Longitudinal Measurement

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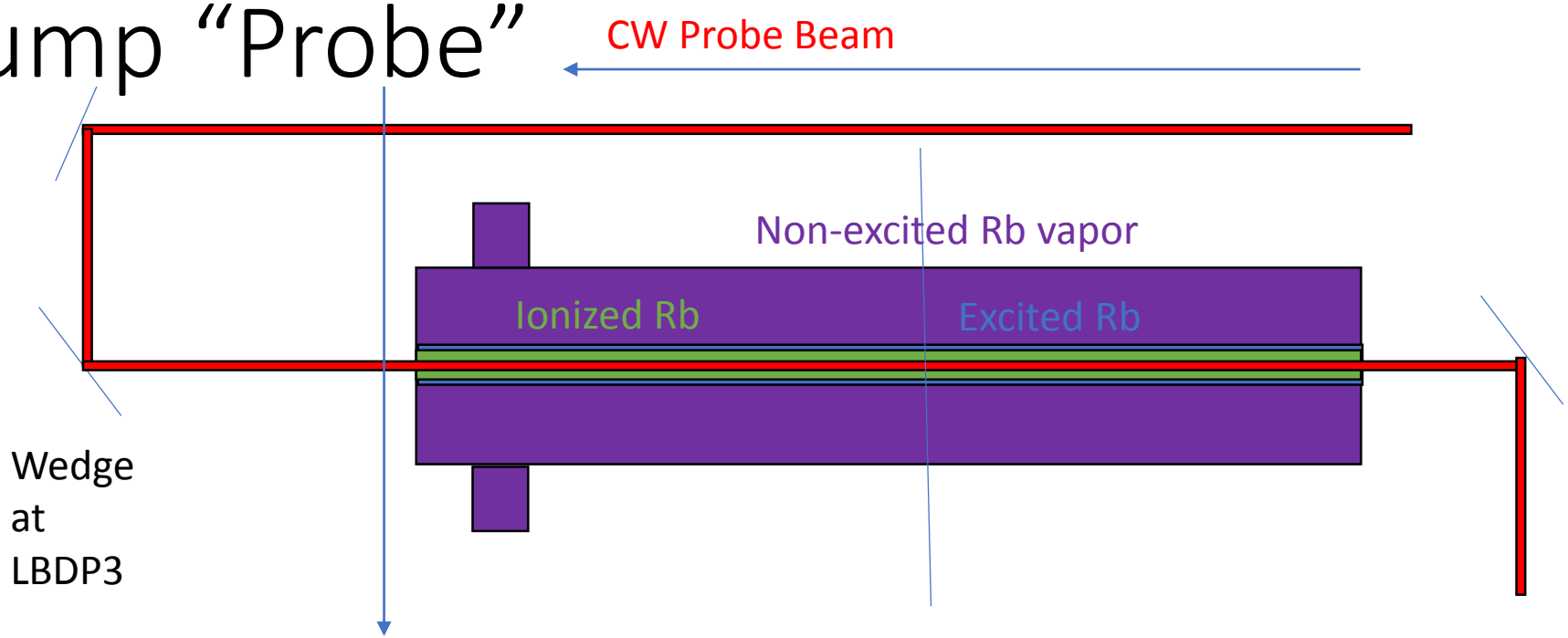
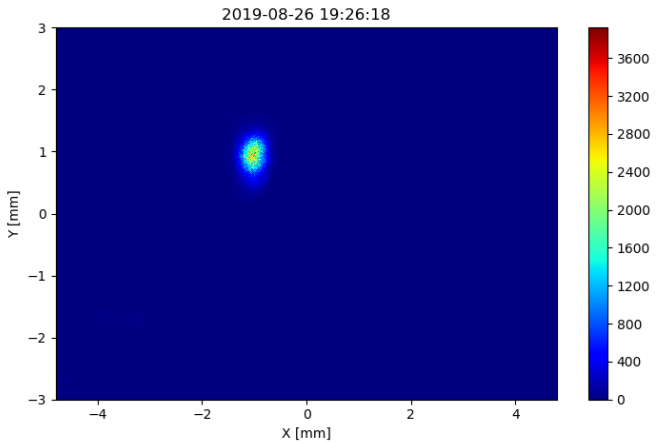
Purpose

