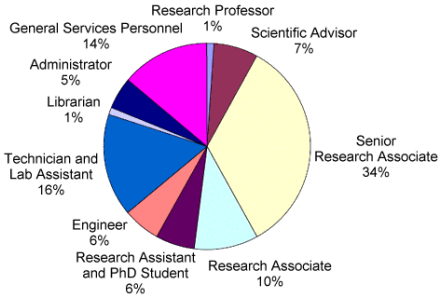
Nuclear physics in Debrecen

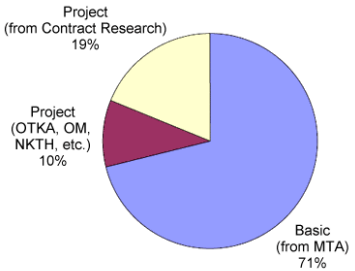
Attila Krasznahorkay

Mintaszöveg szerkesztése

Második szint

- Harmadik szint
  - Negyedik szint
    - Ötödik szint



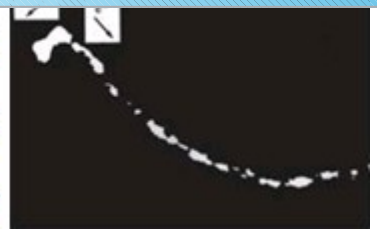


Our first director (Alexander Szalay) was a postdoc of Lord Rutherford in Cambridge at 1936

A. Szalay, J. Csikai: *The Recoil Effect Of The Neutrino In The Beta-Decay Of He6*. Int. Conf. On Mesons And Recently Discovered Particles E 43 Congresso Nazionale Di Fizica, Padova-Venezia, 22-28 Settembre 1957. P. Iv. 8. Società Italiana di Fisica, Padova 1 (1958) 1.

J. Csikai, A. Szalay: *The Electron Neutrino Angular Correlation In The Beta-Decay Of He6*. Comptes rendus du congres international de physique nucleaire. Interations nucleaires aux basses energies et structure des noyaux, Paris, 7-12 Juillet, 1958. Paris. 1 (1959) 840.

A. Szalay, J. Csikai, J. Bacsó: *Critical comments on the investigation of the electron-neutrino angular correlation by the cloud chamber method*. Acta Physica Academiae Scientiarum Hungaricae 13 (1961) 437.



MGC Cyclotron of ATOMKI
An efficient and versatile tool for research and applications

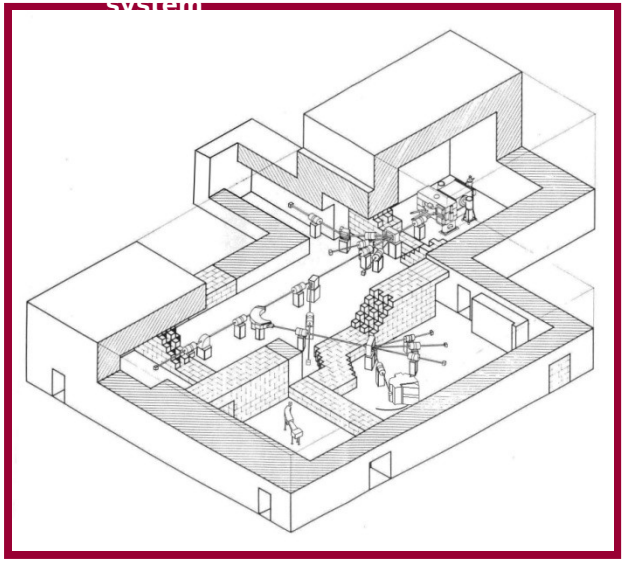
Main beam parameters

Particle beam	Energy [MeV]	Intensity [mA]
proton	2.5 – 18	40
deuteron	1 - 10	40
He-3	4 - 26	10
alpha	2 - 20	20

Energy spread of extracted beam: < 3*10-3

Energy spread of analyzed beam: < 10-3

External target locations: 8 horizontal



Main fields of utilization

Physics research applications	Medical applications	Industrial
Nuclear spectroscopy studies	SPECT-isotopes	TLA for wear
Nuclear astrophysics irradiations	PET-isotopes	CVD Diamond
Nuclear data measurements	Target technology	Radiation

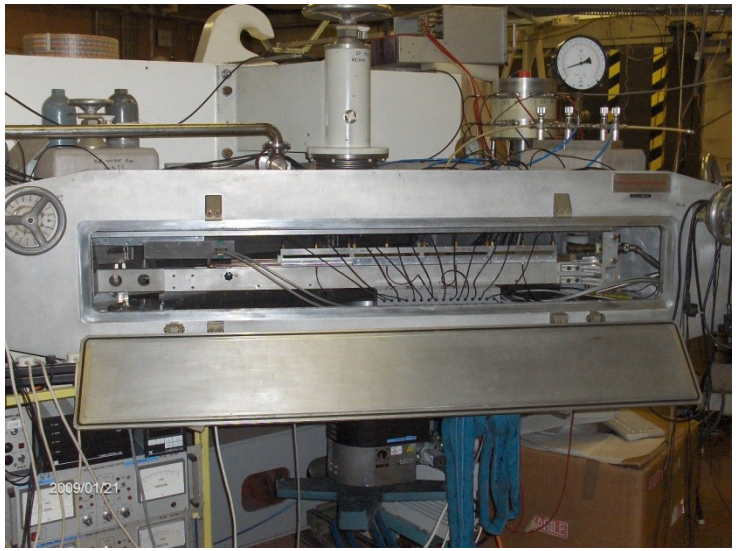
Statistics of operation

		1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	Average
Total time	h	3946	4096	4265	4227	4300	4084	4051	3554	3302	3445	2951	2302	2009	**3579**
Beam on target	h	1168	1520	1792	1685	1803	1791	1973	1086	1353	1690	1061	1239	1242	**1493**
Maintenance	%	11	18	7	9,5	11,2	11	9	12,6	12,7	12,8	11,6	13,6	16,3	**12,0**
Breakdowns	%	2	1	2	0,5	1,5	0,4	0,1	2	1,3	1,8	1,5	3,4	0,1	**1,4**
Availability	%	87	81	91	90	87,3	88,6	90,9	85,4	86	85,4	86,9	83	83,6	**86,6**
Cyclotron on	%	45	47	55	51	48,3	50,7	54,8	36,6	46,8	54,3	41,8	59,4	68,6	**50,7**
Beam tuning	%	15	10	13	11	6,3	6,8	6,2	6	5,8	5,3	5,8	5,6	6,8	**8,0**
Beam on target	%	30	37	42	40	42	43,9	48,7	30,6	41	49	36	53,8	61,8	**42,8**

