TRIUMF

UCN Production Summer 2025

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2026-02-17

TUCAN
TRIUMF Ultracold Advanced Neutron Collaboration

Discovery, accelerated

Experiments Conducted 2025

→ Counts vs current
→ Source saturation (SAT)
→ Source storage lifetime (SSL)
→ SSL varying cooling power
→ SSL with pulsed HEX1 heater
→ Production while cooling
... and more!

Full report found on github:
`https://github.com/ucn-triumf/UCNanalysis/tree/2025/report/main.pdf`

Experiments Conducted 2025

→ Counts vs current	
→ Source saturation (SAT)	TCN6A-040 / TCN6A-450
→ Source storage lifetime (SSL)	TCN6A-050 / TCN6A-150
→ SSL varying cooling power	TCN6A-060
→ SSL with pulsed HEX1 heater	TCN6A-375
→ Production while cooling	TCN6A-500
... and more!	

Full report found on github:
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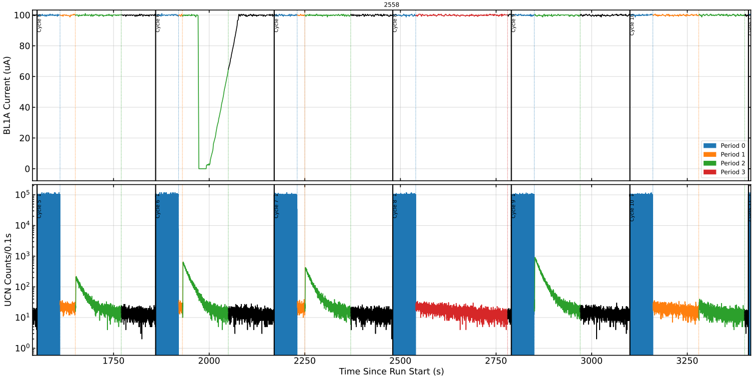
Data Processing

Automated analysis procedure:

→ **Reject bad cycles**: BL1A drops, irregularities due to sequencer

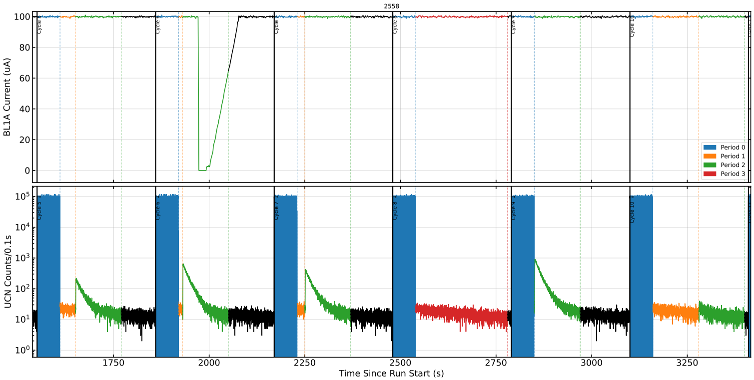


Data Processing

Automated analysis procedure:

→ **Reject bad cycles**: BL1A drops, irregularities due to sequencer

→ **Correct cycle start times**: align falling edge of beam-off counts



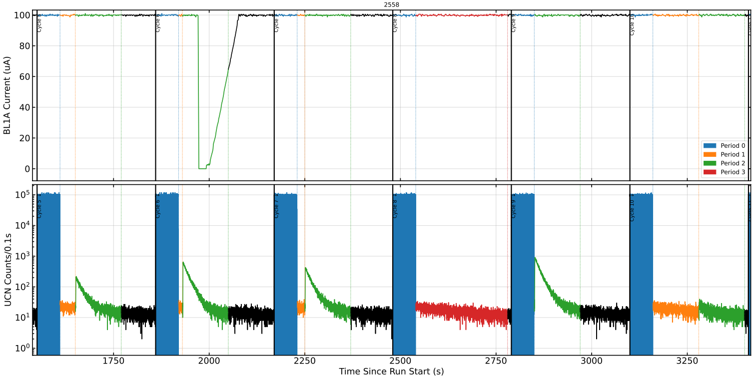
Data Processing

Automated analysis procedure:

→ **Reject bad cycles**: BL1A drops, irregularities due to sequencer

→ **Correct cycle start times**: align falling edge of beam-off counts

→ **Integrate counting periods**: separately integrate last $20\,\text{s}$



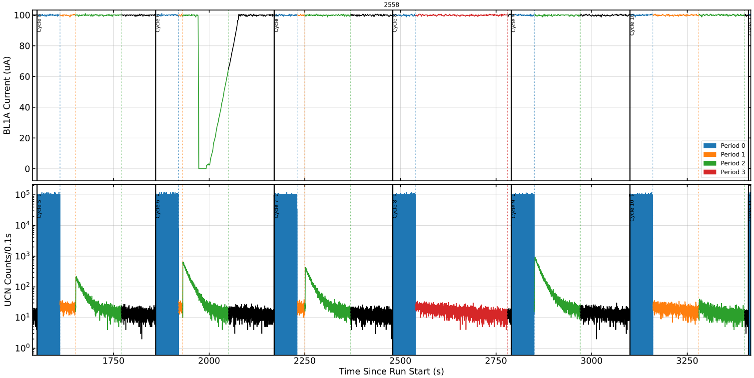
Data Processing

Automated analysis procedure:

→ **Correct cycle start times**: align falling edge of beam-off counts

→ **Integrate counting periods**: separately integrate last $20\,\mathrm{s}$

→ **Integrate background periods over corresponding window**: shift start and end, may integrate the same period several times

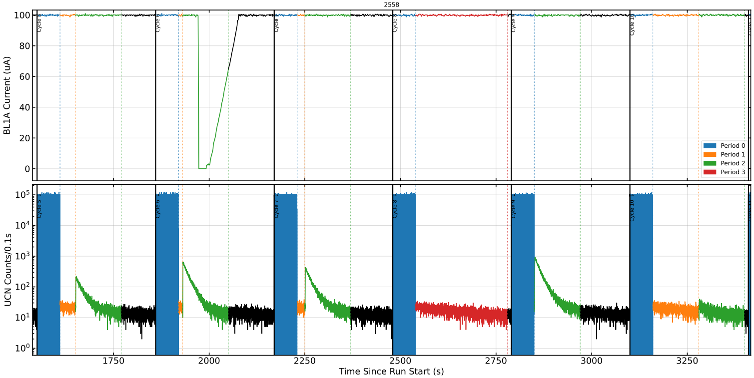


Data Processing

Automated analysis procedure:

→ **Integrate background periods over corresponding window**: shift start and end, may integrate the same period several times

→ **Pair background periods to nearest counting period**: closest is most likely to be most accurate

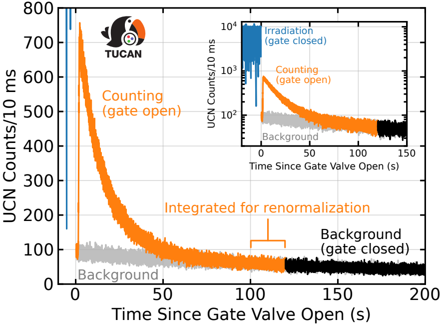


Data Processing

Automated analysis procedure:

→ **Pair background periods to nearest counting period**: closest is most likely to be most accurate

→ **Rescale background**: by the ratio of the last $20\,\mathrm{s}$ integrated



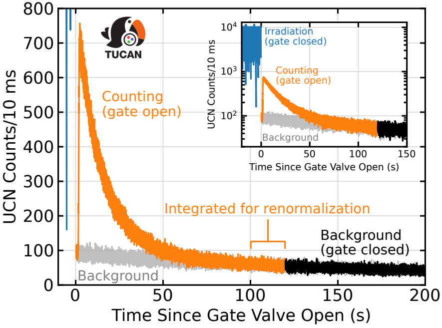
Data Processing

Automated analysis procedure:

→ **Pair background periods to nearest counting period**: closest is most likely to be most accurate

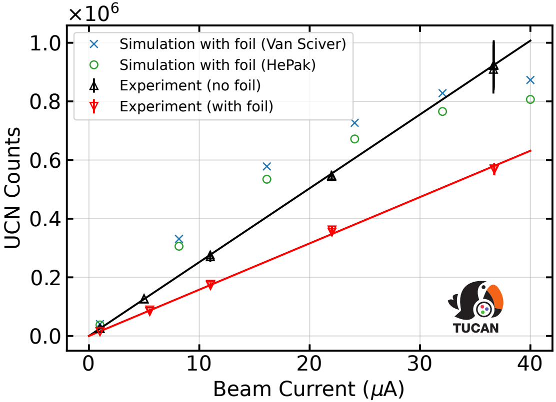
→ **Rescale background**: by the ratio of the last $20\,\mathrm{s}$ integrated