- As of now, other than the self-modulation frequency (seeded and otherwise) we have no way of determining the level of ionization resulting from the ionizing laser propagating through the vapor source.
- A longitudinal measurement can be performed by sending a narrow band (~10’s of kHz line width) and known detuning from the D2 line of Rb (780nm, 5s->5p3/2)

Longitudinal Pump “Probe”

- Tune wavelength of probe didoe beam
- Time resolution is by trigger and sampling
- Here we are looking at the imaginary part of the k as we look at wavelength dependent absorption



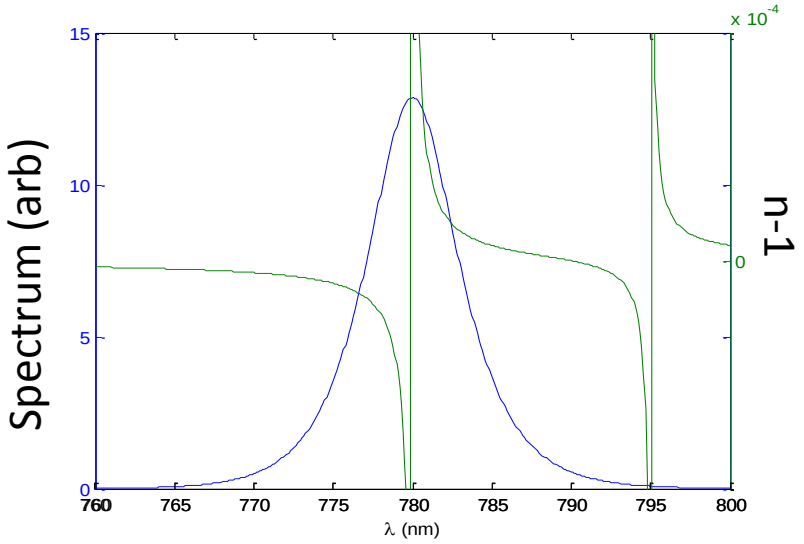


First diode laser light detected on screen in laser room

Gated Camera

Detected power is 40 microWatts.

