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Preliminary study for the detection of neutrons in heavy ion collisions with charged particle detectors

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for EXOCHIM collaboration

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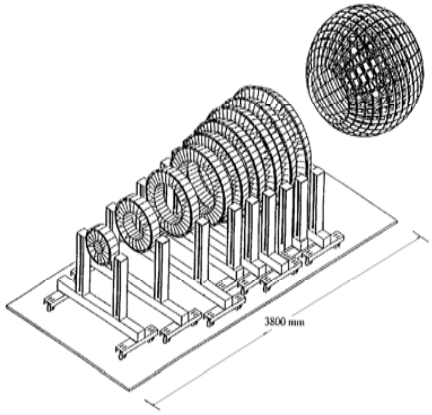


CHIMERA: charged particle 4π multidetector (@LNS) – ΔE-E.

FARCOS (under construction): charged particle correlator (@LNS) – ΔE_1-ΔE_2-E.

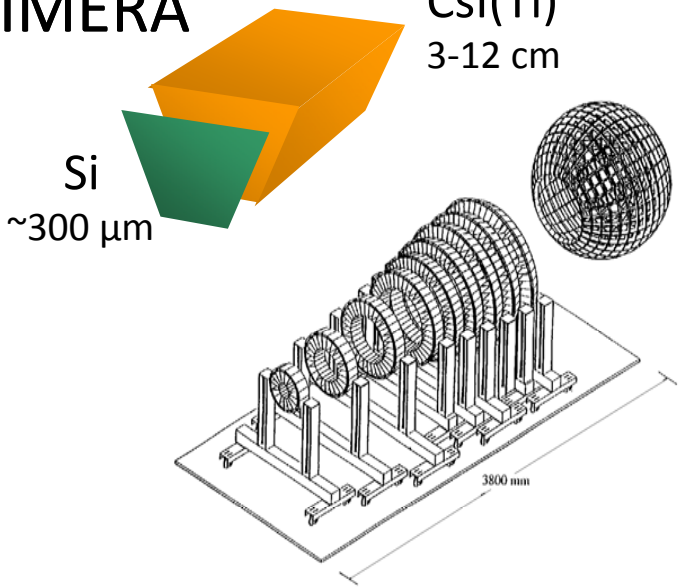
Detector 'upgrade' in order to detect also neutrons.

Final detector structure: as similar as possible to the existing configuration.

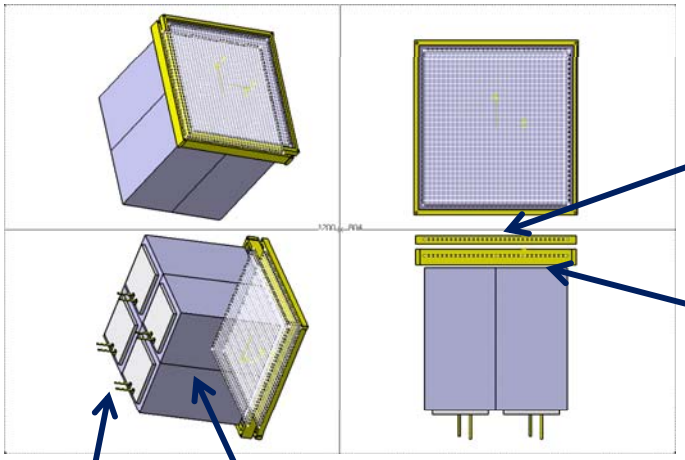
I step: one or more Si detectors (wafer, strip)

