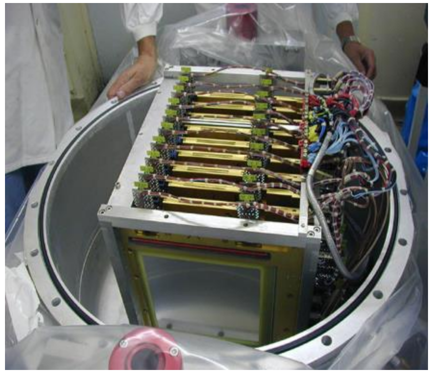
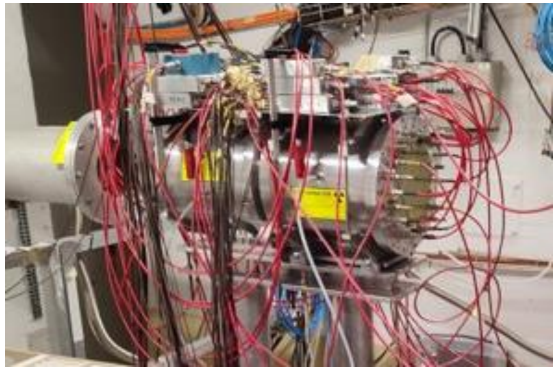
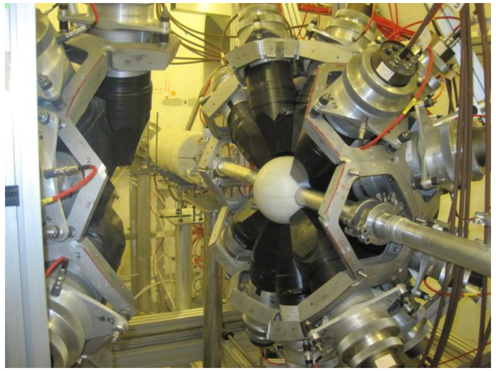
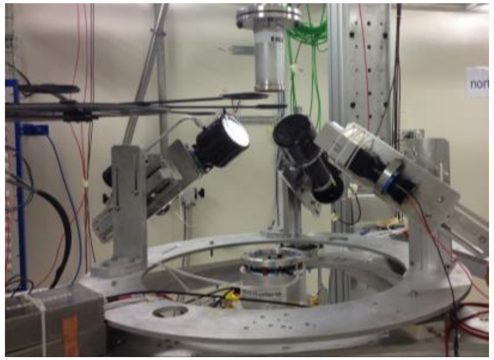
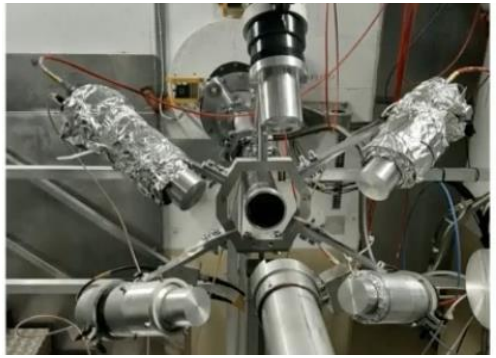






Overview of the n_TOF nuclear data activities

Maria Diakaki,

National Technical University of Athens, GREECE

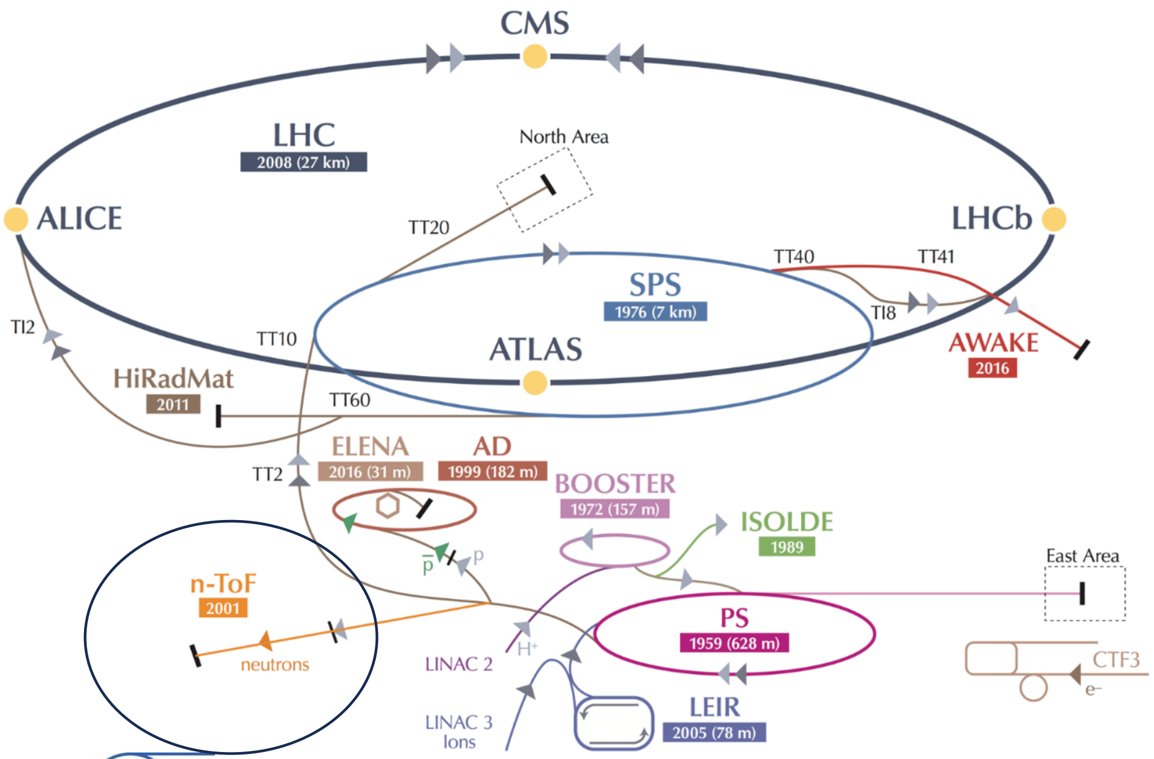
for the **n_TOF collaboration**

The n_TOF collaboration / n_TOF facility

- The n_TOF Collaboration was founded in **2001**:

C. Rubbia et al., *A high resolution spallation driven facility at the CERN-PS to measure neutron cross sections in the interval from 1 eV to 250 MeV*, CERN/LHC/98-02(EET) 1998

- **TODAY**: n_TOF is formed by **152 scientists** (33 PhD students, ~20 PostDocs) from **43 different institutions** in **19 countries** (Europe, USA, Russia, Japan).



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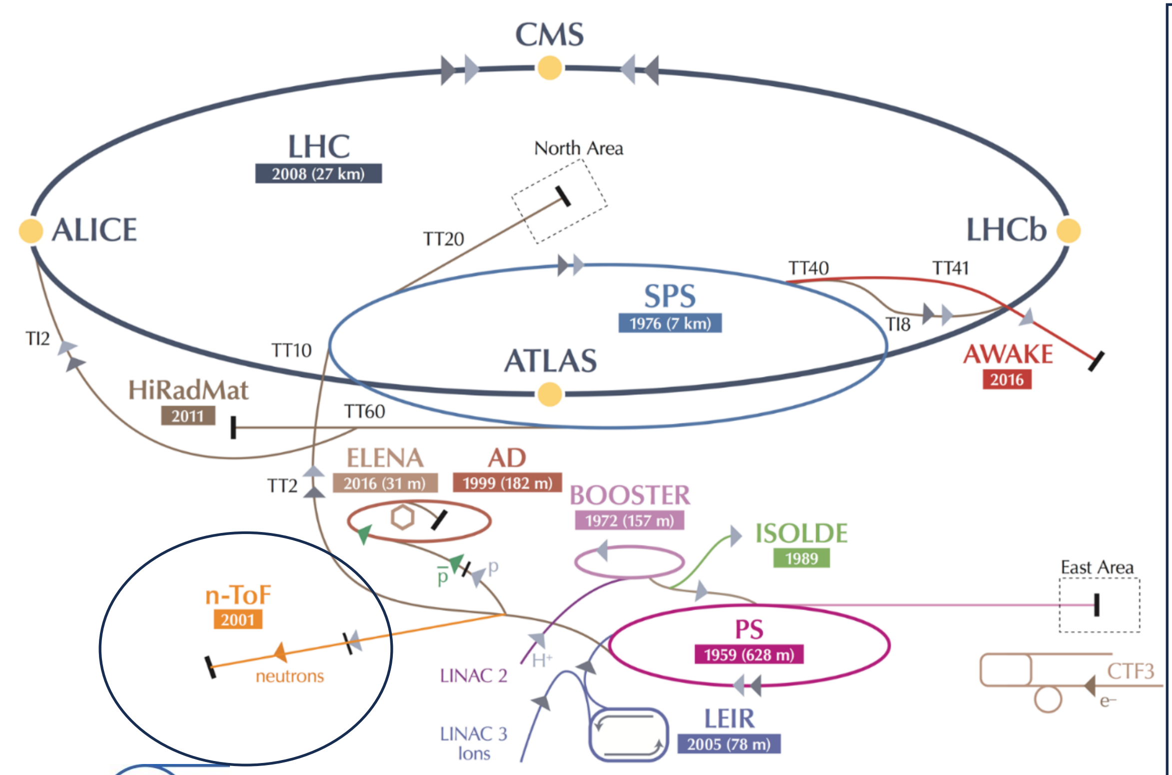
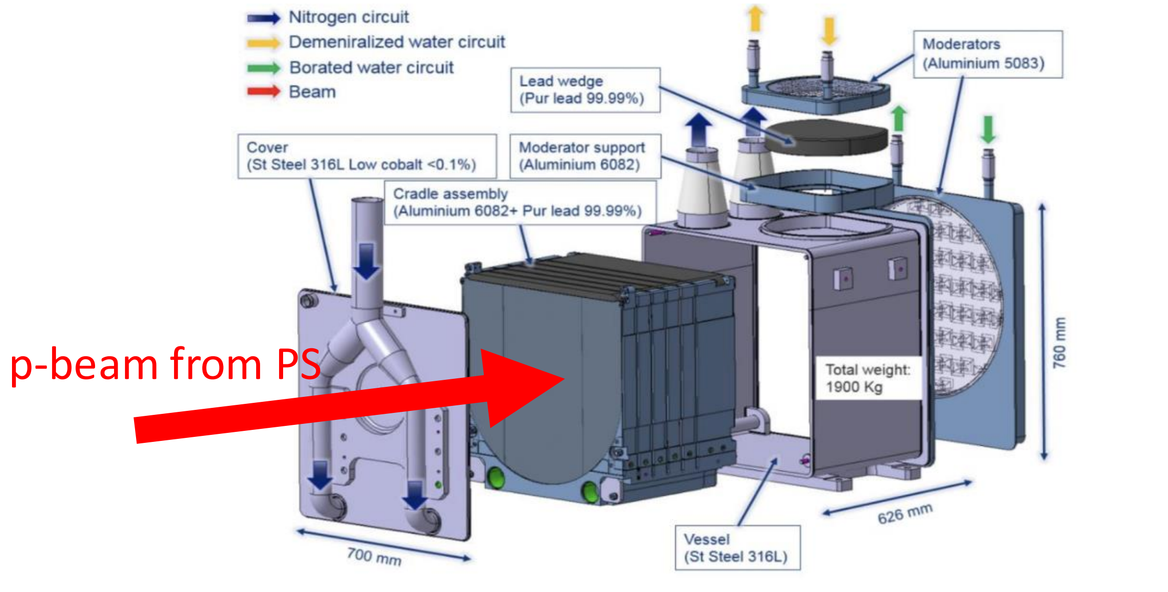


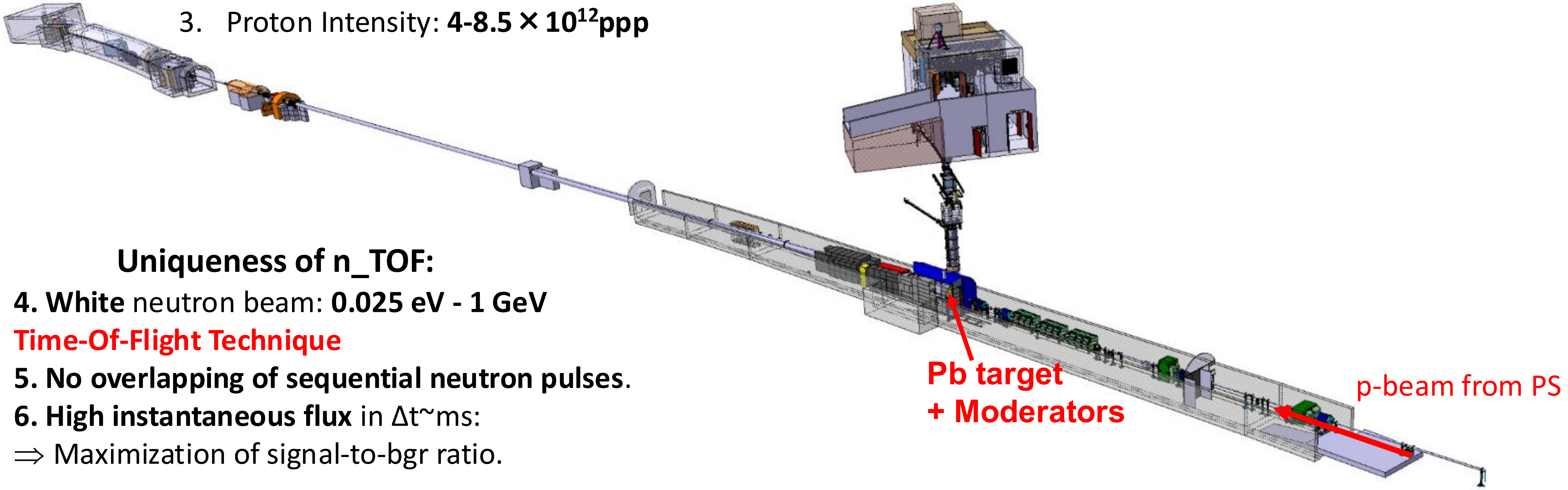
Neutron production: Spallation of high energy protons on a thick Pb target (installed and commissioned in 2021)



The Neutron production facility : n_TOF (CERN)

Main features

1. Proton beam of **20GeV/c** from PS accelerator (CERN).
2. **Pulsed** proton beam (7ns width pulse with <0.8 Hz)
3. Proton Intensity: **4-8.5 × 10^{12}ppp**



Uniqueness of n_TOF:

4. White neutron beam: **0.025 eV - 1 GeV**

Time-Of-Flight Technique

5. No overlapping of sequential neutron pulses.

6. High instantaneous flux in Δt~ms:

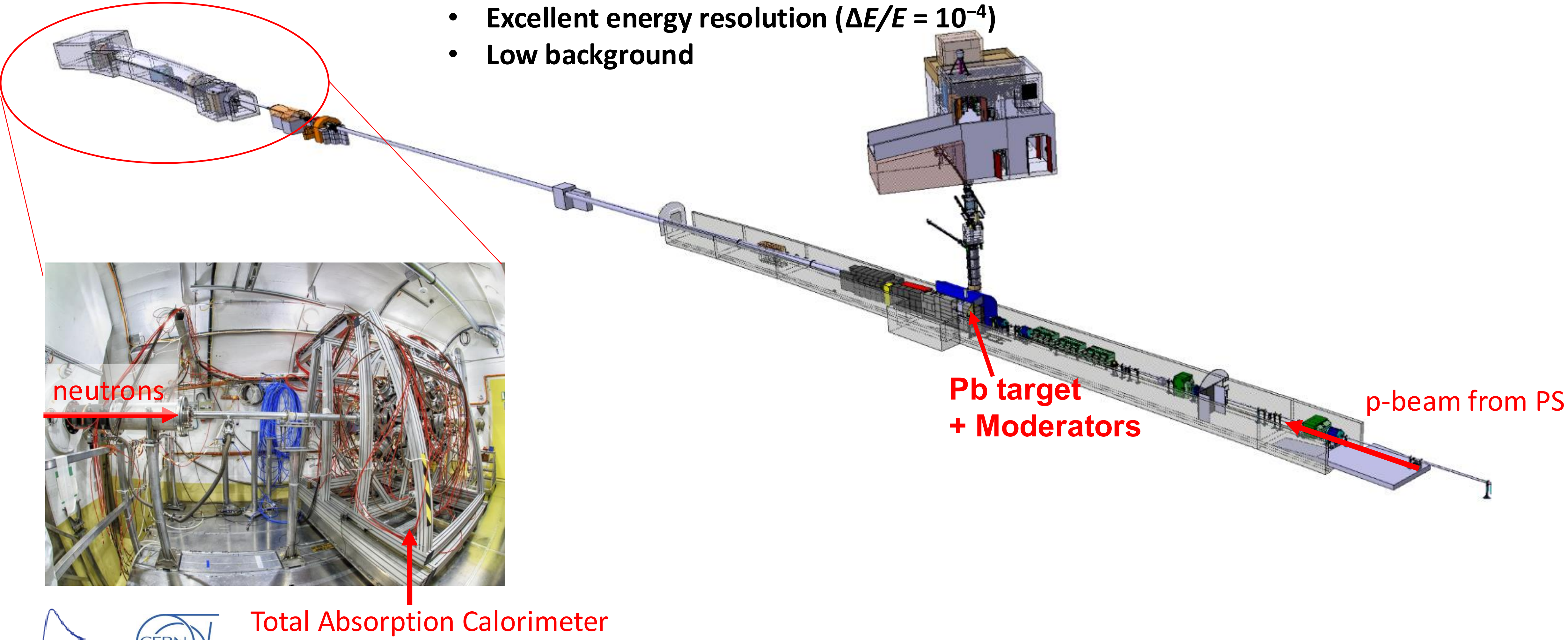
⇒ Maximization of signal-to-bgr ratio.

7. Three experimental areas **EAR1 , EAR2, NEAR**

The Neutron production facility : n_TOF (CERN)

1) Experimental Area **EAR-1**
Flight-path ~**185m**
Commissioned: **2001**

- **high instantaneous neutron flux (~10^5 n/cm2/pulse)**
- **E_n from thermal to GeV**
- **Excellent energy resolution ($\Delta E/E$ = 10^{-4})**
- **Low background**



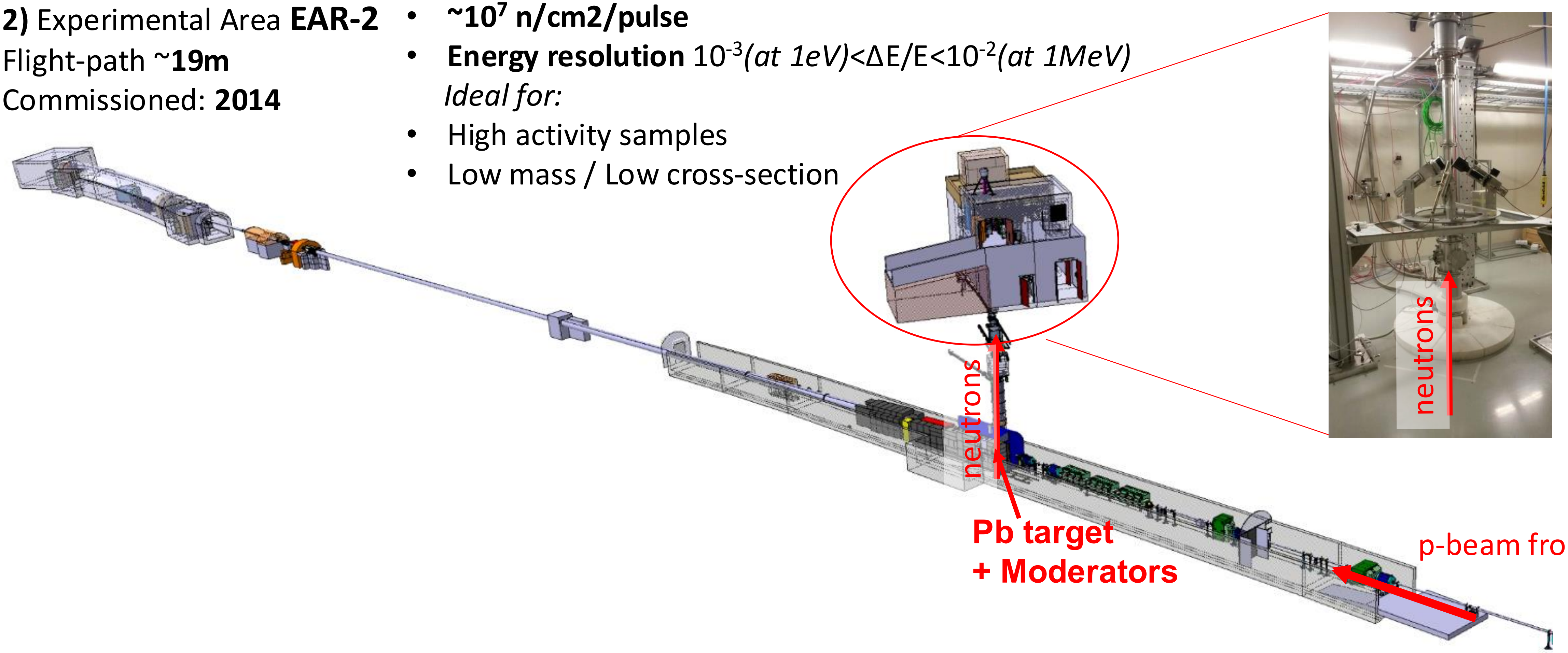
The Neutron production facility : n_TOF (CERN)

2) Experimental Area **EAR-2**
Flight-path ~**19m**
Commissioned: **2014**

- **~10^7 n/cm2/pulse**
- **Energy resolution** 10^{-3}*(at 1eV)*<ΔE/E<10^{-2}*(at 1MeV)*

Ideal for:

- High activity samples
- Low mass / Low cross-section



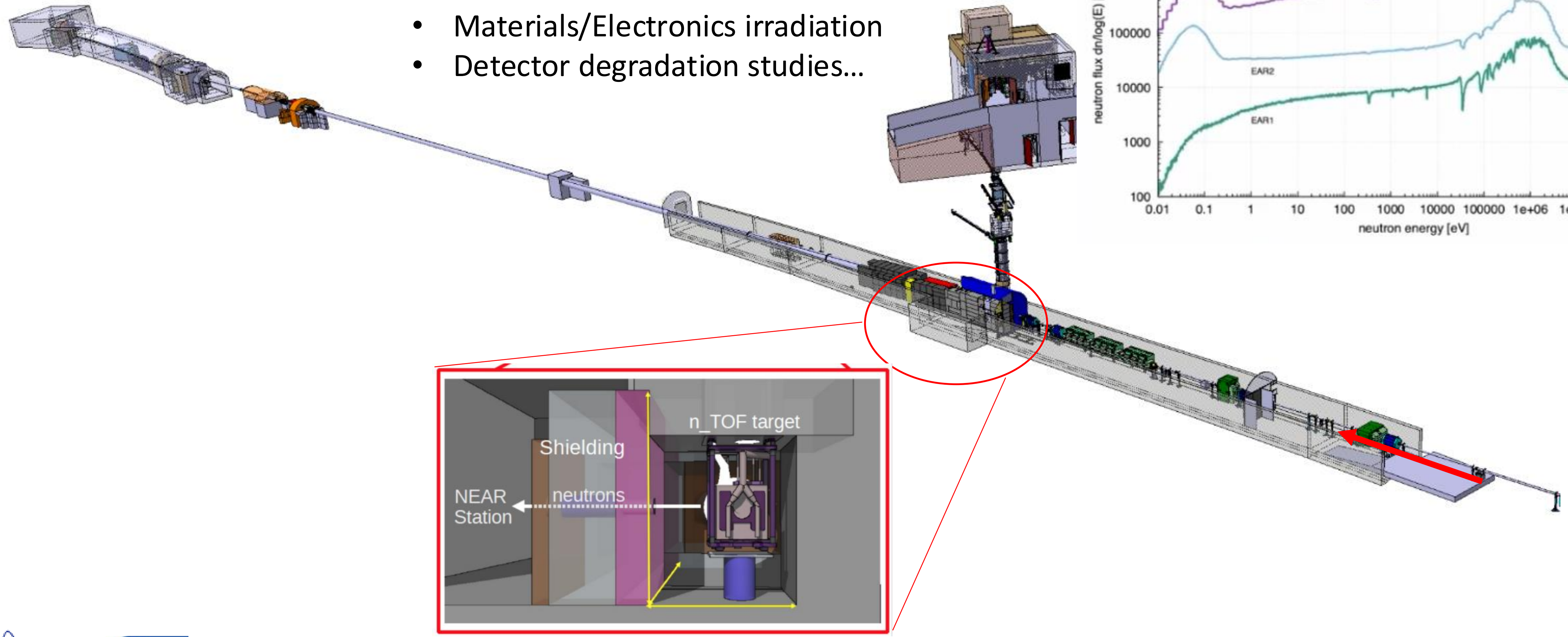
The Neutron production facility : n_TOF (CERN)

