

# WP4 SUMMARY

ESSNUSB WP4 / EURONUNET WG2 - TARGET STATION

# OUTLINES

- **Target Station Facility**
  - **Physics Performance**
  - **Building Design Concept**
  - **Target Station Mechanical Study**

# SUMMARY TALK

## ■ Wednesday 7/11

- WP4 Introduction P. Cupial
- Superbeam N. Vassilopoulos
- Target Station E. Baussan
- Coffee Break
- Target P. Cupial
- Horn Study Mateusz Kosiol
- Power Supply Pascal Poussot

WP4 Session

WP3 + WP4 Session

## ■ Thursday 8/11

- Solenoid Option Maja Olvergard
- Safety Eric Baussan
- Coffee Break
- General Discussion

WP4 Session

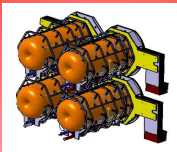
# TARGET STATION FACILITY - GLOBAL WORKING PLANS



## Target Station Facility Sub-Systems

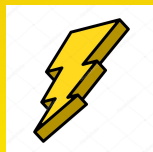
### Target Station

- Target + integration
- Horn
- Four Horn Support
- Proton Beam extraction



### Power Supply System

- Target Station
- Power Supply Unit
- Cooling System
- Stripline Connection



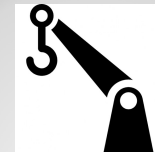
### Fluid System

- Closed cooling Fluid (Helium gas, Water)
- Radioactive Effluents
- Confinement System



