

ISOLDE 1996-1999 Preparing for New Science Opportunities

Georg Bollen

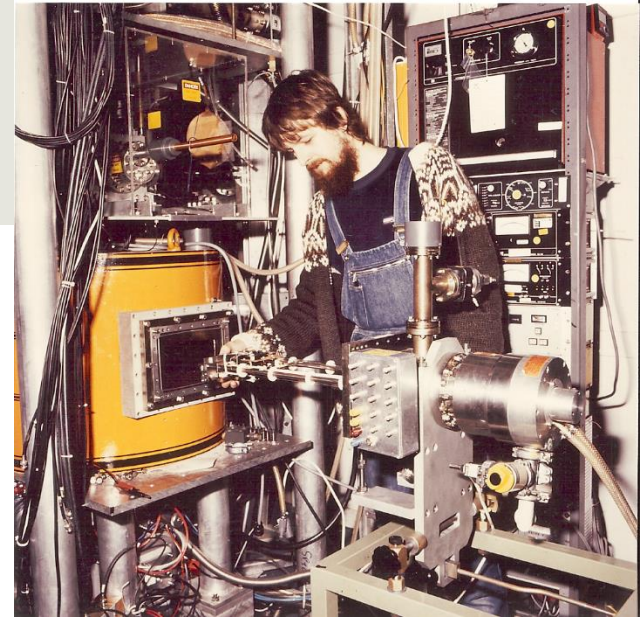
Michigan State University

Facility for Rare Isotope Beams

ISOLDE and me

- Spent in total nearly 8 years at ISOLDE
- 1984: undergraduate (diploma) student from Mainz: laser spectroscopy of neutron-deficient gold isotopes
- 1986-1989: PhD student and CERN Fellow (87-89)
 - Moved with ISOLTRAP (IS 302) from Mainz to CERN
 - First successful mass measurements of rare isotopes with a Penning trap
- **1996-1999 ISOLDE Physics Group Leader**

Thank you ISOLDE!



ISOLDE 1996-1999

Physics Group

- **Physics Coordinators**
 - Olof Tengblad, Doris Forkel-Wirth, Thomas Nilsson
- **Solid State Physics Coordinators**
 - Angela Burkhardt, Sven Jahn
- **Fellows**
 - Mats Lindroos, Ylva Yading, Markku Oinonen, Ari Jokinen, Joakim Cederkäll
- **Associates, long-term visitors**
 - Yuha Äystö, Michael Hass, Chris Heyde, Rob Kiefl, Henry Stroke, Krzysztof Rykaczewski, Gerd Weyer,
- **Many postdocs and students from outside institutions**

First ISOLDE Workshop 1997

ISOLDE Laboratory portrait (Hyperfine Interactions 129 (2000))

ISOLDE 1996-1999

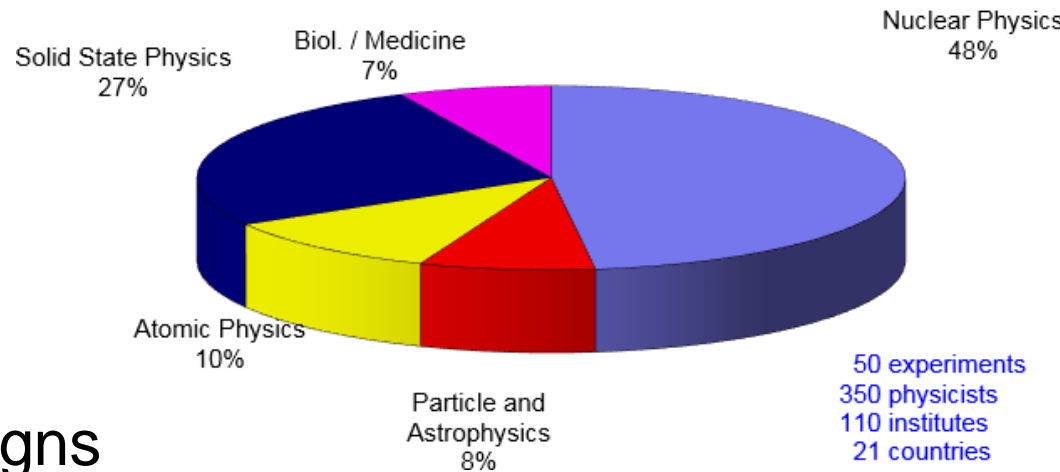
Science and Major Developments

- Broad Science program
 - ISC Chairman Achim Richter

- REX-ISOLDE becoming real
 - Extension of ISOLDE hall
 - Completion of subsystem designs
 - Start of technical construction