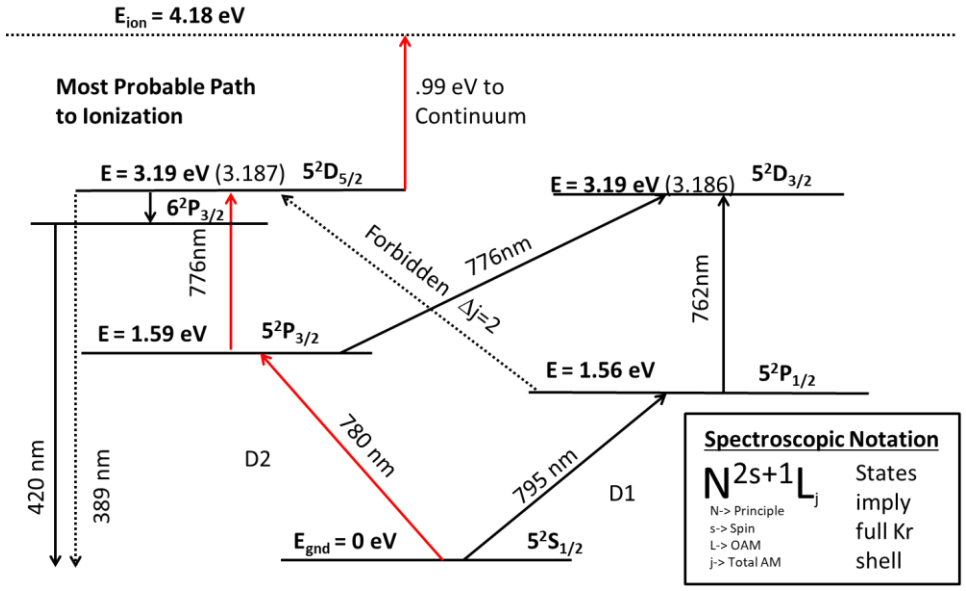
Pulse Propagation in the Linear Regime



We would expect pi phase shift across the bandwidth within a cm

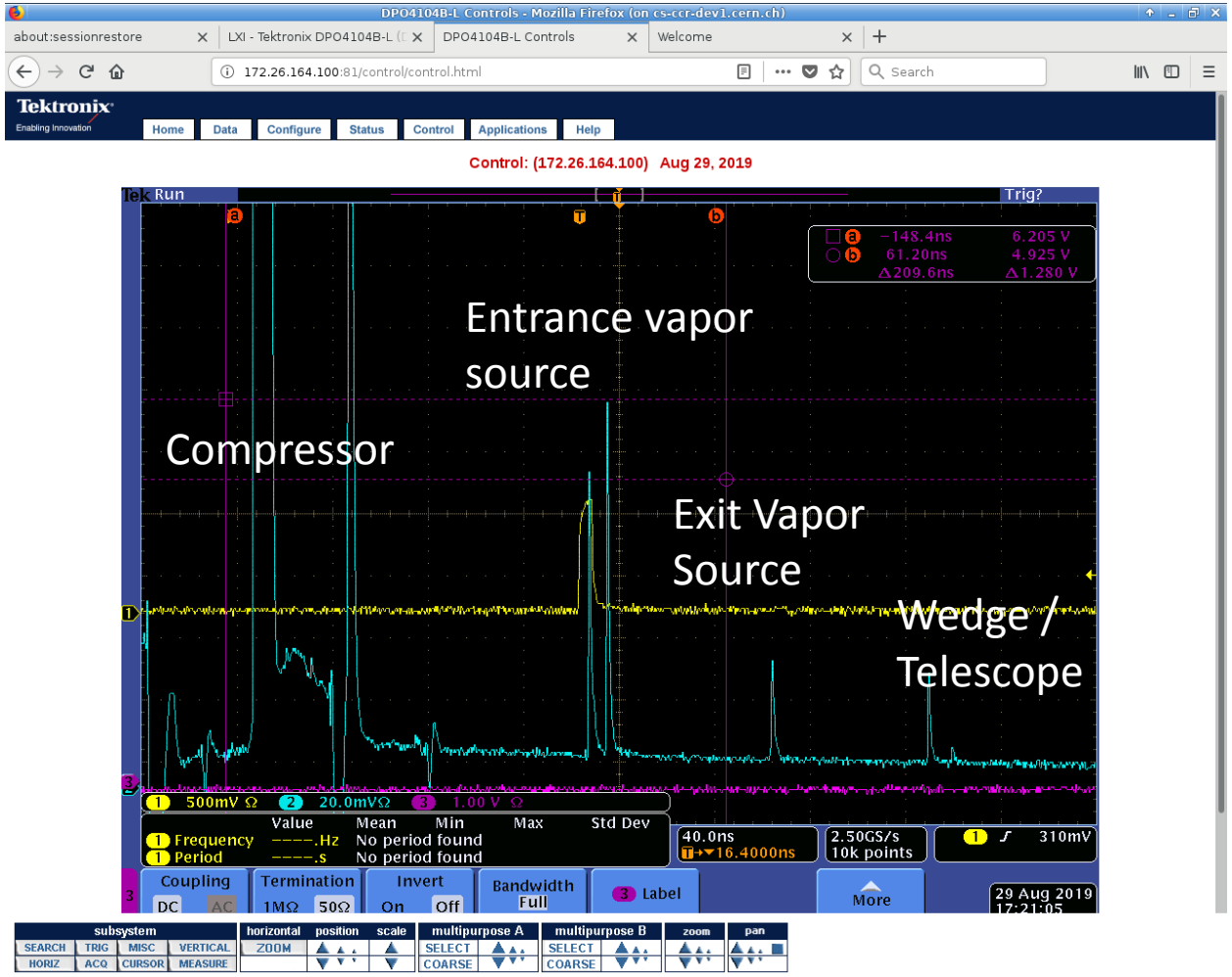
$$\chi_{bound} = \frac{Ne^2}{m\varepsilon_0}\left(\frac{f_1}{{\omega_{01}}^2 - \omega^2 - i\Gamma_1\omega} + \frac{f_2}{{\omega_{02}}^2 - \omega^2 - i\Gamma_2\omega}\right)$$

