ATF1/2 laser-wires

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on behalf of UK Extraction line laserwire collaboration
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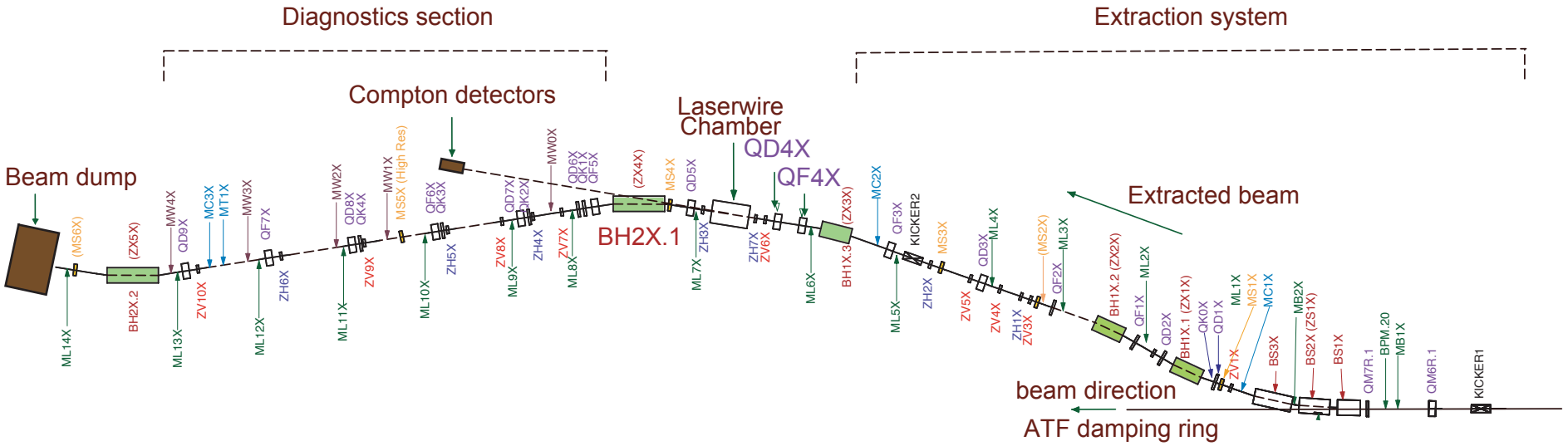
JAI @ Oxford and JAI @ RHUL

Extraction line group aims

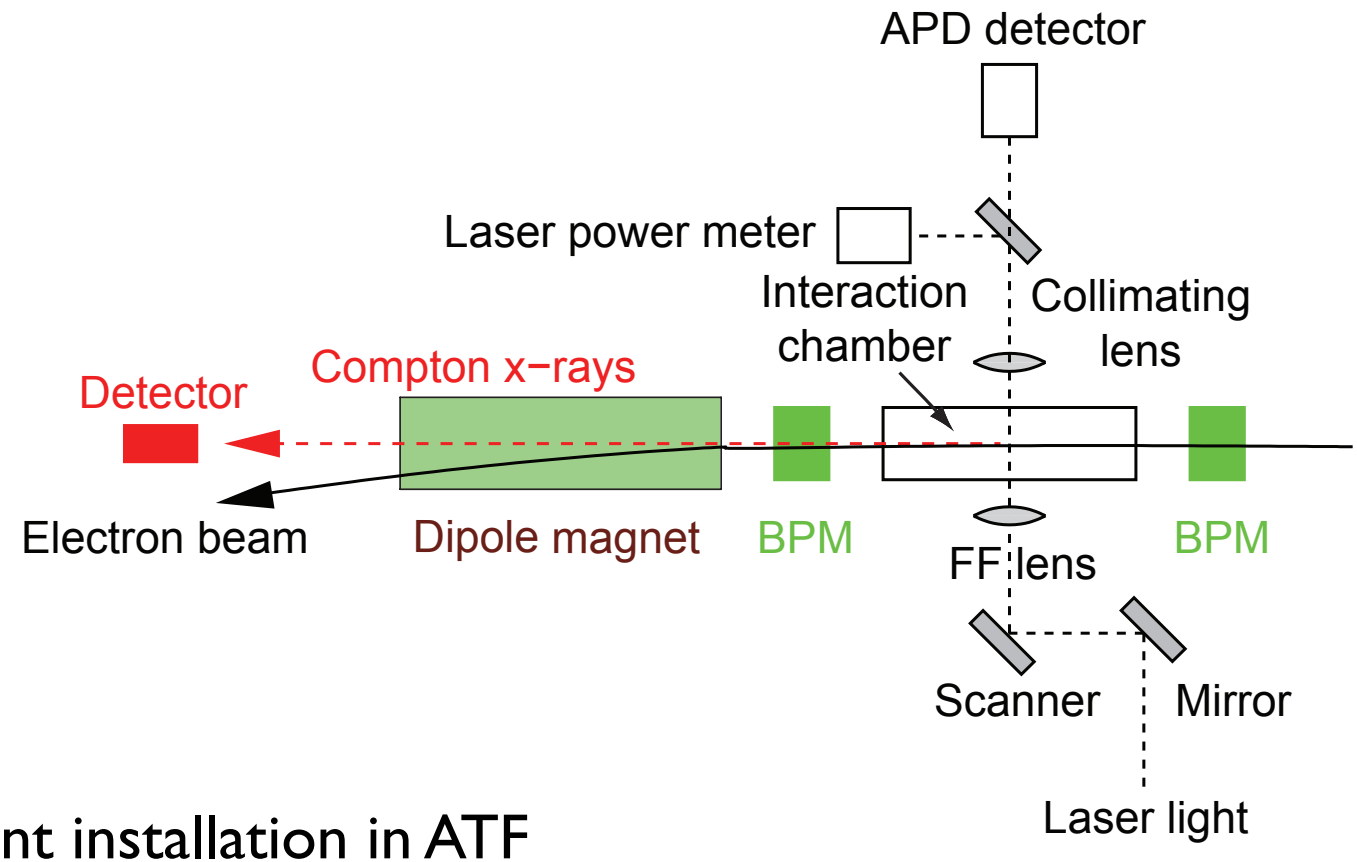
- Develop extraction line ILC laserwire prototype
  - Started with simple 10 micron laser-wire
    - Infrastructure, laser, beam-optics, data aquisition
  - Goal before ATF2, 1 micron laser-wire
    - Require custom optics
      - Aberration corrected optics
    - High power laser system
      - Mode locked, high power ~50 MW
      - Excellent transverse mode quality

ATF installation



- Current installation in ATF
  - In extraction bending system
  - Three types of detector, Cerenkov (air, aerogel) Calorimeter

ATF installation



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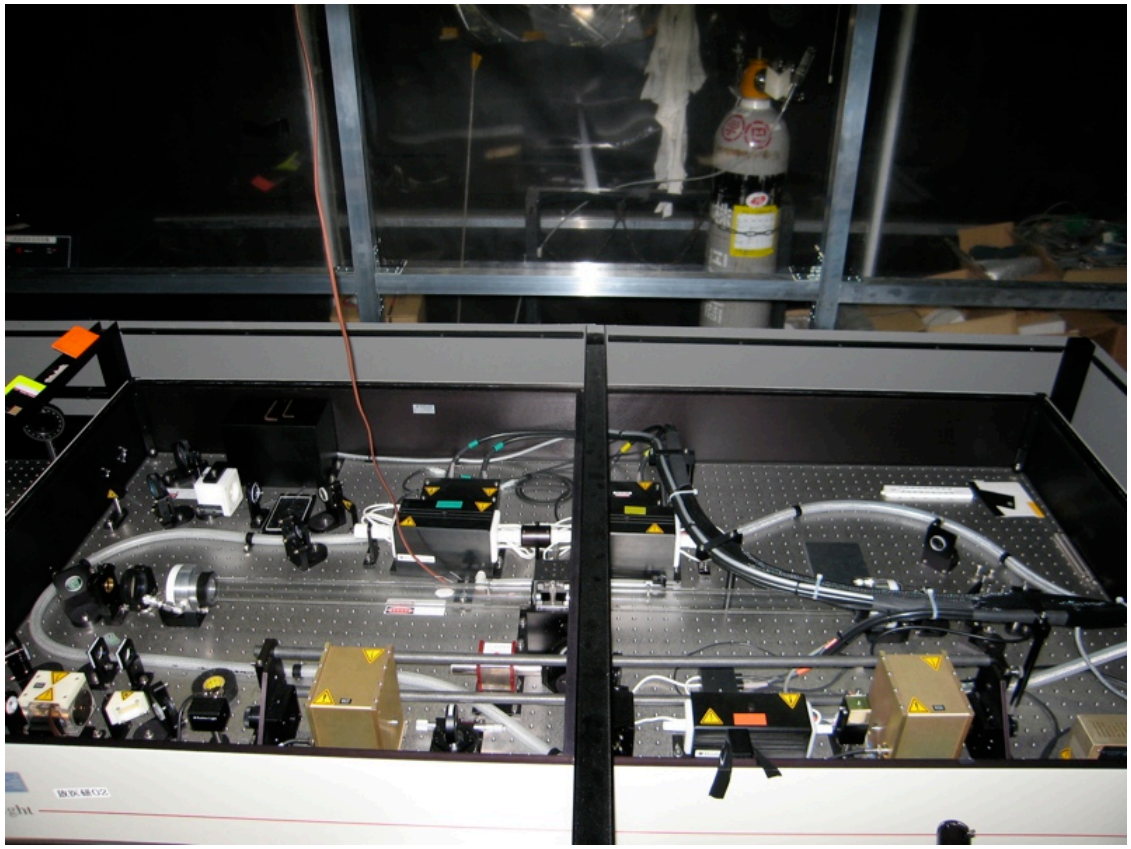
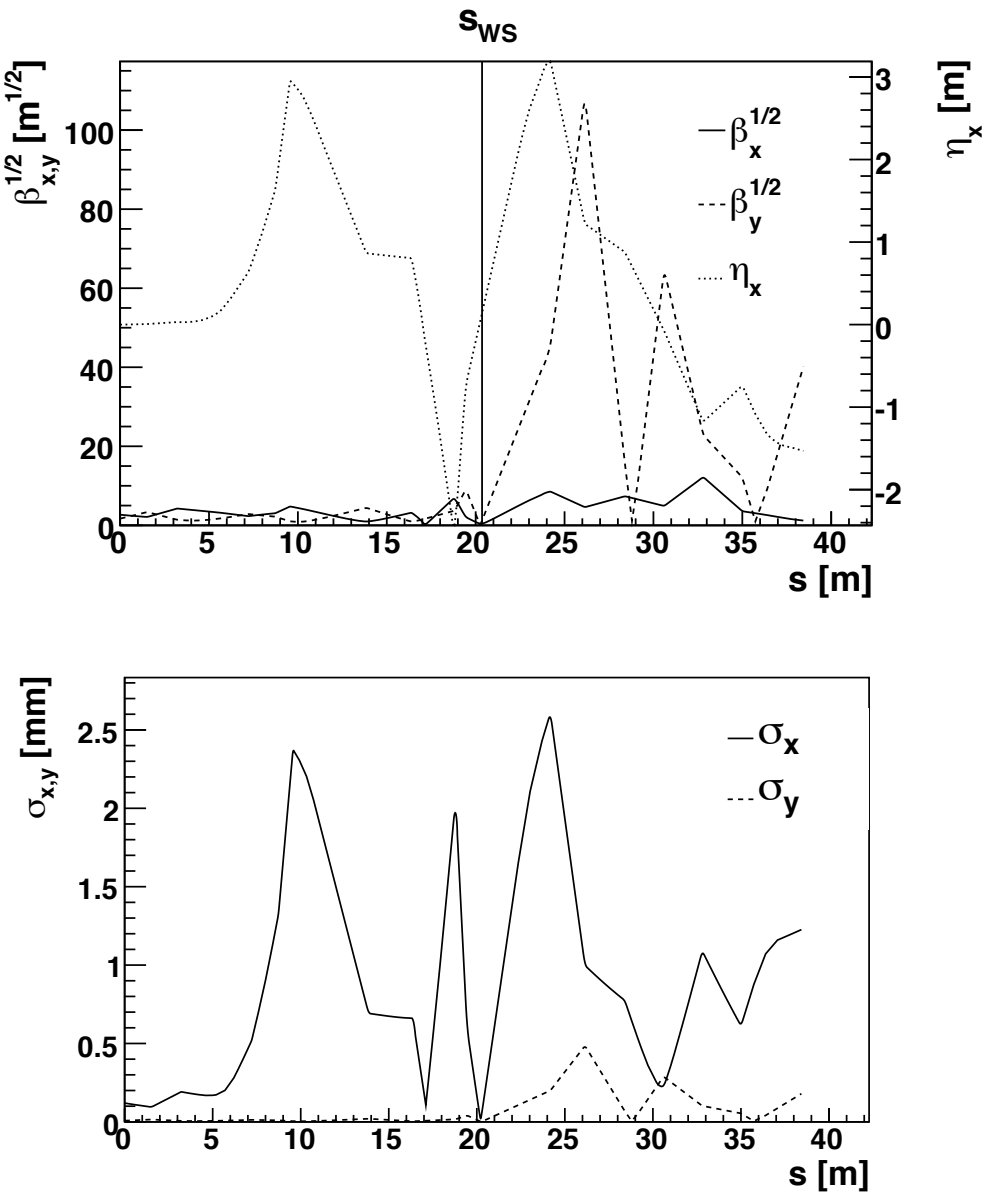
Laser system

- Mode locked Time Bandwith seed laser, 357 MHz
  - 1.5 nJ, 5 ps pulse
- Regenerative amplifier
  - 12 mJ, 150 ps pulse
- Linear two stage amplifier
  - 250 mJ (1.5 GW)



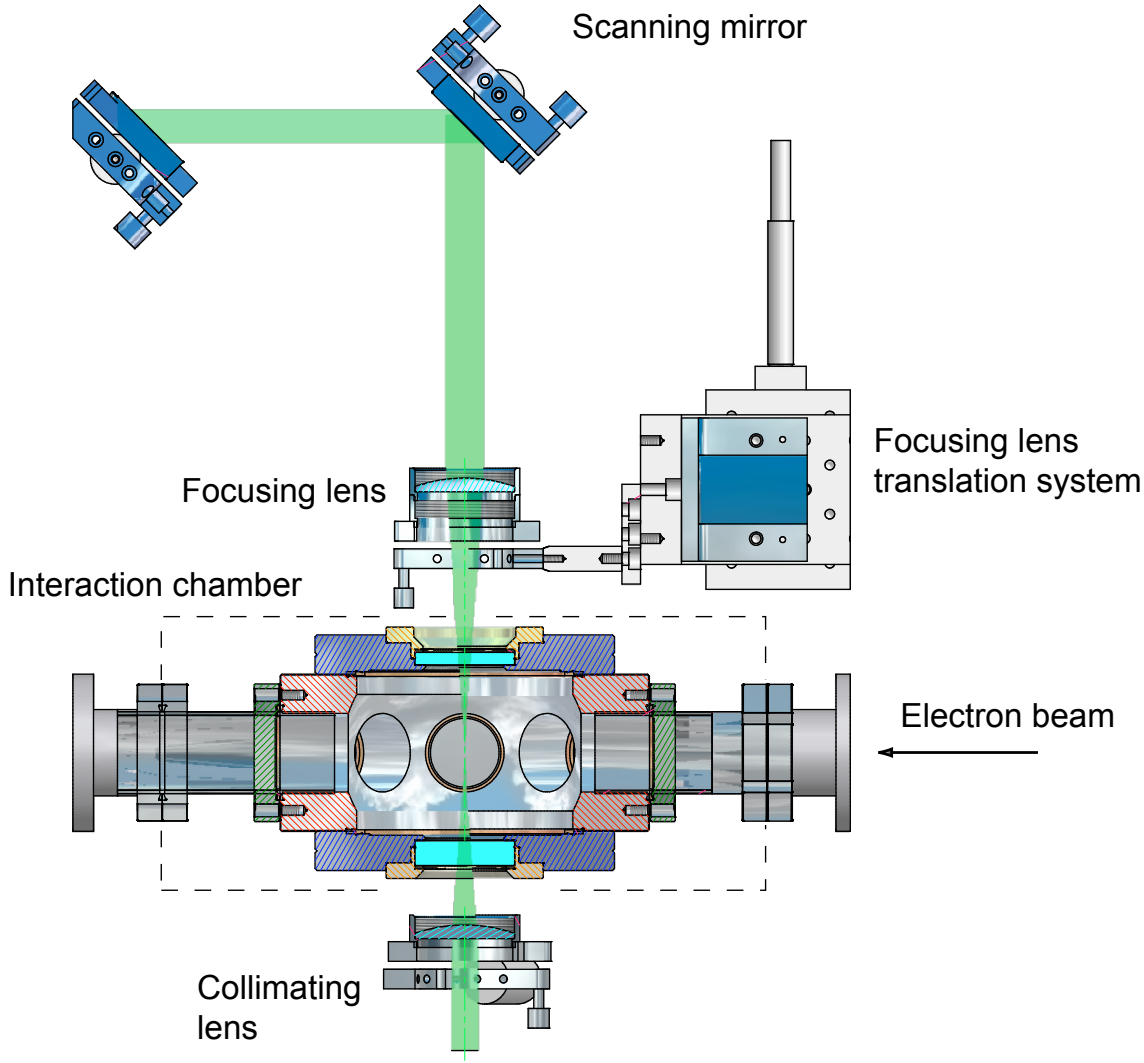
ATF configuration

- Special optics to generate 20x1 micron wait at laserwire location (confirmed with wire scanner)
  - Previous studies not sensitive to 20x1 micron focus
  - New 10x1 laser-wire will resolve problems with ATF LW optics

