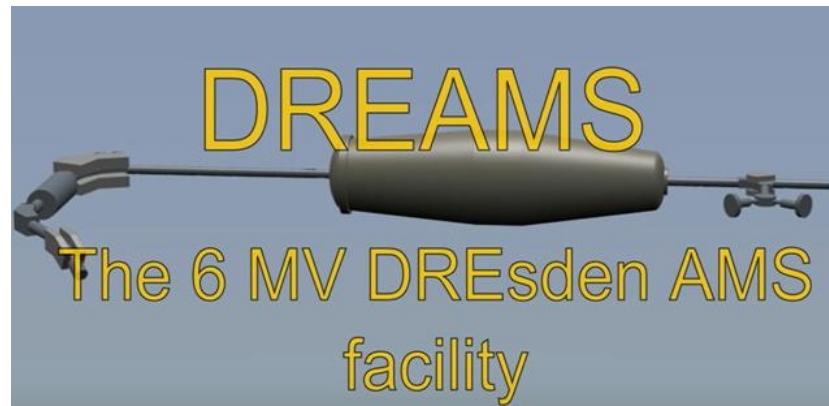




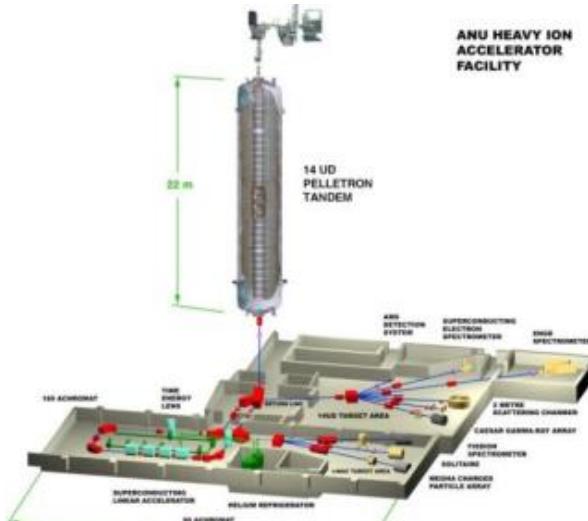
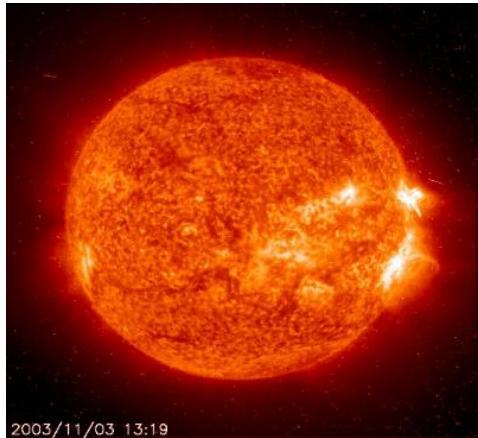
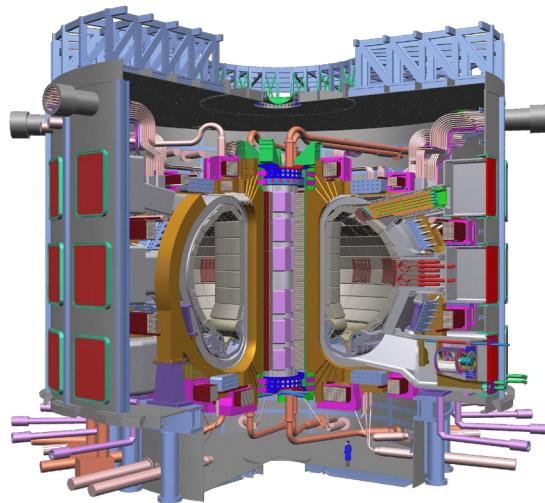
Accelerator mass spectrometry @ Dresden



animation @ www.dresden-ams.de



Accelerator Mass Spectrometry



Some radionuclides measured with AMS

^{55}Fe	2.7 years
^3H	12.3
^{44}Ti	60
^{63}Ni	100
	0
	9
	0

AMS and Nuclear Astrophysics

*limited number of radionuclides – however, if it can be measured with AMS – this is usually by far the most sensitive method
→ AMS = ultra-sensitive*

^{129}I
226 GeV

17 000 000
20 000 000

single atom counting of radionuclides

+ ... more added recently

Near future plan: new state-of-the-art AMS system

- dedicated & compact AMS facility



a number of new & additional isotopes will become accessible

Example: 1-MV facility at ANSTO / Sydney

- **compact 0.3 – 1-Megavolt (MV) accelerator** coupled to an
- innovative new type of **laser/ion cooler** particle-injection system (+ VERA)
- commissioning: early 2023

