The LIONS experimental programme

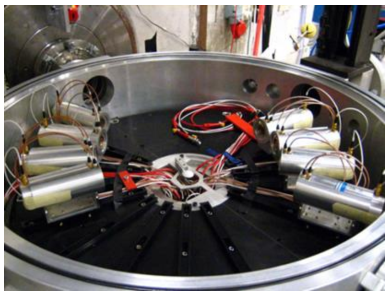
and its relevance for nuclear science and applications,

or

How can NFS help fusion?

Alexander V. Prokofiev[1,*], Diego Tarrío[1], Marc O. Fregeau[2], Xavier Ledoux[2], and Stephan Pomp[1]

[1] Uppsala University, Uppsala, Sweden
[2] GANIL



UPPSALA UNIVERSITET

Outline of the talk

I. *What* do we want to study?

II. *Why* do we want to study it?

III. *How* do we plan to study it?

UPPSALA UNIVERSITET

Outline of the talk

I. ***What* do we want to study?**

II. *Why* do we want to study it?

III. *How* do we plan to study it?

What we want to study:

Light-**ion** production by neutron**s** **(LIONS)**

LIONS experimental programme:

measurements of $\frac{d^2\sigma}{dE\, d\Omega}$ for ${}^{A}_{Z}X(n, LCP)$,

where

LCP = light charged particle = *p, d, t,* ^{3}*He,* α

${}^{A}_{Z}X$ = target nucleus of interest:

- for theory / models / evaluations (e.g. TALYS/TENDL)
- for applications (e.g. gas-production CS for fusion mtrls)
- or for both (which is often the case)

Examples: *C, O, Na, Si, K, Cr, Fe, Pb, Bi, Th, U*

Outline of the talk

UPPSALA UNIVERSITET

I. *What* do we want to study?

II. ***Why*** **do we want to study it? What are the motivations?**

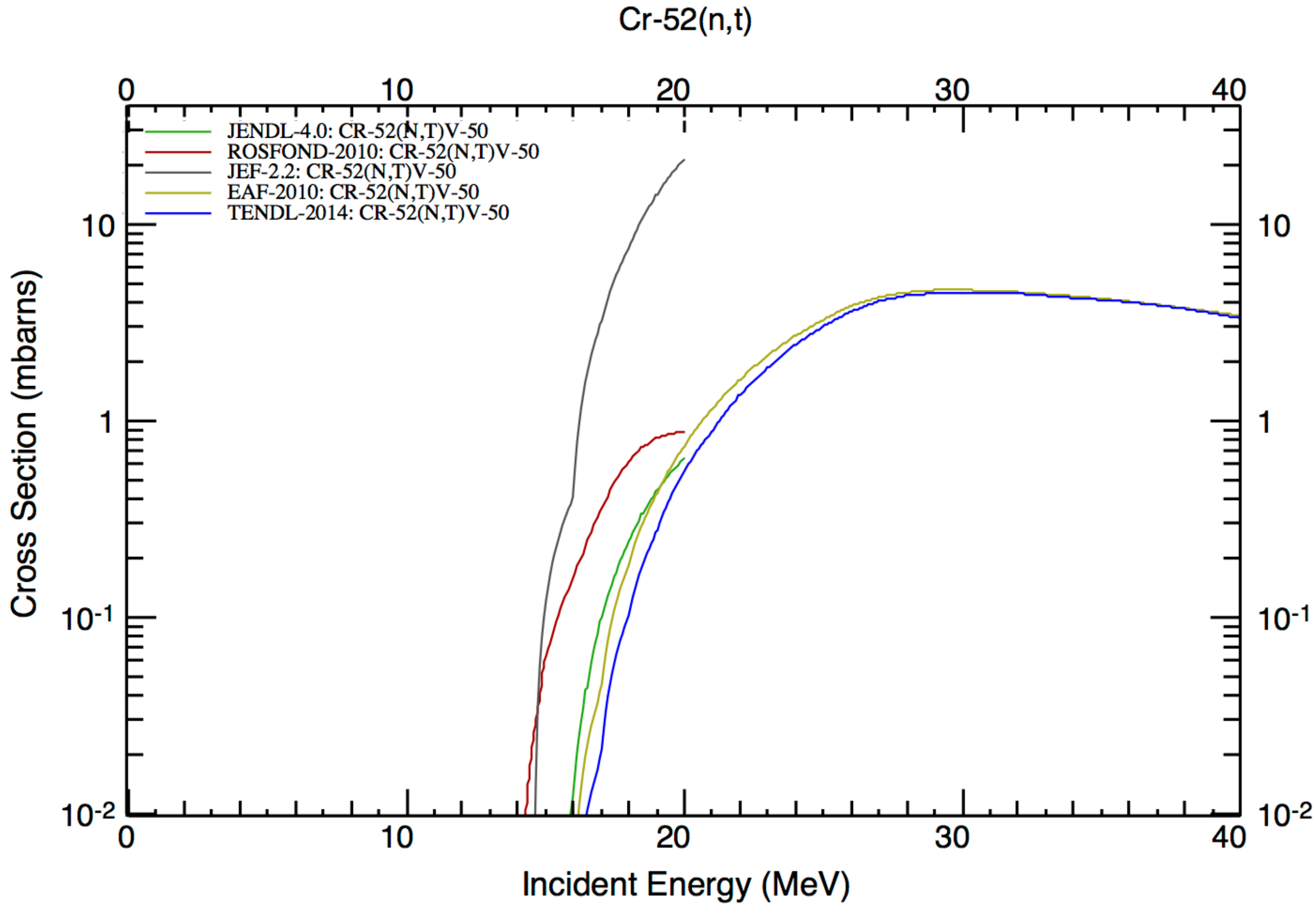
III. *How* do we plan to study it?

