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Accelerator Mass Spectrometry of heavy radioisotopes at energies below 1 MeV

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“Tandy”, small AMS System

Structure

- Brief explanation of Accelerator Mass Spectroscopy
- Introduction of a new, small AMS-facility which already works fine with ^{14}C
- Aluminium: What we did, what we want
- Calcium, Iodine, Beryllium: first measurements

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Accelerator Mass Spectroscopy (AMS)

What it is

- Sample-size: 1 mg - 200 ng
- Principle: Measurement of isotopic ratios with help of an accelerator
- Sensitivity: up to 10^{-15}

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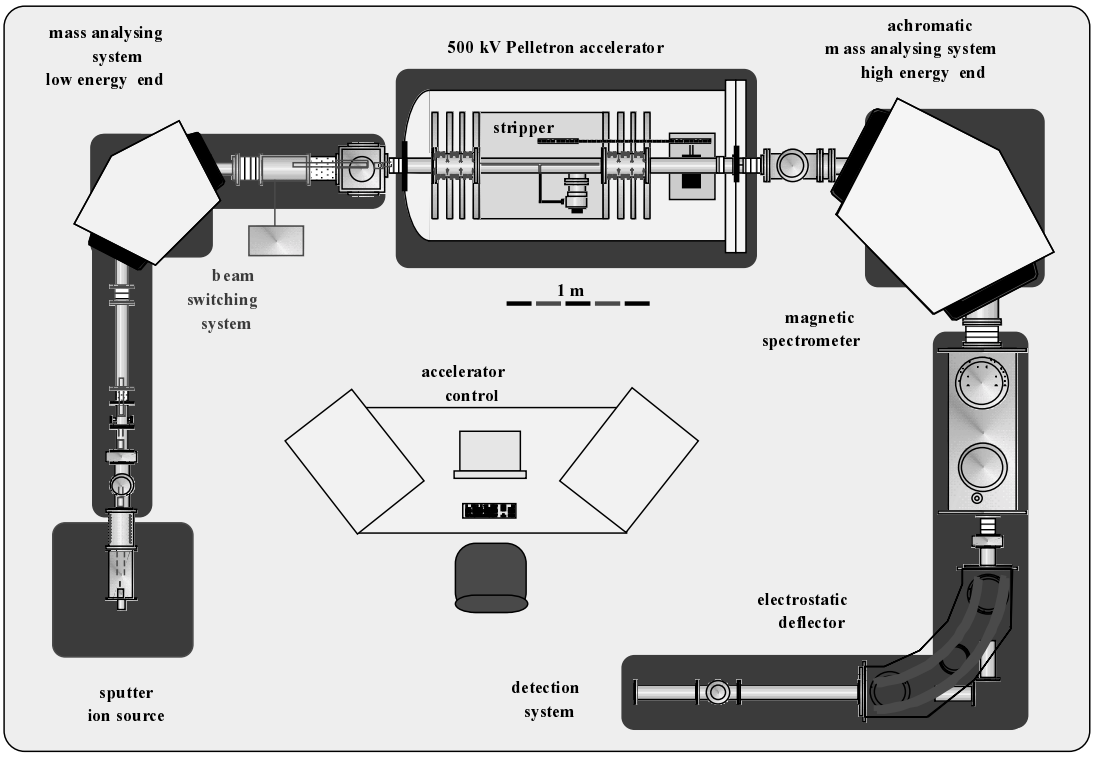
Experimental Setup



Aluminium

- radioactive isotope: ^{26}Al, half-life = 716000 a
- stable isotope: ^{27}Al
- no interfering isobars
- mainly used for geological samples