Nuclear Astrophysics in the Laboratory: Simulation of nucleosynthesis in stars

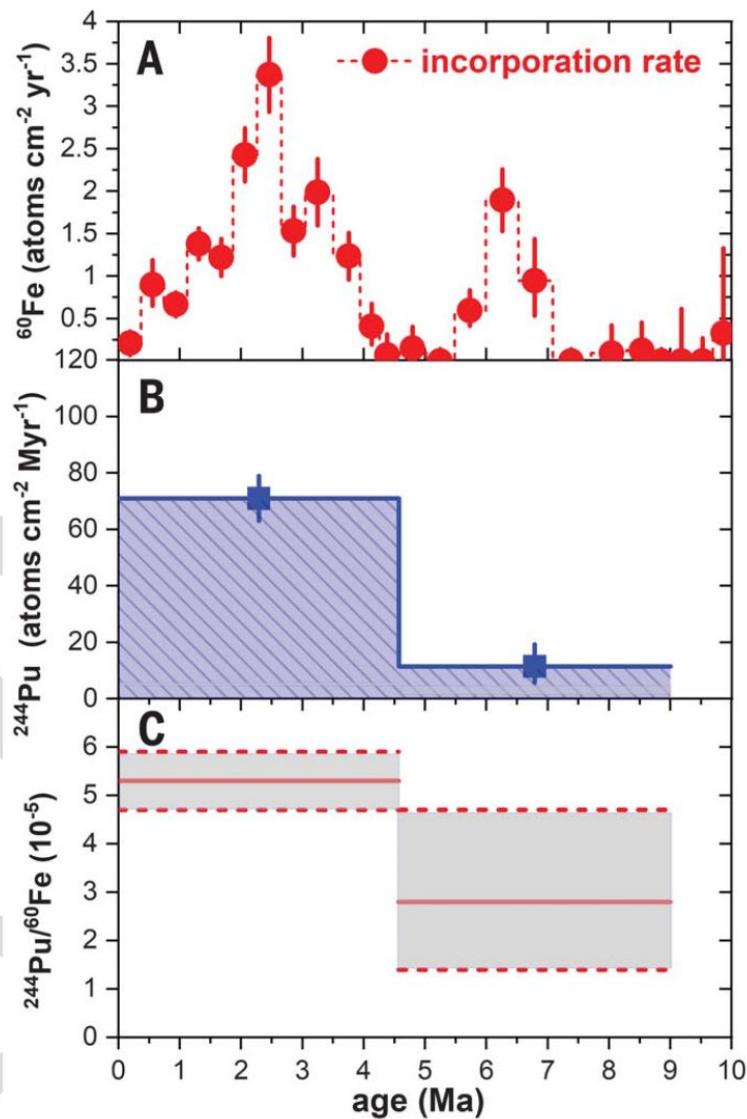
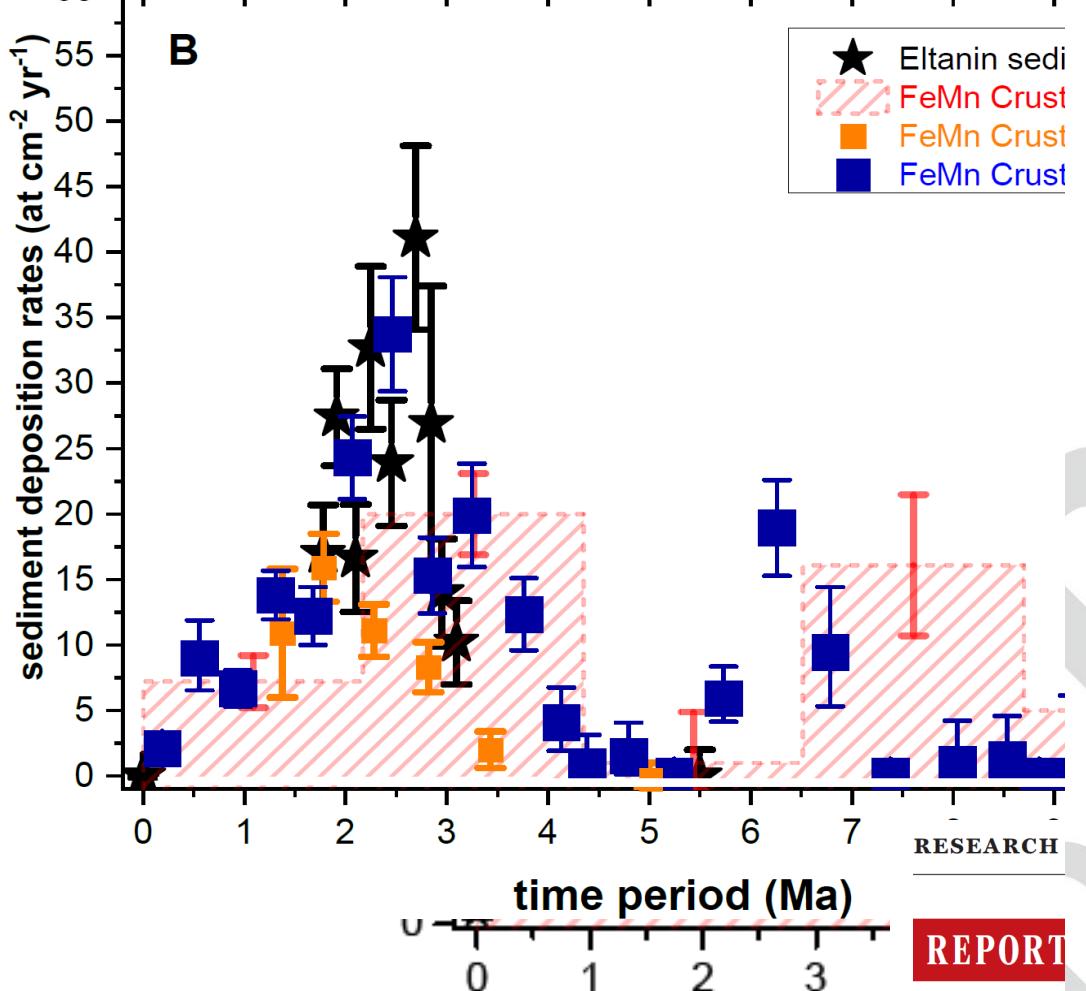
Search for interstellar matter entering the
solar system and Earth