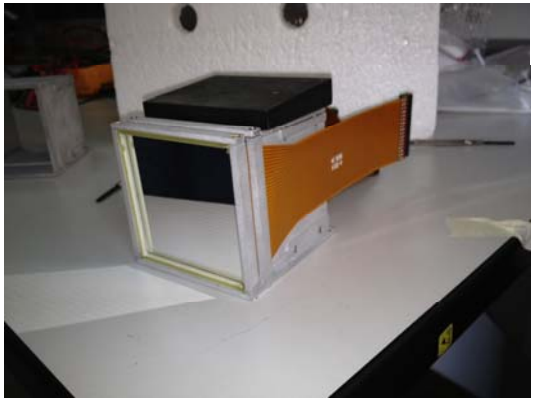
II step: CsI(Tl) scintillator

CHIMERA

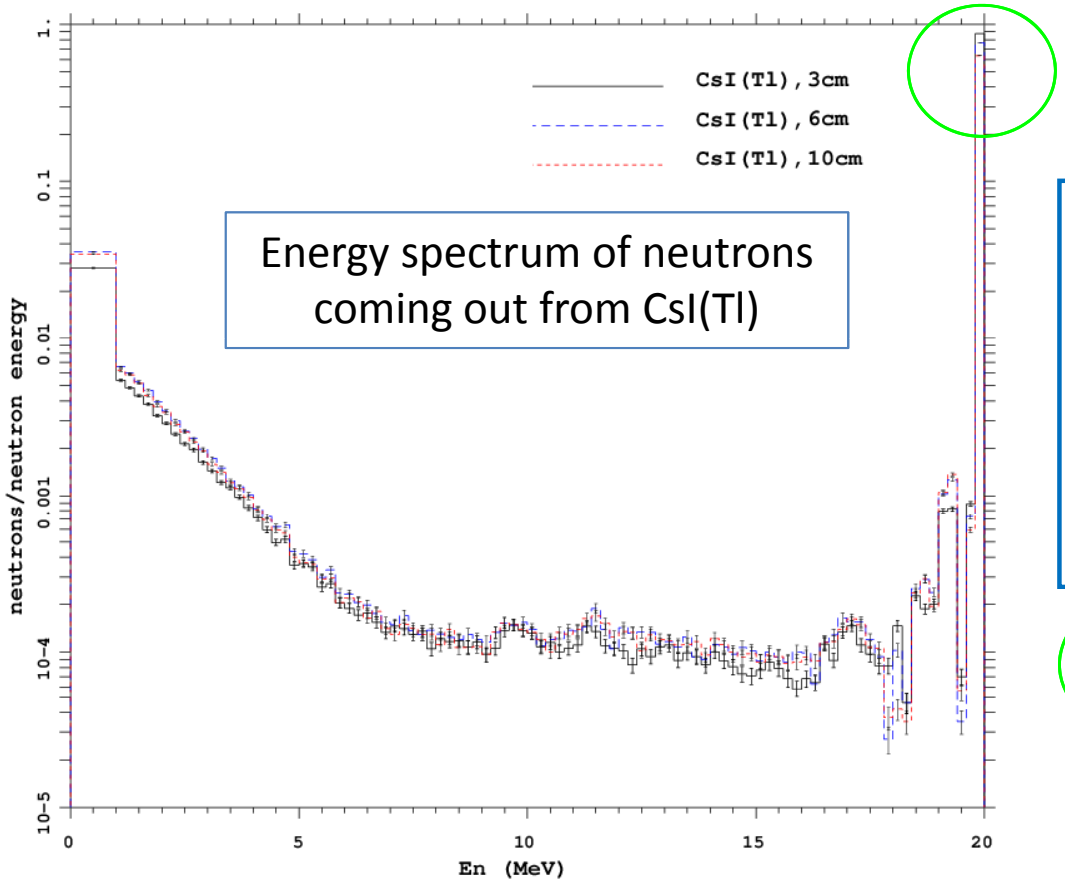


FARCOS
(prototype)





