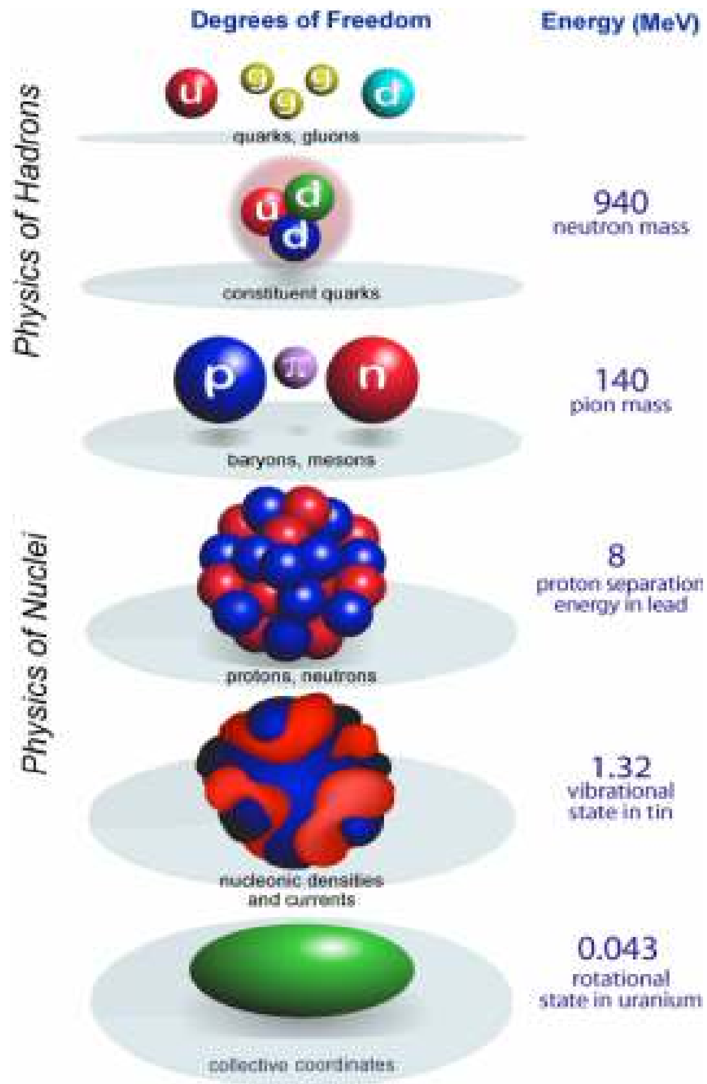
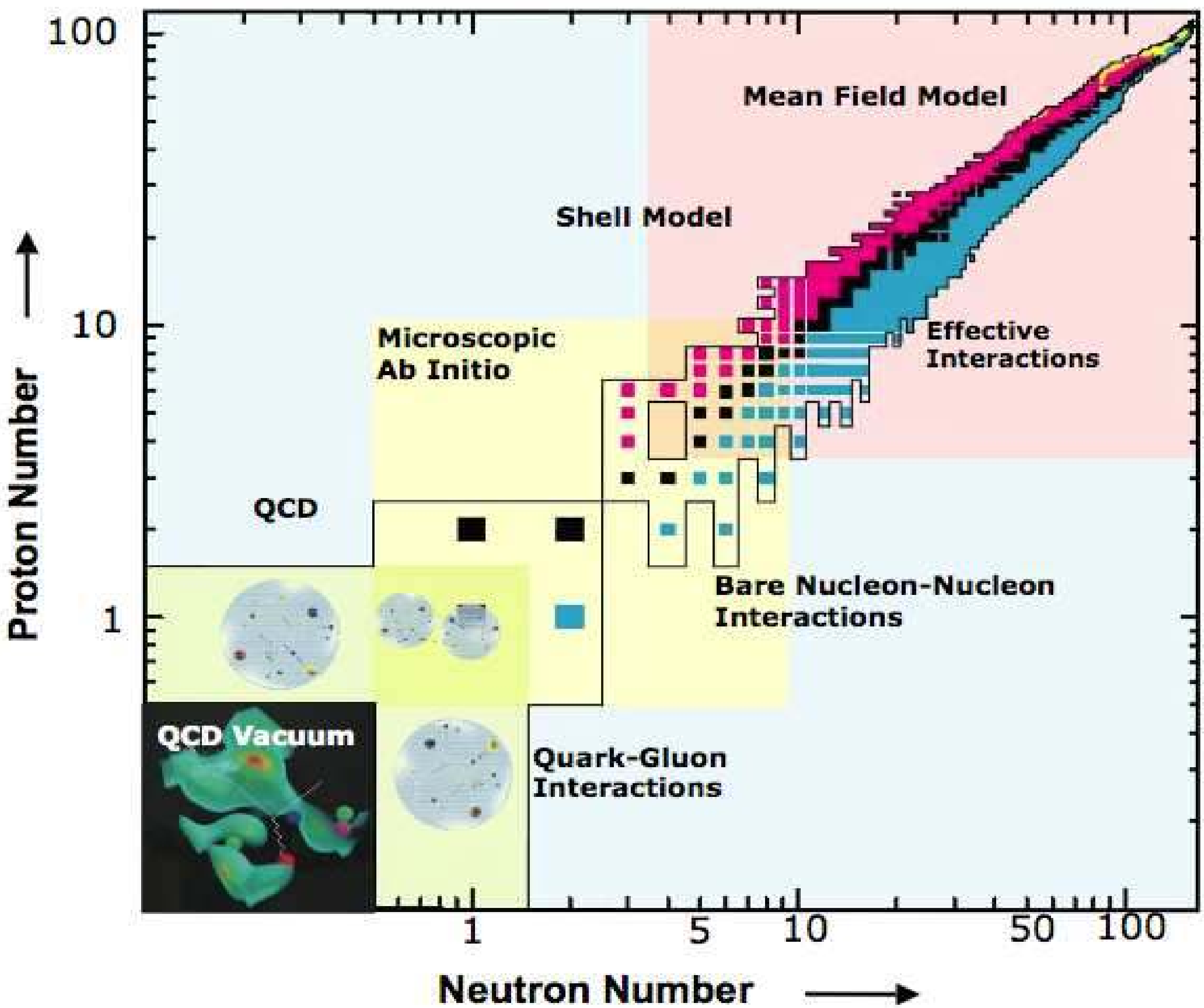
c) Egzotyka jądrowa i jej struktury

