



Recent progress at the WITCH experiment

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ISOLDE and NIPNET collaborations

Weak

Interaction

Trap for

CHarged particles



Outline

- Theory and motivation
- Overview of the setup
- Doing the tests...
 - Taking 30keV beam from ISOLDE/REXTRAP
 - Trapping ions
 - Going for radioactive ions
- Conclusion and outlook

Theory and Motivation

Nuclear beta-decay:

$$n \rightarrow p + e^- + \bar{\nu}_e$$

$$p \rightarrow n + e^+ + \nu_e$$

$$H = H_V(C_V, C'_V) + \text{WITCH} + H_A(C_A, C'_A) + H_T(\text{?}, C'_T) + \cancel{H_P(C_P, C'_P)}$$

Fermi Decay
 $\Delta I = 0, \Delta \pi = 0$

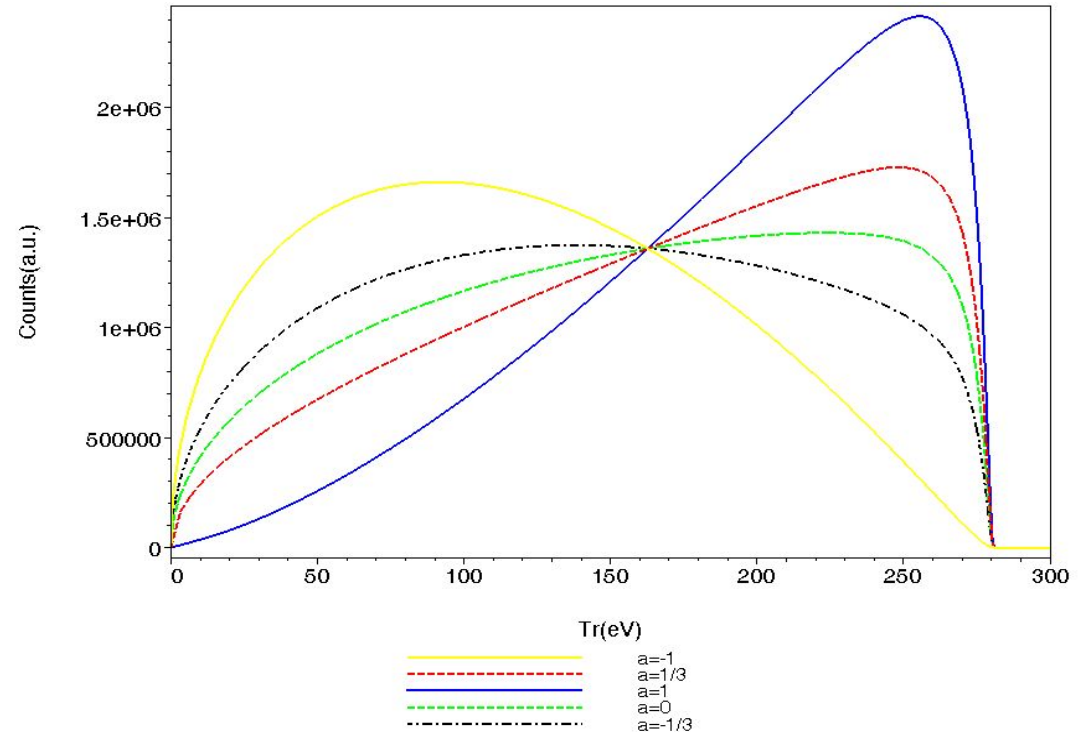
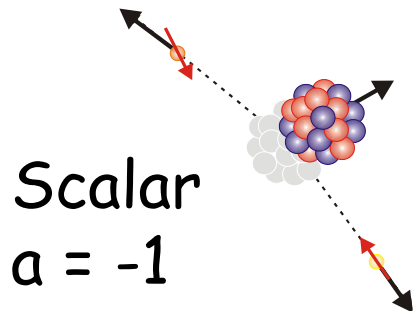
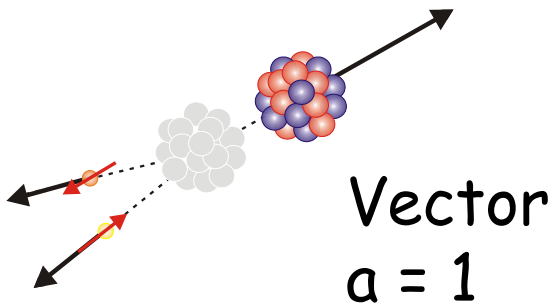
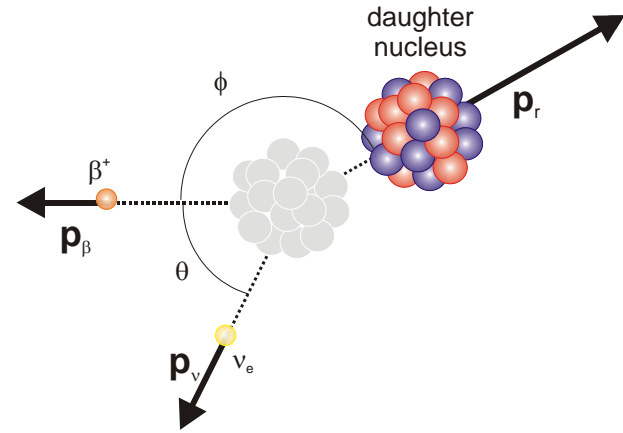
Gamow-Teller Decay
 $\Delta I = 0, 1 \text{ (no } 0 \rightarrow 0), \Delta \pi = 0$

