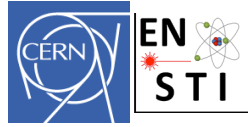


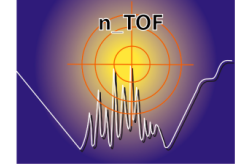
Proposal for n_TOF Experimental Area 2 (EAR-2)

<http://cdsweb.cern.ch/record/1411635?ln=en>

E.Chiaveri on behalf of the n_TOF Collaboration

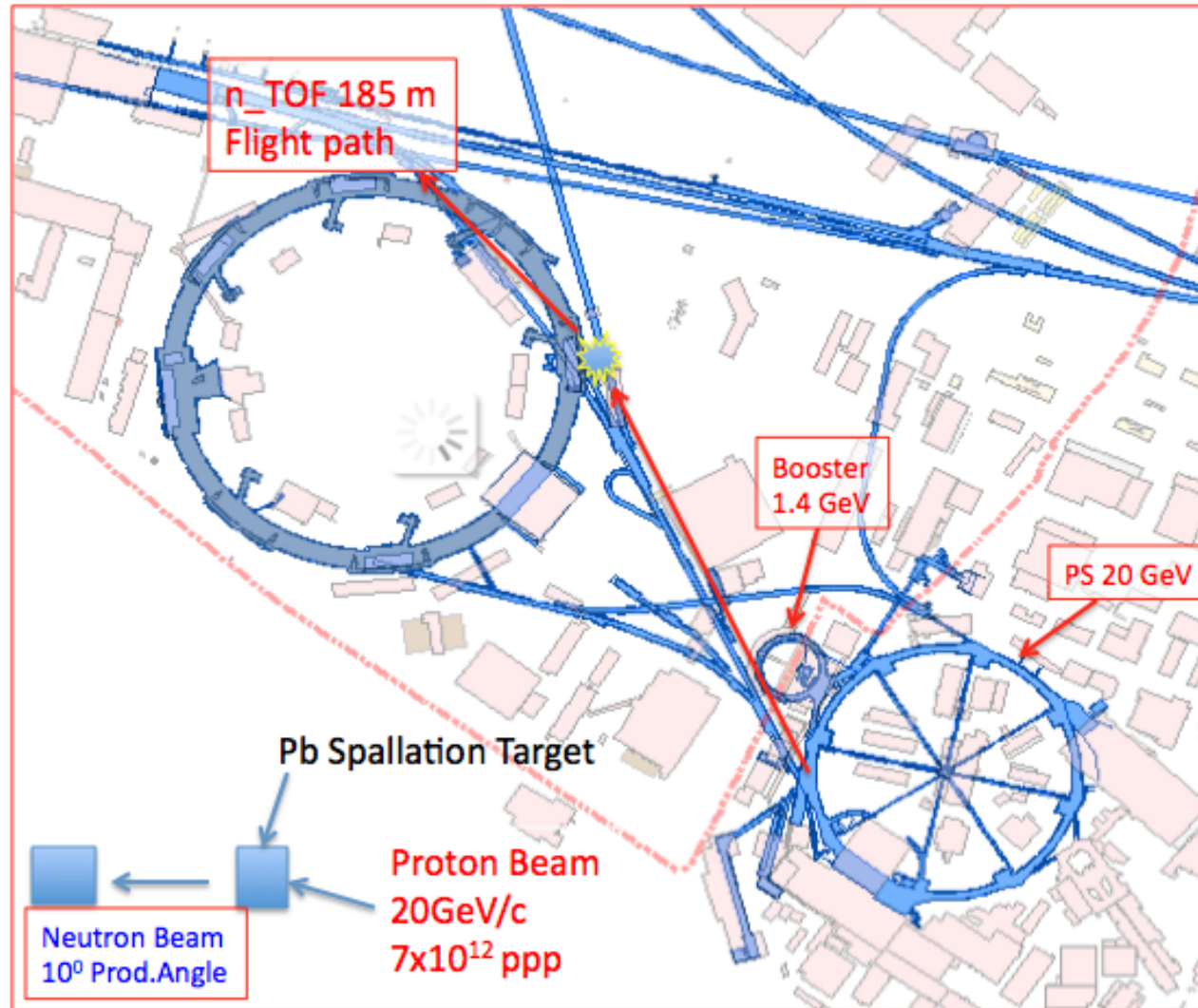
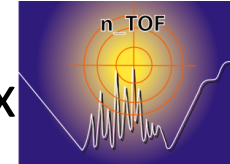


ITEMS

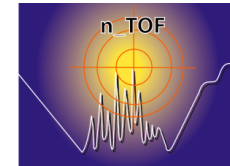


- ✓ Why EAR-2
- ✓ Scientific Motivation
- ✓ Facility Performance
- ✓ Dosimetry and Radiation Damage
- ✓ Radiation Protection Analysis
- ✓ Civil Engineering & Beam Line Study
- ✓ Budget, Man Power & Tentative planning
- ✓ Summary

Schematic view of the proton acceleration complex for n_TOF Facility

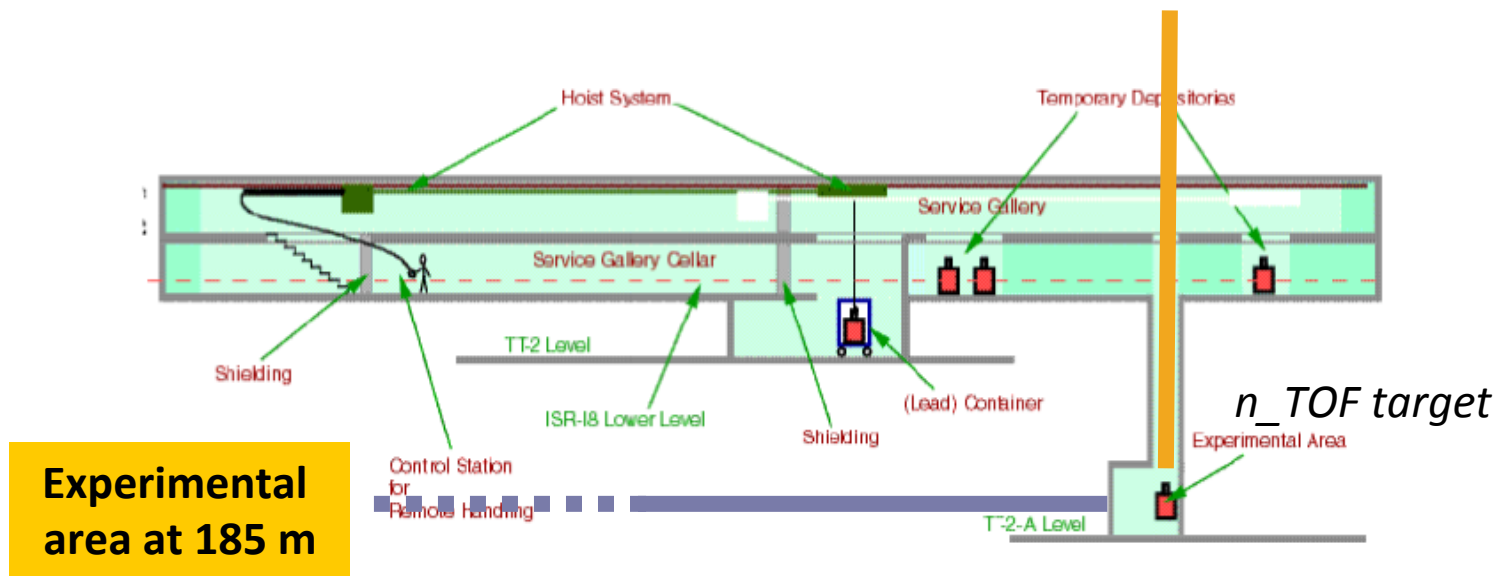


Study for n_TOF 2nd experimental area



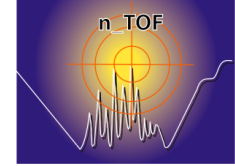
- Future **EAR-2**: flight path ~ 19 m at 90° with respect to the proton beam

New experimental area at 19 m (EAR-2)





Why AREA-2?

