How Nigg used AOM:

1. shift laser frequency
2. in Laser locking system: "noise eater", high bandwidth frequency control
3. shift laser frequency of the σ_+ & π in Raman Operation

How Hempel used AOD for addressing:

Two traps

- I: initially to investigate $^{43}\mathrm{Ca}^+$
- II: $^{40}\mathrm{Ca}^+$ & $^{44}\mathrm{Ca}^+$ two-ion crystal (What's that?)

AC Stark in a composite pulse sequence:

- AOD (*Gooch&Housego, model 45070-5-6.5DEG-633*)
    - frequency detuning between $-50 \sim -90\mathrm{MHz}$
    - **Key addition**
        - Trap II is able to address individual ions in long string, equipped with AOD.
        - Trap I used offset voltage to shuttle the desired ion into the tightly focussed addressed beam over a distance of $10\mu\mathrm{m}$ within $40\mu\mathrm{s}$. This is impractical for longer strings.

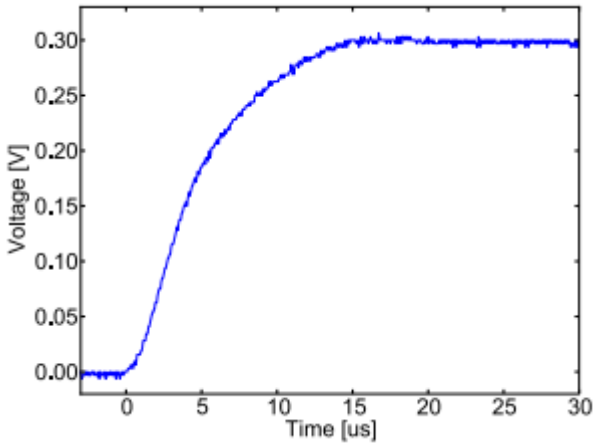
AOM	AOD
speed	large diameter, highly collimated beam

AOM	AOD
extinction ratio	lower v_a for larger number of resovable spots thus *shear mode* (acoustic wave in the direction [110] in $\mathrm{TeO_2}$) is used

- EOD (the EOD used is from *Leysop Ltd., United Kingdom*) used on $^{40}\mathrm{Ca}^+$ linear trap
    - switching speed (~30μs) is given by the time it takes to (dis)charge the deflector's electrodes, and is thus mainly determined by "the amount of current the high voltage amplifier used to drive the device can deliver" (I recognize it as a particular maximal current intensity?).
    - **deflection range is limited** to $3 \sim 5\mathrm{mrad/kV}$

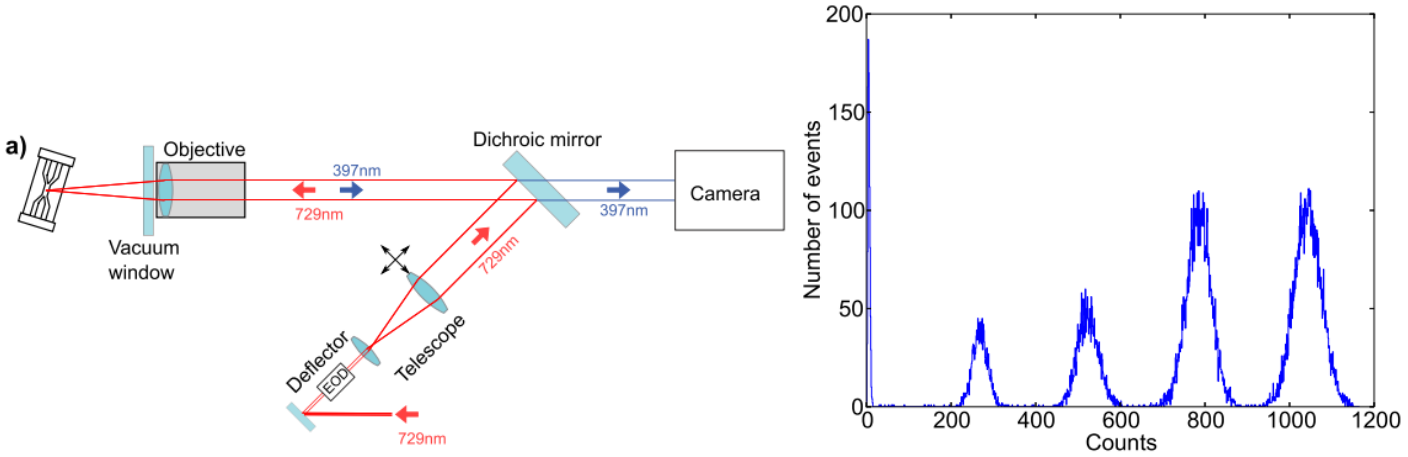
The paper Hempel cited about EOD: New J. Phys. 15 123012

