

ESCRS London 2006

**Carcinogenetic and Mutagenic action of
193-nm, 213-nm and 266-nm laser
radiation.**

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CustomVis Pulzar Z1 Solid State Refractive Laser System



- LASIK, LASEK, Epi-LASIK, PRK, PTK Customized Surgery
- Fast Treatment Times
- Superior Eye tracking
- Easier to use, faster setup, very reliable.

Paul van Saarloos has a commercial interest in this product

Generation of Laser Wavelengths

Excimer 193 nm:

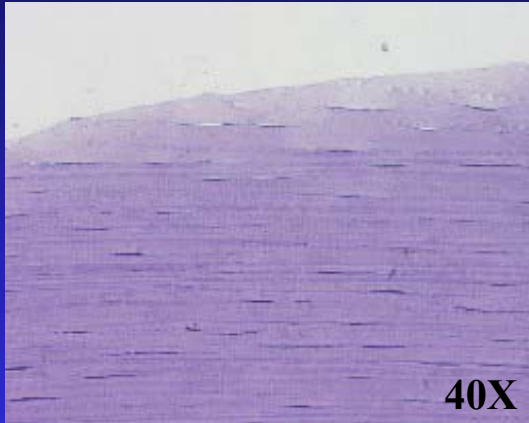
Argon-Fluoride Gas Mixtures

Solid State 213 nm:

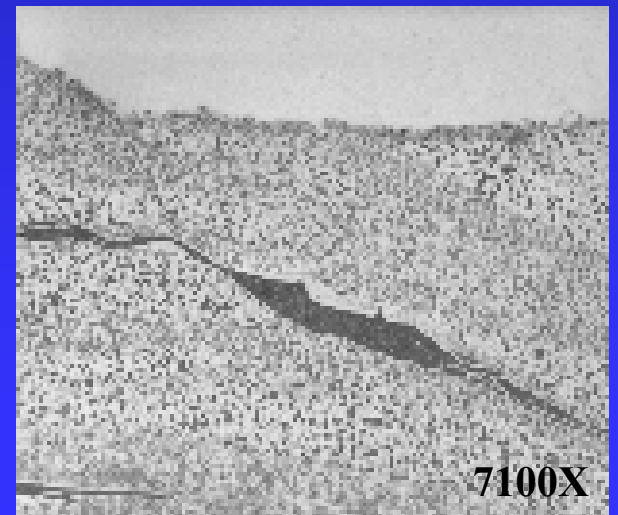
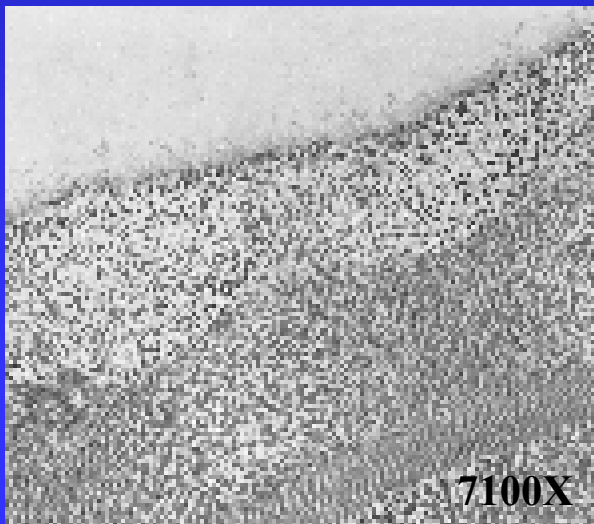
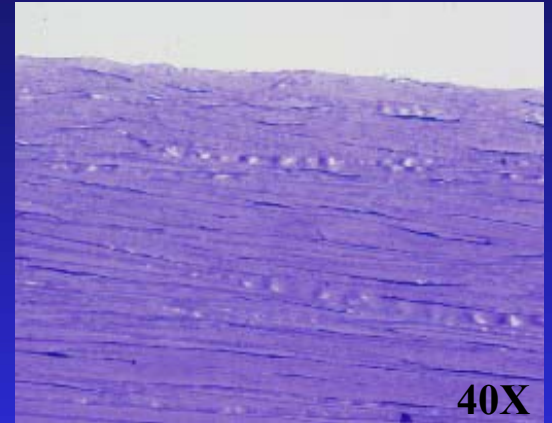
Nd:YAG laser delivered through Non-linear Crystals for frequency conversion.