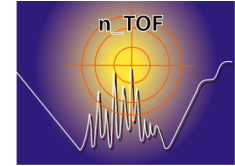


The main advantages of EAR-2 are:

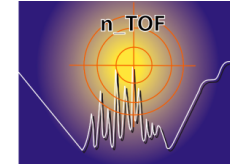
- *Neutrons fluxes on average increased by a factor 25*
- *Very small mass samples (< 1 mg)*
- *Very small cross-sections*
- *Much shorter time scales measurement*



Scientific Case for EAR-2



- Astrophysical Research
- Nuclear Technology Application
- Basic Nuclear Research



- very small samples

important candidates :

^{79}Se , ^{90}Sr , ^{93}Zr , ^{107}Pd , ^{135}Cs , ^{147}Pm , ^{163}Ho , ^{171}Tm , ^{182}Hf , ^{204}Tl

- very small cross sections

important candidates :

^{86}Kr , ^{88}Sr , ^{138}Ba , ^{140}Ce , ^{208}Pb ; isotopes of C, O, Ne, Mg

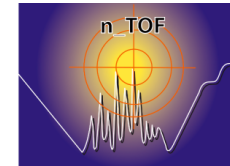
- short measuring times

important candidates :

^{64}Zn , ^{70}Ge , ^{76}Ge , $^{80,82}\text{Kr}$, $^{86,87}\text{Sr}$, $^{95,96}\text{Mo}$, ^{104}Pd , $^{164,166}\text{Er}$,
 ^{198}Hg



EAR-2 Nuclear Technology Application



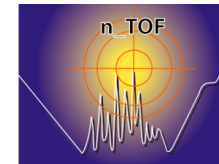
- Higher neutron flux
- Very small samples

Important Candidates:

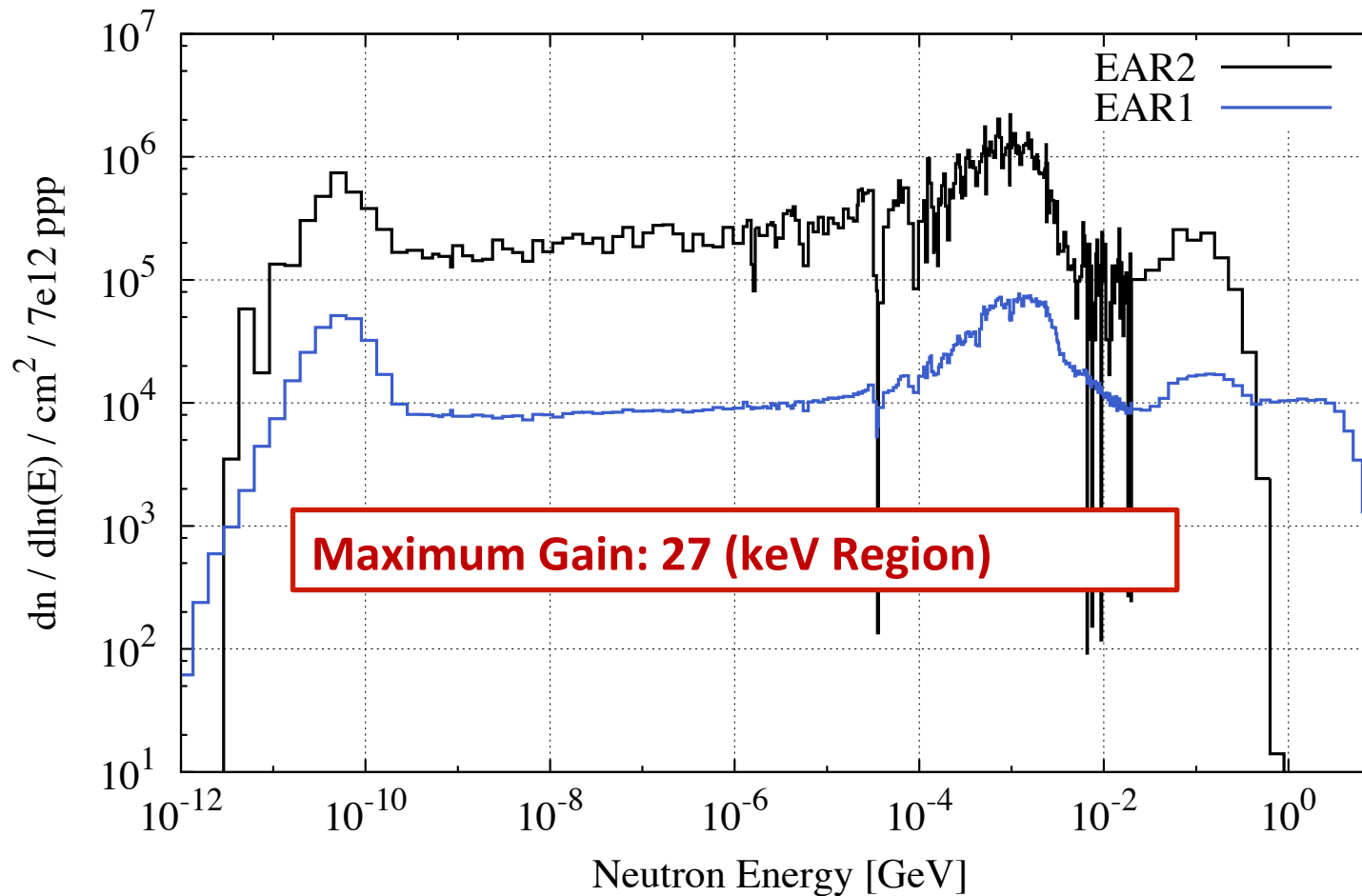
Fission Cross Section : ^{238}Pu (87.7 y)/ ^{241}Pu (14.1 y) ^{244}Cm (18.1 y) $^{242\text{m}}\text{Am}$ (141y) ^{243}Cm (29.1y)

Capture Cross Section : ^{242}Am (141 y)/ ^{243}Cm (29.1 y) ^{231}Pa (32400 y)

Neutron Fluence



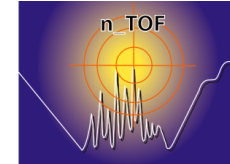
Comparison of the Neutron Fluence in EAR1 and EAR2



Reference for EAR1 : FLUKA Simulations with **fission collimator** (d = 8 cm)

IEFC Workshop 2012

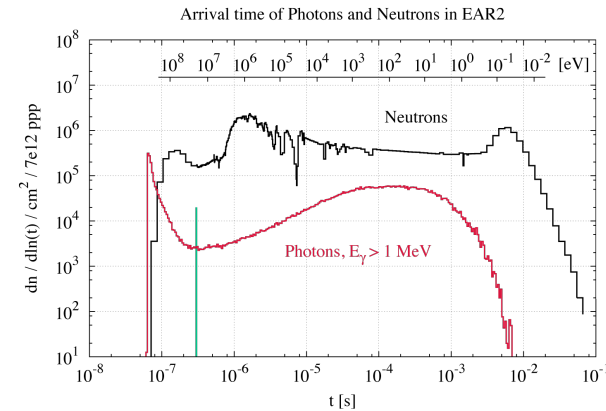
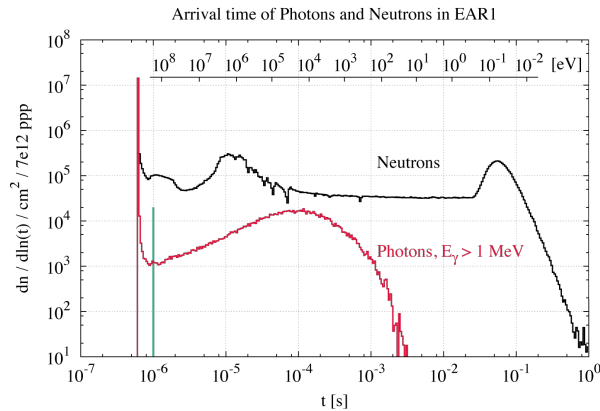
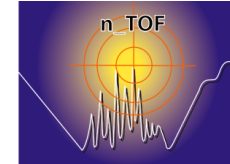
Neutron Fluence Comparison to EAR1



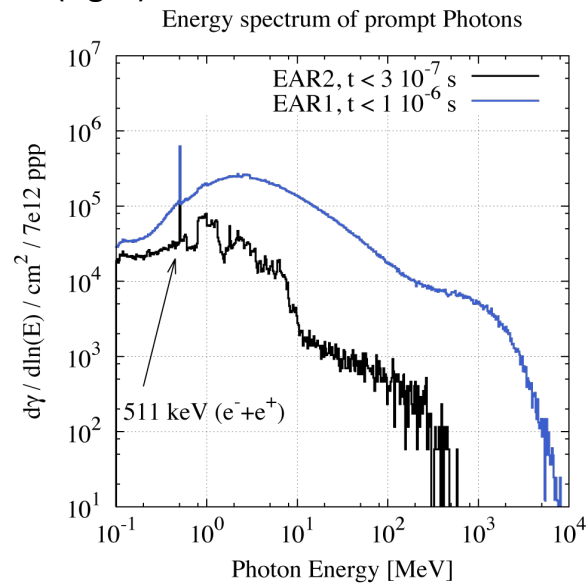
Energy Interval	EAR1		EAR2		Gain
	[n / cm ² / pulse]	Error [%]	[n / cm ² / pulse]	Error [%]	
0.02 – 10 eV	1.07e5	0.2	1.64e6	2.0	15.4
0.01 – 1 keV	3.98e4	0.3	1.07e6	1.4	26.8
1 – 100 keV	5.02e4	0.2	1.36e6	1.3	27.0
0.1 – 10 MeV	1.76e5	0.1	3.00e6	0.9	17.1
10 – 200 MeV	4.15e4	0.3	4.78e5	2.0	11.5
Total Range (0.02 eV – 200 MeV)	4.14e5	0.08	7.54e6	0.6	18.2

Reference for EAR1 : FLUKA Simulations with **fission collimator** (d = 8 cm)

