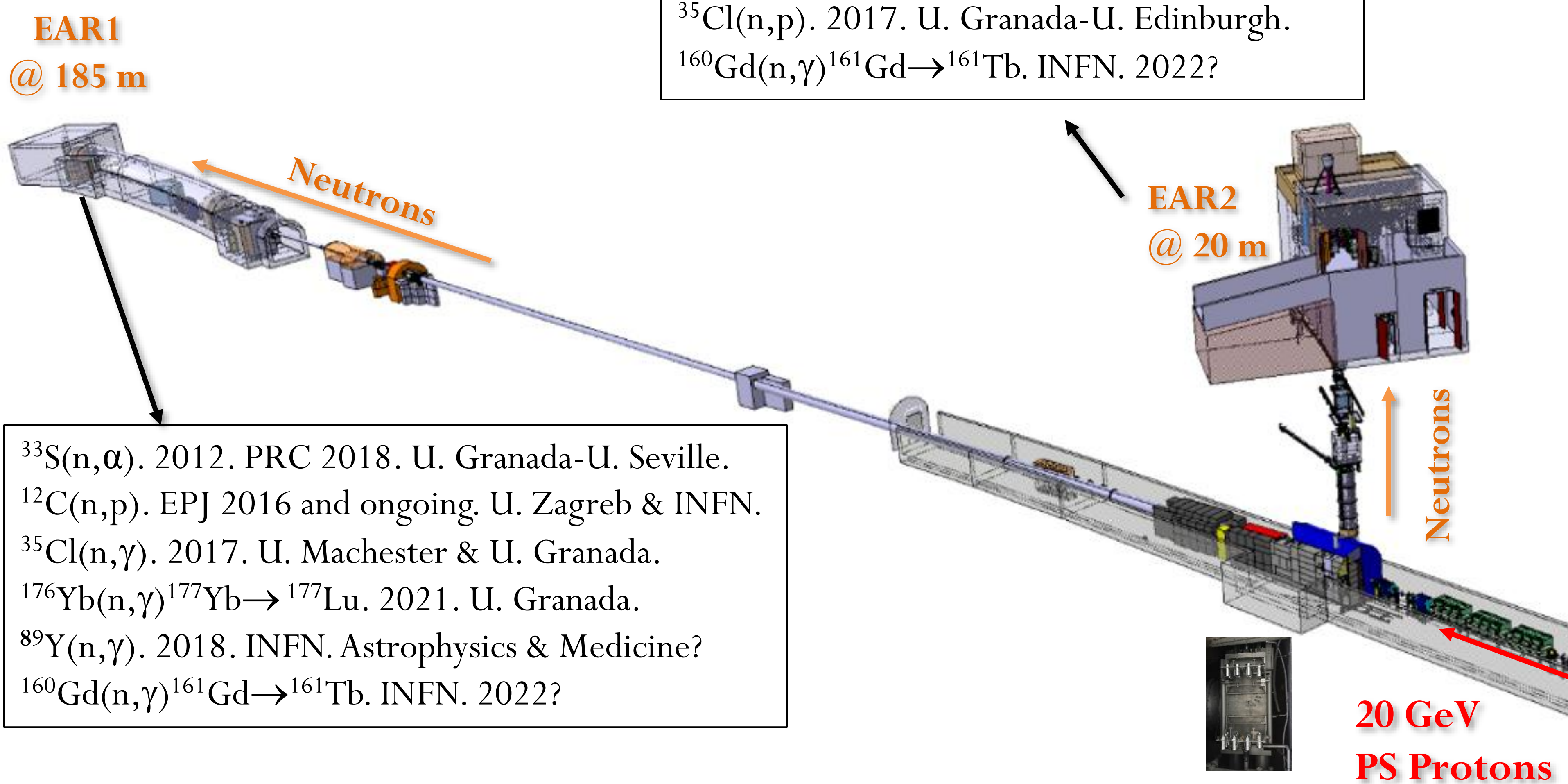
Nuclear Data at n_TOF for Medicine

Javier Praena

Prof. Universidad de Granada (Spain)
CERN Scientific Associate (EP/SME)
n_TOF Physics Coordinator

Experiments for medicine

^{33}S(n,α). 2015. U. Granada-U. Seville-CERN.
^{14}N(n,p). 2017. U. Granada-U. Edinburgh.
^{35}Cl(n,p). 2017. U. Granada-U. Edinburgh.
^{160}Gd(n,γ)^{161}Gd→^{161}Tb. INFN. 2022?



^{33}S(n,α). 2012. PRC 2018. U. Granada-U. Seville.
^{12}C(n,p). EPJ 2016 and ongoing. U. Zagreb & INFN.
^{35}Cl(n,γ). 2017. U. Machester & U. Granada.
^{176}Yb(n,γ)^{177}Yb→ ^{177}Lu. 2021. U. Granada.
^{89}Y(n,γ). 2018. INFN. Astrophysics & Medicine?
^{160}Gd(n,γ)^{161}Gd→^{161}Tb. INFN. 2022?

Experiments at n_TOF: motivations and results

- **Dosimetry related to fast neutrons in protontherapy/photontherapy. Secondary tumours.**
  - $^{12}C(n,p)^{12}B$ in EAR1. Integral finished. Angular-energy distribution, ongoing.

- **Dosimetry in Boron Neutron Capture Therapy (low energy neutrons).**
  - $^{14}N(n,p)$ in EAR2.

    Provides the most important biological dose to healthy tissue.

    Data status opens to variations in the dose of at least 12%, depends on the neutron beam.

    At n_TOF, we have found a further reduction of the 1st resonance, as Wallner by integral.
  - $^{35}Cl(n,p)$ in EAR2.

    Significant dose in healthy tissue in high sensible organs. Ongoing.
  - $^{35}Cl(n,\gamma)$ in EAR1.

    Significant dose in healthy tissue in high sensible organs (15%). Ongoing.

- **New target in Neutron Capture Therapy (low energy neutrons).**
  - $^{33}S(n,\alpha)$ in EAR1.

    We solved the discrepancies in the resonances between ORNL and Geel measurements.
  - $^{33}S(n,\alpha)$ in EAR2.

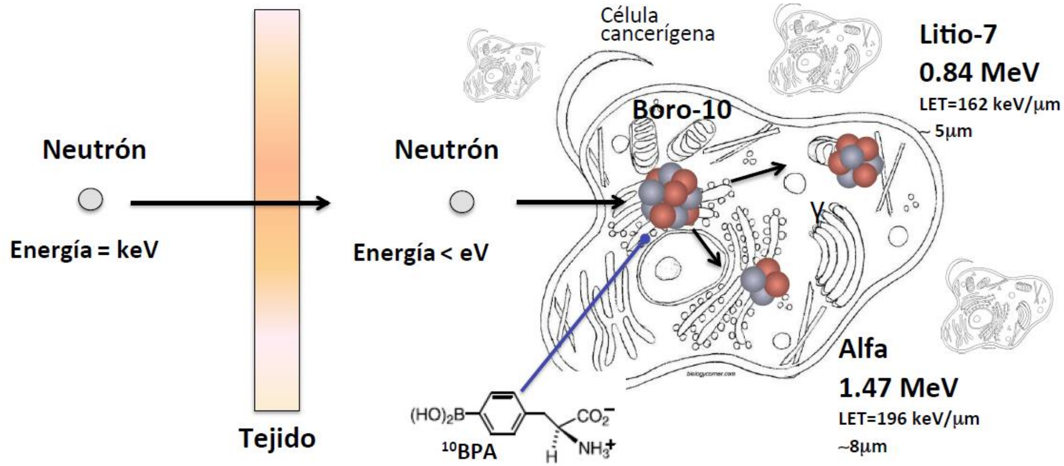
    For the first time data from thermal to 10 keV were measured.

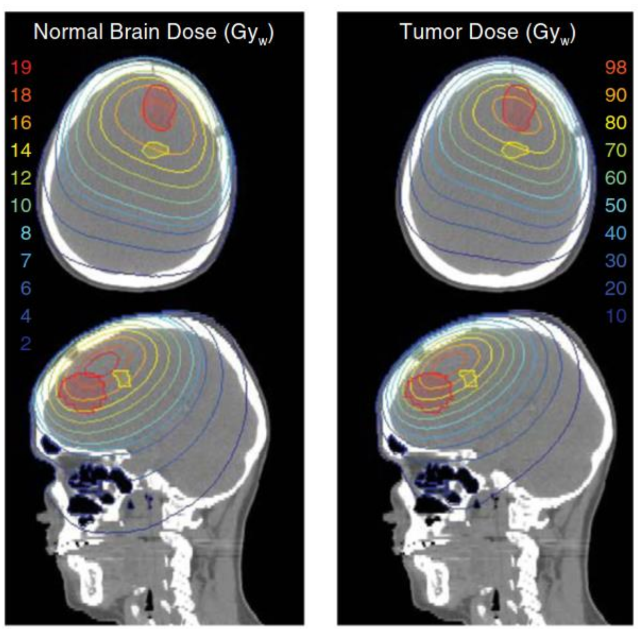
- **Production of radioisotopes for medicine in accelerator-based neutron facilities.**
  - $^{176}Yb(n,\gamma)^{177}Yb \rightarrow {}^{177}Lu$ in EAR1. Theranostics, well stablished. No resonances had been resolved.
  - $^{89}Y(n,\gamma)^{90}Y$ in EAR1. It was proposed for astrophysics. It is also demanded radioisotope.
  - $^{160}Gd(n,\gamma)^{161}Gd \rightarrow {}^{161}Tb$ in EAR1 and EAR2. Production of ^{161}Tb, on study for theranostics.

Boron Neutron Capture Therapy

Boron Neutron Capture Therapy: bases and motivations

Boron-10 compound (BPA) is injected in the blood stream. BPA is preferably absorbed in tumor cells. Tumoral area is irradiated with neutrons in keV-eV rage. Neutrons are moderated in tissue and reach the tumor with thermal energy maximizing the $^{10}B(n,\alpha)^{7}Li$ (2.4 MeV) reaction probability.





The dose on healthy tissue is lower (>factor 4) than in tumor tissue with ^{10}B-load.

The dose in healthy tissue is lower than in photon or proton therapies. No fractioning.

The dose in healthy tissue is the limiting factor in whatever radiotherapy treatment. Nuclear data on key reactions must be measured as accurate as possible (n_TOF).

BNTC: achievements as experimental treatment (in one day)

Barth *et al. Radiation Oncology* 2012, **7**:146
http://www.ro-journal.com/content/7/1/146

RADIATION ONCOLOGY

REVIEW — Open Access

Current status of boron neutron capture therapy of high grade gliomas and recurrent head and neck cancer

Rolf F Barth[1*], M Graca H Vicente[2], Otto K Harling[3], W S Kiger III[4], Kent J Riley[5], Peter J Binns[6], Franz M Wagner[7], Minoru Suzuki[8], Teruhito Aihara[9], Itsuro Kato[10] and Shinji Kawabata[11]

BCNT was always an experimental therapy (patients who suffered other therapies or radiotherapies).

Since 2012, important evolutions in BNCT community:

Japan, Finland, Argentina, Italy, Taiwan (old and new BNCT)

UK, Russia, China, Israel (new BNCT), Spain.

Substitution of the neutron sources:

New accelerator-based facilities are substituting nuclear reactors (new reactors?).

New status of the therapy in each country where BNCT was carried out:

From experimental treatment to conventional one.

Japan: BNCT for melanoma is already included in the Public Health-Care System.

New Boron compounds.

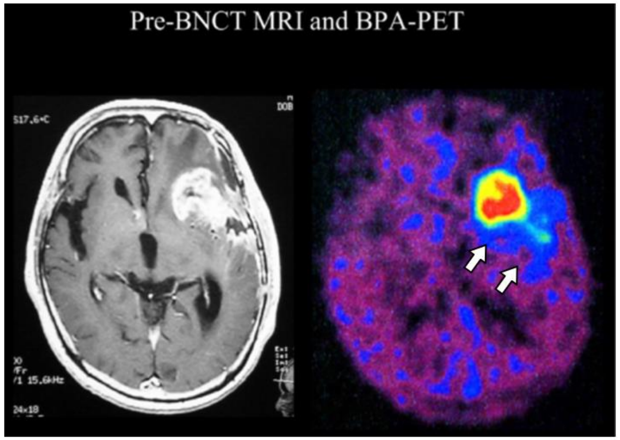
Improvements in BPA and BSH. New targets or cooperative targets.

New data for accurate treatment planning.

