TRIUMF

Canada's national laboratory
for particle and nuclear physics
and accelerator-based science

Note about UCN guide transmission experiment at PSI.

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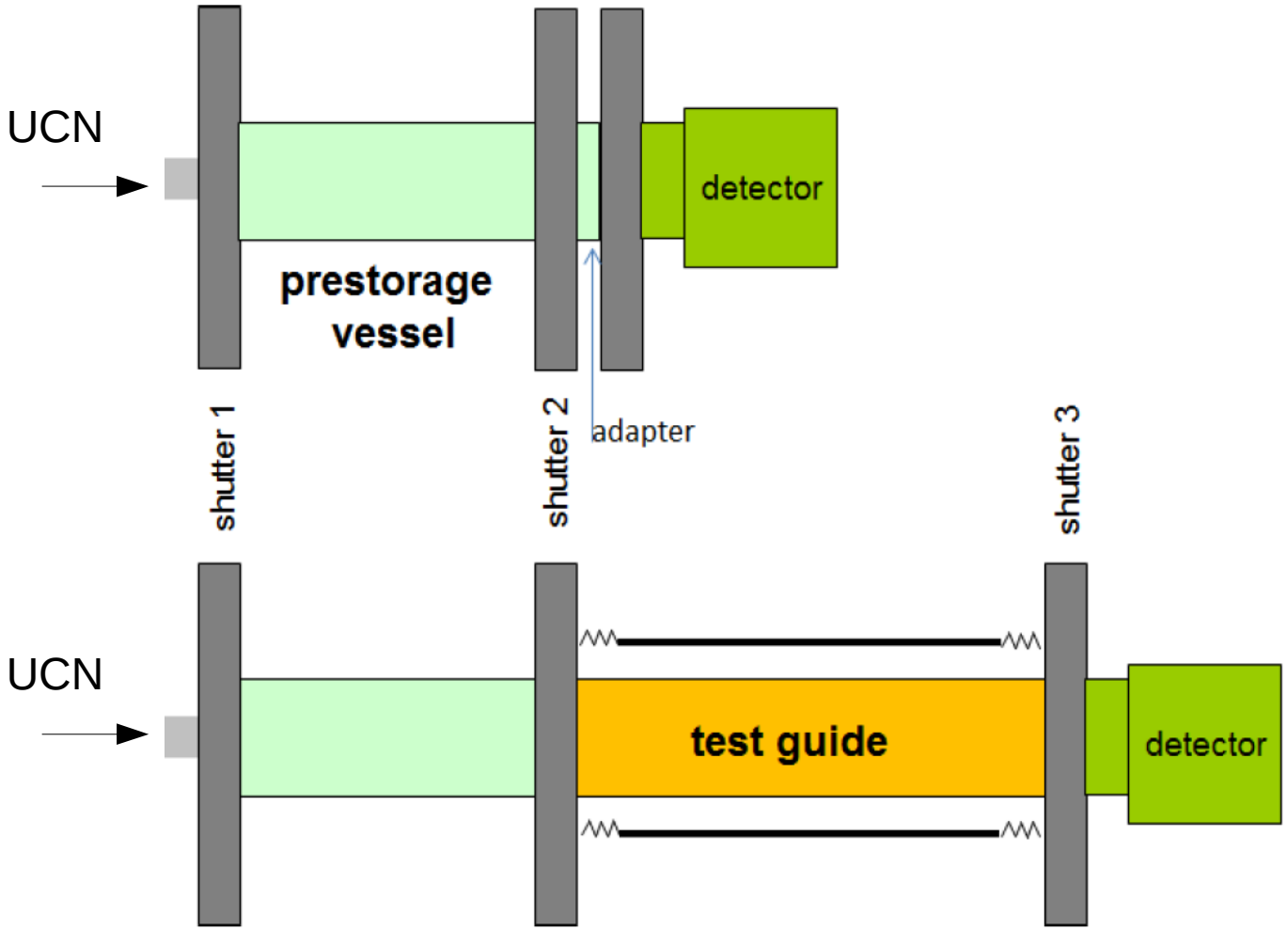
Outline