Search for supernova-produced
radionuclides on Earth

Meteorites

Hubble

^{60}Fe from sedime



Recent near-Earth supernovae probed by deposition of interstellar radioactive ^{60}Fe

A. Wallner¹, J. Feige^{2†}, N. Kinoshita³, M. Paul⁴, L. K. Fifield¹, R. Golser², M. Honda⁵, U. Linnemann⁶, J. G. Rugel⁸, S. G. Tims¹, P. Steier², T. Yamagata⁹ & S. R. Winkler¹

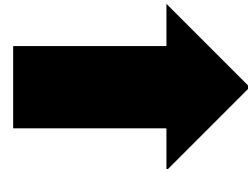
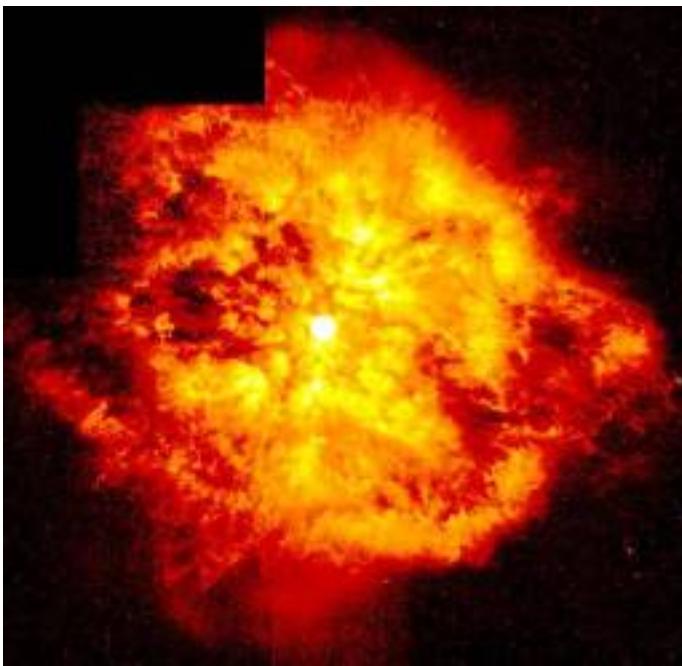
DRESDEN

