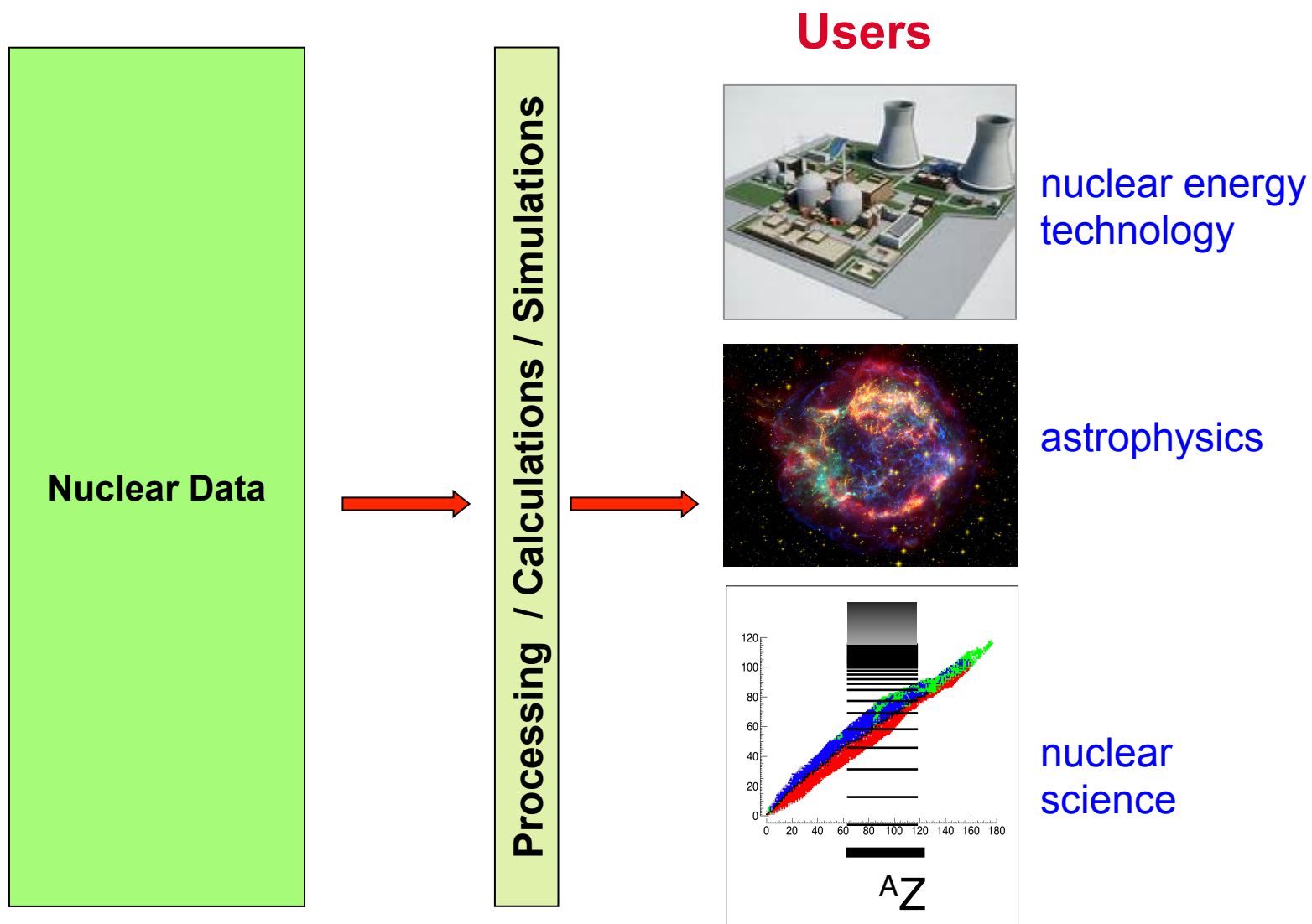
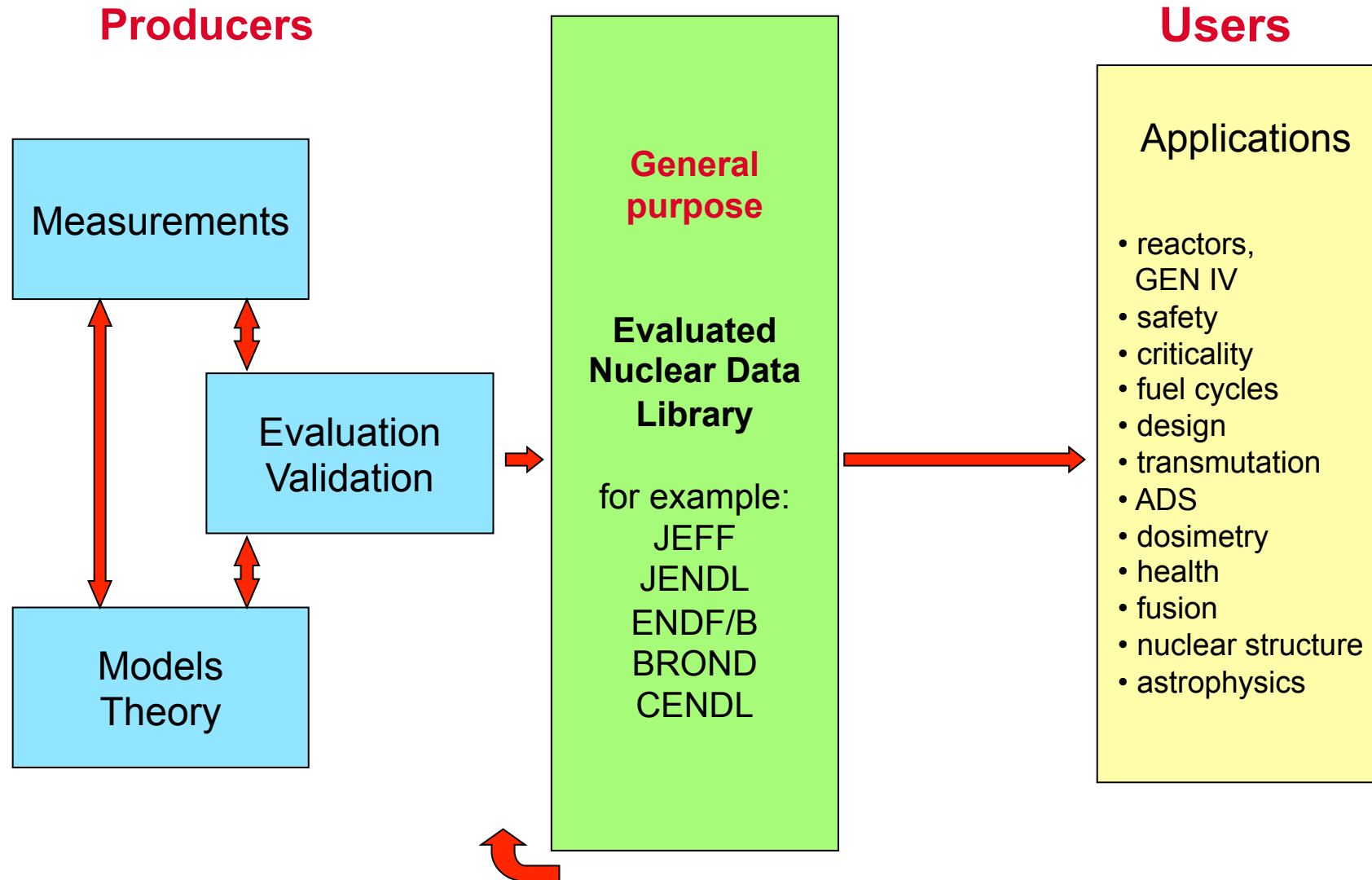


The measurement programme at the neutron time-of-flight facility n_TOF at CERN

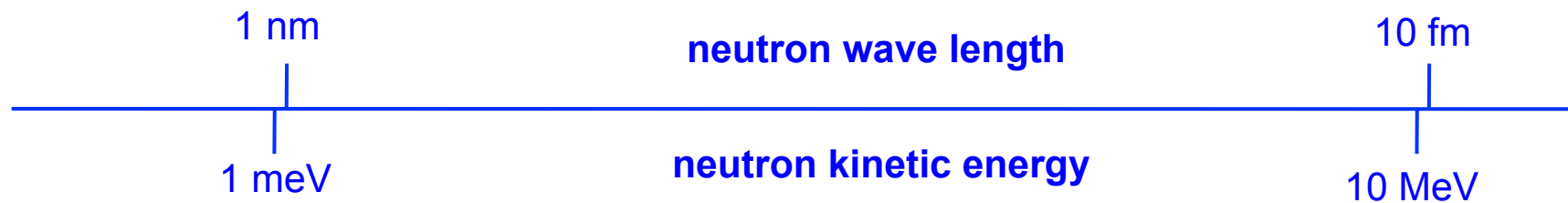
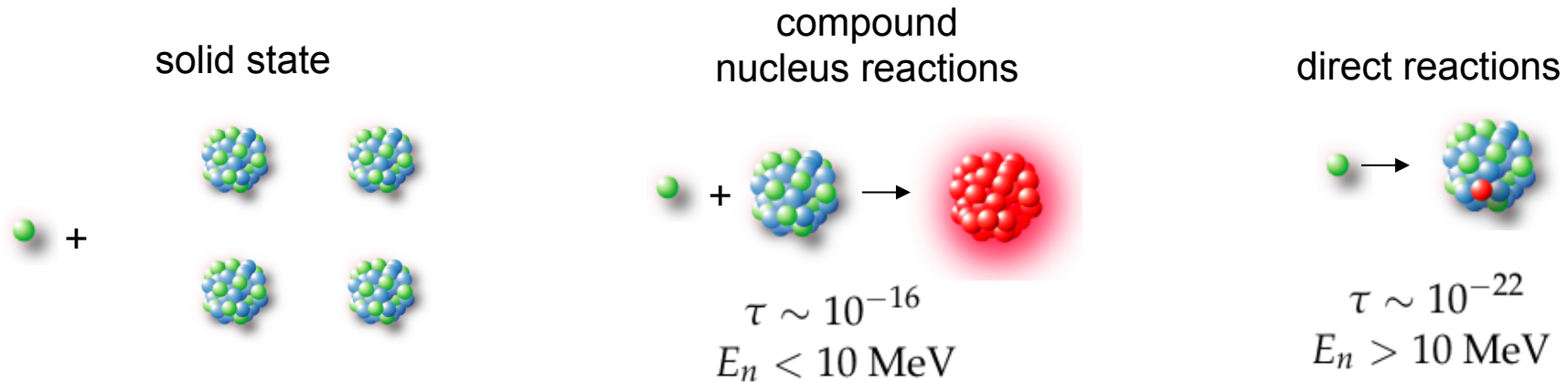
Frank Gunsing
CEA Saclay, Irfu
F-91191 Gif-sur-Yvette

on behalf of the n_TOF Collaboration

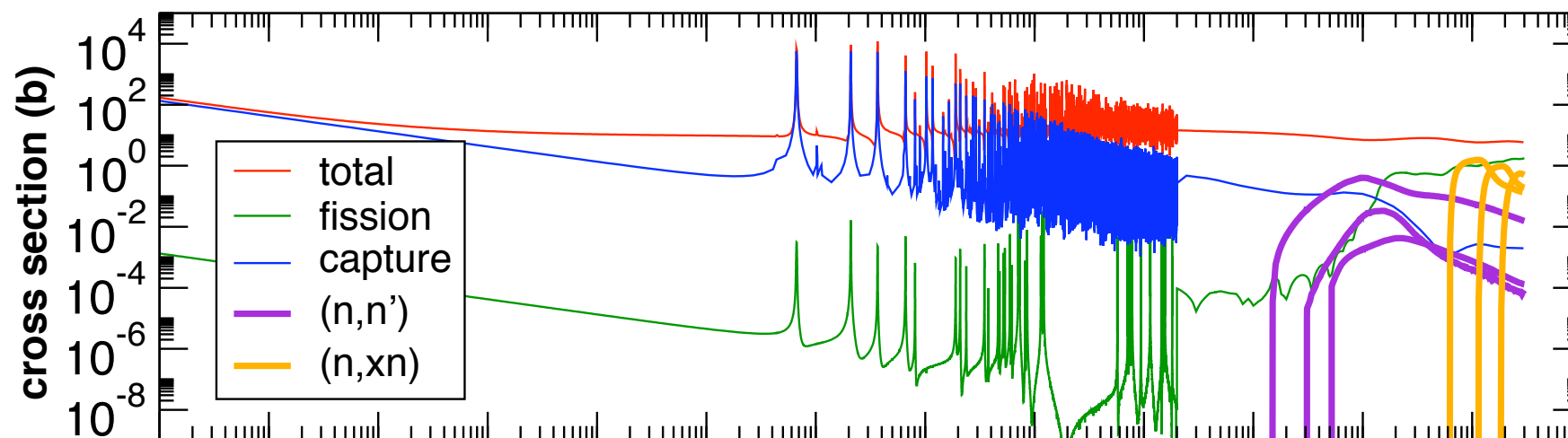




Neutron induced reactions

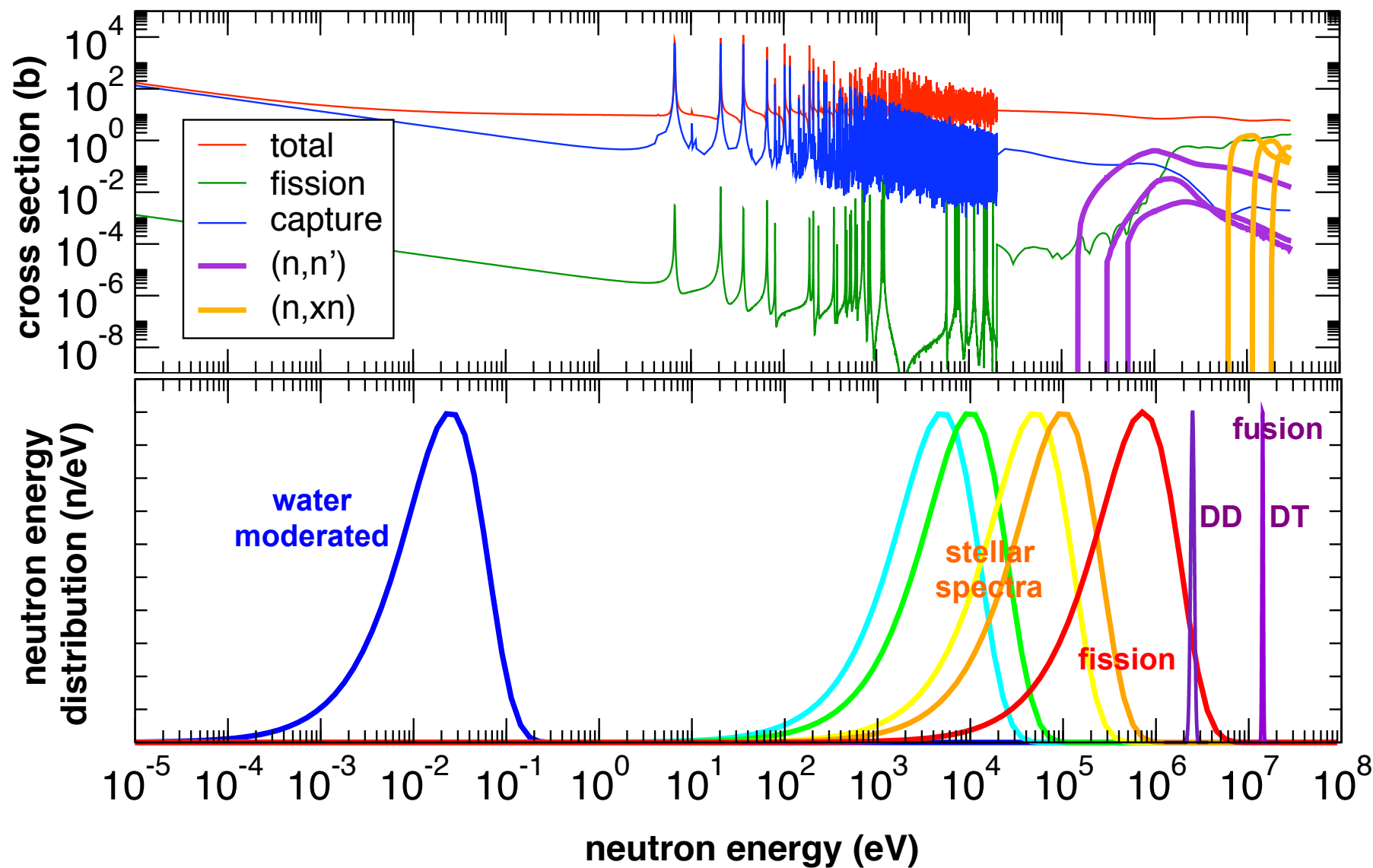


Neutron cross sections



neutron energy (eV)