$$C_S / C_V < 6\% (1\sigma)$$

Theory and Motivation (2)

$$\omega(\theta_{\beta\nu}) \sim 1 + a \cdot \frac{v}{c} \cdot \cos(\theta_{\beta\nu})$$

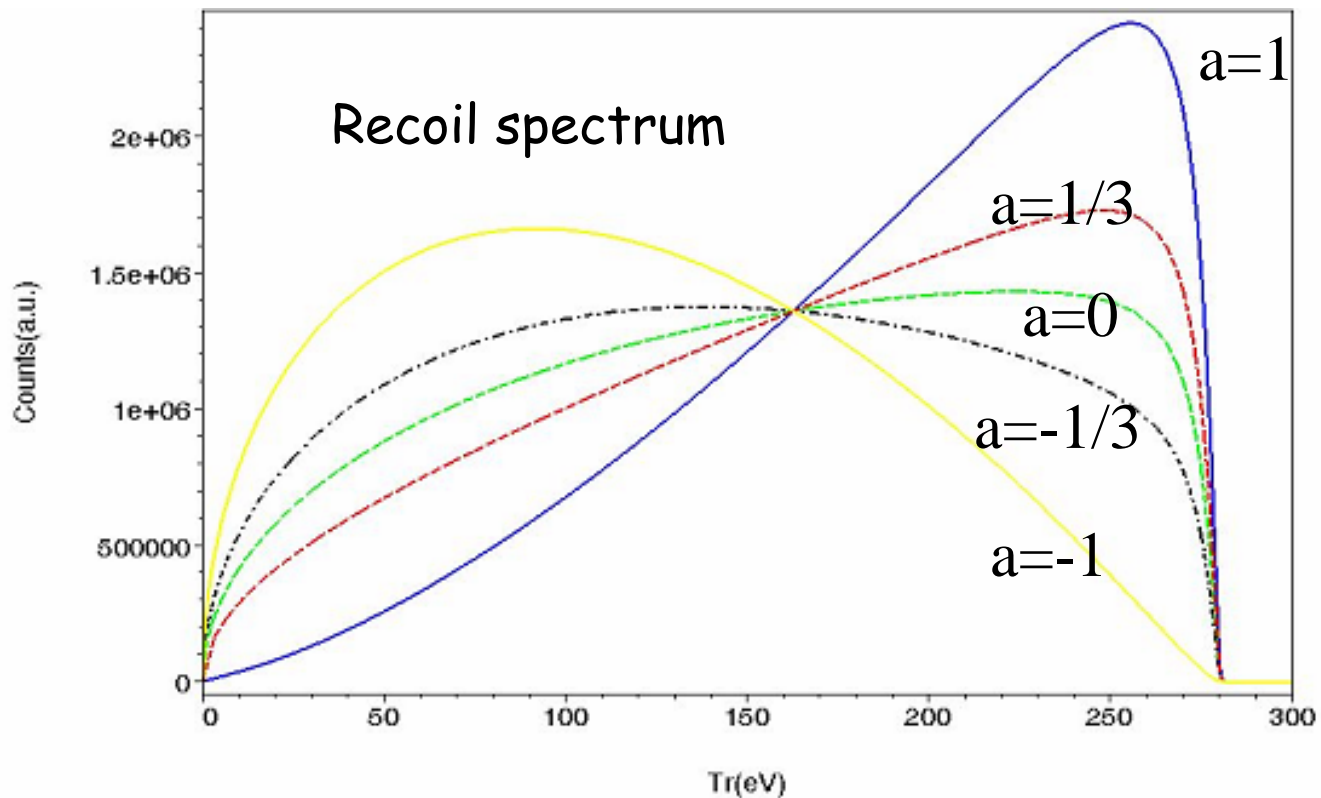
$$a = \frac{|C_V|^2 + |C'_V|^2 - |C_S|^2 - |C'_S|^2}{|C_V|^2 + |C'_V|^2 + |C_S|^2 + |C'_S|^2}$$



