CW gray-track formation in KTP

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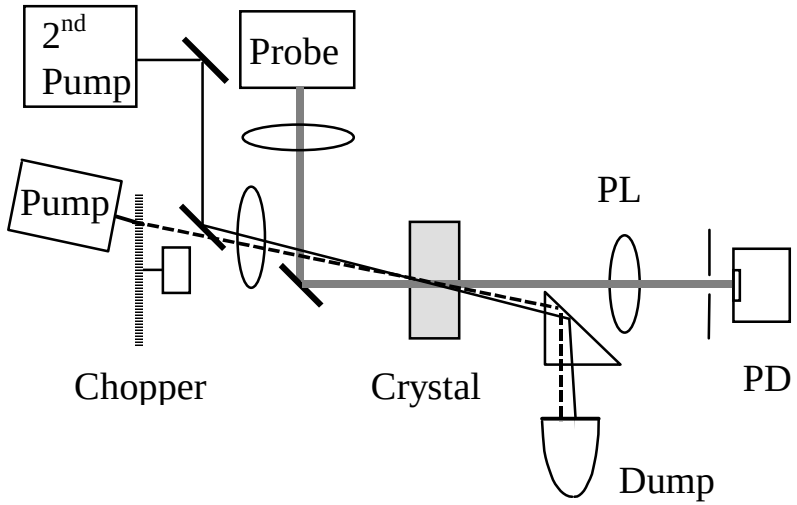
Outline

- Pulsed and CW tracks in KTP
- Photothermal technique
- Double-track build-up
- Model
- Conclusions

‘Pulsed’ and ‘CW’ tracks in KTP

- **Different types of ‘gray tracks’, Scripsick and Ruland (1998):**
  -  **Laser induced photochromic damage at high peak power**
  -  **Laser induced electrochromic damage at high average power, high repetition rate**
  -  **Unidentified laser induced damage at high average power, high repetition rate**
- **We studied CW, high average power case:**
  - **λ = 514 nm**
  - **Power: up to 1.5 W**
  - **Spot diameter: 70 μ**
  - **Maximum power density of 40 kW/cm^2**

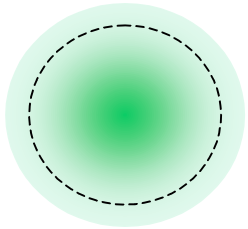
Photothermal technique

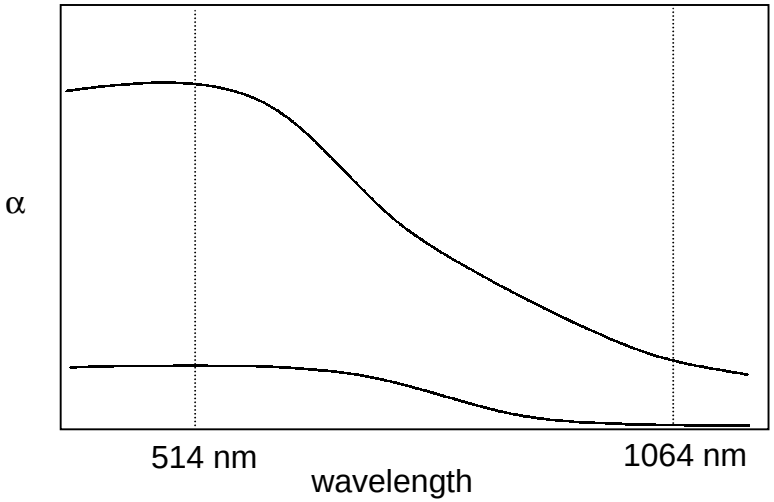


- The technique used in this work is a modification of the thermal lensing technique
- The technique has the interferometric sensitivity: less than 1μW of absorbed power can be detected

Crossed-beam setup for the measurement of a weak absorptioin. PL: projecting lens, PD: photodetector. Second pump is added whenever the influence of light with a different wavelength on absorption of the first pump is to be studied.