Neutron cross sections



Neutron cross sections

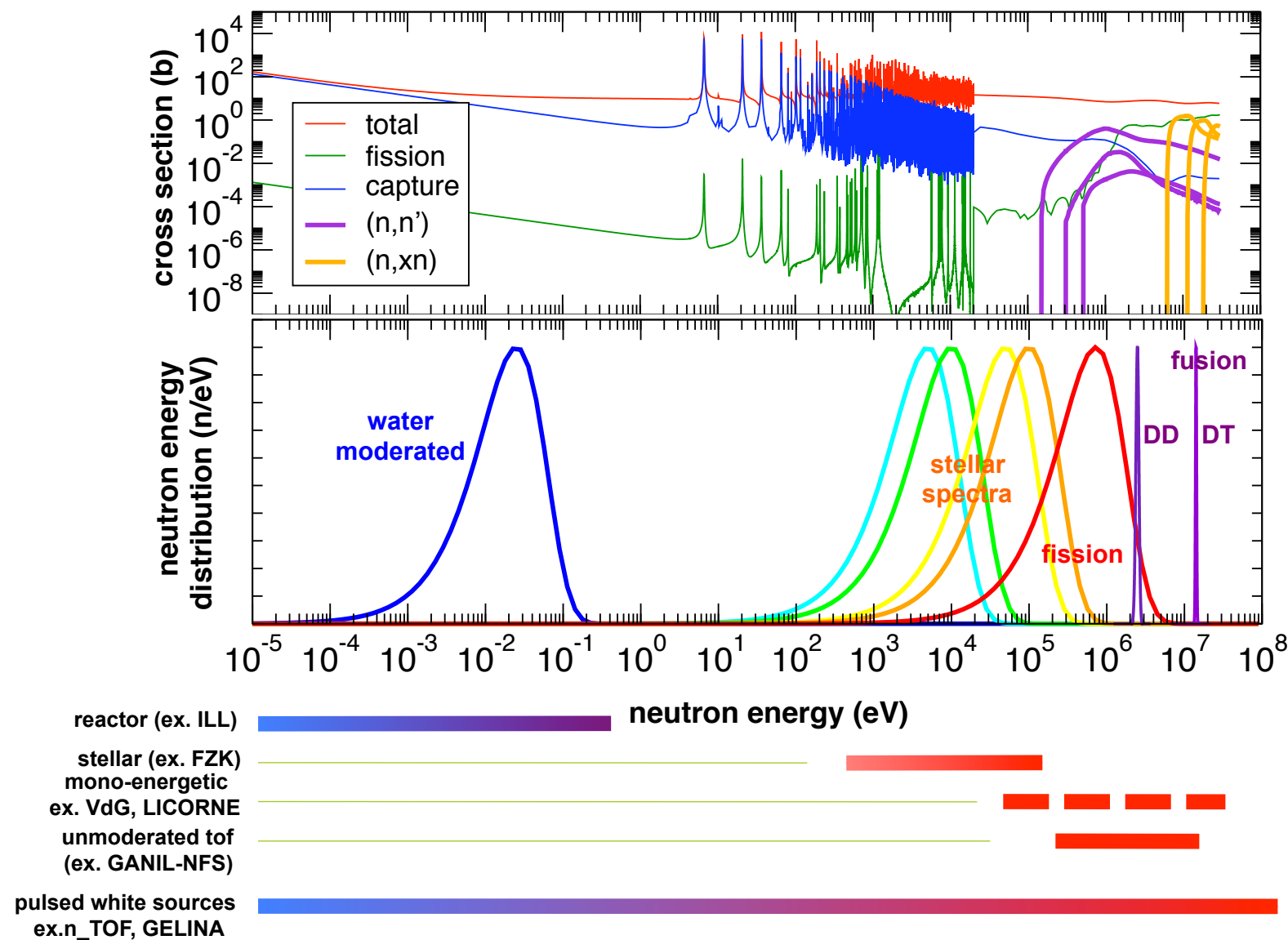
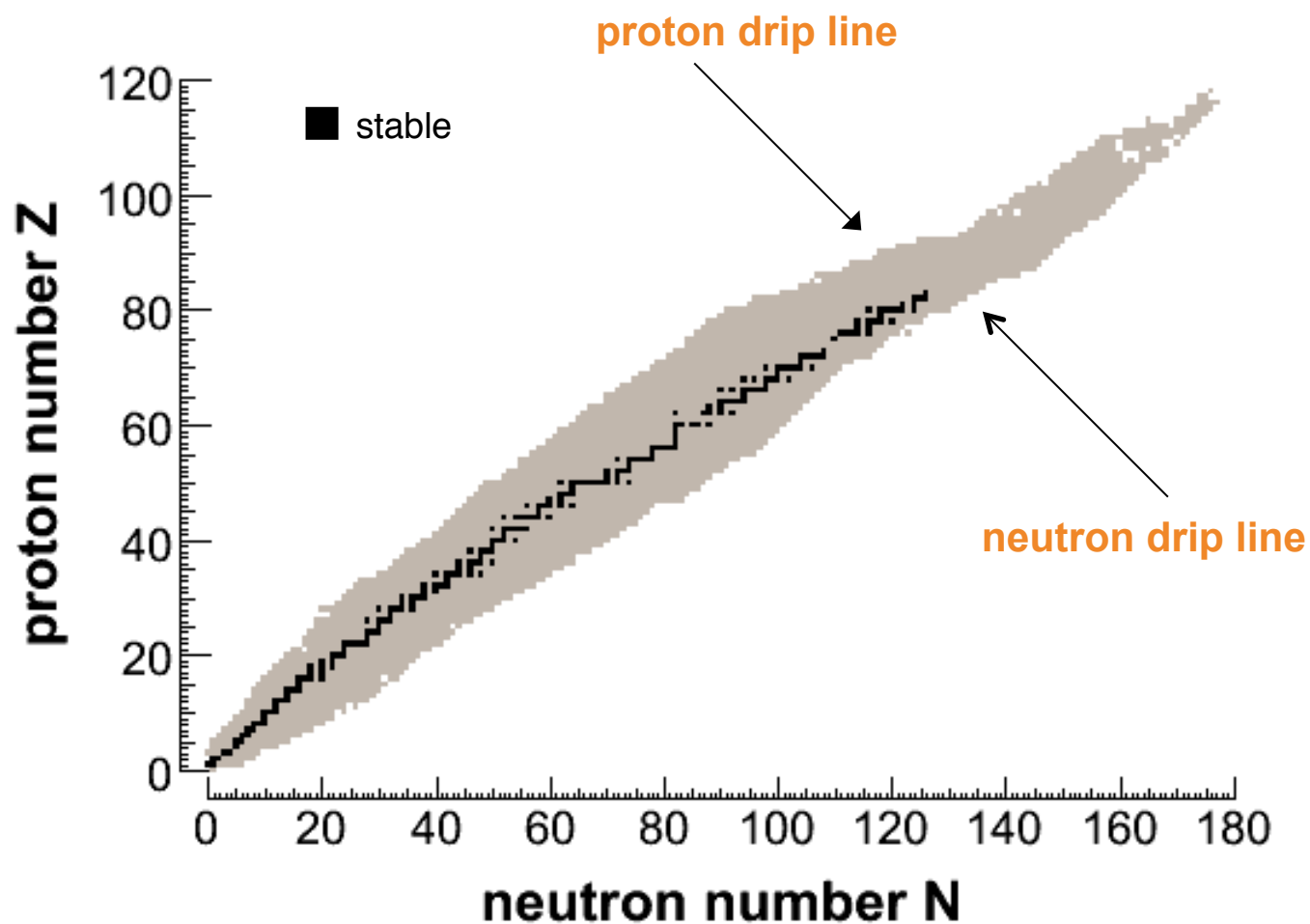
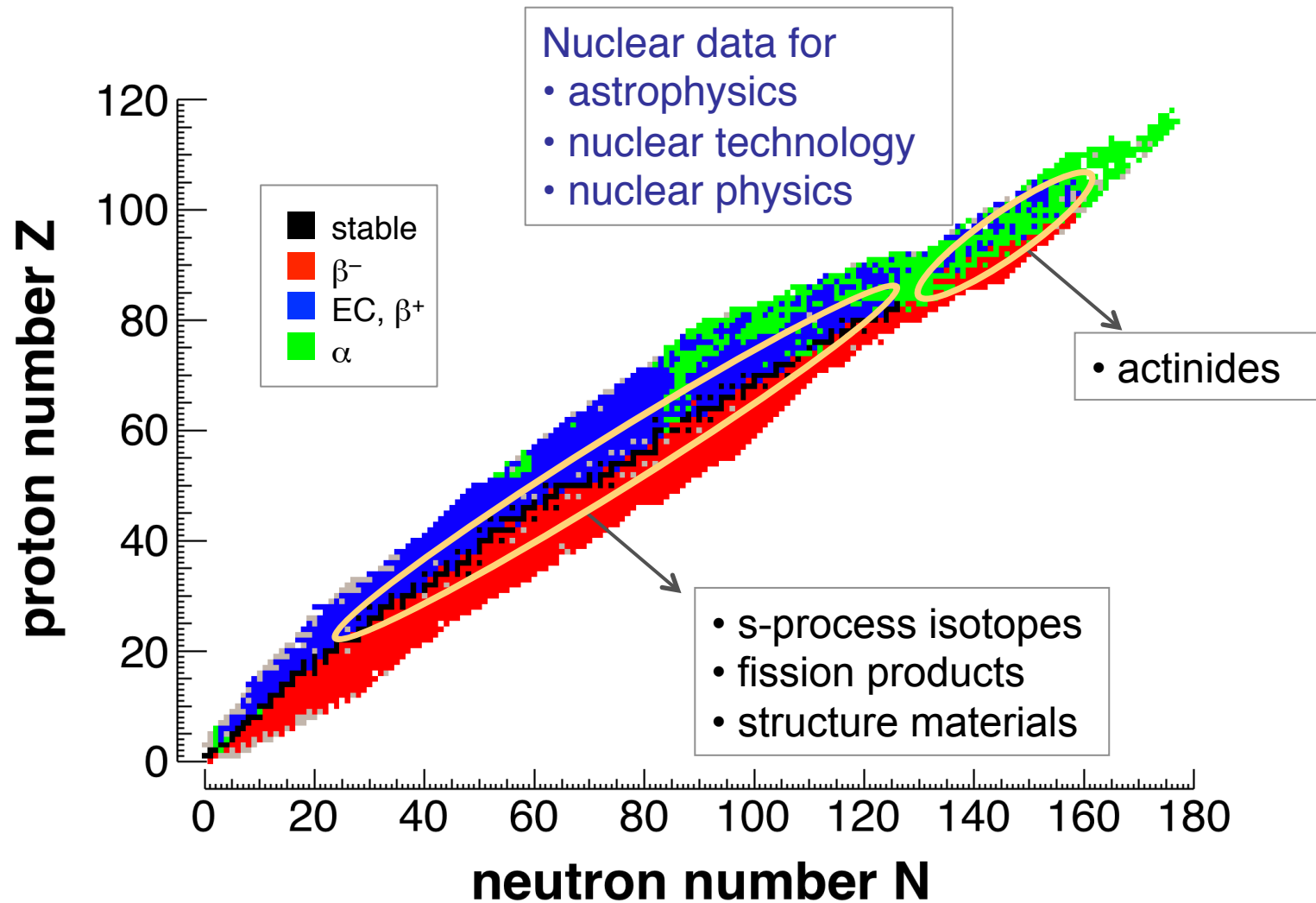
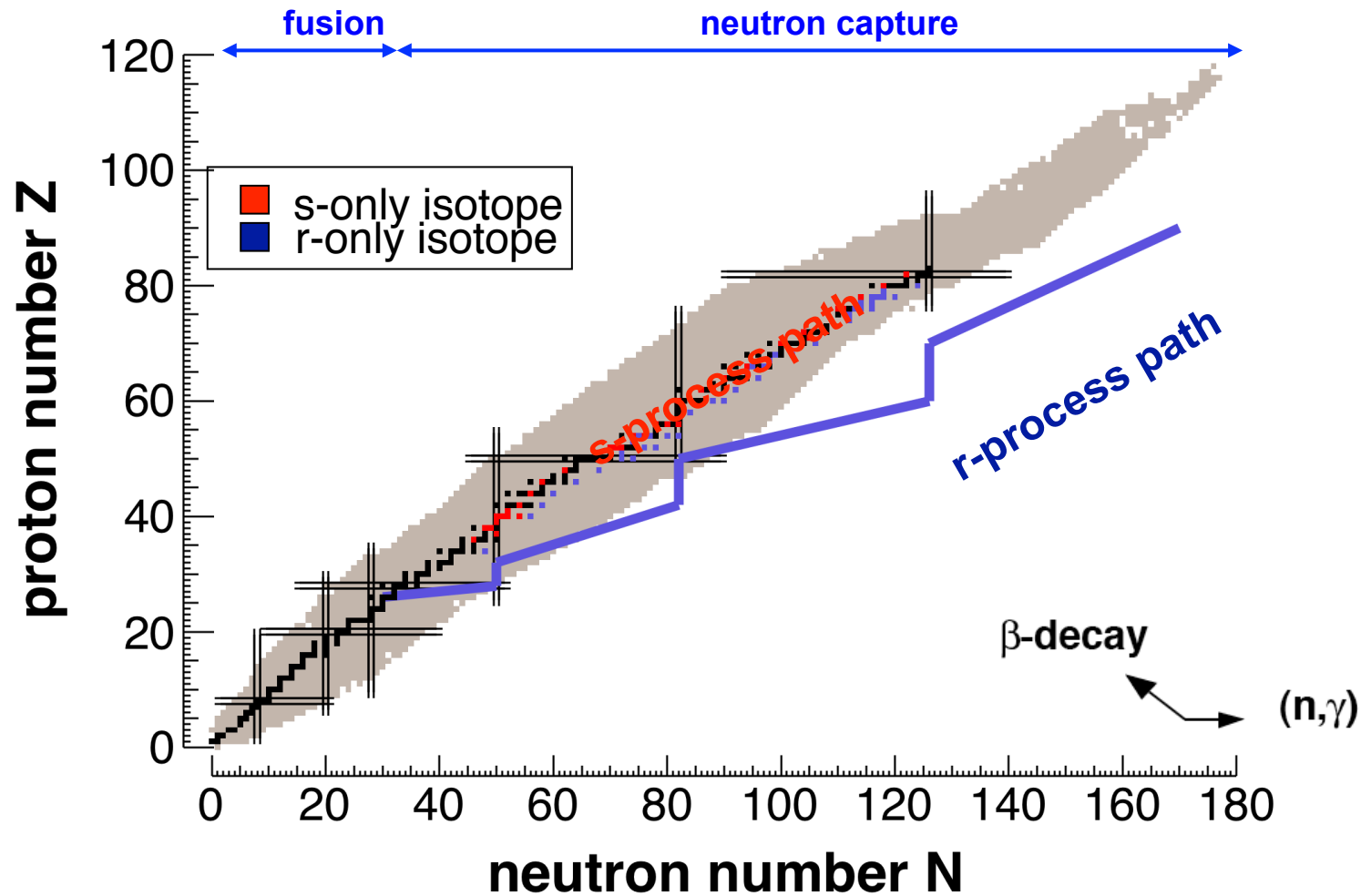


Chart of nuclides

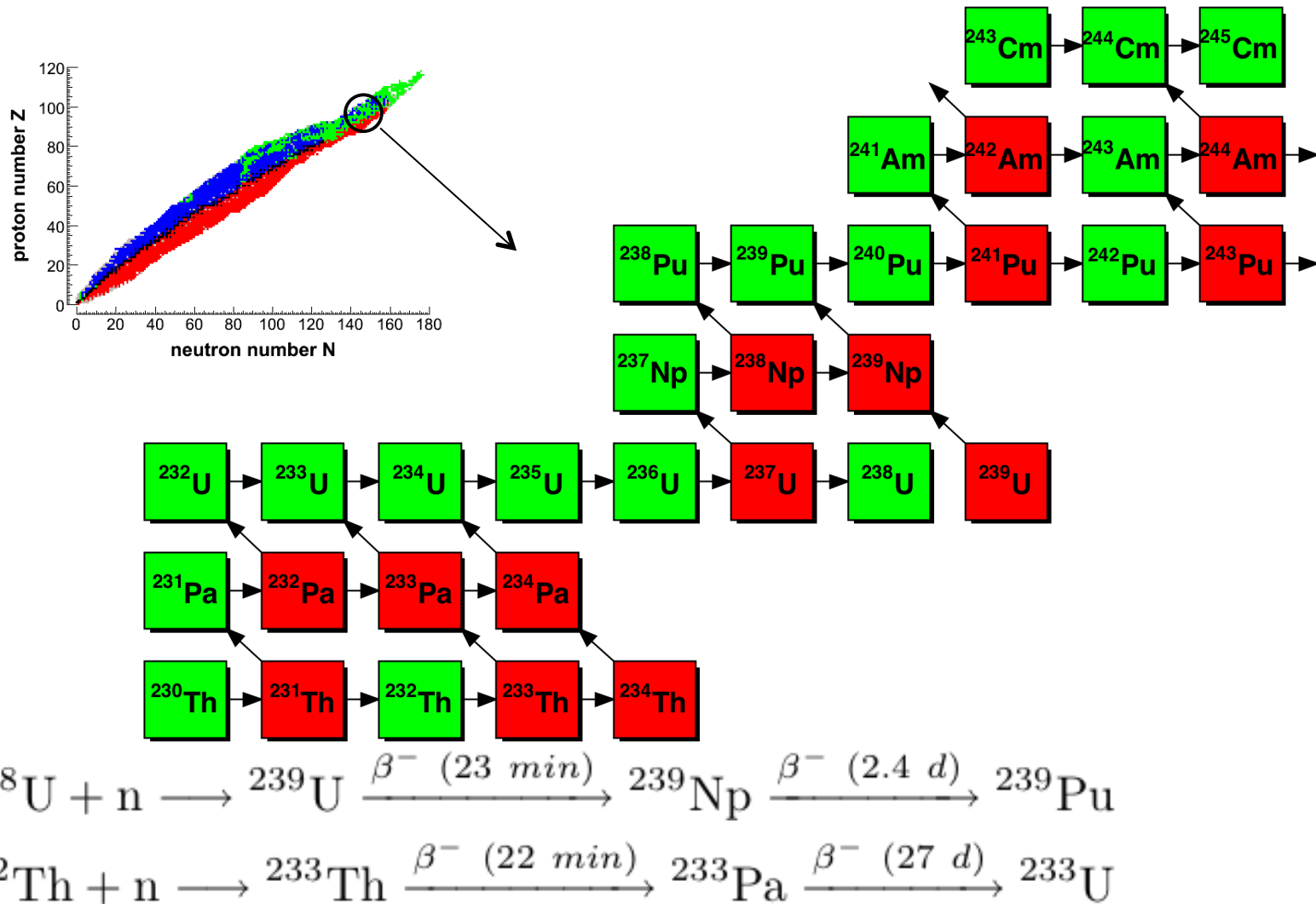


Nuclei of interest for neutron induced reactions

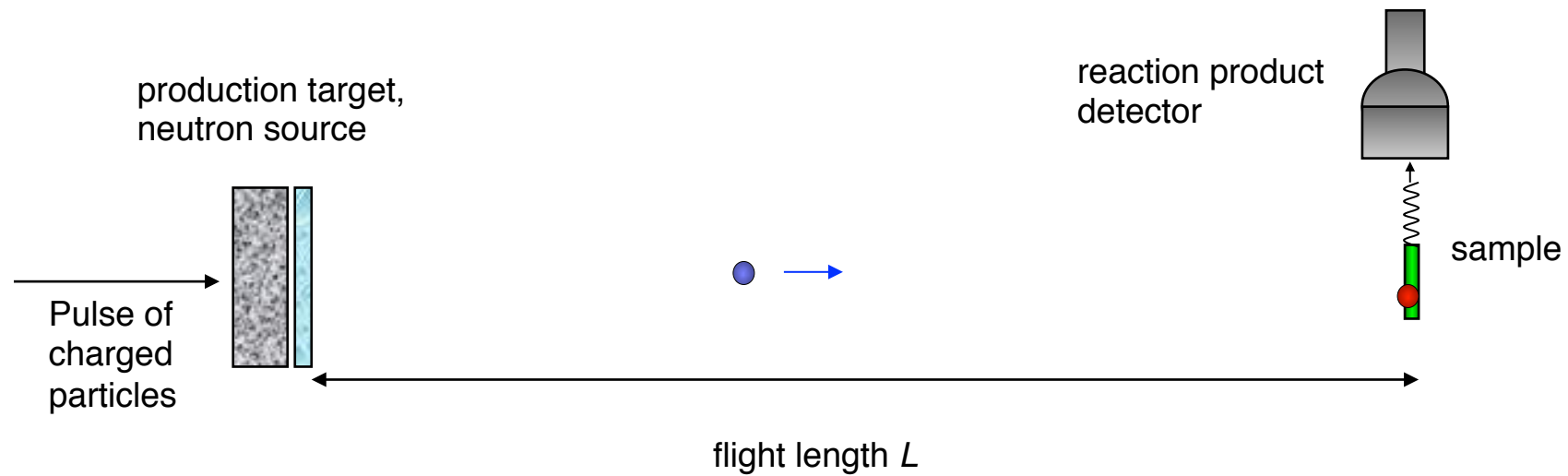




Actinide build-up in reactors ("w" - process)