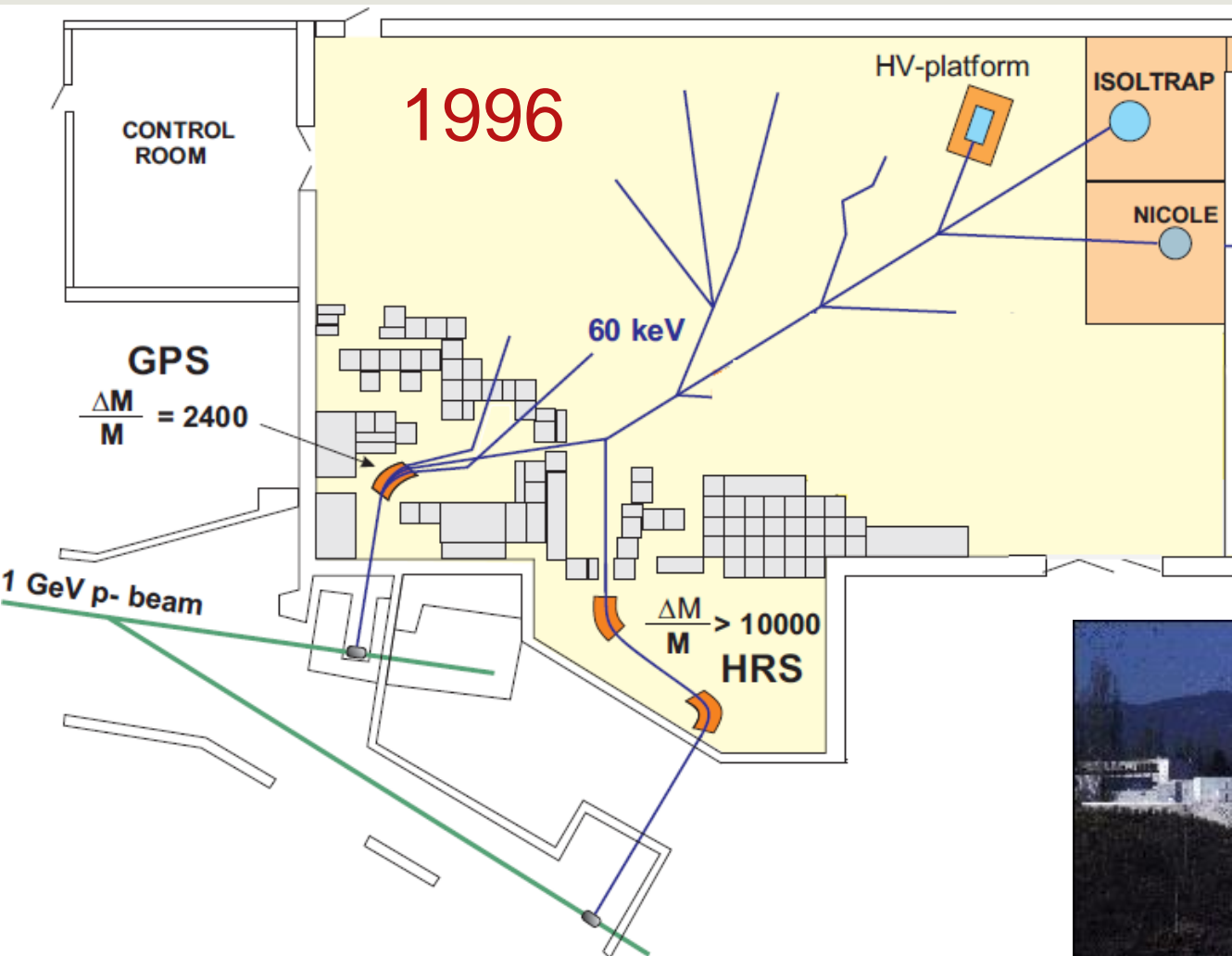
- Major instrumentation being upgraded or implemented
 - ISOLTRAP becomes universal
 - MISTRAL is being installed to complement ISOLTRAP

