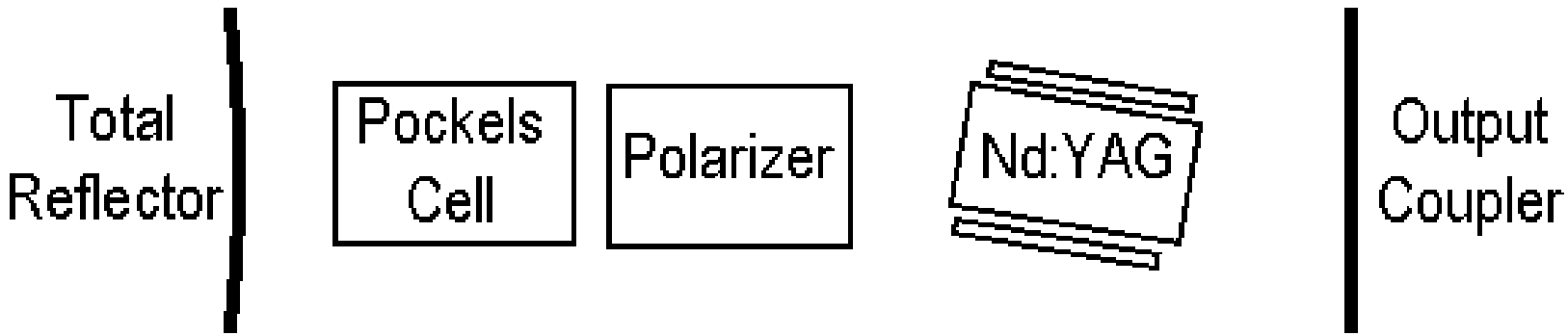
From-Scratch Alignment of a Q-Switched Nd:YAG Laser

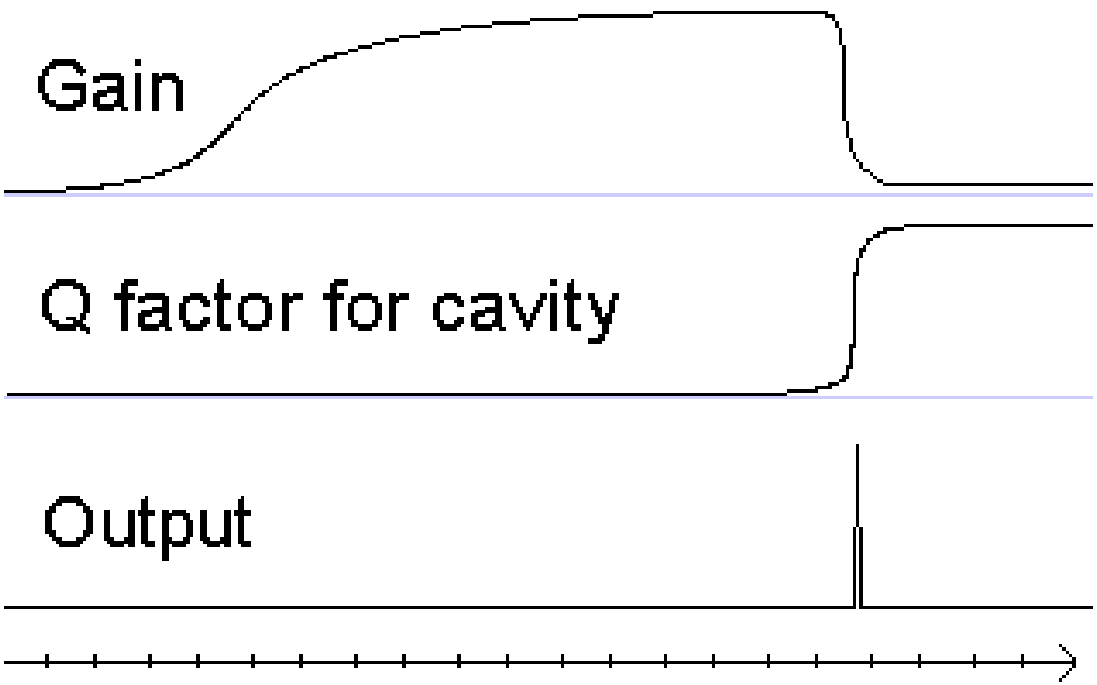
1. Principles of a Q-Switched Laser
2. Cavity construction and choices
3. Alignment procedure
4. Results



Q-Switch Basics

- Fast Q-switching
- Slow excitation mechanism

- Inherently pulsed
- “Giant Pulse” – very high intensity



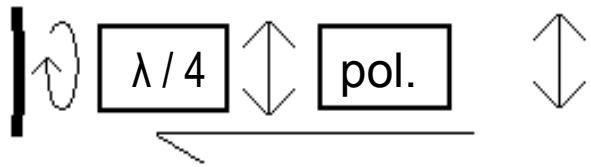
Gain Medium

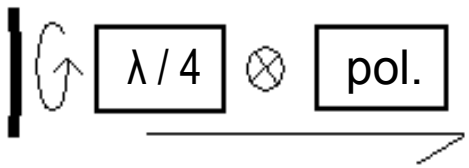
- Nd:YAG is the textbook 4-level laser example
- Solid state: broad energy band N3
- Slow N2 decay + Fast N1 decay: large inversion with long lifetime
- Flashlamps used for excitation

