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(Werner-Heisenberg-Institut)

AWAKE

MPP Group Meeting

J. Moody

31 January 2019

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Laser Propagation Update

- Had two working meetings since kickoff meeting
  - Working with Valentina Lee and Mark Aladi (Wigner) to do ~6 hour analysis code development and cross-checking (verification/validation) sessions per week
- We are first focusing on the Transverse Profile Analysis of the light transmitted from the vapor source after ionization
  - We are currently focusing on the "initial conditions" i.e. the complex transverse electric field distribution at the entrance to the vapor source give to Gabor Demeter (Wigner) for his model
  - Starting with simplest possible model:

$$\mathrm{w(z)} = w_0\sqrt{(1 + (\frac{z - z_0}{z_r})^2)}$$

    - Tried sampling just CAM03,04,05, which have no need for spatial cals
    - "moment arm problem"
      - W is measured for 3 points in z with finite uncertainty and very expected change, i.e uncertainty on w is the same scale as the expected changes in w over sampled parameter range in z
      - Fit is applied and when trying to determine the uncertainties on the parameters, i.e. w0, z0, zr are **large**. z0's uncertainty is several meters
      - How to deal? Sample in far field, in which there is a large expected change in w(z) compared to uncertainty in individual w measurements
      - Look at CAM01, Near field cameras but…
        - » They require spatial calibration due to the imaging systems in front of them

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Obvious Calibration Method

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- Grid target with fiducial markings for scale
- Kick out mirror
- Place target at object plane without touching camera, lens
- Illuminate target
- This can be done as soon as there is access back to TT41 but not until then
- What we have before then: Image of the edge of MP5 with diffuse light

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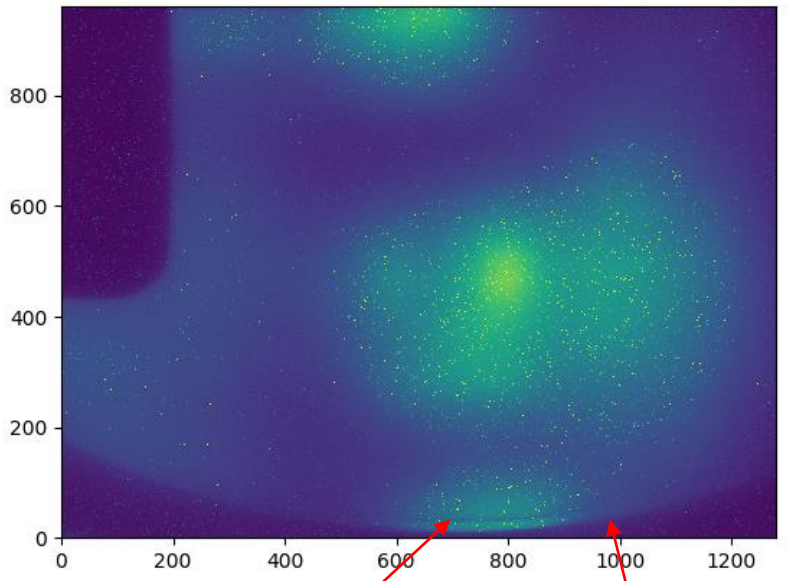
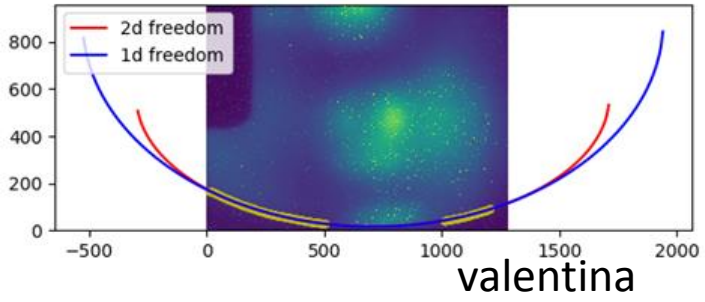
CAM01 Calibration