Photon Fluence

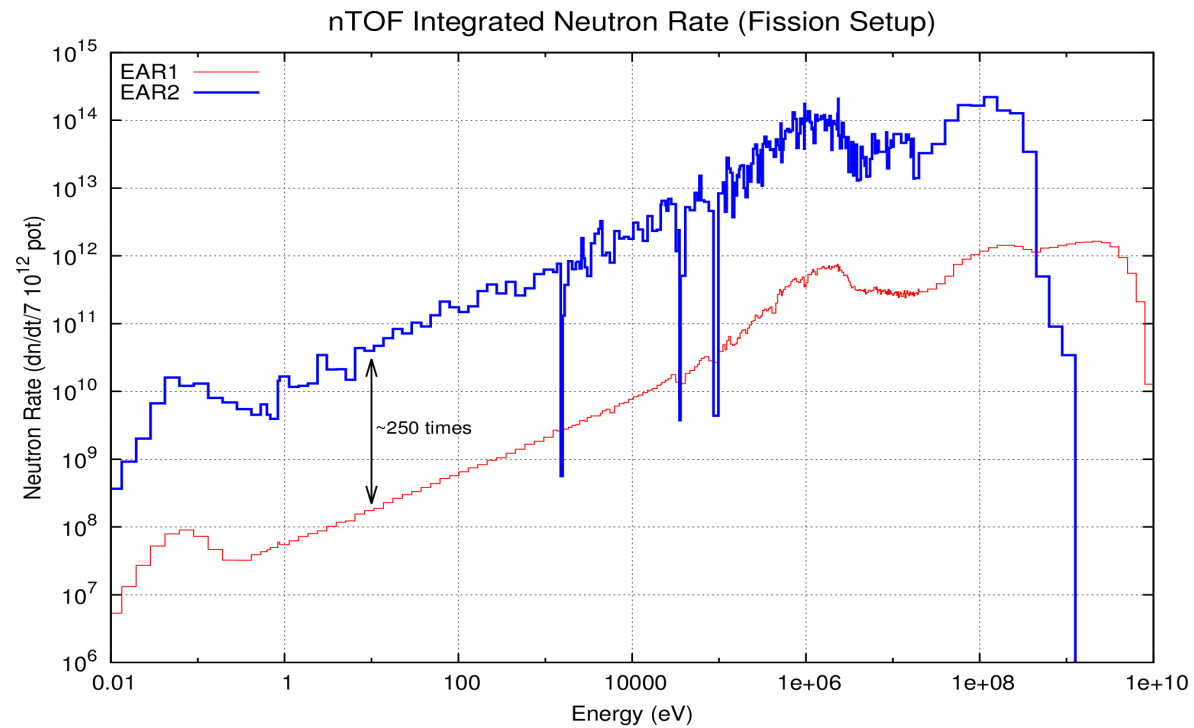


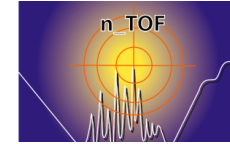
Arrival time of photons (red) and neutrons (black) at EAR-1 (left) and EAR-2 (right)



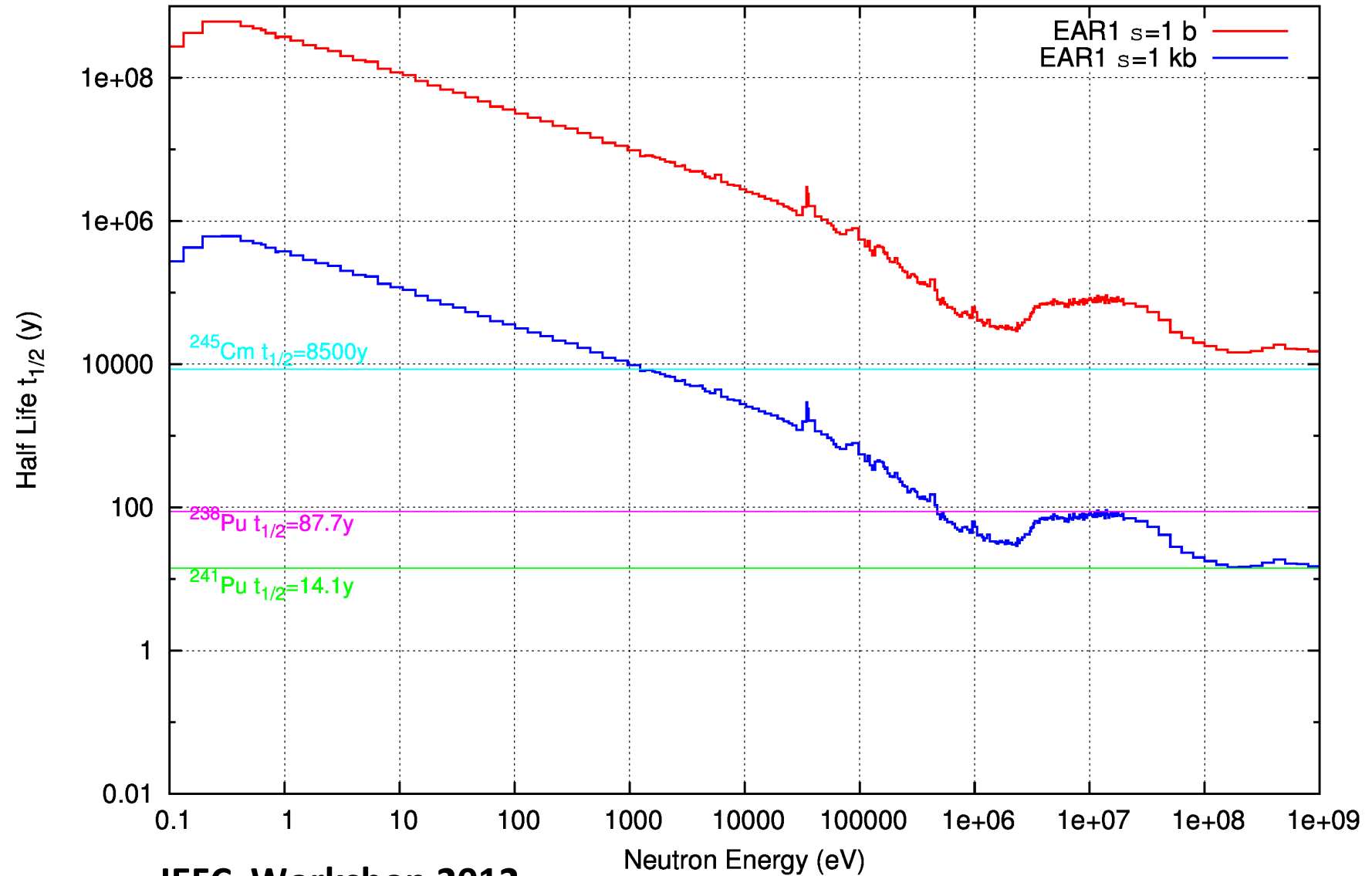
Neutron rate

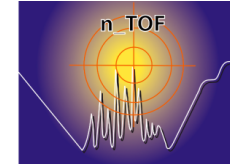
1. 25x higher fluence in EAR-2 wrt EAR-1
 2. 10x times less alphas/gamma during neutron arrival
- 250x times higher neutron rate



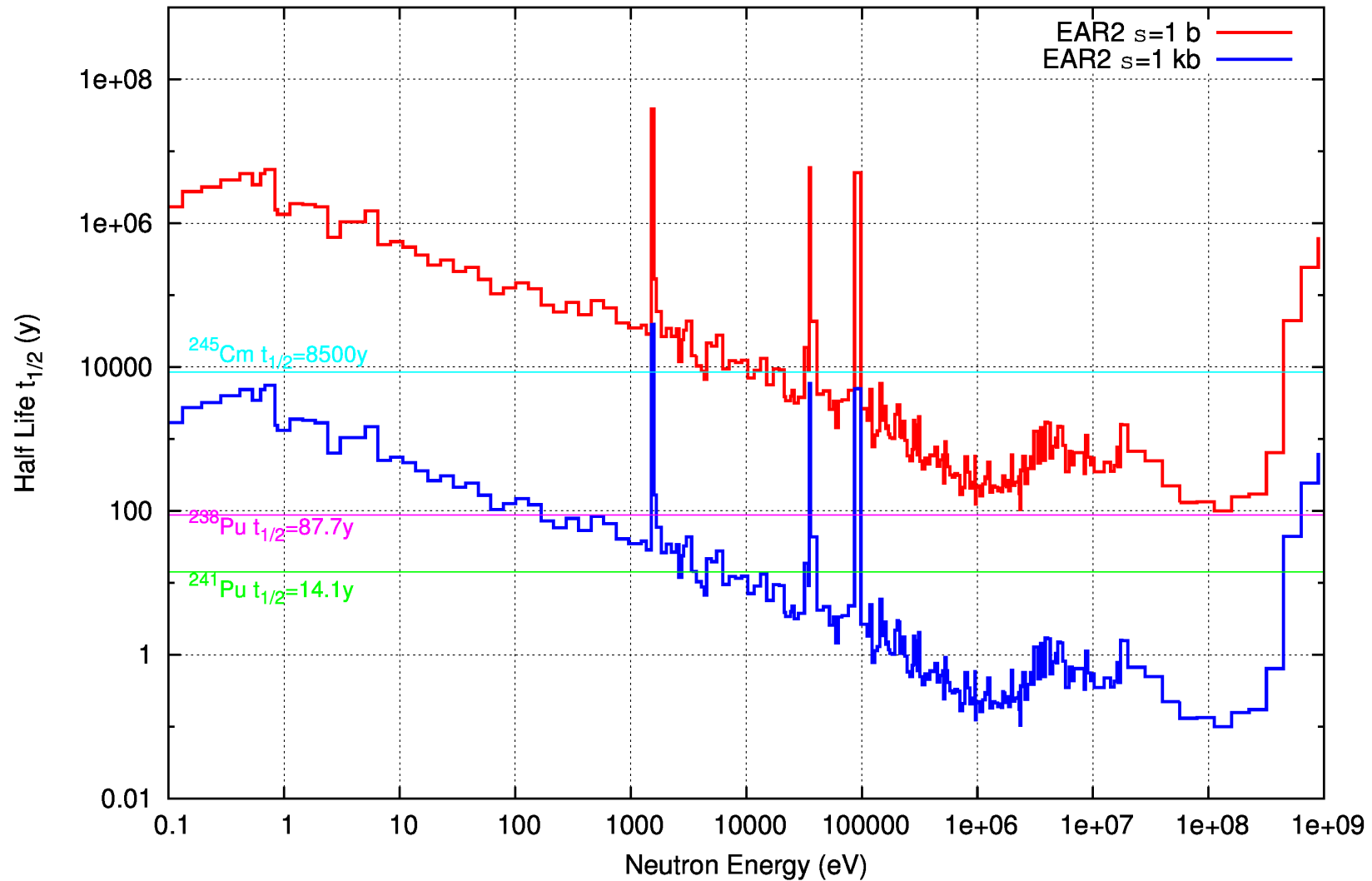


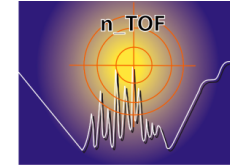
n_TOF Equivalent half life for sgn/bgn=1