Gray track detection: details





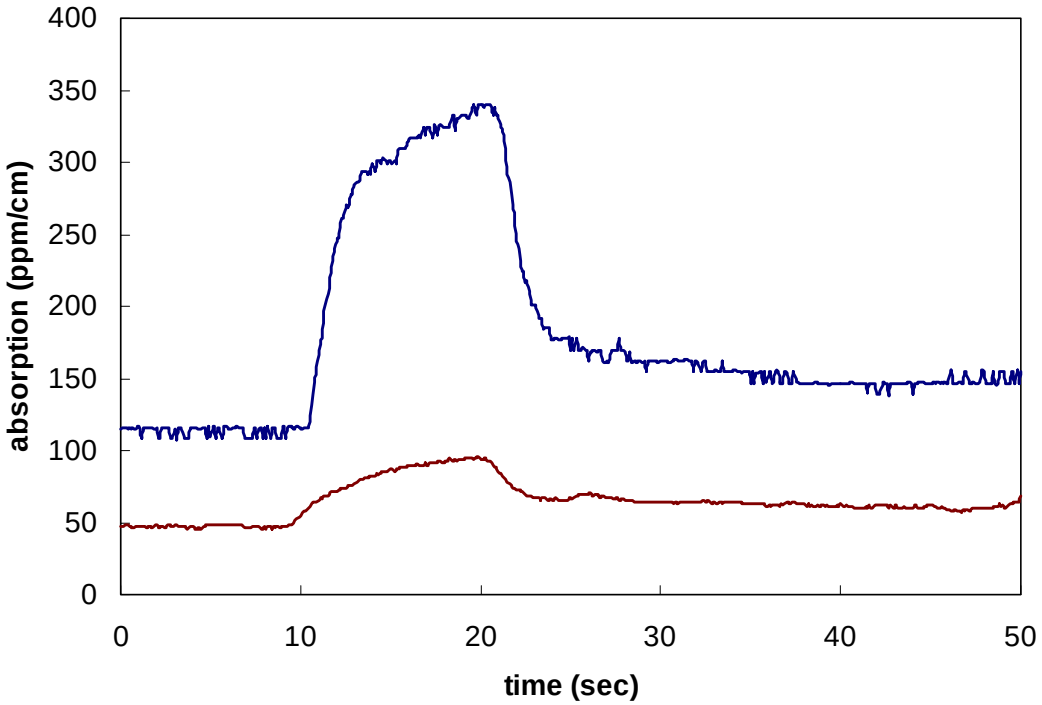
- Two collinear, centered pumps: IR 1064 nm and green 514 nm
- Slightly smaller IR spot to see what happens inside the green beam

- Green beam builds gray track
- Gray track spectrum reaches near IR: its development can be monitored at 1064 nm

Double-track build-up: initial stage

Absorption at 1064 nm:

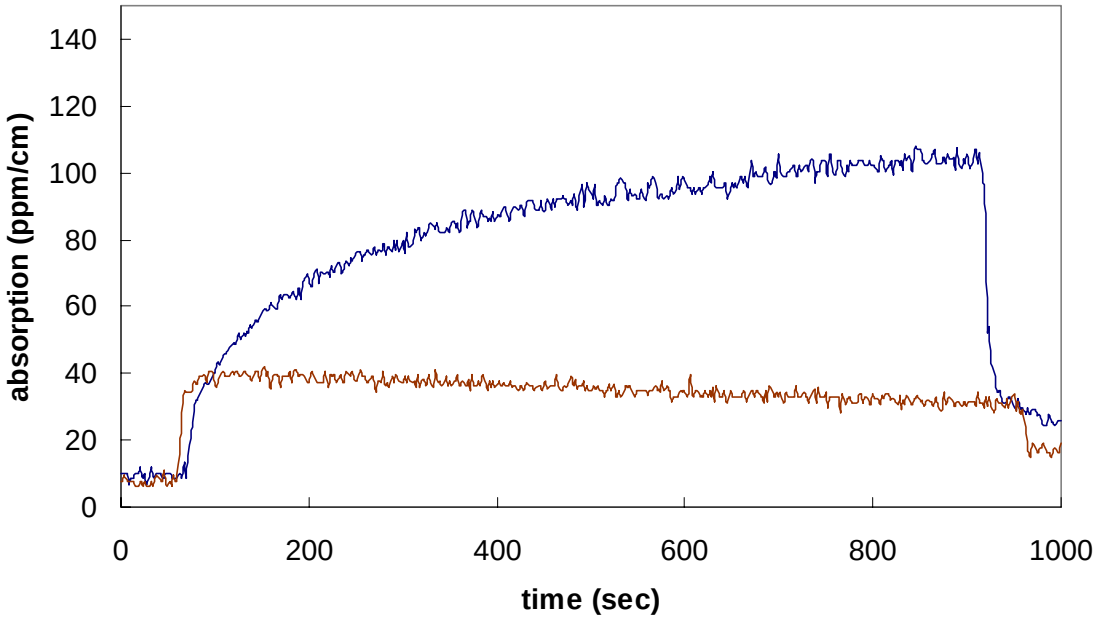
response for 30 kW/cm^2 of CW green applied for 10 sec



- Orders of magnitude different response in different crystals
- Fast and slow components
- Track is within green beam region yet

Double-track build-up: developed stage

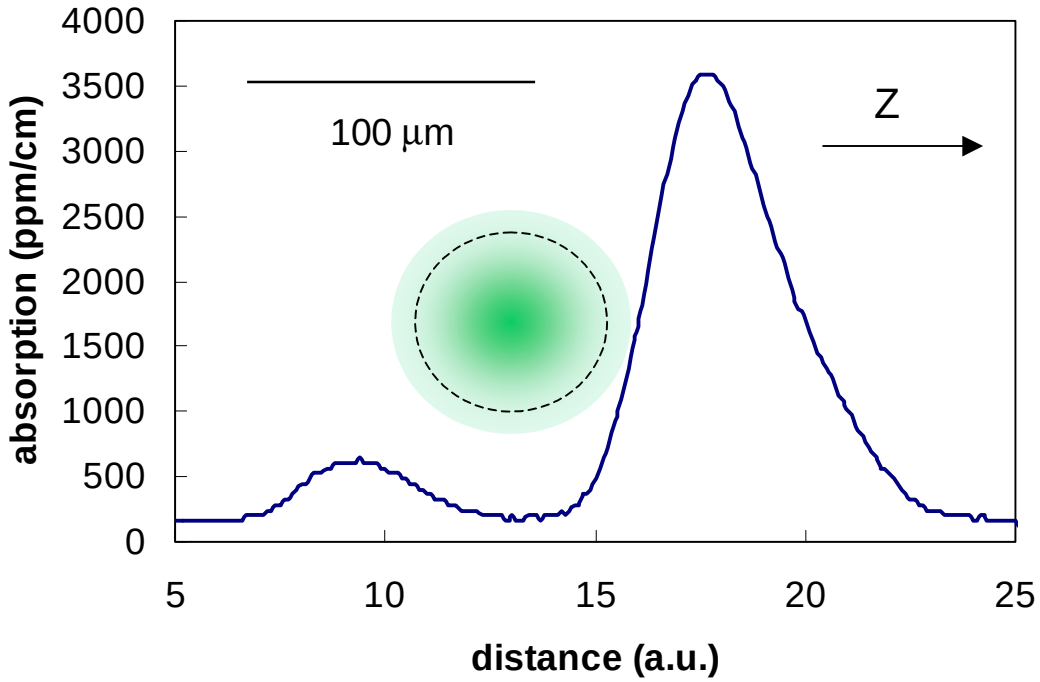
30 kW/cm^2 of CW green applied for 15 min



