WP9/NA4 *Mass Spectrometry* Network

CSFK, HULL, IPGP Paris, ETH Zurich, UNIVIE, HZDR

Associates: Manchester, Copenhagen

Not spectroscopy → it does not involves light ☺

Mass spectrometry allows us to measure the composition of physical samples

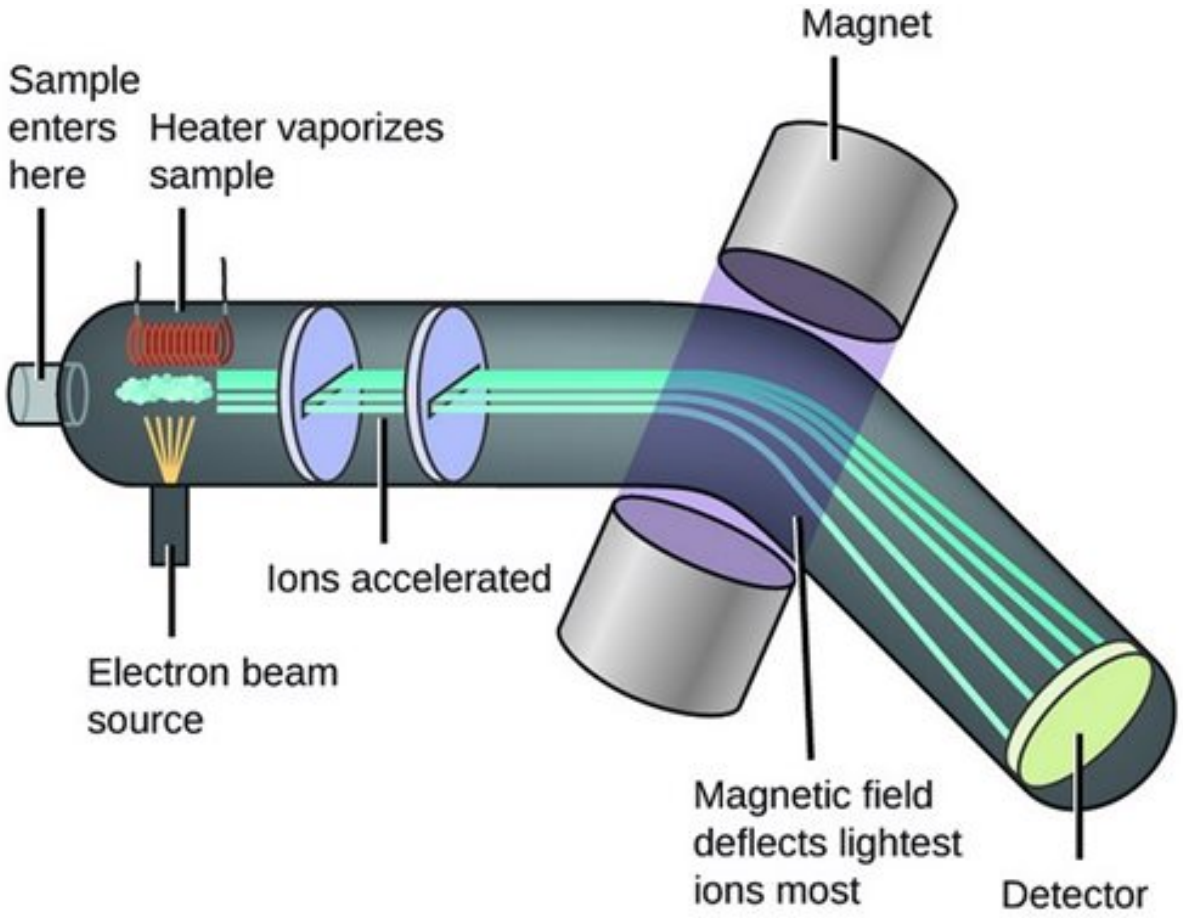
WP9/NA4 ***Mass Spectrometry*** **Network**