Preliminary MCNPX simulations
Tracking SABRINA

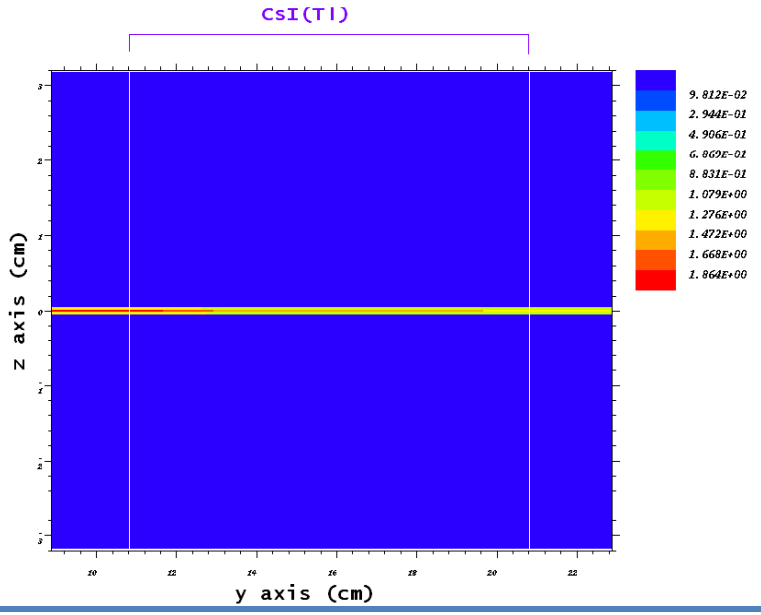


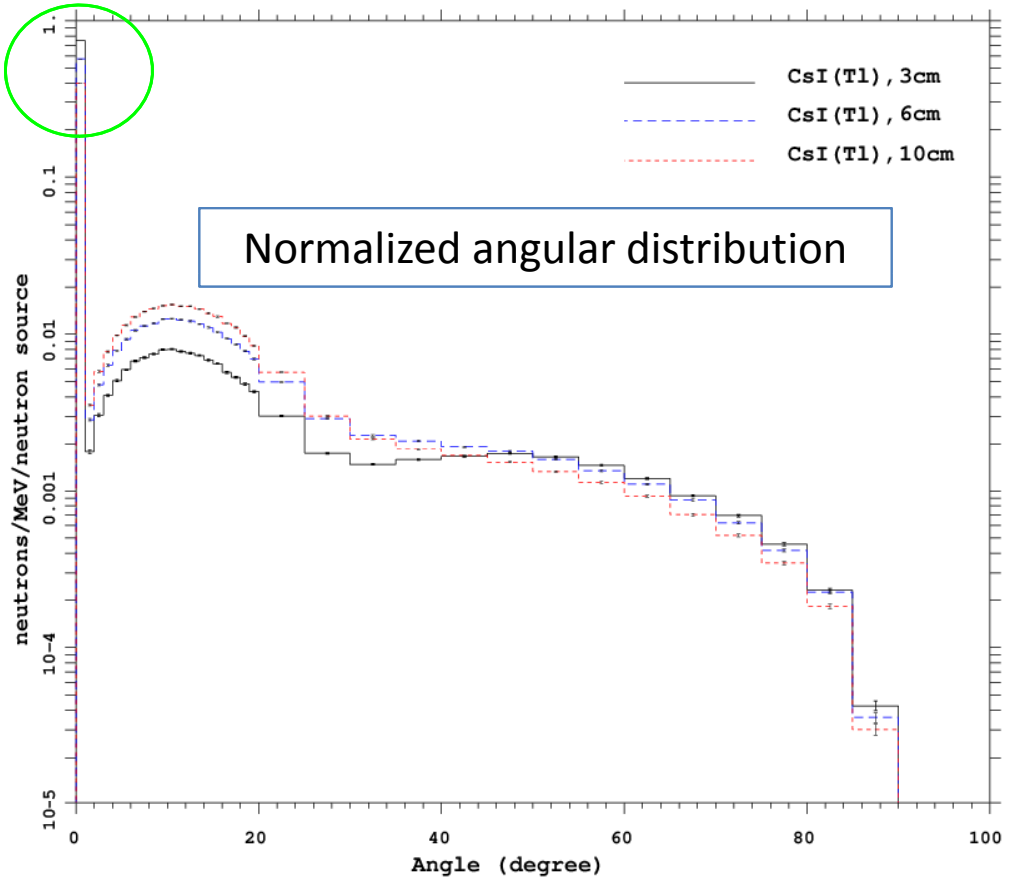
Energy spectrum of neutrons coming out from CsI(Tl)

