Grand Accélérateur National d'Ions Lourds

GANIL

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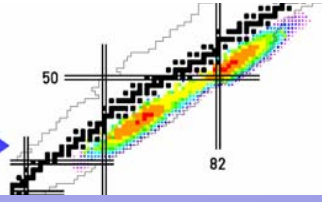
Spiral2



Development of an experimental set-up for the containment of radioactive volatile isotopes in SPIRAL II

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First Workshop on Actinide Target Development

TRIUMF

April 27-29, 2006 - **Vancouver, British Columbia**

Summary

- Simulation tool : MOVAK3D
- Cryotrapping systems

SPIRAL2 PROJECT

OBJECTIVE

Production of neutron-rich exotic nuclei

$A > 40$; N ↗

TOOL

Nuclear fission

PROBLEM

Very strong activity ($7\ 10^{14}$ Bq)

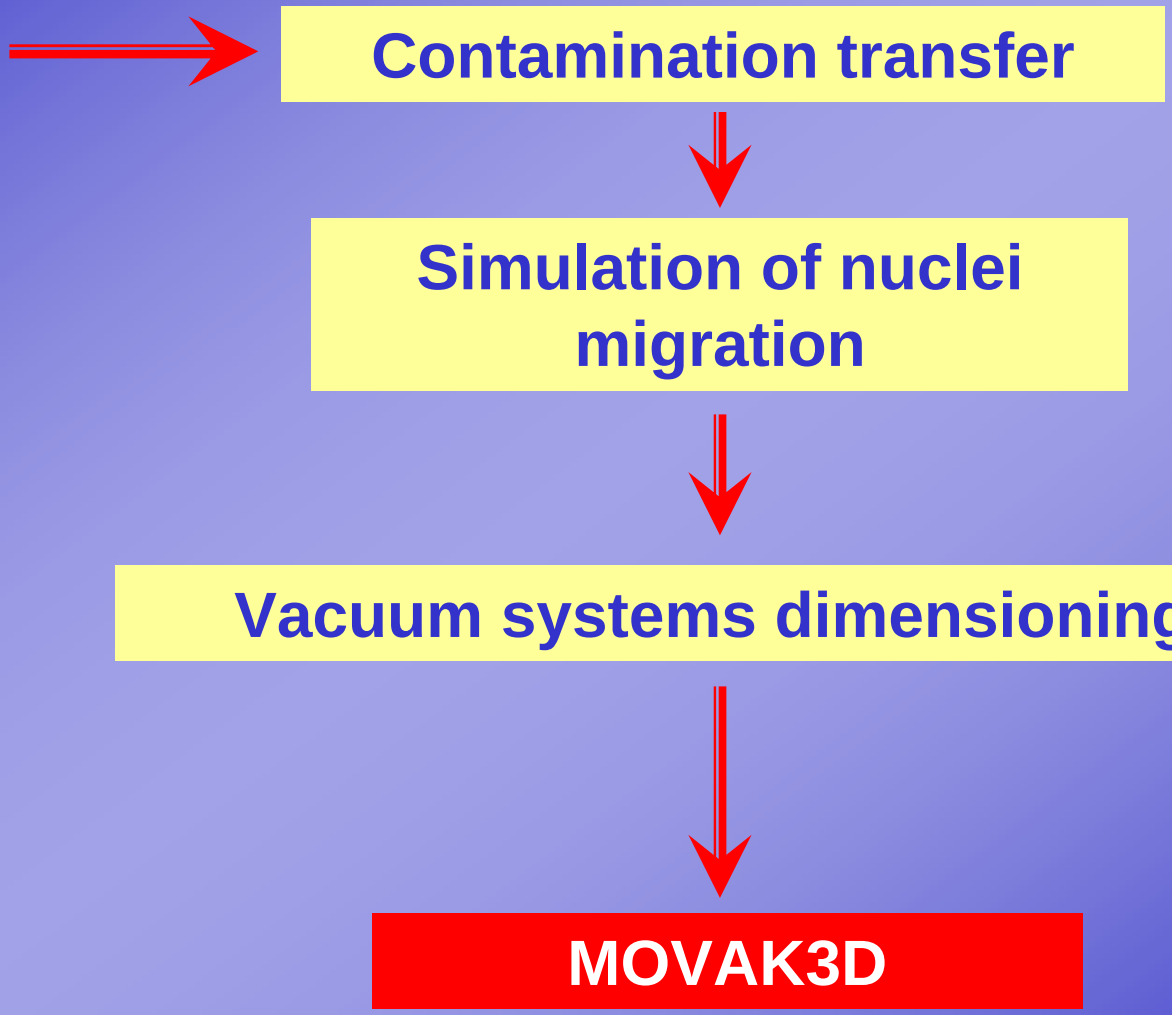
To have an idea :

Target UCx (SPIRAL2) : $8.3\ 10^{13}$ Bq/kg

PWR unloaded : $7.5\ 10^{13}$ Bq/kg

Problematic question :

Very strong radioactivity ~ 7 10^{14} Bq

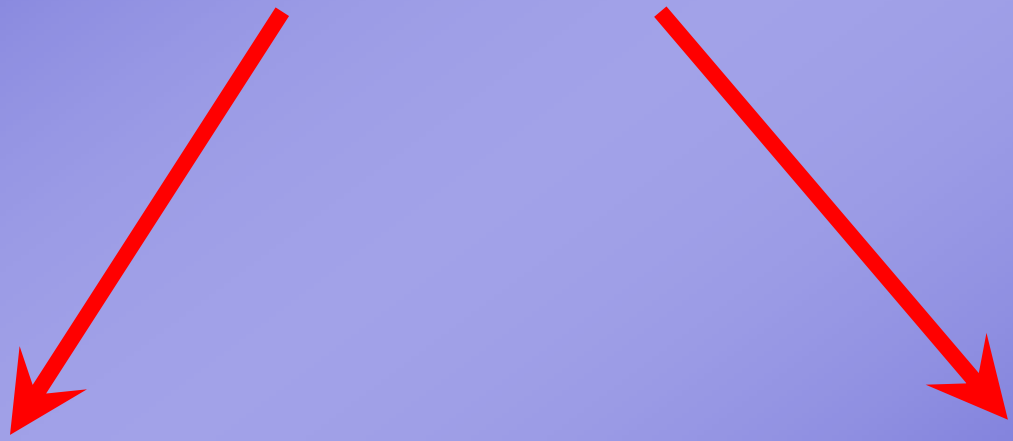


Movak3D Code : description

- Transmission probability
- Molecular regime (very low pressure)
- Any geometric shape
- Monte Carlo Simulation