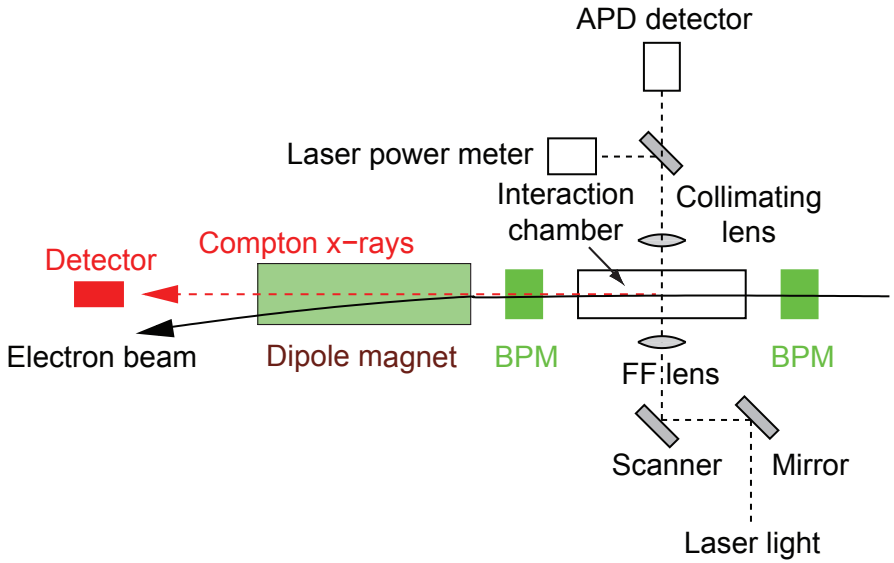


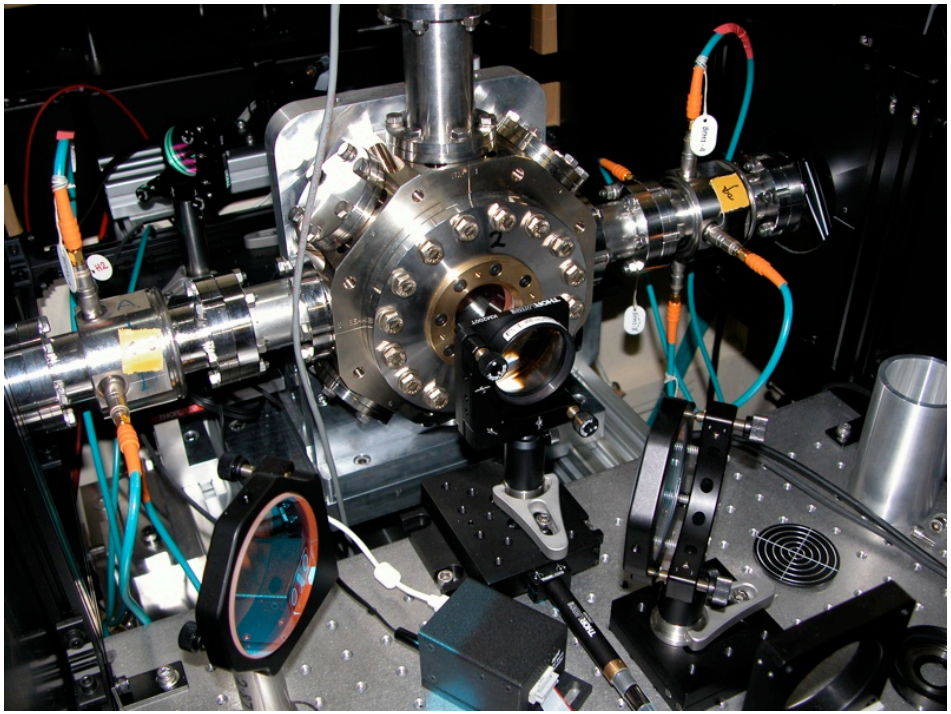
Current laser-wire system

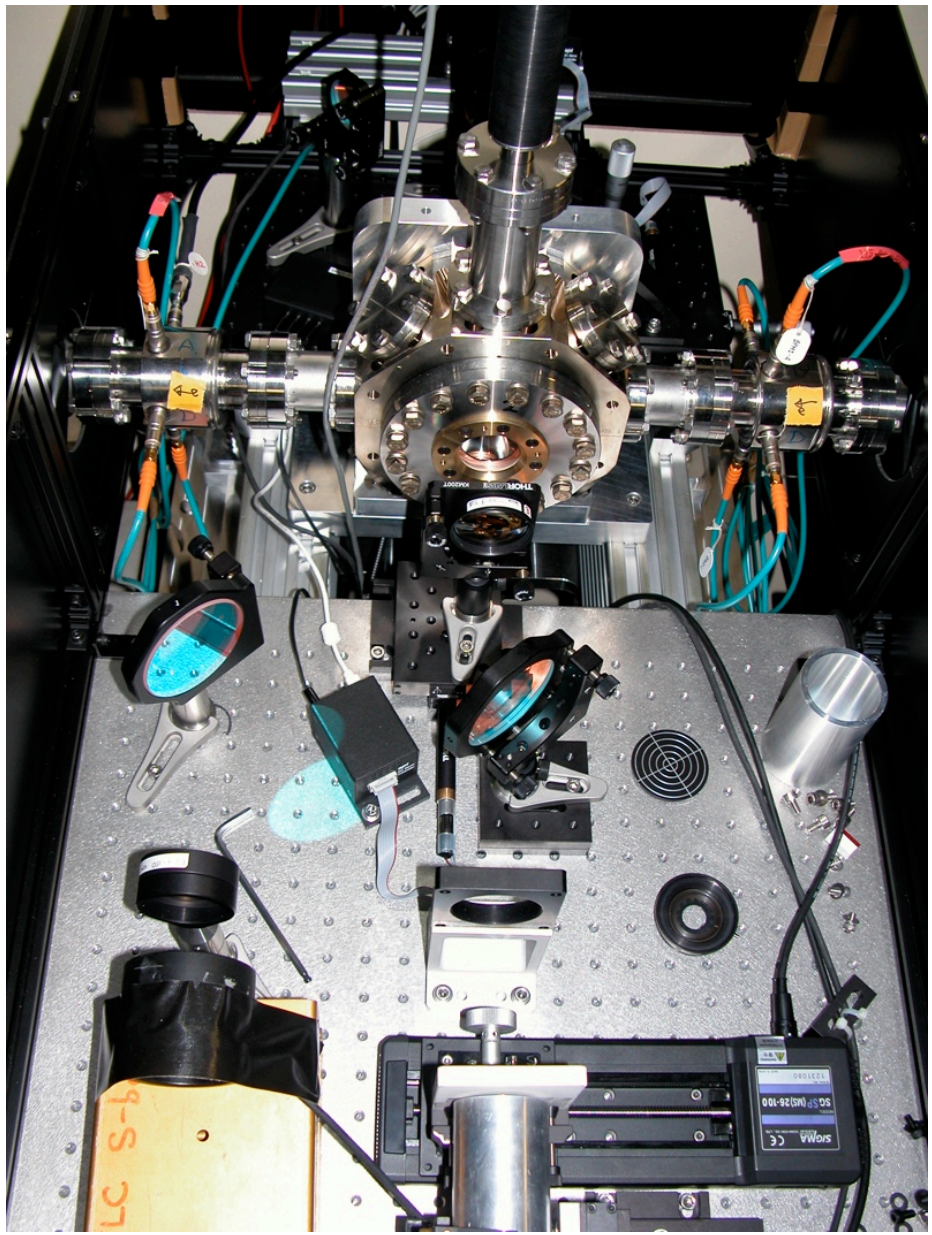
- Commercial plano-convex lens
  - Motorised translation system
- Scanning by standard mirror mount
  - Motorised angle control



Current laser-wire system

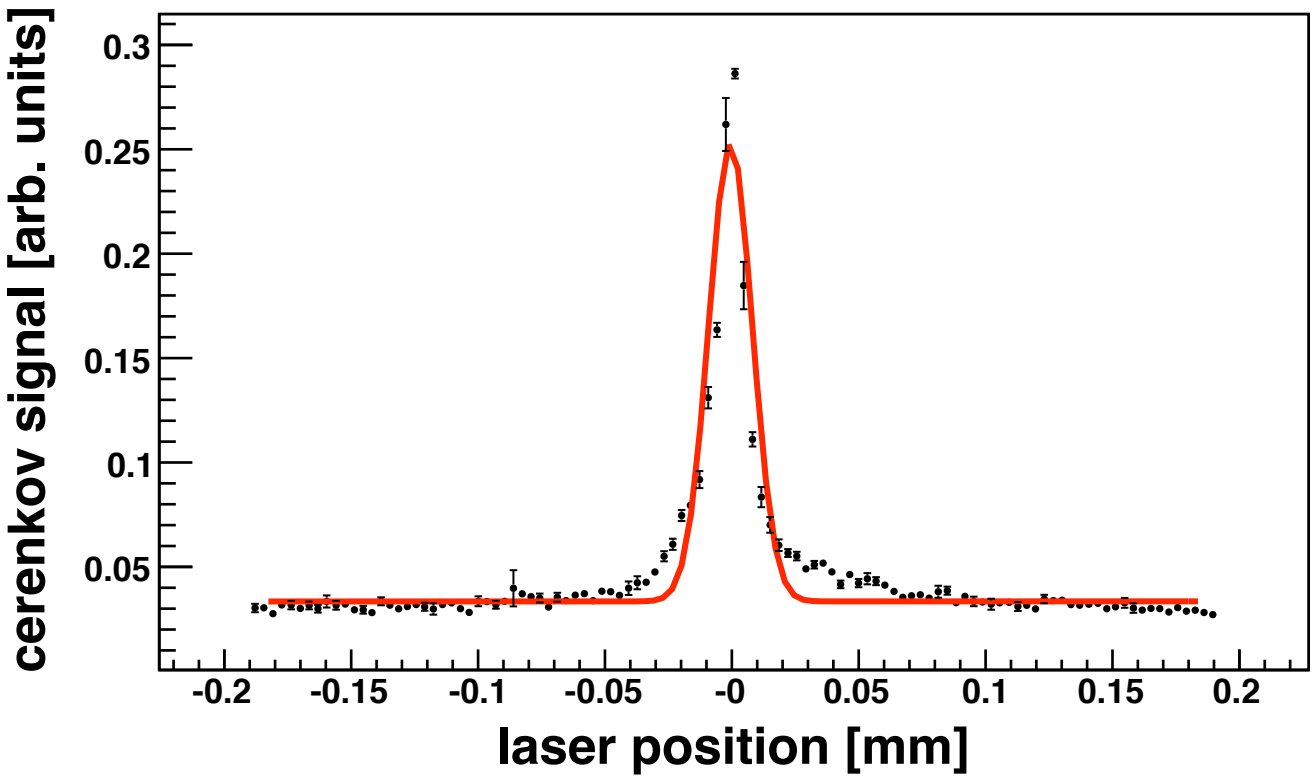






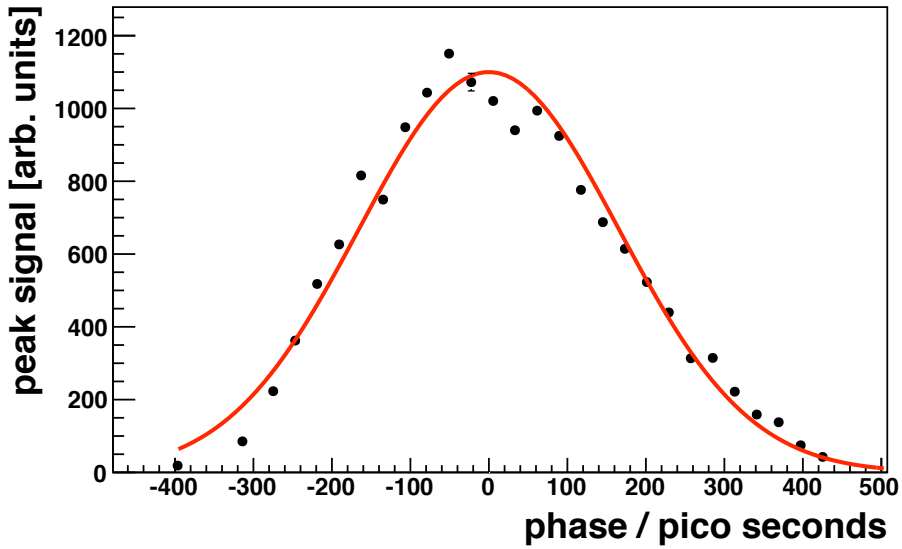
Laser-wire results 2006/7

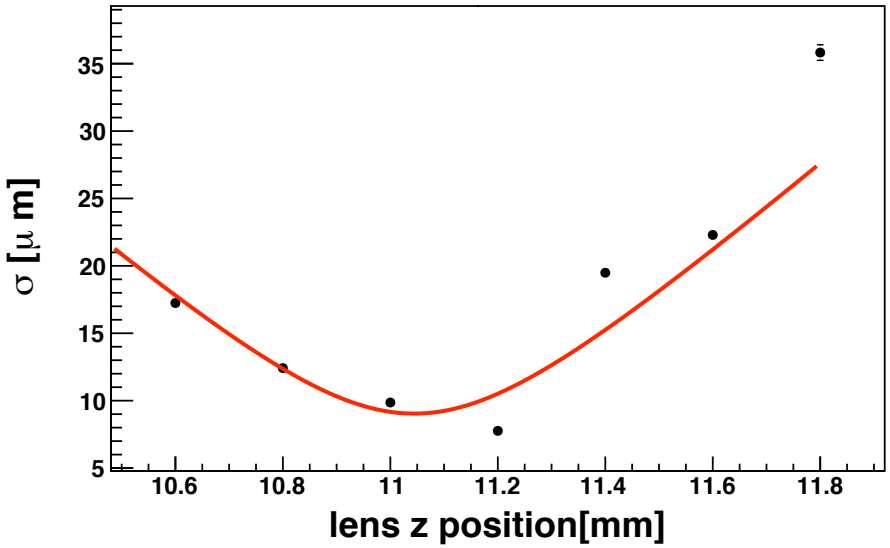
- Example laser-wire scan
  - Clear non-gaussian component
    - Coma
    - Spherical aberrations



Collision tuning

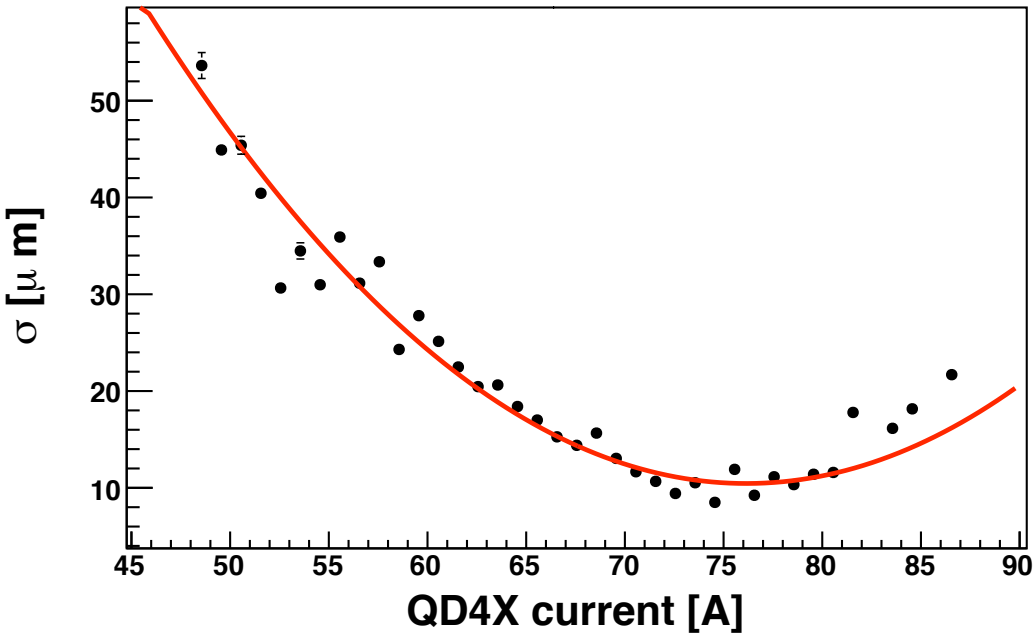
- Once collisions are found
  - Vary phase of mode lock laser, 357 MHz
    - Signal width ~160 ps, consistent with knowledge of laser
  - Tune focus horizontal position





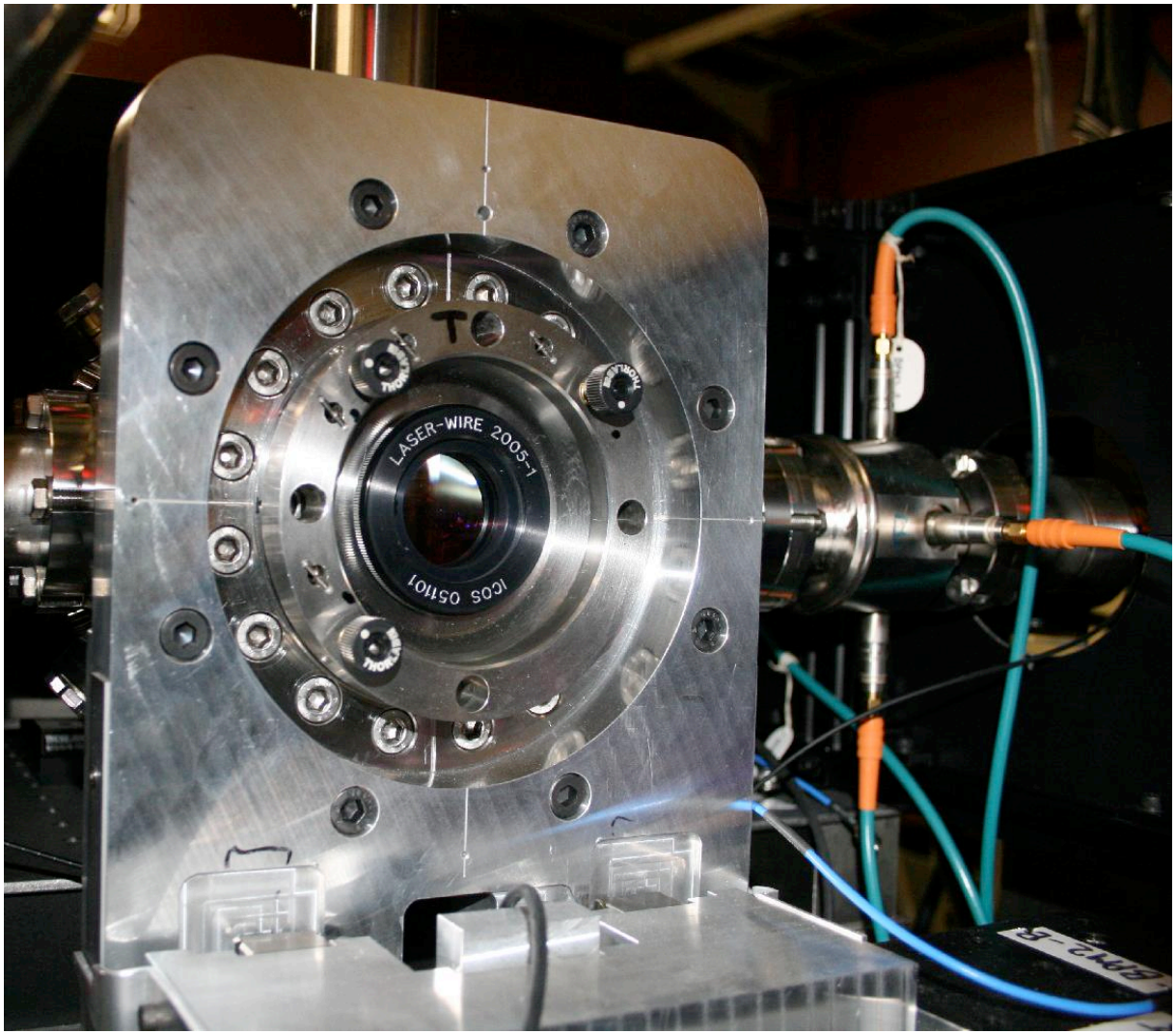
Final results

- Finally quad scan
  - Vary beam size at LW interaction point by varying strength of QD4X
- Clear beam size variation measurement between ~60 and 8 micron
  - Lower limit from laser and spherical aberrations
  - Upper limit signal to noise



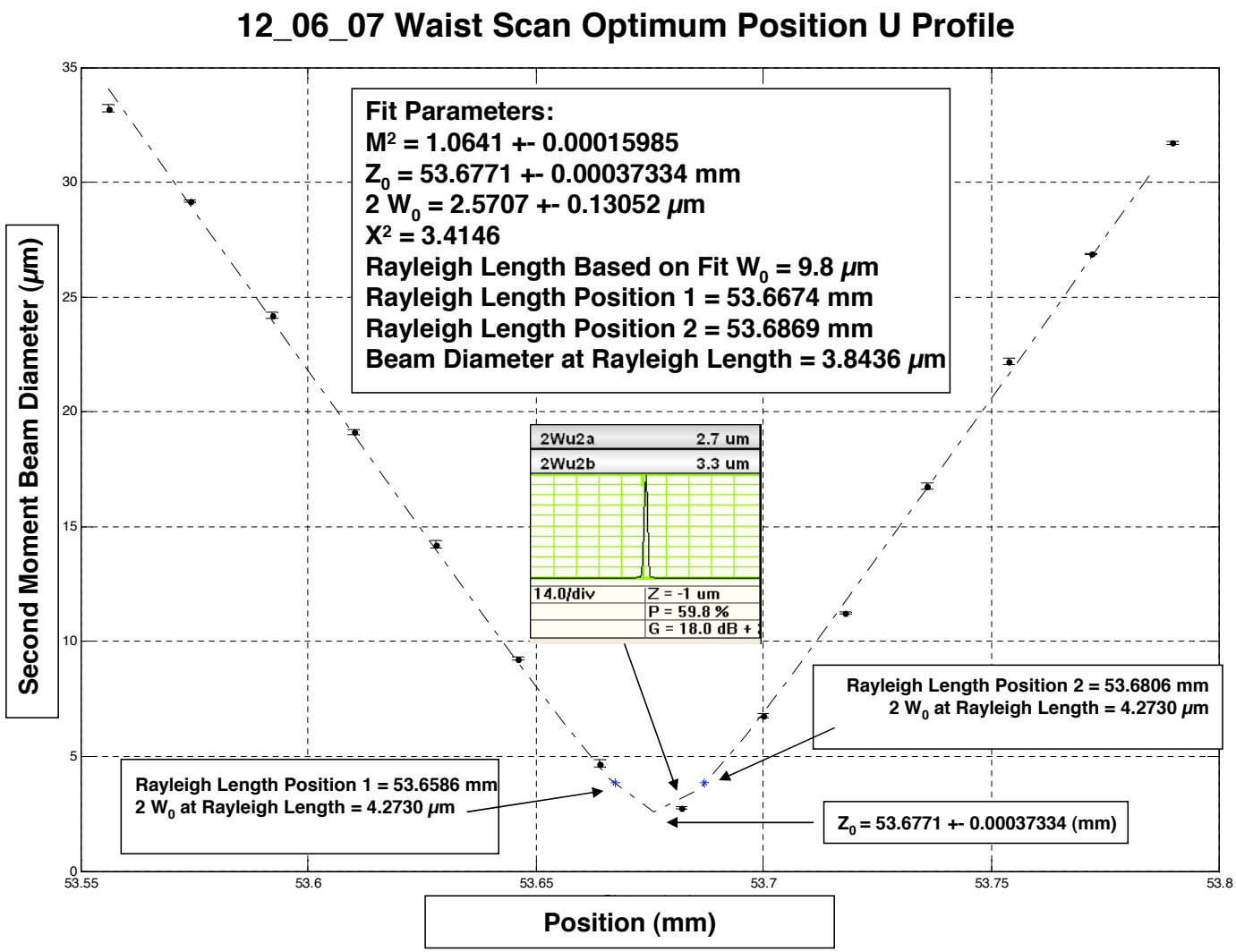
Modified F/2 laserwire

- Two element optic (1 spheric and 1 aspheric)
- Vacuum window (optical flat)
- Lens rigidly fixed to chamber
- Chamber can move in 2 axes
- Focus position fixed with respect to chamber