ISOLDE Physics Program 1995 - 1996



ISOLDE 1996-1999

Preparing for New Science Opportunities

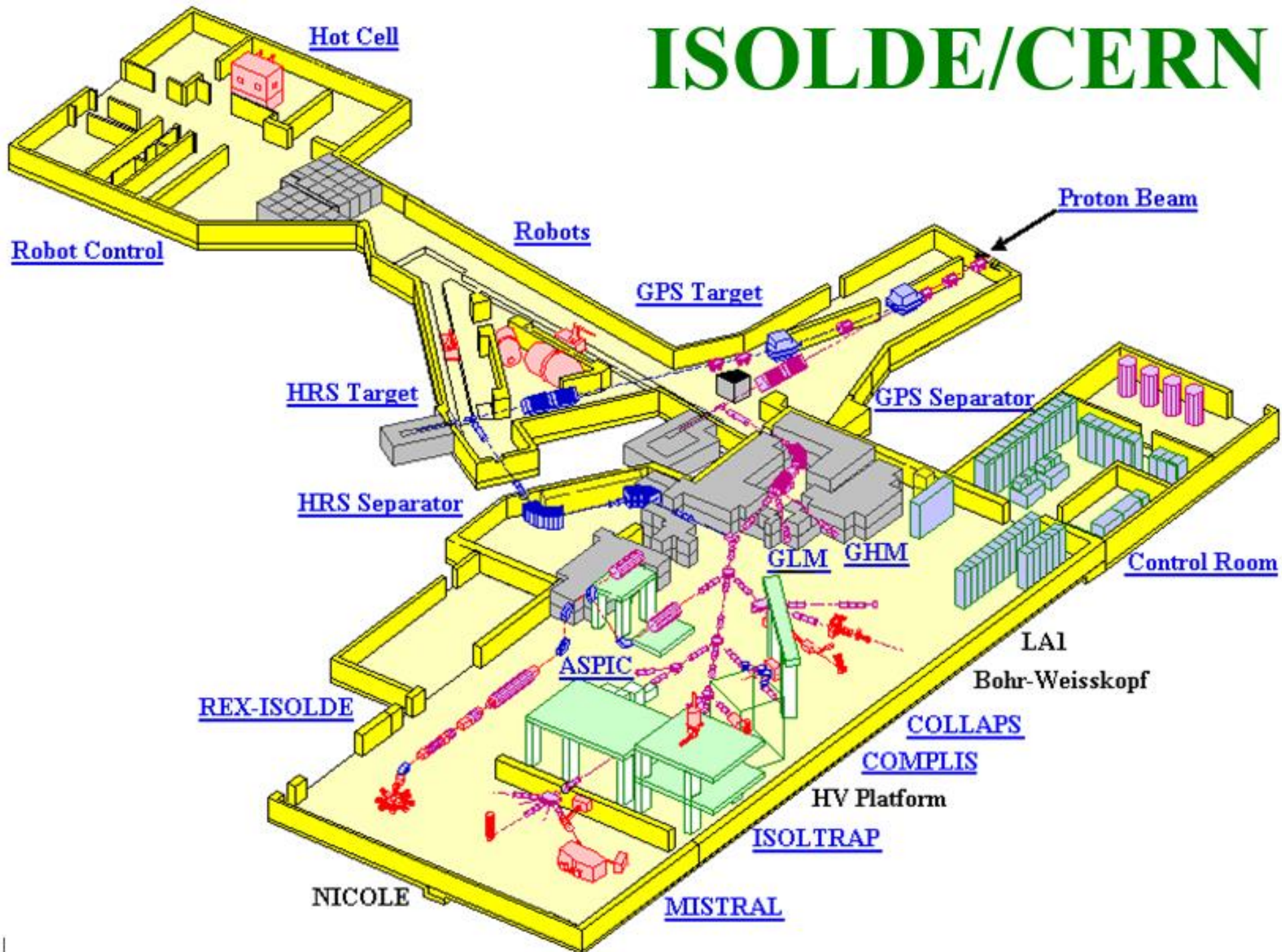


1st extension of
bat 170 to
accommodate
REX-ISOLDE

1997



ISOLDE/CERN

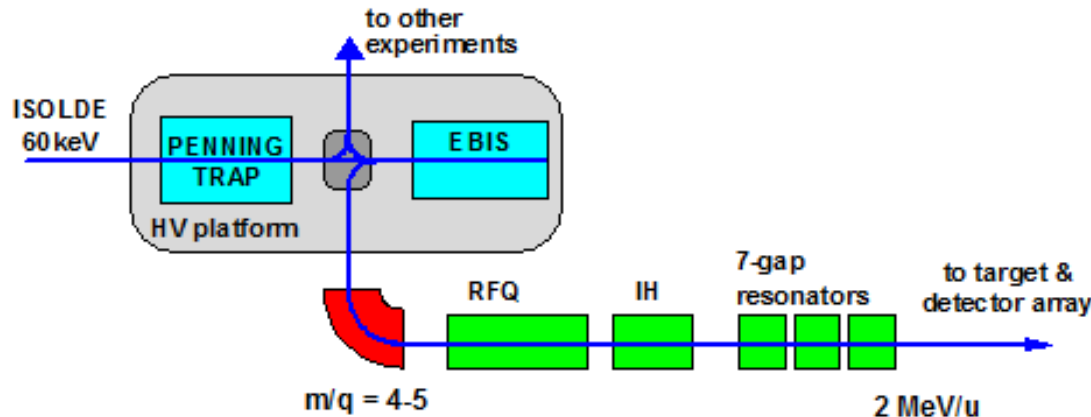


Radioactive beam **EX**periment at **ISOLDE**

(IS 347)

- investigation of very neutron-rich Na-Mg and K-Ca isotopes after Coulomb excitation and neutron transfer at N=20 and N=28
- demonstration of a novel cost-effective and efficient post-acceleration scheme

PRINCIPLE



- accumulation & cooling & bunching
- charge state breeding
- post-acceleration

First 2 MeV beam and experiments in 1998

ISOLDE 1996-1999 REX-ISOLDE

D. Habs, LMU Munich
(Spokesperson)

Many institutions collaborate
to make this happen

	1996	1997	1998
IH-structure			
Design of the drift tube structure and calc. of particle dynamics	XXXXXX		
calculations with MAFIA		XXXXXXXXXX	
construction of the IH-model		XXXXXX	
machining of the model structure		XXXXXX	
field measurements at the model		XXXXXX	
drawing of the IH-vacuum tank	XXXXXX		
machining of the tank		XXXXXXXXXX	
copper plating of the tank			XX
machining of the drift tube structure of the IH-resonator		XX	
copper plating of the structure			XX
build up of the IH-structure at Munich			XXXXXX
rf-tuning			XXXXXX
power tests			XXXXXX
build up at CERN and beam tests			XXXXXX
LINAC control and electronic			XXXXXXXXXXXXXXXXXX

ISOLDE 1996-1999

REX-ISOLDE Experiment

REX-ISOLDE Project

1998-12-14

Spokes person and Project Leader: D. Habs / Munich
 Contact person and Coordination: G. Bollen / CERN

Involved Groups

ISOLDE (Physics) Group(s)	G. Bollen H. Ravn	General coordination of REX project REXTRAP
Univ. Mainz	F. Ames G. Bollen	REXTRAP
Univ. Stockholm/ Manne Siegbahn Laboratory CTH Gothenburg	L. Liljeby	REX-EBIS
LMU Munich	D. Habs O. Kester	Q/A selector + RFQ + IH
MPI Heidelberg	R. von Hahn R. Reppow	7 gap resonators
Univ. Strasbourg	G. Walter	Target chamber
KU Leuven	P. Van Duppen	Beam observation
PS-CO	I. Deloose B. Frammery	Control system
PS-RF	H. Broere M. Vretenar	Low-Level RF