Movak3D Code : validation

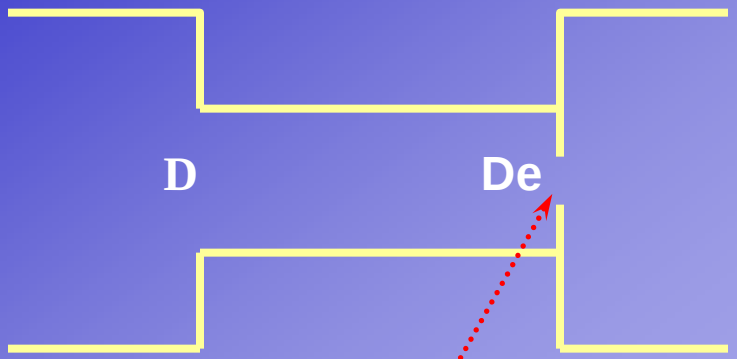
Comparative method

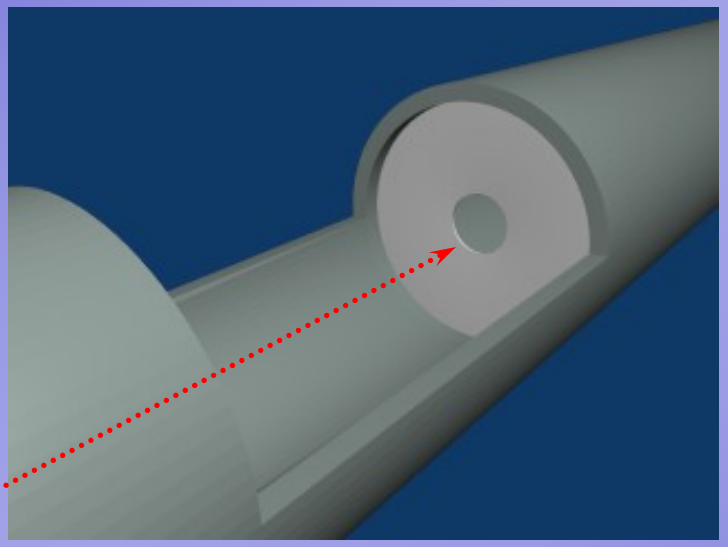


Theoretical formulas

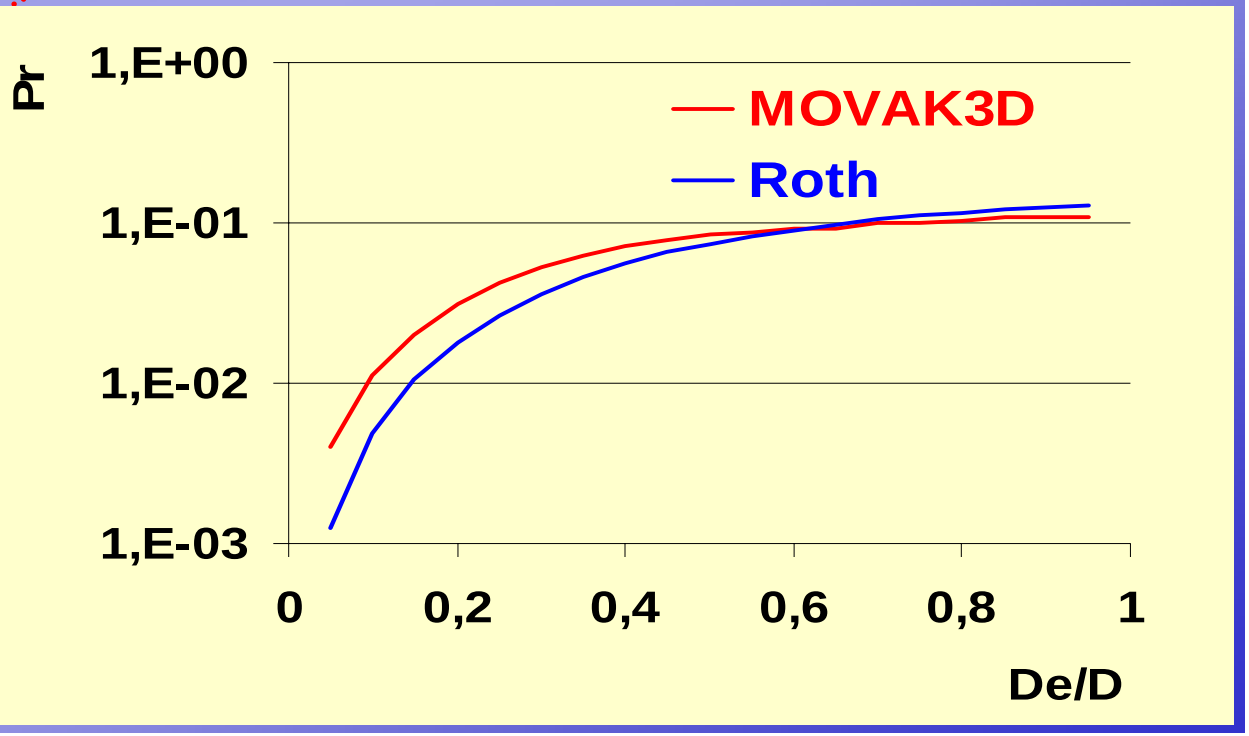
Experimentation

MOVAK3D : Theoretical validation





Diaphragm



Roth, A., 1990, “Vacuum technology”, Elsevier Science Publishers B.V., 3ed edition, Amsterdam.

