TES: status and next steps

ALPS collaboration meeting in Mainz

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07.03.2017

Overview

For the TES detection scheme the following hardware is needed:

Interface to the experiment

- Filter for green light
- Coupling to fiber
- Fibers

Tools

- Splicer
- Clever

Detector system

- Cryostat
  - He compressor
  - (Cooler for the water supplied to the He compressor)
  - Vacuum pump
- TESs
- SQUIDs
- Computer with software
- SQUID electronics
- SQUID software
- 2 channel ADC board

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New cryostat

We checked the market for a ADR replacement:

- Dilution refrigerators are compatable in terms of price and cool down time
- Advantage: continuous operation, high cooling power, no magnet

We contacted the following companies:

- Entropy (Germany)
- Bluefors (Finnland)
- Lyden (Netherlands)
- CryoConcept (France)
- Janis (USA)
- Oxford Instruments (UK)

Tender process

We received funding for a new cryostat and will start a Europe wide tender soon.

- 35 days time window to hand in quotes
- 15 days quoate review by us and the purchasing department
- 10 days to raise objections by outgunned companies
- 3 days cotract signing
- typical delivery time: 6 months

$\Rightarrow$ No cryostat before November 2017

Detector and readout

TES:

- Jörn Beyer promised it will be no problem to get TES from NIST and SQUIDs from PTB
- We might have to buy new SQUID electronics O(10K€)

Readout:

- Alazar dual channel card with up to 250 MSPS and 16 bit resolution is ready to be used
- Hardware (high rate) and software (low rate) trigger are set up
- Onboard FPGA option for triggering not yet exploited

Green light filter

Why?

Avoid dead time and heating of the TES.
Aim: $R_{\lambda=532\,\mathrm{nm}} \approx R_{\mathrm{background}} \approx 10^{-6}\,\mathrm{s}^{-1}|_{\mathrm{TDR}}\ (10^{-4}\,\mathrm{s}^{-1}|_{\mathrm{current}})$

We started working on the attenuation unit again:

- Following Rezas approach and ussing components from him
- 4 new HR1064HT532/45 were bought from LaserComponents
  $\Rightarrow$ Move from transmission of infrared to reflection $\Rightarrow$ possible fluorescence light is produced in transmission

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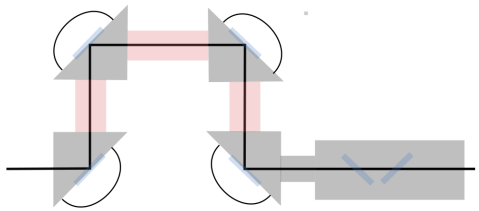
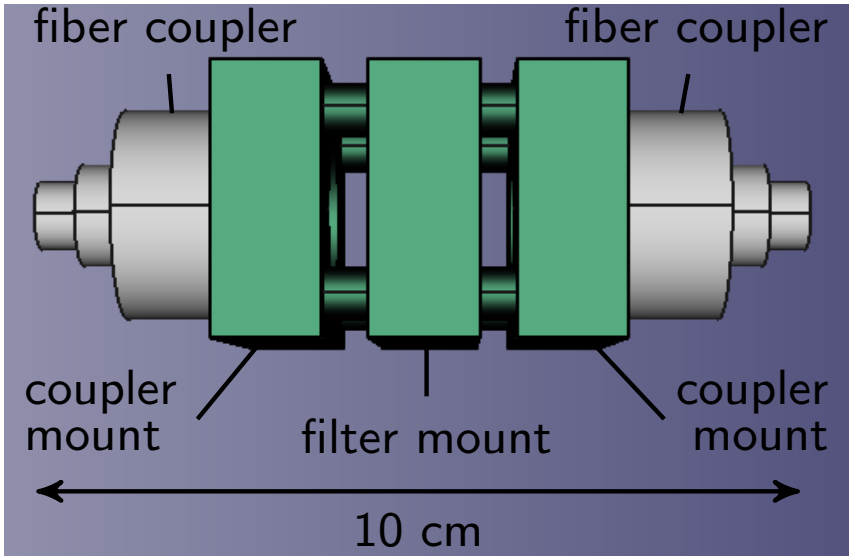
First results:

- Mirrors perform as specified by the manifacturor
- Better performance (reflection of infrared and transmission of green) can be achieved by using an angle different from 45
- 7×10^{-5}(3×10^{-6} for tuned angle) attenuation of green shown for 98 % IR transmission



Black-body radiation filter

- Measured fiber-to-fiber coupling efficiency: 82 %
- Expected coupling efficiency with anti-reflectve coating on fiber tips: 89 %



- Filter option: band-pass filter for (1064 ± 10) nm with transmission for 1064 nm of ≥ 95 % and else a blocking of $\geq$ OD4

