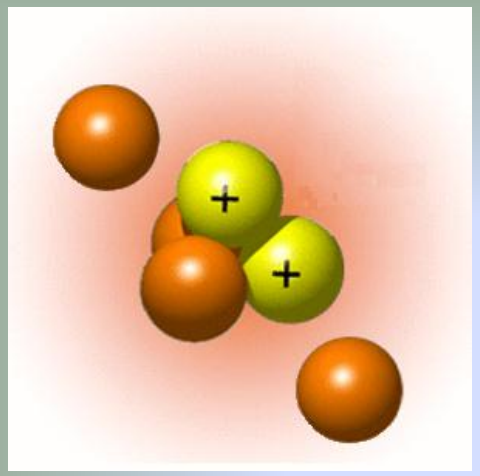


International Workshop on Future Plan with Radioactive Ion Beams

Summary

A.Chatterjee, BARC

17 April 2012

Buzz Words (New Phenomena)

- Low Binding
- Halo Nuclei
- Deviation from $R = r_0 A^{1/3}$
- Borromean Structure
- New Magic Numbers
- Weakening of Spin – Orbit force
- Development of collectivity

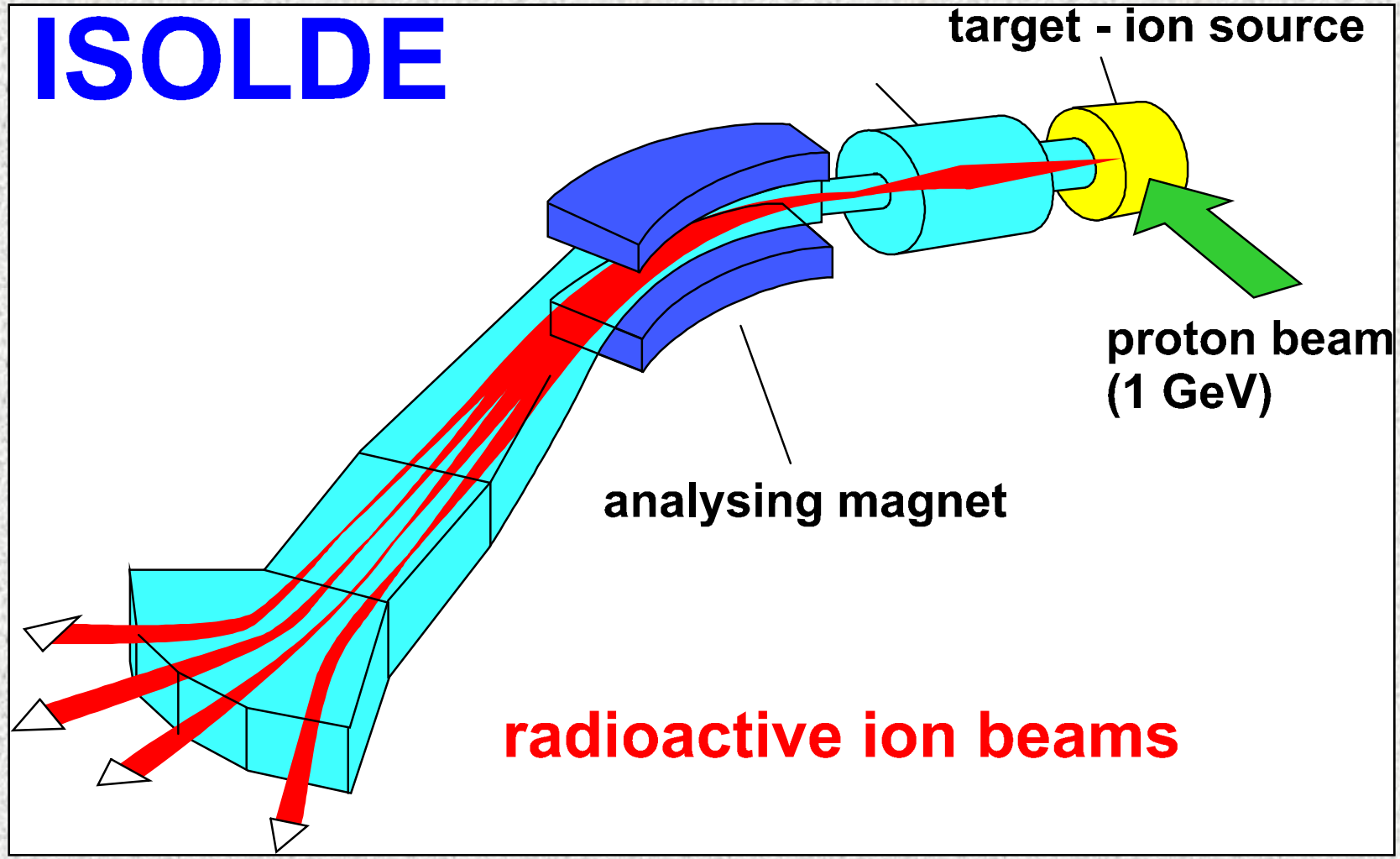
CERN ISOLDE

Machine: *Yorick Blumenfeld, Yacine Kadi, Theirry Stora*
Physics: *Magdalena Kowalska, Peter Reiter*
Solid State and Bio-Physics: *Karl Johnston*