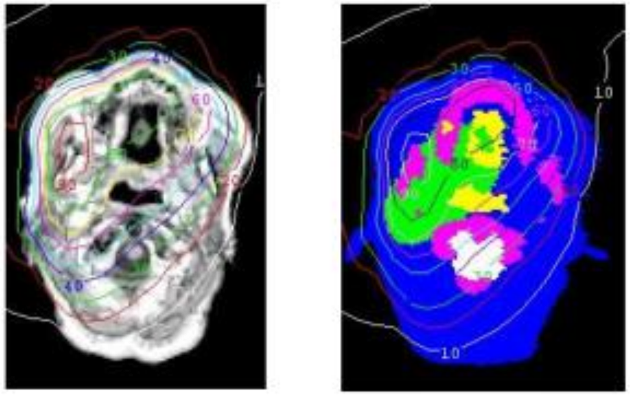
NCT treatment planning systems rely exclusively on Monte Carlo simulations for dose calculations because of the complex, scatter-dominated nature of neutron transport.

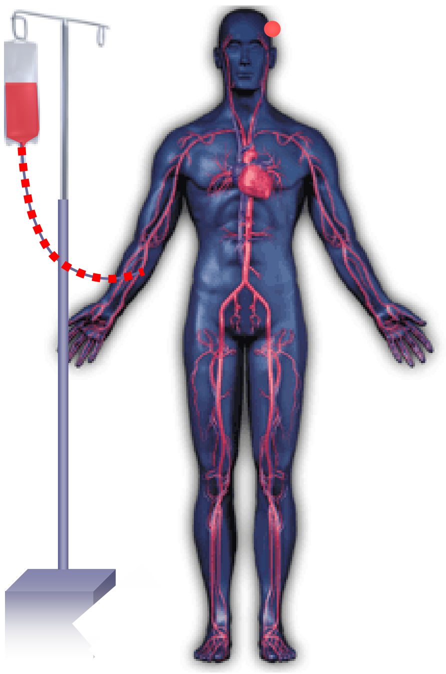
Boron neutron capture therapy: one day treatment (no fractioning)

Boron - BPA uptake with F18-PET



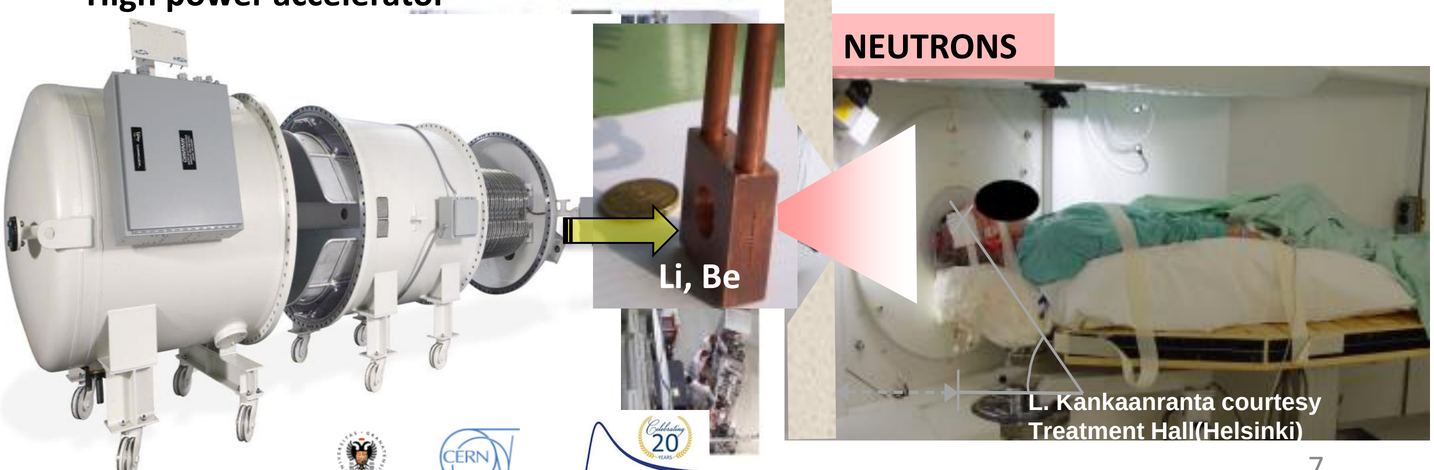
Treatment planning





Neutron irradiation (30 min)

High power accelerator



BNTC: some achievements with nuclear reactors

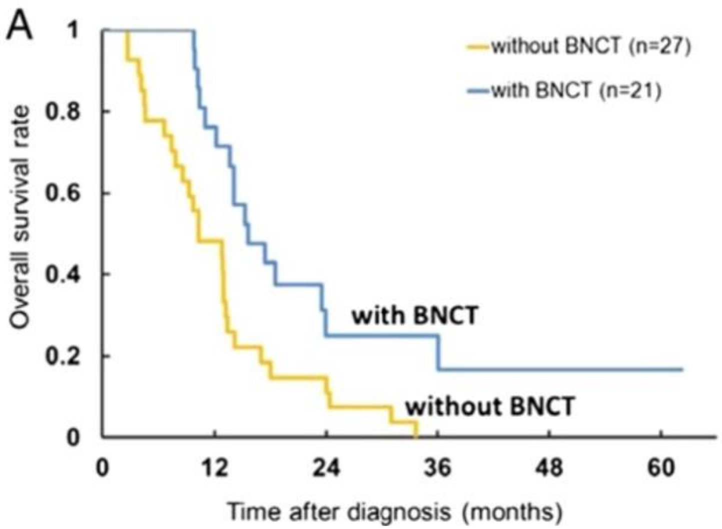


Figure 6 A. Kaplan-Meier estimates of overall survival for all newly diagnosed glioblastoma (WHO grade 4, n = 21). The median survival time of boron neutron capture therapy (BNCT)

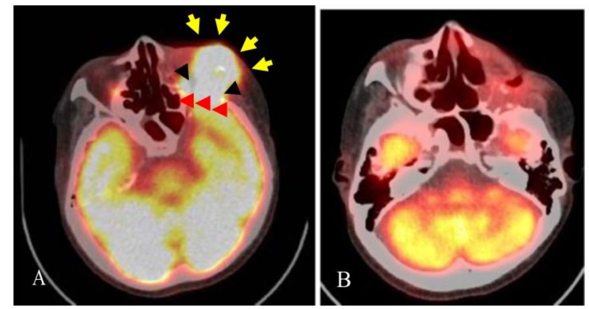


Figure 4 ^{18}FDG-PET study prior and 6 months after BNCT of a 56 year-old male patient with recurrent squamous cell carcinoma of the maxilla. A: FDG accumulated in the left orbital region (arrows) and frontal lobe of brain (arrow heads). **B**: No accumulation of FDG-PET was detected 6 months after BNCT and the patient was disease free for 61 months at the time of the original report. Photographs are from *Applied Radiation and Isotopes*, 67:S37-S42, 2009.

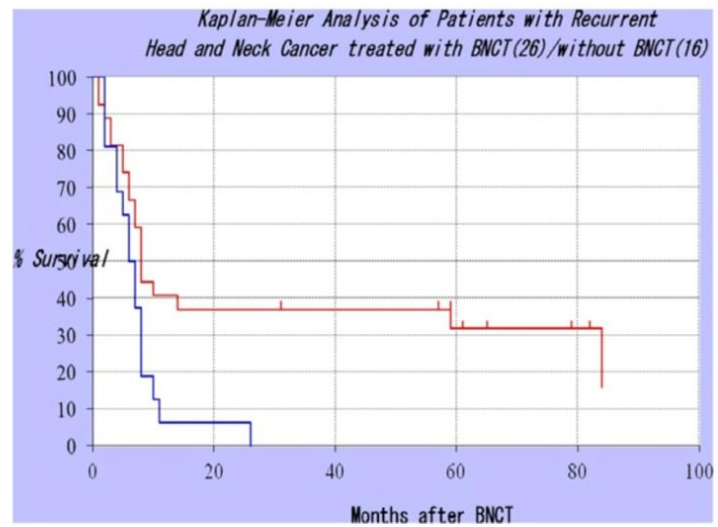


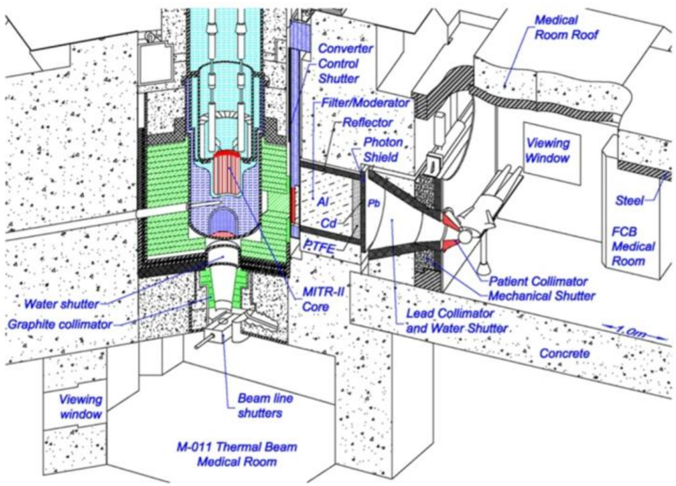
Figure 10 Kaplan-Meier survival plots of patients with recurrent HNC treated by Kato et al. (6) with BNCT (26 cases, red line) and those who treated with other than BNCT (16 cases, blue line). The outcomes for the 26 patients: Mean survival time: 33.6 months, 4-year Overall survival (OS): 37.0%, 6-year OS: 31.7%. Most of the 26 patients had either recurrent or far advanced cancers of the head and neck region and 15 (58%) had regional lymph node metastases and 6 had developed distant metastases. Nineteen of the patients had squamous cell carcinomas, 4 salivary gland carcinomas and 3 had sarcomas. All but one had received standard therapy and developed recurrent tumors for which there were no other treatment options.

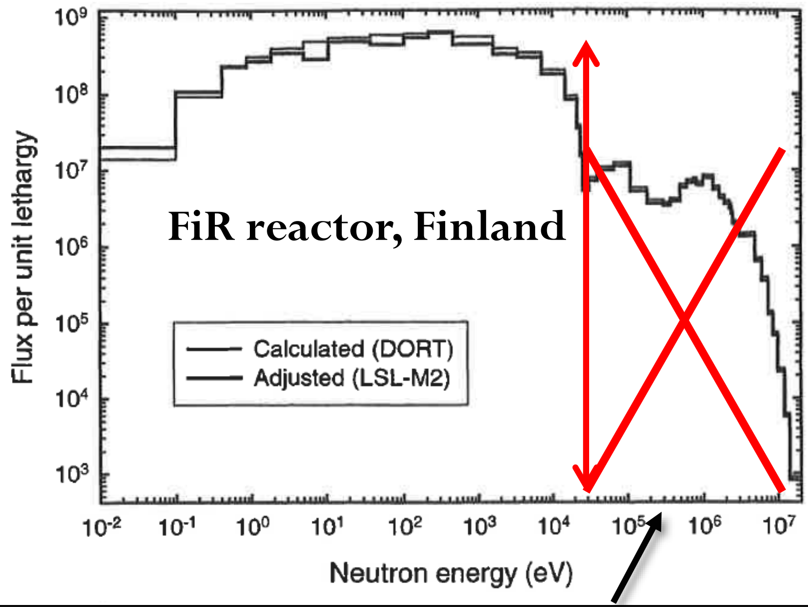
Barth *et al. Radiation Oncology* 2012, **7**:146
http://www.ro-journal.com/content/7/1/146
RADIATION ONCOLOGY
REVIEW Open Access

Current status of boron neutron capture therapy of high grade gliomas and recurrent head and neck cancer

Rolf F Barth[1*], M Graca H Vicente[2], Otto K Harling[3], W S Kiger III[4], Kent J Riley[5], Peter J Binns[6], Franz M Wagner[7], Minoru Suzuki[8], Teruhito Aihara[9], Itsuro Kato[10] and Shinji Kawabata[11]

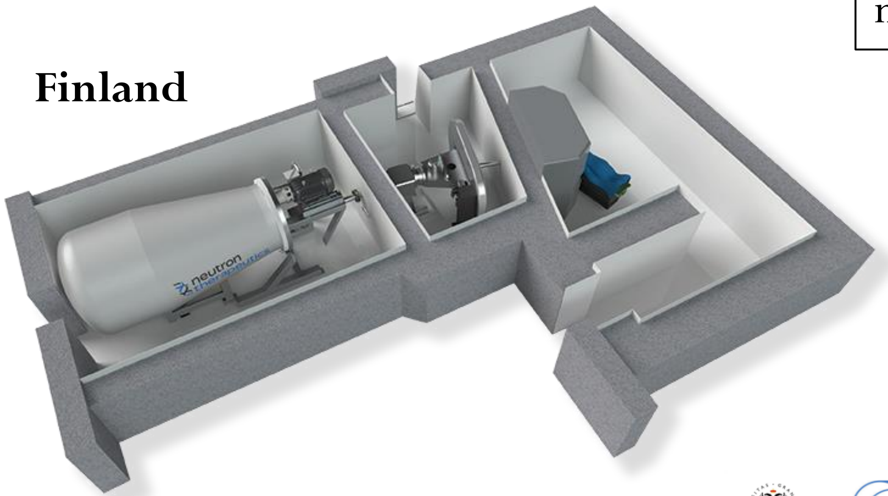
BNTC neutron source: from reactors to accelerators.