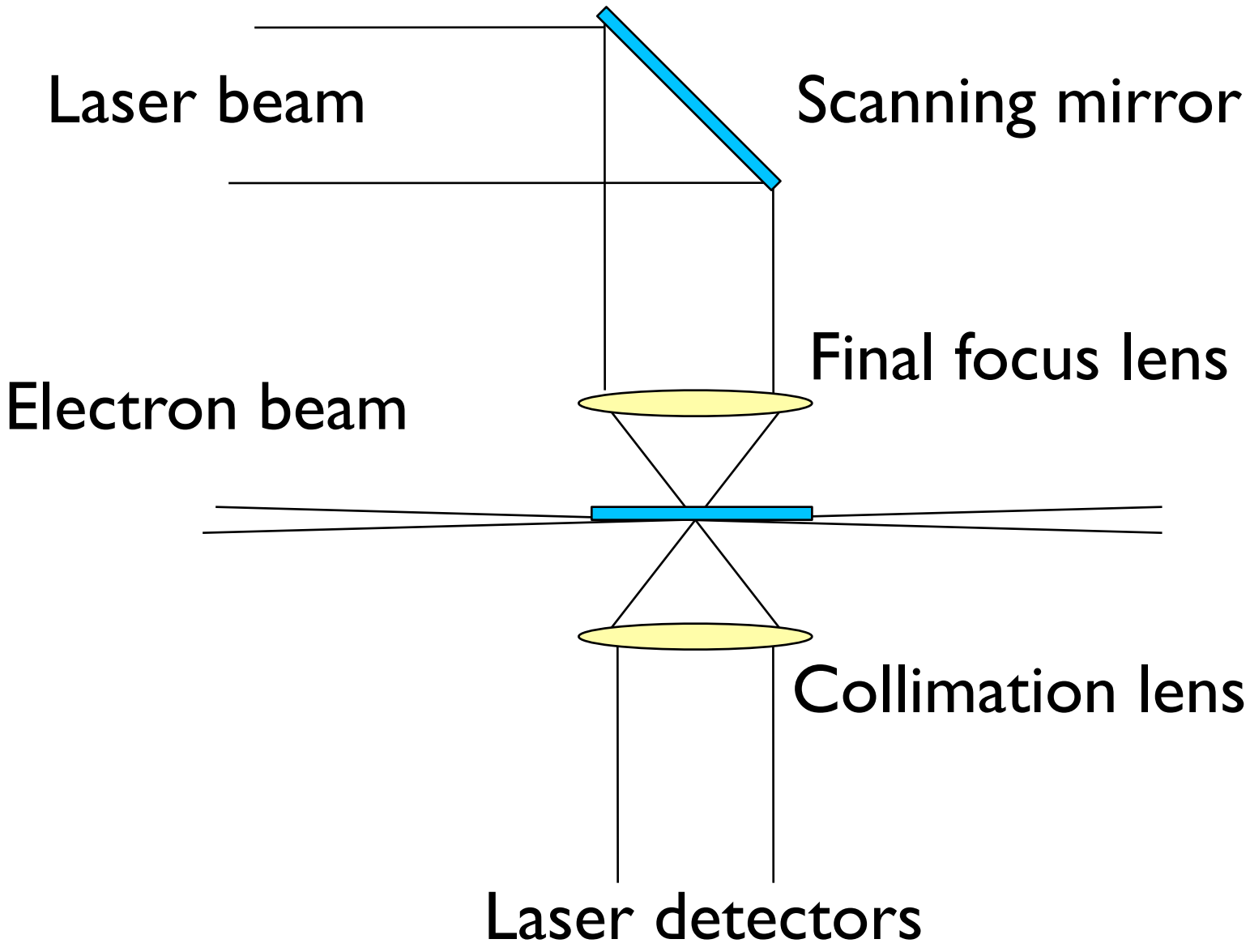


F/2 lens results

- Lens measurements in the lab in Oxford
  - Rotating slit/knife edge profiler



Overlap strategy



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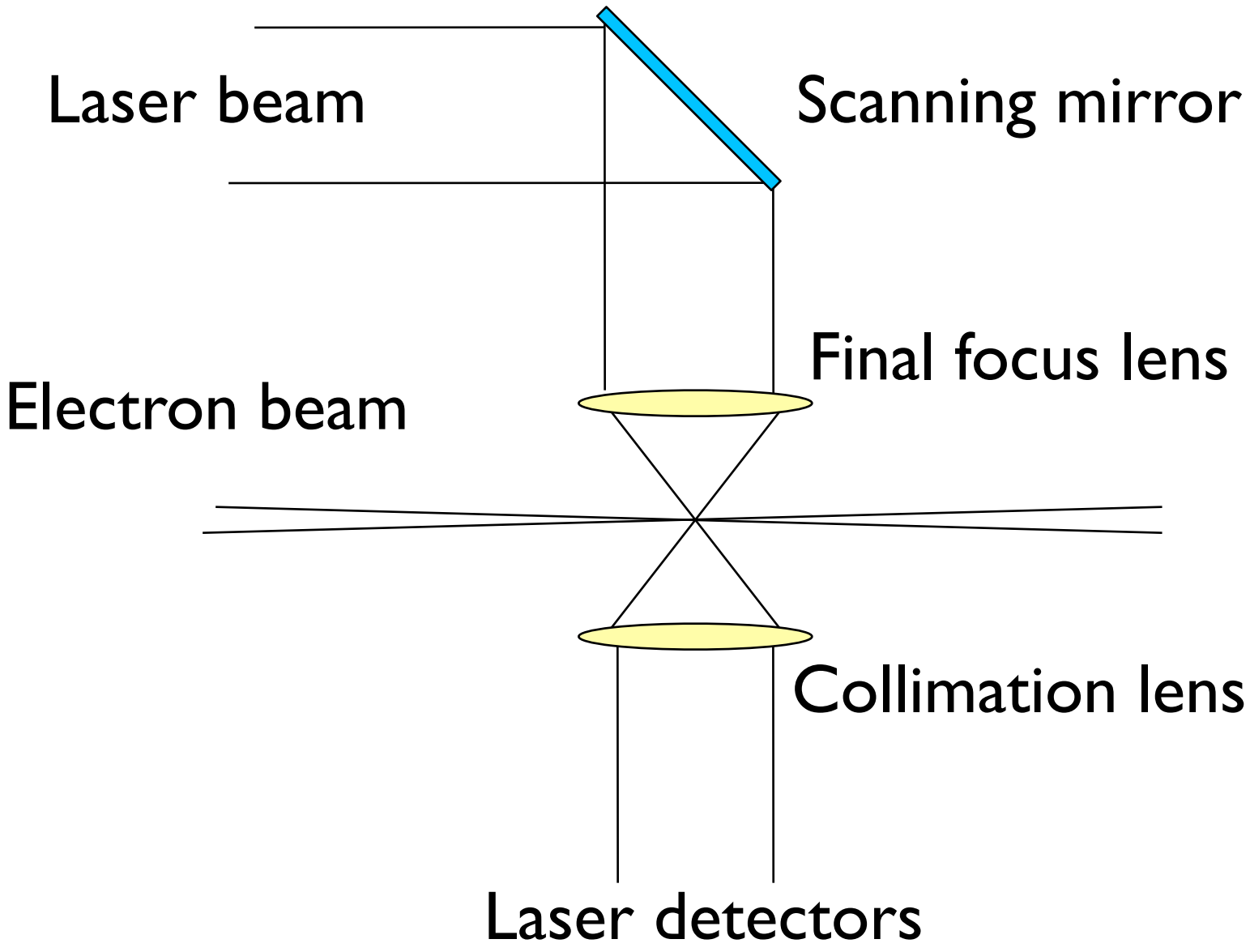

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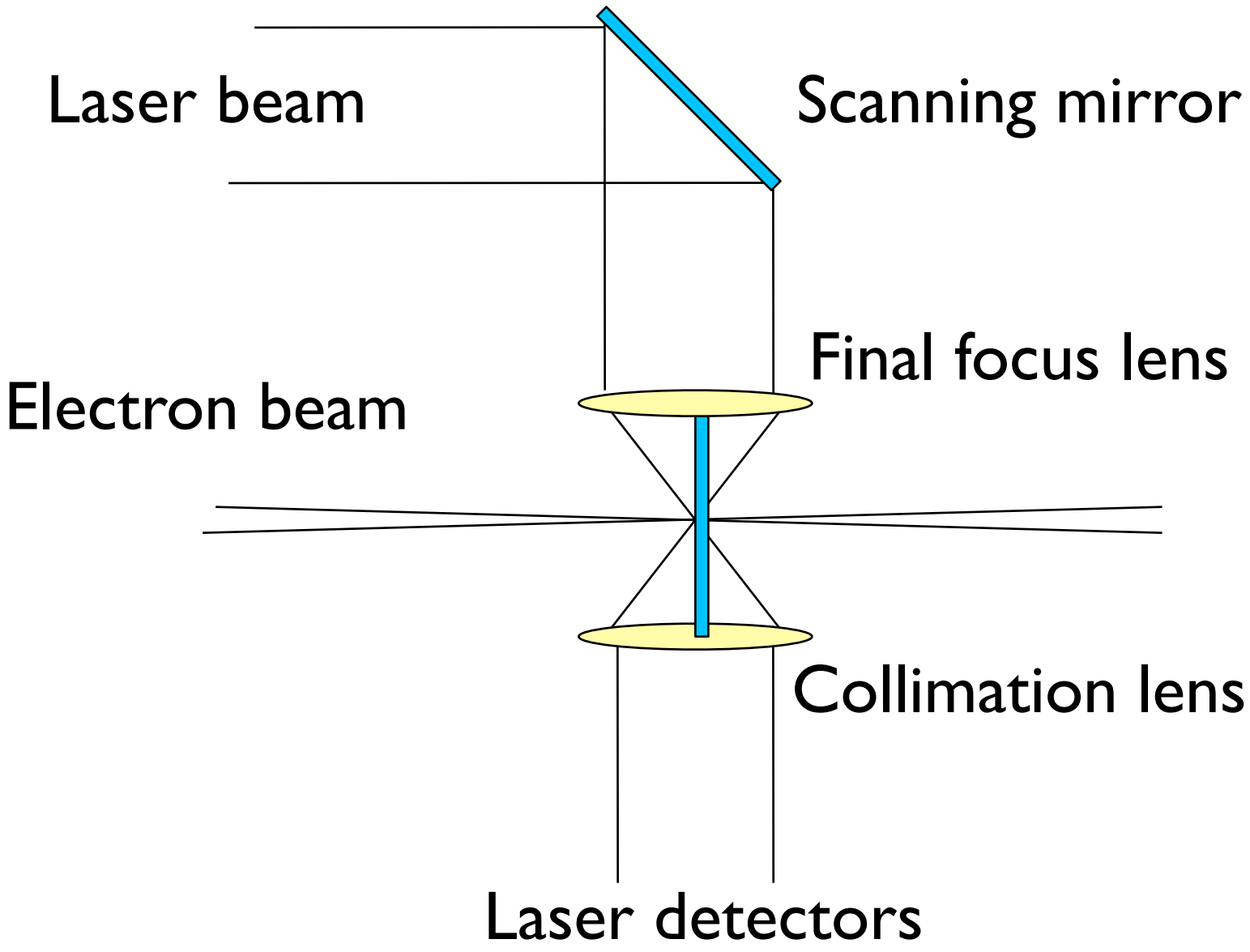

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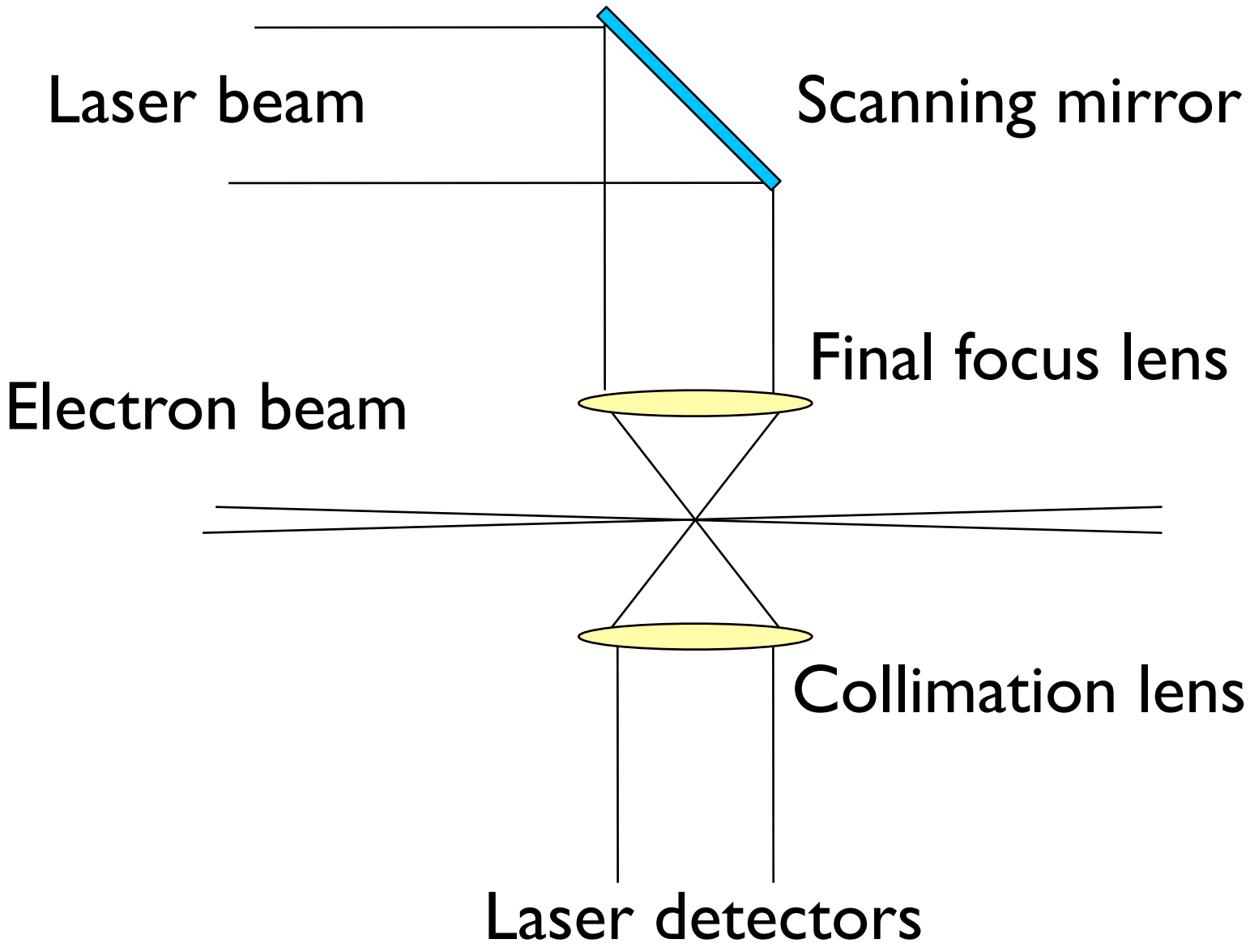

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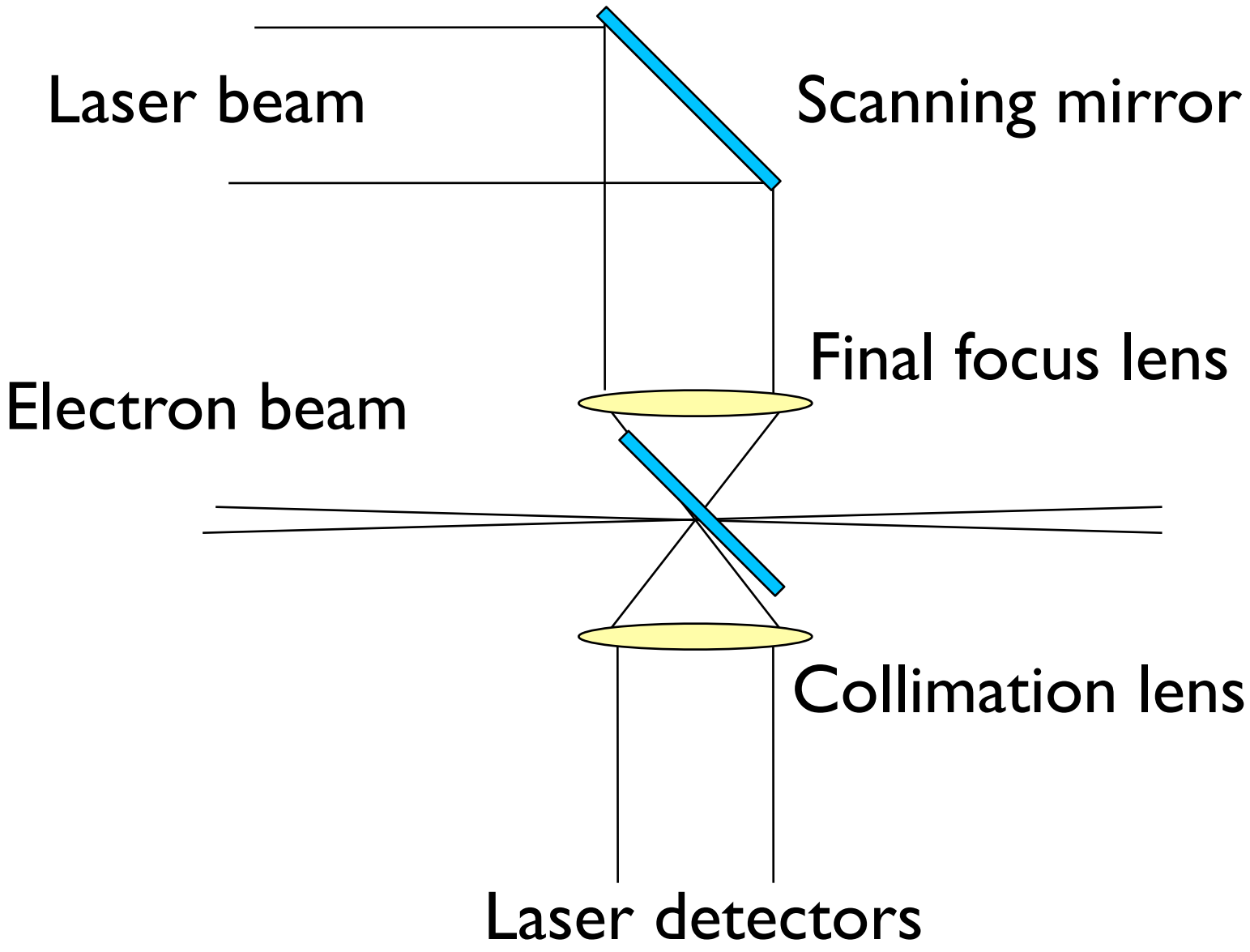

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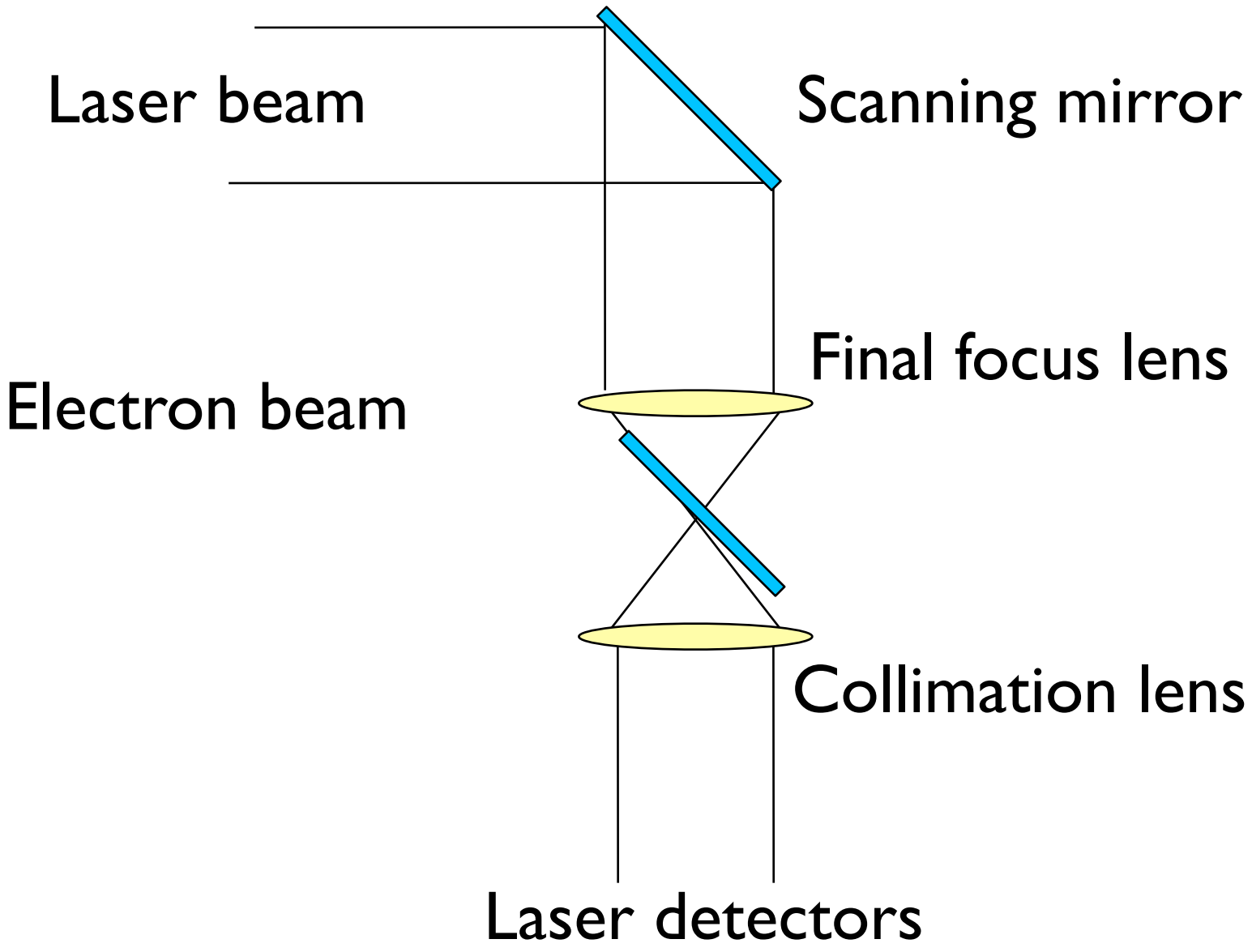