$$k_{bound} = \frac{\omega}{c}\sqrt{1+\chi(\omega)}$$

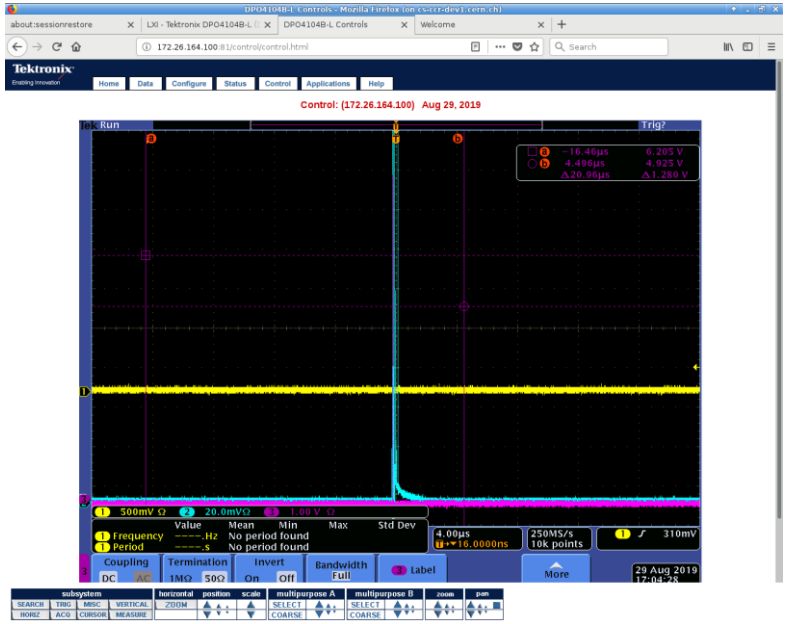


Ti:Sa (ionizing laser) Reflections

- Reflections
- Several Reflections on camera
- Placed photodiode in front of camera in laser room



Reflections when opened (no Rb)