Neutron time-of-flight

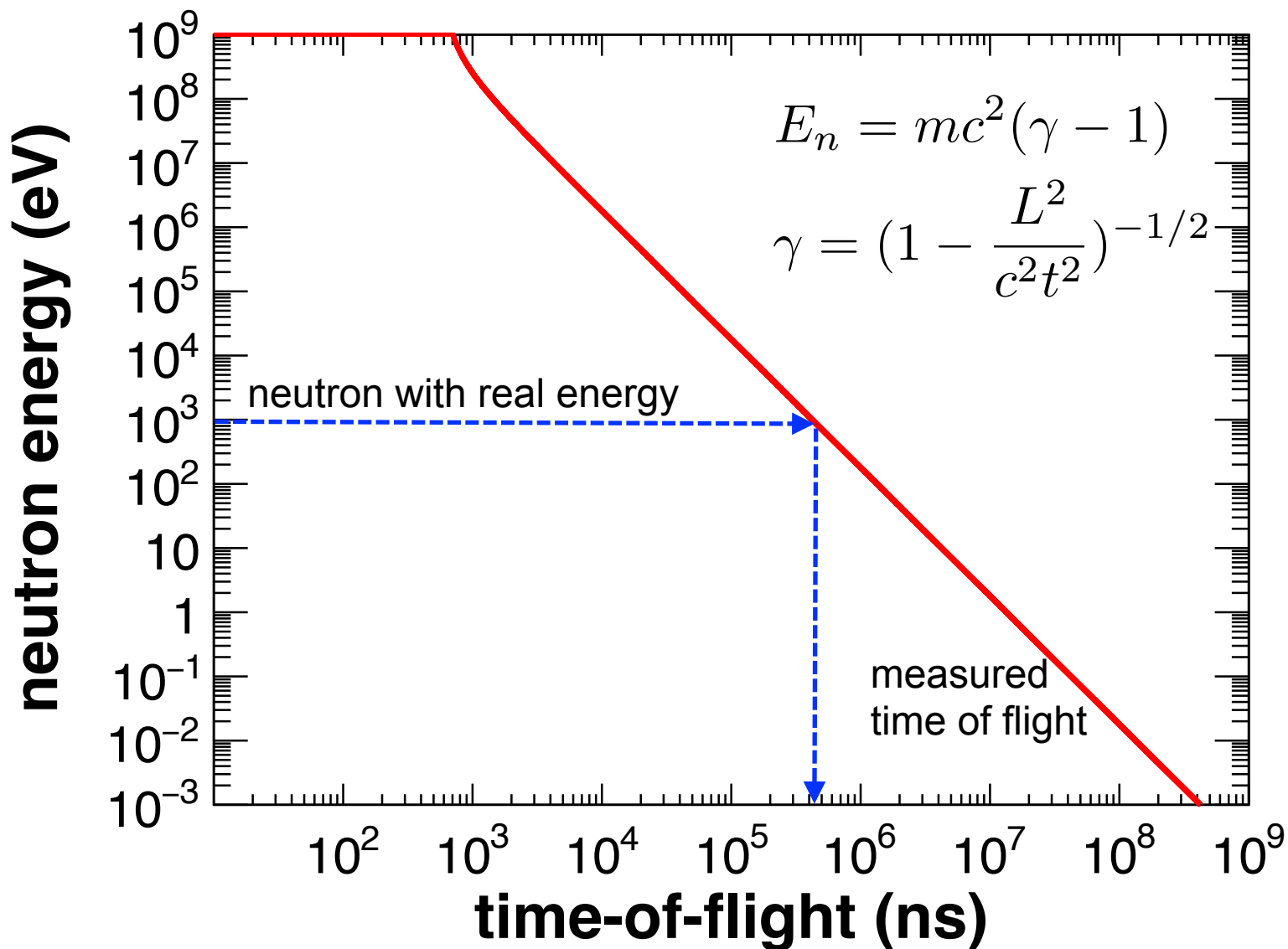


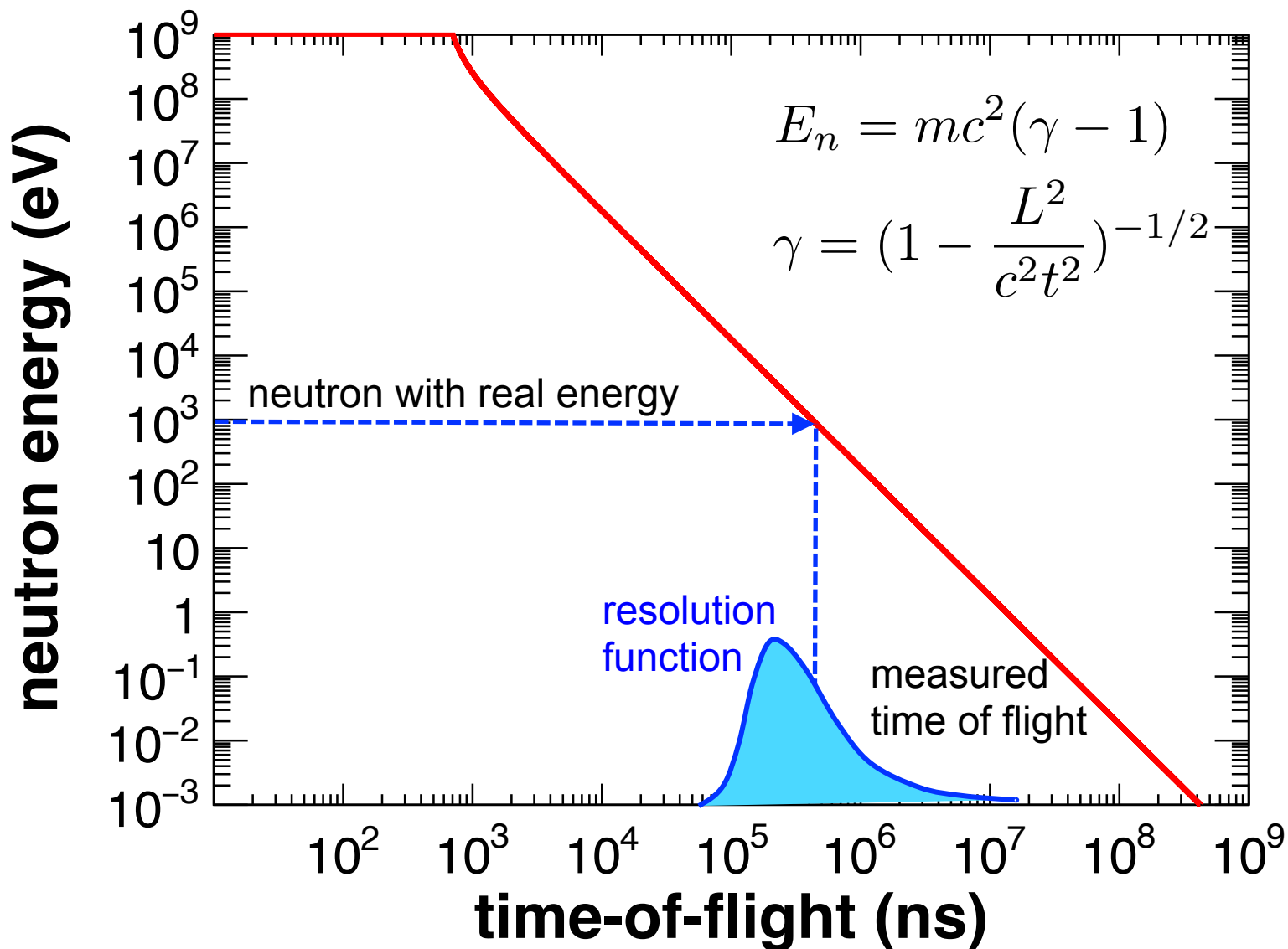
Deduce kinetic energy from neutron by time-of-flight:

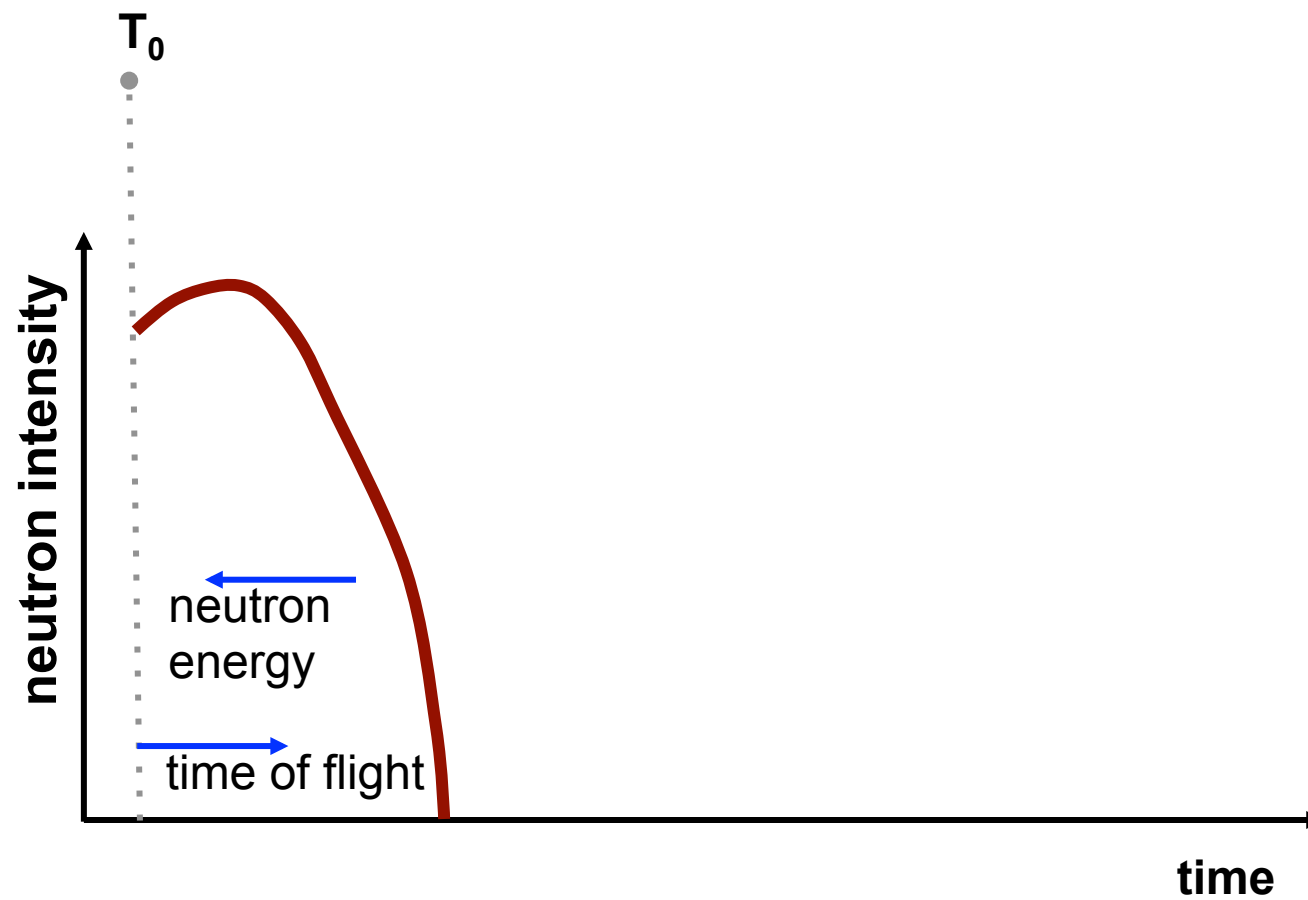
$$E_n = mc^2(\gamma - 1)$$

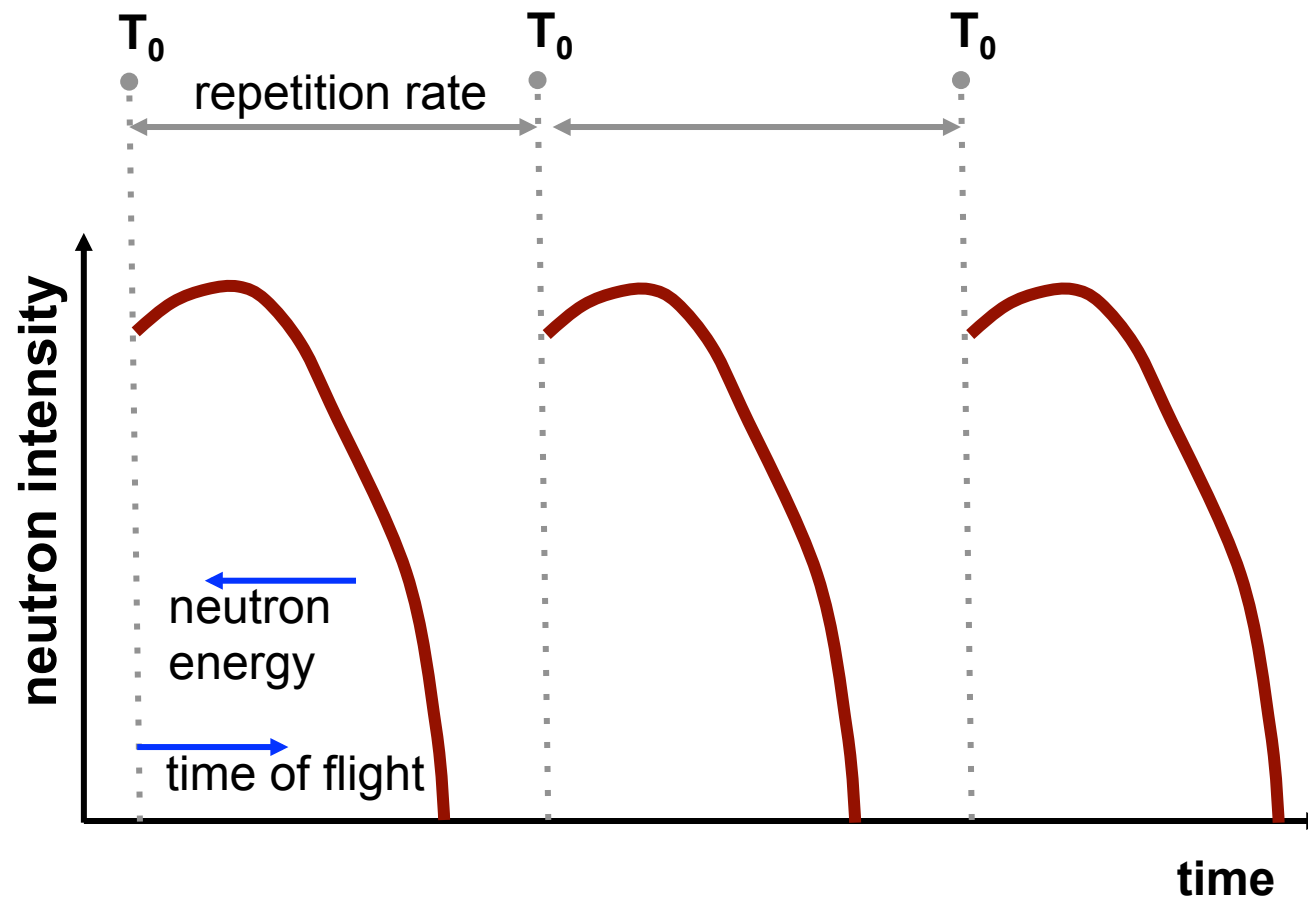
$$\gamma = \left(1 - \frac{L^2}{c^2 t^2}\right)^{-1/2}$$