With accelerators the fast tail is reduced, however a neutron fraction is above 300 keV, $^{14}N(n,p)$ reaction!!!

Finland

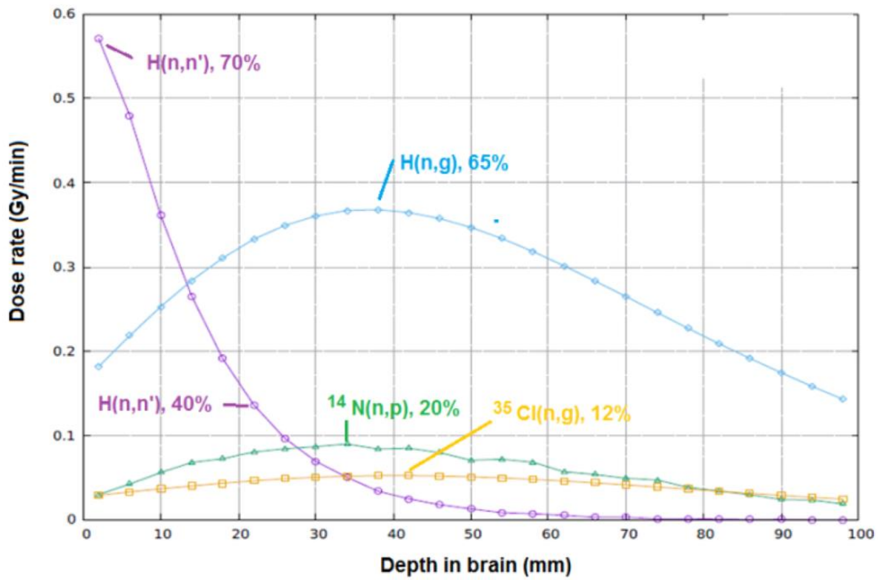


Neutron Therapeutics Company in Finland has already finished the installation. p+Li+BSA.

Dosimetry measurements have been performed.

Permits for therapy are on going.

Dosimetry in healthy tissue is fundamental



Contribution to the dose on healthy tissue for a 10 keV neutron beam.

^{14}N(n,p)^{14}C, ^{35}Cl(n,p)^{35}S, ^{35}Cl(n,γ)^{36}Cl have measured at n_TOF.

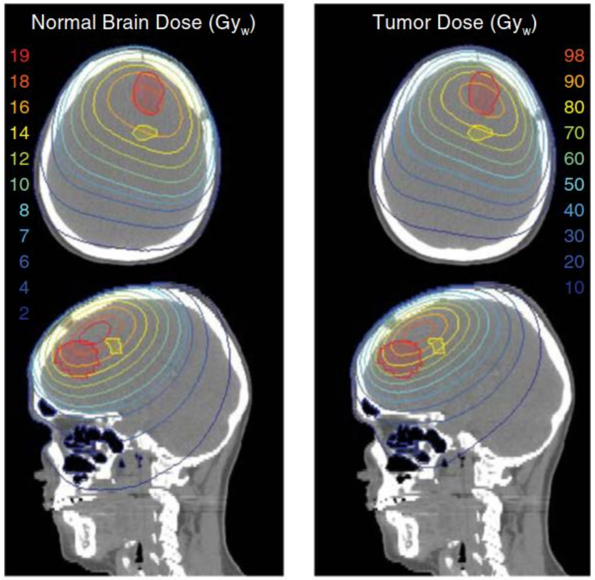
Contribution to the dose on healthy tissue for a 0.4 keV neutron beam

Proceso	$\dot{D}$ global (Gy/min)	% de la $\dot{D}_{Total}$ global	% del total de colisiones
$^{1}H(n,n)^{1}H$	$1.82 \cdot 10^{-3}$	0.74	90.84
$^{12}C(n,n)^{12}C$	$1.37 \cdot 10^{-5}$	$5.54 \cdot 10^{-3}$	1.97
$^{14}N(n,n)^{14}N$	$3.20 \cdot 10^{-6}$	$1.30 \cdot 10^{-3}$	0.53
$^{16}O(n,n)^{16}O$	$3.19 \cdot 10^{-5}$	$1.29 \cdot 10^{-2}$	5.84
$^{35}Cl(n,n)^{35}Cl$	$5.34 \cdot 10^{-8}$	$2.16 \cdot 10^{-5}$	$3.85 \cdot 10^{-2}$
$^{37}Cl(n,n)^{37}Cl$	$1.78 \cdot 10^{-9}$	$7.22 \cdot 10^{-7}$	$7.36 \cdot 10^{-4}$
$^{14}N(n,p)^{14}C$	$3.21 \cdot 10^{-2}$	12.99	$5.37 \cdot 10^{-2}$
$^{35}Cl(n,p)^{35}S$	$3.09 \cdot 10^{-3}$	1.25	$5.26 \cdot 10^{-3}$
$^{1}H(n,\gamma)^{2}H$	0.177	71.76	0.66
$^{35}Cl(n,\gamma)^{36}Cl$	$3.26 \cdot 10^{-2}$	13.21	$6.17 \cdot 10^{-2}$
$^{37}Cl(n,\gamma)^{38}Cl$	$7.65 \cdot 10^{-5}$	$3.10 \cdot 10^{-2}$	$1.65 \cdot 10^{-4}$

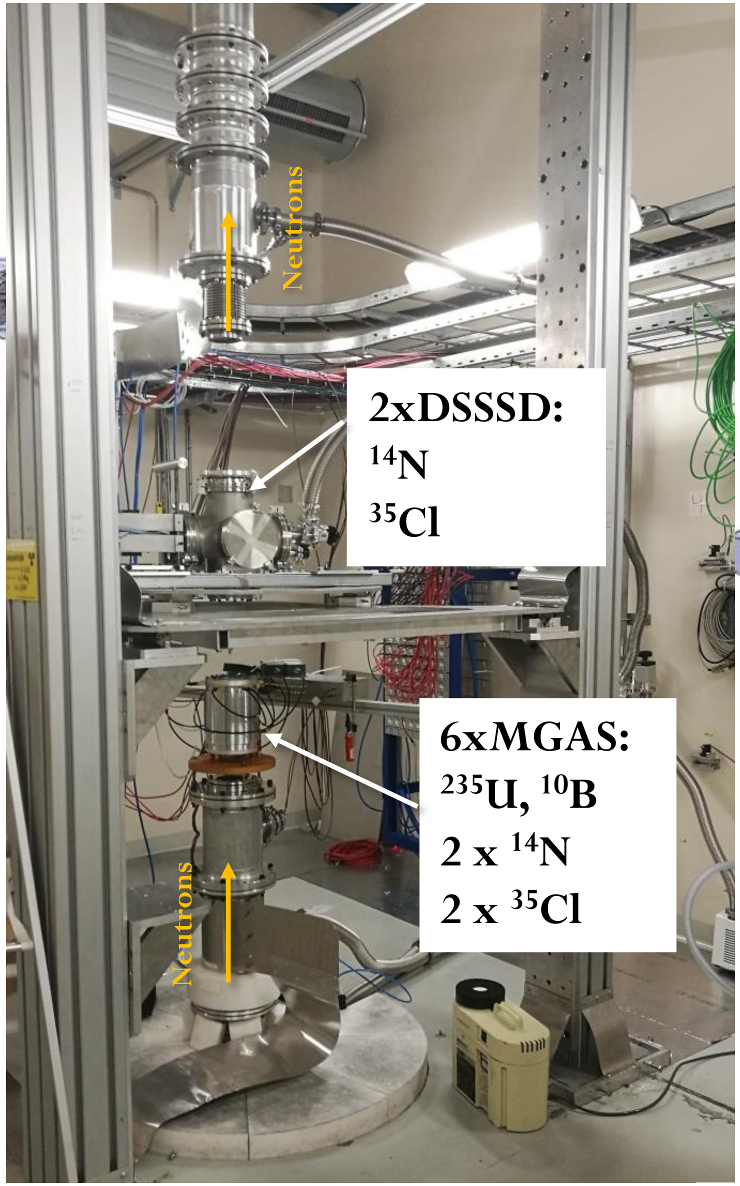
Dosimetry: $^{14}N(n,p)^{14}C$, $^{35}Cl(n,p)^{35}S$, $^{35}Cl(n,\gamma)^{36}Cl$

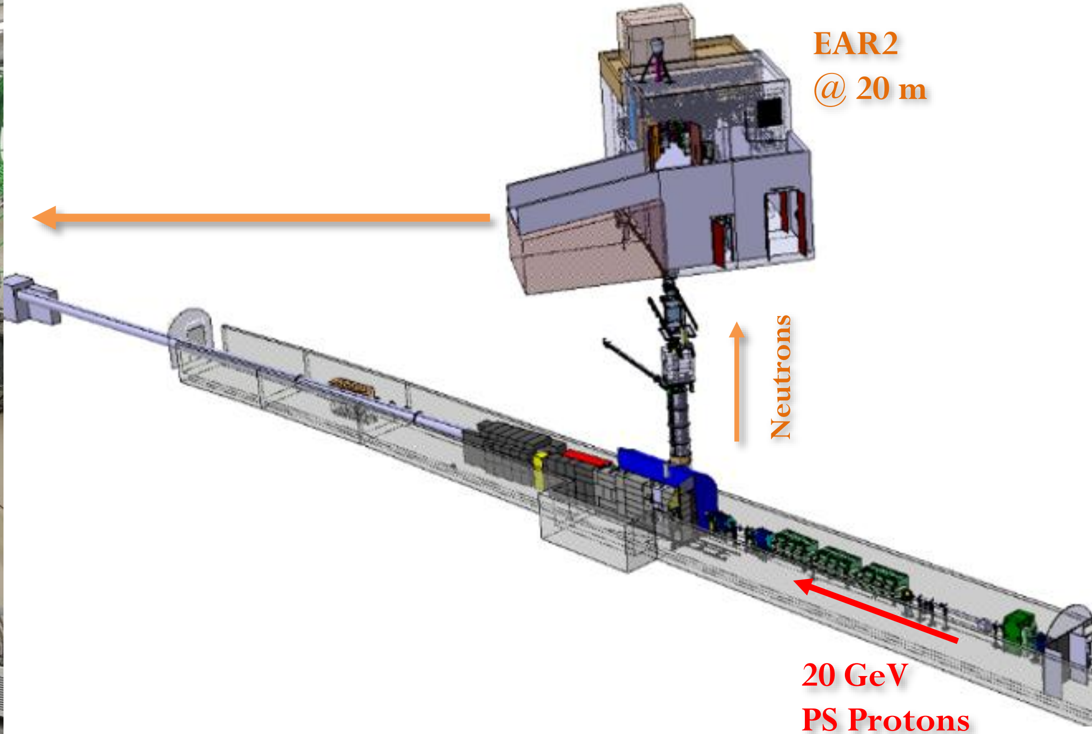
Although the dose in healthy is much lower, the better nuclear data will provide a more realistic Monte Carlo planning, better duration of the neutron irradiation, possible second or third irradiation depending on organ…

The data at n_TOF are very important, and they will be used in the codes.



EAR2 setup for $^{14}N(n,p)^{14}C$ and $^{35}Cl(n,p)^{35}S$.



