RECENT RECOIL BETA-TAGGING DEVELOPMENTS AT JYFL

THE UNIVERSITY of York

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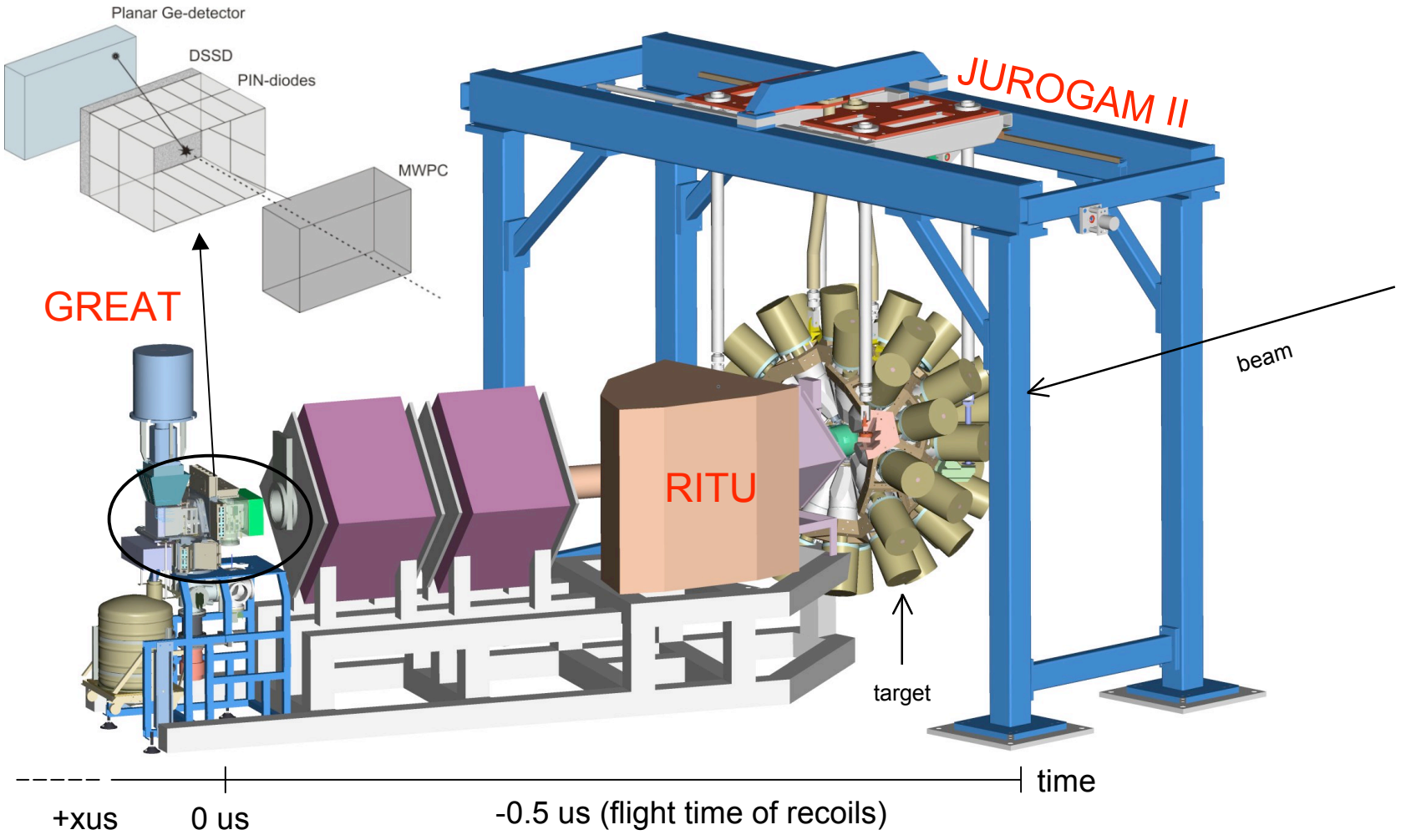
JYFL

Outline

- Basics of Recoil-Beta Tagging
- Recent developments
  - New DSSD (may 2012)
  - Phoswich (may 2012)
  - UoY Tube (august 2011)
- Future prospects
- Summary

Basics of Recoil-Beta Tagging

- RBT is straightforward expansion of RDT.