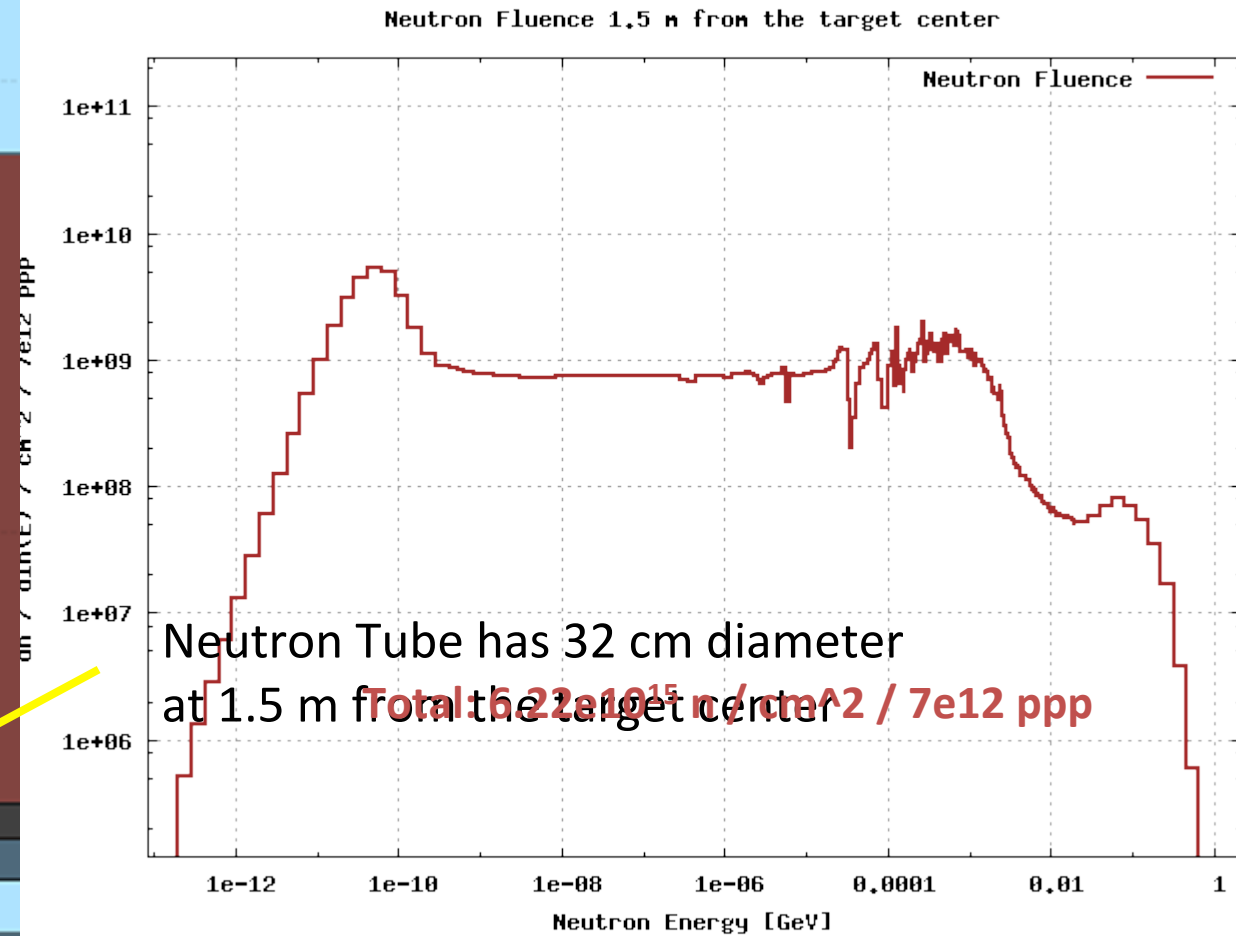
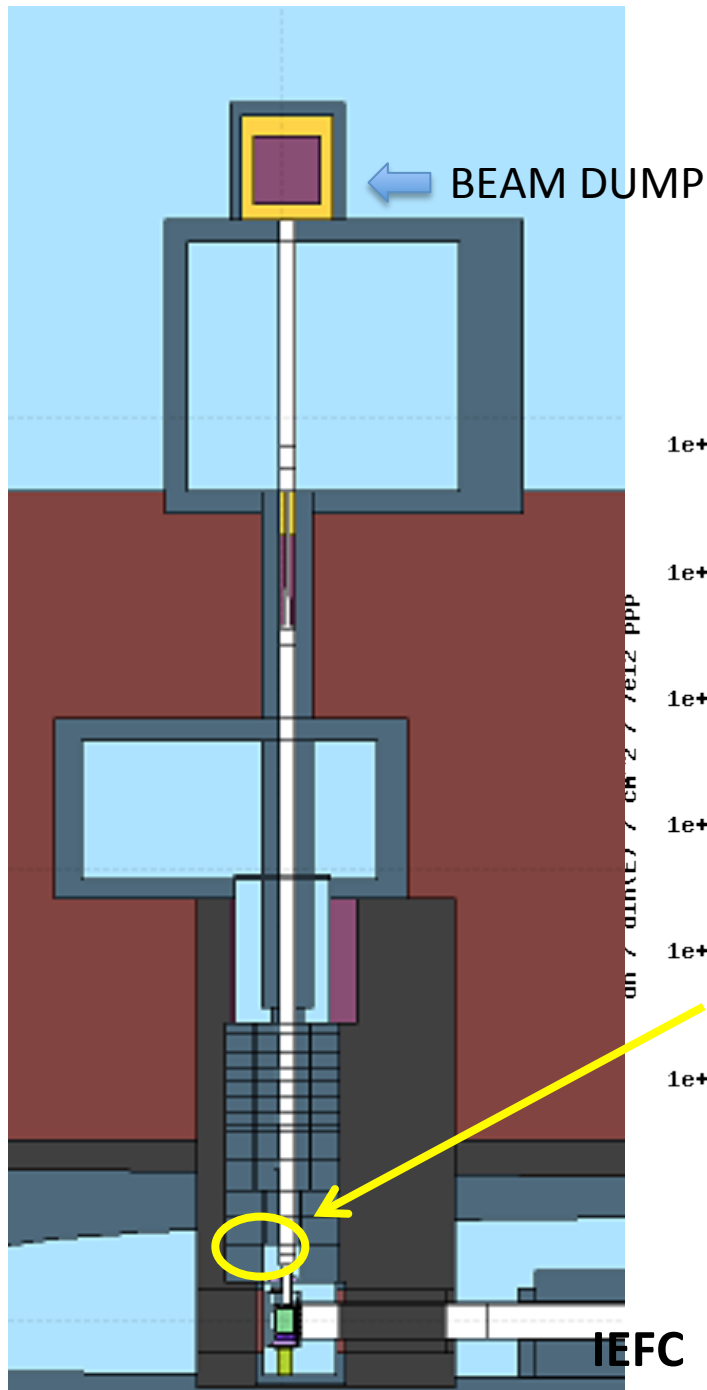


n_TOF Equivalent half life for $\sigma_{gn}/\sigma_{bn}=1$



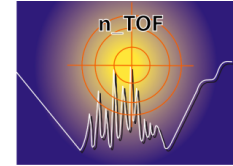


Neutron Fluence for Irradiation

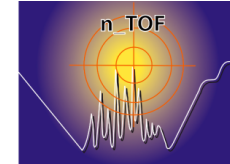




Dosimetry and Radiation Damage Studies



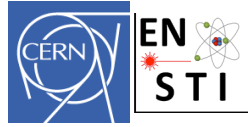
- Characterization and calibrations of passive and active dosimeters as well as of detectors.
- Test in its stray radiation field the radiation resistance of electronic and associated equipment (ex. Optical fibers)
- Perform irradiation of various material and electronic devices for dosimetric studies, detector development, radiation damage on electronics



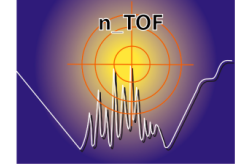
Dosimetry and Radiation Damage Studies

- 1 MeV (Si) equivalent neutron fluence rate. This quantity is a measure for displacement damage in (electronic) silicon-based devices. It can be correlated to its long term damage
- Ambient dose equivalent ($H^*(10)$) rate. This quantity is of relevance for passive and active dosimeters and radiation monitors