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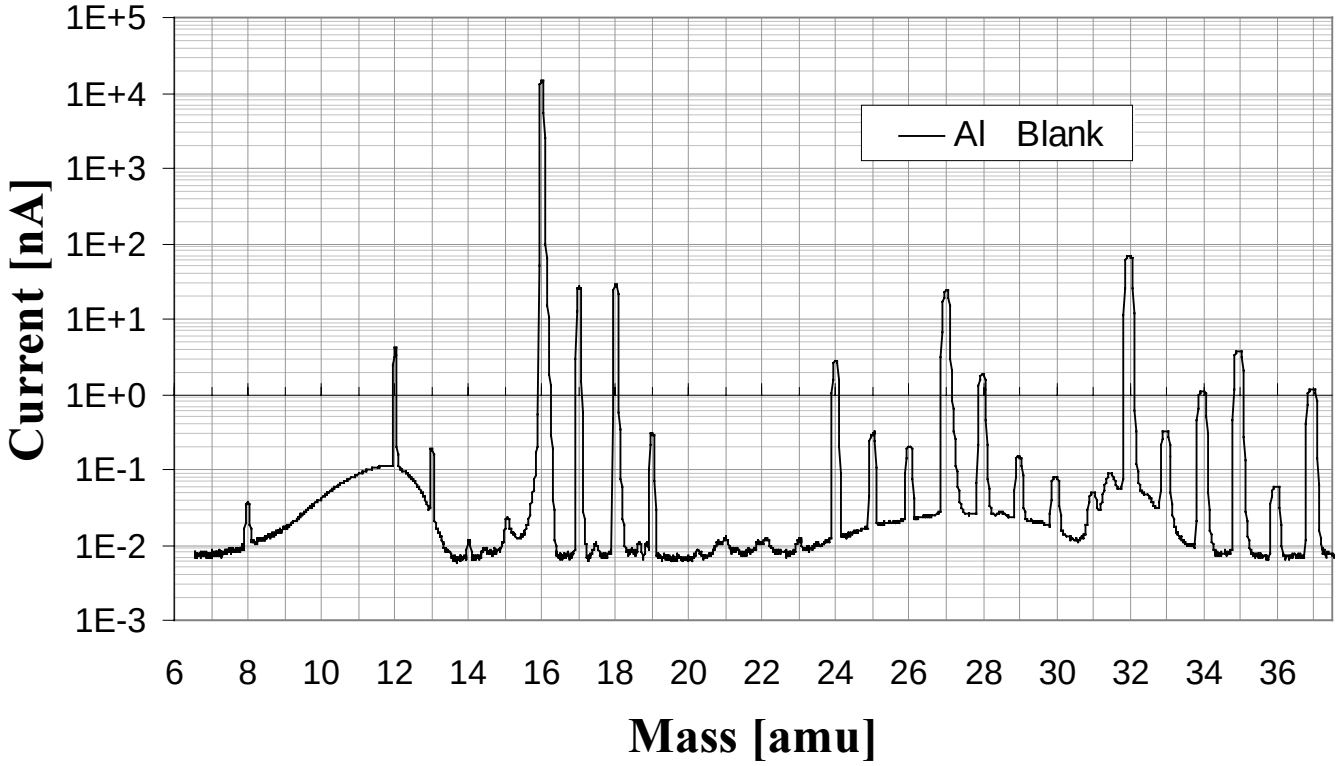
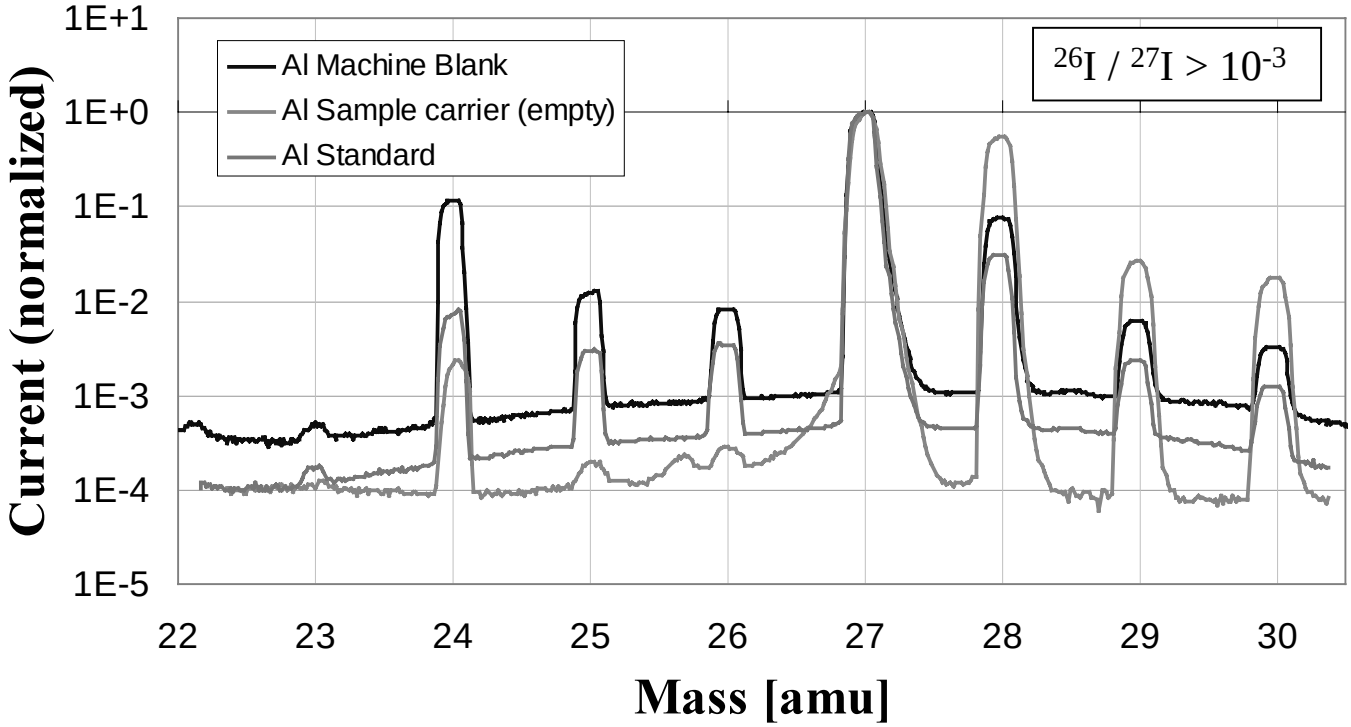
Low Energy Mass Spectra