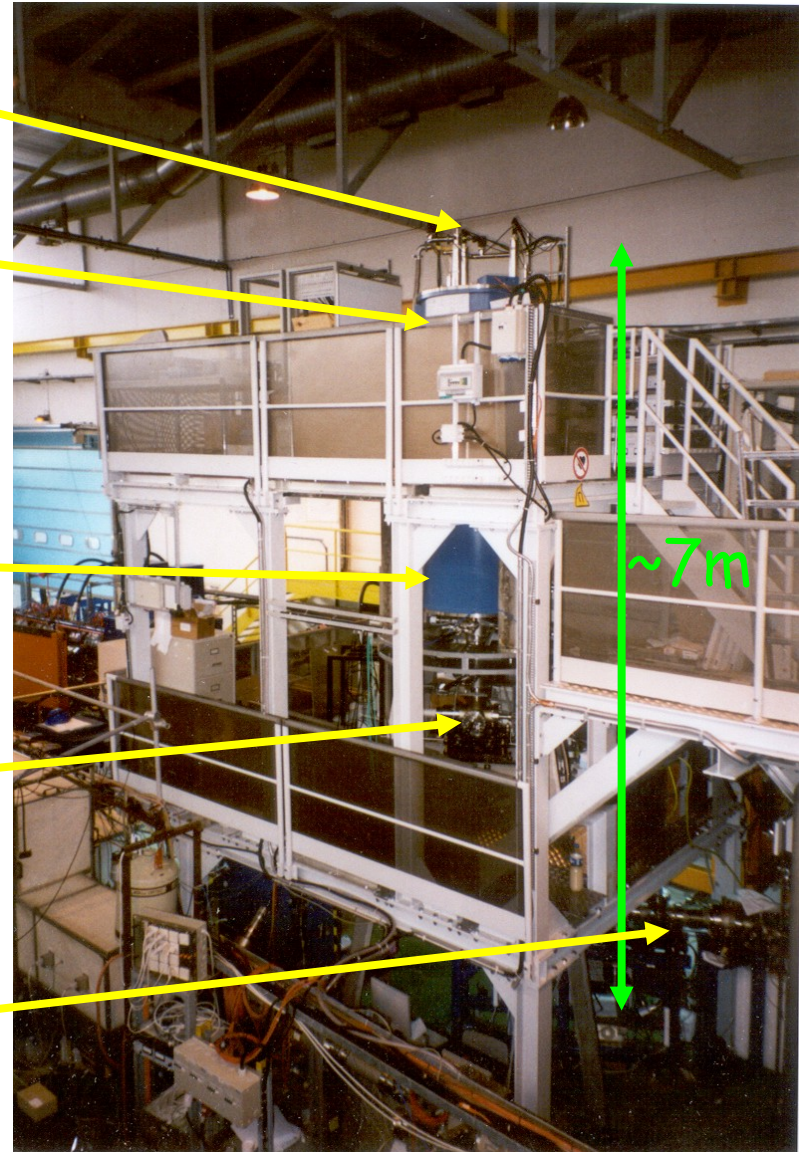
