CEIDEN
PLATAFORMA TECNOLÓGICA DE ENERGÍA NUCLEAR DE FISIÓN

Diseño y construcción de detectores de neutrones según necesidades

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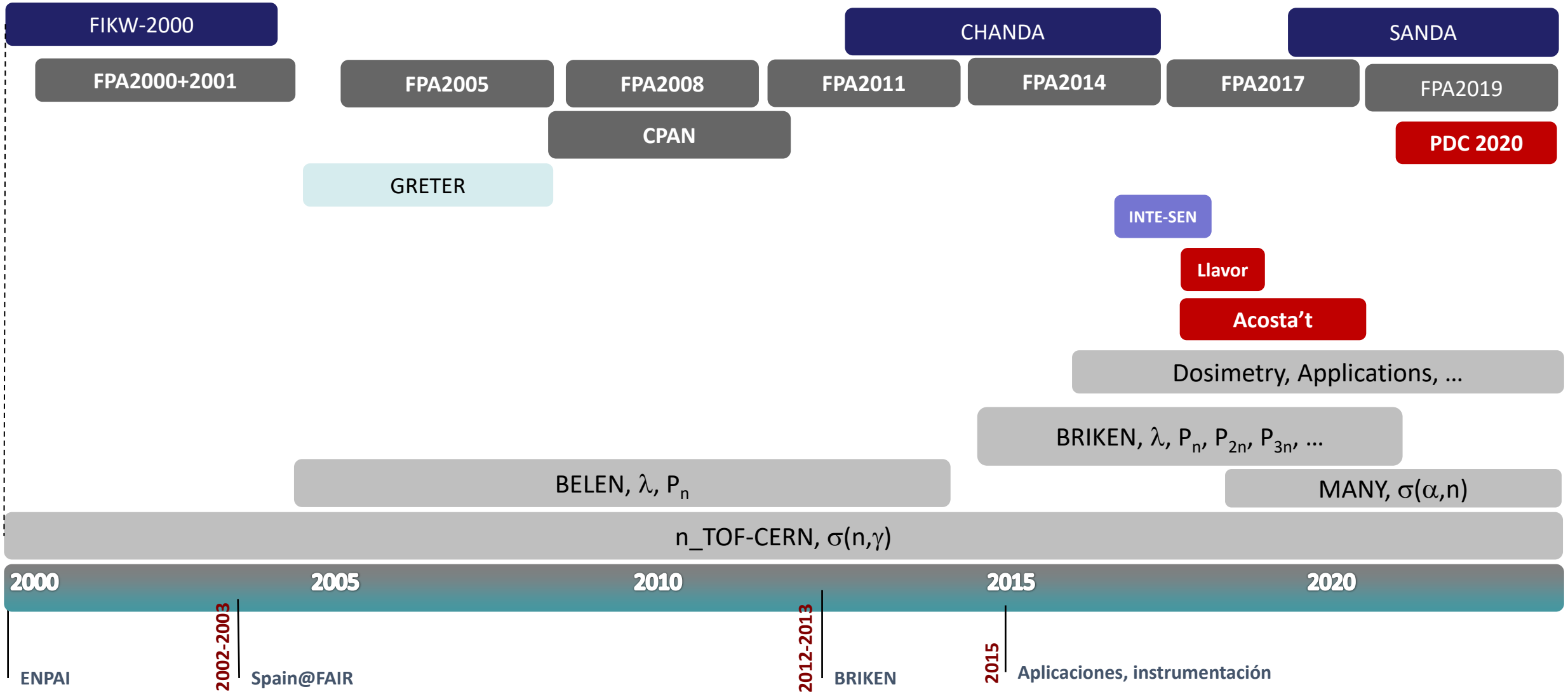
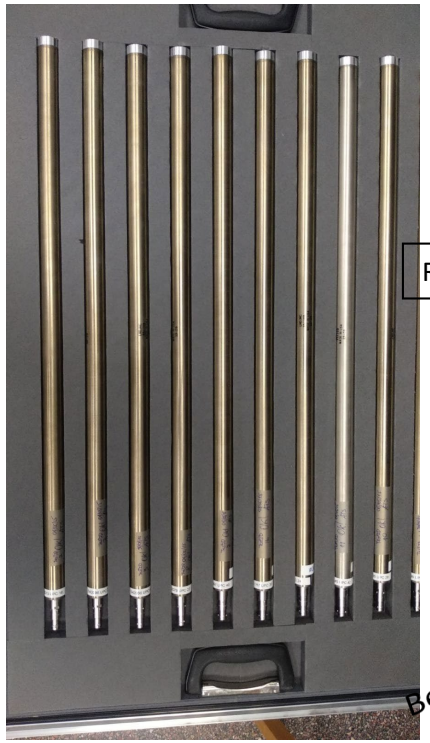
ANT-ENPAI. UPC

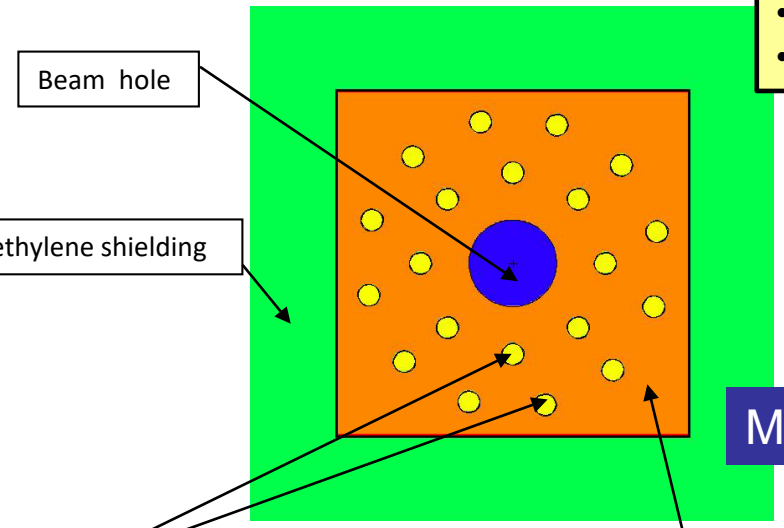


P_n of far from stability isotopes:

The BEta deLayEd Neutron (BELEN) detector



Front view



- **Energy of beta-delayed neutrons not well known**
- **Small number of implanted isotopes**

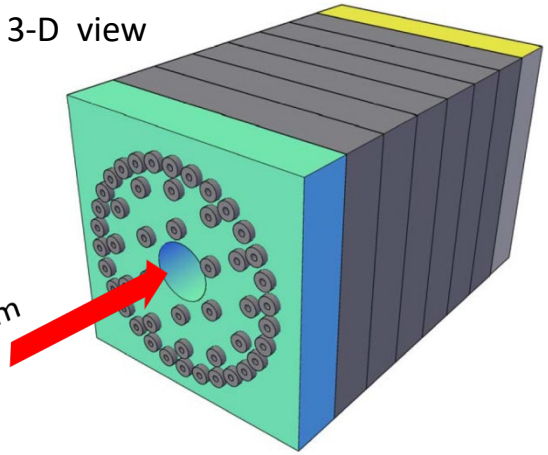
We need:

