Strain studies in diamond NV centers at UC Berkeley

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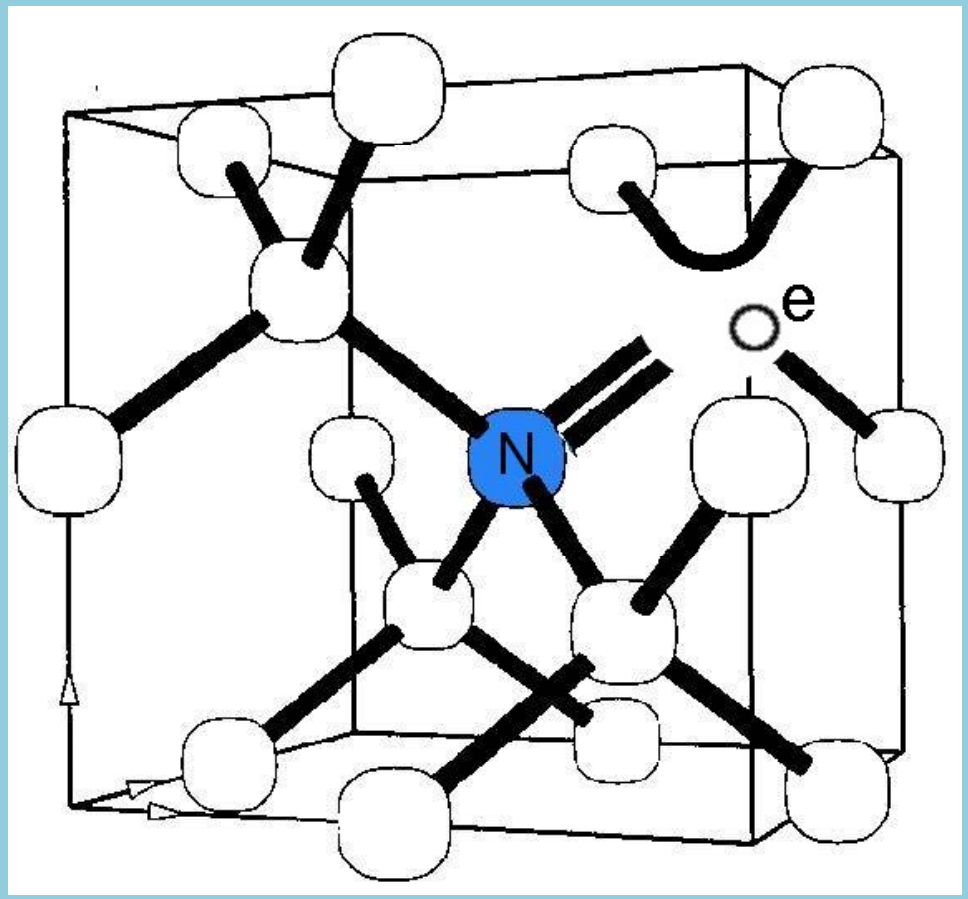
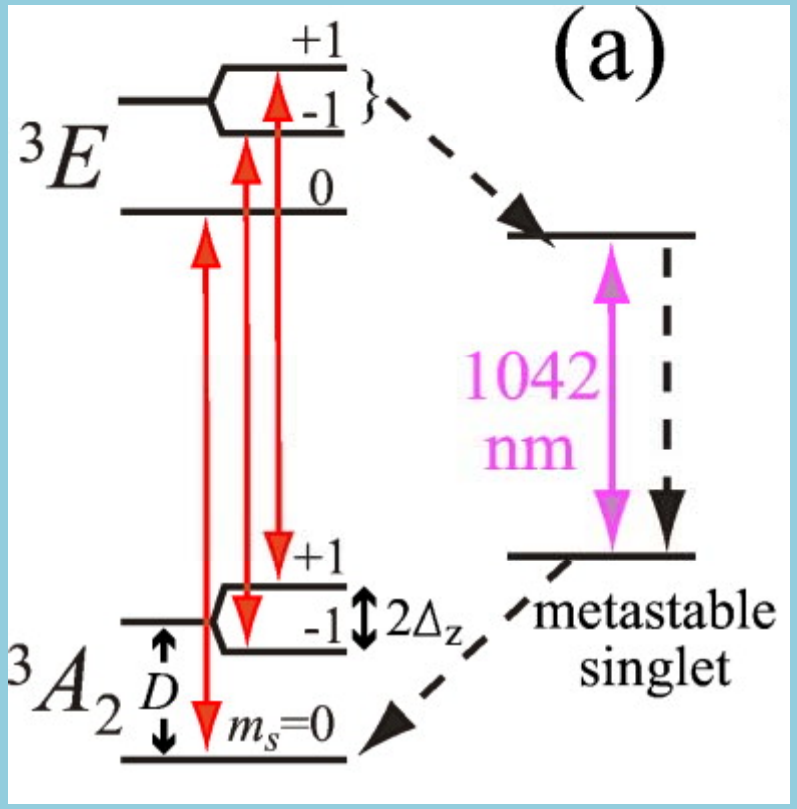
NV^- centers