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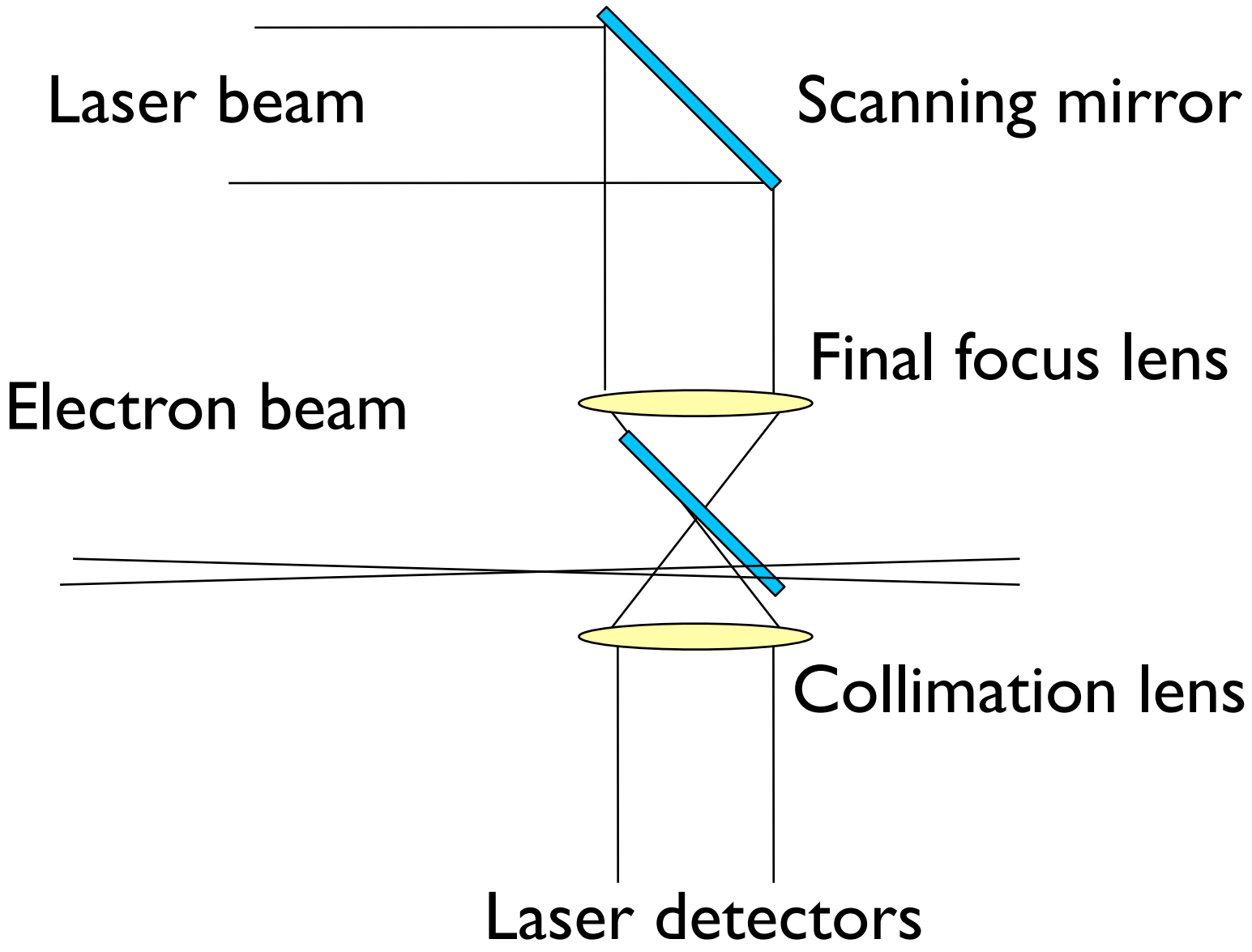

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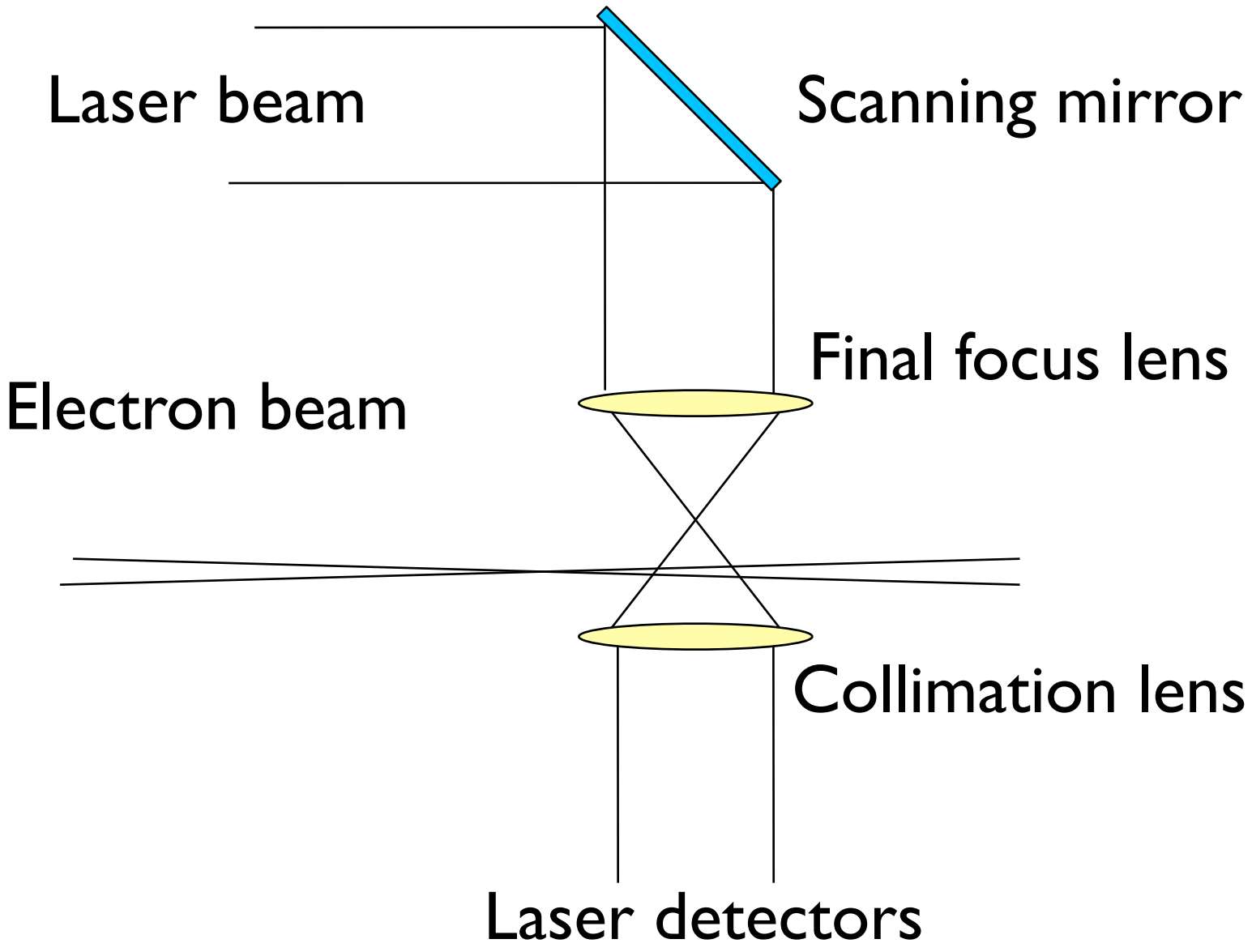

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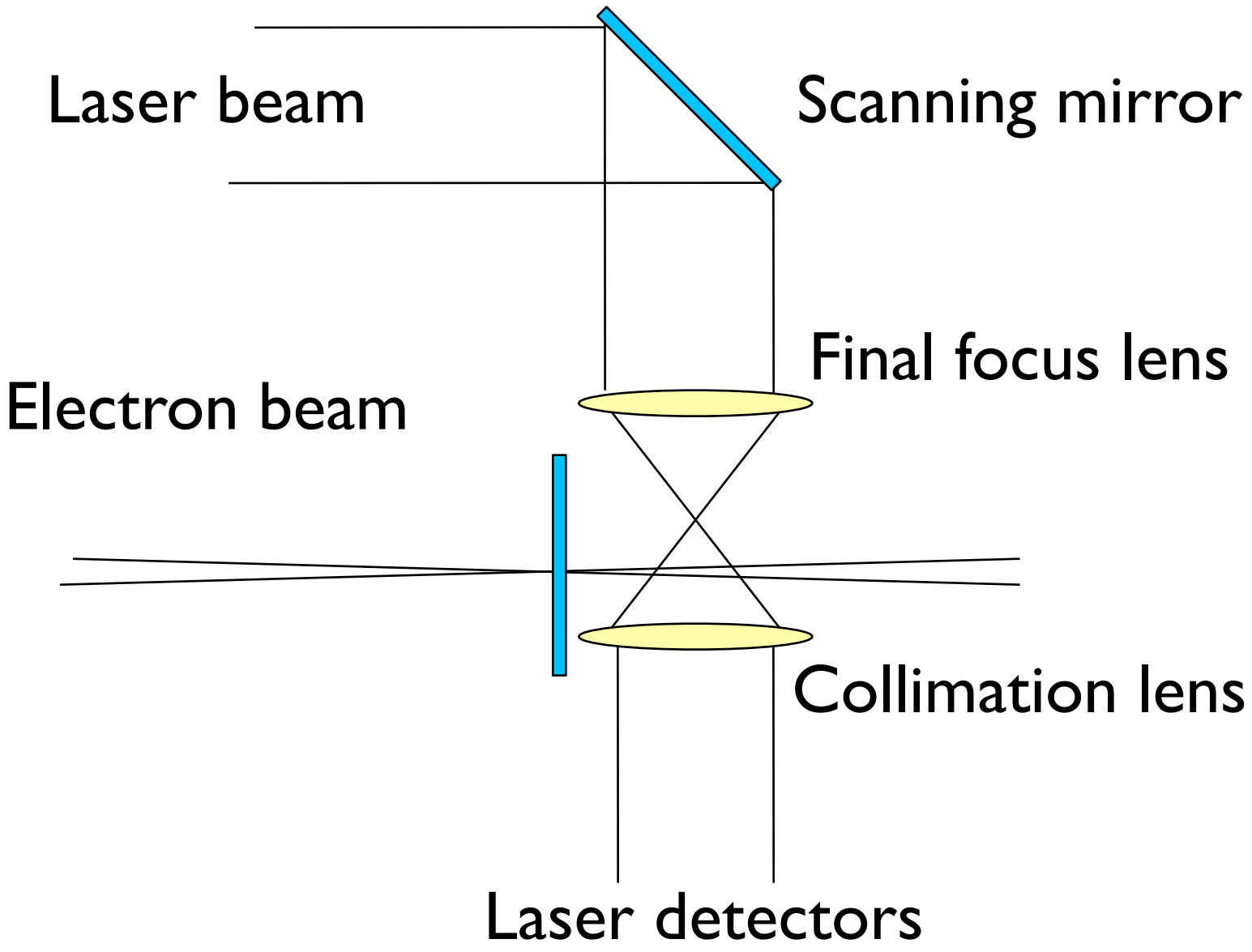

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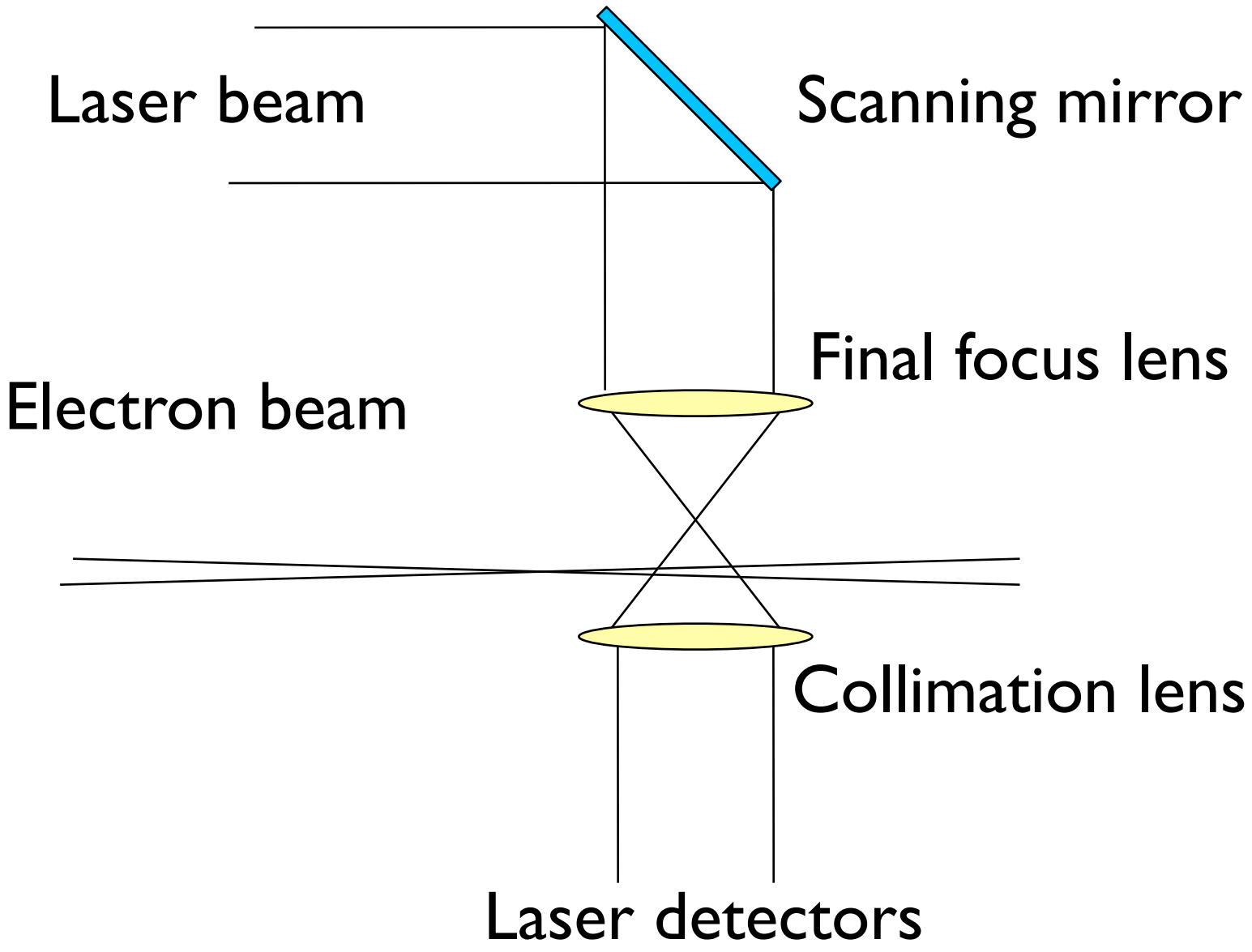

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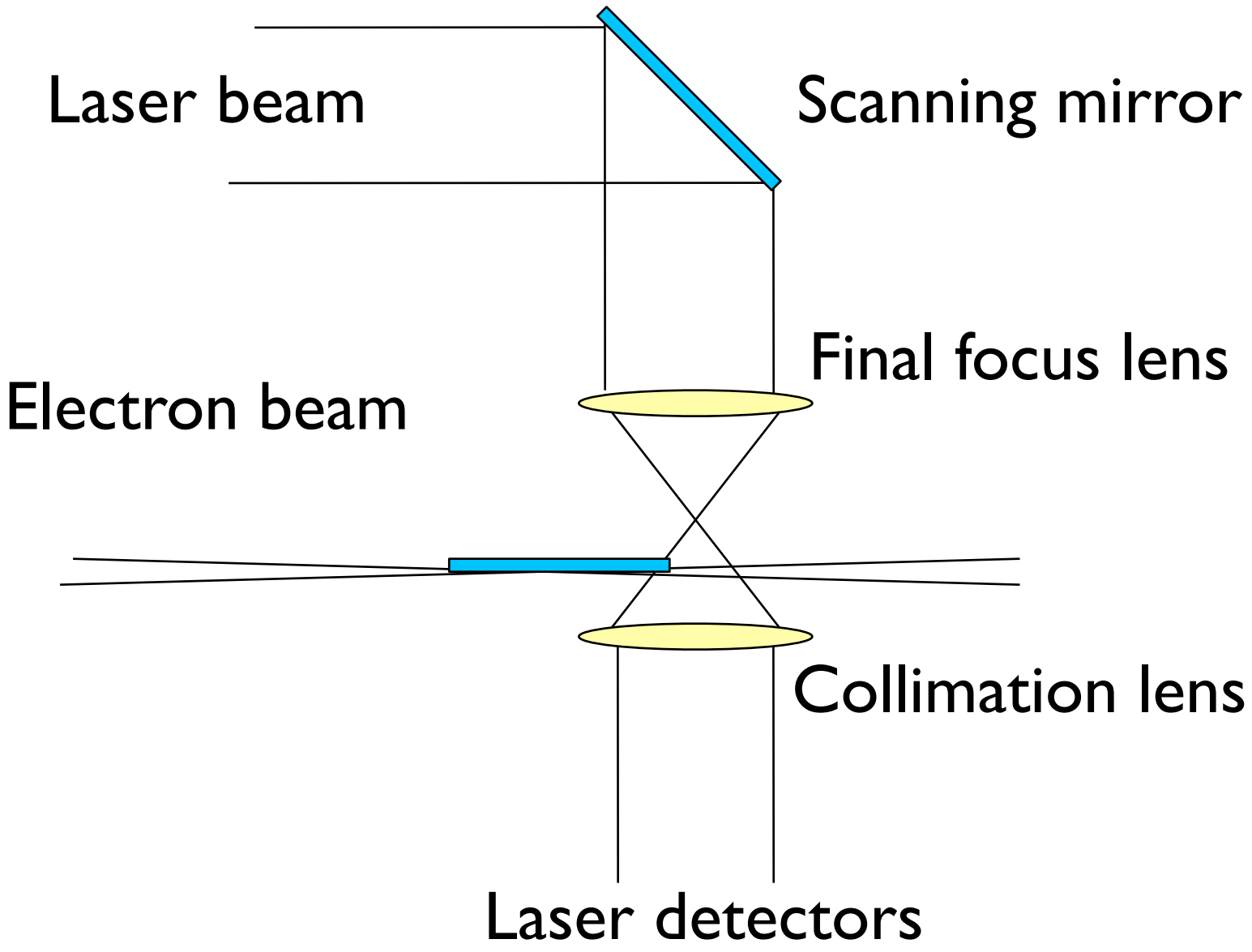

