HISPEC/DESPEC

HISPEC = high-resolution in-flight spectroscopy

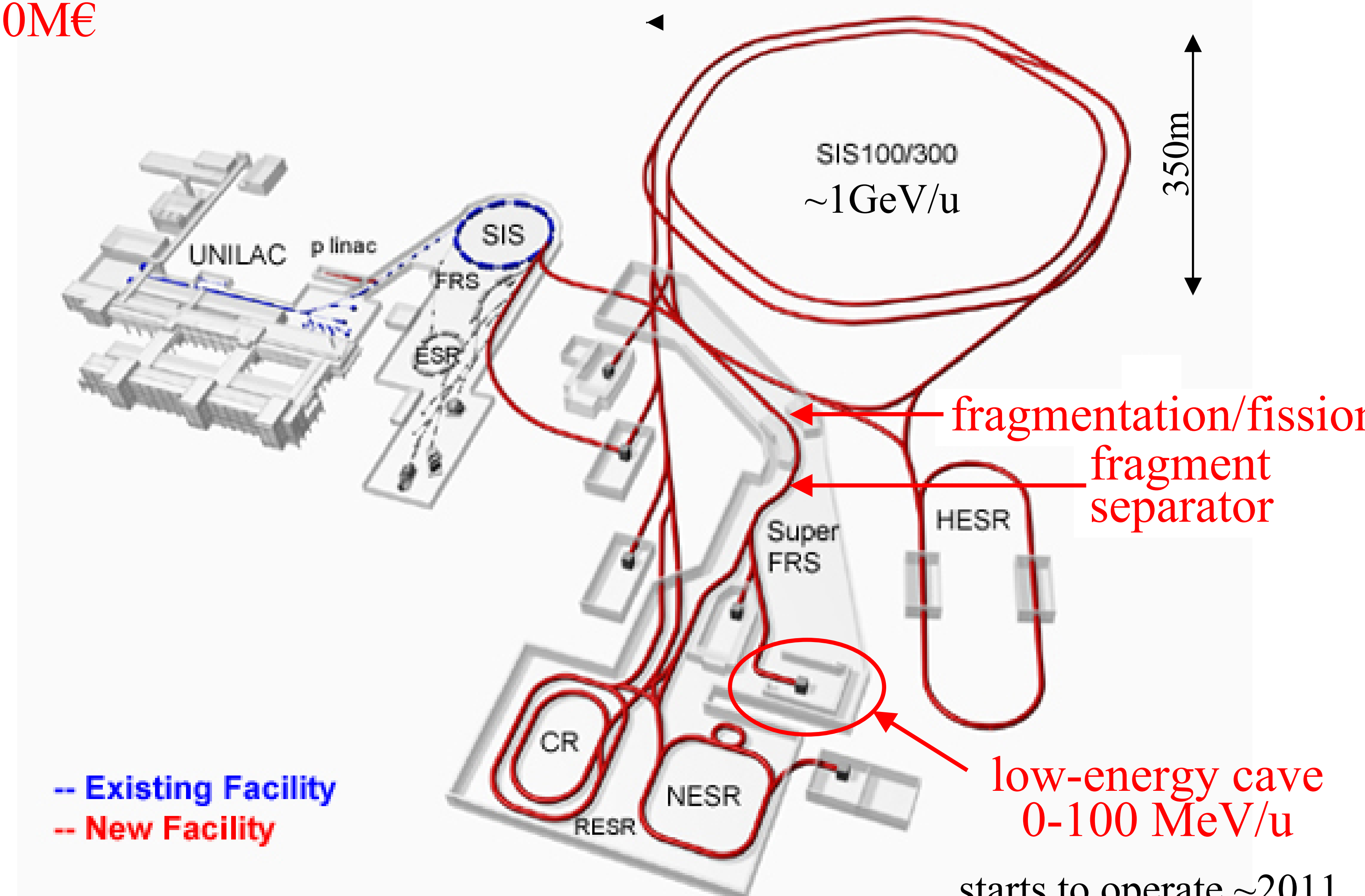
DESPEC = decay spectroscopy

Future:

European Radioactive Ion Beam (fragmentation) facility:

FAIR (Facility for Antiproton and Ion Research) (Darmstadt, Germany)

1000M€



starts to operate ~2011

Features

- ♥ isotopes of all elements; 0 MeV/u < E <100 MeV/u
- ♣ ions with short lifetimes (>100 ns)
- ♦ beam cocktail or mono isotopic beams
- ♠ isomeric beams

HISPEC/DESPEC

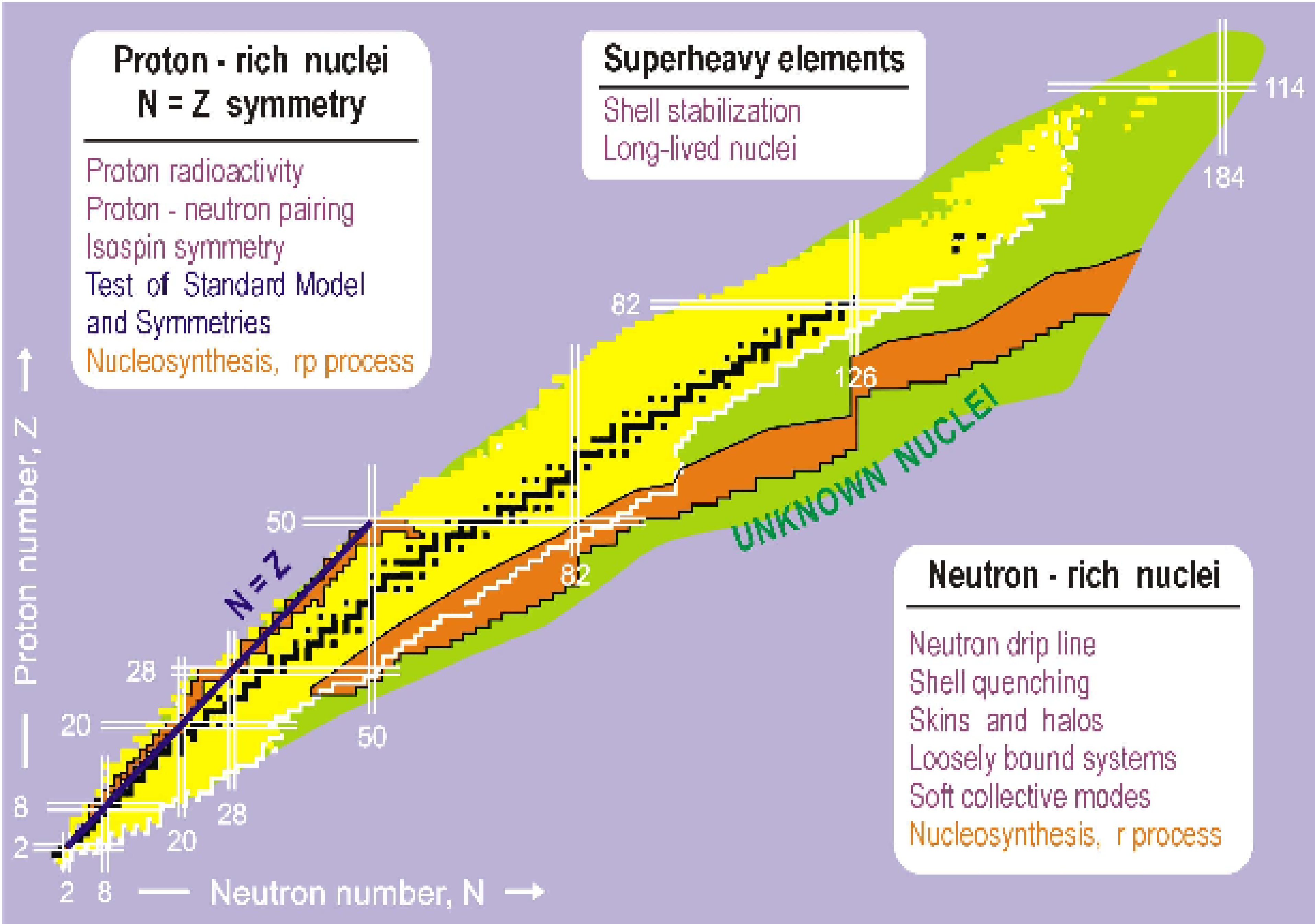
- gamma-ray spectroscopy + +
- particle spectroscopy + +

- beams at Coulomb barrier energies
- **intermediate energy beams: 50-100 MeV/u**
- **decay spectroscopy**

Table 1: Experimental opportunities for high-resolution spectroscopy at the low-energy branch.