- Switching event between neighboring ions takes $15\mu\mathrm{s}$.



Time dependence of the voltage on the EOD switching between two neighboring ions.

- **Phase changing** keeps for $> 100\mu\mathrm{s}$ after switch, but that doesn't affect the ac-Stark effect.
- Calibration routine (Accuracy of 50nm):



i. With the mortorized lens, move the beam onto the center of the ion string

ii. Find the EOD voltages for every individual ions. Fit a Gaussian envelope to the excitation rate as a function of the (?)lens position(?) (Why not as a function of EOD voltage?).

OD qualification:

- deflection range $\Delta\phi = \lambda\Delta f/v_a$ -- Δf ~ AO bandwidth; v_a ~ acoustic wave velocity
  - rf.vl. $\mathrm{RF}: f_0 = 70\mathrm{MHz}, \Delta f = 40\mathrm{MHz}, \Delta\phi = 47\mathrm{mrad}$
- number of resovable spots $N = \frac{\pi}{4}\frac{D\Delta f}{v_a}$
- switching speed: just acoustic transit time $\tau_a = D/v_a$.
  - low enough to avoid motional heat during ion transport
  - high enought to allow arbitrary addressing
- focus position resolution , rf.vl. $3.79\mu\mathrm{m}/\mathrm{MHz}$
- 1st order diffraction efficiency, rf.vl. At $633\mathrm{nm}$ for $0.7\mathrm{W}$ RF, plateau of 92 over $\pm 10\mathrm{MHz}$ around f_0 with a fall-off to ~ 72 at the $\pm 20\mathrm{MHz}$ band edges.

Kumph thesis *2D Arrays of Ion Traps for Large Scale Integration of Quantum Information Processors*:

- $^{40}\mathrm{Ca}^{+}$
- No AOD

- AOM used in
    - control the power and frequency of the lasers (double-pass) 397nm, 729nm, 854nm, 866nm, PC controlled.
    - zero's mode for the 397nm laser beam to reach the ions for far detuned cooling

  I'm sure neither AOD nor AOM are used as deflector

- How addressing is conducted (By *address* it means *turn on and off*?)
    - Fig. 3.6

Options

Gooch & Housego

Standard

- Acousto-Optic Beam Deflector for UV systems (AOBD-UV) 3246 or **3283**. (3283 is prefered.)
    - Both of them work on 355nm and have 1% insertion loss.
    - The major difference between 3246 and 3283 is RF bandwidth, and thus scan angle. In addition, 3283 has a more flat diffraction efficiency. In order to cover a $40\mu\mathrm{m}$ range,
        - 3246: 4.9mrad ~ distance=8.2mm
        - 3283: 1.2mrad ~ distance=33mm
    - > 2D UV beam scanning may be achieved by cascading two UV deflectors in series. Our flexible functionality **AODF Dual Driver** with phase synchronized outputs offers the optimum in RF driver control for 2D scanning.

- RF Drivers. Dual Driver 97-0600x-yy is qualified for 2D scanning.
- AOMC 350-6 6-channel AOM, $F_c = 350\mathrm{MHz}$, TeO2. (This one is ruled out.)

Custom

> 95% of our business is custom versions, designed for each specific high volume customer.

Leysop Ltd.

Standard

- EOD

但确实就是想要有大偏转很难，1kV的驱动只能偏转几mrad。