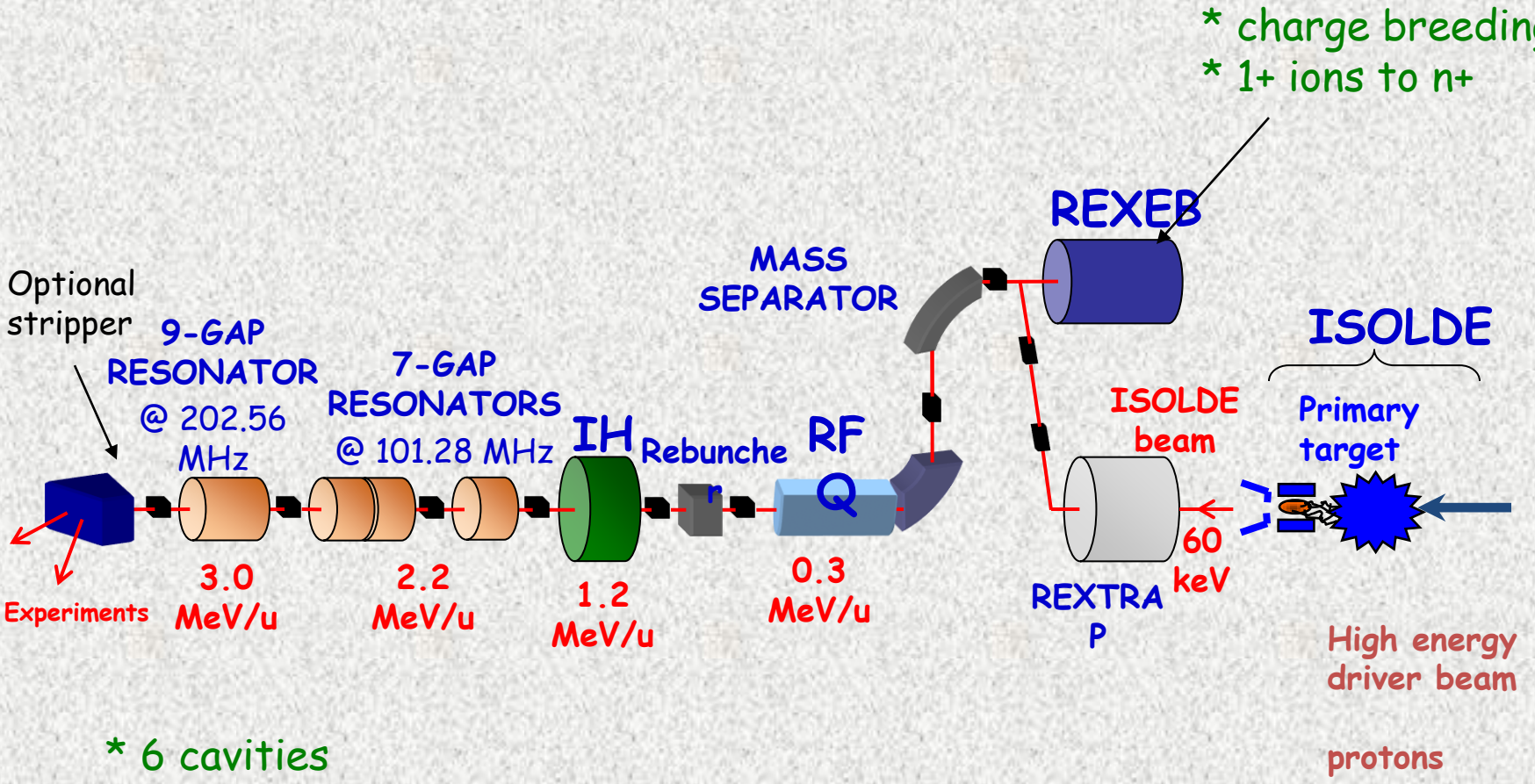
INDIA

RIB at Kolkata: *Sashi Shrivastava*
RIB Physics: *Sarmishtha Bhattacharya* (GANIL), *Aradhana Shrivastava* (GANIL), *Satyen Das* (ISOLDE), *Samit Mandal* (GSI)
Related Physics: *N.Madhavan, Tilak Ghosh, Satyajit Saha, Arun K. Jain, B.K.Nayak, Subinit Roy, Bivash Behra, Rahul Tripathi, Chandi C. Dey, Ajit Sinha*
Theory: *V.K.B.Kota, Sukhendu Sarkar*
Applications: *Susanta Lahiri, Bichitra Ganguly*