Research field	**Experimental method (beam-energy range)**	**Physics goals and observables**	**Beam int.** (particle/s)
Nuclear structure, reactions and astrophysics			
HISPEC	Intermediate energy Coulomb excitation, In-beam spectroscopy of fragmentation products (E/A ~ 100 MeV)	Medium spin structure, Evolution of shell structure and nuclear shapes, transition probabilities, moments,	$10^{1}...10^{5}$
	Multiple Coulomb excitation, direct and deep-inelastic, fusion evaporation reactions (E/A ~ 5 MeV; Coulomb barrier)	high spin structure, single particle structure, dynamical properties, transition probabilities, moments,	$10^{4}...10^{7}$
DESPEC	Decay spectroscopy (E/A = 0 MeV)	half-lives, spins, nuclear moments, GT strength, isomer decay, beta-decay, beta-delayed neutron emission, exotic decays such as two proton, two neutron.	$10^{-5}...10^{3}$

CDR p.65. Some physics questions with radioactive beam

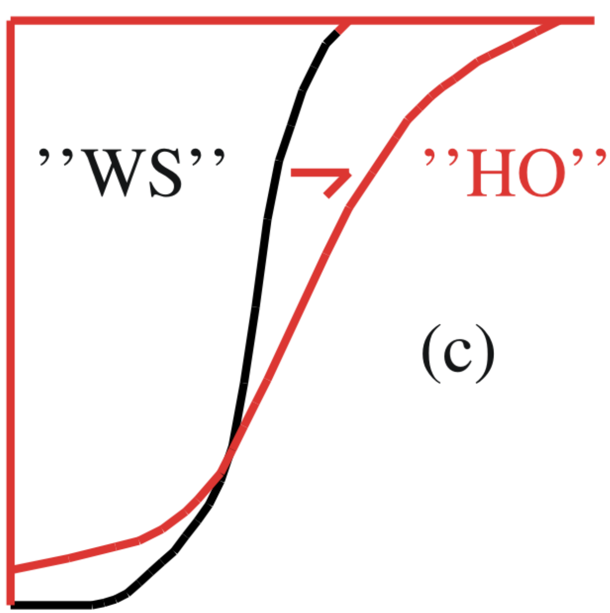


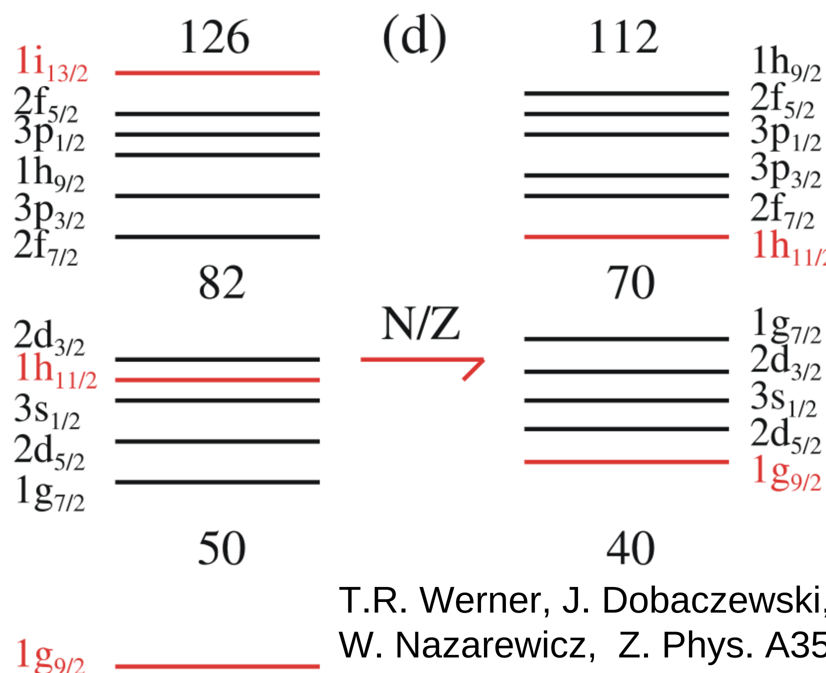
Physics Example: the Zr isotopes (Z=40)

$^{90}Zr_{50}$	$^{104}Zr_{64}$	$^{110}Zr_{70}$	$^{122}Zr_{82}$
spherical	deformed (β=0.45)		spherical ?

