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Wir schaffen Wissen – heute für morgen

Paul Scherrer Institut
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Project ERAWAST – Radionuclides for Astrophysical Application

Objectives of ERAWAST

Exotic Radionuclides from Accelerator WAste for Science and Technology

^{7}Be (53.3d), ^{10}Be (1.6·10^{6}y), ^{26}Al (7.2·10^{5}y), ^{44}Ti (60.4y), ^{53}Mn (3.7·10^{6}y), ^{59}Ni (7.5·10^{4}y), ^{60}Fe (2.6 ·10^{6}y), ^{32}Si (172y) ^{146}Sm (1.03 ·10^{8}y), ^{182}Hf (9 ·10^{6}y)

Application of exotic long-lived isotopes from accelerator waste

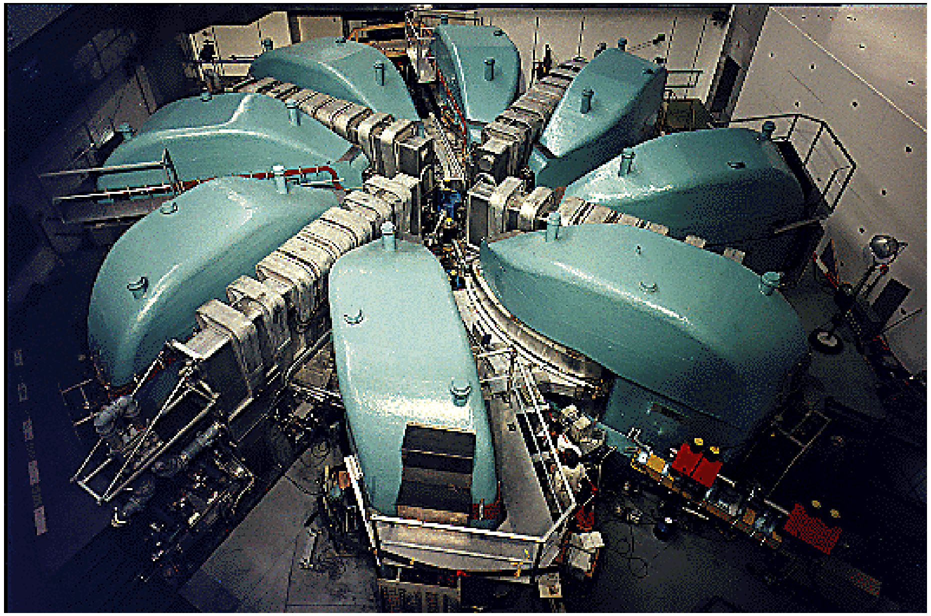
- Nuclide production facilities
- Basic physics research
- Geophysics and Astrophysics
- AMS and RIMS measurement groups
- Life science and nuclear medicine

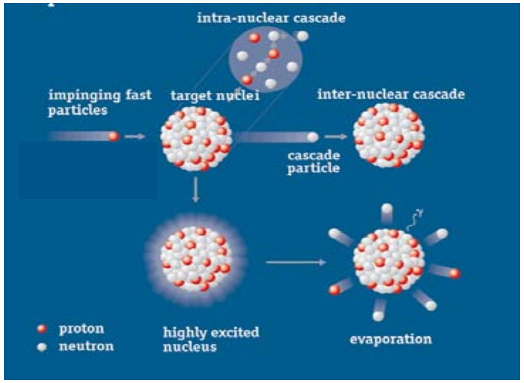
Difficult, expensive and time consuming production

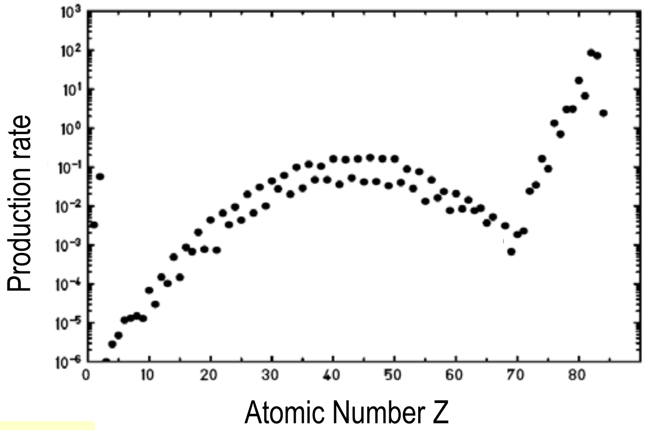
Spallation Reactions
High Energy Accelerator Facilities

