TEQ group meeting on experiment

24/07/2019 - UCL

Participants:

Peter Barker, Antonio Pontin, Jonathan Gosling, Tom Penny (UCL)

Arjan Houtepen (TUDelft)

Michael Drewsen (AU)

Hendrik Ulbricht (Southampton)

Massimiliano Bazzi (INFN)

James Bain (MSquared)

Agenda

09:45 Arrival and start of meeting
10:00 Update on electronics
10:30 Update on particle trapping and detection
11:00 Update on Aarhus electronics, trap blades and parametric heating for detection
11:30 Update on CSL tests with mechanical resonators, particle launching, cryostat
12:00 Update on particles
12:30 Lunch
14:00 Discussion and decision on next steps and timeline for development of AC and DC electronics
14:30 Discussion on detection: detection requirements, new ideas
15:00 Discussion on particle loading: Ideas for loading mechanism (laser induced and Piezo source)
16:00 Conclusion and agreement on next steps, schedule for next meeting

Notes:

-> Moring, updates and reports on things which have been done, problems, ideas

- Max: update on electronics for UCL and Aarhus
  - UCL: AC electronics + mixer (to mix AC and DC), low noise level, correlated noise between the two signals which go into the mixer, design done and estimated noise

level: 160 nV/sqrt{Hz}, high-pass filter for DC with some uncorrelated noise at below 10 Hz for the mixer, noise of amplifier not additive,
    - UCL: Amplifier to =/-250 V used for AC and DC, small gain, low noise.
    - UCL: DC source 53 nV/sqrt{Hz}
    - -> first design exists, realisation at UCL, meeting on details of electronics (Antonio and Max) happened yesterday, PCB will be made in Frascati, Peter is happy.
    - Aarhus: DC source, analog very low noise based on 5V reference, 2.2 nV/sqrt{Hz}, flexibility is important, updates:
        - rise time selector for operations at typical settings for sweeps (operated with a switch),
        - amplitude controller: local or remote.
    - Aarhus: block diagram with DC power supply (reference 5V supply), inverting amplifier (the one used by Michael), mixer, noise after amplifier measured on test board: 30 nV/sqrt{Hz}, gain of 10.
    - Positive/negative voltage issue: both need to be supplied, designed a negative voltage supply to get positive voltages after inverting amplifier or alternative use of non-inverting amplifier. [use of filter to cut high frequencies in the amplifier which are the main noise contributors.] -> noise needs to be low at frequency of trap -> to invert the reference with inverting amplifier is the better for now.
    - Aarhus: implementation: desing details for mechanical parts, option is to use the Aarhus box design, but make a separate box for the TEQ experiment.
    - Analog vs digital: make one DC analog channel for tests if low noise levels can be reached (Michael needs to reduce other noise sources to see the effect of the DC power supply), the analog should fit as voltage reference to DAC system.

- Michael: Aarhus electronics and trap, detection via parametric amplification
    - Electronics: DAC system, experimenting to identify the sources of noise, DAC seems fine, but voltage source (battery low noise) is important, … flexibility
    - Can we use a +/-10V analog input instead of battery for the DAC system, the 10V version of analog is not easy – Max suggests filtering the switching noise …
    - Blades: Aarhus blades made, coated, support structure made, test at UCL May-June, blades shipped back to Aarhus, problem with contact from one side to the other for some contacts, more annealing did not work- removed all gold, next evaporating at the front for blades which are already coated on the side,
    - Parametric amplification for detection: needs to be developed and thought about.

- James Bain: laser at UCL has been moved to a different lab, UCL tried fibre coupling right after the laser, James and Josef offered a fibre coupling for Soltsis output is available and could be used by UCL, discussions will be picked up.

- Antonio Pontin: update on UCL trapping experiments and detection,

    - Linear Paul trap report, camera detection has practical advances, resolution is limited, frequency stability of trap shows effect of noise from air conditioning, measurements of charge jumps, measured small linewidths at 10^{-7} mbar, CoM temperature and excess noise, testing of dissipative collapse models

- Tom Penny: UCL more trapping experiments, Paul trap progress,

  - AC and DC separated for blade trap, connection issue of the two sides, alignment of blades is important to get the trap stable, trap loading with electrospray,

- Arjan Houtepen: particle update
  - What is the ideal particle for the trap?
  - Ytterbium particle blow up in vacuum,
  - List of requirements of particle properties, some aspects of synthesis, properties testing, large absorption by ligands,
  - Stability in trap: surfactant effects vs absorption by ylf material (PL).
  - Core-shell material has been produced and tested, to control surface effects,
  - Can purities be reached which are needed for refrigeration
  - Quantum yield: 30% for core, 86% for core-shell particles.
  - Approach: try more particles: at UoS and UCL. Make a list of possible particles, then try.

- Jonathan Gosling:
  - Optical trapping of YLF particles, core particles, 5 mbar at 1064nm and 1020nm, trap frequency variations may represent the absorption spectrum, try crystal without ytterbium as this seems to absorb,
  - Core-shell, no clear power dependency of line width
  - Stability of laser (intensity), linewidth of laser is not critical.
  - No evident rotation features at 5 mbar, cannot be driven with circular polartised light. (Giulio to try simulations of rotation)

- Hendrik illustrate the situation on the cryostat.

Afternoon discussion on next steps:

- Electronics: low noise reference at 10V, discussion with Max about how to get a low noise reference – on the board,
- Particles: pick-up on particles, monthly skype, shopping list of different particles to try and trap and stabilise.
- Lasers: line width narrowing-UoS, stabilizing-UCL, details to be arrange with MSquared.
- Detection: needs to be discussed during Trieste experiment focus session.
- Loading: laser fs ablation, laser lift-off, Piezo shake-off.
- Next meeting: Trieste, right after workshop.