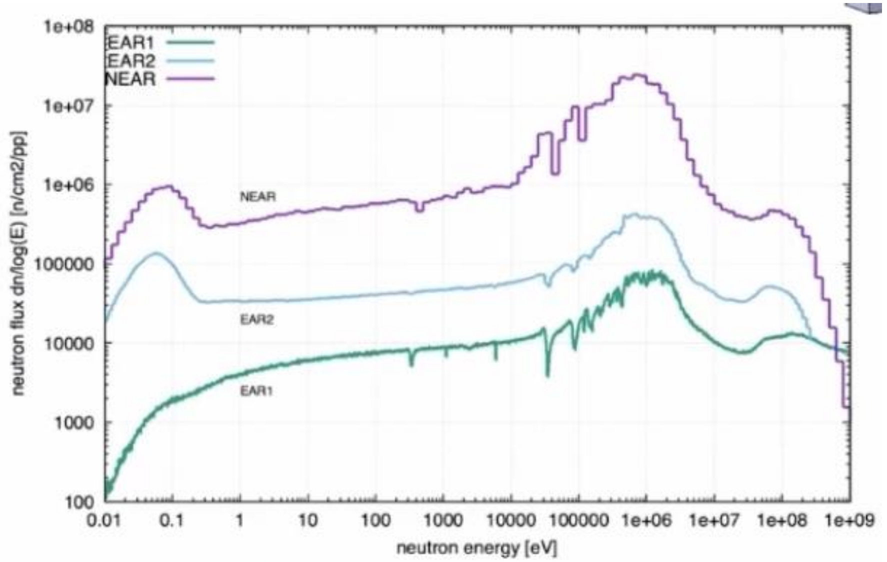
3) Experimental Area **NEAR**
Flight-path ~**2.5 m**
Commissioned: **2021**

- **~10^9 n/cm2/pulse**
- Poor resolution

Suitable for:

- MACS
- Materials/Electronics irradiation
- Detector degradation studies…



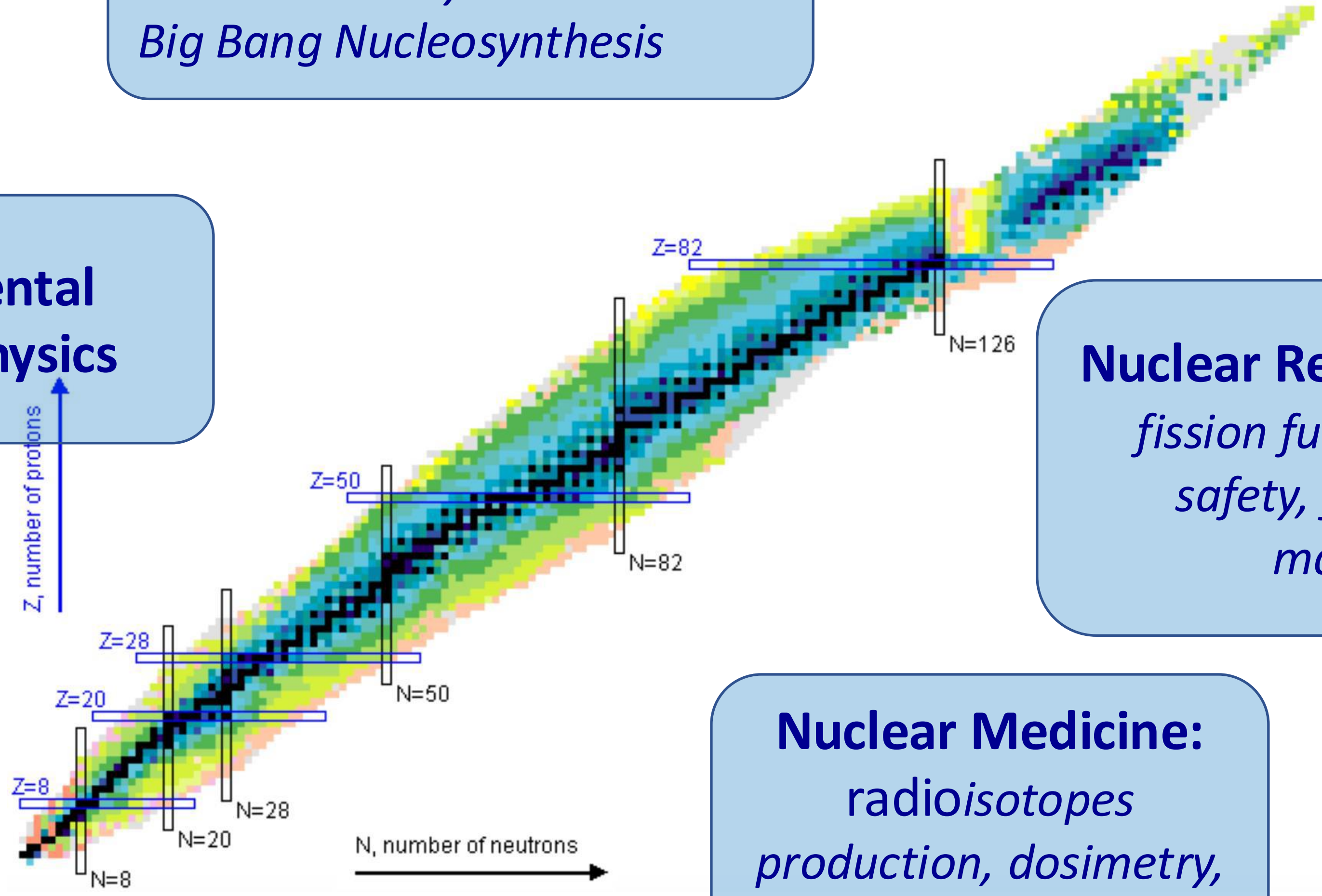


n-Induced Reaction Data Studies for….

Nuclear astrophysics
Stellar Nucleosynthesis
Big Bang Nucleosynthesis

Applications:
electronics, radiation hardness, TOF imaging..

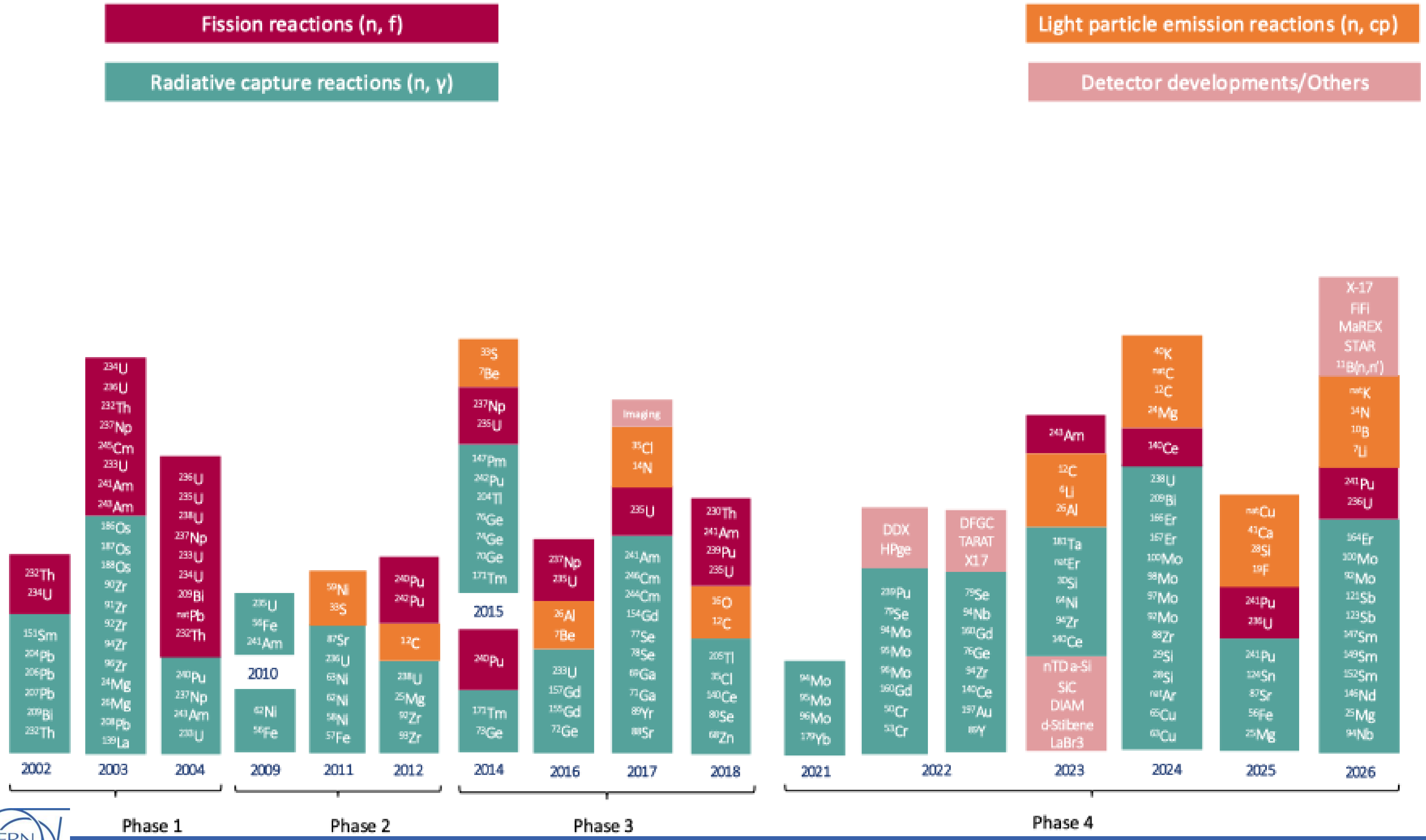
Fundamental nuclear physics



Nuclear Reactor Research:
fission fuel cycles, waste, safety, fission/fusion materials…

Nuclear Medicine:
radio*isotopes production, dosimetry, BNCT…*

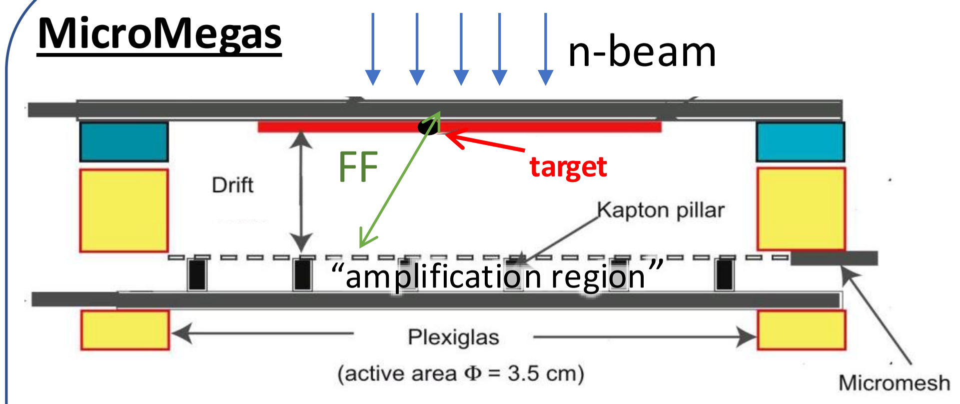
n_TOF measurements (2001 to date)

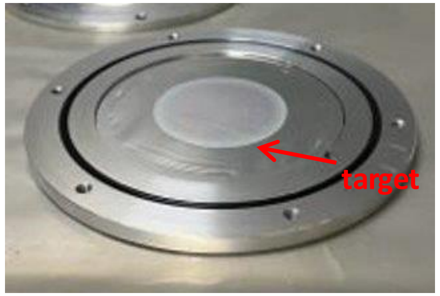


FISSION STUDIES AT n_TOF

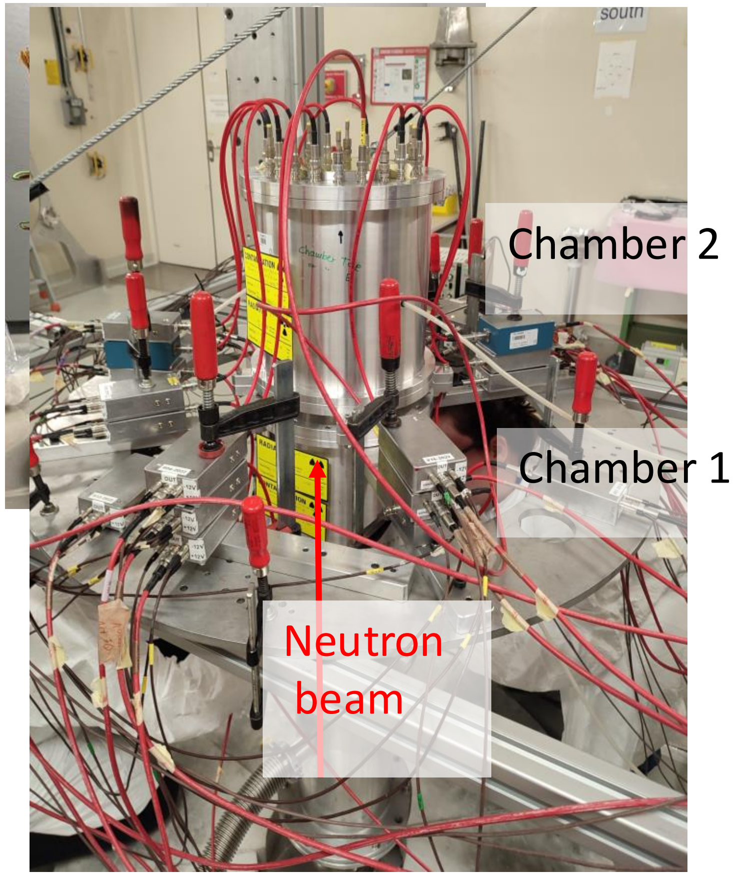
Fission studies – Example ^{243}Am(n,f) cross section

APPLICATION: ^{243}Am **high-level nuclear waste** produced at **nuclear power plants** => **long term radiotoxicity**
=> Important candidate for use as a **burnable actinide** in future reactors. **^{243}Am(n,f) cross section** classified in GRL/NEA.
Goal: To provide the first single high-quality dataset from thermal up to 100s MeV.





- Almost "transparent" for neutrons
- High efficiency (~100% in fission studies)
- Radiation durability
- Fast response & time resolution



EAR2

- We **used 11 specially designed high purity ^{243}Am TARGETS** of **different thickness** (Target preparation Lab – JRC-Geel)
- Total activity **160MBq**
- Reference reactions : **^{235}U(n,f), ^{238}U(n,f), ^{10}B(n,α)**
- **EAR1 and EAR2**

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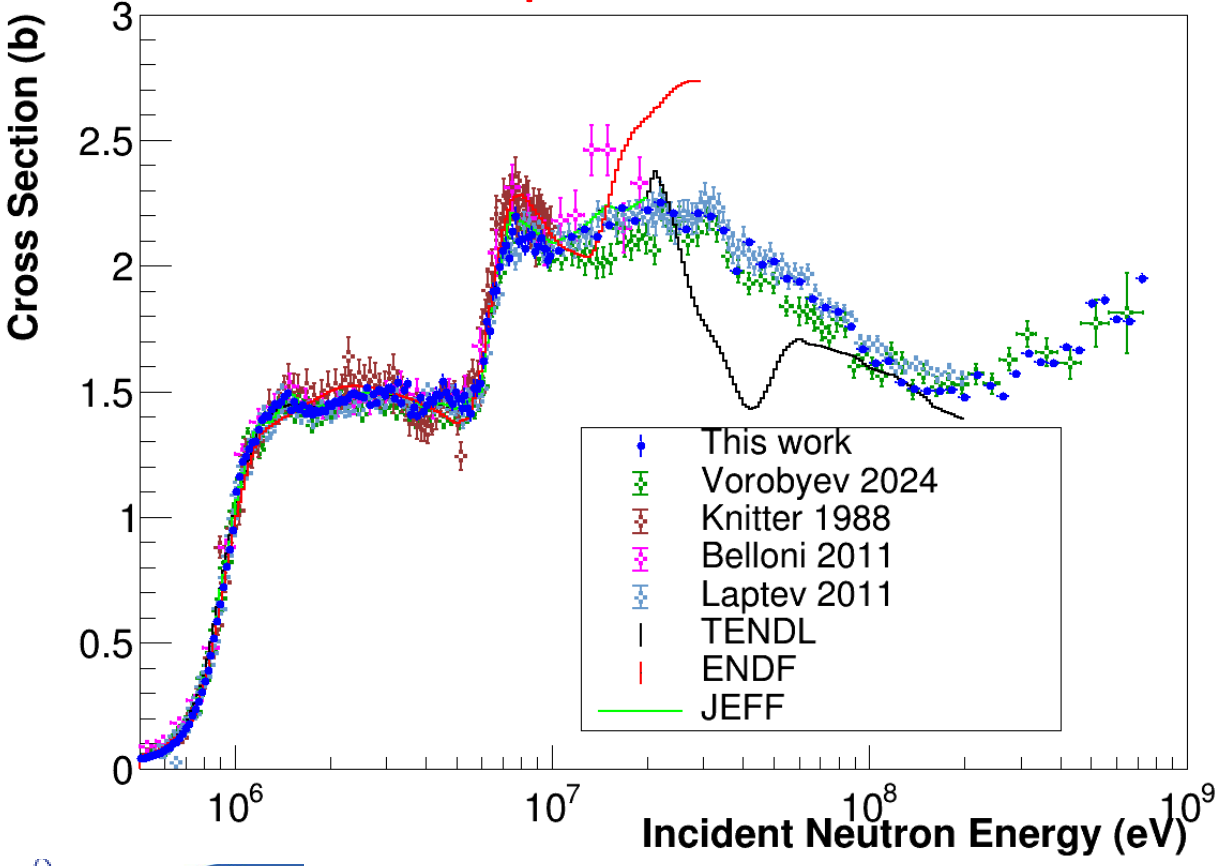
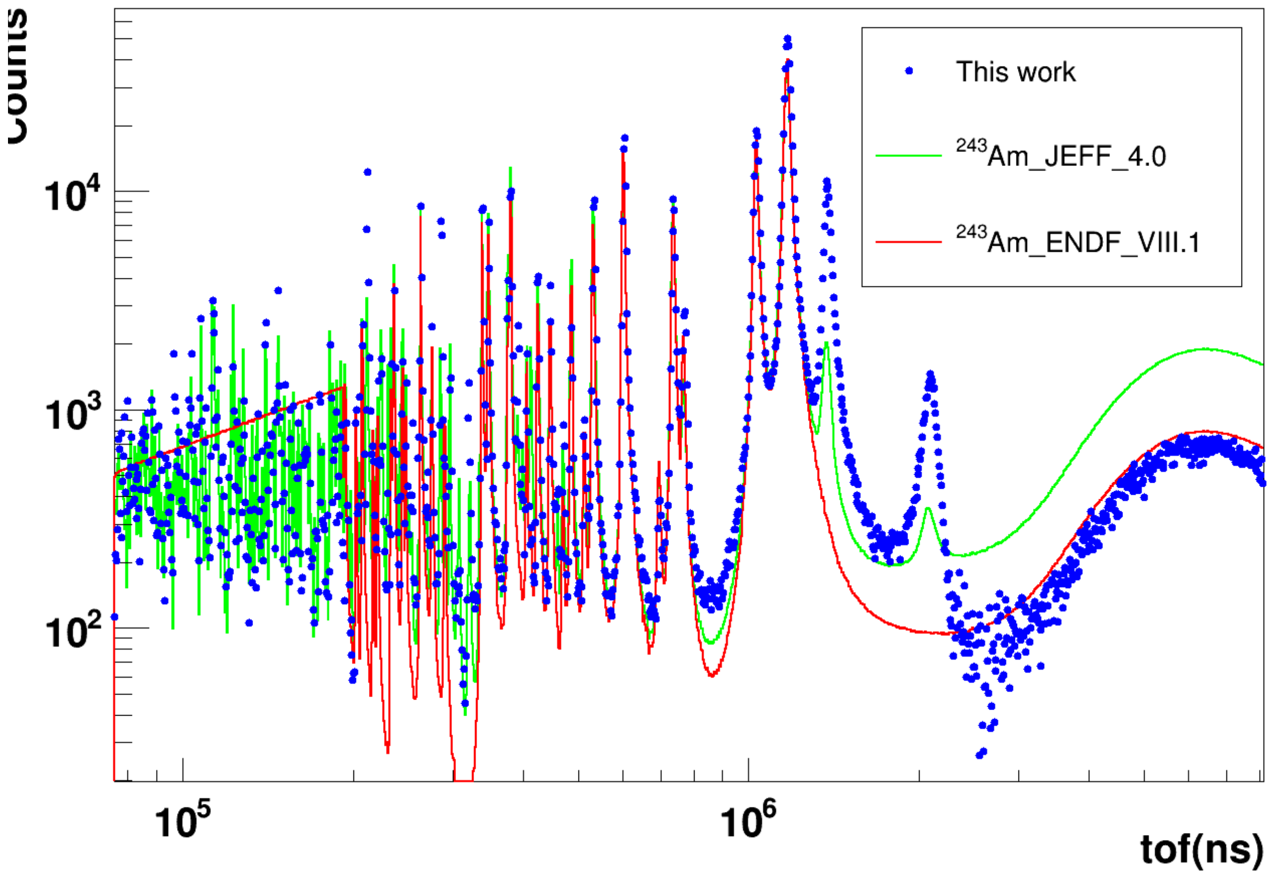
EAR1: up to En~ 700 MeV



EAR2: Resonances resolved for the first time



N. Kyritsis et al., under preparation

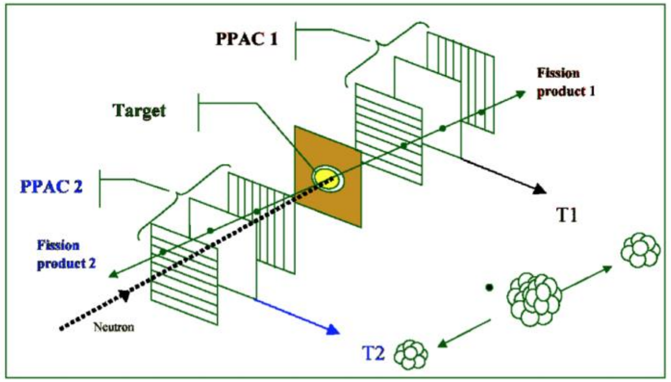
Fission studies – Angular distribution of FFs - PPAC