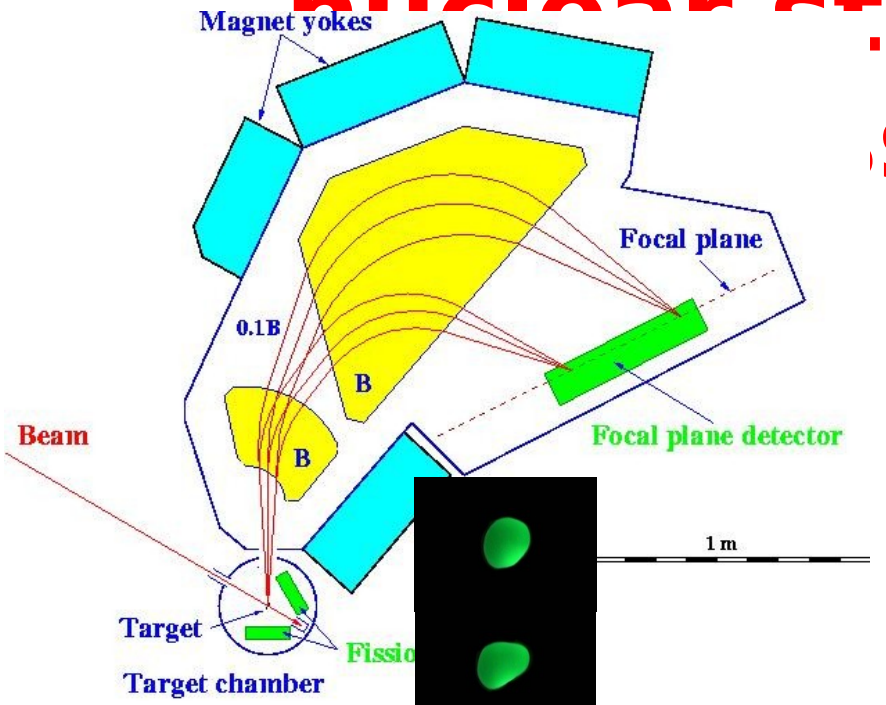
Nuclear- and astrophysics Laboratory

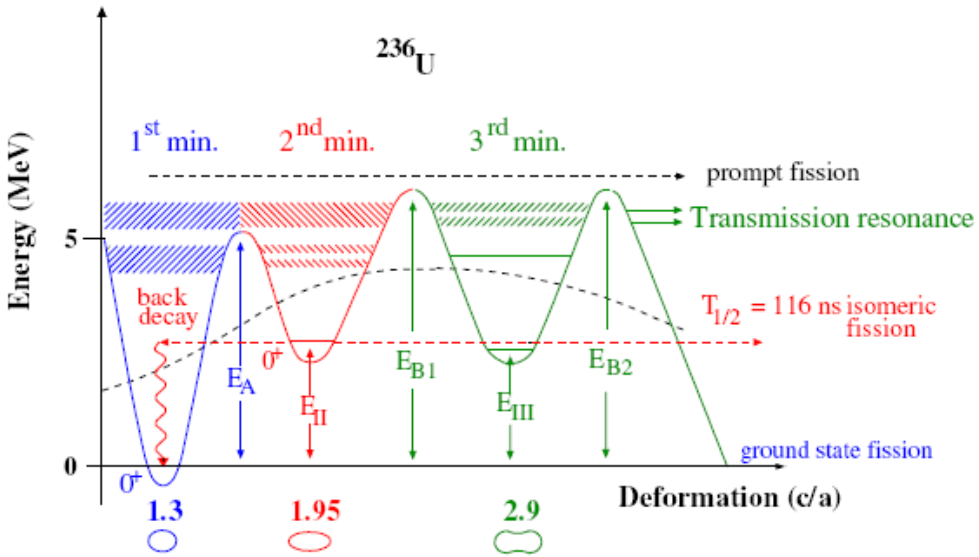
(http://www.atomki.hu/muszerek/fa

K value	80 (26)
Angle of the focal plane	45o
Length of the focal plane	120 cm
Length of the Si detector	72 cm
resolution	1 mm
bending radius	40 - 90 cm
Max field	1.6 (0.8) T
Max solid angle	5.4 msr
Energy range Emax/Emin	4.8
Horizontal magnification	0.34
Vertical magnification	1.7 - 3.3
Energy dispersion	10 mm/%



Super (SD)- and hyperdeformed (HD) nuclear states before





Mintaszöveg szerkesztés
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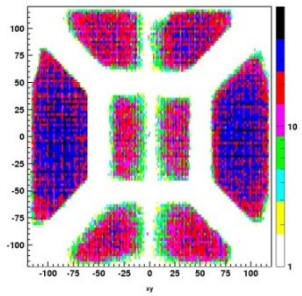

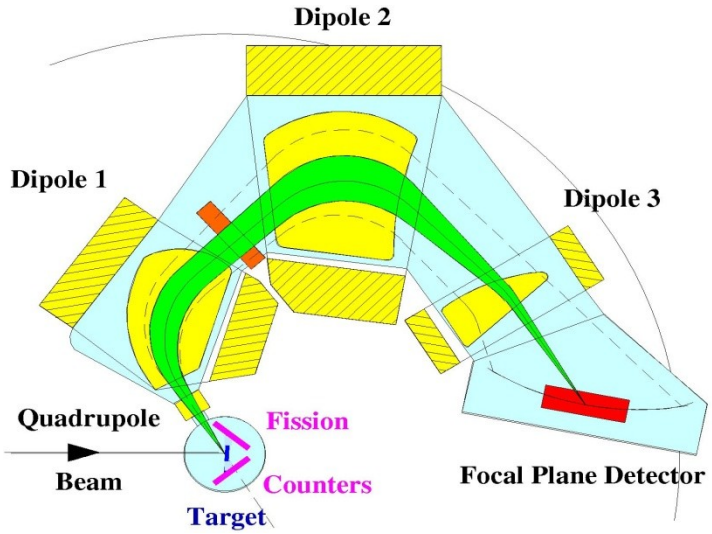

Mintaszöveg szerkesztése
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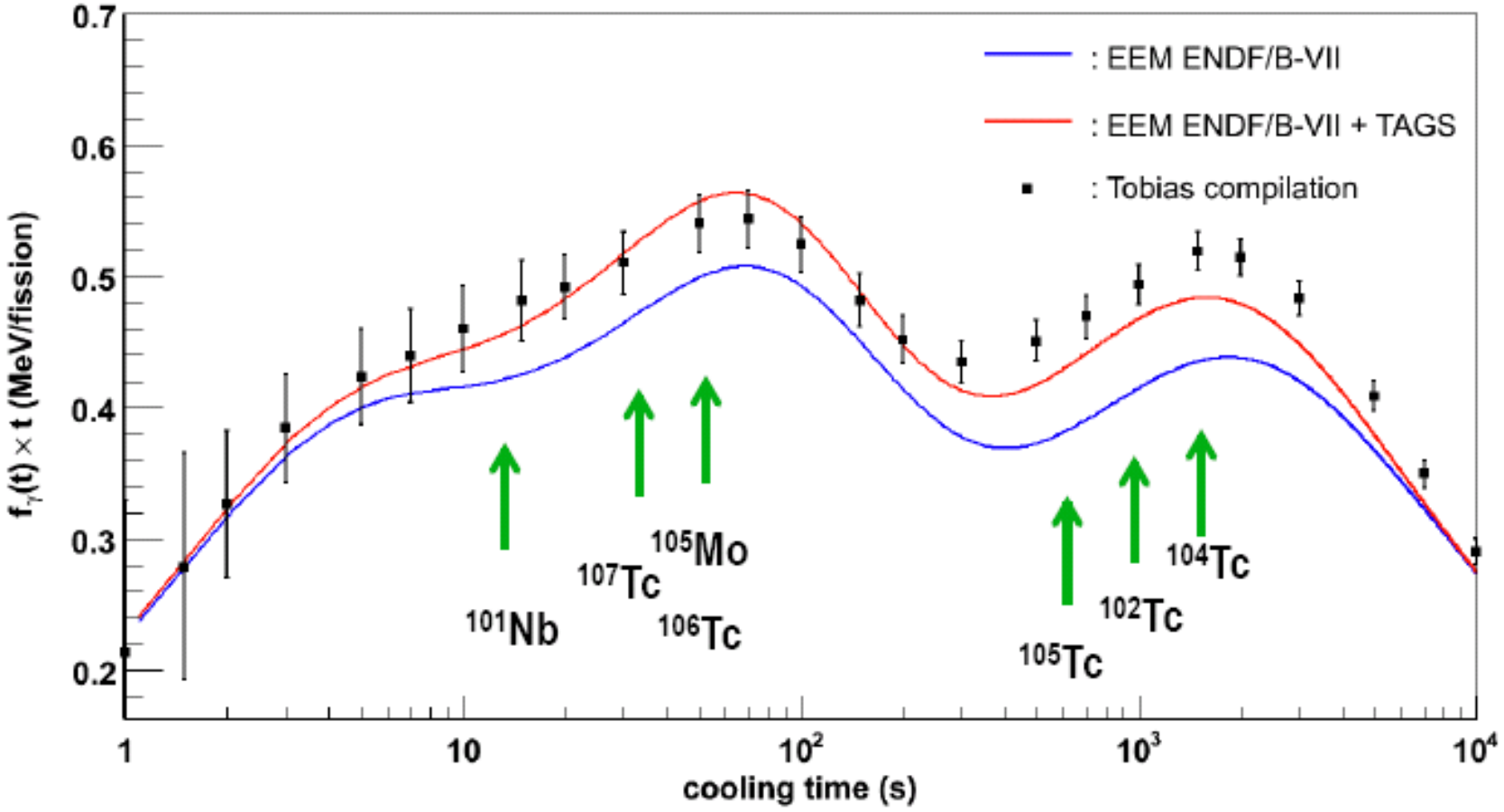
Impact of the results for ^{239}Pu: electromagnetic or γ component



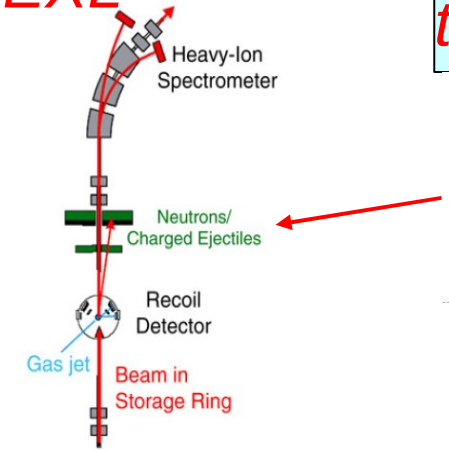
A. Algora, Phys. Rev. Letts. 105, 202505 (2011)

Development *of a new Time-of-Flight neutron spectrometer (LENA) in Atomki for studying Giant Resonances and neutron skins*