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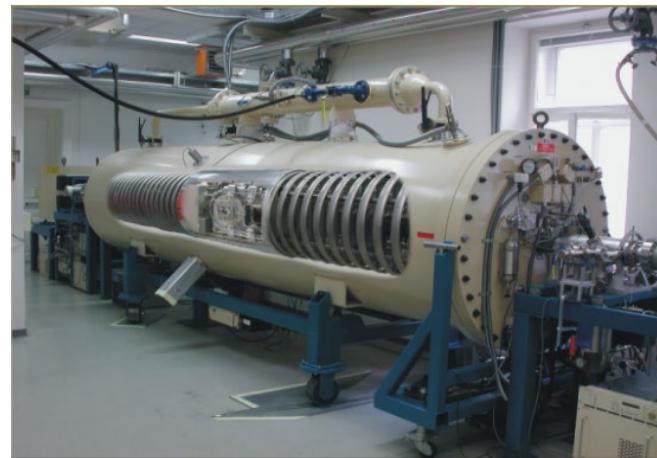
^{60}Fe and ^{244}Pu deposited on Earth constrain the r-process yields of recent nearby supernovae

A. Wallner^{1,2*}, M. B. Froehlich¹, M. A. C. Hotchkis³, N. Kinoshita⁴, M. Paul⁵, M. Martschini^{1†}, S. Pavetich¹, S. G. Tims¹, N. Kivel⁶, D. Schumann⁶, M. Honda^{7†}, H. Matsuzaki⁸, T. Yamagata⁸