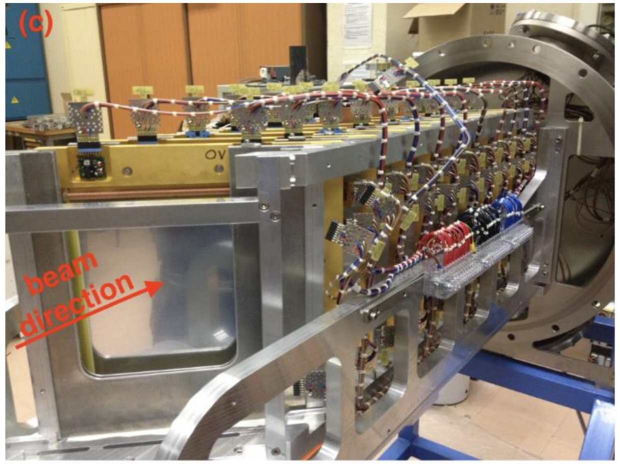
Fission cross section and Fission Fragment angular distribution : **DETECTOR: P**arallel **P**late **A**valanche **C**ounter (**PPAC**):

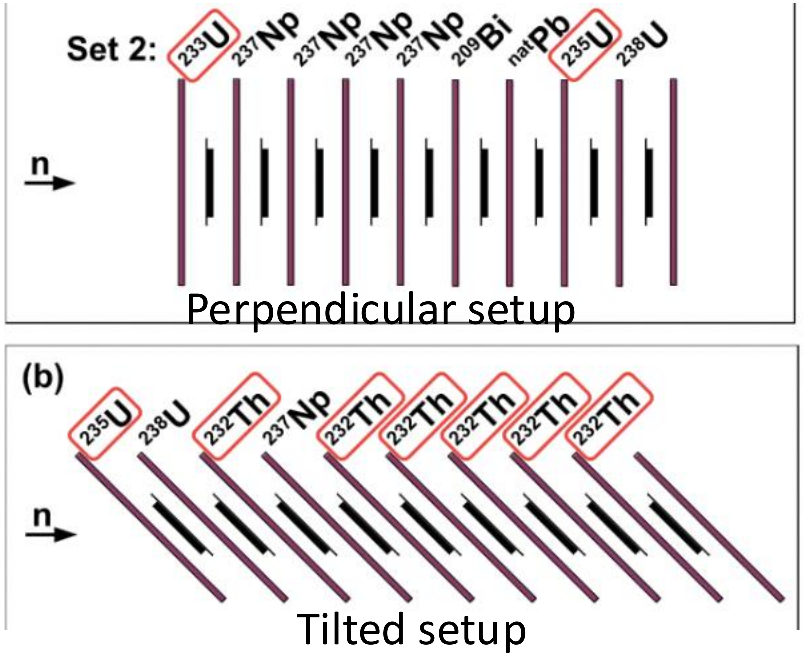
IPN Orsay

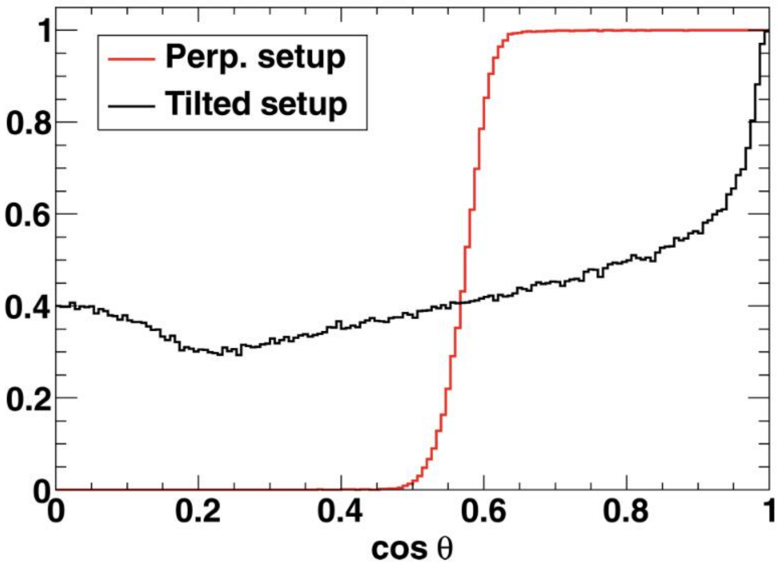
- Main advantages:

1) Very little material: Insensitive to γ-flash
2) Coincidence of FF (10 ns)=> background rejection (e.g alphas, spallation products) & negligible pile-up.
3) FF trajectory reconstruction/Angular distributions of FF.





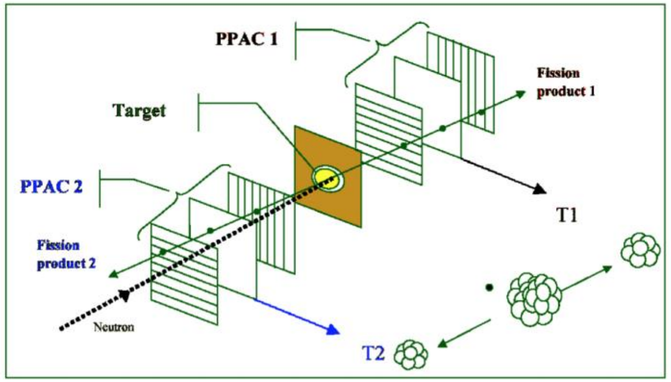


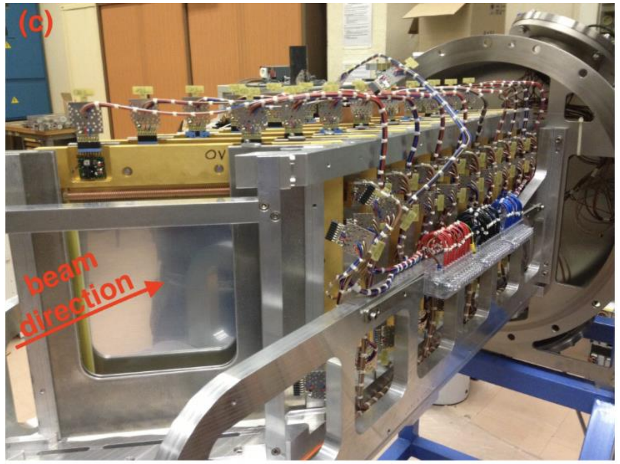


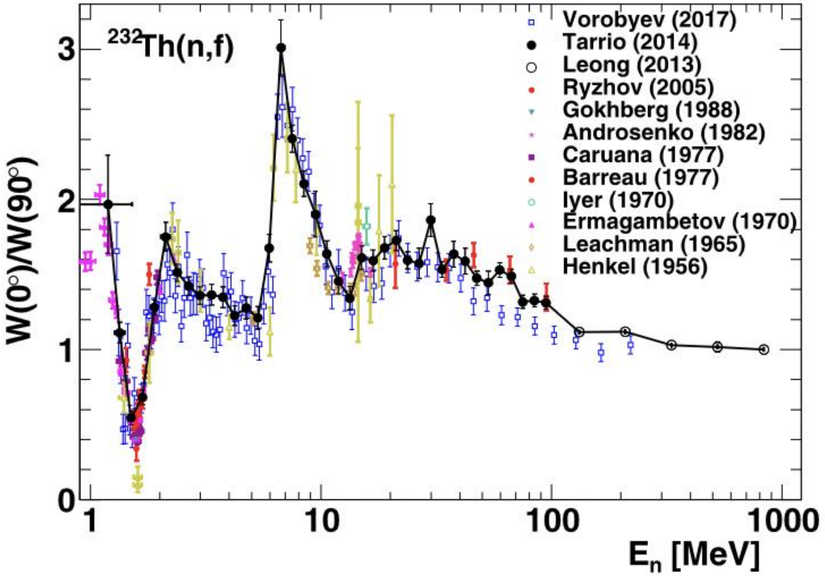
D. Tarrio et al., Nuclear Instruments and Methods A 743 (2014) 79–85

Fission studies – Angular distribution of FFs - PPAC

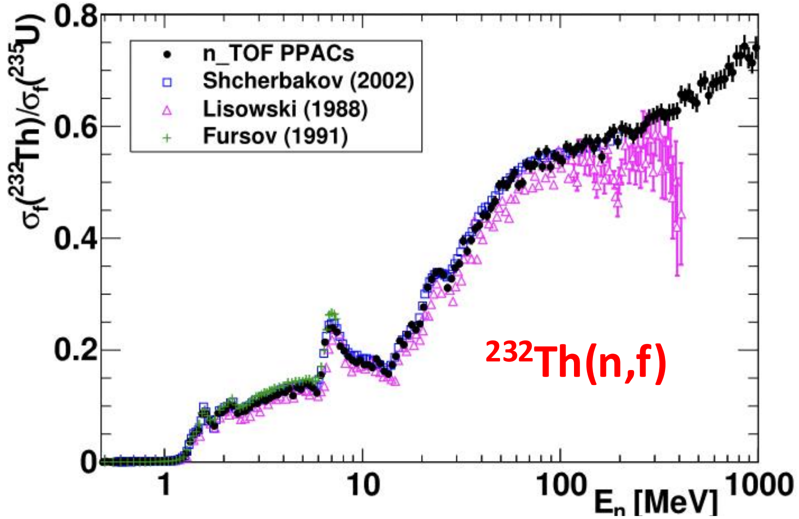
Fission cross section and Fission Fragment angular distribution

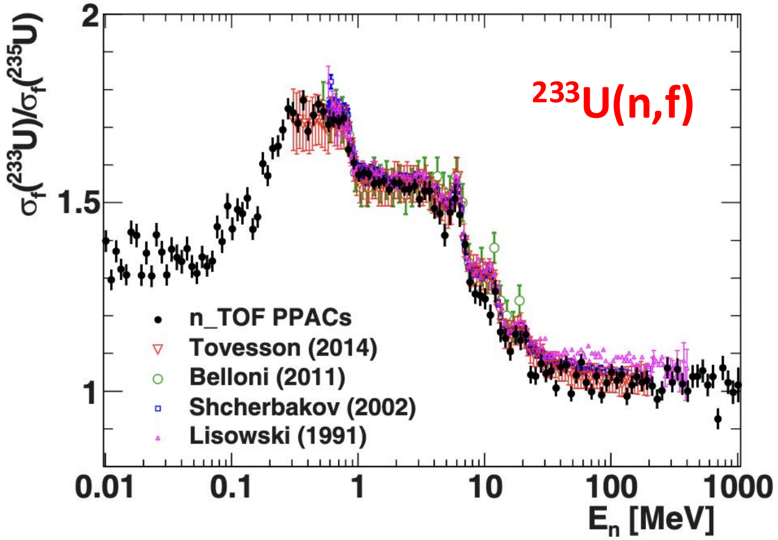






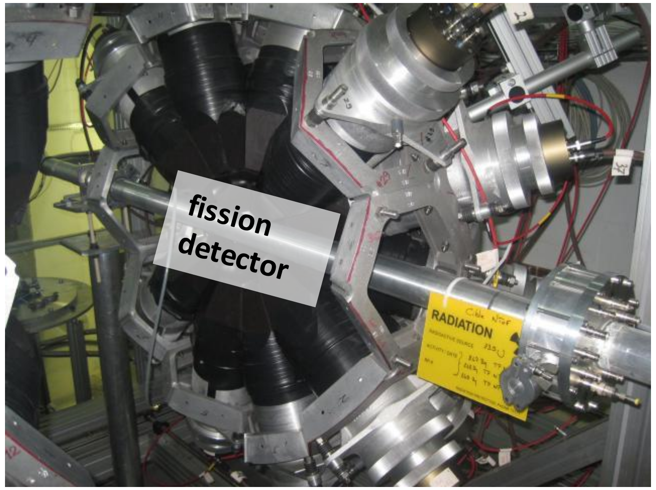
- Fission cross section up to 1 GeV
- FFAD measured

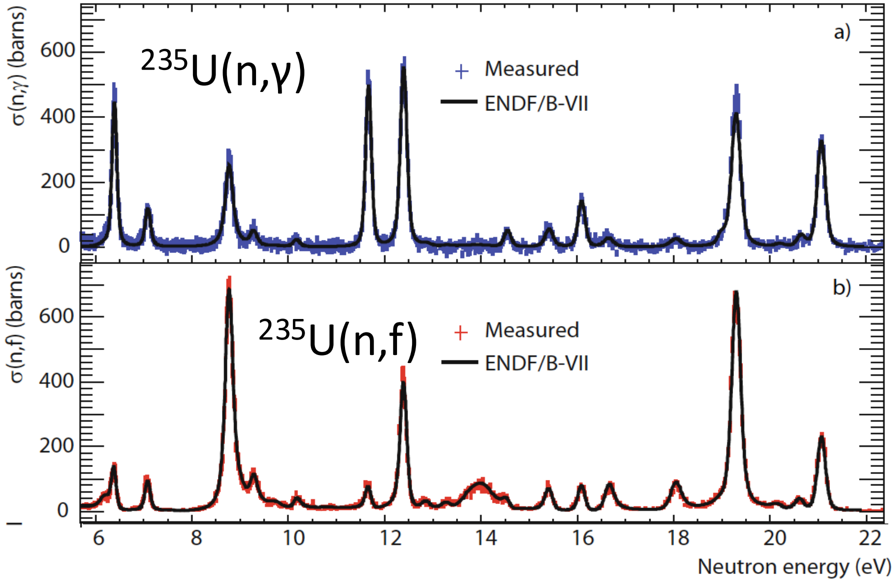




D. Tarrio et al., Physical Review C 107, 044616 (2023)

Simultaneous measurement of (n,γ), (n,f) cross-section





- Capture/Fission of fissile isotopes (^{235}U, ^{233}U, ^{239}Pu, ^{241}Pu…)
- **Fission chamber** in the middle of the **Total Absorption Calorimeter (TAC) – EAR1**

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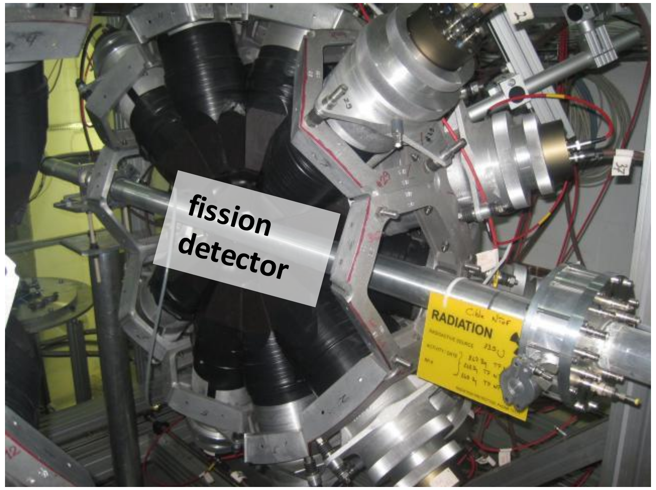

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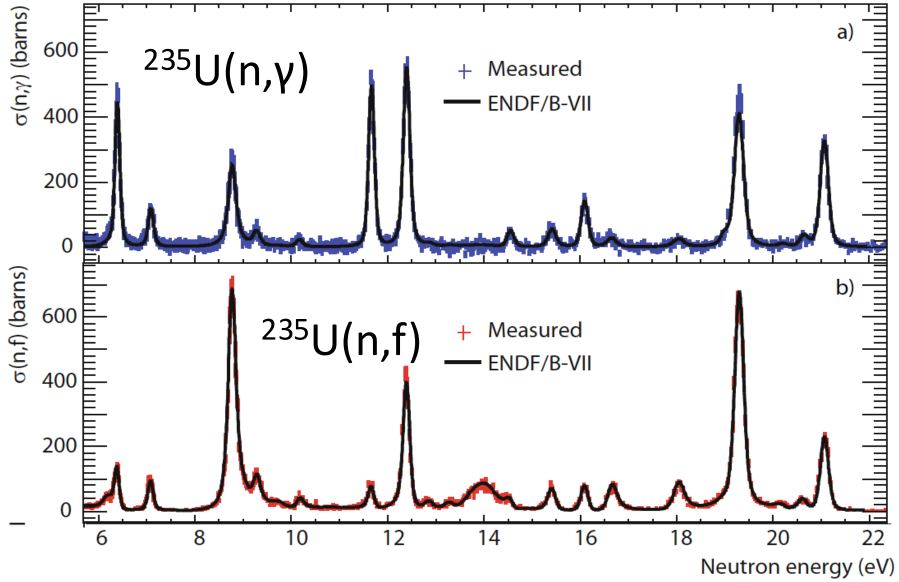
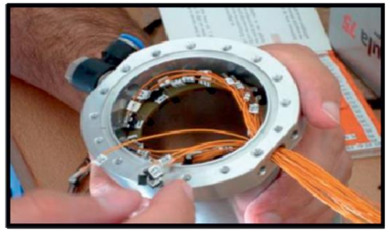
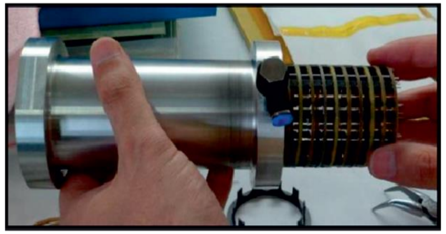


Fission Tagging detector evolution:

1) Micromegas detector:



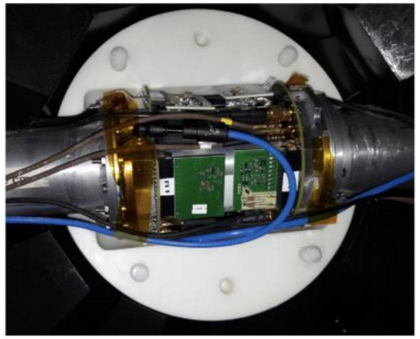


^{235}U(n,γ/f) measurement

C. Guerrero et al., Eur. Phys. J. A (2012) 48: 29

J. Balibrea-Correa et al., Phys. Rev. C 102 (2020) 044615

2) Compact multiplate fission chamber (no amplification)



^{233}U(n,γ/f) measurement

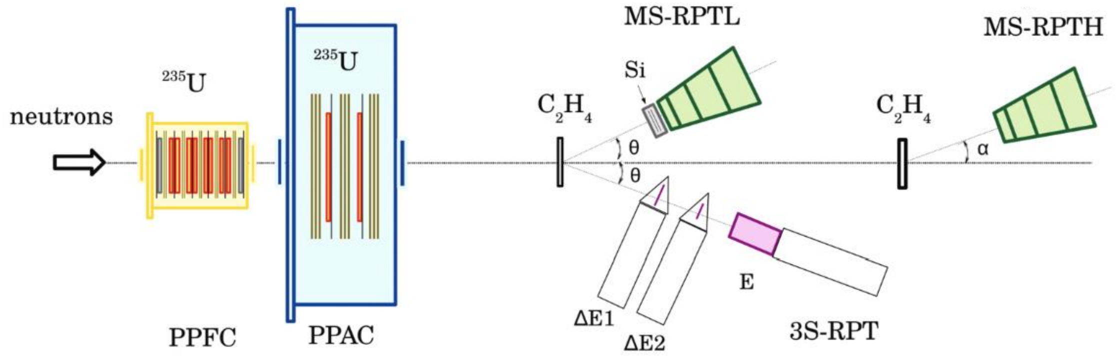
M. Bacak et al., Nucl. Inst. Meth. A. 969 (2020) 163981

3) **^{241}Pu(n,γ/f) measurement:** *see presentation by A. Cahuzac*

4) **^{239}Pu(n,γ/f) measurement:** *see presentation by A. Sanchez Caballero*

Fission studies – revisiting well-known cs

Reaction	Reference reaction	En (area)	Detection system	
$^{235}U(n,f)$	$^{10}B(n,\alpha)/^{6}Li(n,t)$	18meV- 10keV	Silicon	M. Mastromarco et al., Eur. Phys. J. A (2022) 58:147
$^{235}U(n,f)$	$^{10}B(n,\alpha)/^{6}Li(n,t)$	25 meV-170 keV	Silicon	S. Amaducci et al., Eur. Phys. J. A (2019) 55: 120
$^{235}U(n,f)$	$^{10}B(n,\alpha)$	25 meV-100keV	Micromegas	V. Michalopoulou et al., EPJ Web of Conferences , 01030 (2023) V. Michalopoulou et al., Applied radiation and Isotopes 226 (2025) 112063
$^{235}U(n,f)$	$^{1}H(n,el)$	10MeV-440 MeV	PPAC, PPFC, RPT	*A. Manna et al., Phys. Lett. B 860 (2025) 139213*



……effort to extend to 1 GeV (ongoing detector development)

Fission studies – other observables

STEFF: Spectrometer for Exotic Fission Fragments

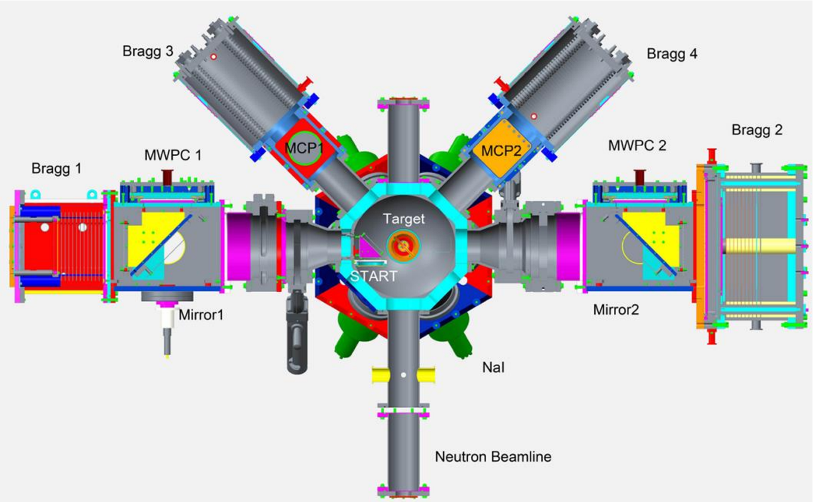
(U. of Manchester)

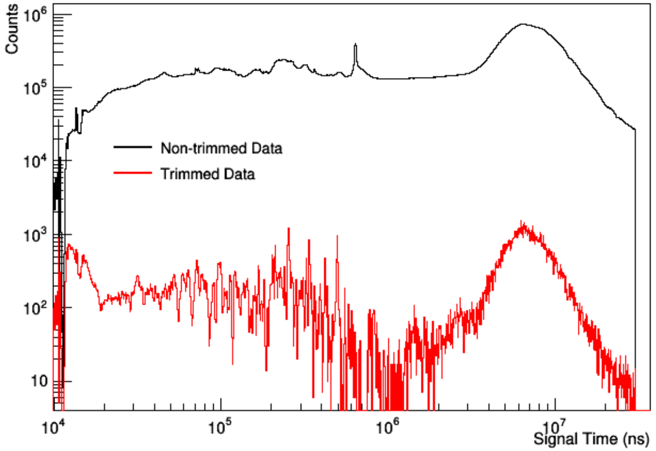
- **Detection & characterisation of FFs**

in **coincidence with γ-rays** (NaI detectors).
(2E-2v method, 4 a.m.u.)