Coulomb excitation → decay

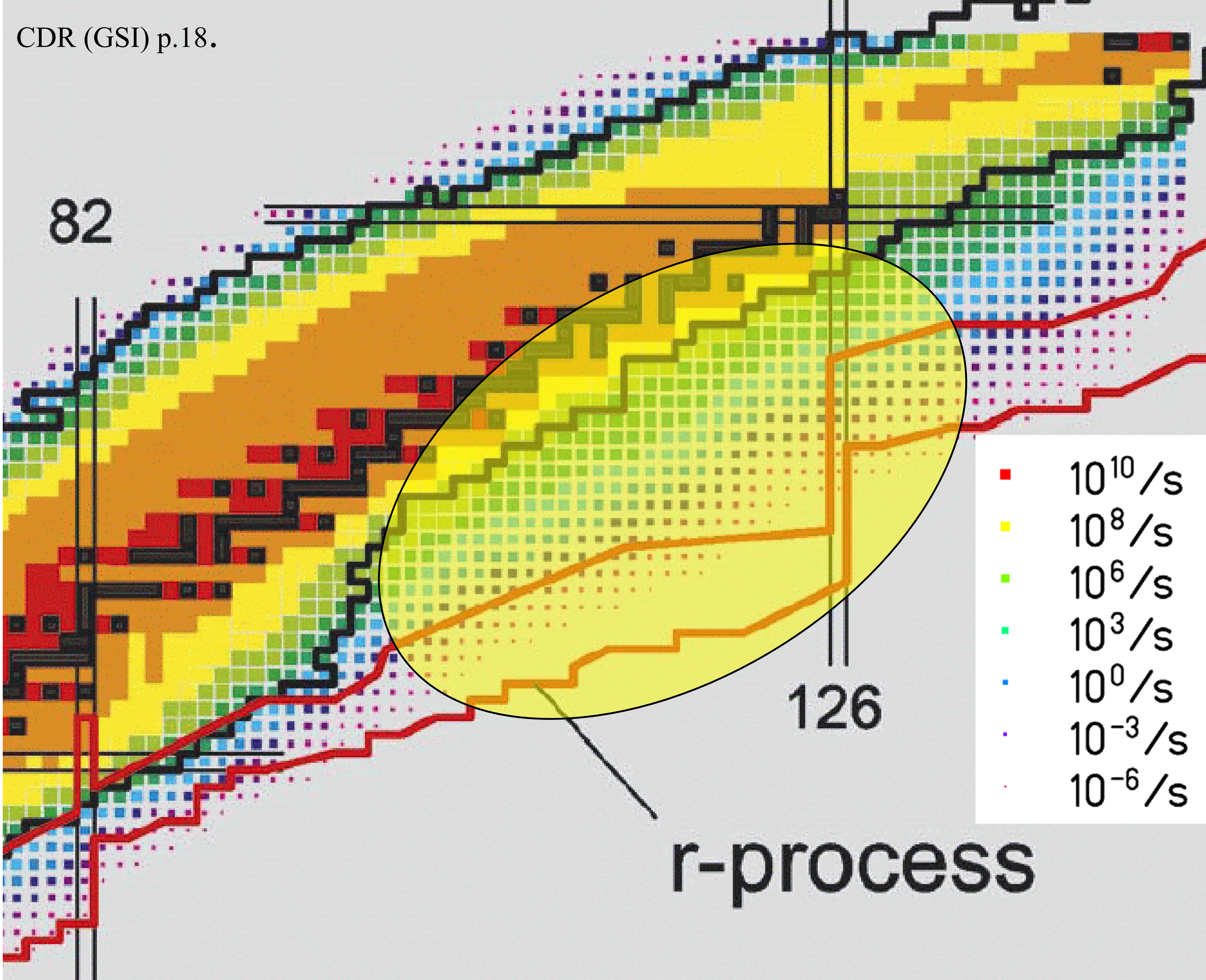
Lifetime: >1 s 1.2 s <1 s





T.R. Werner, J. Dobaczewski, W. Nazarewicz, Z. Phys. A358 (1997) 169

CDR (GSI) p.18.



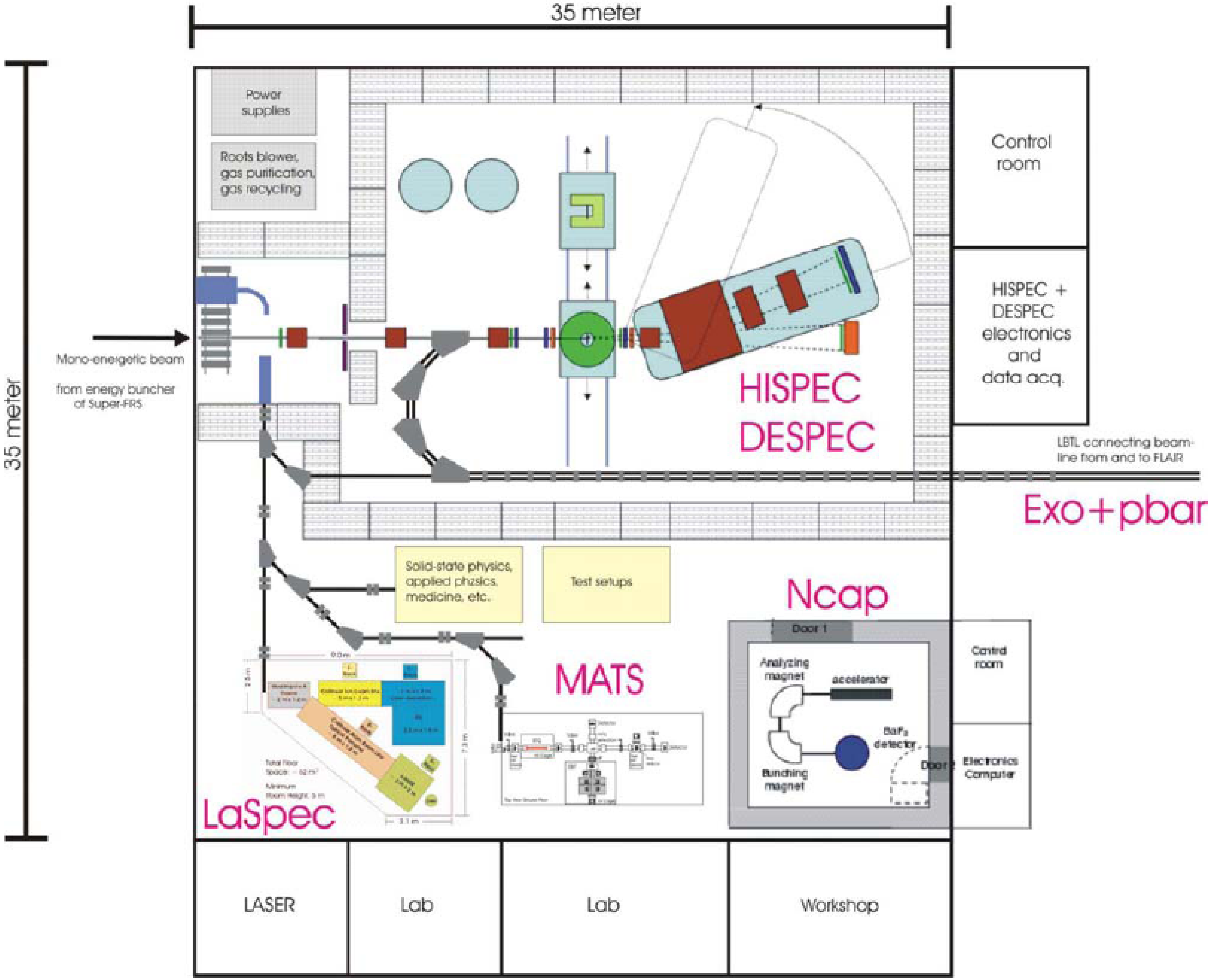
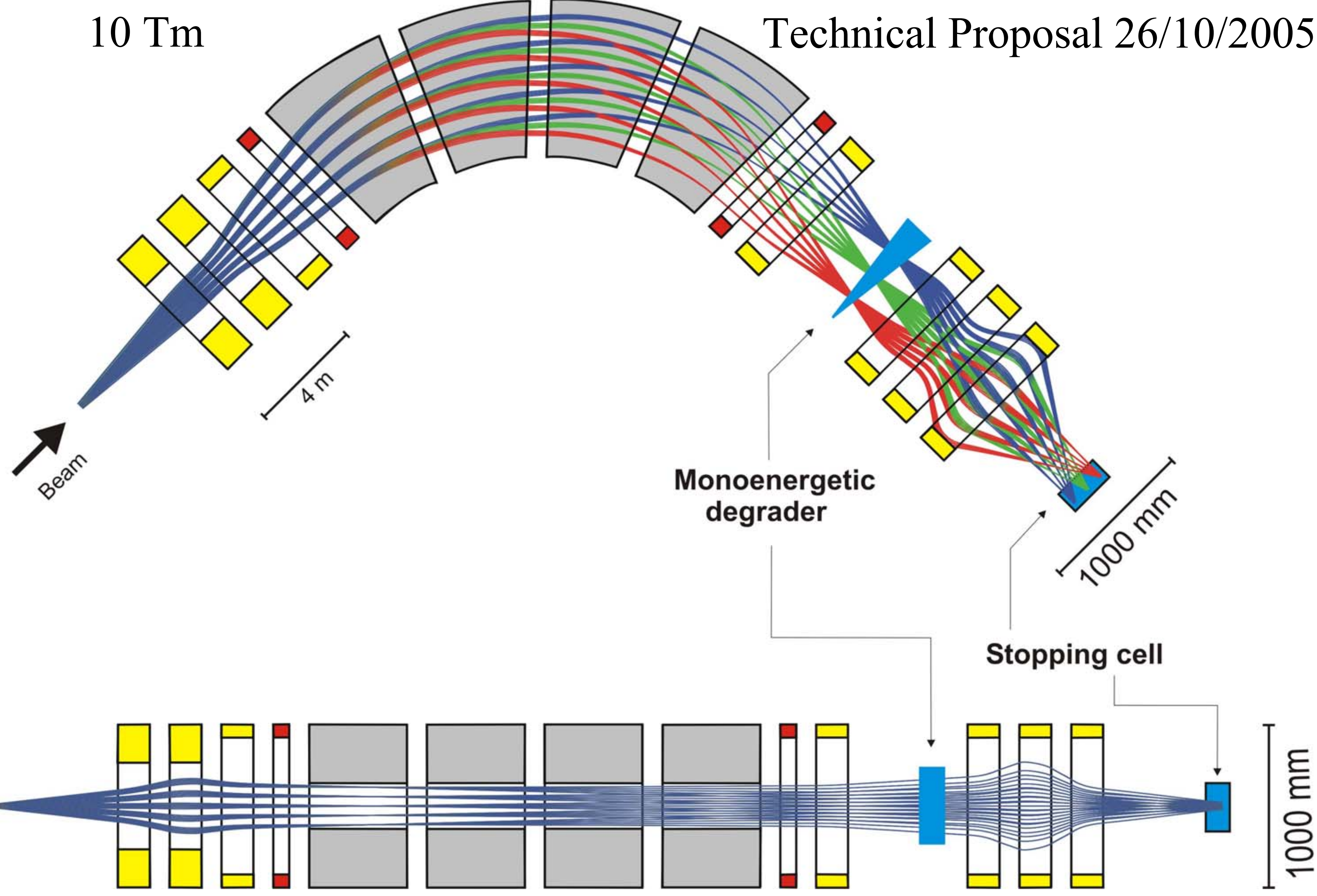