→ **Subtract rescaled background** from signal counts



Counts vs Currents

- → ^{6}Li detector
- → Time structure: 60/0/120 s (Irradiation/Storage/Counting)
- → Agrees well with simulation
- → As shown in initial result paper (in review)



Source Saturation Time

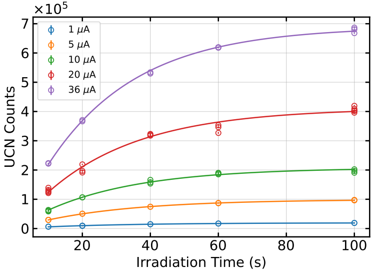
Valve sequence

→ $10\,\mathrm{s}$ to $100\,\mathrm{s}$: irradiation (IV001 closed)
→ $10\,\mathrm{s}$: storage (IV001 closed)
→ $120\,\mathrm{s}$: counting (IV001 open)

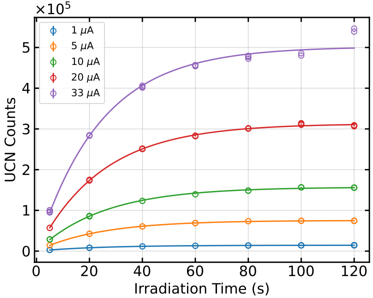
Fit with:

$$N(t) = N_0 \left(1 - e^{-t/\tau}\right)$$

Vary beam current

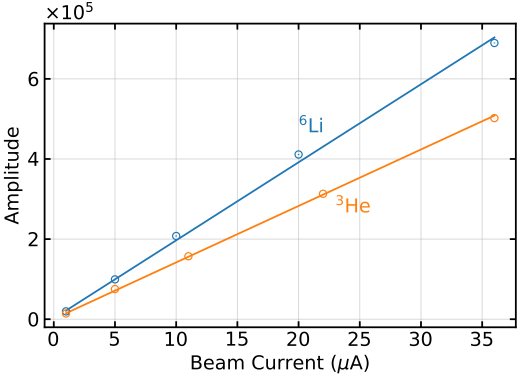


^{6}Li detector (TCN6A-040)



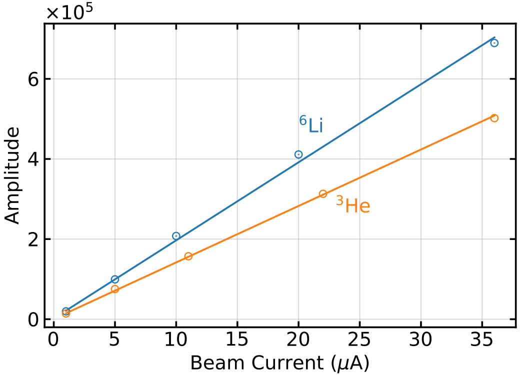
^{3}He detector (TCN6A-450)

Source Saturation Time



Amplitudes are linear as always - less for ^{3}He

Source Saturation Time



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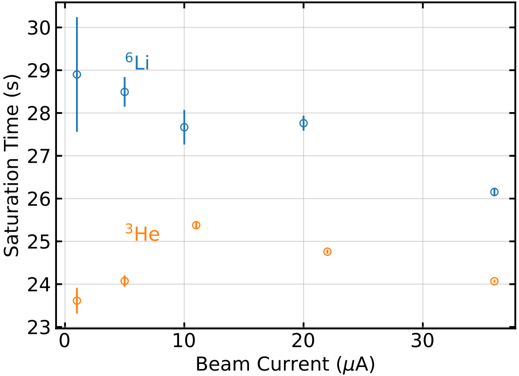


Saturation times are quite different

Source Storage Lifetime

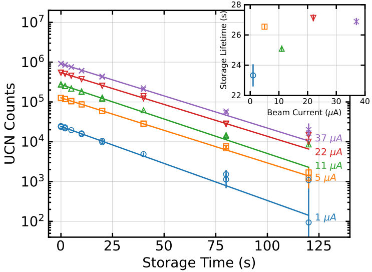
Valve sequence

- $\rightarrow$ $60\,\mathrm{s}$: irradiation (IV001 closed)
- $\rightarrow$ $0\,\mathrm{s}$ to $120\,\mathrm{s}$: storage (IV001 closed)
- $\rightarrow$ $120\,\mathrm{s}$: counting (IV001 open)