microsecond timescale, no additional reflections

Proof of Reflections' Sources

LSSP2 Closed

Upstream
Plunger In

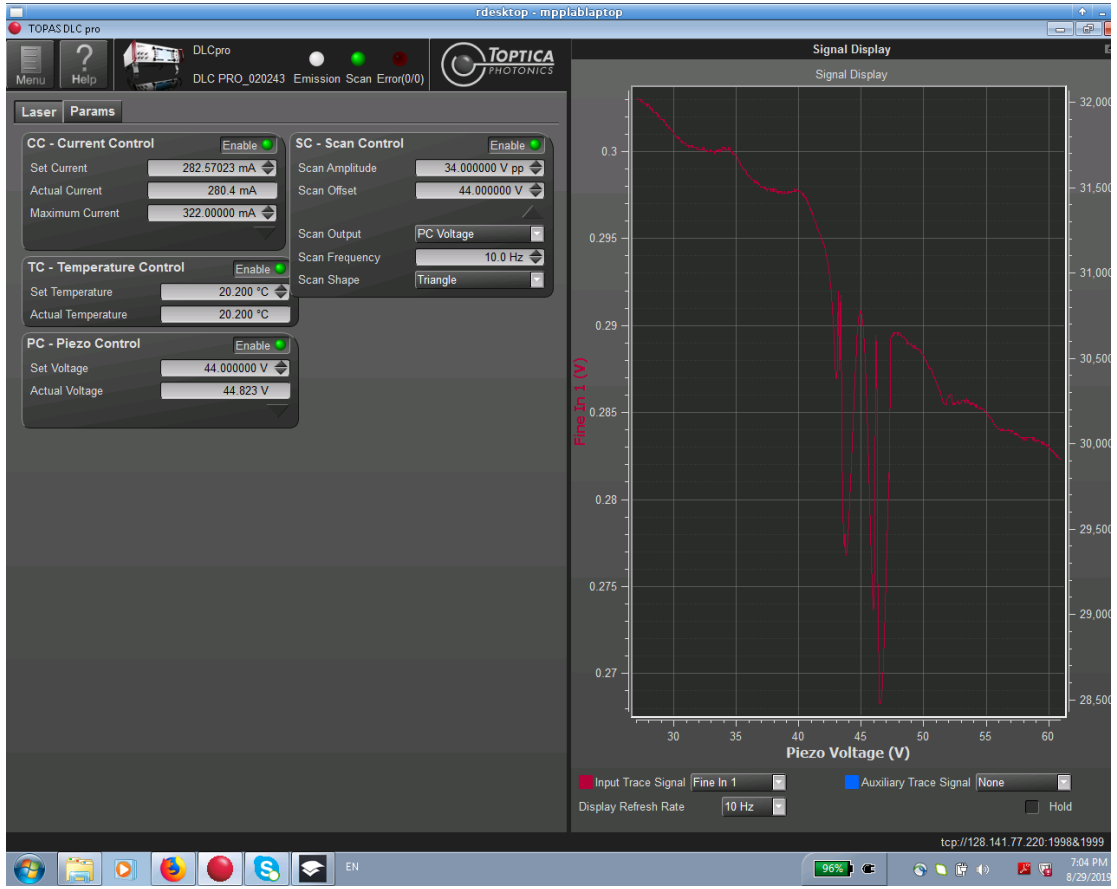
Downstream
Plunger In

Trigger Parameter Selection

- Ideally our first diode laser signal through plasma should appear once ionizing laser exits vapor source
- Reflection from wedge / telescope forces us to push gated trigger back by about 80ns
- Since CW signal, we can get a strong signal with 1 microsecond exposure, but can potentially go to 10ns with at a cost of signal loss
- If we spend the 19k euro on the tunable 420 nm laser, we can avoid several reflections through filtering (and all of the ones from the compressor due to a change in position)