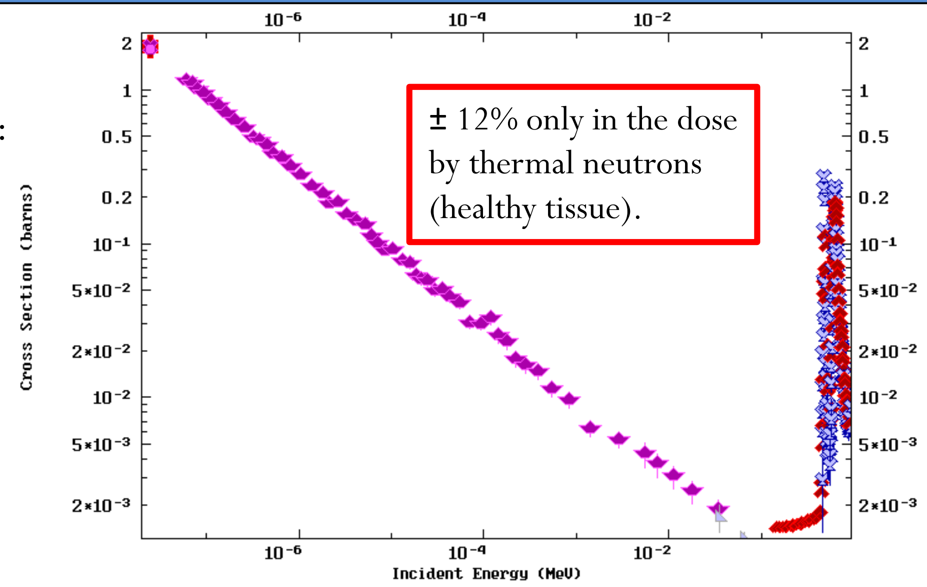


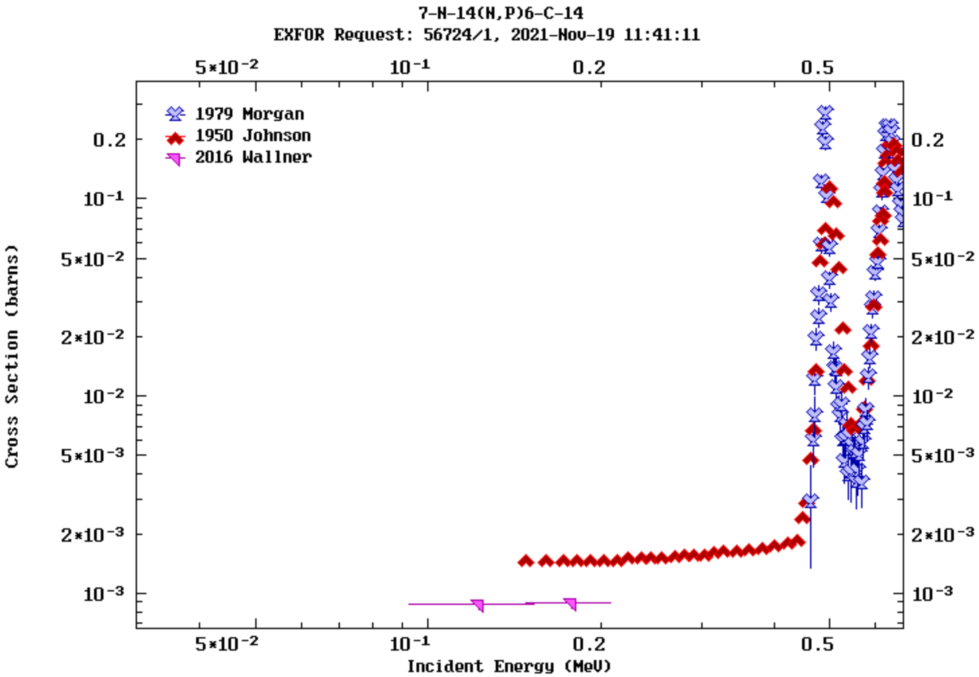
$^{14}N(n,p)^{14}C$ at EAR2: covering all the energy range.

Only partial measurements in the energy for AB-BNCT:

- Thermal
- Above thermal to 80 keV
- Above 100 keV

At n_TOF, we cover the whole energy range.





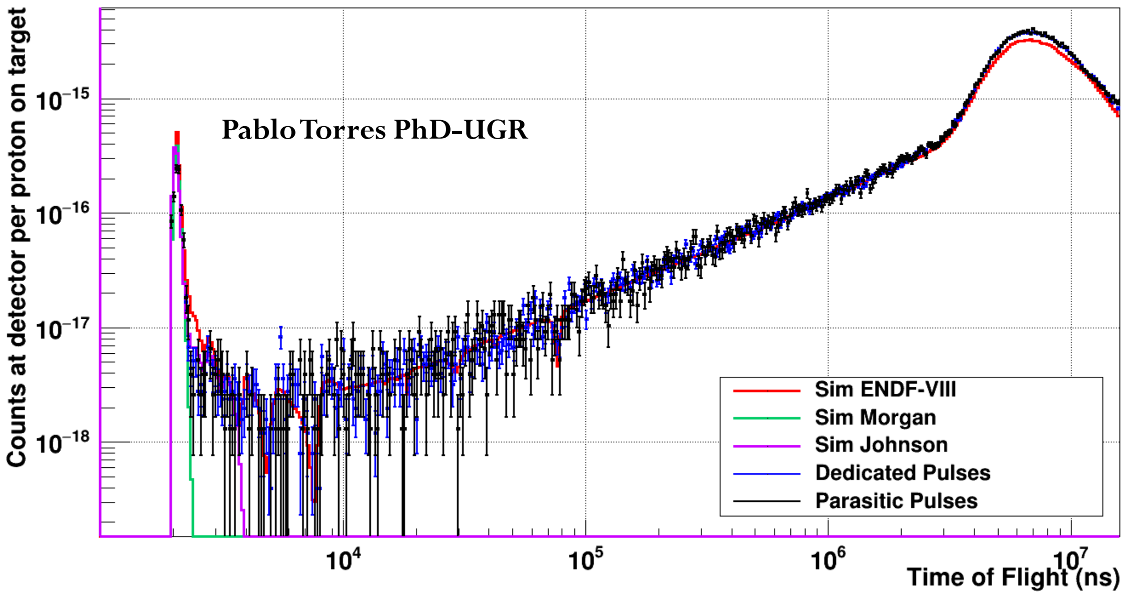
Johnson: first measurement of the first (493 keV) resonance.

After, Morgan provided a lower strength that Johnson

After, Wallner *et al* showed a further reduction factor 3.3 by activation.

At n_TOF, we have found a reduction.

$^{14}N(n,p)^{14}C$ at EAR2: covering range partial previous experiments



It is covered the energy range from thermal to 500 keV.

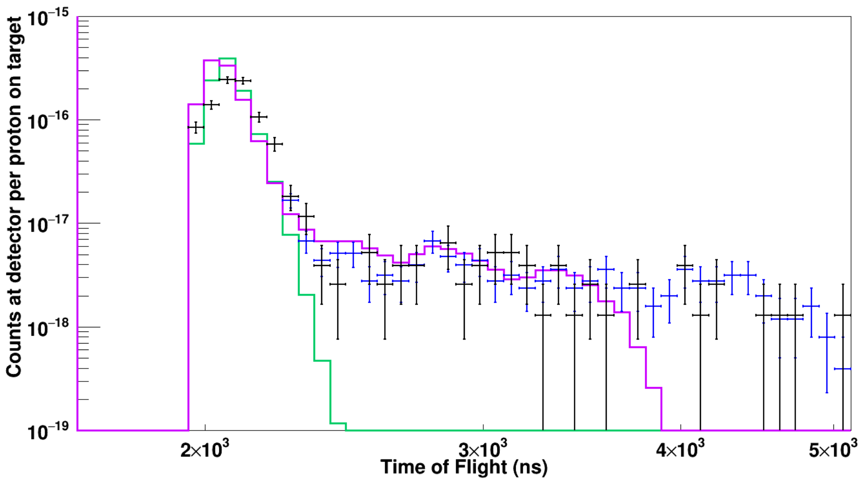
For the first time.

Purple and Green are Johnson and Morgan experimental with the RF-EAR2.

Black points, n_TOF data.

Reduction of factor 1.5 the area of the resonance.

Impact in the dose on healthy tissue and BNCT planning.



Radioisotope production

New facilities for complementary radioisotope production

There is a trend since a decade to use existing and new nuclear facilities for producing radioisotopes (Medicis-Isolde).

The Technetium world crisis in 2009-2010 was an alarm about the way to supply radioisotopes for nuclear medicine. Few reactors world wide.

2009

nature International weekly journal of science

nature news home | news archive | specials | opinion | features | news blog | natur

comments on this story

Stories by subject
- Health and medicine
- Technology
- Physics

Stories by keywords
- Europe
- Isotope
- Medical
- Shortage
- Radioisotope
- Medical imaging
- Hospital
- Reactor closure
- Petten

This article elsewhere
- Blogs linking to this article
- Add to Digg
- Add to Facebook
- Add to Newsvine
- Add to Del.icio.us
- Add to Twitter

Published online 23 October 2008 | Nature | doi:10.1038/news.2008.1186

News

Europe's isotope shortage will continue into 2009

Hospitals forced to use substitute procedures for medical scans.

Paula Gould

A Europe-wide shortage of medical isotopes will continue for at least three months while a Dutch nuclear reactor is repaired. Governments and regulators are now bending their rules concerning the use and transport of radioactive materials so that patients can still undergo diagnostic tests during the supply crisis.

The High Flux Reactor in Petten has been out of action since the end of August (see 'Isotope shortage could delay cancer treatment') after tiny bubbles of gas were found escaping from a pipe into the reactor's cooling system during a routine maintenance inspection. Although the cause of the leak has now been traced

The High Flux Reactor in Petten, the Netherlands, is facing an extended shut-down. NRG

2013

nature International weekly journal of science

Home | News & Comment | Research | Careers & Jobs | Current Issue | Archive | Audio & Video | For Au

Archive > Volume 504 > Issue 7479 > News Feature > Article

NATURE | NEWS FEATURE

Radioisotopes: The medical testing crisis

With a serious shortage of medical isotopes looming, innovative companies are exploring ways to make them without nuclear reactors.

Richard Van Noorden

11 December 2013

PDF | Rights & Permissions

LARRY MULVEHILL/SPL

Many diagnostic scans rely on radioactive technetium-99m.

In 2009, two nuclear research reactors shut down for repairs and maintenance. This was not surprising, given that both were around half a century old. But these reactors happened to produce most of the world's supply of the radioactive tracer technetium-99m, an isotope injected into patients in 70,000 diagnostic scans a day. Hospitals around the world went into a panic.

2020

ANNUAL REVIEWS

Annual Review of Nuclear and Particle Science

The Shortage of Technetium-99m and Possible Solutions

Thomas J. Ruth

TRIUMF, Vancouver, British Columbia V6T2A3, Canada; email: truth@triumf.ca

Annu. Rev. Nucl. Part. Sci. 2020. 70:77–94

First published as a Review in Advance on June 2, 2020

The *Annual Review of Nuclear and Particle Science* is online at nucl.annualreviews.org

https://doi.org/10.1146/annurev-nucl-032020-021829

Keywords

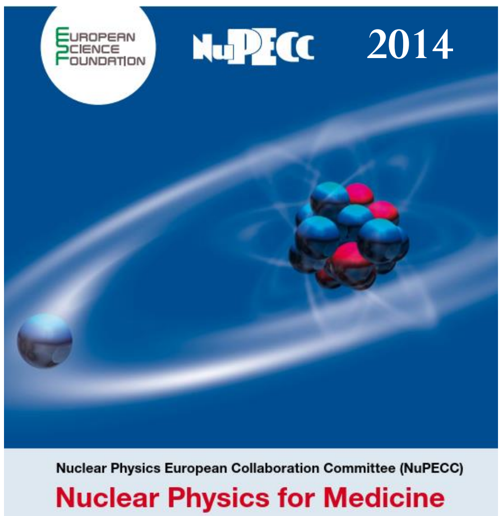
HEU, LEU, ^{99}Mo, ^{99m}Tc, reactor, accelerator

Abstract

Following a major shortage of ^{99}Mo in the 2009–2010 period, concern grew that the aging reactor production facilities needed to be replaced.

New facilities for complementary radioisotope production

International agencies and groups pushed for the use of accelerator-based facilities, as a complementary option.



Another "longer-lived" alpha emitter is ^{211}At. The difficulty of its application resides more in its (bio-) chemistry. Astatine is a heavier homologue of the halogen iodine, but it is also close to the metalloids. For therapeutic applications it is essential to ensure a stable bond to the targeting vector to minimise in vivo delabelling. Efforts are ongoing to improve the understanding of astatine chemistry by experiments with trace quantities supported by computational chemistry [Cha11]. Interestingly, the ionisation potential of astatine, one of the fundamental atomic properties of an element, was only experimentally determined by laser spectroscopy with astatine isotopes produced at ISOLDE (CERN) [Rot13]. This value can now serve as experimental benchmark to support "in silico" design of astatine compounds for nuclear medicine applications.