Fig. 1 Overview of the experimental area of the Low-Energy Branch

10 Tm

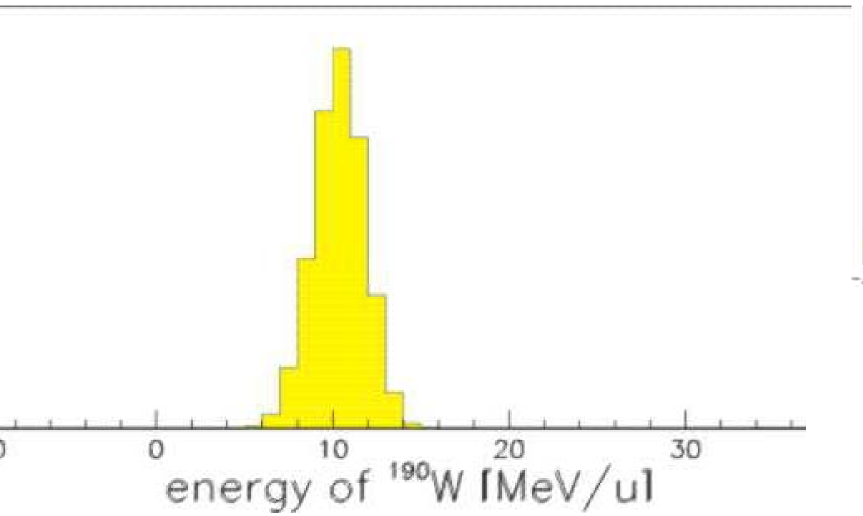
Technical Proposal 26/10/2005

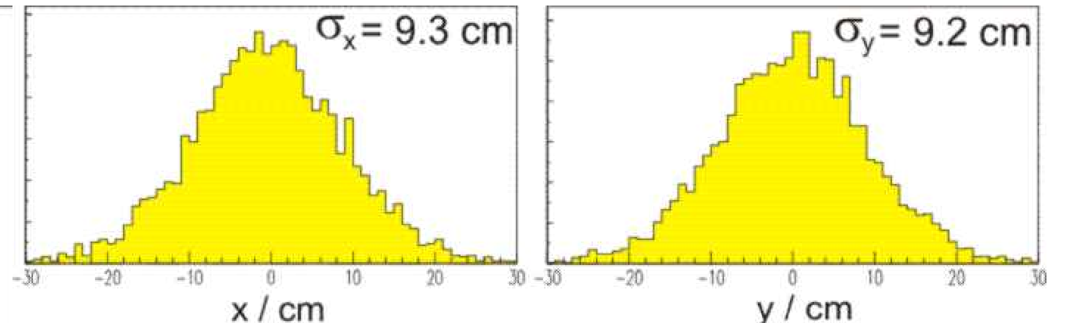


Technical design: Carsten Brandau, Surrey

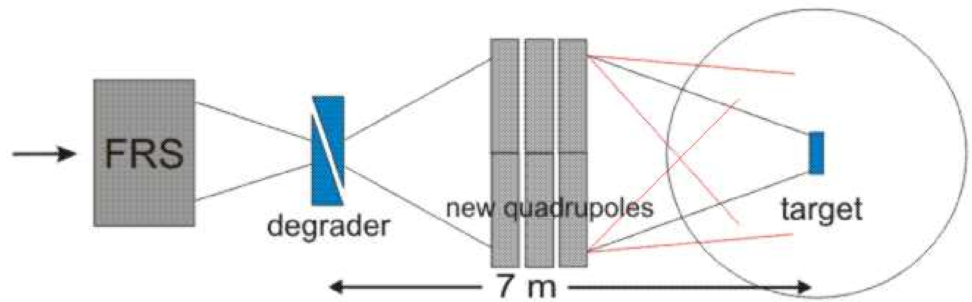
Characteristics of the beam after the energy buncher

300 MeV/u:	$\sigma_E \sim 0.3$ MeV/u	$\sigma_\alpha \sim 5$ mrad
5 MeV/u:	$\sigma_E \sim 3$ MeV/u	$\sigma_\alpha \sim 20$ mrad