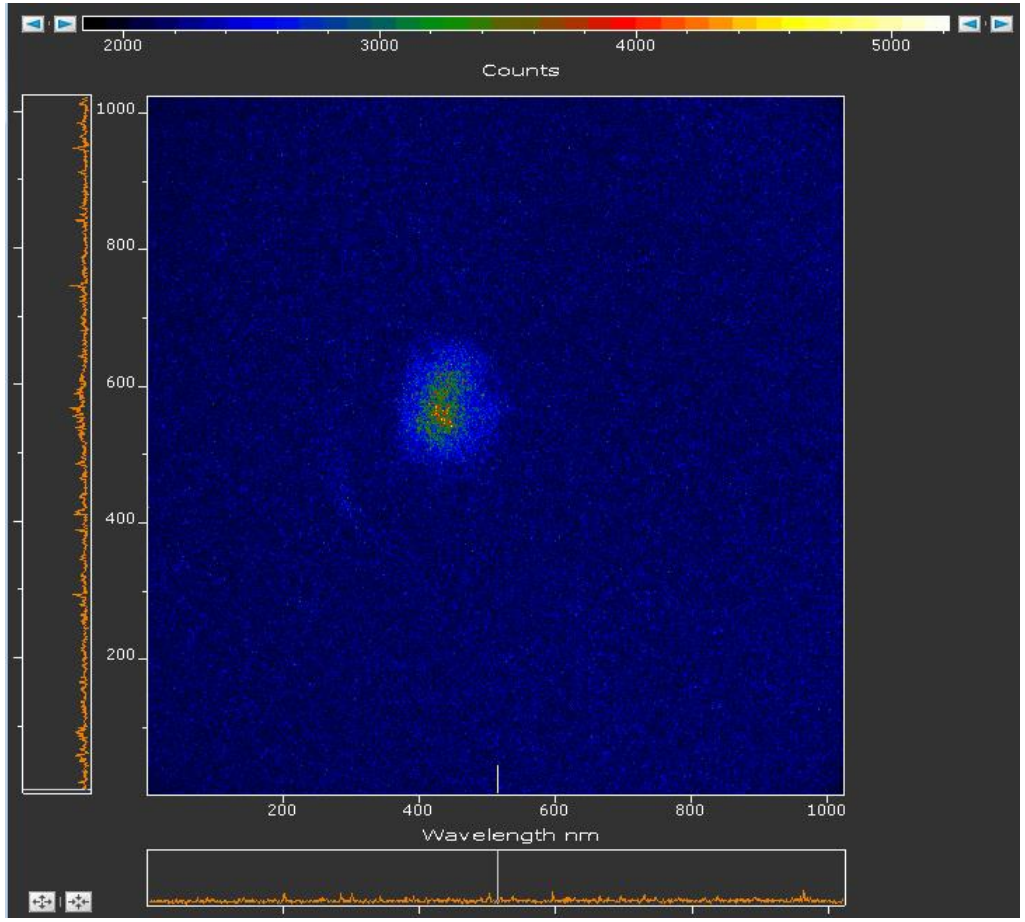
Detuning

- We use a toptica pro diode laser, coarse tuned to 780nm, sub MHz linewidth
- Piezo controller can detune laser by about 100 GHz
- We can select a detuning setting (slowly) to avoid mode-hopping
- Anna-Maria has shown most of this previously in regards to Schlieren measurements