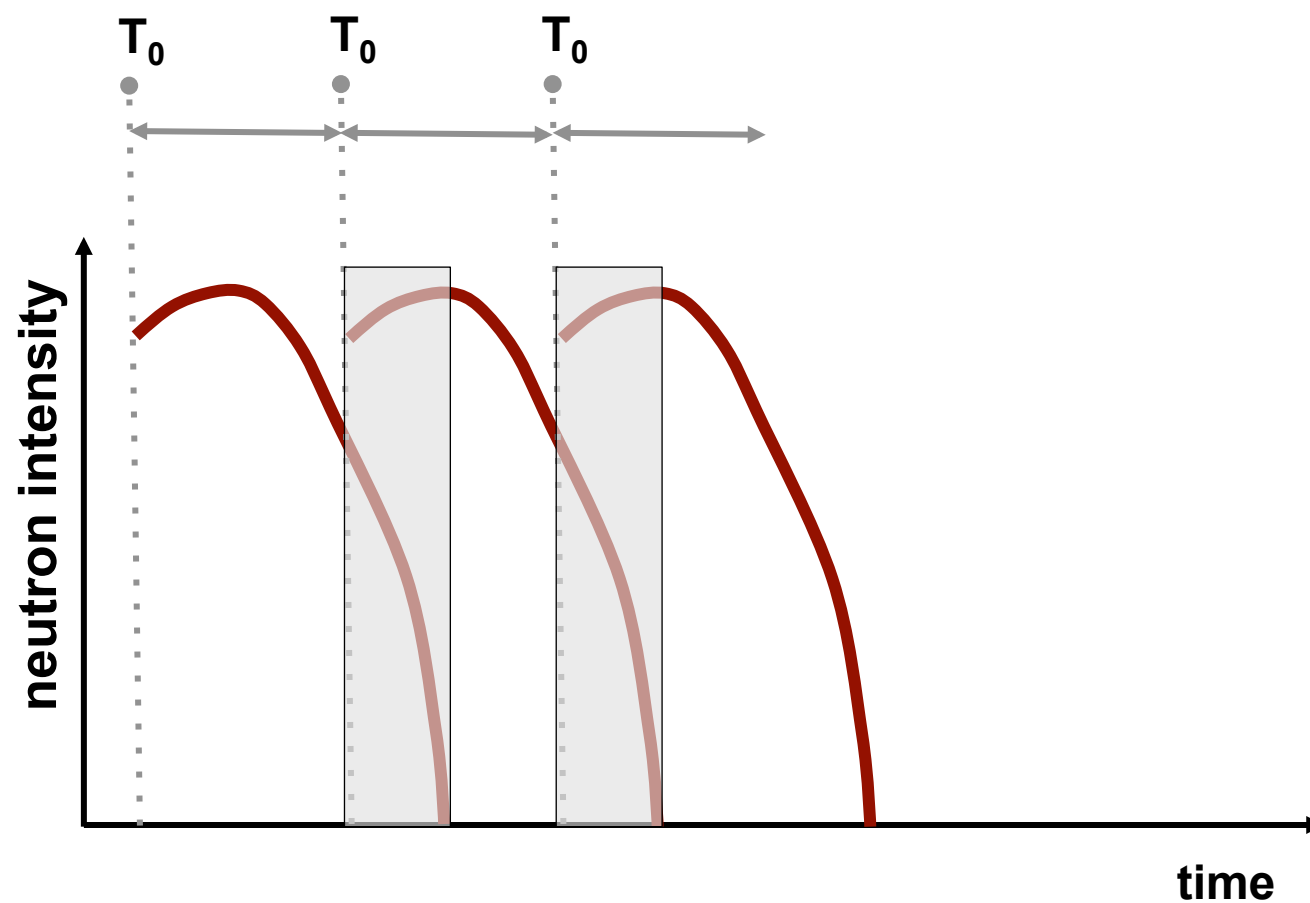
Neutron time-of-flight

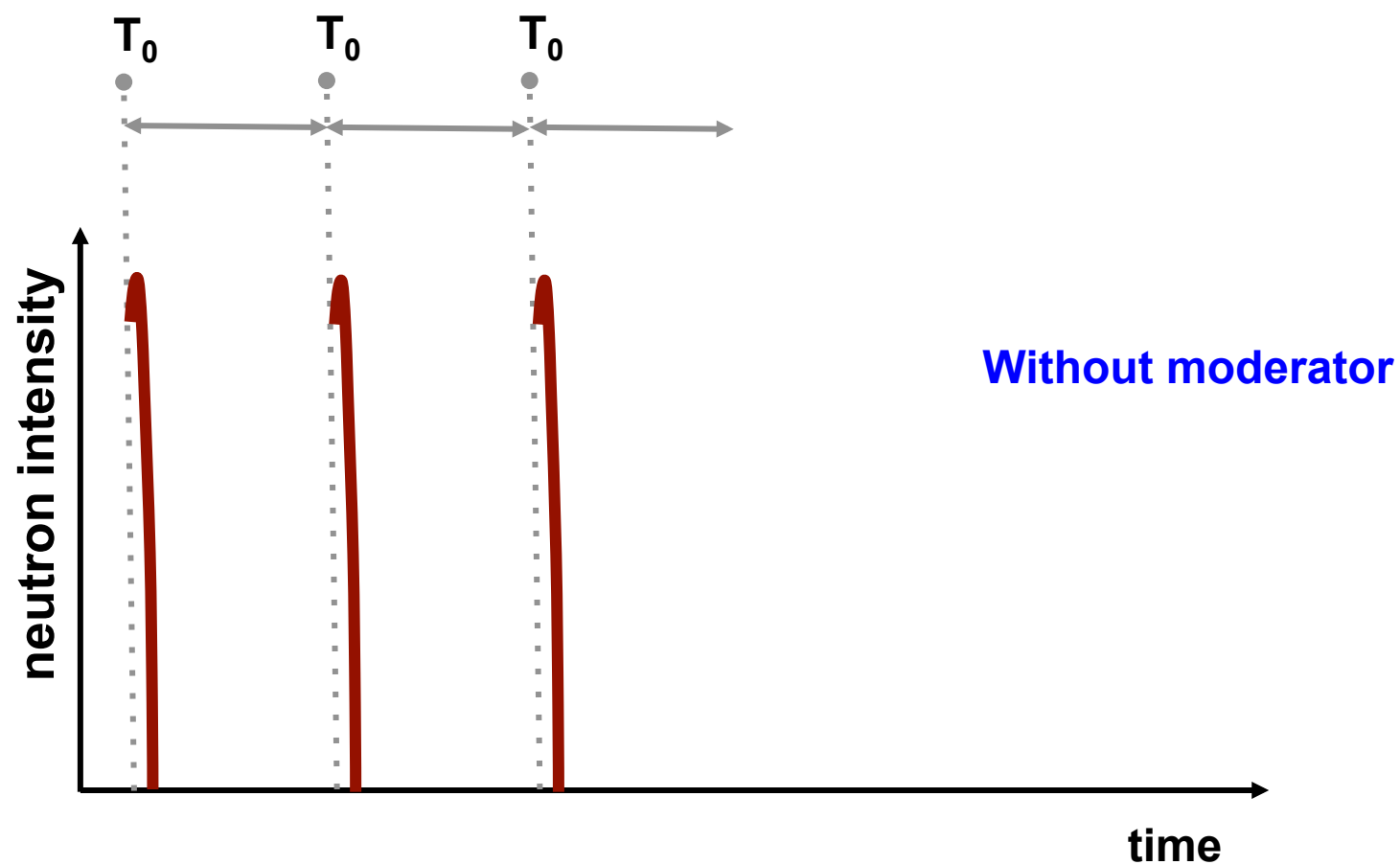


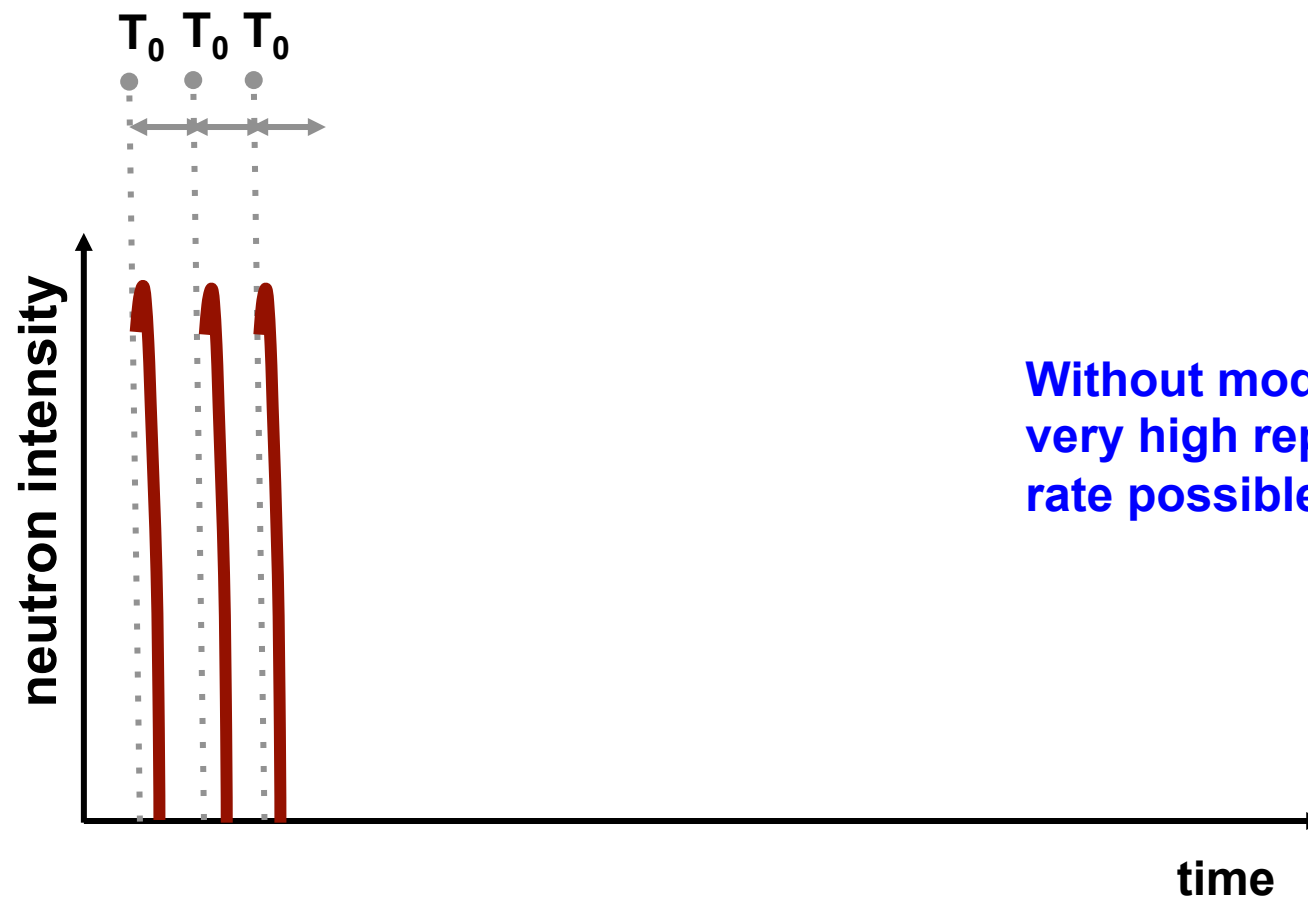






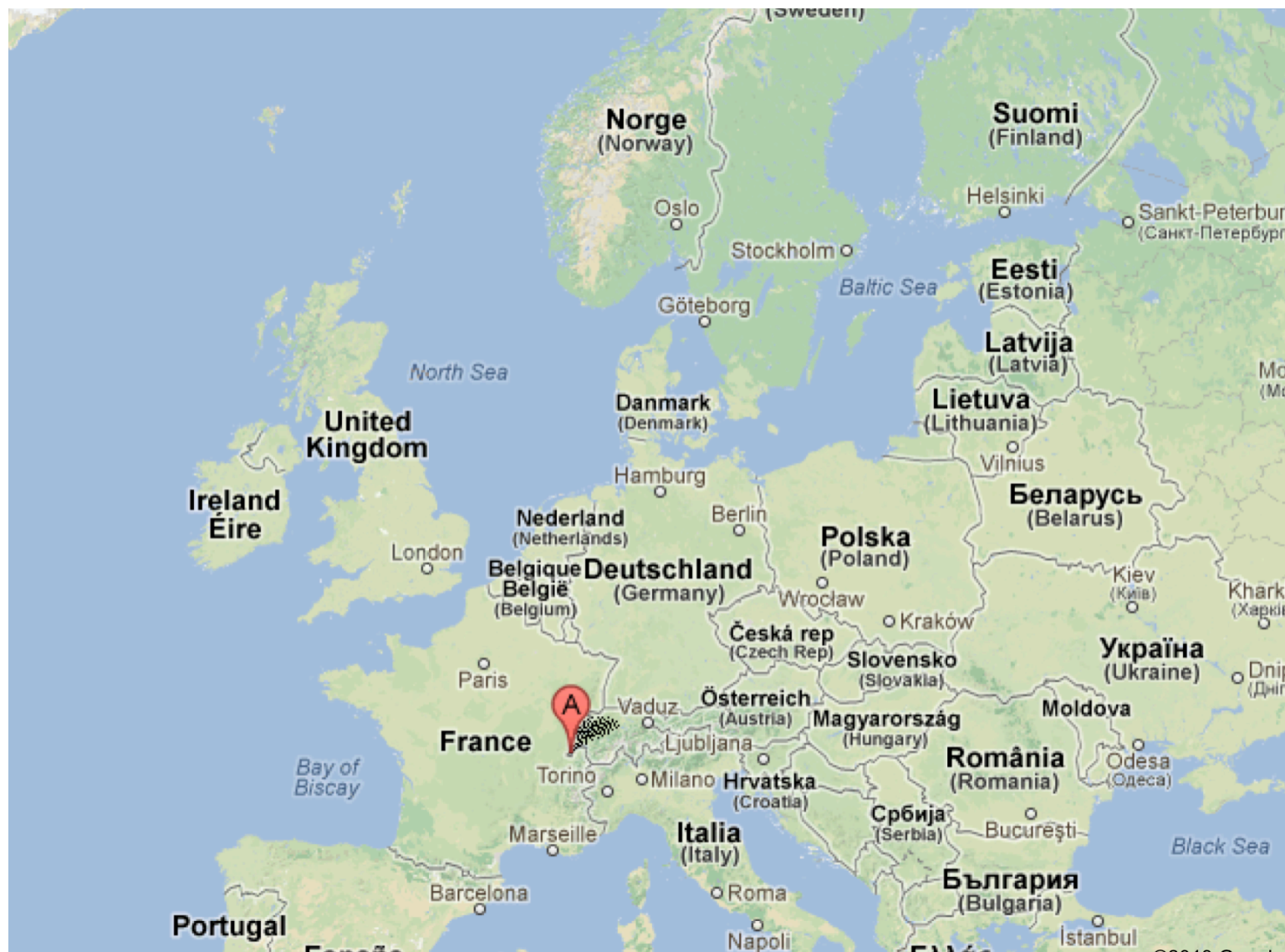






Without moderator,
very high repetition
rate possible.

