Guides transmission measurement at PSI

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TUCAN's goals

1) Scientific goal: neutron electric dipole moment measurement, with a precision of $10^{-27} e \cdot cm$

2) Build the strongest UCN source in the world

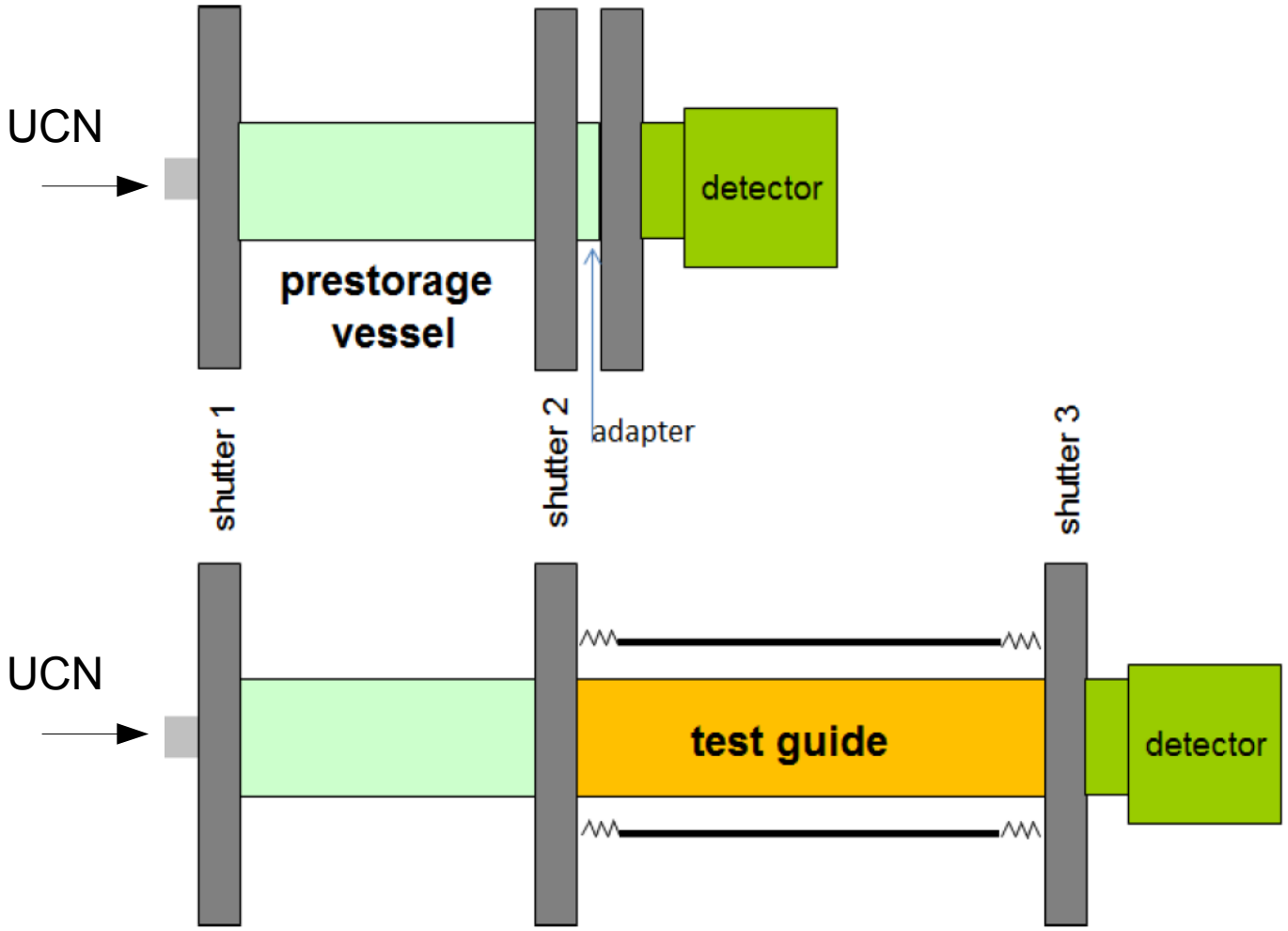
3) Transmission aim: keeping items with a T/m>90%