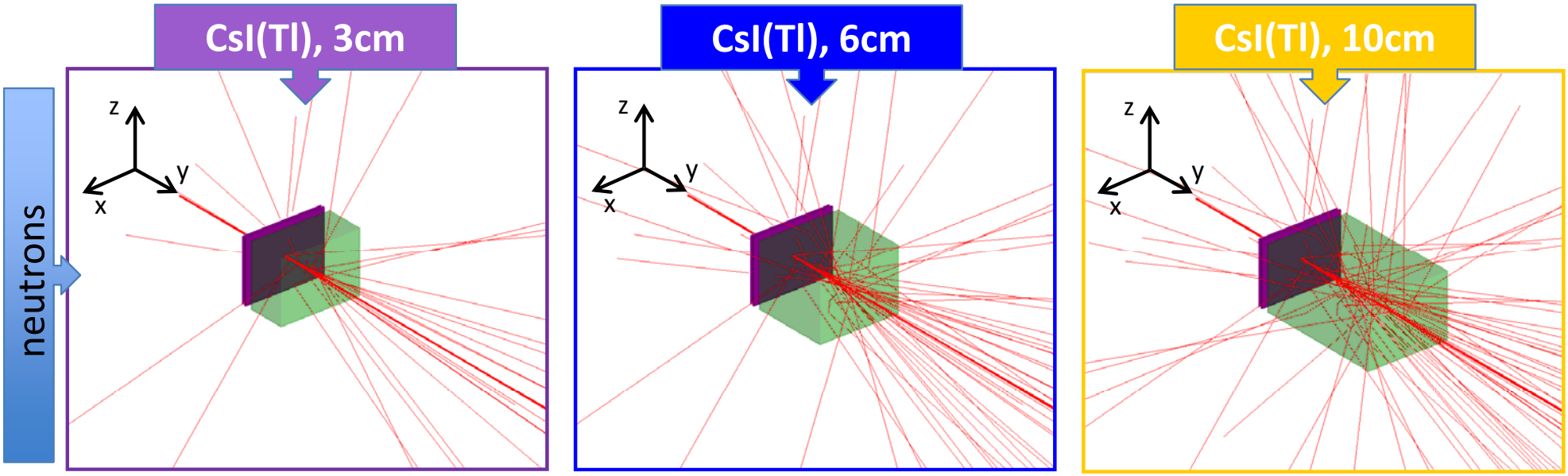
Setup: FARCOS configuration with CsI(Tl) thickness ranging from 3 to 10 cm.

Libraries: LAN150N, TENDL2010/2.

Mix and match method. E_n=20MeV.







SABRINA tracking – 100 histories

Interaction type	CsI(Tl) 3cm	CsI(Tl) 6cm	CsI(Tl) 10cm
(n,n'γ)	12	16	25
(n,2n)	5	11	16
(n,3n)	1	5	5
(n,n_x)	-	5	1
(n,n') in SI(II)	2	1	1
(n,n_x) in Si(II)	1	1	1
(n,n'p) in Si(II)	1	1	1
Elastic scattering in SI(I)	-	1	-
No interaction	88	61	49

No. of interactions in CsI(Tl) (100 histories)