Position	1MeV (Si) eq.n n/cm²/pulse	H*(10) Sv / pulse	High energy (> 20 MeV) hadron fluence h / cm² / pulse	Thermal neutrons n / cm² / pulse
Position 1	3.03×10^9	1.47	1.44×10^8	1.22×10^{10}
Position 2	3.4×10^6	1.3×10^{-3}	4×10^5	1.5×10^6



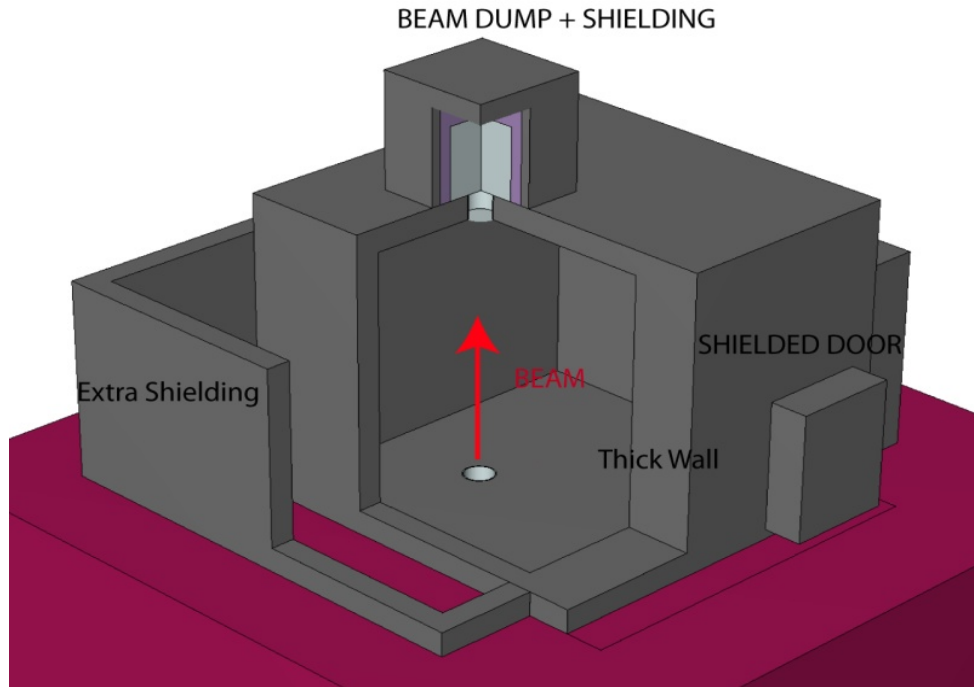
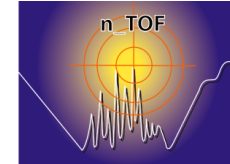
Radioprotection Analysis



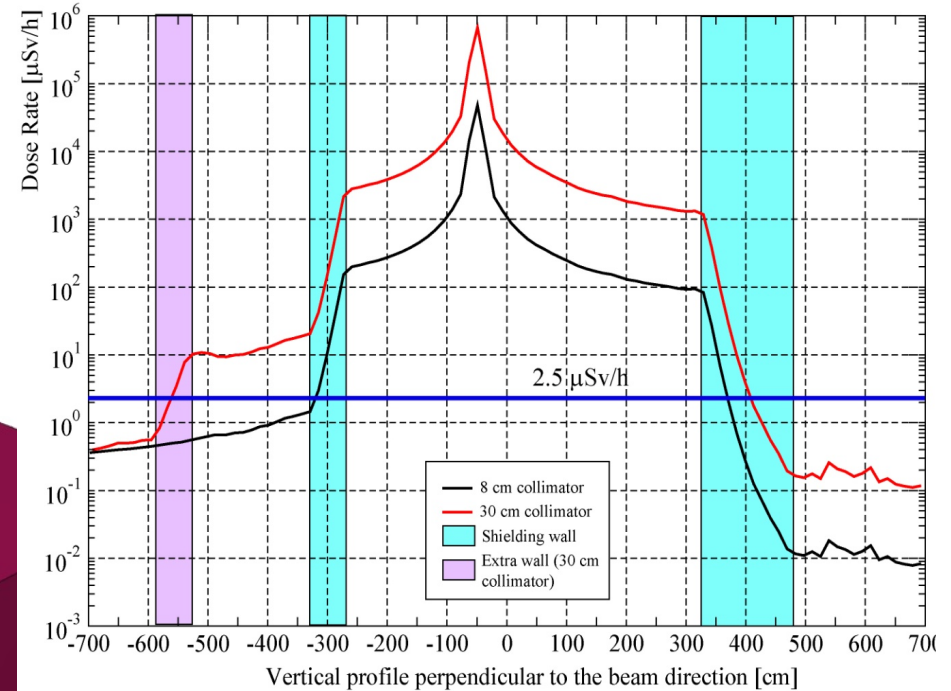
There are two radiation protection aspects:

- *Radiation levels in accessible areas induced by the neutron flux between the target and the experimental area*
- *Use of radioactive samples in the form of unsealed sources*

Radioprotection Analysis (Shielding calculations)

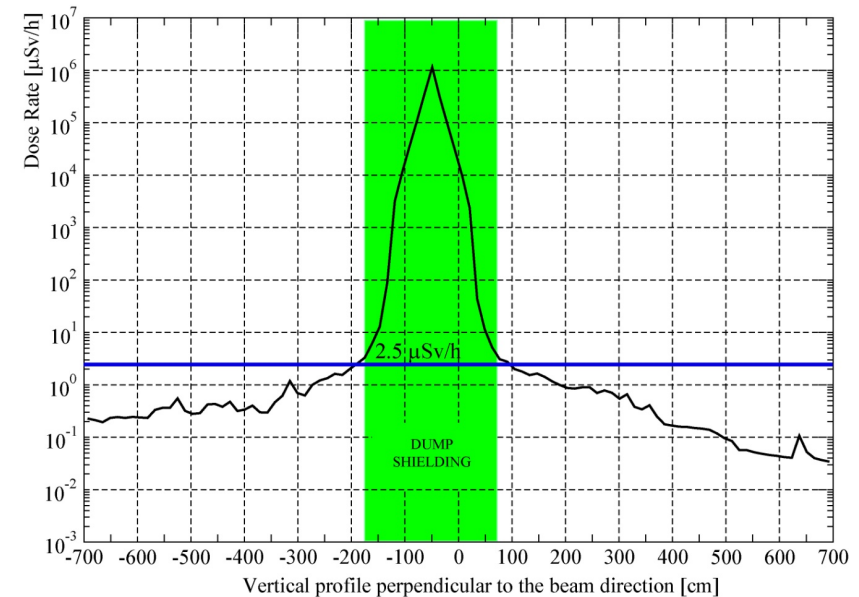
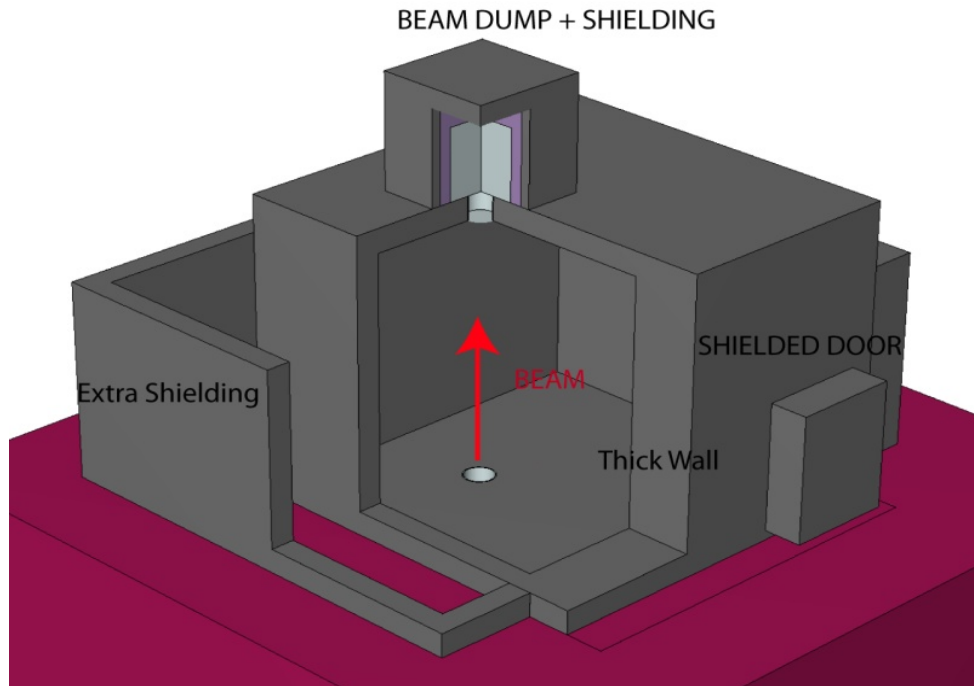
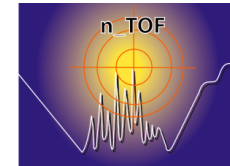


Three dimension view of the experimental area as it is implemented in FLUKA for shielding calculations.