CSFK, HULL, IPGP Paris, ETH Zurich, UNIVIE, HZDR

Associates: Manchester, Copenhagen

Not spectroscopy → it does not involves light ☺

Mass spectrometry allows us to measure the composition of physical samples



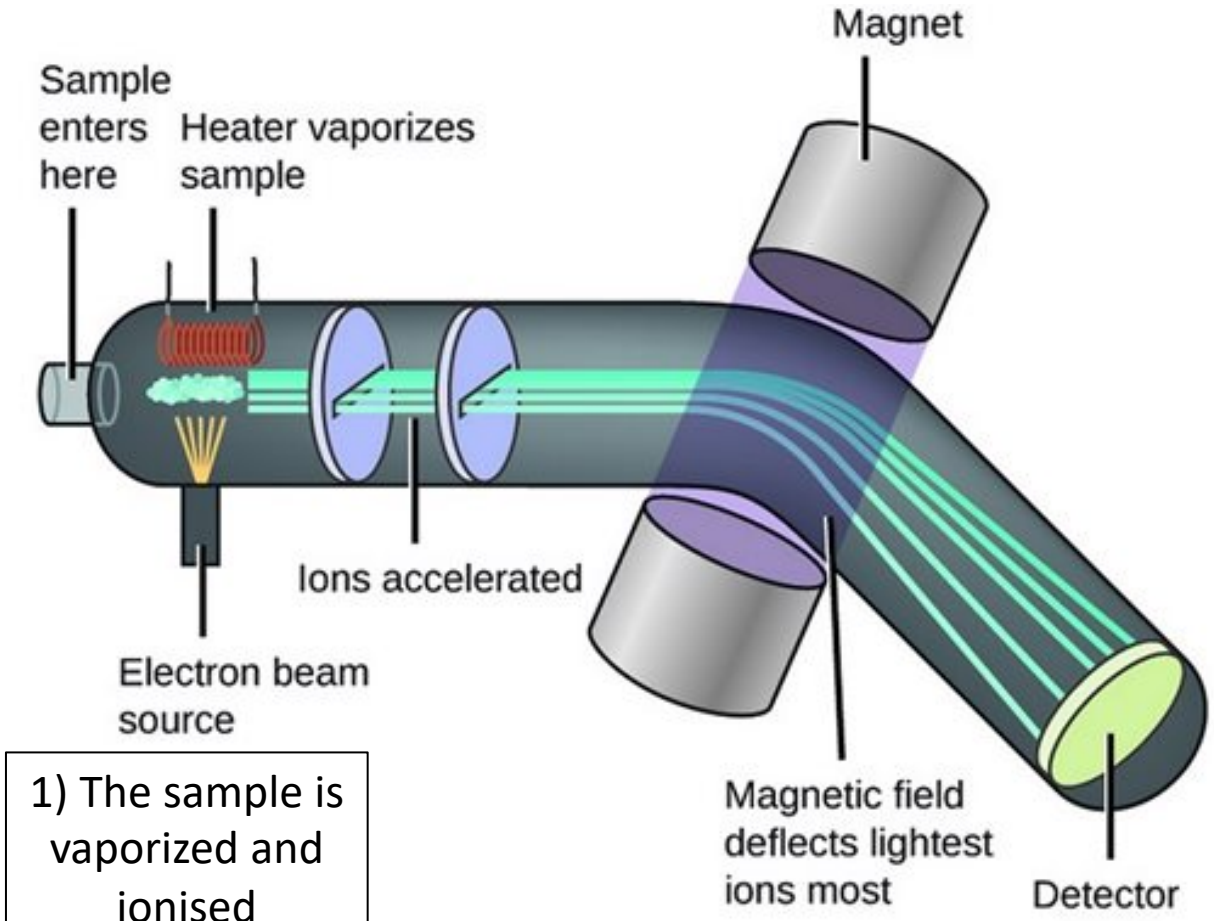
WP9/NA4 *Mass Spectrometry* Network

CSFK, HULL, IPGP Paris, ETH Zurich, UNIVIE, HZDR

Associates: Manchester, Copenhagen

Not spectroscopy → it does not involves light ☺

Mass spectrometry allows us to measure the composition of physical samples