^{211}At-labelled antibodies have been used clinically for treatment of brain cancer [Zal08]. Phase I trials for treatment of prostate cancer micrometastases and of neuroblastoma with ^{211}At labelled antibodies are under preparation.

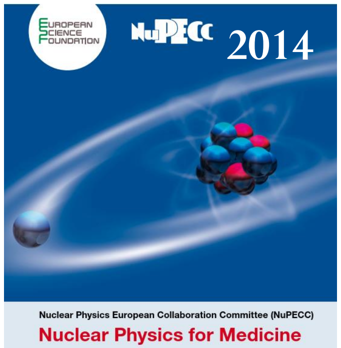
Preclinically ^{211}At-labelled antibodies have been used against acute myeloid leukaemia as well as cancers of the ovary and intestine.

R&D activities in nuclear facilities as ISOLDE provided a better understanding in nuclear medicine

To overcome this restriction a new project called MEDICIS is now under construction. It will make use of the protons that have traversed the ISOLDE targets for additional beam dump irradiations of

New facilities for complementary radioisotope production

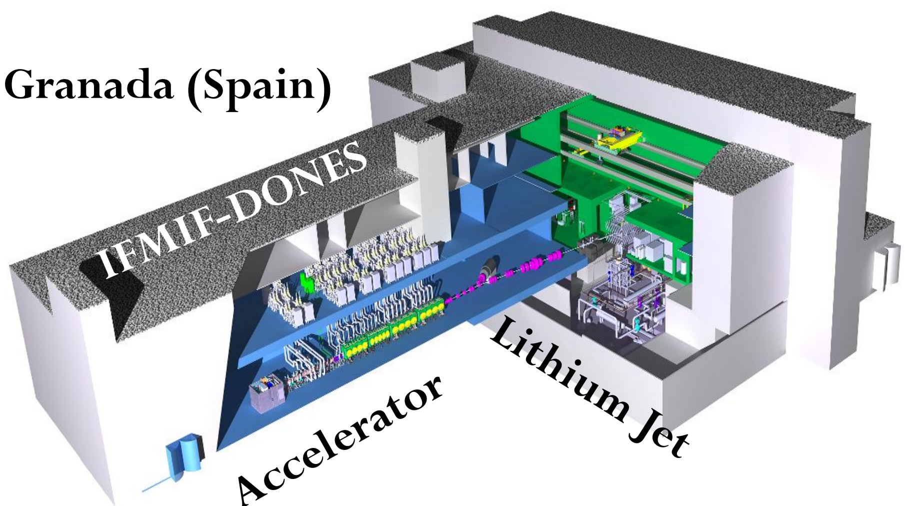
Also, accelerator-based neutron facilities has been considered for the production of radioisotopes for nuclear medicine.



Thus high neutron flux *and* a high capture cross-section are essential to achieve a high specific activity by converting a large fraction of the stable target into the wanted radioisotope. Only ^{60}Co, ^{153}Sm, ^{169}Yb and ^{177}Lu can be produced with

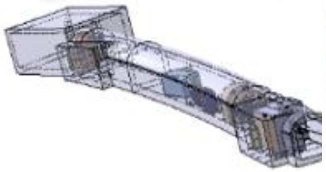
NuPECC
Long Range Plan 2017
Perspectives
in Nuclear Physics

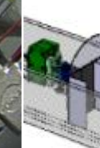
To be used in nuclear medicine, large radionuclide production is required which implies the use of highly intense particle beams (hundreds to thousands of μA) or secondary neutron sources. Targetry to be used in such conditions (kW of power over few cm²) are not an easy task requiring dedicated developments. Such R&D activities are ideally suited to be performed in nuclear physics research laboratories. Production capabilities of some specific nuclei using electron and gamma beams should also be investigated.



^{176}Yb(n,γ)^{177}Yb(2 h)→^{177}Lu (6.5 d) at EAR1

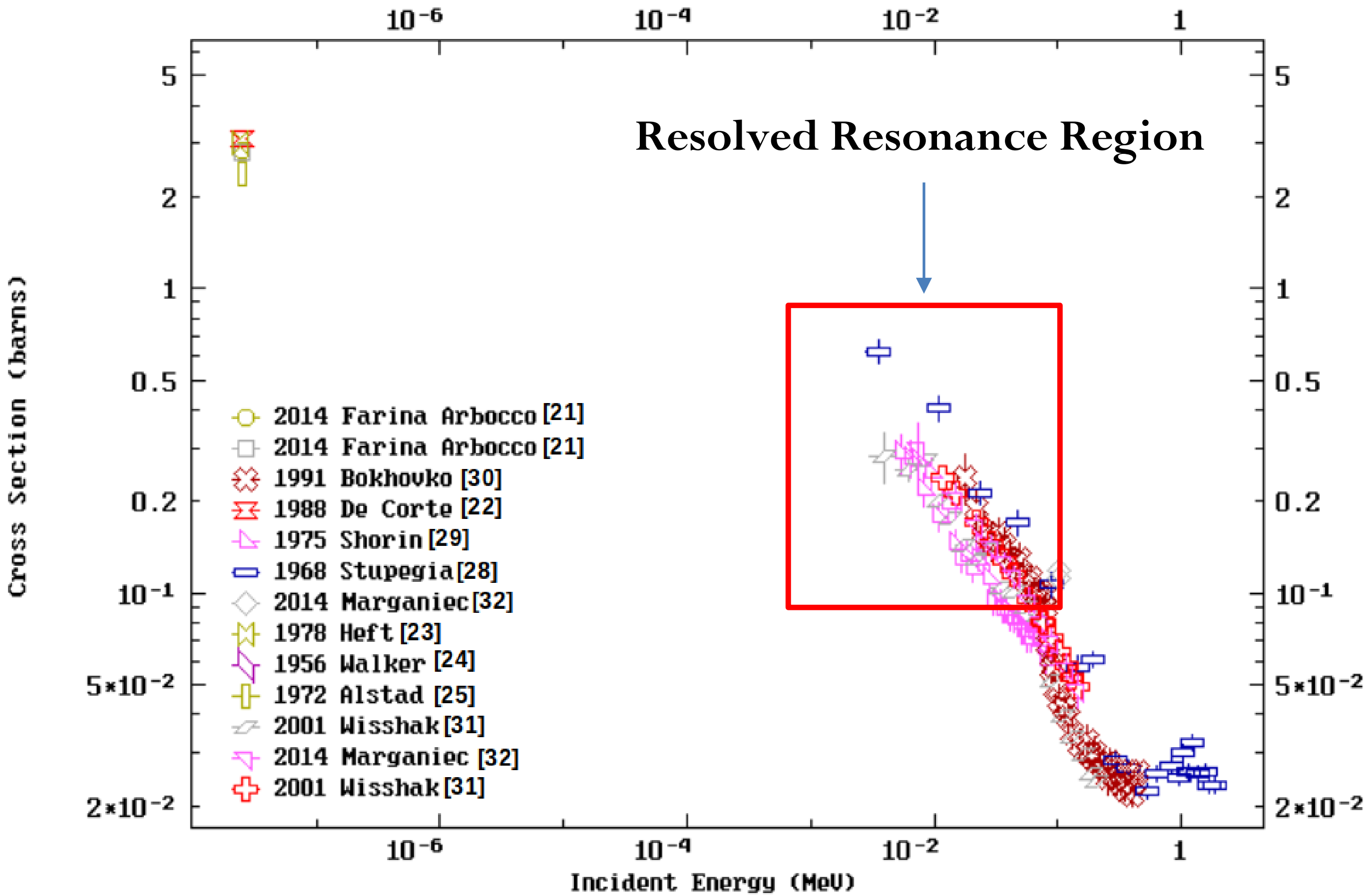
EAR1
@ 185 m



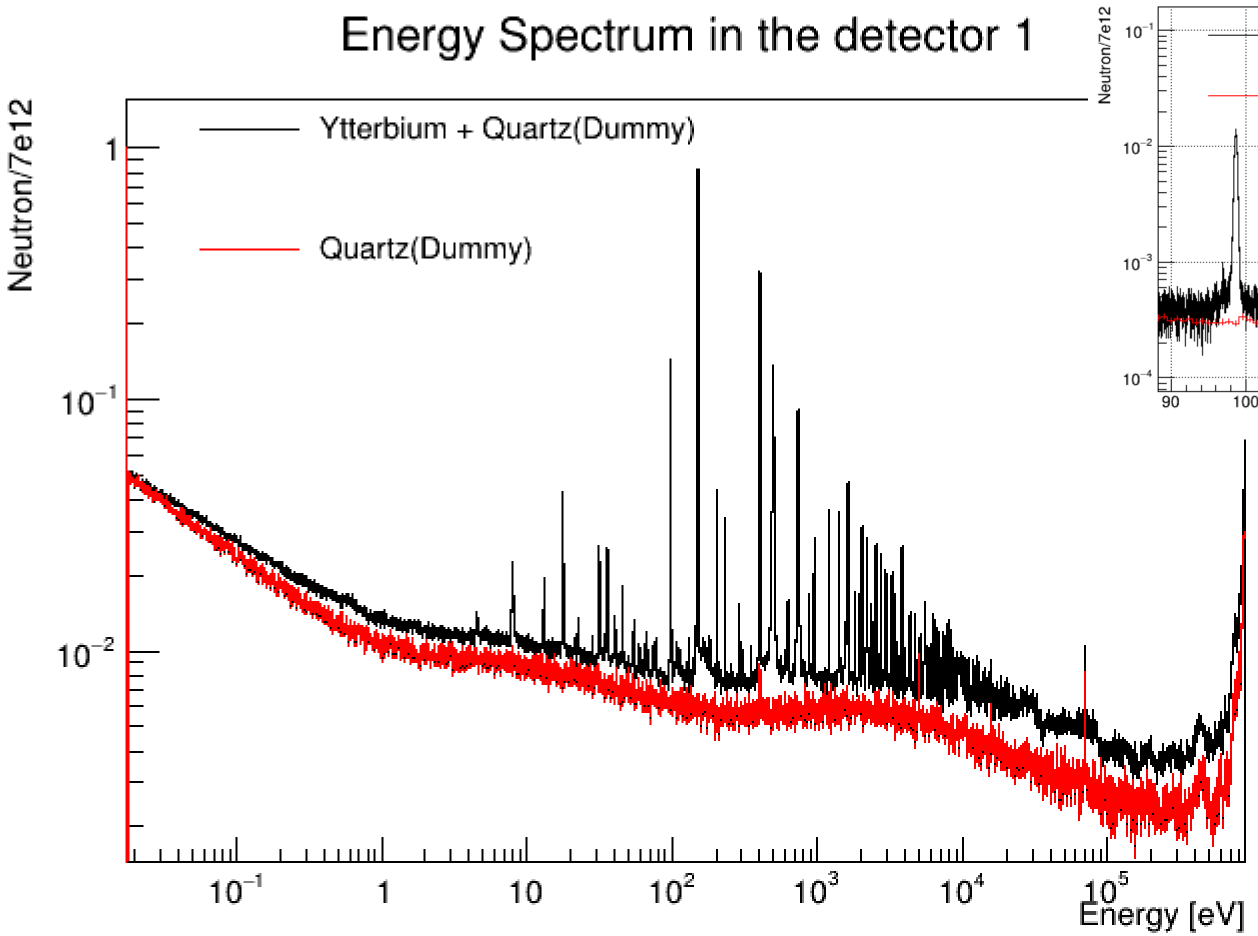


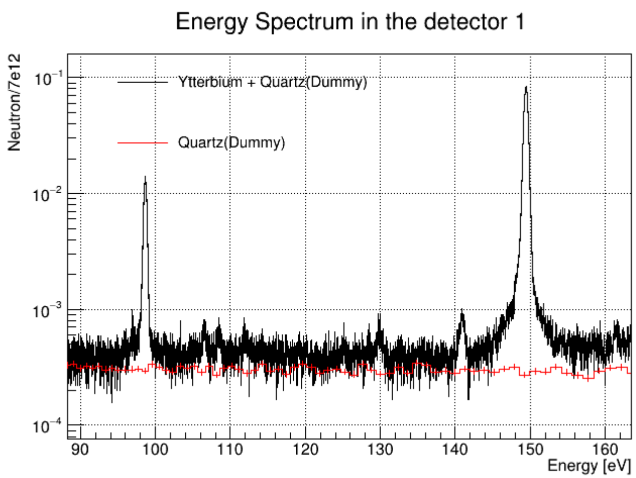
Previous experimental data ^{176}Yb(n,γ)

- No data in the 1/v region
- No resolved resonances. Resonances detected in transmission experiments.