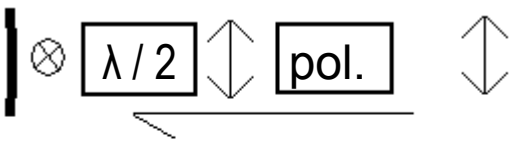
Insert picture from Milloni and Eberly here.
(p.304 or p.415?)

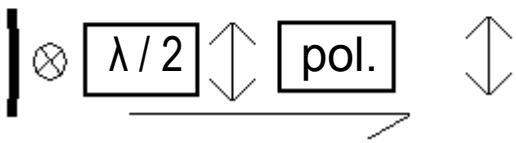
Q-Switch

- Pockels Cell & Polarizer
- Cell: Voltage controlled waveplate
- λ/4: End mirror?





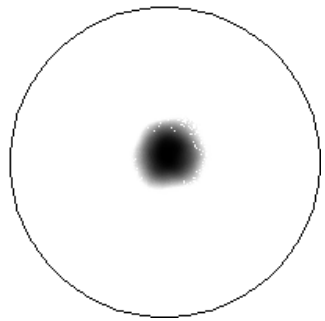


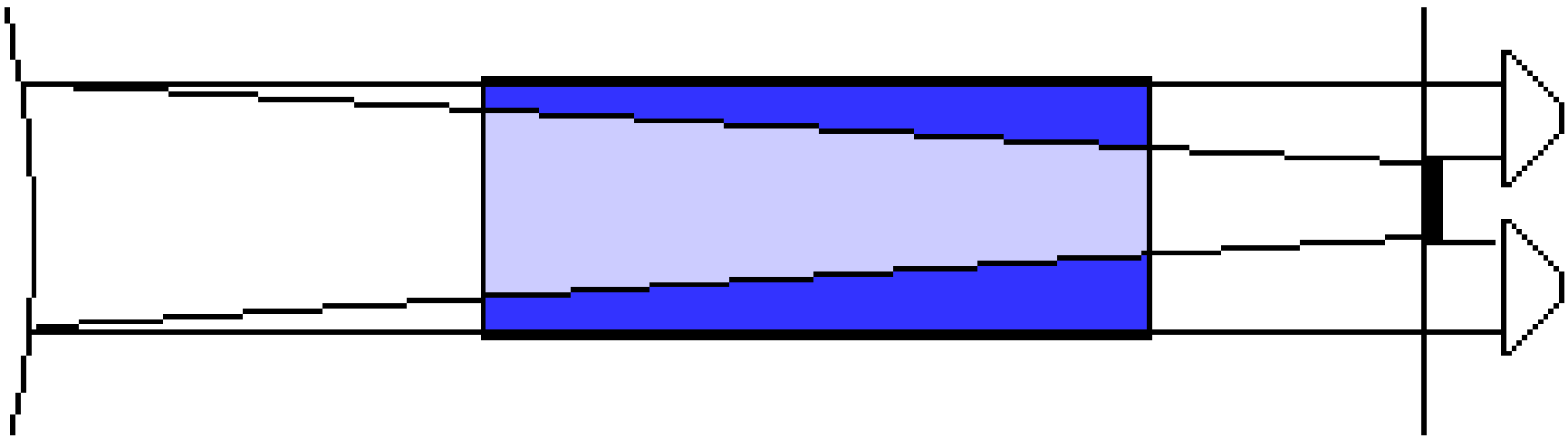


- λ/2: Transparent to the cavity
- Optic axis must be aligned properly!