Histology

213 nm



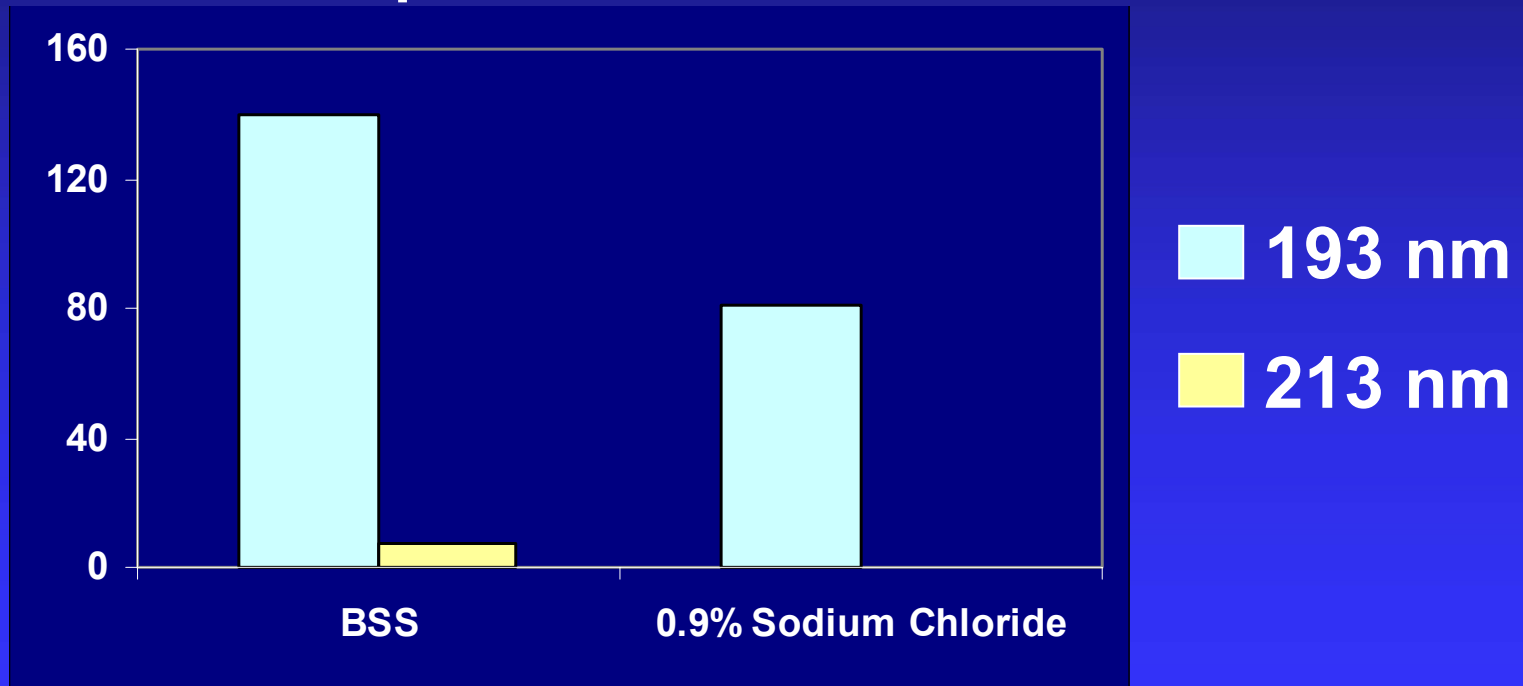
193 nm



Absorbance Characteristics

Attenuation through BSS and NaCl at 213nm is significantly less than for 193nm

Absorption Coefficient

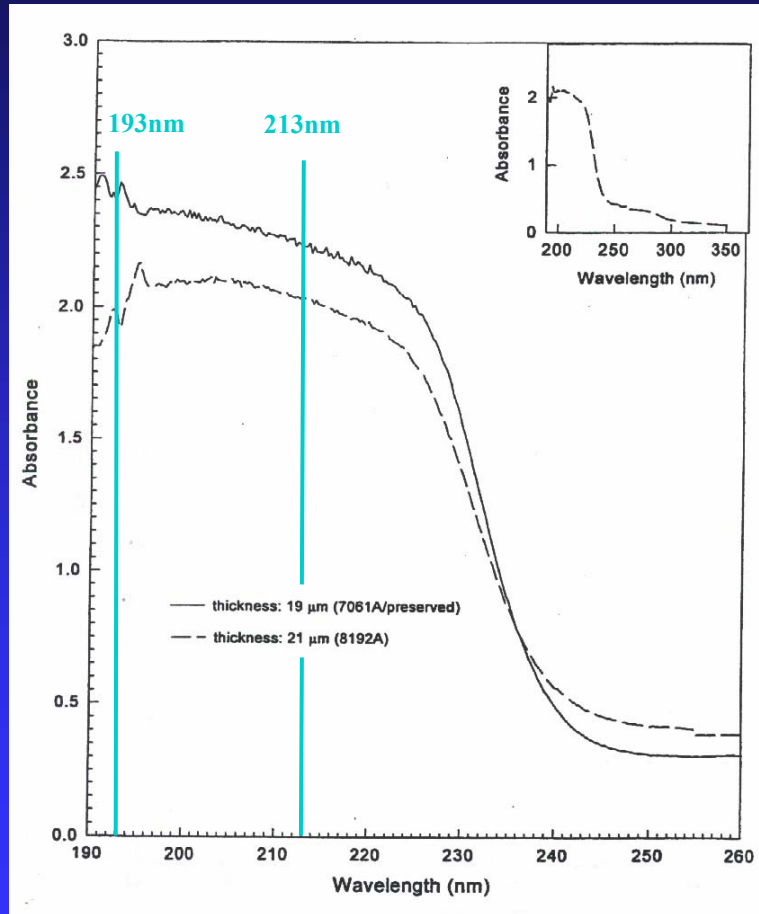


Absorption: Clinical Significance

“The absorbance of 213nm light in BSS & Na Cl is much lower than 193nm”

- More reliable, predictable treatment outcomes