Cyclotron

590 MeV protons, 3 mA

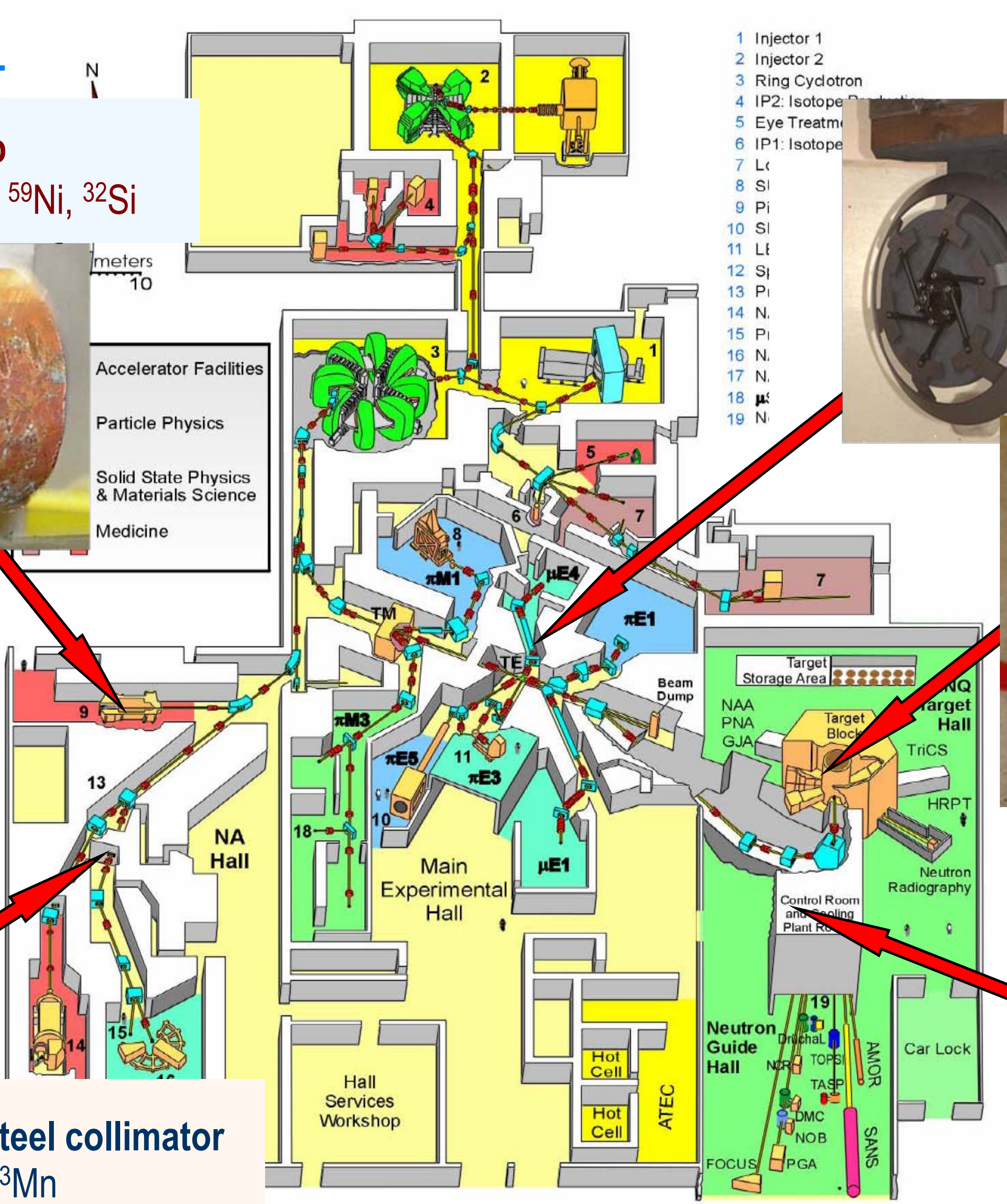






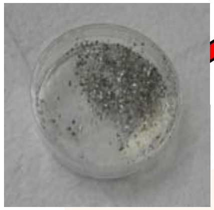
All elements of periodic table with $Z \leq Z_{target} + 1$