MOVAK3D : Experimental validation at 20 K

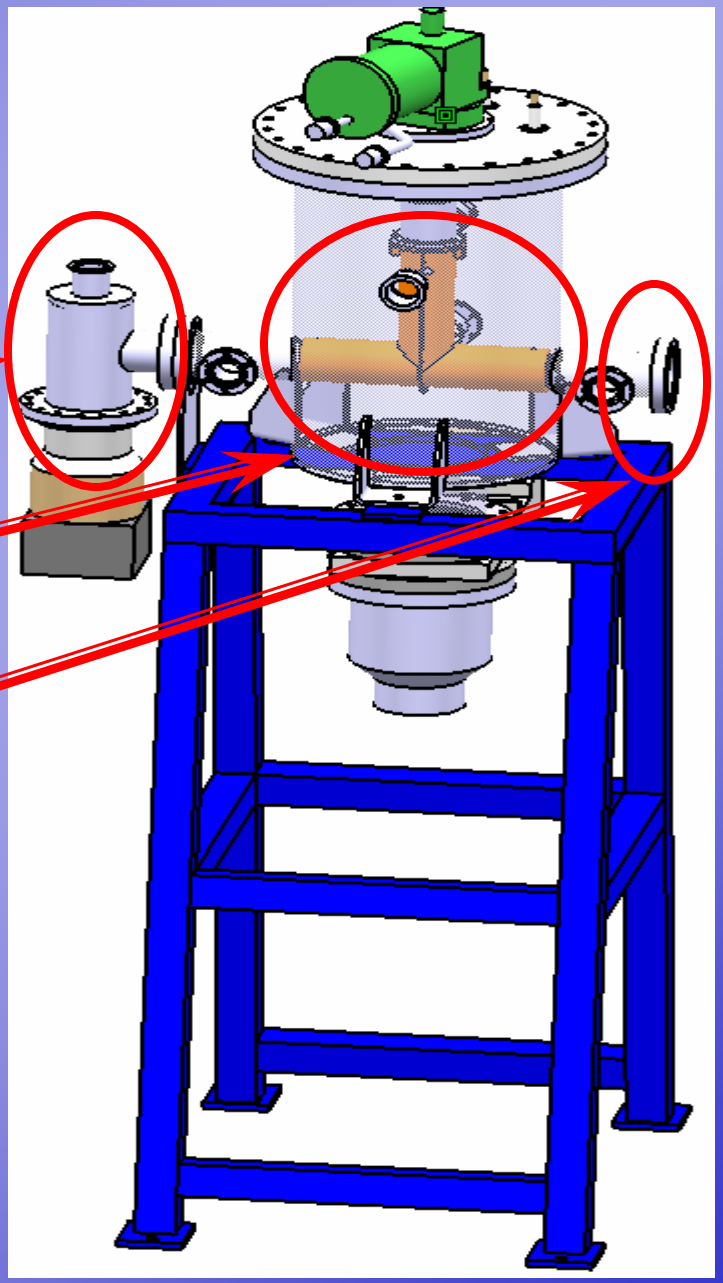
Outgoing flux : Φ_e

Gaz flow at 20 K

Flux entry : Φ_i

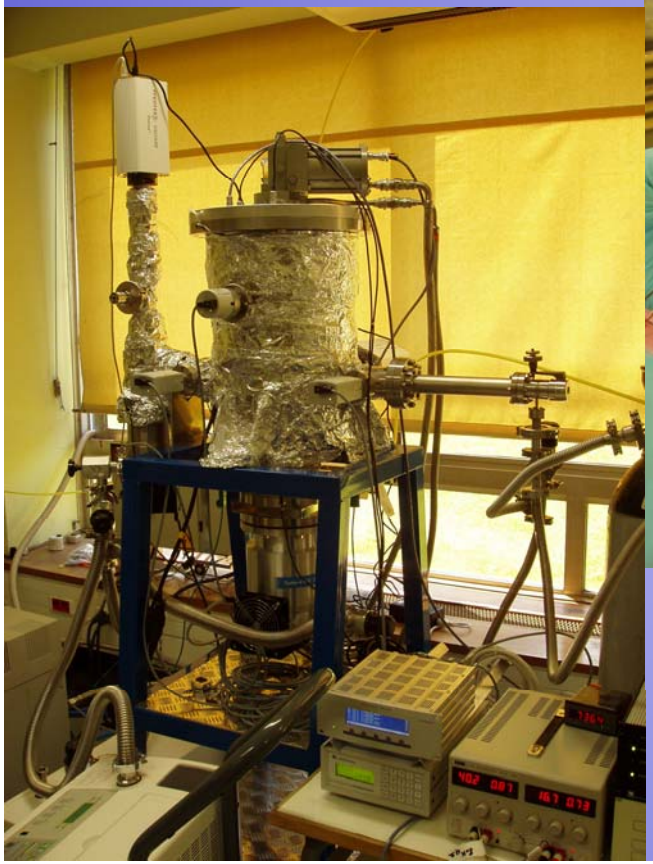
Transmission probability :