REX-ISOLDE Local Responsibilities

1998-12-14

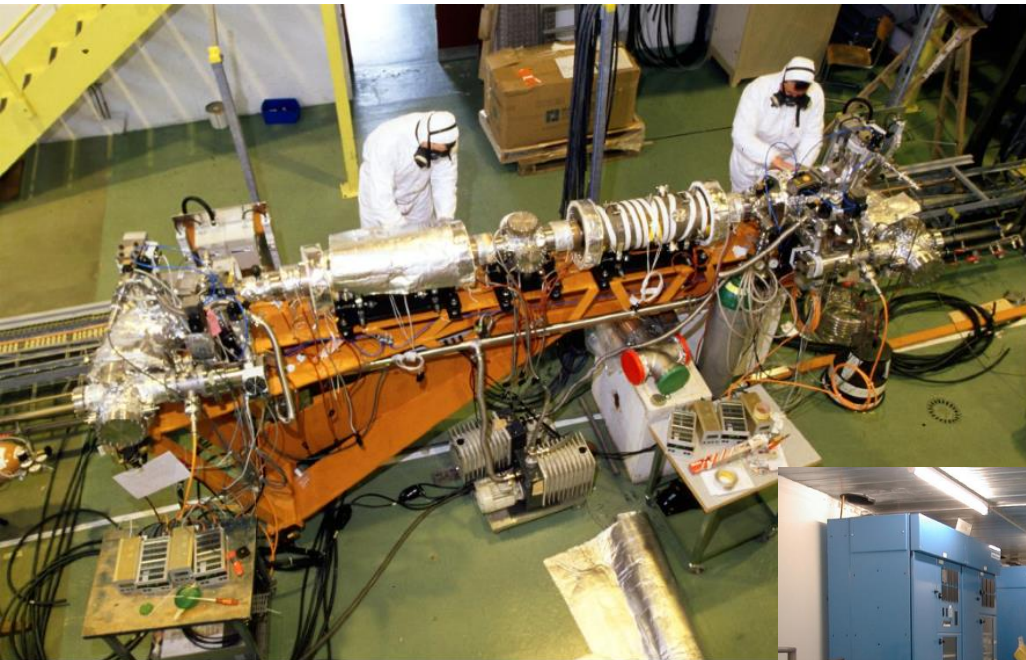
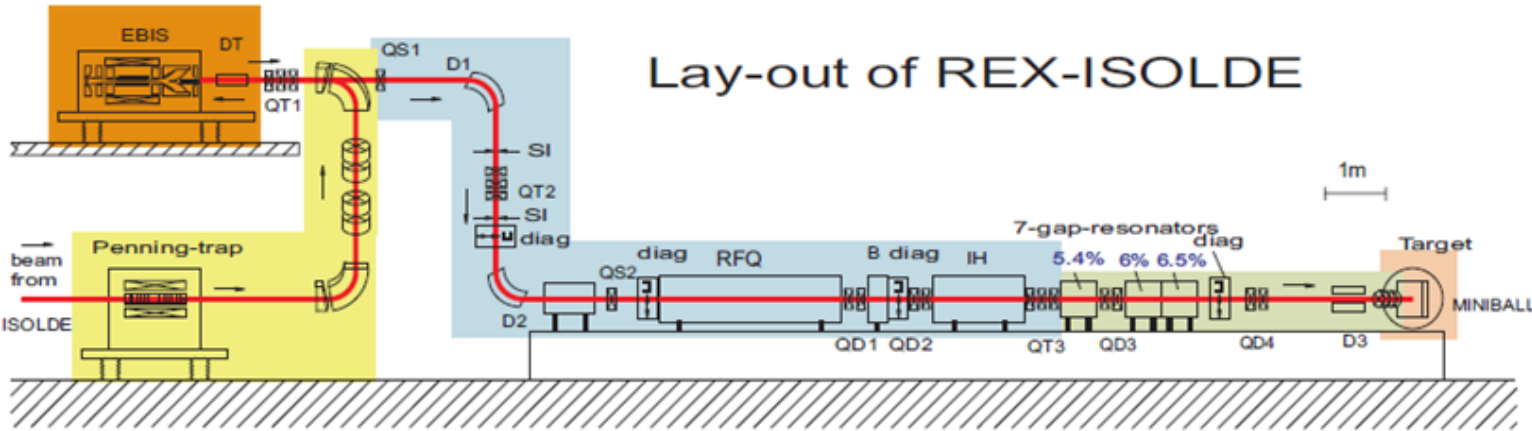
ISOLDE Physics Group

Georg Bollen ISOLDE Physics Group Leader	General coordination of REX project CERN contact person for REX-Experiment REXTRAP project leader	3-1-058	75825 75828
Friedhelm Ames Research Scientist, Mainz	REXTRAP responsible link person to outside groups for techn. issues data base REX vacuum equipment	26-1-025 Bld 170	79415 78314
Markku Oinonen CERN Fellow	Planning of infrastructure work for REX- ISOLDE during 98/99 shut-down REXTRAP	26-1-104	78609
Jürgen Zimmer Technician, Heidelberg	Technical support for REX installation Contact person for installation of REX equipment including vacuum Supervision shut-down infrastructure work	545-R-017 597-R-014 Bld 170	76807 72683 78314
Frederik Wenander Doctoral Student, CERN	REX-EBIS Installation and Test	9-R-012 Bld 170	74413 78314
Pit Schmidt Doctoral Student, Mainz	REXTRAP Installation and Test	26-1-025 Bld 170	72958 78314
Oliver Forstner Doctoral Student, CERN	REXTRAP Installation and Test	26-1-025 Bld 170	79415 78314

ISOLDE Technical Group

Erich Kugler	General installations ISOLDE, experimental Hall, beam-lines, separators, installations, ...	26-1-012	73183 163393
Claude Chollet	Hall supervision, beam line installation, alignment, ...	601-R-005	73949 163822

Building REX-ISOLDE



REXTRAP Accumulator and Buncher



World largest Penning trap

Friedhelm Ames, Oliver Forstner, Pit Schmidt

Preparing for Science with REX-ISOLDE

REX-ISOLDE Physics Perspectives

FIELD	FEATURES	TOPICS	LETTERS OF INTENT / PROPOSALS
Nuclear Structure	Higher Energies	Exotic Matter Distributions: Halos + Skins ^{11}Li , ^7He unbound systems ^6He , ^{10}Li N=Z, High Spins p-Radioactivity	ISC98-23/P105 (IS371) ISC98-11/P100 (IS367) ISC97-25/P93 ISC97-27/I27 ISC97-10/I21 ISC93-12/I6
Nuclear Astrophysics	Variable energy, polarization	$^{35}\text{Ar}(p,\gamma)$ and the rp -Process $^7\text{Be}(p,\gamma)$ and the Solar Neutrinos	ISC 94-21/I11 ISC 97-1/I20
Atomic / Fundamental Physics	Bunched Ions, Highly Charged Ions	PNC, Masses, Weak Interactions Studies, Change in Nuclear Decays, ...	ISC 98-21/I30 ISC 99-13/P111 NEW
Nuclear Solid State Physics	Deep Implantation, Low Concentration	Diffusion, Defects in Semiconductors, Hydrogen in Semiconductors	ISC 94-29/I15 ISC 94-24/I12 ISC 94-I13