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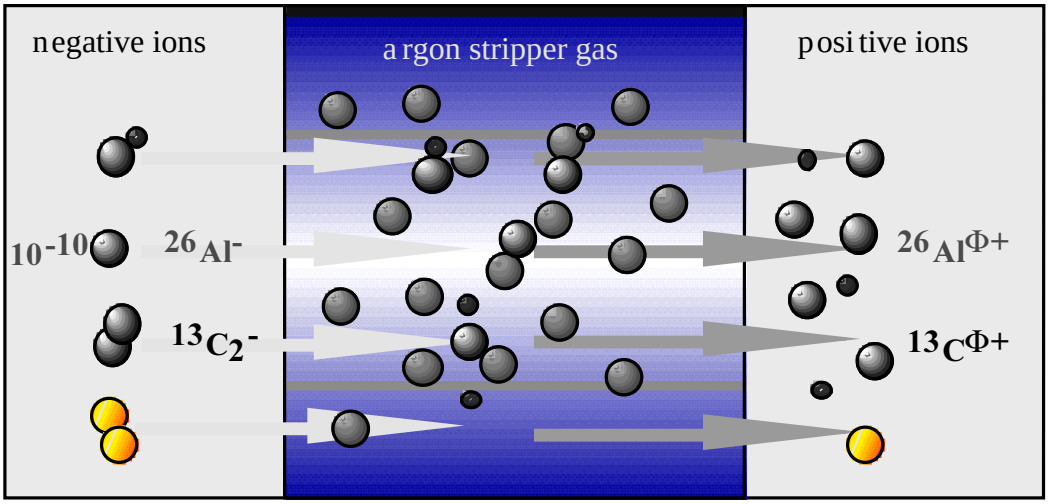
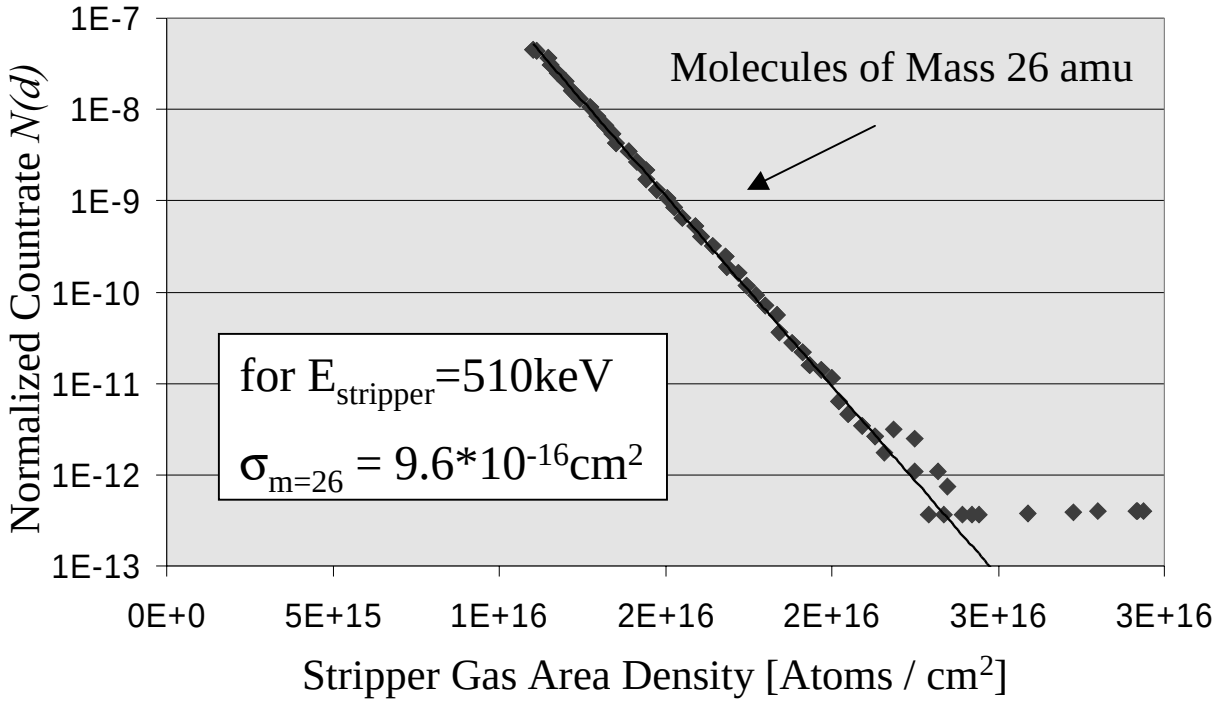
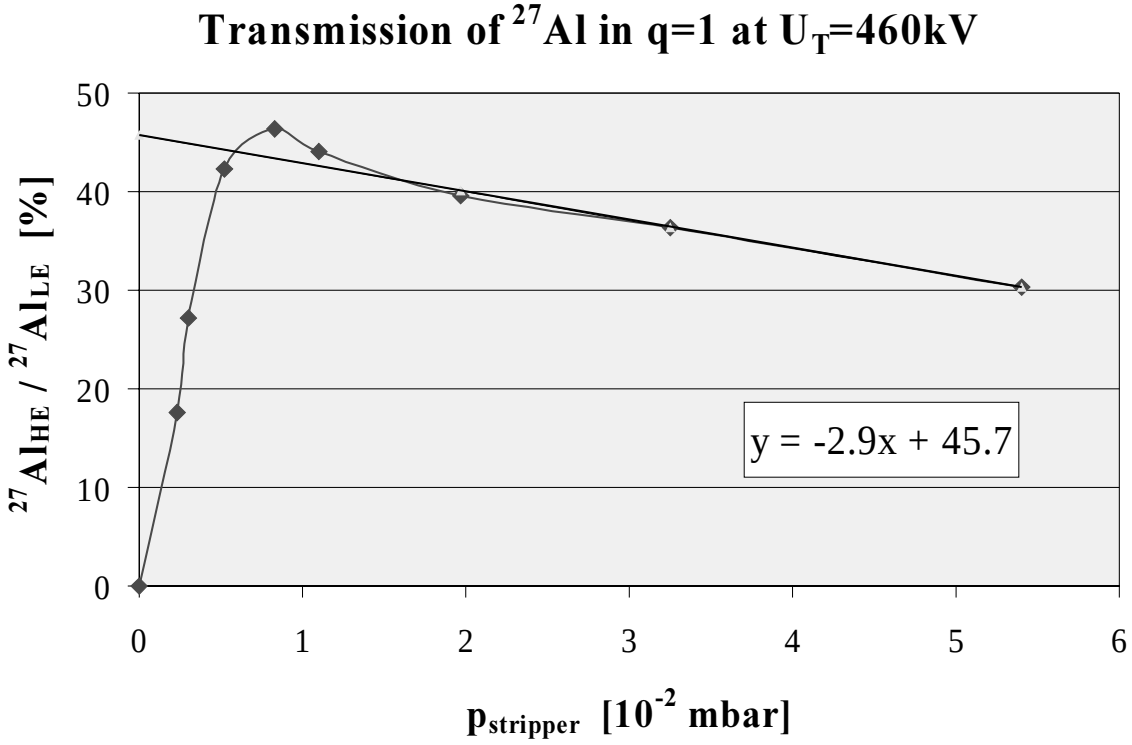
Molecule Destruction Cross Section