Copper beam dump
^{44}Ti, ^{53}Mn, ^{26}Al, ^{60}Fe, ^{59}Ni, ^{32}Si



Myon production
^{10}Be

SINQ target STIP
^{207}Bi, ^{172}Hf, ^{173}Lu, ^{194}Hg, ^{202}Pb, ^{205}Pb, ^{125}Sb, ^{106}Ru, ^{44}Ti, ^{26}Al, ^{53}Mn



Stainless steel collimator
^{44}Ti , ^{26}Al, ^{53}Mn

SINQ cooling water
^{10}Be

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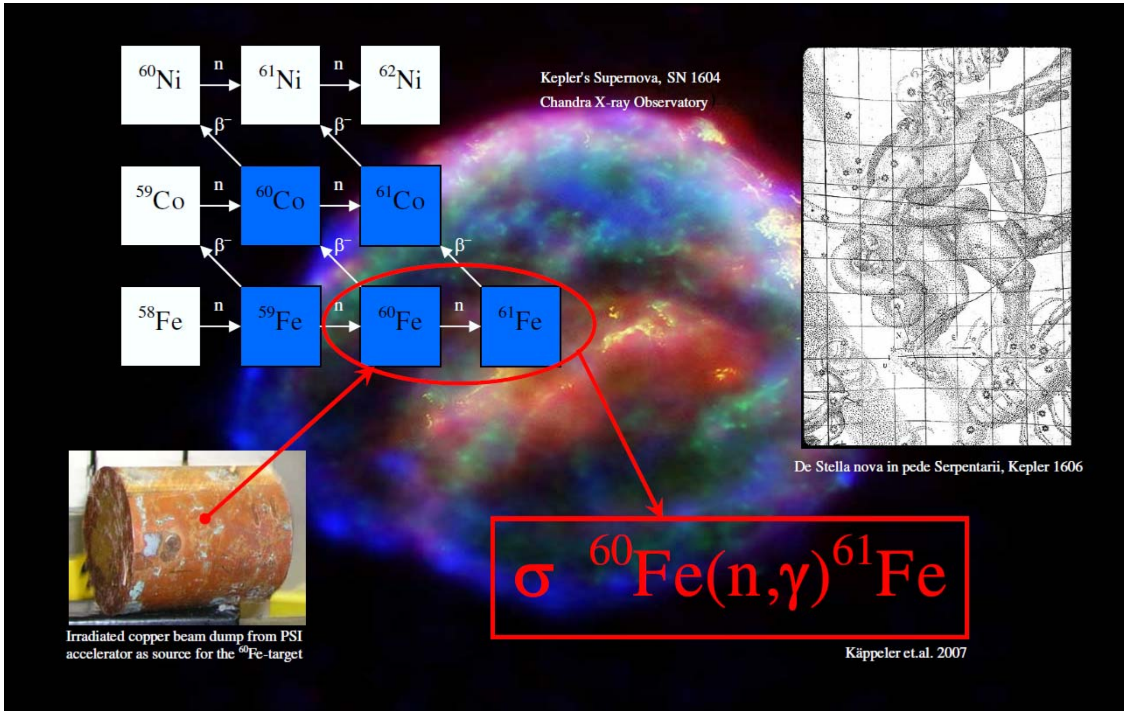
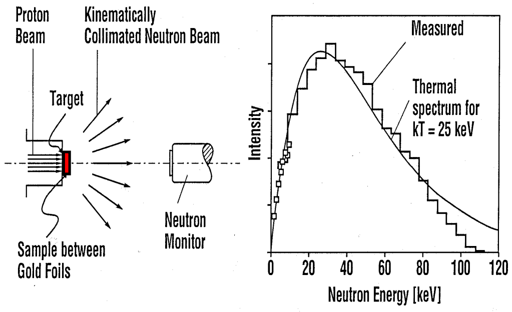
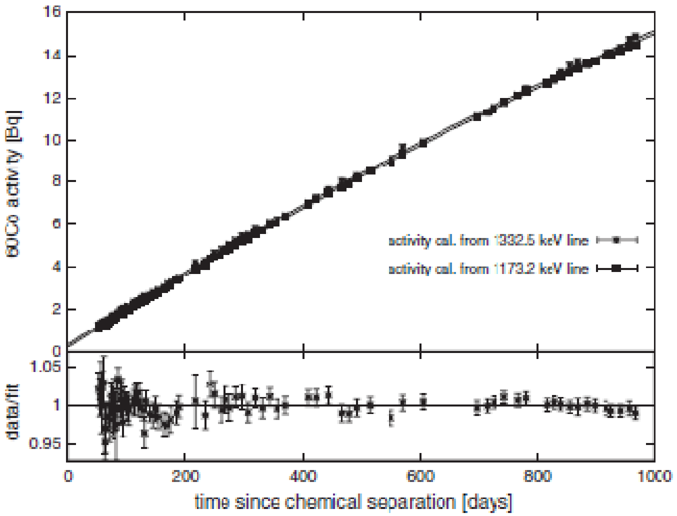
Summary