Solid State Physics

■ Prime time for Solid State Physics at ISOLDE

Electrical and optical properties of semiconductors

Effect of doping level and defect concentration

Basic mechanisms need to be understood

- Diffusion of self atoms, defects and impurities
- Formation of defects and defect complexes
- Lattice location of impurities and dopants

Surface and Interface Studies

Magnetic properties of single layers

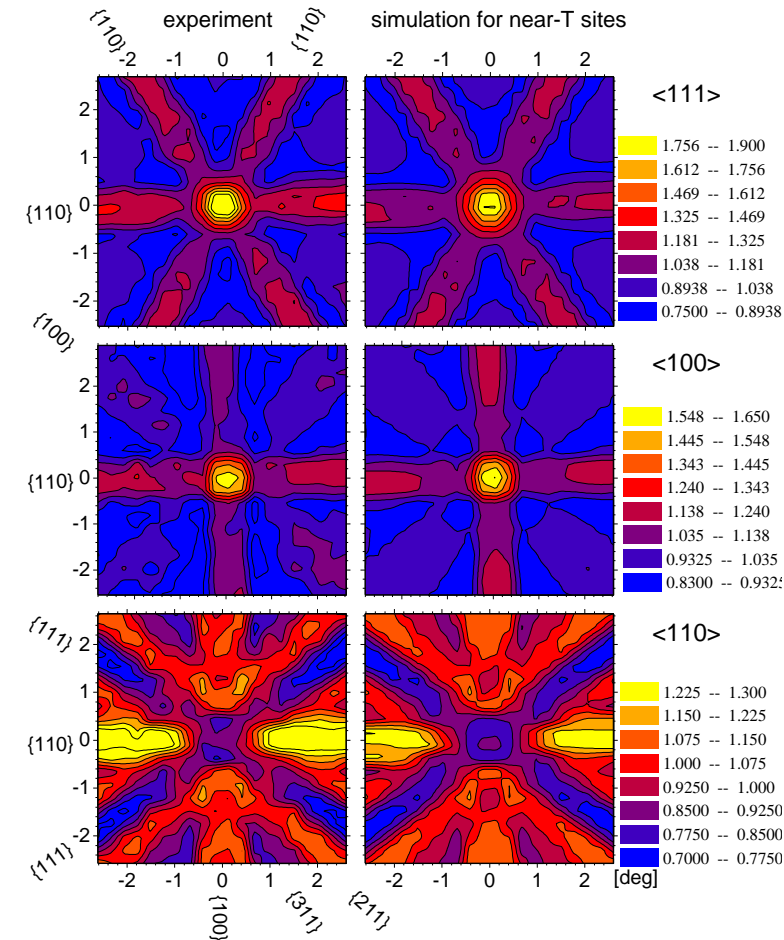
High-T_c Superconductors

Structure of HgBa₂CuO_{4+δ}

Ceramics

Diffusion of C and N in amorphous ceramics

e⁻ emission channeling patterns from ^{167m}Er in p-Si:B, FZ
E=150-206 keV, T_i=20°C, T_a=900°C, T_m=20°C



U. Wahl et al.

¹⁶⁷Er lattice site in Si

PRL 79 (1997) 2069

ERSOBNV.ORG

Life Science

Bio Medical Research at ISOLDE

Example:
samarium isotopes

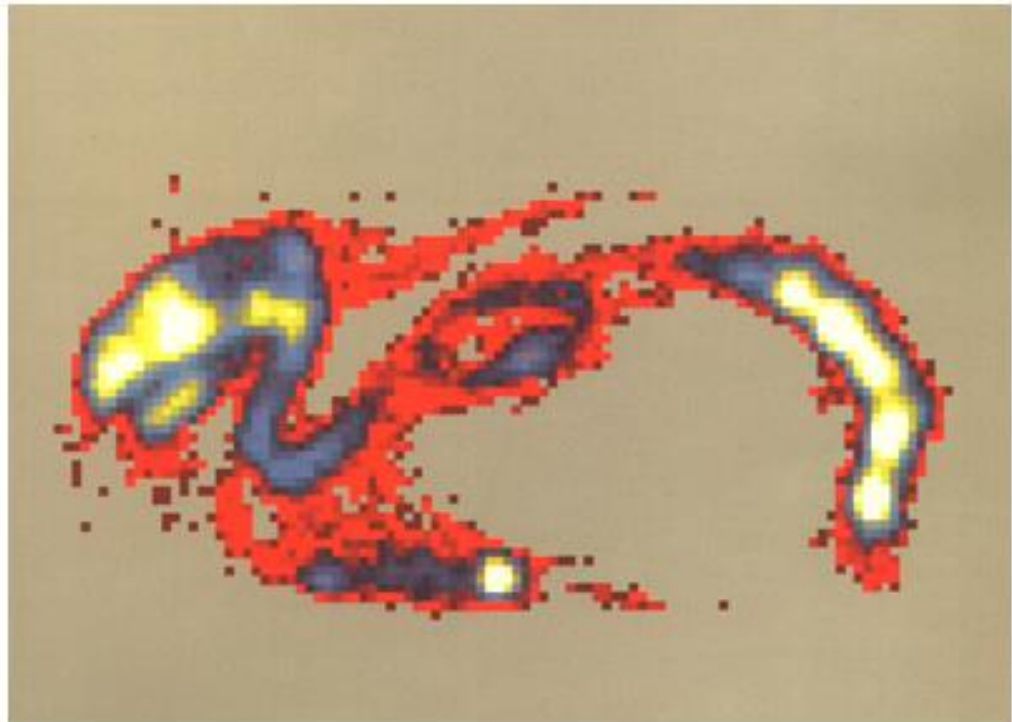
in vivo dosimetry by positron emission tomography (PET)