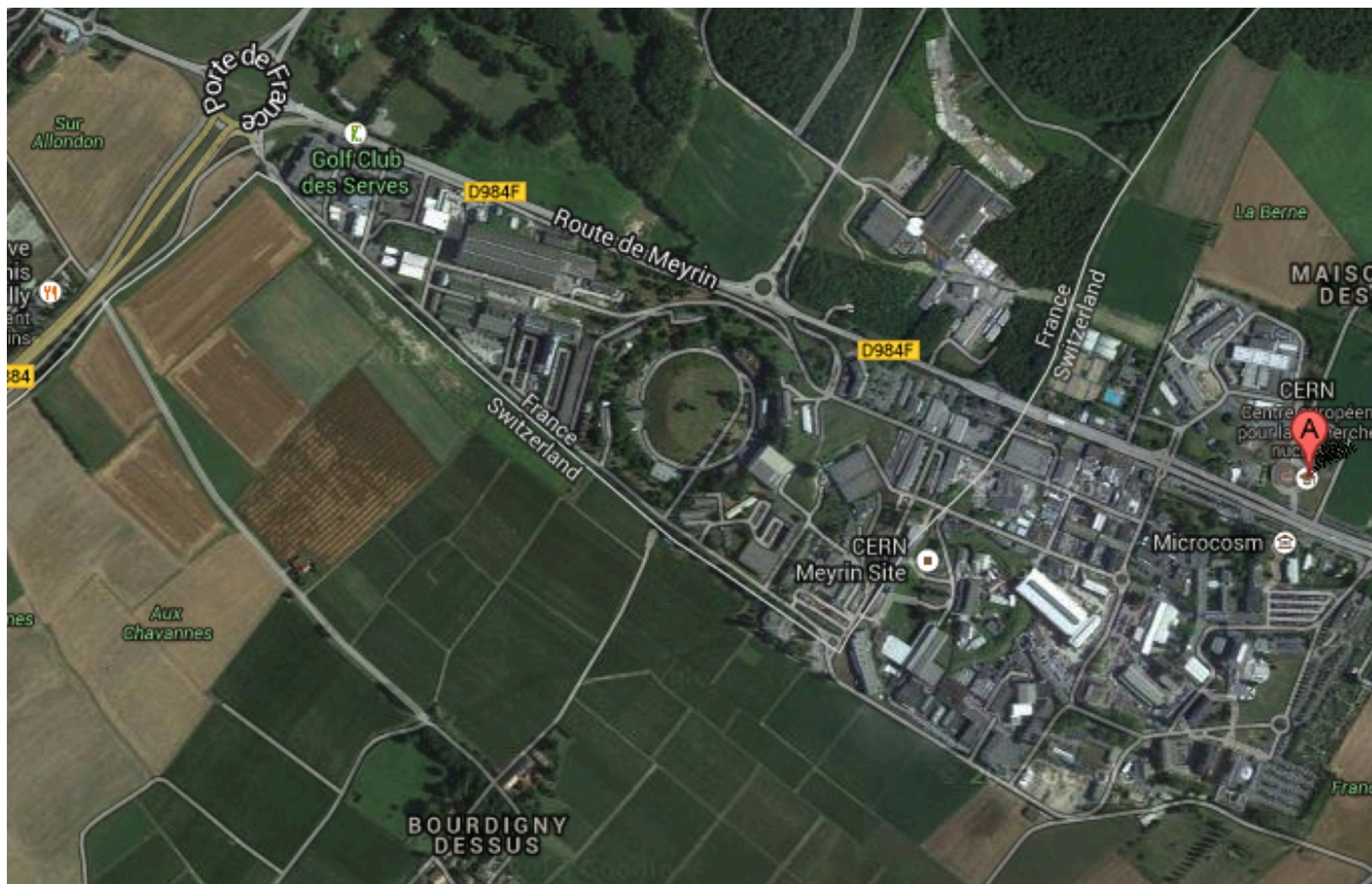
The n_TOF facility at CERN



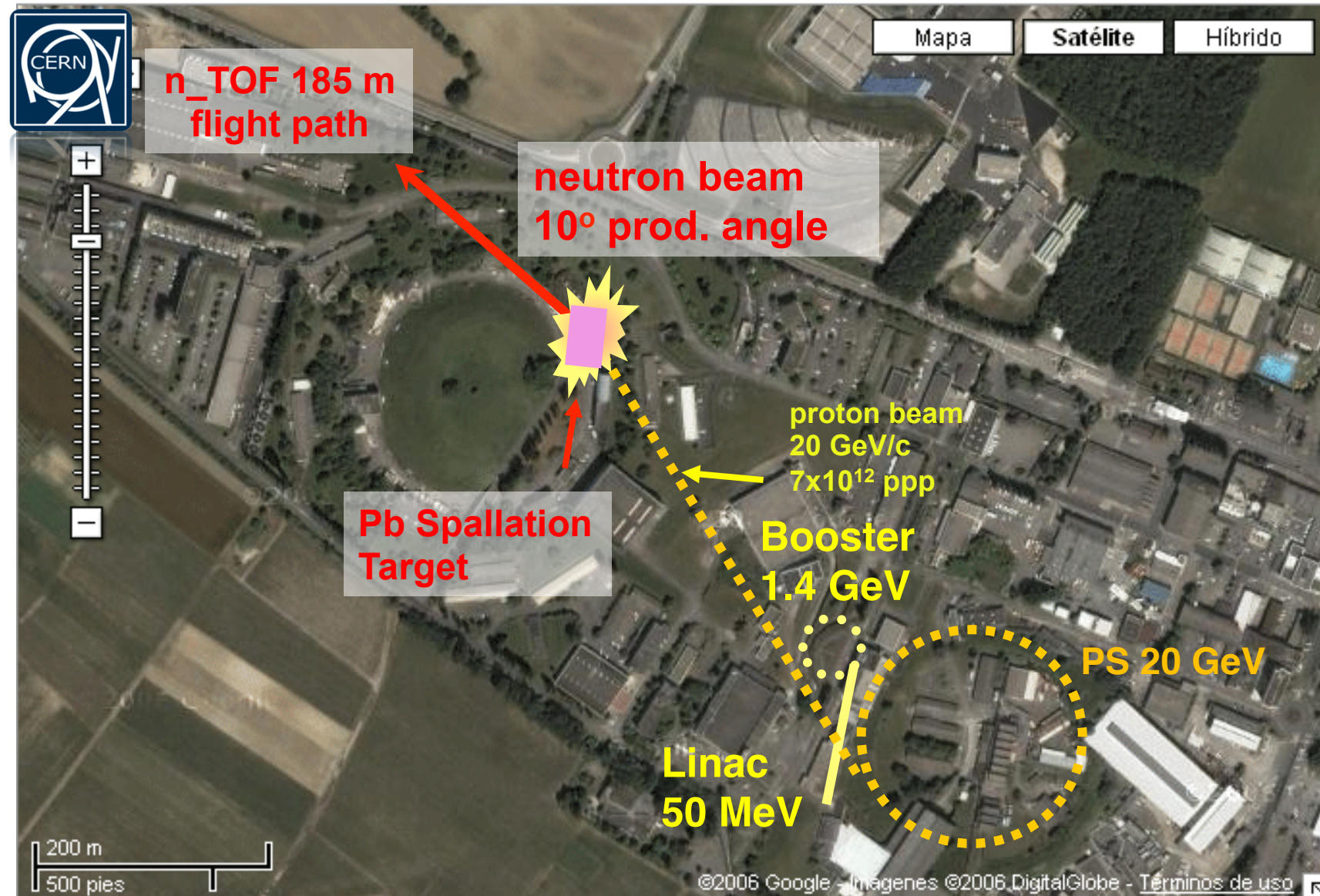
The n_TOF facility at CERN



The n_TOF facility at CERN

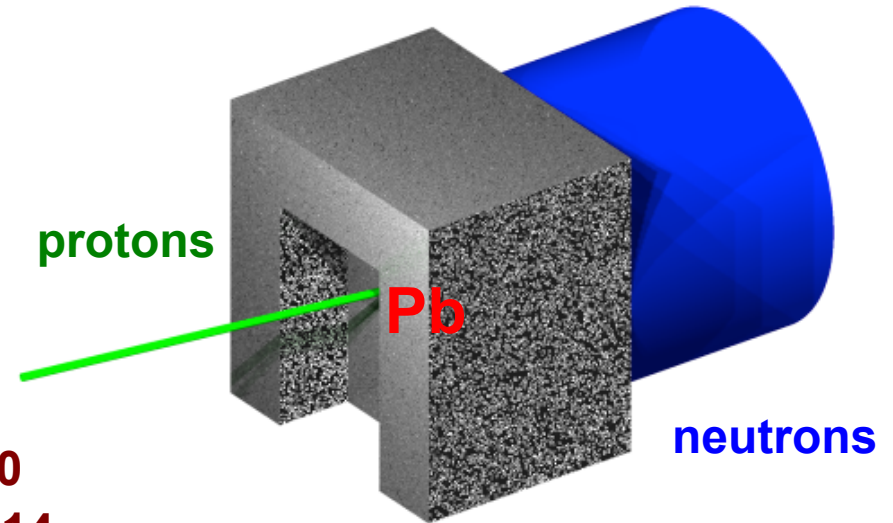


The n_TOF facility at CERN



Pulsed white neutron source:

- 20 GeV/c protons
- neutrons from spallation
- 6 ns rms pulse width
- frequency 1 pulse/2.4 seconds
- separate cooling and moderation
- flight path length EAR1: 185 m, **since 2000**
- **flight path length EAR2: 20 m, since 2014**
- @source: 7×10^{12} protons/pulse
- @source: 2×10^{15} neutrons/pulse
- @EAR1: $5 \cdot 10^5$ (capture) – $5 \cdot 10^7$ (fission) neutrons/pulse



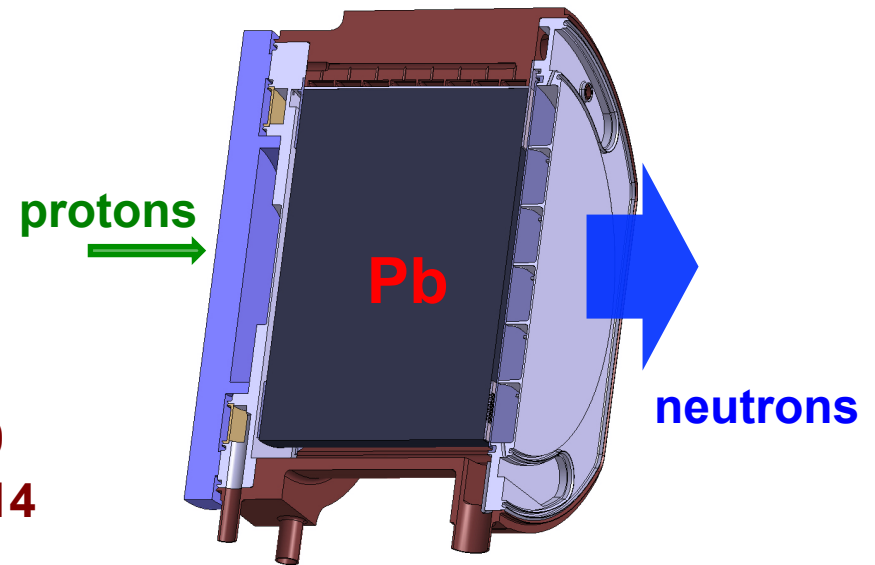
**phase I target
2001-2004**

Main features:

- Large energy range in one experiment (0.1 eV - 250 MeV)
- Favorable signal to noise ratio for capture on radioactive isotopes (actinides, fission products)

Pulsed white neutron source:

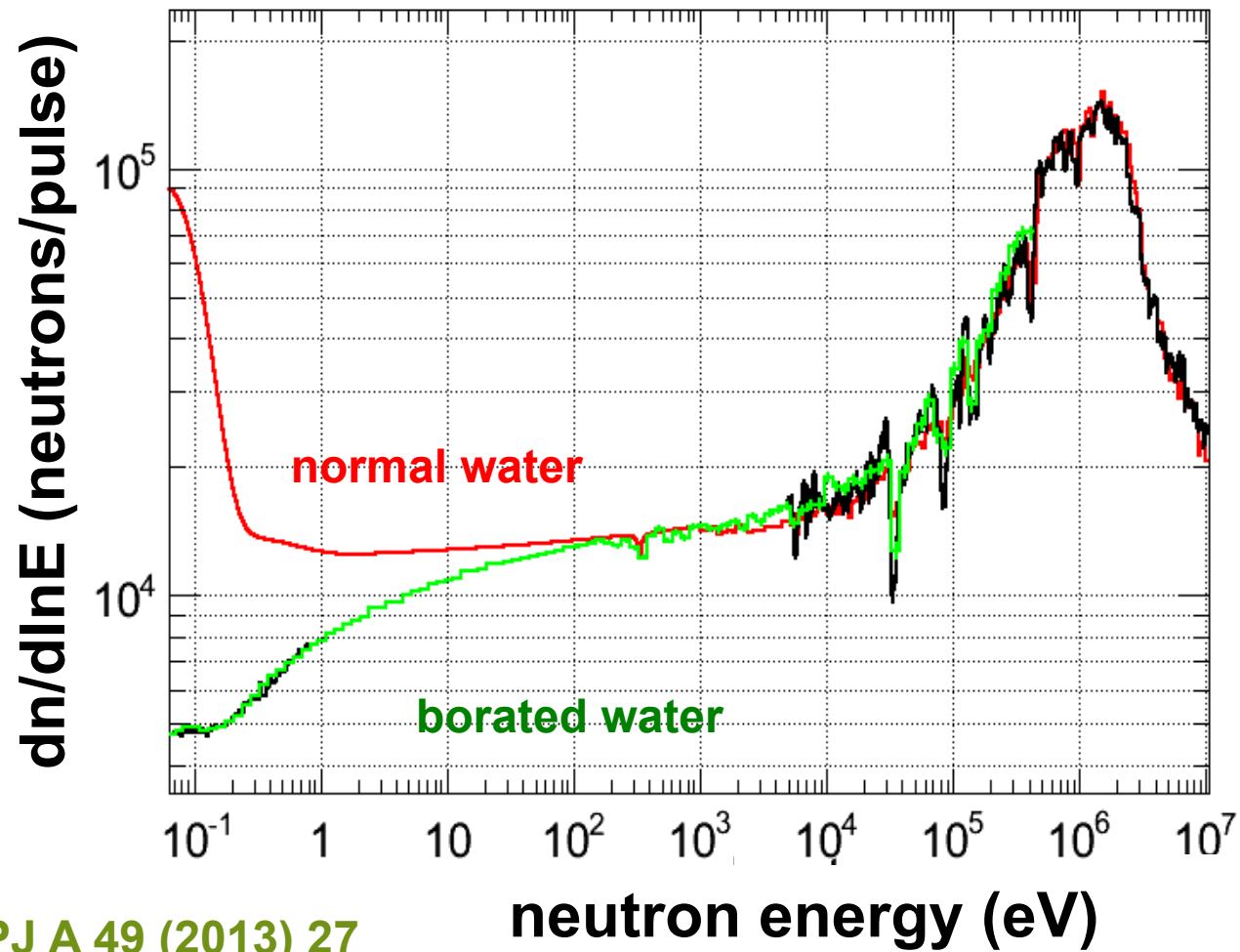
- 20 GeV/c protons
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- @source: 7×10^{12} protons/pulse
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- @EAR1: $5 \cdot 10^5$ (capture) – $5 \cdot 10^7$ (fission) neutrons/pulse



**phase II-III target
2009-present**

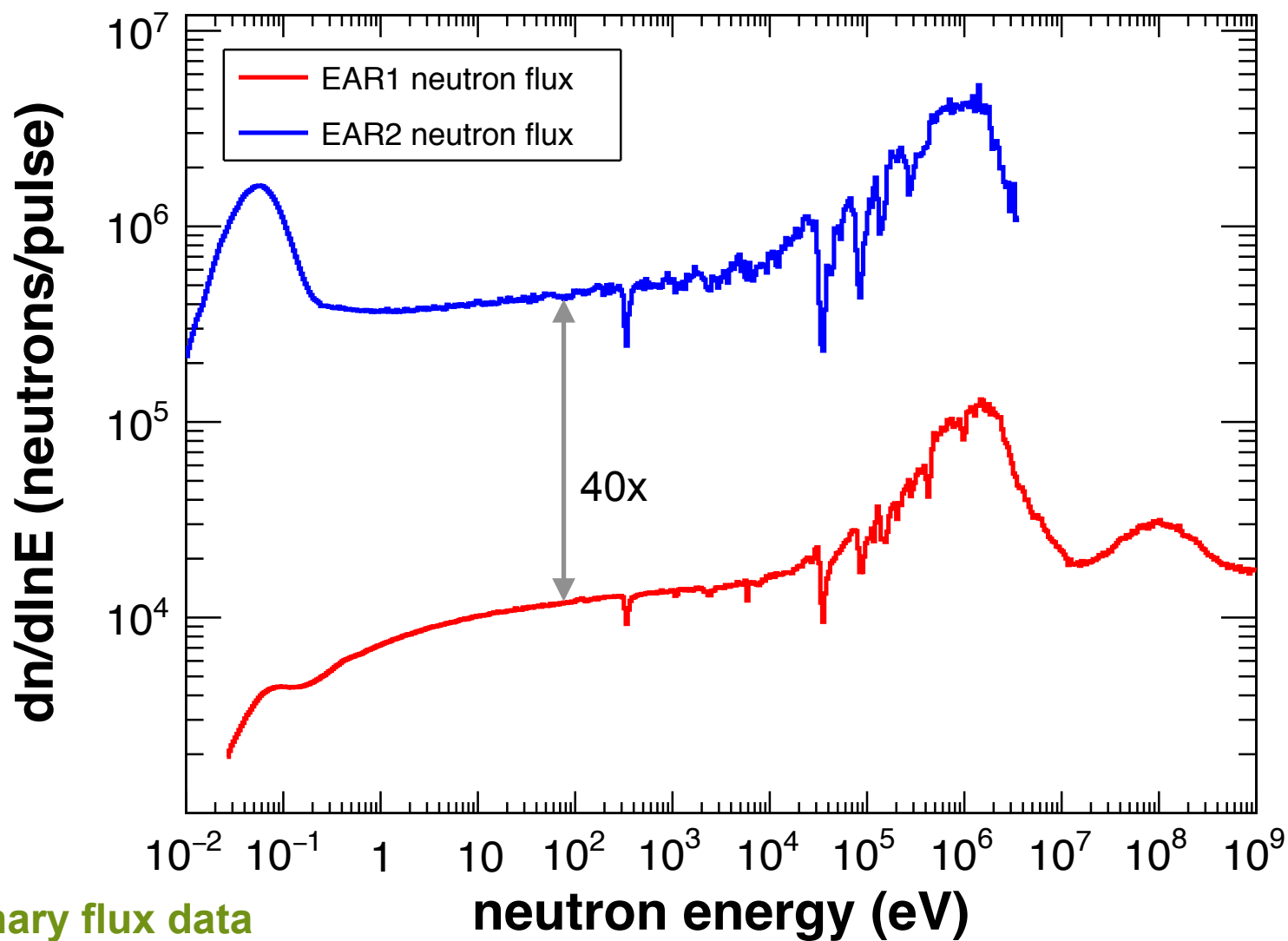
Main features:

- Large energy range in one experiment (0.1 eV - 250 MeV)
- Favorable signal to noise ratio for capture on radioactive isotopes (actinides, fission products)



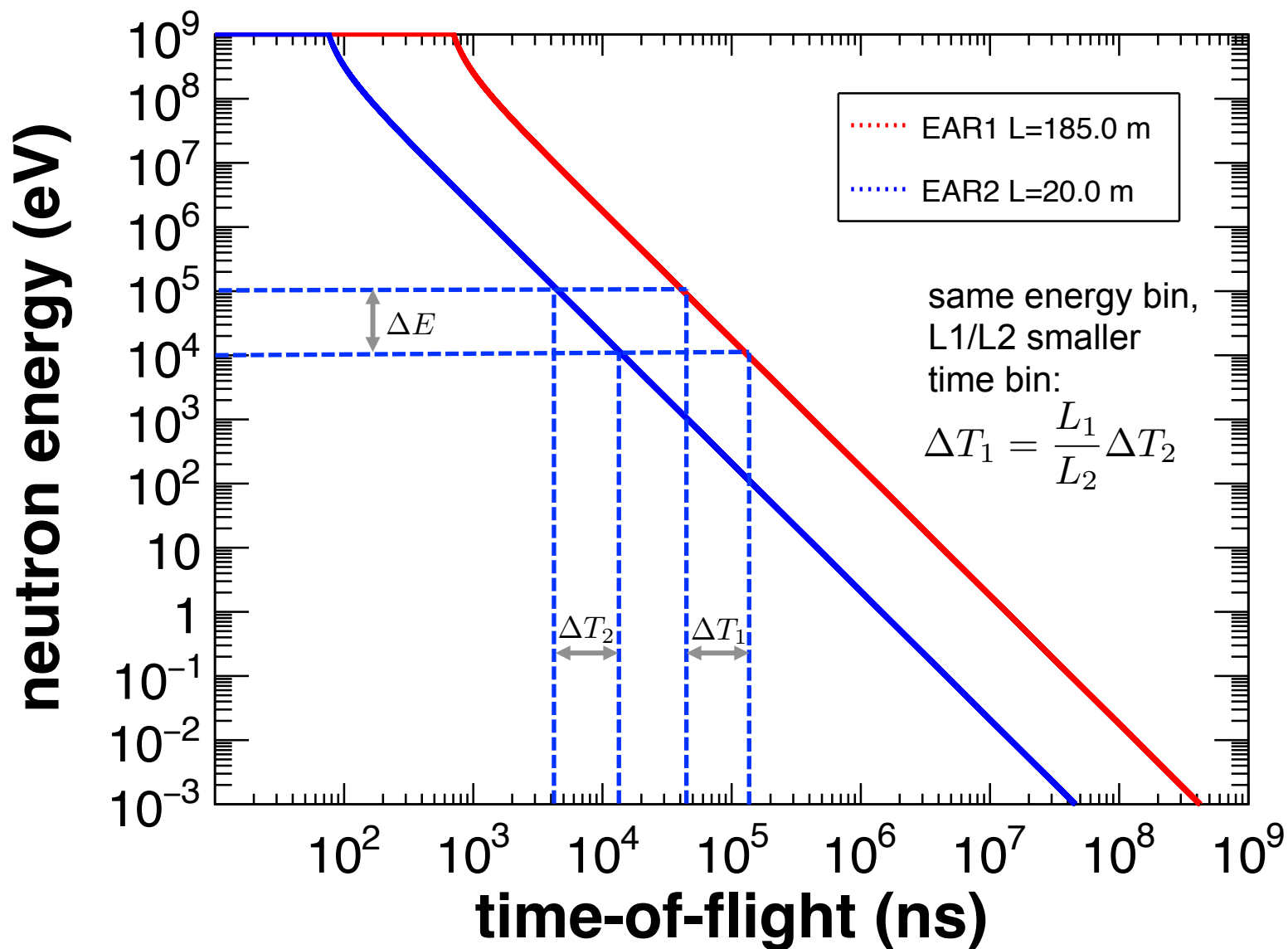
from: EPJ A 49 (2013) 27

The n_TOF neutron spectrum EAR1

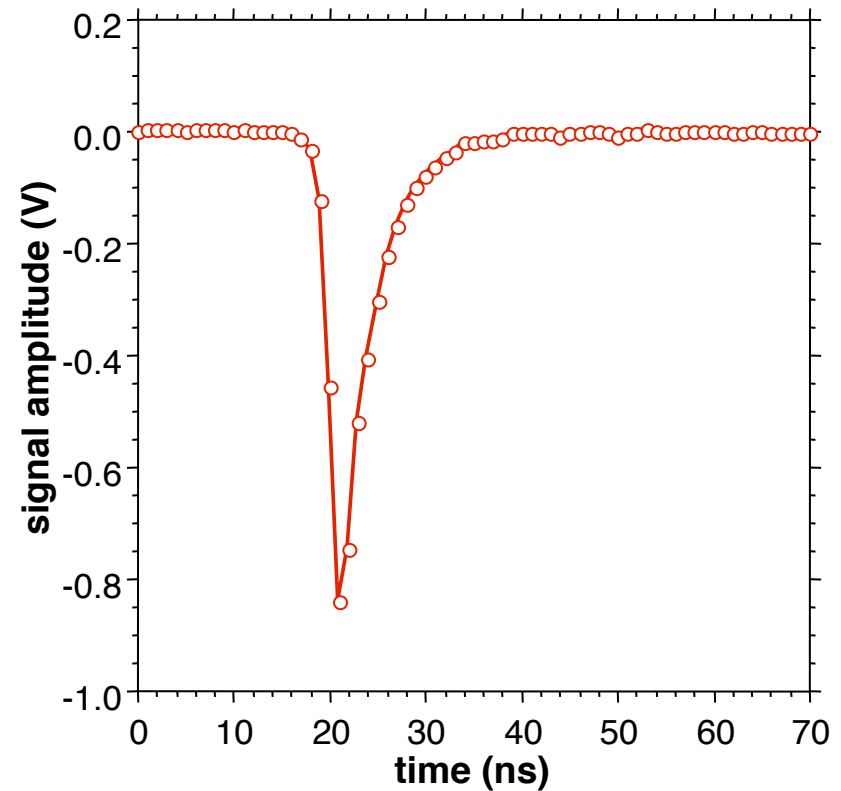
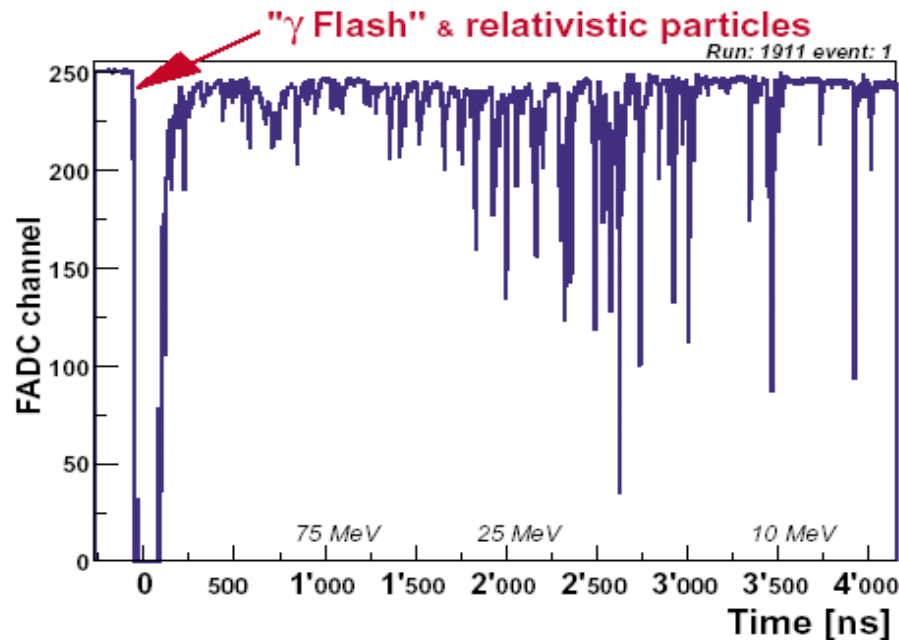