Experiment principle

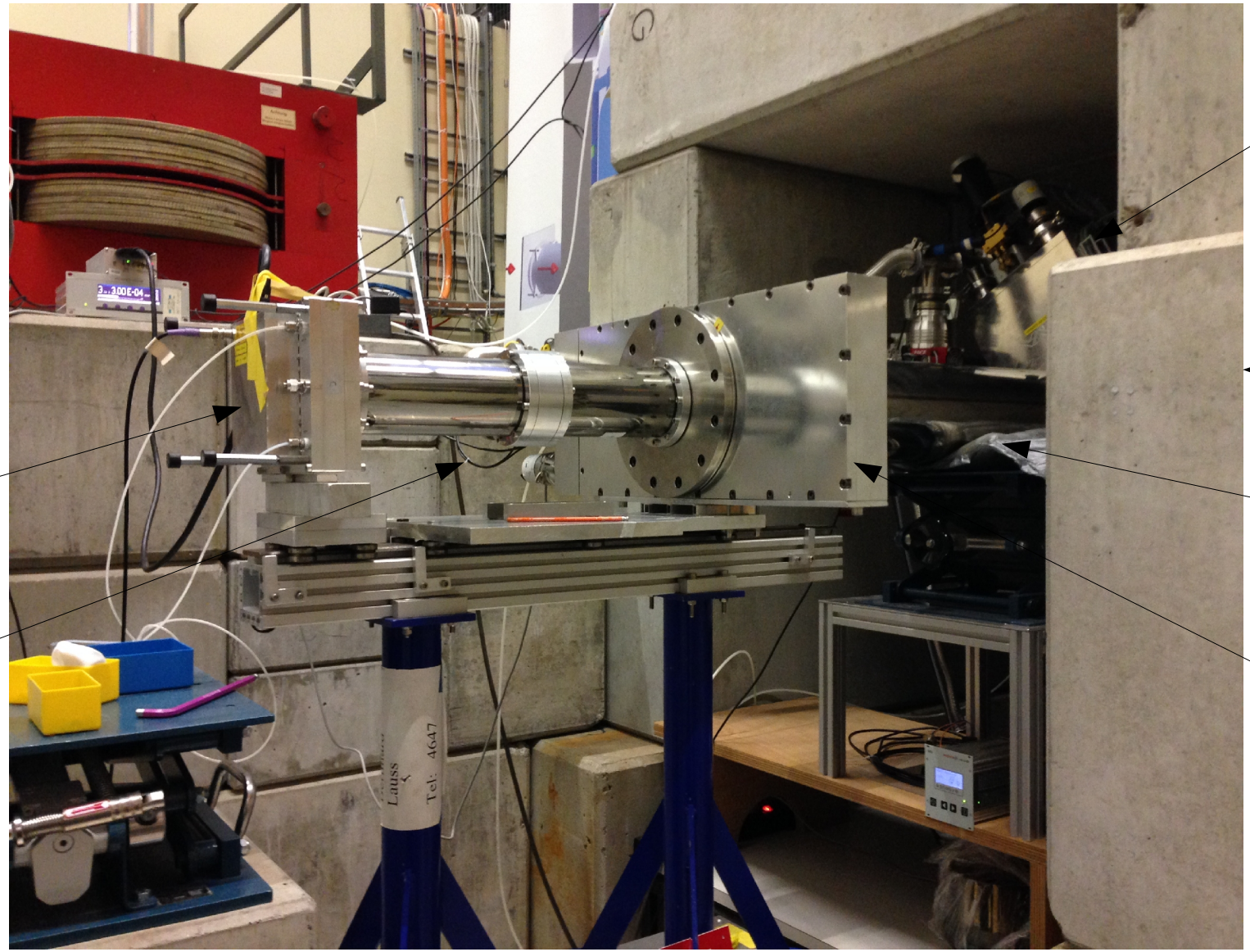
- The transmission of a set of UCN guides was measured at PSI last December using the method described in