n_TOF experimental data $^{176}Yb(n,\gamma)$





Francisco García Infantes
PhD CERN/UGR

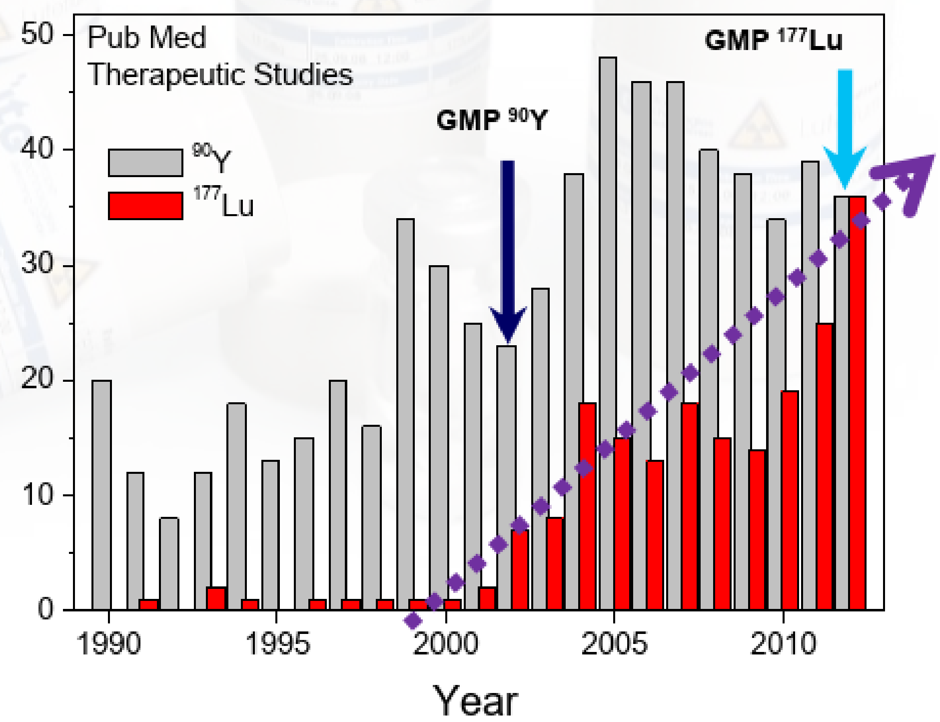
Preliminary data show that resonances have resolved for the first time and data in the 1/v region.

^{177}Lu rising demand & ^{90}Y well established

- Theragnostic = diagnosis and therapy.
- At present, it is produced in nuclear reactors.
- Rising demand radioisotope.
- Y-90 is also of interest for complementary production.

Number of scientific publications vs time:

Therapeutic applications of ^{90}Y and ^{177}Lu



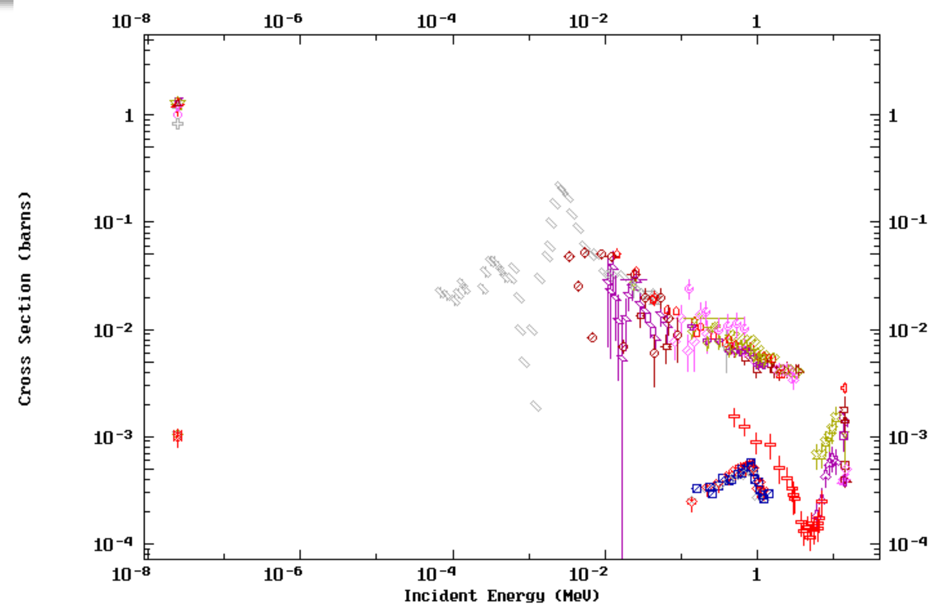
^{90}Y well established: again, unique data

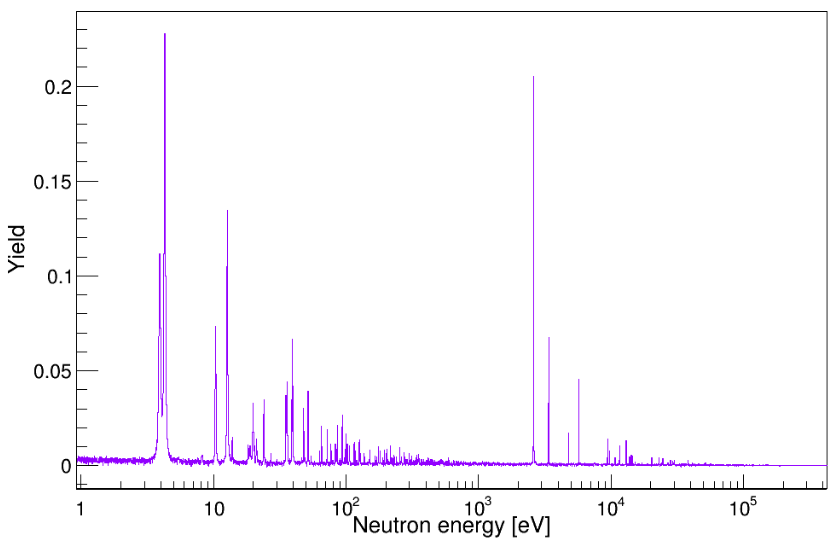
EUROPEAN ORGANIZATION FOR NUCLEAR RESEARCH
Proposal to the ISOLDE and Neutron Time-of-Flight Committee

Neutron capture cross section of ^{88}Sr and ^{89}Y

[08/01/2016]

G. Tagliente[1], M. Barbagallo[1,8], N. Colonna[1], S. Cristallo[2], L. A. Damone[1], A.C. Larsen[3,4], M. Lugaro[5], C.Massimi[6], M. Mastromarco[1], P.M. Milazzo[7], F. Mingrone[8], and the n_TOF collaboration.





Preliminary data show that resonances have resolved for the first time and data in the 1/v region.

Conclusions

The n_TOF facility is providing unique data for medicine.

^{160}Gd(n,γ)^{161}Gd→^{161}Tb, will provide data for new radioisotope

AB-BNCT is opening a new framework and market:

Accelerators, targets, BSA and treatment planning codes.

Companies: Neutron Therapeutics, TAE Life Sciences…

Public institutions: Japan.

Radioisotope market, Reuters Report:

10 billion€ in 2017 and it is expected to grow 12.3% until to 2023.

The major hindrance is the high capital investments required, cyclotron.

CERN MEDICIS facility is an excellent example to be followed and synergies should be found.

NEAR opens new possibilities for medicine applications: to be studied.

Thank you

Javier Praena

Prof. Universidad de Granada (Spain)
CERN Scientific Associate (EP/SME)
n_TOF Physics Coordinator

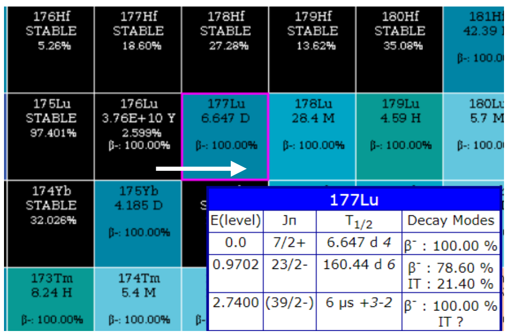
^{177}Lu production routes

“Carrier Added”

^{176}Lu(n,γ) → ^{177}Lu + ^{177m}Lu

Higher production. Lower specific activity.

^{177m}Lu is produced (0.05%), 160 days.

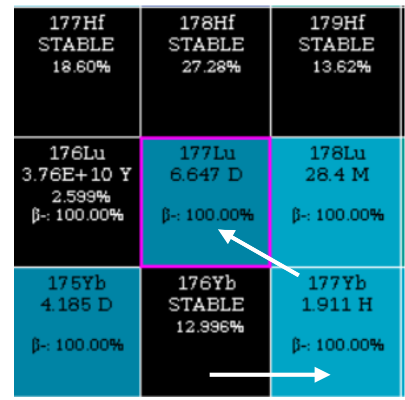


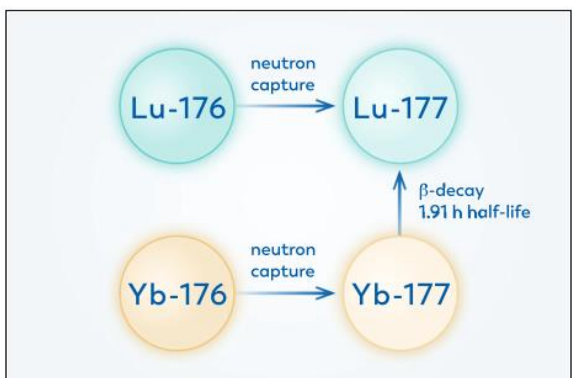
“Non Carrier Added”

^{176}Yb(n,γ)^{177}Yb (→ ^{177}Lu)

Lower production. Higher specific activity.

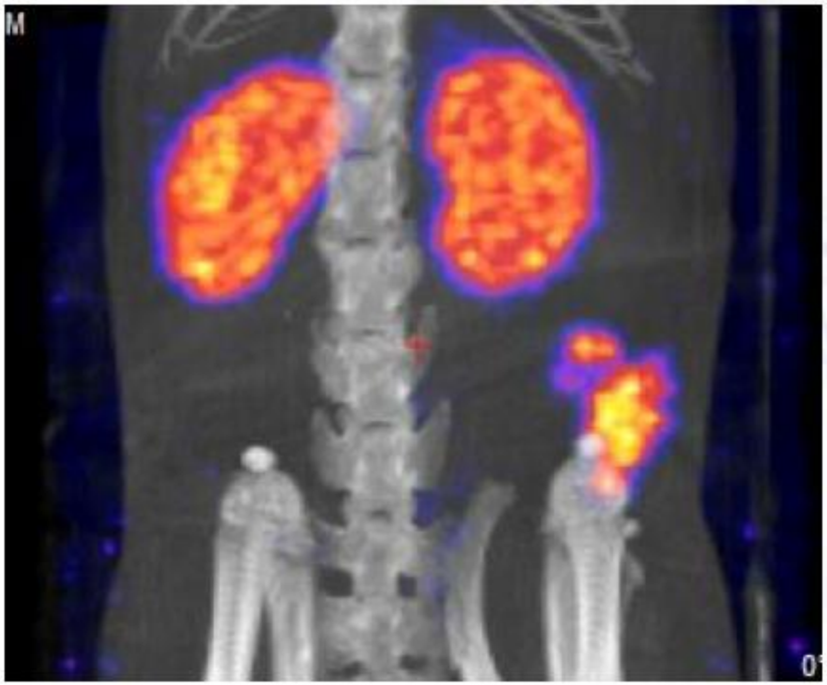
^{177m}Lu is negligible (<0.0001%)





Specific activity: impact on tumor uptake

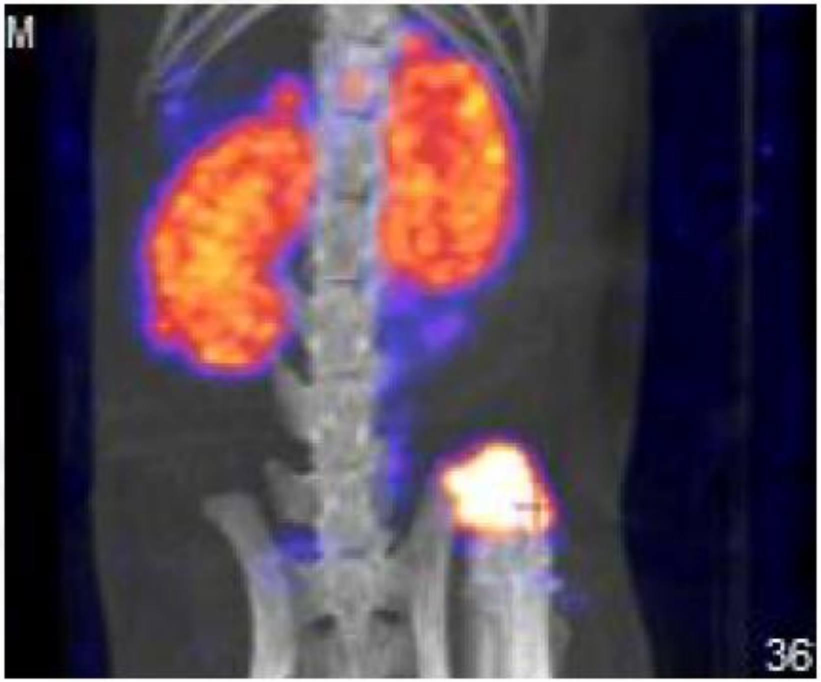
“Carrier Added”



300 MBq of ^{177}Lu c.a.

Dose to tumor - 35 Gy

“Non Carrier Added”



300 MBq of ^{177}Lu n.c.a.

Dose to tumor - 70 Gy

Marion de Jong et al.; 2012 ICTR-PHE

Perspectives during the YETS and after

- To finish the analysis regarding the commissioning.
- 28/02/2021 proton beam back, low intensity.
- Physics Program: ^{79}Se(n,γ) (INTC-P-580) EAR1, ^{94}Nb(n,γ) (INTC-P-577) EAR2,…

Proton beam

- Fixed impact point of the proton beam on target.