CERN ISOLDE - low energy and post accelerated RIBs since 40 years



REX- Isolde

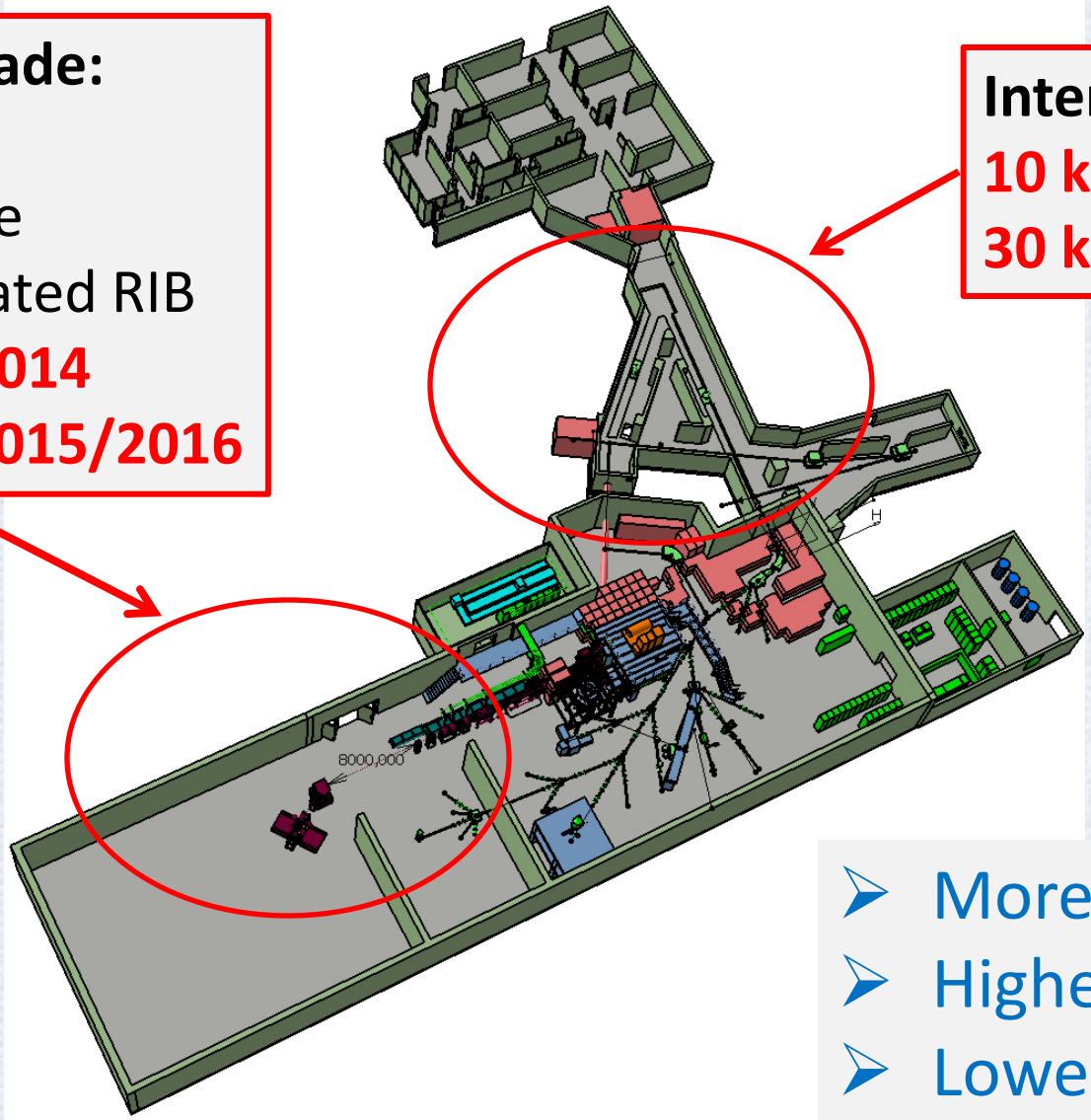


* 6 cavities
* 100 and 200 MHz, ~100 kW
* 300 keV/u to 3 MeV/u

HIE-ISOLDE

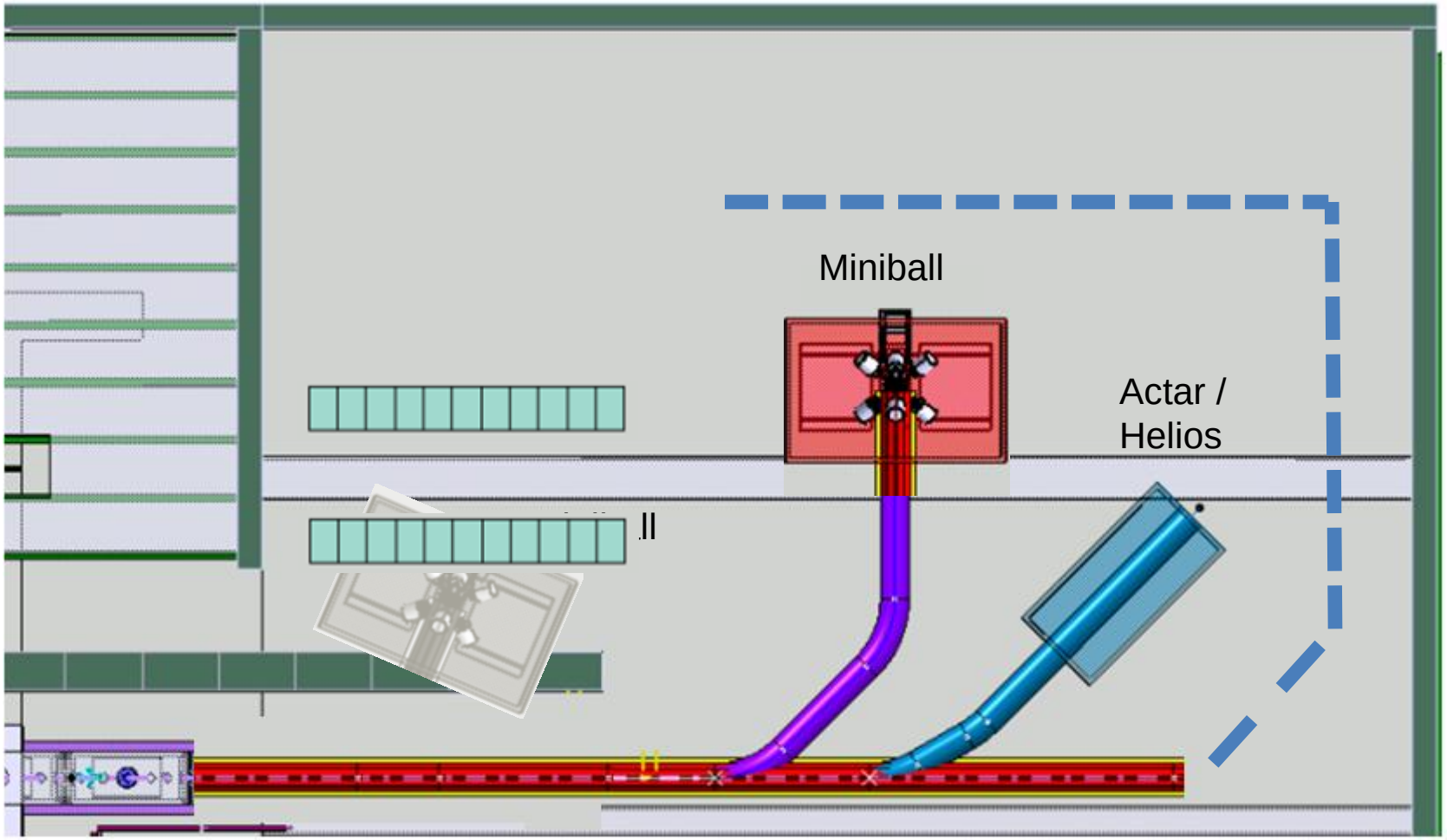
Energy Upgrade:
SC LINAC +
infrastructure
Post-accelerated RIB
5.5 MeV/u 2014
10 MeV/u 2015/2016