  (NIMA **807**, 30-40 (2016))

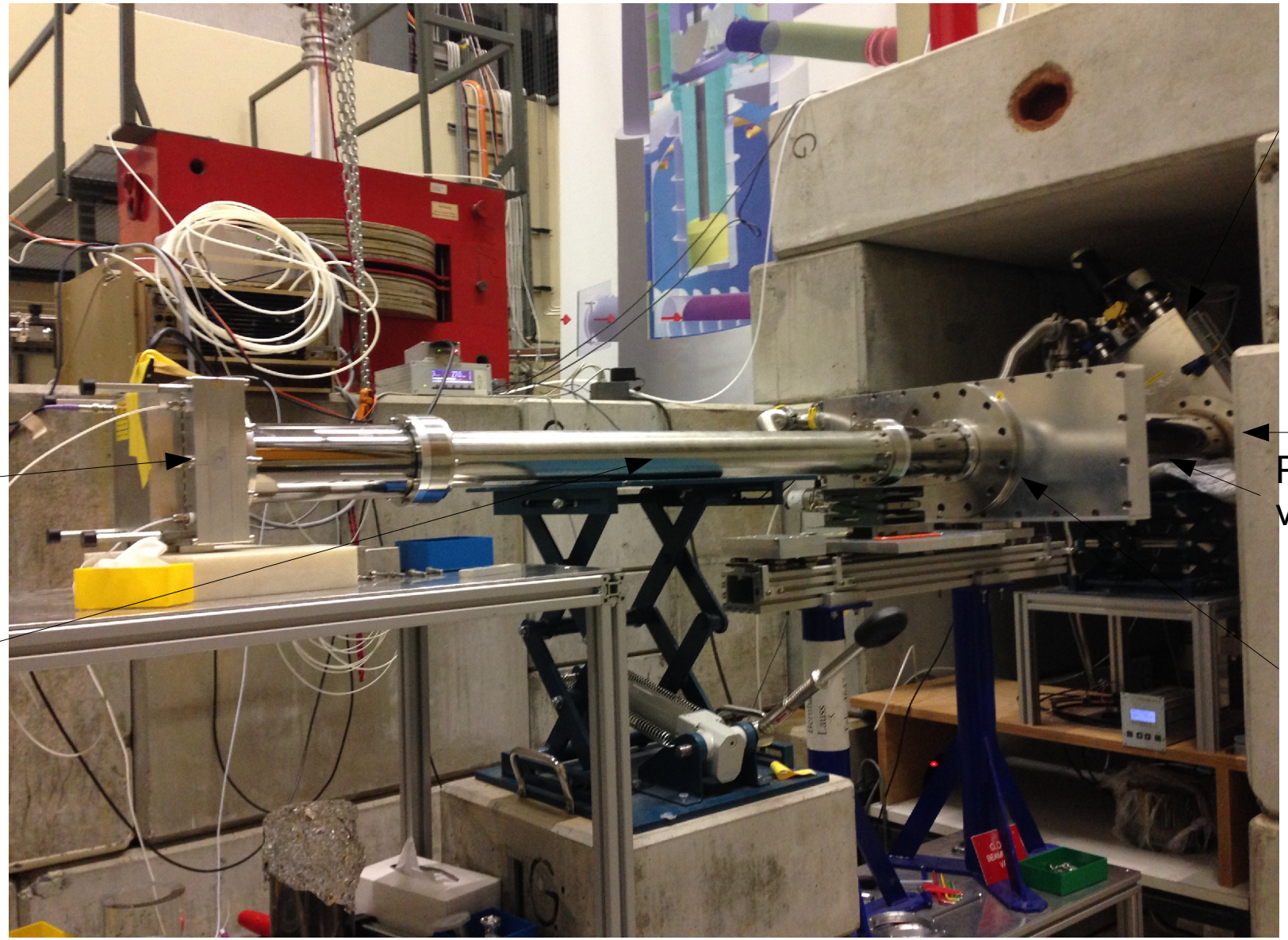
- The method uses a prestorage vessel in order to shape the UCN energy spectrum