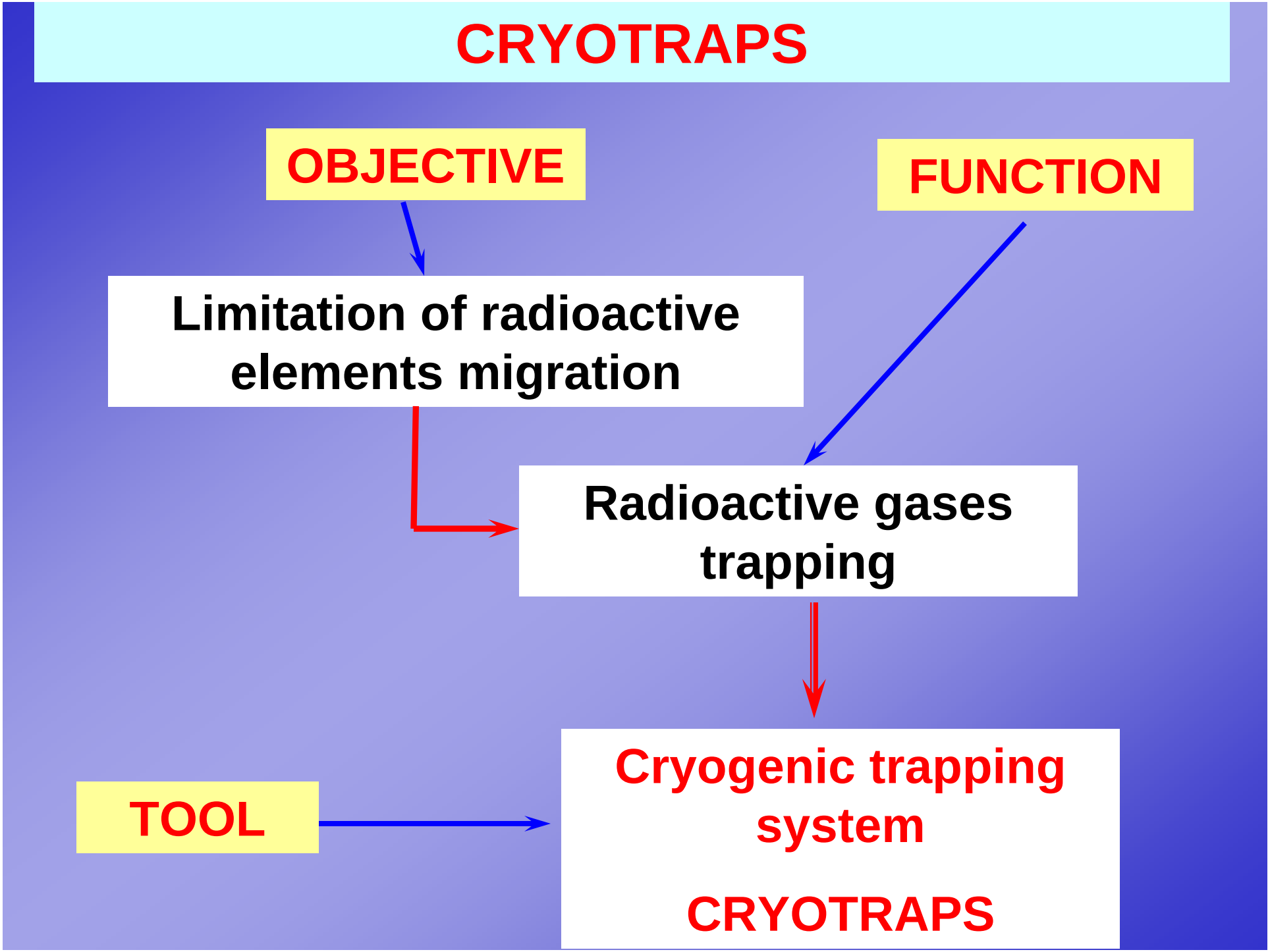
$P_r = \Phi_e/\Phi_i$



	Measurement	MOVAK3D	
N2	0.21 ± 0.063	0.12 ± 0.01	%
Ar	0.19 ± 0.057	0.12 ± 0.01	%

MOVAK3D : Experimental validation at 20 K




CRYOTRAPS
OBJECTIVE
FUNCTION
Limitation of radioactive elements migration
Radioactive gases trapping
TOOL
Cryogenic trapping system
CRYOTRAPS

For which temperature gases from UCx target can be condensed on cupper surface (i.e s = 1) ?

Radioactive gases in the target UCx after 90 days of irradiation

$4\ 10^{14}$ Bq

Hypothesis :

T_{fusion} < 2000 °C → element in gaseous state

80 K

Te, Ba, Sr, Sb, In,…, H_2O

GR1 : $3.5\ 10^{14}$ Bq

20 K

N2, O2, CO2, CO, rare gases

GR2 : $5.5\ 10^{13}$ Bq

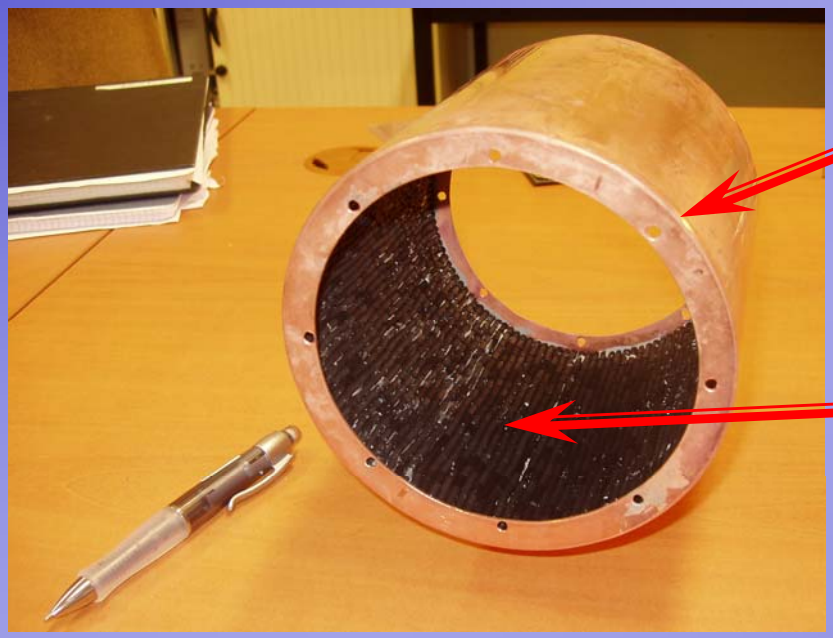
20 K with a solid absorber

H_2 ; H_3

GR3 : $1.4\ 10^{8}$ Bq

Activated charcoal effect on some gases

We add to this part activated charcoal and we observe the impact on the gas transmission