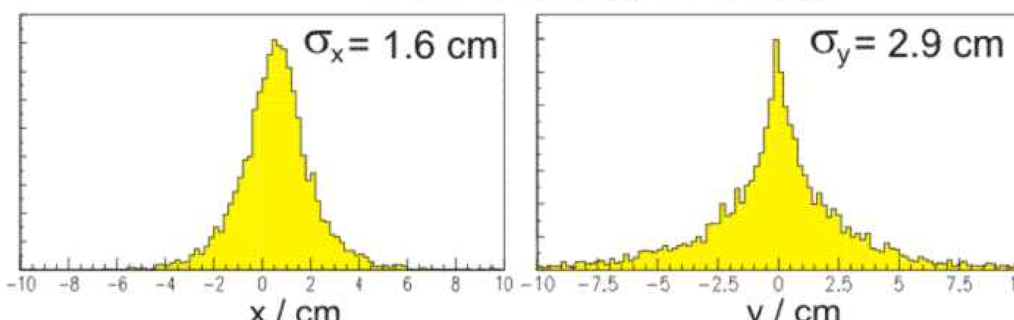


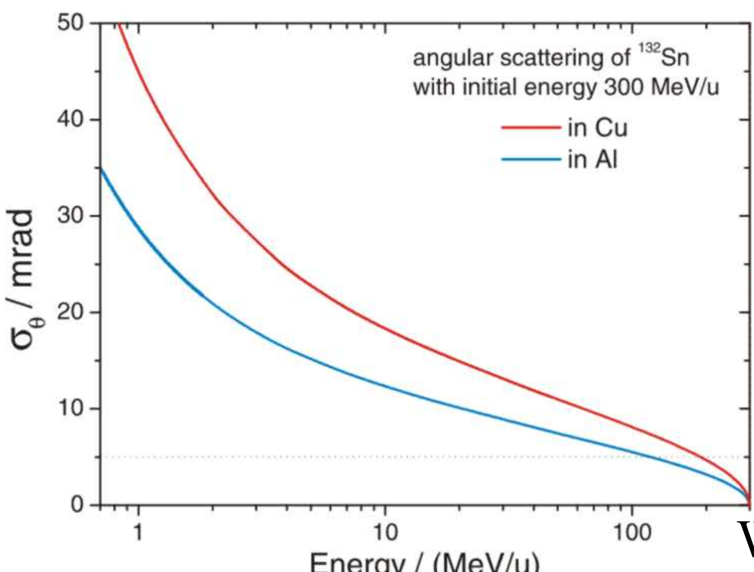


Refocusing of the low energy beam



limit of E = 5 MeV/u ± 2.5 MeV/u





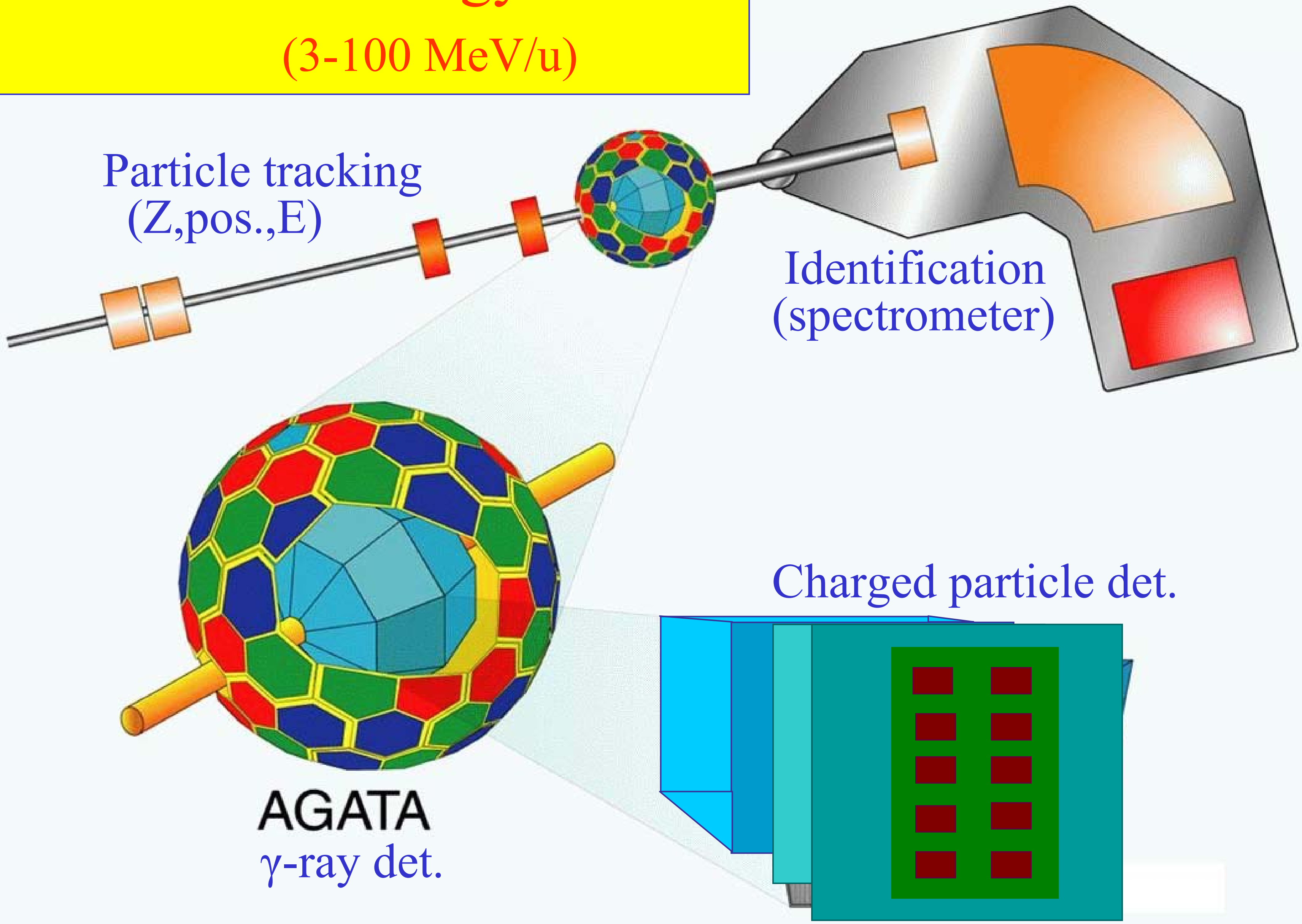
Warning: FRS, not SFRS

Courtesy of H. Weick

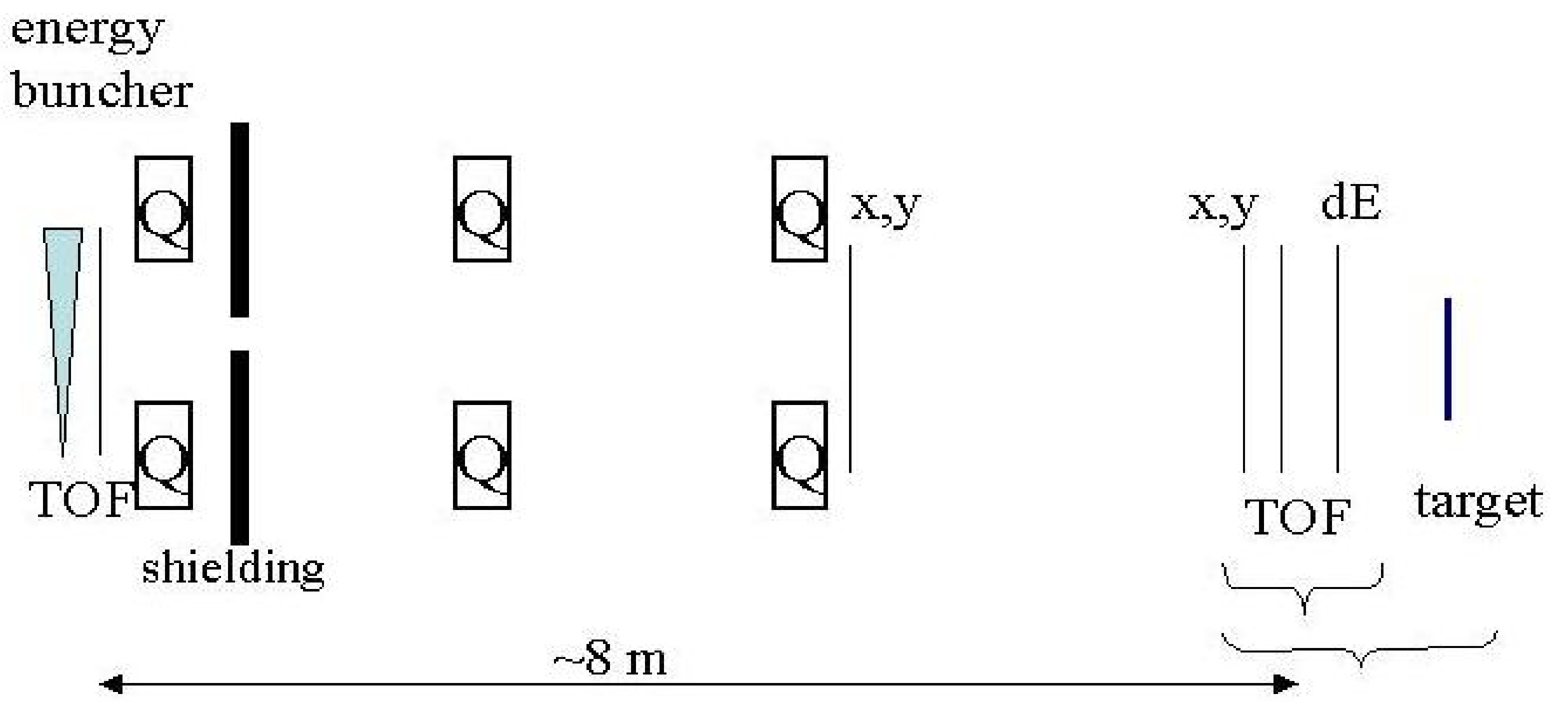
Detectors

Beam detectors (Z,E,pos.)
Gamma-ray detectors AGATA
Charged particle detectors dE-E for 50-100 MeV/u
4 PI dE-E for Coulomb barrier
Plungers
Tracking of outgoing particles, (spectrometer, dE/E+TOF)
ALADIN (intermediate energy)
later: dedicated one for 3-100 MeV/u
Implantation and decay detector DSSD
DESPEC Ge array
Fast timing BaF2, other?
Neutron detectors
Total absorption spectrometer NaI:Tl, BaF2, LaBr3:Ce
Electro magnetic moments