^{142}Sm (ϵ , $T_{1/2} = 72\text{m}$) \Rightarrow

^{142}Pm (β^+ , $T_{1/2} = 40\text{s}$)

therapy

^{153}Sm (β^- , $T_{1/2} = 47\text{h}$)

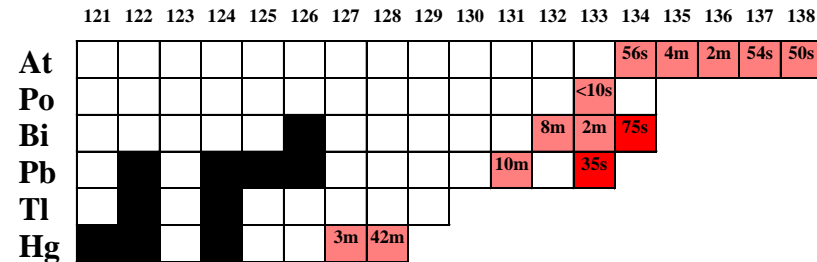


PET scan of a rabbit 60 min p.i. of ISOLDE produced ^{142}Sm in EDTMP solution

Nuclear Spectroscopy

Discovery of New Isotopes

Exploring New Regions - East of ^{208}Pb



- only little information and slow progress:

Hahn & Meitner: ^{214}Pb , ^{210}Tl

- Important for:
 - r-process nucleosynthesis
 - predictions of properties of superheavy elements

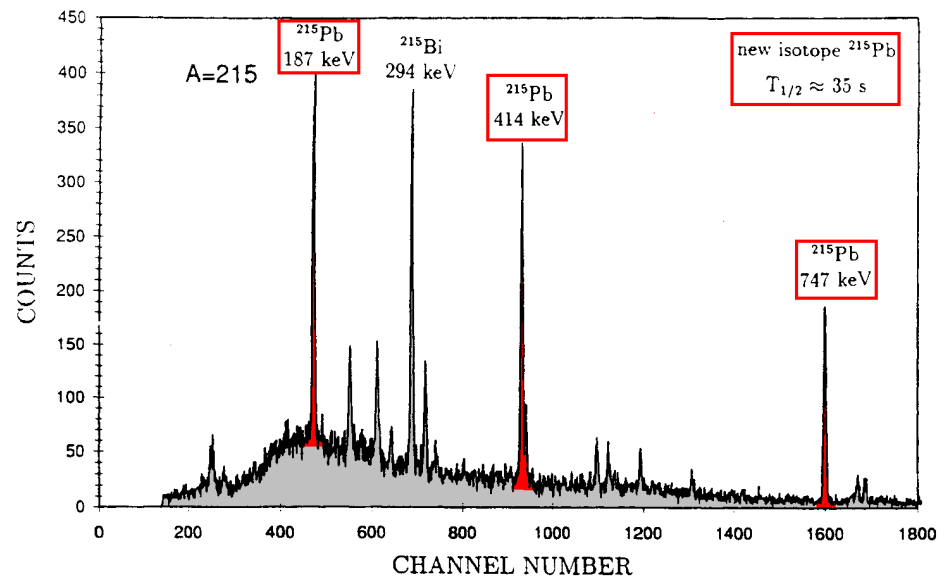
- Half-lives
- Masses

.....

Pulsed release technique at ISOLDE :

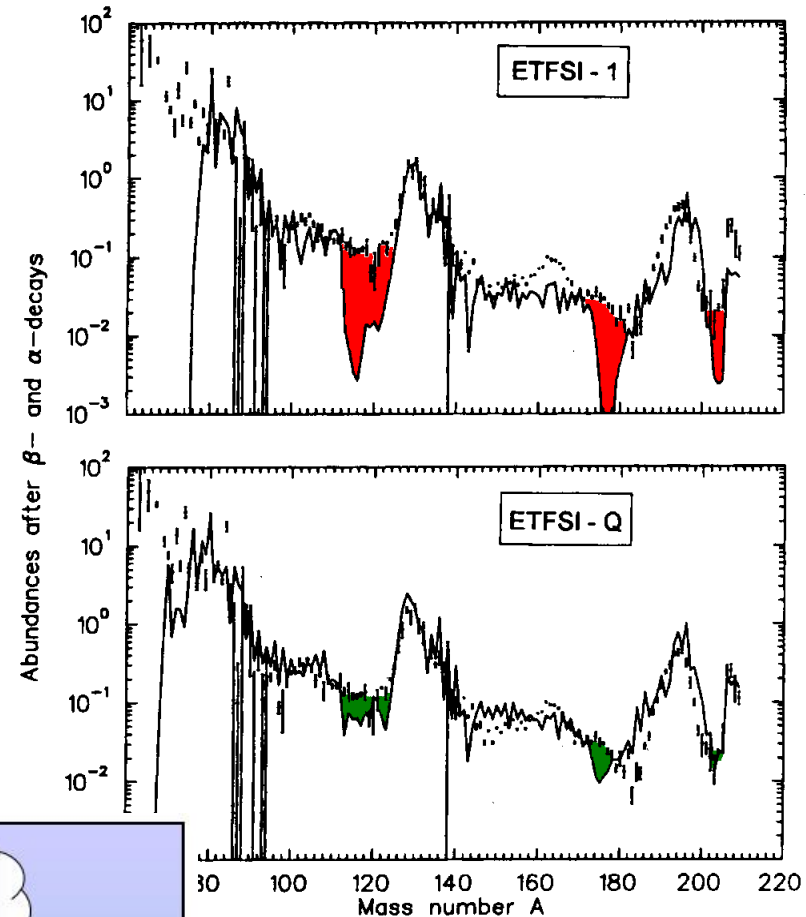
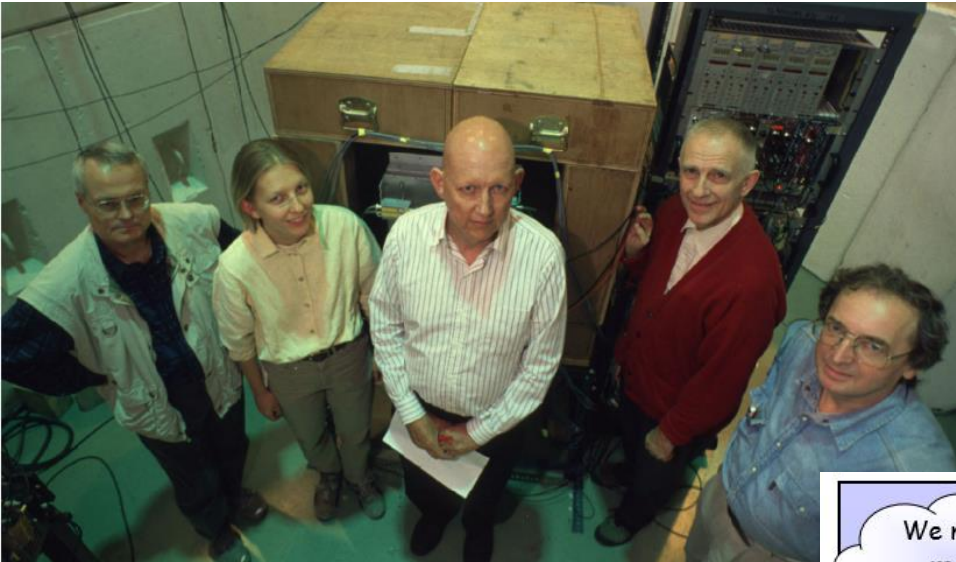
^{215}Pb (N=133), ^{217}Bi (N=134), ($Y > 10^3/\text{s}$)