To be shown: Is the alignment maintained when cooling the bench

- Test at $-80\,^{\circ}$C with dry ice
- Final test at 70 K in some cryostat

Overview

The current software frame work is written in C++. ROOT is mainly used in the analysis package and optional for the alpsIO and alazar package.
Packages:

- alpsIO: Handling of acquired and simulated data.
- alazar: Data taking with ALAZAR boards used by the TES data acquisition system and the fast monitoring discussed above.
- analysis: TES data simulation, TES data analysis, time line analysis.

alpsIO package

Supported data formats:

- ROOT files (offers good data compression)
- Binary files (useful for fast readout)
- Text files (support is only given for reading them in order to convert old TES data)

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Data structure:

- Vector of data samples (2 byte for RAW and 8 byte for converted data) per buffer and channel
- Timestamp and trigger information per buffer and channel
- Meta data like sampling frequency, acquisition type (time line/triggered data), acquisition device (ATS9626, ATS9416, DPO7104C)

alazar package

General:

- Effort was put into this package to write it as generic as possible ⇒ Supporting all ALAZAR boards
- It makes use of the ALAZAR SDK
- We implemeted only dual port *Direct Memory Access* ⇒ While data taking data is already transfered to host memory

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Readout modes:

- Contiuous acquisition ⇒ Limited by the host memory and data transfer rate from the board to the host memory and finally by the time needed to write data to disk
- Software triggered
- External triggered

Analysis package

Simulation:

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- Noise $\Rightarrow$ Sampling noise from a measured noise spectrum includes also the bandwidth of the SQUID electronics

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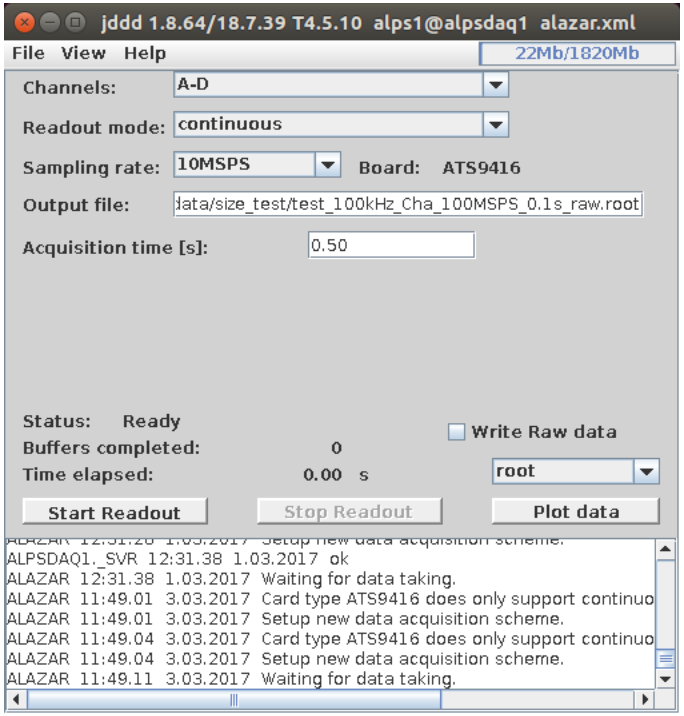
Misc:

- FFT including different window function of time line data
- Fixing the desired frequency resolution allows to split the time line and calculate an average noise per frequency bin $\Rightarrow$ Averaging is either done by considering the median or the arithmetic mean