HISPEC – Low energy cave
(3-100 MeV/u)



Beam tracking and identifying detectors



Most promising:

Diamond CVD detectors (E/A=50-100 MeV) or 'traditional' (scintillator and Multi-Wire)

Carbon foil (electron emission) + multichannel plates (E/A=5 MeV)

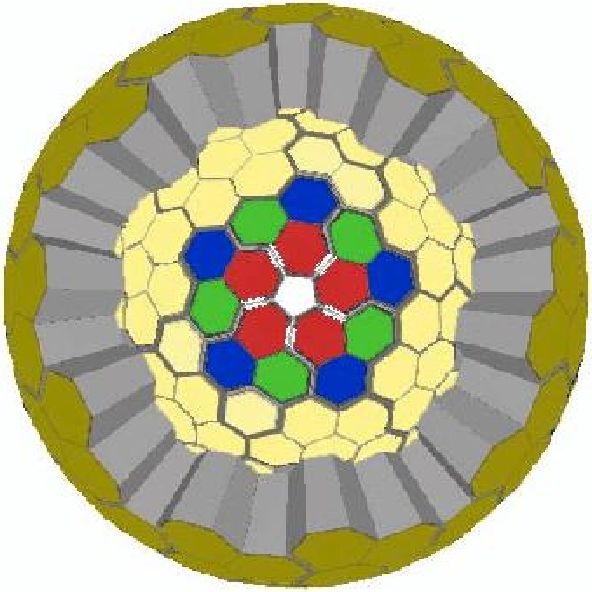
Gamma-ray detection: AGATA

v/c~0.5; multiplicity: 1-5

target-detector distance: 15 cm

	RISING (today)	AGATA demonstrator (**1*π***) + RISING ~2010	
Efficiency :	3%	10.5% **(~15%)**	+ ~3%
FWHM:	20 keV	7.6 keV	~40 keV

Much increased sensitivity compared to RISING

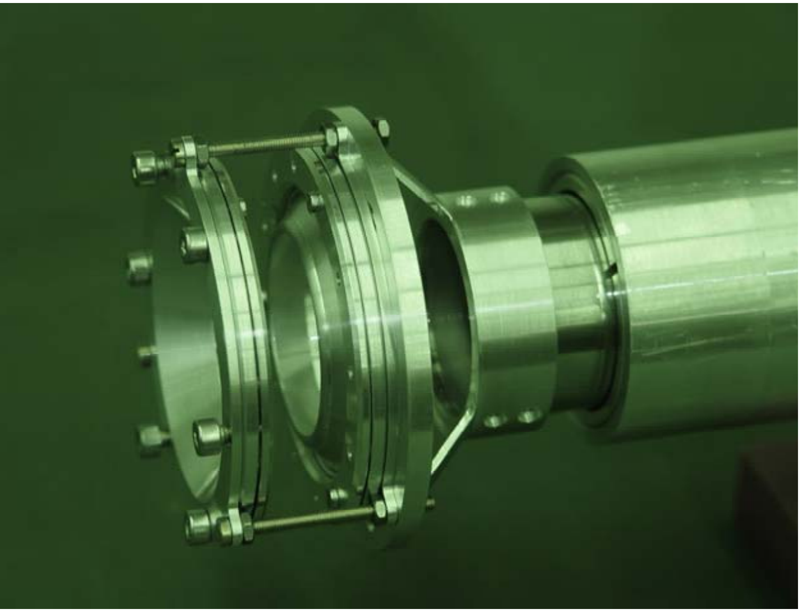


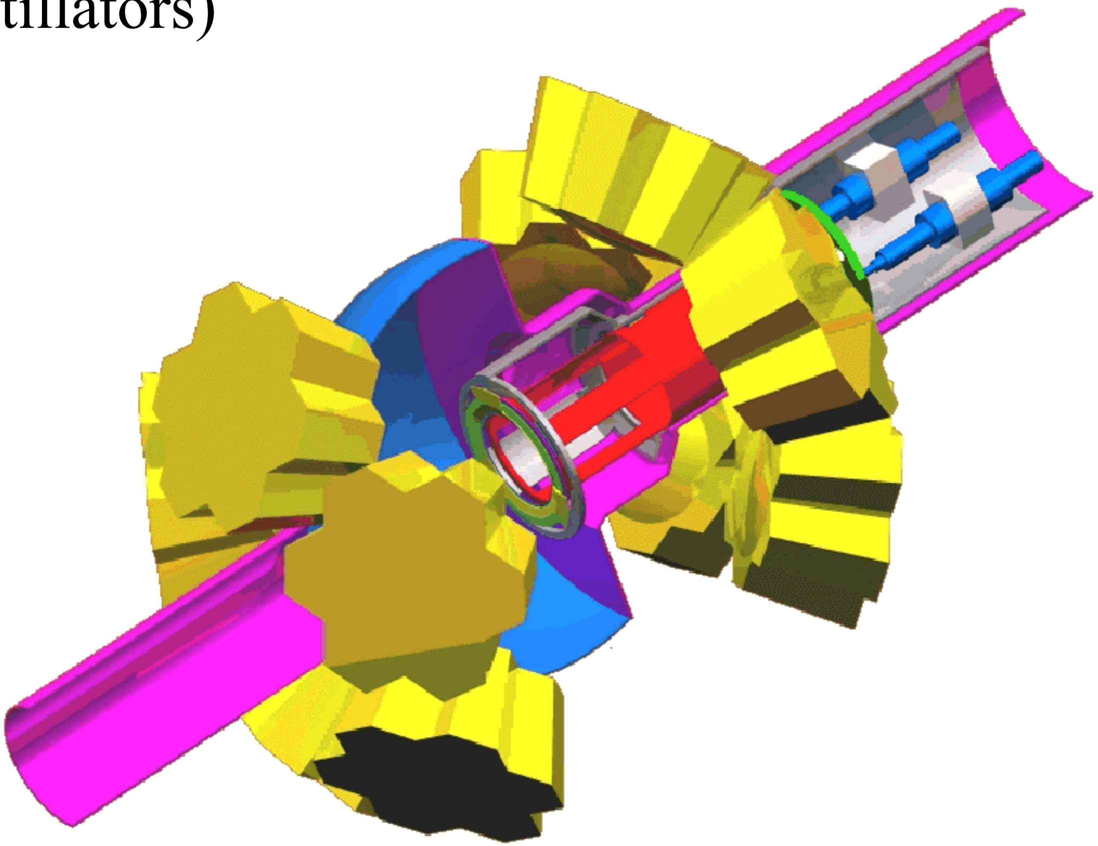
Possibility of angular distribution and polarisation measurements,
Coincidence measurements, g-factors (transient field method)
Determination of source position (?) (target vs. degrader)

Electromagnetic transition strength measurements (lifetimes)

(plungers and fast scintillators)

Plungers:





Not stopper foil, but degrader foil
has to work connected to gamma
and charged particle detectors
identification after reaction (to clean spectra from background)

Particle identification after the target

dE-E detectors, good Z resolution, bad A resolution (β spread)

M.Bentley et al.