- Experiment principle
- Measurement
- Preliminary results
- Next step - plan
- Conclusion

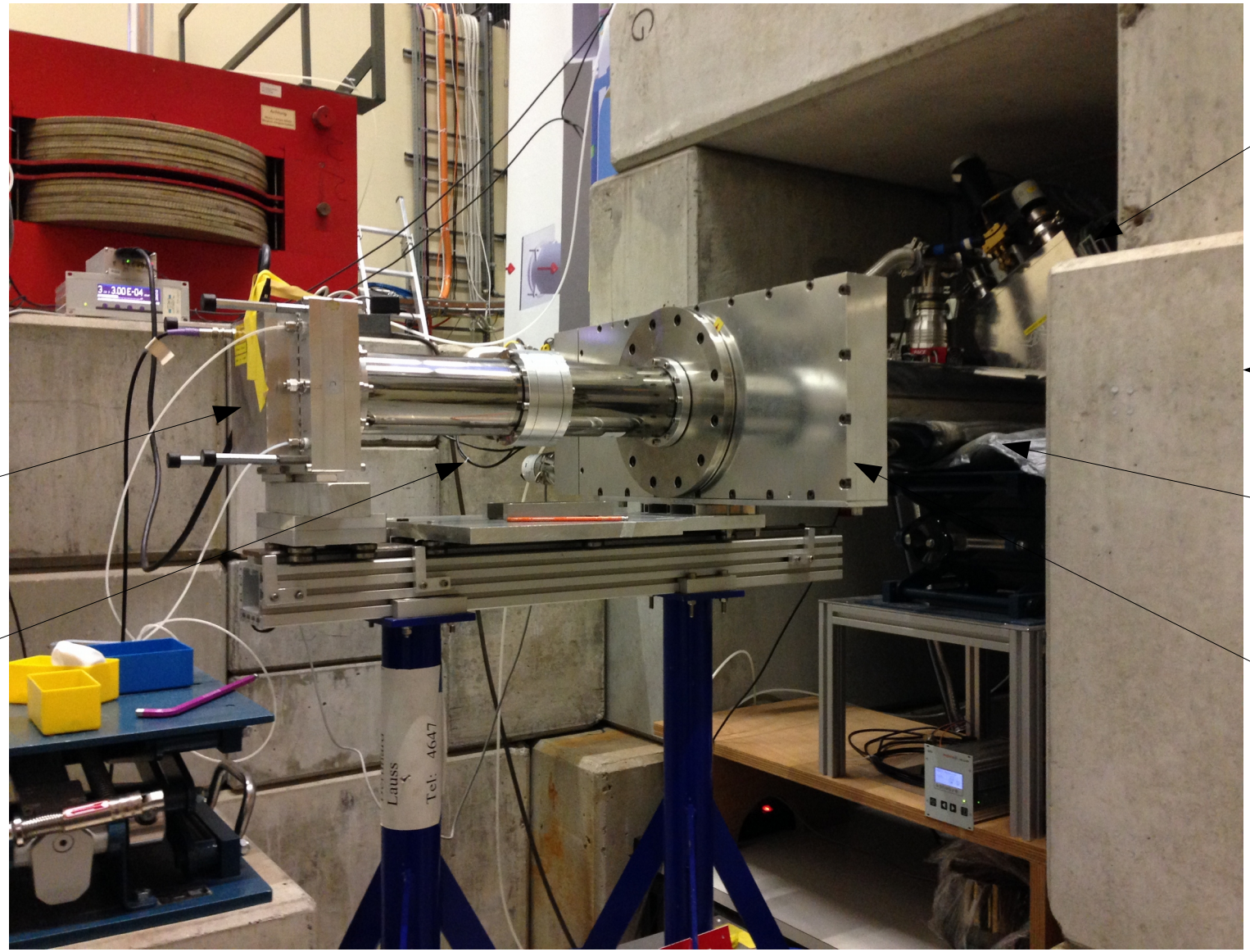
Experiment principle

- The transmission of a set of UCN guides was measured at PSI in December 2017 using the method described in (NIMA **807**, 30-40 (2016))