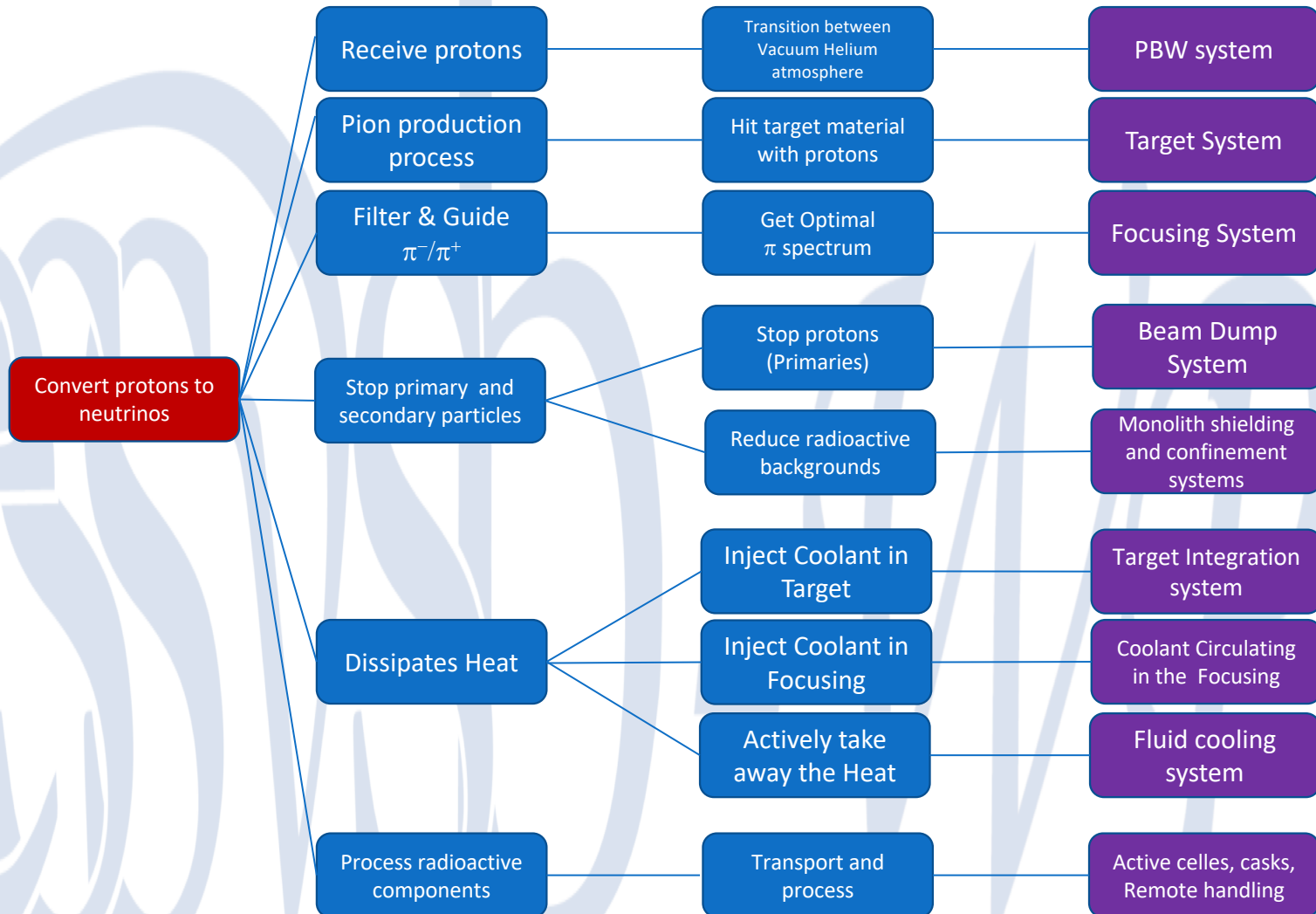
### Handling and Logistic

- Active Cell
- Casks
- Remote Handling

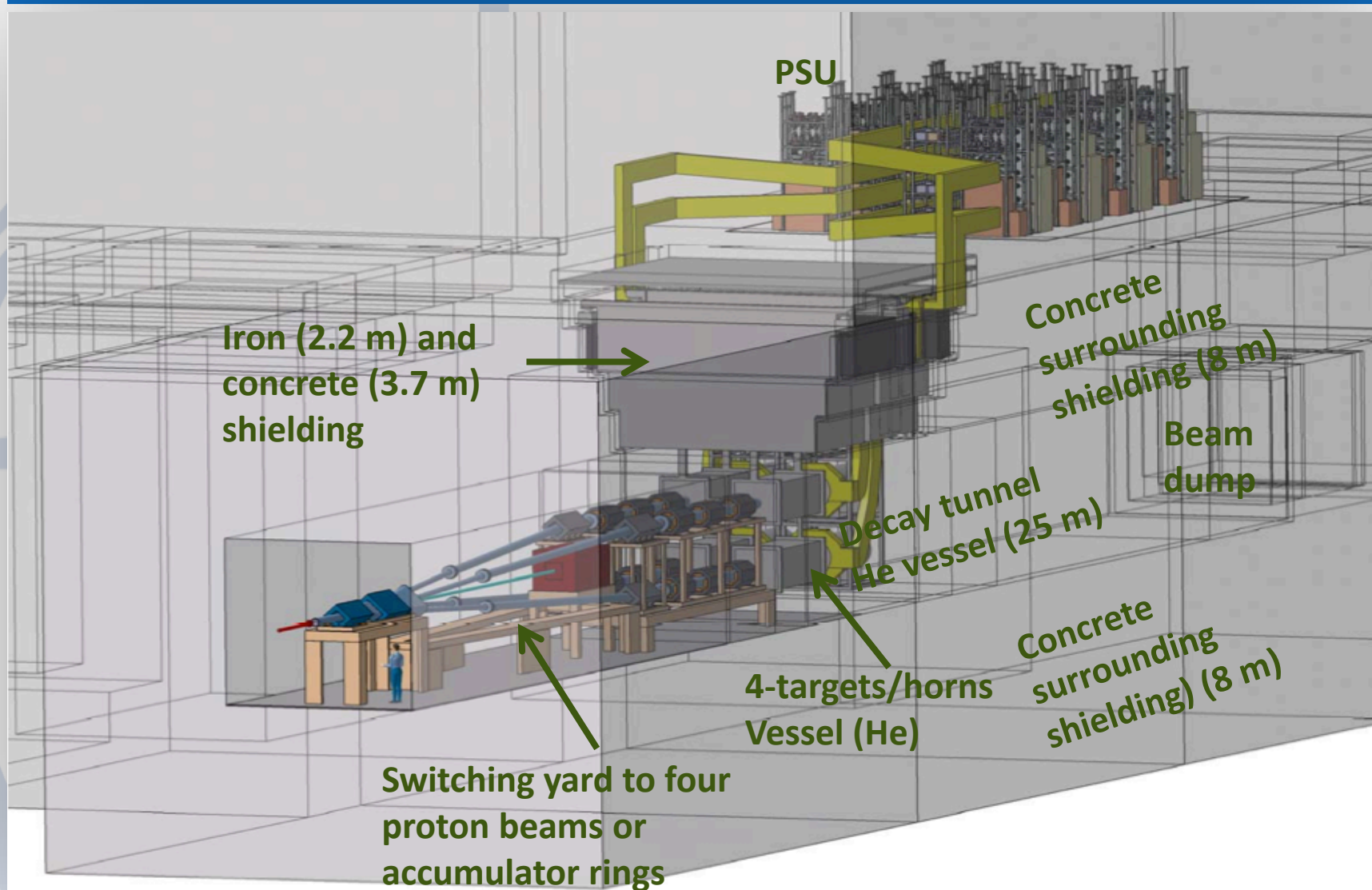




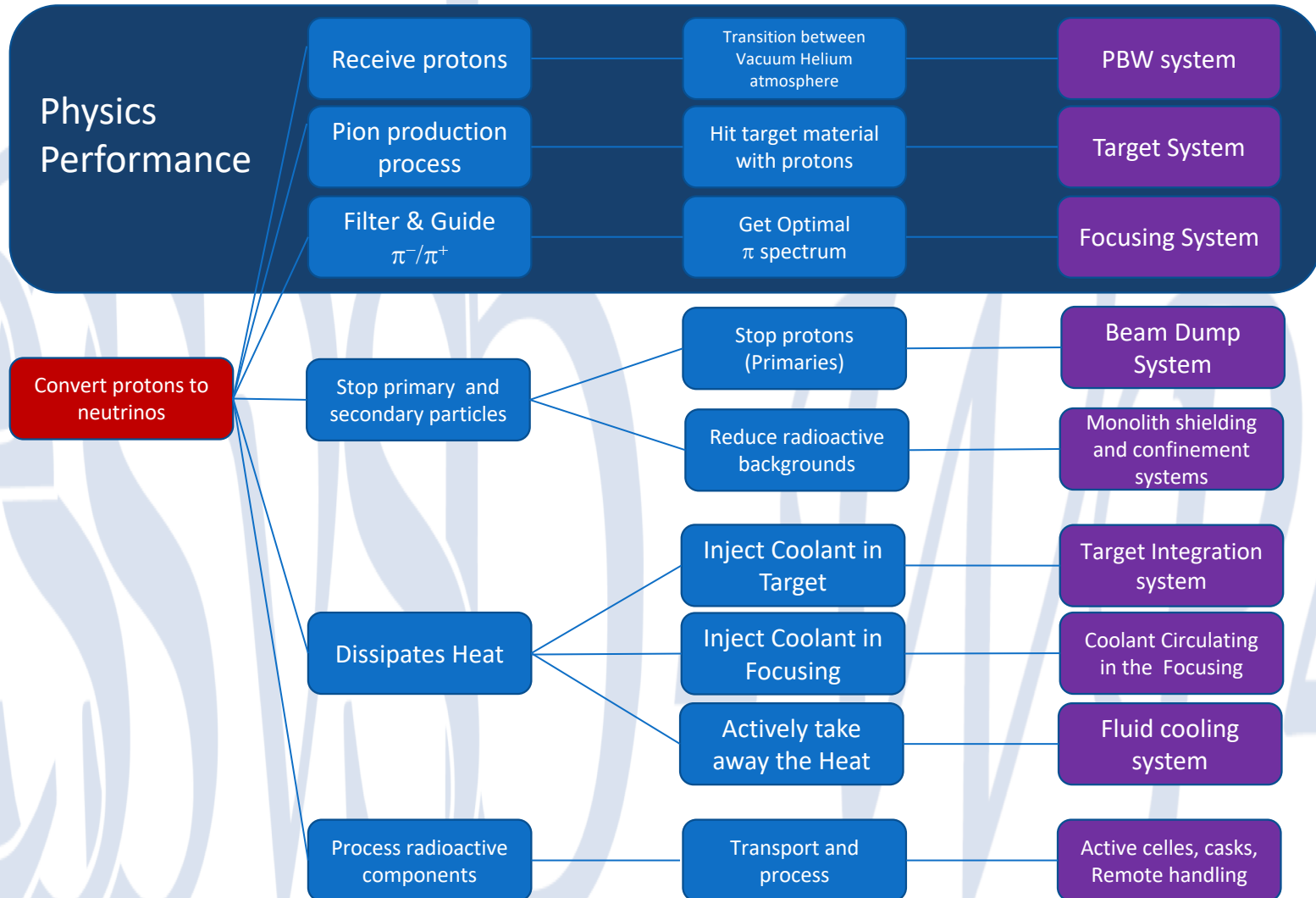
# ESSNUSB TARGET STATION FUNCTIONALITIES



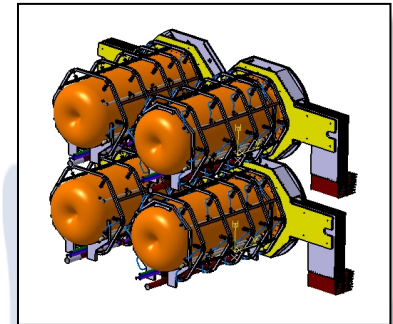
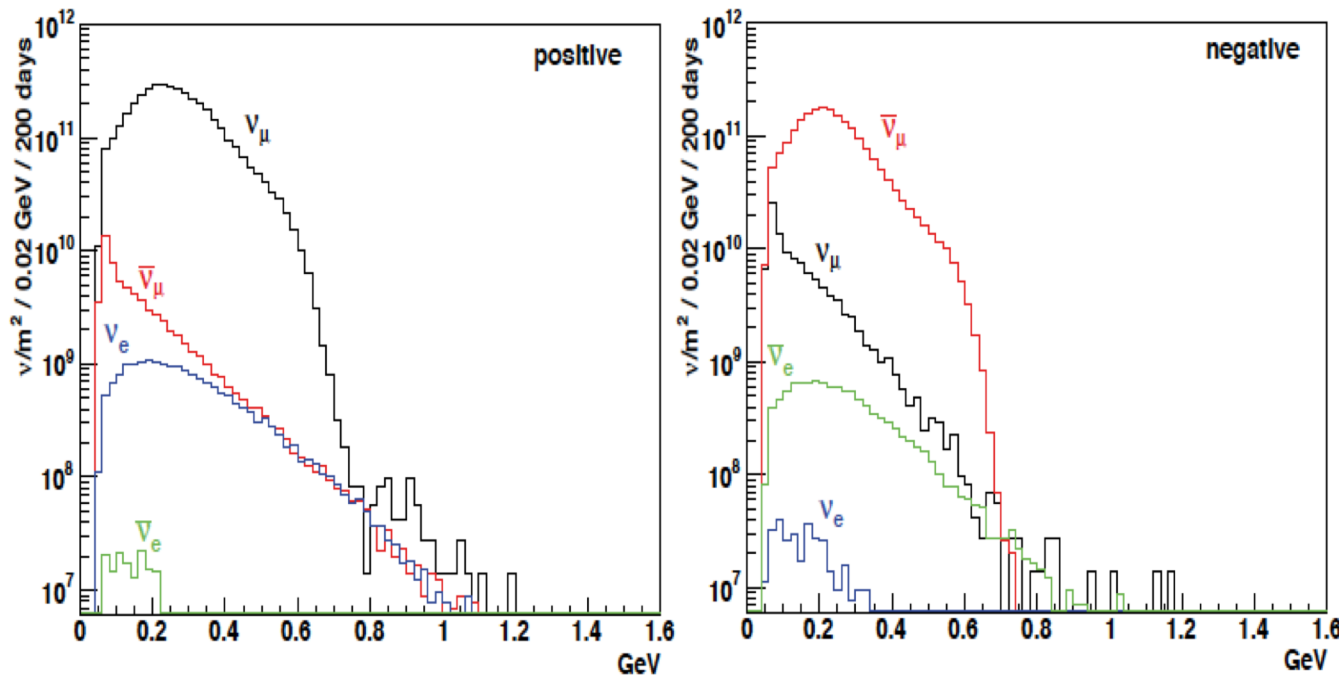
# TARGET STATION FACILITY



# ESSNUSB TARGET STATION FUNCTIONALITIES



# PHYSICS PERFORMANCES : HORN OPTION



at 100 km from  
the target and  
per year  
(in absence of  
oscillations)

- Decided to keep the EUROnu design
- Physics results was (is) second to Neutrino Factory

N. Vassilopoulos

	positive		negative	
	$N_\nu (\times 10^{10})/m^2$	%	$N_\nu (\times 10^{10})/m^2$	%
$\nu_\mu$	396	97.9	11	1.6
$\bar{\nu}_\mu$	6.6	1.6	206	94.5
$\nu_e$	1.9	0.5	0.04	0.01
$\bar{\nu}_e$	0.02	0.005	1.1	0.5

# PHYSICS PERFORMANCES : OTHER OPTIONS

abandoned

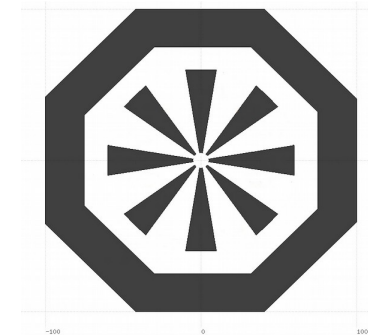
- Superconducting van der Meer horn
  - not realistic due to quenching when particles cross the conducting surface