Example: Data acqisition and analysis



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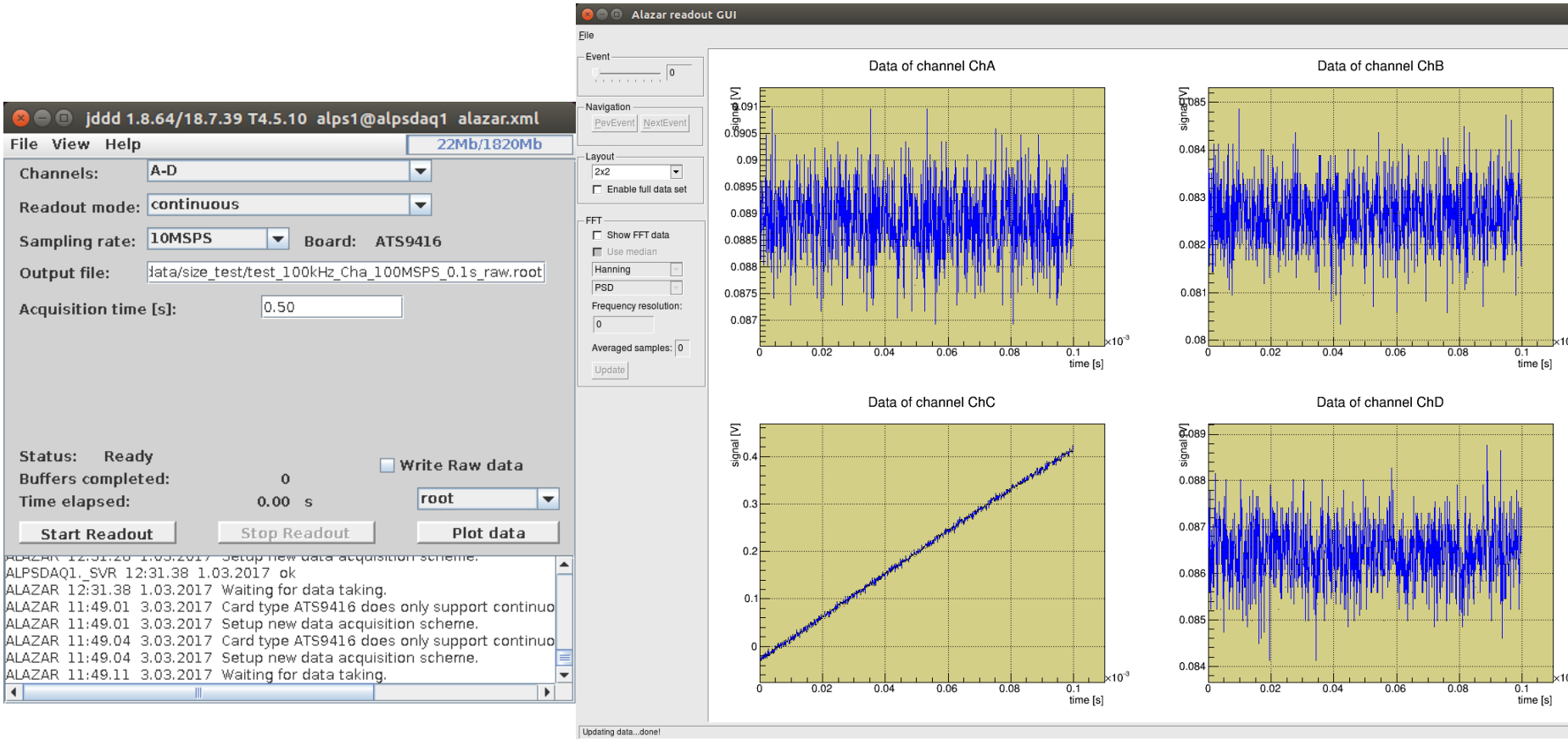

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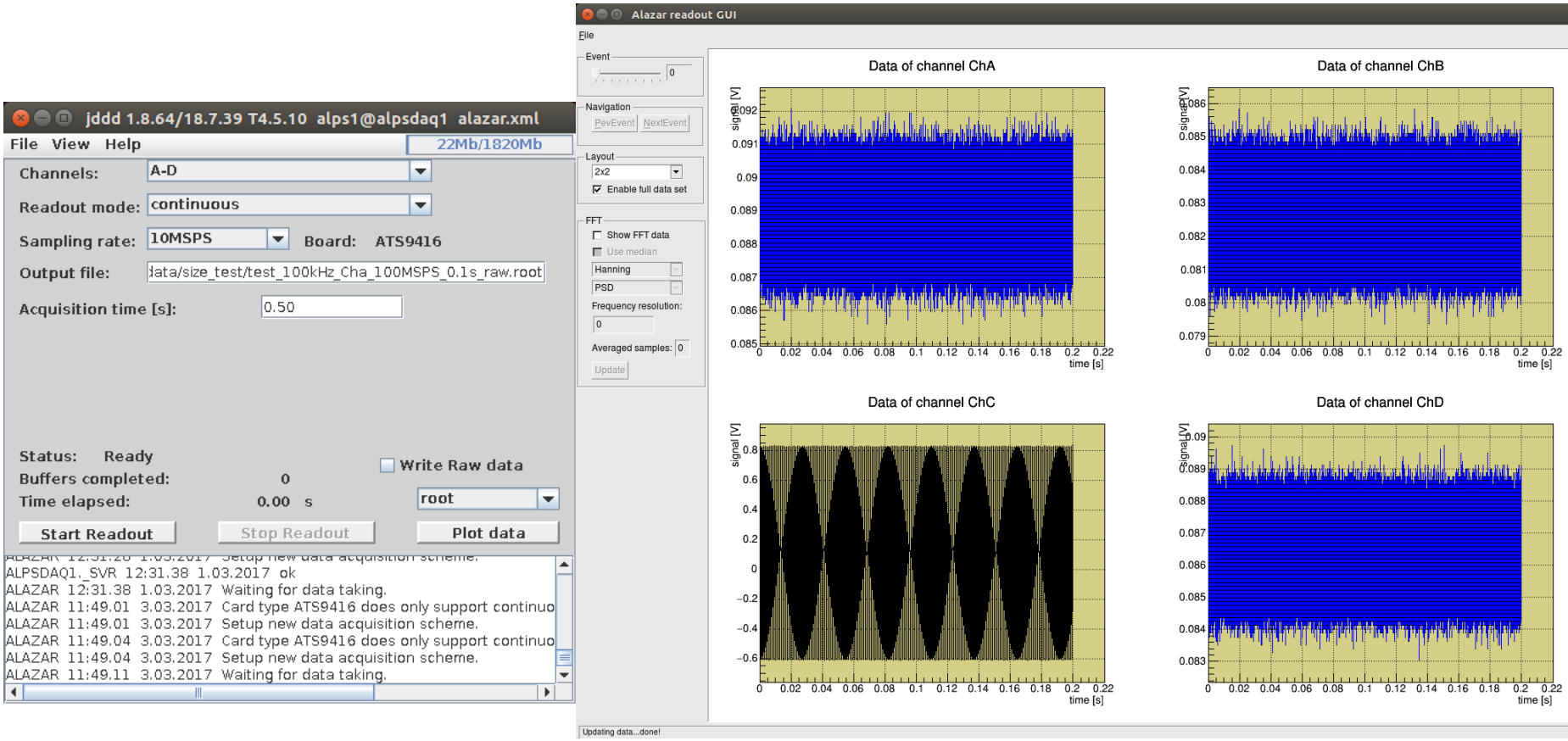