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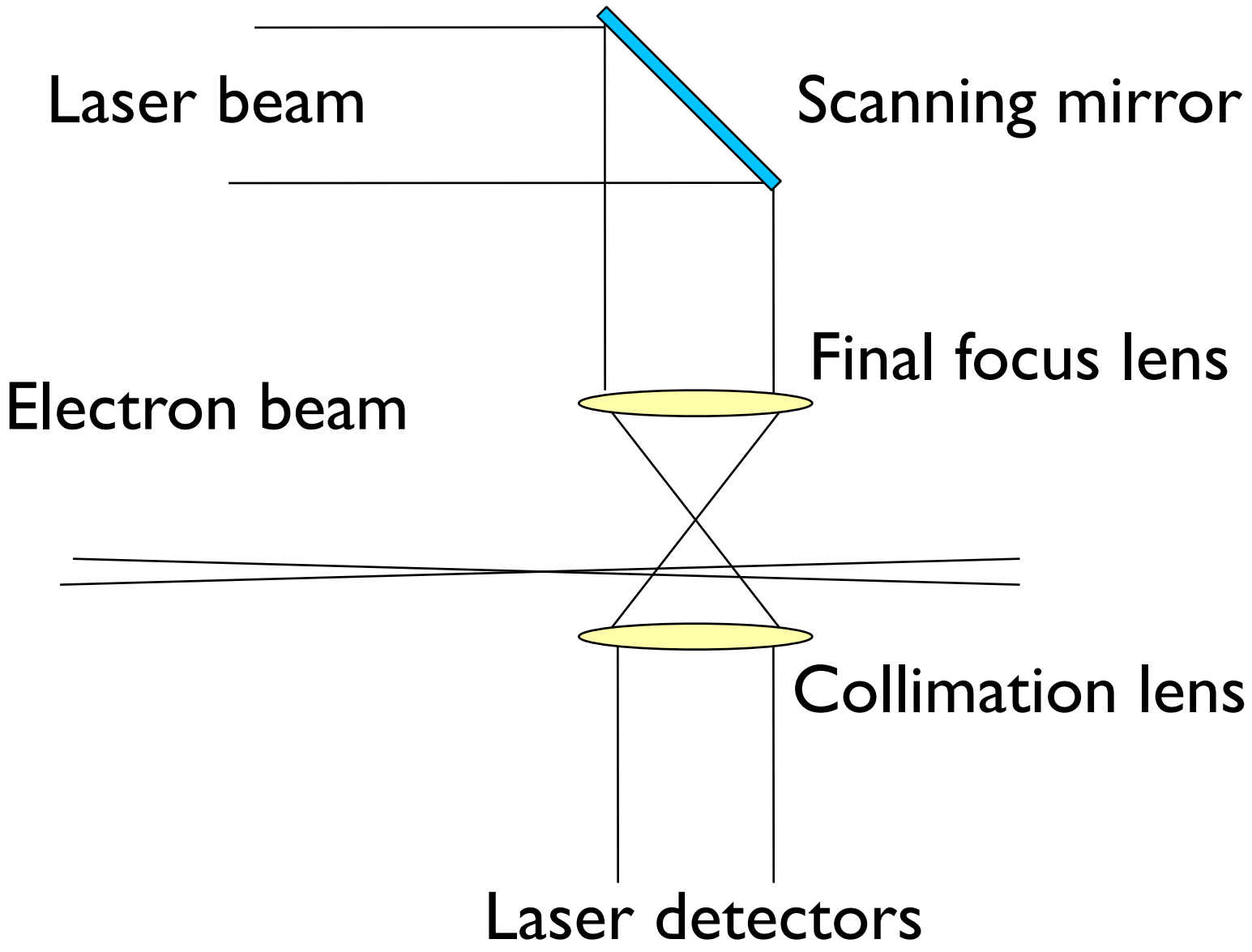

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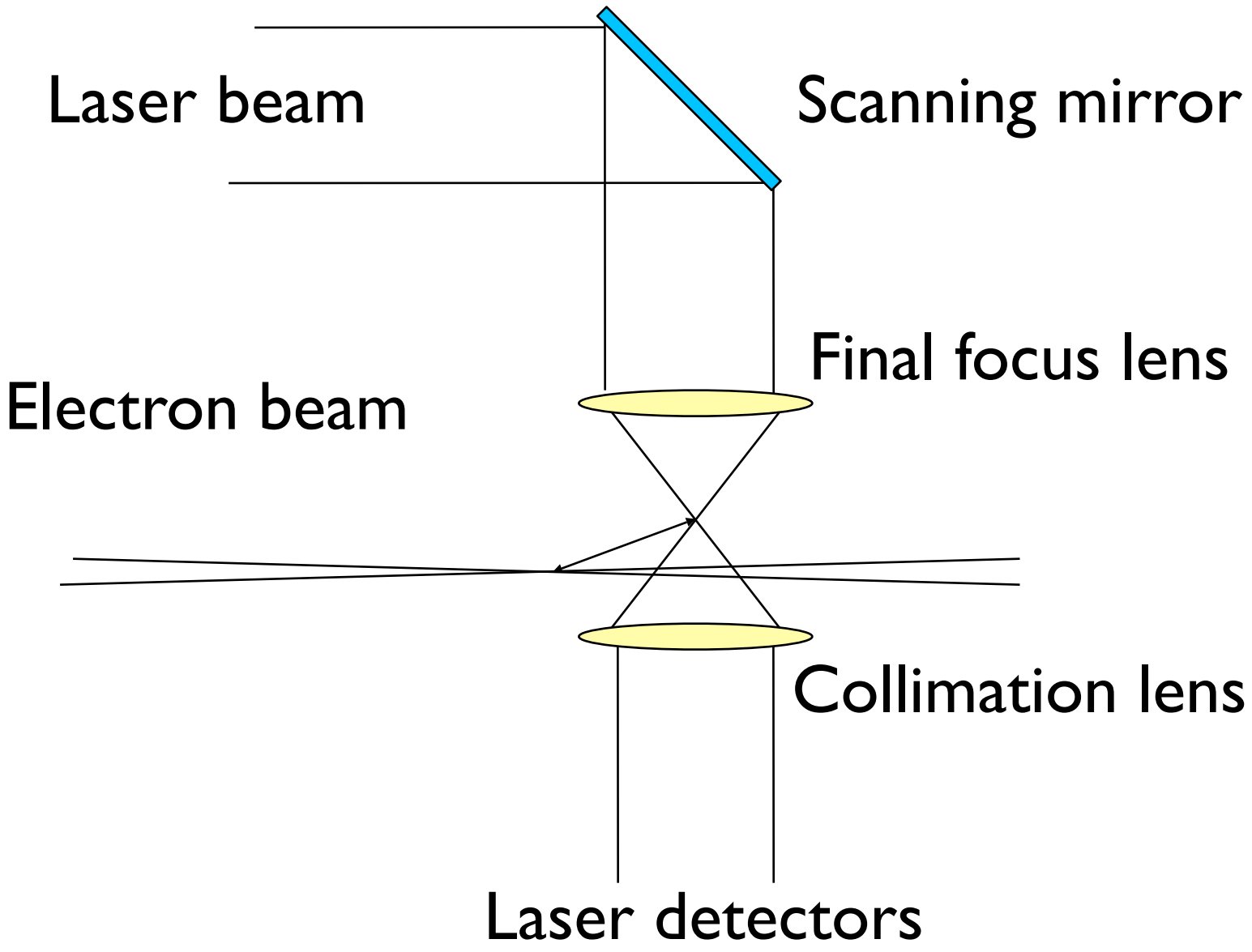

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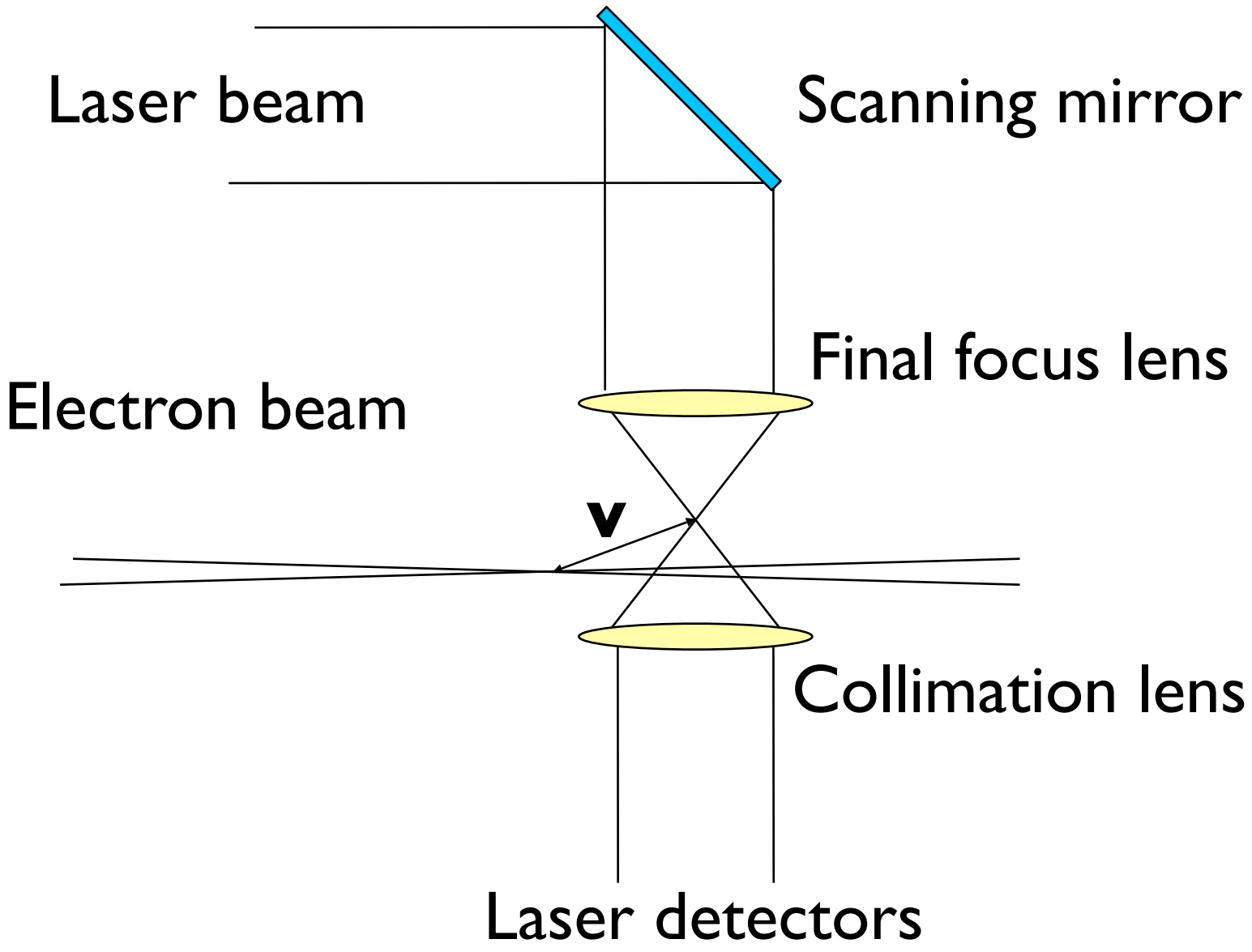

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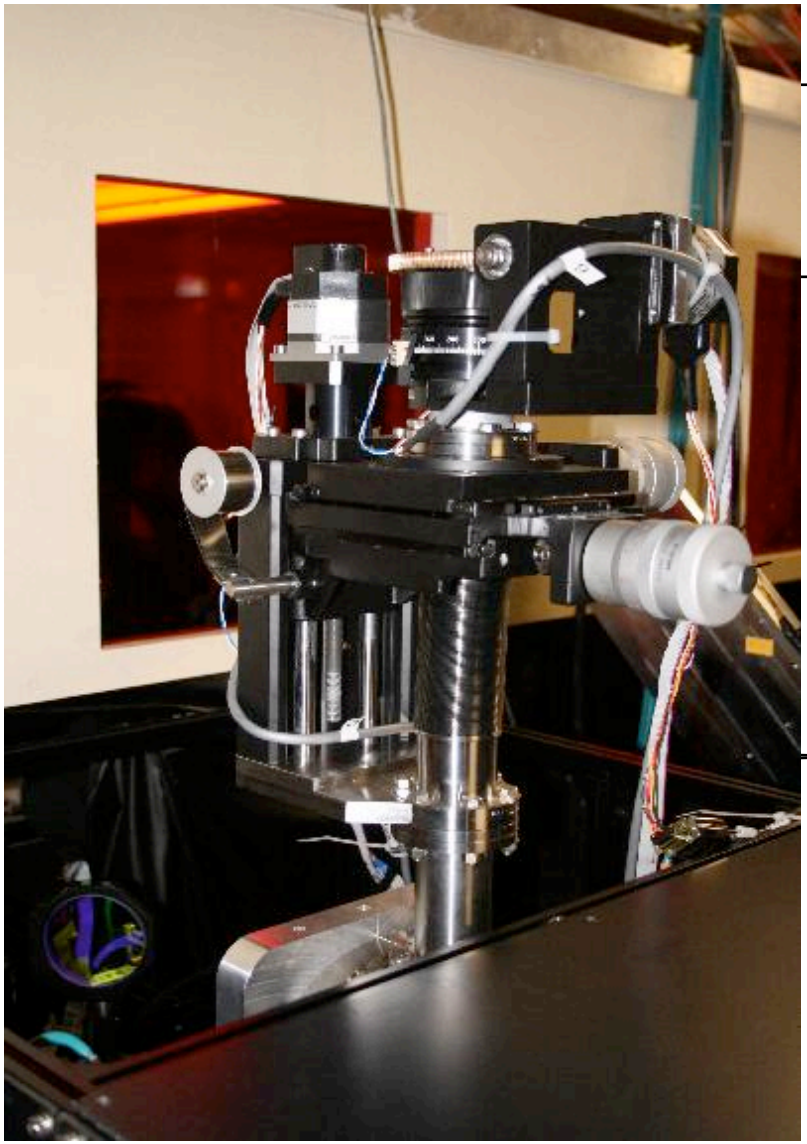
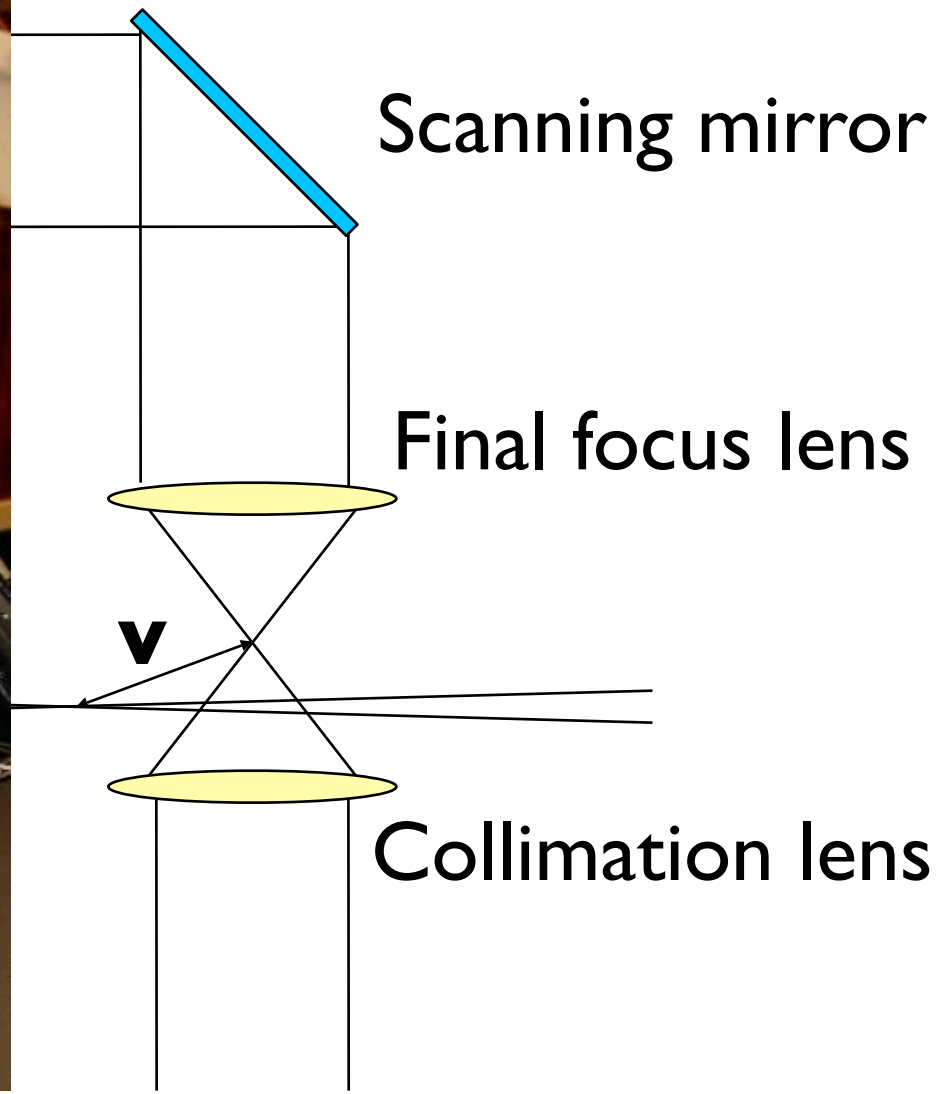
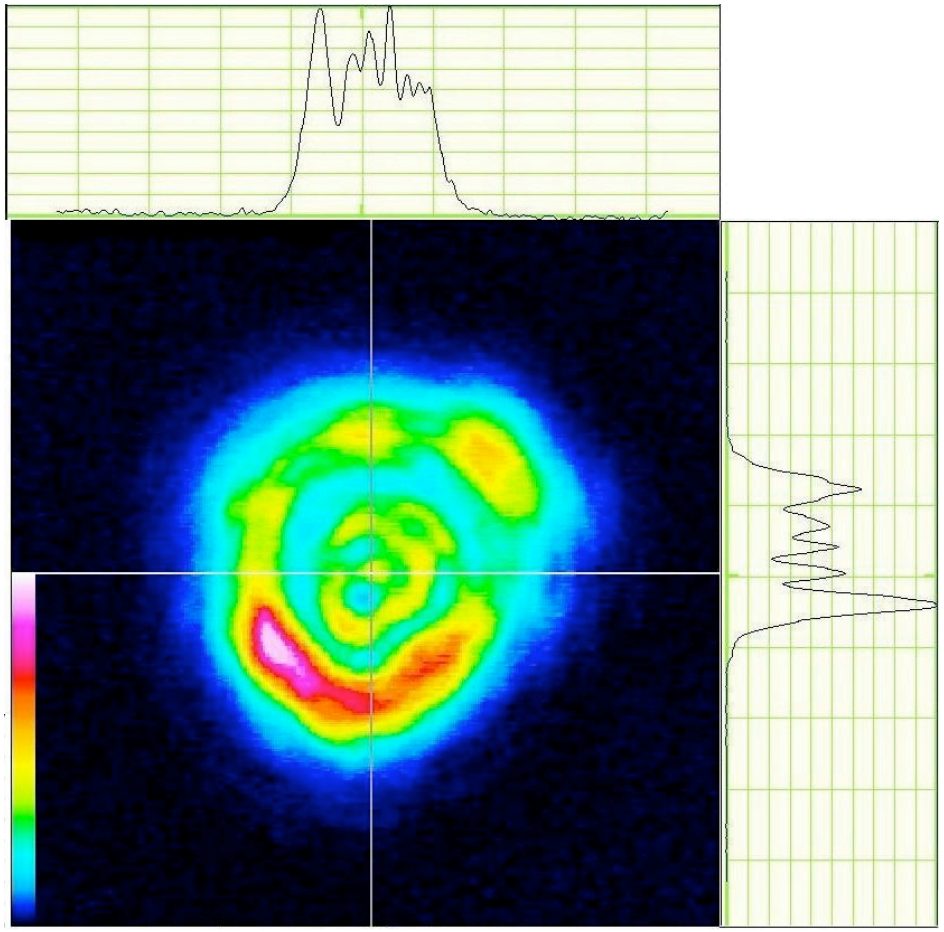