Resonator Choices

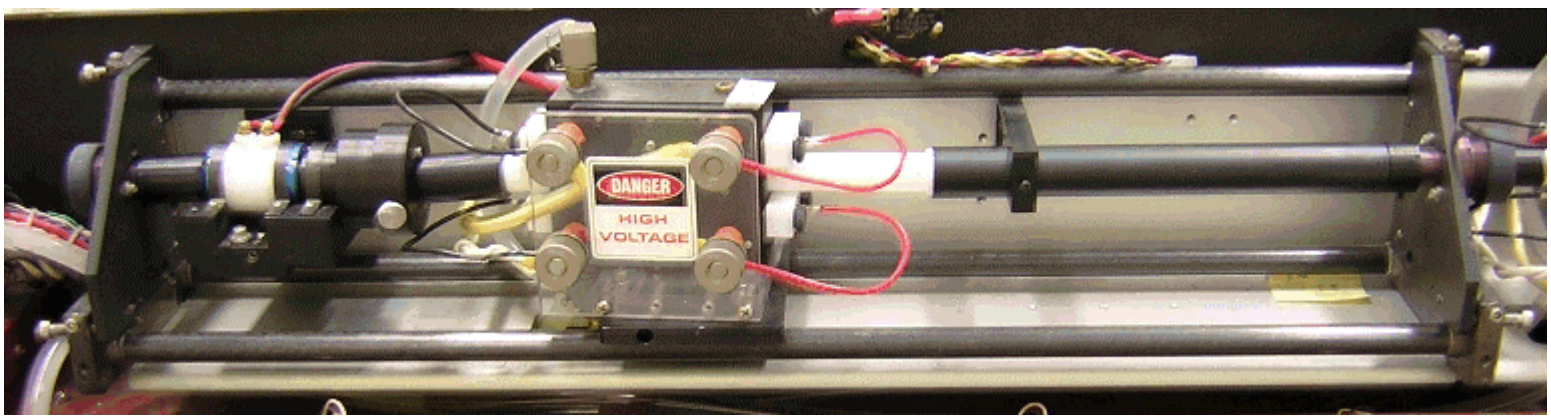
- Unstable Resonator design
  - Low gain: build intensity from many passes
  - High gain: few passes, fill medium with mode
- Total reflector: convex
- Diffraction spot output coupler, flat mirror (?)





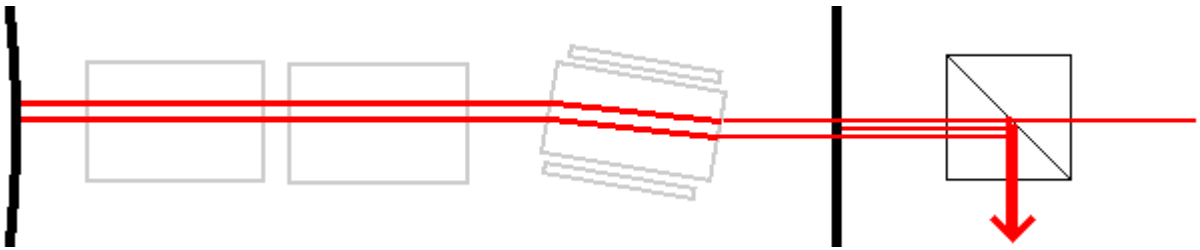
Alignment Methods

- Pre-align the mirrors
- Pre-adjust the pitch and yaw of the Pockels cell
- First round of threshold and holdoff adjustments
- Clean up output mode
- Lather, Rinse, Repeat.



Pre-adjustment

- HeNe: rough position for the mirrors.



- Berry's "black sandwich"
- Crossed polarizers across a birefringent crystal (the Pockels cell)
- Yields orientation of optic axis of crystal

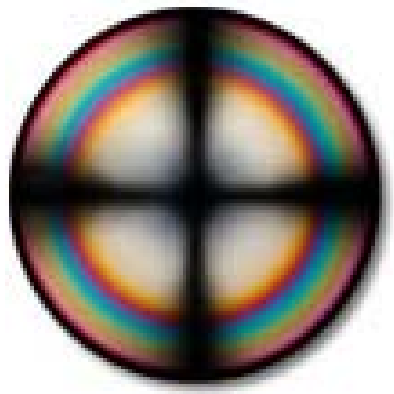


Image taken from http://www.olympusmicro.com/primer/techniques/polarized/polarizedintro.html

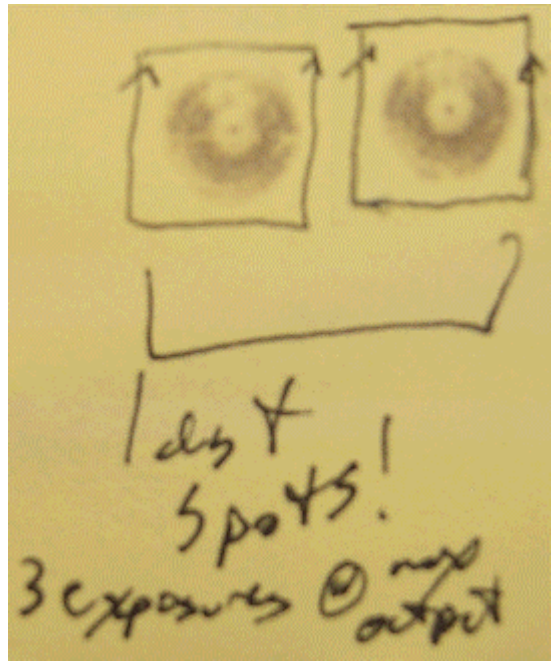
First Threshold/Holdoff

- Threshold: minimum lamp energy to see lasing
- Holdoff: maximum lamp energy before Pockels cell “leaks”

- The cavity must be aligned to the cell…
- …and the cell must be aligned to the cavity.
- Iterative alignment procedure: adjust the cell for both threshold and holdoff, then the cavity, then the repeat.