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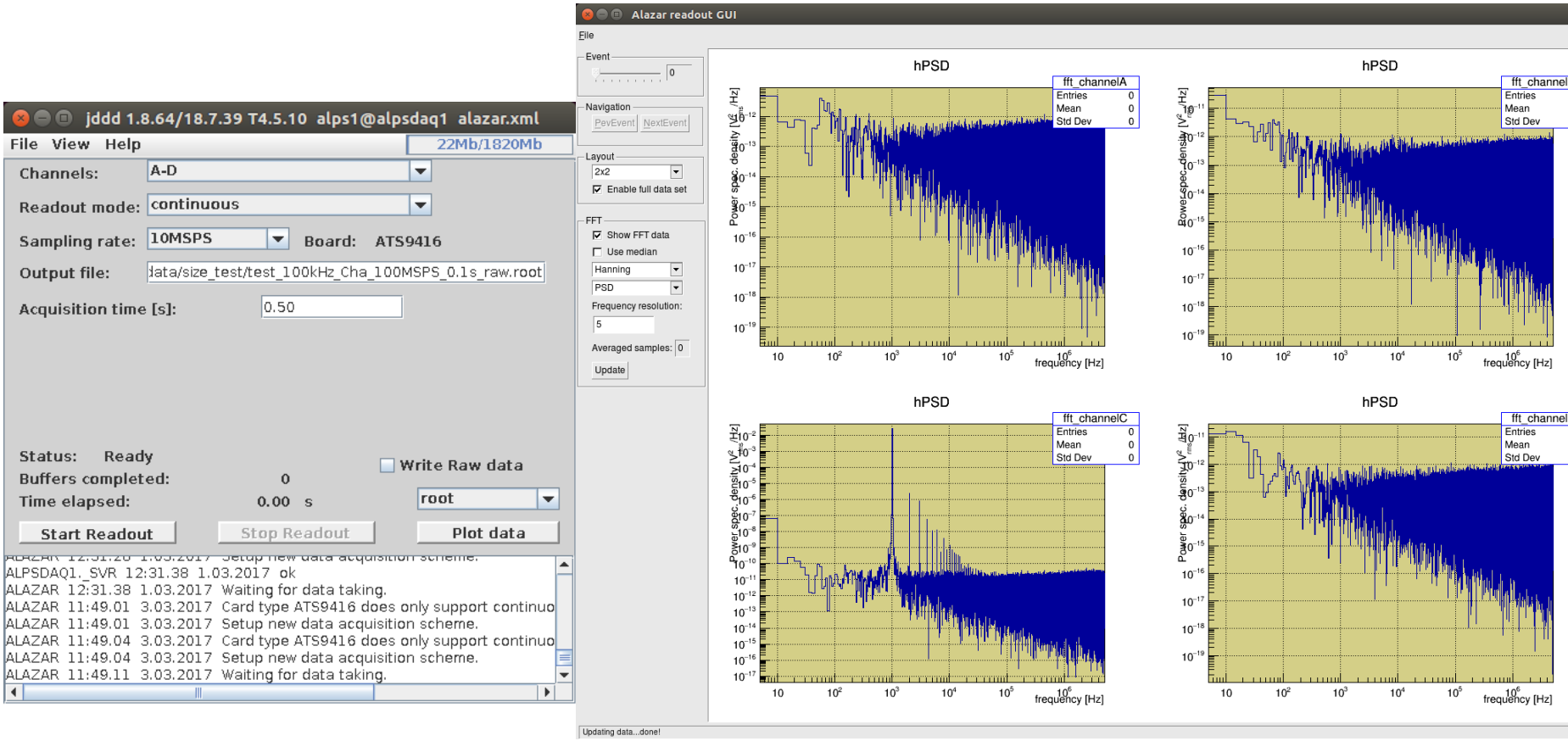