3. FAIR-aktualności



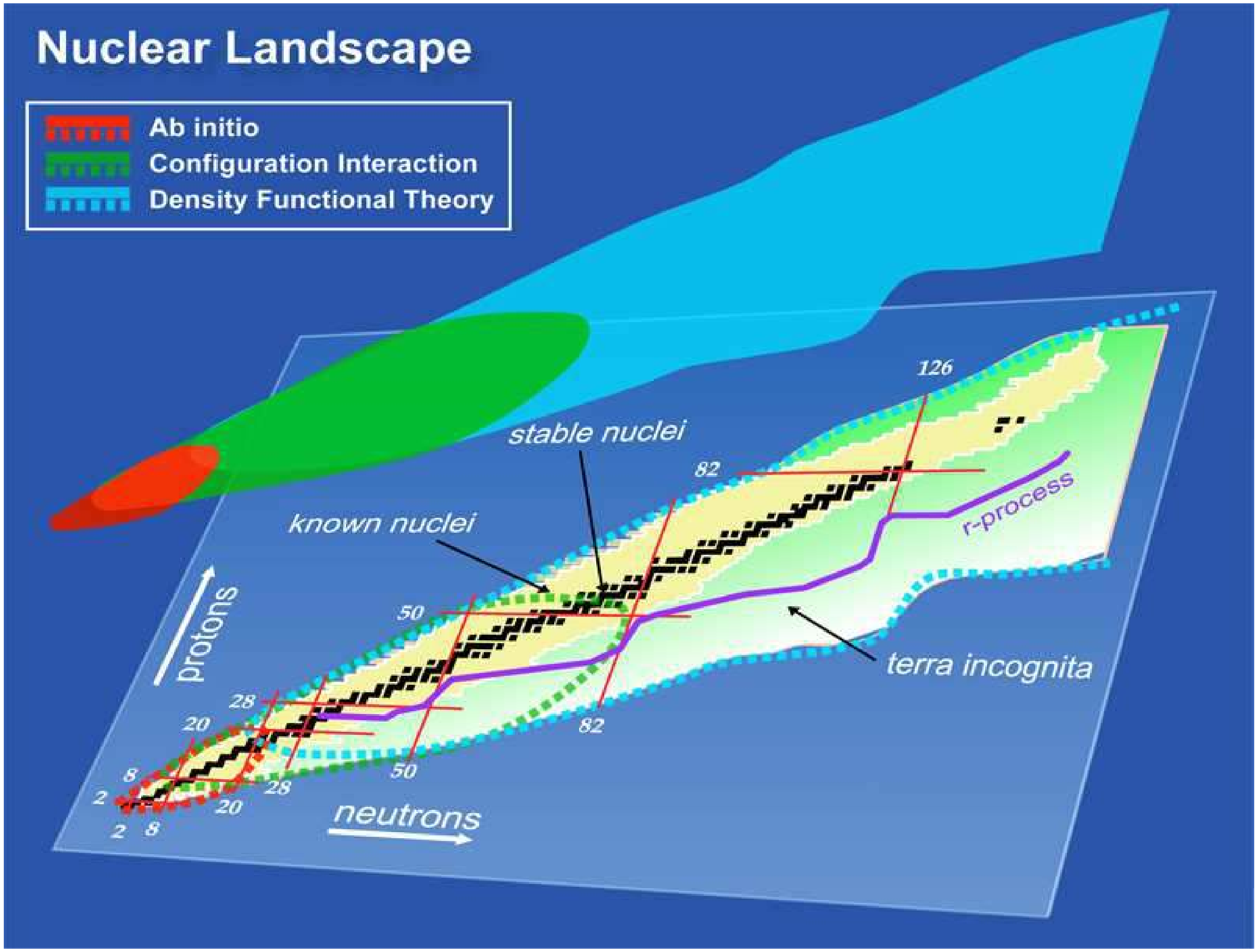
Nuclear Structure

J. Dobaczewski

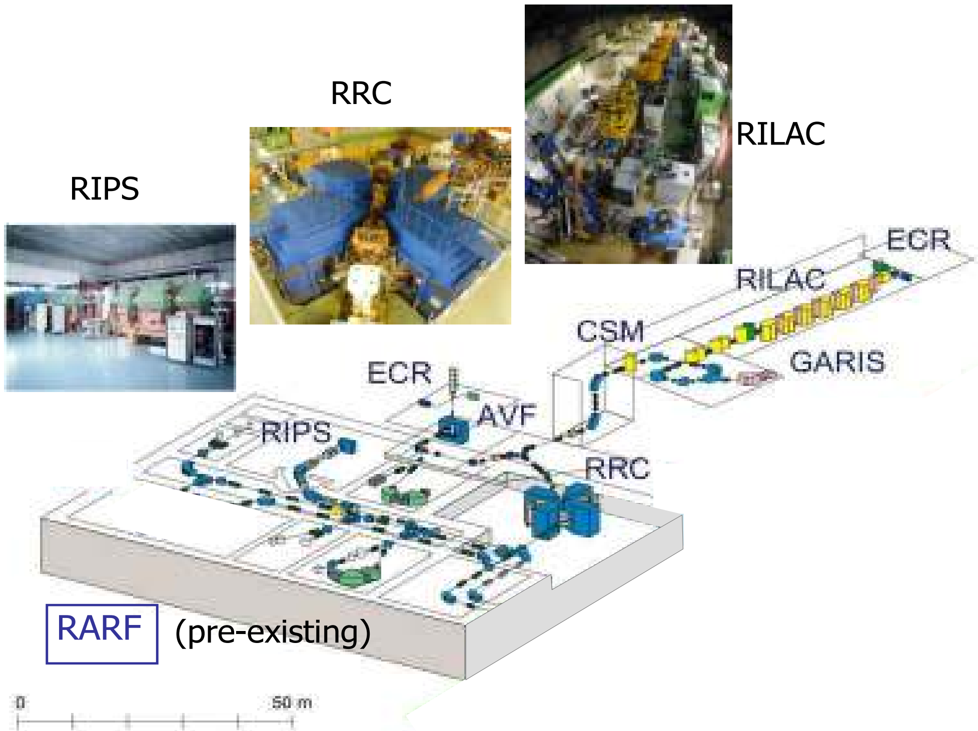


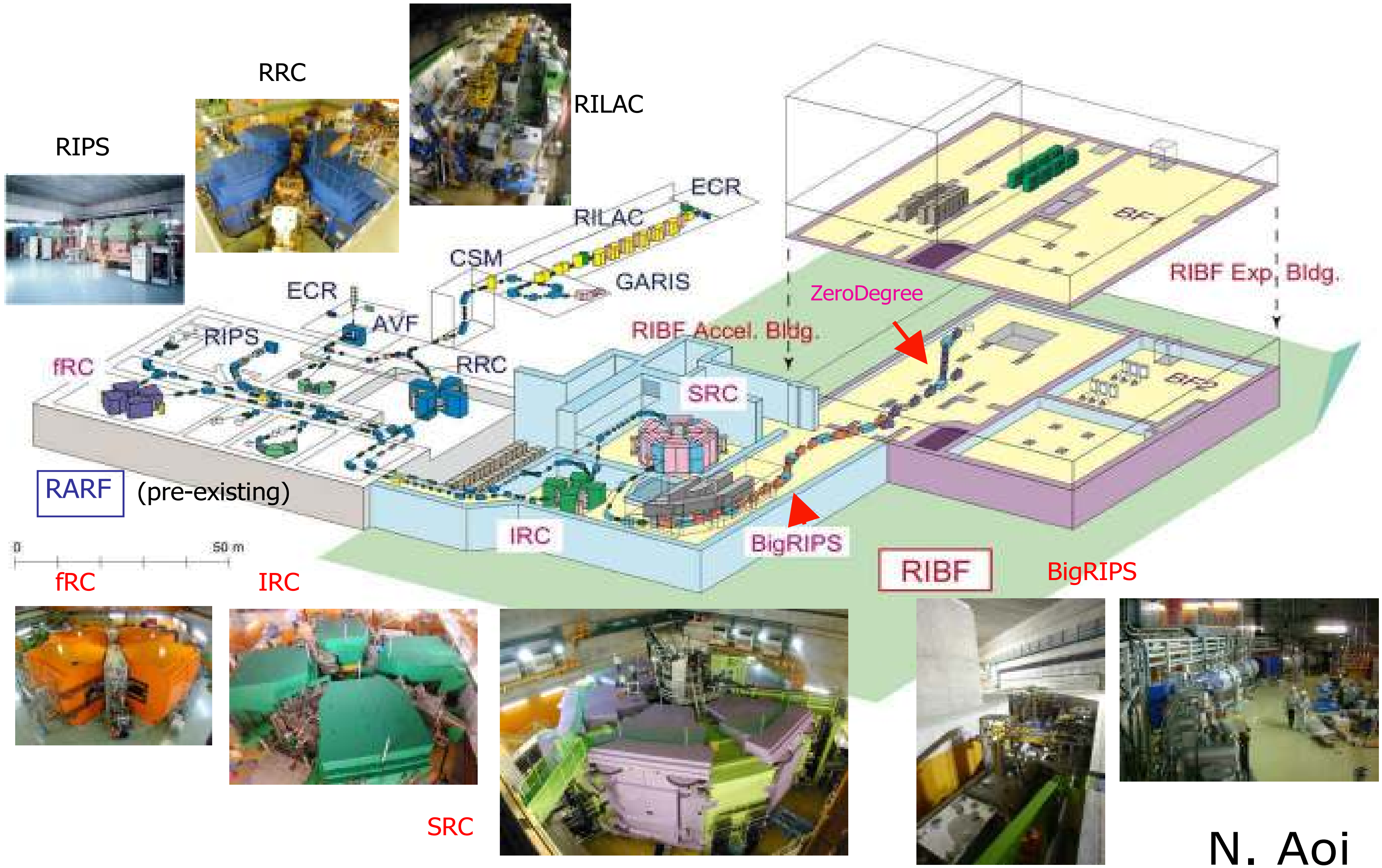
J. Dobaczewski

Universal Nuclear Energy Density Functional



J. Dobaczewski


RIPS
RRC
RILAC
ECR
RILAC
CSM
GARIS
ECR
AVF
RIPS
RRC
RARF
(pre-existing)
0
50 m


RIPS
RRC
RILAC
ECR
RILAC
CSM
GARIS
ECR
AVF
RIPS
fRC
RRC
RIBF Accel. Bldg.
ZeroDegree
RIBF Exp. Bldg.
BF1
BF2
SRC
IRC
BigRIPS
RARF
(pre-existing)
0
50 m
RIBF
fRC
IRC
SRC
BigRIPS

N. Aoi

Day One Working Group

Feb. 2007~ (Just after the 1st PAC)

Mission

Coordinate DayOne experiments

to be performed **efficiently** with **maximum output**

Simple (exp., analysis)
Large impact
Ready to run

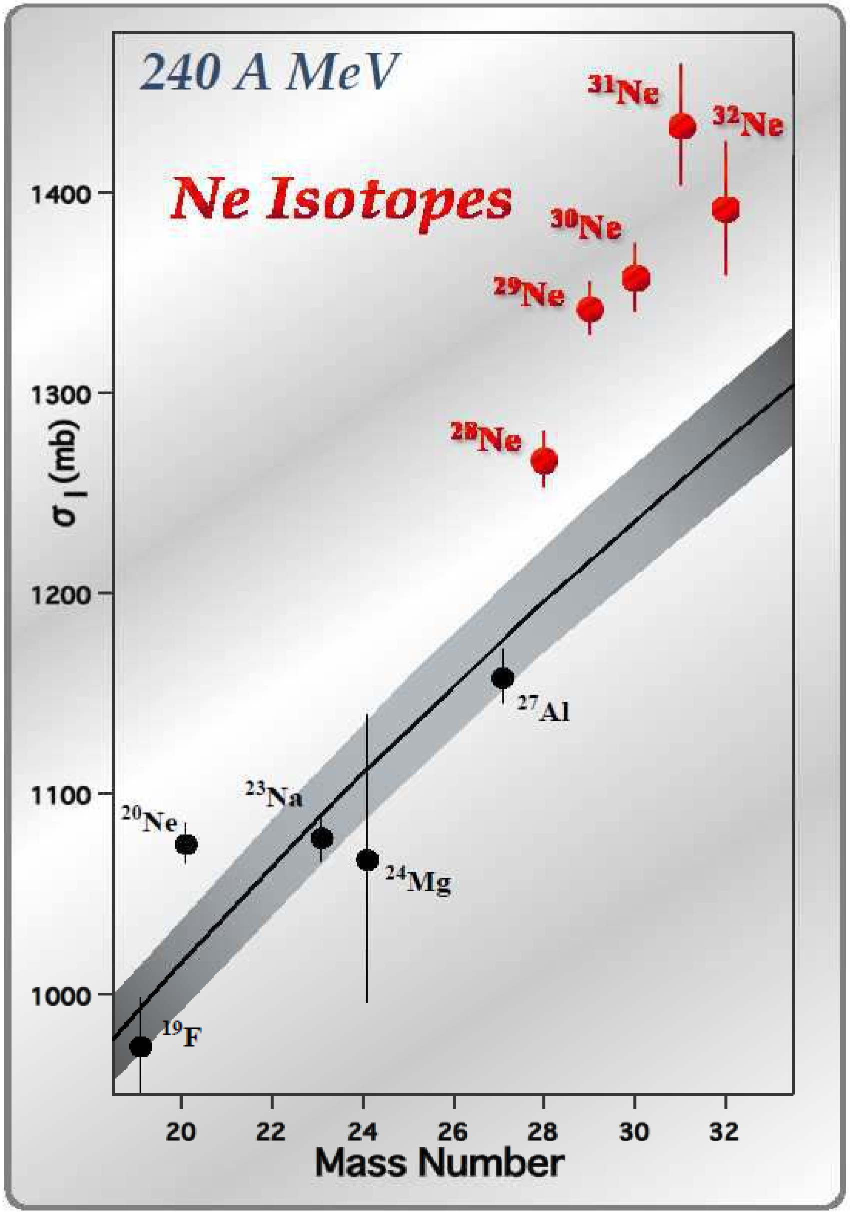
Exchange information among
Experimenters
Accelerator
BigRIPS teams

N. Aoi

^{48}Ca+Be Secondary Beam Production

	Present (BigRIPS)	Previous (RIPS)
^{22}C	10 cps	6 mcps
^{30}Ne	300 cps	0.2 cps
^{31}Ne	10 cps	20 c/4days
^{32}Ne	5 cps	
^{42}Si	15 cps	

N. Aoi



- σ_I($^{28\text{-}32}$Ne + C target)
  at 250 MeV/u
  with BigRIPS
- σ_I enhancement
  at island of inversion
  especially for ^{31}Ne
- Large σ_I in ^{31}Ne
  (*p*-wave halo?)

N. Aoi

Milestones

=== 2006 ===

Dec. 28th

First Beam $^{27}Al^{10+}$ 345 MeV/u at RIBF-SRC

===2007===

Feb BigRIPS construction completed

Mar

12th $^{86}Kr^{31+}$ beam at 345 MeV/u several pnA.

13th First RI Production with ^{86}Kr beam

23rd First successful acceleration of $^{238}U^{86+}$ beam (0.002 pnA)