- Installed in **EAR-2** (2015):

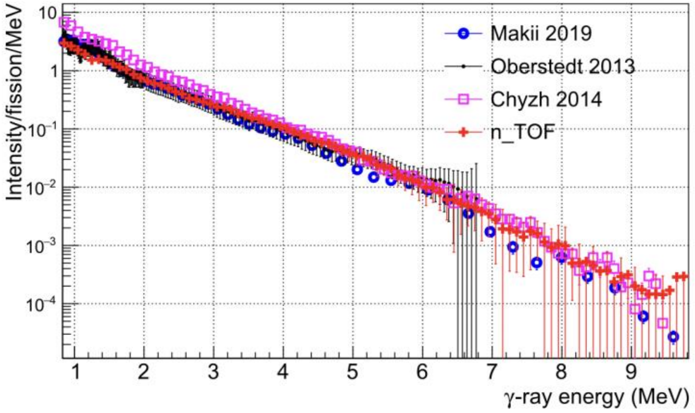
1) measurement of **^{235}U prompt fission γ-ray spectra (2015)**.
2) measurement of **^{239}Pu prompt fission γ-ray spectra (2018)**.





=> Very strong background rejection capabilities : **S/B~0.001**.

^{235}U:



T. Wright et al., Eur. Phys. J. A (2024) 60:70

Fission studies – other observables - developments

FiFI (Fission Fragment Identification) setup

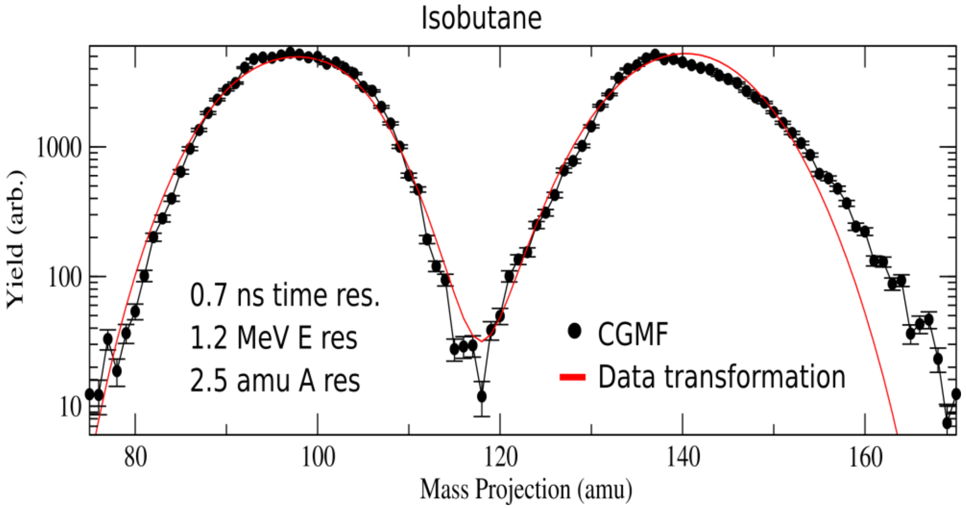
(U. of Manchester)

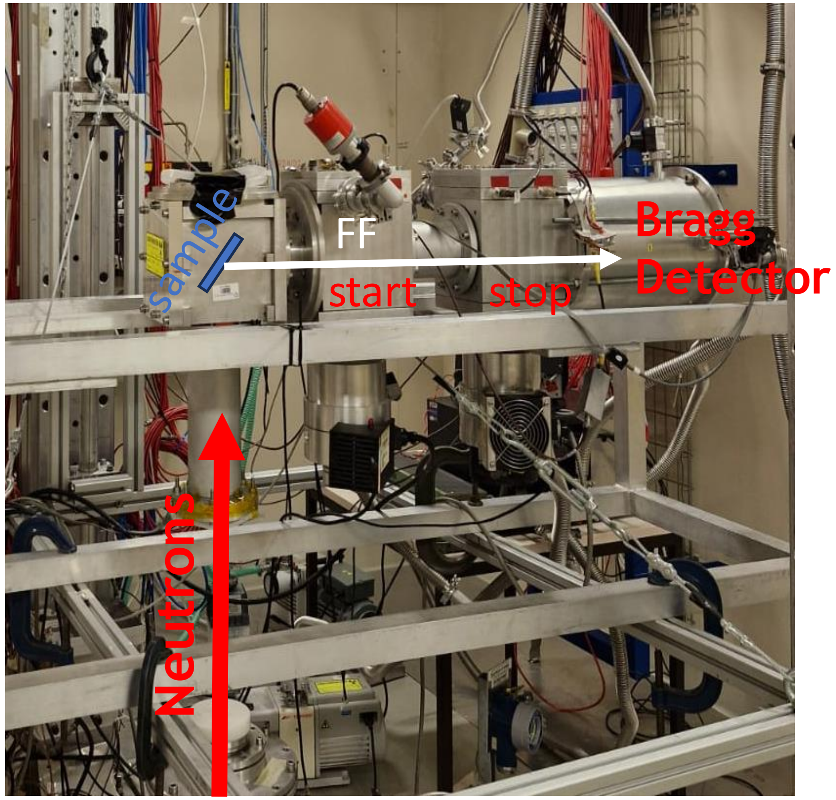
- **Detection & characterisation of FFs (1E-1v)**

Kinetic energy + velocity => Mass (2.5 amu)

- Installed in **EAR-2** : ^{235}U mass distribution.

First test results:





- Bragg detector: coaxial ionization chamber
- start/stop detectors: MCP
- 0.5 m flightpath

….. measurements with ^{243}Am and other actinides

….. fission neutrons / γ-rays detection (also with Micromegas)

N. Sosnin et al., CERN-INTC-2025-054 / INTC-I-294

(n,γ) STUDIES AT n_TOF

Neutron-induced Capture Studies

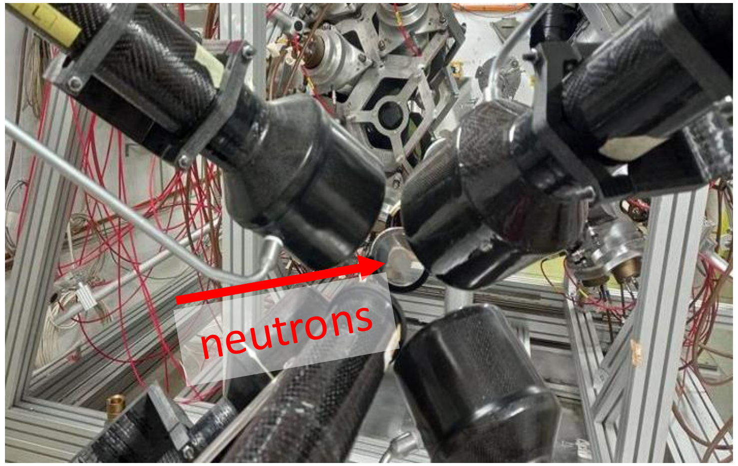
Detection systems:

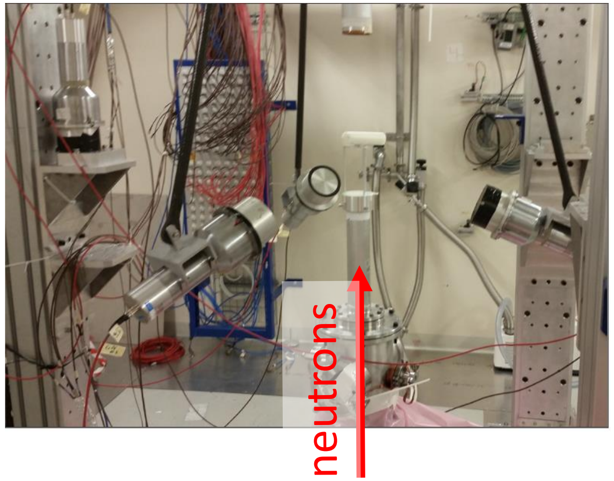
- **Liquid scintillators : C_6D_6**

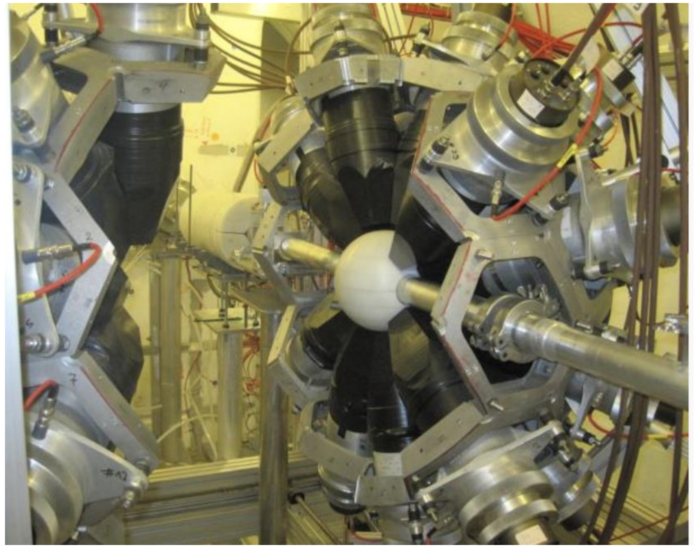
EAR1 (stable/not very radioactive)
EAR2 (highly radiactive / small quantity / low cross section)
eg. $^{50-53}$Cr*, ^{56}Fe**

- **TAC (Total Absorption Calorimeter)**: BaF_2

eg. ^{87}Sr, $^{234-238}$U, ^{244}Cm, ^{233}U, ^{239}Pu*







** see presentation by P. Pérez-Maroto*
***see presentation by A. B. Allannavar*
**** see presentation by A. Sanchez Caballero*

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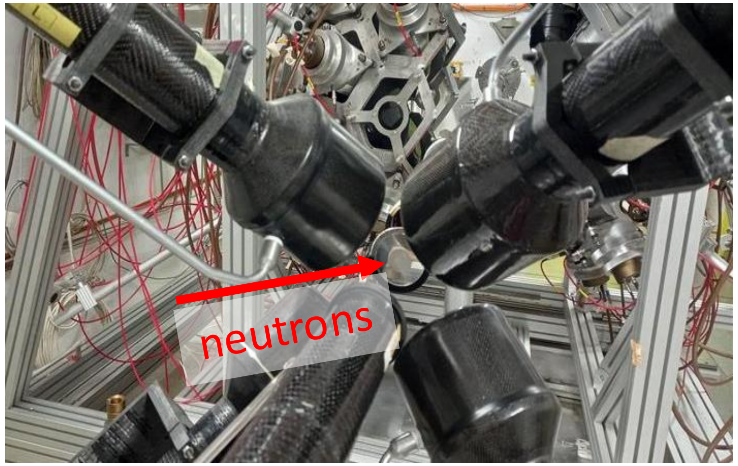
- **COMBINATIONS (EARs + Detection systems):**

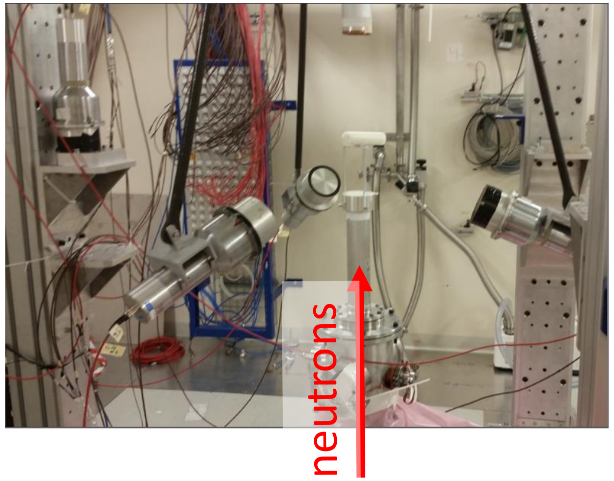
Challenging: ^{244}Cm ($t_{1/2}$~18 y)

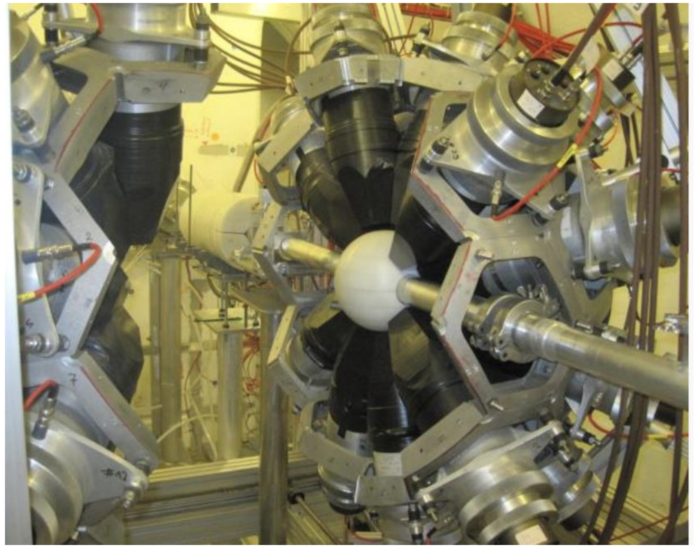
- Motivation: Management of nuclear waste & safety
- **<1 mg** samples of Cm provided by JAEA (Japan)

Effective combination of the **TAC** and **C_6D_6** :
1.EAR2 with C6D6 from 7 to 400 eV
2.EAR1 with the TAC from 7 to 100 eV

V. Alcayne et al. Annals of Nuclear Energy, 227, 2026
V. Alcayne et al. European Physical Journal A, 60, 240, 2024.







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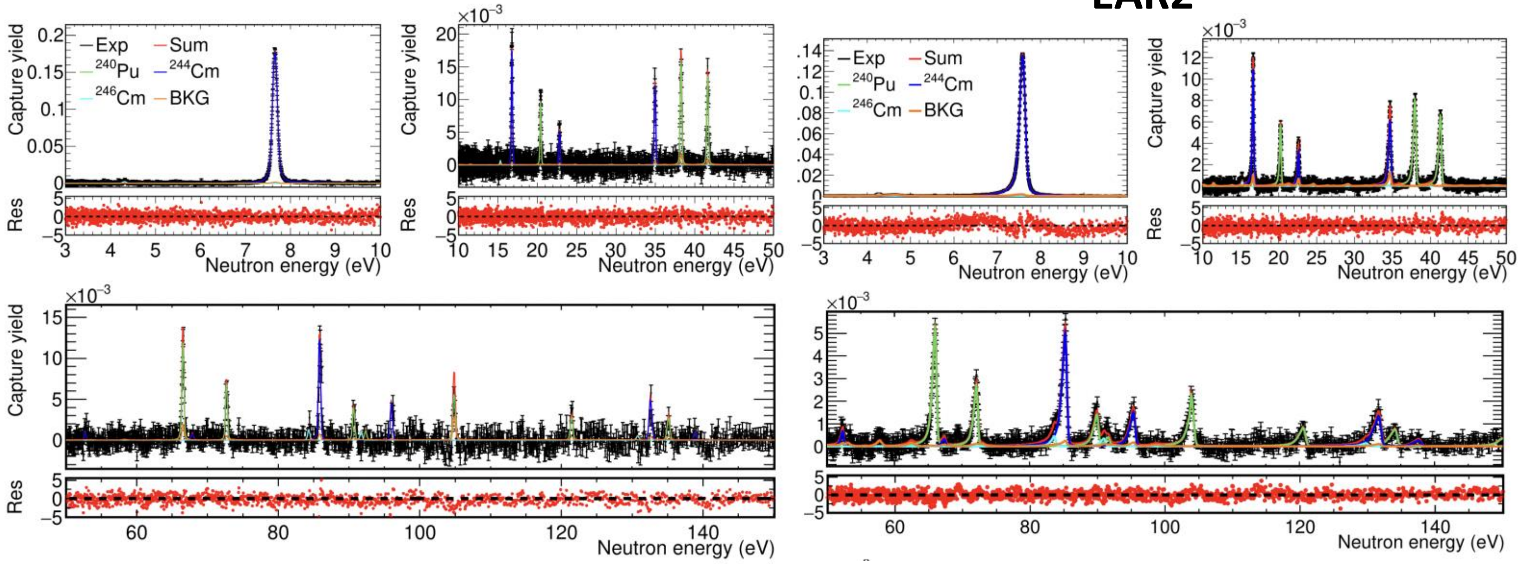
eg. $^{50-53}$Cr*, ^{56}Fe**

- **TAC (Total Absorption Calorimeter)**: BaF_2
eg. ^{87}Sr, $^{234-238}$U, ^{244}Cm, ^{233}U, ^{239}Pu*

EAR1

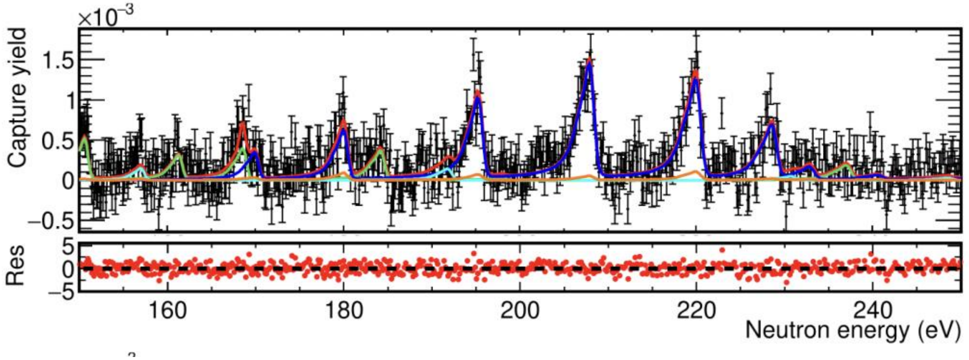
EAR2



- **COMBINATIONS**:

Challenging: ^{244}Cm ($t_{1/2}$~18 y)
- Motivation: Management of nuclear waste & safety
- **<1 mg** samples of Cm provided by JAEA (Japan)

EAR2



Effective combination of the **TAC** and **C_6D_6** :
1.EAR2 with C6D6 from 7 to 400 eV
2.EAR1 with the TAC from 7 to 100 eV

V. Alcayne et al. Annals of Nuclear Energy, 227, 2026
V. Alcayne et al. European Physical Journal A, 60, 240, 2024.

Neutron-induced Capture Studies

Detection systems:

- **Liquid scintillators : C_6D_6**

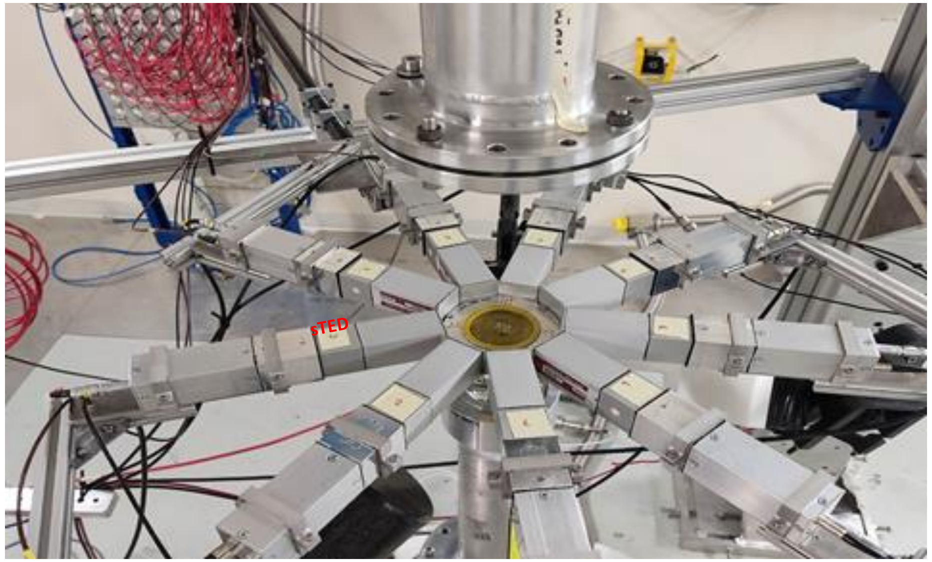
EAR1 (stable/not very radioactive)
EAR2 (highly radiactive small quantity/ low cross section)
eg. $^{50-53}Cr$* , ^{56}Fe**

- **TAC (Total Absorption Calorimeter)**: BaF_2

eg. ^{87}Sr, $^{234-238}U$, ^{244}Cm, ^{233}U, ^{239}Pu*

- VERY RECENTLY : **sTED (EAR2)***

Maximisation of EAR2 capabilities:



Challenging measurement on radioactive ^{94}Nb ($t_{1/2}$~2.10^4 y)

- Produced at ILL by irradiating hyper pure ^{93}Nb
- **Low mass** (304 mg)
- Only **~1% ^{94}Nb/^{93}Nb**
- **10.1 MBq activity**

J. Balibrea-Correa et al. accepted in Phys. Rev. Lett.

*** J. Balibrea-Correa et al., Nucl Instrum Meth. in Phys. Res. A 1072 (2025) 170110**
V. Alcayne et al., Radiation Physics and Chemistry, 217, art. no. 111525 (2024)

OTHER REACTION STUDIES AT n_TOF

Neutron-induced Charged Particle Emission Studies

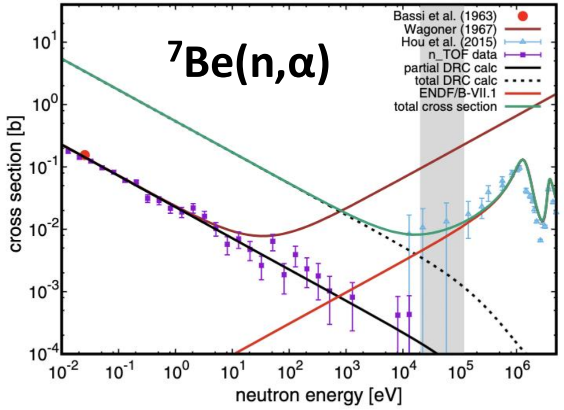
Detection systems:

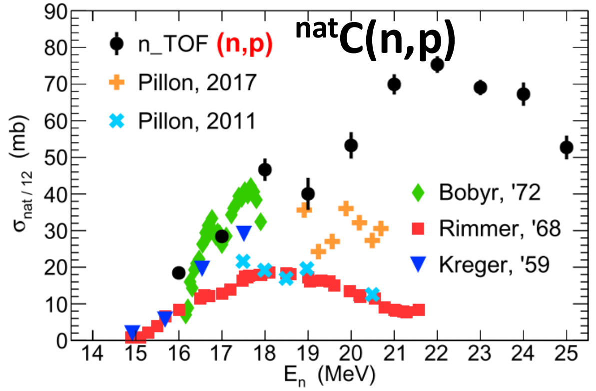
- Solid state:

Si (ΔE/E, position sensitive, DSSD), Diamond

- Gaseous:

Micromegas detectors





Reaction	En (area)	Detection system	
59Ni(n, α)	160-260eV	**sCVD (EAR1)**	*C. Weiss et al., Nucl. Data Sheets 120 (2014)*
^{7}Be(n,α)	10^{-2}-10^{4} eV	**Si (EAR2)**	*M. Barbagallo et al., Physical Review Letters 117, 152701 (2016).*
^{7}Be(n,p)	0.025 eV-325keV	**Si, ΔE/E, pos. sensitive (EAR2)**	L. Damone et al., Physical Review Letters 121, 042701 (2018)
^{33}S(n,α)		**Micromegas (EAR1+EAR2)**	*J. Praena et al., Physical Review C 97, 064603 (2018).*
^{26}Al(n,p) **^{26}Al(n,α)**	0.025 eV-150 keV 0.025 eV-160 keV	**Si, ΔE/E, pos. sensitive EAR2**	C. Lederer-Woods, Physical Review C 104, L02280 (2021) /*Physical Review C 104 (3), L032803 (2021*
^{14}N(n,p)	10 meV-800keV	**DSSSD + Micromegas EAR2**	Pablo Torres-Sánchez et al., Physical Review C 107, 064617 (2023)
^{nat}C(n,p) / ^{nat}C(n,d)	15-25 MeV	**Si, ΔE/E, pos. sensitive (EAR1)**	*P. Žugec et al., Phys. Lett. B 868 (2025) 139713*
^{35}Cl(n,p)	0.025 eV-120 keV	**Micromegas EAR2**	*M.A Martinez-Cañadaset al., European Physical Journal A (2026) 62:90.*