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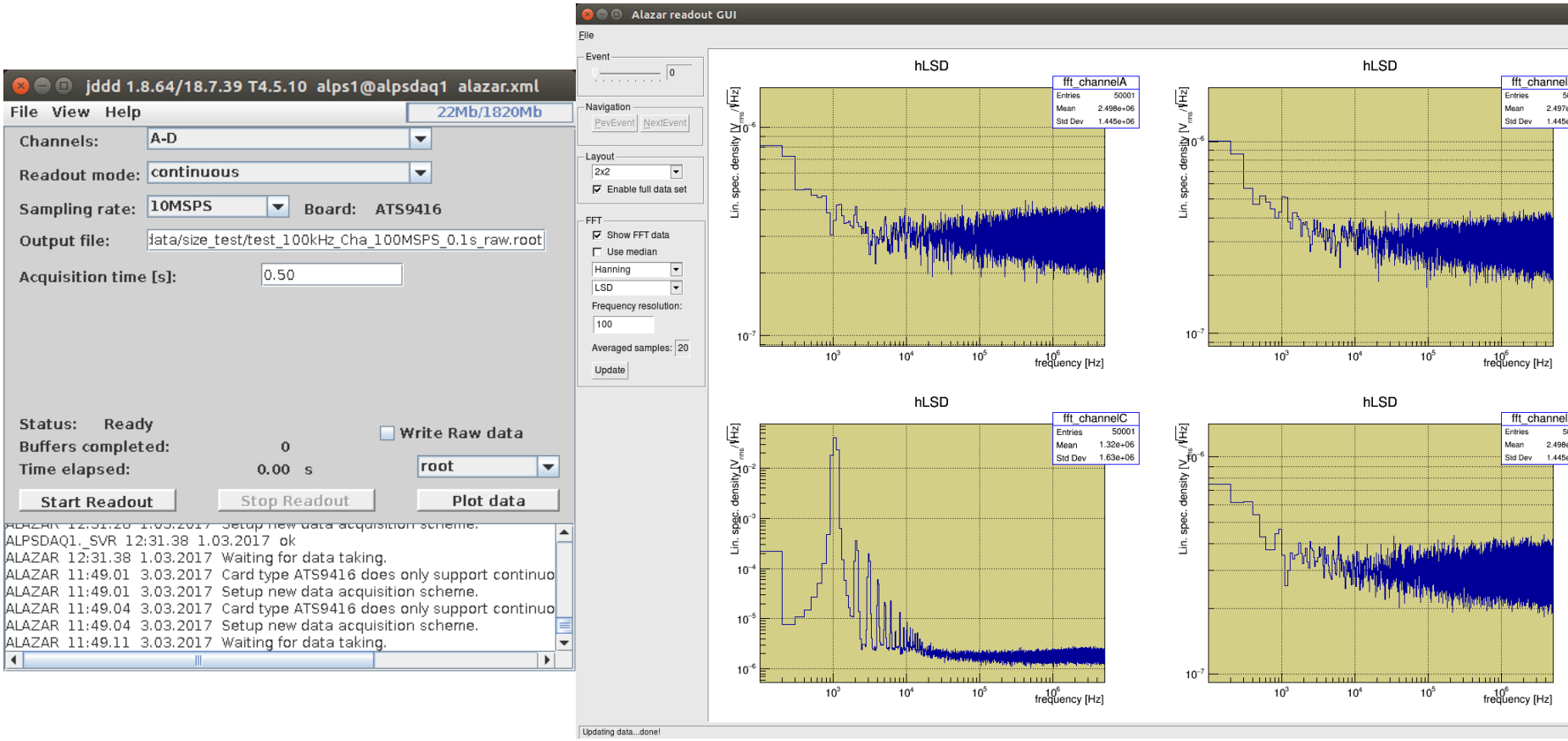