doubtful

- Solenoid(s)
  - superconducting
  - dipoles added for charge separation

promising

- Los Alamos device
  - normal-conducting
  - DC or long pulses



# PHYSICS PERFORMANCES : OTHER OPTIONS

## Los Alamos device: result



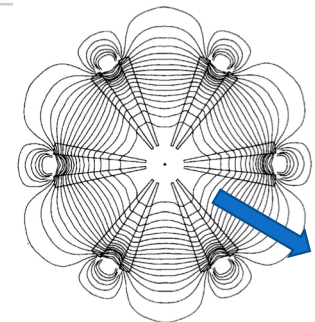
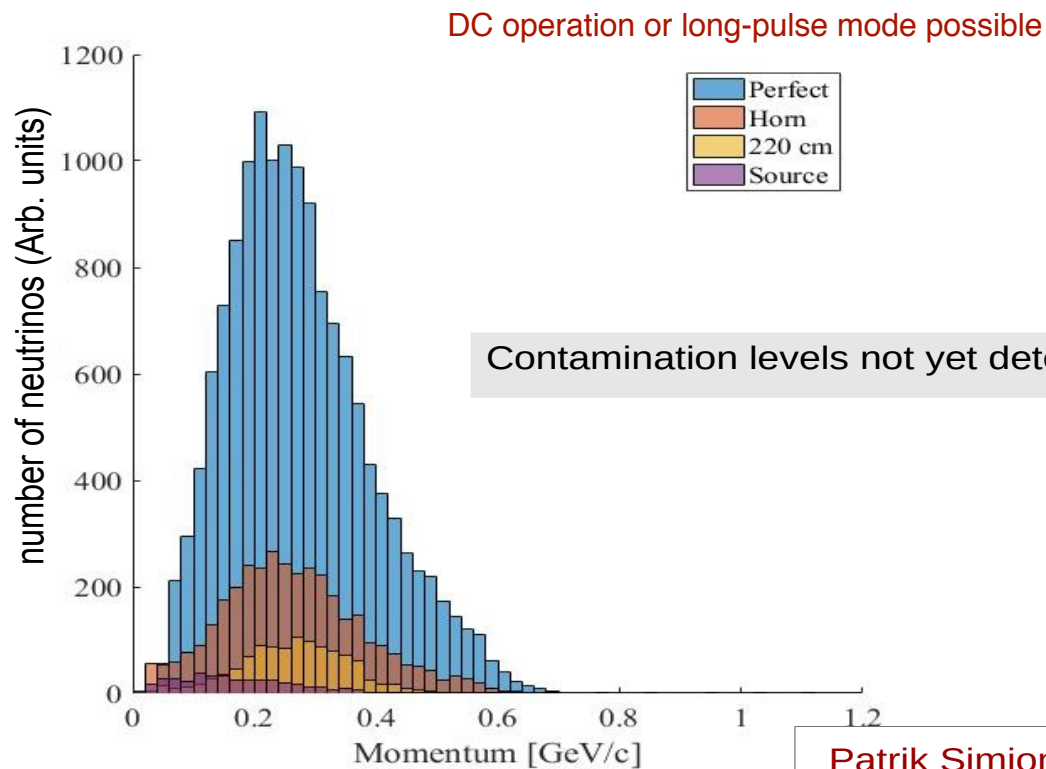
UPPSALA  
UNIVERSITET

M. Olvegård

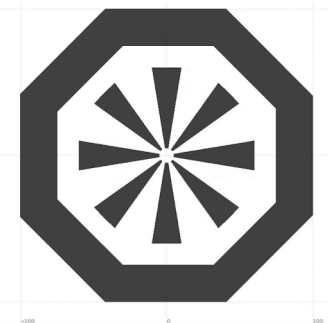
ESSnuSB  
meeting,  
Strasbourg

2018-11-08

19 (24)