$$N(d) = N_0 * e^{-\sigma * d}$$



Yield



	Tandy (0.46 MV, $q=1^+$)	Tandem (4.7 MV, $q=3^+$)
Charge State Distribution	>45%	
Transmission	30%	20%
Ion Optical Losses	30%	

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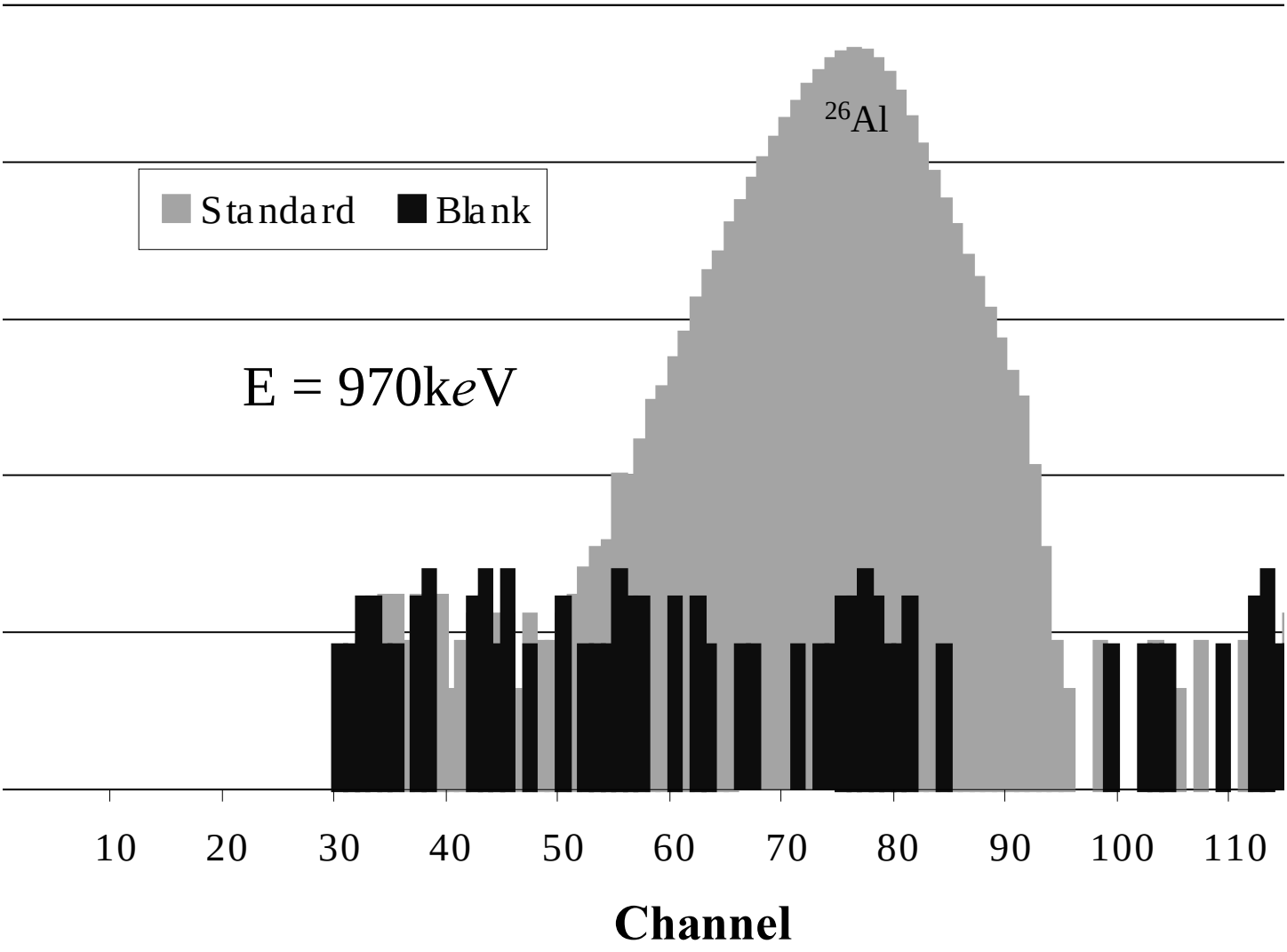
Energy Spectra of ^{26}Al Standard & Blank Samples