β -gated γ -spectrum for A=215 (data taking <30s)



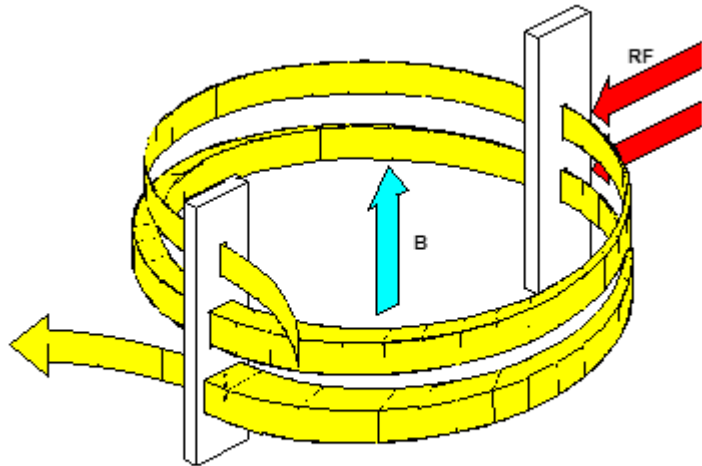
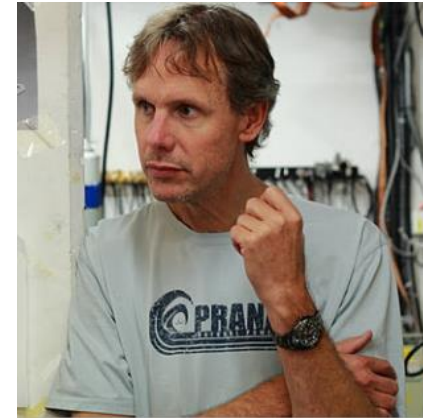
Nuclear Astrophysics

- K. L. Kratz et al.
Laser isotope and isomer separation of heavy Ag nuclides: Half-life of the r-process waiting-point nuclide Ag-129 and structure of neutron-rich Cd nuclides



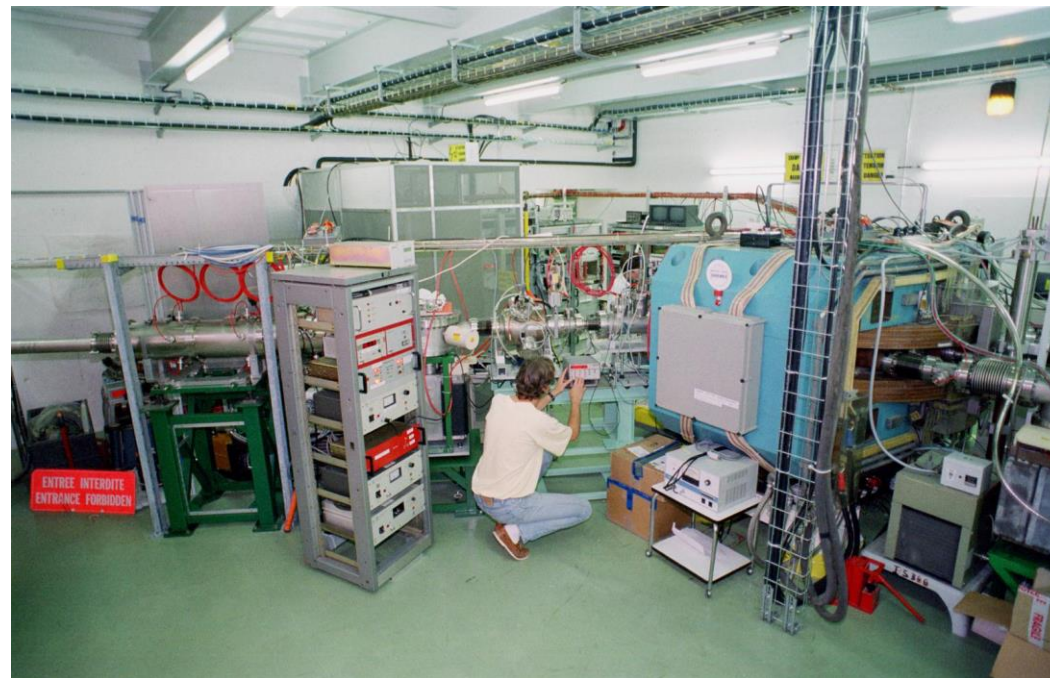
Direct Mass Measurements MISTRAL – new to ISOLDE