1) The sample is vaporized and ionised

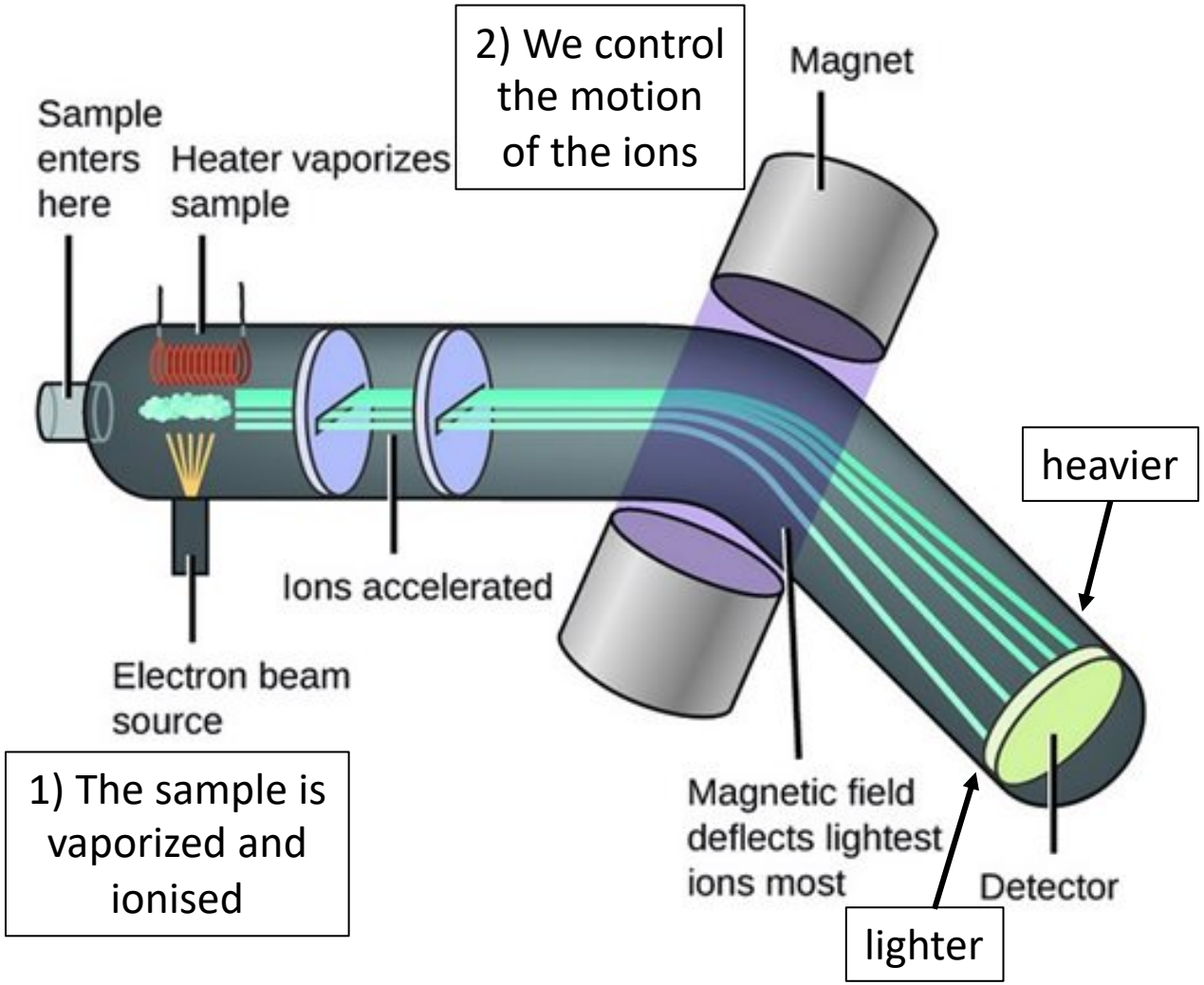
WP9/NA4 *Mass Spectrometry* Network

CSFK, HULL, IPGP Paris, ETH Zurich, UNIVIE, HZDR

Associates: Manchester, Copenhagen

Not spectroscopy → it does not involves light ☺

Mass spectrometry allows us to measure the composition of physical samples



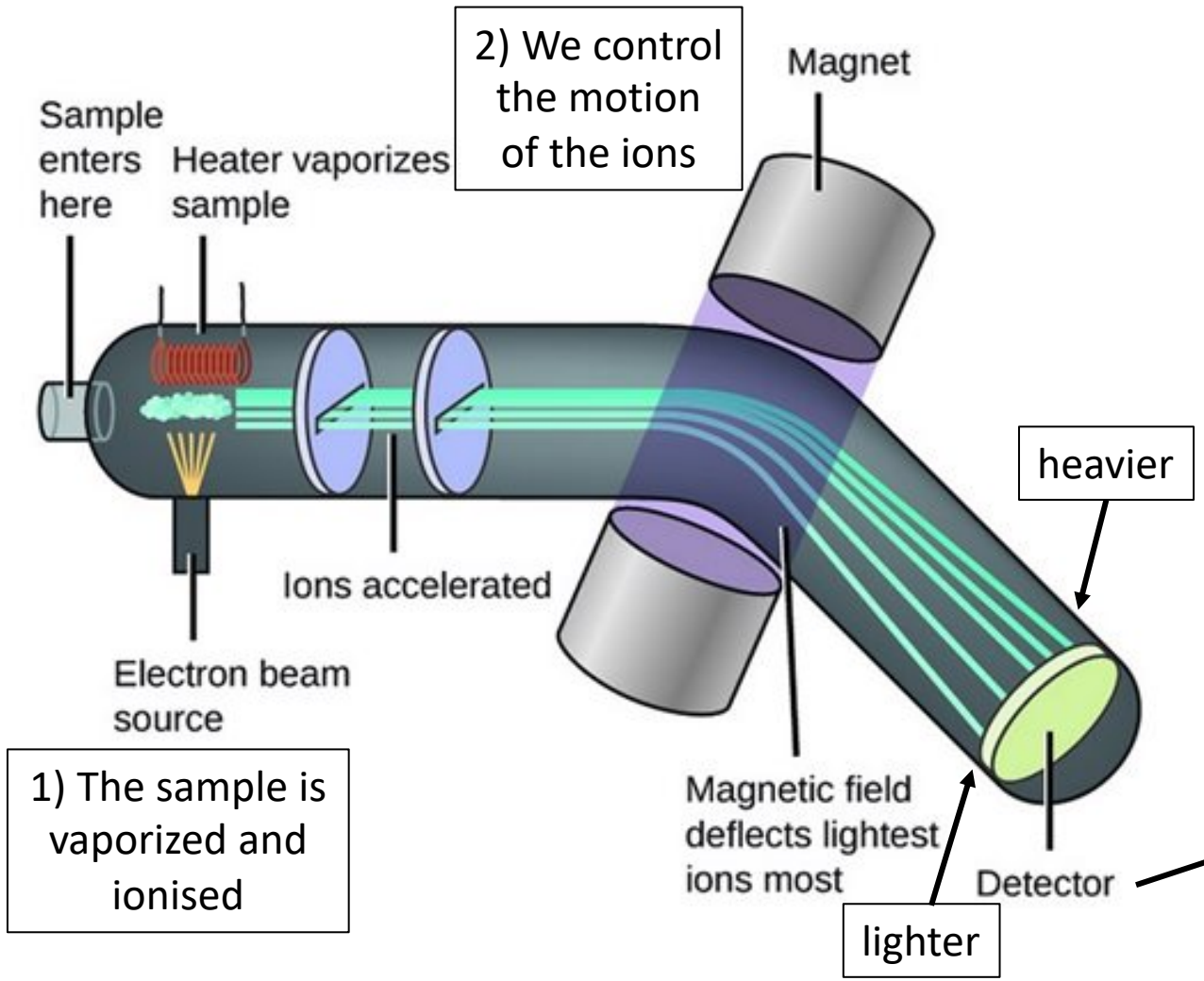
WP9/NA4 *Mass Spectrometry* Network

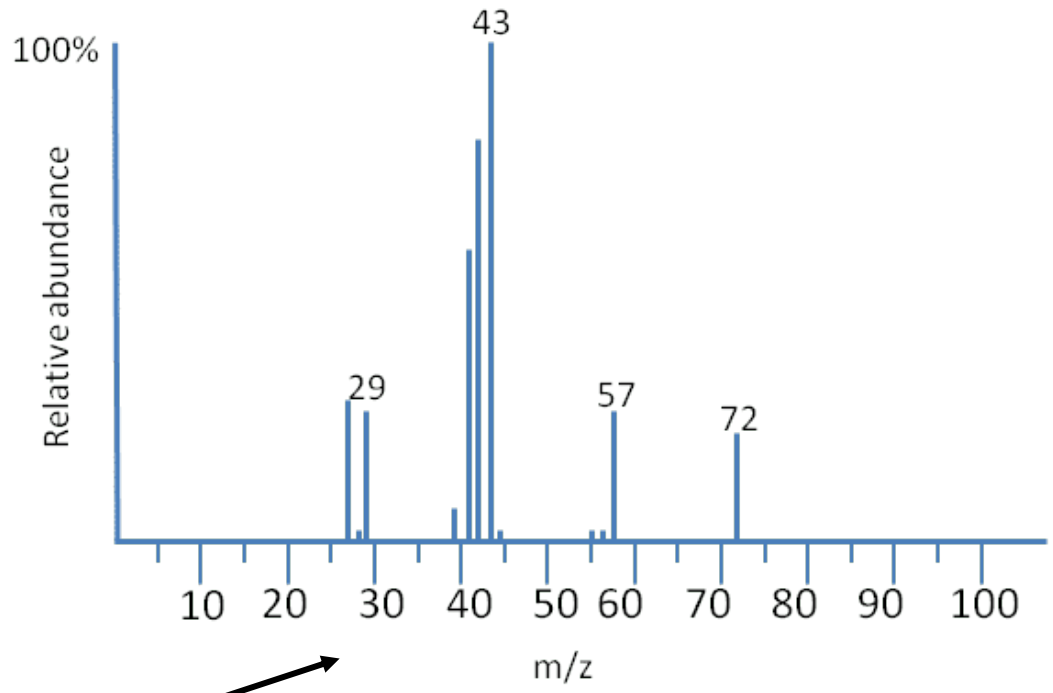
CSFK, HULL, IPGP Paris, ETH Zurich, UNIVIE, HZDR