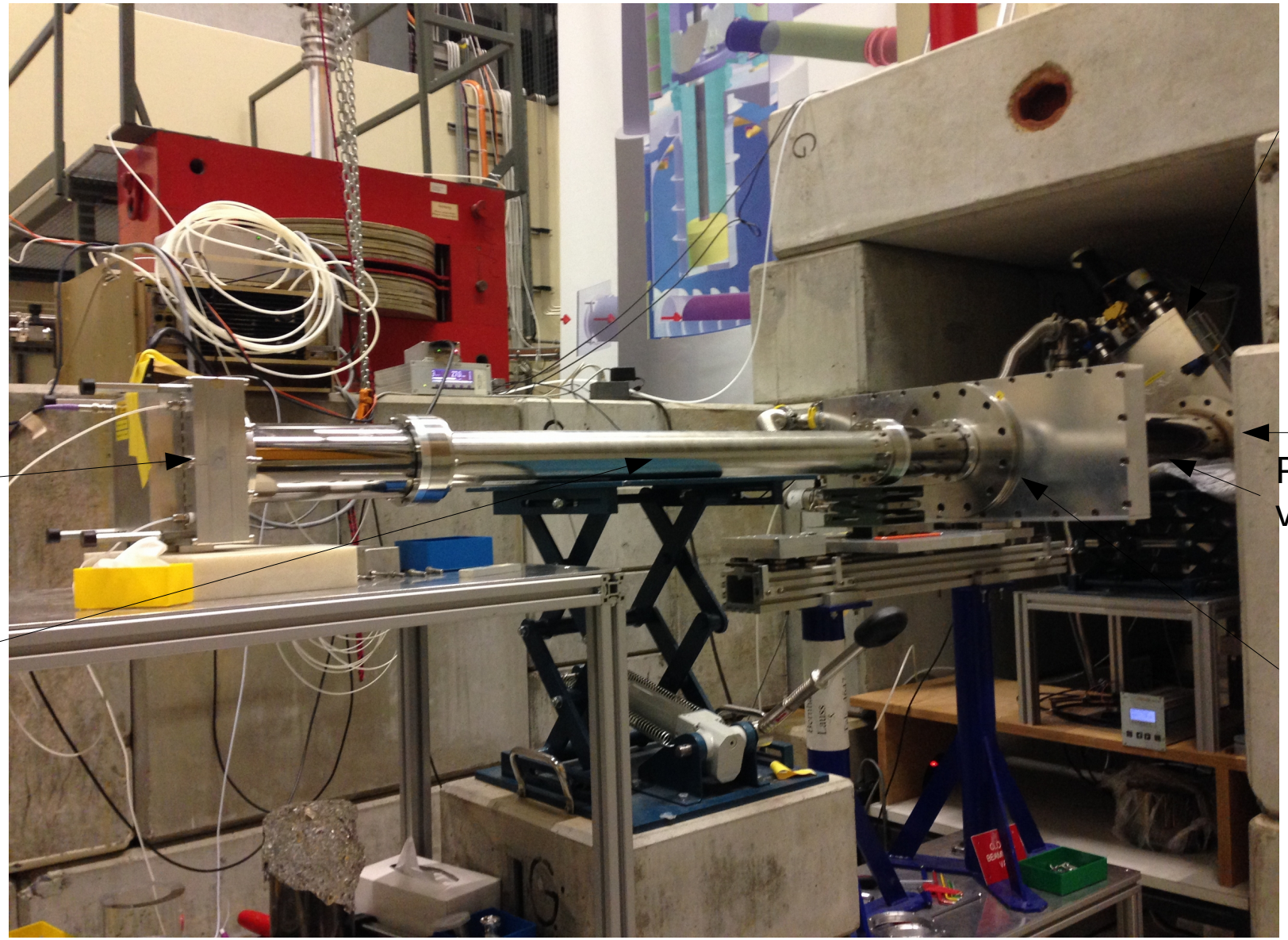
- The method uses a prestorage vessel in order to shape the UCN energy spectrum