- MISTRAL to complement ISOLTRAP
 - Less precise but very fast
 - Access to shortest-lived isotopes far from stability
- Smith type RF spectrometer



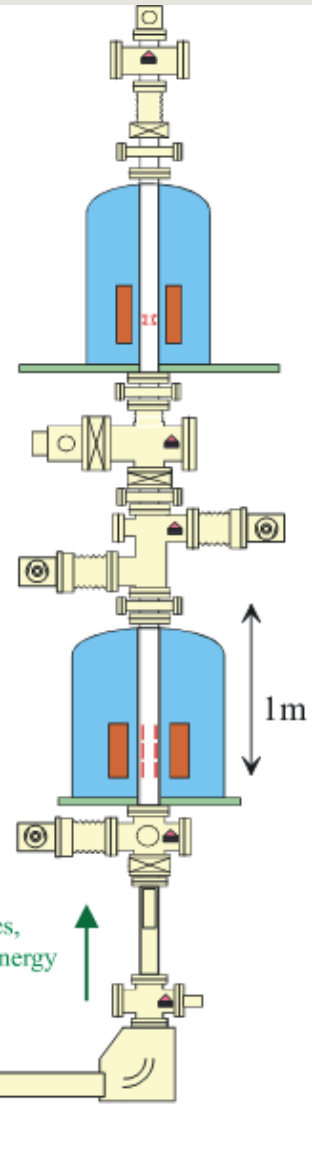
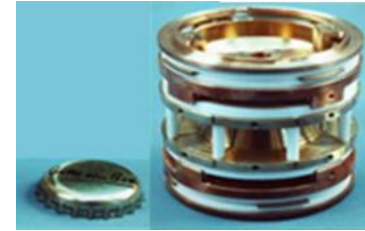
$$\omega_c = \frac{qB}{m} \quad \omega_{\text{RF}} = \left[n + \frac{1}{2} \right] \omega_c \quad R = 2\pi n \frac{D_m}{w}$$

M. De Saint Simon, D. Lunney et al.,



Direct Mass Measurements ISOLTRAP

- Successful measuring masses since 1987
- Improvements
 - 2nd generation precision trap (1989)
 - Isobar separator based on mass-selective buffergas cooling in Penning trap(1994)
- Limitation to overcome
 - Stopping-reionization scheme restricts access to certain elements
- Accumulation, cooling, and bunching with buffergas-filled RFQ traps (1997)



Friedhelm Ames, Dietrich Beck, Jens Dilling, Frank Herfurth, Albert Kellerbauer, Harald Raimbault-Hartmann, Markku Oinonen, Stefan Schwarz, ...

Direct Mass Measurements ISOLTRAP becomes universal

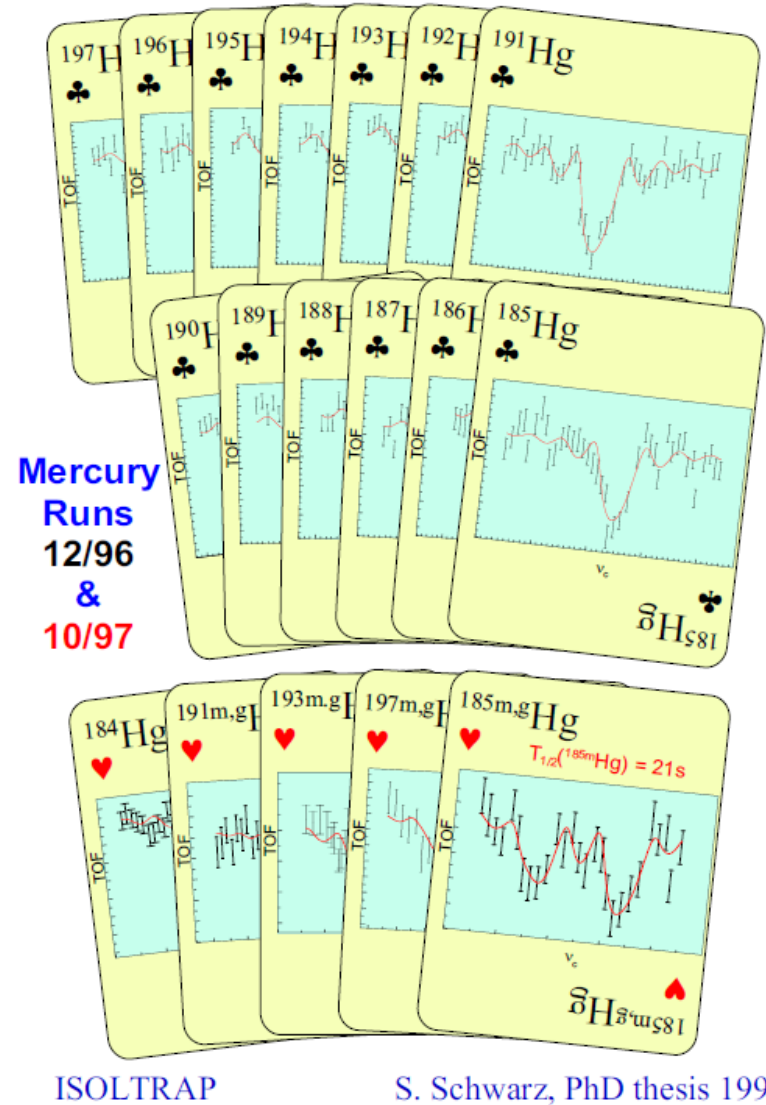
- Accumulation, cooling, and bunching with buffergas filled RFQ traps
 - Collaborator Bob Moore (McGill U)



Stefan Schwarz, Bob Moore



Frank Herfurth, Jens Dilling, Alban Kellerbauer, ...





Happy Birthday!