Associates: Manchester, Copenhagen

Not spectroscopy → it does not involves light ☺

Mass spectrometry allows us to measure the composition of physical samples





3) Obtain a spectra as function of mass/charge → isotopes

WP9/NA4 *Mass Spectrometry* Network

CSFK, HULL, IPGP Paris, ETH Zurich, UNIVIE, HZDR

Associates: Manchester, Copenhagen

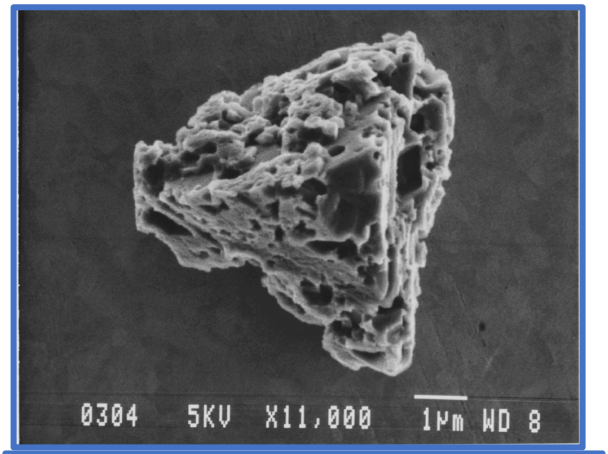
Mass spectrometry allows us to measure the composition of physical samples and see the direct signature of stellar nucleosynthesis

WP9/NA4 *Mass Spectrometry* Network

CSFK, HULL, IPGP Paris, ETH Zurich, UNIVIE, HZDR

Associates: Manchester, Copenhagen

Mass spectrometry allows us to measure the composition of physical samples and see the direct signature of stellar nucleosynthesis



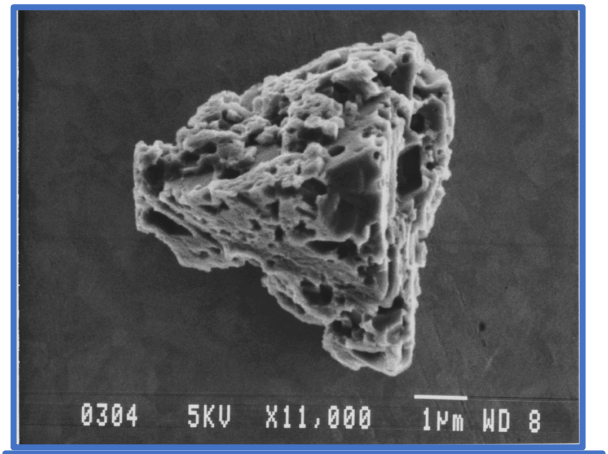
A most famous example are **stardust grains** extracted from meteorites: these grains formed in stars and supernovae

WP9/NA4 *Mass Spectrometry* Network

CSFK, HULL, IPGP Paris, ETH Zurich, UNIVIE, HZDR

Associates: Manchester, Copenhagen

Mass spectrometry allows us to measure the composition of physical samples and see the direct signature of stellar nucleosynthesis



A most famous example are **stardust grains** extracted from meteorites: these grains formed in stars and supernovae

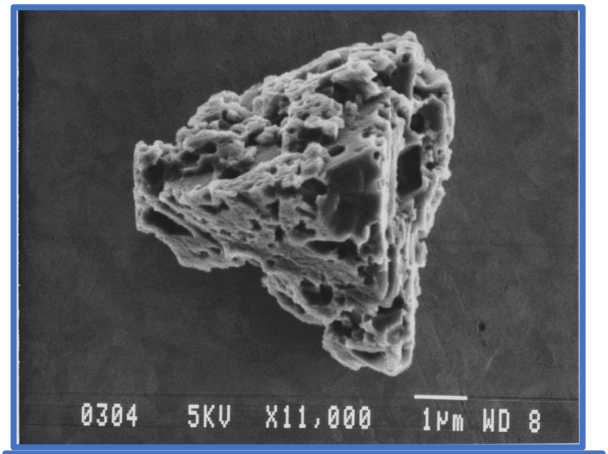
Another most famous example is **deep-sea crust**: these rocks collect radioactive nuclei from supernovae

WP9/NA4 *Mass Spectrometry* Network

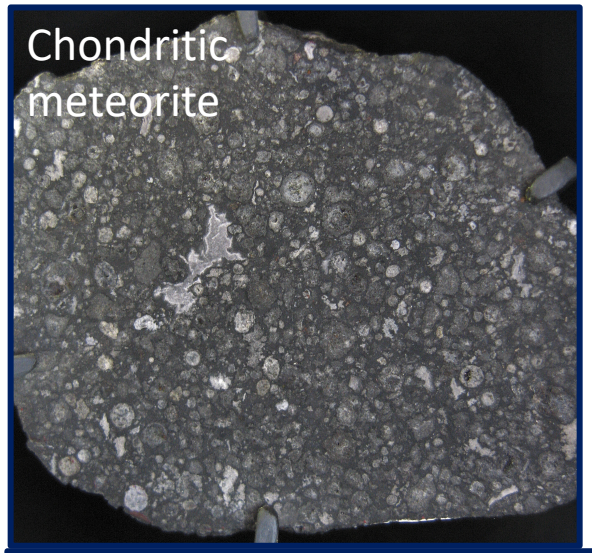
CSFK, HULL, IPGP Paris, ETH Zurich, UNIVIE, HZDR