- **Our Needs for Physics:**
  - Proton pulses with two different intensities: 7.5-8.5e12 and 2-3.5e12.
  - 1.05e17 protons per day made in 30 days, in average, as the campaigns before the LS2.

- **Our Constrains from Target:**
  - Maximum average intensity on target = 160e10 p/s
  - Dimensions for high intensity pulses ≈ 215 mm^2.
  - Dimensions for low intensity pulses ≈ 40 mm^2.

Thanks to the PS team for the constant feedback for improving the quality of the proton beam

ESFRI facility. City host: Granada

FUSION FOR ENERGY
IFMIF DONES GRANADA
EUROfusion
GOBIERNO DE ESPAÑA
MINISTERIO DE CIENCIA E INNOVACIÓN
Junta de Andalucía
Consejería de Transformación Económica, Industria, Conocimiento y Universidades
Laboratorio Nacional de Fusión
Ciemat
UNIVERSIDAD DE GRANADA
KIT
INFN Istituto Nazionale di Fisica Nucleare
ENEA
cea
TÉCNICO LISBOA
CCFE
UK Atomic Energy Authority
EMPRESARIOS AGRUPADOS
IFPiLM
mta EK
ongranada TECH CITY
Warsaw University of Technology
SCK•CEN

Login ESFRI MOS Contact Search

ESFRI

ABOUT | ESFRI ROADMAP | EVENTS | NEWS | WORLD OF RIS | LIBRARY | PRESS

Strategy Report on Research Infrastructures ROADMAP 2018 | Part 1 STRATEGY REPORT | Part 2 LANDSCAPE ANALYSIS | Part 3 PROJECTS & LANDMARKS

Part 3

PROJECTS & LANDMARKS

DOWNLOAD PART 3

ENERGY / PROJECT

IFMIF-DONES

International Fusion Materials Irradiation facility - DEMO Oriented NEutron Source

lead country
ES
prospective member countries
HR
prospectives entities
EUROfusion
The full list of research institutions involved must be found in the website of the RI

TIMELINE

Roadmap Entry
2018
Design Phase
2007-2015
Preparation Phase
2015-2019
Implementation/Construction Phase
2019-2029
Operation Start
2029

ESTIMATED COSTS

capital value
710 M€
design
150 M€
preparation
40 M€
construction
420 M€
operation
50 M€/year

TYPE

single-sited

LEGAL STATUS

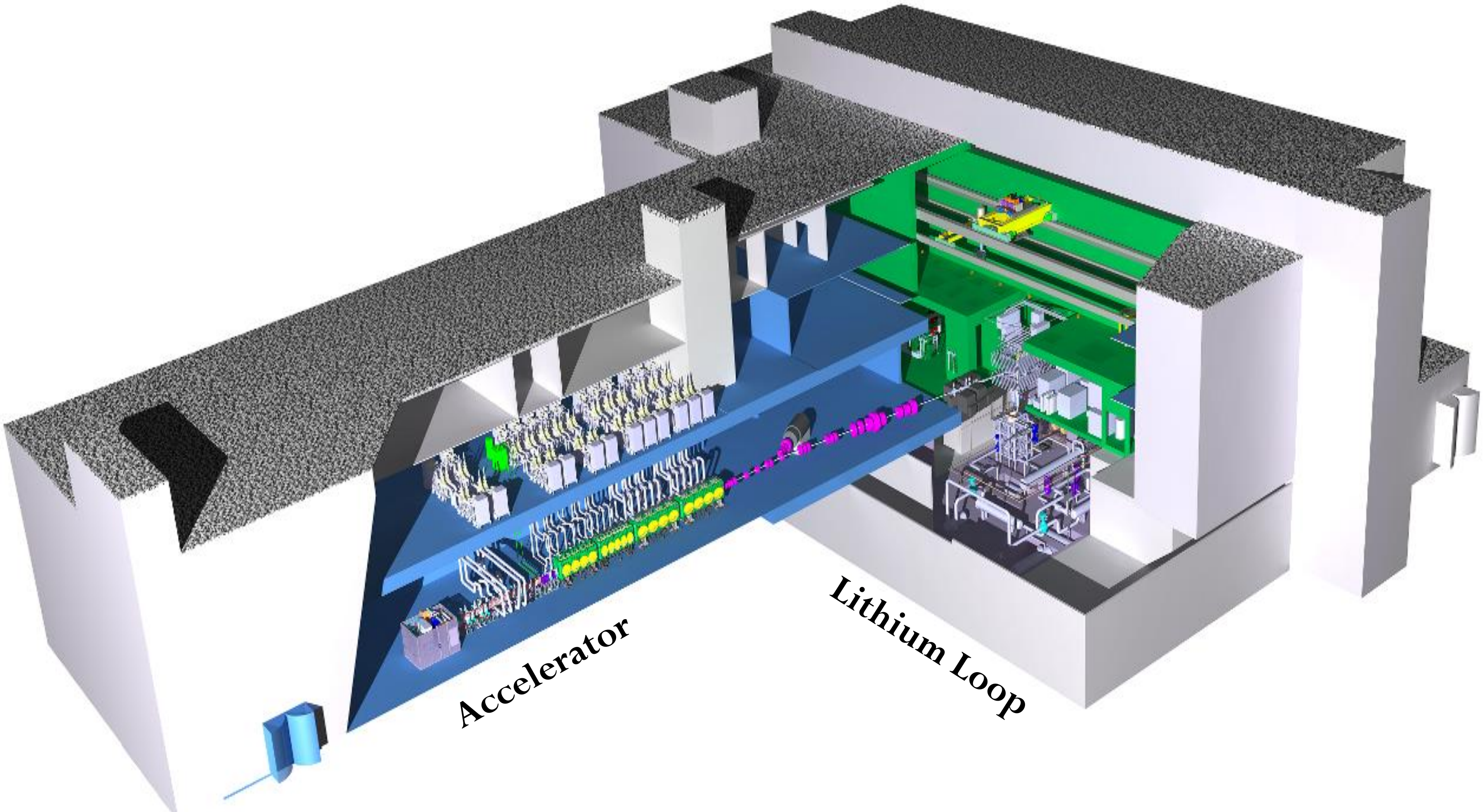
pending

POLITICAL SUPPORT

UNIVERSIDAD DE GRANADA
CERN
nTOF

Spain-Croatia. City host: Granada

The facility goal: produce neutrons

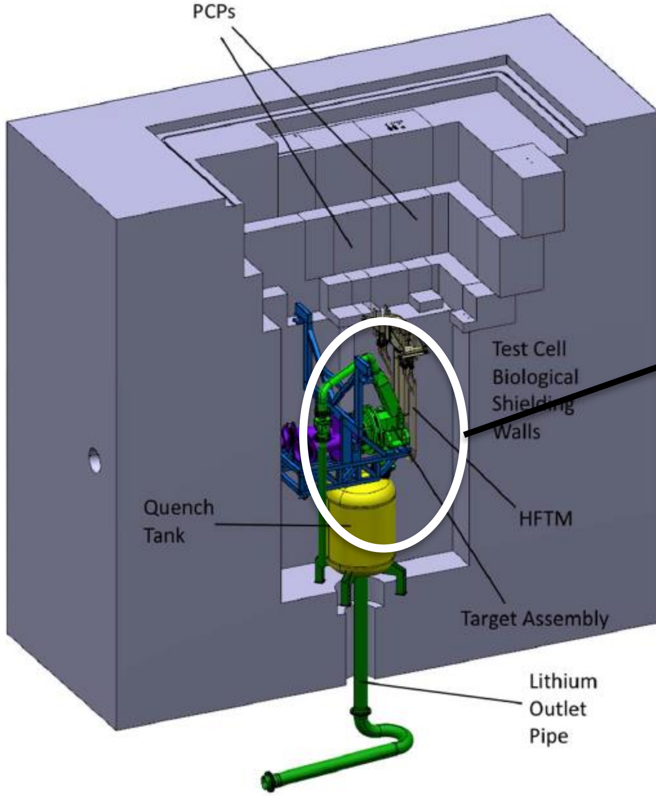


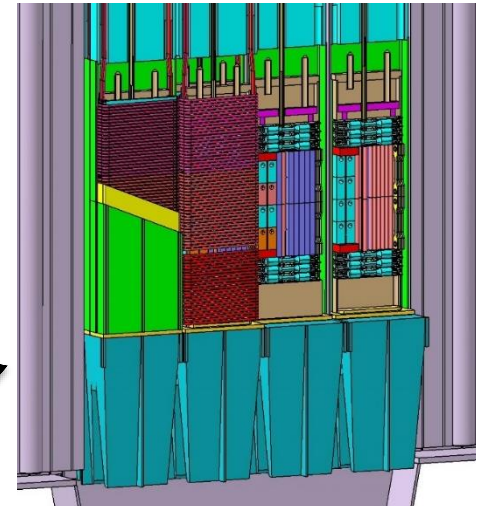
Neutron damage in key pieces of fusion reactors

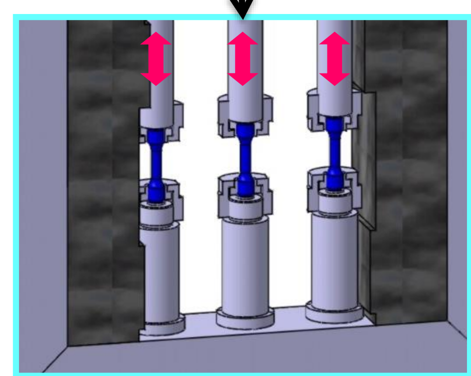
The goal of IFMIF-DONES is to produce neutrons-like DEMO fusion reactor.

Study the behaviour of several key pieces of DEMO.

Irradiations will last several months.

