UCN Data with the Vertical Source

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TUCAN Collaboration Meeting
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Prototype UCN Source

- Vertical UCN source from Japan
- Shipped to TRIUMF in 2016
- Installation and first cooling (2017 Spring)
- **First UCN production (2017 Nov-Dec)**

Overall UCN Experiments

- **UCN Yield:** vs beam current
  vs irradiation time and beam current
  vs temperature
  vs time

- **UCN Storage Liftime:** vs beam current
  vs temperature
  vs time

Wolfgang Schreyer : Comparison with PENTrack simulations

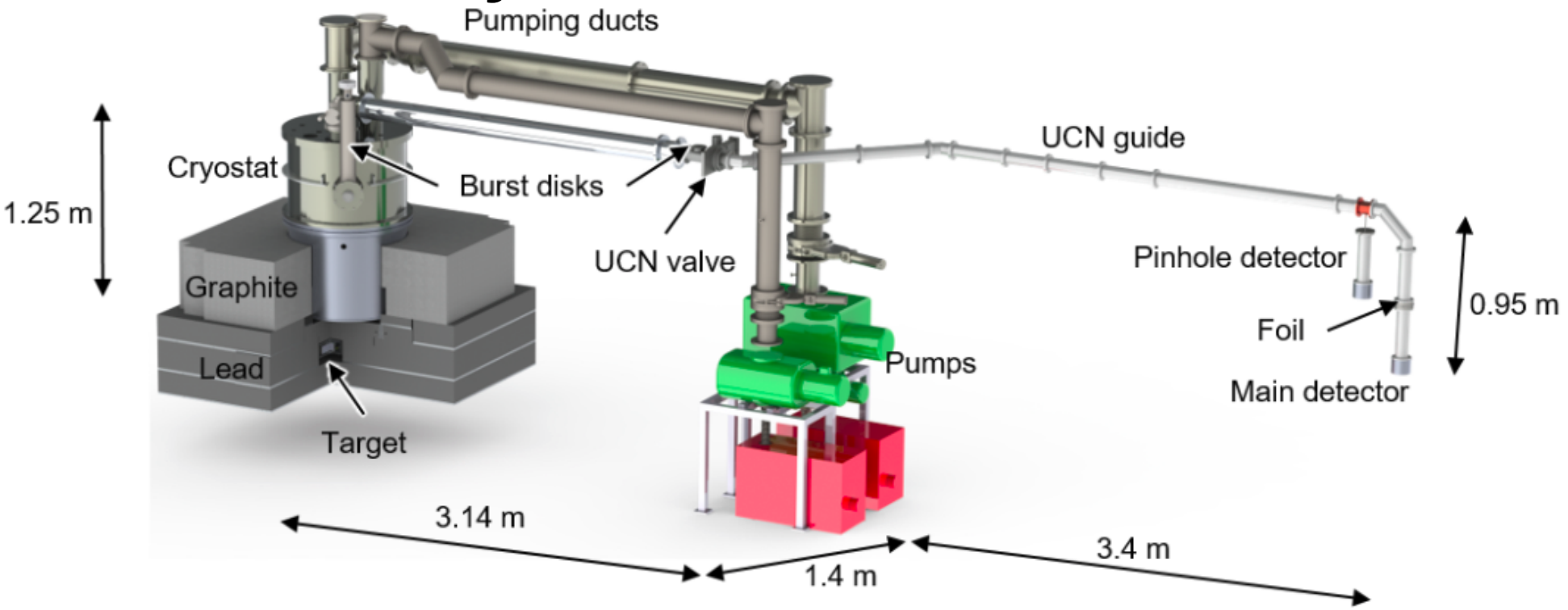
Steve Sidhu : UCN guide transmission

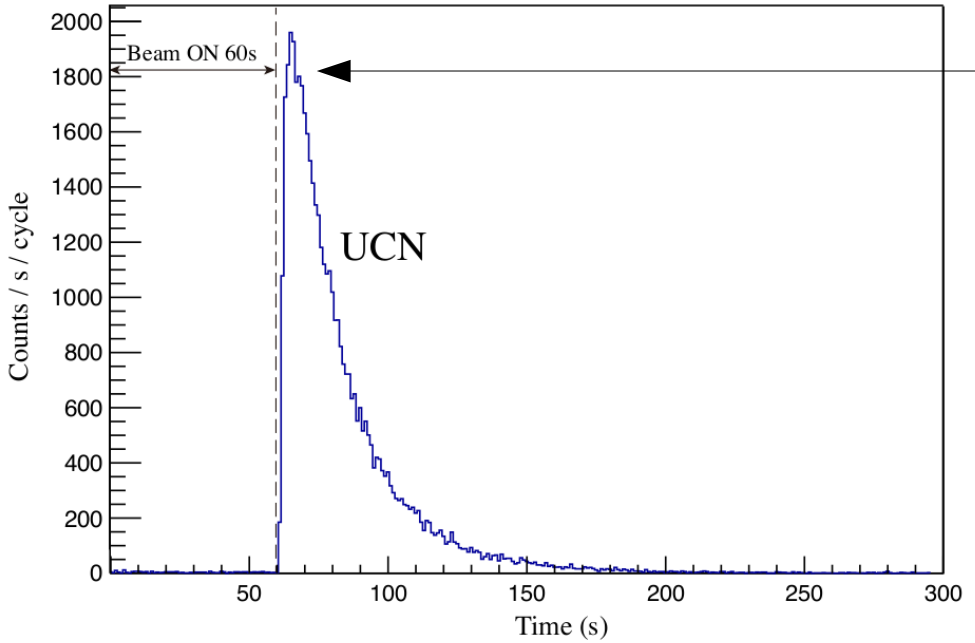
- **Steady-State UCN**

  Production: vs temperature
  for proton beam vs heater power calibration

- **UCN Guide transmission**
- **Pinhole Storage Lifetime (In progress)**

UCN Cycle of Measurement





These are UCN!