Nucleosynthesis in the laboratory



(I) sample activation

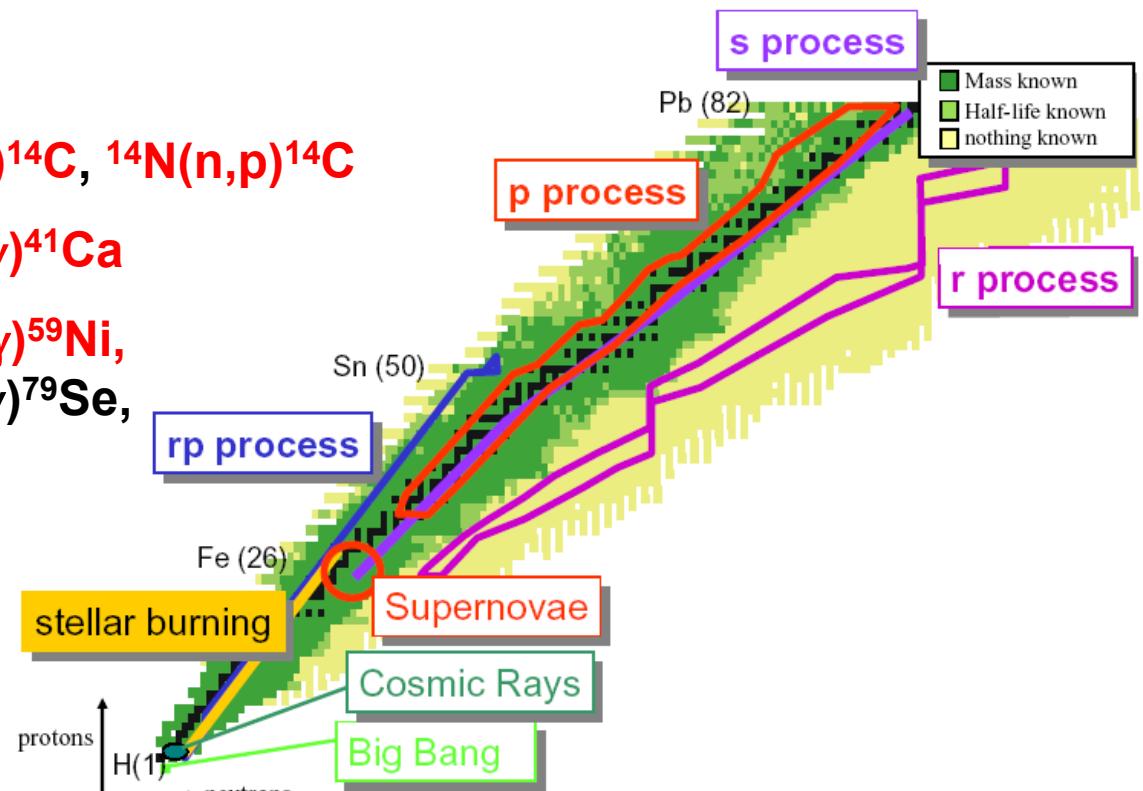


(II) AMS: analysis

Applications of AMS to Astrophysics

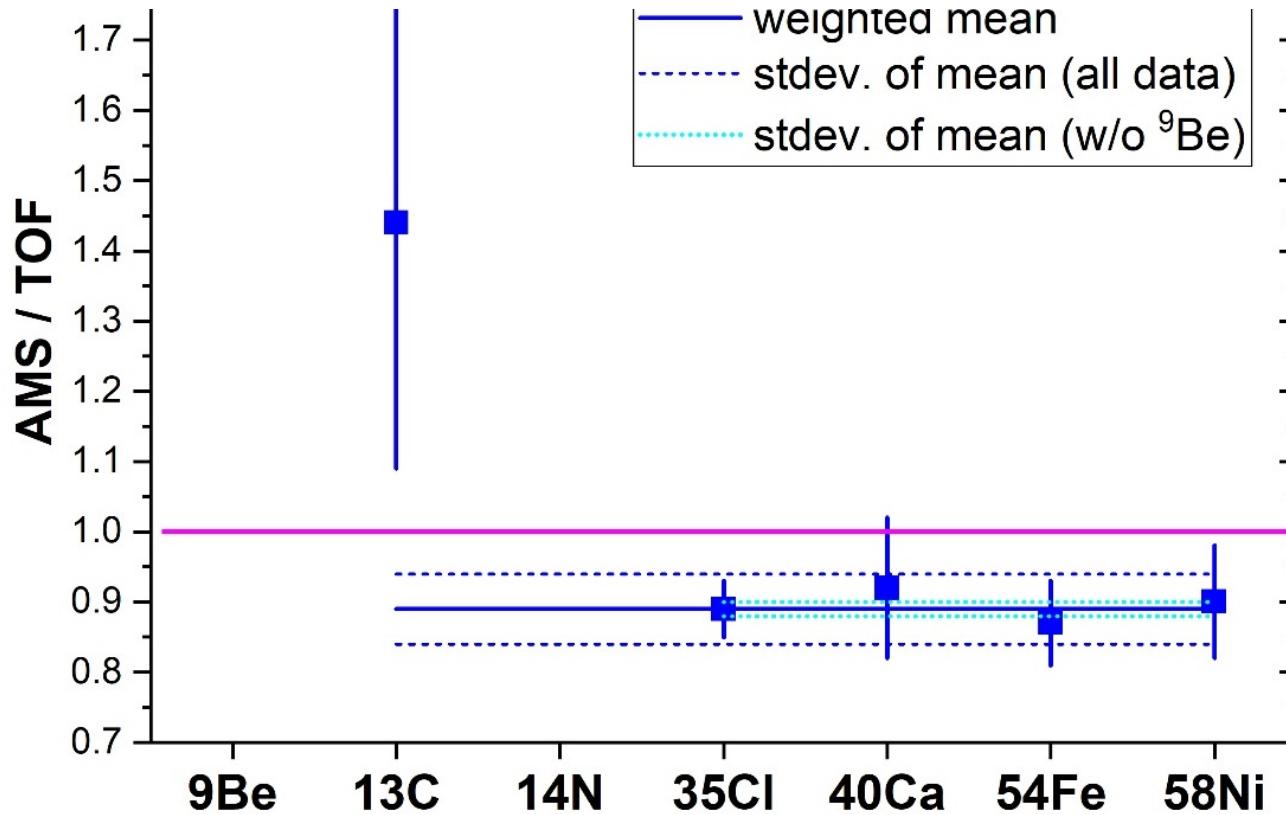
Nuclear reaction data - cross-section measurements

- $^9\text{Be}(\text{n}, \gamma)^{10}\text{Be}$, $^{13}\text{C}(\text{n}, \gamma)^{14}\text{C}$, $^{14}\text{N}(\text{n}, \text{p})^{14}\text{C}$
- $^{35}\text{Cl}(\text{n}, \gamma)^{36}\text{Cl}$, $^{40}\text{Ca}(\text{n}, \gamma)^{41}\text{Ca}$
- $^{54}\text{Fe}(\text{n}, \gamma)^{55}\text{Fe}$, $^{58}\text{Ni}(\text{n}, \gamma)^{59}\text{Ni}$,
 $^{62}\text{Ni}(\text{n}, \gamma)^{63}\text{Ni}$, $^{78}\text{Se}(\text{n}, \gamma)^{79}\text{Se}$,
- $^{209}\text{Bi}(\text{n}, \gamma)^{210}\text{Bi}$,
-



AMS vs complementary technique: TOF

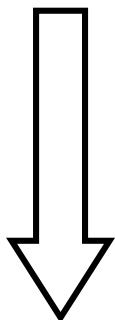
Systematic offsets between independent methods (neutron-time-of-flight vs. activation + AMS)