- Initially comparable responses may proceed differently
- After a certain time absorption in the green beam region reaches maximum and starts to drop
- Outside the green beam region double-track appears and proceeds to grow

Double-track profile

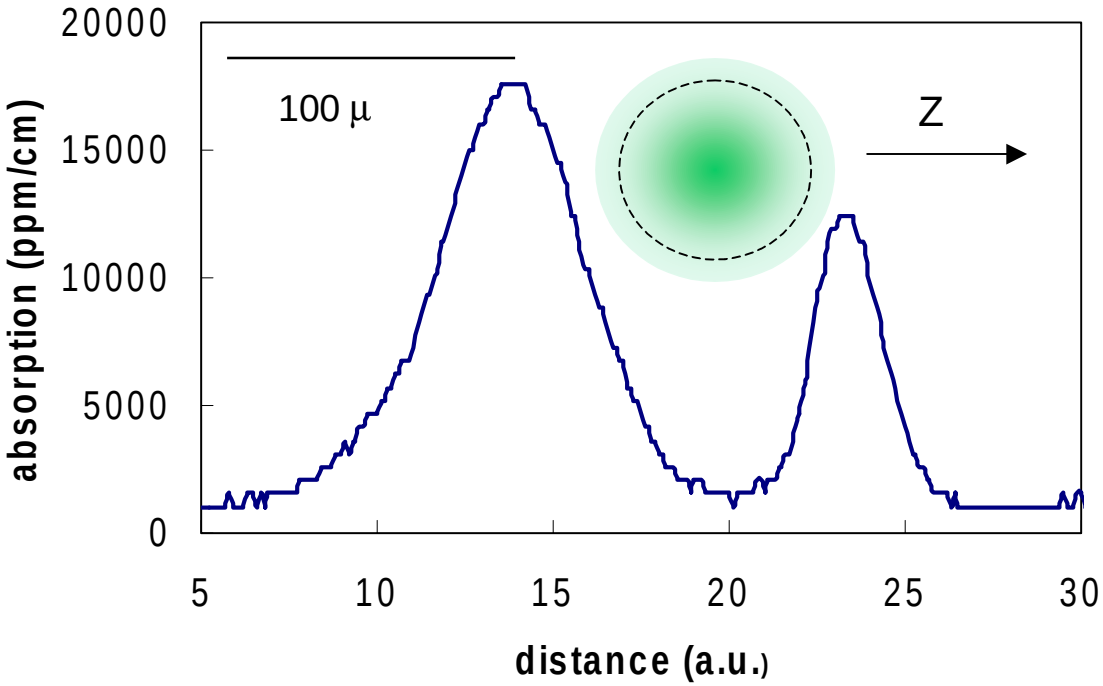
IR track profile: strong track



- High peak from the +Z side of the green beam
- Lower peak from the -Z side
- 120 microns between peaks with a green spot of 70 microns

Double-track profile

Green profile: strong track



- Peaks are comparable in height
- Location of peaks the same as for IR

Model

Laser induced electrochromic damage: electrolysis in the green beam region initiated by a photogalvanic current

$$j_e = \sigma_e E + kI$$
$$j_i = \sigma_i E$$

$$j_e + j_i = 0$$
$$E = -\frac{kI}{\sigma_e + \sigma_i}$$

$$E \approx -\frac{kI}{\sigma_i} \to 0$$
$$j_i = -kI$$

- KTP is known as an ionic conductor
- Rapid, within minutes, drift of the absorption maximum on the +Z side of green beam further in the +Z direction when the green pump is shifted in this direction
- Less gray-tracking corresponded with apparently high-resistivity KTP
- Photorefraction was directly observed in RTP and high-resistivity KTP

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Conclusions

- CW track in KTP looks like this 
- Photogalvanic effect + ionic conductivity build double-track

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