Sopa Labnotes (January 2024)

This is a part of the SoPa labnotes. The full labnotes can be found here: +Labnotes SoPa **Participants:** @Lilo H @Brian B @Anton E @Malaika G **SoPa philosophy:** Reduce the number of boxes on the experiment, however if they are unavoidable let the future generation enjoy the experiment more by hiding jokes in them.

To-Do	In Dev	Deployed	Discussion
glue mirror and lens in - check lens position in mount - check setup before - monitoring 3D MOT powers analog in and save during sequence	- get ready to put objective in		
(**Hiwi) Tasks:** - waveplates from Andy testing - longterm power measurement setup for new K laser - Artta log box - Temperature - humidity - vacuum pressures!! or python script arduino - NAS Server data mirroring - orders - SMA Winkelstücke - order rf splitters for frequency counters - Imaging Repumper Scan (Seq loading) - Shutter in D2 3D path of Potassium - Experiment Control tasks - Implement single Flourescence Image after MOT loading (its for free!) - HOW for dual species: - “Easiest” way if one understands gus: Flag that looks at date and plays one specific (MOT-)sequence (could be absorption) - Define Standard ROIs and button/dropdown that automatically loads them (maybe read out sdff TOF and f_Zyla and define specific ROI for each combination) - safe TOF for scan - Look at how values in ROI impact colorscale (colorscale should probably depend on minimal value in raw pic, not on minimal value in ROI) - GUS Mario cart sound problematic?	(**Hiwi/ Intern) Tasks:** - Flowboxen (Helmut) - high field imaging (Malaika) - Temperatur stabilisation() - Na Lasers Piezo control (HiWi, Bachelor) - Make Phasespace Density script (like time_of_fligth_script) - “Zeitstrahl”: Track atom number at different checkpoints in sequence for Na alone, NaK and K alone - Also measure		

To-Do	In Dev	Deployed	Discussion
	- Also measure temperatures at each of these checkpoints		
Groupmeeting 31.08.23: - try low density, fast feshbach field approach: - maybe only one dipole laser - try no microwave evap and low mag trap **Thorlabs order:** - 2” silver mirror			

31 January 2024

objective characterization

- another measurement width dichroic mirror after secondary lens, tilting the dichroic mirror as far as possible
  https://www.dropbox.com/scl/fi/kchn19qsparuazltutrgp/imaging_FOV_widths_y_K_dichroic_tilt.pdf?dl=0&rlkey=sebqeas6vvhyykv393k4ul26z
  https://www.dropbox.com/scl/fi/s7hxxuvnejb7q8j336j0p/imaging_FOV_widths_x_K_dichroic_tilt.pdf?dl=0&rlkey=8w96l8npyrzybcmdvojllvc48
- impression is, that the peak got shifted and a bit worse and broadened for x widths
- below diffraction limit squeezed area broadened as well
- atm we think the increase in widths/ abberations are introduced by passing not colimated through a thick glass plate. # 30 January 2024 ## objective characterization
- still working on FOV measurements
- improved plotting style of Na measurement from 22.1:
  https://www.dropbox.com/scl/fi/19c23j7hd8bjy9hnx8qxn/imaging_FOV_widths_x.pdf?dl=0&rlkey=d0z5imj7tibh1kg64z9s97cky
  https://www.dropbox.com/scl/fi/4o8xnolutaguyd4xjqtr1/imaging_FOV_widths_y.pdf?dl=0&rlkey=kmyujocynqs6fdl8oioor5euc
- peak images are indeed not so concluding
- swapping steup to K: change secondary lens, replace camera filter
- taking a second set of data, since the iris was forgotten to take out
  https://www.dropbox.com/scl/fi/3r5kra9nmqiqvr3o563xr/imaging_FOV_widths_x_K.pdf?dl=0&rlkey=w81qr49zxa83dyduanjdob0ua
  https://www.dropbox.com/scl/fi/3odpkbelax73622lfwi5v/imaging_FOV_widths_y_K.pdf?dl=0&rlkey=y9xyt9c3z6w3119g1dc7ckezm
- putting in dichroic to check the effect of the dichroic to the FOV.
- the dichroic is placed after the secondary lens, due to spactial constrains → only K is measured
  https://www.dropbox.com/scl/fi/g0kb5cds4pzy9n92p67ih/imaging_FOV_widths_y_K_dichroic.pdf?dl=0&rlkey=4p00plt8i2bg58iyb47zp28dv
  https://www.dropbox.com/scl/fi/jmqavn3e6sp4zt6u9irxr/imaging_FOV_widths_x_K_dichroic.pdf?dl=0&rlkey=l5dgu213x6islidcgbzlpblm0
- observing a line like peak profile, resulting in a large with in one dimension, and squeezed (below the diffraction limit) in the other dimension
- x dimension is getting really large, this might be due to the 45° tilt in that direction