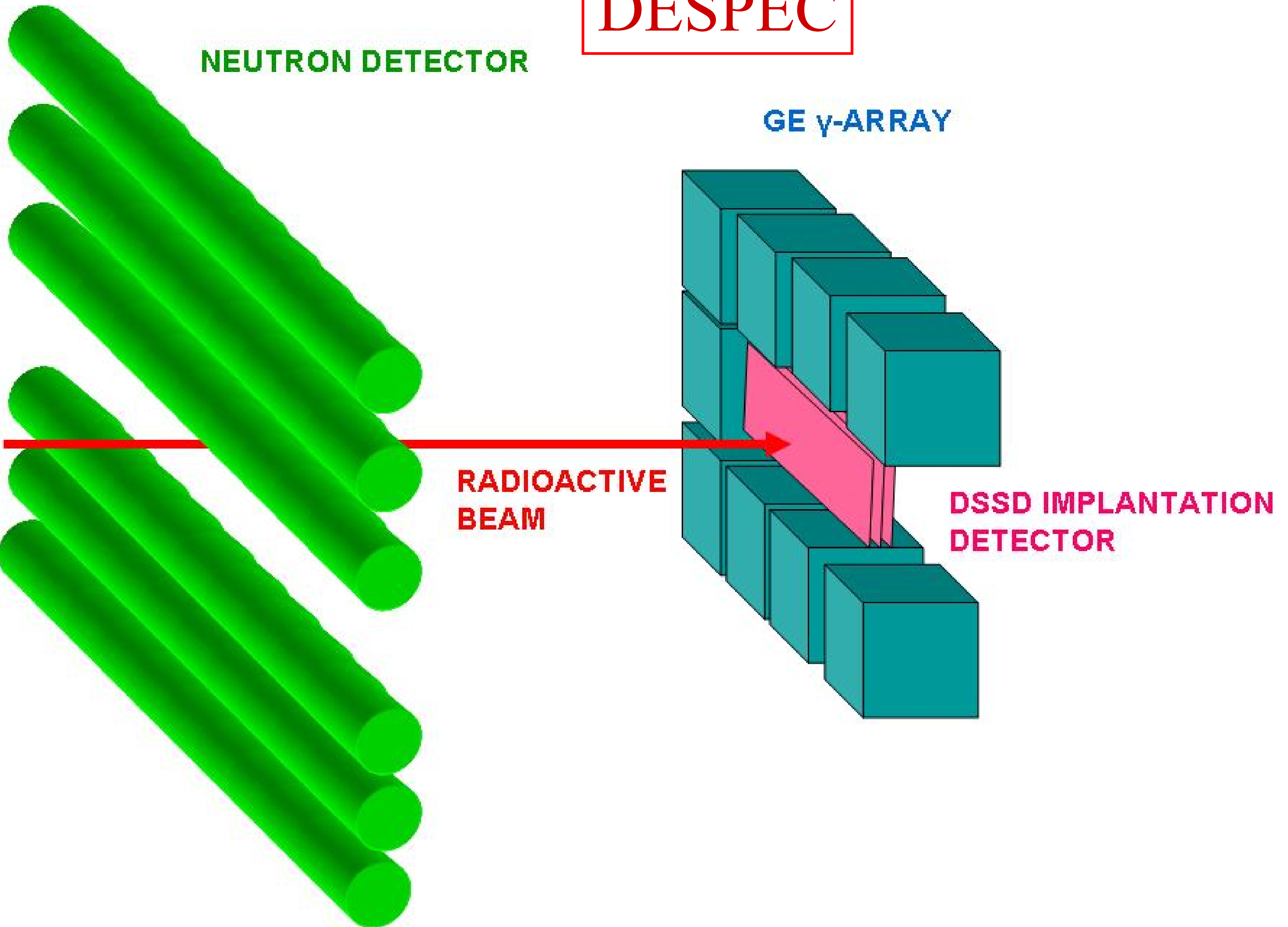
TOF + dE-E huge detector size needed

Bρ + TOF + dE-E reduced transmission

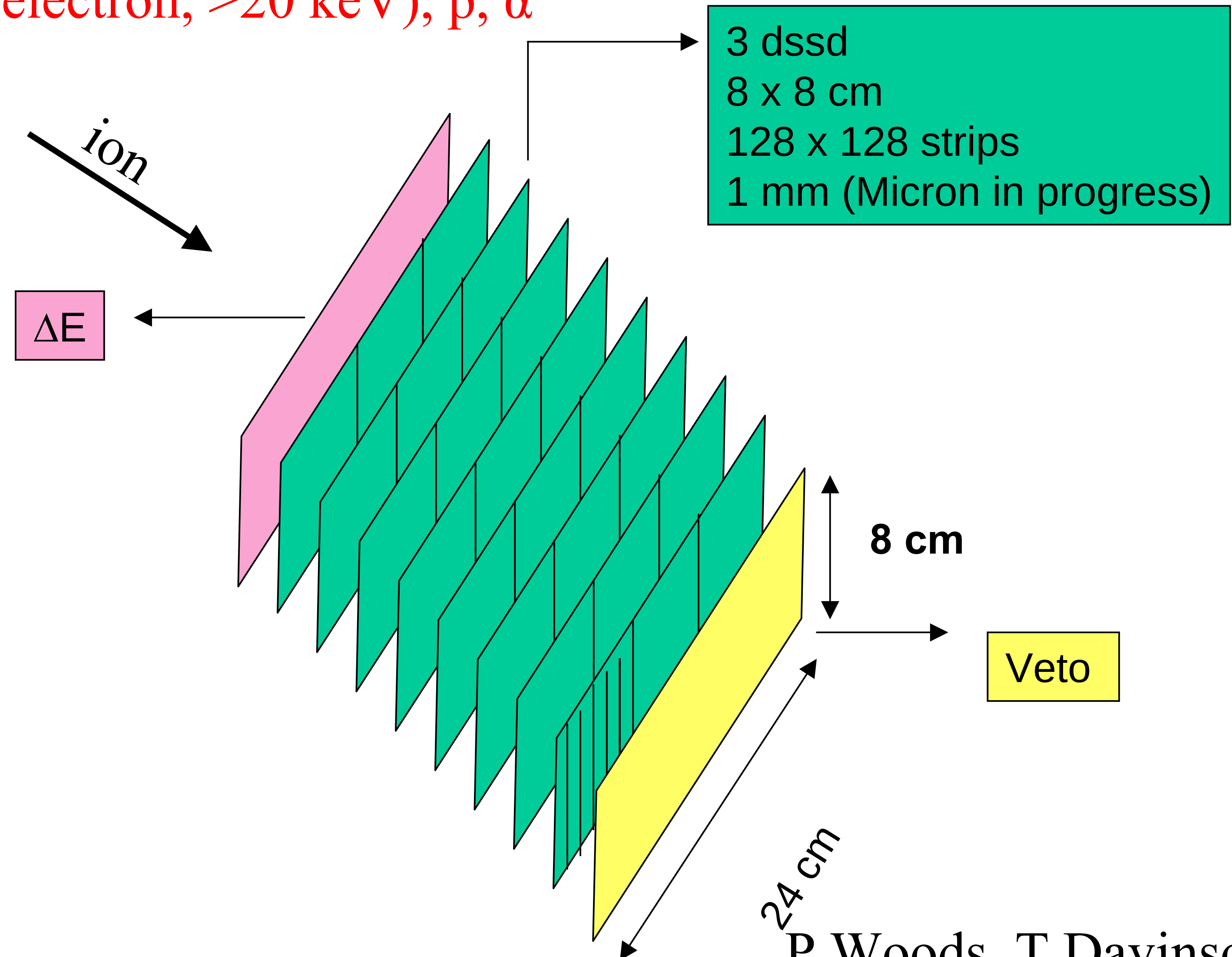
initially existing ALADIN magnet

Later: dedicated magnetic spectrometer for E/A=3-100 MeV

DESPEC


NEUTRON DETECTOR
GE γ-ARRAY
RADIOACTIVE BEAM
DSSD IMPLANTATION DETECTOR

Implantation and decay detector
β (and IC electron, >20 keV), p, α



P.Woods, T.Davinson et al.