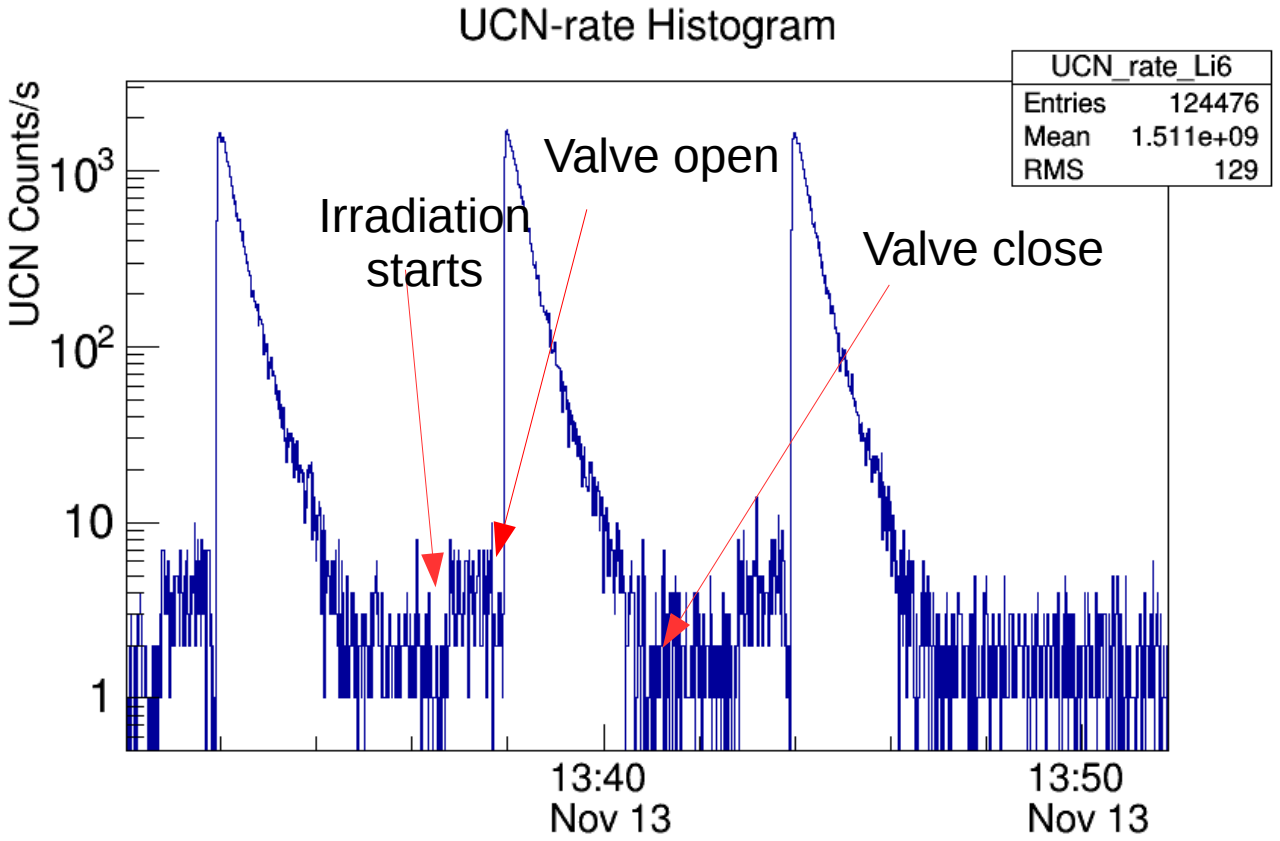
Typicall UCN cycle:
- 1 muA beam current
- 60 s irradiation

UCN Counts Measurements

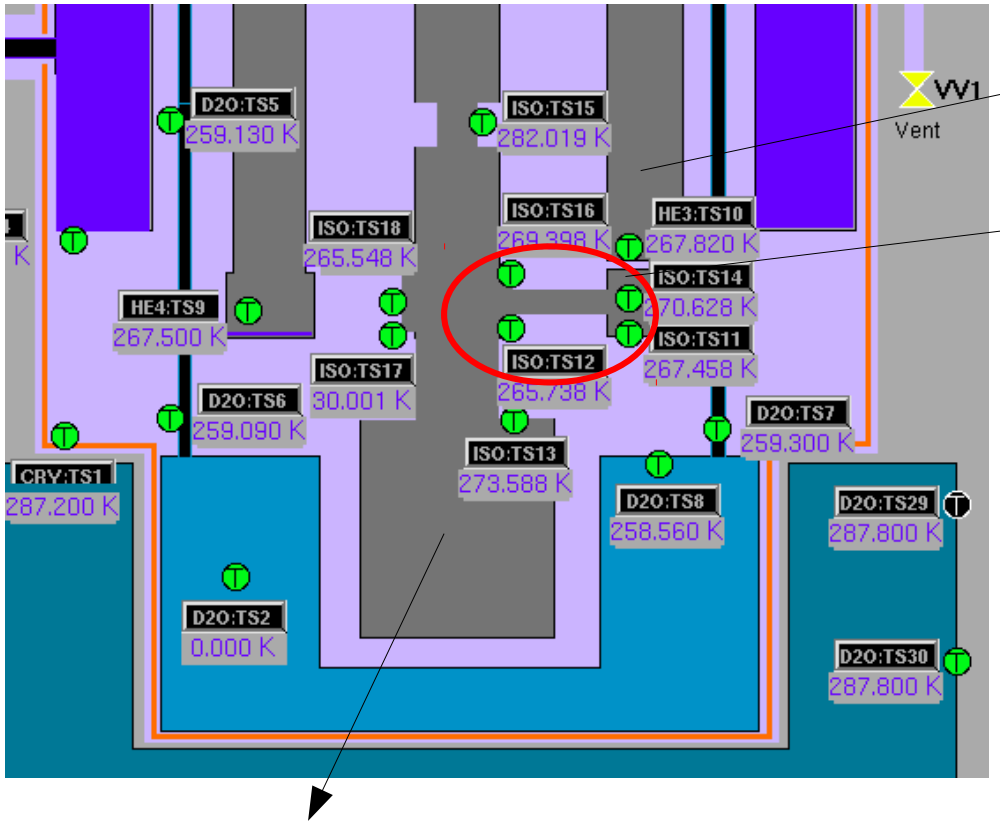
UCN Counts Estimation

UCN Counts = UCN detected by the detector during valve open time – Background counts

Background counts =
(UCN background rate before the irradiation) * (valve open time)