UPPSALA UNIVERSITET

Motivations for the LIONS programme coming from applications

- Advanced reactors (Generation IV)
- Accelerator-driven systems (ADS)
- Medical applications
- Dosimetry in aerospace applications
- Radiation effects in electronics
- **Fusion**

Example 1: ^{52}Cr(n,t) - *Data*



- Not a single experimental data point
- Evaluations are not guided -> disagree a lot

Example 1: $^{52}Cr(n,t)$ - *Motivation*

- Cr is one of the main constituents in steels to be used in fusion reactors.
- E.g. Cr content in steel 316LN-IG (”ITER Grade”) is 17% by weight.
- Tritium production must be known.
- New experimental data have been requested by the fusion community via High-Priority Request List maintained by OECD NEA, since “*No further progress* [in the evaluation/simulation work] *can be made without new experimental data*”

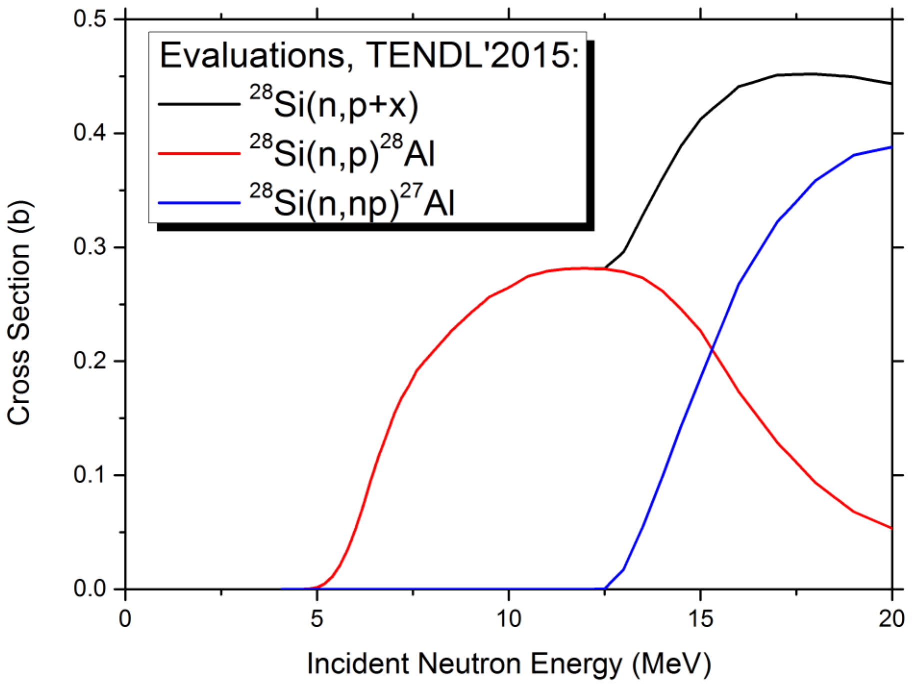
Example 2: ^{28}Si(n,np) and ^{28}Si(n,d) - *Motivation*