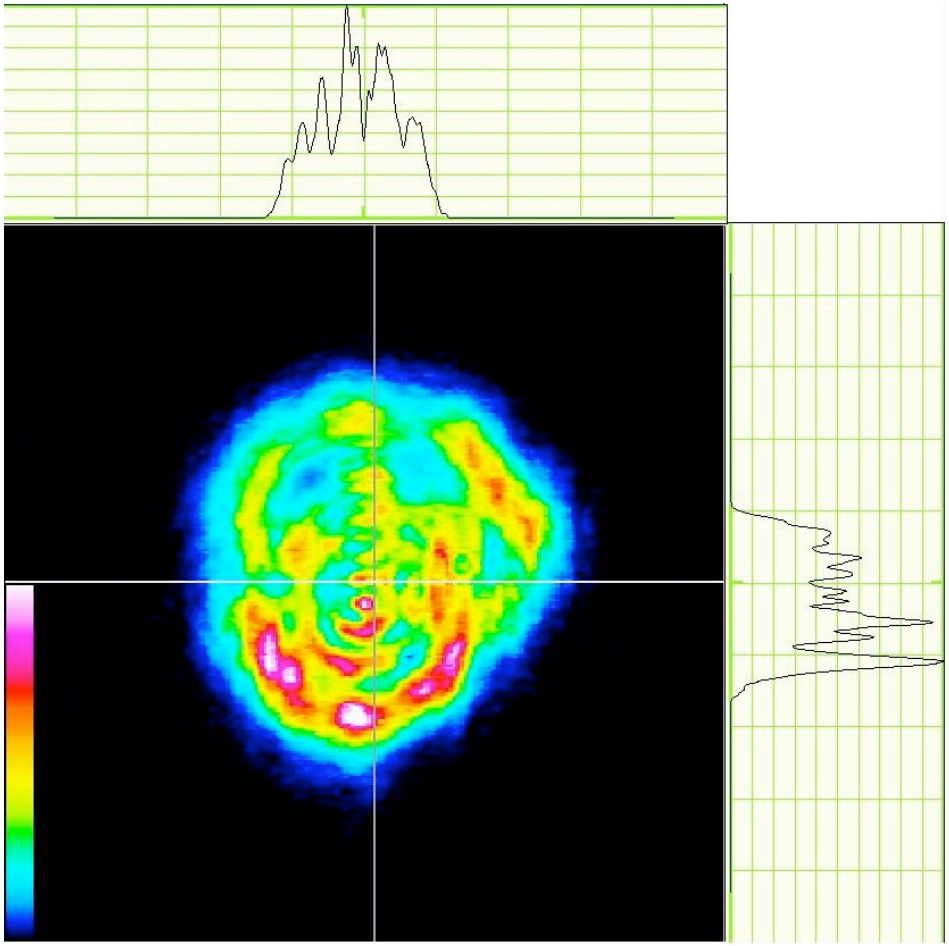


Laser quality

1064 nm profile

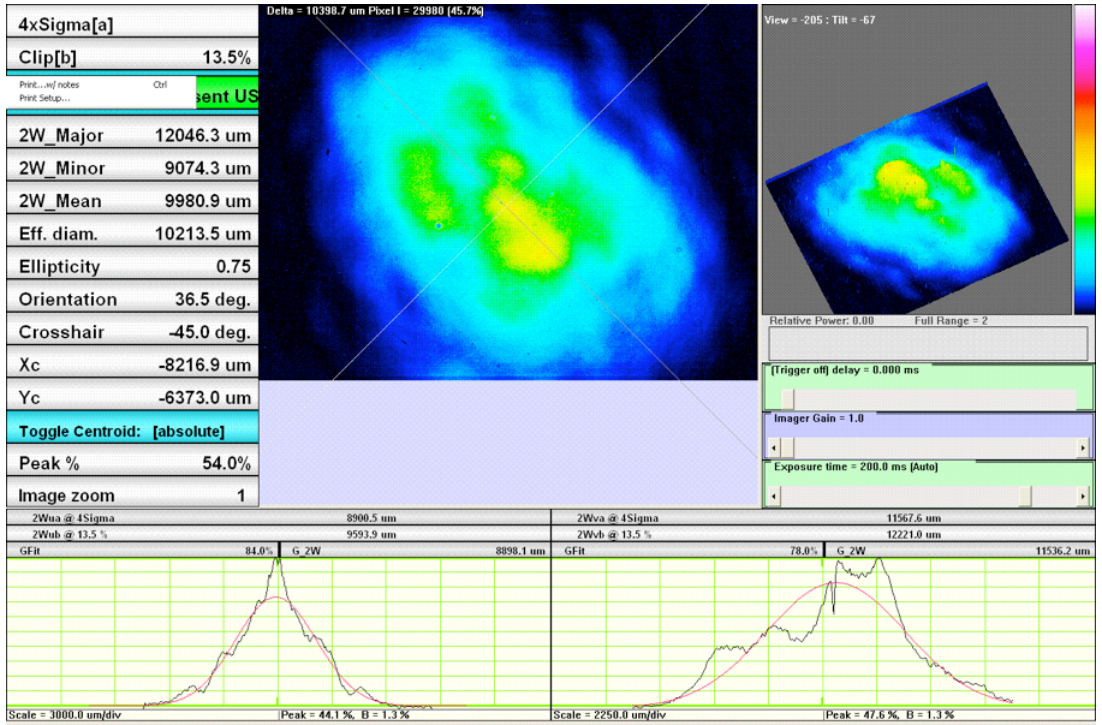


532 nm profile

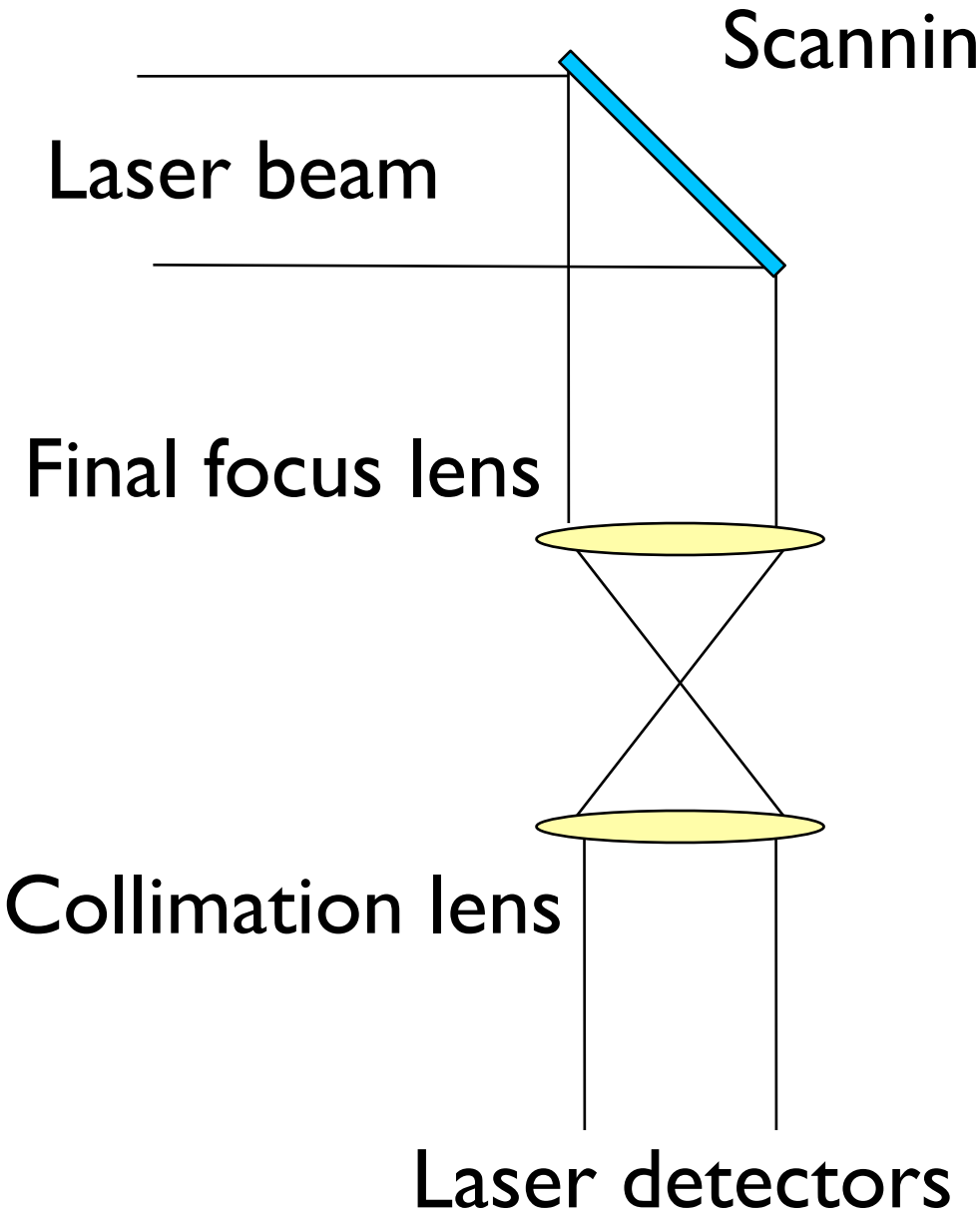


Modified laser results

- Laser was designed for maximum output power
  - Flat top pulse, maximizes pulse energy output
  - Modified light transport in laser to amplify TEM_{00}
  - Beam in tunnel is improved but still far



F/2 Alignment



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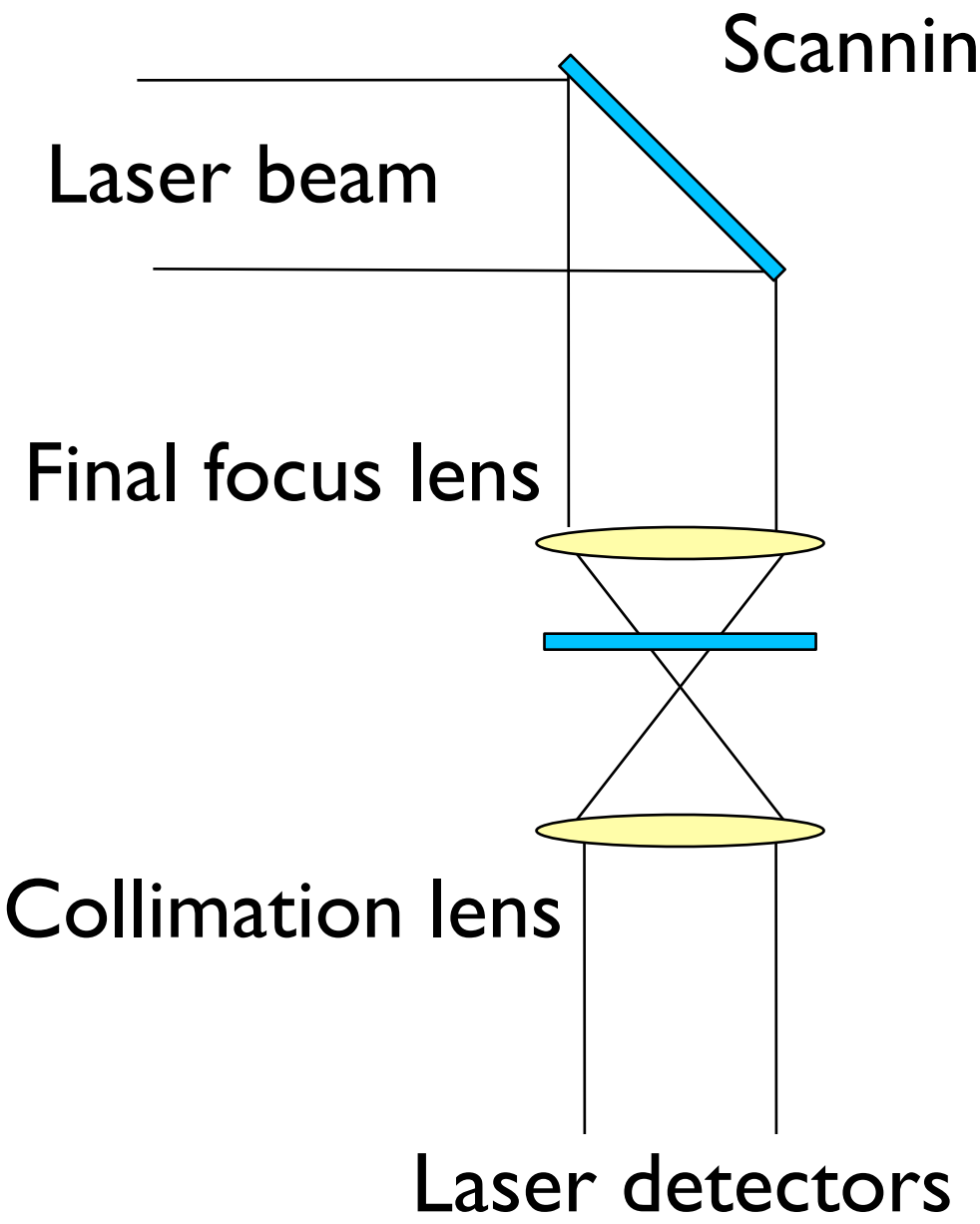

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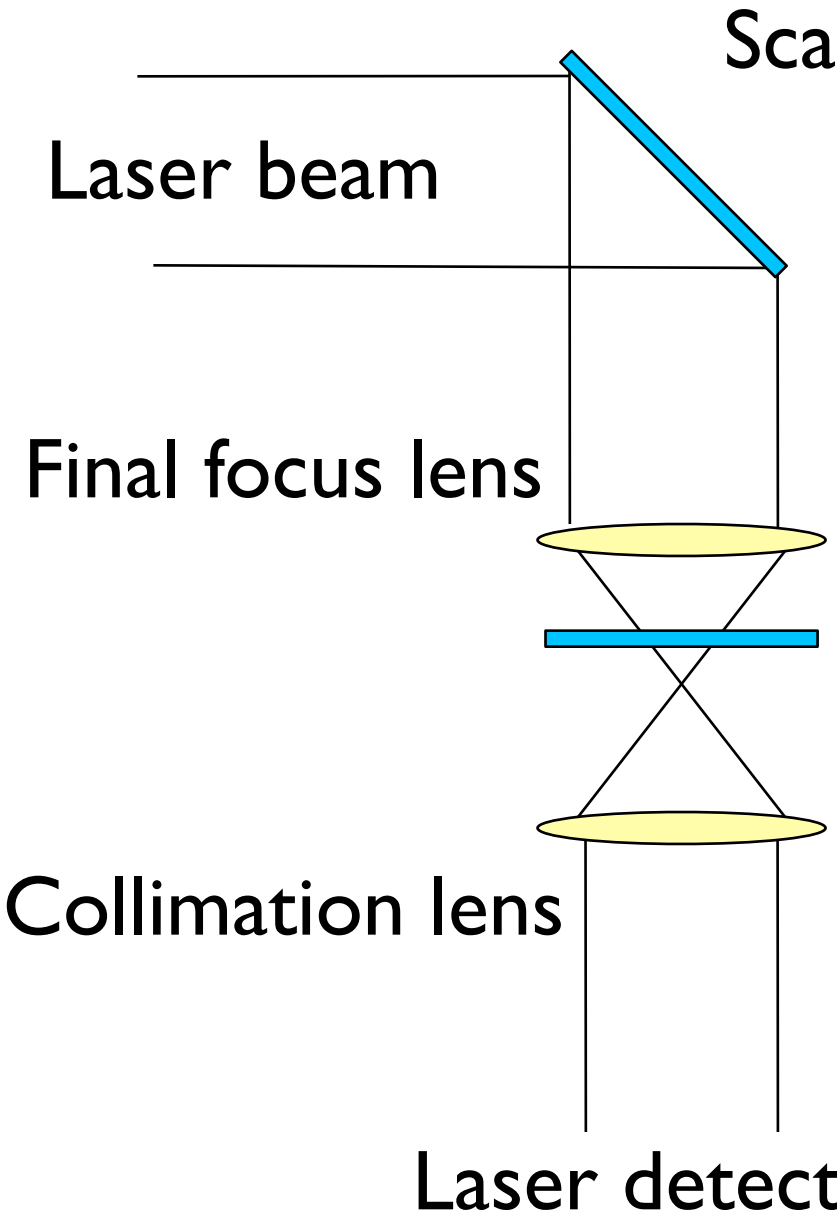

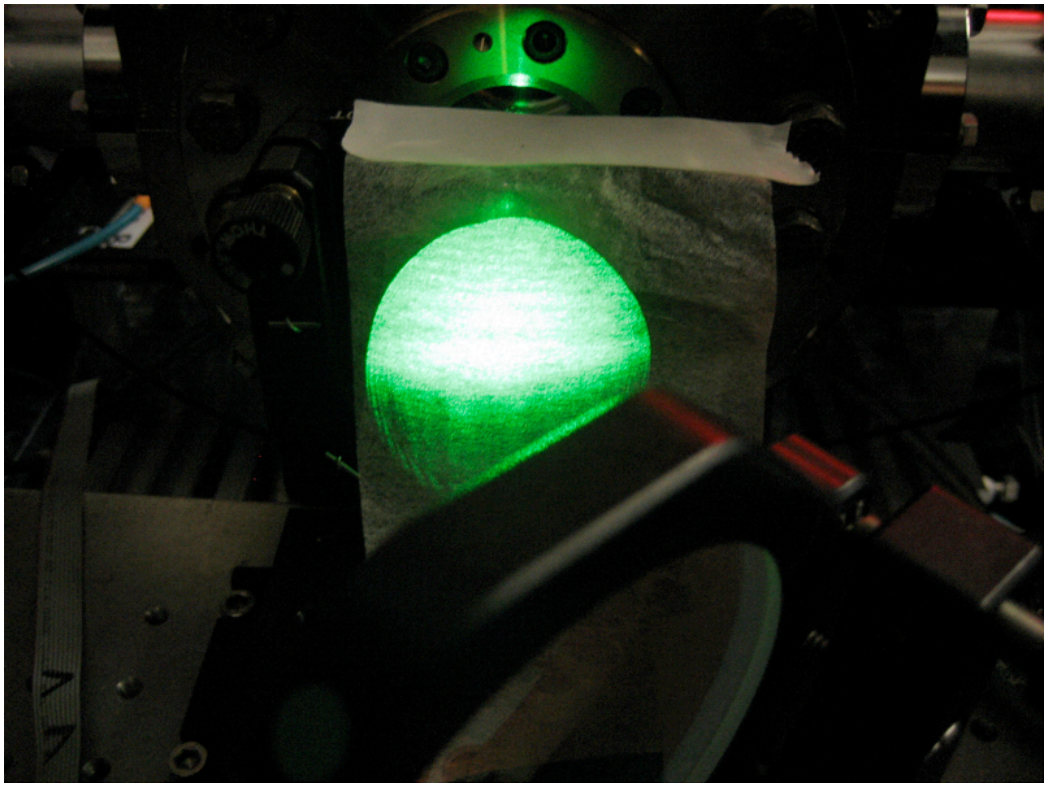

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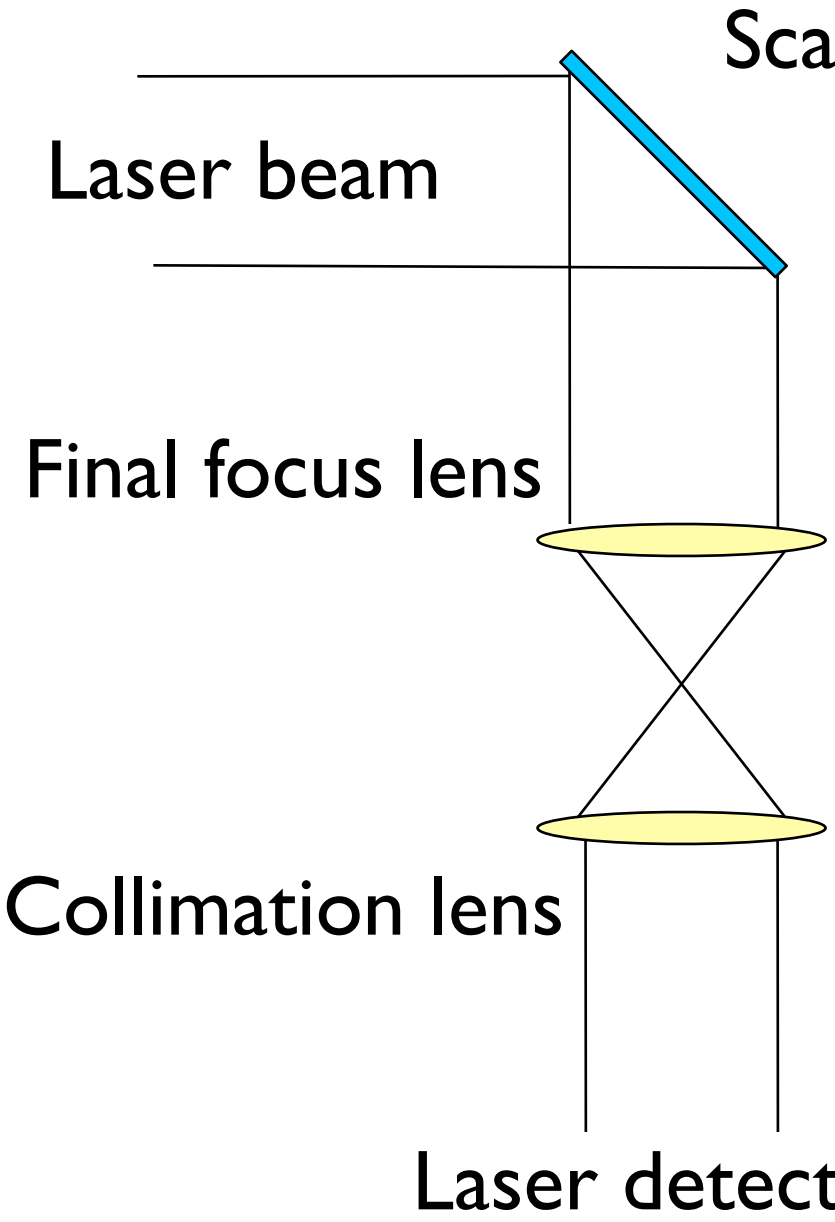