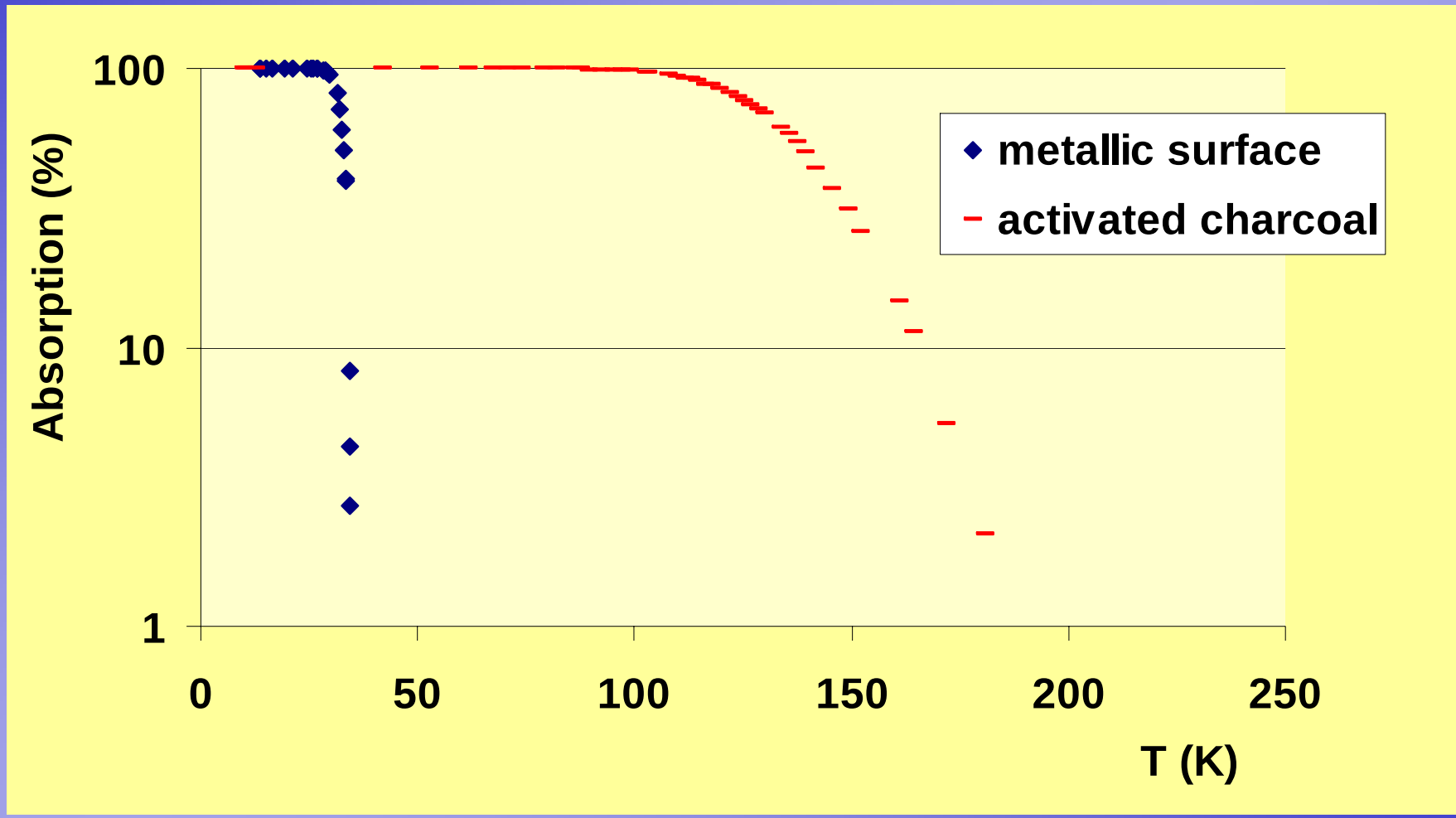
Activated charcoal

Experience with two gases

- nitrogen
- hydrogen

Transmission probability = f(temperature)

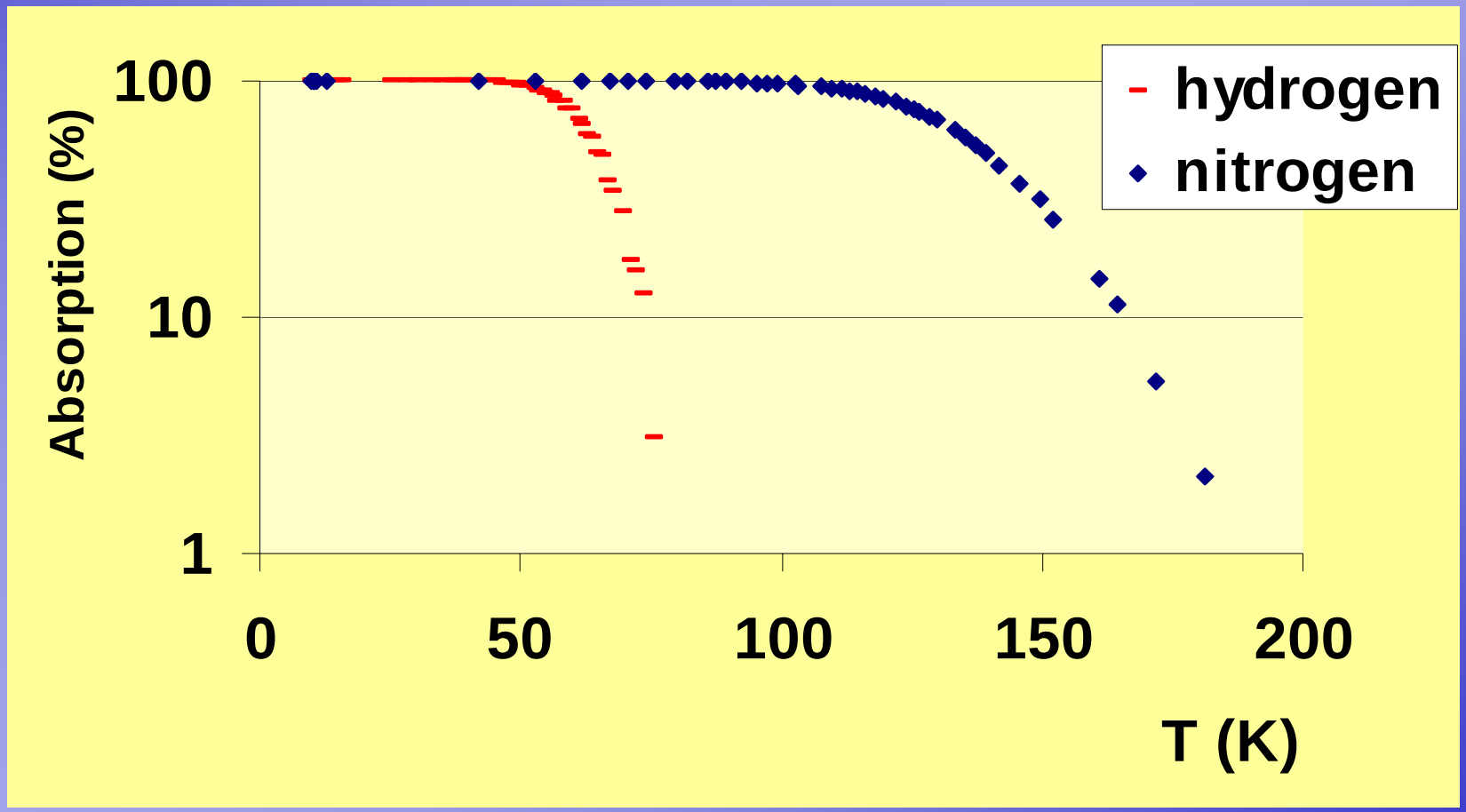
Nitrogen absorption on activated charcoal