Set up


Shutter 1
UCN
UCN detector
Prestorage vessel
Adapter
Shutter 2

Set up


Shutter 1
UCN detector
UCN Prestorage vessel
Guide
Shutter 2

Tested guides

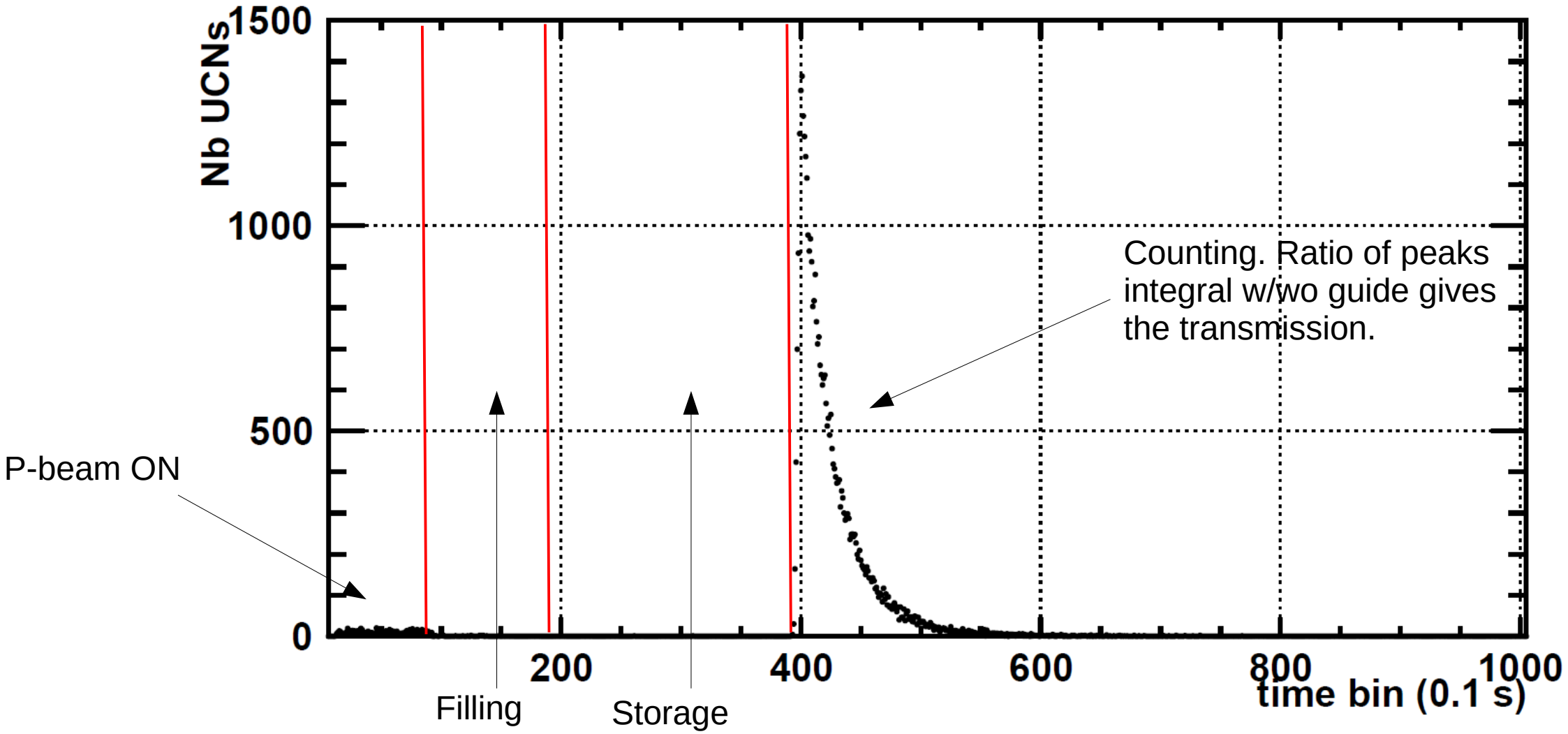
- 5 guides were tested:
  - EP SUS guide “UGD01”
  - Hand polished SUS guide “UGD03”
  - EP SUS guide with NiP coating
  - JP SUS guide with NiP
  - JP Ti guide with NiP