- **High efficiency**
- **Flat efficiency**
- **Optimal configuration**

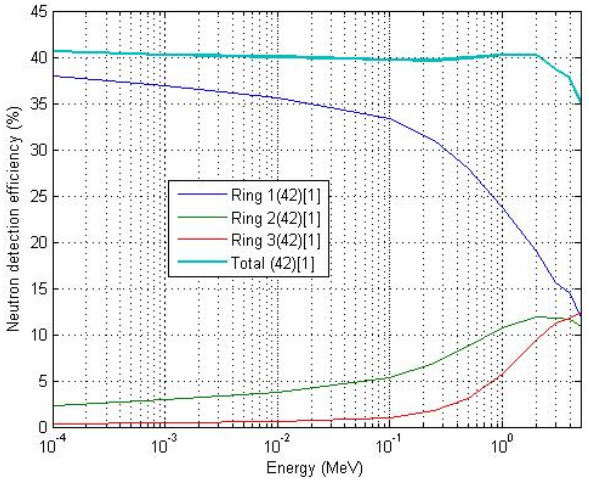
MC: MCNP, Geant4, …

- **The efficiency depends on many parameters:**
  - **Type of single detector**
  - **Diameter of beam hole**
  - **Number of neutron counters**
  - **Distance of counters to the center of polyethylene matrix**
  - **Number of rings**

3-D view

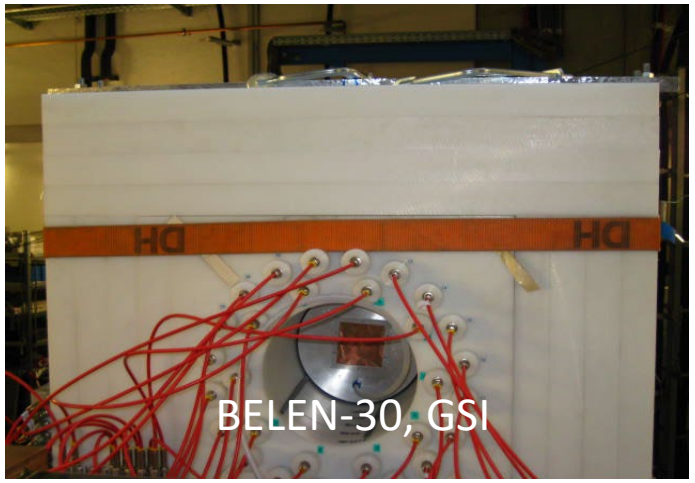


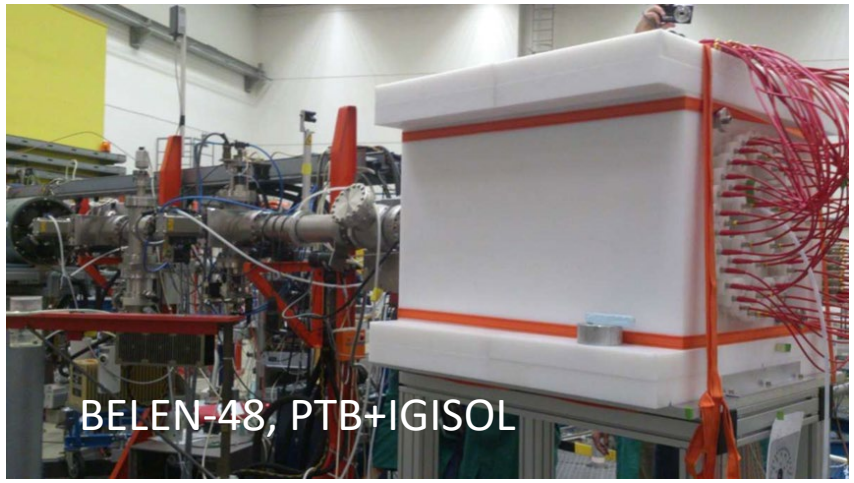
Neutron detection efficiency

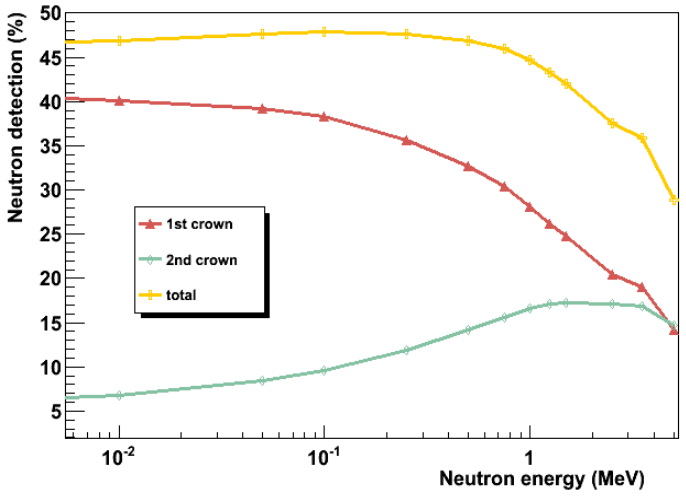


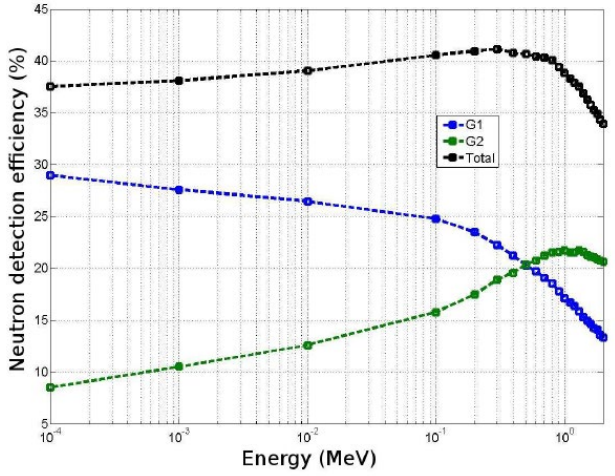
^{3}He (CO_2) LND proportional counters. 60 cm x 2.5 cm, 8, 10 and 20 atm