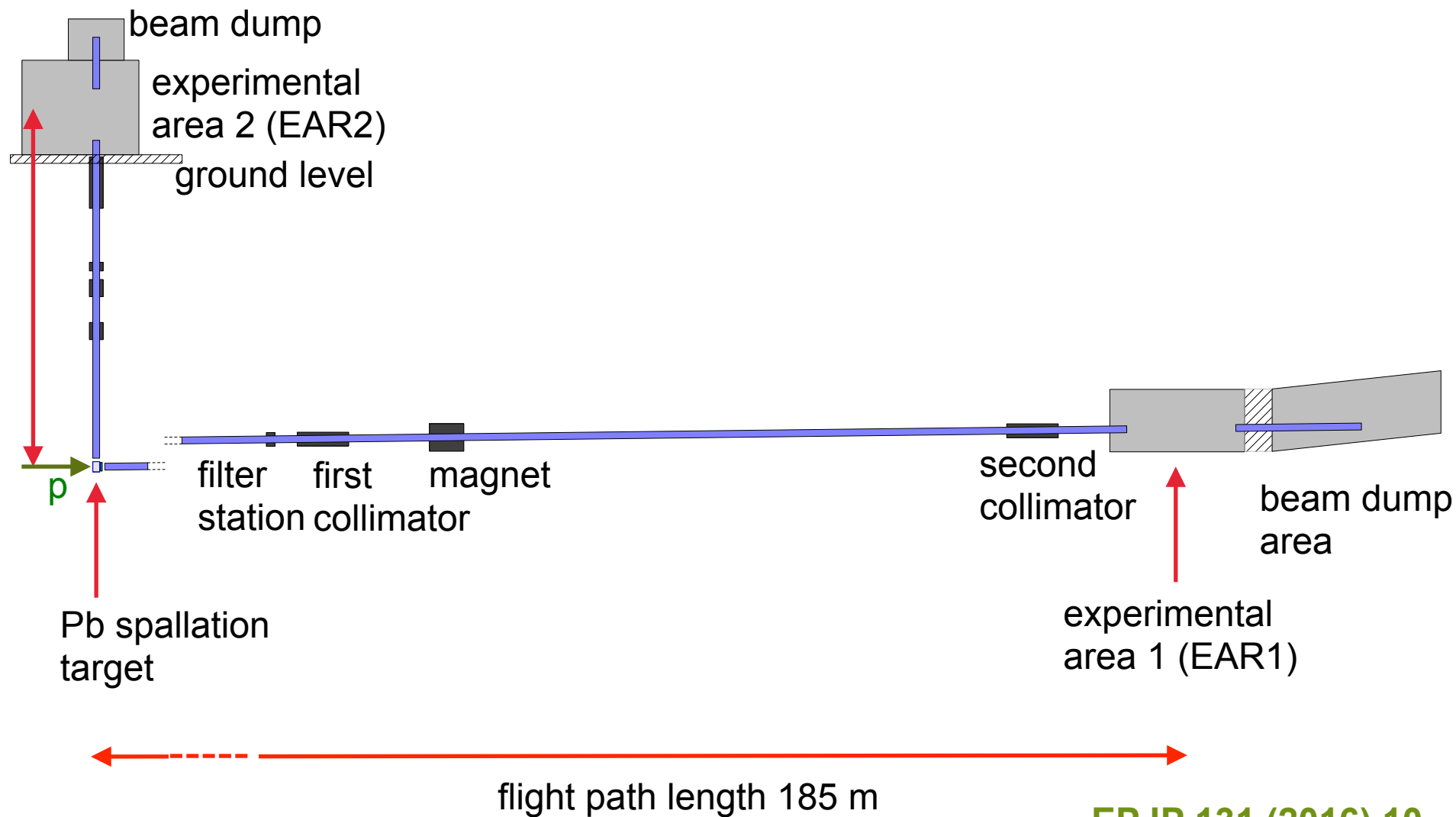
preliminary flux data

TOF-energy relation at n_TOF



- Continuous sampling of detector output (zero deadtime)
- Offline event construction from timing and pulse height analysis (**PHA**)
- In some cases also pulse shape analysis (**PSA**) for particle identification
- Since Phase-III, new DAQ with 100 ms time window possible.

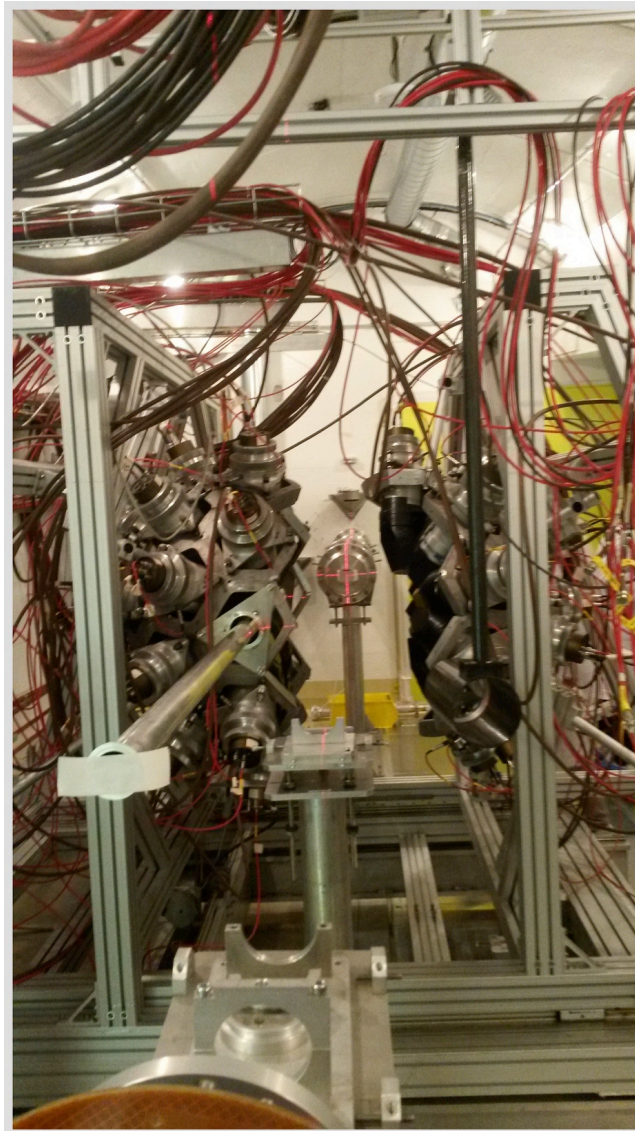




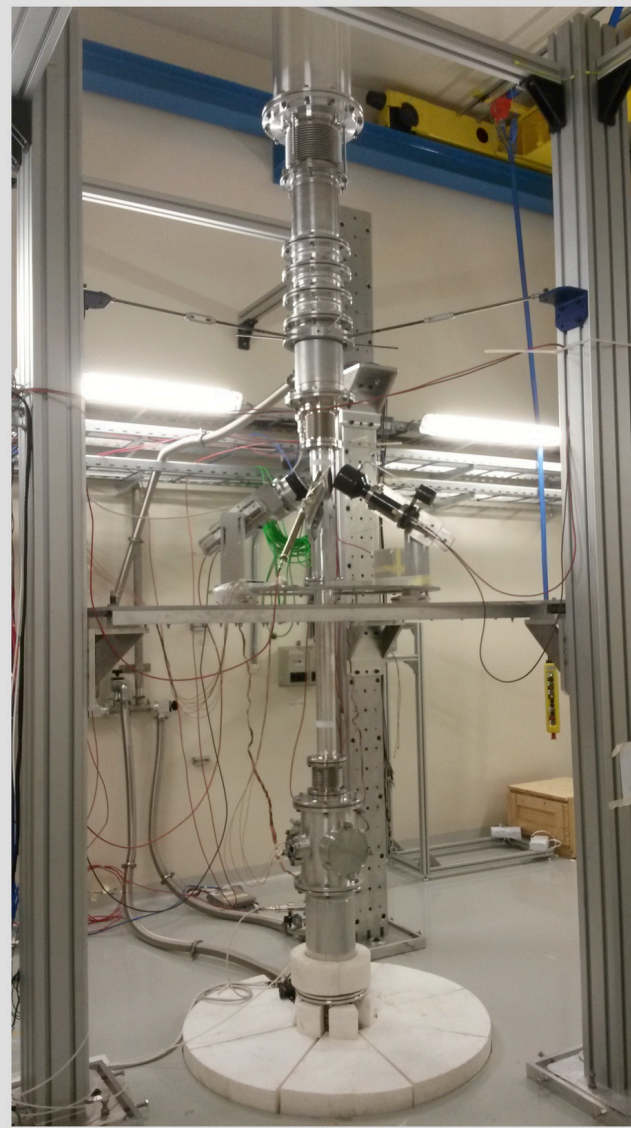
EPJP 131 (2016) 10

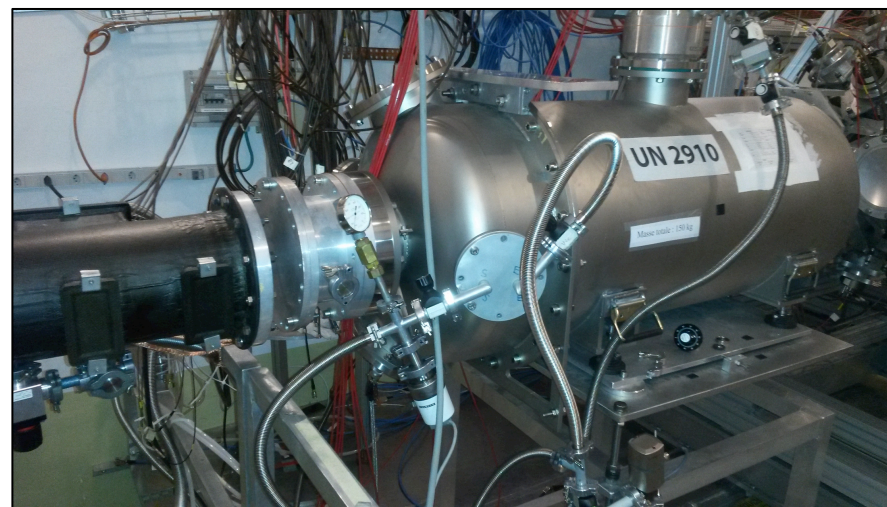
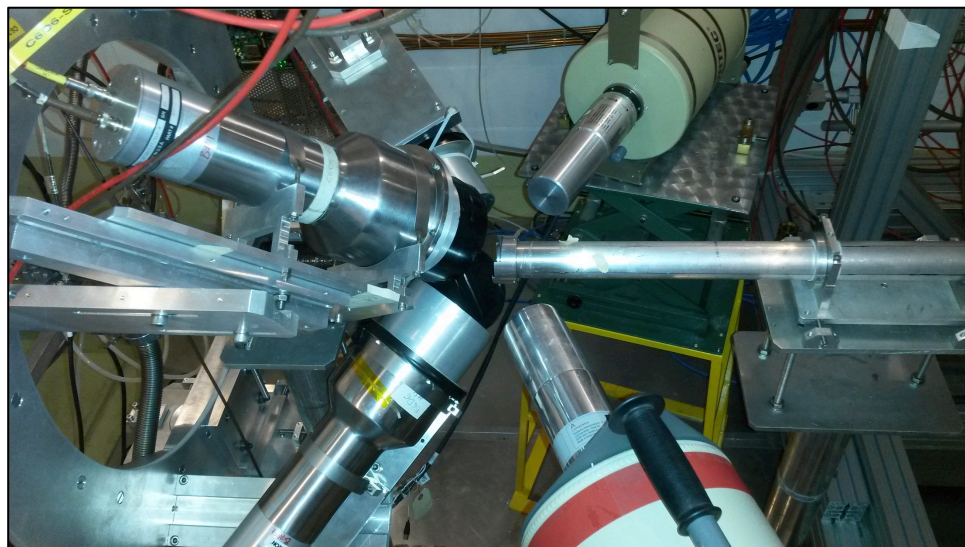
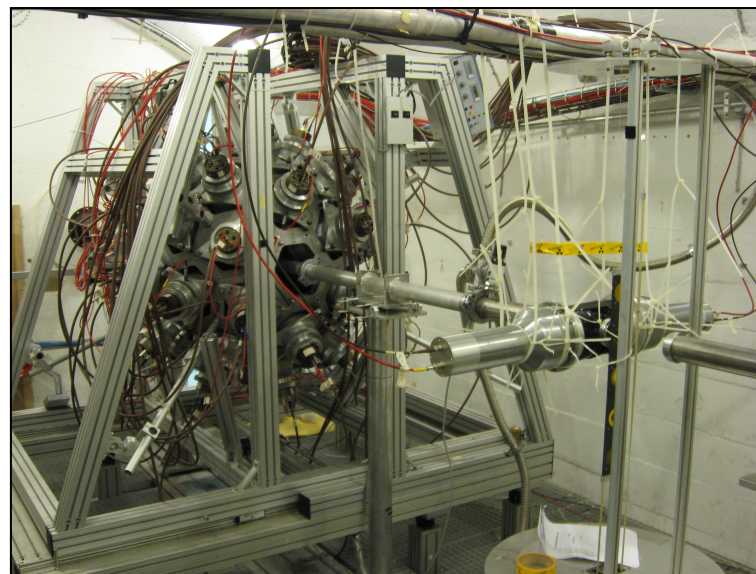
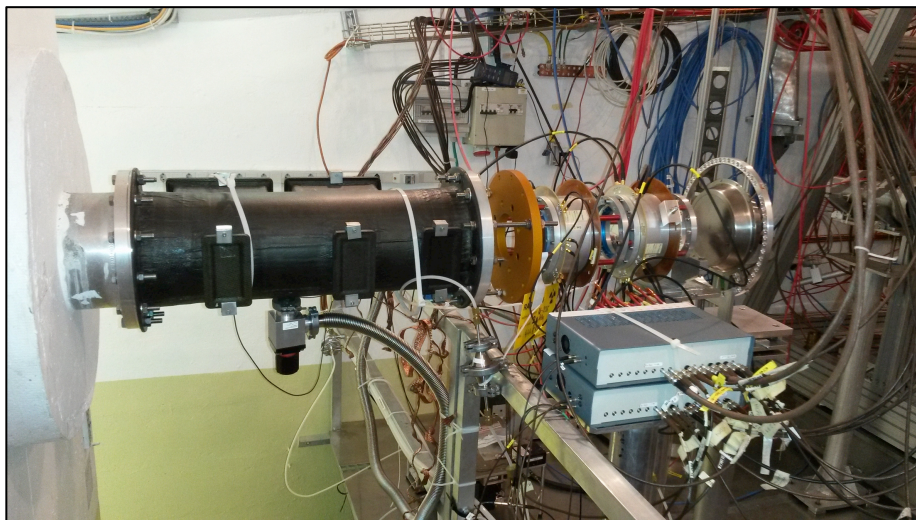
EAR1 – EAR2