- **Radionuclides separated**
  - ^{7}Be – 10 GBq
  - ^{10}Be – 20 μg
  - ^{44}Ti – 10 MBq
  - ^{53}Mn – $2 \cdot 10^{17}$ atoms
  - ^{60}Fe – $5 \cdot 10^{16}$ atoms
- **Radionuclides available**
  - ^{7}Be – unlimited
  - ^{10}Be – 100 μg
  - ^{26}Al – 20 kBq (10^{18} atoms)
  - ^{59}Ni – 8 MBq (10^{19} atoms)
  - ^{44}Ti – 0.5-1 GBq (10^{18} atoms)
  - ^{53}Mn – 500 kBq (10^{19} atoms)
  - ^{60}Fe – $5 \cdot 10^{16}$ atoms
  - ^{32}Si – 10 MBq (10^{16} atoms)
- **Possibilities for other irradiation positions (SINQ, beam dumps, collimators)**

^{60}Fe half-life and neutron capture cross section







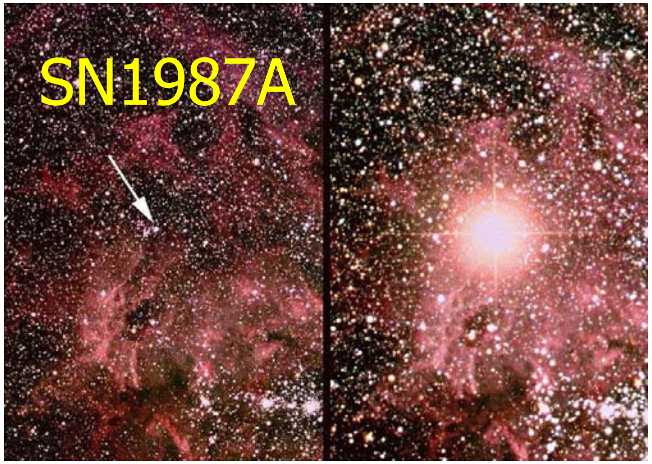
$\langle\sigma\rangle = 10.2 \pm 2.9$ mbarn

$T_{1/2} = 2.62 \pm 0.04 \cdot 10^6$ years

Physical Review Letters, 102 (15) 2009
Physical Review Letters, 103 (7) 2009

Core Collapse Supernovae

Explosion mechanism is extremely complex
Good diagnostic – **^{44}Ti**
Produced in significant quantity
Gamma-ray observable – 1157 keV
Quantity produced is sensitive to underlying physics