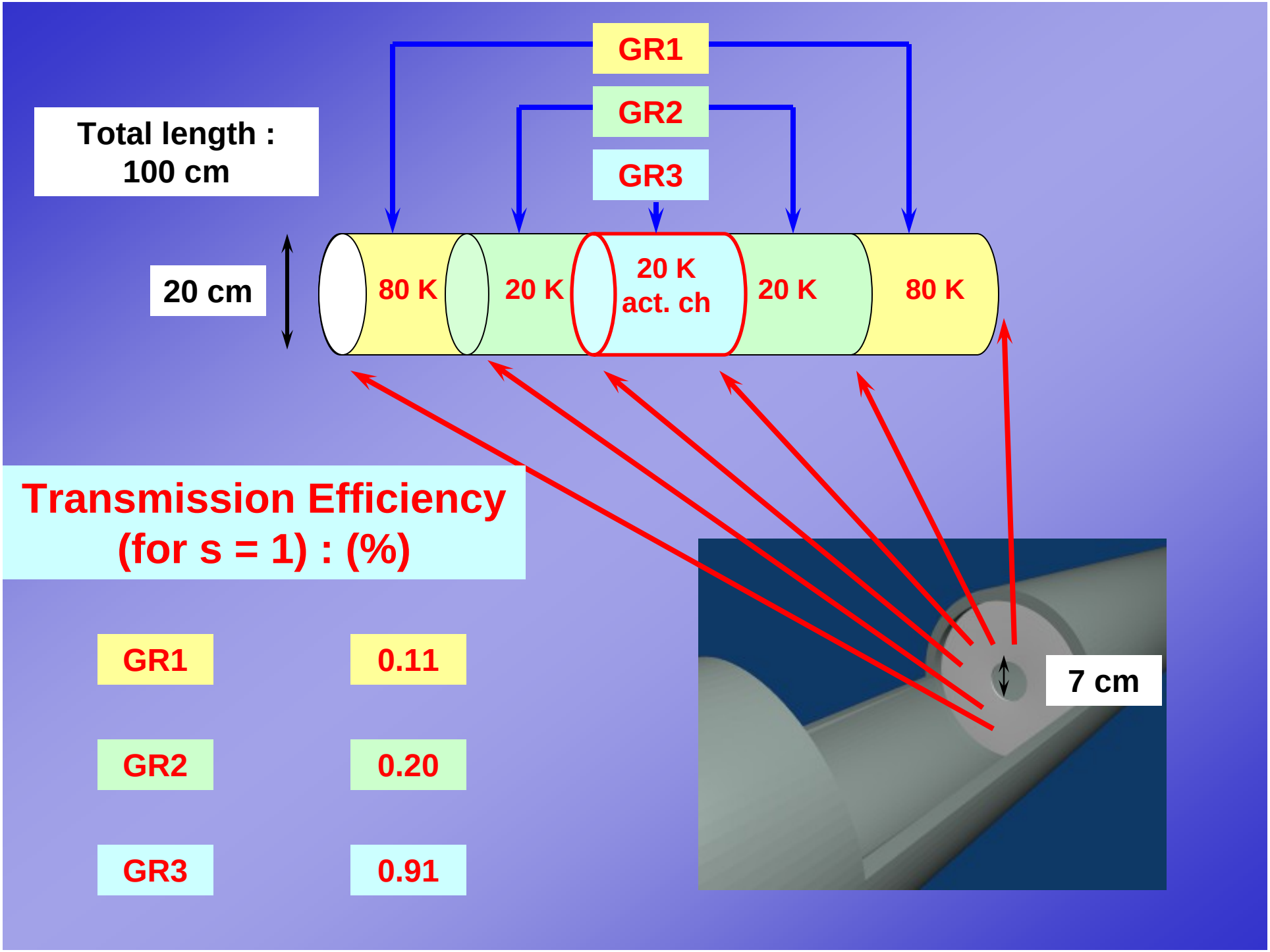


Hydrogen absorption on activated charcoal

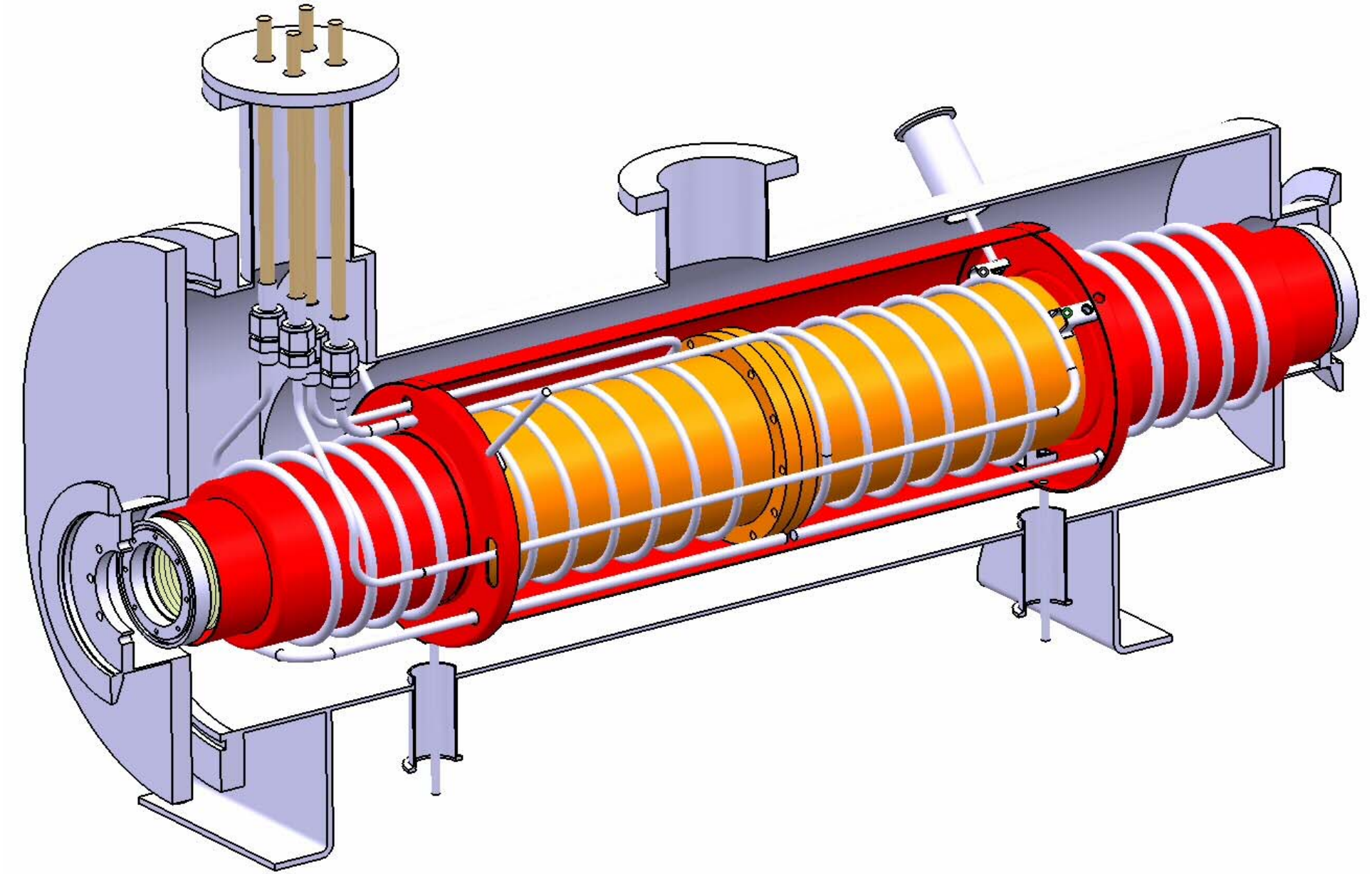
Hydrogen is difficult to be condensed on any metallic surface

It is necessary to add activated charcoal to make