27th First RI production with ^{238}U fission

May

16th ^{238}U beam 0.02 pnA → ^{125}Pd, ^{126}Pd production

=== 2008 ===

Nov ZeroDegree Commissioning

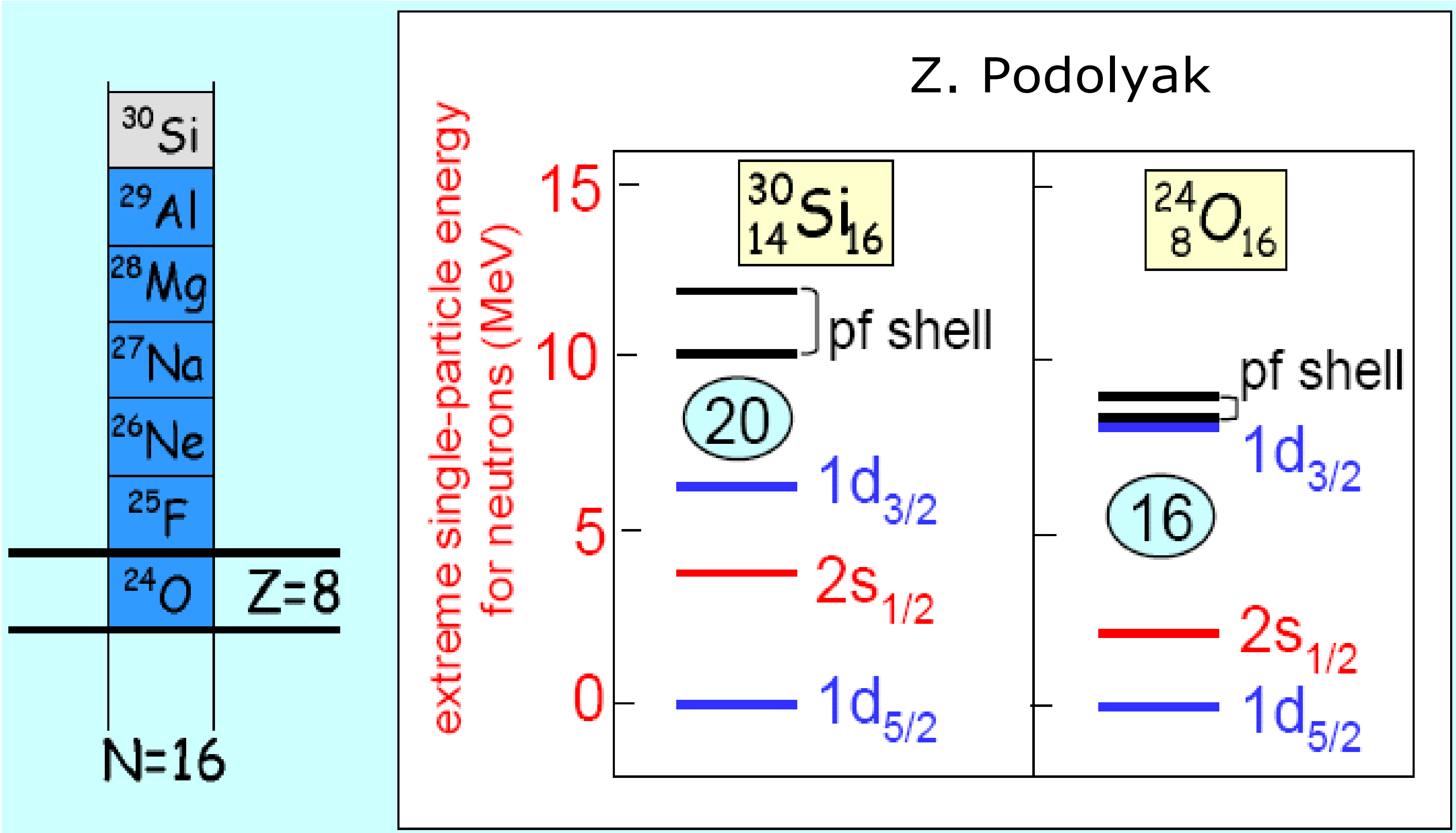
^{238}U beam 0.3 pnA → >20 new isotopes

Dec 180pnA ^{48}Ca → DayOne experiments

=== 2009 ===

Mar/May SHARAQ commissioning

N. Aoi



Standard magic numbers: 2, 8, 20

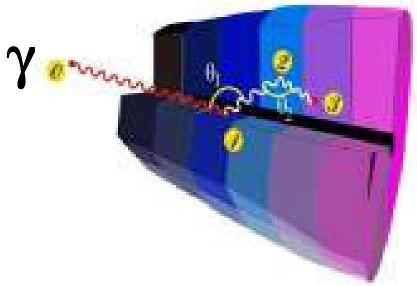
New magic number: **16** ~~20~~

How does the ordering of quantum states alter?

Ingredients of γ-Tracking

1

Highly segmented HPGe detectors



2

Digital electronics to record and process segment signals

3

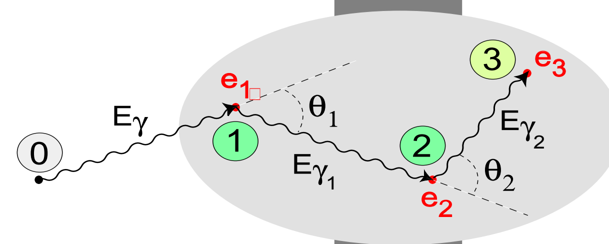
Pulse Shape Analysis to decompose recorded waves

Identified interaction

$(x,y,z,E,t)_i$

4

Reconstruction of tracks e.g. by evaluation of permutations of interaction points