Measured Background: $^{26}Al / ^{27}Al < 1.5 \cdot 10^{-13}$

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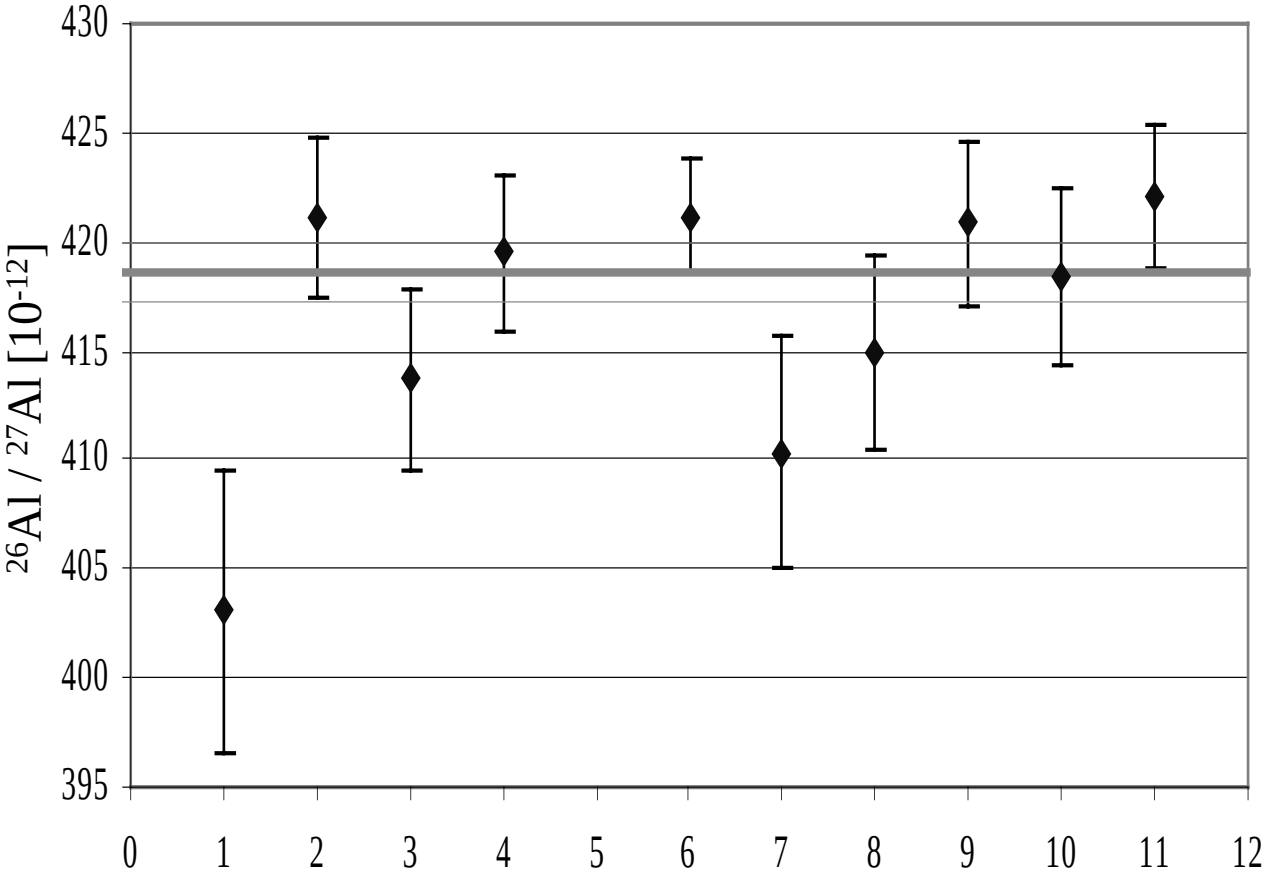
Reproducibility of Standard Sample Measurements