DREAMS

fundamental physics

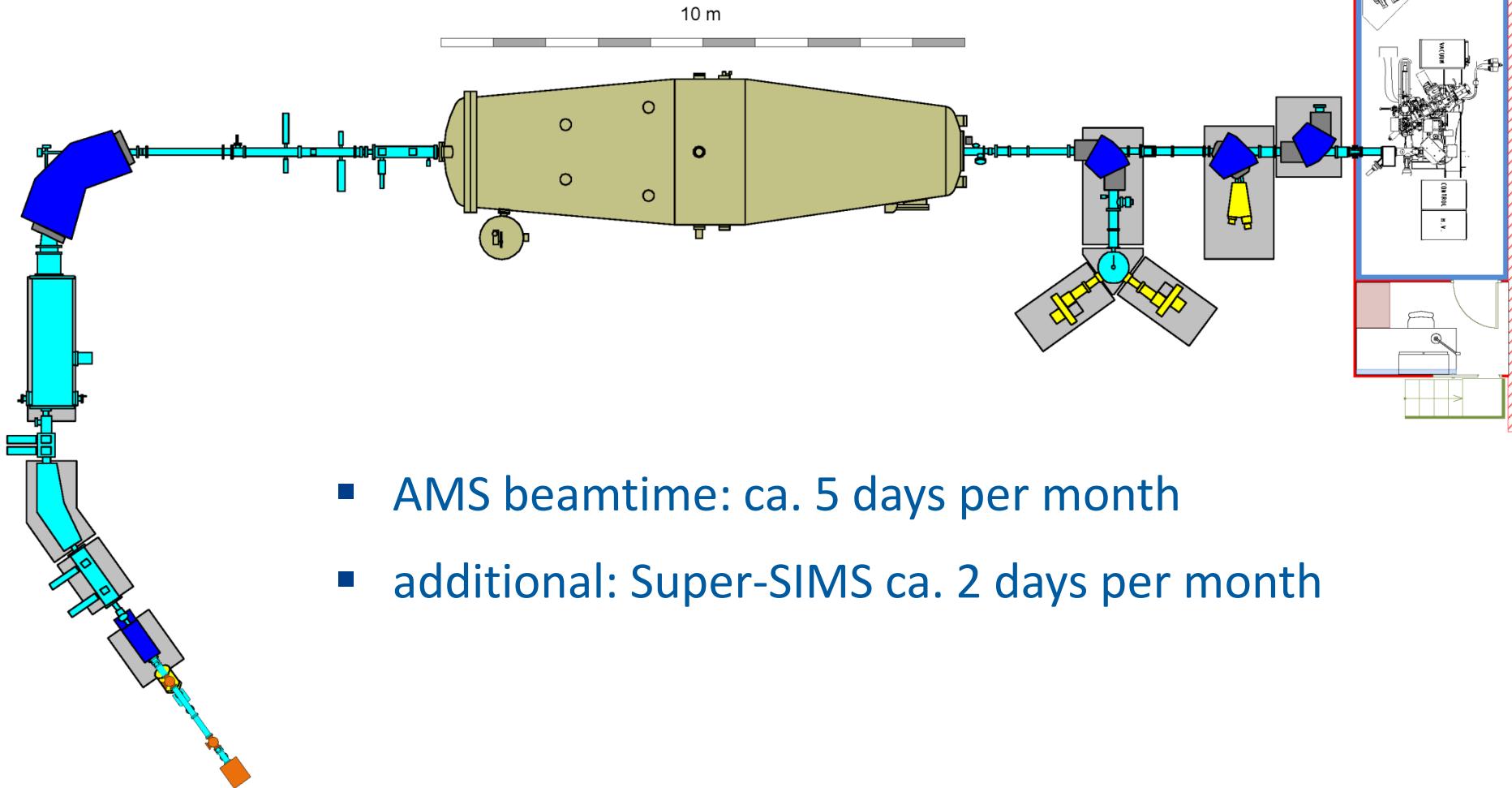


applied sciences

^{39}Ar	269
^{14}C	5 730
^{59}Ni	75 000
^{41}Ca	104 000
^{81}Kr	230 000
^{79}Se	280 000
^{36}Cl	301 000
^{26}Al	720 000
^{10}Be	1 388 000
^{60}Fe	2 600 000
^{53}Mn	3 600 000
^{182}Hf	8 900 000
^{129}I	17 000 000
^{236}U	23 000 000
$^{239-244}\text{Pu}, ^{247}\text{Cm}$	- 81 000 000

*atom counting of radionuclides
via isotope ratio measurements*

DREAMS – 6-MV accelerator



- AMS beamtime: ca. 5 days per month
- additional: Super-SIMS ca. 2 days per month