Intensity Upgrade:
10 kW
30 kW option later



- More Species
- Higher purity
- Lower emittances

Beam Transfer Line Stage 1



Straight line with 2 branches – Oct 2013 - Sept 2014

Miniball move: Oct 2013 – April 2014

Collaboration Opportunities

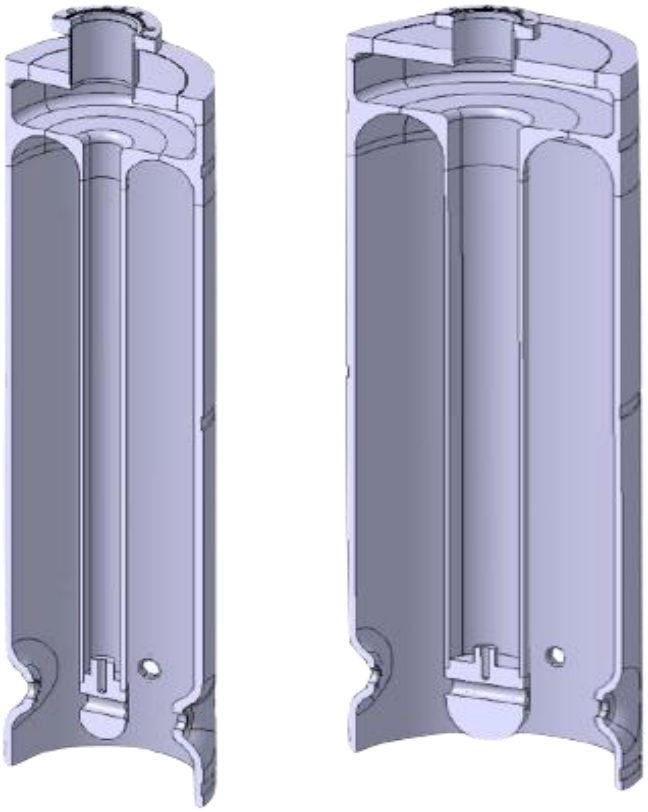
- **Experiments**
- **Technology**

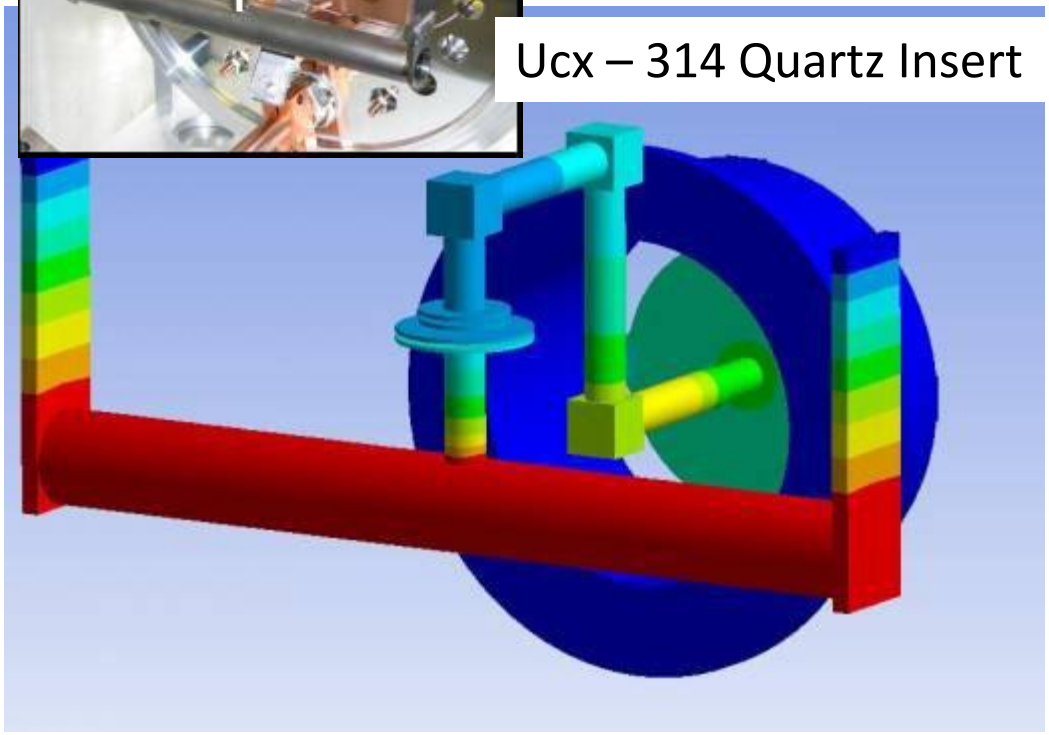
Accelerating structures

Target Technology

Low β

High β



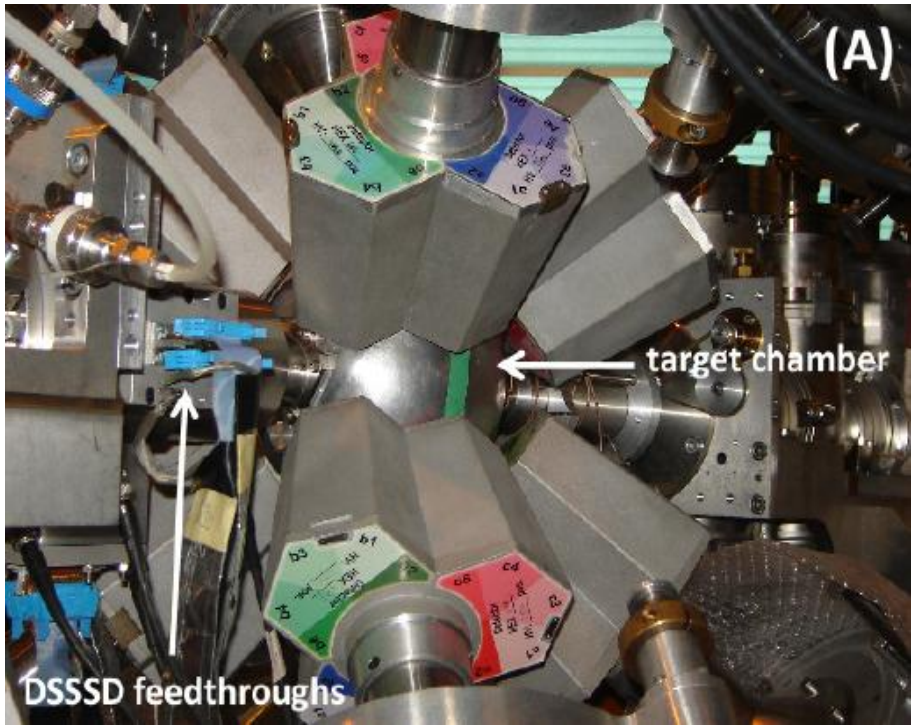


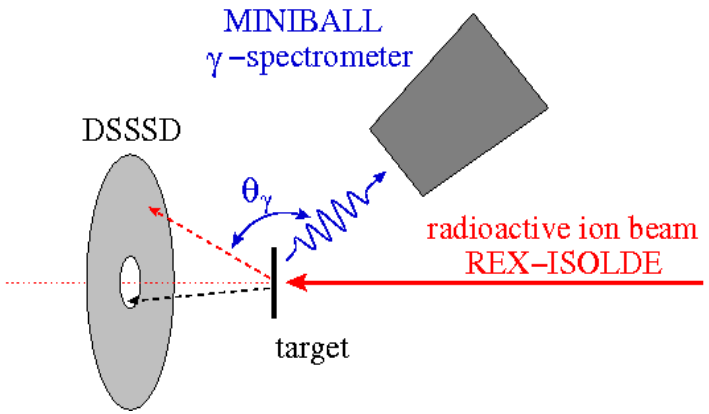
Ucx – 314 Quartz Insert