Gradient field



Fluka Model  
With Black Body

Patrik Simion

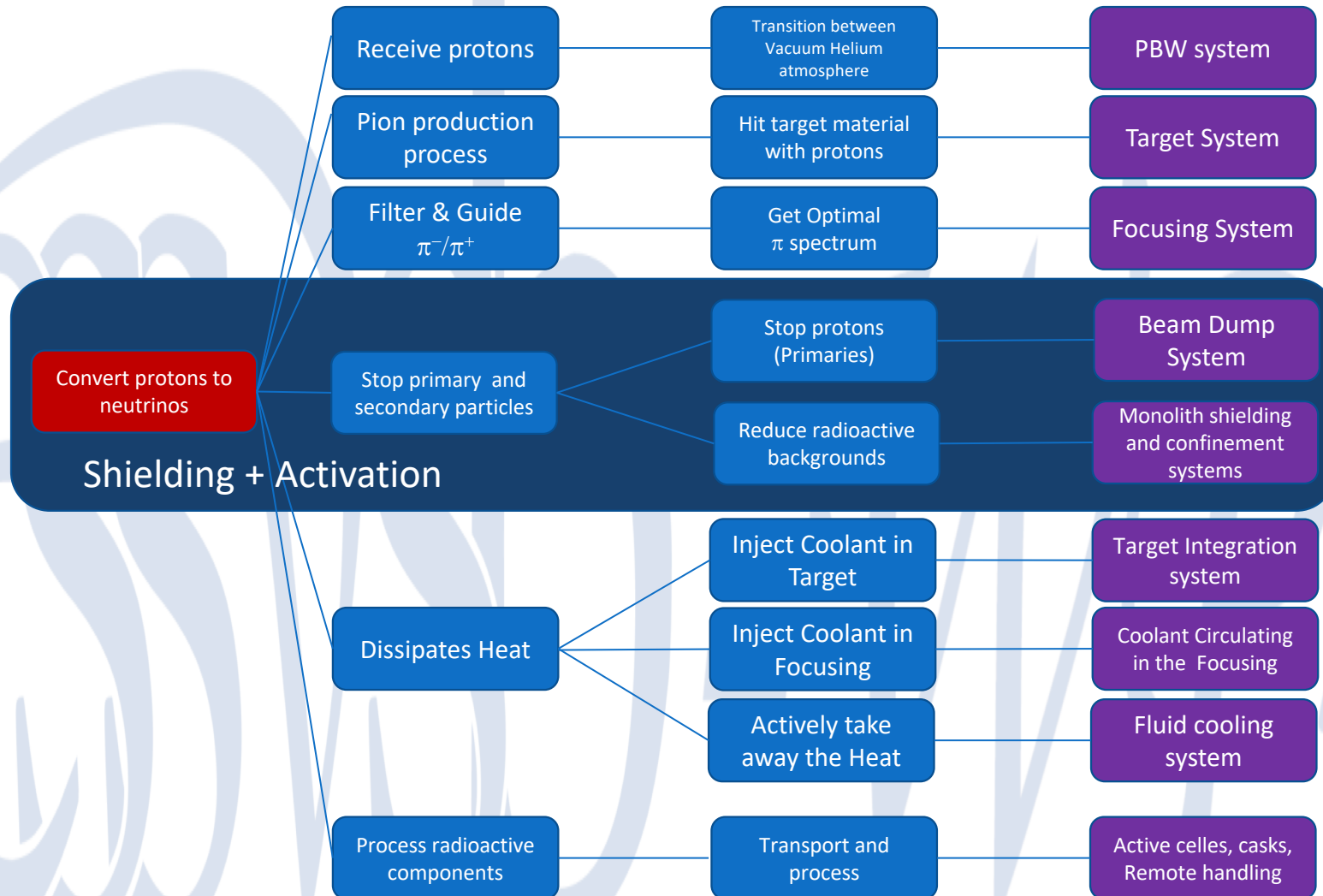
# PHYSICS PERFORMANCES

## ■ Next Steps

- Update the full FLUKA simulation implement the four horns the neutrino beam
- Compare with Geant4 Simulation
- Provide the new fluxes for near and far detectors WP5+WP6
- Several alternatives option are under investigation but Los Alamos Collector is promising but more study are necessary
  - Increase the acceptance and the efficiency by optimizing shapes and currents
  - Check contamination levels
  - Power deposition remains to be investigated



# ESSNUSB TARGET STATION FUNCTIONALITIES

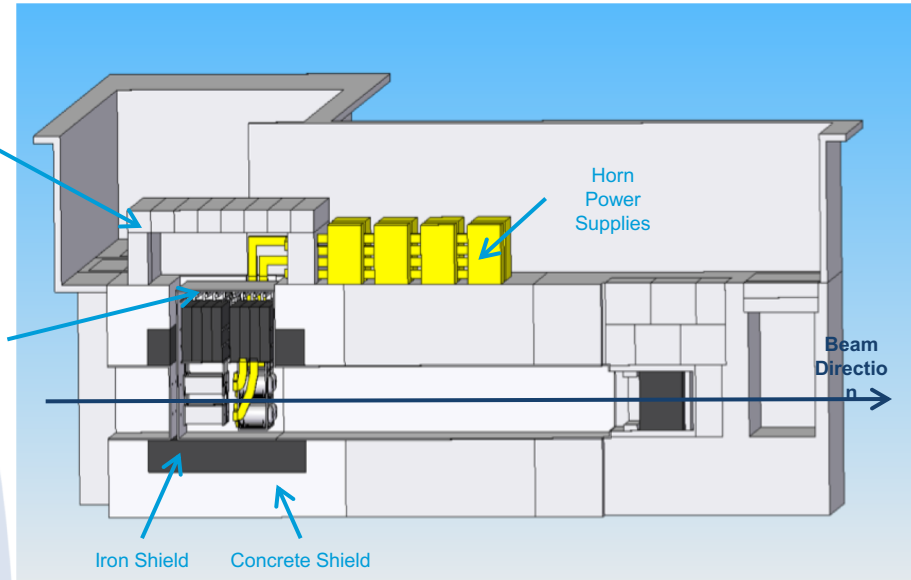
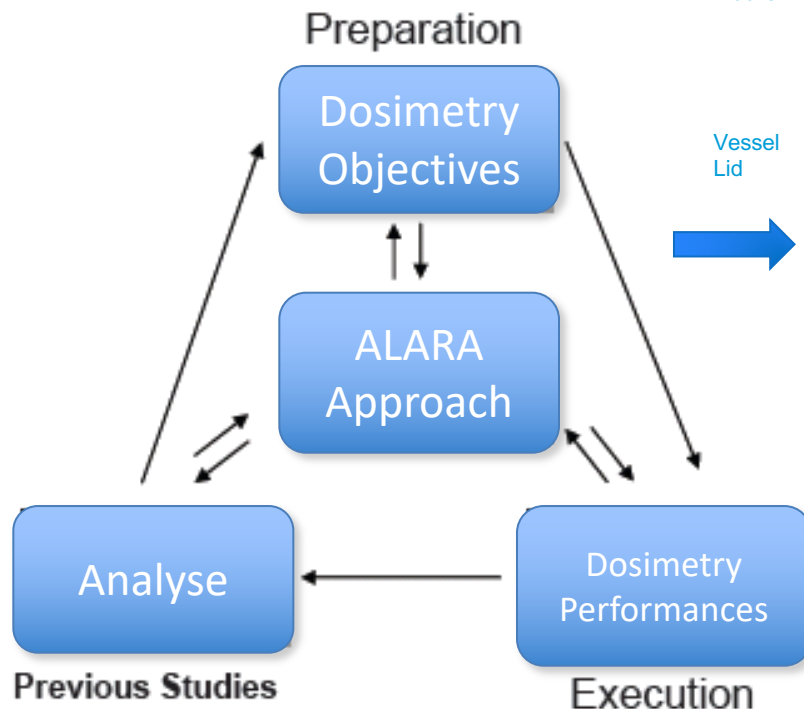




# TARGET STATION FACILITY - GLOBAL WORKING PLANS

## ALARA Approach:

Anticipate and reduce individual and collective exposition to radiations.