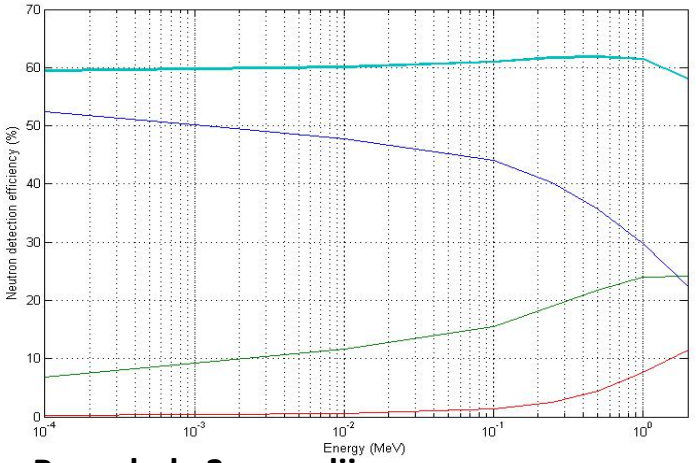
BELEN. GSI, IGISOL





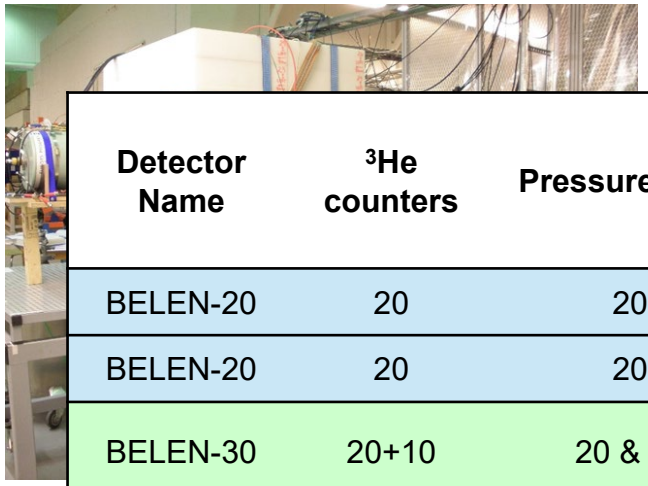


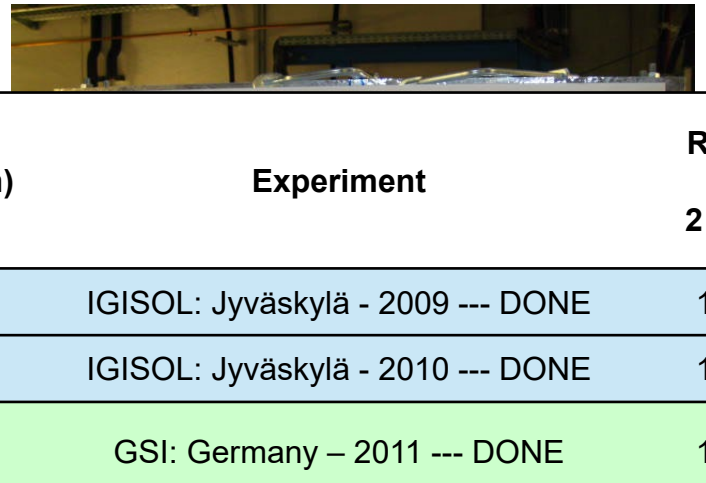


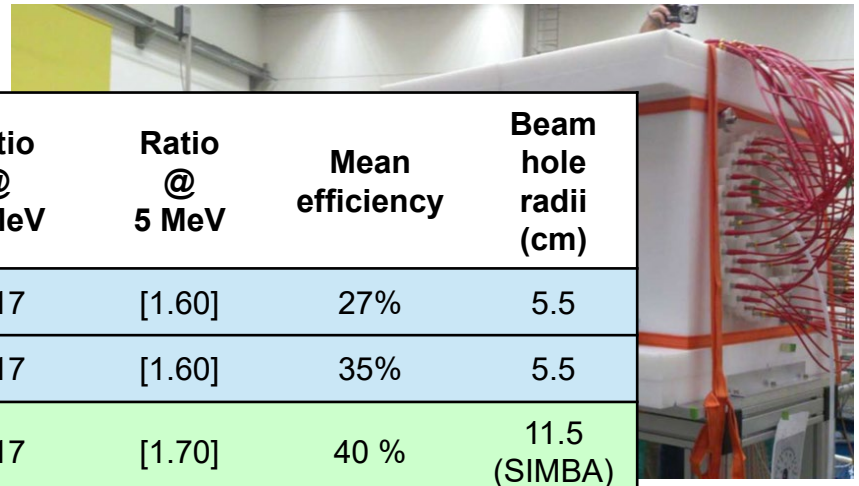


Beam hole 3 cm radii

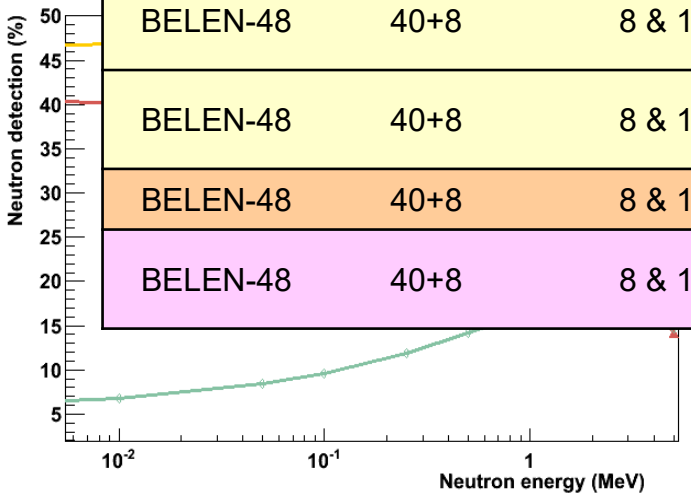
BELEN. GSI, IGISOL

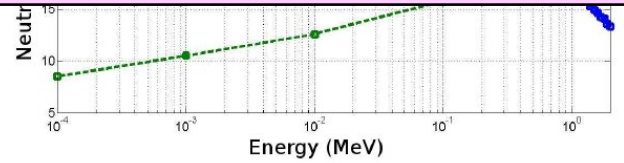


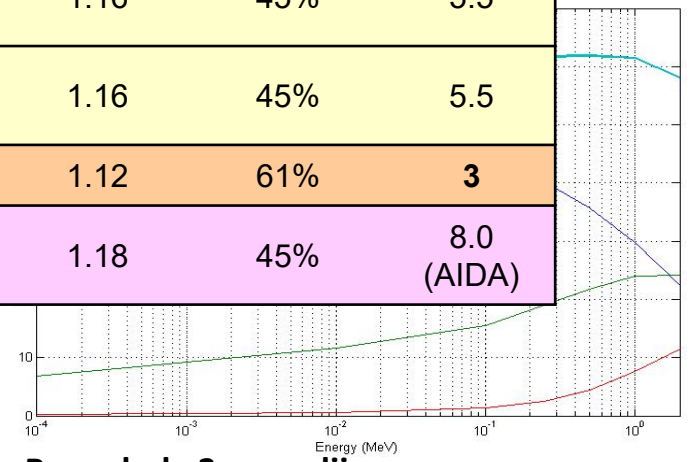




Detector Name	^{3}He counters	Pressure (atm)	Experiment	Ratio @ 2 MeV	Ratio @ 5 MeV	Mean efficiency	Beam hole radii (cm)
BELEN-20	20	20	IGISOL: Jyväskylä - 2009 --- DONE	1.17	[1.60]	27%	5.5
BELEN-20	20	20	IGISOL: Jyväskylä - 2010 --- DONE	1.17	[1.60]	35%	5.5
BELEN-30	20+10	20 & 10	GSI: Germany – 2011 --- DONE	1.17	[1.70]	40 %	11.5 (SIMBA)
BELEN-48	40+8	8 & 10	PTB: Germany-06/2013 (Detector calibration) --- DONE	1.02	1.16	45%	5.5
BELEN-48	40+8	8 & 10	IGISOL: Jyväskylä – DONE	1.02	1.16	45%	5.5
BELEN-48	40+8	8 & 10	IGISOL: Jyväskylä -- DONE	1.02	1.12	61%	**3**
BELEN-48	40+8	8 & 10	FAIR / DESPEC	1.07	1.18	45%	8.0 (AIDA)