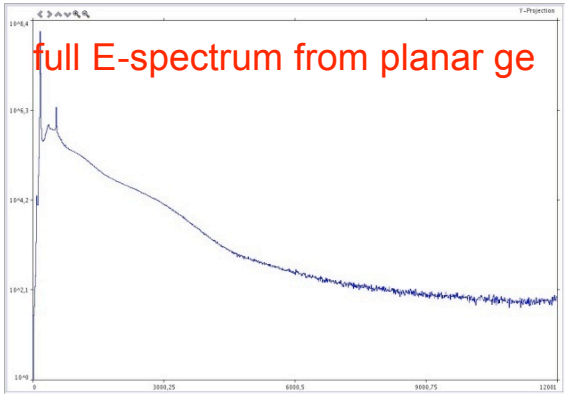


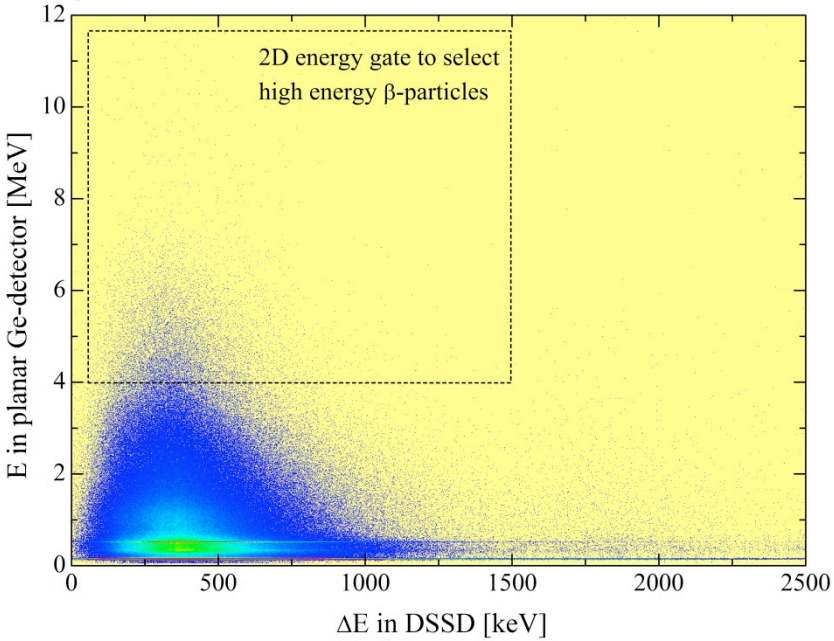
+ TDR & Grain -online analysis software

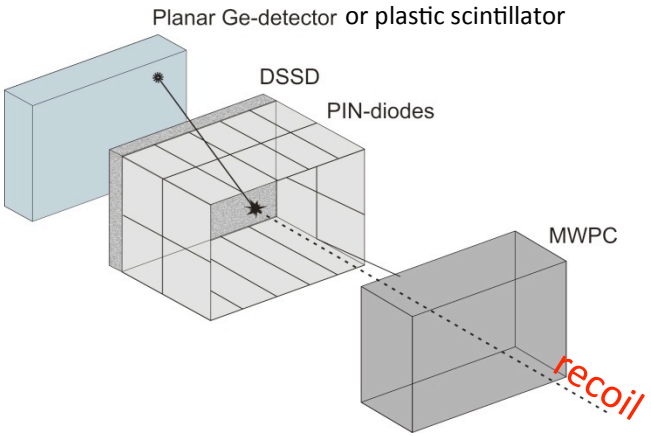
Basics of Recoil-Beta Tagging

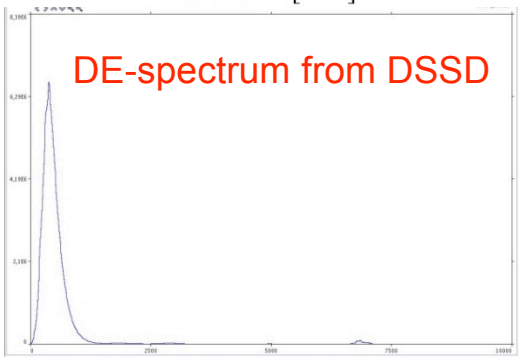
- Limiting factors: High beta-decay endpoint energy and short half-life are desired → Fermi superallowed beta emitters can be studied with RBT. Cold reactions are preferred to suppress other reaction channels.

- High energy beta-particle identification is carried out by using coincidences between the silicon strip detector (DE information, x-axis) and the planar ge-detector or plastic scintillator detector (full E information, y-axis).









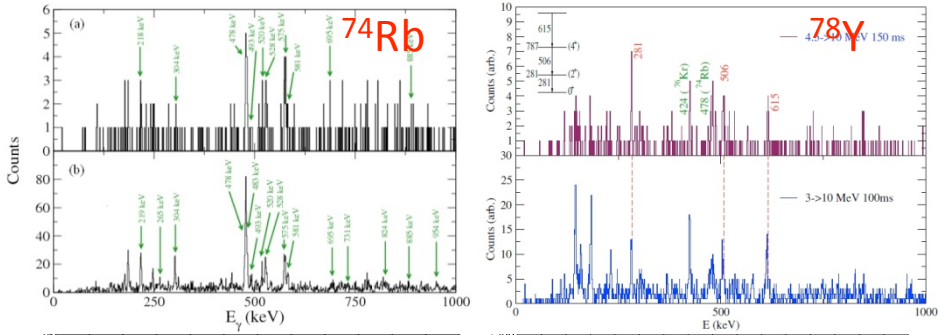
Basics of Recoil-Beta Tagging

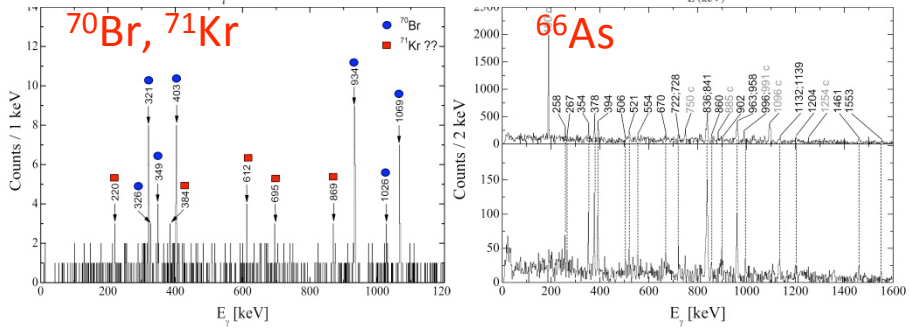
- Series of succesfull experiments have been already made: ^{74}Rb (published), ^{78}Y (published), ^{70}Br, ^{71}Kr, ^{66}As (to be published).