UCN Counts vs Temperature

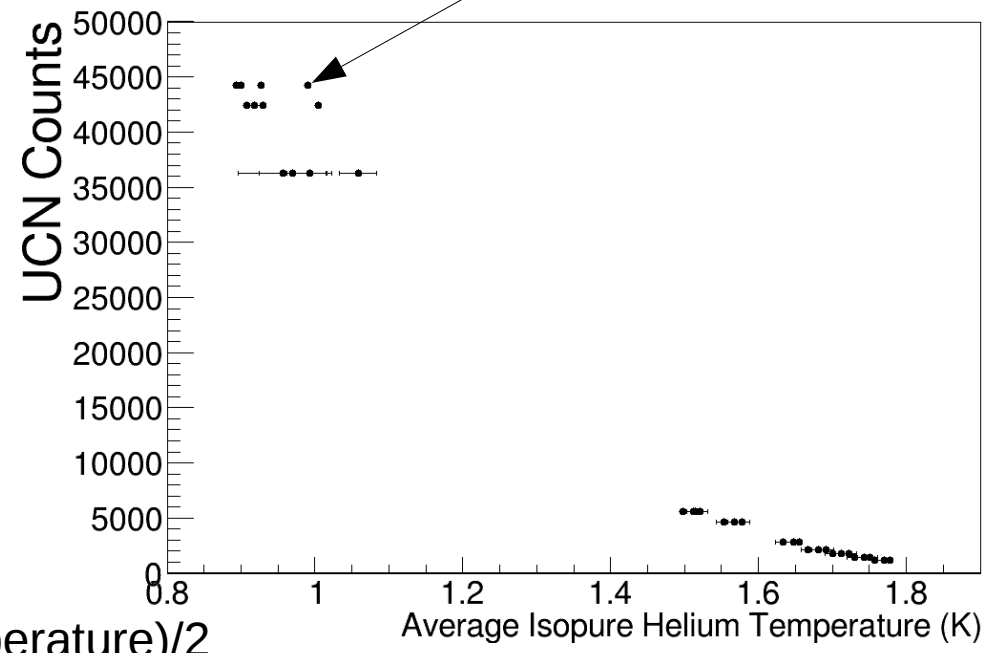


He3 pot

Heat exchanger

Different temperature sensors

Superfluid helium bottle

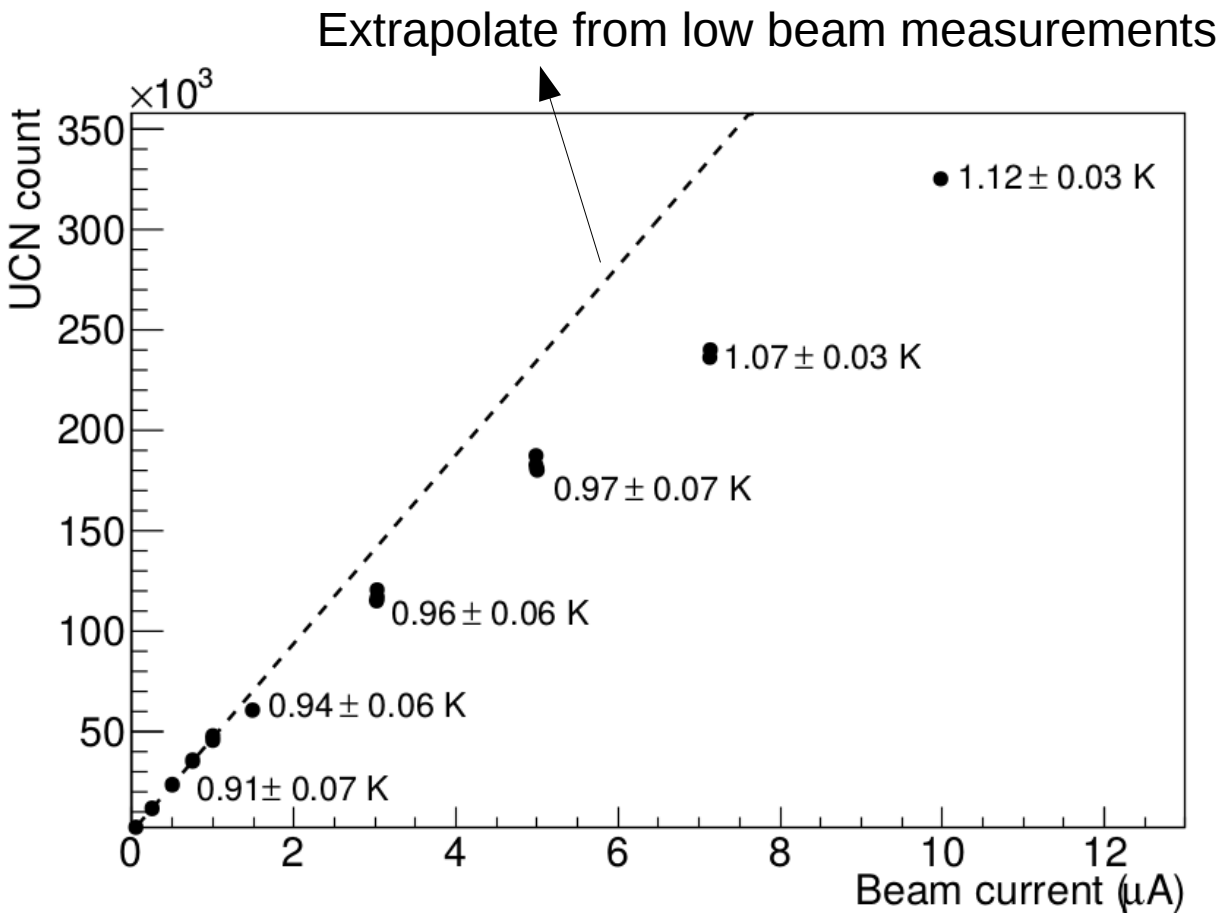


Horizontal Error bar = (max temperature – min temperature)/2