Associates: Manchester, Copenhagen

Mass spectrometry allows us to measure the composition of physical samples and see the direct signature of stellar nucleosynthesis



A most famous example are **stardust grains** extracted from meteorites: these grains formed in stars and supernovae



Meteoritic rocks and their inclusions contain signatures of stellar nucleosynthesis! albeit very diluted

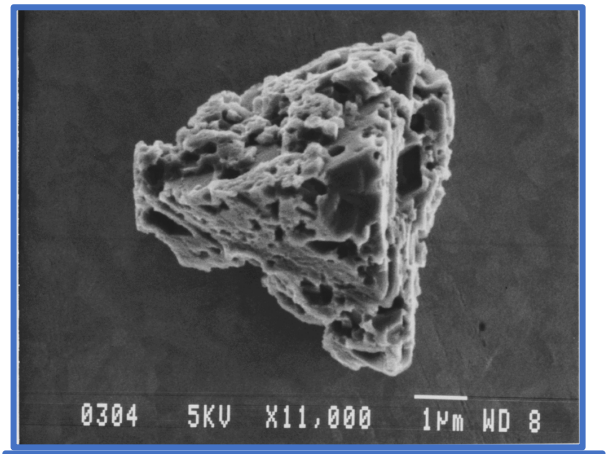
Another most famous example is **deep-sea crust**: these rocks collect radioactive nuclei from supernovae

WP9/NA4 *Mass Spectrometry* Network

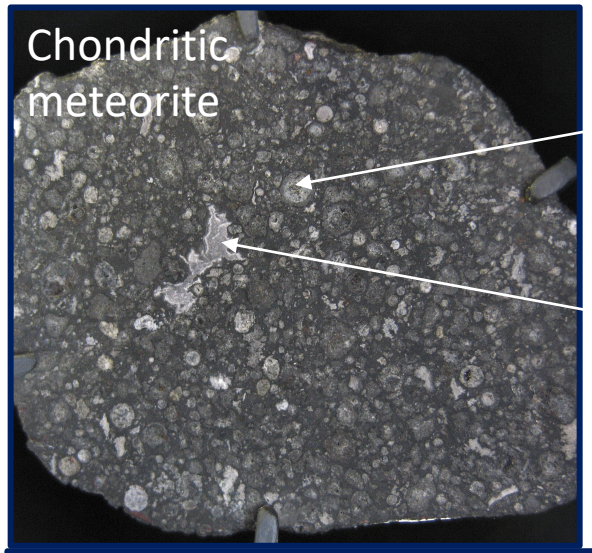
CSFK, HULL, IPGP Paris, ETH Zurich, UNIVIE, HZDR

Associates: Manchester, Copenhagen

Mass spectrometry allows us to measure the composition of physical samples and see the direct signature of stellar nucleosynthesis



A most famous example are **stardust grains** extracted from meteorites: these grains formed in stars and supernovae



Chondrules: roundish previously melted droplets

Calcium-aluminium-rich inclusions: the oldest solids in the Solar System, they tell us the age of the Sun

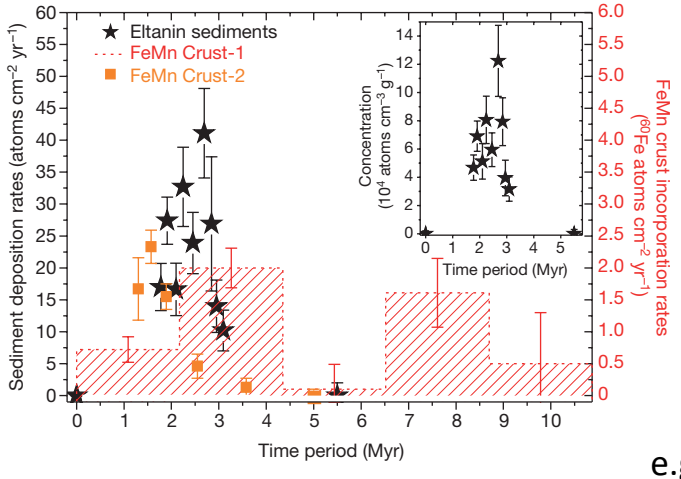
Meteoritic rocks and their inclusions contain signatures of stellar nucleosynthesis! albeit very diluted

Another most famous example is **deep-sea crust**: these rocks collect radioactive nuclei from supernovae

WP9/NA4 *Mass Spectrometry* Network

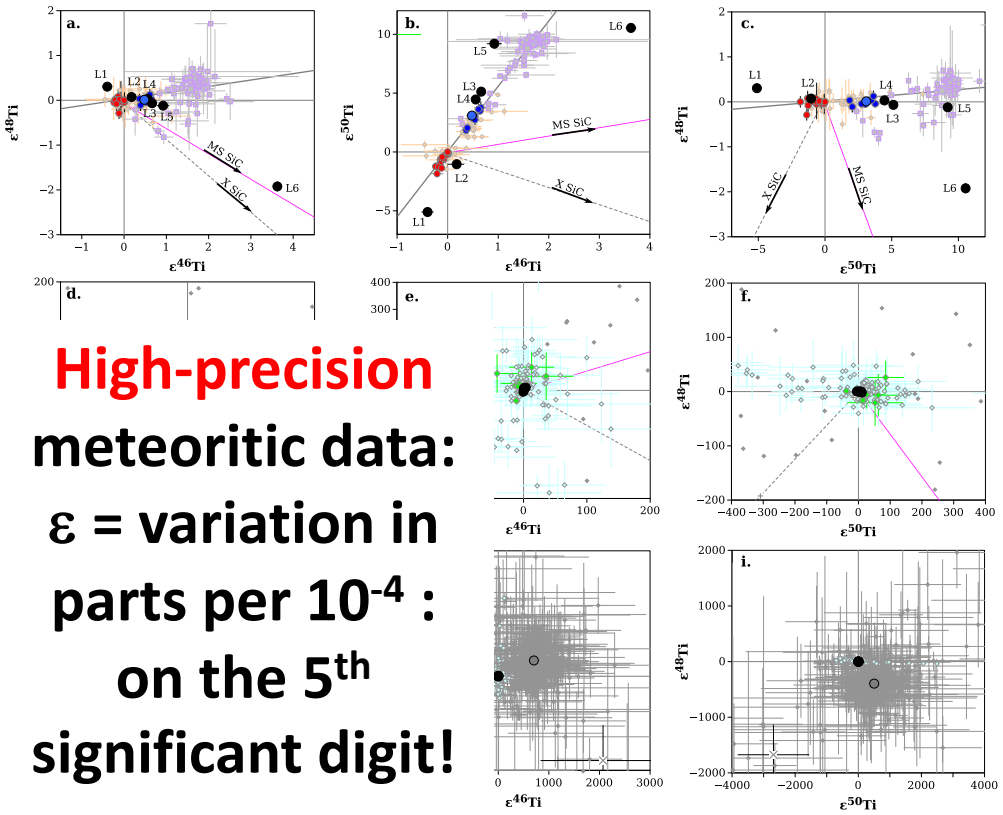
CSFK, HULL, IPGP Paris, ETH Zurich, UNIVIE, HZDR