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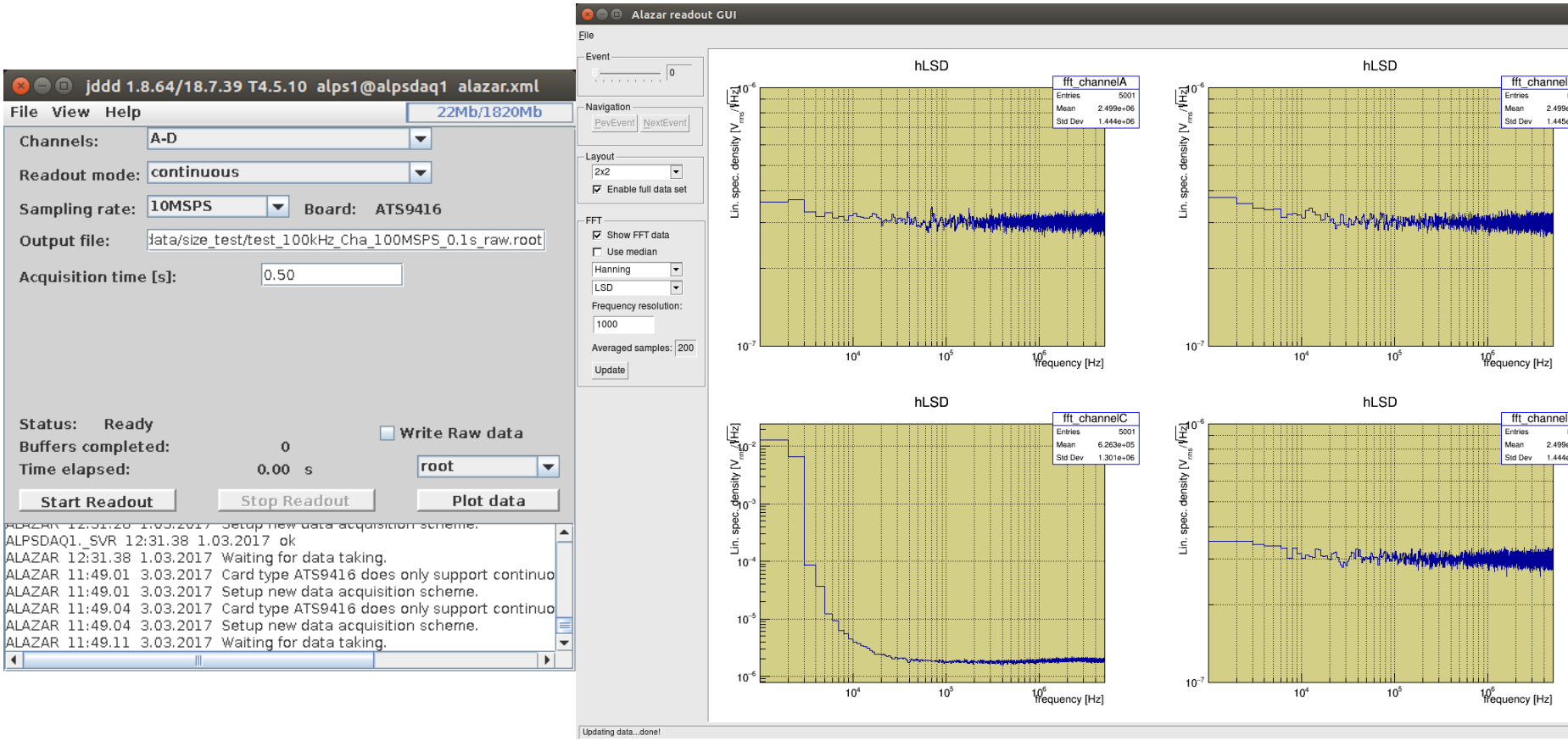