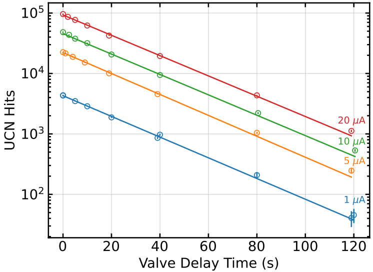
Fit with:

$$N(t) = N_0 e^{-t/\tau}$$

Vary beam current

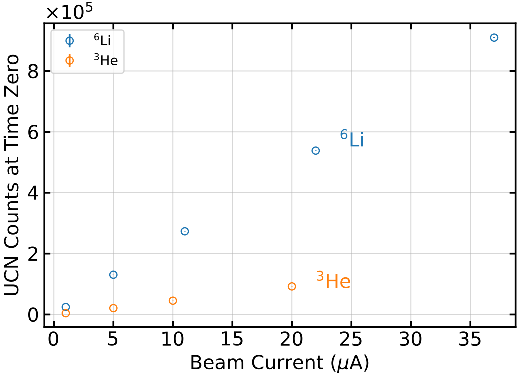


^{6}Li detector (TCN6A-050)



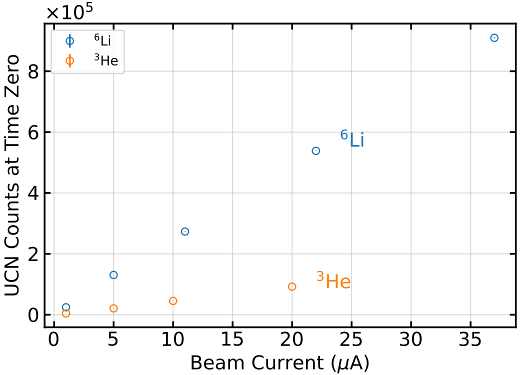
^{3}He detector (TCN6A-150)

Source Storage Lifetime

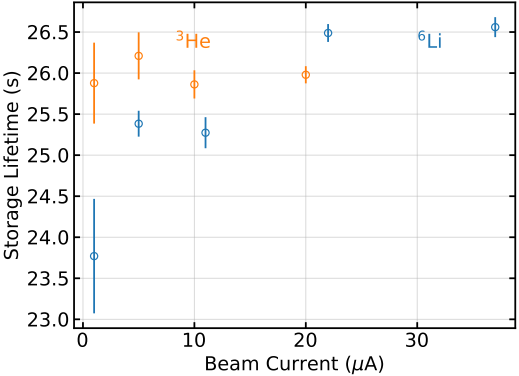


Amplitudes are linear as always - less for ^{3}He

Source Storage Lifetime



Amplitudes are linear as always - less for ^{3}He



Storage lifetimes are similar

SSL Varying Cooling Power

Valve sequence

- $\rightarrow$ 60 s: irradiation (IV001 closed)
- $\rightarrow$ 0 s to 120 s: storage (IV001 closed)
- $\rightarrow$ 120 s: counting (IV001 open)

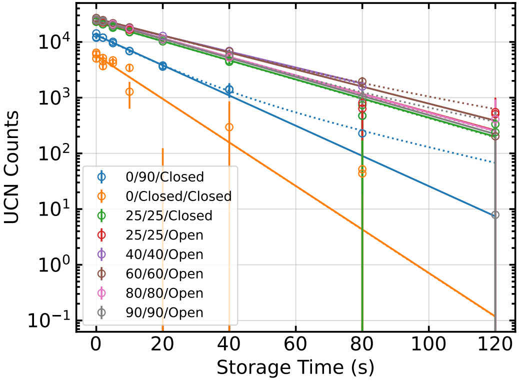
Fit with:

$$N(t) = N_0 e^{-t/\tau}$$

and

$$N(t) = N_0 \left(f e^{-t/\tau_1} + (1-f) e^{-t/\tau_2} \right)$$

Repeat for varying MP101/MP102 pump speeds and GV102 status.