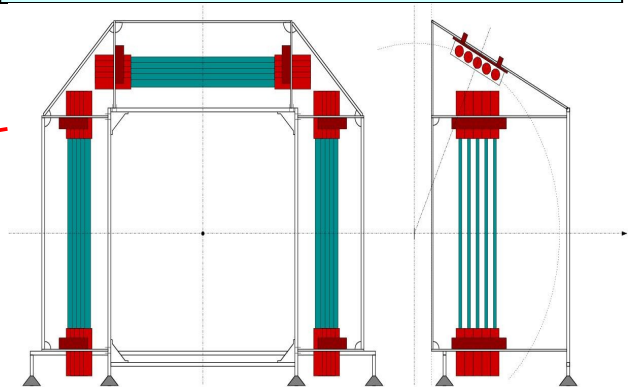
Sixth Framework Programme

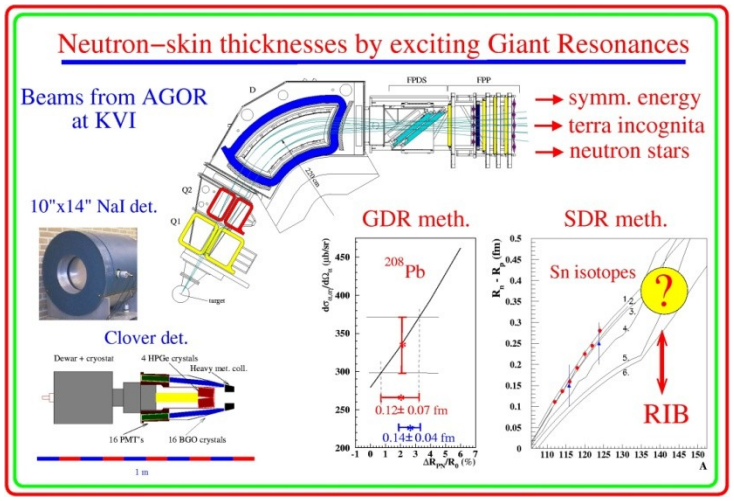
Isovector GR's in unstable nuclei

R3B, EXL



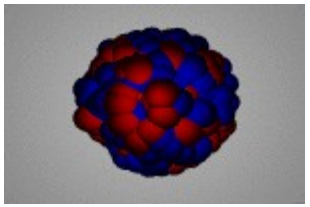
Planned geometry of the LENA detector

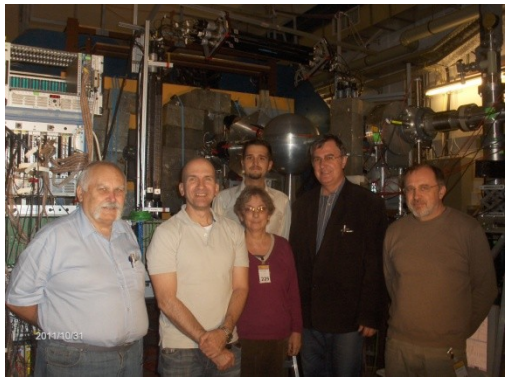


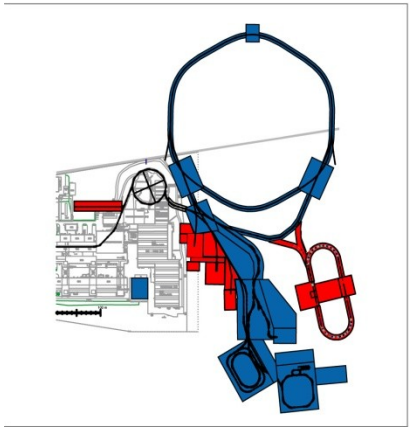


NEUTRON SKIN

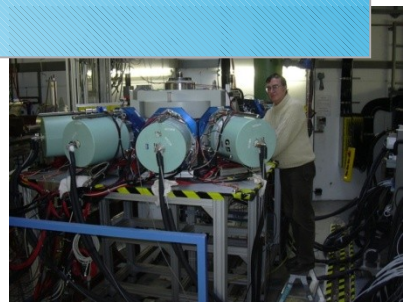
GSI Helmholtzzentrum für Schwerionenfo







Experiments at GSI, Germany



Recent prosals

· T. Aumann (S393) Neutron-rich Nuclei at and Beyond the Dripline in the Range Z=4 to Z=10Studied in Kinematically Complete Measurements of Direct Reactions at Relativistic Energies

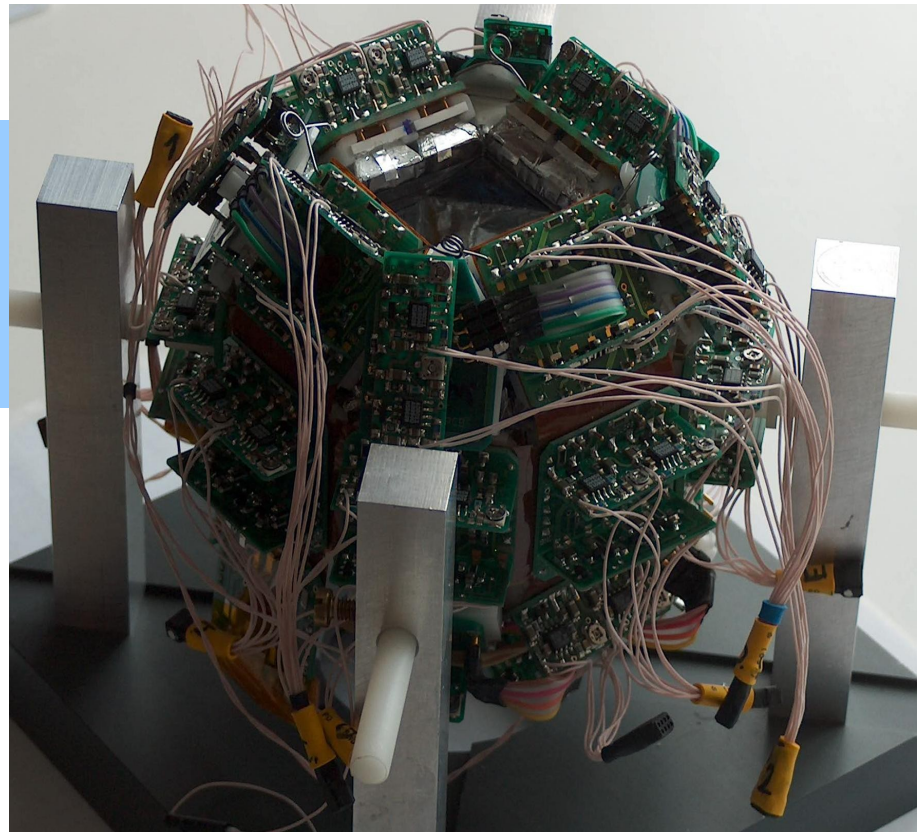
· N. Kalantar (E105) Start up of part of the EXL physics program with 56Ni

· R. Reifarth (S405) 64Ni(p,n) reaction measurements in inverse kinematics at the LAND/R3B setup in Cave C

· A.Krasznahorkay (S408) Constraining the symmetry energy of the EoS by precise neutron-skin thickness measurements

· T. Aumann (S412) Isovector and isoscalar electric dipole and quadrupole response of neutronrich Sn nuclei

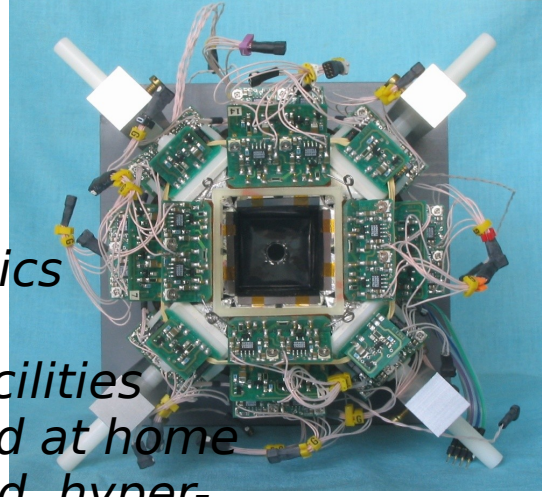
Energy resolution (5.5 MeV for α-particles)	2%
Efficiency for protons	70%
Efficiency for α-particles	50%



Motivations in detector R&D:

- *Traditions of instrumental developments in ATOMKI*
  production of state-of-the-art detectors and electronics

- *Involvement of researchers in physics at large-scale facilities*
  Contributions to 'mile-stone' experiments abroad and at home
  (study of nuclei under extreme conditions: super- and hyper-deformation, neutron-skin and halo, etc)



DIAMANT: a *high-granularity ancillary detector array of ~80 pcs of CsI(Tl) scintillators*

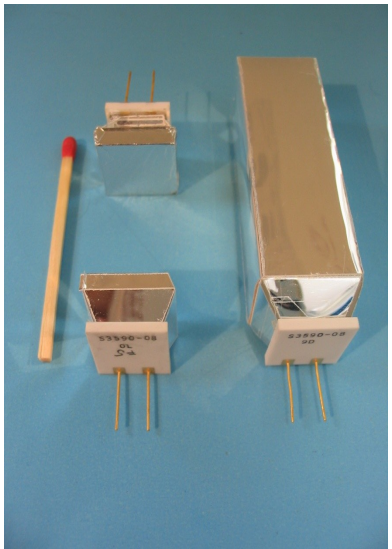
Efficiency: [% of 4π]