$^{26}Al / ^{27}Al = 419 \cdot 10^{-12}$
± 0.34%

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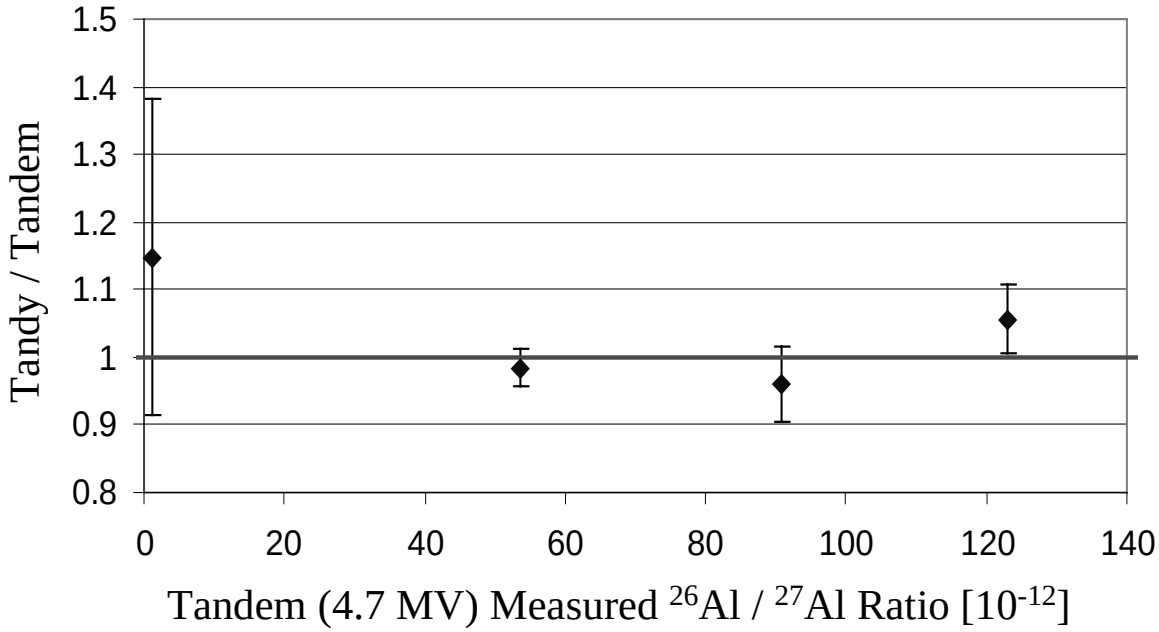
Measured Results Compared

Tandy (0.46 MV) ⟷ Tandem (4.7 MV)



Sample: Nr.	Tandem.: [10^{-12}]	Std. Dev.: [%]	Tandy: [10^{-12}]	Std. Dev.: [%]	Δ [%]
SA 1037	1.3	6.80	1.5	19.22	14.76%
SA 1125	53.5	2.70	52.7	0.96	-1.53%
SA 1127	90.8	5.70	87.2	1.36	-3.92%
SA 1039	123.0	1.90	130.0	4.43	5.67%

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Preliminary Summary

- Background: ca. 10^{-13}
- Aim: 10^{-14}

- Idea: background results from ^{27}Al

- further suppression of ^{27}Al
- Identification of wrong particles via Time of Flight (TOF)

Calcium

- radioactive isotope: ^{41}Ca, half-life = 104000 a ± 5000 a
- stable isotope: ^{40}Ca
- interfering isobar: ^{41}K, therefore extraction of CaH_3^-
- high interest for use as tracer for bio-medical applications