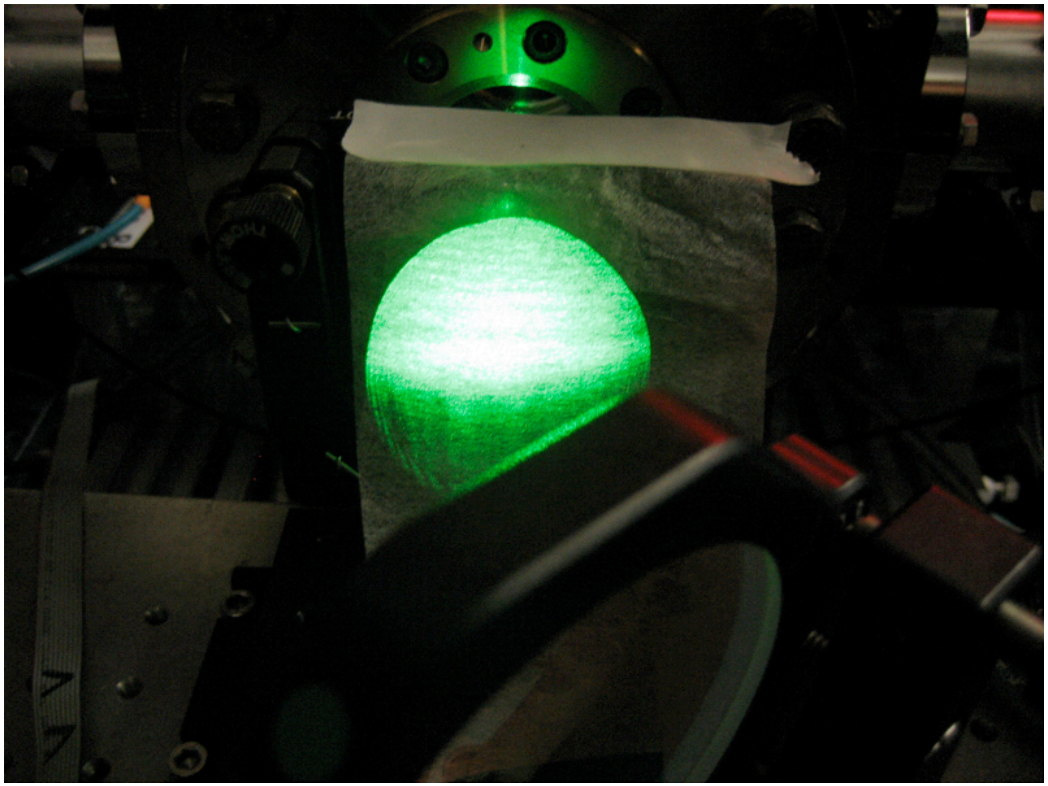

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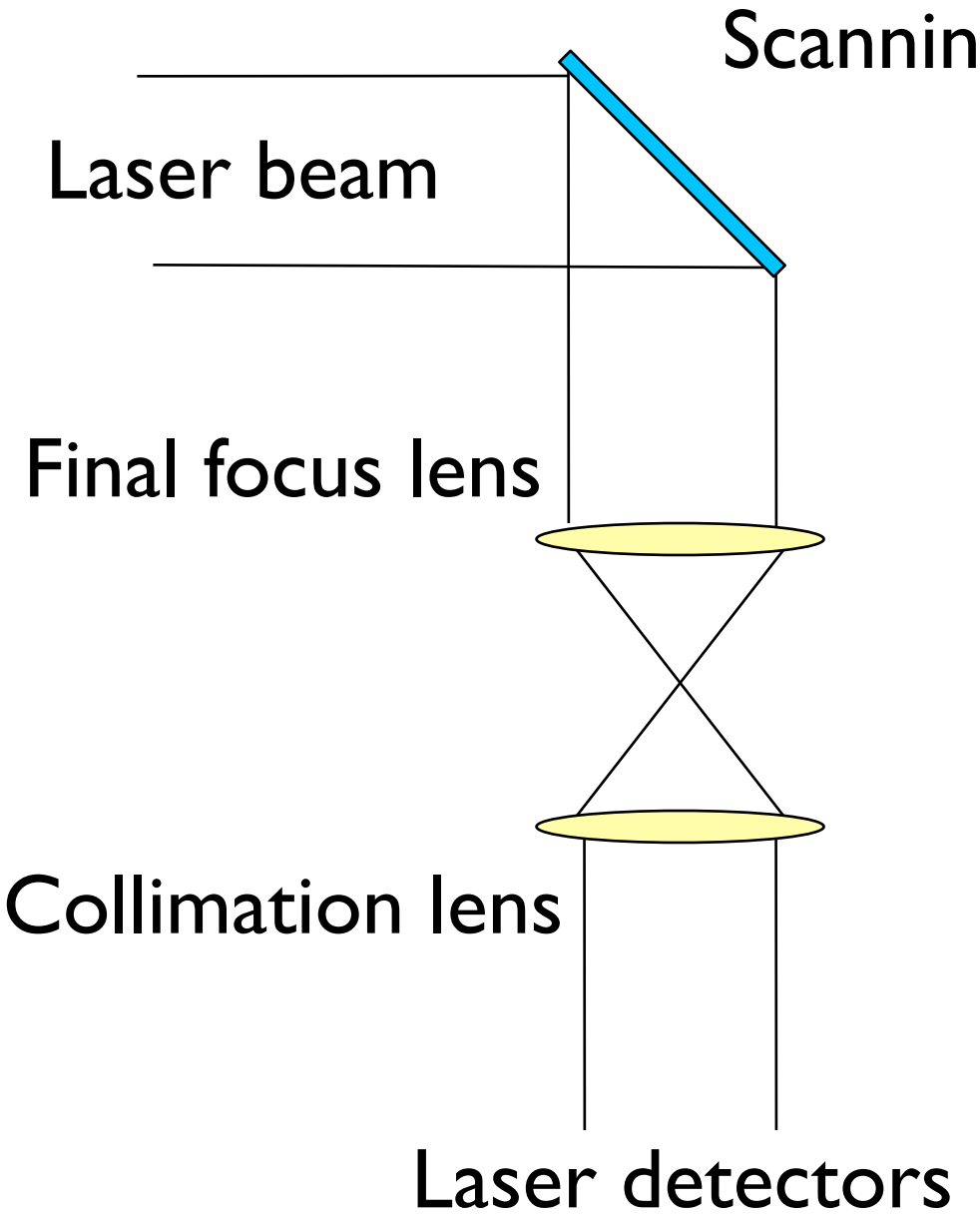

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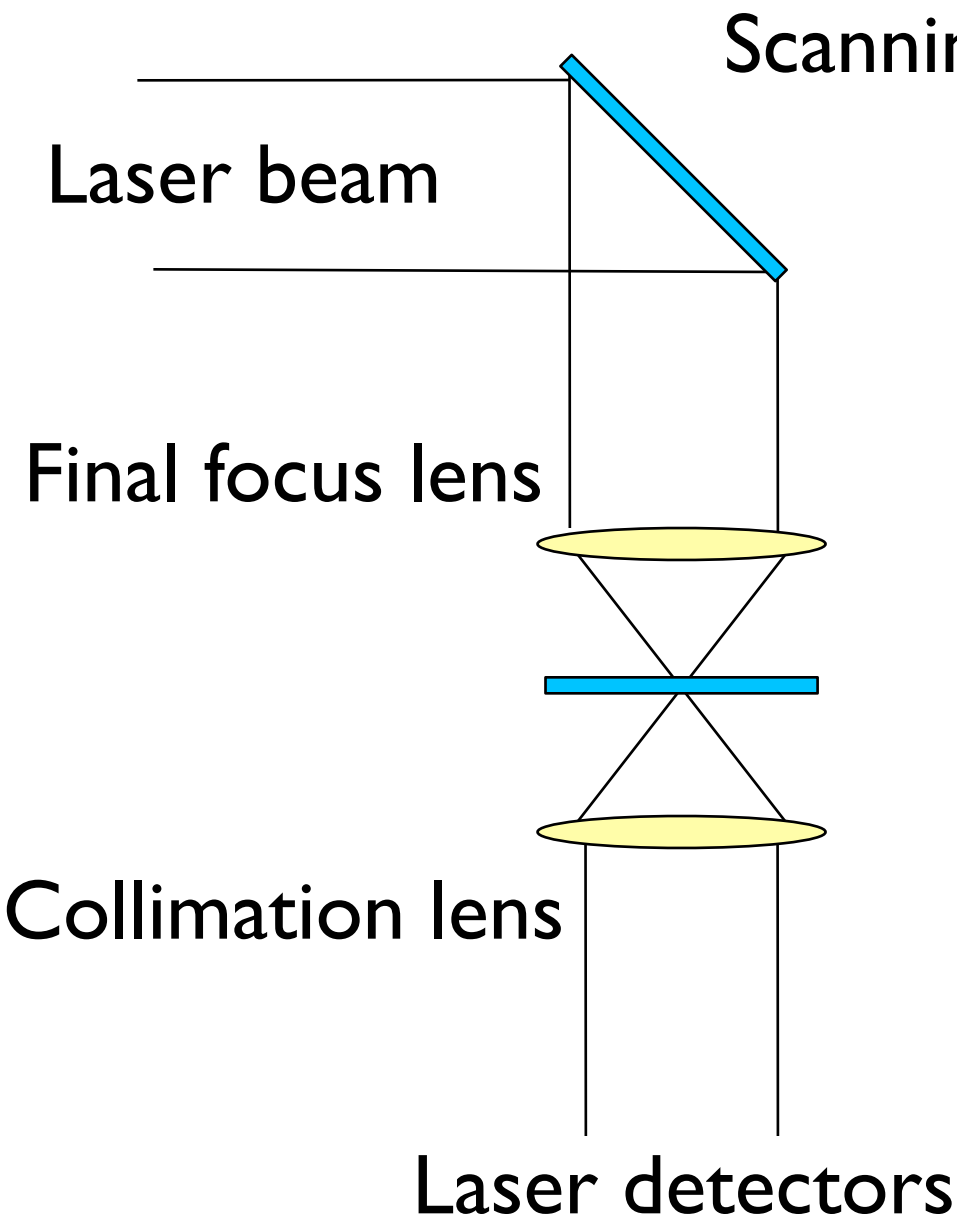

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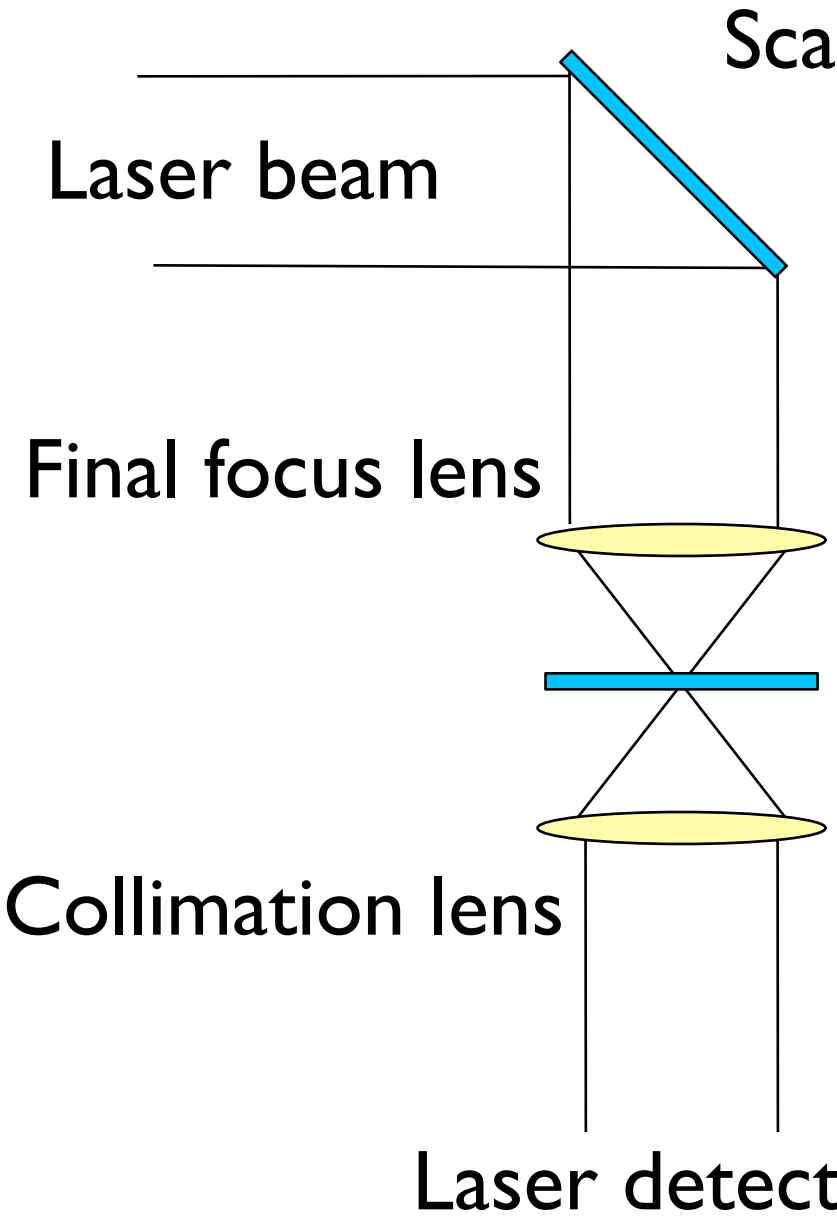

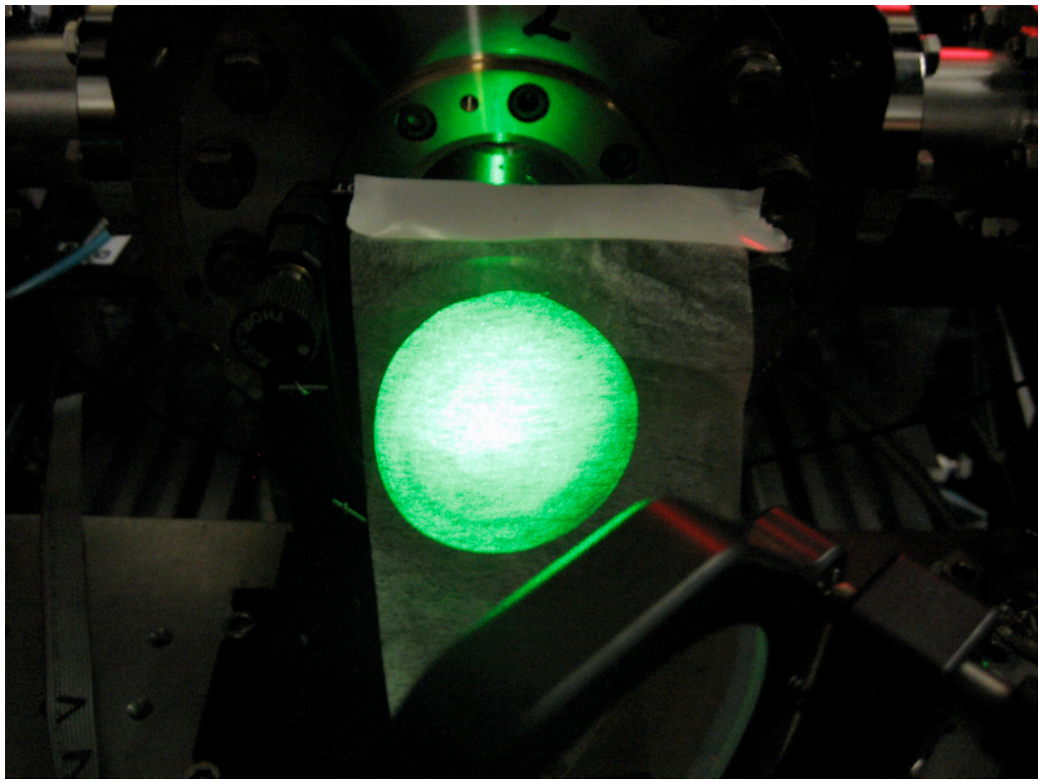

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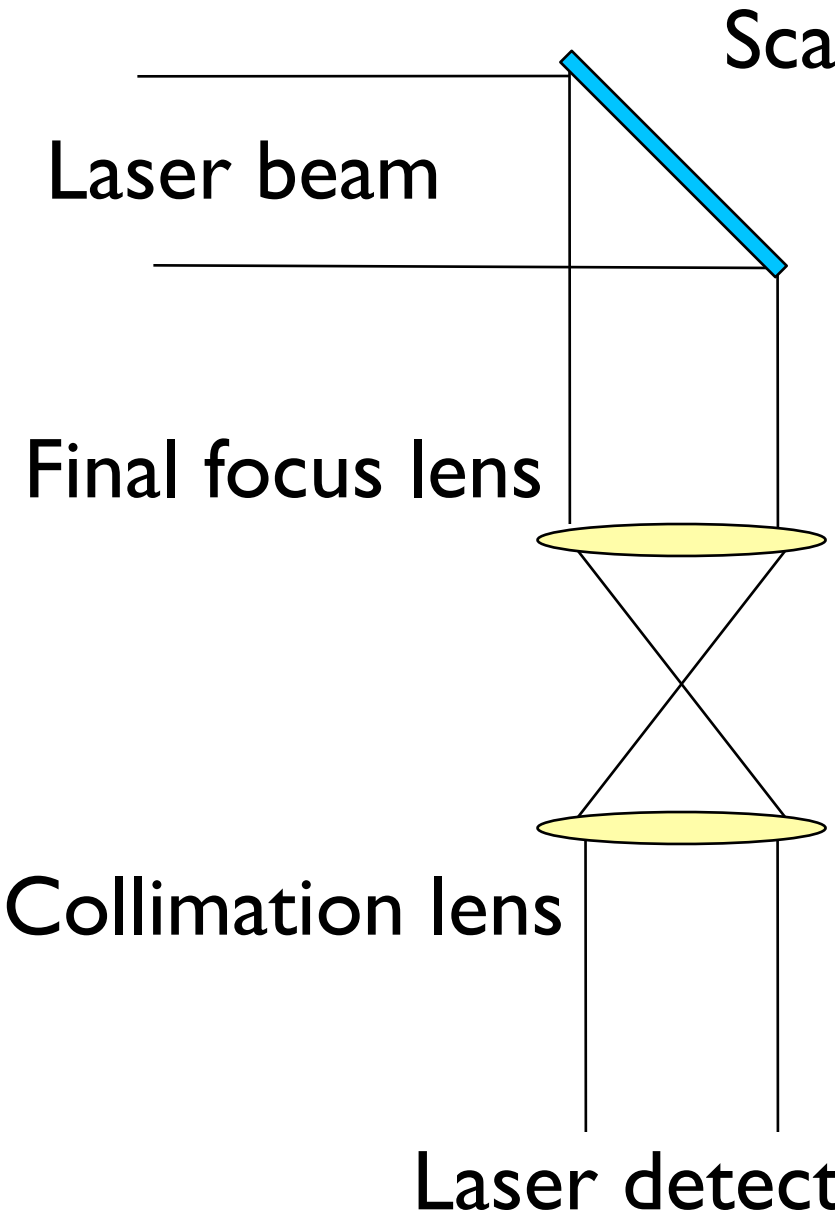

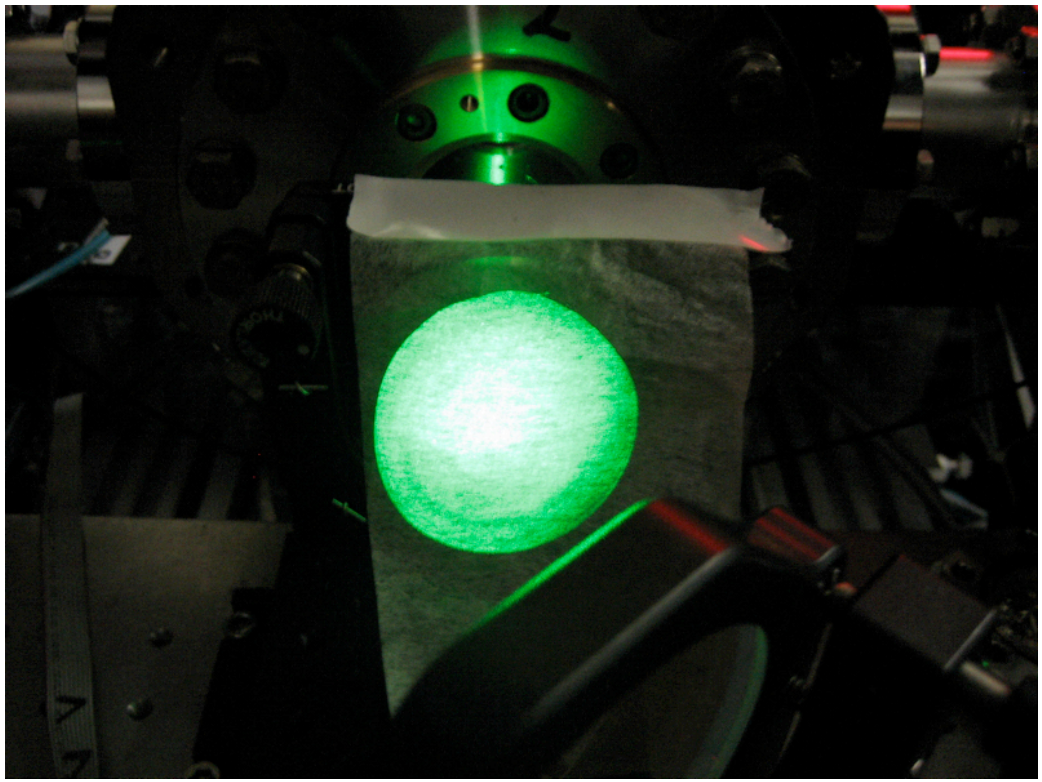

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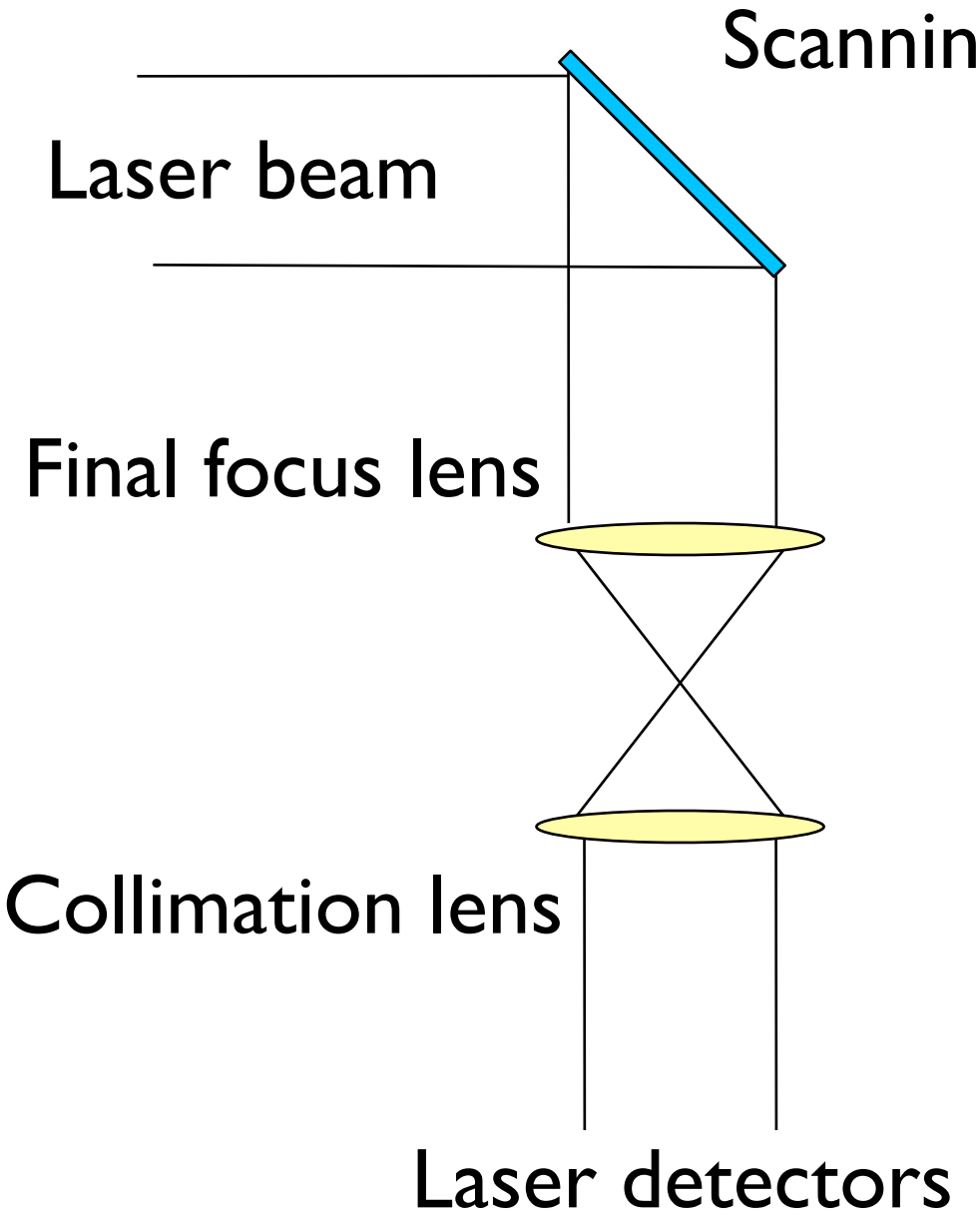