Measurement

- Sequence:
  - Trigger from the control room in order to start the run
  - 1.4 mA p-beam on target for 8 seconds. Shutter 2 is closed, shutter 1 is opened.
  - Wait for the volume to be filled. Bernhard perform a pre-study before we arrived in order to estimate the optimal filling time, defined here to 8.6 s
  - Close shutter 1 and store the UCN during a given time (5 s to 100 s)
  - Open shutter 2, count the stored UCN

Measurement

- Typical spectrum:

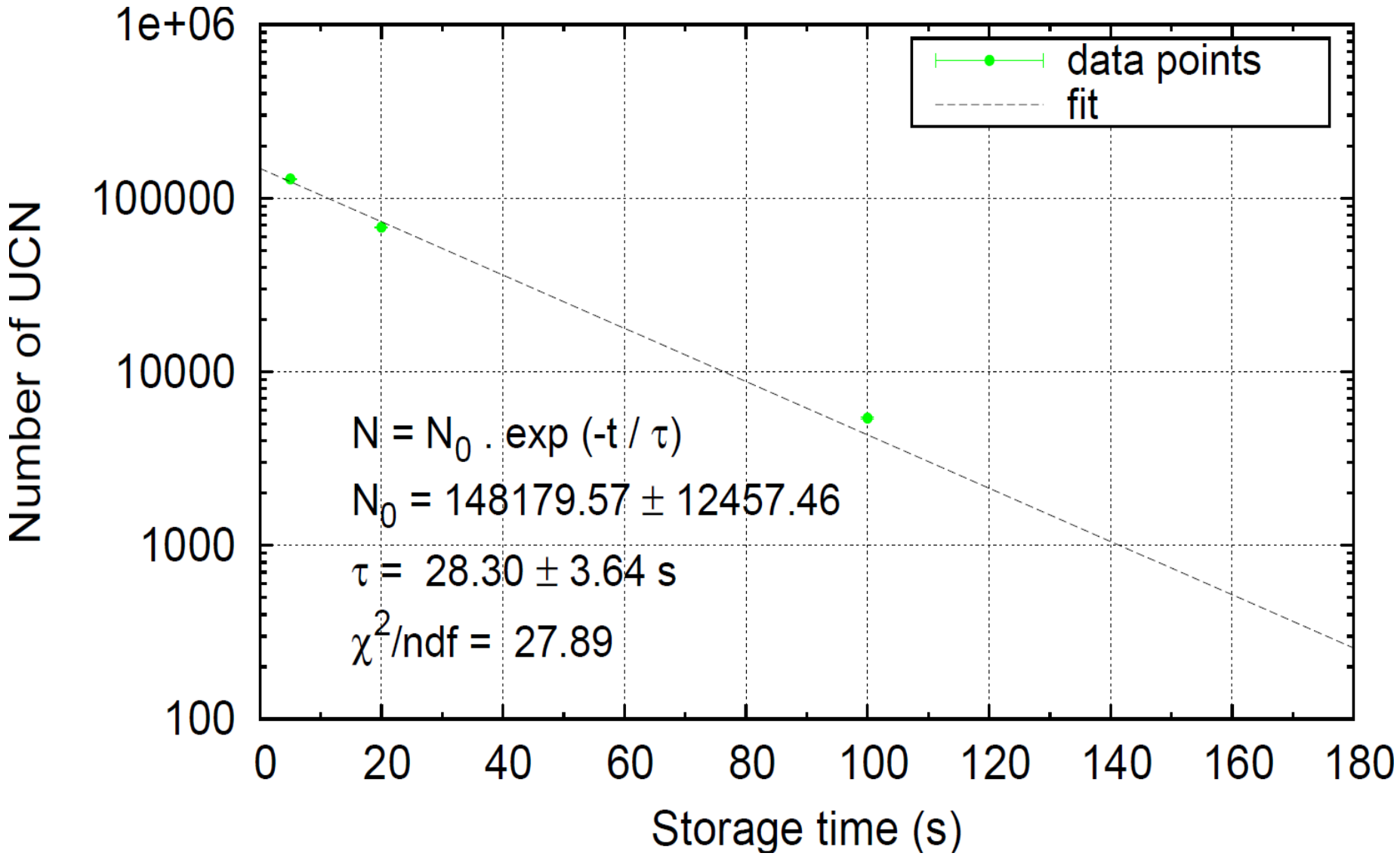


Measurement

- Systematic budget:
  - DAQ and electronics timing: tested in NIMA **807** 30-40 (2016): about 10^{-5}
  - Source performances decrease from 1 cycle to the next one: ~10^{-4} (see after). But correction is required
  - Proton current stability: ~10^{-3}
  - UCN leak through the shutter: 0.1 UCN/s on average → negligible regarding our statistics