possible the trapping of tritium molecules

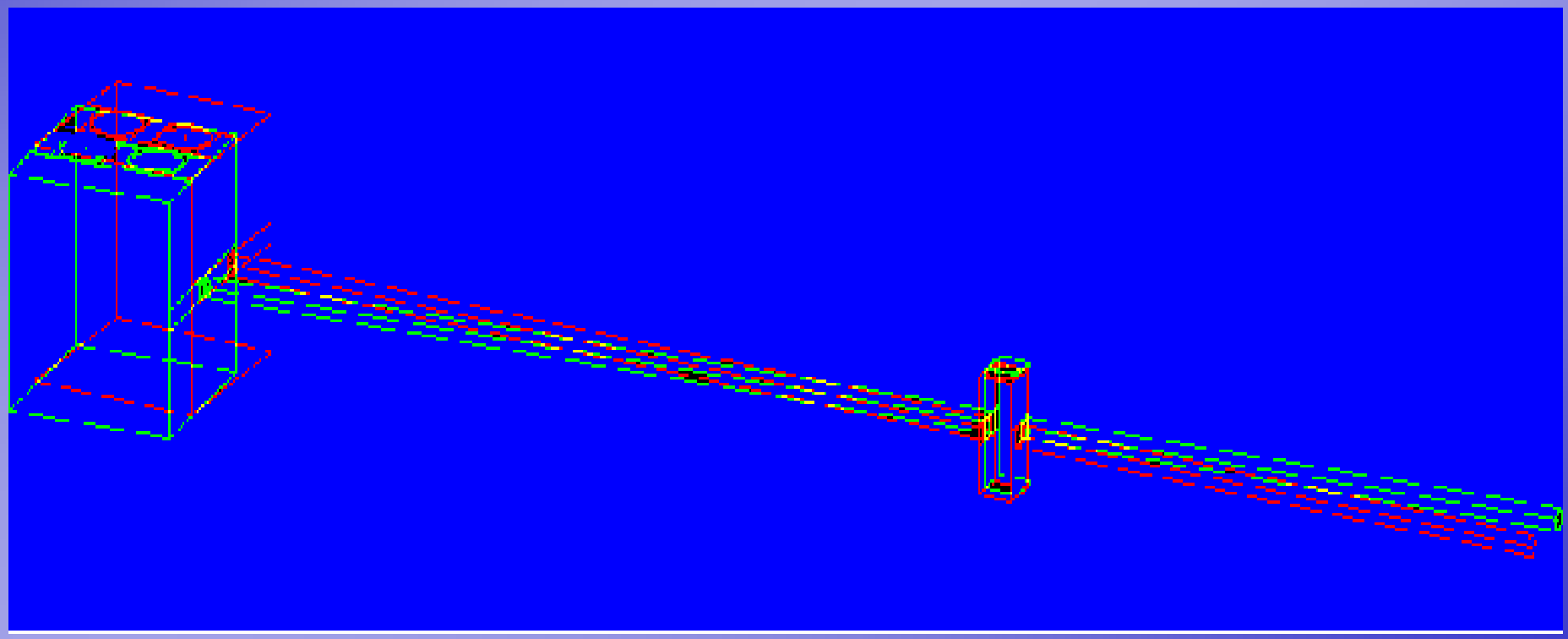



GR1
GR2
GR3
Total length :
100 cm
20 cm
80 K
20 K
20 K
act. ch
20 K
80 K
Transmission Efficiency
(for s = 1) : (%)
GR1
0.11
GR2
0.20
GR3
0.91
7 cm