γεομετριχαλ: ≈ 90

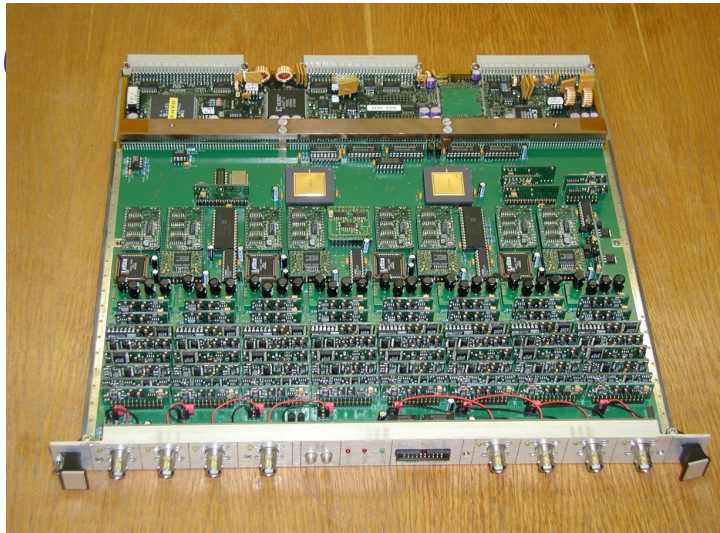
δετ. προτονσ: ≈ 70

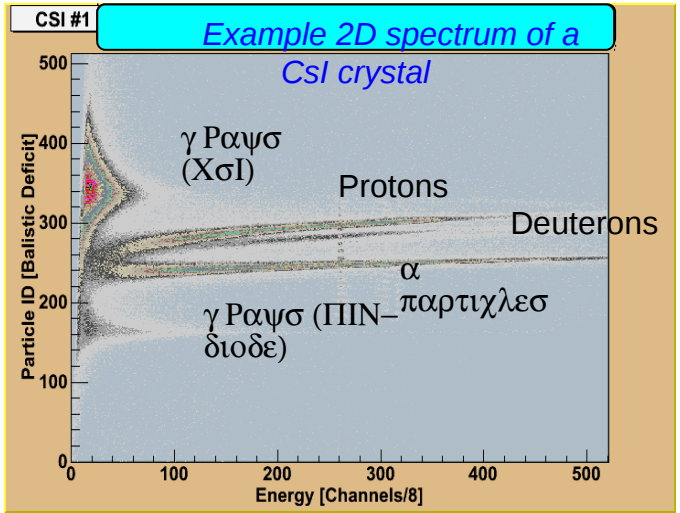
δετ. αλπηασ: ≈ 50

The CsI detectors



The VXI signal processor card of DIAMANT





LETTER

Published in: Nature 469, 68-71 (2011)

doi:10.1038/nature09644

Evidence for a spin-aligned neutron–proton paired phase from the level structure of ^{92}Pd

B. Cederwall[1], F. Ghazi Moradi[1], T. Bäck[1], A. Johnson[1], J. Blomqvist[1], E. Clément[2], G. de France[2], R. Wadsworth[3], K. Andgren[1], K. Lagergren[1,4], A. Dijon[2], G. Jaworski[5,6], R. Liotta[1], C. Qi[1], B. M. Nyakó[7], J. Nyberg[8], M. Palacz[5], H. Al-Azri[3], A. Algora[9], G. de Angelis[10], A. Ataç[11], S. Bhattacharyya[2]†, T. Brock[3], J. R. Brown[3], P. Davies[3], A. Di Nitto[12], Zs. Dombrádi[7], A. Gadea[9], J. Gál[7], B. Hadinia[1], F. Johnston-Theasby[3], P. Joshi[3], K. Juhász[13], R. Julin[14], A. Jungclaus[15], G. Kalinka[7], S. O. Kara[11], A. Khaplanov[1], J. Kownacki[5], G. La Rana[12], S. M. Lenzi[16], J. Molnár[7], R. Moro[12], D. R. Napoli[10], B. S. Nara Singh[3], A. Persson[1], F. Recchia[16], M. Sandzelius[1]†, J.-N. Scheurer[17], G. Sletten[18], D. Sohler[7], P.-A. Söderström[8], M. J. Taylor[3], J. Timár[7], J. J. Valiente-Dobón[10], E. Vardaci[12] & S. Williams[19]

Members of the Hungarian team

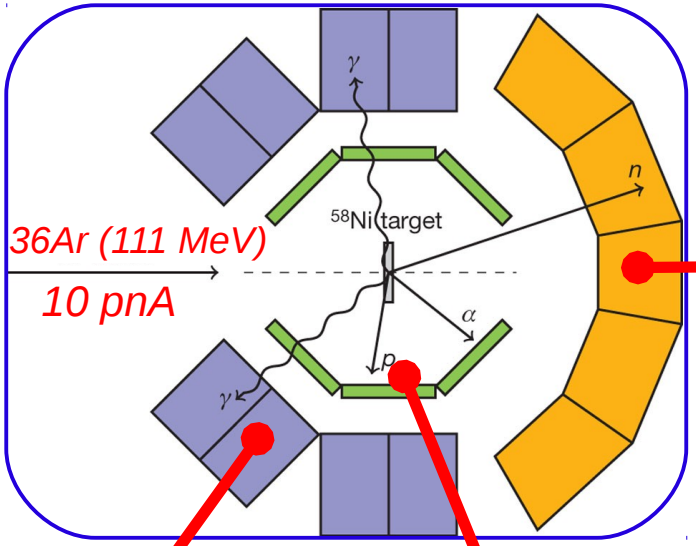
[1]Department of Physics, Royal Institute of Technology, SE-10691 Stockholm, Sweden. [2]Grand Accélérateur National d'Ions Lourds (GANIL), CEA/DSM – CNRS/IN2P3, F-14076 Caen Cedex 5, France. [3]Department of Physics, University of York, York YO10 5DD, UK. [4]Joint Institute for Heavy-Ion Research, Holifield Radioactive Ion Beam Facility, Oak Ridge, Tennessee 37831, USA. [5]Heavy Ion Laboratory, University of Warsaw, 02-093 Warsaw, Poland. [6]Faculty of Physics, Warsaw University of Technology, Koszykowa 75, 00-662 Warsaw, Poland. [7]Institute of Nuclear Research of the Hungarian Academy of Sciences, ATOMKI, H-4001 Debrecen, Hungary. [8]Department of Physics and Astronomy, Uppsala University, SE-75121 Uppsala, Sweden. [9]IFIC, CSIC, University of Valencia, E-46071 Valencia, Spain. [10]Instituto Nazionale di Fisica Nucleare, Laboratori Nazionali di Legnaro, I-35020 Legnaro, Italy. [11]Department of Physics, Ankara University, 06100 Tandogan Ankara, Turkey. [12]Dipartimento di Scienze Fisiche, Università di Napoli and Instituto Nazionale di Fisica Nucleare, I-80126 Napoli, Italy. [13]Department of Information Technology, University of Debrecen, H-4010 Debrecen, Hungary. [14]Department of Physics, University of Jyväskylä, FIN-40014 Jyväskylä, Finland. [15]Instituto de Estructura de la Materia, CSIC, E-28006 Madrid, Spain. [16]Diparimento di Fisica dell'Università di Padova and Instituto Nazionale di Fisica Nucleare, Sezione di Padova, I-35122 Padova, Italy. [17]Université Bordeaux 1, CNRS/IN2P3, Centre d'Etudes Nucléaires de Bordeaux Gradignan, F-33175 Gradignan, France. [18]The Niels Bohr Institute, University of Copenhagen, 2100 Copenhagen, Denmark. [19]TRIUMF, Vancouver, British Columbia V6T 2A3, Canada. †Present addresses: VECC, 1/AF Bidhan Nagar, Kolkata 700064, India (S.B.); Department of Physics, University of Jyväskylä, FIN-40014 Jyväskylä, Finland (M.S.).

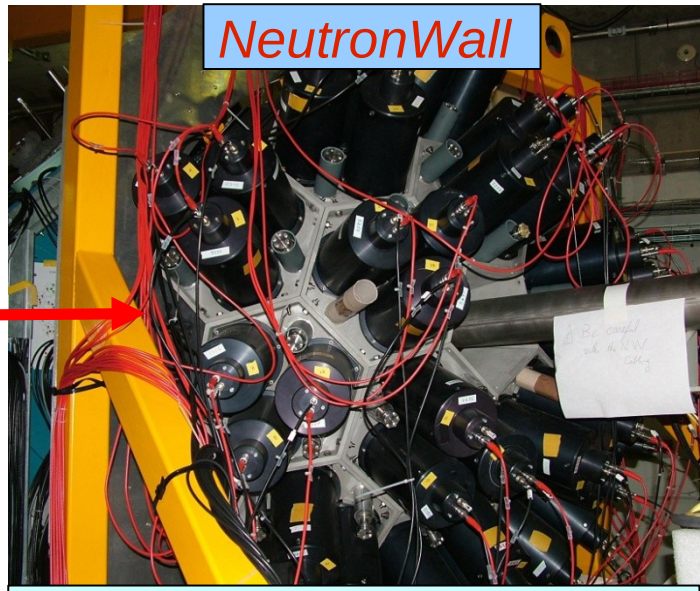
Coupling of powerful detector systems
EXOGAM + DIAMANT + NeutronWall