Prestorage

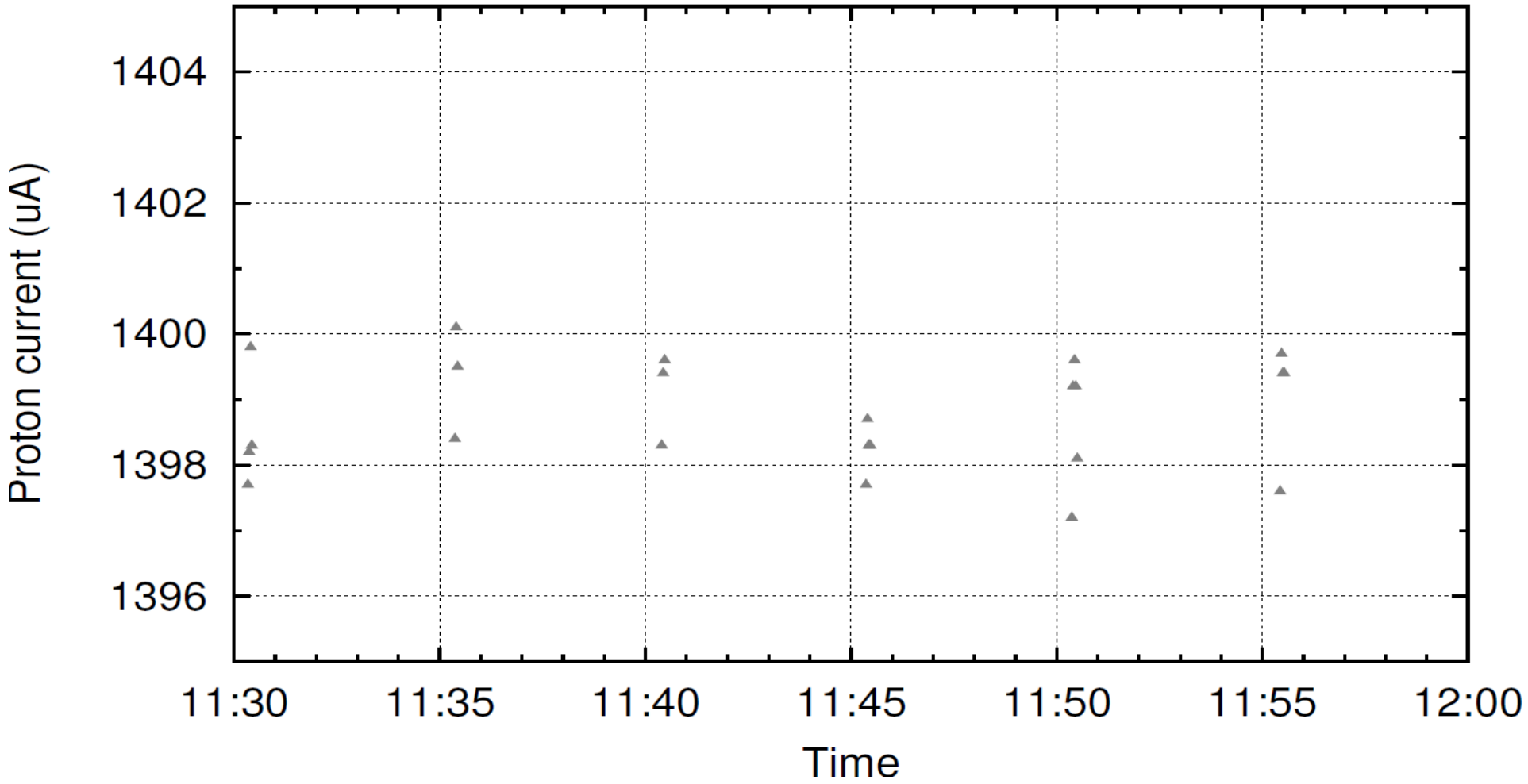
- Prestorage vessel storage time



Ries thesis (2016):