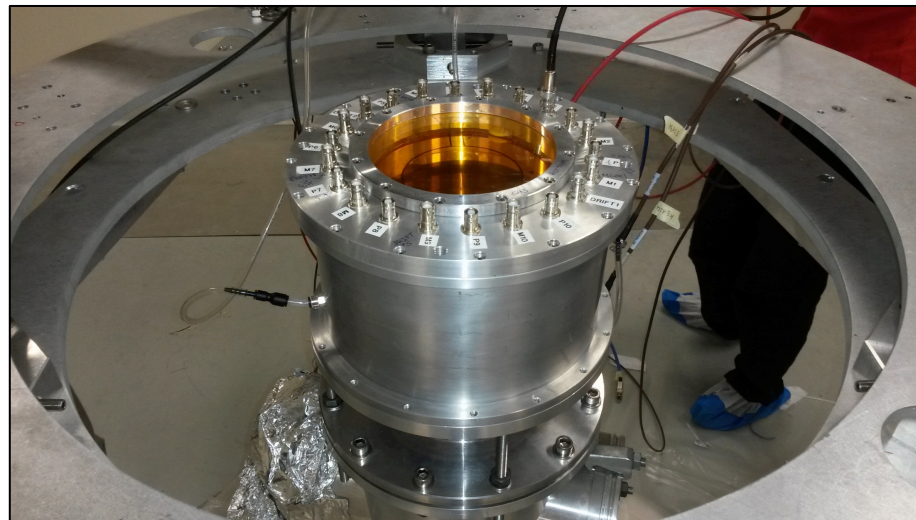
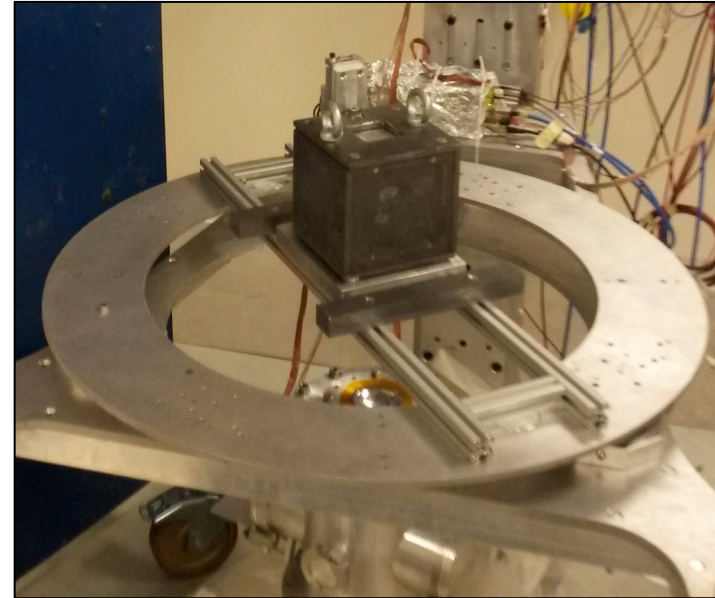
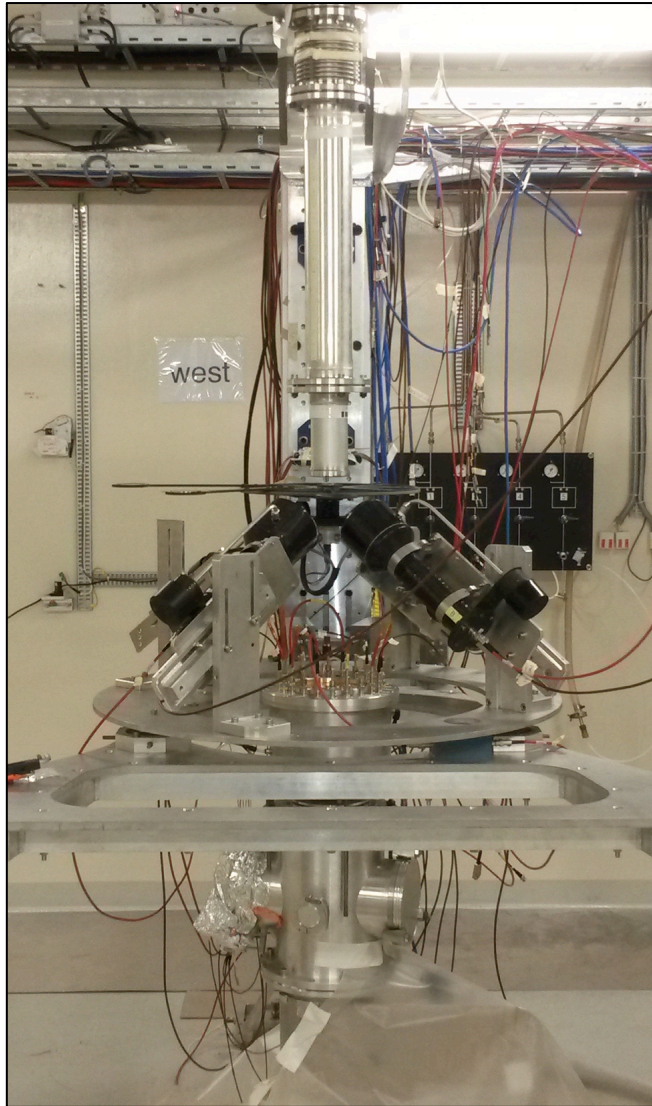
EAR1

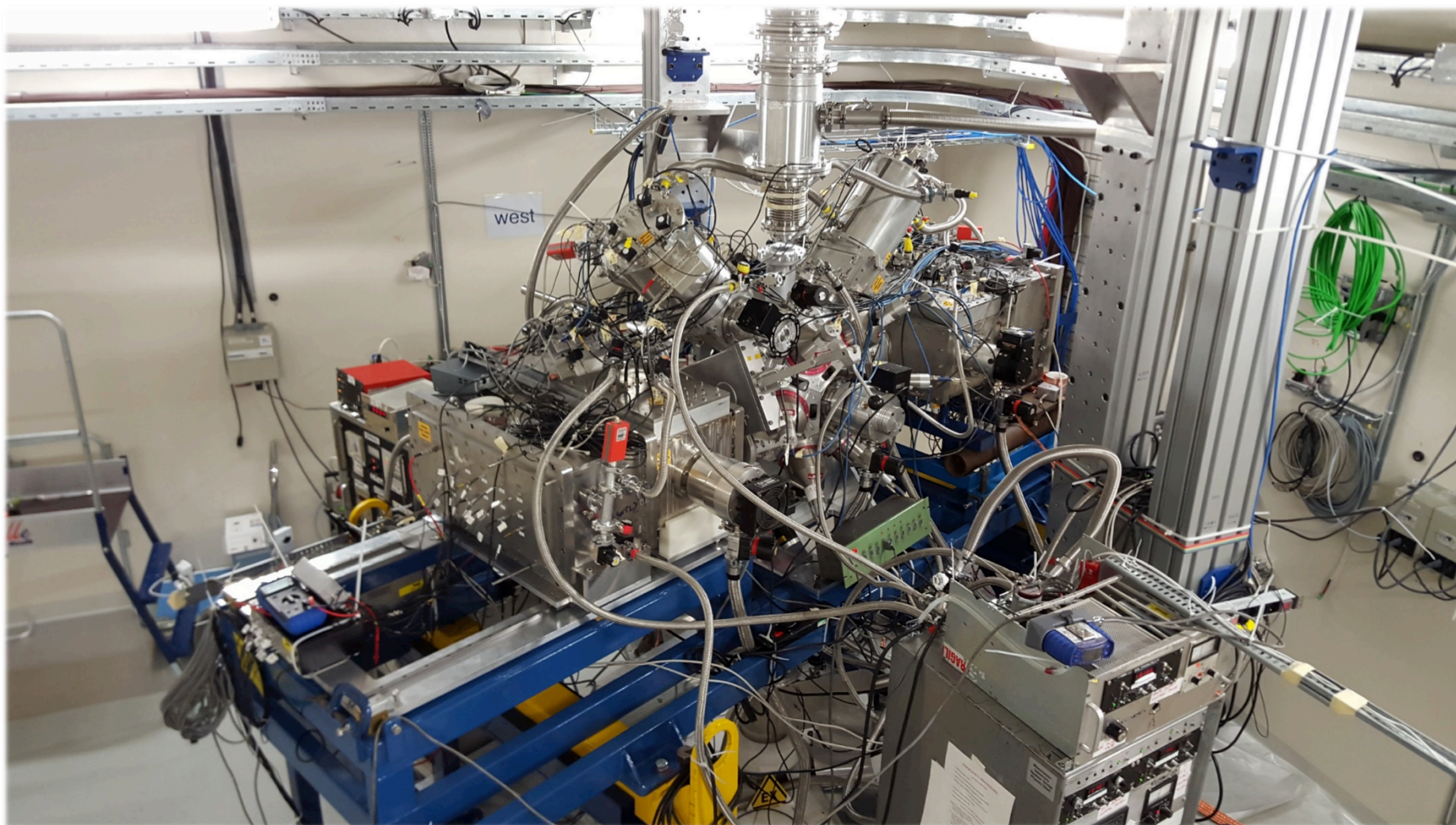


EAR2









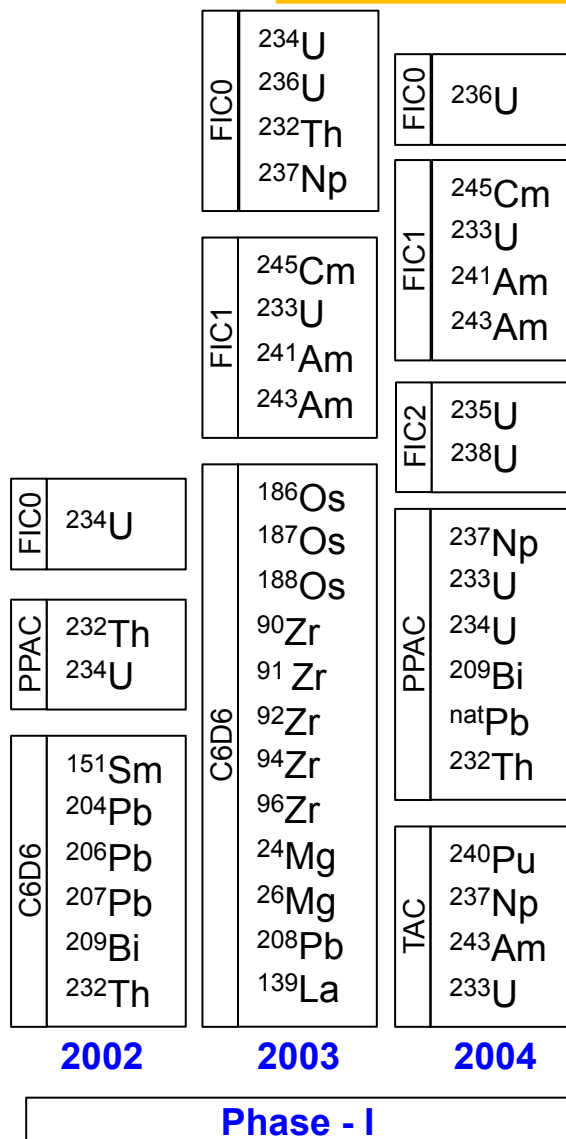
FIC0	^{234}U
------	------------------

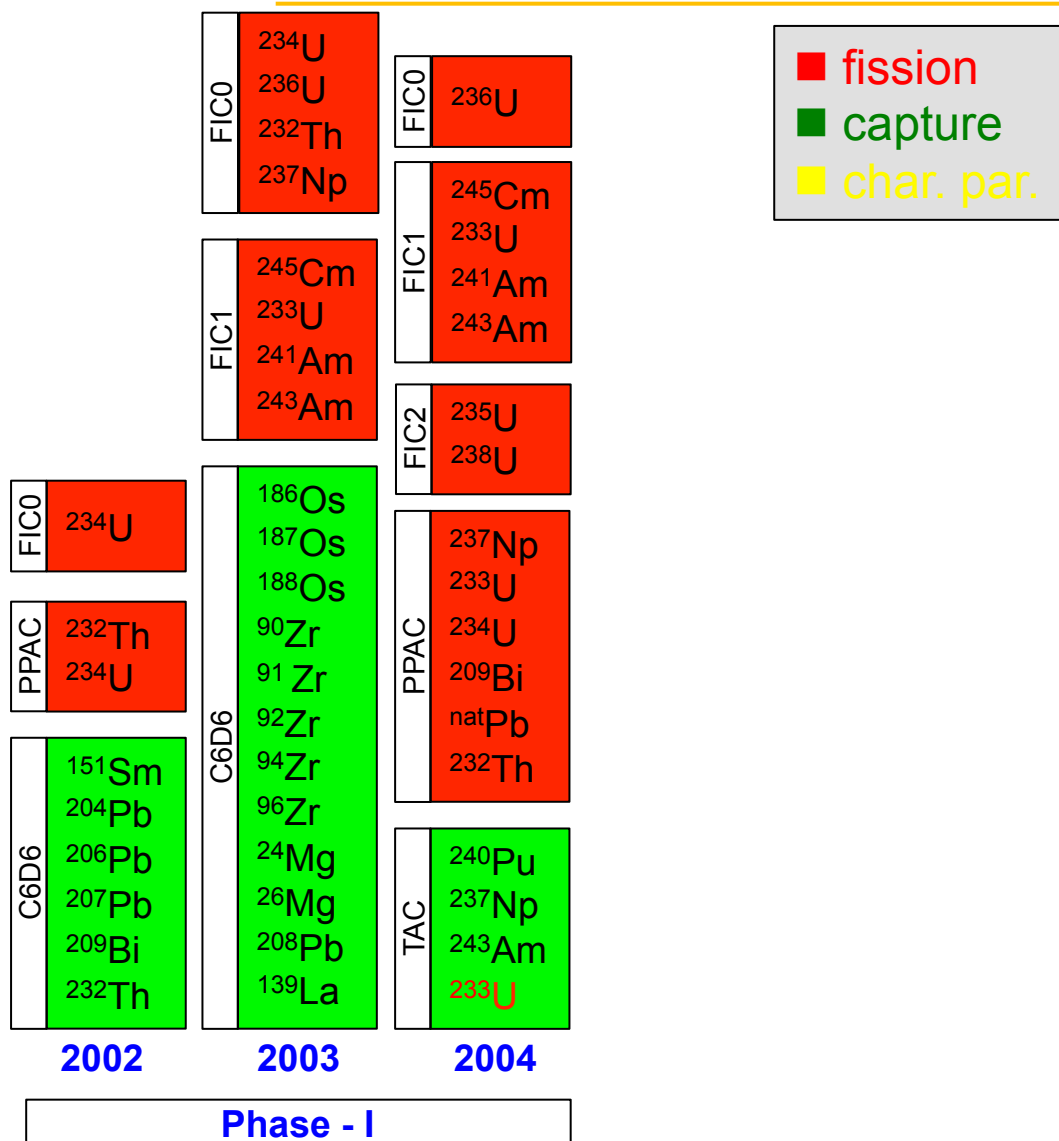
PPAC	^{232}Th ^{234}U
------	---------------------------------------

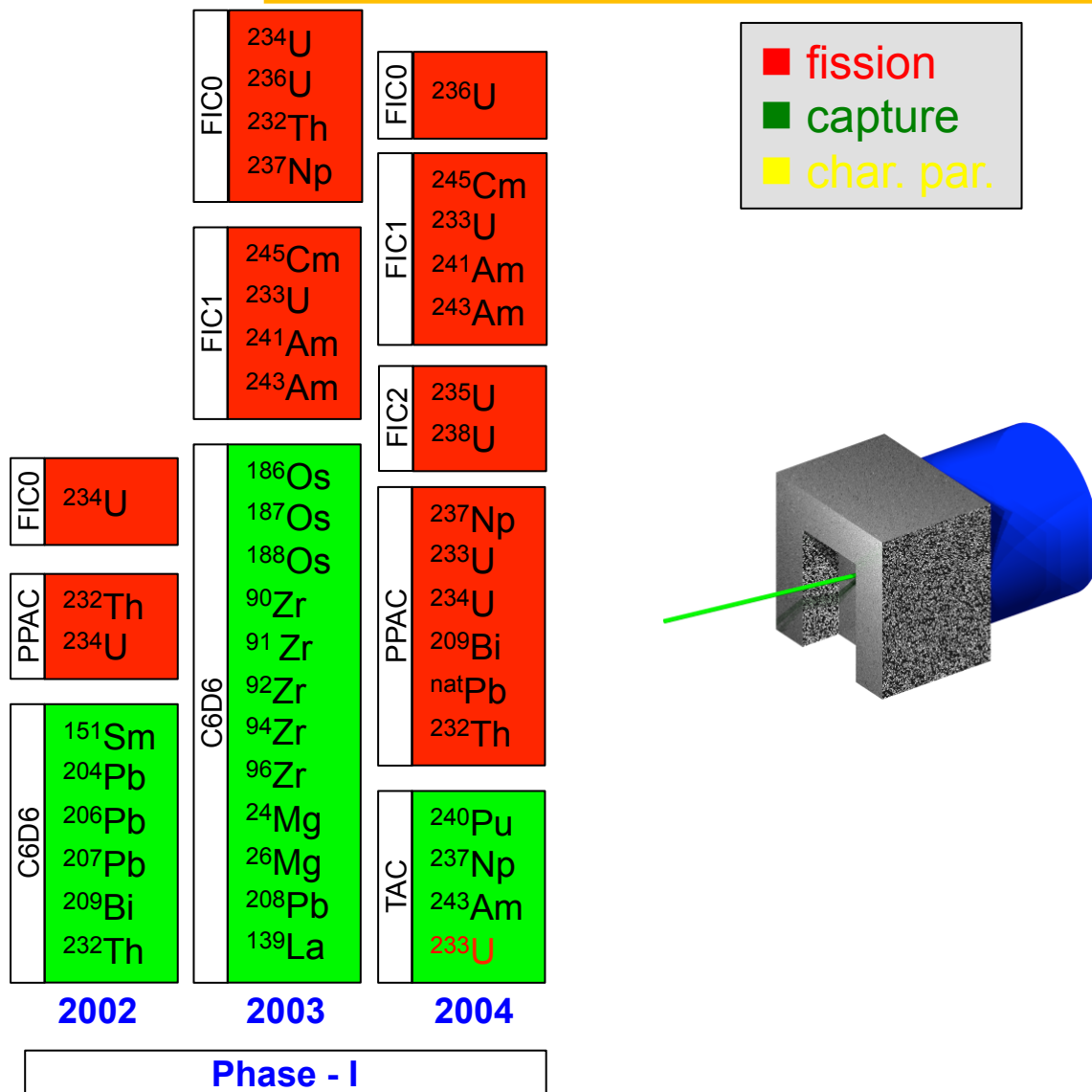
C6D6	^{151}Sm ^{204}Pb ^{206}Pb ^{207}Pb ^{209}Bi ^{232}Th
------	--