- to support this hypthesis we plan to take another set of data were the mirror is tilten as much as possible in y as well # 26 January 2024
- measuring Powers on Experiment Table and Laser Table to see if MOT performs poorly because of some fiber coupling. | Beam | Power on Laser table [mW] | Power on experiment table [mW] | | —- | ———————- | ———————- | | | | | | | | | | | |
- Temperature, Preassure and Humidity on the experiment table are being recorded every ten minuites with three Adafruit BME280 sensors:
  - Sensor 1: Above the experiment table, right beneath AC
  - Sensor 2: on experiment table, beneath science chamber
  - Sensor 3: Middle of the laboratory Some sensors only work when specific cables are connected to specific Pins on the sensor:
  - Sensor 2:
    - lilac → VIN
    - brown → GND
    - white → SCK
    - blue → SDO
    - grey → SDI
    - red → CS
  - Sensor 3:
    - yellow → VIN
    - blue → GND
    - black → SCK
    - grey → SDO
    - green → SDI
    - orange → CS
- The .txt file with data can be found on the Computer with IP adress 10.0.2.9 at: This PC > Documents > Temperatures_experiment_table_2024-02-02_17-09-35.txt Here the start time of the measurement is given in the filename. Times within the file refer to the start time in the filename. # 23 January 2024
- Morning atom numbers:
  - The first shot issue has returns!
- NS scan02
- EW scan03
- New Mot Current scan data (scan007) # 22 January 2024 ## objective Characterization
- another FOV measurement for sodium with larger range
- a smearig out for large displacements of camera are noticed → a secon dataset is taken with refocusing by eye each step https://www.dropbox.com/scl/fi/fxfsjolo5sizldcx5lok4/imaging_FOV_x.pdf?dl=0&rlkey=7kxy37tcj60zfeh0ga0ool82x https://www.dropbox.com/scl/fi/vnsfnv75h2y97t1p6zio9/imaging_FOV_y.pdf?dl=0&rlkey=q55143pnria79muhkboabaxz7
- → nothing visible on plot. turns out to be most likely the effect of a bad FOV, since FOV is defined as the area were the image is sharp with a fixed lens position
- 30.1 optimize plotting style:
- somehow there is good range and after that widths are high and than smaller again
- figure below cuts off after points are getting up
- to get the colorbar sensitive in the good regime, the data is filtered using a cutoff # 19 January 2024
- Scanned magnetic trap evaporation ramps:

    - scan004: microwave evap duration: 1.5s to 5s, end of evap frequency: 1762.5, p_TOF = 0.2 ms → N_max = 10^5 atoms at 4.5 s, width_min = 105 pixels at 2.5 s optimum: **3s** with N = 7 * 10^4 and width = 110 pixels
    - scan005: microwave evap duration: 1.5s to 5s, end of evap frequency: 1755 → optimum: 3s with N = 9.5 * 10^4 and width = 130 pixels
    - scan006: microwave evap duration: 1.5s to 5s, end of evap frequency: 1770 → optimum: 4.5s with N = 9 * 10^4 and width = 140 pixels
    - scan007: microwave evap duration: 1.5s to 5s, end of evap frequency: 1764 → optimum: worse than scan 004
    - scan008: microwave evap duration: 1.5s to 5s, end of evap frequency: 1750 → optimum: **3s** with N = 9 * 10^4 and width = 137 pixels
    - scan009: microwave evap duration: 1.5s to 5s, end of evap frequency: 1760 → optimum: 3s with N = 7.2 * 10^4 and width = 117 pixels

- changed the dipole trap evaporation ramp to an exponential

    - scan010: scanned the time constant values: 0.2 to 2 in steps of 0.3, p_DipoleEvapFinalInt = 0.5 → Atom number increases up to ~7600 Atoms and then stays roughly const for time constants larger than 0.8, after ~ 2s of hold time after the ramp atoms are still there
    - scan011: scanned the time constant values: 0.1 to 3 in steps of 0.2, p_DipoleEvapFinalInt = 0.5 → Denstity and Atom number seems to stay constant for time constants > 0.6

- Flipped the polarity on the top bottom power supplie for the bias coils.