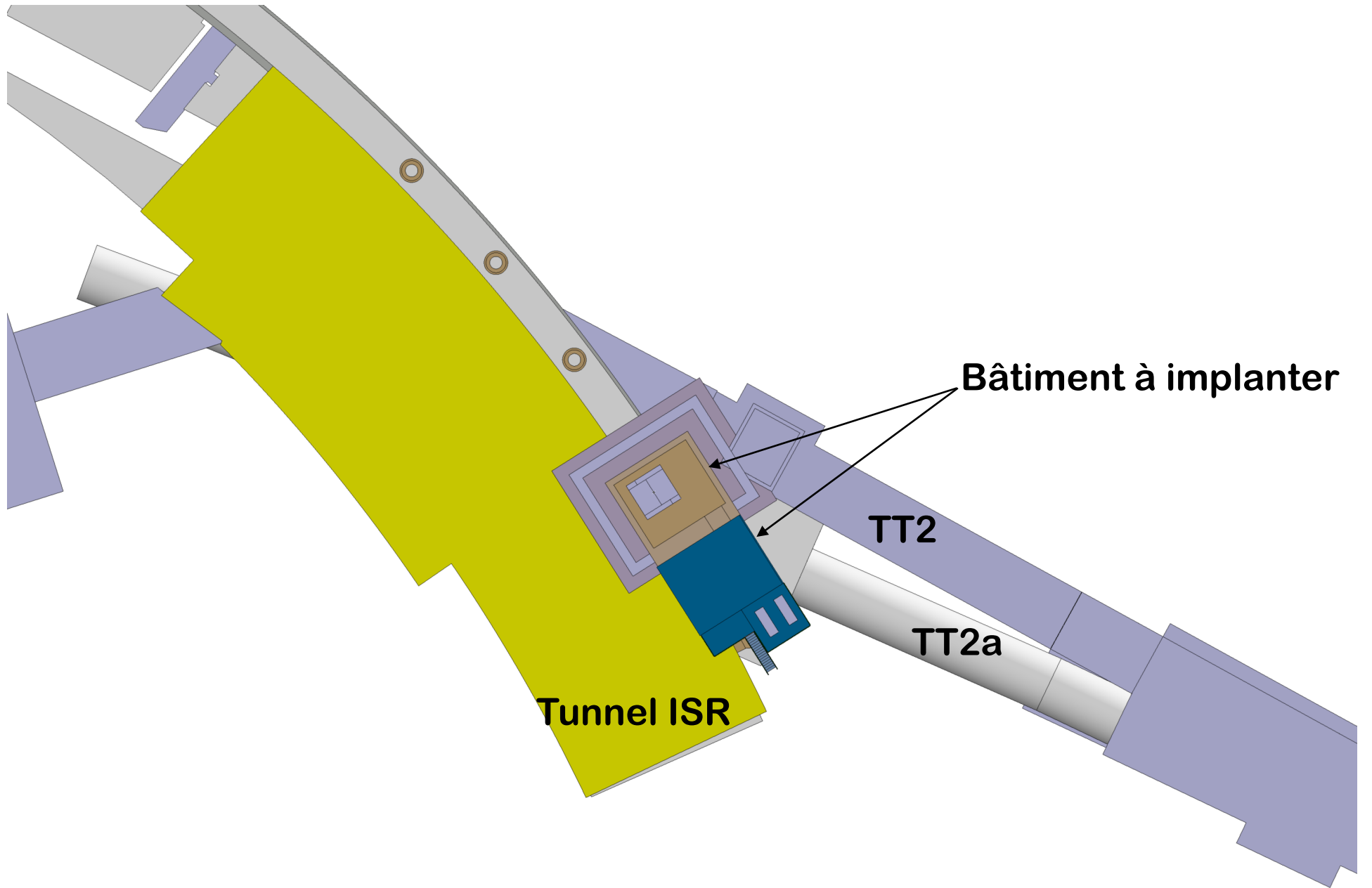
Dose rate profile perpendicular to the beam direction considering the neutrons intensity which correspond to the 30 cm collimator (red curve) and 8 cm collimator (black curve) impinging on a scattering target on the left.

Radioprotection Analysis (Beam Dump Calculation)

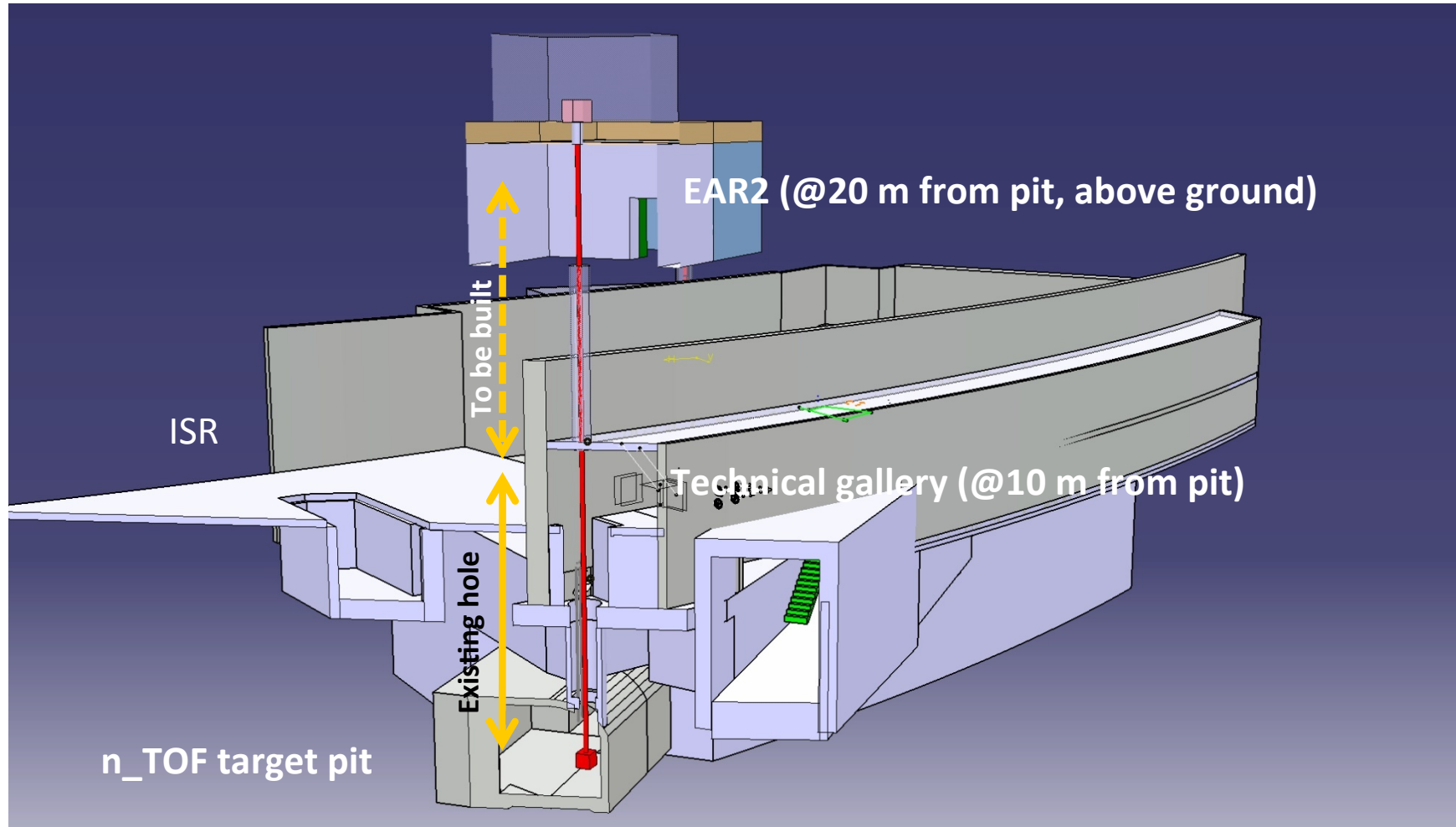
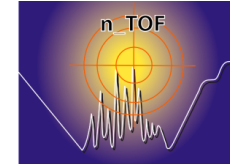


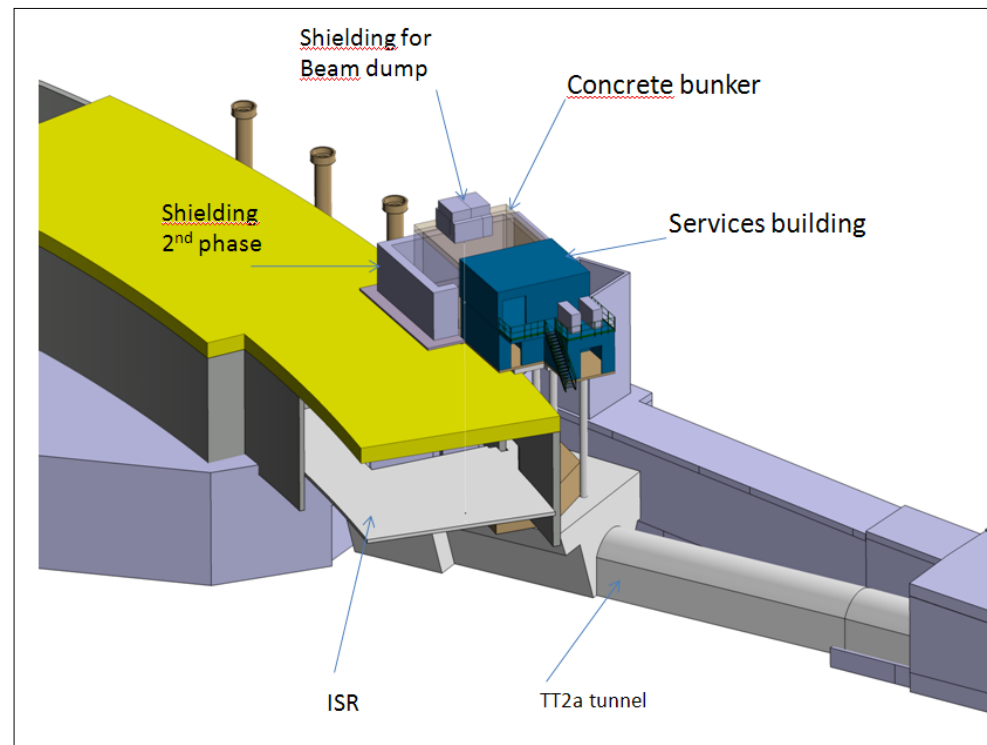
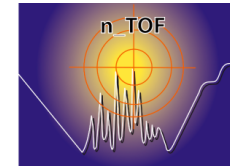
Three dimension view of the experimental area as it is implemented in FLUKA for shielding calculations.