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

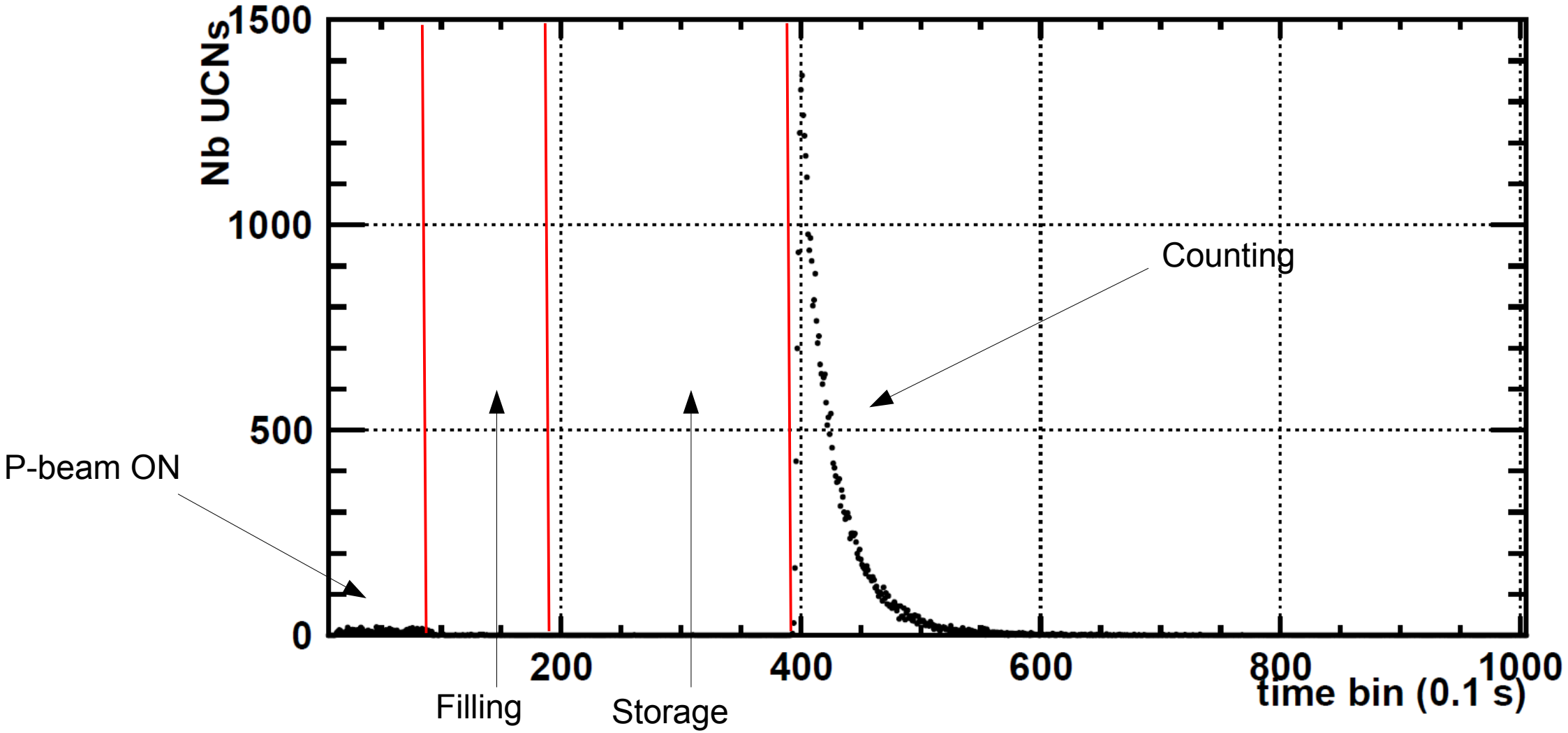
- 5 guides were tested:
  - EP SUS guide “UGD01”
  - Hand polished SUS guide “UGD03”
  - EP SUS guide with NiP coating
  - JP SUS guide with NiP
  - JP Ti guide with NiP