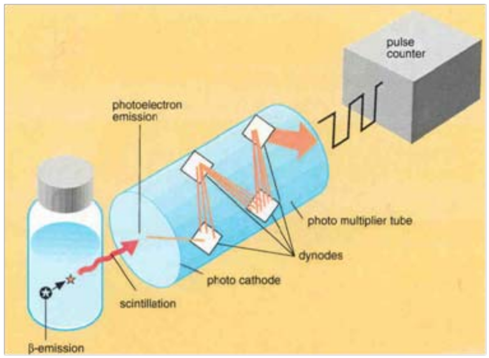


^{44}Ti abundance determined by only a few key reactions:

Triple α
^{40}Ca(α,γ)^{44}Ti
^{44}Ti(α,γ)^{48}Cr
^{44}Ti(α,p)^{47}V

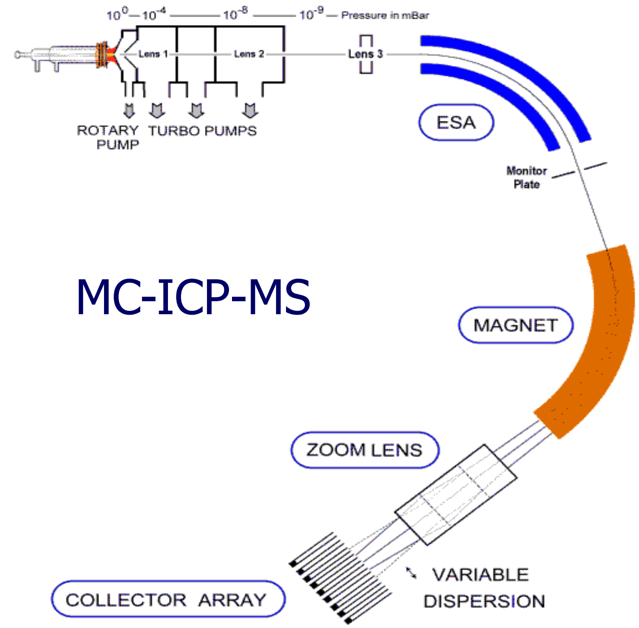
^{10}Be Half-life

LSC



$$T_{1/2\ {}^{10}Be} = \frac{N_{{}^{10}Be}}{A_{{}^{10}Be}} \ln 2$$

MC-ICP-MS



- ICP-MS can measure isotope ratios for the Beryllium isotopes BUT – only one stable Be isotope - **^{9}Be**
- Second point for mass bias correction - **^{7}Be**

  quantified by 478 keV gamma line

  ^{7}Be (53 d) → ^{7}Li (stable)
- ICP-MS in principle possible, but interference with ^{7}Li, ^{10}B

PAUL SCHERRER INSTITUT PSI

2nd workshop on Exotic Radionuclides from Accelerator Waste for Science and Technology (ERAWAST II)

from 29 August 2011 to 02 September 2011 (Europe/Zurich) *Paul Scherrer Institut*
Europe/Zurich timezone

Overview

Scientific Background

Scientific Programme

Accommodation

International Advisory Committee

Local organizing Committee

Abstracts and Proceedings

Registration

Deadlines

Support

The goal

The first exploratory workshop, ERAWAST I, held at PSI in November 2006, explored the possibility of an international network for the exploitation of accelerator waste materials with regard to use as a source of exotic radionuclides for basic science and technological applications. The workshop brought together partners from both the production facilities as well as application domains. The main outcome of this workshop was the establishment of an international collaboration, and the identification of both "early-to realize" and "long-term" experiments and applications. After 5 years, it is time to evaluate the main achievements and to define future work and possibilities.

The topics

- Production and separation of exotic radionuclides
- Nuclear astrophysics
- Basic nuclear physics
- Accelerator mass spectrometry
- Nanotechnology
- Geophysics and geochemistry

Hosting organization

Paul Scherrer Institute Villigen, in cooperation with the Swiss National Science Foundation (SNSF).

Dates:	from 29 August 2011 00:00 to 02 September 2011 23:55
Timezone:	Europe/Zurich
Location:	*Paul Scherrer Institut* Villigen (Switzerland) Room: OSGA E06
Chairs:	Dr. Schumann, Dorothea
Material:	Announcements & Flyer Template

http://indico.psi.ch/event/erawast
Last modified: 07 December 2010 17:37

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