Things to conisder:

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- mag trap loading.
- dipole position.
- zero point for the mag feilds for the darkspot and for the mag trap.
Play with the placement of the darkspot for differernt offset currents and
see if there is a change or if one can return to the past atom number even
after changing the bias.
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18 January 2024

- experiment runs really unstabely, we usually have a hard time getting the BEC back each morning
- measuring Phase Space denstiy at the end of MAG trap:
    - scan008: microwave evap till 1762.5 MHz, temperature: ~43

      $$\mu$$

      K, phase space density: 2.9e-5
    - scan009: microwave evap till 1755 MHz, temperature: ~75

      $$\mu$$

      K (x-direction), 57

      $$\mu$$

      K (y-direction); phase space density: 1.5e-5
    - scan010: microwave evap till 1762.5, 3.5s long, after first evap ramp in Dipole trap
        - tempx = 18muK, tempy = 17muK
        - psd = 5.6e-5
    - scan011: microwave evap till 1762.5, 3.5s long, after first evap ramp in Dipole trap
        - tempx = 15muK, tempy = 12muK
        - psd = 9.3e-5
    - scan013: microwave evap till 1762.5, 3.5s long, after second evap ramp in Dipole trap
    - scan014: microwave evap till 1755, 3.5s long, after second evap ramp in Dipole trap

17 January 2024

- Yesterday we got a BEC back by optimizing the script, but hte experiment runs really unstabely, so we didn't manage the get a proper number of atoms in the BEC today (there were less than 10000 atoms left after evap, so it felt like a coinflip from shot to shot if we get a BEC or not)
- we noptice that the slower power needs some time between shots to get back up to a stable power. Directly after a shot its at 280mW and it goes up to 315mW if you wait for a while (on the timescale of a minute).
- Managed to get a BEC back. Turned the oven up to 175 and changed the slower detuning to 255(this is still not optimal but works) again. There is still something fluctuation that makes shots go to yero atoms at random. This needs to be hunted down. # 15 January 2024 ## objective characterization
- change setup for FOV measurement camera position is marked with clamps, to take out and back in
- first FOV measurement
- camera position is shifted in 2mm steps, resulting of shifting a peak by three rows.
- zero camera position is 12 mm
- for plotting, the full zero position image is taken all other image adding three columns to left and right
- need to scan a larger FOV # January 12, 2024 ## Hunting Na Atoms Episode III: The Polarization Strikes back
- optimized 2D mot such that we have signal after all evaporation ramps in the dipole trap.
    - pics were taken with the original Na-BEC script, costum imaging script does not give the same result
    - we need to adjust costum imaging script such that it gives the same result as the original Na-BEC script. Things that were different in costum imaging script:
        - MagTrapHighHoldTime = 3 → 3.5
        - MagTrapRampUpTime = 100m → 80m
        - p_SodiumImagInt (for Zyla) = 1.5 → 1.45
        - p_DipoleIntBlue = 7 → 9
        - p_DipoleEvapFinalInt = 3 → 2.2
        - p_CurrOffEW = 0.005 → 0.004
        - p_SodiumMolInt = 2 → 1.35 This seemed to be the problem! Sounds like stray light to me, Molasses where off for both scripts:
            - better signal in Dipole Trap when MOT cooler AOM has less RF power kinda suggest that something is there where it shouldn't
            - p_SodiumMolInt = 0 gives even better results (9700 atoms left after evap)
            - still some differences, the BEC script barely changes the MotInt parameter and still always gives better results than the costum imaging script. Maybe look at end of Mot and start of magtrap again, there seems to be something happening there.
        - Final result: we have good signal after all evap ramps with both scripts, so condensing doesn't seem too far off (hopefully)
- started working on scans with multiple parameters
    - These scans work better with the "costum imaging" script, because it has more functionality than the other script
    - added a "daily mot scan" in the script and in the interpreter. This takes pictures of the MOT every day without us needing to do anything for it. With this we can have long term measurements of atom numbers and temperatures in the MOT, if we add more monitoring (e.g. quadruple pass efficiency) later, we can correlate everything with each other
    - p_TOF should always be specified in the scan itself, such that it is saved as parameter in the resulting scan file
- quadruple pass is very unstable, maybe monitor its performance in the future? # 10 January 2024
- borrowed a polarimeter from Lorians group to check polarizations of 2d and 3d mot
- noticed that 2D Mot beams are Very imbalanced (looks like a factor of 2 in power, 13mW in one and 26mW in the other for one beampath in a rough measurement/ no fixed powermeter)
- other beam path is bad too
- we think it probably works because the polarization is messed up for these too and the "effective" power in the form of circularly polarized light is probably similar