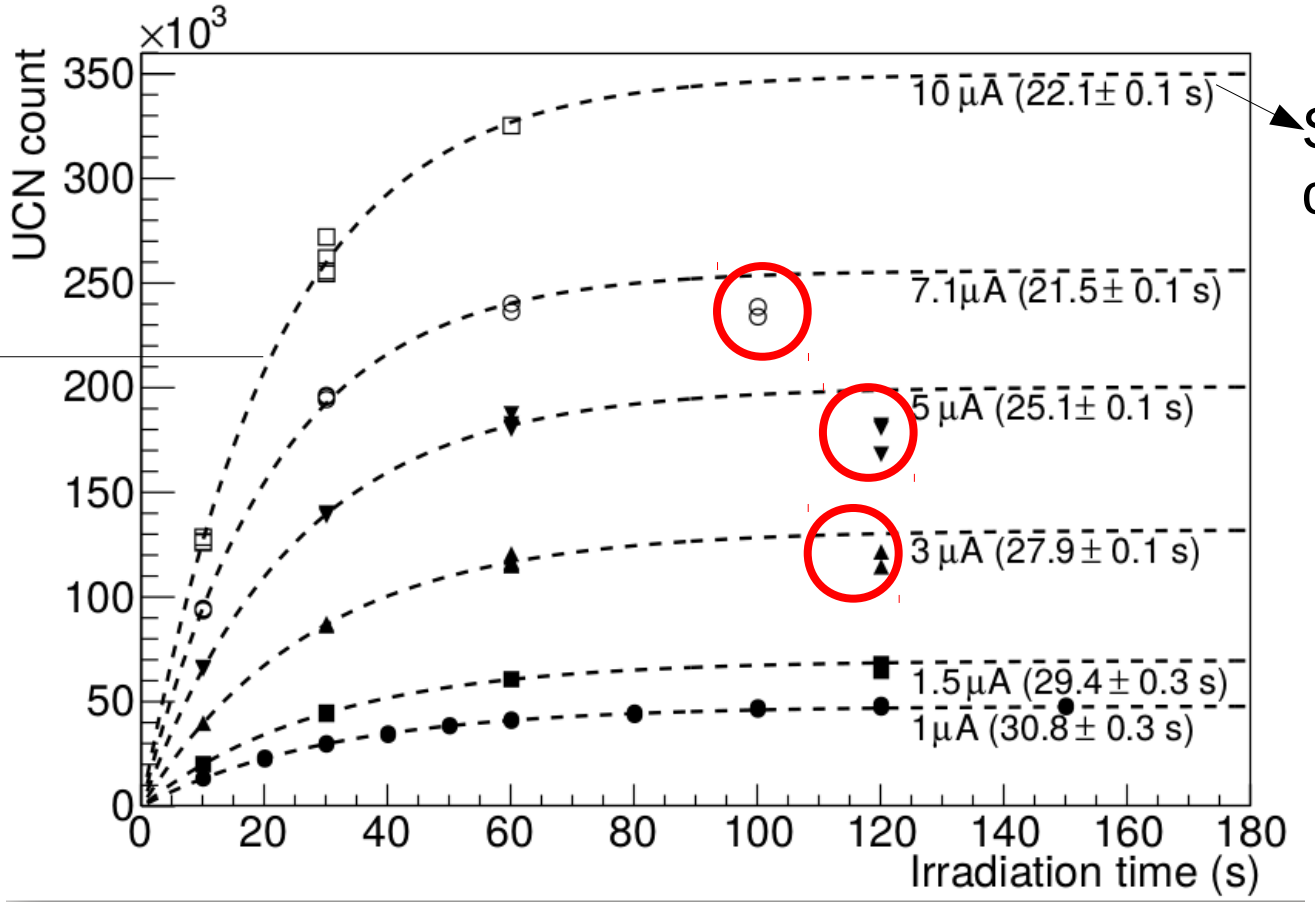
- Increase in temperature -> Increase in upscattering rate -> lower UCN counts

UCN Counts vs Beam Current

- 60 s target irradiation
- Full range of all temperature sensors
- Higher beam currents increases heat load and isopure temperature