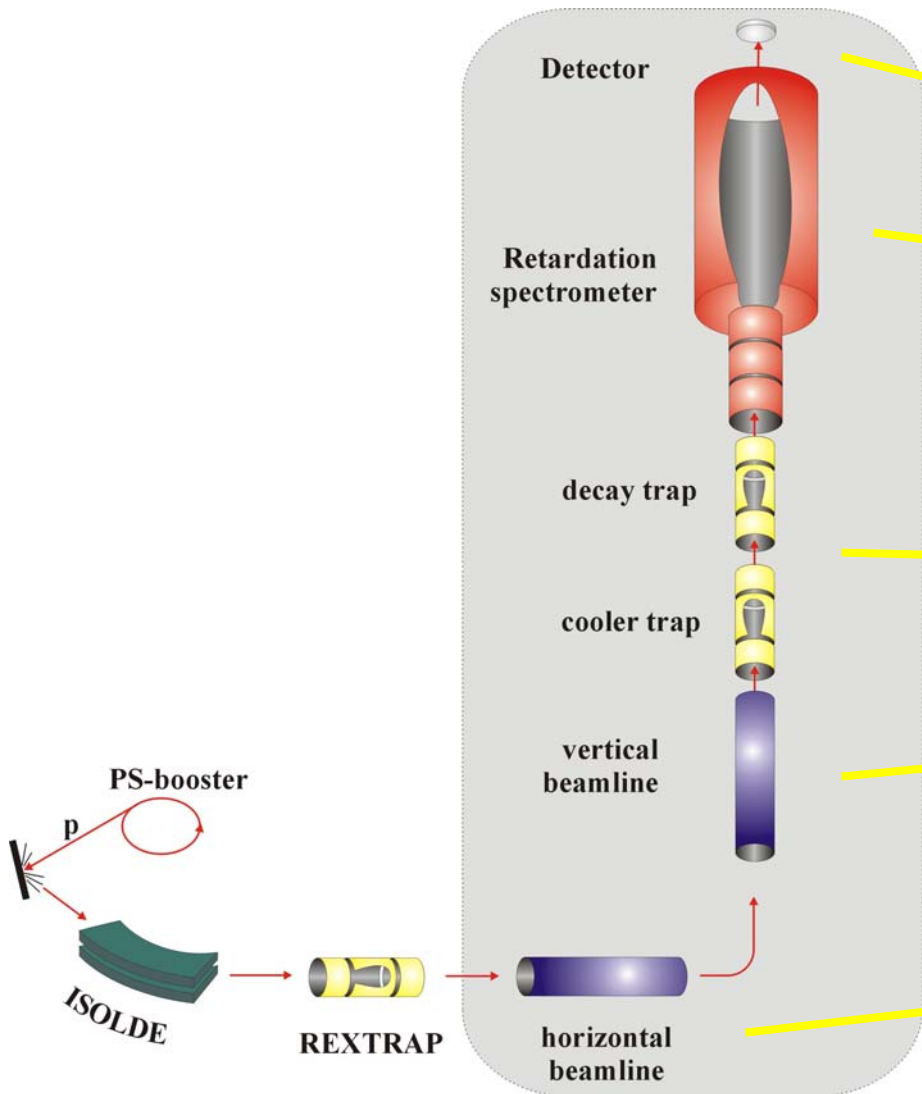
Theory and Motivation