Neutron-induced Charged Particle Emission Studies

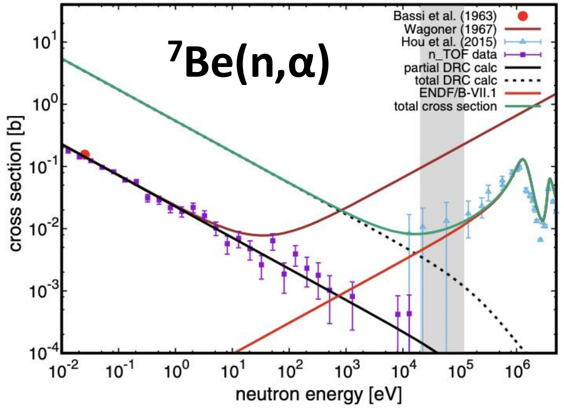
Detection systems:

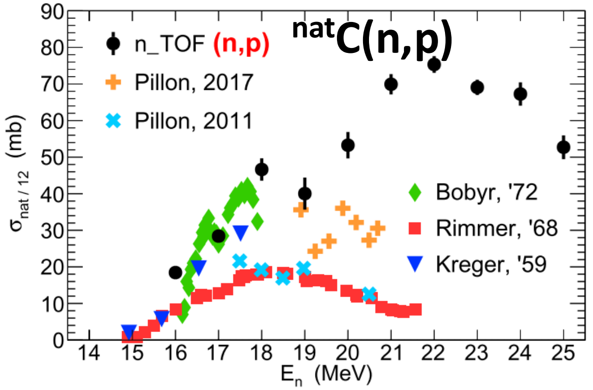
- Solid state:

Si (ΔE/E, position sensitive, DSSD), Diamond

- Gaseous:

Micromegas detectors





Reaction	En (area)	Detection system	
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^{7}Be(n,p)	0.025 eV-325keV	**Si, ΔE/E, pos. sensitive (EAR2)**	L. Damone et al., Physical Review Letters 121, 042701 (2018)
^{33}S(n,α			*64603*
^{26}Al(n, **^{26}Al(n,**			04, L022803 *803 (2021)*
^{14}N(n,p		**EAR2**	view C 107
^{nat}C(n,p) / ^{nat}C(n,d)	15-25 MeV	**Si, ΔE/E, pos. sensitive (EAR1)**	*P. Žugec et al., Phys. Lett. B 868 (2025) 139713*
^{35}Cl(n,p)	0.025 eV-120 keV	**Micromegas EAR2**	*M.A Martinez-Cañadaset al., European Physical Journal A (2026) 62:90.*

effort to

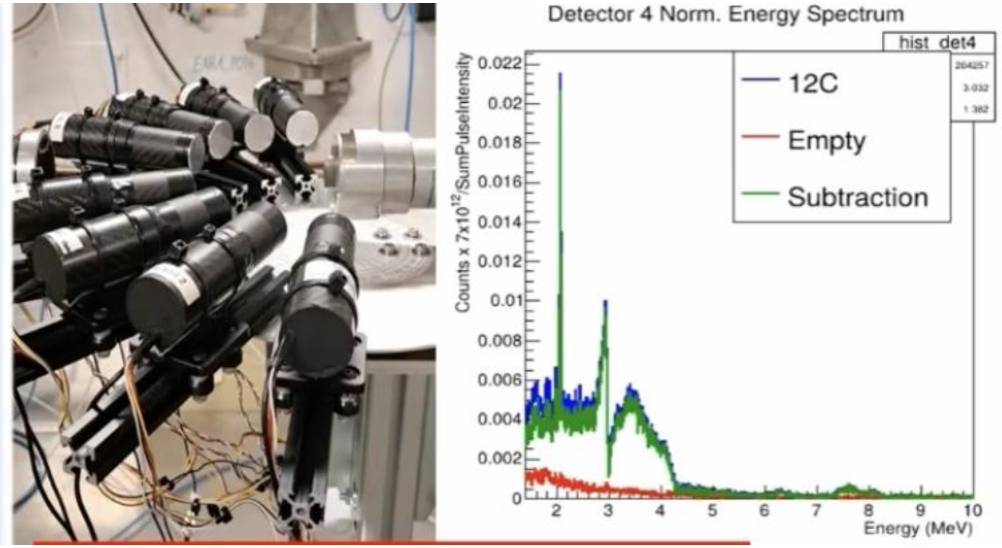
- ***extend to >100 MeV.***
- ***improve charged particle detection with Annular Silicon detector***
- ***presentation by K. Stasiak on ^{39}K(n,cp)***

(ongoing detector developments)

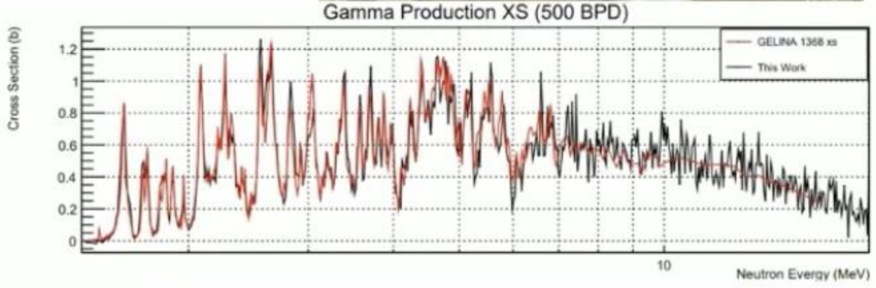
Other neutron-induced reaction studies - DEVELOPMENTS

(n,el/inl) / (n,xnγ):

neutron detection:
STILBENE detectors
(*INFN Catania*)
^{12}C(n,el):



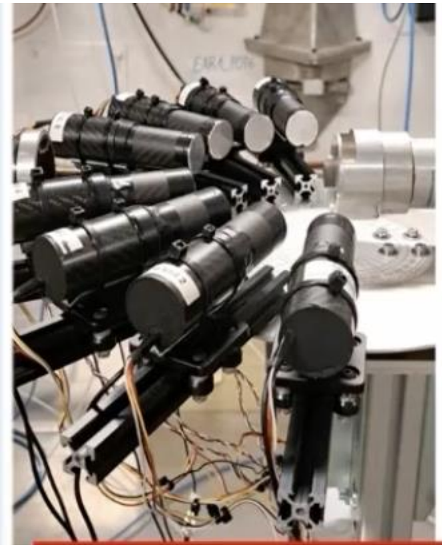
γ-ray spectroscopy
HPGe / $LaBr_3$(Ce)
^{24}Mg(n,n'):

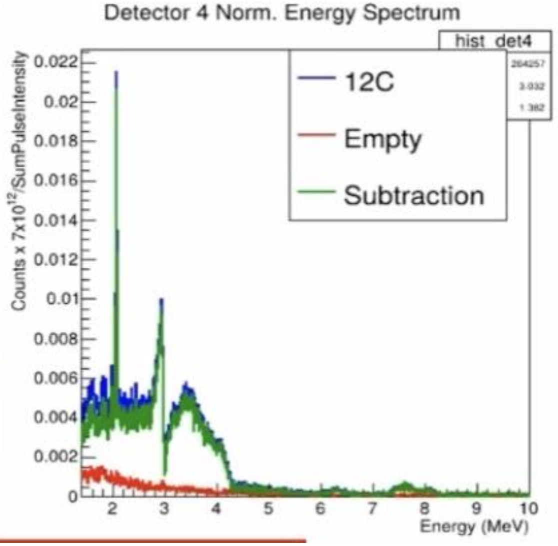


Other neutron-induced reaction studies - DEVELOPMENTS

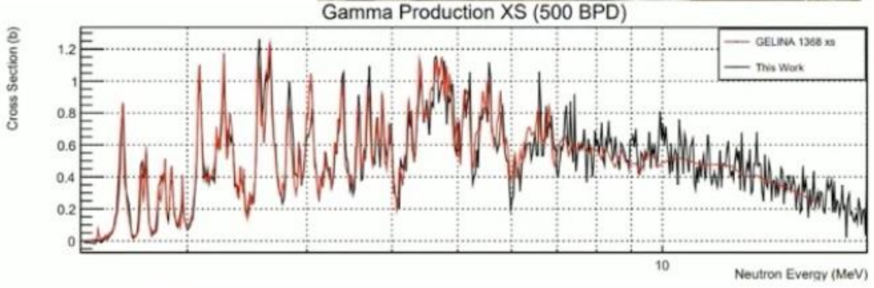
(n,el/inl) / (n,xnγ):

neutron detection:
STILBENE detectors
(*INFN Catania*)
^{12}C(n,el):

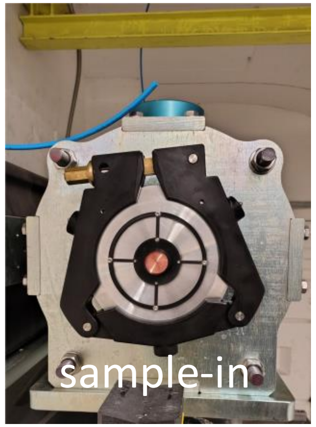


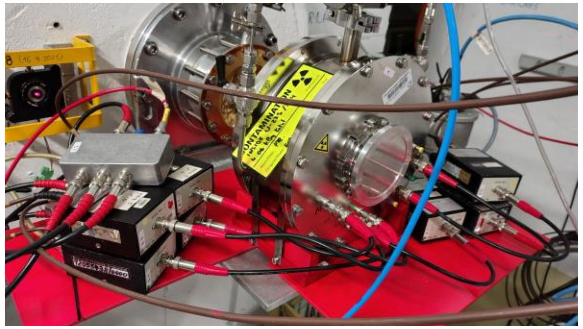


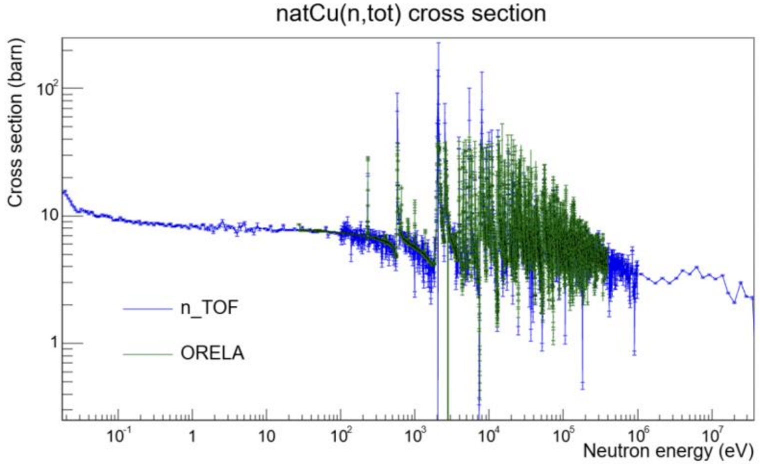
γ-ray spectroscopy
HPGe / $LaBr_3$(Ce)
^{24}Mg(n,n'):



(n,tot):
^{nat}Cu(n,tot):







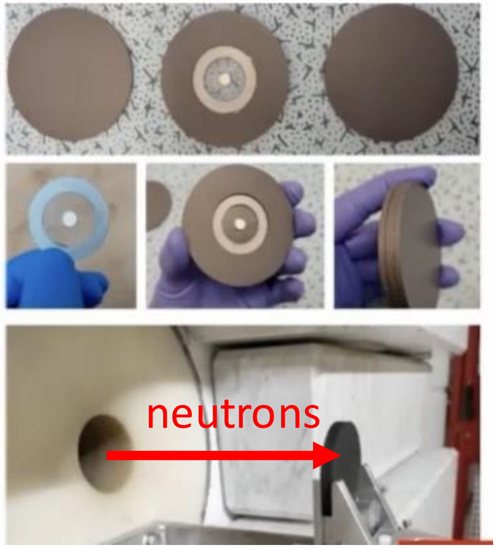
Other neutron-induced reaction studies

ONGOING developments for
<u>NEAR station</u>

1) Activation Measurements

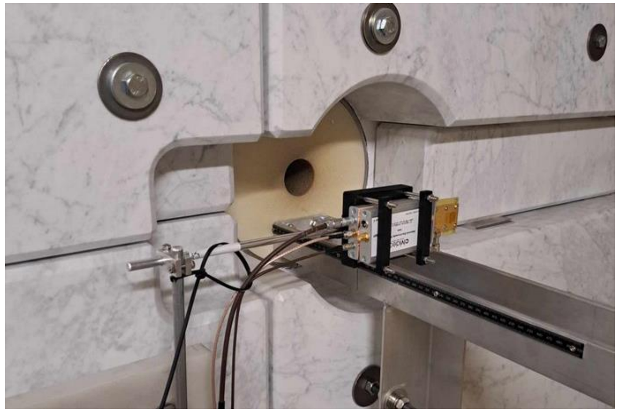
- **spectral averaged measurements**
- **MACS**
- **Cycling Activation Technique**
- **γ-spectroscopy station developments**

N. Patronis et al., Eur. Phys. J. A (2025) 61:215

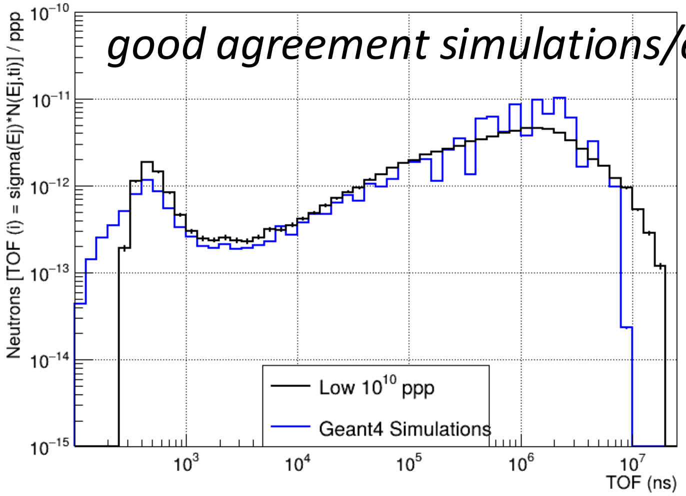


2) In-beam measurements (diamond detector)

K. Kaperoni et al.,
HNPS Advances in Nuclear Physics Vol. 32, 164–172 (2025)



good agreement simulations/experiment



Conclusions

Since 2001, n_TOF collaboration has **an important contribution to the nuclear data field**, with **several high quality measurements** on **stable / long-lived/ short –lived isotopes**. Some examples given here.

Use of continuously improved, purpose-designed experimental areas / setups / targets / state-of-the-art techniques. (In-house expertise)

Results obtained so far made **publicly available** to the international community via **EXFOR** and **n_TOF Twiki page:** https://twiki.cern.ch/twiki/bin/view/NTOFPublic/DataDissemination (**E. Dupont**) can help improve current evaluated databases and constrain theoretical models.

What's next????

- Shutdown (LS3) : September 2026 - late 2028:

Time to complete data analyses and prepare the bright future!!

- Facility / detector developments for **challenging measurements** ,
- Synergies and collaborations inside and outside CERN.
- Expansion of n_TOF physics program / family……

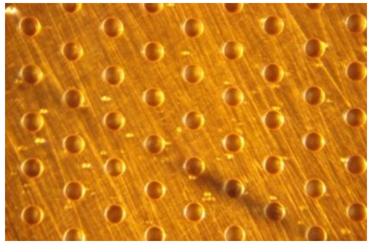
Thank you!
Merci!
Ευχαριστώ!

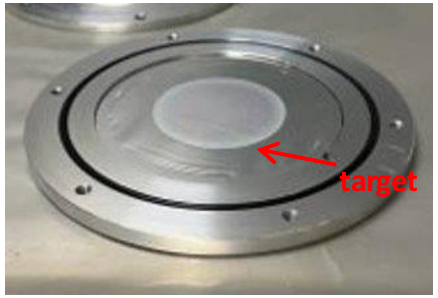
Detection system: Micromegas detector

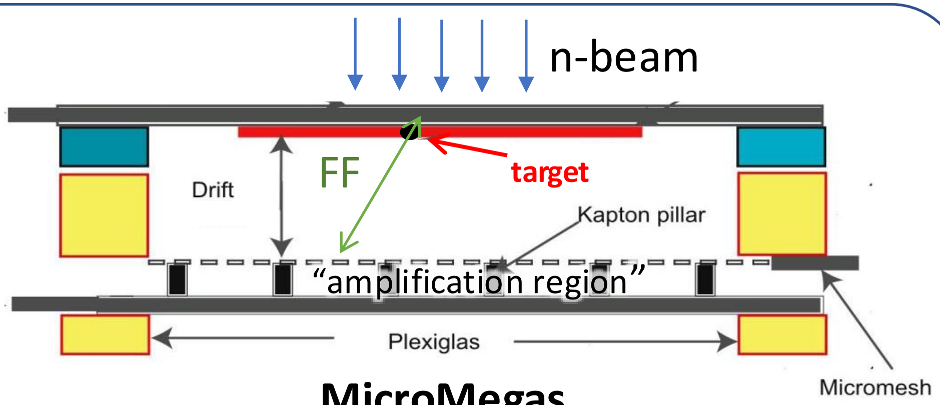
Gaseous detector/two regions separated by *”Micromesh”:*

1)“drift region”(few mm) : low electric field

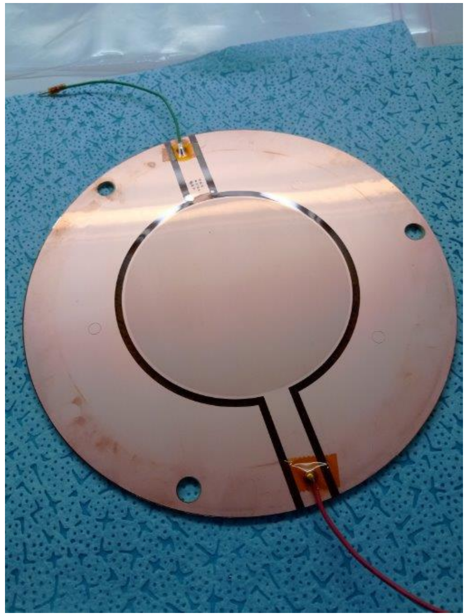
2)“amplification region” (50 μm): high electric field => amplification







MicroMegas

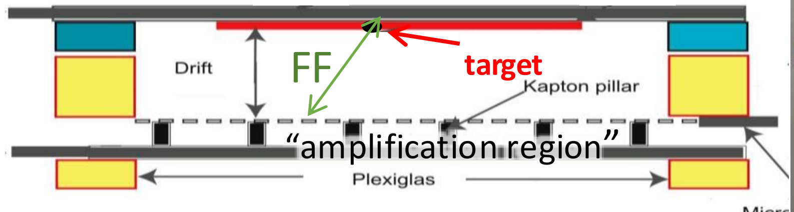


- Minimal material (almost ”transparent” for neutrons)
- High detection efficiency (100% in fission studies)
- Radiation durability - important when highly radioactive samples (e.g. actinides) are used
- Fast response & time resolution

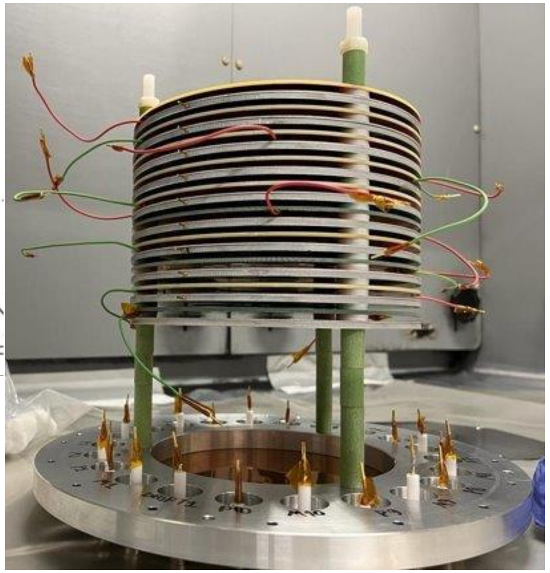
S. Andriamoje et al., J. Korean Phys. Soc. **59**(2(3)), 1597 - 1600 (2011)

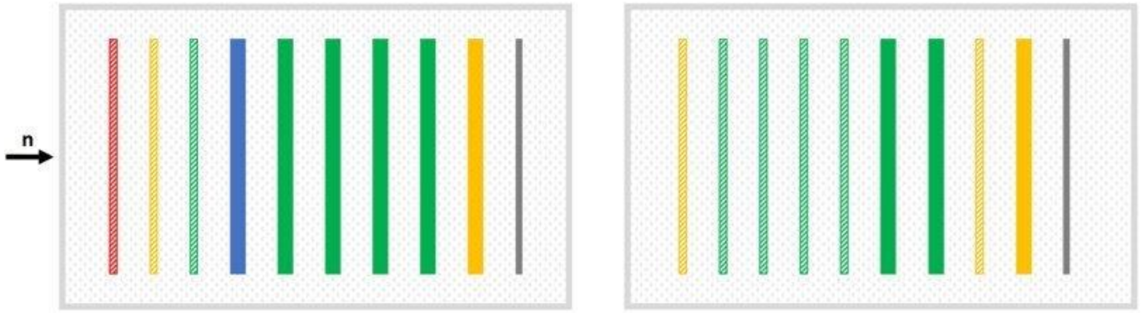
Detection system: Actinide Targets (^{243}Am(n,f))

- **High-Purity ^{243}Am and reference samples** provided by the **EC-JRC Geel target Laboratory**
- **6-cm** diameter thin disk deposited on a thin Al backing
- We used 11 ^{243}Am TARGETS of **different thickness**
  - **Avoid pile-up and keep high reaction rates** in all regions
  - Protect detectors from potential radiation damage
- Total activity **~160MBq**
- Reference reactions : **^{235}U(n,f), ^{238}U(n,f), ^{10}B(n,α)**