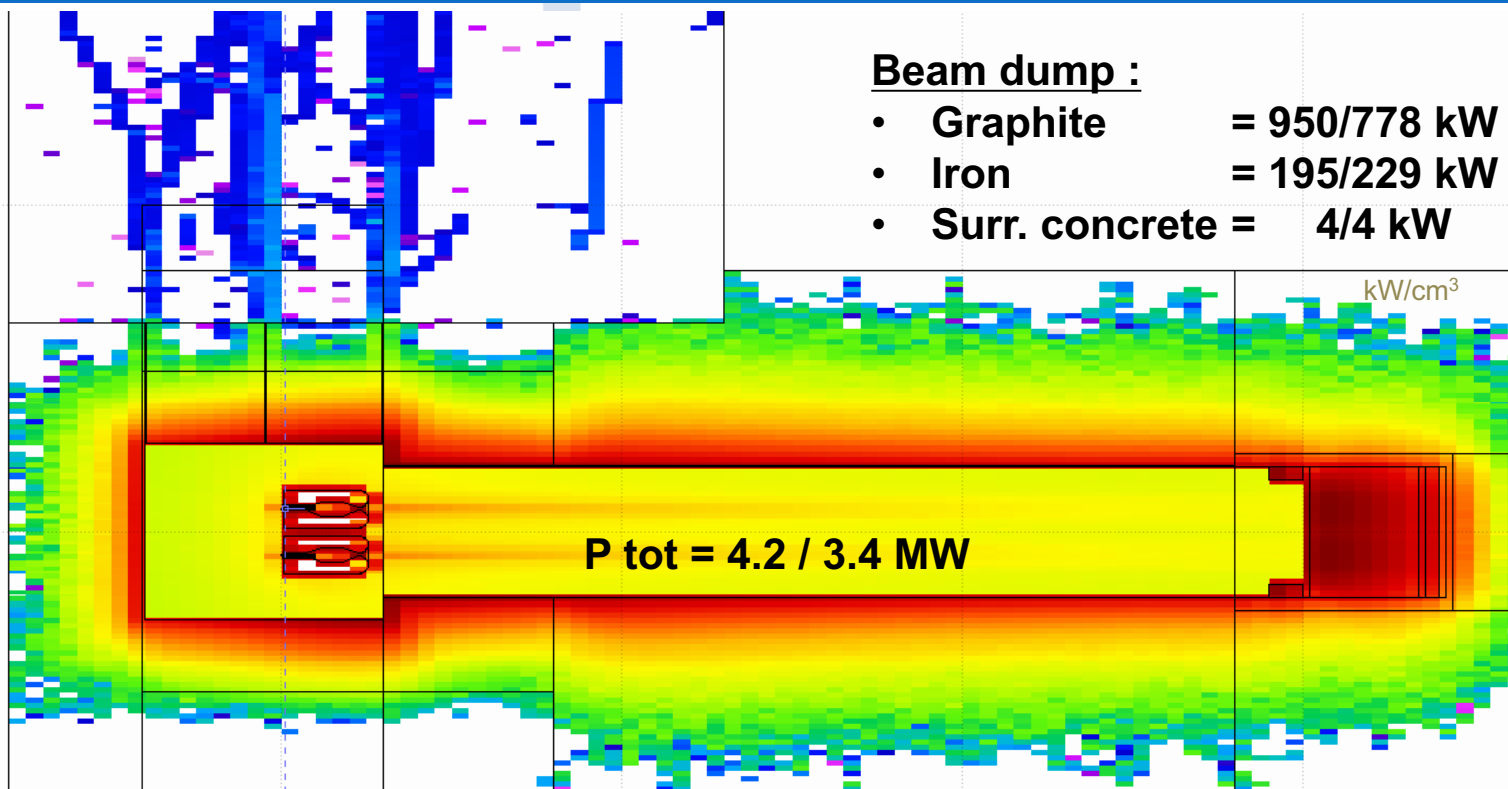
## Building “rooms”

- Open Top geometry for the Target Station Room, Decay Tunnel, Beam Dump
- Hot Cell (Repair Target Station elements)
- Morgue (Store radioactive wastes)
- Horn Power Supply Room , Power supply outside of the main building ?

=> Energy Deposition and Dose Rate Estimation  
with FLUKA Simulation

**As Low As Reasonably Achievable**  
Feedback from previous experiments is crucial

## TARGET STATION ENERGY DEPOSITION : ESSNUSB 1.6 MW / EURONU 1.3 MW



### Horns/Target gallery

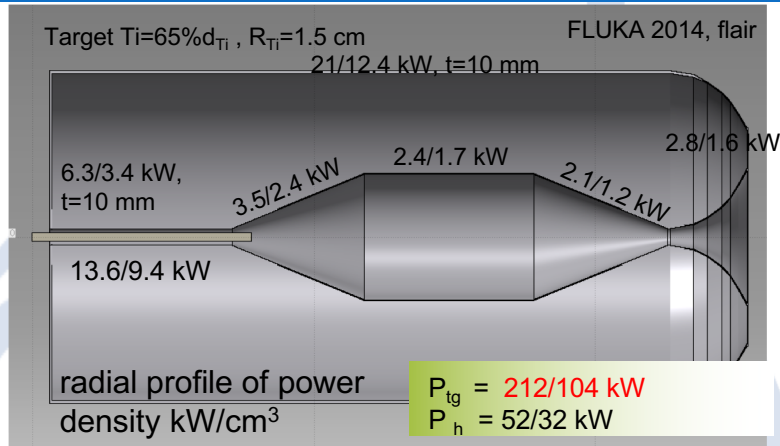
- Iron = 613/437 kW
- Horn = 50/ 32 kW
- Target = 168/ 85 kW

### Decay tunnel

- Iron vessel = 424/390 kW
- Upstream iron = 670/610 kW
- Surr. concrete = 467/485 kW

(N. Vassilopoulos)

# MATERIAL ACTIVATION



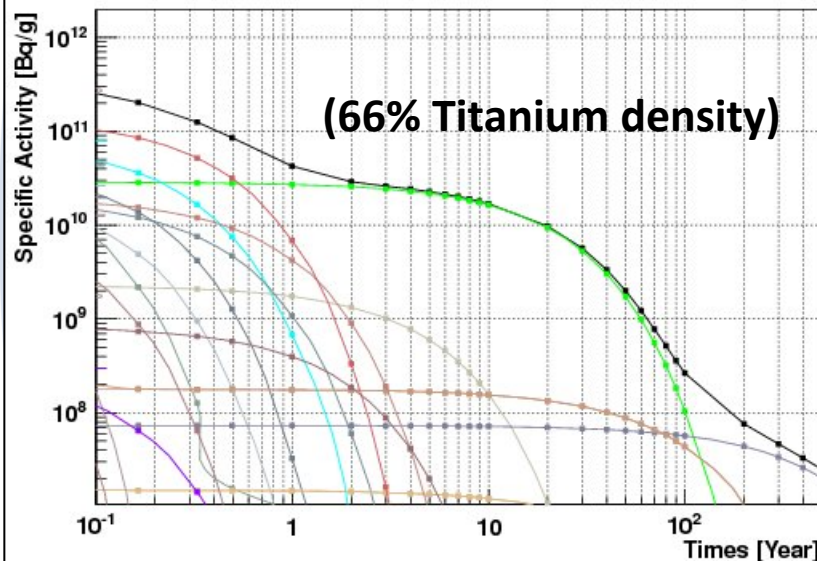
Target => Titanium (66% density)