A nitrogen-vacancy center consists of a nitrogen next to a vacancy in the carbon lattice of diamond

Very brief review of NV^- centers

Energy Levels



What are they good for?

- Magnetometry- high sensitivity and spatial resolution, competitive with Squid magnetometers
- Quantum Information and Control

Ground state Hamiltonian

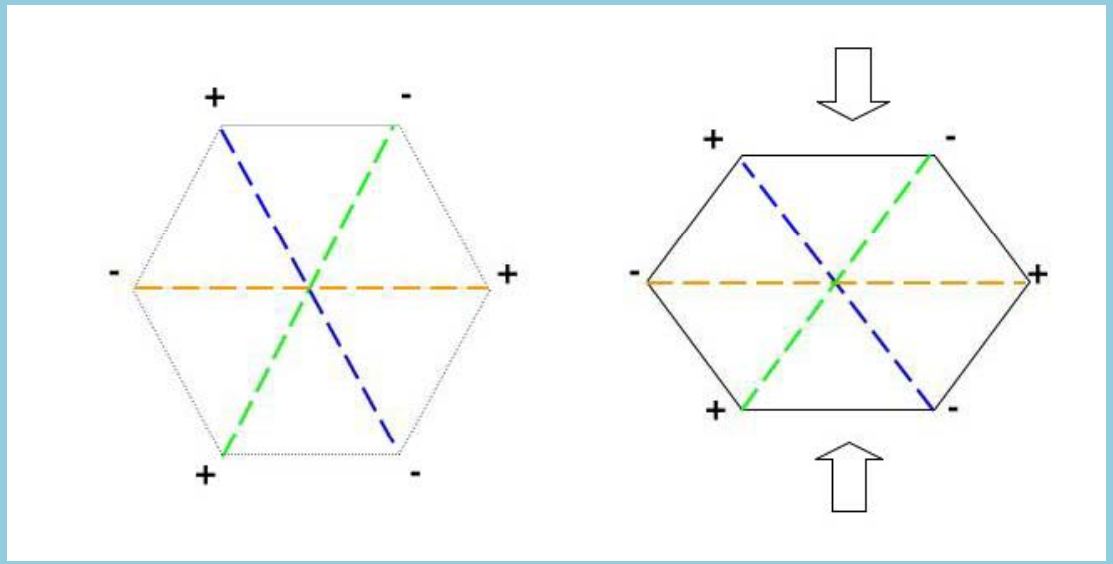
$$H = DS_z^2 + E\left(S_x^2 - S_y^2\right) + \mu g \vec{B} \cdot \vec{S}$$

D $\approx$ 2.87 GHz and is related to spin-spin interaction

E $\approx$ a few MHz and is related to the strain

Strain and its causes

- Displacement of atomic positions
- Can be applied by mechanical force ie. “squeezing” or electric field. Effect from electric field related to *piezoelectric effect*
- Any deformation of crystal structure leads to strain, even in absence of external force or field.