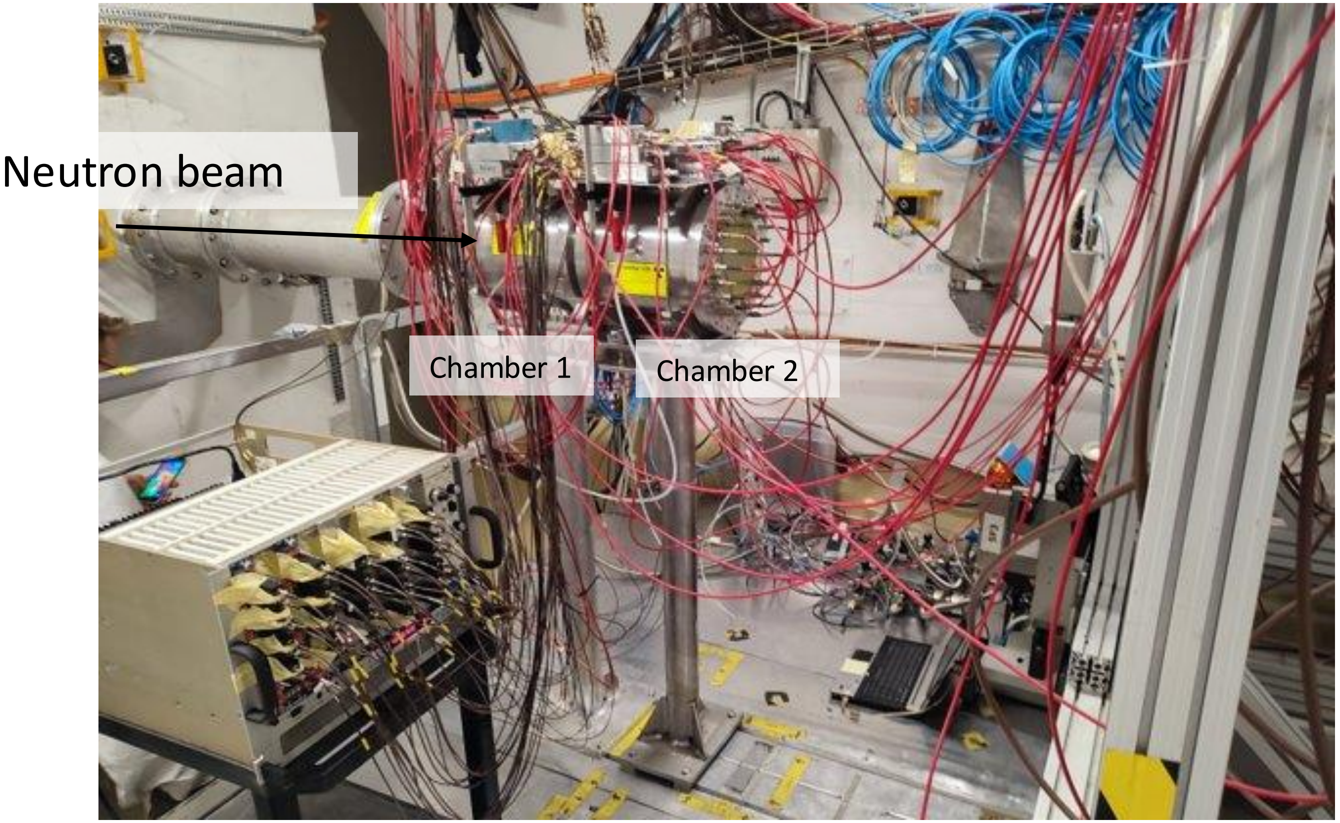
MicroMegas



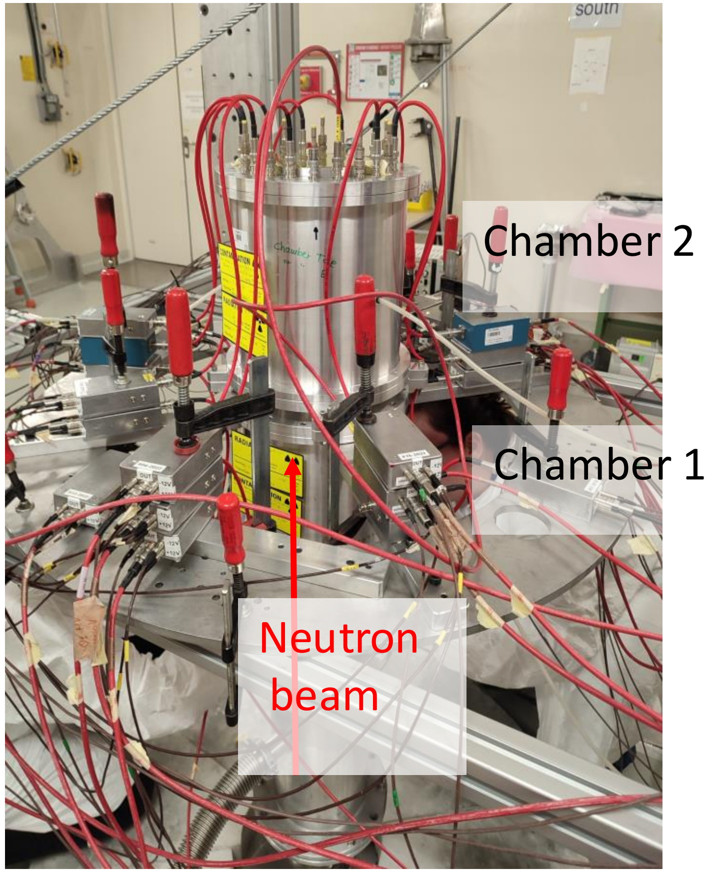


Housed in 2 chambers

Mounting the experiment (~3 month experiment):



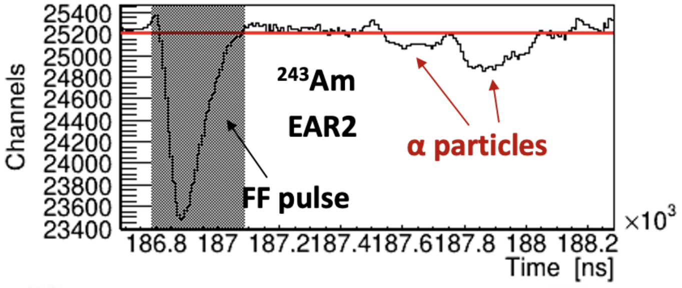
EAR1

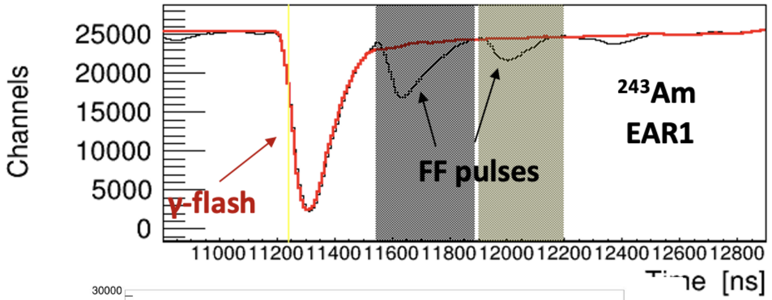


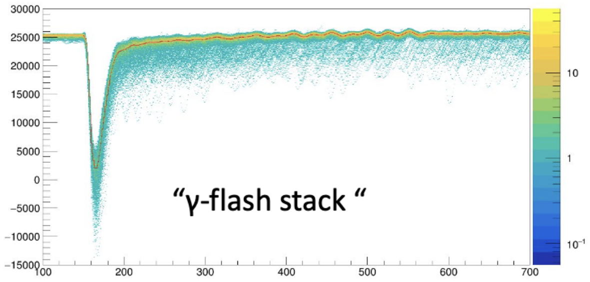
EAR2

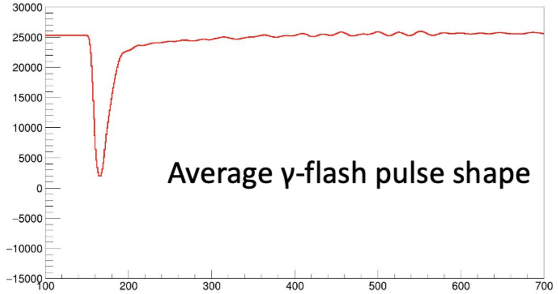
Fission detection system (Micromegas): Typical Recorded signals

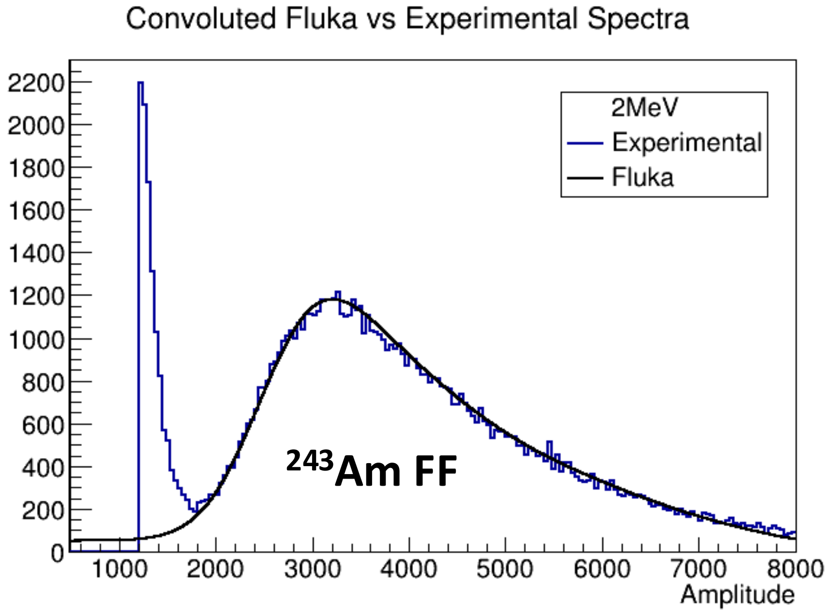
Experimental Raw Data











- Pulse shape analysis (PSA) routines for **pulse recognition**
- **Average γ-flash shape** extracted from 2D stack of multiple γ-flash movies
- γ-flash average shape **subtracted from raw data, different** for each sample
- Good γ-flash subtraction **necessary for high energy pulse recognition**

7

Nuclear Data Cycle:

Cross section of **n-induced reactions** needed with **high accuracy** (accurate **nuclear data**)

↓

Active field of research, various facilities worldwide provide EXPERIMENTAL nuclear data (effort: lower uncertainties)

↓

Nuclear Data Evaluation :
International Evaluated Nuclear Libraries (ENDF, JEFF, JENDL, CENDL…)

↓

- **Validation with integral measurements and Usage in Application**
- **Improvement of Fundamental nuclear physics**

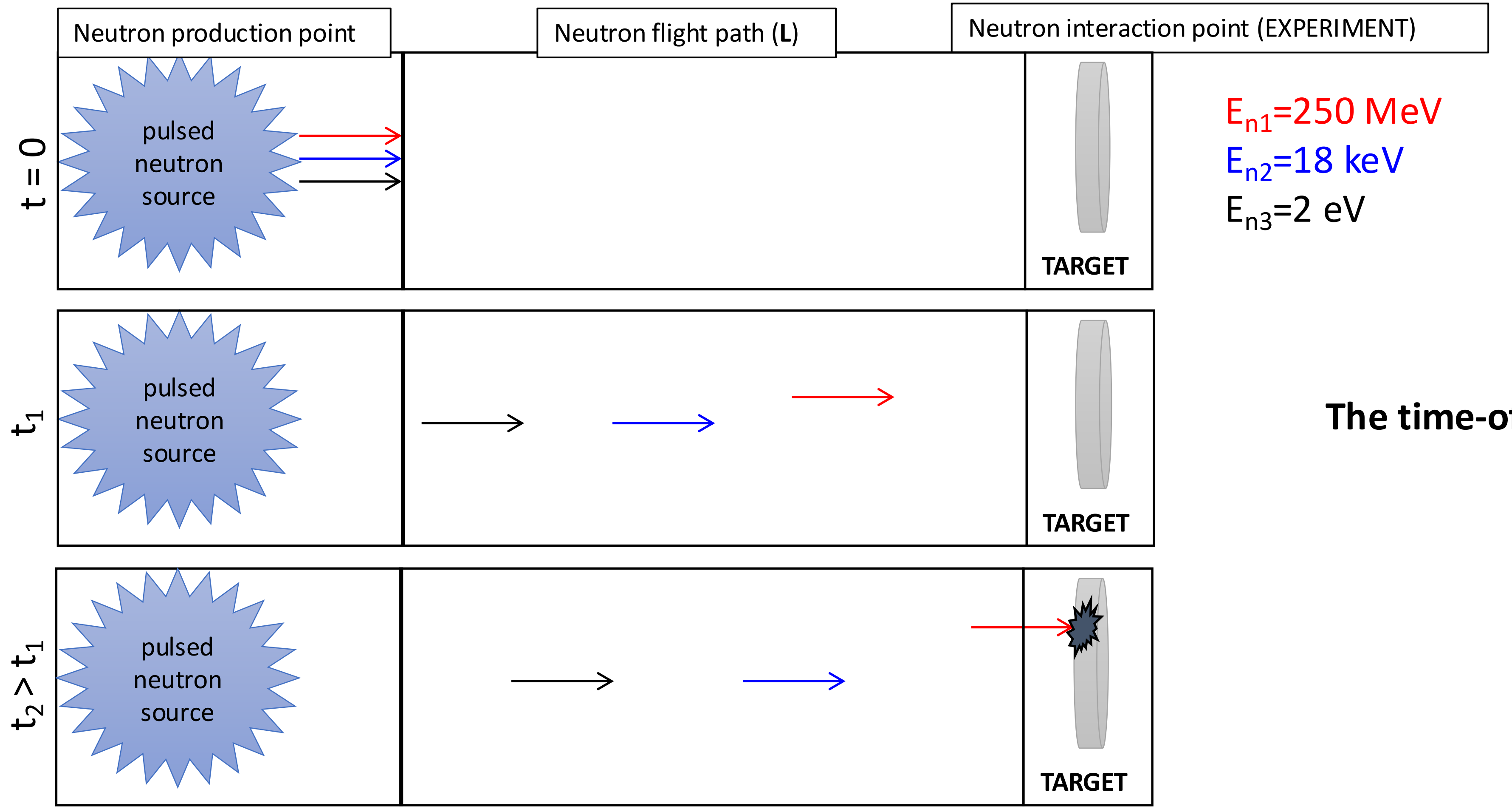
=> Constrain + test nuclear models=> improve predicting power.

Collaboration driven facility and not user facility with external users. Very important for profound collaboration for the successful outcome of all experiments / fruitful exchange of ideas and setups / proper fostering of young researchers.

n_TOF is **world's largest neutron cross section data producer** for reactor technologies. CERN is highly visible at the international databases available at the IAEA and NEA/OCDE websites.

- It is a **unique place for measuring highly radioactive isotopes** such as actinides.
- n_TOF is driven by **world's largest collaboration of nuclear data physicists**.
- Since its creation, **we have performed over 142 high quality cross section measurements** related to nuclear technologies, 78 of them also relevant to astrophysics.
- **n_TOF has trained various generations of young European neutron physicists**, many of them holding now permanent positions across Europe.
- **n_TOF has linked CERN to the nuclear data EURATOM programs** since 2000, including the support of the construction of the experiment, personnel, equipment and transnational access.
- **We have ambitious plans for the future**, involving more challenging measurements, developing new experimental techniques (see N. Patronis' talk) and are currently evaluating several facility upgrades.

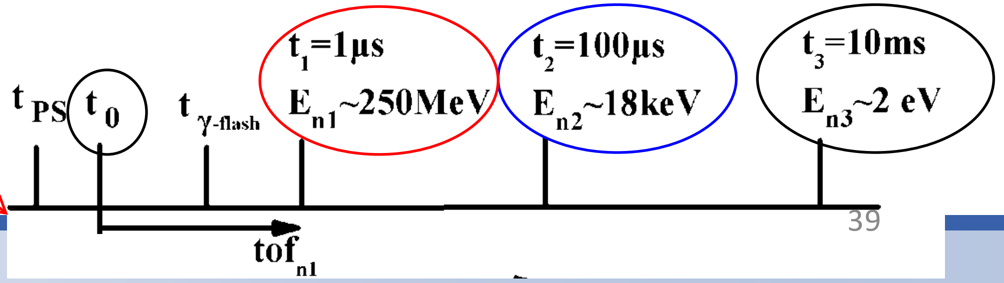
How do we estimate the neutron energy ??????



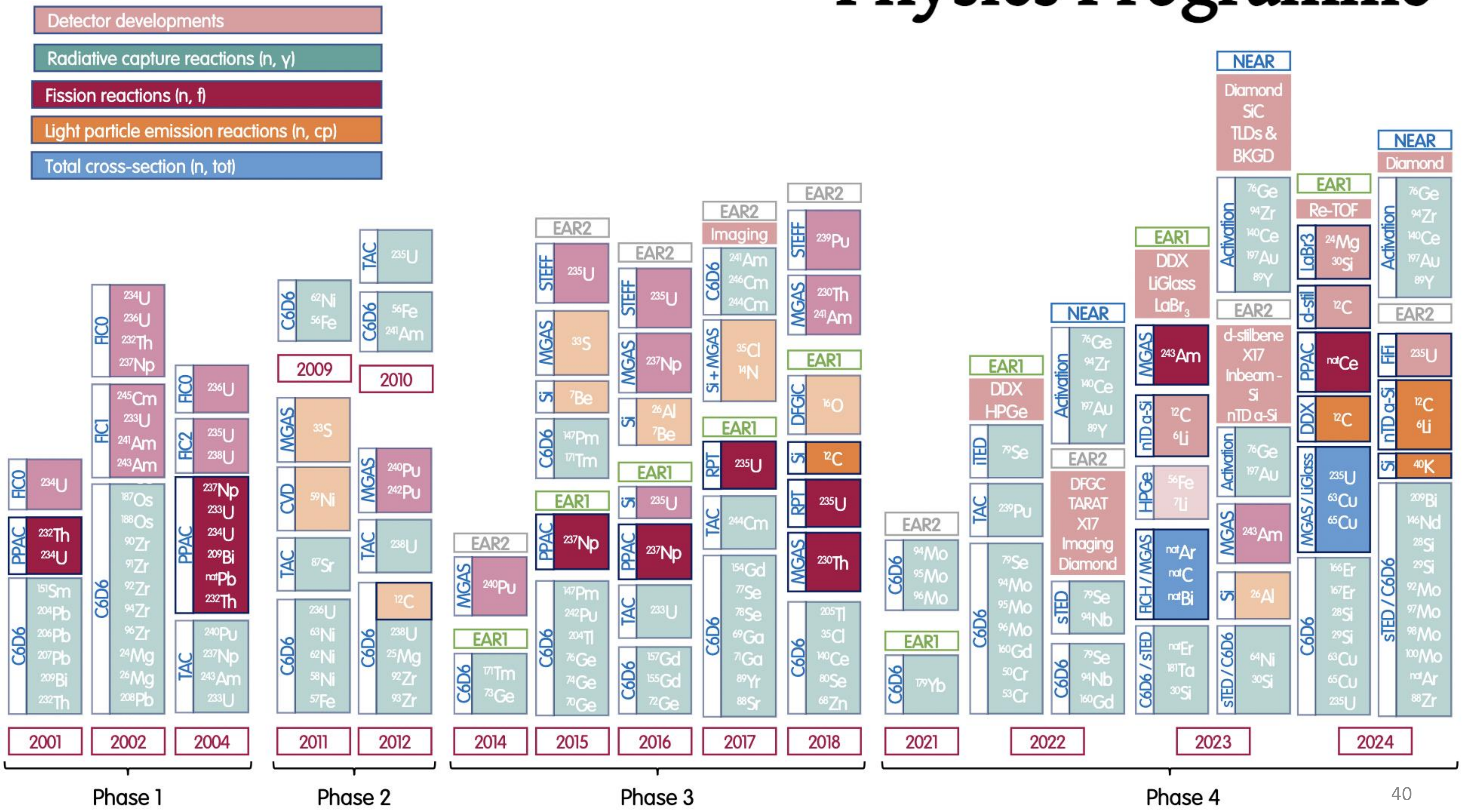
E_{n1}=250 MeV
E_{n2}=18 keV
E_{n3}=2 eV

The time-of-flight technique

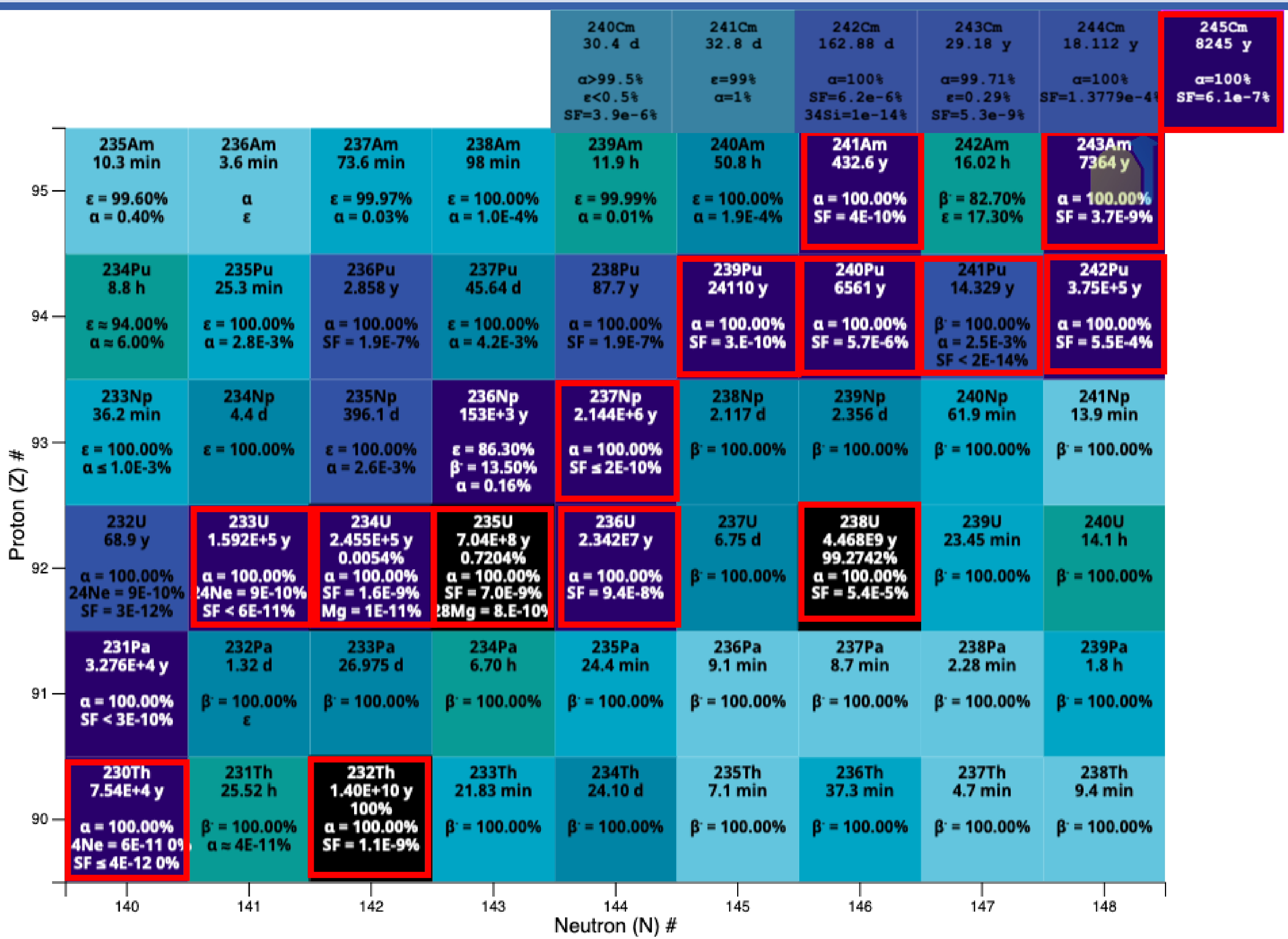
$$E_n = m_n c^2 \left(\frac{1}{\sqrt{1-\beta^2}} - 1 \right), \quad \beta = \frac{v_n}{c} = \frac{L}{c \cdot tof}$$



Physics Programme

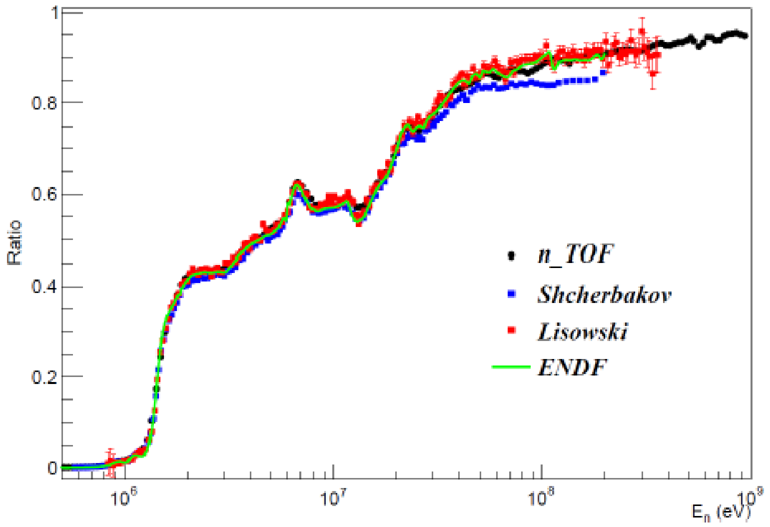


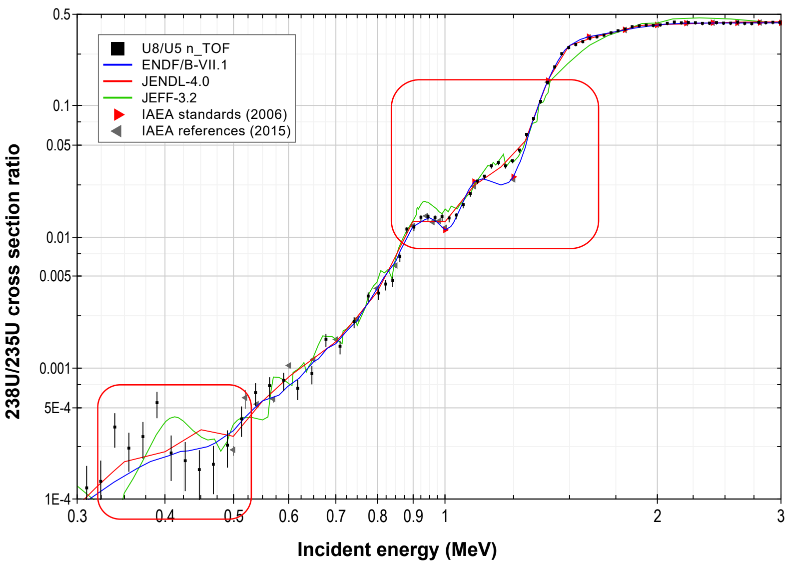
Fission studies – CROSS SECTIONS



Fission studies – revisiting well-known cs

Reaction	En (area)	Detection system	
$^{238}U(n,f)$ / $^{235}U(n,f)$	600 keV- 1 GeV	PPAC (3 configs) +FIC	*C. Paradela et al., Phys. Rev C 024602 (2015)*
$^{238}U(n,f)$ / $^{235}U(n,f)$	300keV-2 MeV	Micromegas+PPACs	*M. Diakaki et al., EPJ Web of Conferences* ***111****, 02002 (2016)*





Ongoing work….