- In order to study even more exotic nuclei, current level of data quality should be improved:

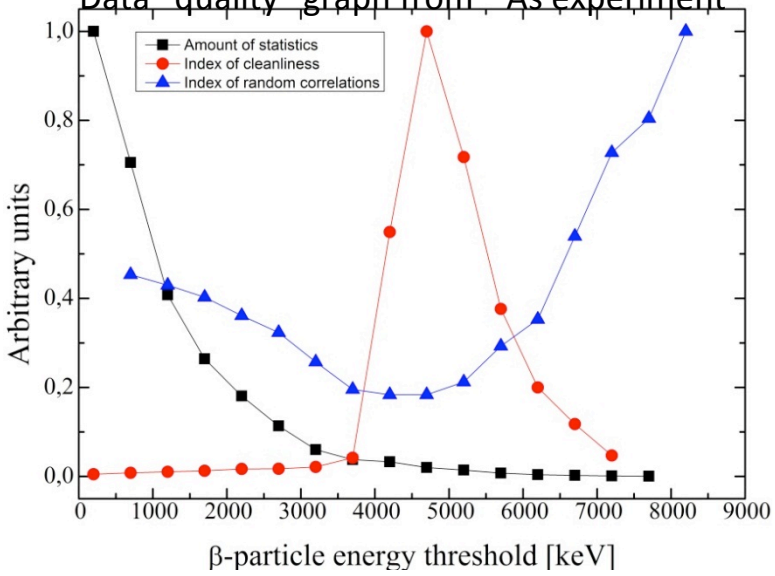
  - Cleaner spectra with higher statistics -> veto off charge particle evaporation channels. Increase sensitivity in mass selection -> MARA.

  - Eliminate random correlations -> moderate running speed and longer experiments, improved focal plane detector systems.



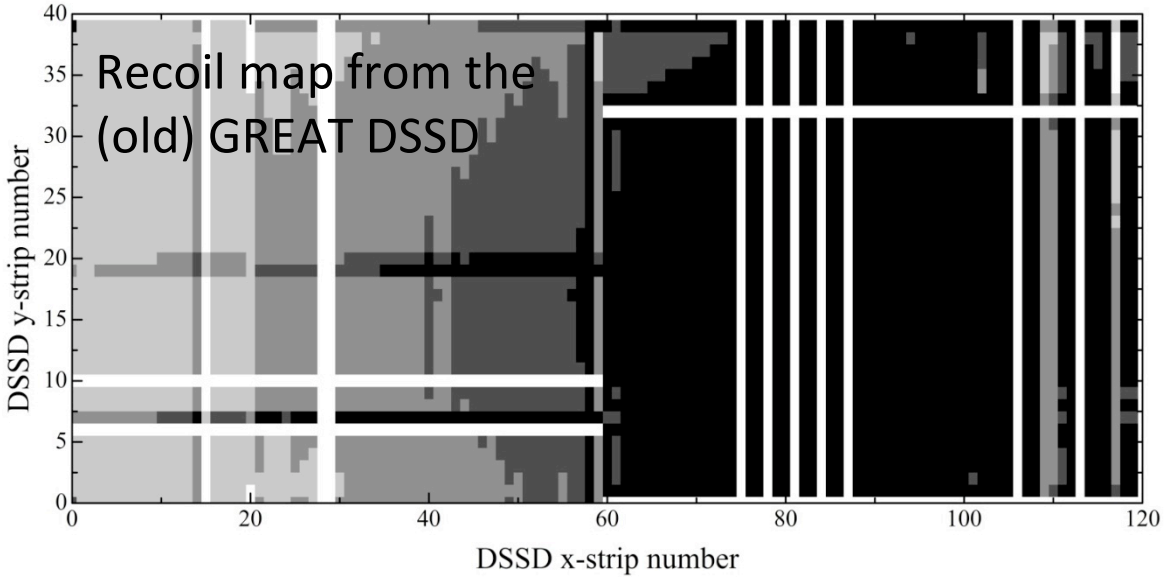


Data "quality" graph from ^{66}As experiment



New DSSD

- As RITU is designed to operate on heavy mass regions, recoil separation is not anymore optimal in the A~70 region.
- Recoil distribution is focused on the right hand side of the DSSD (beam and scattered components follow closely the recoil distribution so it can not be centered).
- 8 kHz rate is impinged only on the half of the active area of the DSSD which in turn increases risk of random correlations!
- Device was tested with $^{28}Si + ^{40}Ca$ reaction at E_b=75 MeV with various different beam intensities (simultaneously with phoswich or planar ge set-up).