UPPSALA UNIVERSITET

- SiC is a potential very low activation structural material for a fusion power reactor.
- ^{28}Si is the main isotope (92%) in ^{nat}Si
- The reactions in question lead to ^{27}Al – unwanted, because of the subsequent ^{27}Al(n,2n)^{26}Al reaction:
  - $T_{1/2}$ (^{26}Al)= 720,000 y
  - ^{26}Al is a high-energy γ emitter
- The concentration of ^{26}Al in SiC determines whether the decommissioned fusion blanket qualifies for recycling
- No trustworthy experimental data
- Cannot be studied by activation techniques
- Evaluations are discrepant by a factor of 10

Example 2: ^{28}Si(n,np) and ^{28}Si(n,d) - *Data and method*

- No trustworthy data on (n,np), (n,d)
- Abundant data on (n,p)
- An idea of H. Vonach:
  - Measure (n,p+x)
  - Subtract (n,p)
  - Thus deduce (n,np)



UPPSALA UNIVERSITET

Outline of the talk

I. ***What*** do we want to study?

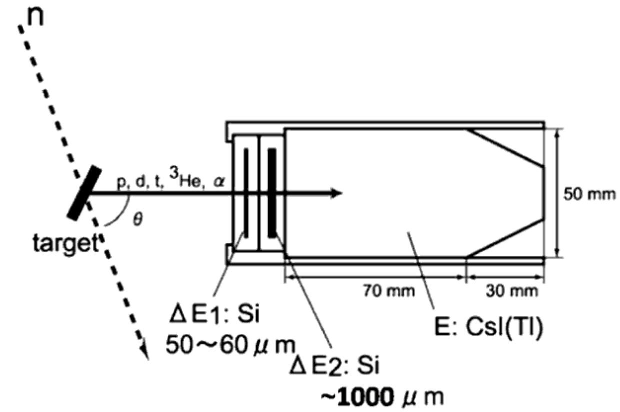
II. ***Why*** do we want to study it?

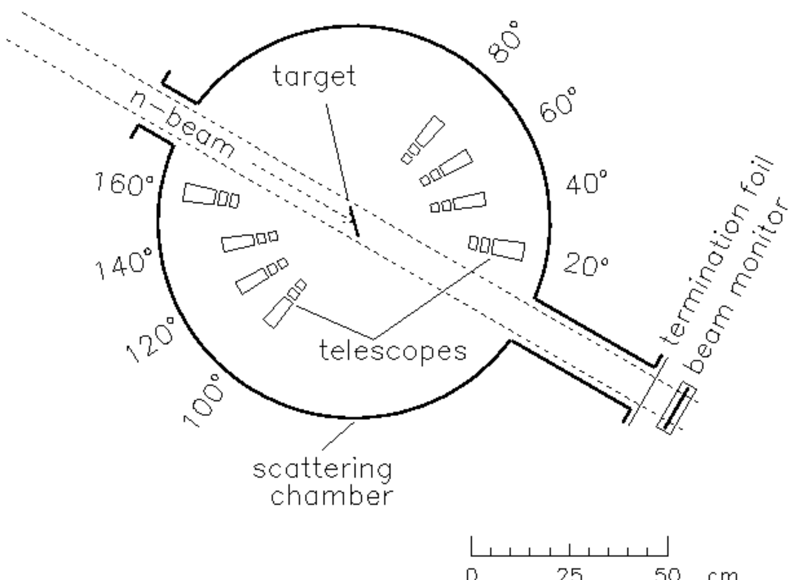
***III. How* do we plan to study it? What are the methods?**