Horn => Anticorodal 110 alloy

Al (95.5%), Si(1.3%), Mg(1.2%), Cr(0.2%),  
Mn(1%), Fe (0.5%), Zn(0.2%), Cu(0.1%)

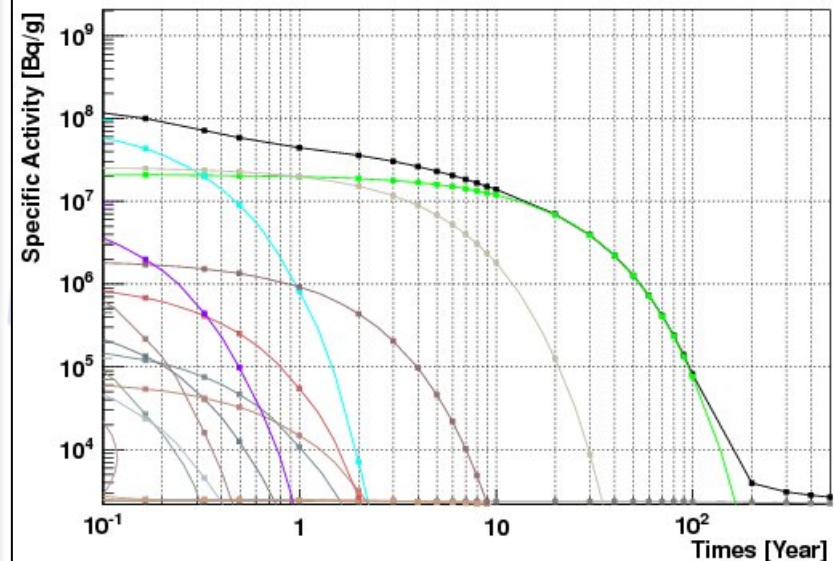
Specific activity evolution with cooling times for the Titanium Target