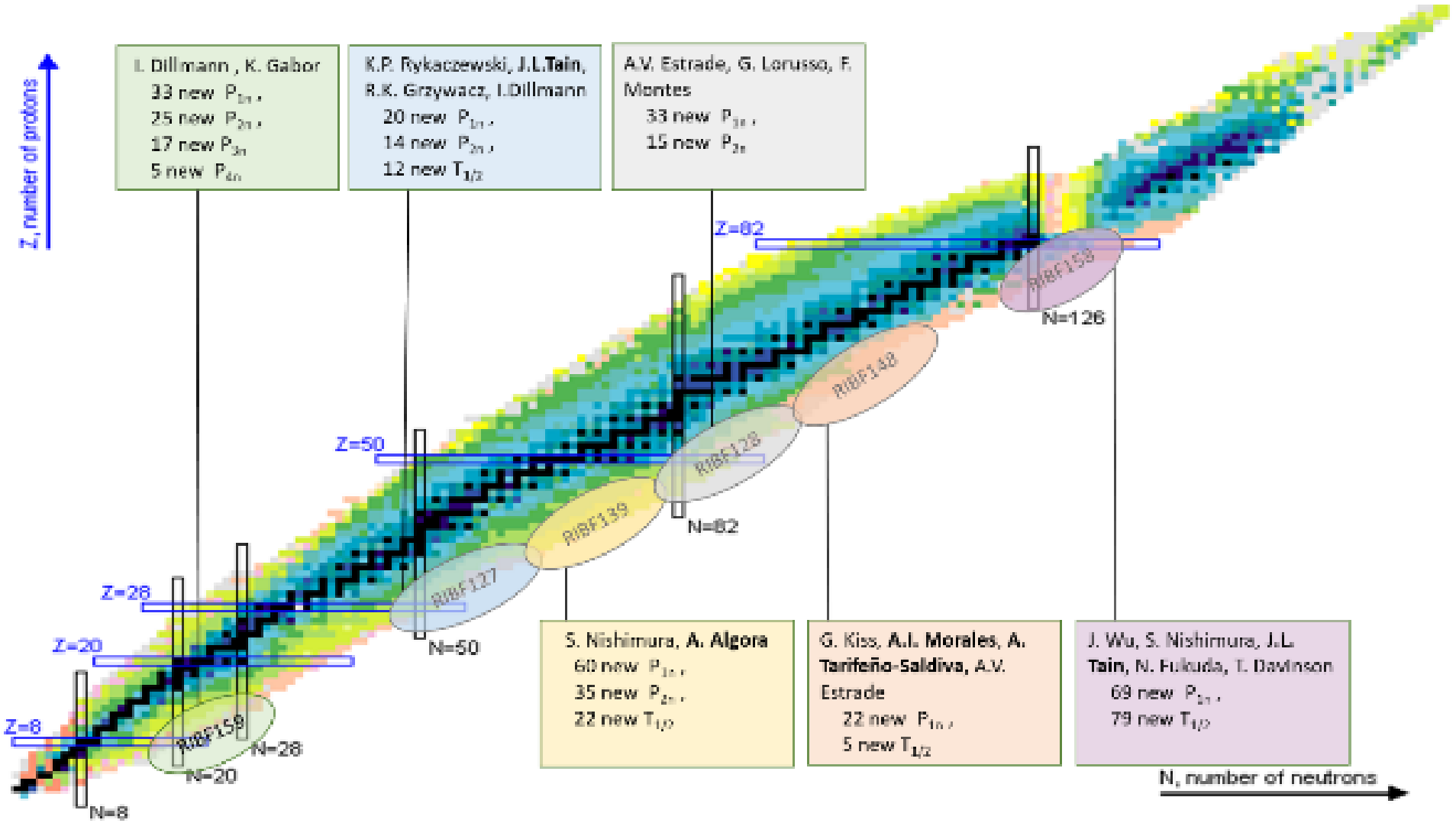






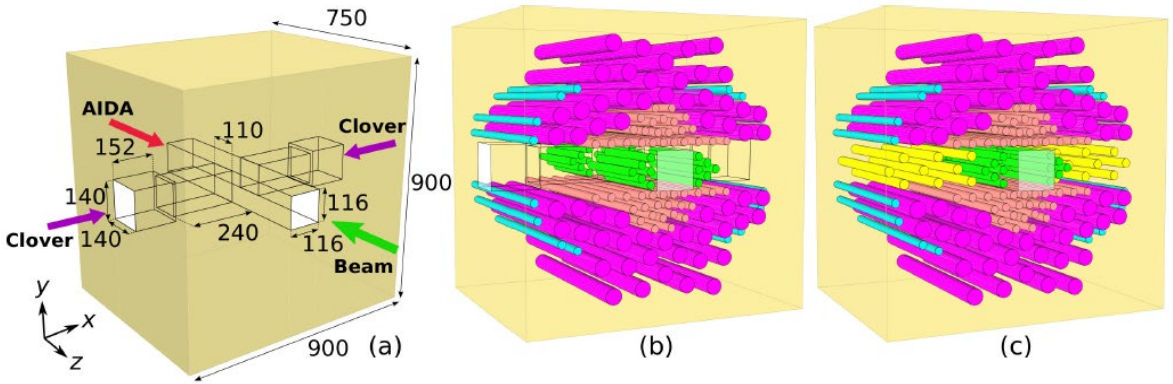
Beam hole 3 cm radii

BRIKEN: BELEN for RIKEN

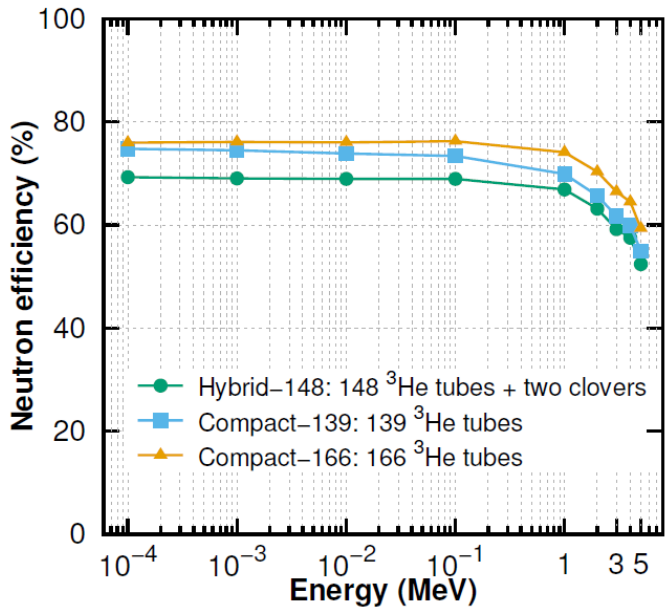


BRIKEN: BELEN for RIKEN

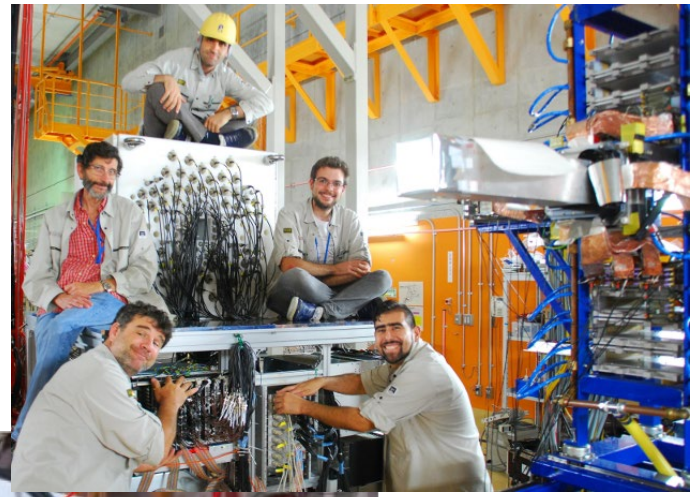
MC iterativo

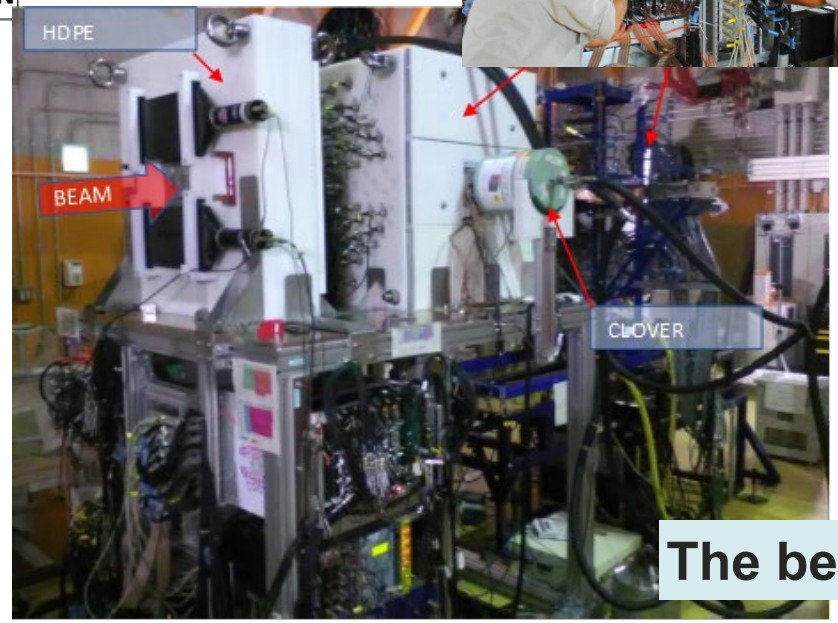


Tube color code: Type **B** and **R** Type **I** Type **K** Type **E** Type **N**



BRIKEN 148H