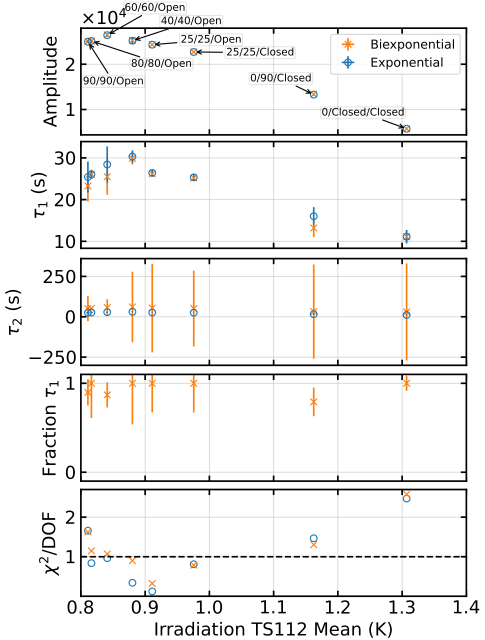


^{6}Li detector at $1\,\mu$A, no foil (TCN6A-060). Pump speeds in Hz. Solid lines: single exp fit, dashed lines: biexponential fit.

SSL Varying Cooling Power

As a function of the average TS112 (HEX1) during the irradiation period.

- → Amplitude: Production decreases with increasing temperature
- → τ: storage lifetime decreases with temperature too
- → Biexponential fit is not really worthwhile



SSL With Pulsed HTR001

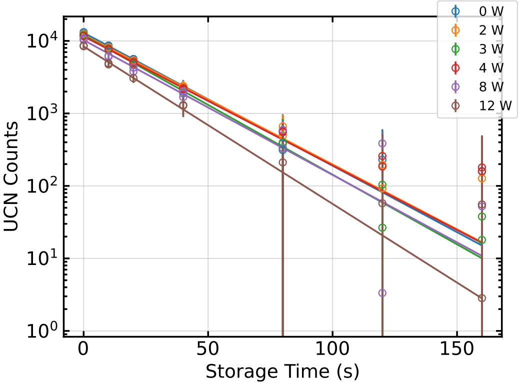
Valve sequence

- → $60\,$s: irradiation (IV001 closed)
- → $0\,$s to $160\,$s: storage (IV001 closed)
- → $120\,$s: counting (IV001 open)

Fit with:

$$N(t) = N_0 e^{-t/\tau}$$

Turn on HTR001 (HEX1) only while the beam is on.

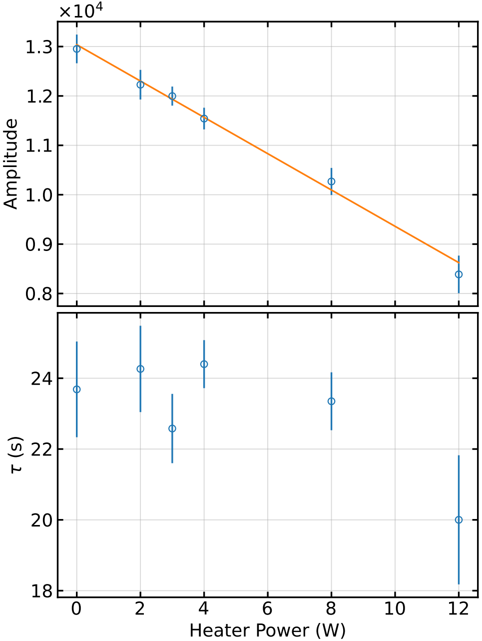


^{6}Li detector at $1\,\mu$A, with foil (TCN6A-375).
Fits are not great at long times.

SSL With Pulsed HTR001

→ Amplitude: Production decreases with increasing heater power

→ τ: storage lifetime mostly unaffected?



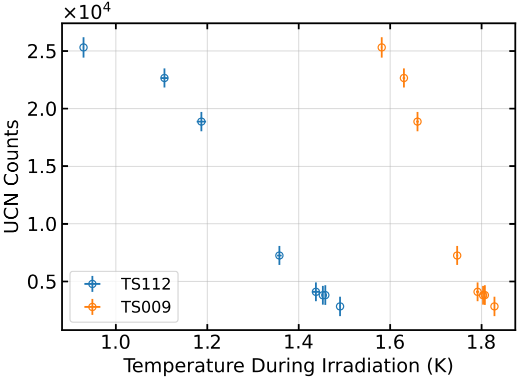
Production During Cooling

After extreme conservation mode, some isopure was lost, but we take data while cooling the source back to base.

Valve sequence

- $\rightarrow$ 60 s: irradiation (IV001 closed)
- $\rightarrow$ 0 s: storage (IV001 closed)
- $\rightarrow$ 240 s: counting (IV001 open)

More counts at lower temperatures (as expected)



^{6}Li detector at 1 μA, no foil (TCN6A-500)

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Questions?

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