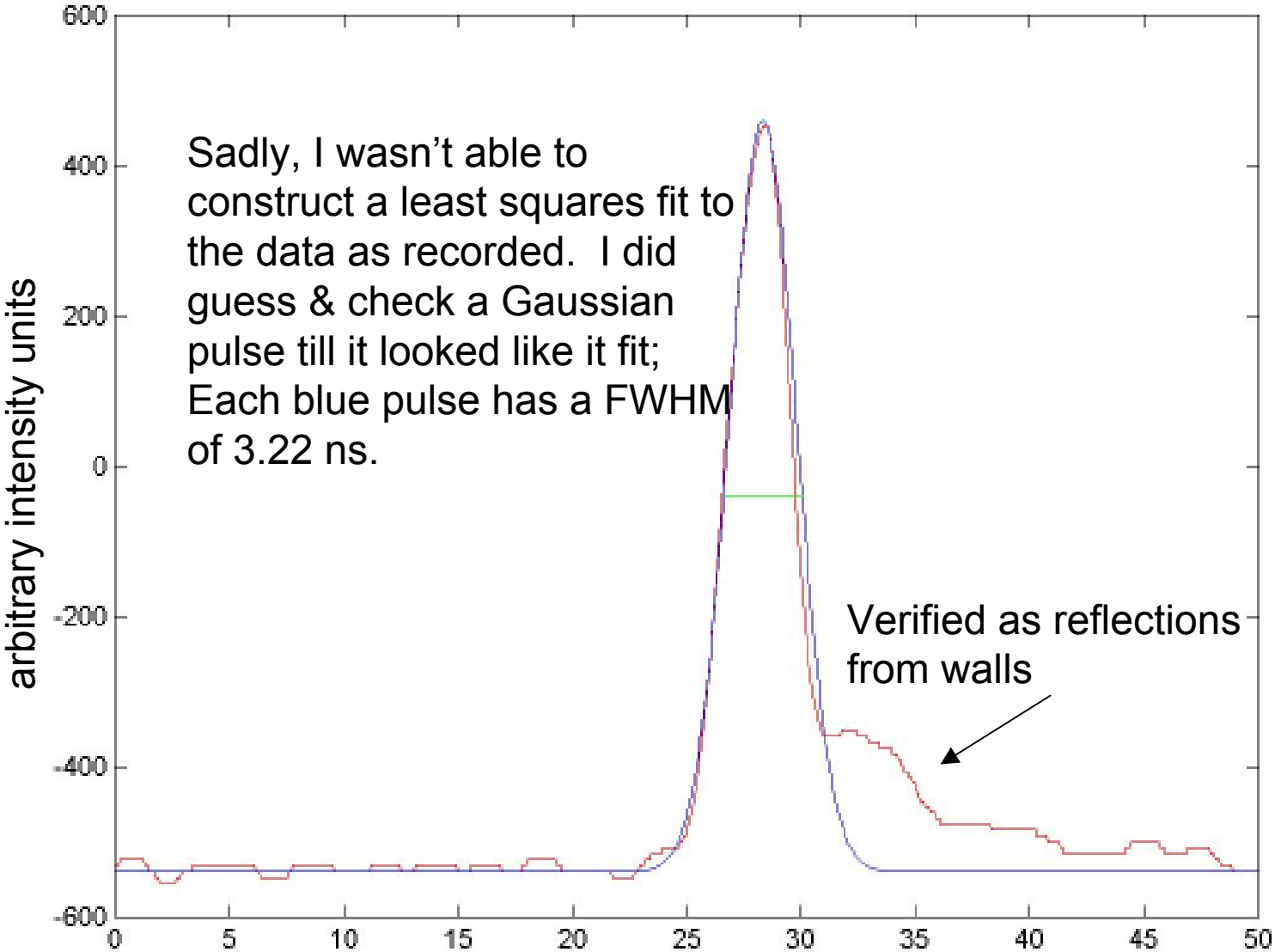
Output mode

- Post-It Notes™ have many uses… infrared will slightly burn the glue…
- Normal incidence on output coupler → Poisson spot



- Mode is important!
- Improve the mode slightly, but be careful!
- Holdoff extremely sensitive to mirror alignment; avoid large power output in breakthrough mode