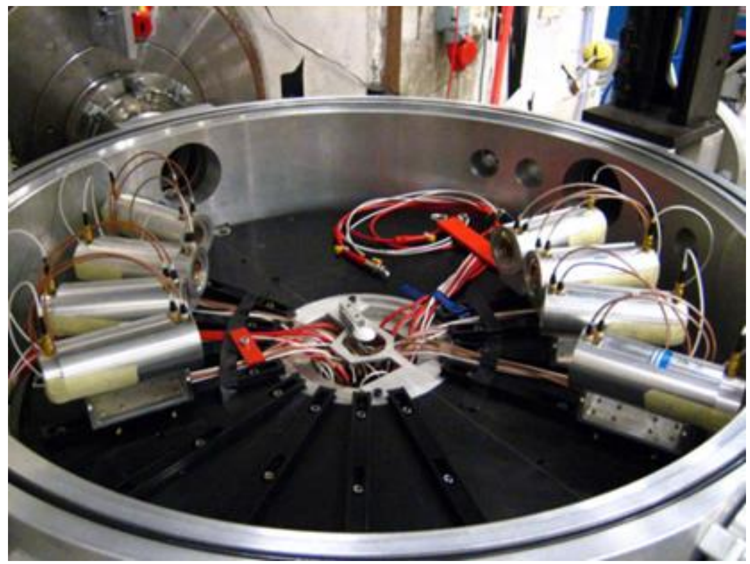
How-to: The Medley chamber @ NFS (I)

- A target exposed to neutrons
- 8 telescopes at 20-160° angles
- Each telescope consists of:
  - 50-um thick Si detector
  - 1000-um thick Si detector
  - 5-cm long CsI(Tl) crystal
- detection & identification of light ions