UCN Counts at Different Irradiation Times and Beam Current



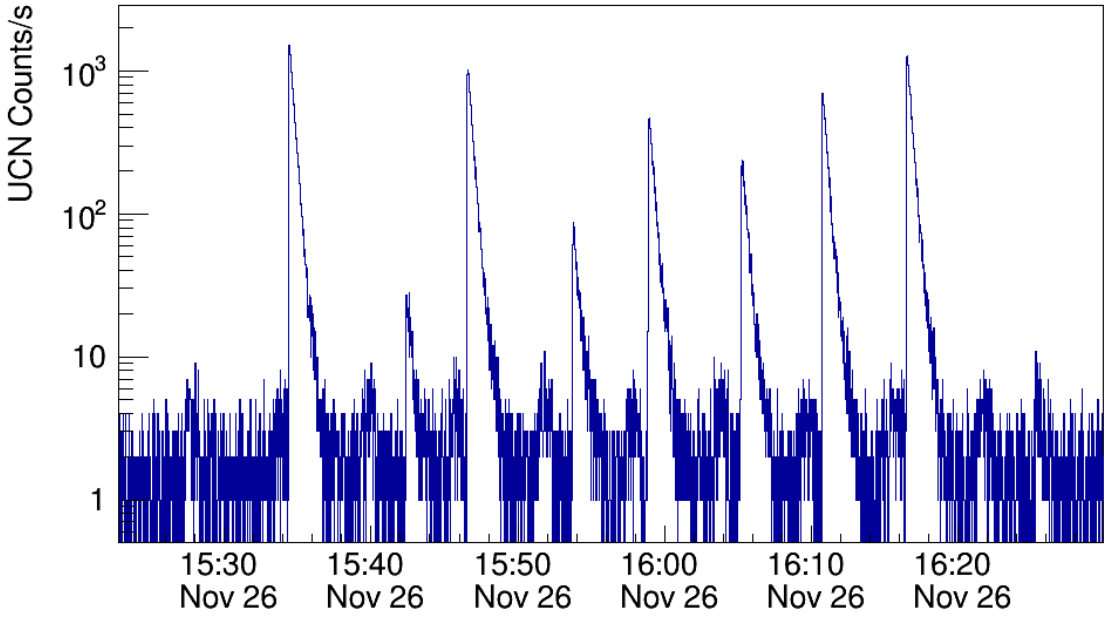
Saturation time constant

Fit to 60 s

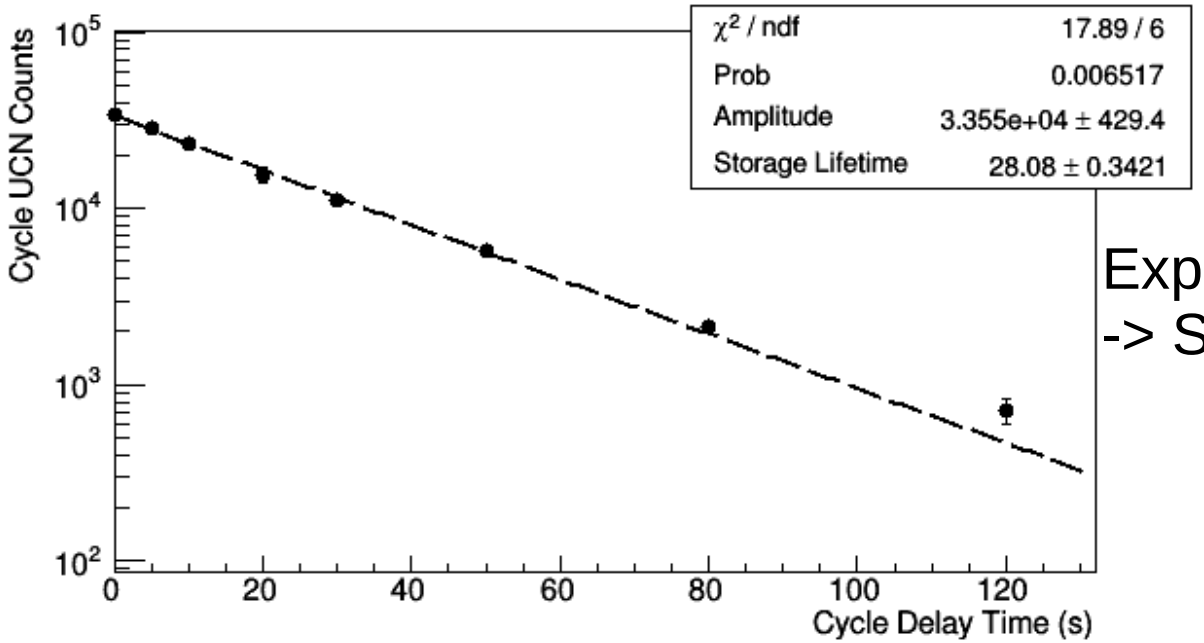
- Higher beam current and longer irradiation times -> higher isopure temperature

Storage Lifetime Measurement

Storage Lifetime Estimation

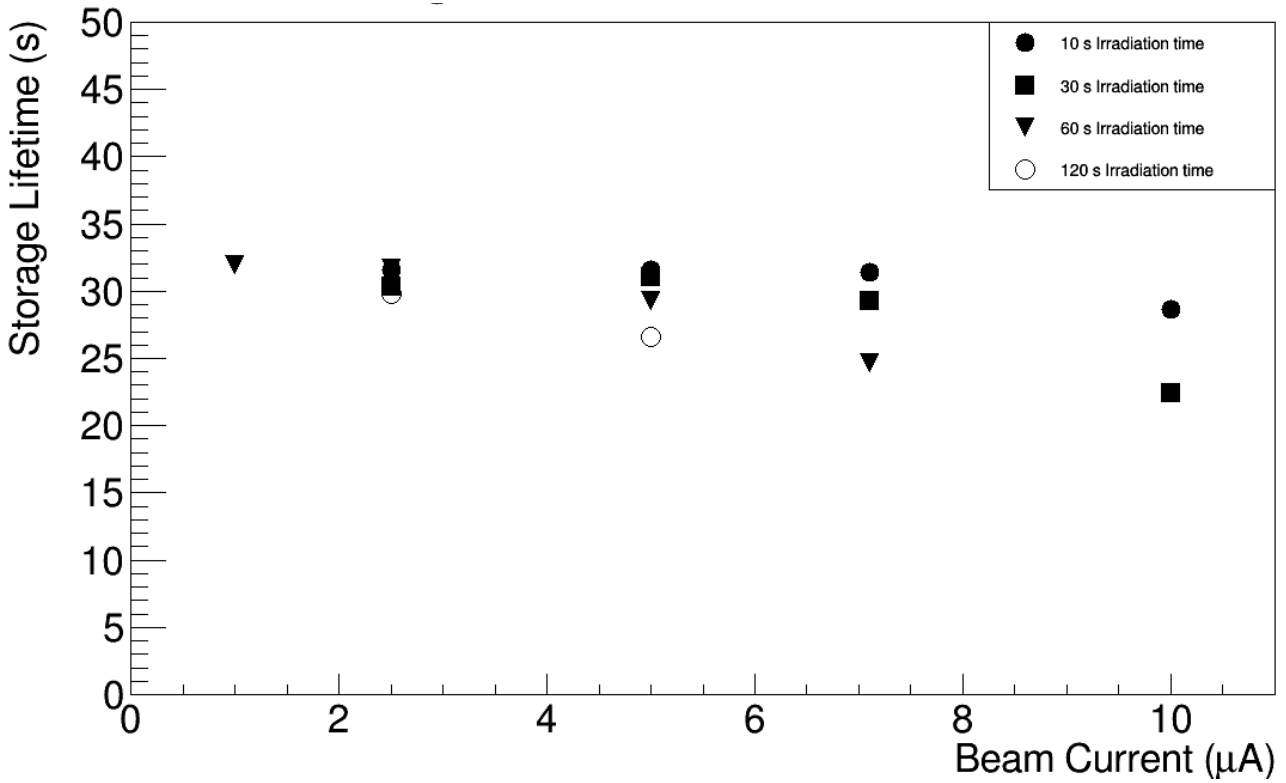


- UCN rate at different valve open delay times 0 s to 170 s
- 1muA , 60 s irradiation time