Final Threshold/Holdoff



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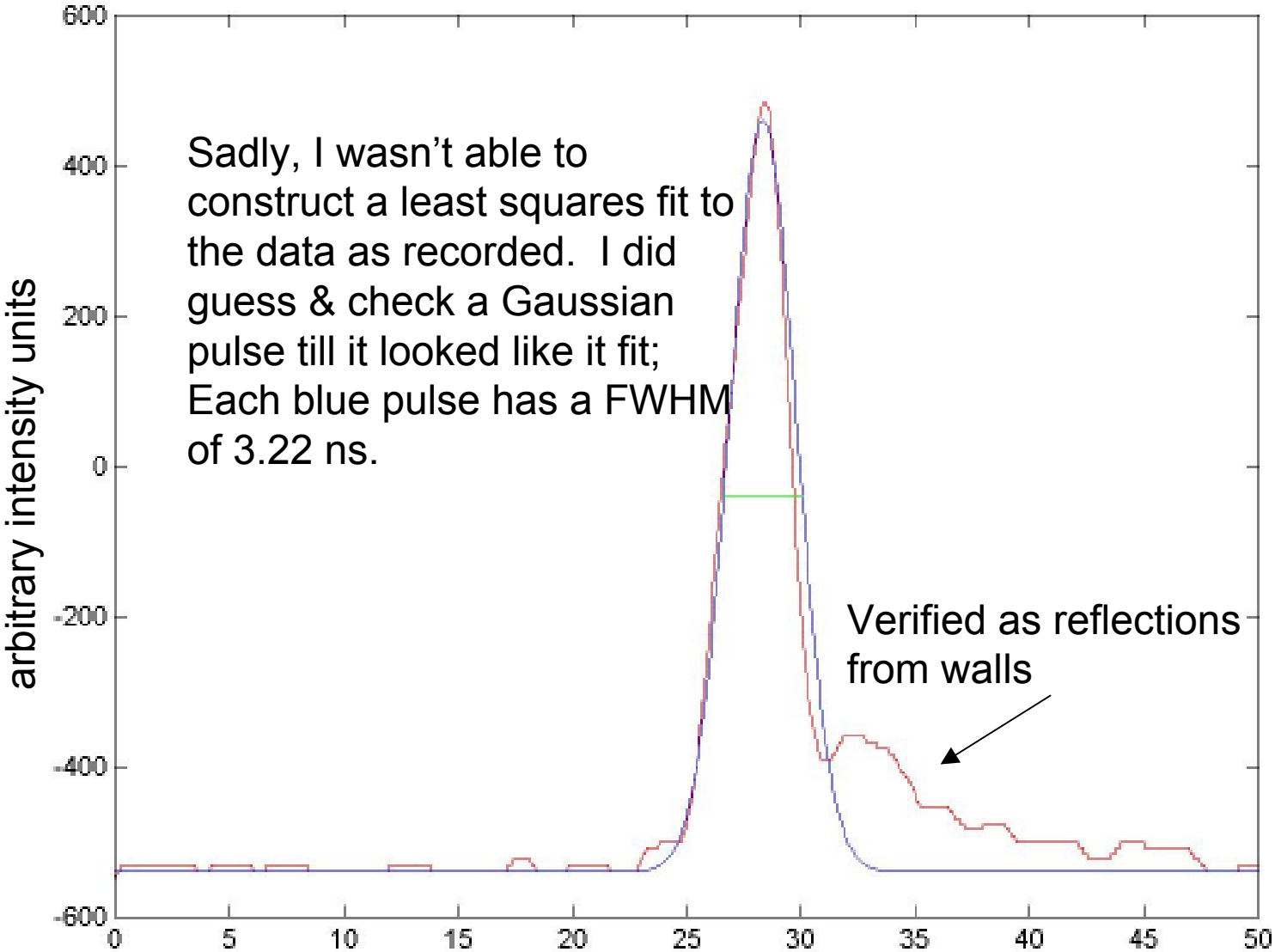