  (*p*, *d*, *t*, ^3He and α) with the ΔE-ΔE-E technique

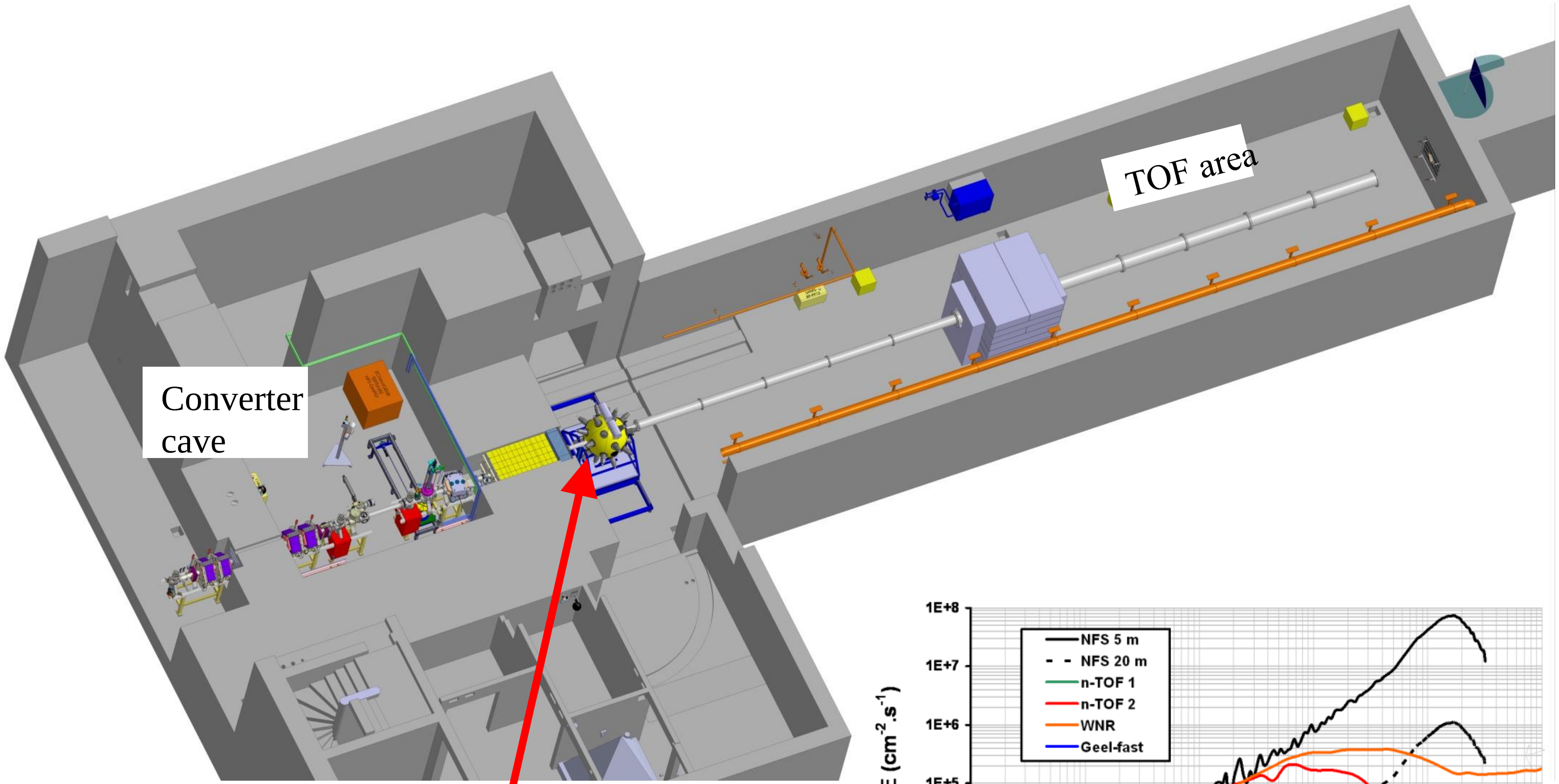


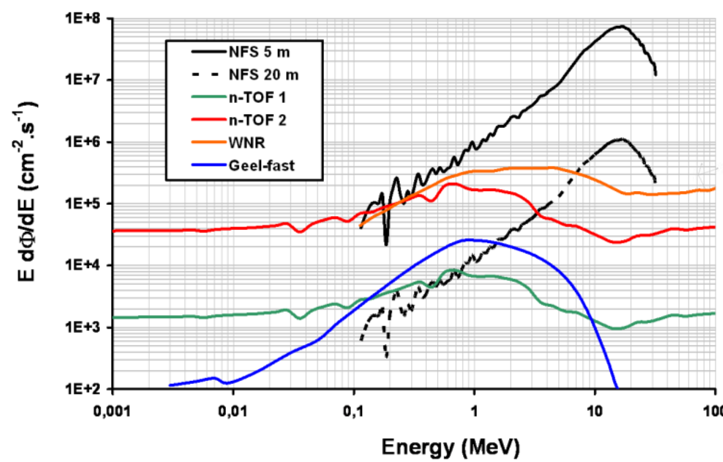




UPPSALA
UNIVERSITET

How-to: The Medley chamber @NFS (II)





The planned Medley position,
5 m from the n-source

UPPSALA UNIVERSITET

Status, funding, and synergies

- The NFS facility: see presentations of Drs. X Ledoux & M O Fregeau
- The Medley chamber and the detectors: tested, to be transported to GANIL
- First beam time approved by GANIL PAC in June 2016 (Carbon + QMN, E721)
- Funding granted by the EU CHANDA PAC in March 2017 - *we had to renounce it because of the delay with Spiral2...*
- An application submited to Swedish Research council
- A synergy with commissioning of the NFS facility: Medley in LIONS mode to be used for spectral fluence measurements
- A synergy with the coming FISHES project, looking forward to submission to PAC in 2018

Thank you for your time!
Questions please!