Fermi β -decay: $H = H_V(C_V, C'_V) + H_S(C_S, C'_S)$

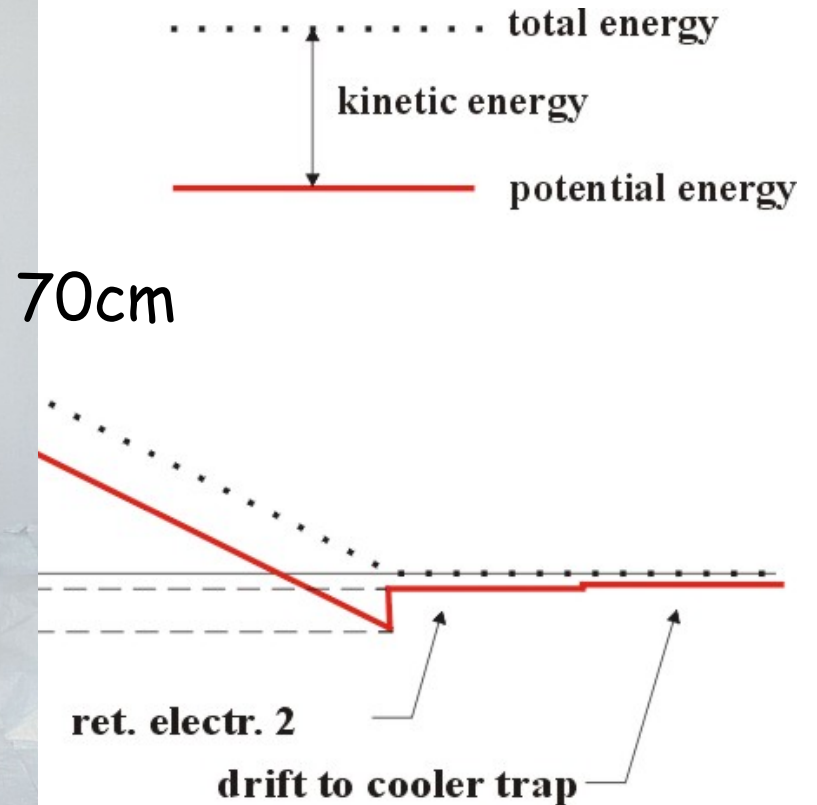
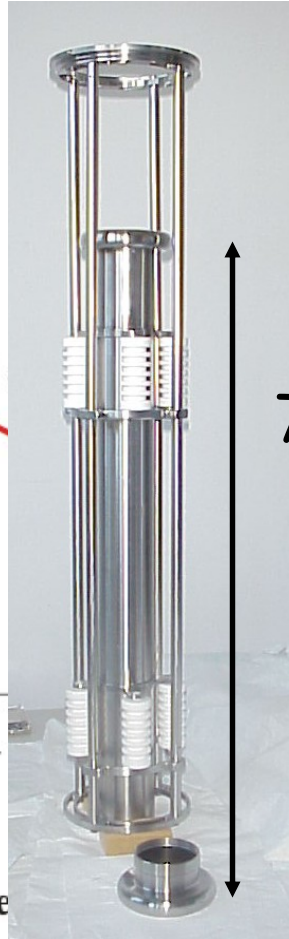
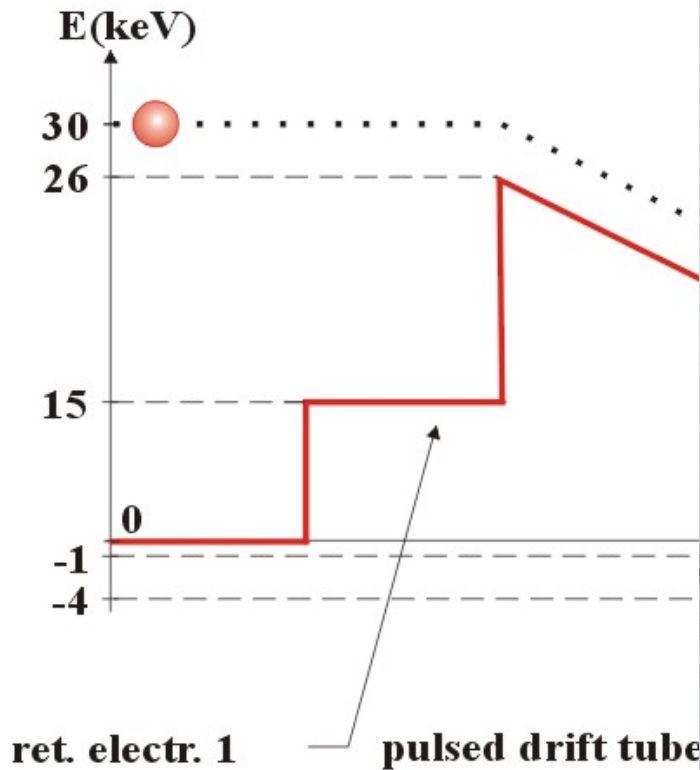
Standard model: $V=1, S=0$ ($a=1$); experimentally: $S < 6\%$
 $S > 0 \rightarrow a < 1$ ($a = \beta$ - v correlation coefficient)