GANIL spiral2 laboratoire commun CEA/DSM CNRS/IN2P3

2 weeks of beamtime

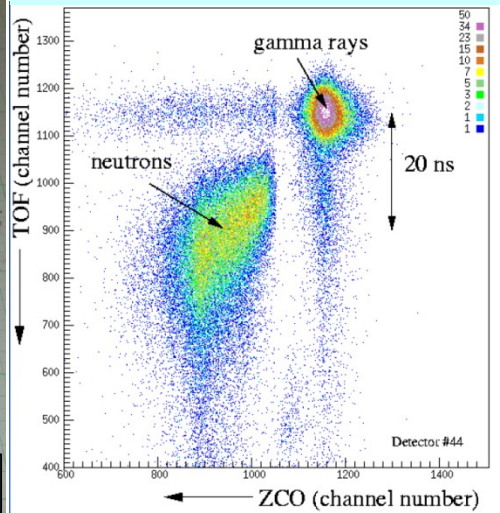
58Ni target: enriched to 99.83%

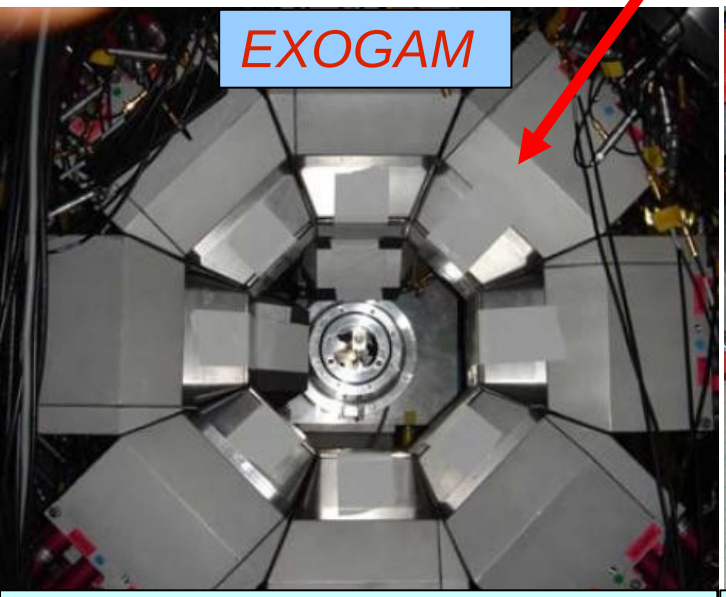




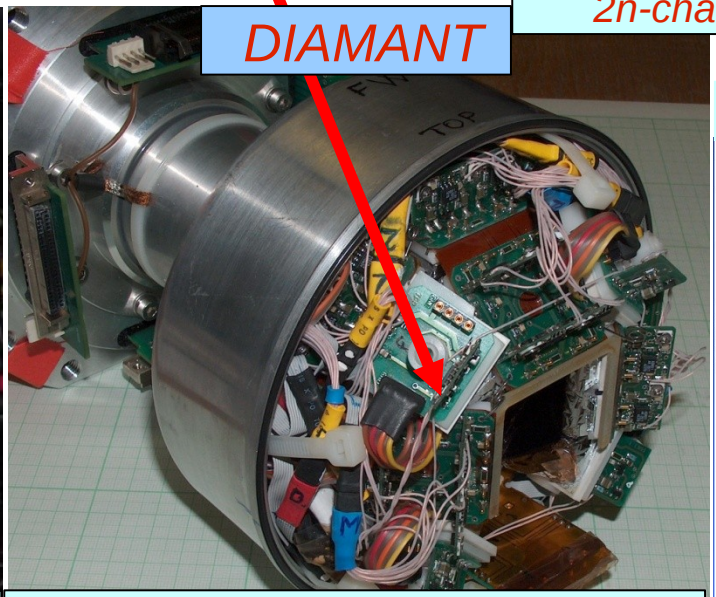
50 liquid scintillators, to select the 2n-channel; n-γ discrimination

realized by TOF + ZCO





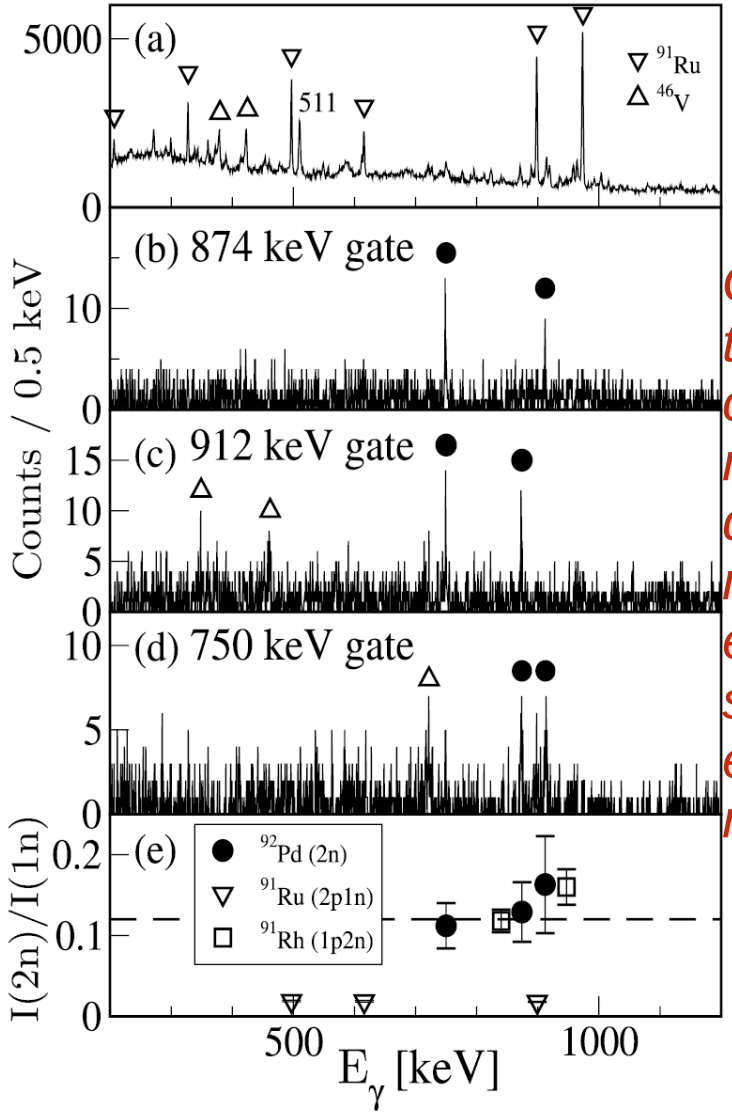
11 clovers, select γγ-coincidences



80 CsI, reject charged-particle channels

First identification of excited states in 92Pd

γγ + 2n-selection + "no charged particles"



Gated coincidence spectra

Three new γ-rays assigned to 92Pd

- in coinc. with 2 neutrons

- charged particle veto

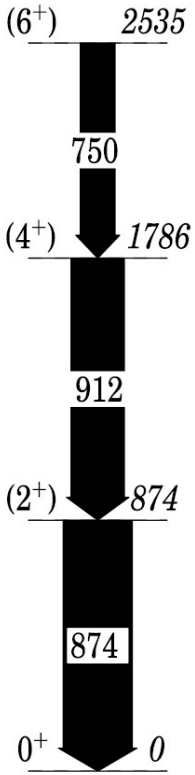
- mutually coincident γ-s

- contaminants

excluded

Test of reaction channels

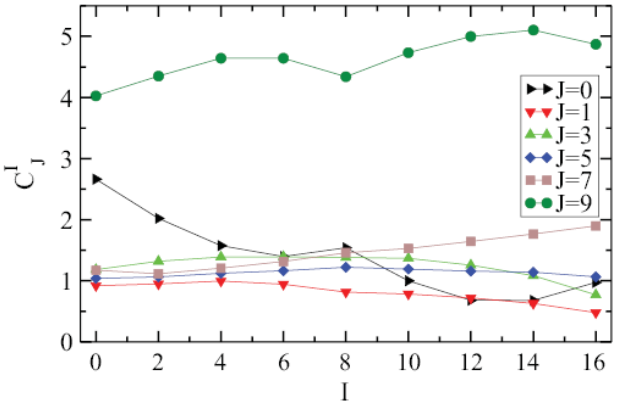
The proposed level scheme of 92Pd



Interpretation: ***New spin-aligned np coupling scheme in 92Pd***

1. *- energy-systematics can only be reproduced by assuming T=0 isoscalar np-pairing;*
   - (g9/2)-2, "fully aligned" Jπ = 9+ pn pairs are do
   (strong attractive pn-interaction: overlap
   - such Jπ = 9+ pairs couple into deuteron-like, T=0 isoscalar pn-pairs ha
   dominance in determining the structure

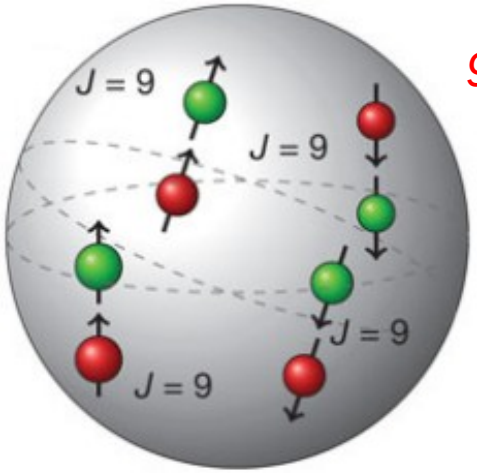
B(E2)'s should be measured!