Associates: Manchester, Copenhagen



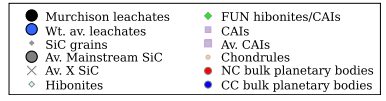
High-sensitivity deep crust data: $^{60}Fe/^{56}Fe < 10^{-12}$

e.g. Wallner et al. 2016



High-precision meteoritic data: ε = variation in parts per 10^{-4} : on the 5th significant digit!

e.g. Burkhardt et al. 2019

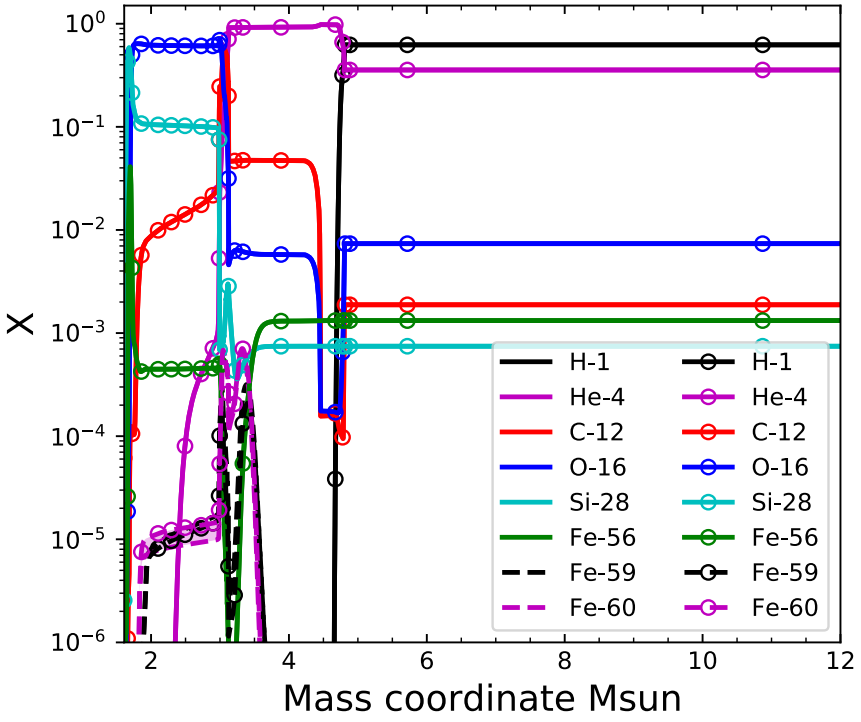


WP9/NA4 *Mass Spectrometry* Network

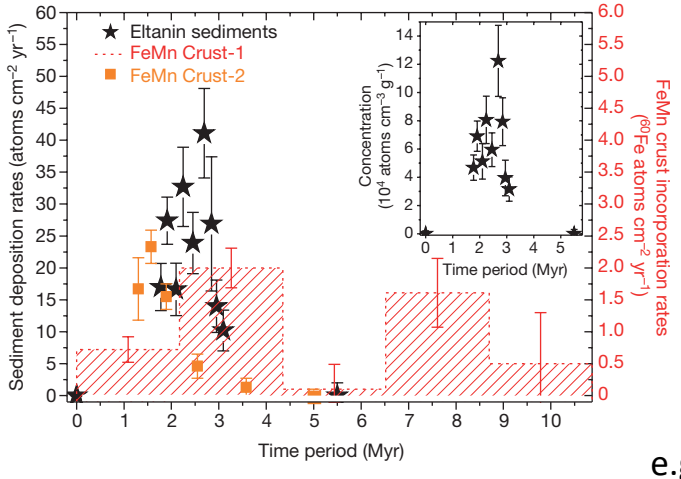
CSFK, HULL, IPGP Paris, ETH Zurich, UNIVIE, HZDR