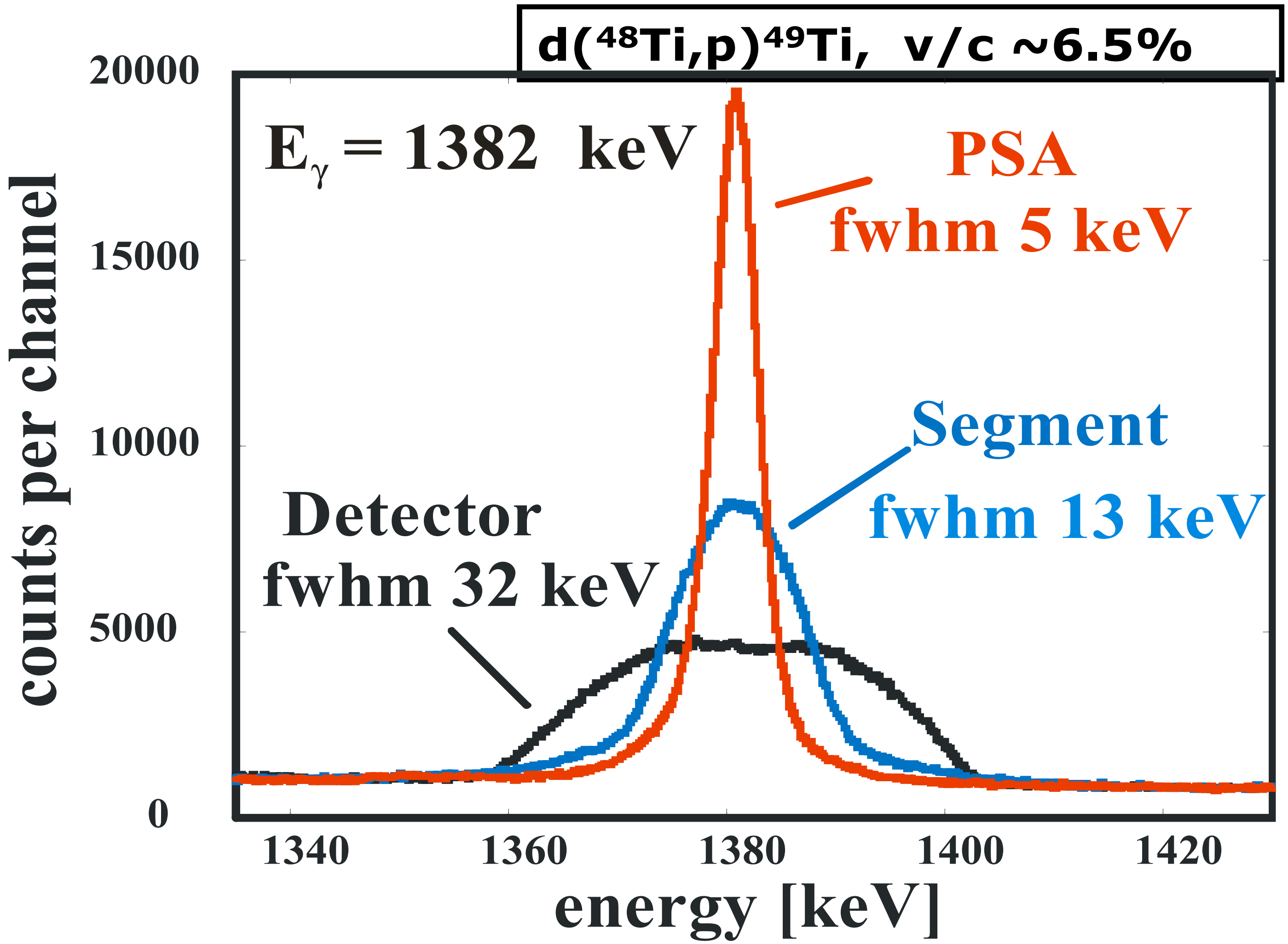


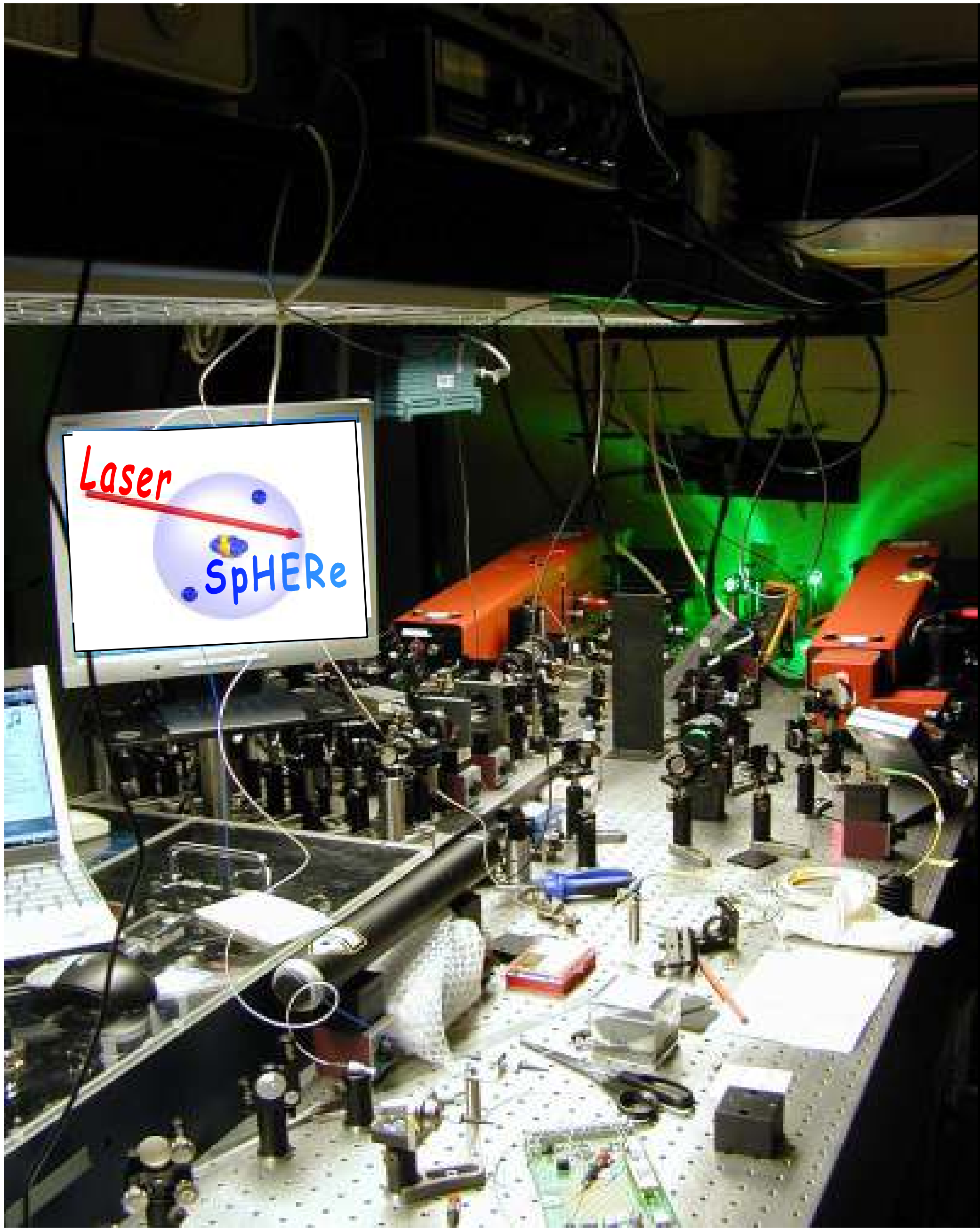
reconstructed γ rays

Z. Podolyak

Relativistic energy beams => huge reduction of Doppler broadening

Z. Podolyak



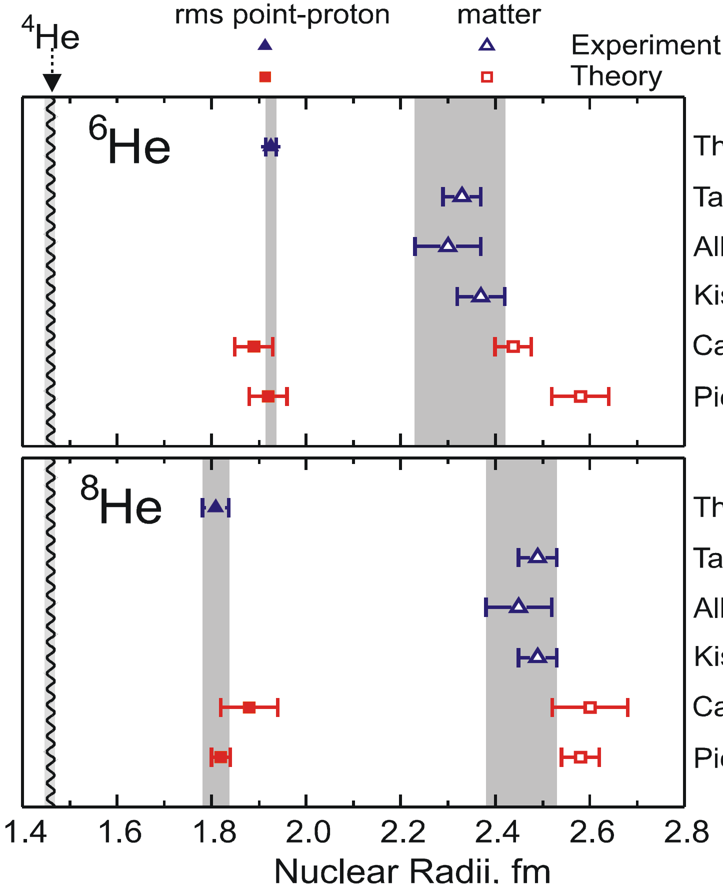


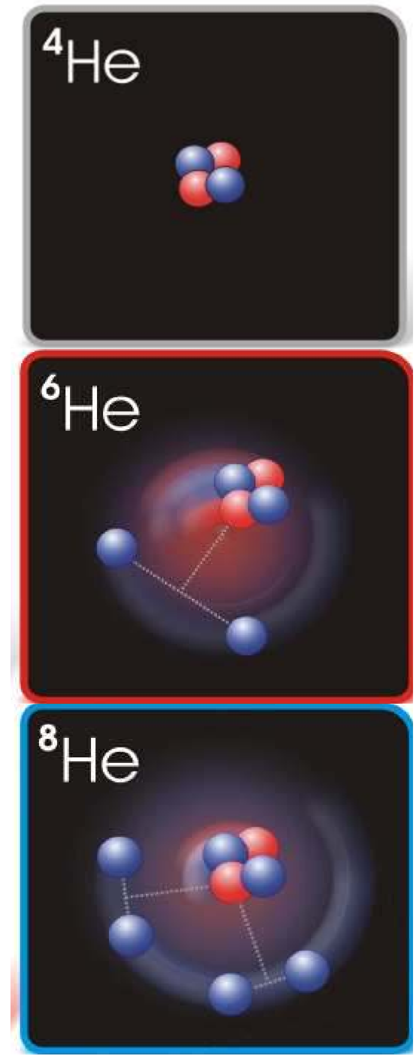
Nuclear Charge Radii of Light Halo Nuclei