The MINIBALL Coulomb excitation setup

segmented Si detector for particle detection (DSSSD)

- 16 rings (front side)
- 96 strips (back side)
- angle coverage: θ_{lab} = 16-55°
- ΔE-E measurement possible (pad)



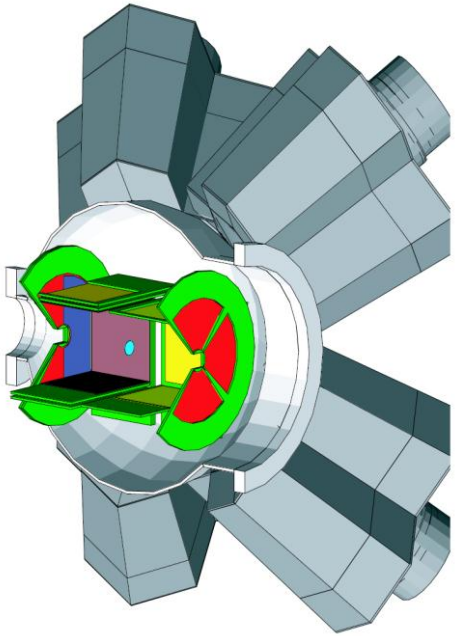


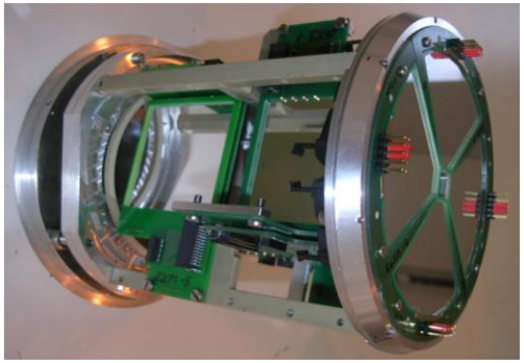
The T-REX setup

T-REX: Si detector array for Transfer experiments at REX-ISOLDE

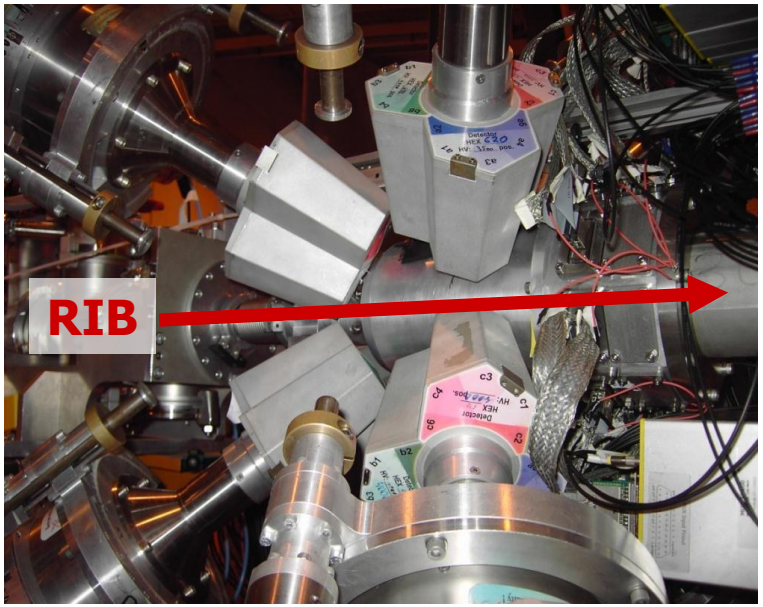
- large solid angle (58% of 4π)
- position sensitive
- PID (ΔE-E): p, d, t, α,
  … and e^- from β-decay (!)

