Operational Experience of a High-Intensity Accelerator-based Fast Neutron Source Based on a Liquid-Lithium Target

D. Kijel[1], A. Arenshtam[1], S. Halfon[1,2], G. Feinberg[1,2], M. Paul[2], L. Weismann[1], D. Berkovits[1], , I. Eliyahu[1], A. Kreisel[1], G. Shimel[1], A. Shor[1] and I .Silverman[1]

[1]*Soreq NRC, Yavne, Israel 81800,* [2]*Racah Institute of Physics, Hebrew University, Jerusalem, Israel 91904*

Motivation

➢With SARAF phase I: creating unique high intensity fast neutron flux for advance research on:

1. Nuclear Medicine (cancer therapy)
2. Nuclear astrophysics (nucleosynthesis)
3. Generation IV reactor and ADS design (cross section measurements)

➢In SARAF phase II:

1. Radioactive beams
2. Fusion reactor material testing
3. Unique radiopharmaceuticals production

P-III
P-II
P-I

requires rabbit system for transferring sample to counting station

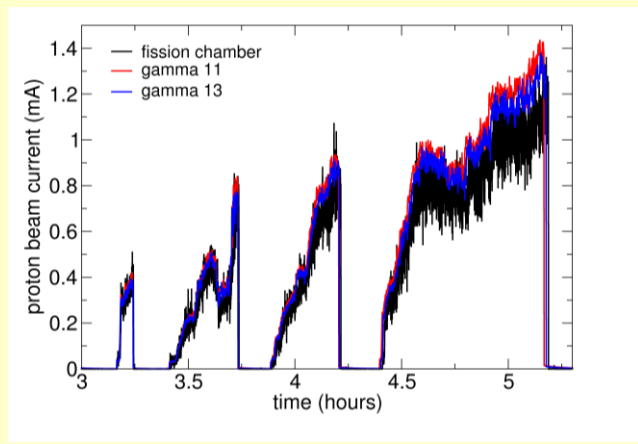
product $t_{1/2}$ / detect. / Target	$t_{1/2}$ < 1 s online	0.1m < $t_{1/2}$ < 10m offline, Ge/scint	1h < $t_{1/2}$ < 1 y offline, Ge	$t_{1/2}$ > 10 y offline, AMS
stable		^{7}Li, ^{15}N, ^{18}O, ^{19}F, ^{22}Ne, ^{26}Mg, ^{27}Al…	^{nat}Zr, ^{nat}Ce ^{209}Bi ^{87}Rb(nat) ^{31}Si	^{92}Zr, ^{92}Mo, ^{106}Pd
radioactive	^{7}Be	^{99g}Tc (2×10^{5} y) ^{10}Be, ^{14}C ^{60}Fe ^{A}U(n,γ), ^{A}U(n,f)	^{90}Sr	

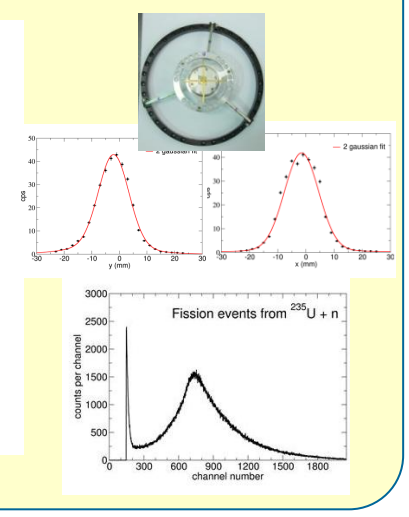
Summary

- A fully operating liquid lithium target system has been built at Soreq
- The target has gone successful operational and heat load tests with SARAF phase I proton beam
- Neutron flux is 2*10^{10} n/s @ 30 keV
- An upgrade for fast neutrons source of 10^{12} n/s is in progress