Piezoelectric effect

http://www.amateur-radio-wiki.net/index.php?title=Piezoelectric_Effect

My Research:
Inherent strain

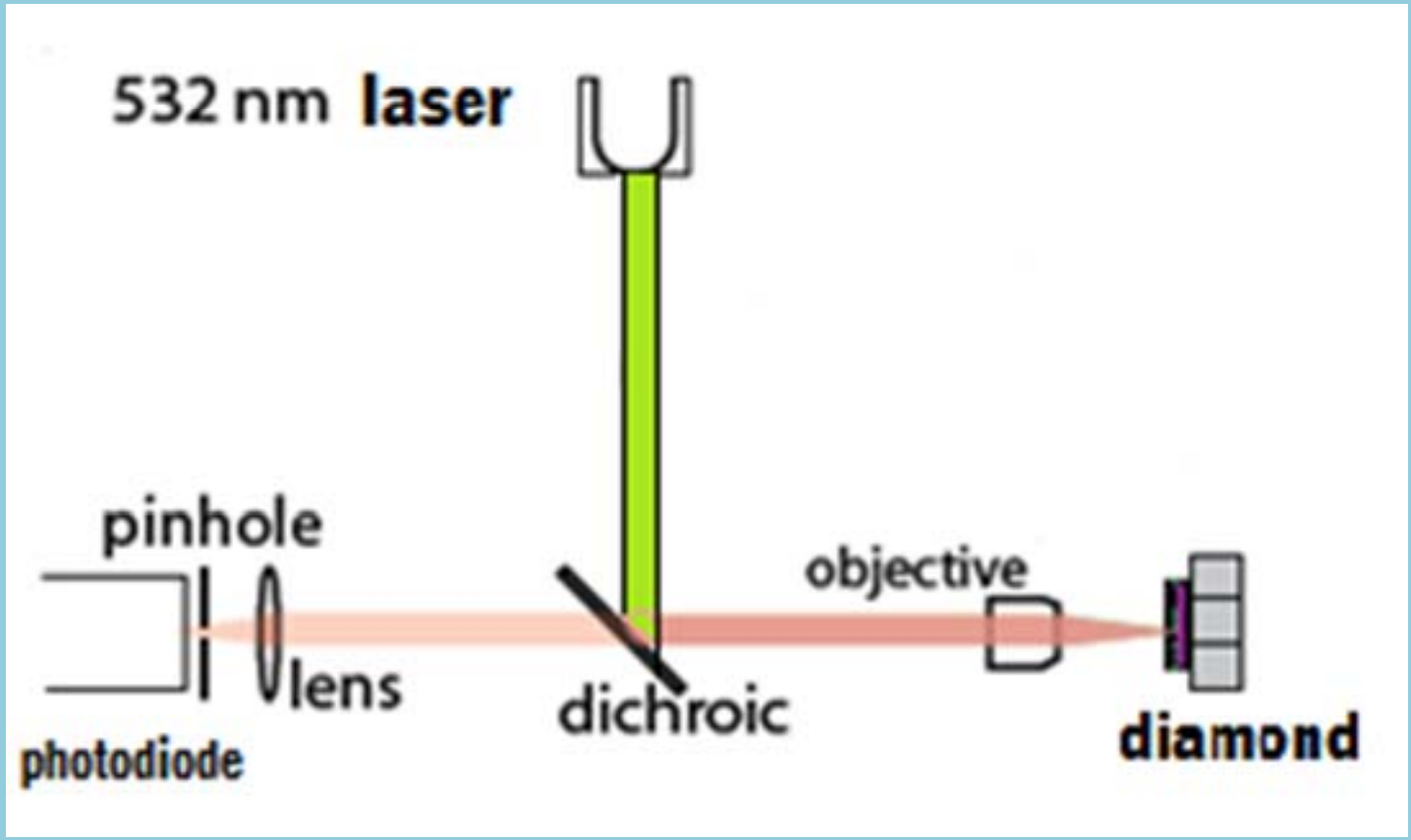
Who cares? (Why stress over strain?)

Answer:

1) Destroys linearity of splitting at low B-fields (few Gauss)
2) May cause problems for quantum computing