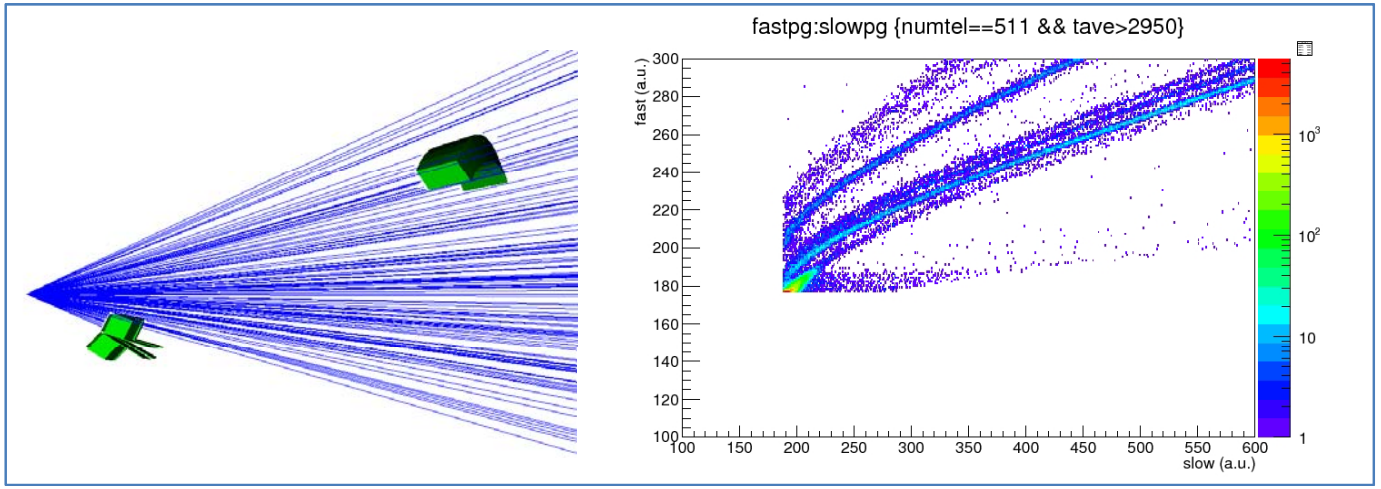
In CsI(Tl) 6cm thick:

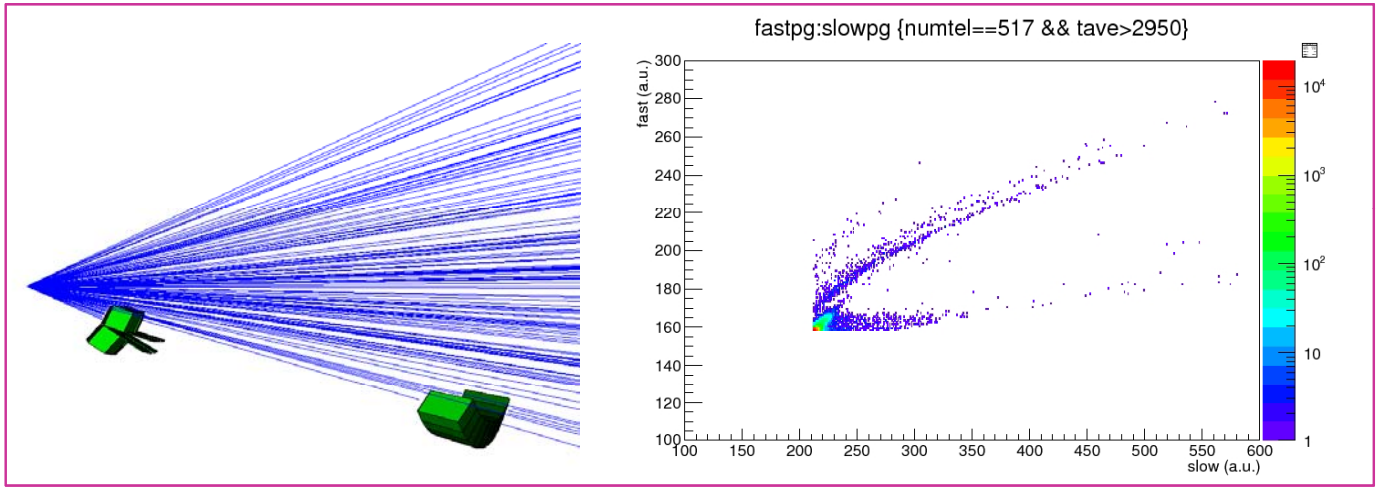
- ≈ 23% of incident neutrons experience interactions
- ≈ 13% of neutrons (both from the source and secondary ones) exit from lateral surfaces of CsI(Tl)