- Fluctuations in corneal hydration or environmental humidity are unlikely to have a significant effect upon the performance of the solid state laser
- Colder, more efficient ablation with less energy wasted heating water.

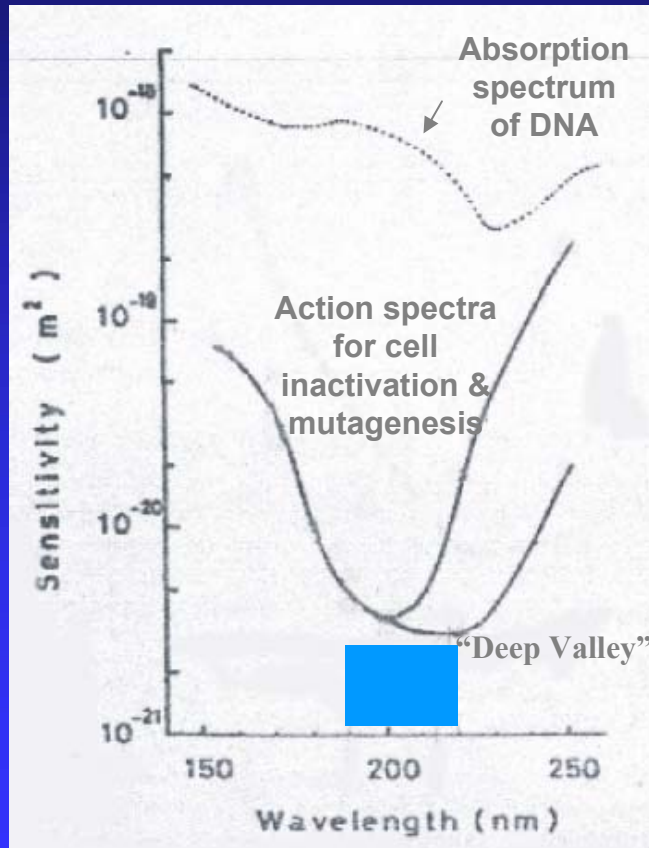
UV Absorption Spectra of Human Cornea



- The absorbance dependence on the wavelength for two human corneal samples between 260nm and 190nm
- A “window of ablation” in the far UV region between 220nm-190nm.