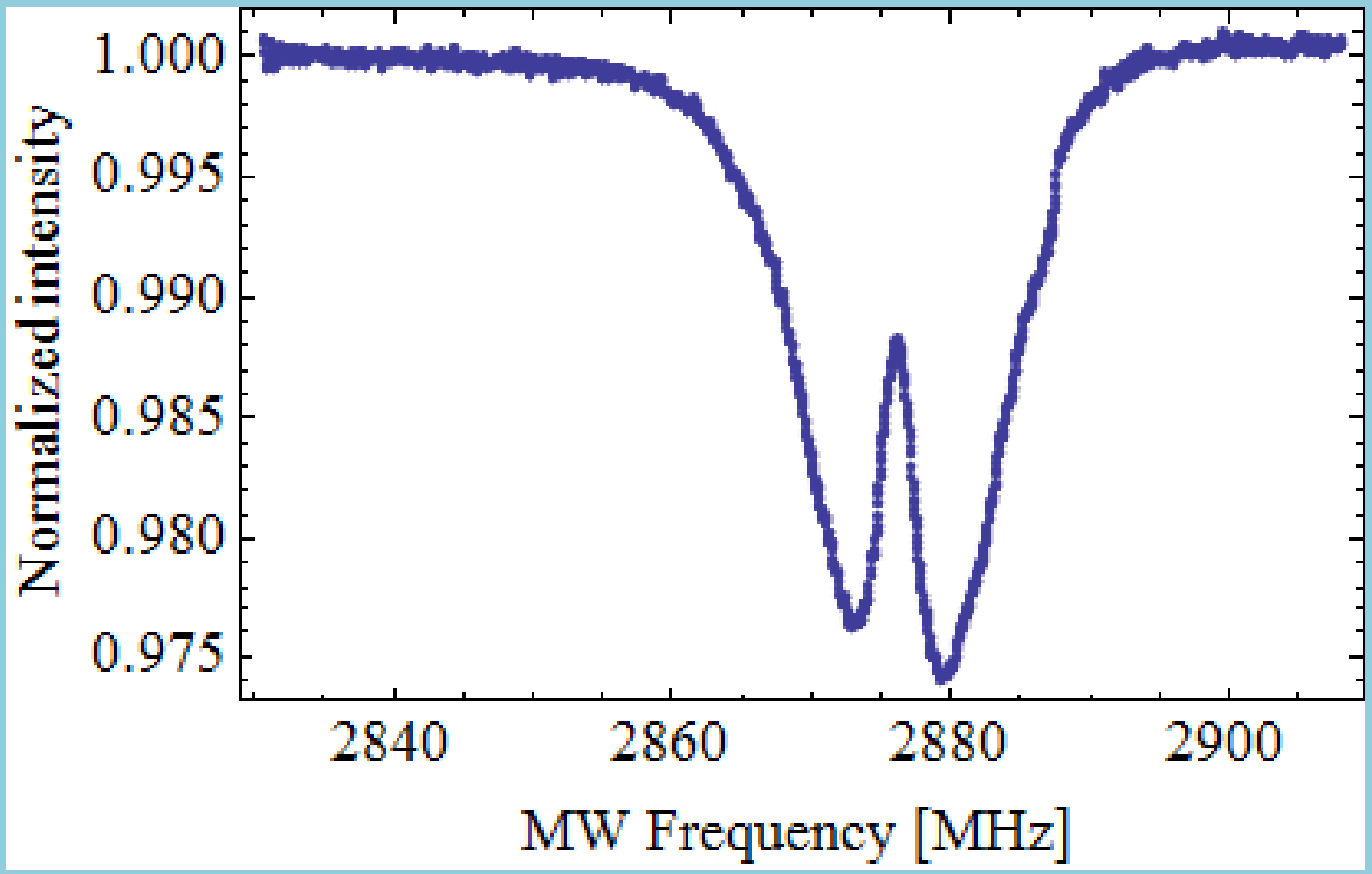
Question is: What are major sources of this deformation?
Defects? Graphitization? Vacancies?