τ=29.5+/-0.5 s

Cyclotron stability

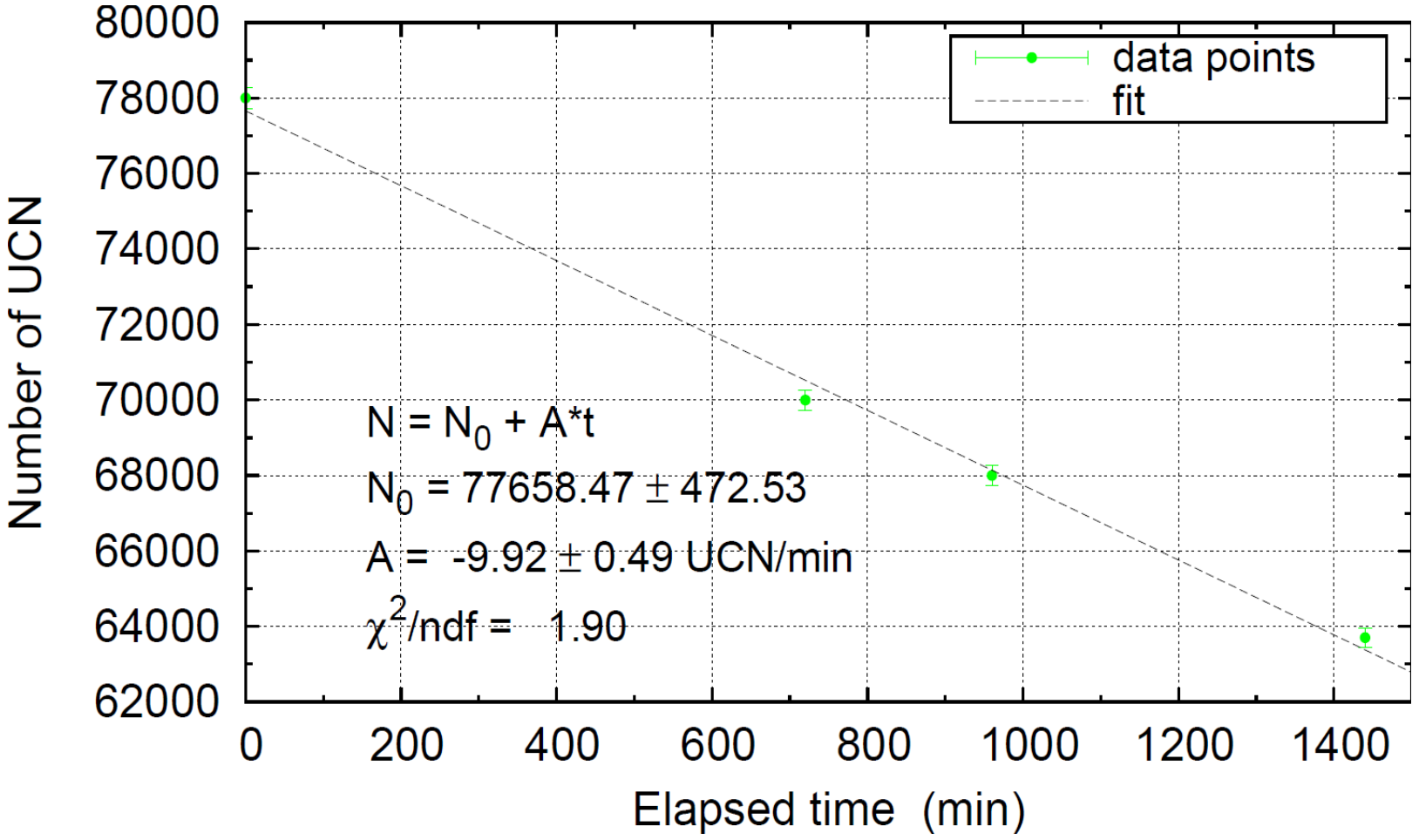
- P-beam current: checked every 2 s.