Cytotoxicity & Mutagenicity

Action spectra for cell inactivation and mutagenesis for bacterial and yeast cells after exposure to radiation in a vacuum



- 190- 220nm range less sensitive

- Nuclear DNA could be protected from this range of UV light by the surrounding cytoplasmic components

In Vitro: Cytotoxicity & Mutagenicity

- *In vitro* study, Kaido *et al.*, (2002) (Coherent Medical) compared mutagenic and cytotoxic potential between 193nm and 213nm
- Showed 213nm had greater effect than 193nm

Technical issues with this *in vitro* study:-

- 1) Cells wet – shielded 193nm radiation and not 213nm
- 2) Laser Fluence too low ($4\text{mJ}/\text{cm}^2$) to dry cells
- 3) 213nm beam contaminated with 266nm radiation.

In vivo DNA Damage Study

300 μ m ablation of both eyes of fifteen live $\frac{1}{2}$ lop rabbits

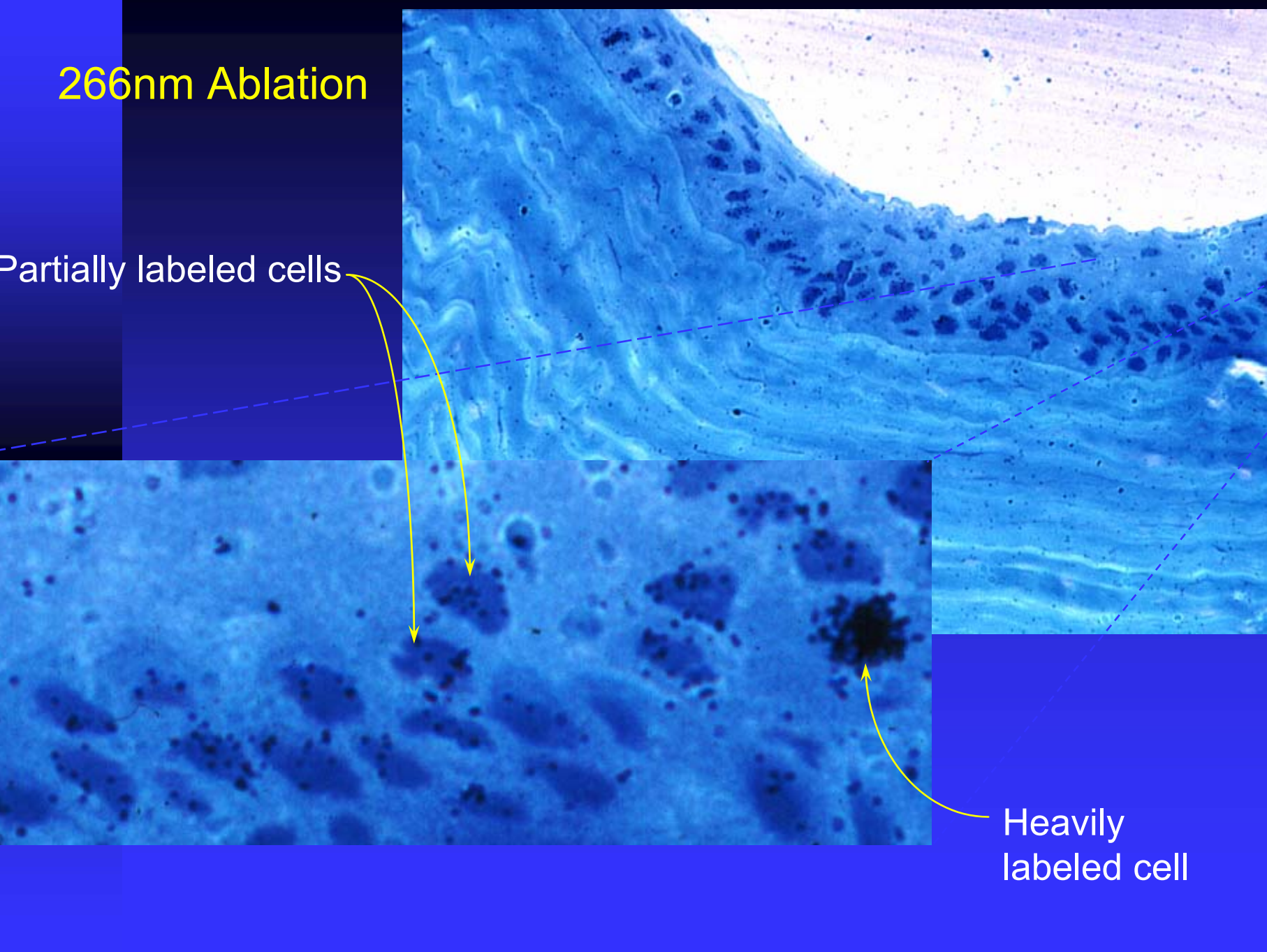
- 5 rabbits with 193nm Excimer as -ve control
- 5 rabbits with 266nm as +ve control
- 5 rabbits with 213nm