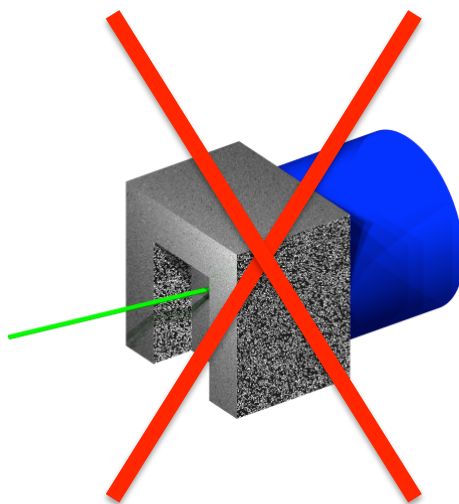
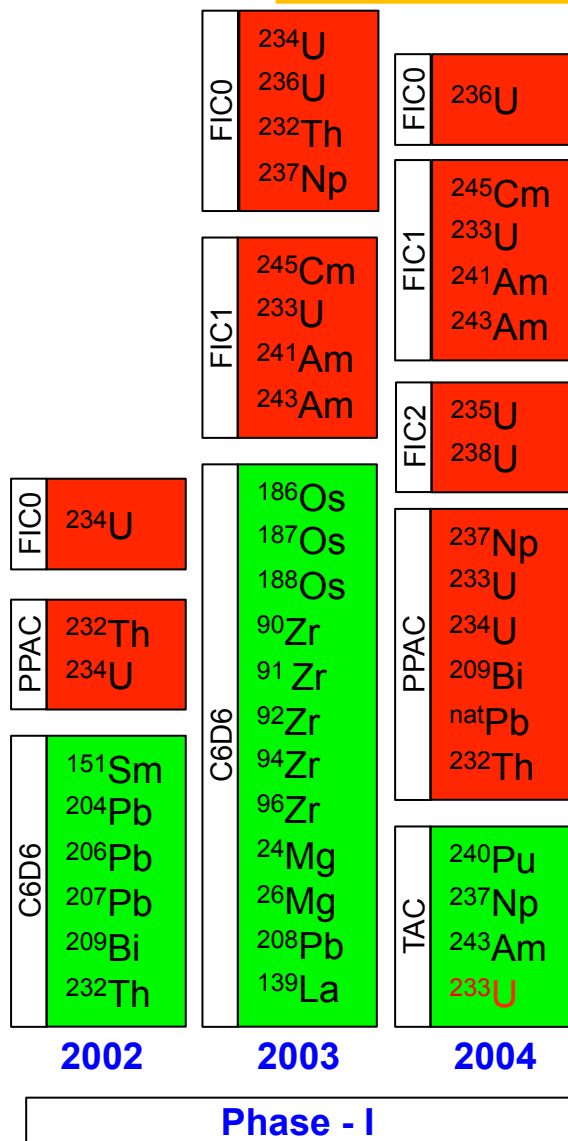
2002

Phase - I

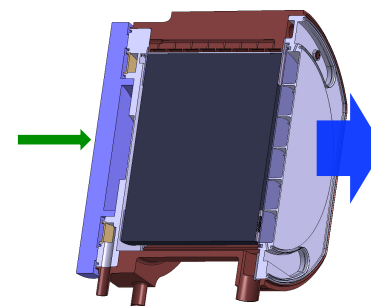




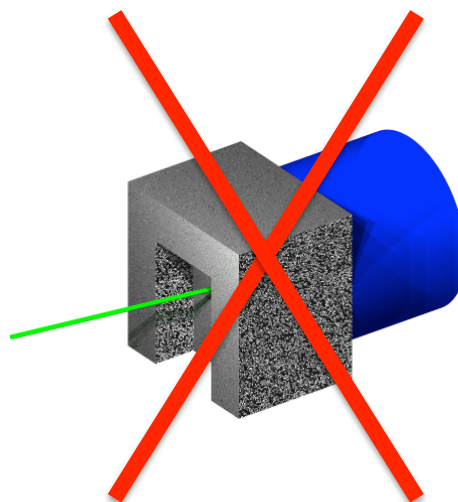
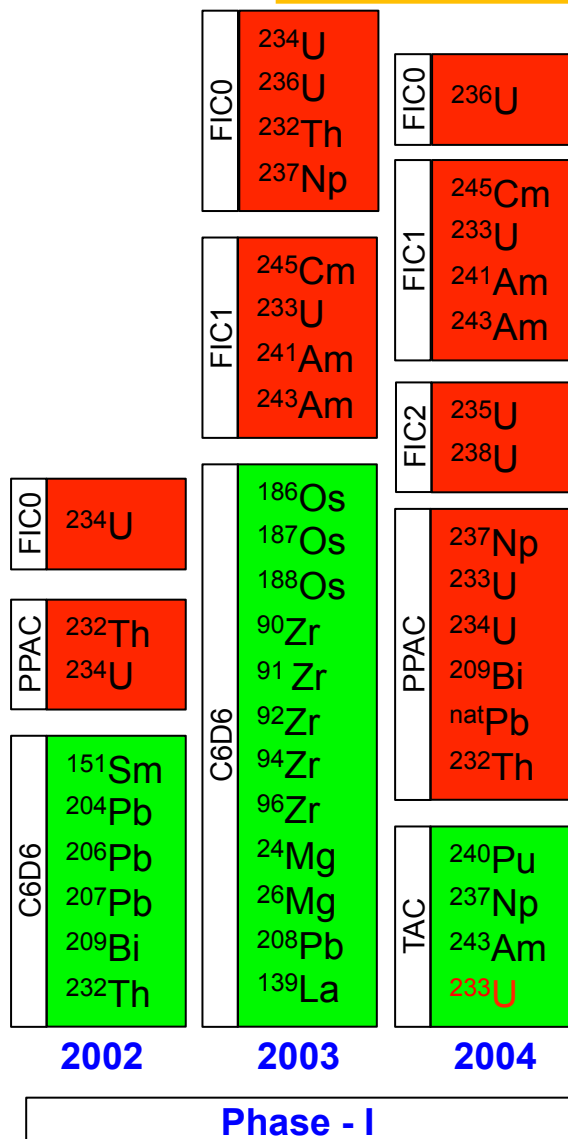




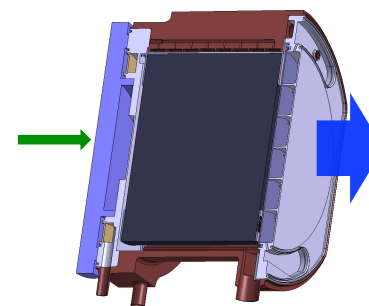
phase I target
2001 – 2004



phase II target
2009 – today

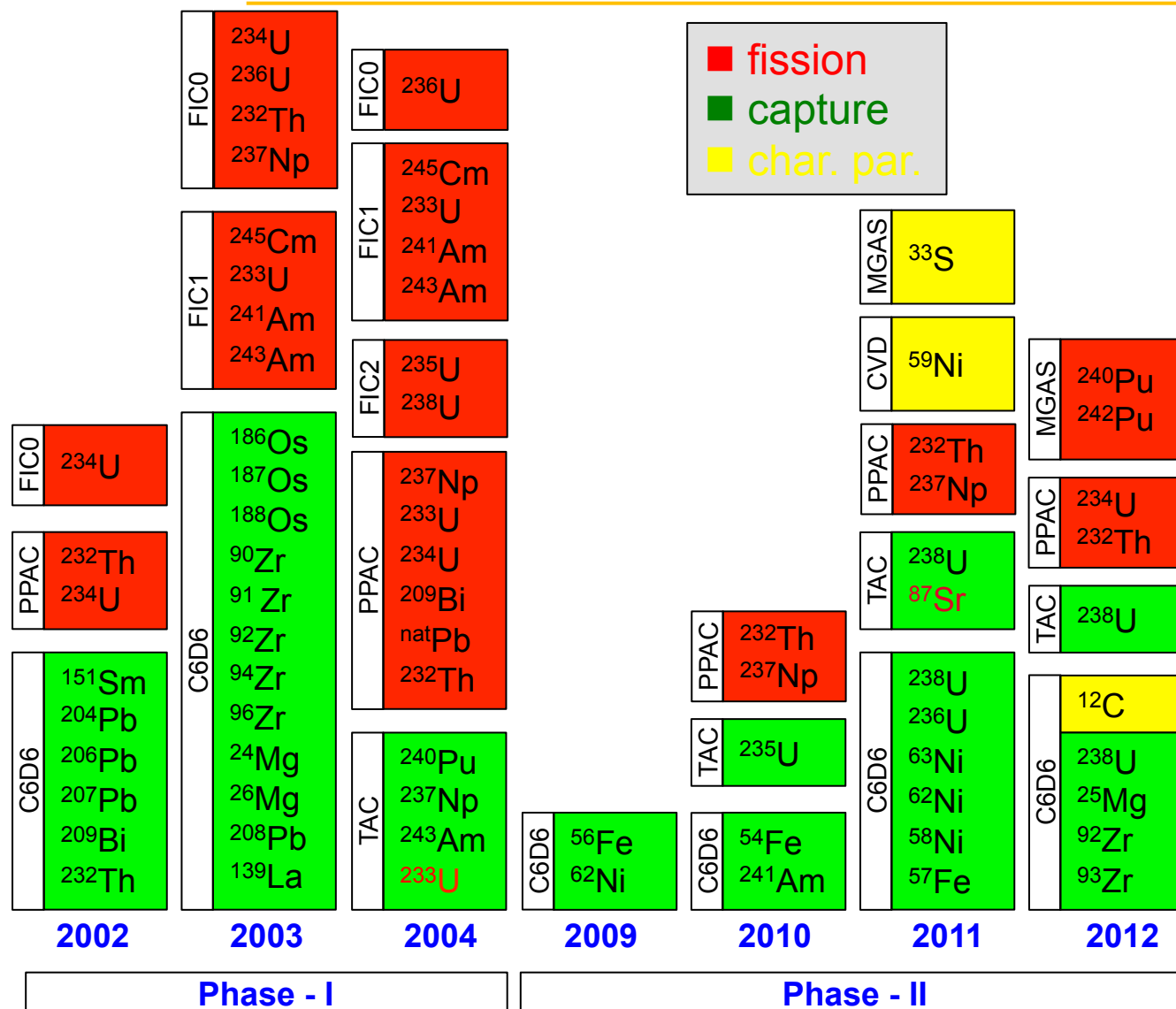


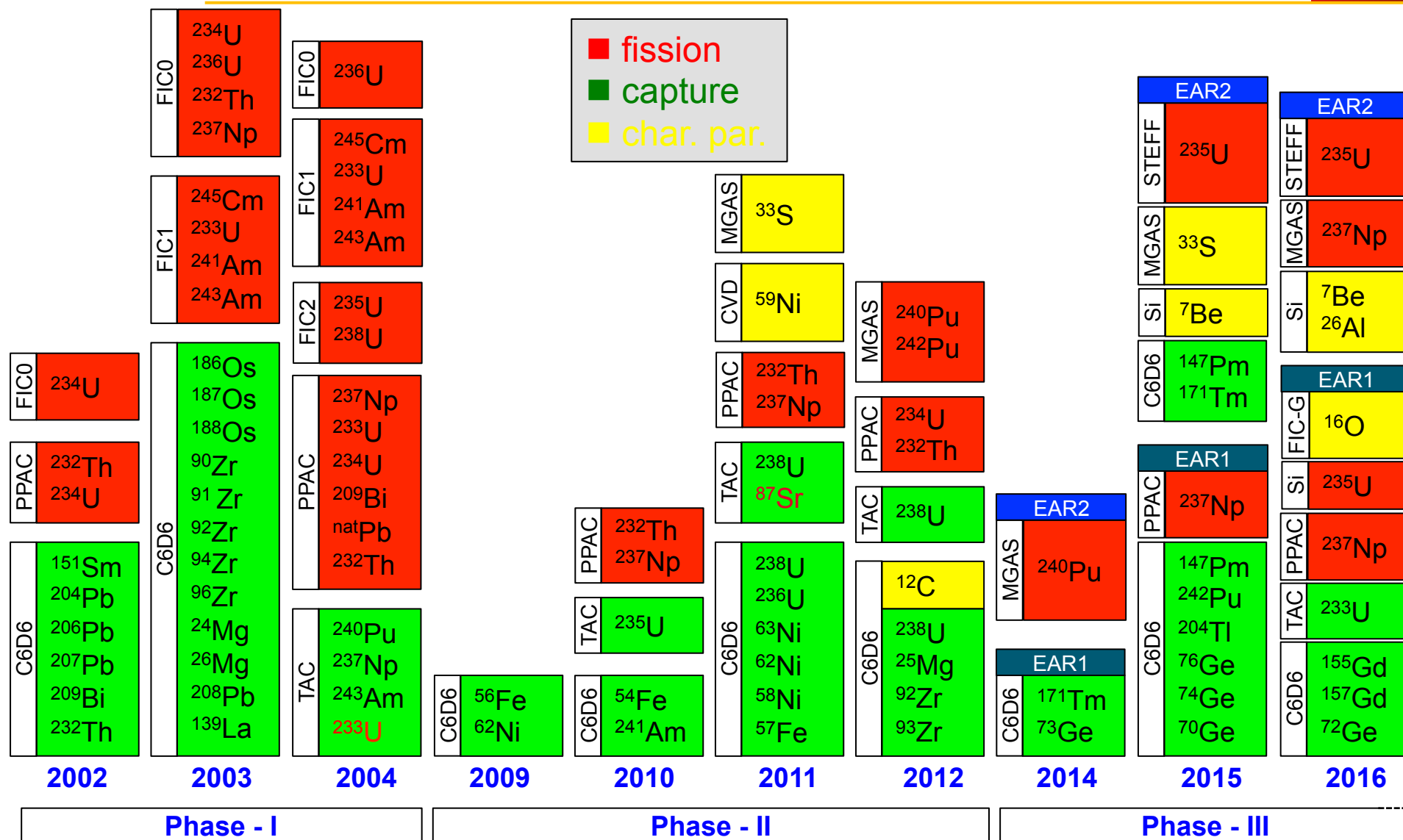
phase I target
2001 – 2004



phase II target
2009 – today

+ borated water
+ class A lab





EAR1

- $^{35}\text{Cl}(n,p)$
- $^{69,71}\text{Ga}(n,\gamma)$
- $^{88}\text{Sr}(n,\gamma)$
- $^{89}\text{Y}(n,\gamma)$
- $^{231}\text{Pa}(n,f)$
- others

EAR2

- $^{14}\text{N}(n,p)$
- $^{244,246}\text{Cm}(n,\gamma)$
- $^{241}\text{Am}(n,\gamma)$
- $^{243}\text{Am}(n,f)$
- $^{239,241}\text{Pu}(n,f)$
- others

sample availability

- The n_TOF Collaboration consists of about 120 persons and 40 institutes.
- Measured data are lost for Nuclear Data if not properly documented and submitted to EXFOR
- Many datasets taken, renewed awareness of need for dissemination
- New experiments depend critically on
 - detector development
 - sample preparation

n_TOF

I127	E. Chiaveri	The n_TOF facility
R220	Y. H. Chen	n_TOF EAR2 neutron beam
S222	J. Lerendegui-Marco	Simulations spallation target
I136	C. Weiss	Diamond detectors
I059	E. Gonzalez	CHANDA
R299	G. Sibbens	JRC target production
I297	D. Schumann	PSI sample production
R493	E. Dupont	Data dissemination

EAR1 data

S131	M. Bacak	$^{233}\text{U}(n,\gamma/f)$
S416	E. Leal-Cidoncha	$^{234}\text{U}(n,f)$
R028	J. Balibrea	$^{235}\text{U}(n,\gamma/f)$
S132	L. Cosentino	$^{235}\text{U}(n,f)$
S031	M. Mastromarco	$^{236}\text{U}(n,\gamma)$
R118	F. Mingrone	$^{238}\text{U}(n,\gamma)$
S032	J. Lerendegui-Marco	$^{242}\text{Pu}(n,\gamma)$
R036	E. Mendoza	$^{241}\text{Am}(n,\gamma)$

EAR2 data

R046	N. Colonna	$^7\text{Be}(n,\alpha/p)$
R047	M. Sabaté-Gilarte	$^{33}\text{S}(n,\alpha)$
R042	C. Guerrero	$^{147}\text{Pm}(n,\gamma), ^{171}\text{Tm}(n,\gamma)$
R171	T. Wright	$^{235}\text{U}(n,f)\text{FF}$
R093	A. Stamatopoulos	$^{240}\text{Pu}(n,f)$

O. Aberle, J. Andrzejewski, L. Audouin, V. Bécaries, M. Bacak, J. Balibrea-Correa, M. Barbagallo, S. Barros, F. Bečvář, C. Beinrucker, F. Belloni, E. Berthoumieux, J. Billowes, D. Bosnar, A. Brown, M. Brugger, M. Caamaño, F. Calviño, M. Calviani, D. Cano-Ott, R. Cardella, A. Casanovas, D. M. Castelluccio, F. Cerutti, Y. H. Chen, E. Chiaveri, N. Colonna, M. A. Cortés-Giraldo, G. Cortés, L. Cosentino, L. A. Damone, K. Deo, M. Diakaki, C. Domingo-Pardo, R. Dressler, E. Dupont, I. Durán, B. Fernández-Domínguez, A. Ferrari, P. Ferreira, P. Finocchiaro, R. J. W. Frost, V. Furman, S. Ganesan, A. R. García, A. Gawlik, I. Gheorghe, S. Gilardoni, T. Glodariu, I. F. Gonçalves, E. González, A. Goverdovski, E. Griesmayer, C. Guerrero, K. Göbel, F. Gunsing, H. Harada, T. Heftrich, S. Heinitz, A. Hernández-Prieto, J. Heyse, D. G. Jenkins, E. Jericha, F. Käppeler, Y. Kadi, A. Kalamara, T. Katabuchi, P. Kavargin, V. Ketlerov, V. Khryachkov, A. Kimura, N. Kivel, M. Kokkoris, M. Krtička, D. Kurtulgil, E. Leal-Cidoncha, C. Lederer, H. Leeb, J. Lerendegui, M. Licata, S. Lo Meo, S. J. Lonsdale, R. Losito, D. Macina, J. Marganec, T. Martínez, A. Masi, C. Massimi, P. Mastinu, M. Mastro marco, F. Matteucci, E. A. Maugeri, A. Mazzone, E. Mendoza, A. Mengoni, P. M. Milazzo, F. Mingrone, M. Mirea, S. Montesano, A. Musumarra, R. Nolte, A. Negret, A. Oprea, F. R. Palomo-Pinto, C. Paradela, N. Patronis, A. Pavlik, J. Perkowski, I. Porras, J. Praena, J. M. Quesada, D. Radeck, K. Rajeev, T. Rauscher, R. Reifarth, A. Riego-Perez, M. Robles, P. Rout, C. Rubbia, J. A. Ryan, M. Sabaté-Gilarte, A. Saxena, P. Schillebeeckx, S. Schmidt, D. Schumann, P. Sedyshev, A. G. Smith, N. V. Sosnin, A. Stamatopoulos, S. V. Suryanarayana, G. Tagliente, J. L. Tain, A. Tarifeño-Saldivia, D. Tarrío, L. Tassan-Got, A. Tsinganis, S. Valenta, G. Vannini, V. Variale, P. Vaz, A. Ventura, V. Vlachoudis, R. Vlastou, A. Wallner, S. Warren, M. Weigand, C. Weiss, C. Wolf, P. J. Woods, T. Wright, and P. Žugec
(the n_TOF Collaboration)