Dose rate profile perpendicular to the beam direction at the beam dump level considering the neutrons intensity which correspond to the 30 cm collimator.



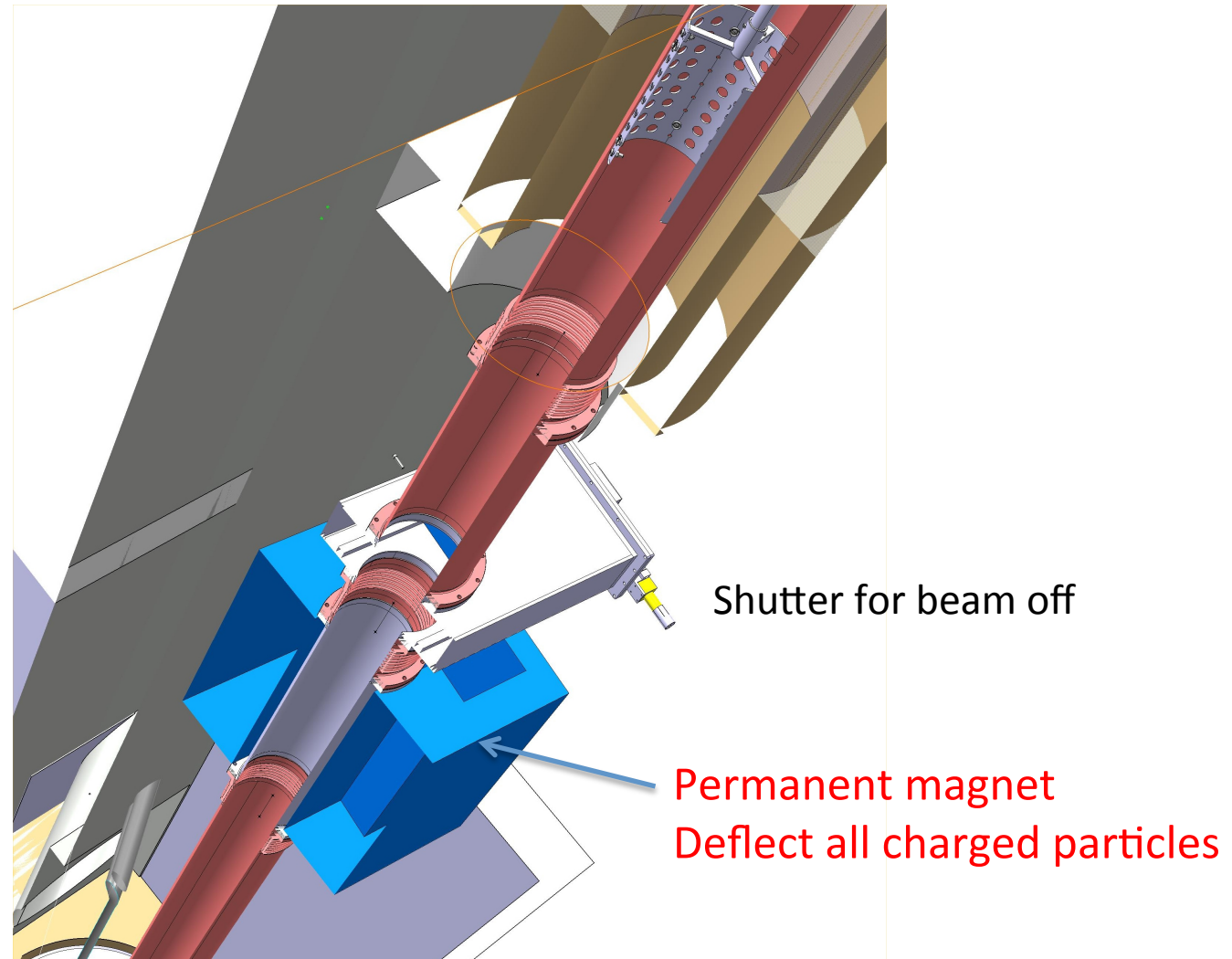
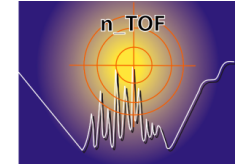
Overview of the n_TOF spallation target area





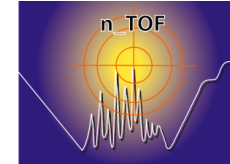
- Additional shielding for an upgrade of the facility for testing electronics components or material tests, which will be done without collimator, can be implemented in a second building stage by adding a base plate around the building and by positioning concrete shielding blocks as a wall around the facility

Beam line with Permanent magnet



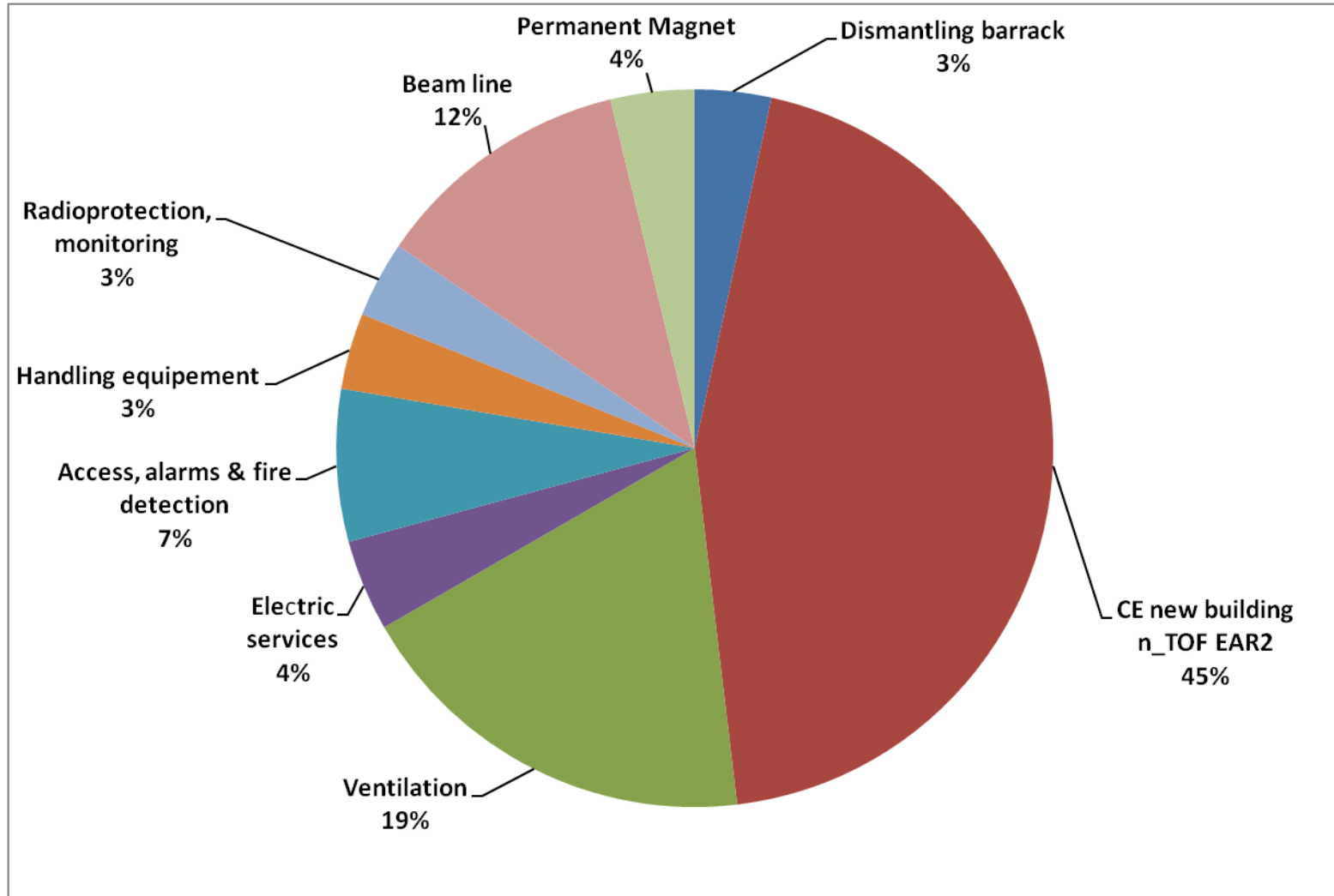
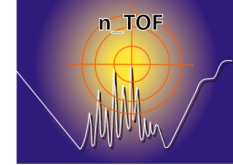