Technical details:
Barrel: 140 mm ΔE / 16 resistive strips
1000 mm E / pad
Backward CD: 500 mm ΔE / DSSSD
500 mm E / pad





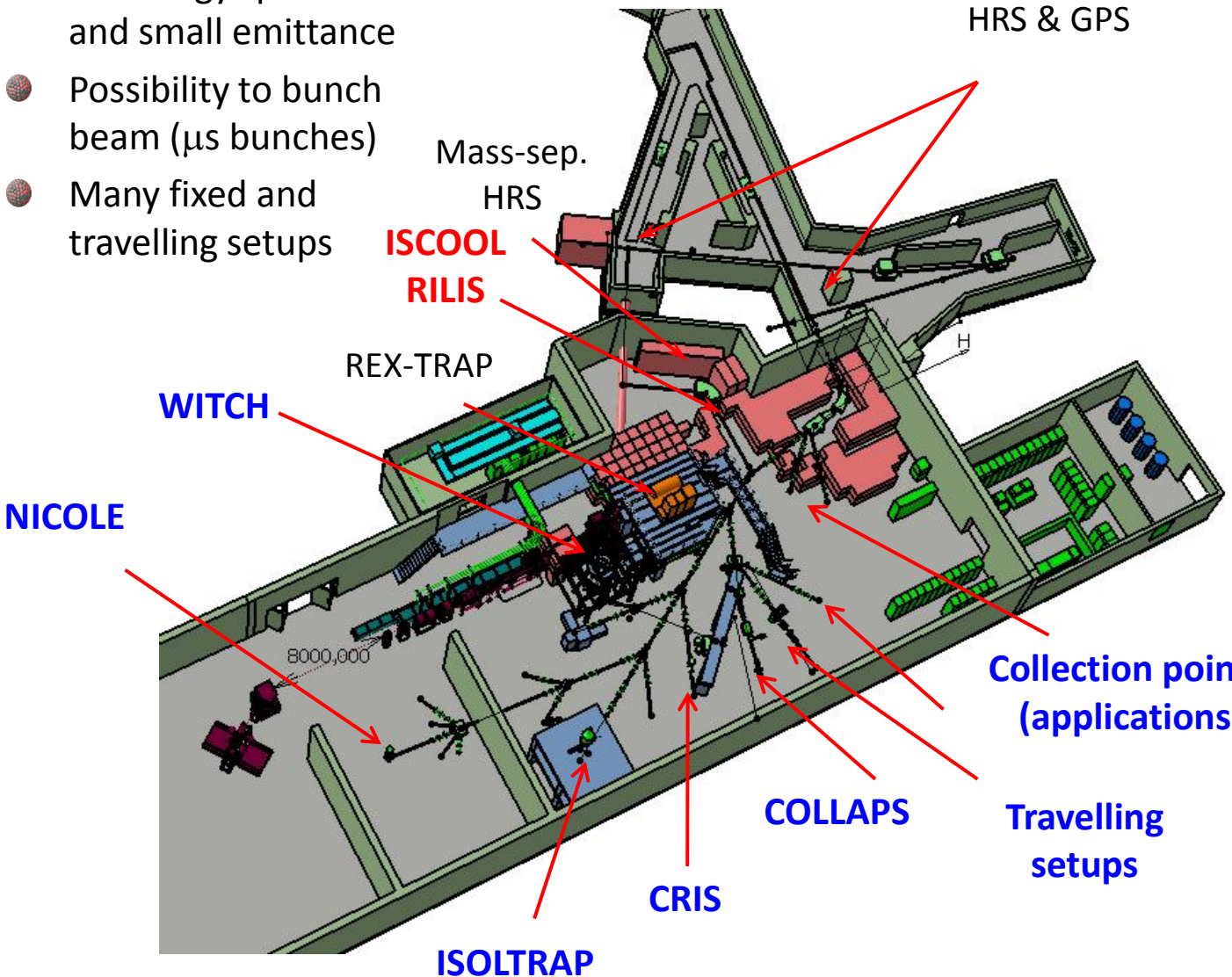
V. Bildstein, K. Wimmer,
Th. Kröll, R. Gernhäuser et al.
(funded by TU München,
KU Leuven, U Edinburgh, CSNSM
Orsay, TU Darmstadt)



Low-energy ISOLDE (M.Kowalska)

Nuclear Physics
Fundamental Physics
Astrophysics
Atomic Physics

- 30-60 keV ion beam
- eV energy spread and small emittance
- Possibility to bunch beam (μs bunches)
- Many fixed and travelling setups



CRIS

- Collinear Resonant Ionisation Spectroscopy
- High sensitivity, lower resolution -> perfect for heavy ions

1. Bunched ion beam of ~1μs temporal width

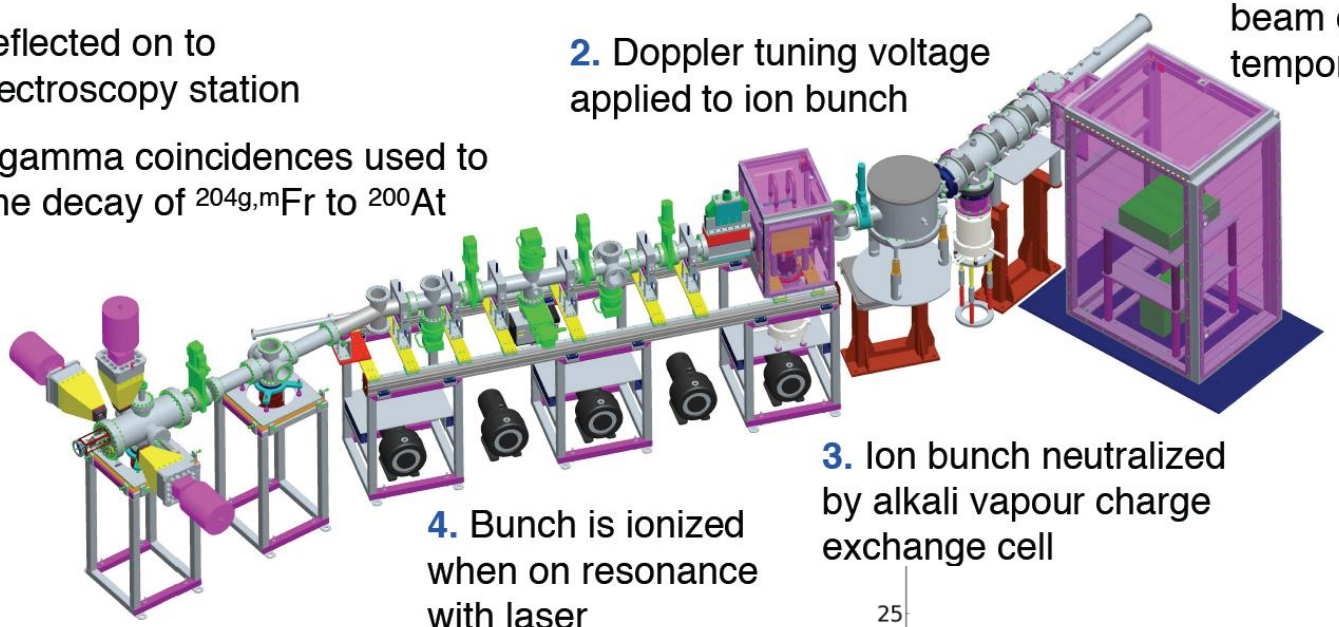
2. Doppler tuning voltage applied to ion bunch