Associates: Manchester, Copenhagen

Stellar nucleosynthesis models

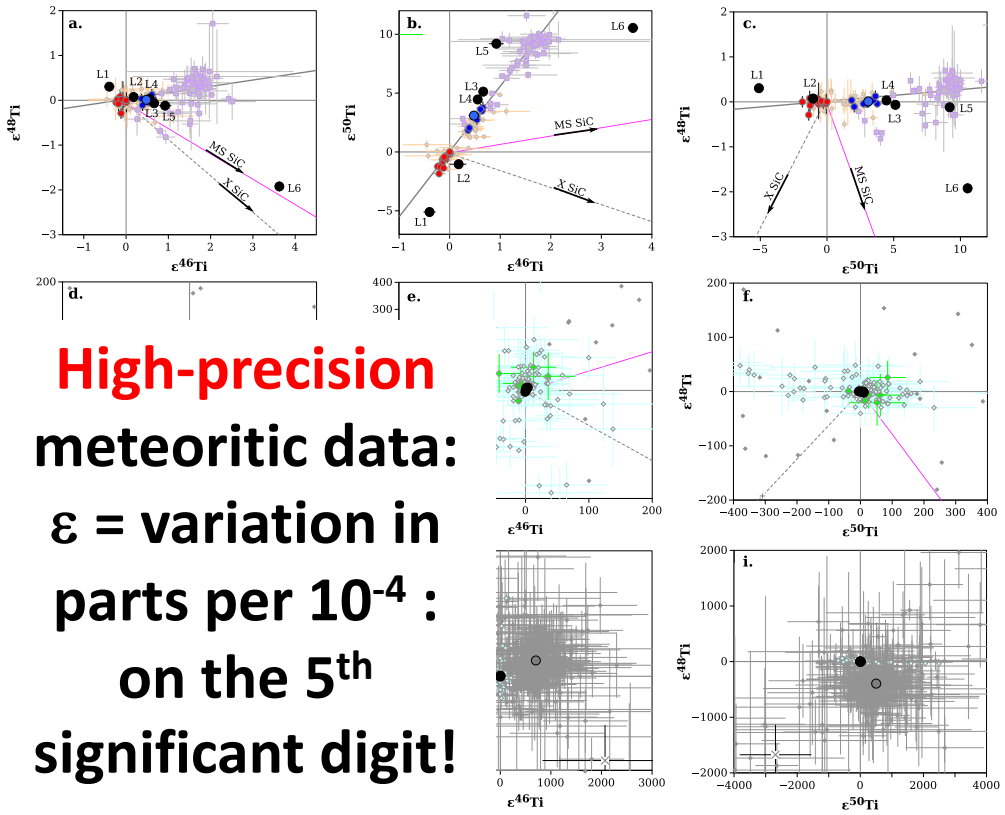


A core-collapse supernova spaghetti plot by M. Pignatari



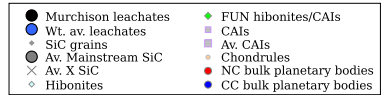
High-sensitivity deep crust data: $^{60}Fe/^{56}Fe < 10^{-12}$

e.g. Wallner et al. 2016



High-precision meteoritic data: ε = variation in parts per 10^{-4} : on the 5th significant digit!