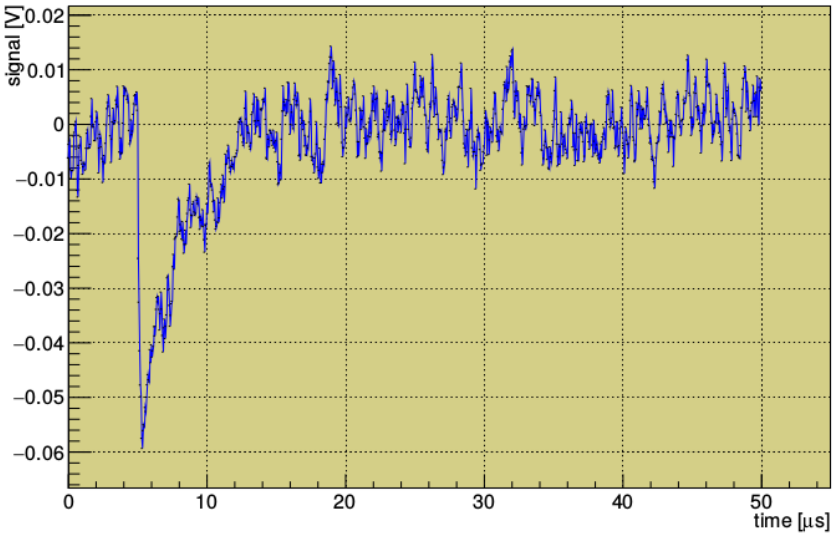
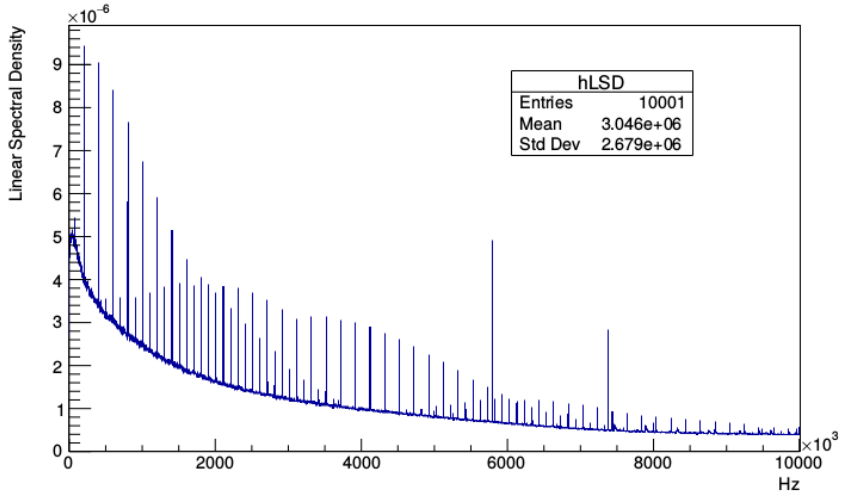
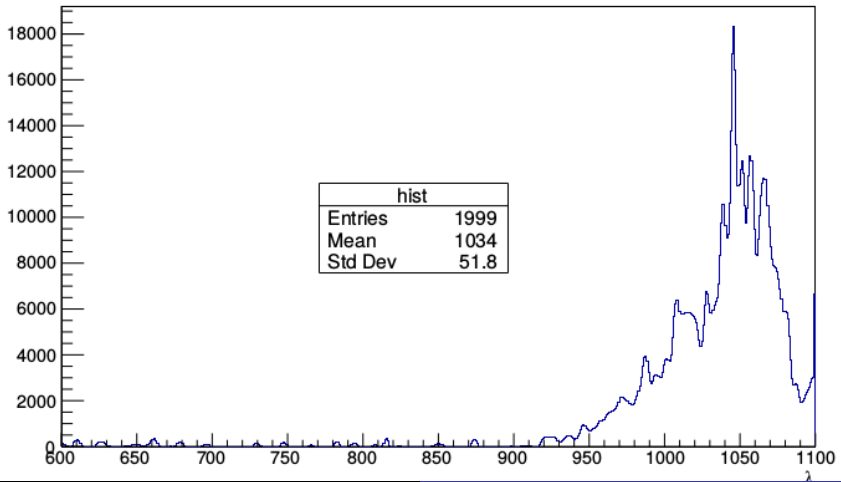