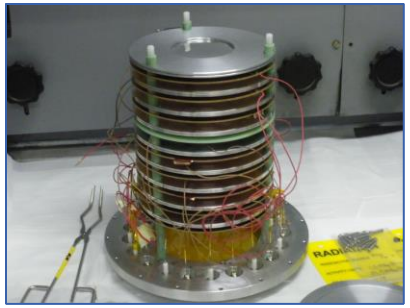
Fission studies – CROSS SECTIONS

Detection systems:

- **<u>FIC detector (EAR-1)</u>**

Fast **I**onization **C**hamber

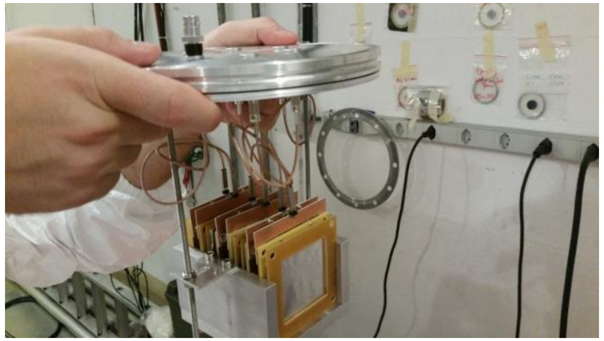
developed by the JINR (Dubna), IPPE (Obninsk), EET group (CERN).



- **<u>MicroMegas detector (EAR-1+EAR-2)</u>**

(microbulk technology)

developed by IRFU(CEA) + CERN

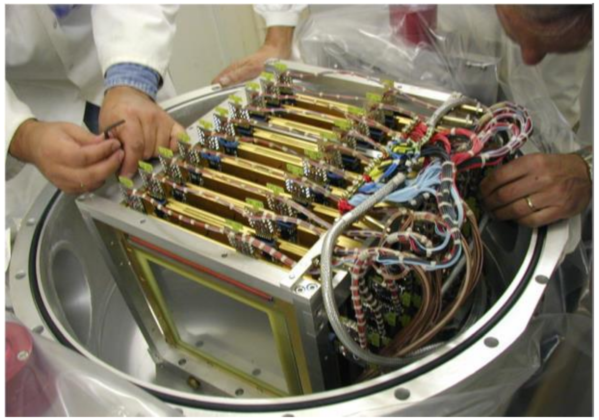


- **<u>Silicon detectors (EAR-1)</u>**

- **<u>PPAC detector (2 geometries) (EAR-1+EAR-2)</u>**

Parallel **P**late **A**valanche **C**ounter

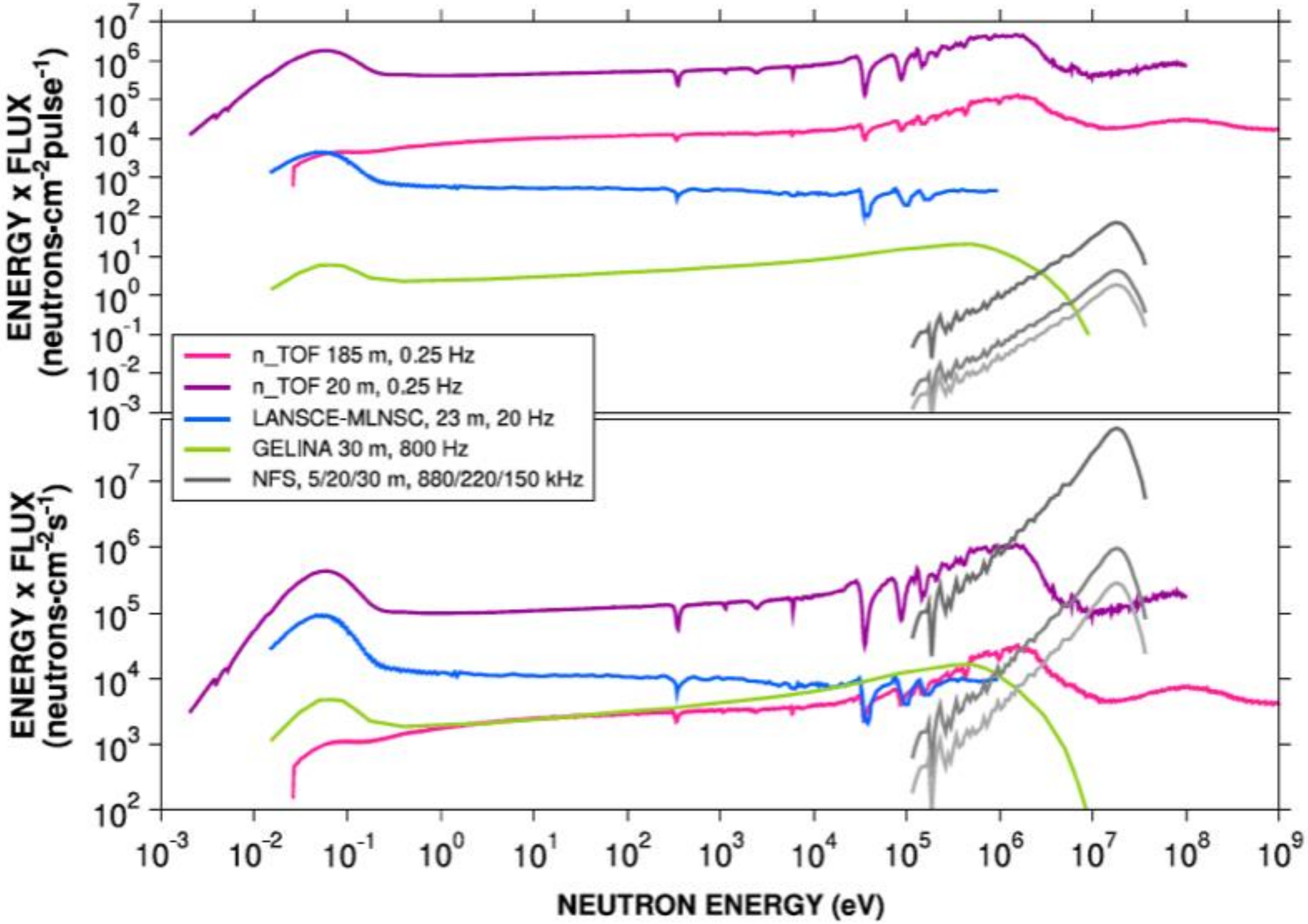
developed by IPN, Universite Paris-Sud



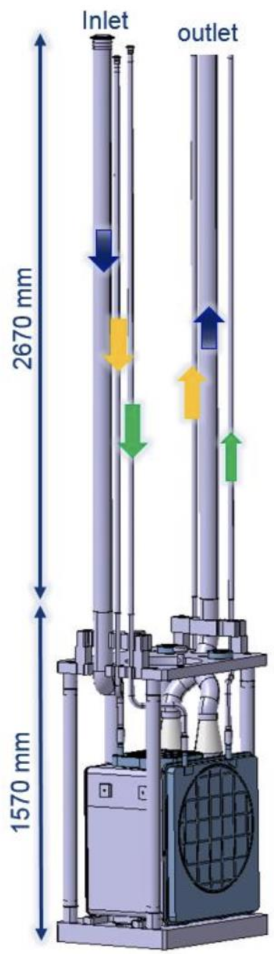
- **<u>Compact fission chambers</u>**

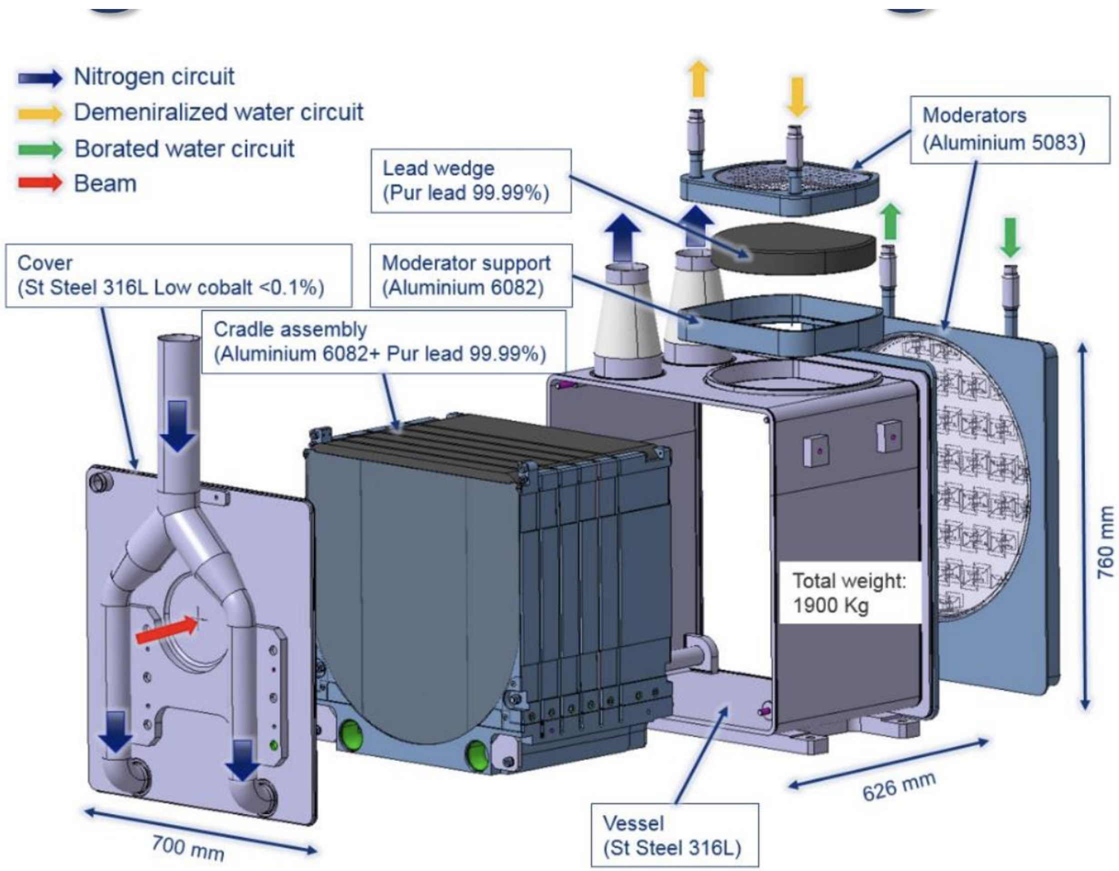
developed by CEA, University of Lodz

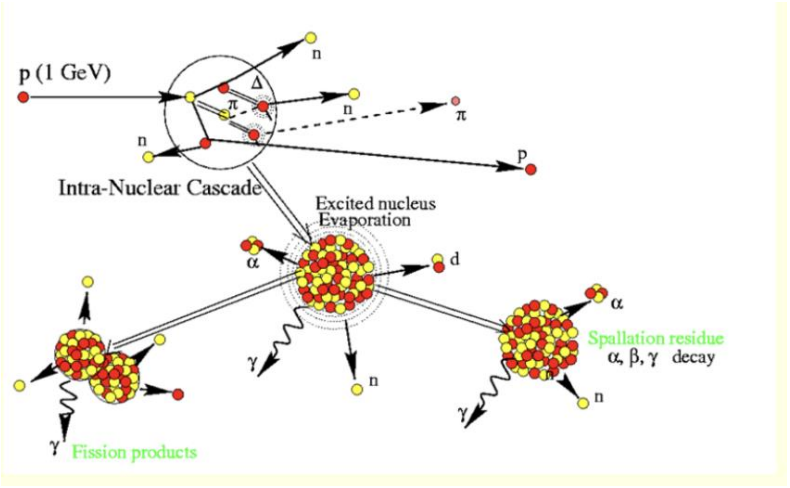
n_TOF and other facilities



3rd generation spallation target (n_TOF)