\*From EUROnu

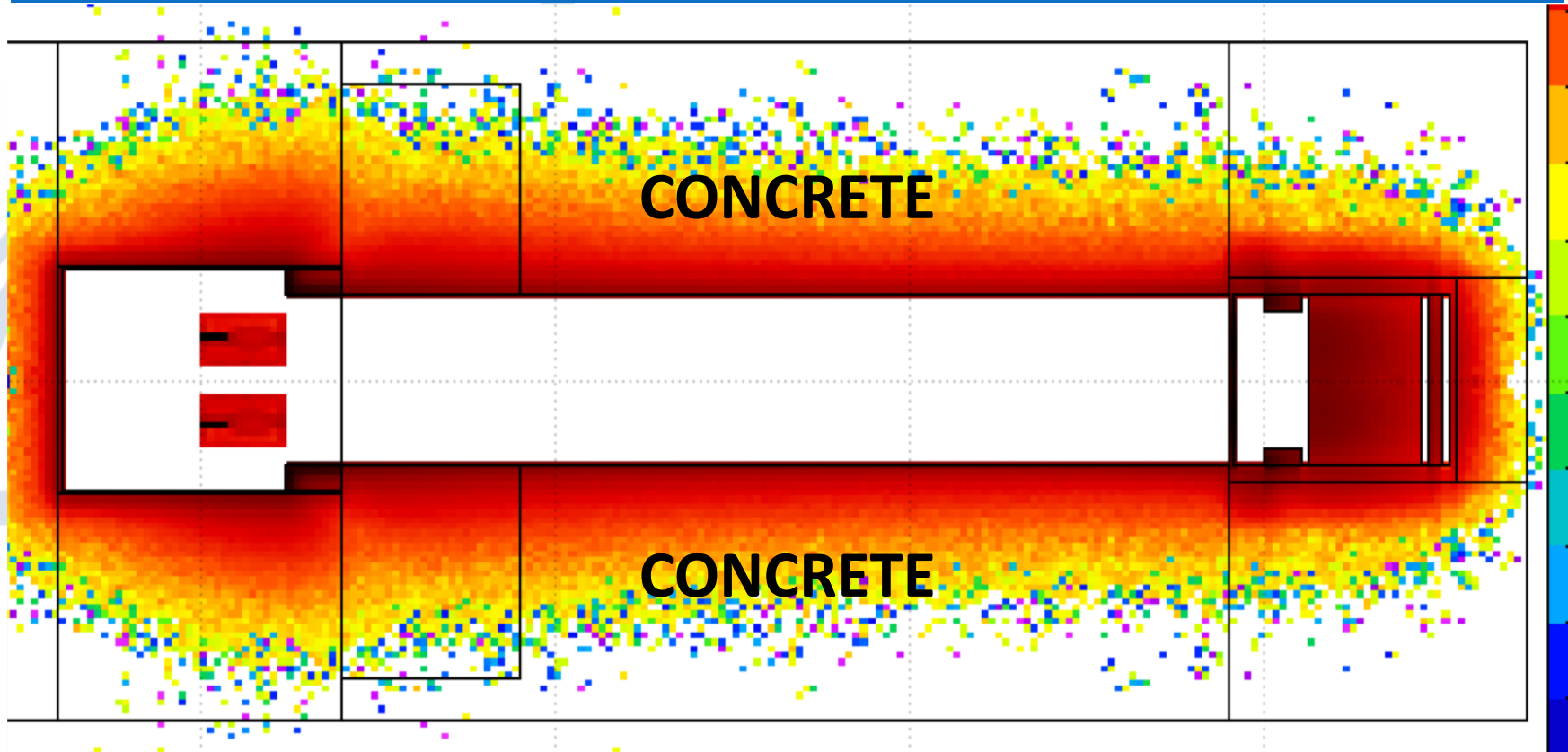


Specific activity evolution with cooling times for the Aluminum Horn

\* From EUROnu



# ENVIRONMENTAL IMPACT

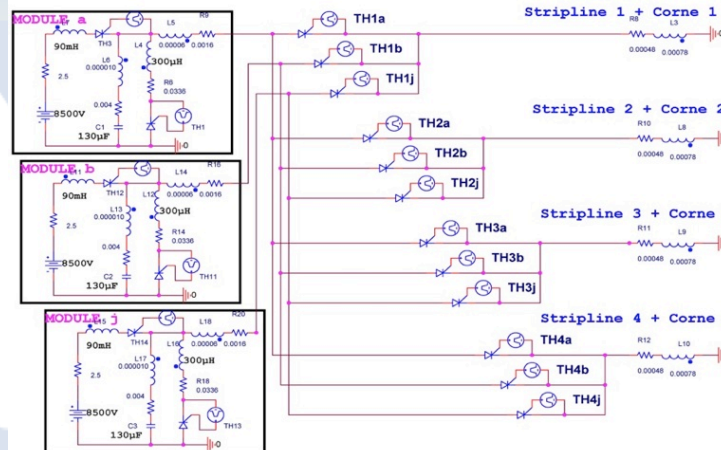
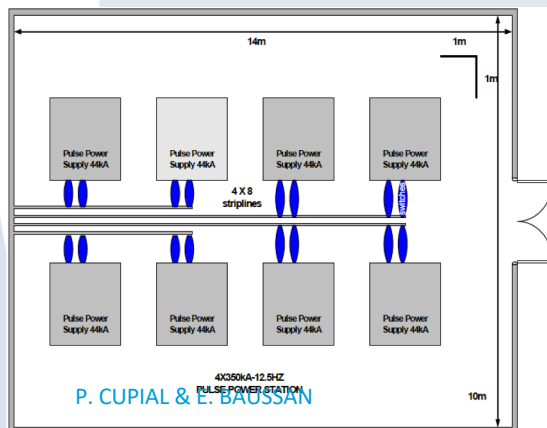
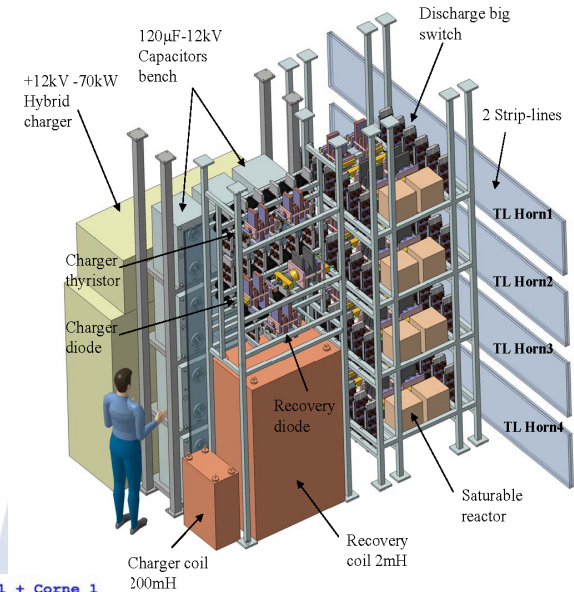
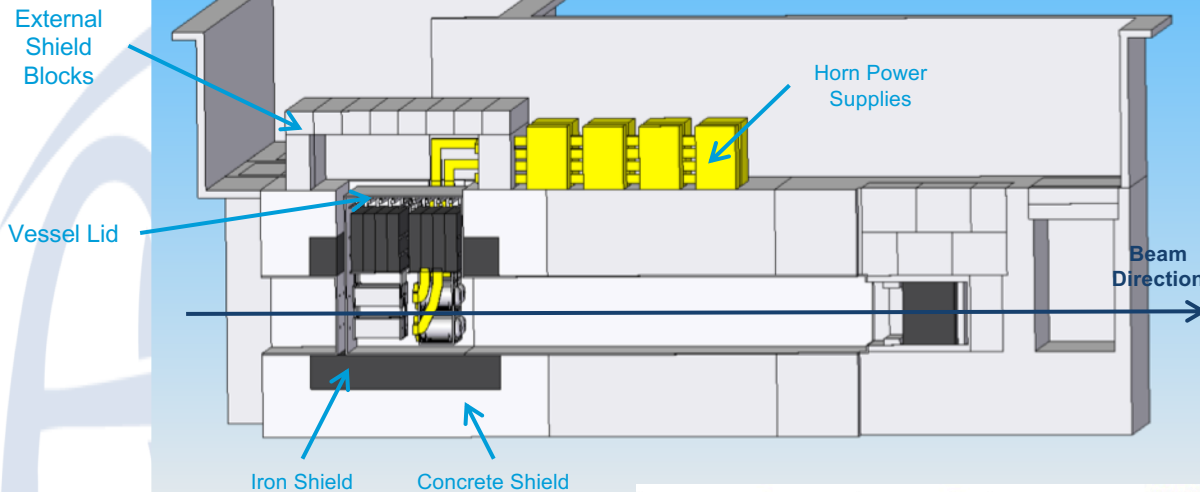


Among of all the radionuclide's created  $^{22}\text{Na}$  and tritium could represent a hazard by contaminating the ground water. Limits in activity after 1y=200days of beam:

=> Next Step : Adapt this study with new conditions,  
Interaction with ESS safety people crucial

# POWER SUPPLY PLANT CURRENT DESIGN

P. Poussot



- each MODULE delivers a current of 44kA max at  $F=50\text{HZ}$
- For each HORN : current of 350kA max at 12.5HZ
- energy recuperation (>90%) and reinjection
- lifetime > 13 Bcycles (10 years, 200 days/year)

30/10/2018

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Next Steps => Upgrade with the new Beam Pulse Structure from accumulator : Very Challenging !!



# TARGET CHALLENGES IN THE BASELINE