DNA Analysis

- **Technique by Nuss, Puliafito and Dehm to detect unscheduled DNA synthesis (UDS)**
- **Enucleated eyes incubated in calf serum with radioactive thymine into DNA for 3 days**
- **Fixed, embedded into 2-3mm sections**
- **Dipped into photographic emulsion, left for 2 weeks, fixed and stained**
- **All cells, partially labeled cells (disrupted DNA replication) and heavily labeled cells (normal cell division) counted**

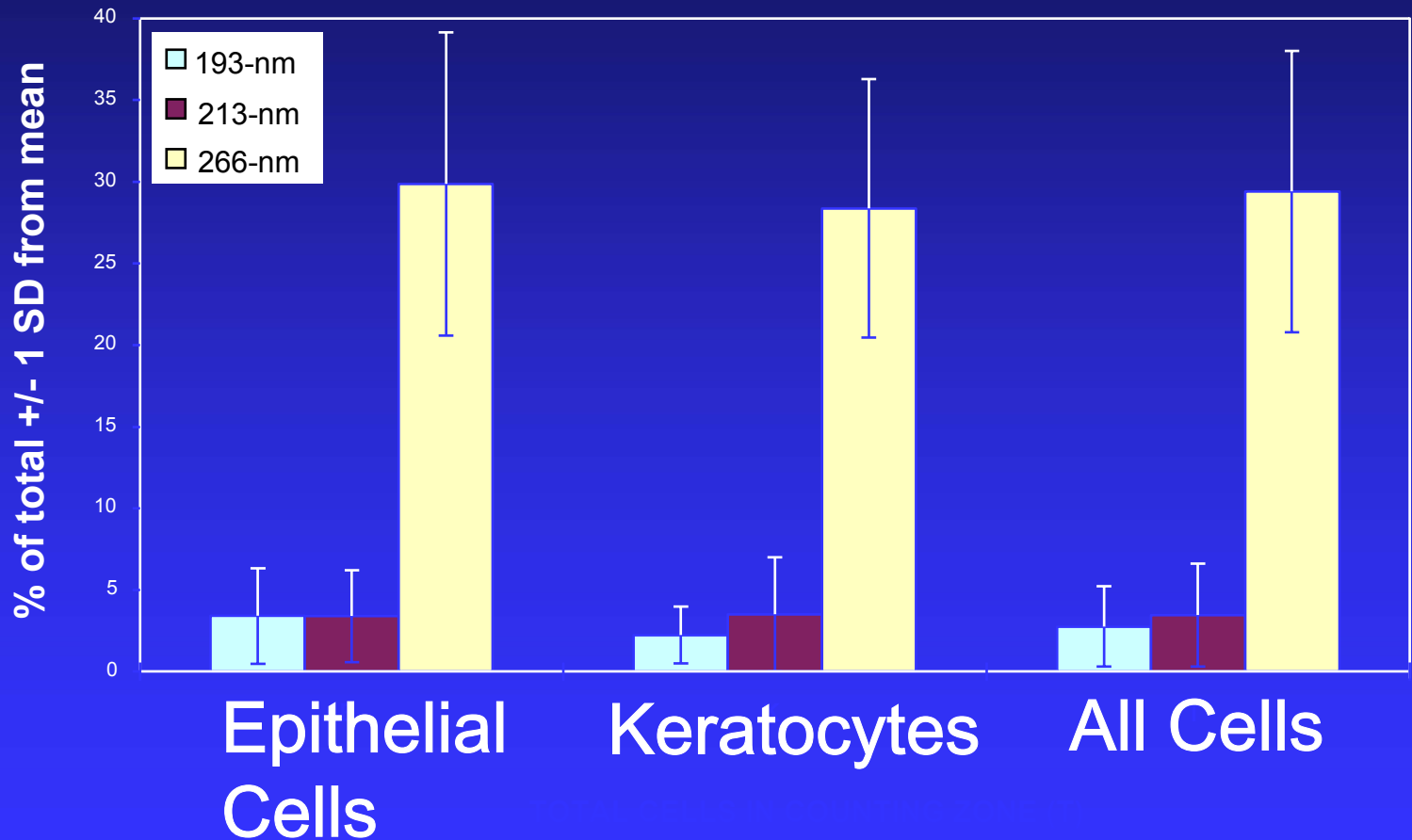
266nm Ablation

Partially labeled cells



Heavily labeled cell

Percentage of cells with Unscheduled DNA Synthesis



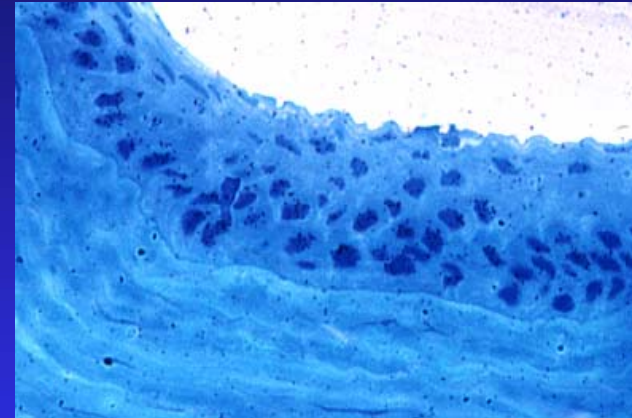
DNA Damage *In vivo* study:

Unscheduled DNA Synthesis (UDS)

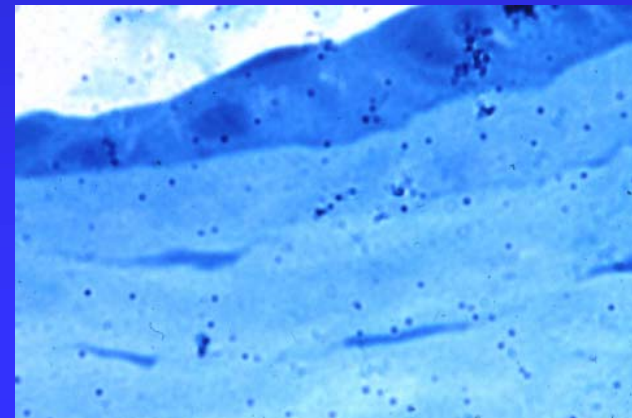
- 266nm: significantly more DNA damage.
- For 193 & 213 nm: < 5% (average) of cells were affected.
- 193 & 213 nm SAME. Both produce Minimal DNA damage.