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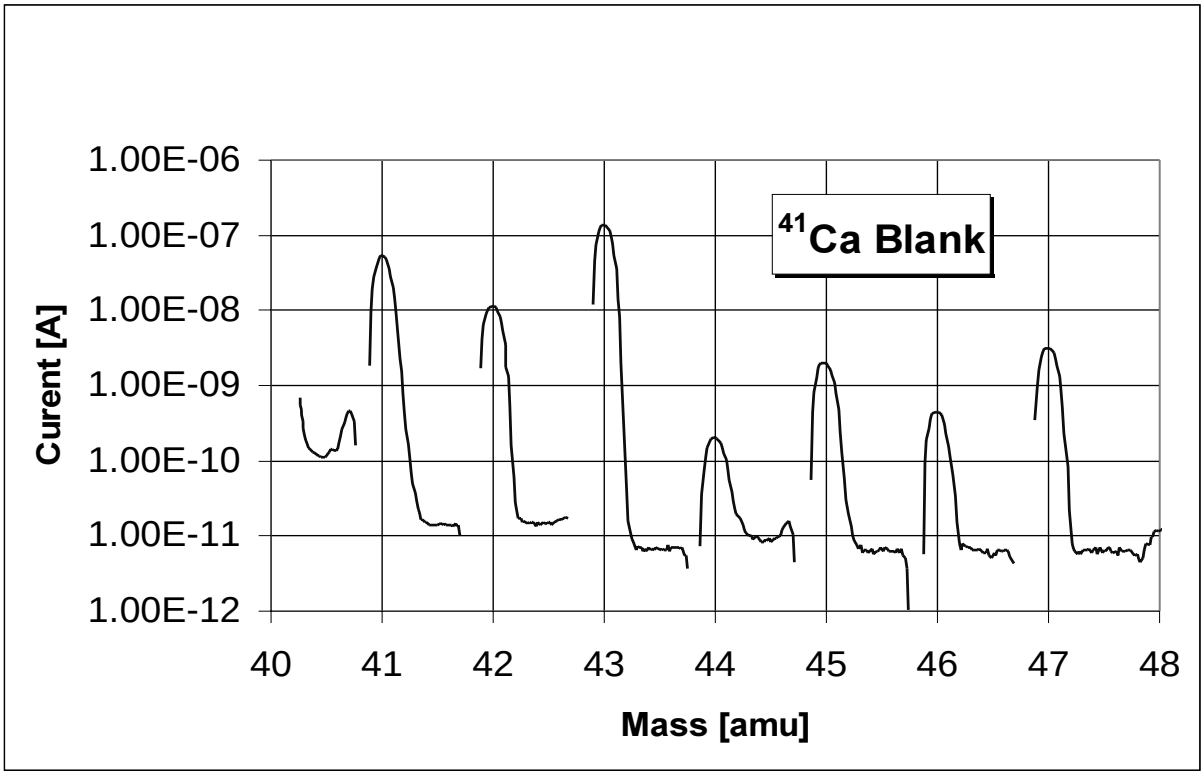

First Results:

Ratio for a standard sample: ^{41}Ca / $^{40}Ca = 49.5 * 10^{-10}$

Background: $2 * 10^{-11}$

Transmission: 25 %

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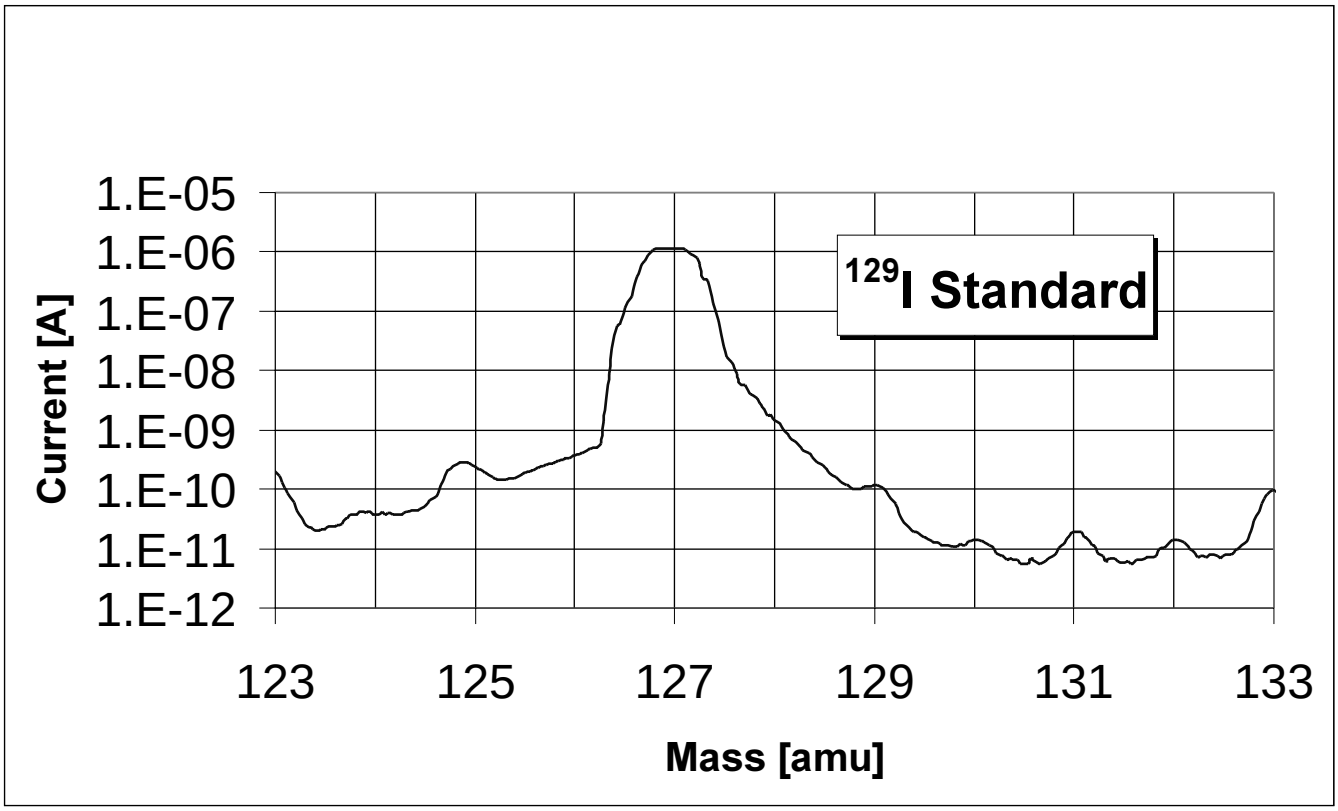