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:

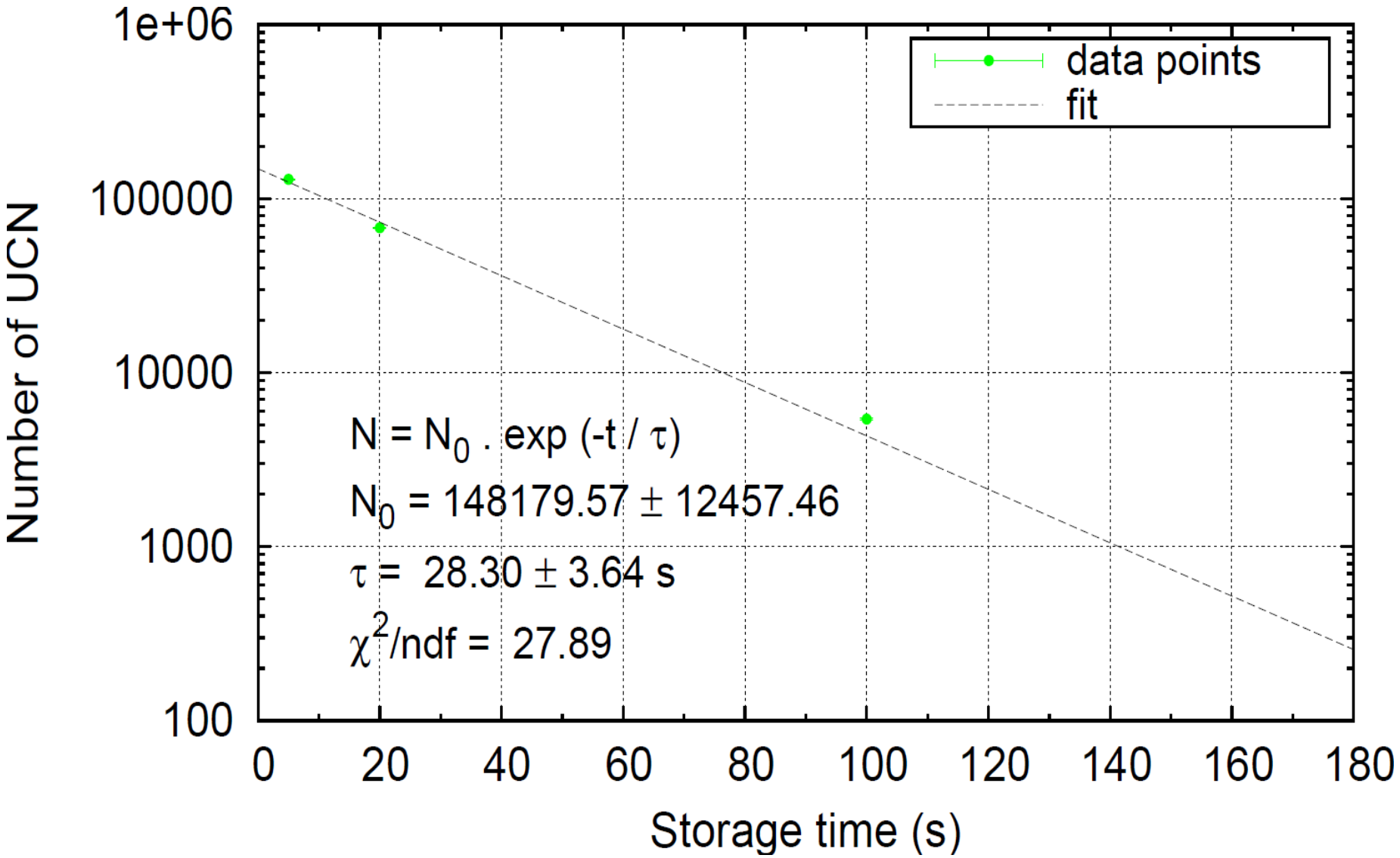


Measurement

- 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). Correction is required
  - Proton current stability: ~10^{-3}
  - UCN leak through the shutter: 0.1 UCN/s on average → negligible regarding our statistics