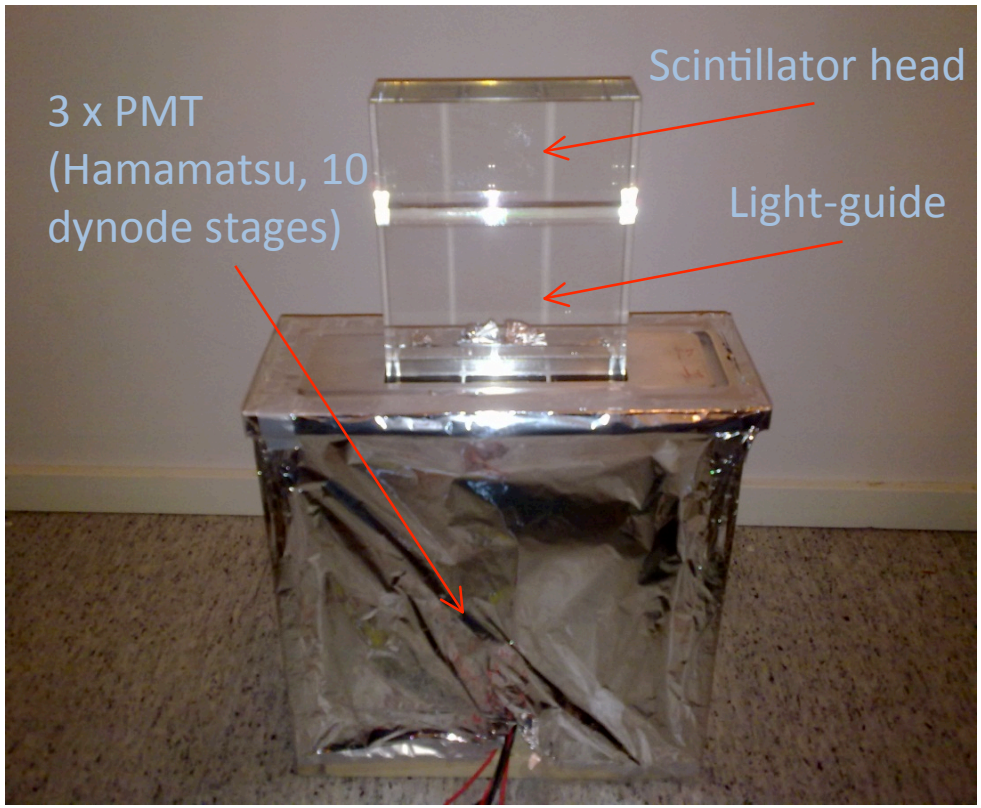


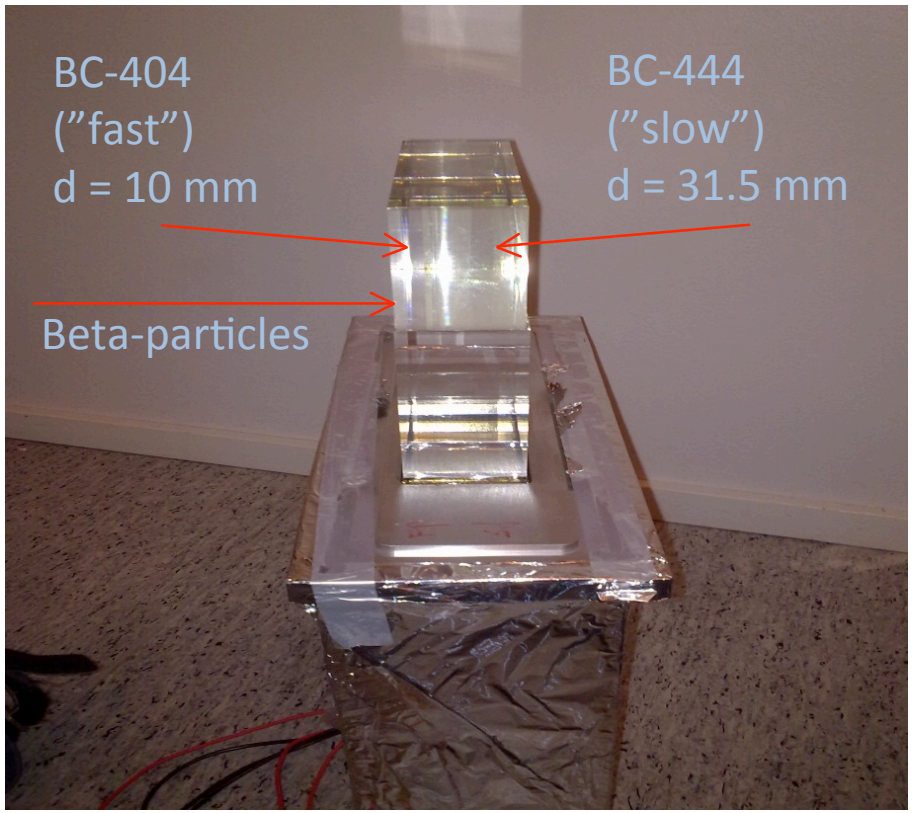
New DSSD design

- Only right hand side works as an active detector.
- Consists of 120 x 80 strips with strip pitch of 0.480 mm
- 500 mm thick
- In total ~10000 pixels!
- -> 0.8 Hz recoil rate / pixel.

Phoswich scintillator

- High/low energy beta-particle detection and discrimination: Direct energy & full pile-up discrimination!
- Beta/gamma discrimination
- Discriminations can be done on the basis of pulse shape analysis.