Transmission for I^{3+} : 2.8 %

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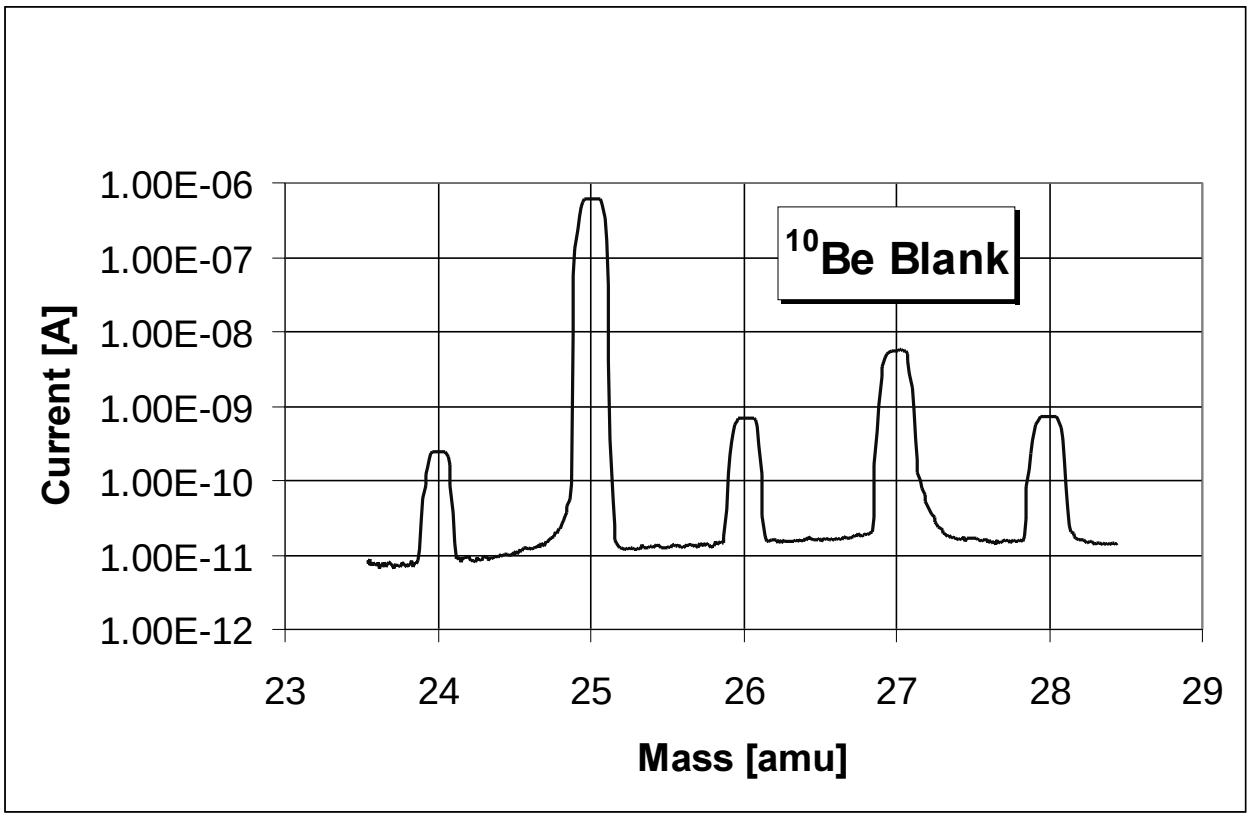

Transmission for Be^{2+}: 13 %

Tandem

http://ihp-power1.ethz.ch/IPP/tandem/nuclides.html

Tandy

Isotope	Extracted Ion	Neg. Ion Current [uA]	Terminal Voltage [MV]	Stripper	Charge State	Trans-mission [%]	Ion Energy [MeV]	Back-ground
^{10}Be	BeO^-	0.77	0.46	Ar-Gas	2^+	13	0.863	?
^{14}C	C^-	15-30	0.46	Ar-Gas	1^+	> 40	0.969	$2*10^{-15}$
^{26}Al	Al^-	0.15	0.46	Ar-Gas	1^+	26	0.969	10^{-13}
^{41}Ca	CaH_3^-	0.03	0.39	Ar-Gas	1^+	25	0.816	$2*10^{-11}$
^{129}I	I^-	0.1	0.24	Ar-Gas	3^+	2.8	0.981	?