e.g. Burkhardt et al. 2019

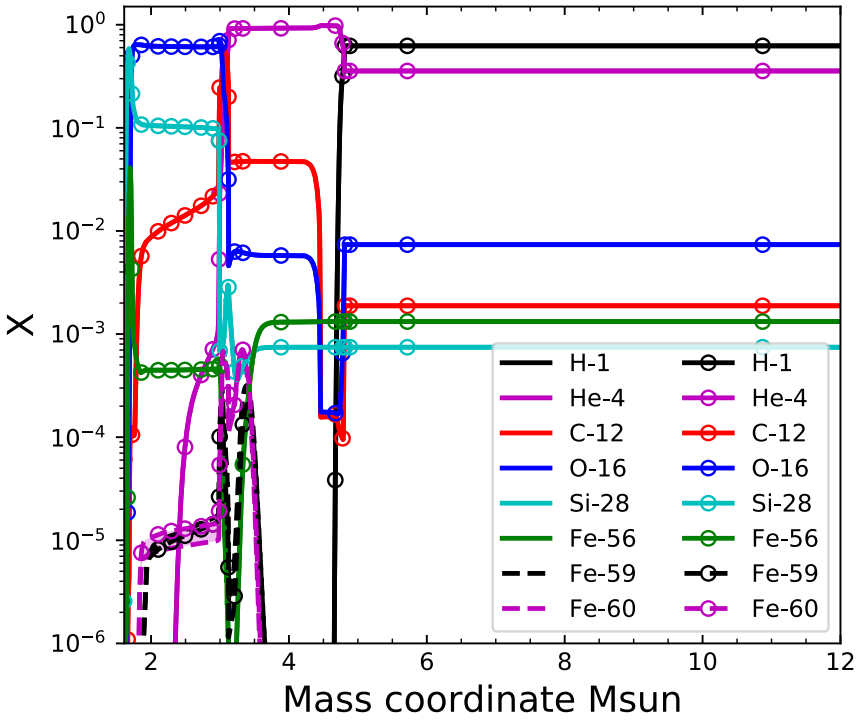


WP9/NA4 *Mass Spectrometry* Network

CSFK, HULL, IPGP Paris, ETH Zurich, UNIVIE, HZDR

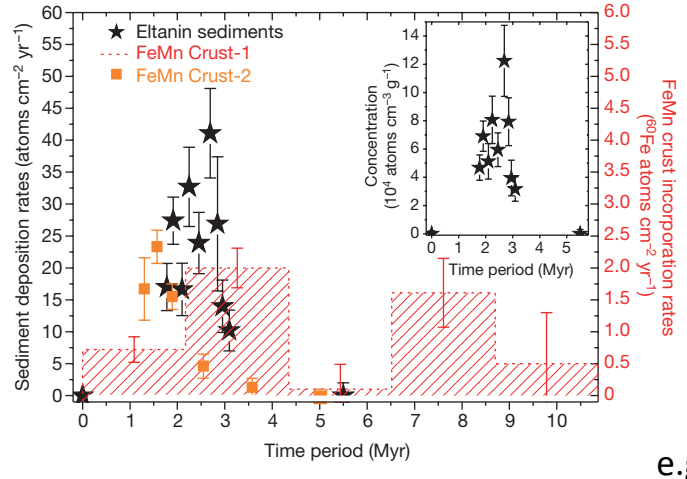
Associates: Manchester, Copenhagen

Stellar nucleosynthesis models



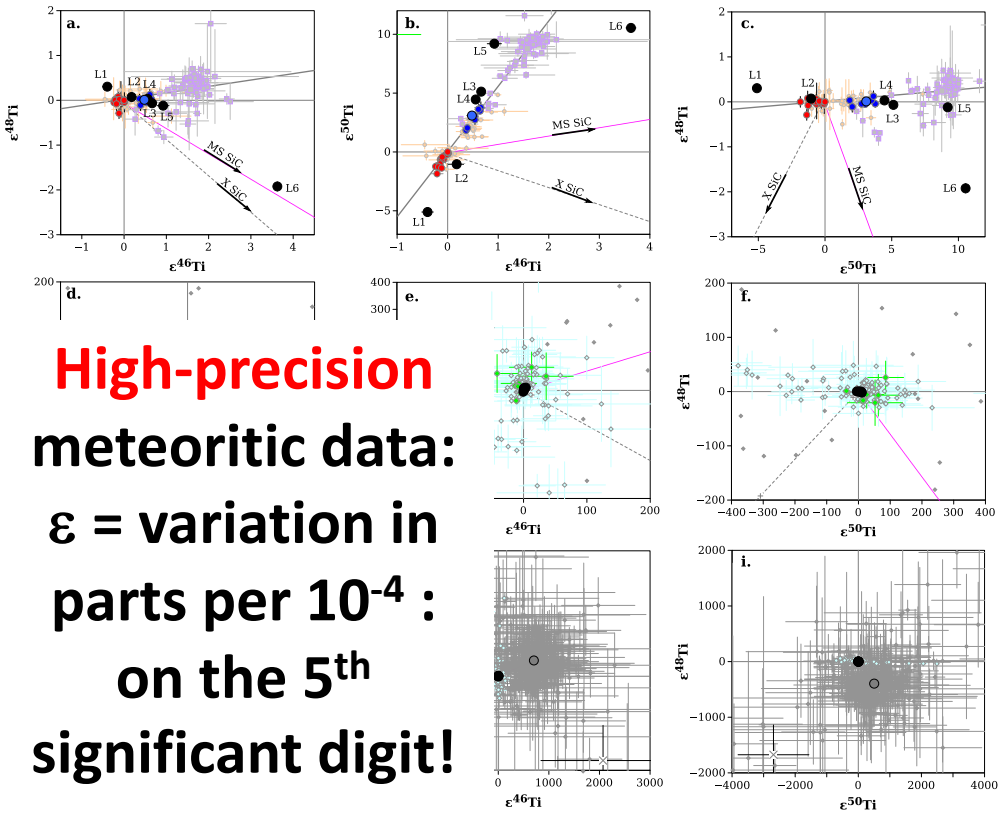
A core-collapse supernova spaghetti plot by M. Pignatari

How do we go from here to there and back?



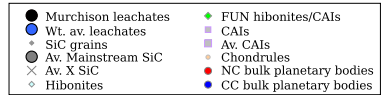
High-sensitivity deep crust data: $^{60}Fe/^{56}Fe < 10^{-12}$

e.g. Wallner et al. 2016



High-precision meteoritic data: ε = variation in parts per 10^{-4} : on the 5th significant digit!

e.g. Burkhardt et al. 2019



Computational algorithms to translate and interpret from stars to meteorites and Earth samples and back

1) Translate predictions from stellar yields into **units and representations** from laboratory analysis of meteorites

2) Predict expected variations to be seen in Solar System materials and stardust grains, including **nucleosynthesis, chemistry,** and **dust condensation plus implantation** of ionised noble gases into dust grains

3) Produce, transport and incorporate **radioisotopes** in Earth material

Computational algorithms to translate and interpret from stars to meteorites and Earth samples and back

1) Translate predictions from stellar yields into **units and representations** from laboratory analysis of meteorites

2) Predict expected variations to be seen in Solar System materials and stardust grains, including **nucleosynthesis, chemistry,** and **dust condensation plus implantation** of ionised noble gases into dust grains

3) Produce, transport and incorporate **radioisotopes** in Earth material

Online database of data from meteorites and their inclusions (similar to the presolar grain database)

Computational algorithms to translate and interpret from stars to meteorites and Earth samples and back

1) Translate predictions from stellar yields into **units and representations** from laboratory analysis of meteorites
2) Predict expected variations to be seen in Solar System materials and stardust grains, including **nucleosynthesis, chemistry,** and **dust condensation plus implantation** of ionised noble gases into dust grains
3) Produce, transport and incorporate **radioisotopes** in Earth material

Online database of data from meteorites and their inclusions (similar to the presolar grain database)

Generate an online database of example predictions representing nuclear astrophysics model predictions of correlations between stable/stable and radioactive/stable abundances of specific isotopes

In practice there will be a **code developer**, and then all of us will provide ***inputs*** and be ***users***

Work package number	9	Lead beneficiary		CSFK/17	
Work package title	NA4 Mass Spectrometry Network				
Participant number	1	2	9	17	30	32
Short name of participant	HZDR	UNIVIE	IPGP	CSFK	ETH Zürich	UHULL
Person-months per participant	0	6	10	14	12	3
Participant number	Assoc.	Assoc.				
Short name of participant	Univ. Manchester	Univ. Copenhagen				

Maria Lugaro, theory

Anton Wallner, deep crust

Marc Chaussidon, meteorites

Marco Pignatari, theory

Robin Golser, deep crust

Maria Schonbachler, meteorites

Martin Bizzarro, meteorites

Jamie Gilmour, meteorites/noble gases

Within the spirit of INFRA **Integrating Activities for Starting Communities:**

This is not the whole job, and we will not have full, final results!

The objective is to start to make the tools and preparing people

Objectives

We aim to offer the first combined multi-disciplinary training in both the laboratory analyses of Solar System materials showing signatures of stellar nucleosynthesis, and the nuclear astrophysics modelling necessary to interpret such signatures. We will build

i) a new generation of scientists who can effectively operate at the interface between nuclear astrophysics and laboratory sample analysis and can act as future trainers for researcher groups

ii) the new tools (codes, methods, comprehensive approaches) required for communicating and operating at such interface. We will create and strengthen inter-disciplinary communities made of individuals with multi-disciplinary experience and communicating skills, who can disseminate this knowledge to the wider community.