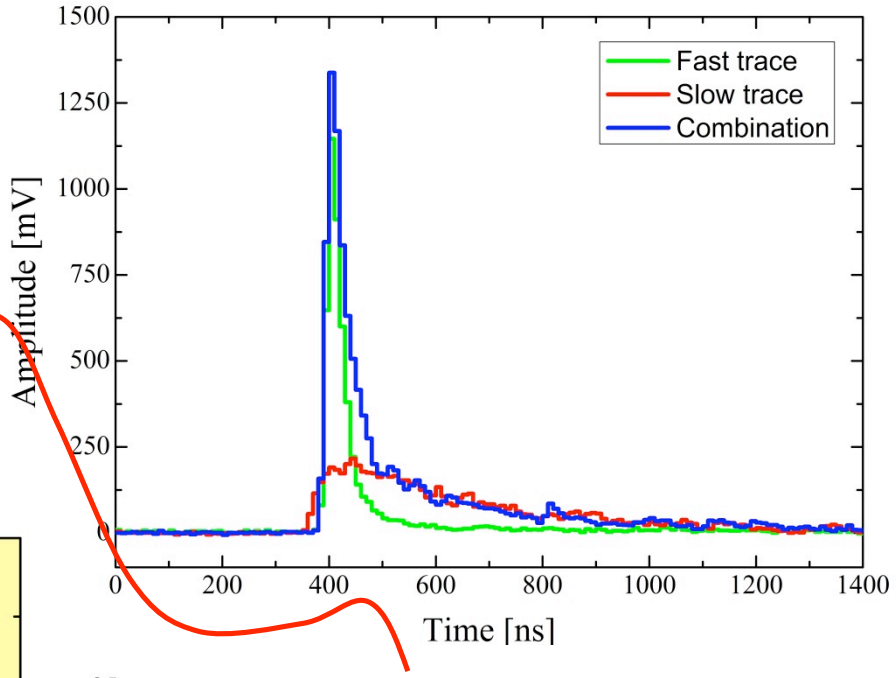


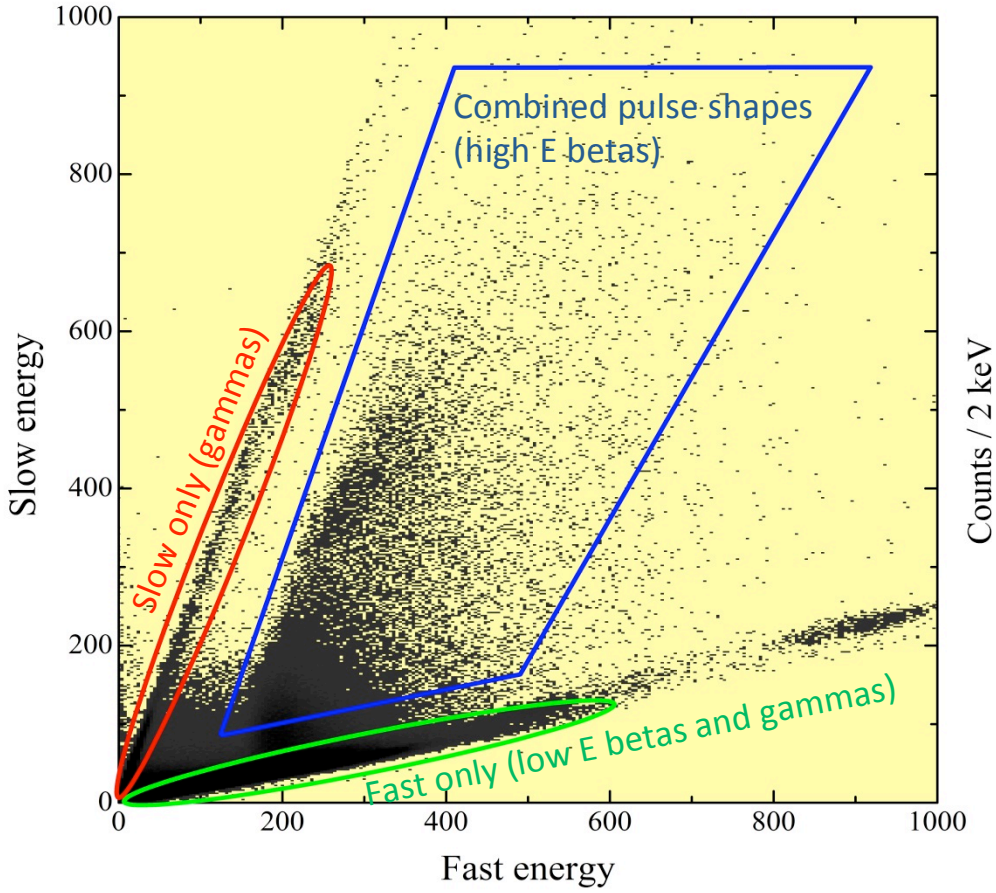


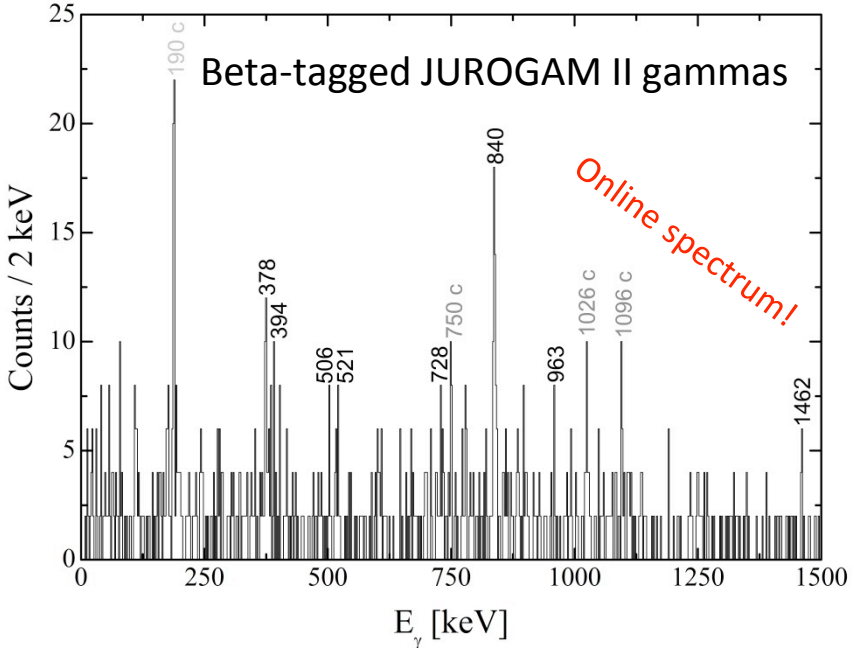
- BC-404: rise time ~ 0.7 ns, decay time ~ 1.8 ns, light output 68 % of anthracene
- BC-444: rise time ~ 19.5 ns, decay time ~ 285 ns, light output 41 % of anthracene