- (toni) started checking the polarizations for the 2D mot. It didn't load the 3D mot afterwards, so we adjusted the powers such that everything is balanced and started optimizing stuff.
  - the adjustment of powers and polarizations should strongly influence the position of the 2D mot, so I tried my luck with the pointing of the slower beam, which gave us a signal to optimize on (blinking 3D mot was possible with imaging repumper)
  - touched the push beam a bunch in the hope of improving our loading rate, in hindsight this was probably stupid, since it is harder to go back now (if we even want to go back). currently the push beam is not doing anything (blocking it doesn't)

9 January 2024

- more differences between scripts:
  - dipole beam is set to lower power during hybrid trap in BEC script
  - magtrap ramp doesnt go all the way down for BEC script, only goes to 2.5V and then directly to 0
  - dipole ramps are not symmetric for custom imaging script, since one dipole AOM path saturates with less voltage (test which ramp/starting voltage works best here)
  - 20s loading time instead of 6?
- We wanted to check the MOT power and if it's at its best (scans 1-4). We see that we can actually have quite the improvement, but we don't know how these voltages correspond to actual 3D mot cooler power, so we measure that (scans suggest that 1.6V is optimum):
  -
- we also scanned repumper power and found a new optimum at 2.7V
- same for MotCFreq,new optimum at 2. # 8 January 2024

(toni)

- noticed that Costum Imaging script gives different result for atom number in dipole trap than BEC script, so I want to compare them and make costum imaging better again

- atom numbers of costum imaging script and BEC script: | Stage | picture time [s] | TOF [ms] | atom number BEC script | atom number costum imaging script | | ——————— | ————— | ——— | ——————— | ——————————— | | MOT | 6 (6.2) | 3 | 1.35e8 | 1.13e8 | | Molasses | 6.2049 | 3 | - | 1.07e8 | | magnetic trap (no Evap) | 9.6532 (9.8349) | 0.1 | 2.65e7 | 2.73e7 (more spread out) |

- one difference that could be useful: I noticed that the triggers for the mako are different in the BEC script: the trigger is given earlier, but everything else is the same, such that the actual overlap between the Mako exposure and the imaging light is really small → one can have higher intensity light without oversaturating the reference imaging. Maybe interesting when we are doing imaging calibration on atomnumber for the mako

- we also saw that shorter ramp in costum imaging script pushes mag trap even further up, whereas mag trap in BEC script looks a lot denser even though atom number is similar (but gradient coil is not fully ramped to 0 in BEC script) # 4 January 2024

(brian and toni)

- optimized the 3D mot on the signal in the magentic trap. We saw some improvement, but it seemed not very significant # 3 January 2024

(toni)

- coming into the lab and locking lasers I noticed that Bachelor laser's coupling into SHG wasn't stable → started optimization alg.
  - noticed that we have a MOT even while Bachelorlaser was optimizing
- optimized 2D mot on 3D-MOT atom number with 6s load time and 3ms TOF
  - adjusted second to last mirror on the bottom left of 2D mot (when looking east),

the beam was not hitting the waveplate properly
    - got the beam to hit properly and got the same atom number by adjusting bottom left and top right 2d mot mirrors
    - by adjusting pushbeam and changing slower detuning I got a 40% increase in Atoms (now at 1.45e8)
- noticed that it looks like 30% of Atoms are caught in the last 200ms of the MOT, which is where the MOT cooler AOM is ramped. Scanning these parameters now to know how they behave:
    - scan002: p_SodiumMotCFreq at end of MOT with 5ms TOF
    - scan003-scan005: p_SodiumMotCFreqFinal at end of MOT with 5ms TOF → seems to saturate at 3.7 V, which we take as the new Value
    - scan006: p_SodiumMotCInt (lilo pointed out that coupling changes when going far away from the regular detuning, so I want to see if the effect seen in scan003-005 can be explained by the light intensity and the frequency is not that important) → seems not to be the case
    - scan007+scan010: p_SodiumMotRFreqFinal
    - scan008-009: p_SodiumMotRFreq
- the change of the first shots compared to all other shots is still noticable significantly even
- though we thought the slow recovery of the push AOM was the problem.