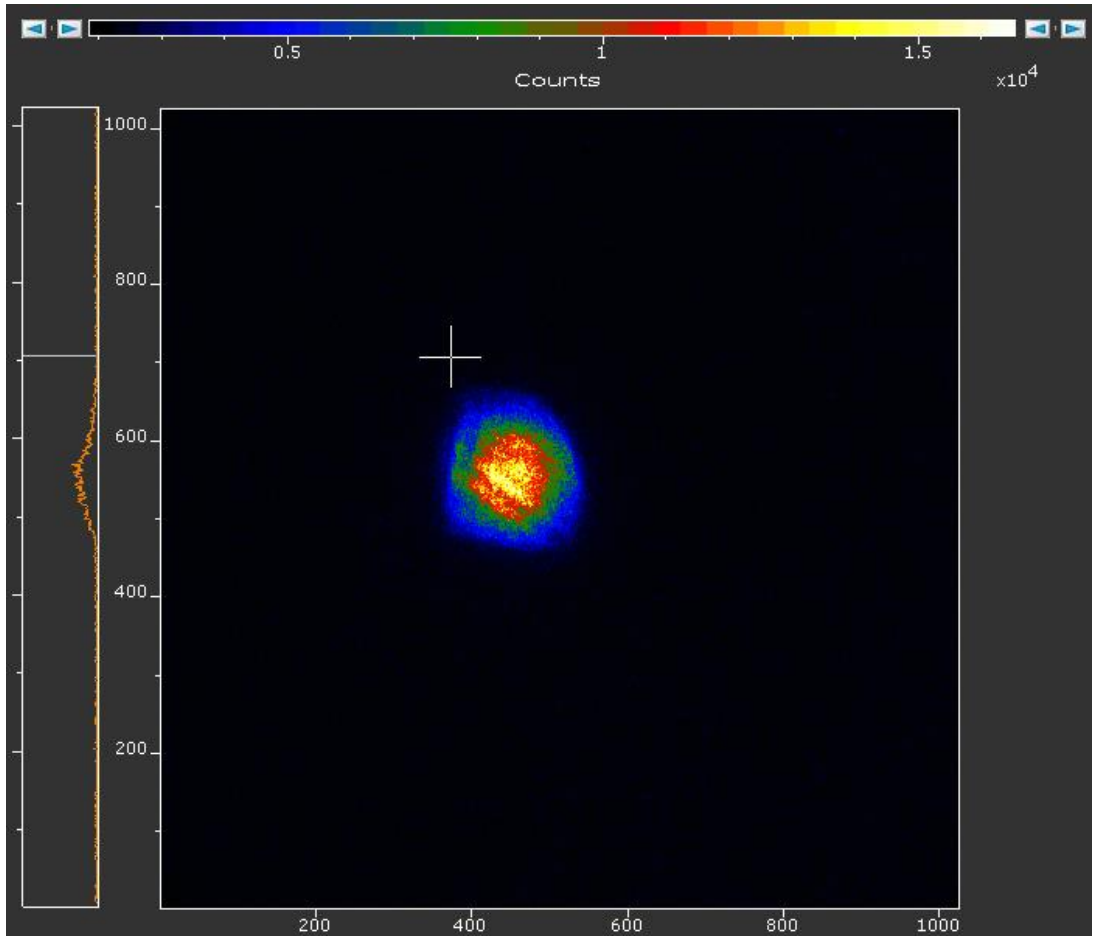


Scan of Rb absorption in room temperature cell

Preliminary Results

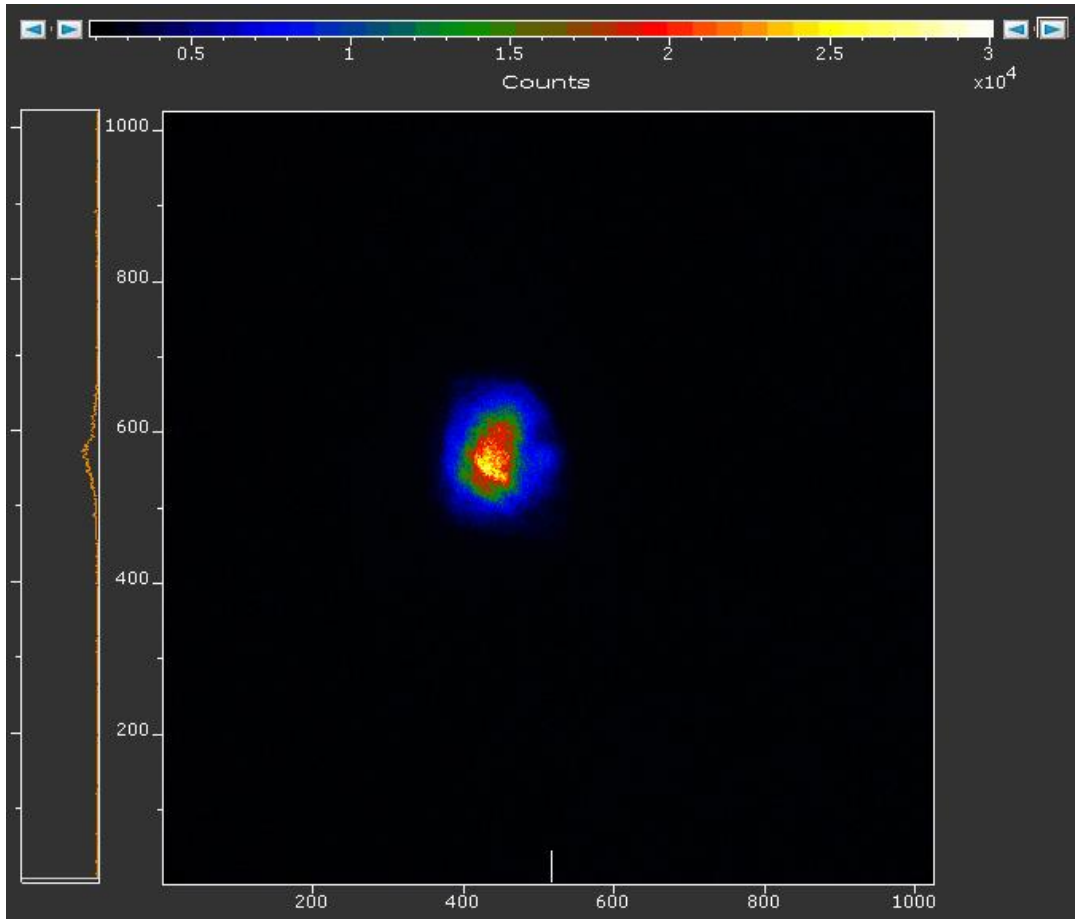


Detuned to weaker absorption



With 80 mJ

Closed Valves (reduced Rb)



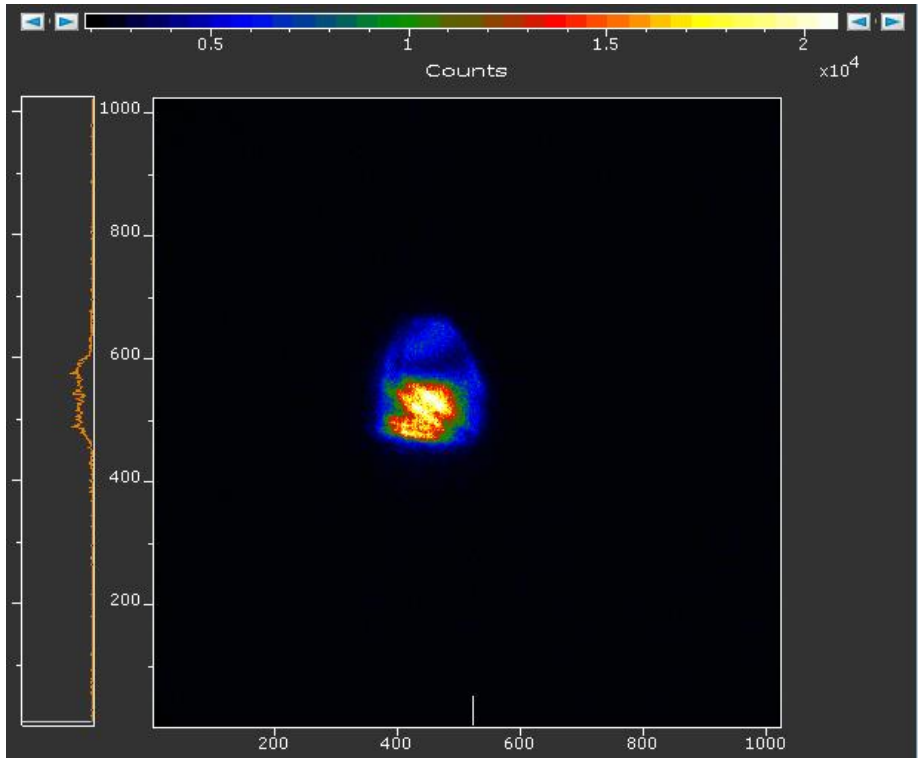
Closed Valves No ionization laser

Alignment

- Very difficult, ill equipped for good alignment
- Can implement two ‘corner screen’ fingers
  - Fairly standard way of performing alignment for ICS experiments but now two to establish lines.

Rb Valves closed still affect the laser

- With valves closed Residual rubidium steers the diode laser severely
- So of course in need to wait out the low density Rb outgassing



Steering of beam by ionizing laser with valves closed

Fun times from CERN

- CV dumped water down the elevator shaft, made waterfall in control room, dropped on timing racks, lost triggers for a few days
- Access system drops to closed
  - Twice with people inside
  - Once prevented us from getting in
  - Once just when no one was in
  - Tomasz claims its some network issue in loop