Correlation between implanted ion and decay

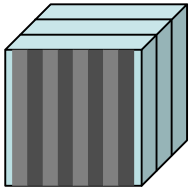
3x128x128=49152 pixels

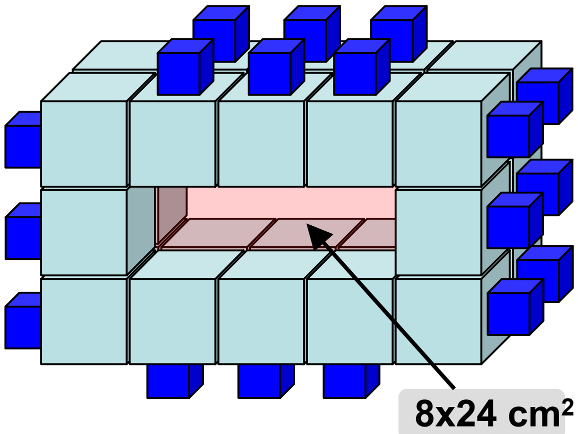
8x3x128+8x128=4096 channels

Two very different dynamic ranges

A modular high resolution γ-detection array

for β and isomeric decays



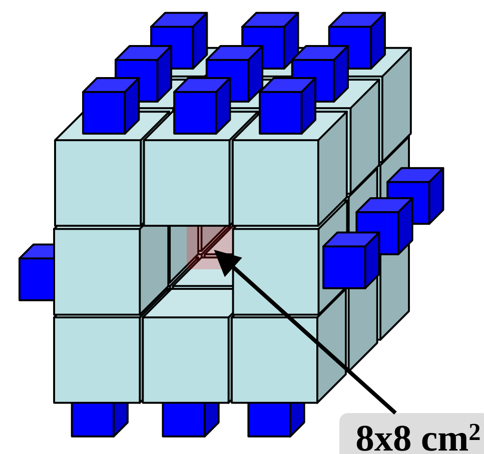


P_{ph} 21.7 %
P/T 0.43

Features of the proposed **stacked planar strip** array.

Detectors	24
Planar elements per detector unit	3
Strips per element	8 + 8
Electronics channels	1152
Effective number of voxels	13824

High granularity:
promt flash (and summing)
Tracking (correlation with implantation)
Ang corr and pol
(will benefit from Agata developments)



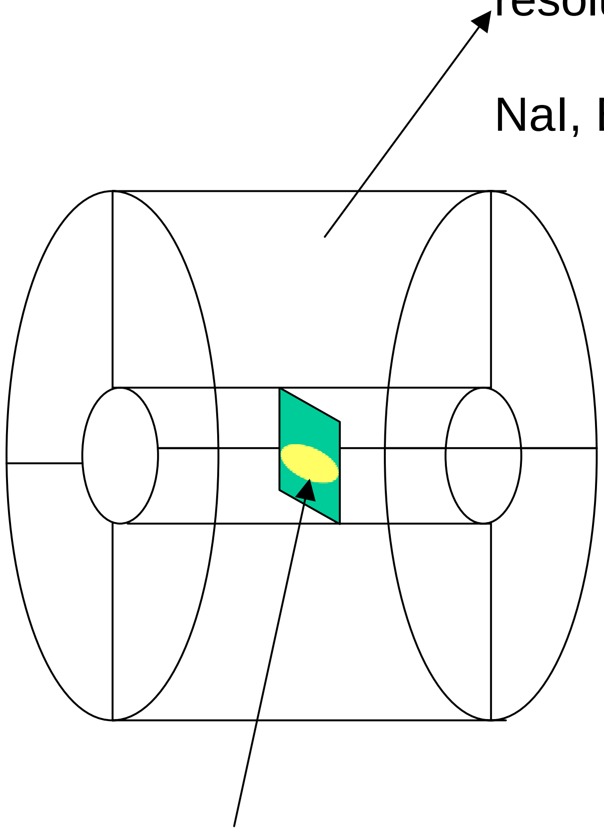
Total Absorption Spectrometer

TAS

Scintillator crystal
With “good”
resolution and eff:

NaI, BaF2, new material

Neutrons interact in the
system but need moderation
time



Implantation
In the middle
of the crystal

Debrecen (A. Algora), Gatchina (L. Batist),
GSI (M. Gorska, J. Gerl),
Uni. Autonoma Madrid (A. Jungclaus),
St. Petersburg (I. Izosimov), Uni. Surrey
(W. Gelletly, P. Regan, Z. P. Walker),
IFIC Valencia (B. Rubio, J.L. Tain)

and includes PhD student.

After CORE (8^{th} of July 2005)

Item	Cost (M Euro)	Available manpower (FTE)	Additional Manpower (FTE)
Beam tracking and identification detectors	0.5	4	6
HISPEC/DESPEC beam line	0.420		
Mechanics (rails, support, etc) + installation	0.260		
Common EDAQ (350kEuro of it: common NUSTAR)	0.609	2	10
Safety	0.156		
Cabling and related	0.180		
Active targets	0.3	0	2
AGATA	From other resources	1	5
HYDE charged particle detectors for reaction studies	1.5	5	8
Charged particle detector LYCA (50-100 MeV/u)	0.530	3	5
Plunger	0.113	2	6
Magnetic spectrometer	0.1 (ALADIN) + 3.5 (new design)	2	15
DSSD implantation and decay det.	0.975	5	9
DESPEC high resolution gamma det.	4.9	6	24
Fast timing	0.47	3	3
Neutron detectors	1.064	4	13
Total absorption spectrometer	0.5	4	4
Isomeric moments	0.15	5	3
Total	16.227	46	113

HISPEC/DESPEC collaboration structure

Management Board

Spokesperson(HISPEC)	Zsolt Podolyák / Wolfram Korten
Spokesperson(DESPEC)	Berta Rubio
Deputy (HISPEC)	Jan Jolie
Deputy (DESPEC)	Phil Woods
Project manager (HISPEC)	Juergen Gerl
Project manager (DESPEC)	Magda Gorska

Technical Board

	member	affiliation
beam tracking and identification detectors	J.M. Quesada	University Sevilla, Spain
AGATA	J. Simpson	CCLRC Daresbury,UK
HYDE charged particle detectors for reaction studies	I. Martel	Huelva University, Spain
Charged particle detectors for structure studies	D. Rudolph	Lund University, Sweden
Plunger	A. Dewald	Koln University, Germany
Magnetic spectrometer	D. Ackermann	GSI Darmstadt, Germany
DSSD implantation and decay detector	P.J. Woods	Edinburgh University, UK
DESPEC high resolution gamma detectors	A. Jungclaus	Universidad Autonoma de Madrid, Spain
Neutron detectors	D. Cano-Ott	CIEMAT Madrid, Spain
Total absorption spectrometer	L. Batist	PNPI Gatchina, Russia
Fast timing with BaF2	H. Mach	Uppsala University, Sweden
Isomeric moments	D. Balabanski	Camerino University, Italy
Electronics and Data acquisition	J. Nyberg	Uppsala University, Sweden

Collaboration Board

The members are the signatories of the Memorandum of Understanding.

STI to HISPEC/DESPEC spokespersons

By late autumn 2005 an updated Technical Design Report of the FAIR project needs to be prepared, within given resource boundaries.
To this end, the STI chair together with the FAIR project management have set-up Cost Review (CORE) groups, with the intent to help experiment collaborations and the accelerator teams to establish a cost book of components and to scrutinize the layout of each section of the accelerator facility, the detectors and experimental stations to fit into the financial framework of the FAIR Project.

HISPEC/DESPEC Specific comments

Part of the basic research program as defined by the CDR	✓
Part of the core experimental facility of FAIR	yes

- A better structure and organisation for the development of the technically challenging instrumentation for slowed down beams must be presented.
- The effective manpower situation of HISPEC/DESPEC has to be clarified.

The experiment is approved, on the basis of the LOI and the TP, to work towards the TDR. The approval of the low energy part depends on the resolution of the open issues.

Conclusions

Working groups
Simulations, design going on
Strong correlation between different groups
(EDAQ, same detectors etc)
Some groups already obtained money related specifically to
HISPEC/DESPEC
MoU signed (32 institutions), new needed
Experience from GSI (RISING), GANIL, MSU, RIKEN etc.
more 'tests' needed

THANKS