Trying to calibrate CAM01 from MP5's partial image on it



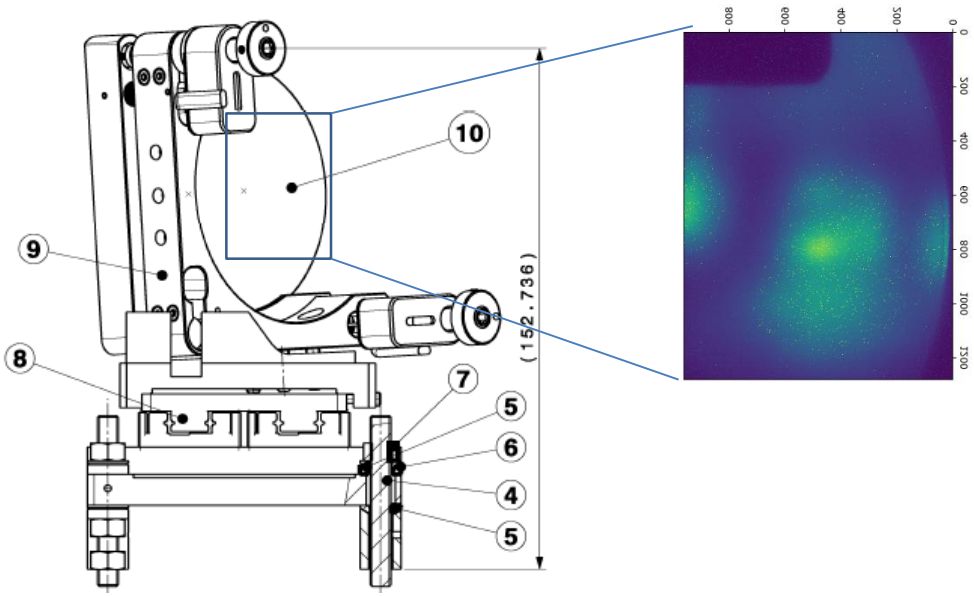


Can extract the effective pixel size at the object plane but:

- Has the same 'moment arm' problem as the w(z) problem mentioned before
- Fitting the ellipse that results from a disk rotated by ~45 degrees has pretty bad sensitivity to ellipse axis scale parameters
- How to deal again? Place more information. This time, we can use the technical drawings for the holder

Trying to calibrate CAM01 from MP5's partial image on it

Valentin (not Valentina) provided me with this nice technical drawing, including scale and uncertainty (via tolerances)



Using this we can get a fairly good calibration with uncertainty to Gabor, limit the uncertainty on z0, then confirm it an compare to the easier to do experimental method of kickout, and image of illuminated target.

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Laser Propagation Update

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- More on transverse profile analysis:
  - After we get this simplest possible model, we will:
    - assume 0 order Gaussian,
    - use the radius of curvature for the phase fronts
    - move to z-z0 for the front of the vapor source,
    - generate the field map based on CAM03's intensity and phase from gaussian (z-z0)
  - Gabor will use this as an input into his model then compare to the outputs measured at the "pickoff camera"
  - We will then see if the overall sigma scales as expected or if there is a big discrepancy outside uncertainty
  - If there is a discrepancy then we will use the more sophisticated initial conditions from averages / lineouts of the full field phase reconstruction Valentina did before

- Once we get this project going, we will start attacking the cool spectral features (blue to red shift above collapse threshold) and coordinate with Jerome and Andrea from UniGe to attack that problem

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July Experiment Update

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- Streak/Stable gated Schlieren and spectrum of transmitted laser:
  - Requested additional channels from Heiko for ~10ps rms jitter triggers
  - May need to try to do pull from streak room to LBDP3 or Schlieren setups (cheapest option, but nonpermanent, needs to be dismantled after measurements)
- Backward interferometry:
  - Talked to Fabian about logistics of getting a fiber pulled
  - Trying to get a total cost estimate
  - Patric suggests reasonably demonstrating that we can get fringes before committing large resource load to fiber pull
    - Need to build / borrow some sort of interferometer
    - While compressor is open can couple Anna's fiber laser to see 0 order bounce and combine in interferometer to try to observe fringes
    - Cannot do full scale fringe test without having full access system online (Open LSSP2)

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Schlieren Update

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- Two students interested in bachelor's theses related to the schlieren:
  - Felix Weschler
  - Bastian Rapp
- Felix:
  - double majoring in CS/Physics and finished his first thesis in CS on numerical modelling of a light field microscope
- Bastian:
  - Will be interviewed today to see if he would like to join
- The schlieren project will be split with Felix focusing on the calibration solely
- Bastian would start looking at data with timestamps without a full calibration to see if he can get a sense of the scale of the change of the schlieren signal as a function of time
- Both would work on the physical setup of the calibration at MPP, split between DAQ and optical setup, and collect data but the analysis of the calibration would be Felix's responsibility and Bastian could then use those results potentially for the time dependent Schlieren

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New Ideas?

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- Looking into strong field atomic stabilization, the expected limitations, and whether our plasma source beats the expected 'atomic stabilization'
  - Jerome told me a few times that the expected maximum ionization should be around 90% typically
  - These are due to these "Kramers-Henneberger" (K-H) states in strong fields that modify the potential that the valence electron sees
  - These states keep the electron from flying away from the nucleus and therefore 'bound' but with high kinetic energy
  - There can be a resonant transition down to regular atomic states as the field decreases in intensity when the pulse leaves
  - We **clearly** have better than 90% ionization due to the self modulation, so:
    - Does the Rb setup violate some sort of convention, approximation or assumption that the atomic stabilization predicts of ~90% final ionization
    - Is there something that we are missing and this is actually occurring
  - Will :
    - Investigate read papers on stabilization look for model validity issues
    - Put together convincing plots of ~99% or better ionization
    - Go talk to Jerome and Andrea about this with all arguments developed

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