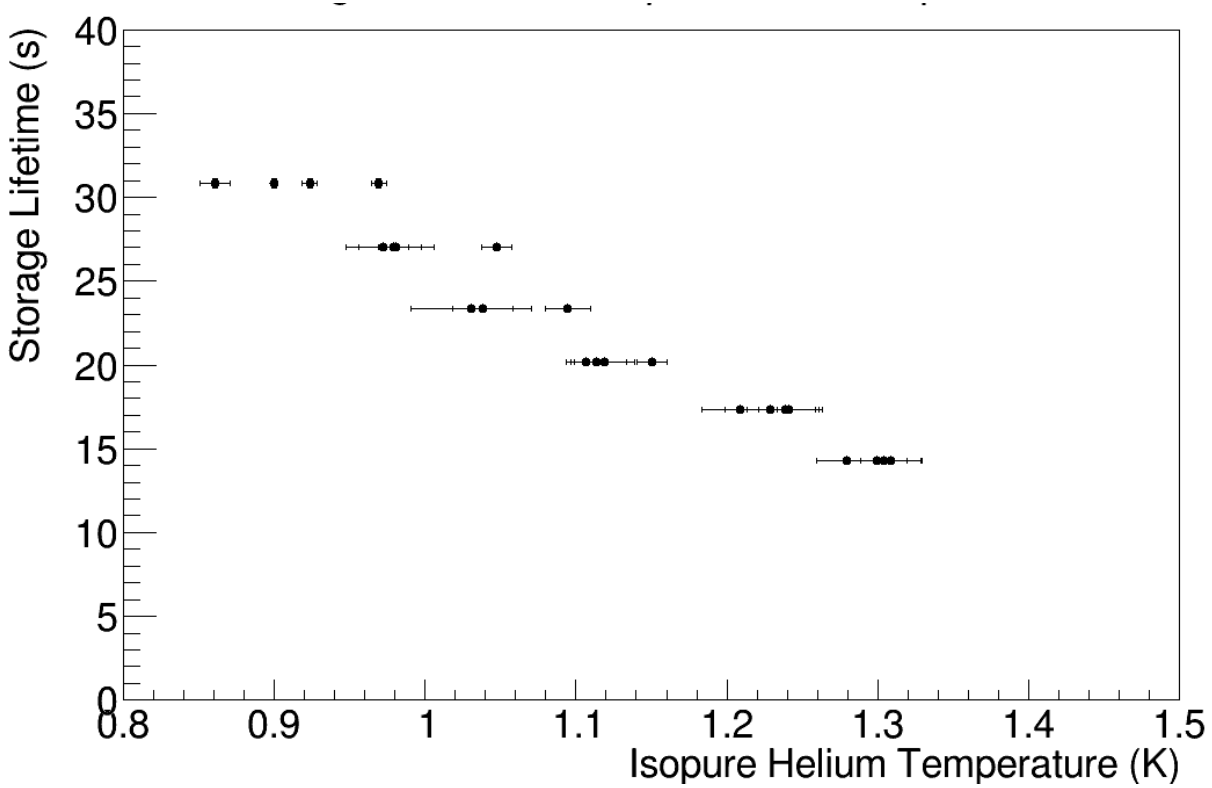
Exponential fit to the data (to 120 s) -> Storage lifetime

Storage Lifetime vs Beam Current And Irradiation Times



Higher beam currents and longer irradiation times decrease the storage lifetime in the source (Higher isopure helium temperature and higher upscattering rate)

Storage Lifetime vs Temperature



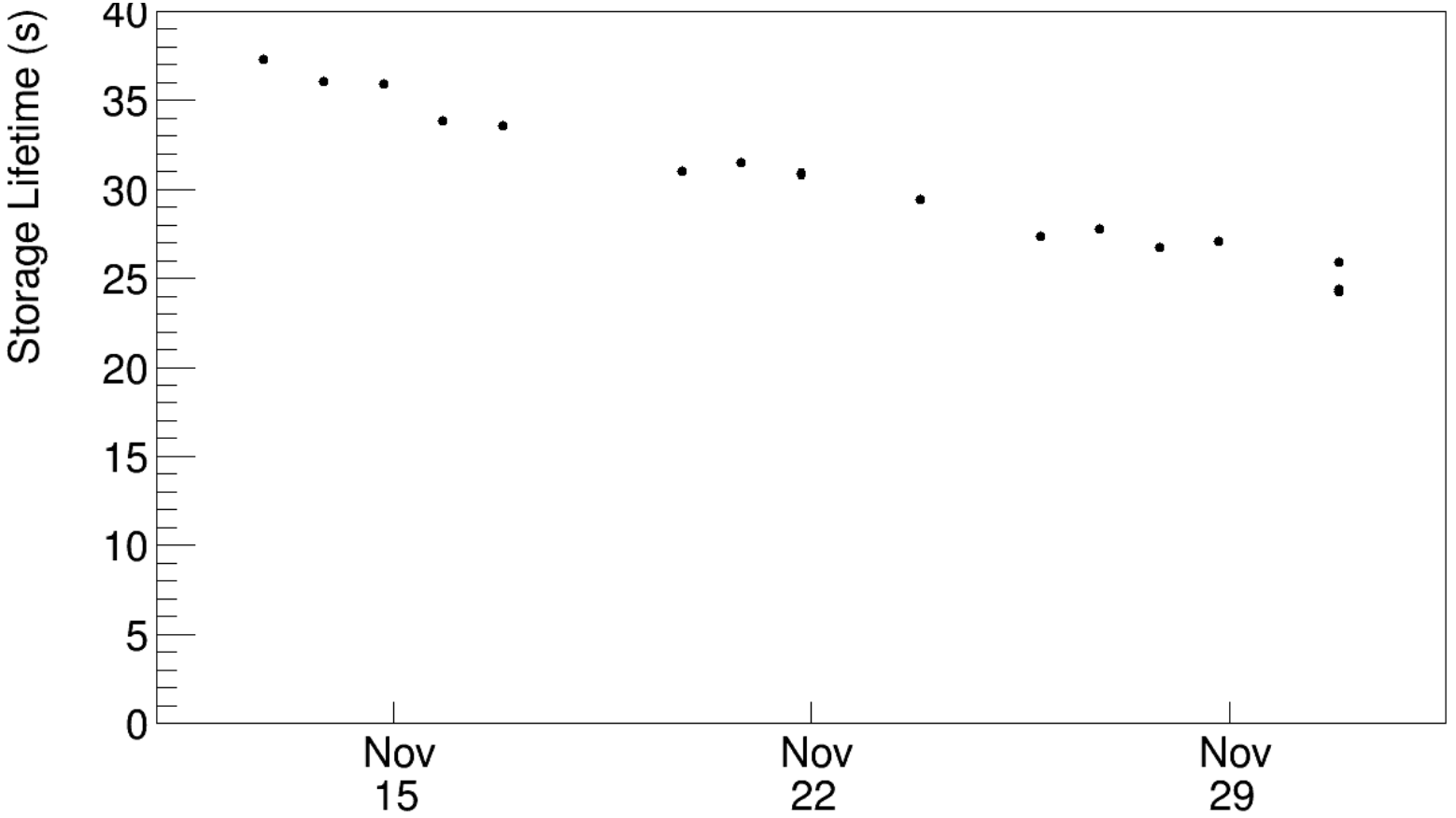
Higher isopure helium temperature -> Higher upscattering rate of UCN -> shorter storage lifetimes