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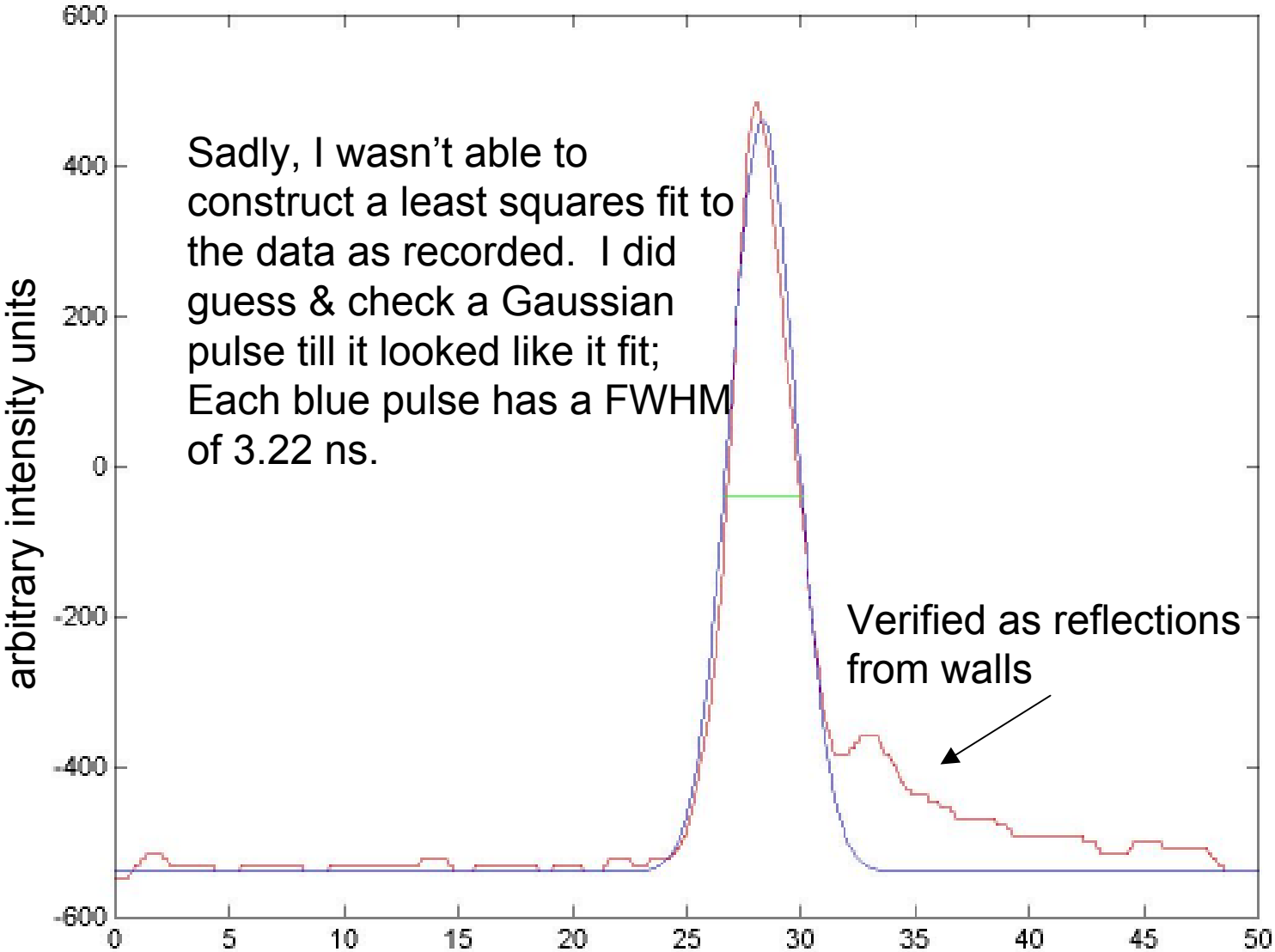

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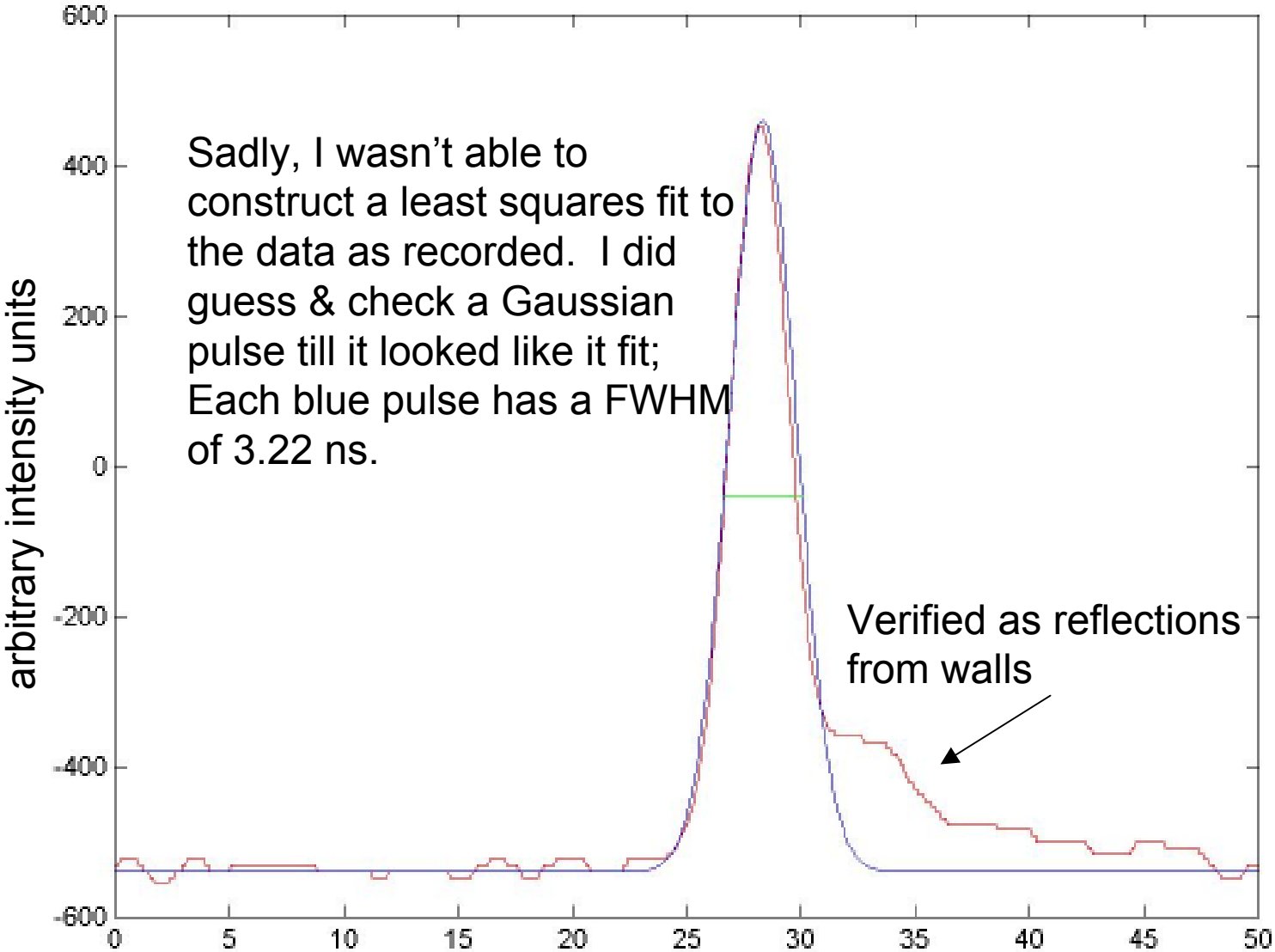