Phoswich scintillator

- Traces were recorded from Lyrtech ADCs.
- Pulse shapes were categorized online by rudimentary algorithm.
- On the basis of online analysis, device works and can be utilized for tagging purposes!
- We still need to resolve the possible gain in data quality…

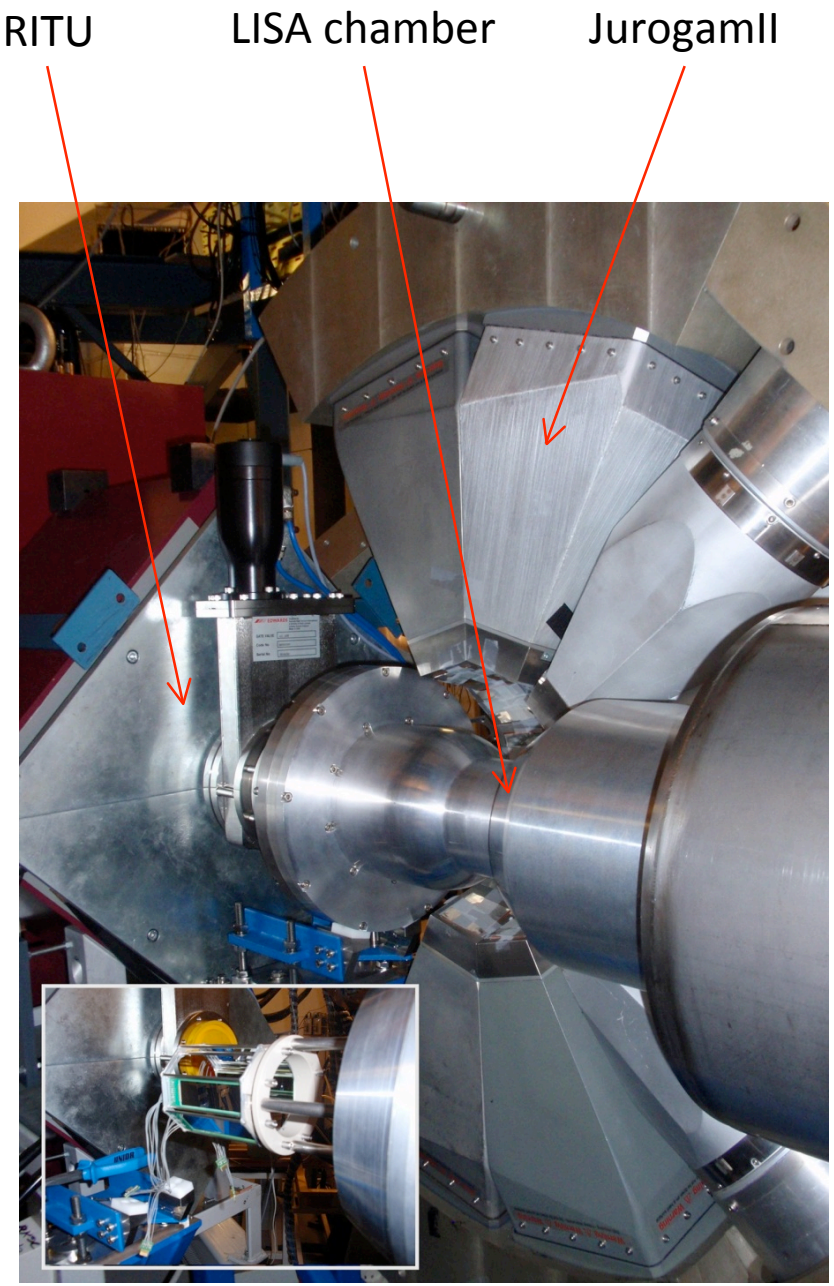






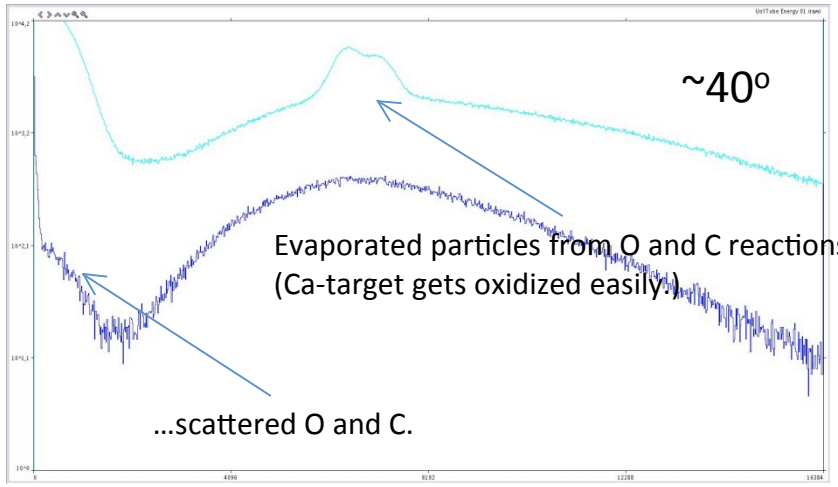
UoY Tube

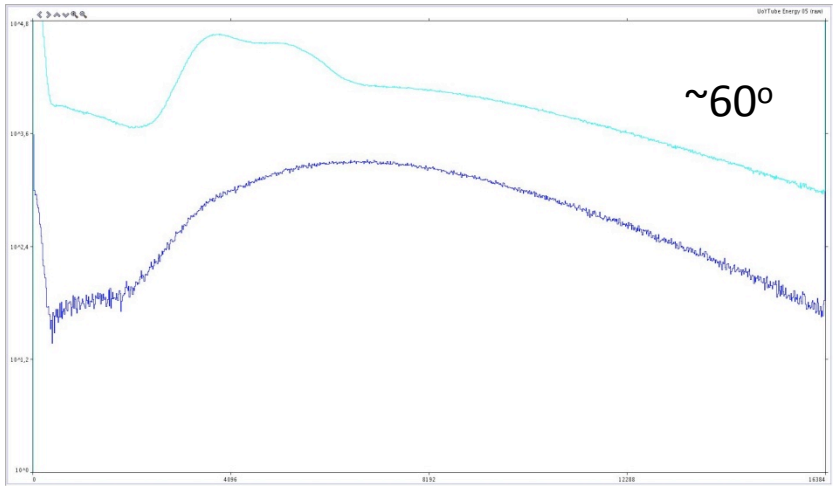
- Designed to suppress events associated with cp evaporation channels.