Ch. Qi et al.: Phys. Rev. C84,021301(R) 2011

Danos & Gillet: Phys. Rev. 161,(1967) 1034]

: coupling of "fully aligned" pn-
w. opposit spin (np-quartets)
: spin-alignment of the quartets



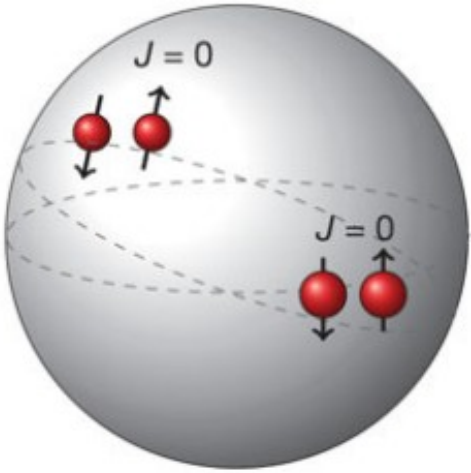
92Pd: 100Sn – 4n, – 4p

pn-hole quartets

96Pd: 100Sn – 4p

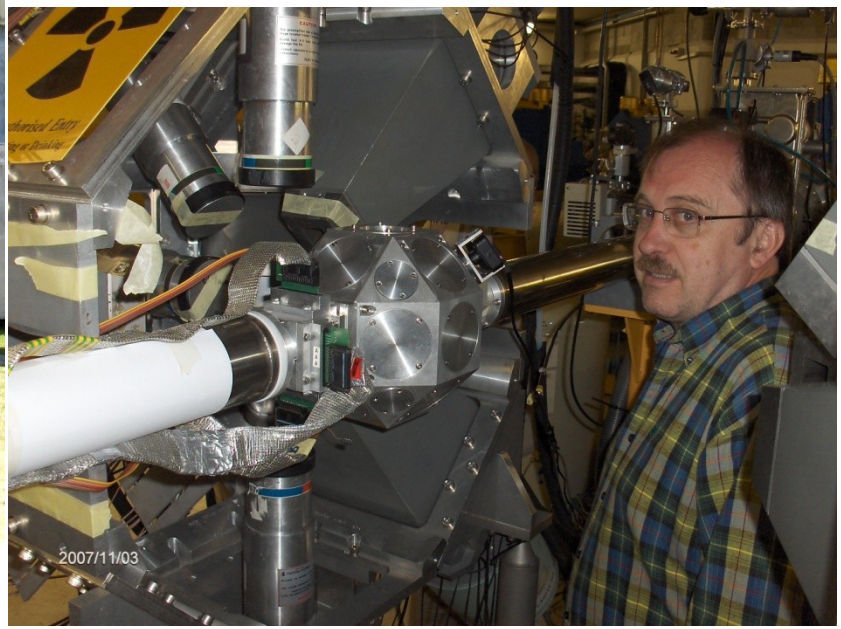
pp-hole pairs

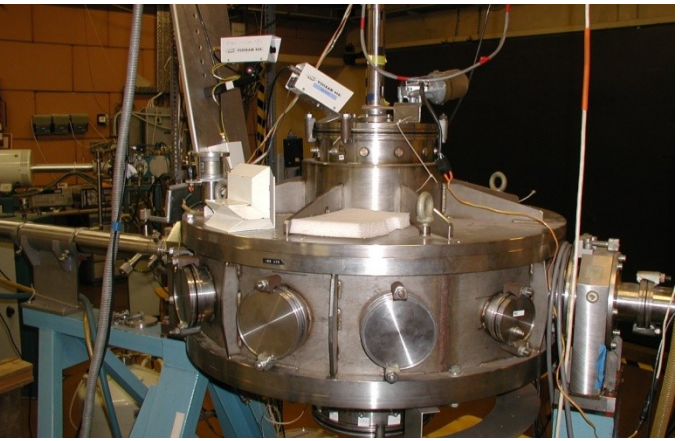
n-s & p-s all in g9/2 !

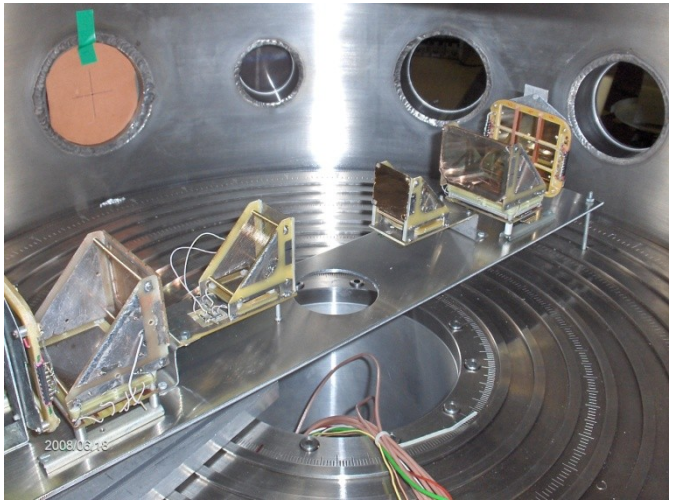



iThemba
LABS
ASSEMBLY POINT
D+N BLOCKS
2006/11/03


2007/11/03


2007/11/03

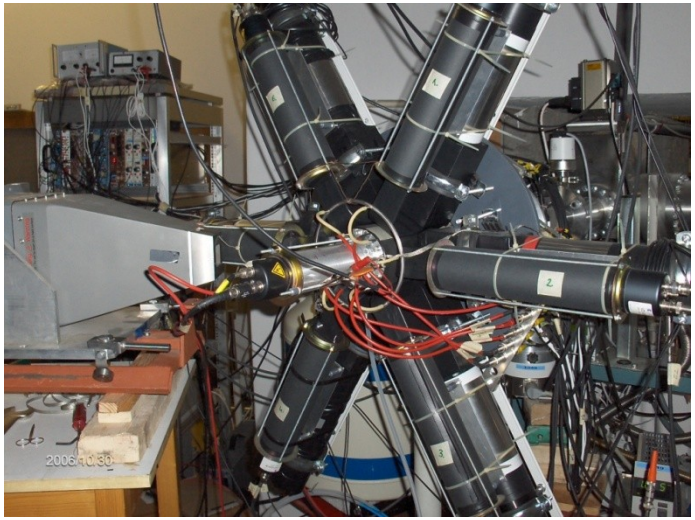



2008.06.18


2008.06.18

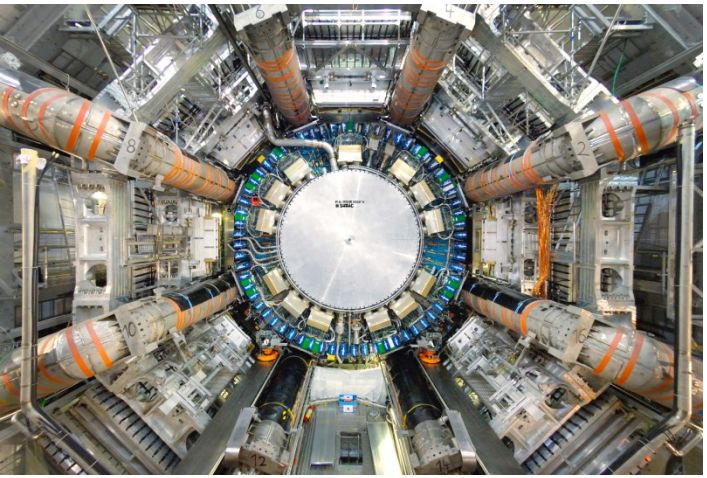
Volume	470 cm3
Efficiency (@ 1332 keV, in add-back mode)	125 %
Energy resolution (@ 1332 keV)	~ 2.2 keV
Compton supression	~ 3

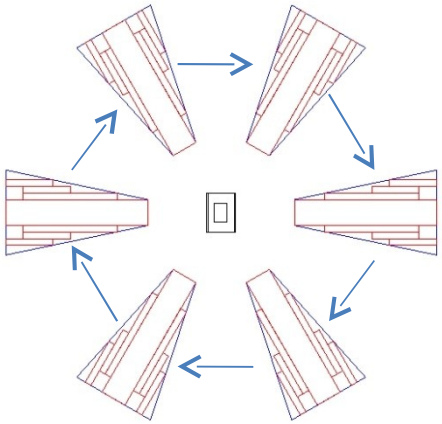
Time resolution	< 1 ns
Angular resolution	< 3o
Energy resolution	< 10%
Coincidency eff	