D. Koll et al.: dating of interstellar signals cosmogenic Be-10



FeMnCrust KD237

*3.7 kg
Pacific Ocean
4830 m below sea level*

*-
up to 25 Myr Old*

*... the same crust as used in
K. Knie et al. (2004), detection of interstellar Fe-60
A. Wallner et al. (2015), interstellar Pu-244*

Archiv



ANSTO, Sydney



MIT Earth, Atmospheric and Planetary Sciences

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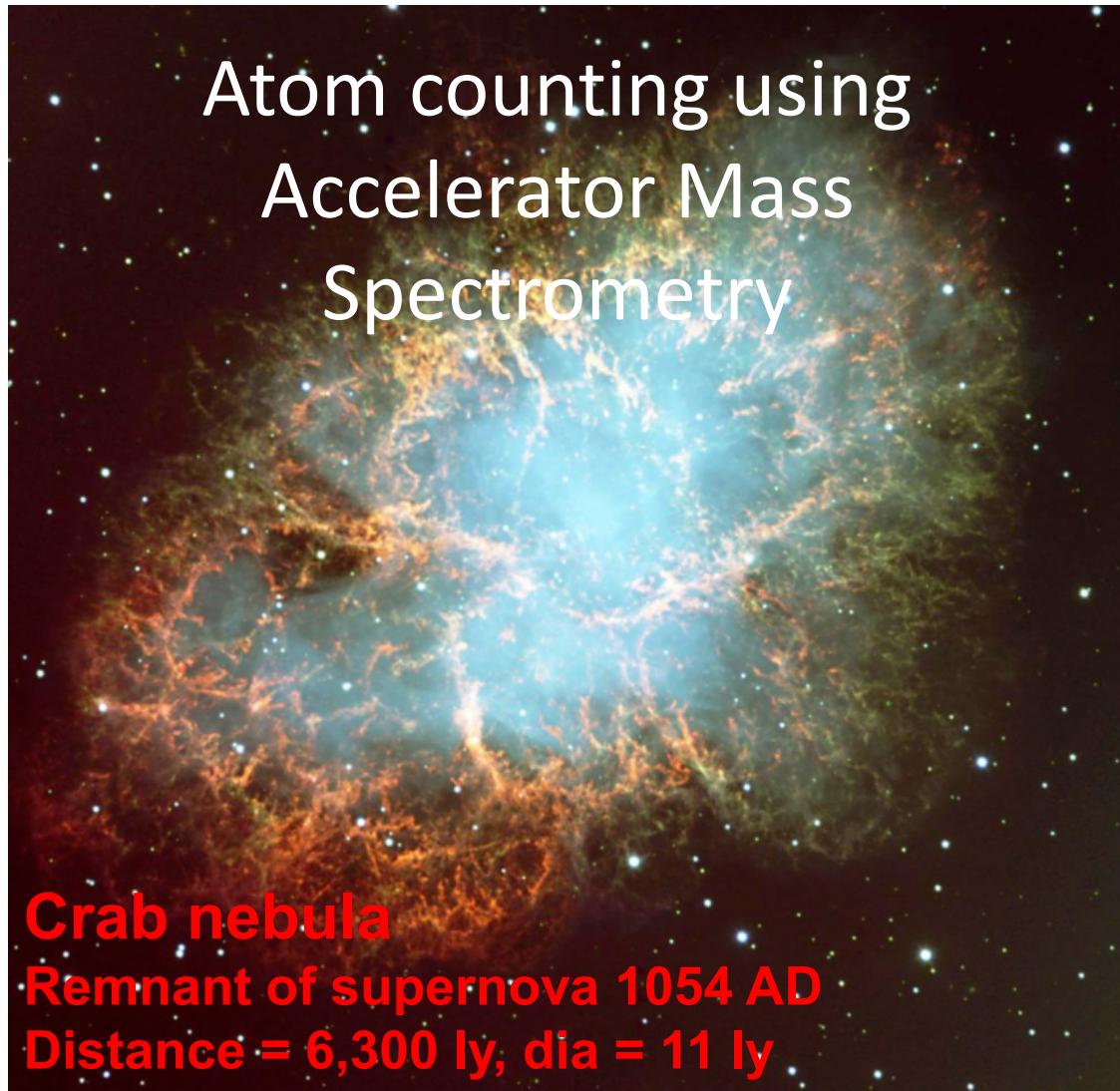
DRESDEN
concept

h2dr

Member of the Helmholtz Association

Accelerator Mass Spectrometry & Isotope Research - Prof. Dr. Anton Wallner | www.hzdr.de