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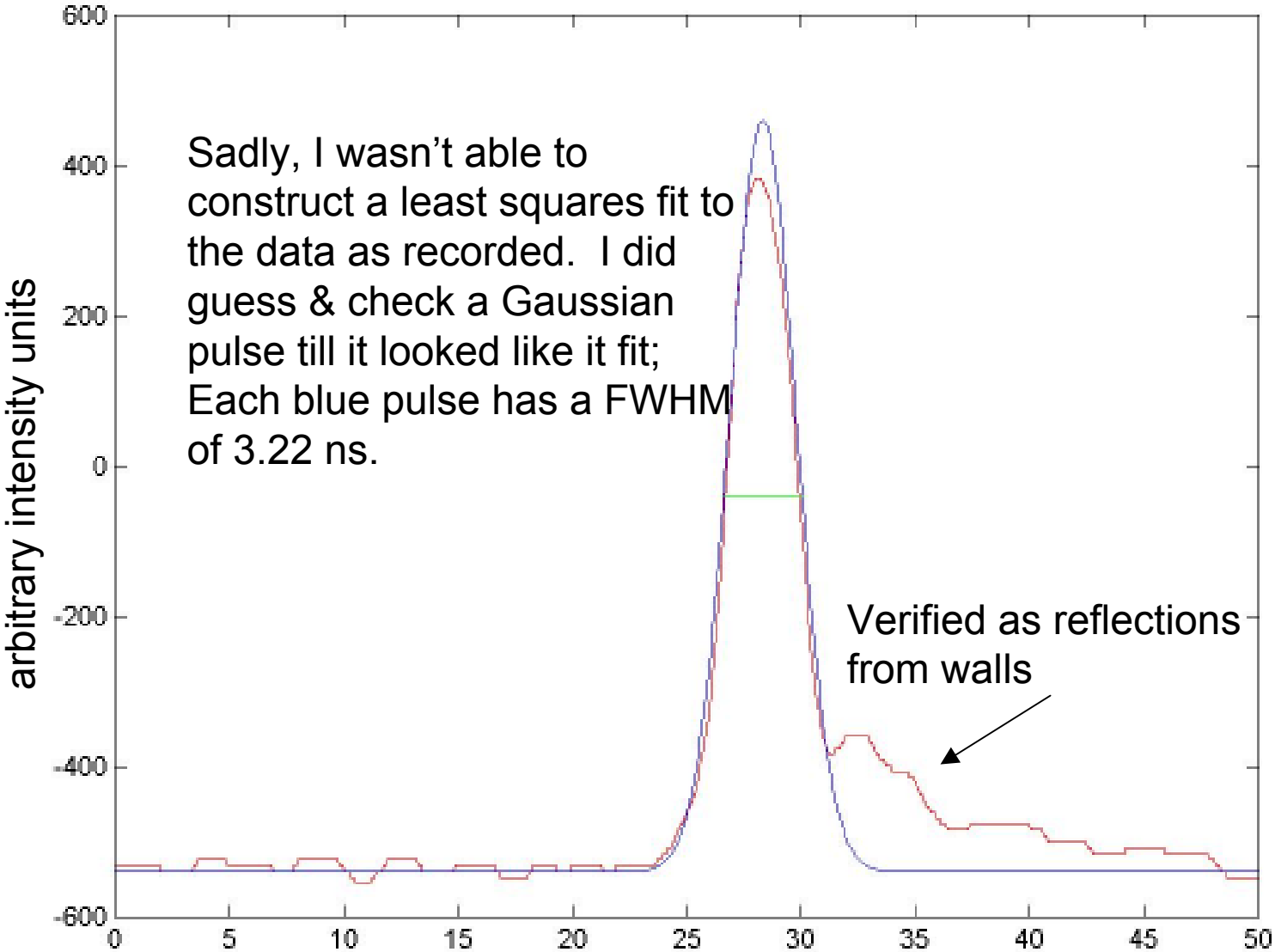