266nm

Positive Control

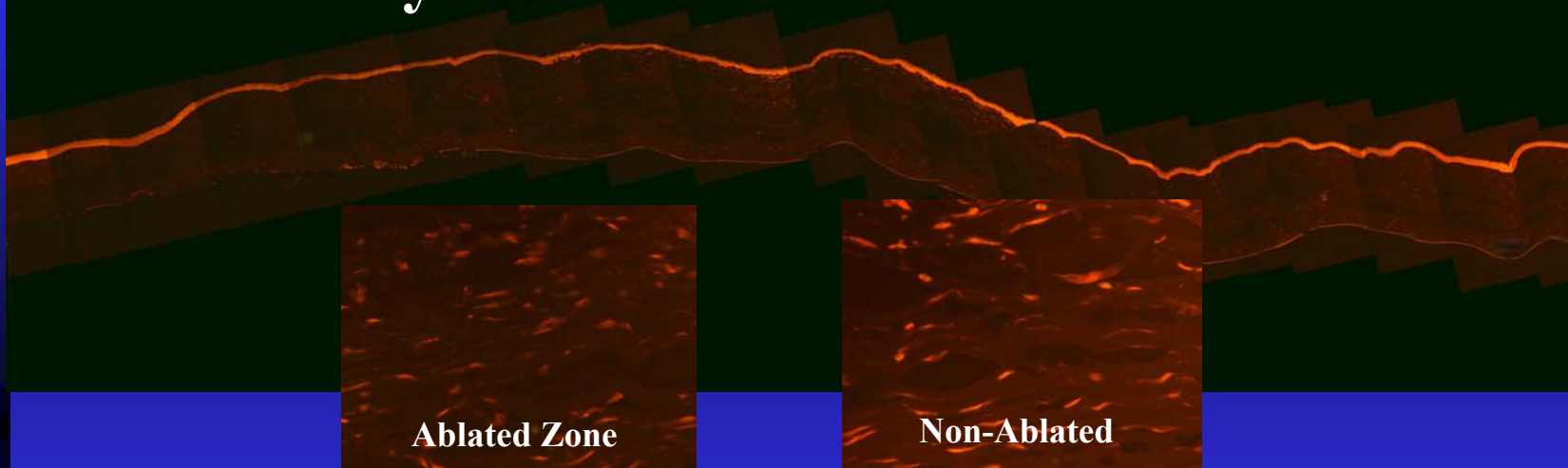


213nm

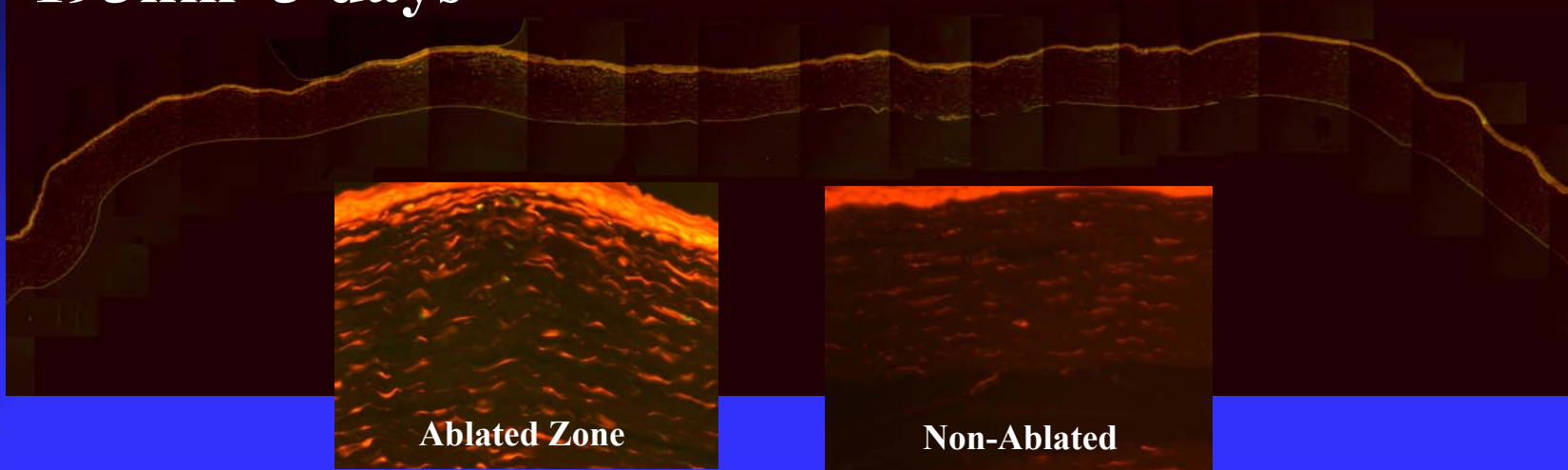


TUNEL Staining of Rabbit cornea following PRK

213nm 3 days



193nm 3 days



Solid State Lasers May Be An Improved Option for Refractive Surgery

SAFE

- Molecular and histological studies reveal similar results to 193nm
- In vivo mutagenicity studies – 213 as safe as 193

PERFORMANCE ADVANTAGES

- Transmission through Aqueous solutions
- Higher Corneal Ablation Efficiency
- May Produce Less Thermal Effect

THANK YOU!!!!