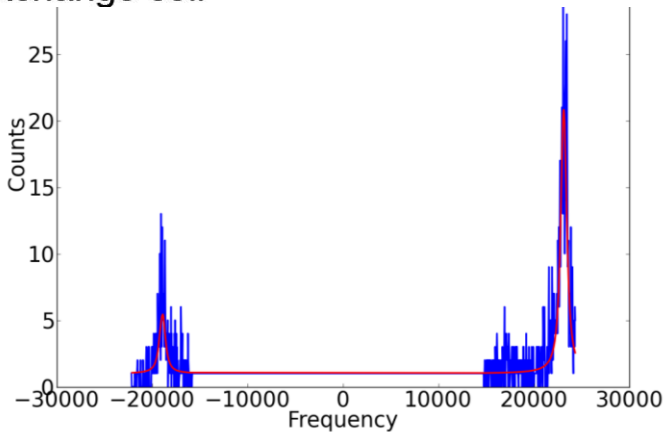
3. Ion bunch neutralized by alkali vapour charge exchange cell

4. Bunch is ionized when on resonance with laser

5. Ions deflected on to decay spectroscopy station

6. Alpha-gamma coincidences used to identify the decay of ^{204g,m}Fr to ^{200}At





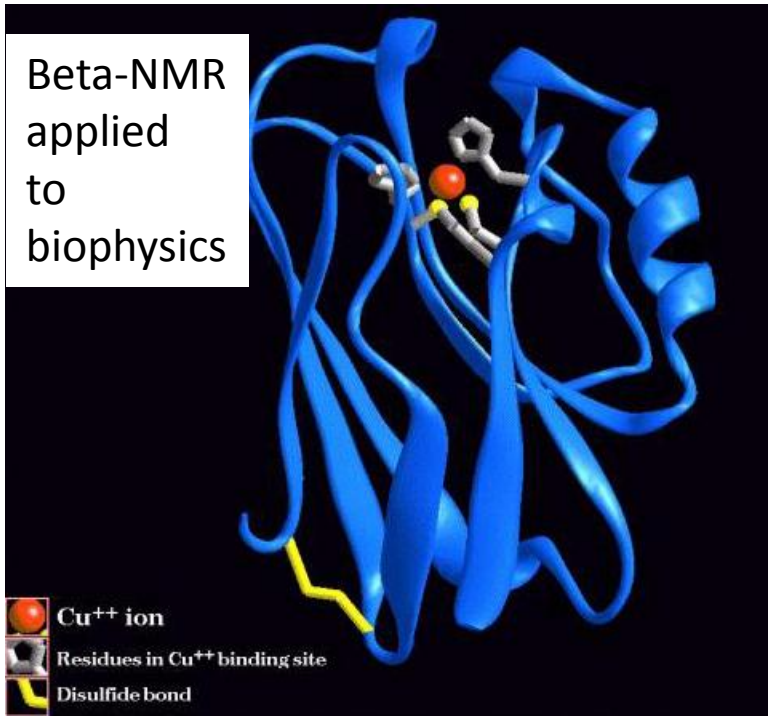
First physics experiment in 2011:
HFS and decay of 207Fr

Open projects:

IS471: Collinear resonant ionization laser spectroscopy of rare francium isotopes

IS531: Collinear resonant ionization spectroscopy for neutron-rich copper isotopes

Solid State and Bio-Physics



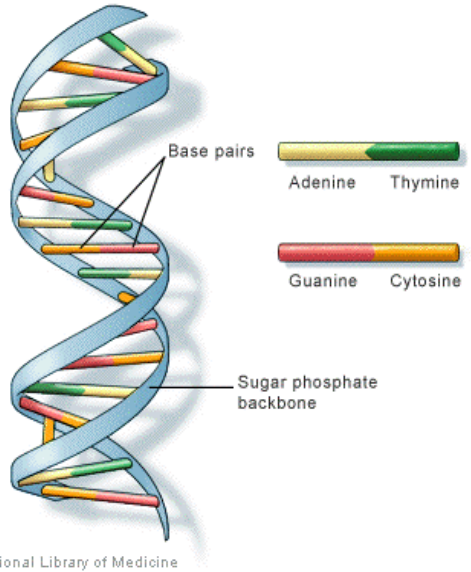
- Radioactive measurements
- Unique information: achievable using radioactive implantations/probes.
- Synergy between groups e.g. extension of biophysics methods for studying graphene and fullerenes (Prof Das).
- Huge range of beams available at ISOLDE
- New developments under preparation e.g. β-NMR for biophysics

Ushashi Dutta Pramanik – Proposal
BARC NPD : RIB Technology
Sashi Shrivastava/Alok Chakrabarty

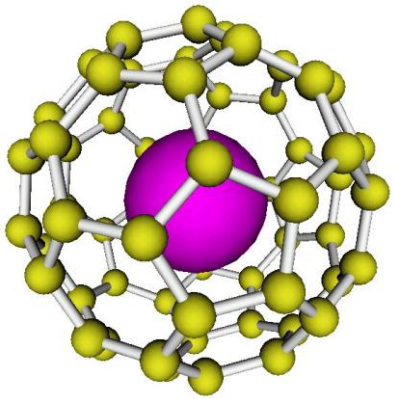
Sushanta Lahiri: Radiochemical nuclides of interest in Pb-Bi irradiated targets
Satyajit Saha