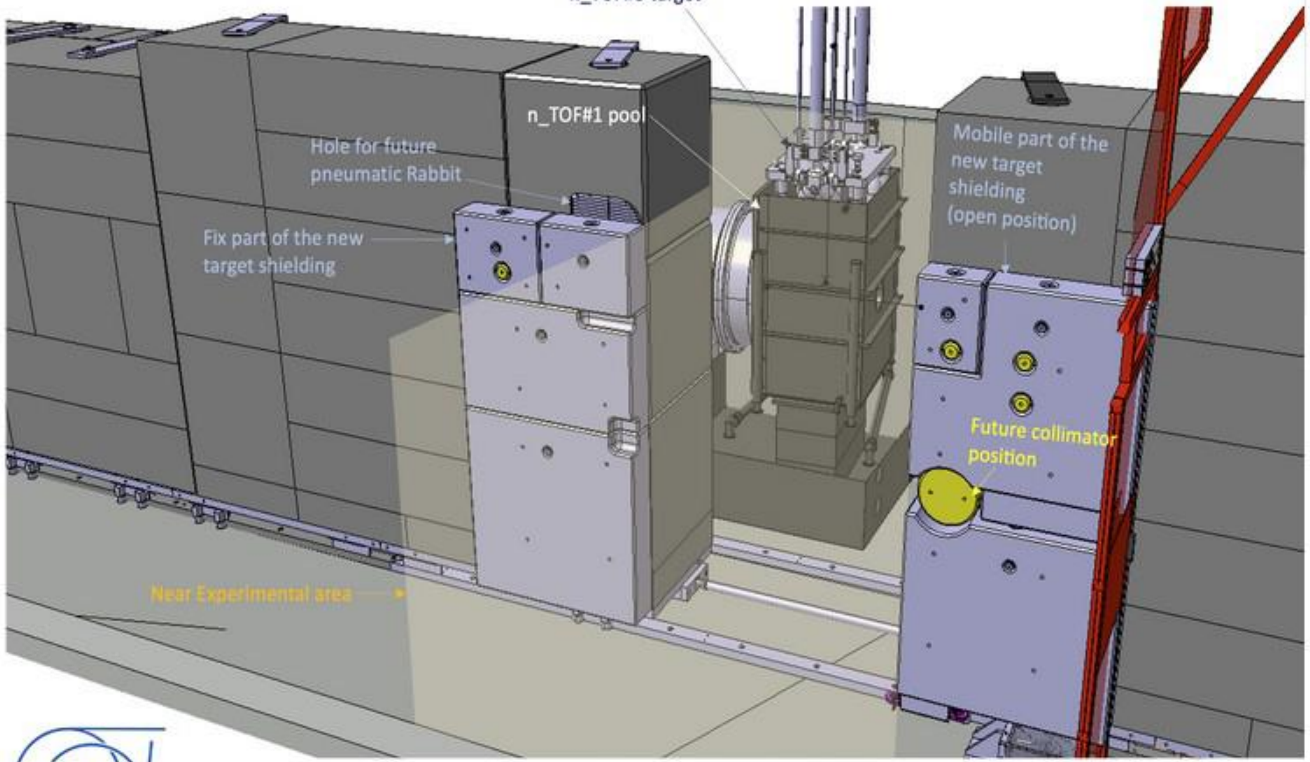




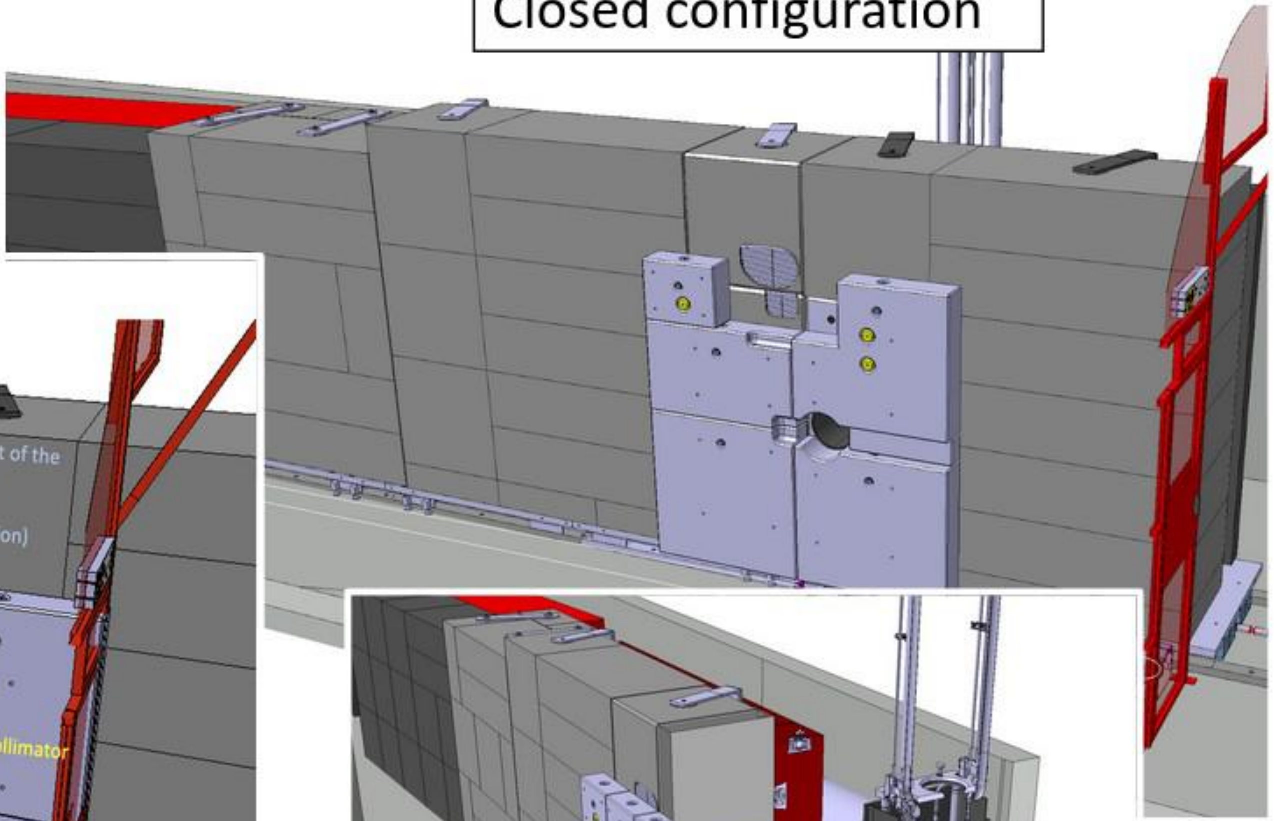
courtesy of Oliver Aberle, CERN

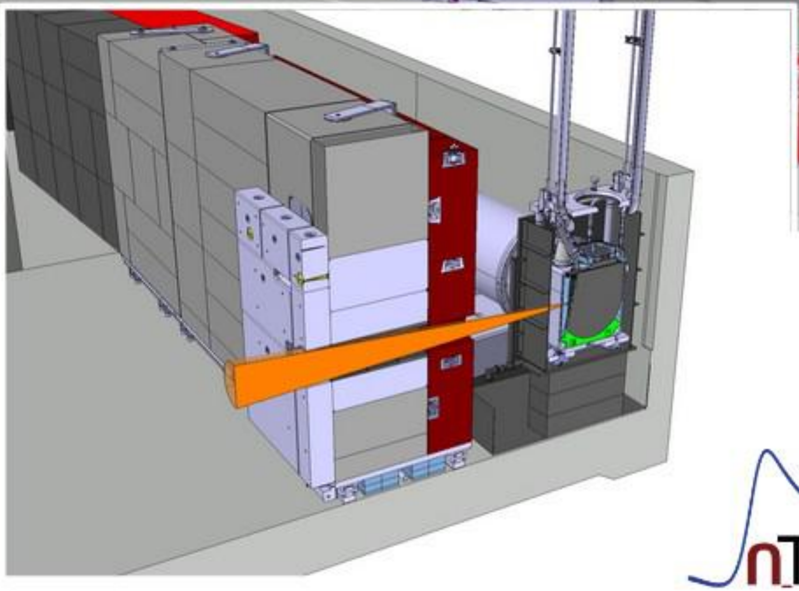
The NEAR Station

Open configuration

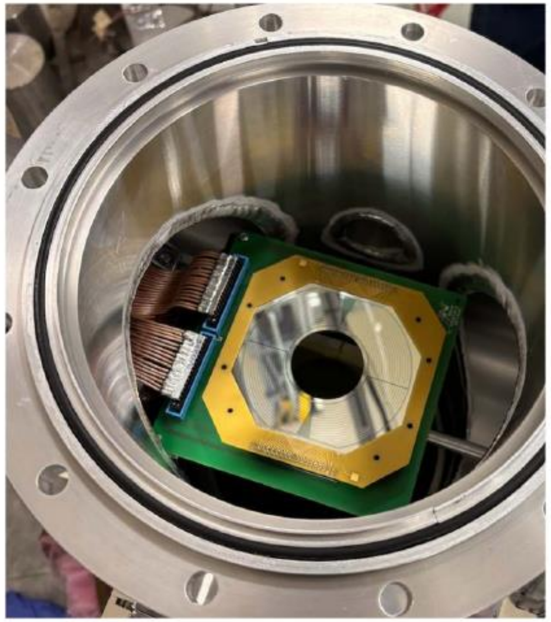


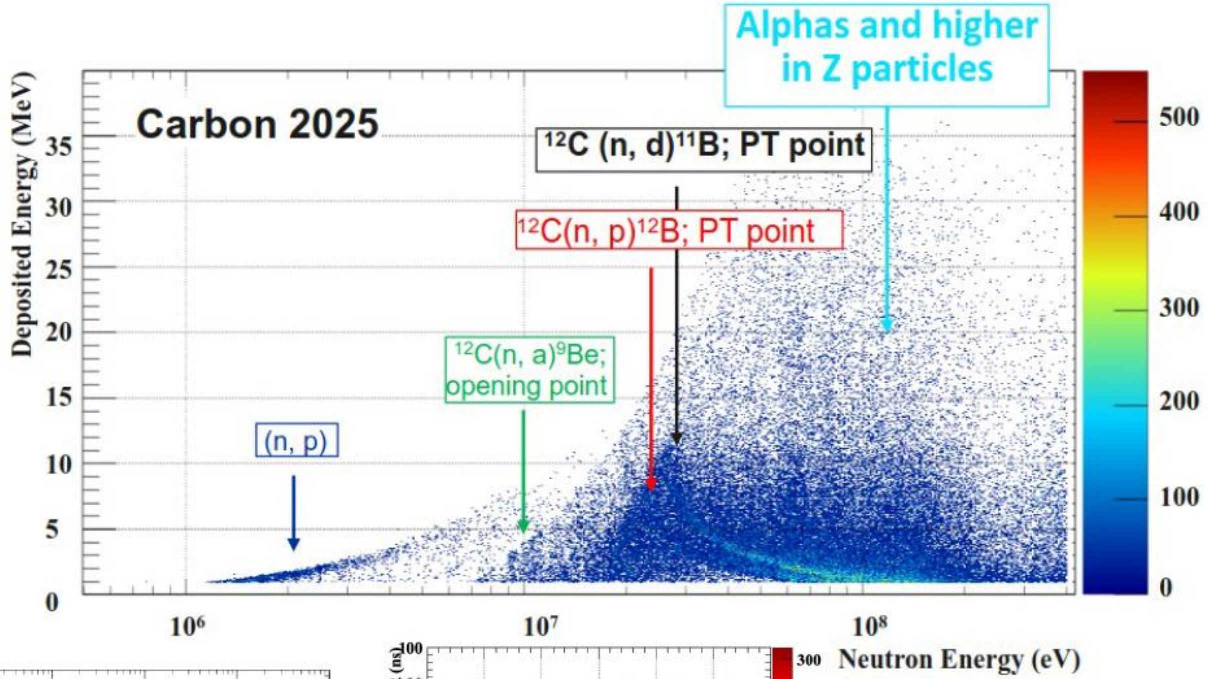
Closed configuration





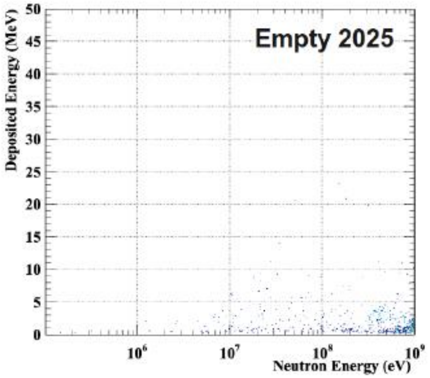
Ongoing....(n,cp) detector development

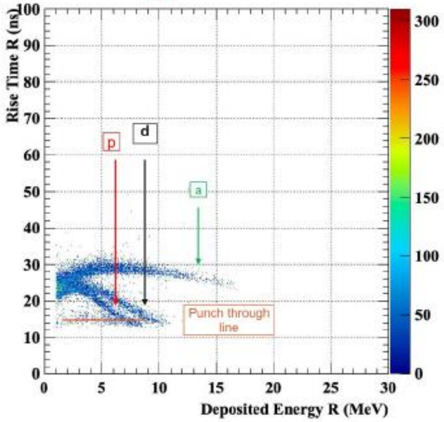




Single-stage detector coupled with PSA software with Identification Methods:

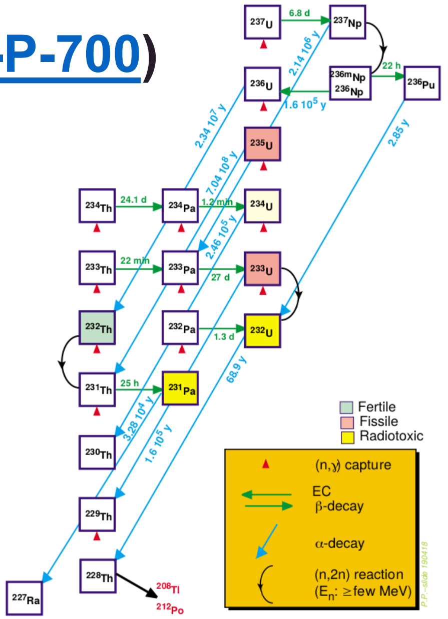
1. Different stopping powers
2. Signal Shape Analysis
   (e.g. Rise Time, ToT)





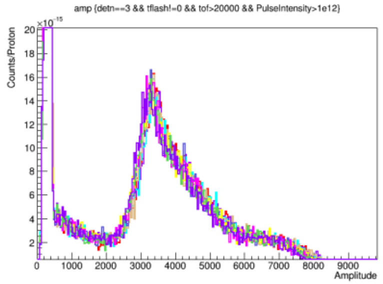
Charge discrimination between Z= 1 and Z= 2 at 2.5 MeV is achieved

^{236}U(n,f) measurement at n_TOF (CERN-INTC-2024-029; INTC-P-700)

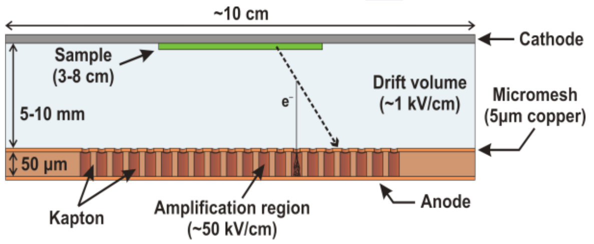


- High accuracy cross section data for neutron-induced reactions are needed over a wide energy range for the design, feasibility ans sensitivity studies on advanced nuclear systems
- The ^{236}U isotope ($T_{1/2}$ = 23.42x10^6 years) has the longest half-life compared
- to any other fission product or actinide produced in nuclear reactors
- Its specific activity (2.4 MBq/gr) is 190 times higher that the one of ^{238}U→ significantly contributes to the radioactivity of reprocessed uranium
- In current reactors based on U/Pu fuel, ^{236}U is produced by (n,γ) on ^{235}U→ considerably affects the neutron balance in the reactor core as well as the
- fuel composition
- Moreover, ^{236}U builds up in the equilibrium state in the Th/U fuel cycle
- For the development of fast nuclear reactors and accelerator driven systems (ADS) the knowledge of its fission cross section is required with 5% accuracy

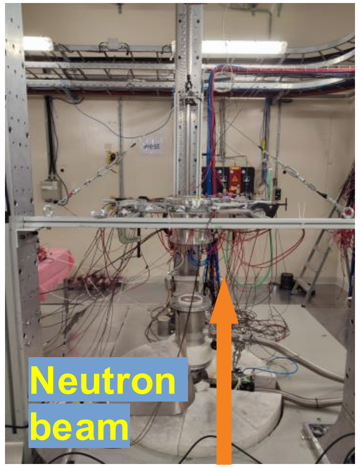
Gain stability



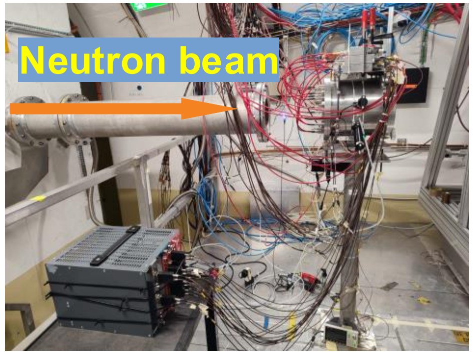
Micromegas detectors



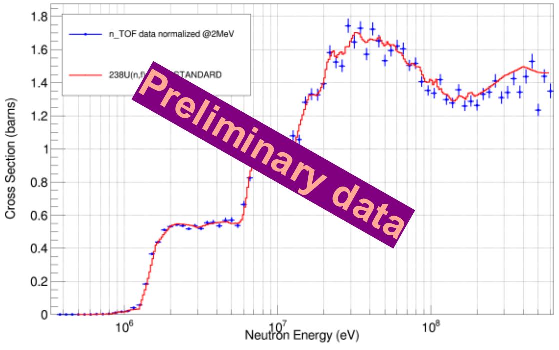
Setup @ EAR-2 for the low energy region



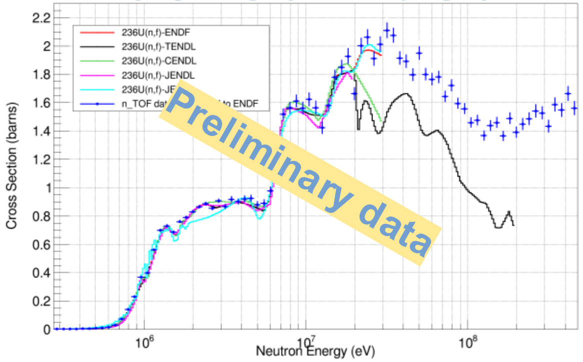
Setup @ EAR-1 for the high energy region



CS: U8 wrt U5



CS: U6 wrt U5

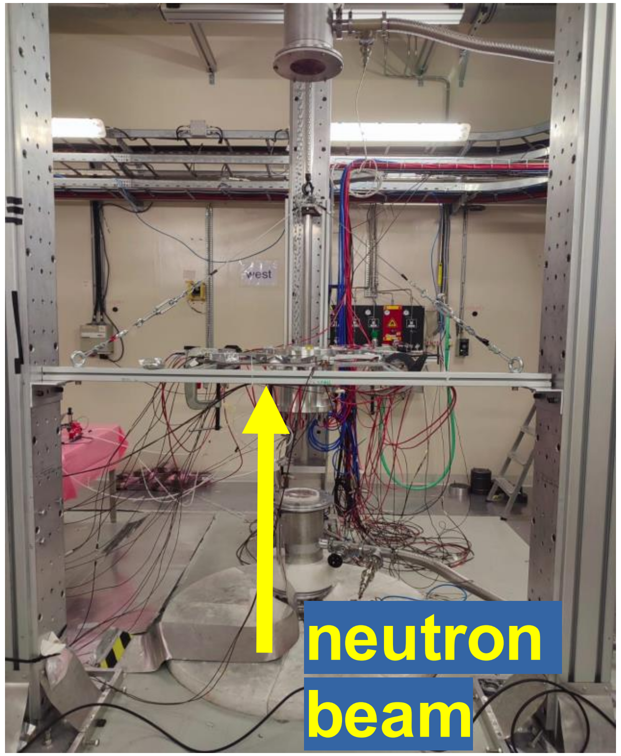


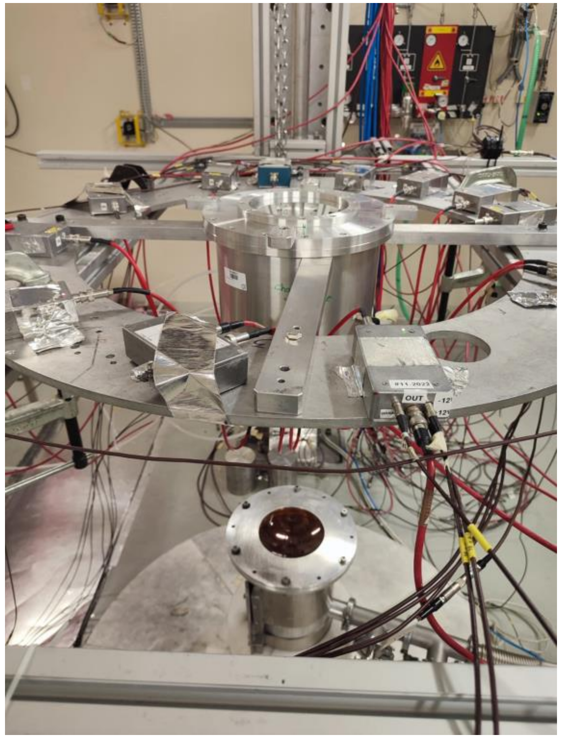
This project has received funding from the European Union's Horizon Europe Research and Innovation programme under Grant Agreement No 101057511 (EURO-LABS project).

Experimental setup

- Fission chamber with 9 x Micromegas detectors
- 4 x p- Stilbene detectors around the fission chamber→ test study for the prompt neutron spectrum

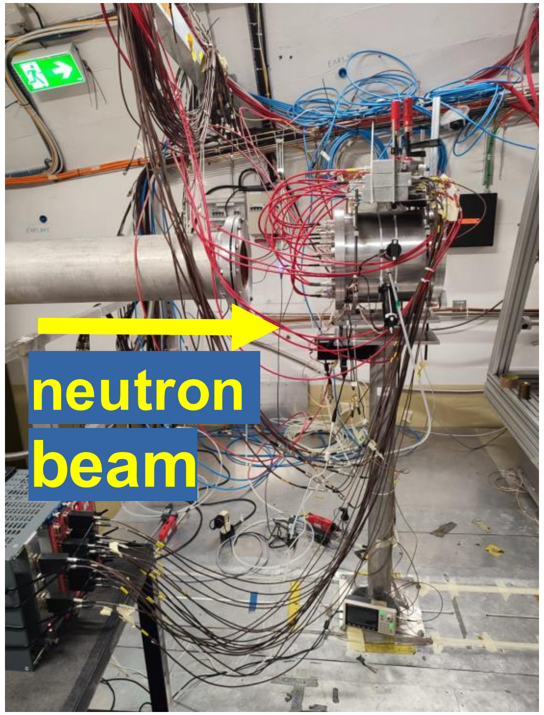
EAR-2

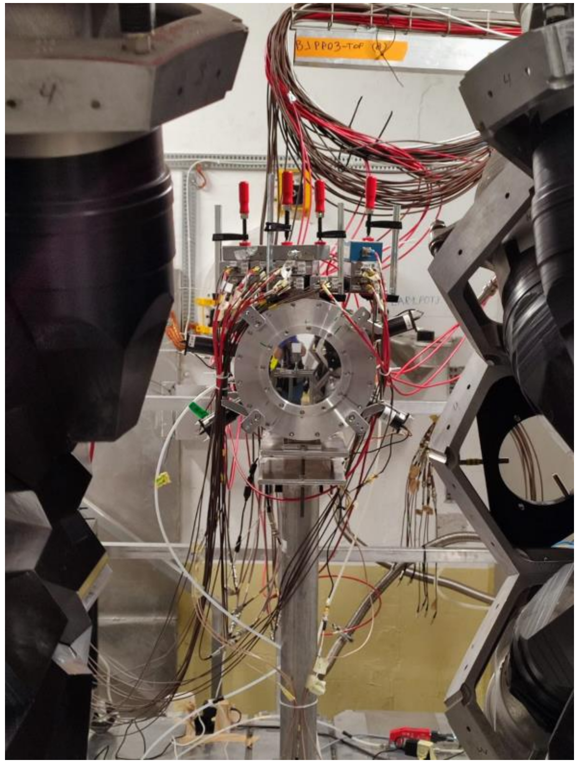




Setup @ EAR-2 for the
low energy region

EAR-1



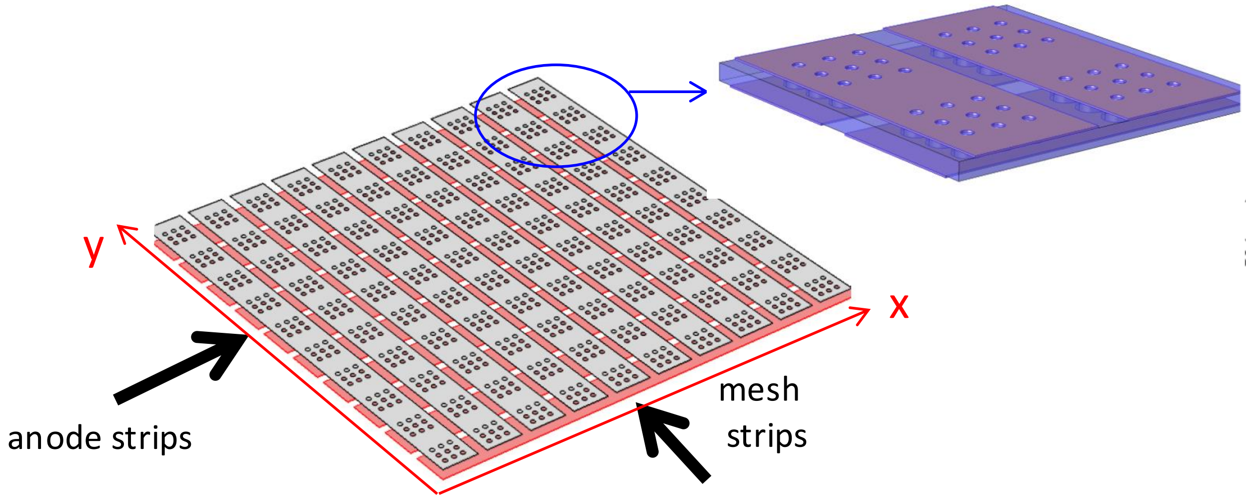


Setup @ EAR-1 for the
high energy region

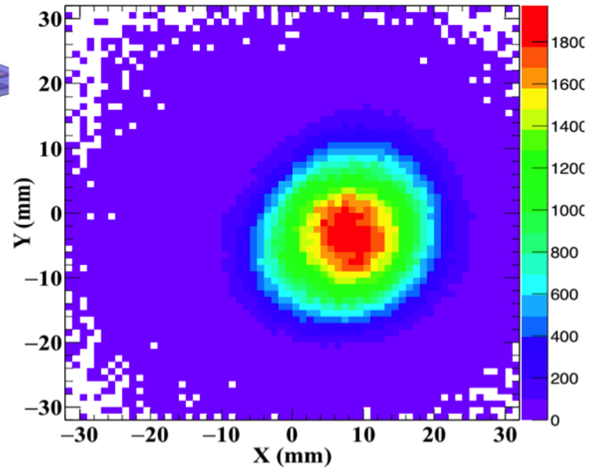
DETECTOR DEVELOPMENTS

EXTRA OUTCOMES: Proper detector + electronics systems' development / improvements
Target fabrication, new facilities etc.

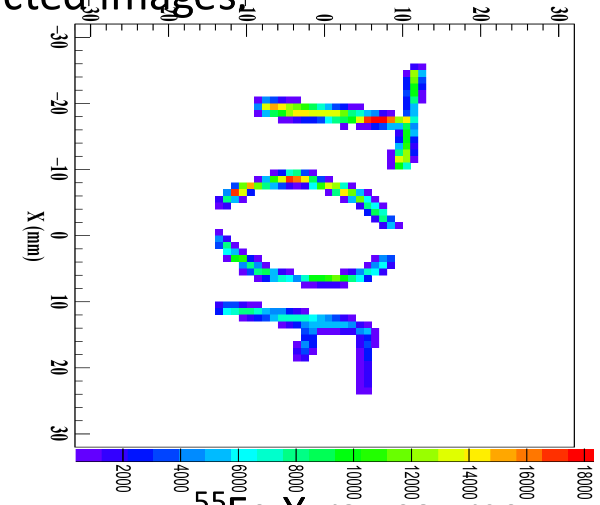
Examples: 1) *«Transparent» neutron beam profiler: Micromegas microbulk detector technology*



reconstructed images:



n_TOF EAR-2

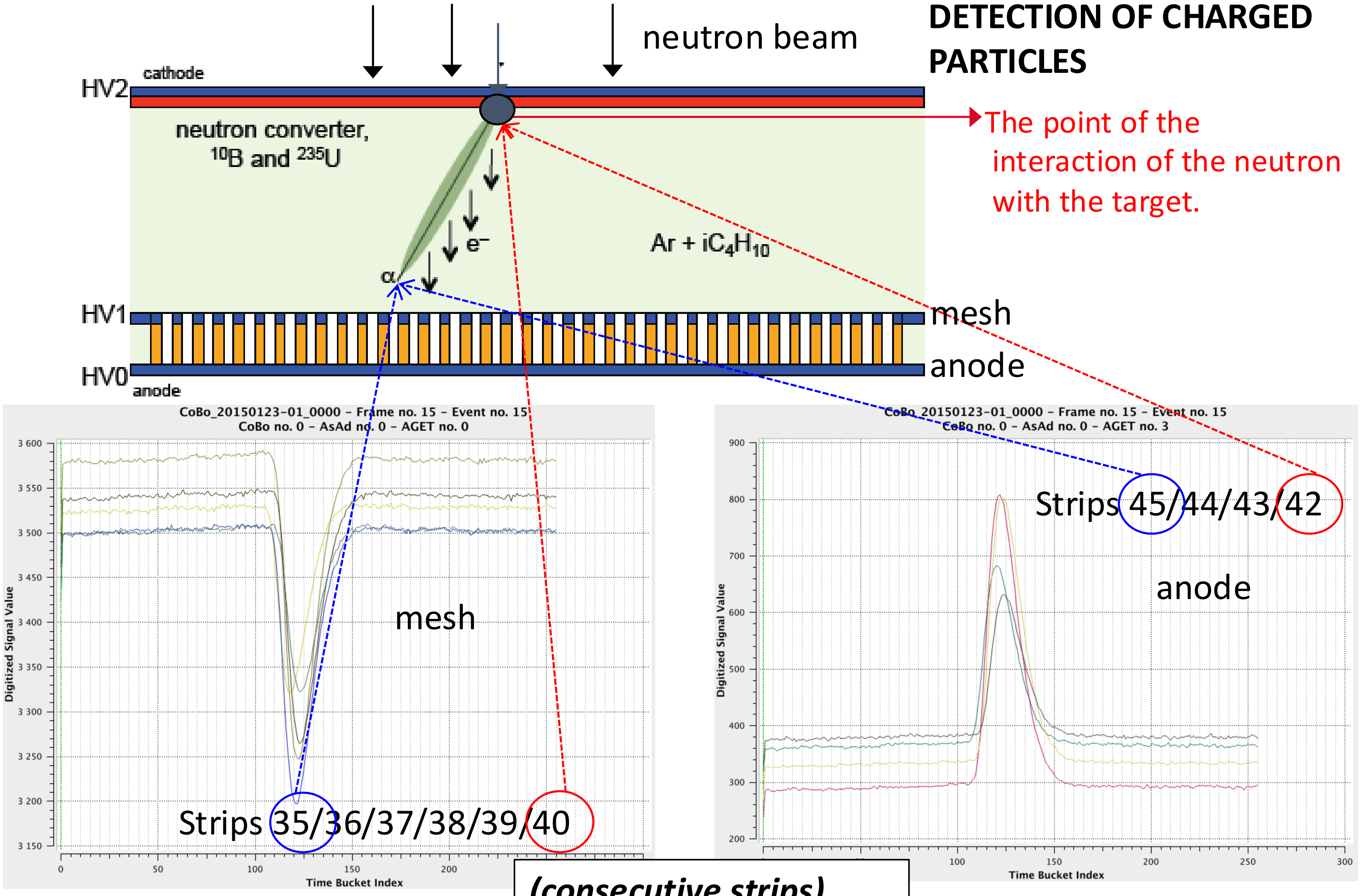


^{55}Fe X-ray source

M. Diakaki et al., Nuclear Inst. and Methods in Physics Research, A 903 (2018) 46–55

NEUTRON BEAM PROFILE EXTRACTION

DETECTION OF CHARGED PARTICLES



(consecutive strips)