NV^- experimental setup

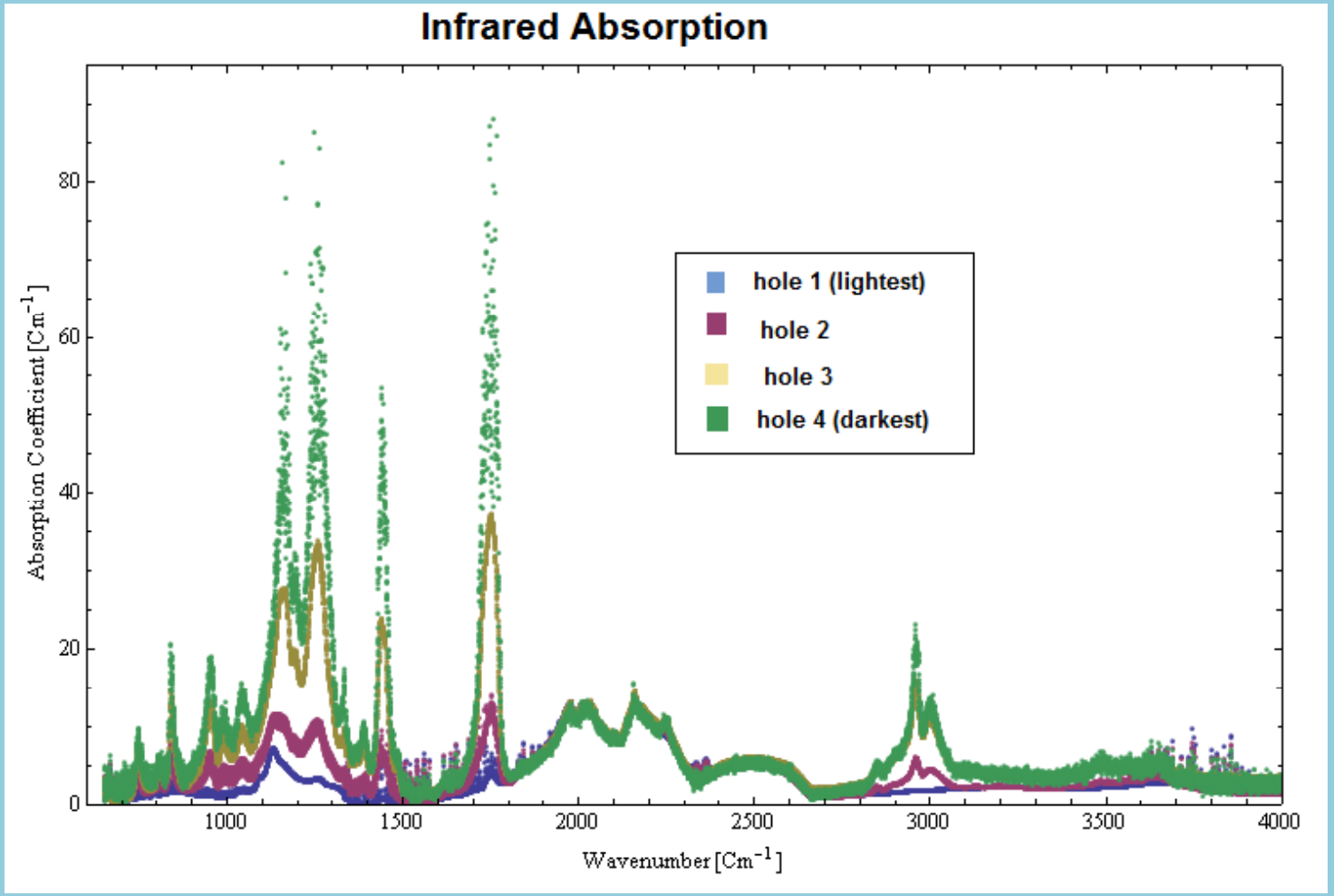


The green laser excites the electrons in the NV centers, creating a red fluorescence, which is then detected by a photodiode.