We got (many) issues with cyclotron stability...
All the runs with way larger beam fluctuations were removed from the analysis.

UCN yield variation

- Source's performances: decrease with time!



Measurements non reproducible. Must be normalized.

Data format and analysis

- Given data are ToF in ascii format (1 time is 1 detected UCN)
- Turned into ROOT trees, then plotted (see previous ToF plot)
- Background subtracted, bin summed, then ratio of counts (w/wo test guide) in order to extract the transmission.
- Additional renormalization done using the source performances decreasing data
- Guides are 1 m long so t given in %/m
- As said before, different storage times for different energy spectrum (the longer we wait the softer the spectrum if). MC should be necessary in order to get the real spectrum.
- Also, there is a 54 neV cut due to Al window of the Cascade detector.

Preliminary results

- Transmission for the 5 guides was measured, for 5s, 20s and 100s storage time. 100s measurements are still being analyzed at the moment (low statistics, not well understood effects…)

- JP guides have poor performances. Bad roughness? Surface contamination?
  - SUS(5s): 69.8(1)%/m
  - SUS(20s): 71.4(1)%/m
  - Ti(5s): 48(1)%/m
  - Ti(20s): 51(1)%/m
- Error is now mainly stat and also increased to 1%. Need to check this more carefully.

Preliminary results

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- TRIUMF guides also shown interesting results...
  - UGD01(5s): 88.5(1)%/m
  - UGD01(20s): 88.4(1)%/m
  - UGD03(5s): 93.8(1)%/m ← better than UGD01!
  - UGD03(20s):94.7(1)%/m
  - SUS with NiP coating(5s): 97.1(1)%/m
  - SUS with NiP coating(20s): 96.7(1)%/m

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  - UGD01(20s): 88.4(1)%/m ← Same result as TRIUMF exp?
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Next steps - plans

- Make everything accessible → I created a folder for MFL and PSI experiments on TRWIN (UCN/epierre/PSI and UCN/epierre/MLF , will move stuff there soon.

- How do we place these results compared to the experiment at TRIUMF? Both for a single paper? I think it makes sense. In that case, include last December data as well? Again, makes sense for me.
- I don’t know what are Steve’s plans, but could be nice to get things done with him.

Conclusion

- Transmission of SUS guides with and without NiP coating was measured at PSI. Data are still being analyzed concerning the low statistics measurements. Similar data were taken also at TRIUMF for two guides, see previous talk.

- A transmission of about 95%/m was measured for EP SUS with NiP coating, which is in agreement with previous measurements made by the PSI group and which fulfil our requirement for the next generation UCN source.