- Consists of 96 20 x 20 mm CsI crystals (Hamamatsu) divided into 6 flanges (8 x 2 crystals in each flange).
- Signal chain: Mesytech preamplifiers -> ”GO-box” -> Lyrtech ADCs.
- Measured detection efficiency for 1 charged particle is 80-90 %.



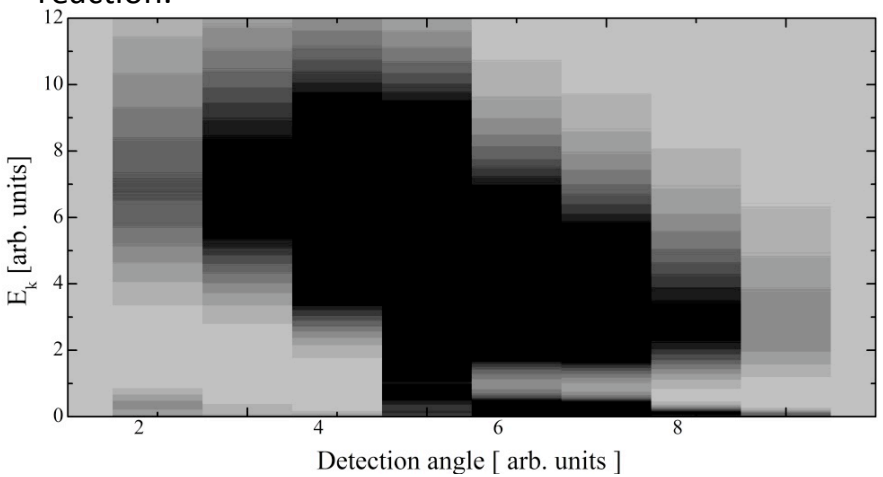
UoY Tube

Comparison of recoil gated (blue curve) and raw UoYTube (light blue) spectra from ^{28}Si + ^{40}Ca reaction.

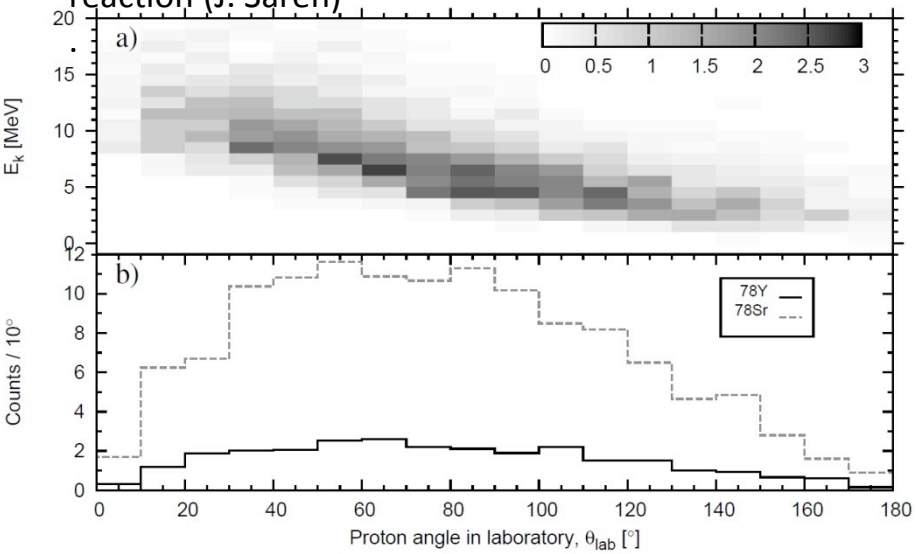




Measured distribution of evaporated particles in ^{28}Si + ^{40}Ca reaction.