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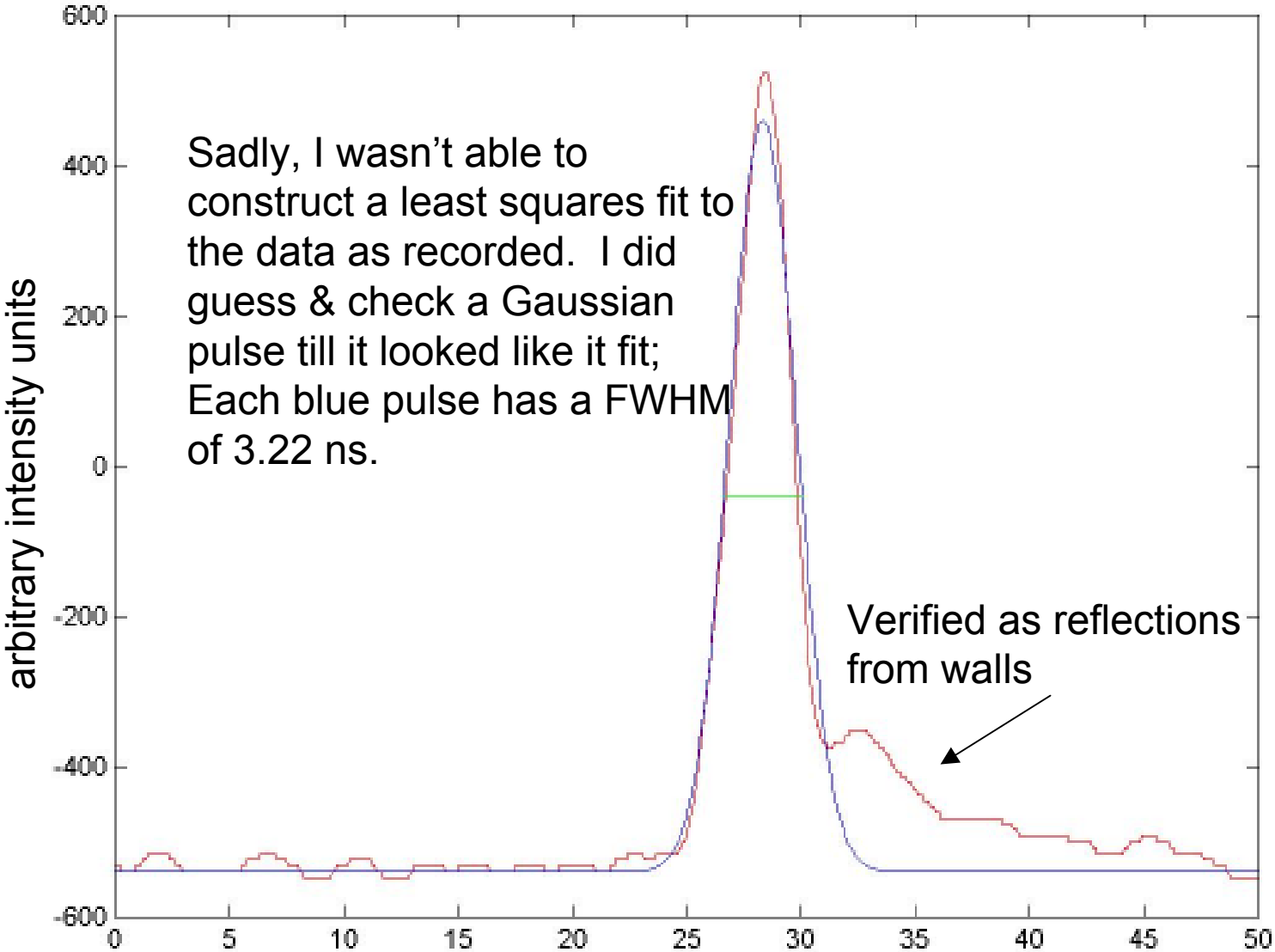

References

Lasers, Peter Milonni and Joseph Eberly, (Wiley, 1988).
Introduction to Modern Optics, Grant R. Fowles, (Dover, 1989)
http://www.olympusmicro.com/primer/techniques/polarized/polarizedintro.html
http://www.dctech.com/eureka/short-stories/poisson.php