$$1/\tau = 1/\tau_{up} + 1/\tau_{ab} + 1/\tau_{\beta} + 1/\tau_{W}$$

$$1/\tau_{up} = B\,T^{7} \longrightarrow$$ See Wolfgang's talk

Storage Lifetime over Time

Daily standard storage lifetime measurement of 1muA and 60 s irradiation time

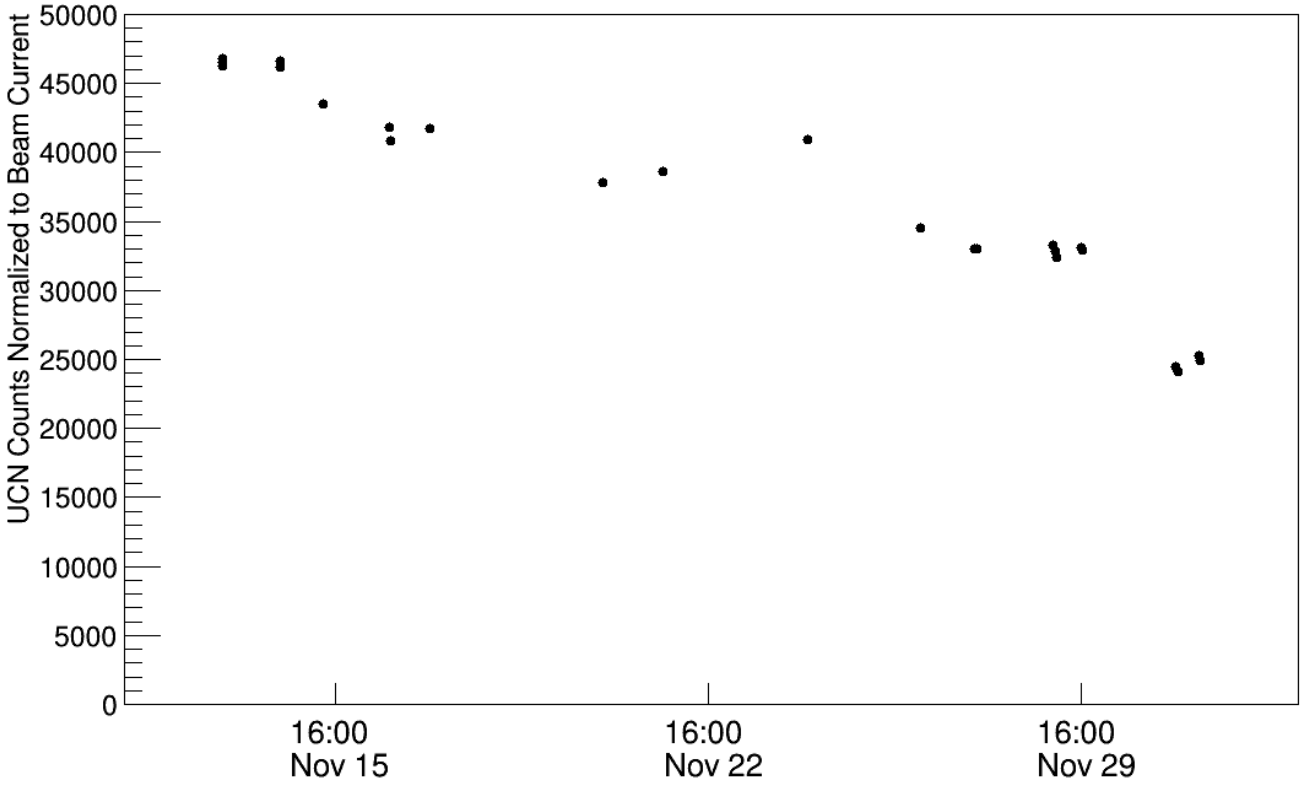


~ 30% decrease over 2 weeks

Source contamination?

UCN Counts over Time

Standard measurement of **1 muA** beam current and **60 s** target irradiation time over the course of UCN experimental run