Example: Energy resolution

We estimated the energy resolution assuming a realistic laser spectrum.







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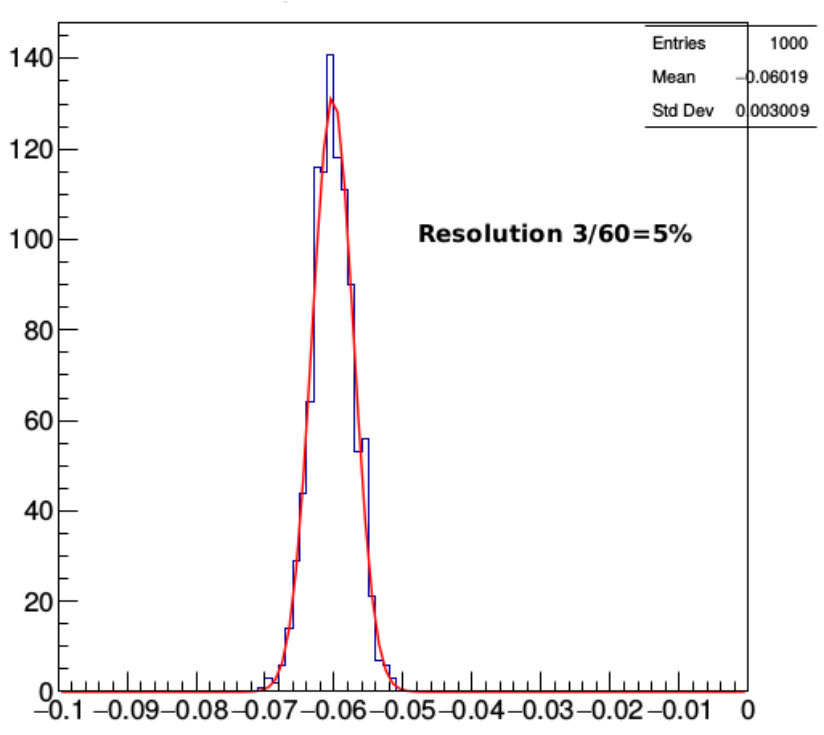
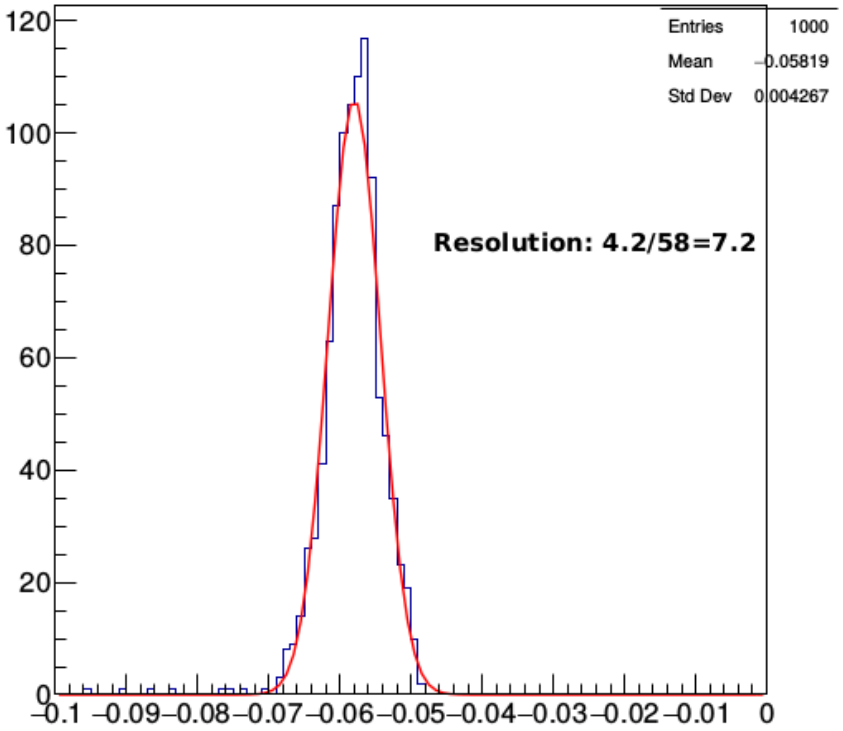
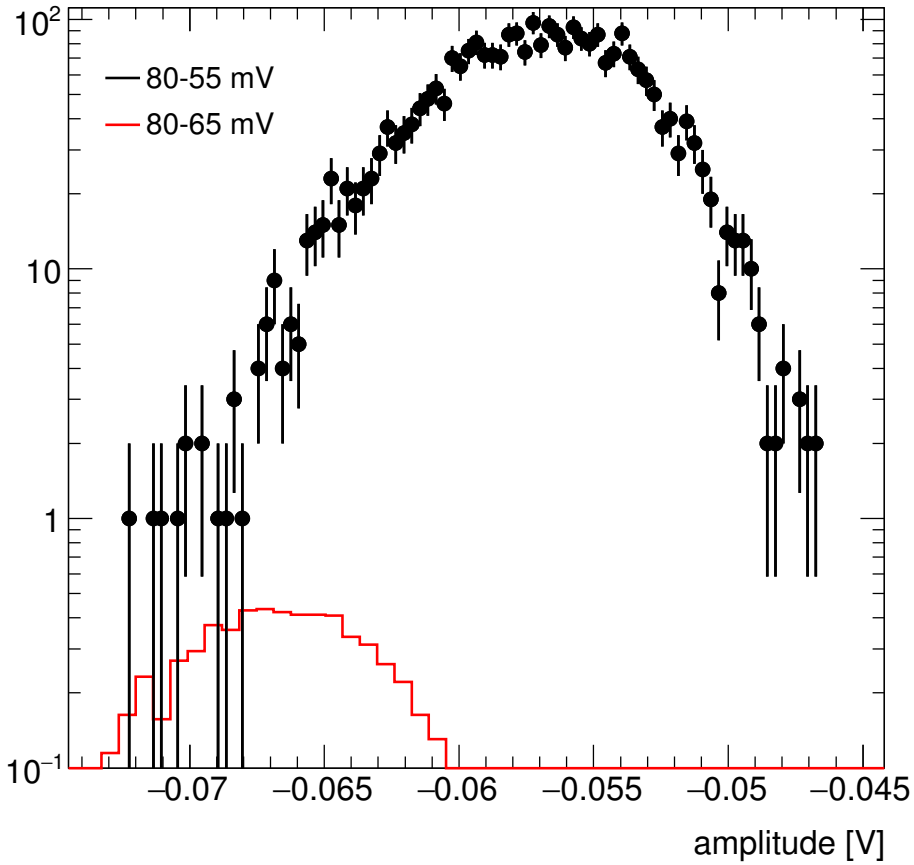




Estimation of black-body photon reduction by the filter bench

- Filter cut-off is set to −65 mV
- 1 order of magnitude suppression in the signal region (around −65 mV)



Summary

- We will have a new cryostat by the end of 2017
- TES detection scheme should be operagtional in 2018 again
- Optimization of backgroud reduction is ongoing
- Software for data acquisition and analysis is in place to be tested