NV^- Resonance Spectrum at zero-field

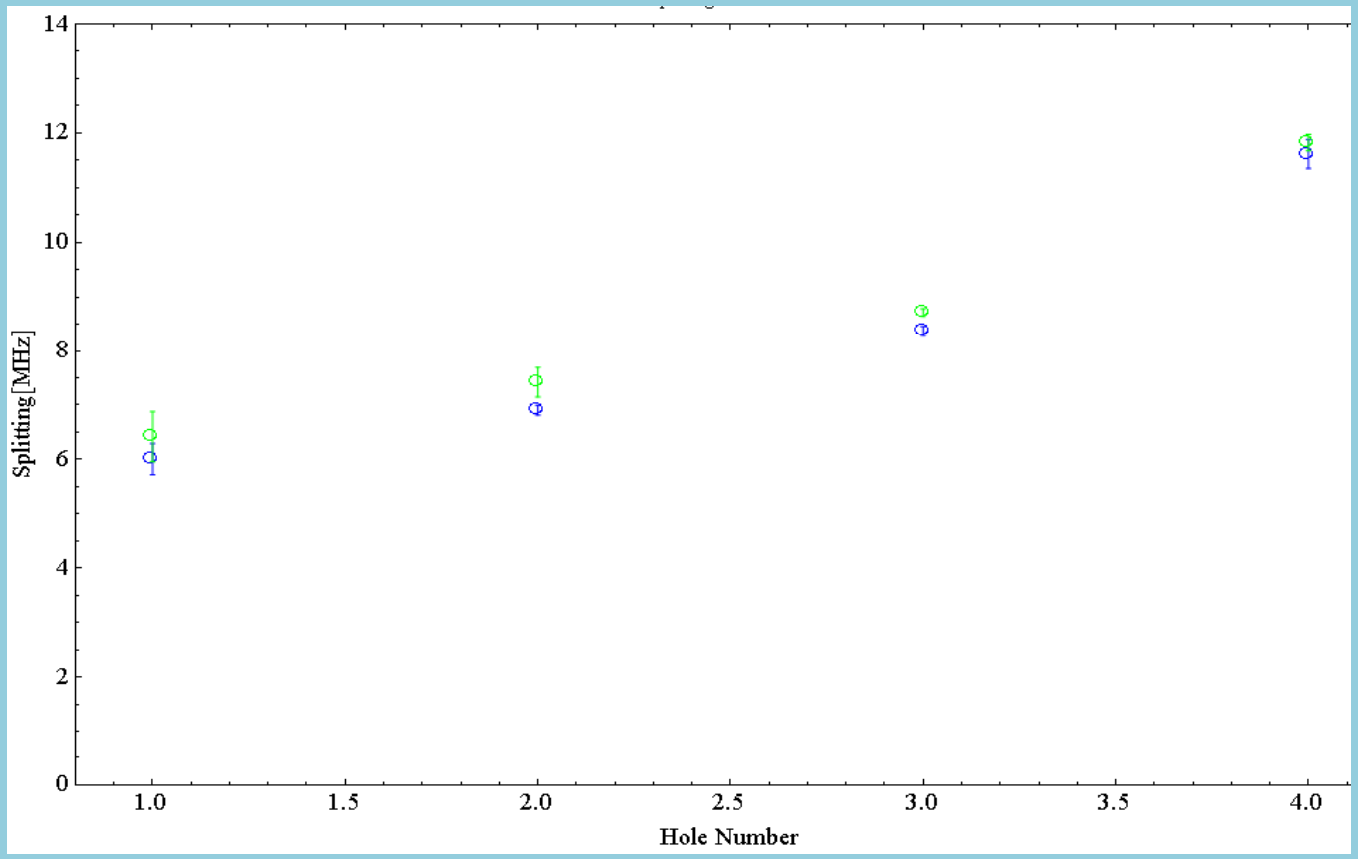


Examined a diamond that contained varying amounts of irradiation damage



Each absorption spectrum is for a different spot on the diamond, It shows increasing amounts of defect creation from irradiation

Tentatively found that zero field splitting increased with increasing irradiation damage



Increasing irradiation damage

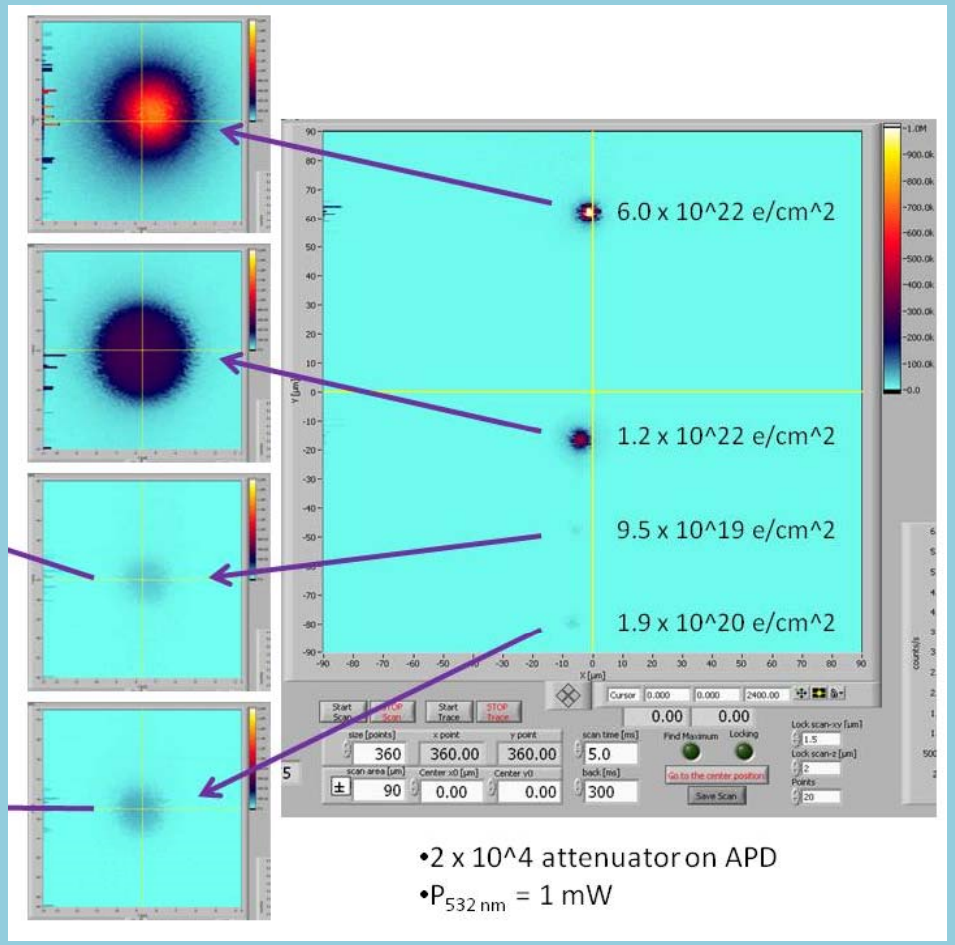
Blue is before 1200 C anneal
Green is after 1200C anneal