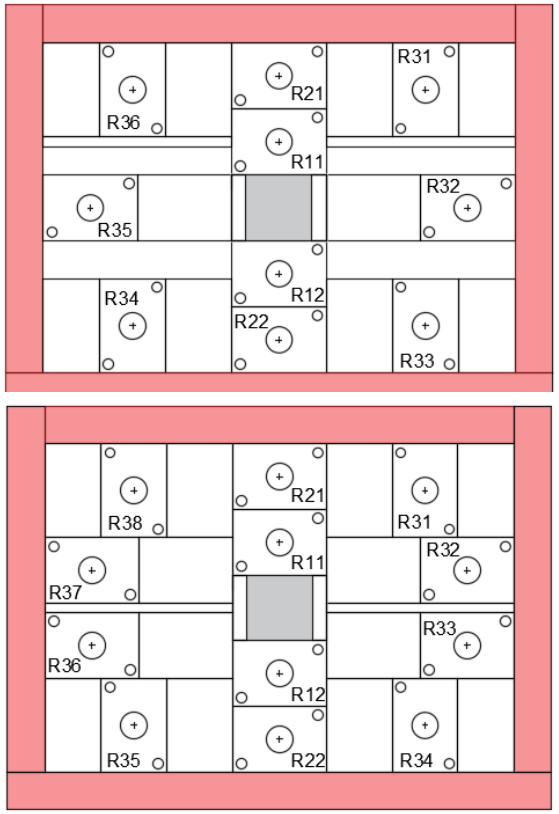




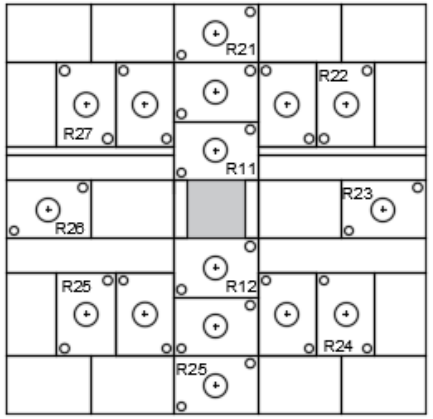
The best in the world

σ(α, n) Reactions. miniBELEN (MANY-Coll)

- Source of neutrons for the slow neutron capture nucleosynthesis (the s-process).
- α-particles capture process (the α-process).
- Neutron-induced background in underground laboratories.
- Neutron-induced background in nuclear facilities such as particle accelerators and nuclear reactors.