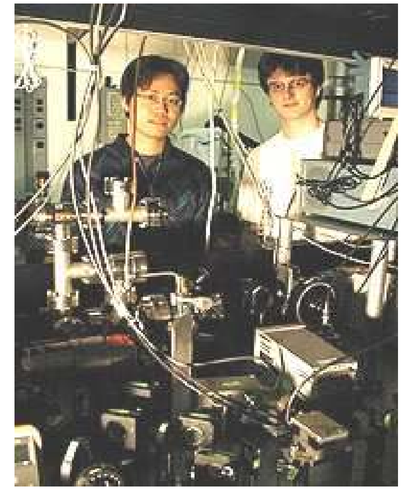
Wilfried Nörtershäuser

http://www.kernchemie.uni-mainz.de/laser/

^{6,8}He - Results







P. Mueller
L.-B. Wang

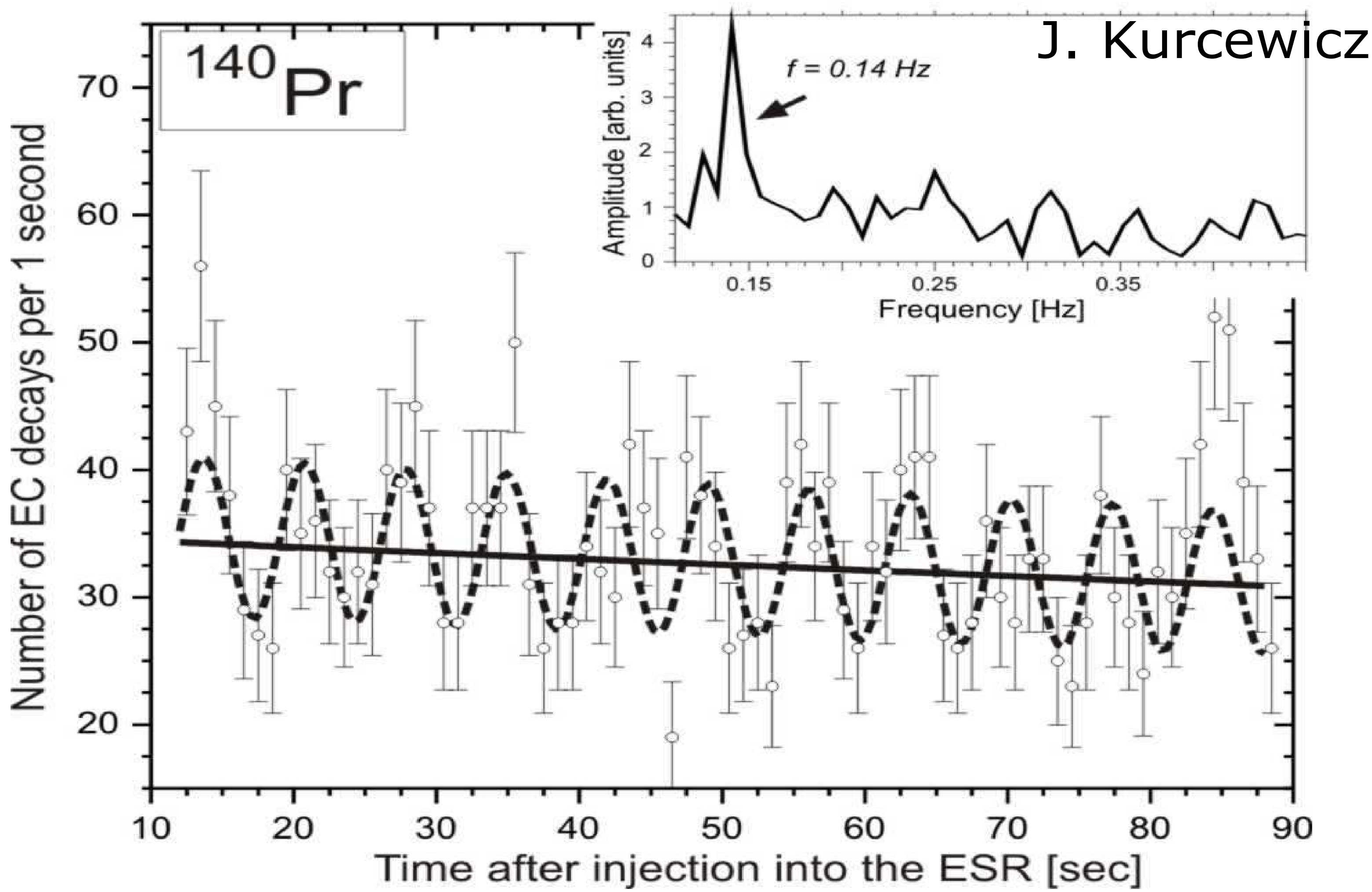
Courtesy of P. Mueller

Experimental Storage Ring

J. Kurcewicz

The ESR: 108m, 10^{-11} mbar, 2 MHz, E= 400 MeV/u,
electron- stochastic- cooling

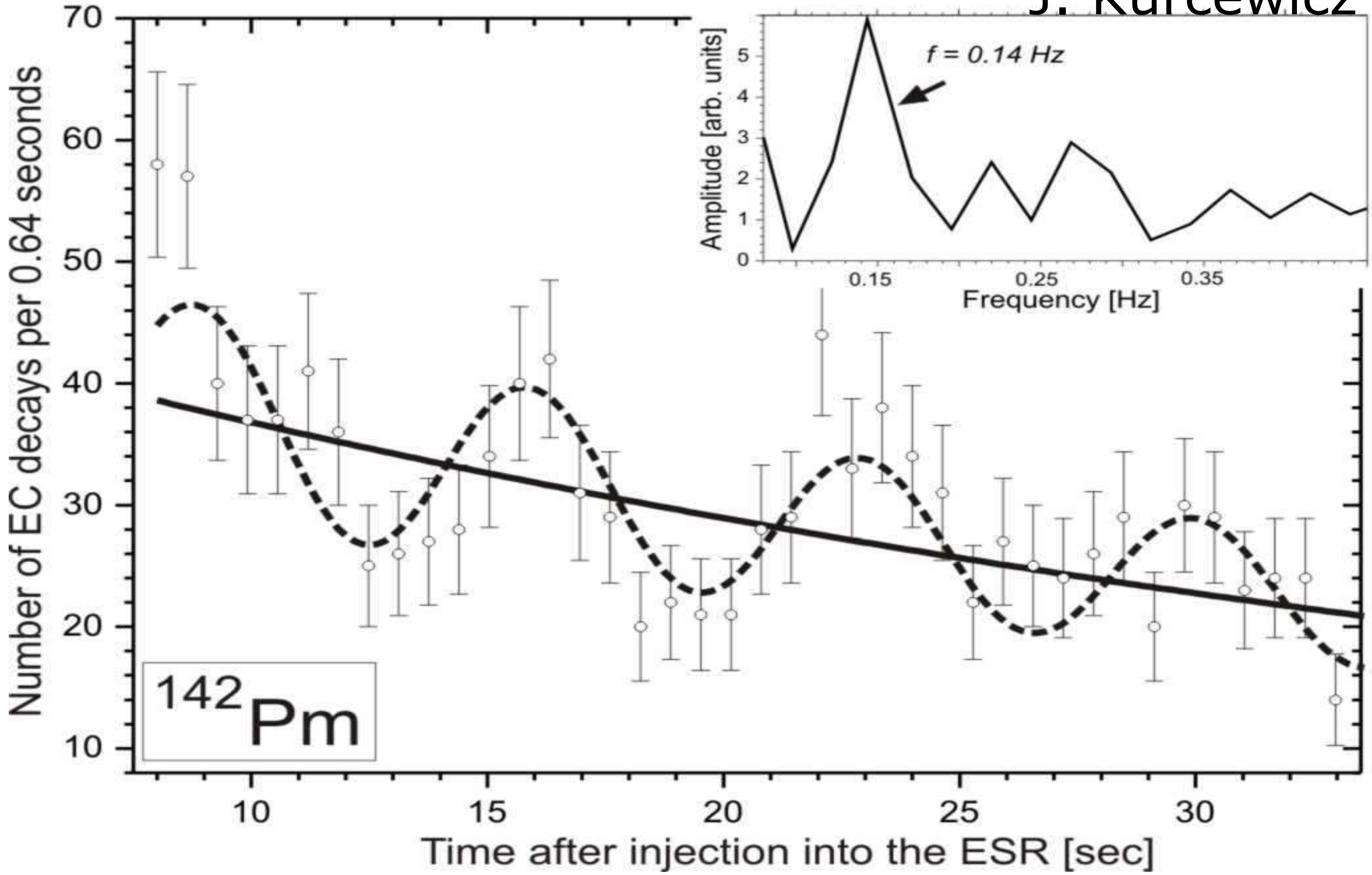
$^{140}Pr^{58+}$ all runs: 2650 EC decays from 7102 injections