Decrease because of contamination and different experimental configuration

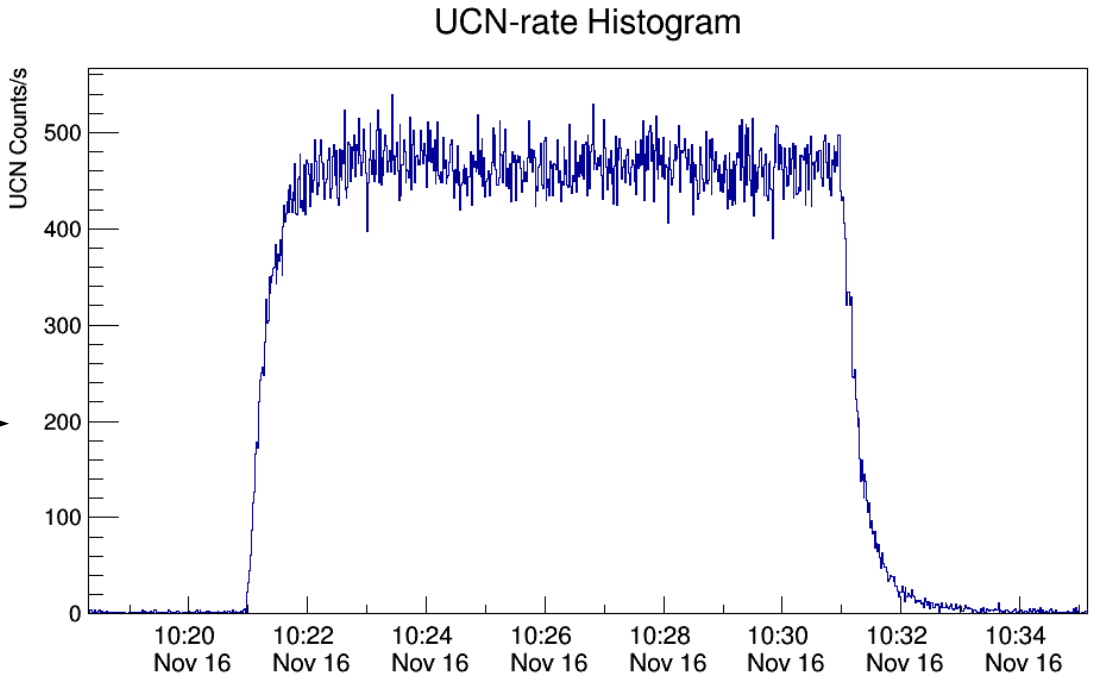
Steady-State UCN Production

Steady-State UCN Production

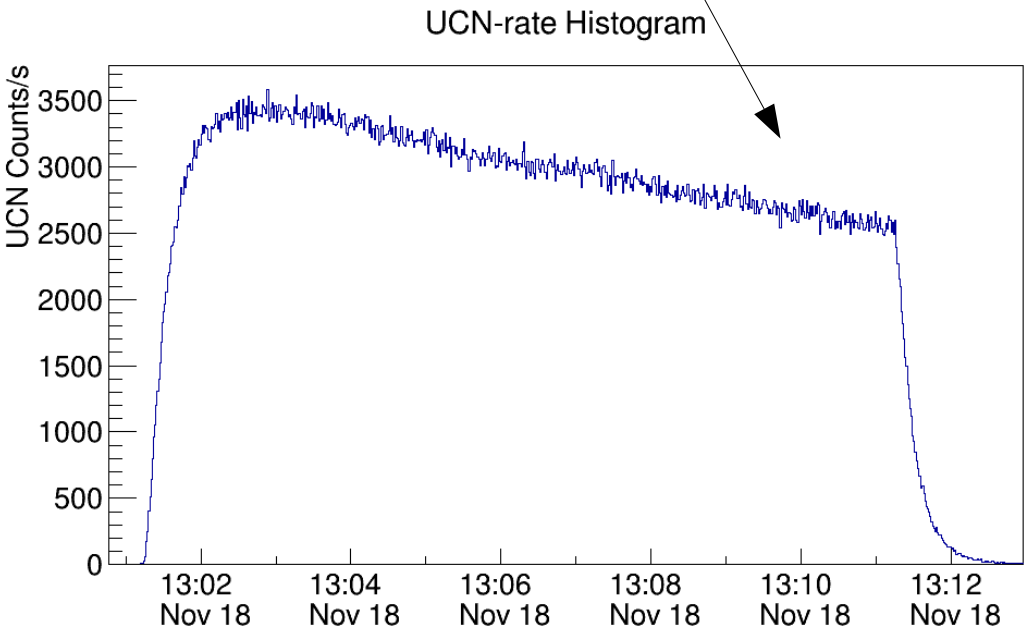
- UCN valve is left open

- Target irradiation for 10 min

- 0.3 muA beam current



- Data taken at higher beam currents (3muA)



Is it consistent with BT^7 ??

See Wolfgang's talk

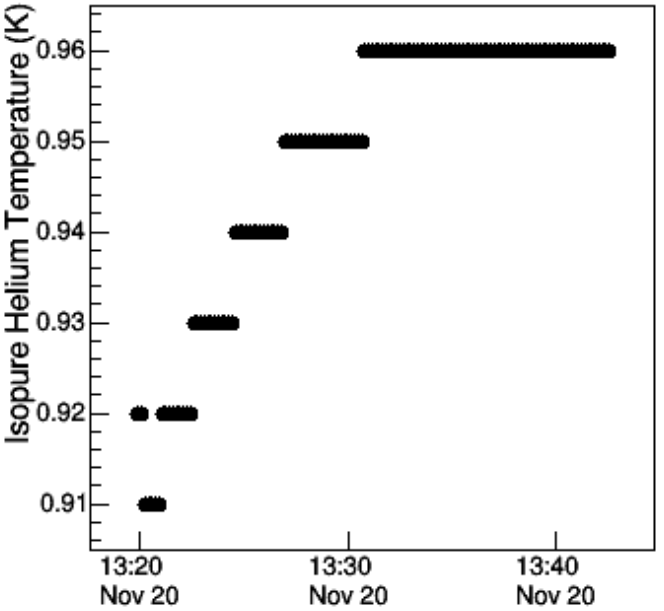
Proton Beam vs Heater power

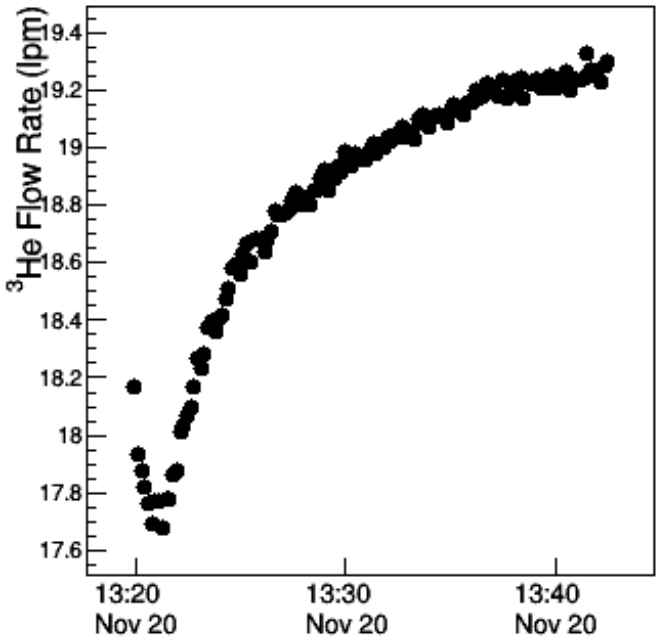
Problems:

- Did not wait long enough between the cycles for temperature and He3 flow rate stabilization
- Cryostat autofill was running -> Change in He3 flow rate, cooling power and isopure helium temperature
- Did not irradiate the target long enough for temperature and He3 flow rate to reach a stable value

Example of a Problem Run

- Isopure Temperature stabalized but the He3 flow rate did not
- Did not wait long enough before starting the run so that the temperature and flow rate are low and stable





Final Points

- Storage lifetime decreased from 37 s to 27 s over 2 weeks period
- Maximum UCN counts of 325k at 10 muA beam current
- Maximum UCN counts of 40 k at 1muA beam current
- Steady state UCN rate of 1600 UCN/s*muA
- Would be good to understand isopure temperatures (which sensor is right?)
- Do not take data while running helium autofill if interested in He3 flow rate
- Wait long enough between the cycles to let the cryostat go back to the stable state

Thank You!