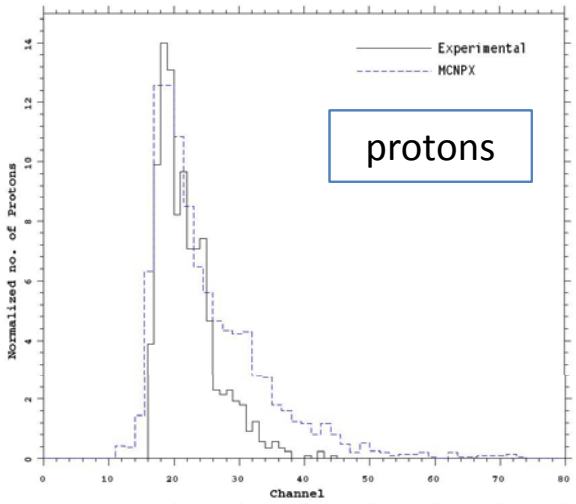
Signal in surrounding detectors?!?!

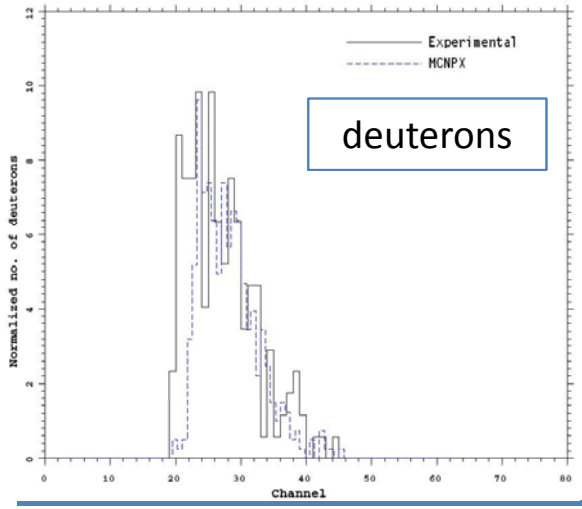
Validation of MCNPX simulations

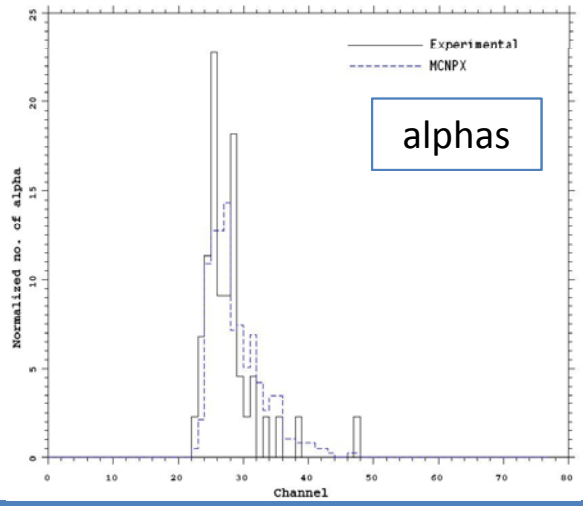
INKIISSY experiment @LNS
$^{124}Xe+^{64}Zn$@35AMeV
Part of ring8 and ring9 of CHIMERA detector are in the shadow beyond FARCOS.











Relative yield (%)	Experiment	MCNPX
Y_{d}/Y_{p}	19.7	21.7
Y_{t}/Y_{p}	3.4	11.4
Y_{3He}/Y_{p}	2.0	1.2
Y_{alpha}/Y_{p}	5.0	20.

CONCLUSIONS

(preliminary)

✓ Monte Carlo simulations allow to evaluate the level of 'perturbation' experienced by neutrons in CHIMERA/FARCOS detectors and cross-talk effects.

✓ Comparison among MCNPX simulations and experimental data (INKIISSY experiment@LNS) allow us to validate theoretical models, used libraries and methods.

✓ Once validated, simulations can help us to define a method to account for background and other side effects thus to reconstruct energy spectrum of neutrons coming from the source.

✓ Finally, simulation results can be used to define the 'best' way to upgrade CHIMERA (or FARCOS) with a neutron detection system.

✓ First data analysis results of the INKIISSY experiment would indicate the chance to detect neutrons by properly shadowing CHIMERA Si-CsI(Tl) telescopes thus suggesting an 'easy' and 'cheap' way to upgrade CHIMERA for neutron detection.

Analysis is still in progress!

Properties of new scintillators are also being investigated!