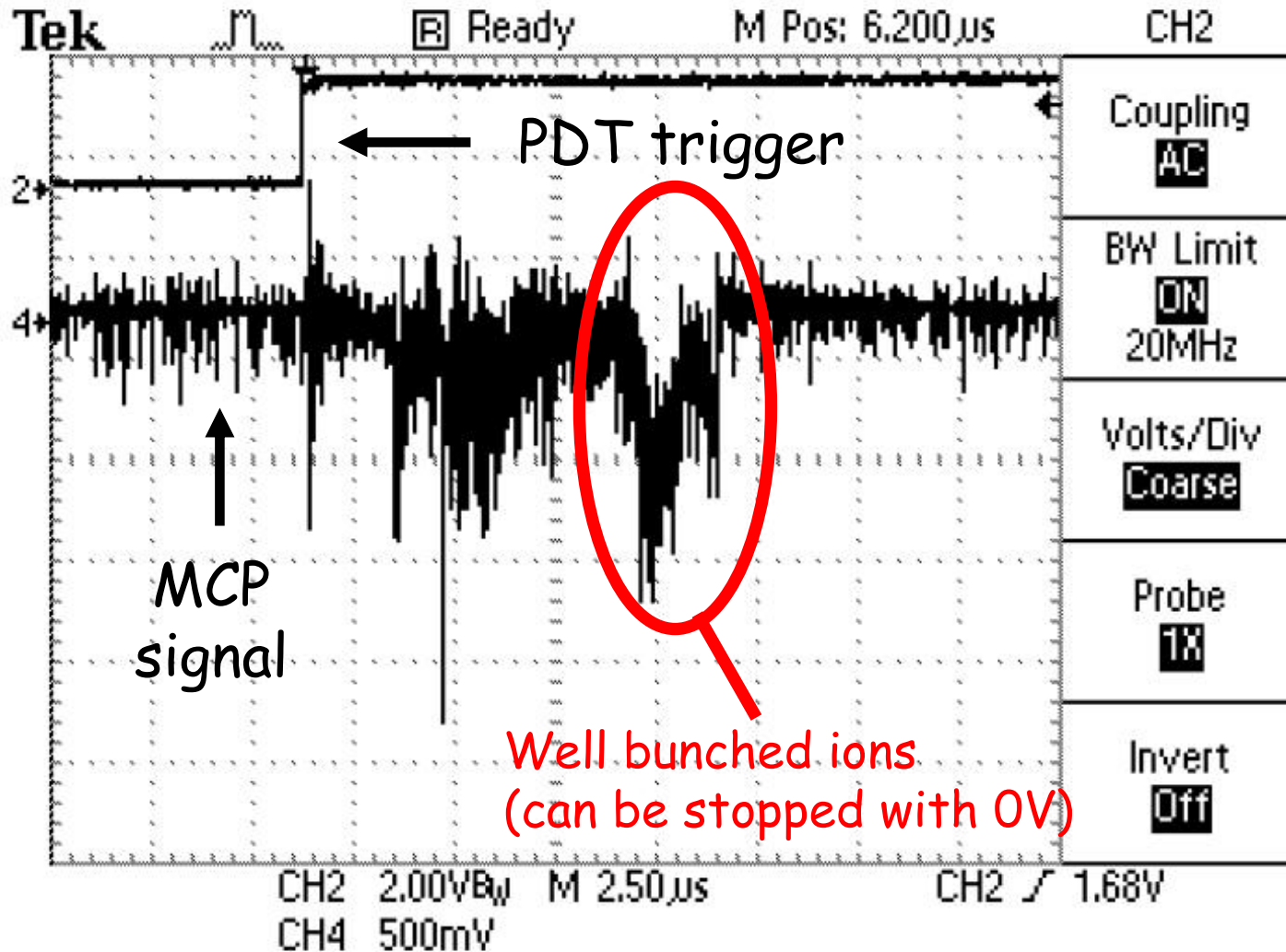
Overview of the setup



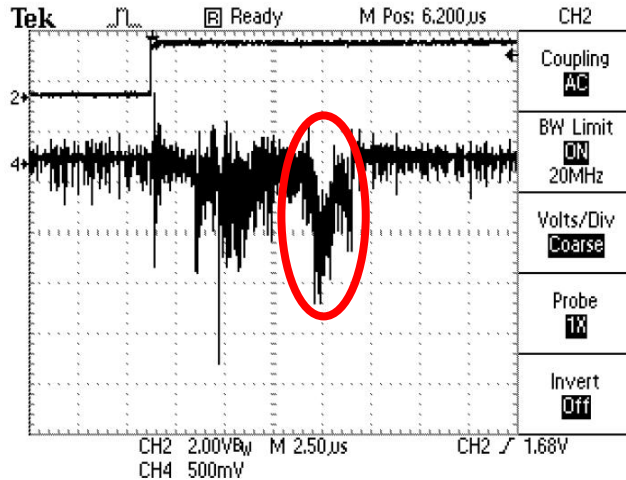
Taking 30keV beam



Taking 30keV beam



Taking 30keV beam



TDS 224 - 8:14:36 AM 8/6/2004

- length of REXTRAP bunch: $\sim 10\mu\text{s}$
- 30keV beam traveltime through PDT: $\sim 5\mu\text{s}$
- switching time: $\sim 1.5\mu\text{s}$
- theoretical efficiency estimate: $\sim 35\%$
- experimental estimate: $\sim 10\%$ (this includes ion optics)