Extraterrestrial Radionuclides on Earth



Atom counting using
Accelerator Mass
Spectrometry

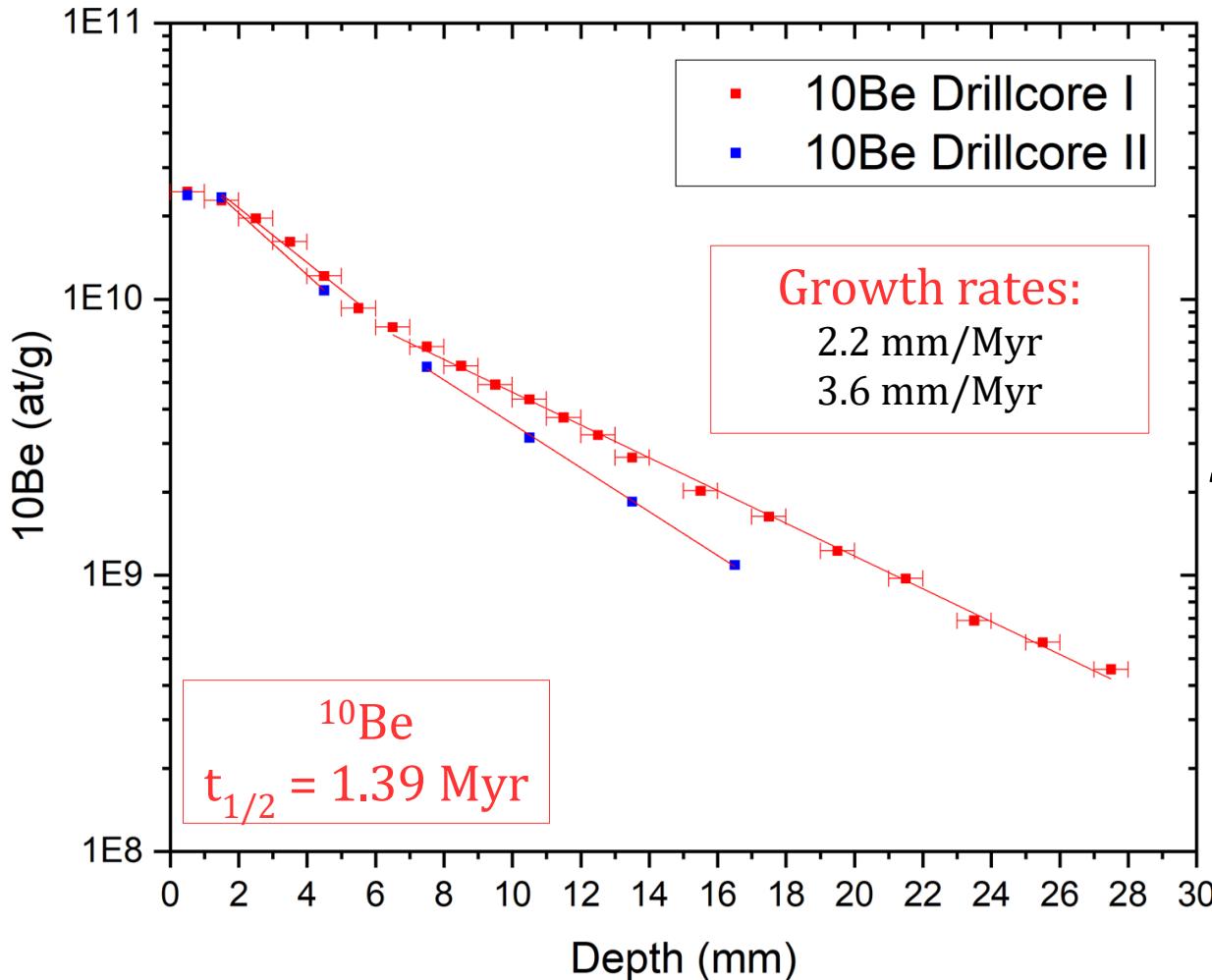
Crab nebula
Remnant of supernova 1054 AD
Distance = 6,300 ly, dia = 11 ly

Can we find isotopic fingerprints of the ISM (interstellar medium) in terrestrial archives?

Radionuclides contain time information as they can serve as radioactive clocks!

^{244}Pu (80 Myr)
 ^{60}Fe (2.6 Myr)

Cosmogenic Be-10 - preliminary



AMS @ HZDR

6 MV Tandetron

Sensitivity: few $\times 10^{-16}$