Subinit Roy

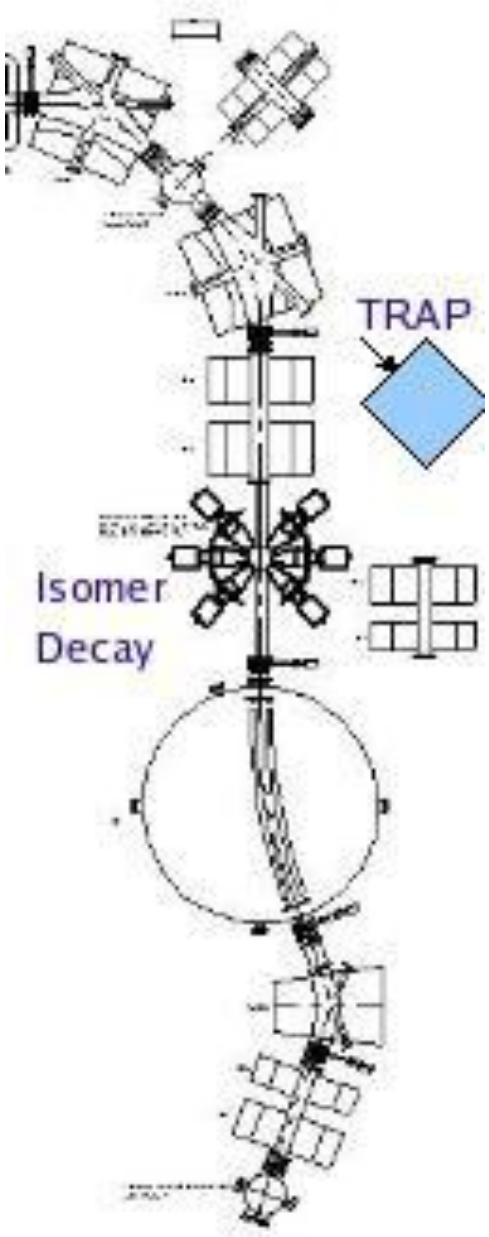
- Fusion and scattering of 6,7Li projectiles
- Low energy transfer reactions studies to for astrophysical
- S-factor
- Investigation of cluster states and its application to astrophysical problems



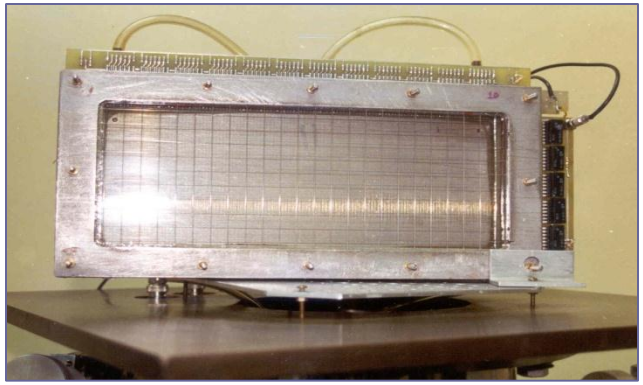
Bichitra Ganguly: **Chemical Perspectives**
Satyen Das: Hyperfine Interaction Studies
CC.Dey: Perturbed Ang. Correlation



Fulerene Cage

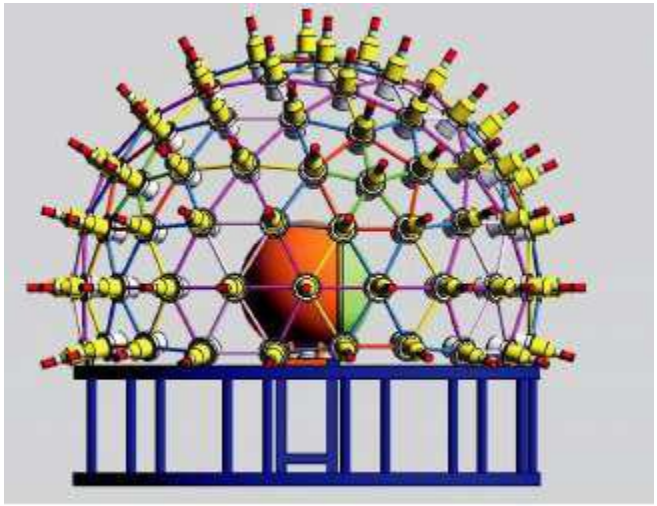


N.Madhavan (IUAC, New Delhi)
HIRA and HYRA spectrometers at IUAC
^{7}Be RIB beams from HIRA
HIMALAY - Heavy Ion Mass Analyzer coupled to Large gAmma arraY (!)
Samit Mandal (Delhi Univ) Multinucleon Transfer



Tilak Ghosh (SINP)
Width of Fission Mass Distribution
Fission Angular Distribution
Quasi fission

Rahul Tripathi (Radiochemistry Divn., BARC)
Fission studies
Decay scheme studies using radiochemical methods
Bk isotopes, 194Th^{g}
Proposed decay scheme studies at ISOLDE



Bivash Behera (Punjab University)
Dissipation, neutron multiplicities

B.K.Nayak: Surrogate reactions

Suggestion: Lanthanum Bromide with n-array setup at ISOLDE for studies such as 233Th(d,p)234Th and other reactions relevant to the r-process
BARC. P.U., Delhi, SINP, TIFR and others

Ajit Sinha (IUC) Barrier distribution for ^{30,32}Mg on ^{40}Ca using quasi elastic scattering
Arun Jain (BARC) Knockout reactions
Core knockout of a halo nucleus (making it hollow!)
Samit Mandal (Delhi University) Multinucleon transfer reactions
Sarmistha Bhattacharya: Spectroscopy using VAMOS SPIRAL, GANIL
Aradhana Shrivastava Fusion and transfer ^{6,8}He SPIRAL, GANIL

Nuclear structure theory: V.K.B.Kota, Sukhendu Sarkar

Thank You