Trapping ions



Trapping 'real' ions

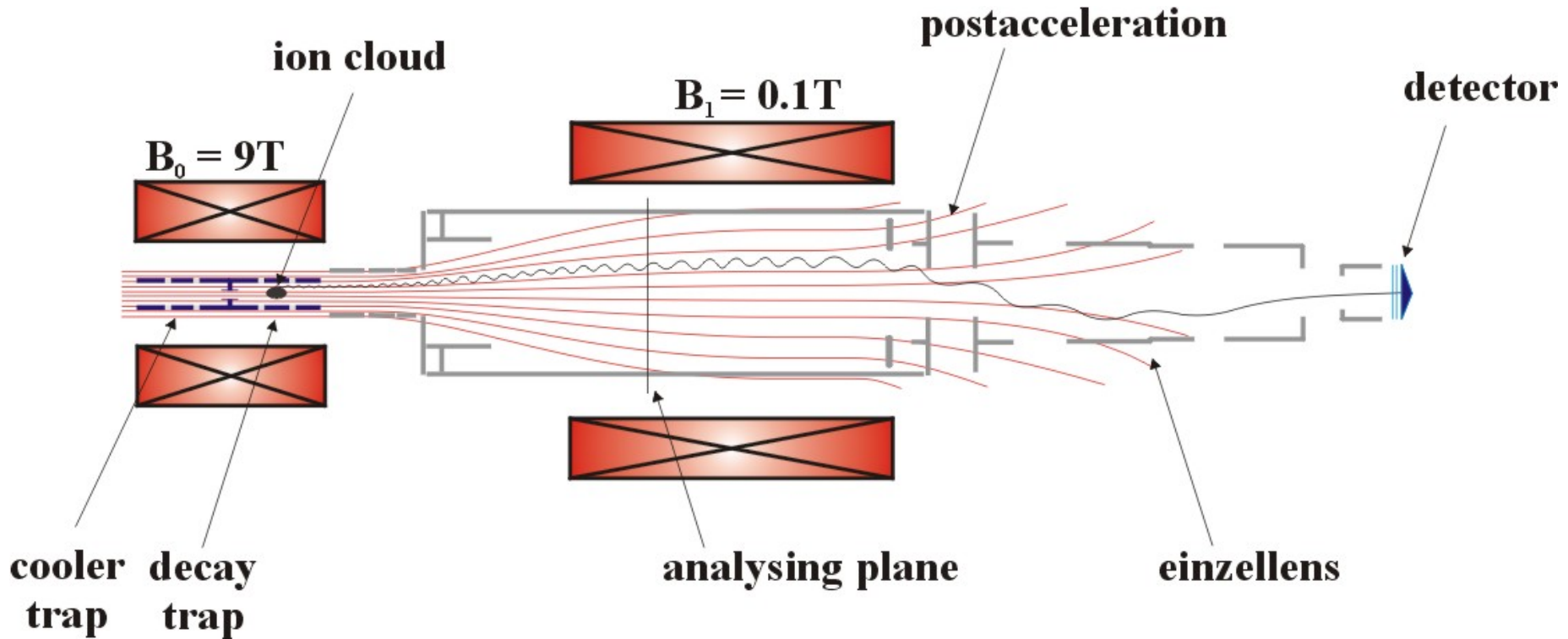
- $^{39}\text{K}^+$ ions from REXTRAP surface ion source (offline)
- Transfer to traps: $\sim 0.1\%$ (beam lines+PDT+injection B-field)
- Trapping in cooler trap: $\sim 50\%$
- Cooling in cooler trap
- ω_- and ω_+ result in blow-up of the ion cloud and the ions get blocked by the pumping barrier between the traps
- Transfer between traps $\sim 70\%$
- Storage in decay trap of ^{36}Ar $O(1s)$ ($t_{1/2}^{35}\text{Ar} = 1.78\text{s}$)

Problems:

- Transfer still gives too high energy in decay trap
-> broadening of response function in recoil measurement
- ω_c does not work correctly due to oscillations in electronics
- Who ordered the fluorine??? Teflon contains fluorine...

These problems should not prevent us from detecting recoils

Spectrometer principle



Spectrometer reality



Inserted into magnet system vacuum chamber

Going for radioactive ions



Conclusion and outlook

- ✓ Succeeded in pulsing 30keV ions
 - ✓ For the first time trapped 'real' ions
 - ✓ Basic trapping tests preformed (ω_- , ω_+ , cooling, transfer)
 - ✓ Working spectrometer
 - ✓ First radioactive elements in WITCH
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- Look for the recoils
 - Work on everything that gave problems (electronics...) during the coming ISOLDE shutdown period
 - Upgrade to 60keV PDT
 - Before precision experiment: check systematic effects
 - Continue doing tests, tests and more tests...

<http://www.fys.kuleuven.ac.be/iks/ko/research/witch>