Irradiation result

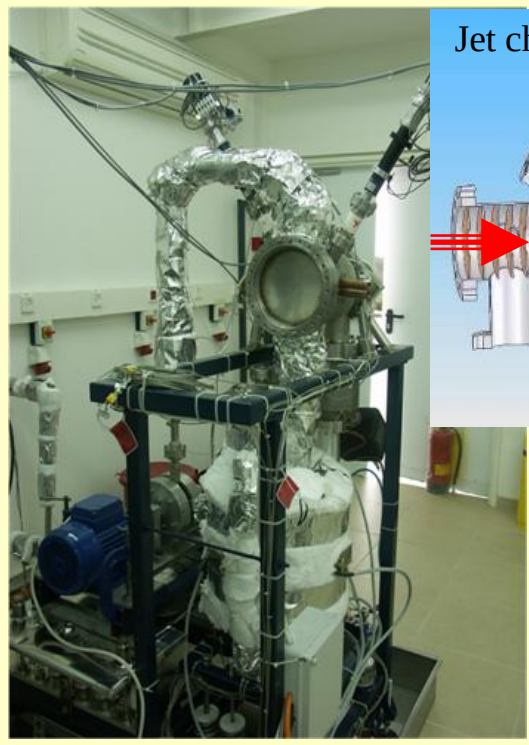
➢Peak power densities: 2.8 kW/cm^2,~0.5 MW/cm^3