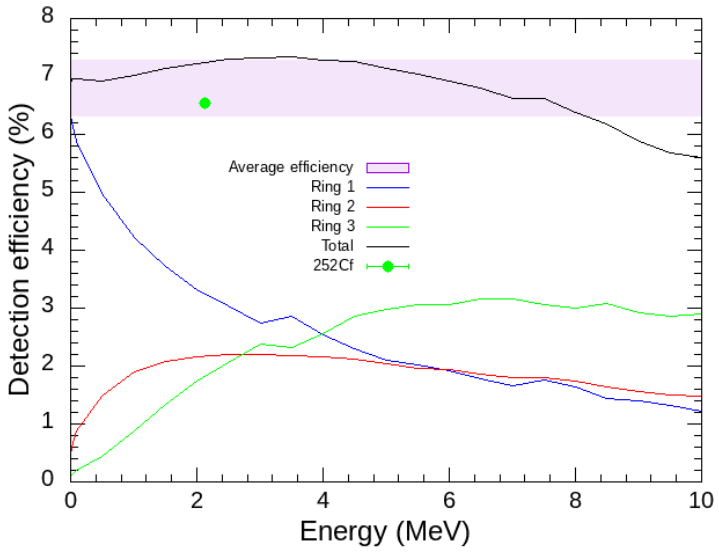


Parametric design

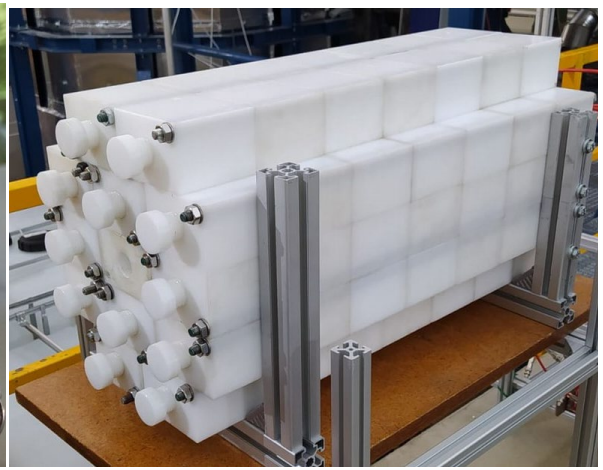


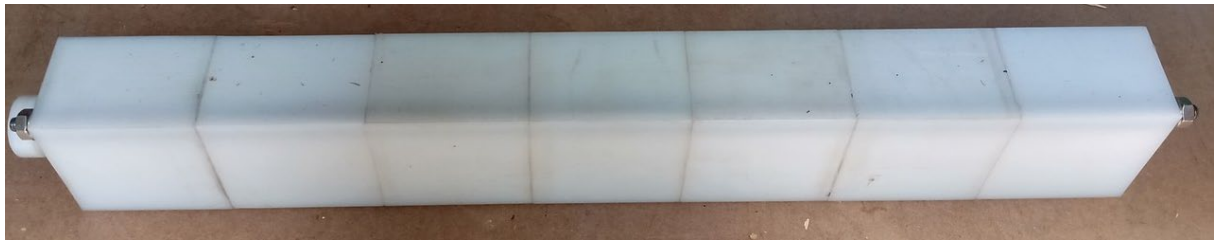
We need:

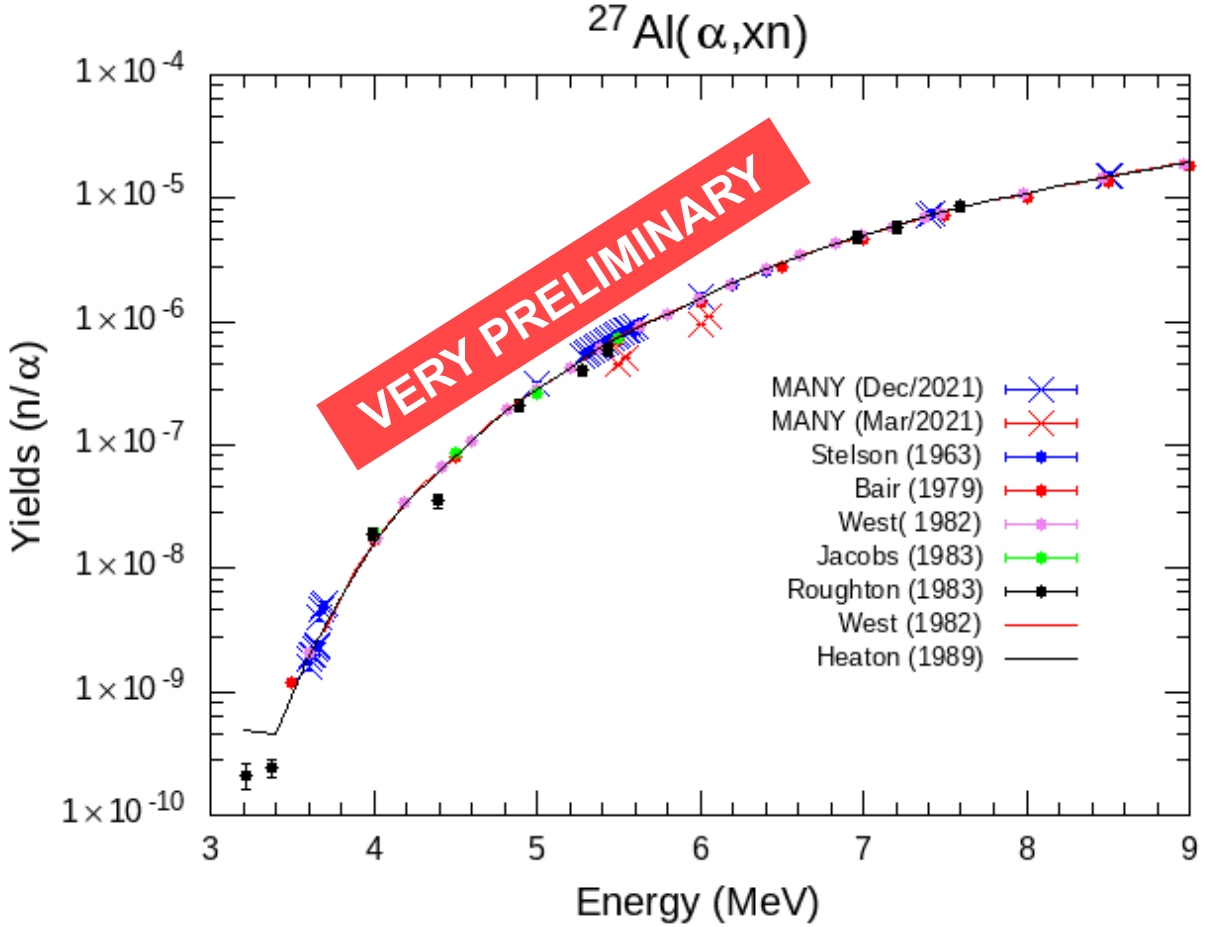
- **Not very high total efficiency**
- **Flat efficiency**
- **Portability, modularity**



MANY-Collaboration. miniBELEN







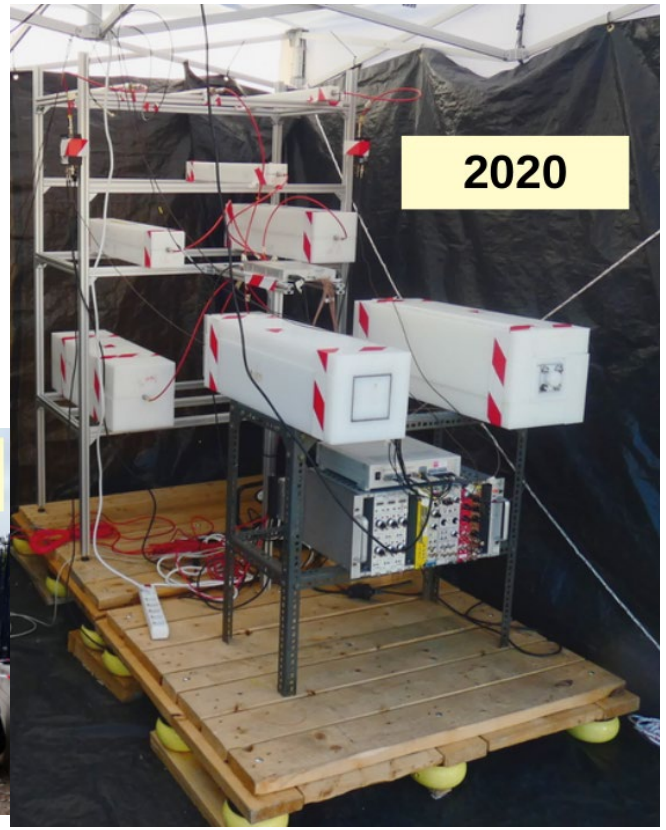
HENSA

Presented by: A. Tarifeño (This morning)

- Cosmic neutrons
- Neutron background in underground laboratories.