Cost EAR-2

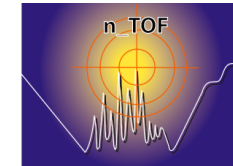


n_TOF Estimated Budget		INDICO
	Group	[KCHF]
Dismantling barrack 559	GS-SE	100
CE new building n_TOF	GS-SE	1,300
Ventilation	EN-CV	540
Electric services	EN-EL	120
Elec. general services		80
UPS		40
Access, alarms & fire detection	GS-ASE	200
Access, interlock system		120
Fire detection, alarms		80
Handling equipment	EN-HE	100
Crane		70
Monorail modification		30
Radioprotection, monitoring	DGS-RP	100
Beam line	EN-MEF	340
New target concrete tap		70
New shaft collimation, shielding		50
Dump		50
Vacuum chambers, pump, control		70
Shielded door entrance		50
Gas supply facility		20
Detector support facility (vertical)		30
Permanent Magnet	TE-MSC	110
Total [KCHF]		2,910
Contingency		10%
Total [KCHF]		3,201

Cost EAR-2

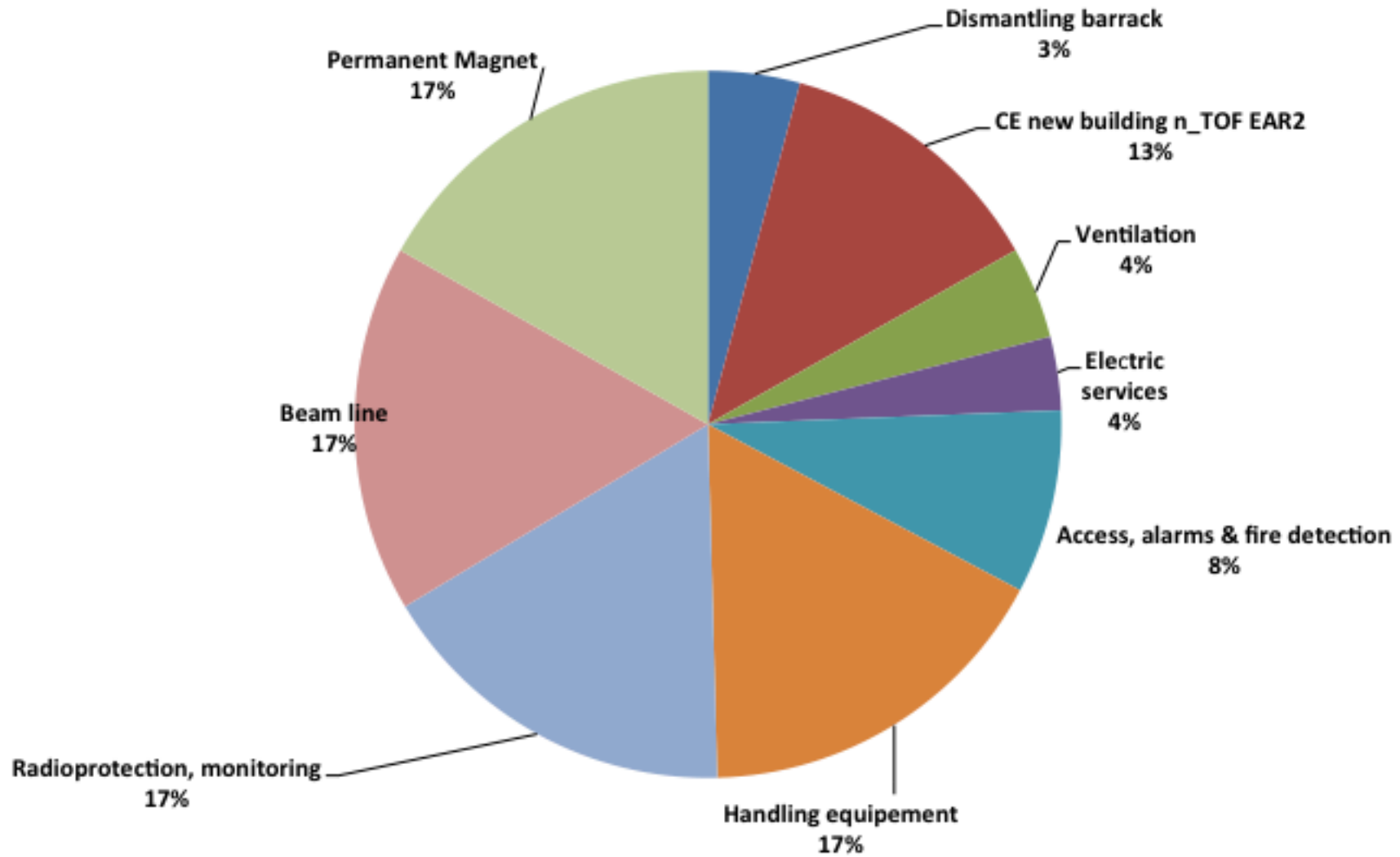
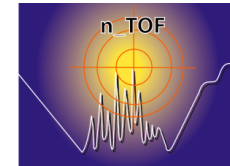


Man Power EAR-2

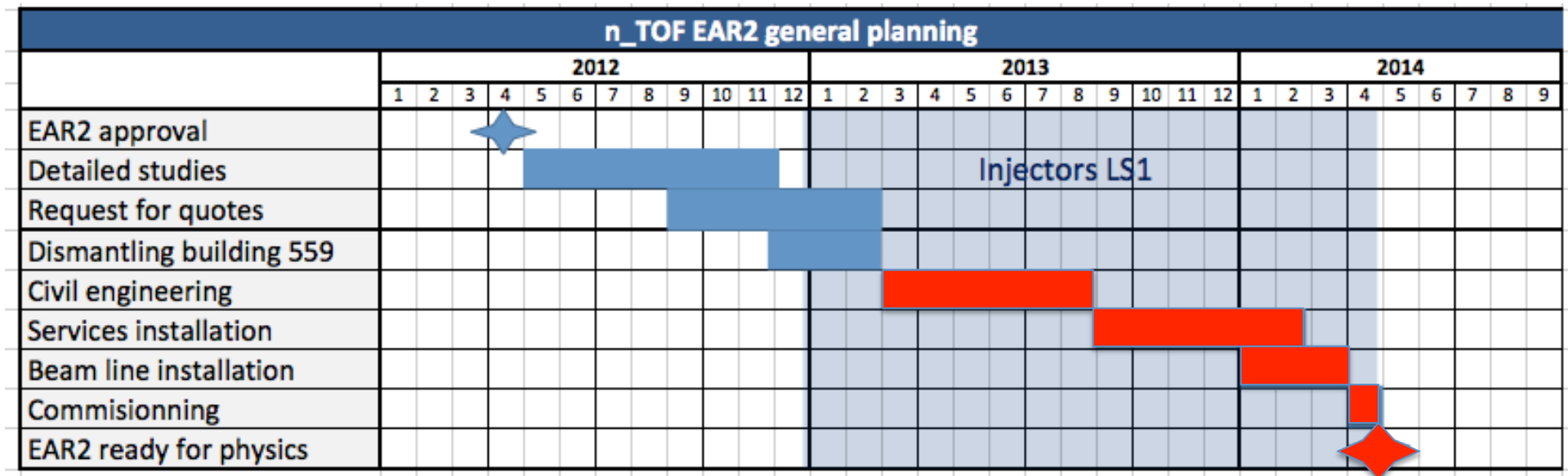
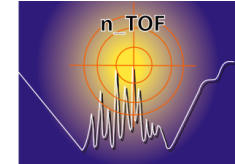


n_TOF estimated Man Power	Group	INDICO	YEAR	
		FTE		
Dismantling barrack 559	GS-SE	0.25	2012	
CE new building n_TOF	GS-SE	0.75	2012	Study&Purchasing Procedure
		1	2013/2014	Civil Engineering work
Ventilation	EN-CV	0.25	2012	Call for tender
		0.50	2014	Installation
Electric services	EN-EL	0.2	2012	Study
		0.5	2014	Installation
Access, alarms & fire detection	GS-ASE	0.5	2014	Installation
Handling equipment	EN-HE	1.0	2013/2014	Installation+actual pit modification
Radioprotection, monitoring	DGS-RP	1.0	2012/2013	Study
		0.5	2014	Installation+monitoring
Beam line	EN-MEF	1.0	2012	Study
Permanent Magnet	TE-MSC	1	2013	Study&Construction
Total [FTE]		8.45		
Contingency		10%		
Total [FTE]		9.3		

Man Power EAR-2

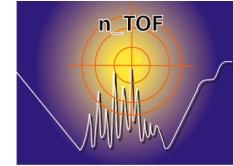


Planning EAR-2





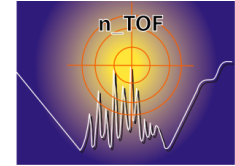
EAR-2 Proposal-Conclusion



- The n_TOF Collaboration Board strongly supports the Proposal for EAR-2
- The n_TOF facility is already unique in the world in terms of the instantaneous neutron flux and low background
- The addition of the EAR-2 with its enhanced capabilities will increase the physics reach of the installation
- EAR-2 will open new opportunities in the measurement of neutron-induced reactions with unprecedented accuracy for various important fields of physics:
 - nuclear technology, nuclear astrophysics and stellar evolution, basic research, medical applications, dosimetry and radiation damage



Summary



- Discussions well advanced with the different CERN groups (GS/SE, EN/MEF, EN/CV, EN/EL, DGS/RP, TE/MSC, GS/ASE, EN/HE)
- Given the importance of the project, the n_TOF Collaboration is ready to make efforts to proceed with the construction during LS1 taking into account other CERN priorities