Yu.A. Litvinov, F. Bosch, N. Winckler et al., Phys. Lett. B 664 (2008) 162-168

$^{142}Pm^{60+}$: zoom on the first 33 s after injection

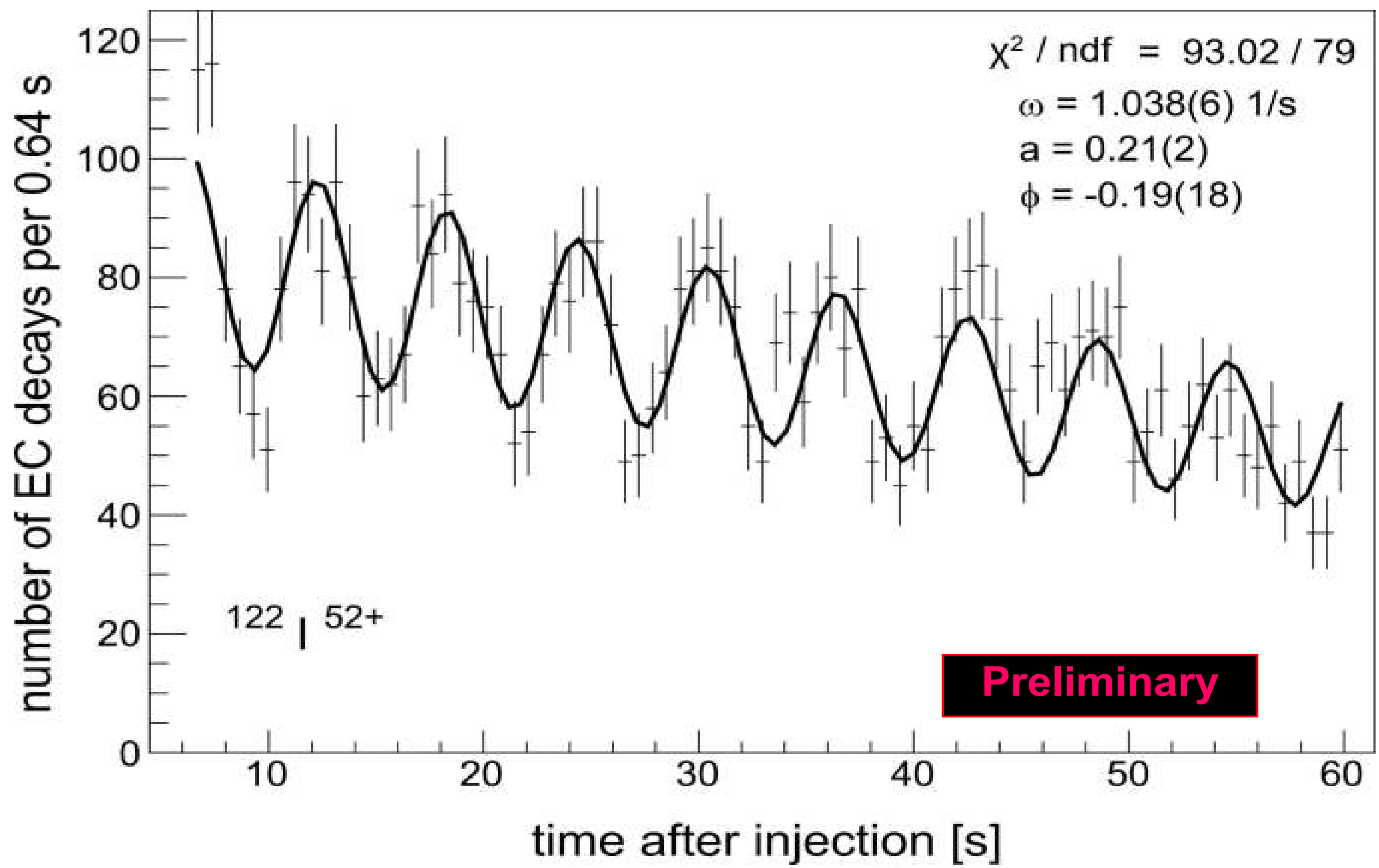
J. Kurcewicz



Yu.A. Litvinov, F. Bosch, N. Winckler et al., Phys. Lett. **B 664** (2008) 162-168

$^{122}I^{52+}$: preliminary results

J. Kurcewicz



Fit by : $dN_{EC}/dt = N_0\ \lambda_{EC}\ \exp(-\lambda t)\ [1 + a\cos(\omega t + \varphi)]$

Mazurian Lakes Conference on Physics

XXXI Mazurian Lakes Conference on Physics
NUCLEAR PHYSICS and the Road to Fair
August 30 – September 6, 2009 PIASKI Poland

Przegląd wyników analiz teoretycznych oraz rezultatów eksperymentalnych (RHIC/BNL, SPS (NA49/SHINE)/CERN, HERA/DESY, (HADES, FOPI, ESR) SIS18/GSI, BES3/BEPCII, COSY Jülich, RIBF, LNS Catania, AD/CERN, U400M/Dubna, HRIBF Oak Ridge, TRIUMF, Argonne, GANIL, ISOLDE/CERN)

Na wyniki doświadczalne z FAIR trzeba poczekać ...

Kierunek FAIR
Przystanek Mazury

1. FAIR-przypomnienie
2. XXXI Mazurian Lakes Conference *Nuclear Physics and the Road to FAIR*

a) QCD i materia hadronowa

b) Antyprotony

c) Egzotyka jądrowa i jej struktury

3. FAIR-aktualności


FAIR - Facility for Antiproton and Ion Research

White Paper

The Modularized Start Version

October 2009

... the revised civil construction costs, which increased by 290 M€ from 282 M€ to 572 M€ ...

For this purpose the start version as agreed upon in 2007 is now structured in six modules:

Module 0:	Heavy-Ion Synchrotron SIS100 – basis and core facility of FAIR – required for all science programmes
Module 1:	CBM/HADES cave, experimental hall for APPA and detector calibrations
Module 2:	Super-FRS for NuSTAR
Module 3:	Antiproton facility for PANDA, providing further options also for NuSTAR ring physics
Module 4:	Second cave for NuSTAR, NESR storage ring for NuSTAR and APPA, building for antimatter programme FLAIR
Module 5:	RESR storage ring for higher beam intensity for PANDA and parallel operation with NuSTAR

Based on recent cost estimates and the firm commitments on funding of FAIR Member States the new Start Version is comprised of Modules 0 – 1 – 2 – 3, in the following called the Modularized Start Version.