We need:

- **Spectrometric capability**
- **High efficiency**
- **Portability, modularity**

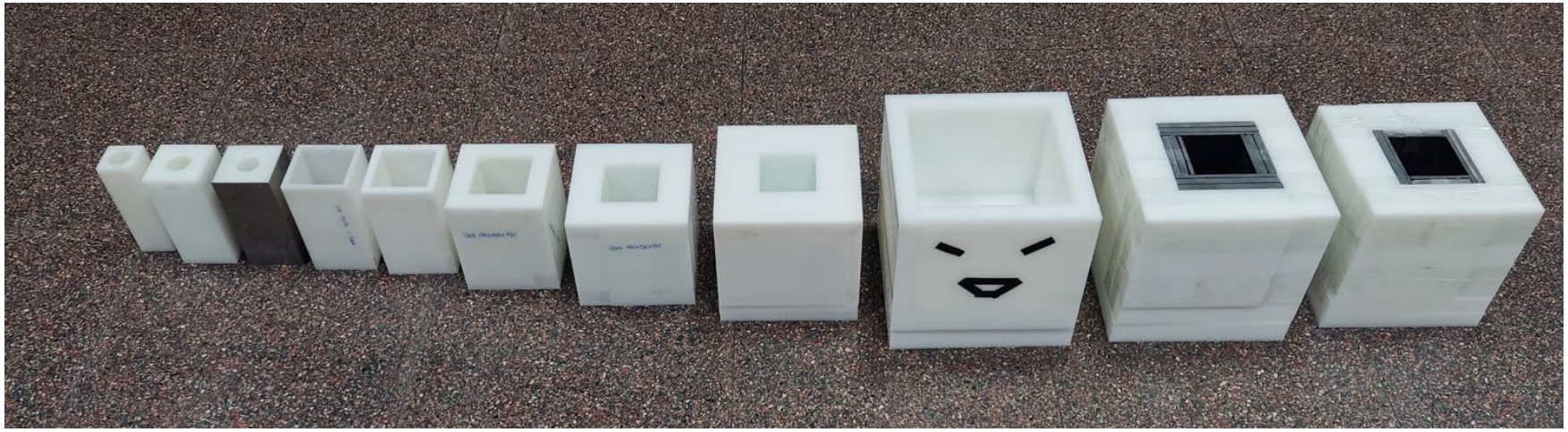


NESTA: **N**ested n**E**utron **S**pec**T**rometry **A**rray

Portable extended neutron spectrometer for particle accelerator environments (high flux and pulsed facilities)
Applications: Laser facilities, fusion plasmas, spallation sources, medical facilities (hadron & radiotherapy)

We need:

- **Low efficiency**
- **Spectrometric capabilities up to high energies**
- **Portability, modularity**