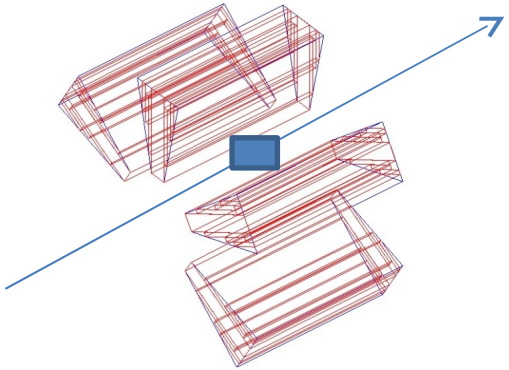


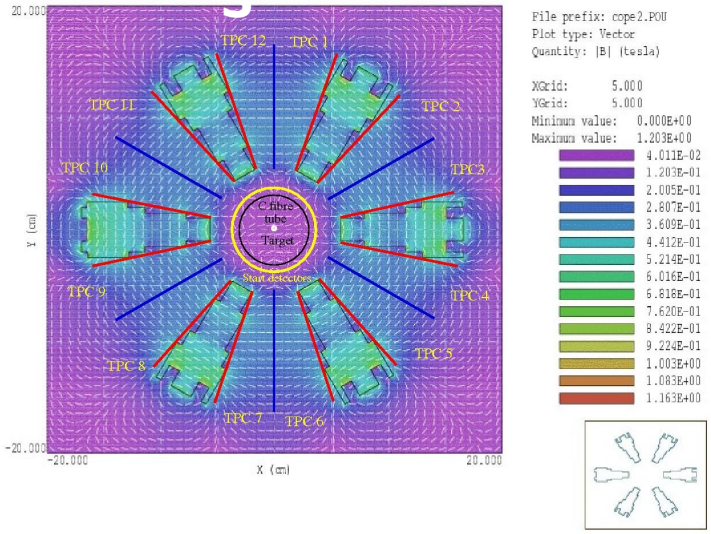
Searching for a new elusive boson in nuclear transitions

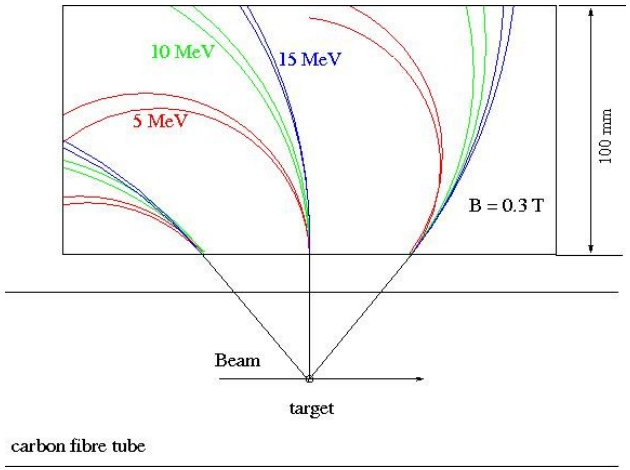
A Compact Positron Electron spectrometer (COPE) for internal pair creation studies (ENSAR support)



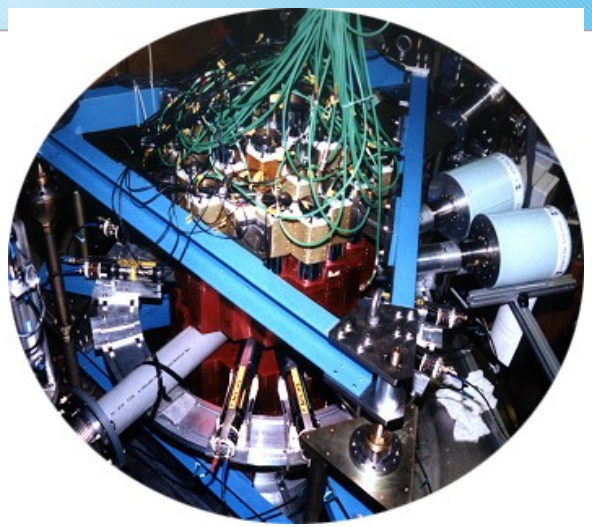


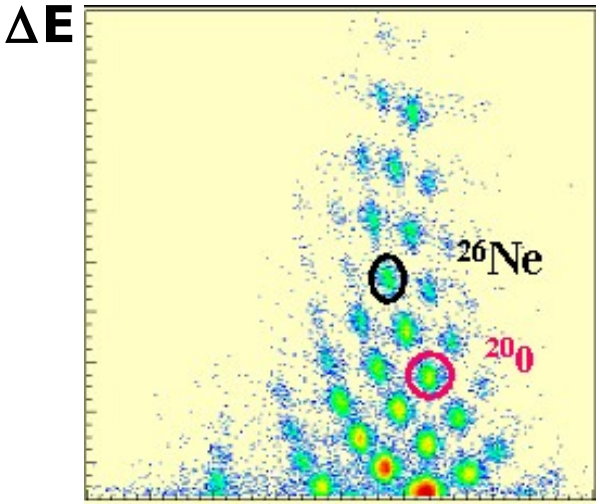


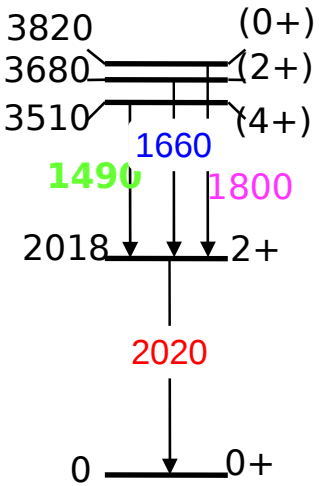




Experiments at GANIL, France







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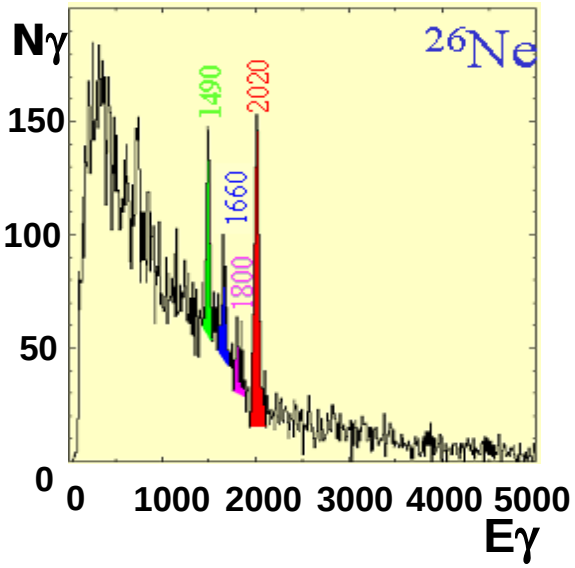

ypical research topics we were (are) nvolved at GANIL

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Recentl prosals

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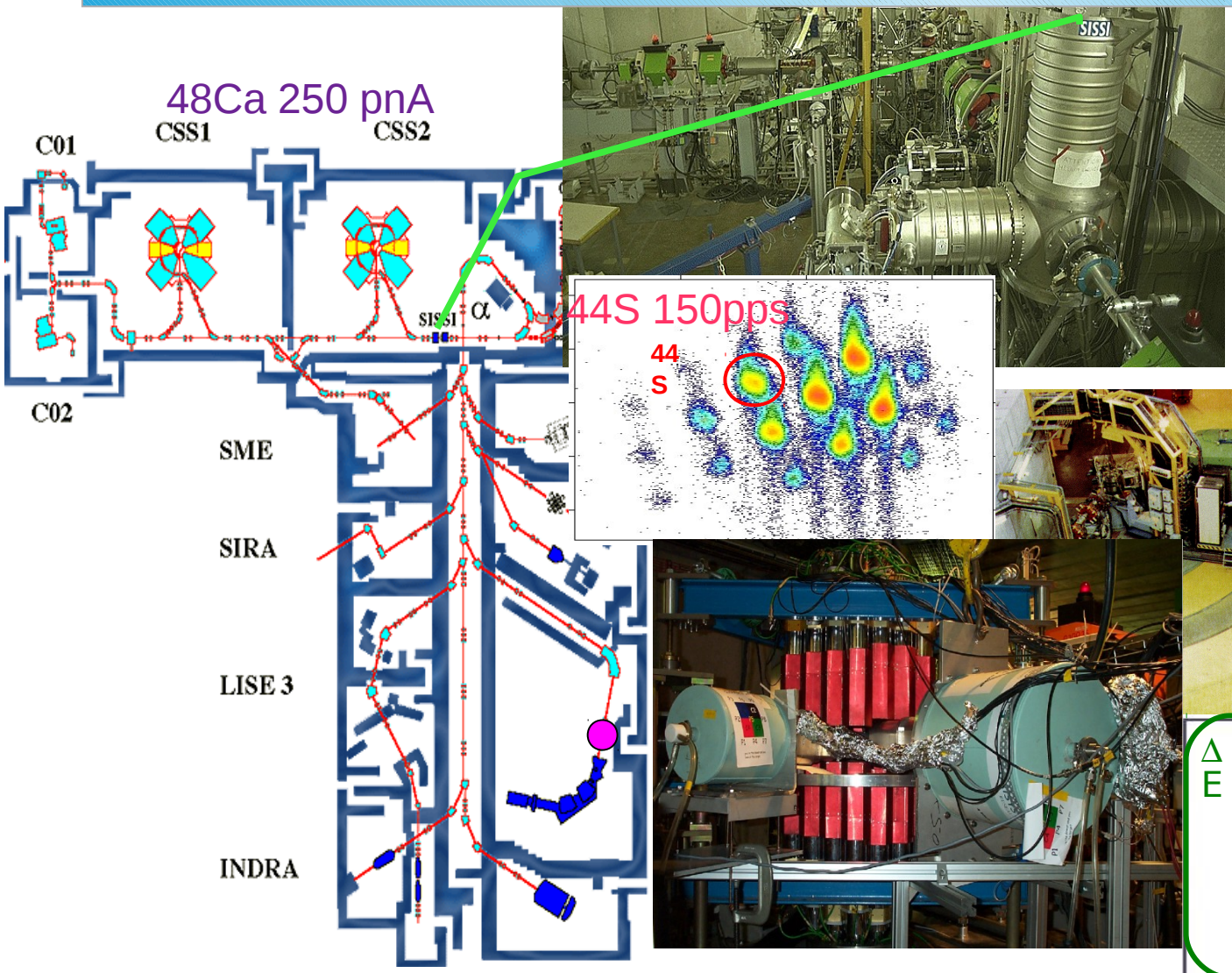
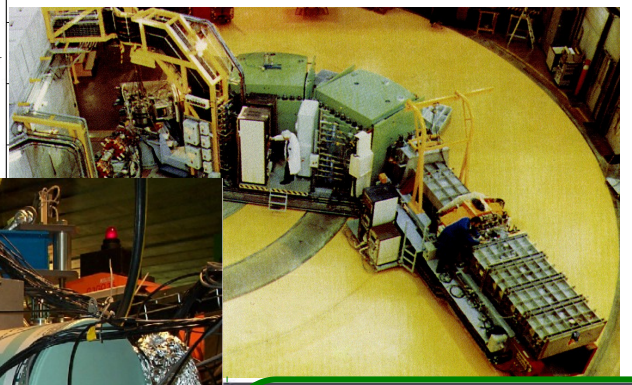
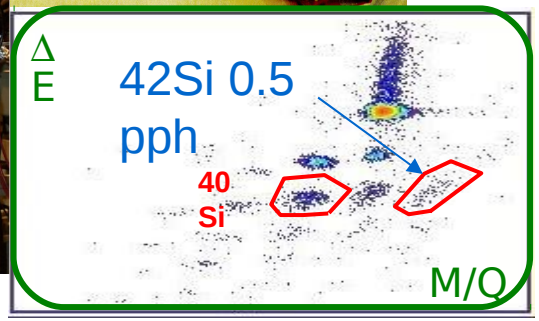
Experiments at RIKEN, Japan