0 – 1 –2 – 3

Module configurations	Explanations	Goals and challenges	Scientific users
Module 0 SIS100 with connection to existing GSI accelerators	Central accelerator unit, used by all science programmes	Novel accelerator technologies (e.g. fast-ramping superconducting magnets, compact broad band radio-frequency resonators, XHV, ...)	all research programmes **Total number ~2500**
Module 1 Experimental areas	Buildings housing the CBM/HADES detectors and experiment set-ups for atomic physics, BIOMAT, and high-energy experiments (APPA)	Experiments on dense, strongly correlated nuclear matter with CBM/HADES; high-energy atomic physics, plasma, materials science, and bio (medical) science (ESA reference lab)	500 HADES/CBM 660 APPA **1,160 Total**
Module 2 Super-FRS (without CR)	Central NUSTAR instrument: RIB generation and isotope separator with one fixed-target branch and ring branch	Radioactive ion beams (RIB); nuclear structure and reactions, nuclear astrophysics	840 NUSTAR
Module 3 High-energy antiprotons (p-linac, anti-proton target, CR, HESR)	Generation and preparation of intense antiproton beams with the HESR for PANDA	Hadron physics and QCD with antiprotons with HESR/PANDA; cooled precision beams, hypermatter nuclei	420 PANDA

4 – 5

Module configurations	Explanations	Goals and challenges	Scientific users
Module 4 Low-energy RIBs and antiprotons	NESR ring with hall; FLAIR hall and second fixed-target area for NuSTAR	Experiment stations for decelerated highly-charged ions for APPA and low-energy antiproton programme (FLAIR), Electron cooled RIBs for NUSTAR	660 APPA 840 NUSTAR **Total 1,500**
Module 5 RESR storage ring	Parallel operation of NuSTAR and APPA with PANDA, increased intensity of antiproton beam	Full parallel operation mode; maximum luminosity for PANDA	840 NUSTAR 420 PANDA 660 APPA **1,920 Total**

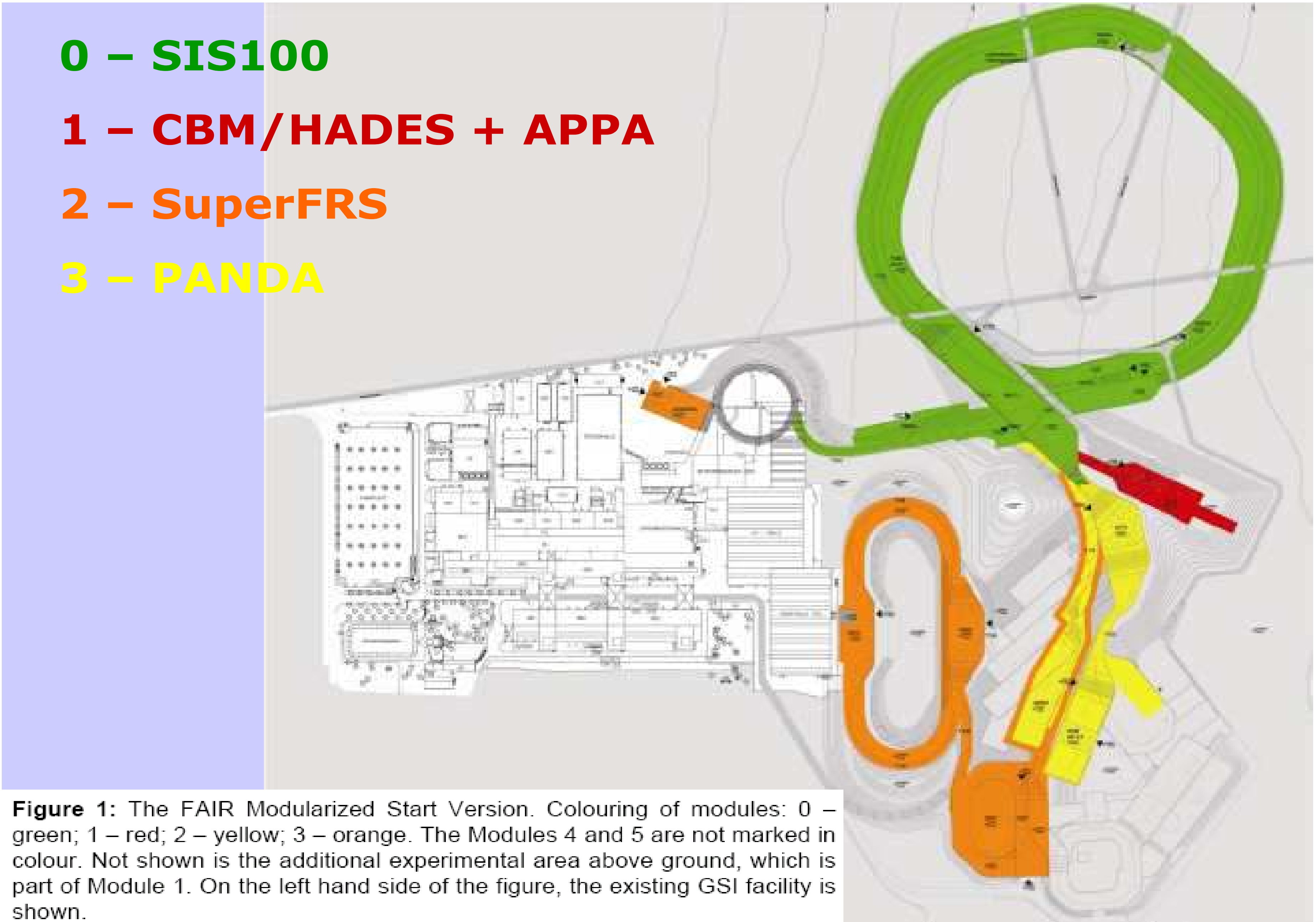


Figure 1: The FAIR Modularized Start Version. Colouring of modules: 0 – green; 1 – red; 2 – yellow; 3 – orange. The Modules 4 and 5 are not marked in colour. Not shown is the additional experimental area above ground, which is part of Module 1. On the left hand side of the figure, the existing GSI facility is shown.

Harmonogram

0 – SIS100

1 – CBM/HADES + APPA

2 – SuperFRS

3 – PANDA

The roadmap for the accelerator and civil construction is shown in the following table:

Module	Construction time (months)	Start of construction	Readiness for operation
0	72	2010 / 11	2015 / 16
1	28	2010 / 11	2015 / 16
2	60	2012	2016
3	60	2012	2016

Firm commitments from the FAIR partners (in k€)

Prezes Rady Ministrów

INSTRUKCJA NEGOCJACYJNA

[redacted]

Arabia Saudyjska: 12Meuro (IX 2009)

FAIR Countries	Total declared Contribution
Austria	5.000
China	12.000
Finland	5.000
France	27.000
Germany	705.000
Great Britain	8.000
Greece	4.000
India	36.000
Italy	42.000
Poland	23.740
Romania	11.870
Russia	178.050
Slovenia	12.000
Slovakia	6.000
Spain	19.000
Sweden	10.000
Total	**1.104.660**
Firm Commitments	**1.038.660**
	not firm for the first batch

Arabia Saudyjska w FAIR

Dr Simone Richter
Dyrektor Administracyjny FAIR

Dr Jacek Gierliński

Jego Wysokość książę dr Turki al Saud

Prof. Boris Sharkov
Dyrektor FAIR


Dziękuję
za uwagę