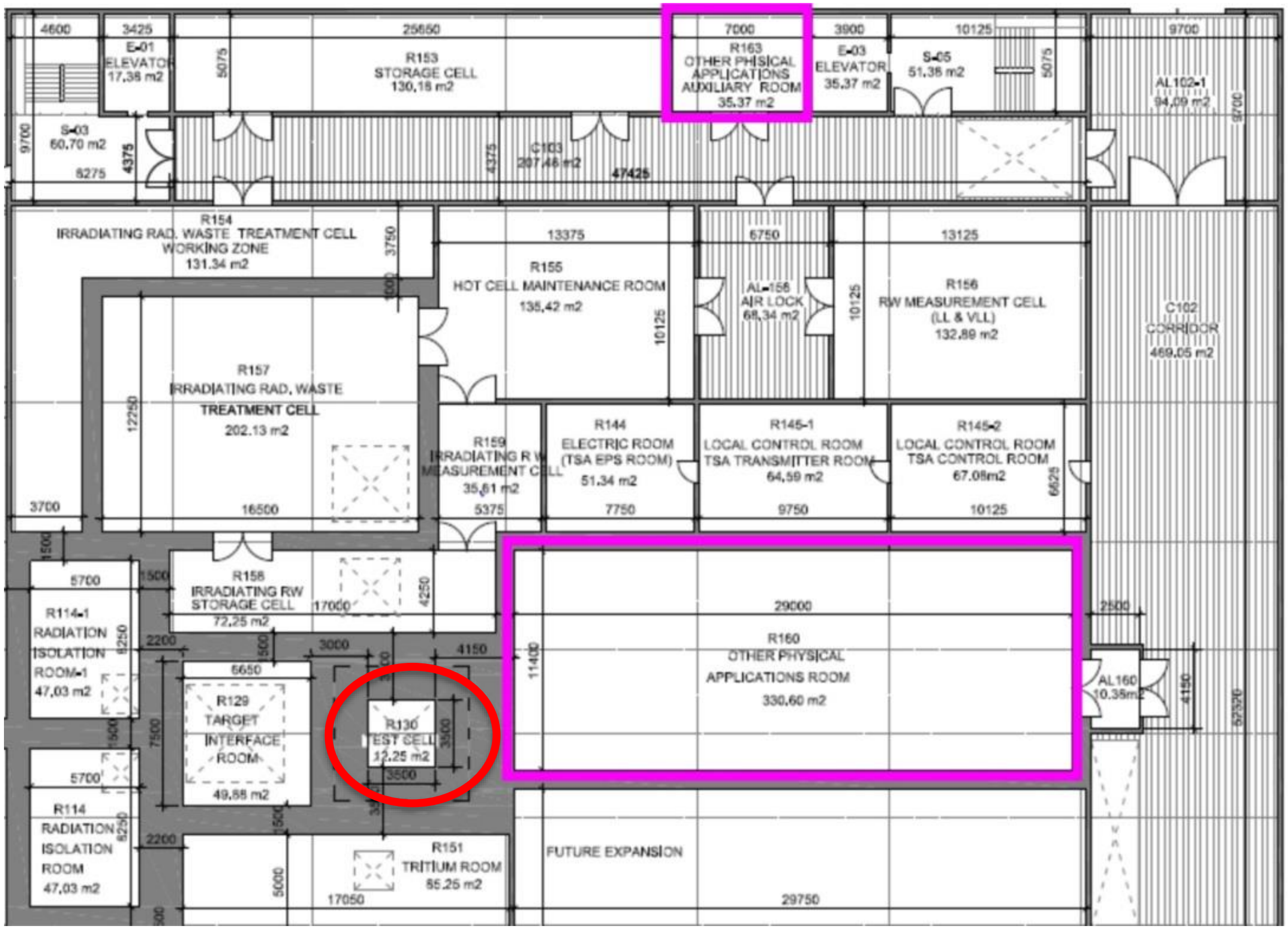






Other applications: in and out the bunker.

The design of the building of IFMIF-DONES has already included an experimental hall (R160) next to the bunker where the neutrons are produced.



UGR and the other applications.

EUROfusion	Power Plant Physics & Technology	IFMIF DONES

Report IDM Ref. No.		Version: see IDM

Report
ENS-7.2.3.1-T13-06-N1
Feasibility study of the use of DONES for radioisotope production, electronics irradiation and neutron scattering

	Deliverable		Technical Report
	Management Report	X	Technical Note
	Other	Specify:	

		Document Id.	ENS-7.2.3.1-T13-06-N1
Work Package:	WPENS	Issue Date	21/01/2020

Document/Report Authors (refer to first page of actual report/document for a complete list)	
Authors:	J. Praena, F. García Infantes, P. Torres-Sánchez, M. Macías, A. Roldán, I. Porras, F. Arias de Saavedra
RU:	CIEMAT / University of Granada (Spain)

Links to other files (CATIA CAD Files, Interface database, ...)	
Title:	n/a
URL:	*n/a*

IDM Report Review & Approval	
IDM role	Name(s)
Author and co-author(s):	J. Praena, F. García Infantes, P. Torres-Sánchez, M. Macías, A. Roldán, I. Porras, F. Arias de Saavedra. (Authors of Section 1: A. Ibarra, U. Fischer, F. Mota)
Reviewer(s) Technical Issues:	W. Krolas, J. Castellanos and F. Arbeiter
Reviewer PMU:	No
Approver:	A. Ibarra

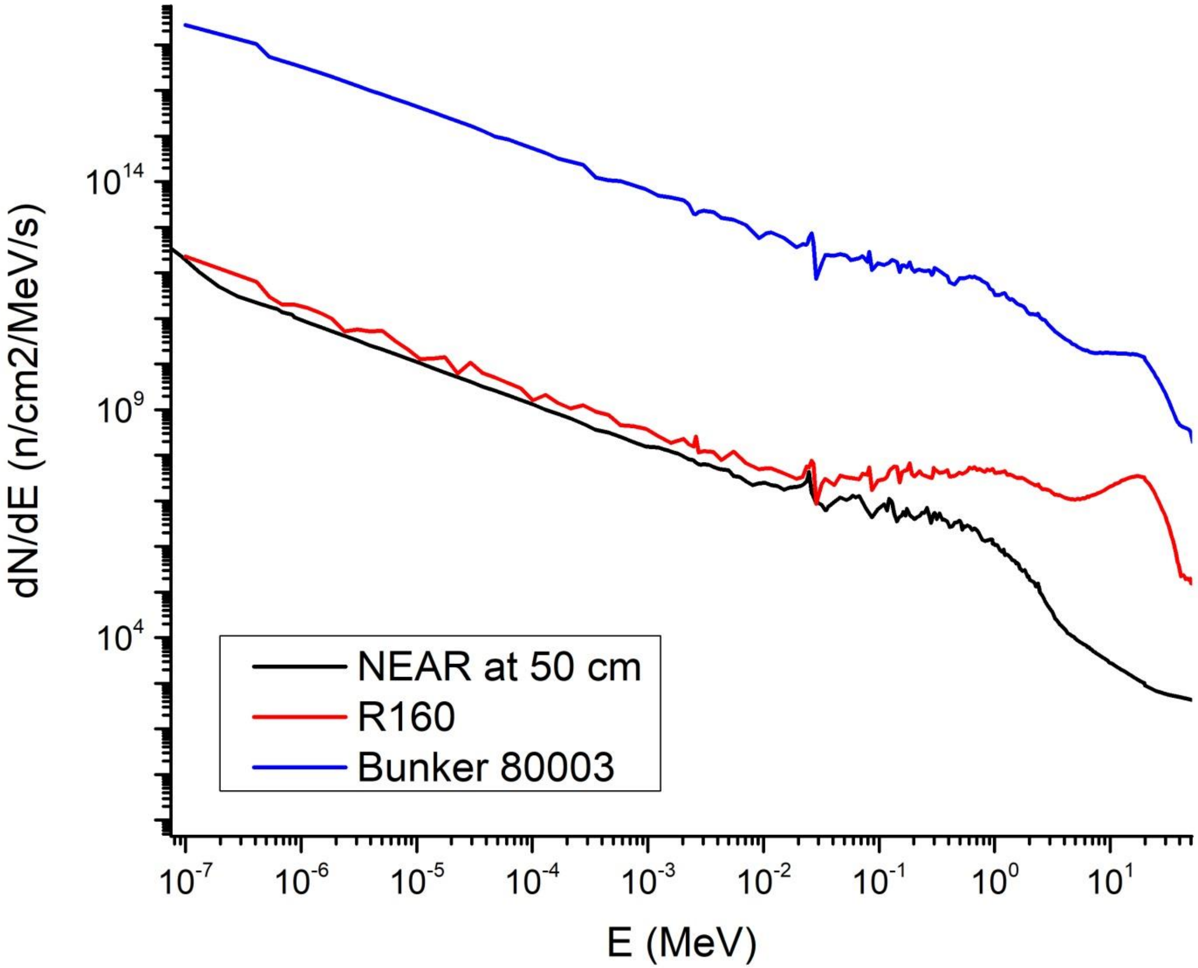
EPJ Web of Conferences **239**, 23001 (2020) https://doi.org/10.1051/epjconf/202023923001
ND2019

Radioisotope production at the IFMIF-DONES facility

Javier Praena[1,*], *Francisco* Garcia-Infantes[1], *Rafael* Rivera[1], *Laura* Fernandez-Maza[2], *Fernando* Arias de Saavedra[1], and *Ignacio* Porras[1]

[1]Universidad de Granada, Granada, Spain
[2]Hospital Virgen de la Arrixaca, Murcia, Spain

N_TOF versus DONES



New facilities for complementary radioisotope production

European Journal of Nuclear Medicine and Molecular Imaging
https://doi.org/10.1007/s00259-021-05392-2

EDITORIAL

Check for updates

Challenges and future options for the production of lutetium-177

W. V. Vogel[1] · S. C. van der Marck[2] · M. W. J. Versleijen[1]

Published online: 11 May 2021

Discussion

In the coming years, production of medical isotopes will remain a matter of clinical, financial and political debate. There are multiple routes to production of ^{99}Mo, potentially involving investments in several current and new techniques. But it remains a vital question whether future facilities, of which an increasing number may be optimized for ^{99}Mo production alone, can also produce the full range of other required medical isotopes.

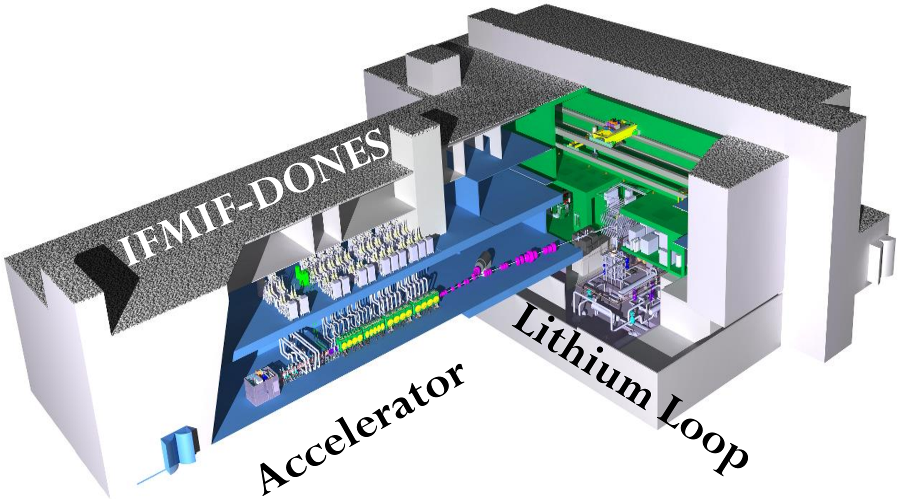
We identify ^{177}Lu, which already is an indispensable isotope for radionuclide therapy and will become even more so with increasing number of treatable prostate cancer patients, as an important candidate isotope that may not be produced in sufficient quantities in the near future, in case of insufficient availability of high-flux neutron irradiation facilities. In 2015,

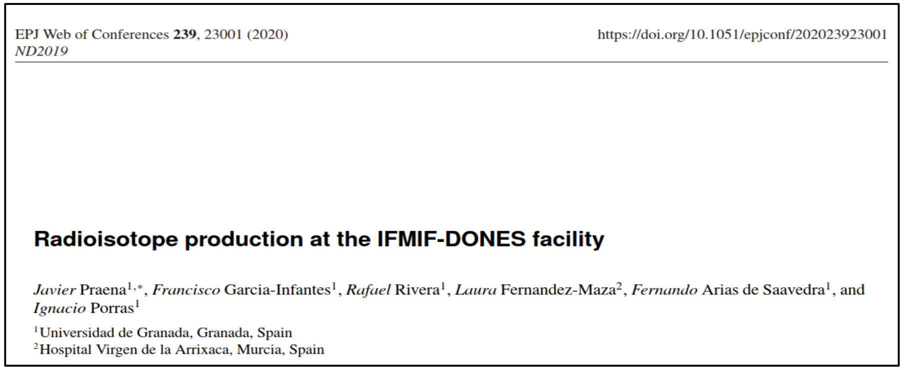
New facilities for complementary radioisotope production

Facilities under designed and construction as IFMIF-DONES (Granada, Spain) considers the production of radioisotopes for medicine as an complementary application.

MEDICIS-ISOLDE-CERN is an excellent successful example.

Nuclear data are needed to calculate the specific activity of the most adequate radioisotopes.




EPJ Web of Conferences **239**, 23001 (2020) https://doi.org/10.1051/epjconf/202023923001
ND2019

Radioisotope production at the IFMIF-DONES facility

Javier Praena[1,*], *Francisco* Garcia-Infantes[1], *Rafael* Rivera[1], *Laura* Fernandez-Maza[2], *Fernando* Arias de Saavedra[1], and *Ignacio* Porras[1]

[1]Universidad de Granada, Granada, Spain
[2]Hospital Virgen de la Arrixaca, Murcia, Spain