Prestorage

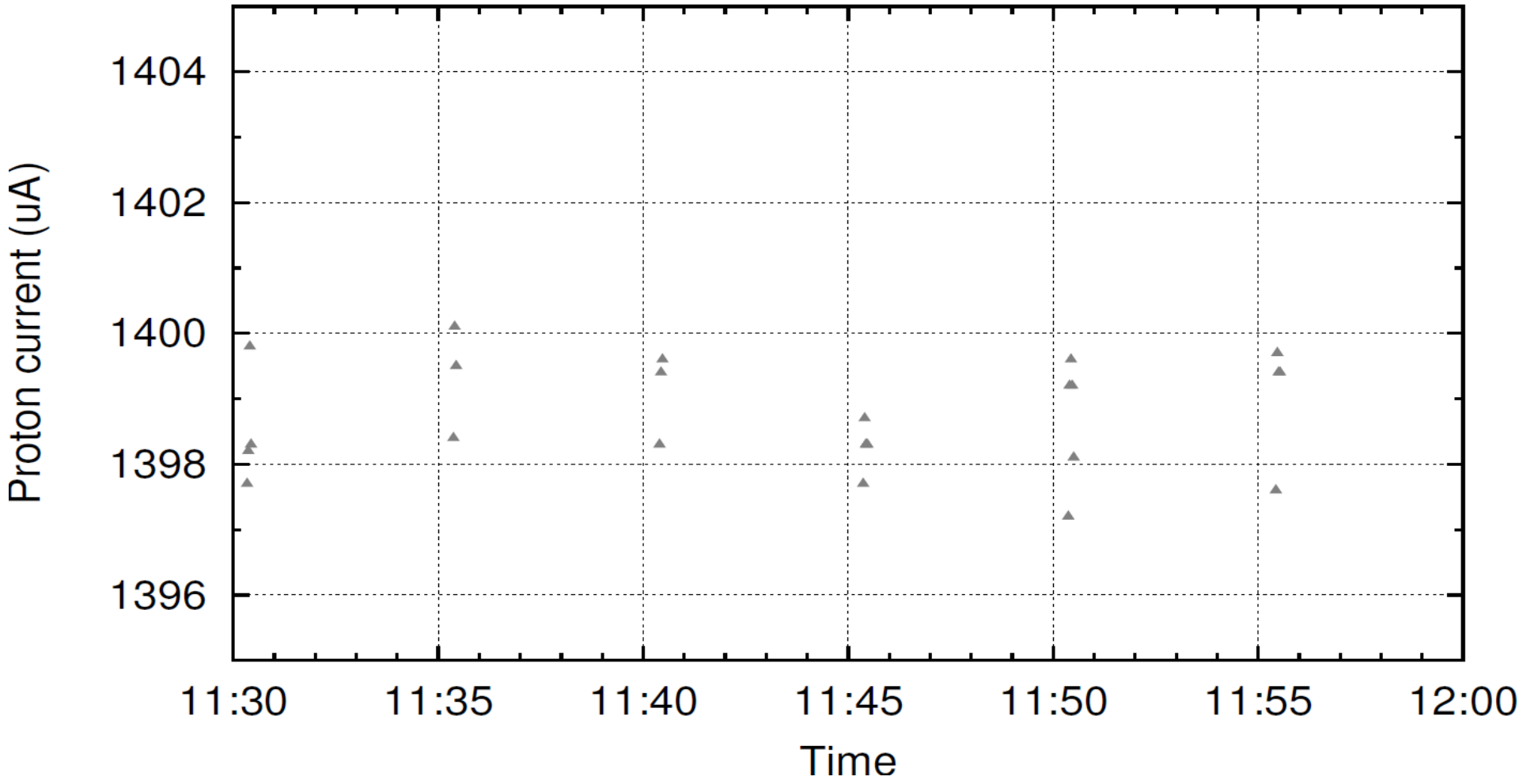
- Prestorage vessel storage time



Ries thesis (2016):
τ=29.5+/-0.5 s

Cyclotron stability

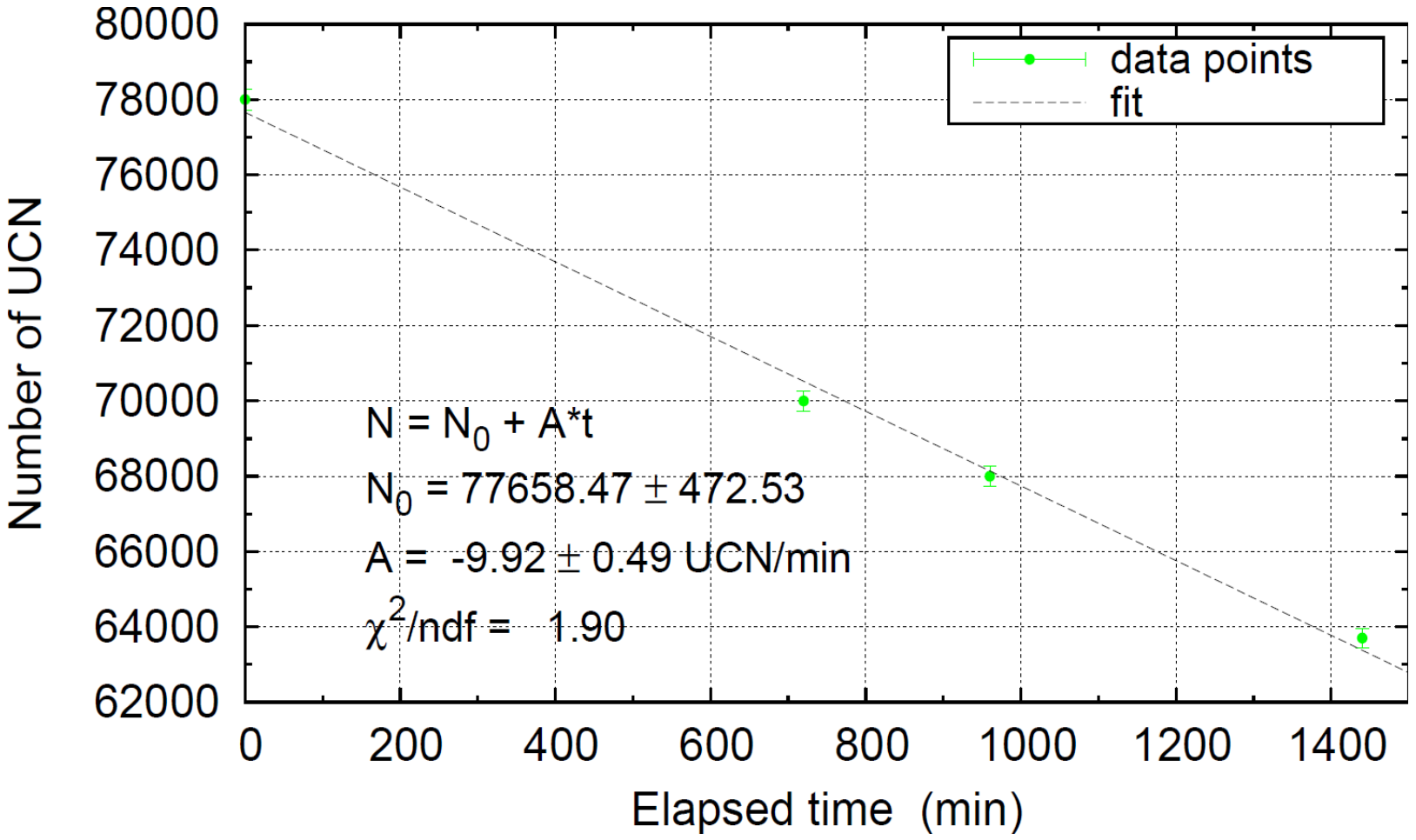
- P-beam current: checked every 2 s.



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.

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

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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Same result as TRIUMF exp.

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.