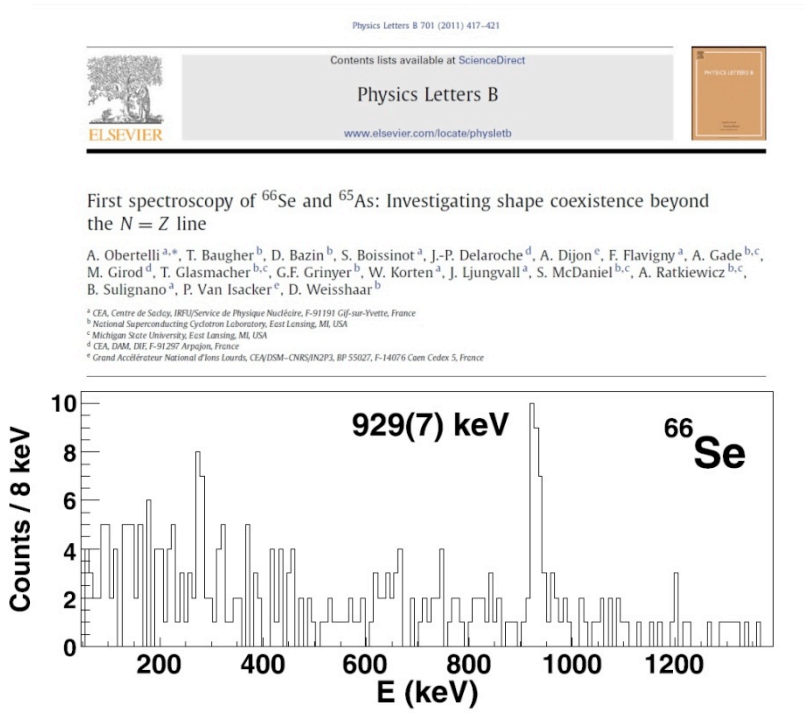


Simulated distribution of evaporated particles in ^{40}Ca + ^{40}Ca reaction (J. Saren)

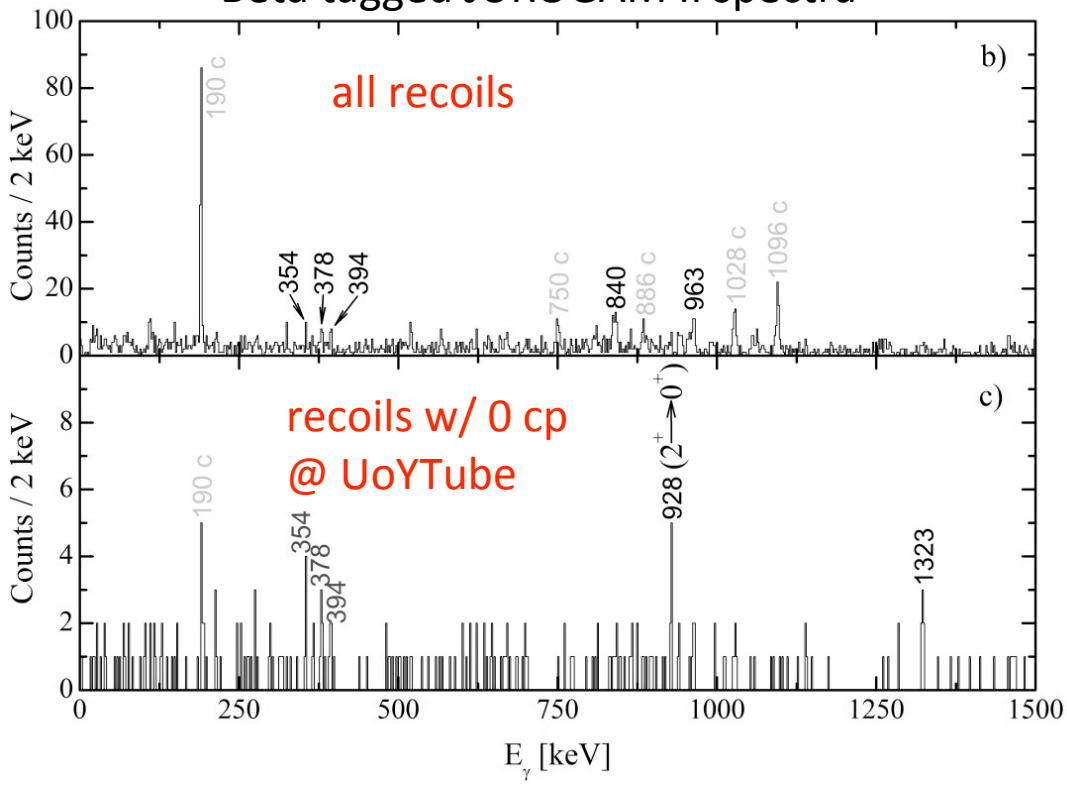


UoY Tube

- Test was performed in August 2011 (~50 hours beam on target w/ various I_b).
- Reaction of ^{28}Si + ^{40}Ca was utilized at E_b=75 MeV to populate excited states in ^{66}Se via 2n evaporation channel.
- This was good test case as the 2^+ -> 0^+ transition in ^{66}Se has been recently identified by A. Obertelli.



Beta tagged JUROGAM II spectra



Future prospects

- Detailed and quantitative analysis of the latest test data needed.
- Redesign of UoYTube in order to obtain yet higher cp detection efficinecy: pack CsI crystals tighter and increase cp detection angle (increase lenght or decrease radius of the tube).
- New target chamber for UoYTube needed to allow easier operation of the device.
- Analyse pulse shapes also from UoYTube in order to distinguish between evaporated protons and alphas.
- Combine all developed devices for an experiment…
- …which could be RBT study of ^{70}Kr.
- Posibilites provided by MARA vacuum mode separator? RBT collaboration has certainly exciting times ahead!

Summary

- RBT has been used successfully in several experiments to obtain spectroscopic information on N~Z nuclei.
- Three new devices developed to (hopefully) increase data quality in RBT experiments.
- $2^+ \rightarrow 0^+$ transition seen in ^{66}Se again, maybe $4^+ \rightarrow 2^+$ aswell…

Thanks for your attention!