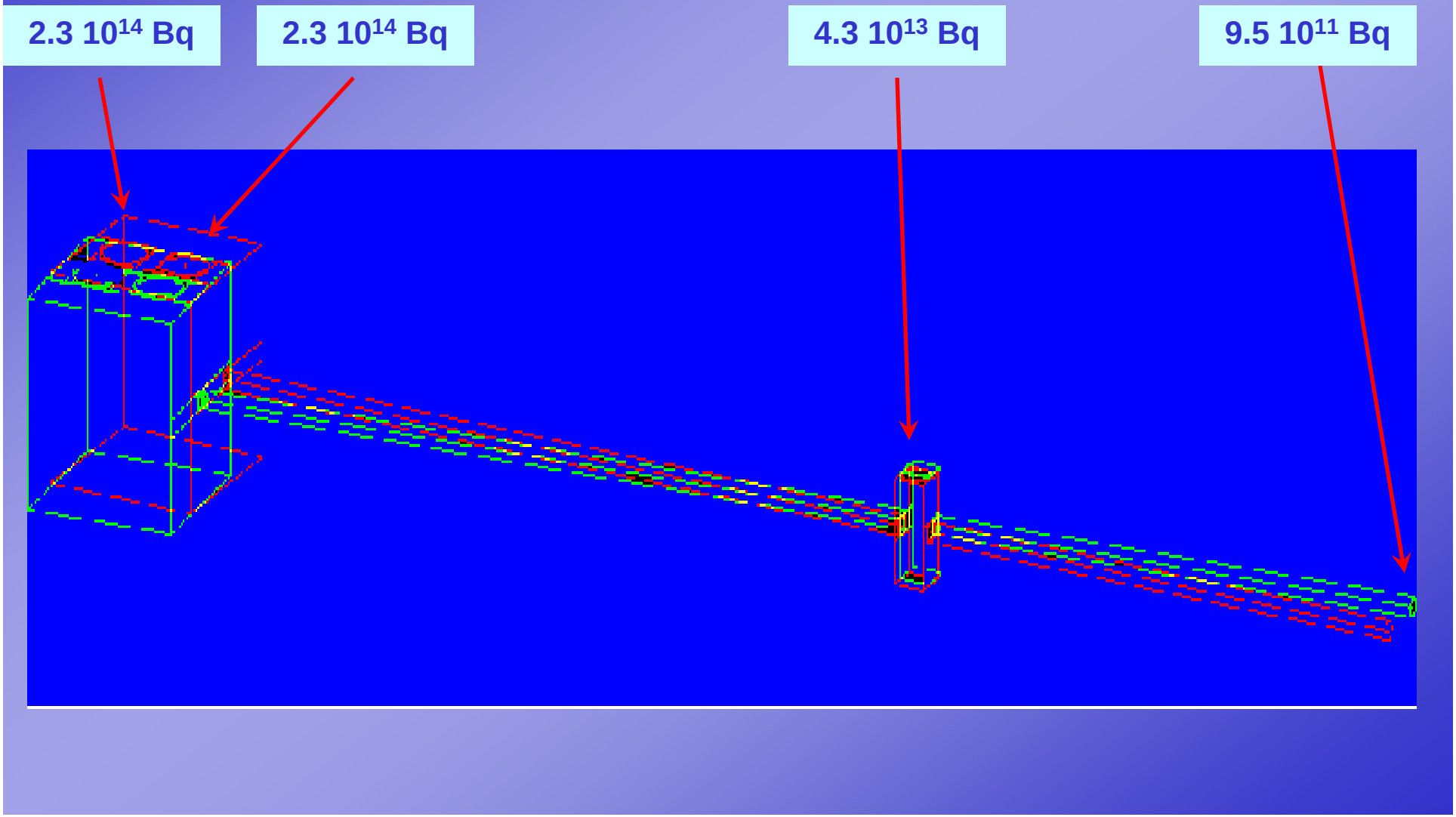
CRYOTRAPS DESIGN



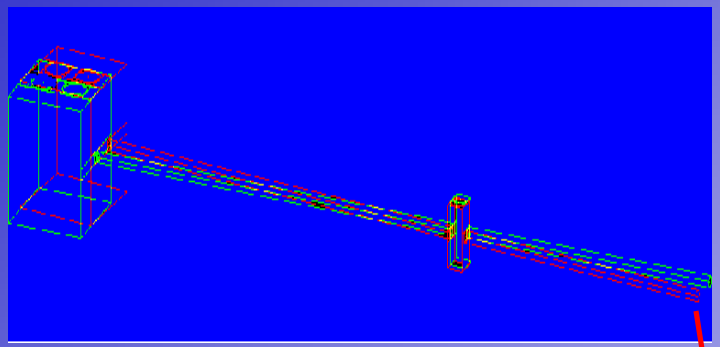
First beam line in Wien version



First beam line in Wien version

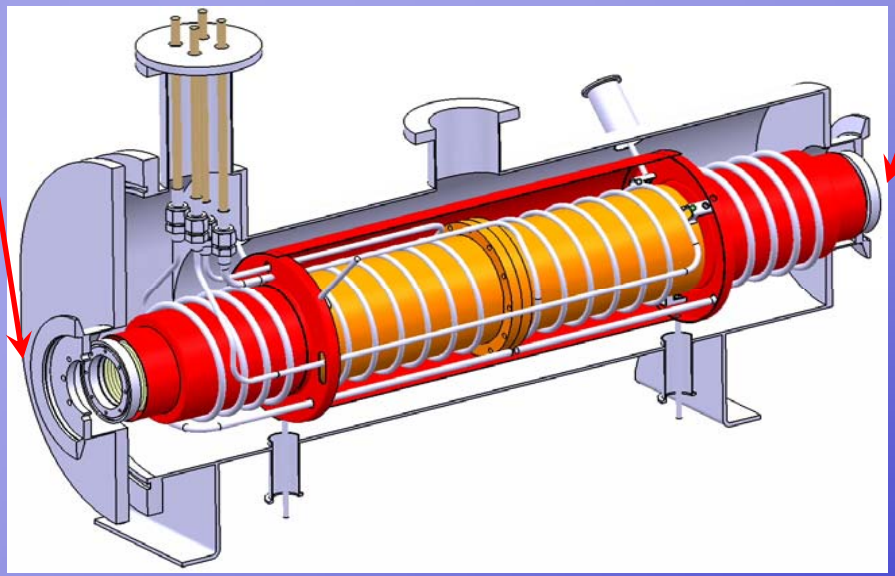


First beam line in Wien version



0.11 %

1.0 10^{9} Bq



9.5 10^{11} Bq

Conclusion and prospects

- Good agreement between Movak3D and measurements and theoretical formulas
- Cryotraps prototype under construction at GANIL
- Cryotraps prototype and cryogenic source tests this year
- Modeling of some significant phenomena for gases transfer (like accommodation) are in development in GANIL