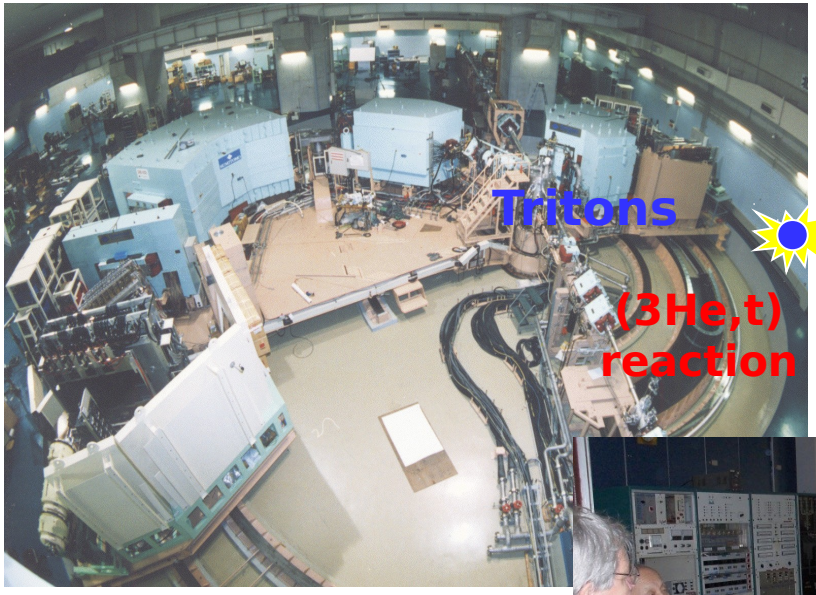






Experiments in Osaka, Japan

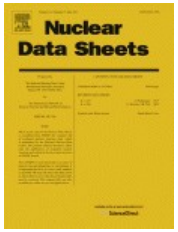
The relative energy resolution is the best in the world (ΔE/E ≈ 10-5).



Nuclear-structure data evaluation

NSDD – International Network of Nuclear Structure and Decay Data Evaluators

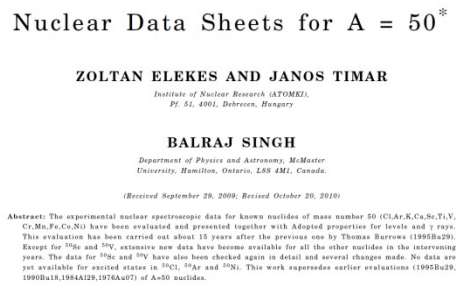
Coordinates: IAEA
Led by: Brookhaven Nat. Lab.
Activity: critical evaluation of nuclear structure and decay data and their publication in the ENSDF online database and in Nuclear Data Sheets



Aim: to provide researchers and applications with up to date reliable nuclear structure data

Results: from 2009 2 mass chains (2 papers)

from 2011 ATOMKI is a center
1 mass chain / year
A = 101 - 105
2 persons 0.5 FTE



Nuclear Data Sheets for A = 50*

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(Received September 28, 2009; Revised October 20, 2010)

Abstract: The experimental nuclear spectroscopic data for known nuclides of mass number 50 (Cl,Ar,K,Ca,Sc,Ti,V, Cr,Mn,Fe,Co,Ni) have been evaluated and presented together with Adopted properties for levels and γ rays. This evaluation has been carried out about 15 years after the previous one by Thomas Burrows (1995Bu29). Except for ^{50}Sc and ^{50}V, extensive new data have become available for all the other nuclides in the intervening years. The data for ^{50}Sc and ^{50}V have also been checked again in detail and several changes made. No data are yet available for excited states in ^{50}Cl, ^{50}Ar and ^{50}Ni. This work supersedes earlier evaluations (1995Bu29, 1990Bu18,1984Al29,1976Aa07) of A=50 nuclides.

ENSDF DATA EVALUATION CENTERS (www.nndc.bnl.gov/nsdd/Datacenters)

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A-Chain Evaluation Responsibility

Center	Mass Chains
a. US/NNDC	45-50,57,58,60-73(ex 62-64),82-88 (ex 83), 94-97,99,118,119,136-148,150, 152-165 (ex 164), 180-183,185,189,230-240,>249
b. US/NDP	241-249
c. US/LBL	21-30,59,81,83,90-93,166-171,184,186, 187,191-193,210-217
d. US/TUNL	2-20
e. US/ANL	106-112,176-179,199-209
f. India	218-229
g. Russia/StP	130-135,146
h. PRC	51-56,62,63,195-198
i. France	113-117
j. Japan	120-129
k. Kuwait	74-80
l. Canada	1,31-44,64,89,98,100,149, 151,164,188,190,194
m. Australia	172-175
n. Hungary	101-105

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odik szint
Harmadik szint
- Ne
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ENS '97

ENS 2000

ENS'05

ENS 2000

ENS 2000

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Hungary

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- Towards understanding the structure of nucleons
- New experimental techniques, facilities for radioactive beams

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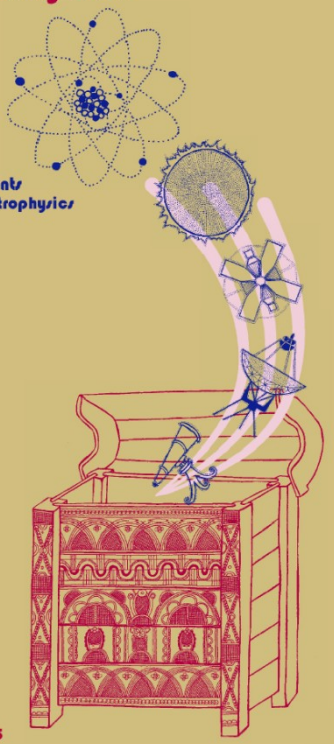
Big-bang nucleosynthesis
Stellar nucleosynthesis
Explosive nucleosynthesis
Cross-section measurements and nuclear data for astrophysics
Neutrino physics
Nuclear structure far from stability
Rare-ion-beam facilities and experiments
Perspectives of nuclear physics and astrophysics



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- Harmadik szint
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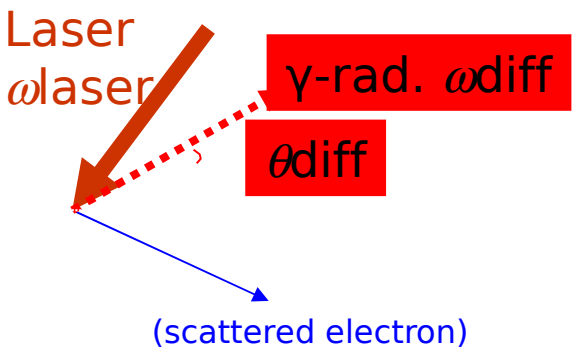

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