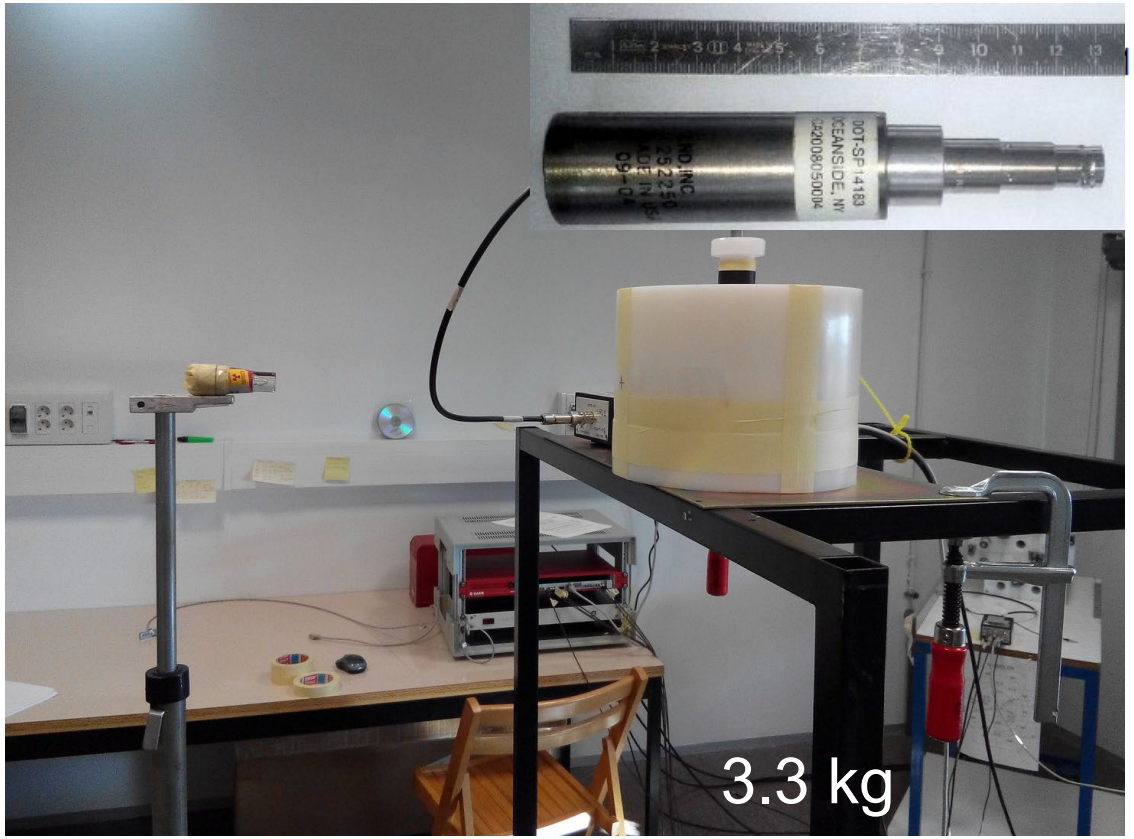


Neutron dosimetry

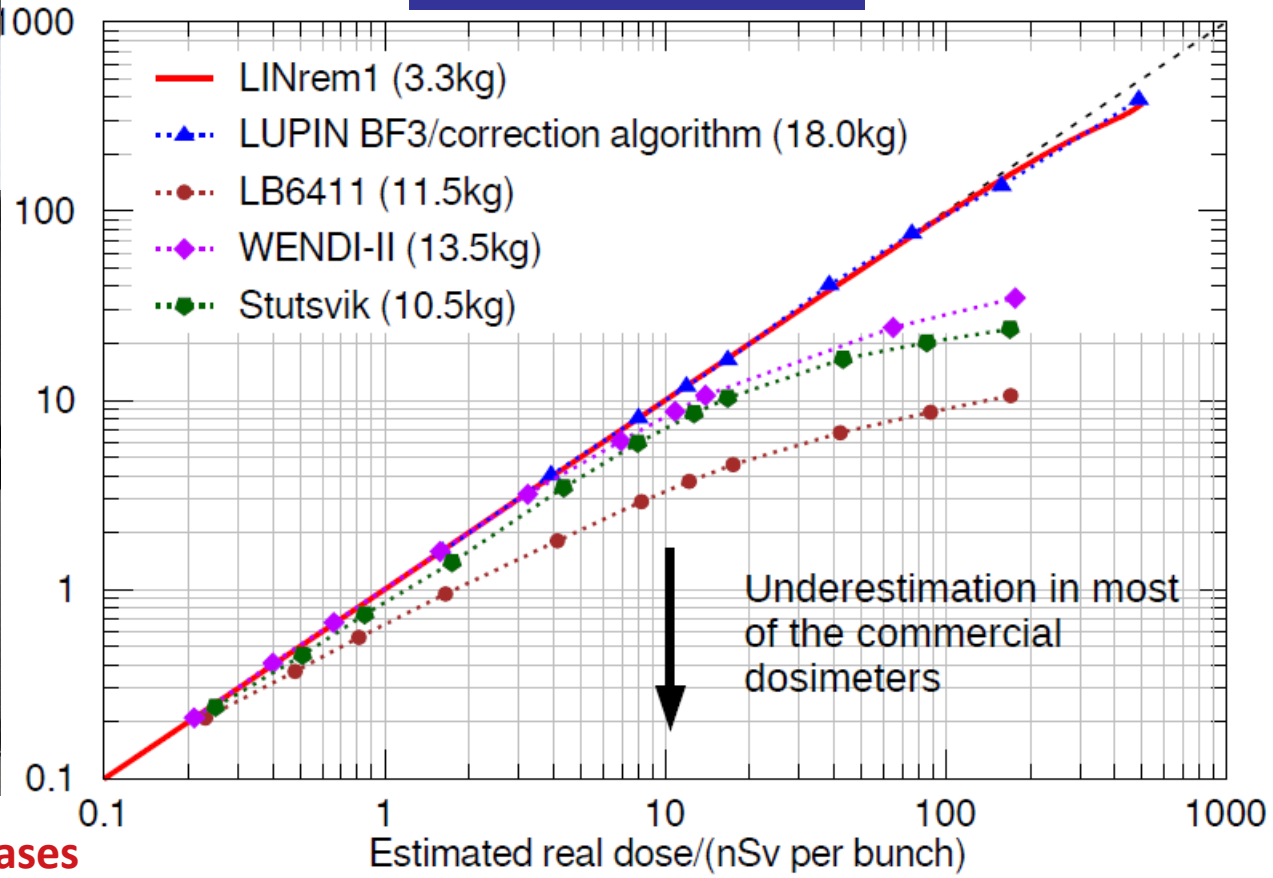
Most of the commercial dosimeter are not suited for pulsed neutron fields.
Current commercial dosimeters are heavy and therefore difficult to handle.

We need:

- **Low weight**
- **Better response in pulsed beams**
- **Extended energy range**



See A. Tarifeño talk

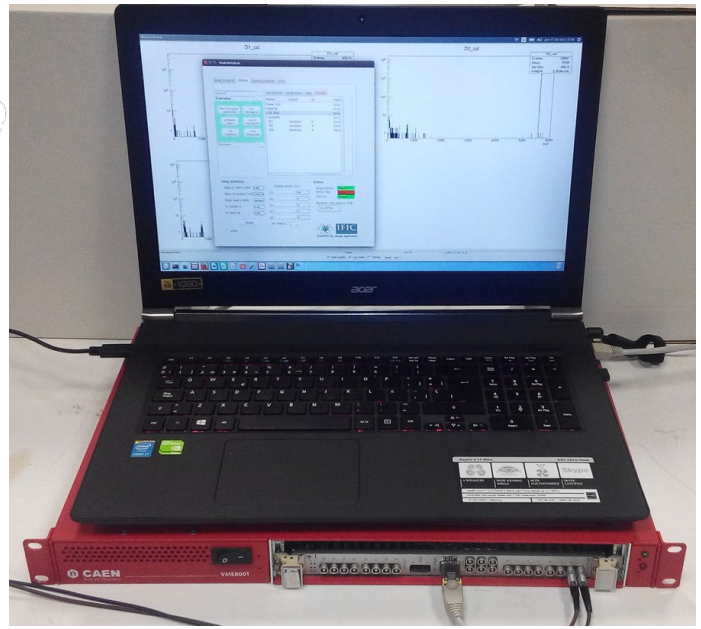


***PCT/EP2021/052074 favorable. Now starting national phases**

Main resources

UPC+IFIC 3He-tubes stock for 2022									
Detector	Gas	Group	Units	Pressure (atm)	Total length (cm)	Tube length (cm)	Diameter (inch)	Gas length (cm)	Active length (cm)
LDN 252266	3He, CO2	IFIC	10	10	67.59	63.72	1	63.3	60
LND 252231	He3, Ar, CO2	UPC	1	10.1	63.1	53.2	1	53.2	50
LND 252285	3He, CO2	UPC	39	8	67.59	63.72	1	63.3	60
LND 252303	3He, CO2	UPC	1	4	67.59	63.72	1	63.3	60
LND 252248	3He, CO2	UPC	1	20	67.59	63.72	1	63.3	60
LND 252241	He3, CO2	UPC	1	20	38.65	33.97	1	33.97	30.48
LND 252251	3He, CO2	IFIC	1	20	15.35	20.7	1	15.43	13.1
LND 252250	3He, CO2	IFIC	2	10	12.75	7.06	1	7.46	5.13
VT-70060	3He, CO2	UPC	1	8	11	8	0.5	6.4	5
VT-70061	3He, CO2	UPC	2	8	11	8	5/8	6.4	5
Long tubes			52						
Small tubes			7						

+ 16-24 in 2023



Portable digital acquisition system:

- Based on the digitizer Struck SIS3316 (10 modules, 160 channels)
- Controlled by GASIFIC via ethernet connection.
- 16 channels, trigger-less mode.
- Online and offline acquisition modes.
- Internal timestamp, ideal for data sorting and correlation analysis.
- For use with neutron counters, silicon detectors, HPGe, scintillators, etc.

Summary

- 16+ years experience in developing neutron detectors
- Large(est) stock of ^{3}He proportional counters
- Very adaptable DAQ system
- Excellent performance of P_n, $\sigma(\alpha,n)$, … detectors
- Very large campaign of cosmic neutrons
- Background measurements in underground laboratories
- Light weight and pulsed fields capable, novel neutron dosimeter design. Patent
- Open to collaborate