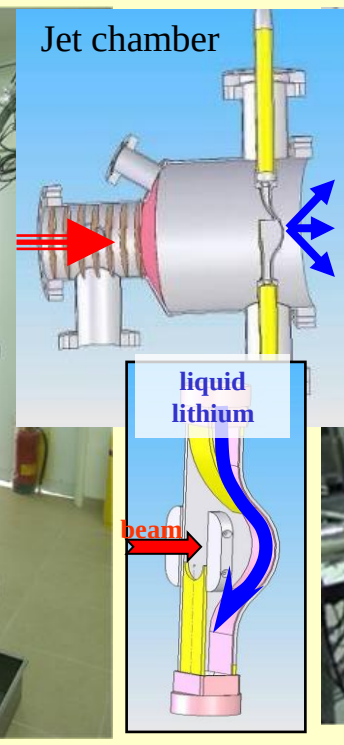


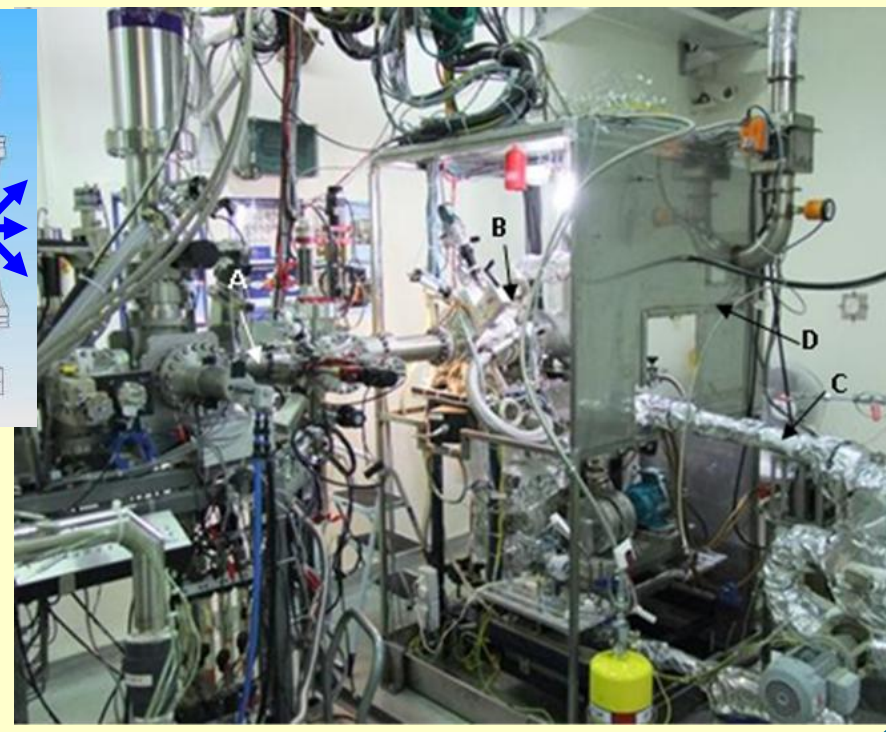


Target system

➢Proton energy: ~2 MeV
➢Proton current: <3.5 mA
➢T ≈ 220^{0}C
➢T$_{max}$ ≈ 350^{0}C
➢Jet: 18 mm x 1.5 mm
➢Lithium velocity: 2-7 m/s
➢Wall assisted lithium jet



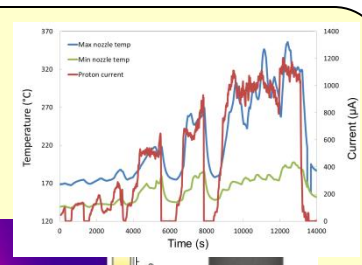


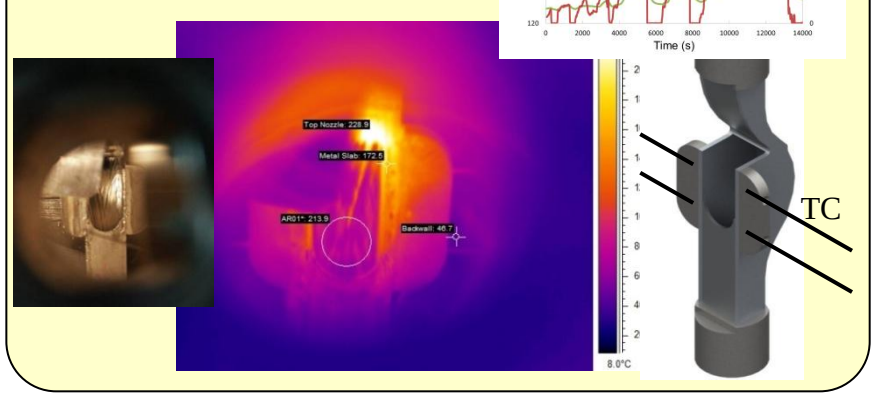


S. Halfon et al., Review of Scientific Instruments 84, 123507 (2013).

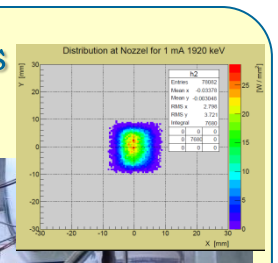
Target diagnostics

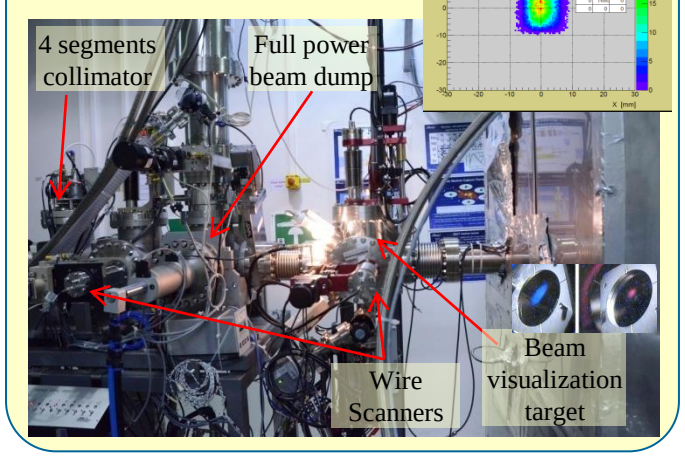
➢Video Camera
➢In-target thermocouples
➢IR Camera





Beam diagnostics





Fire safety

➢Multi layer fire prevention and suppression system