Current work- Looking at TEM irradiated spots

Diamond sample was irradiated using
a TEM (Transmission Electron Microscope)

200 KeV electrons instead of a few MeV

Preliminary results (as of today) : E ≈ 3 MHz with < 0.5 MHz variation



Future Research

- Dependence of strain on:

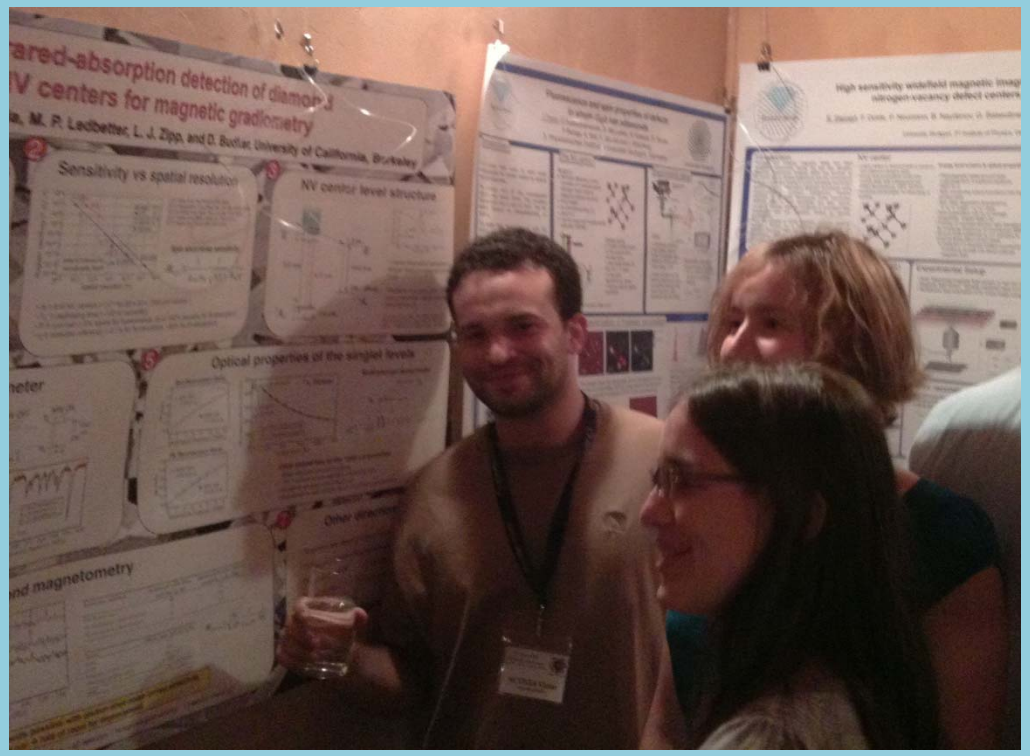
-Substitutional nitrogen

-type of diamond (HPHT vs. CVD)

-energy of electrons

Acknowledgements

Thanks to:
Victor Acosta,
Andrey Jarmola,
Dmitry Budker,
+others for their help
during this project



Recent PhD graduate Victor Acosta