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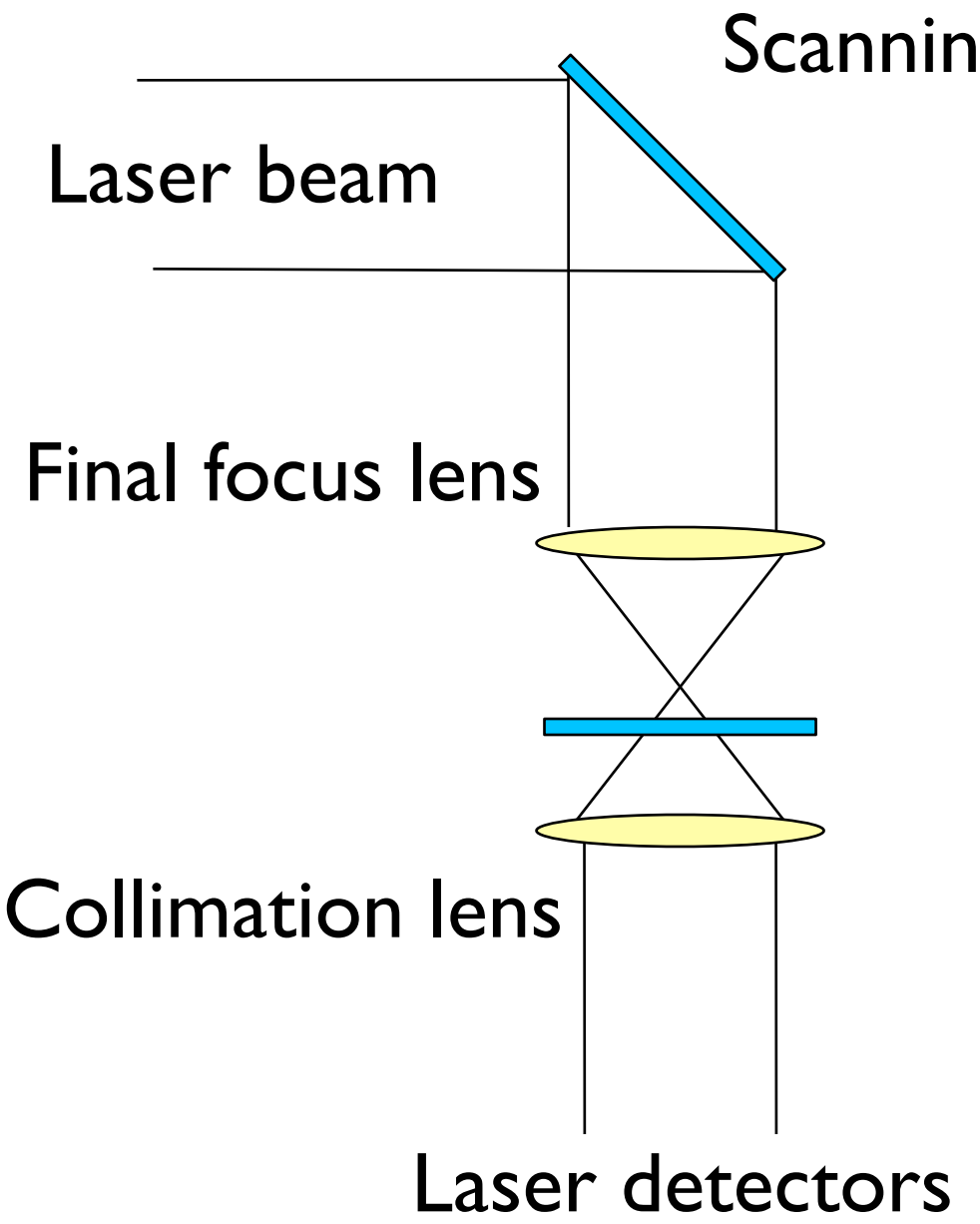

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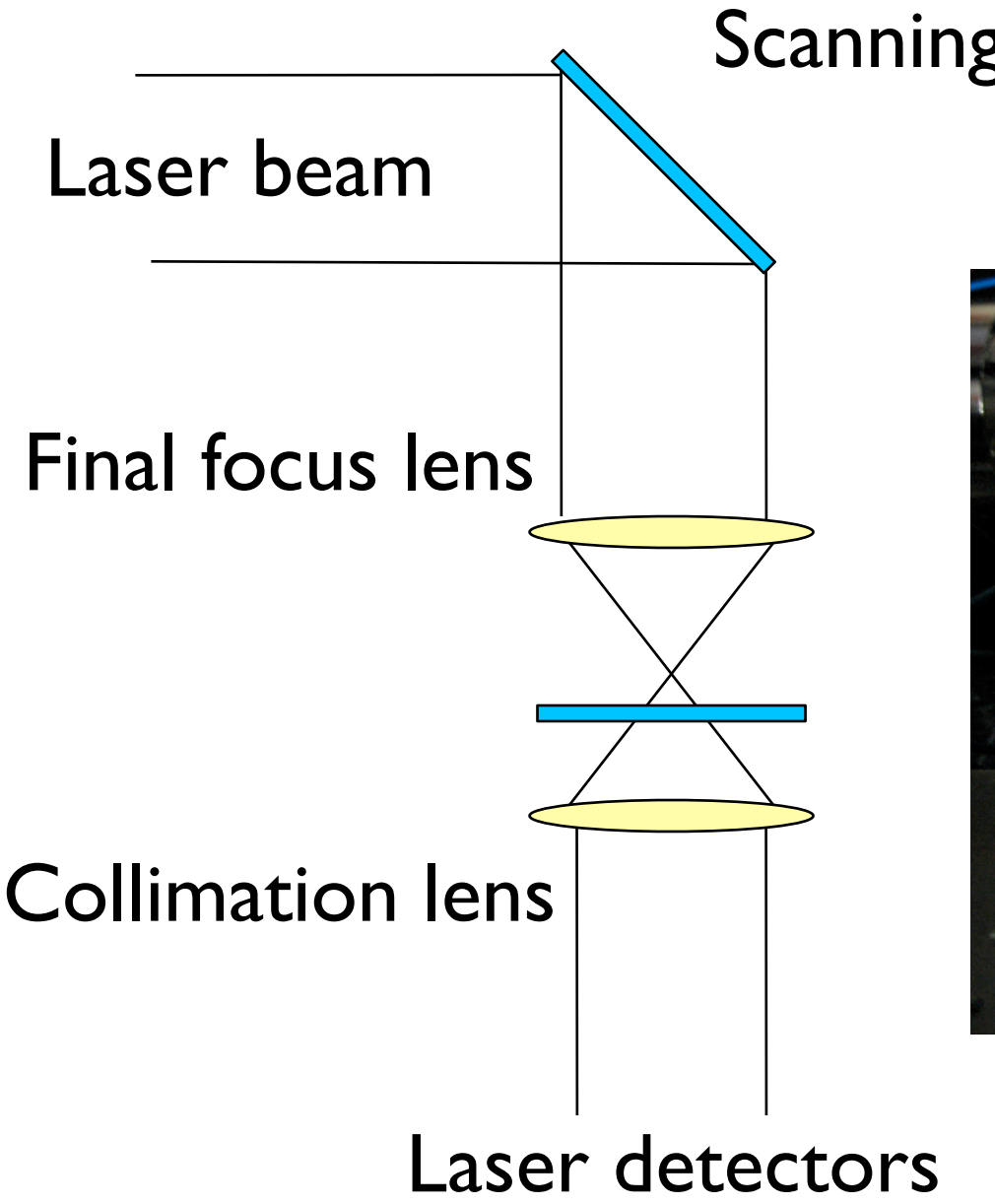
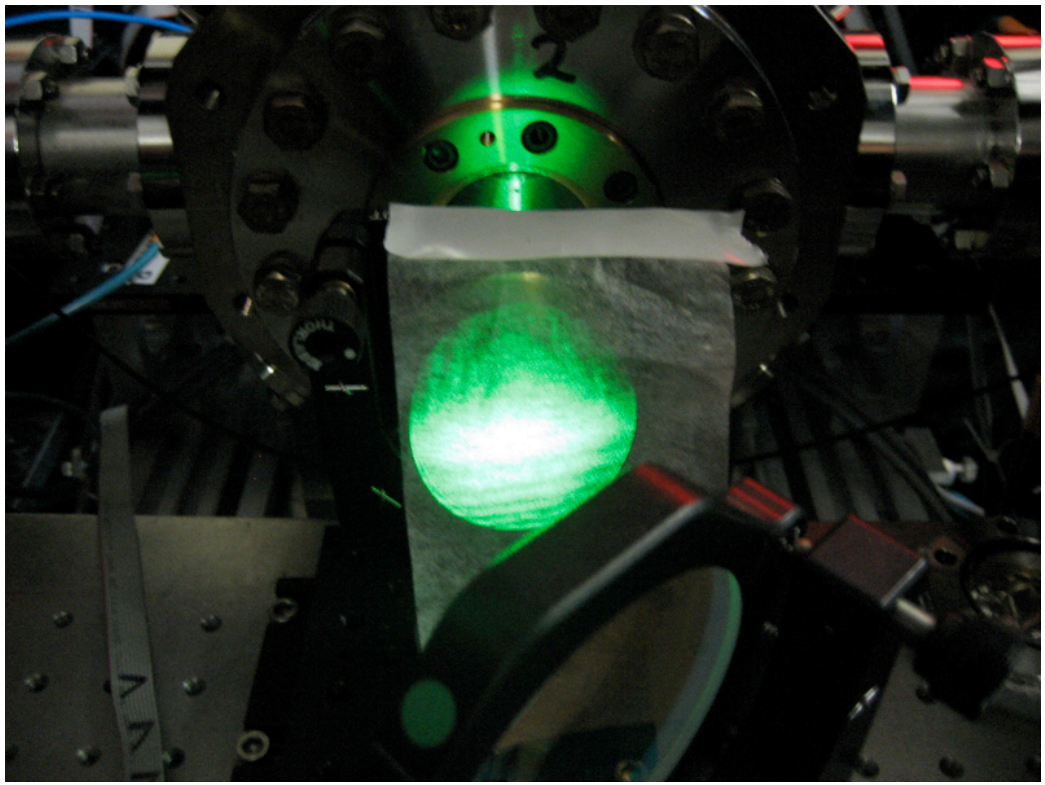
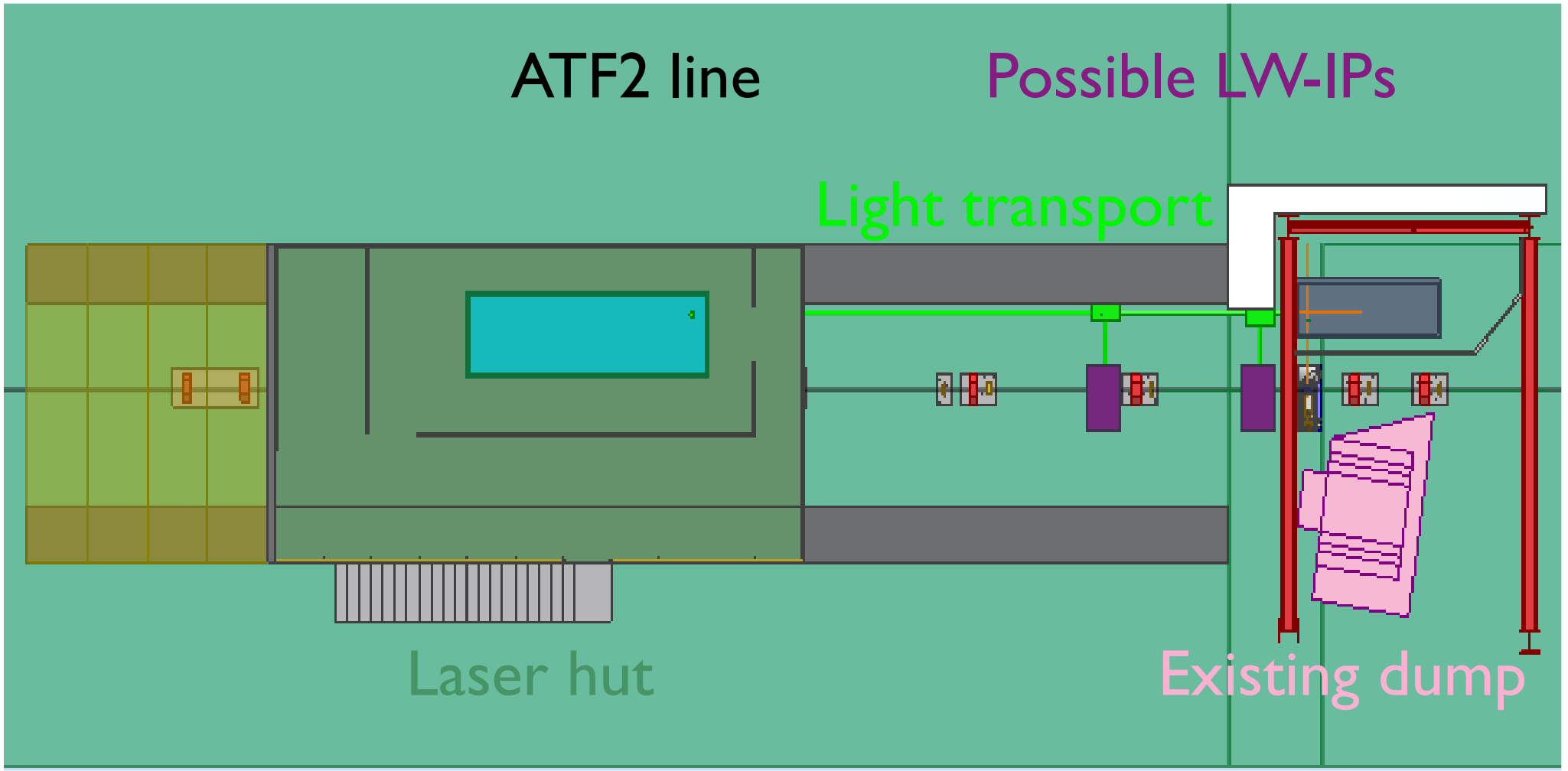




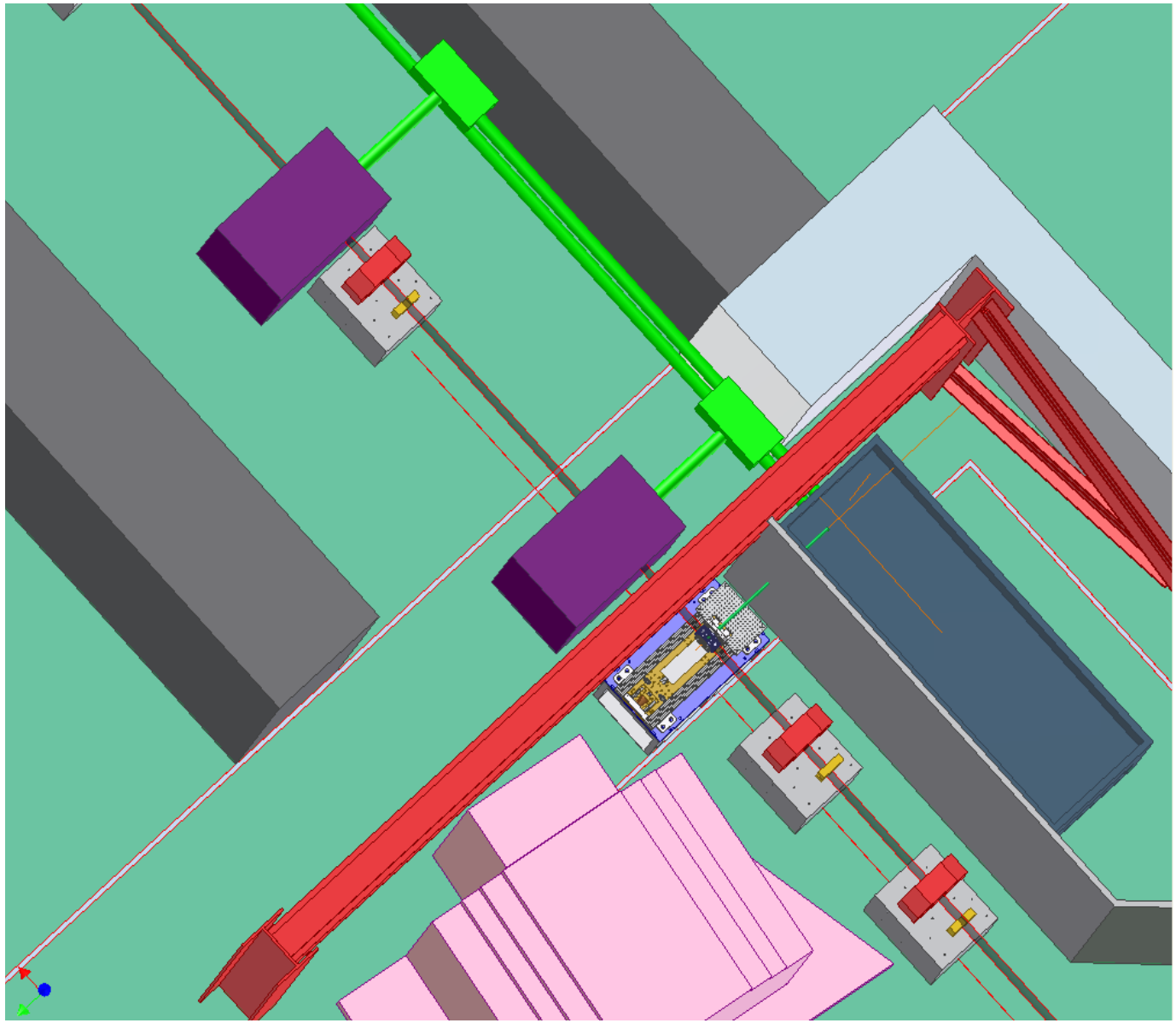
ATF2 plan

- Progress toward ILC specification laser-wire system
  - Operational improvements
    - laser stability
    - Finding overlap efficiently
  - Physics
    - Laser transverse mode
    - Lens aberrations and coma
  - Move existing laser-wire system over to new ATF2 location and laser hut installation
  - Optics should not be a problem (dispersion free region in ATF2)

ATF2 layout


ATF2 line
Possible LW-IPs
Light transport
Laser hut
Existing dump

ATF2 layout



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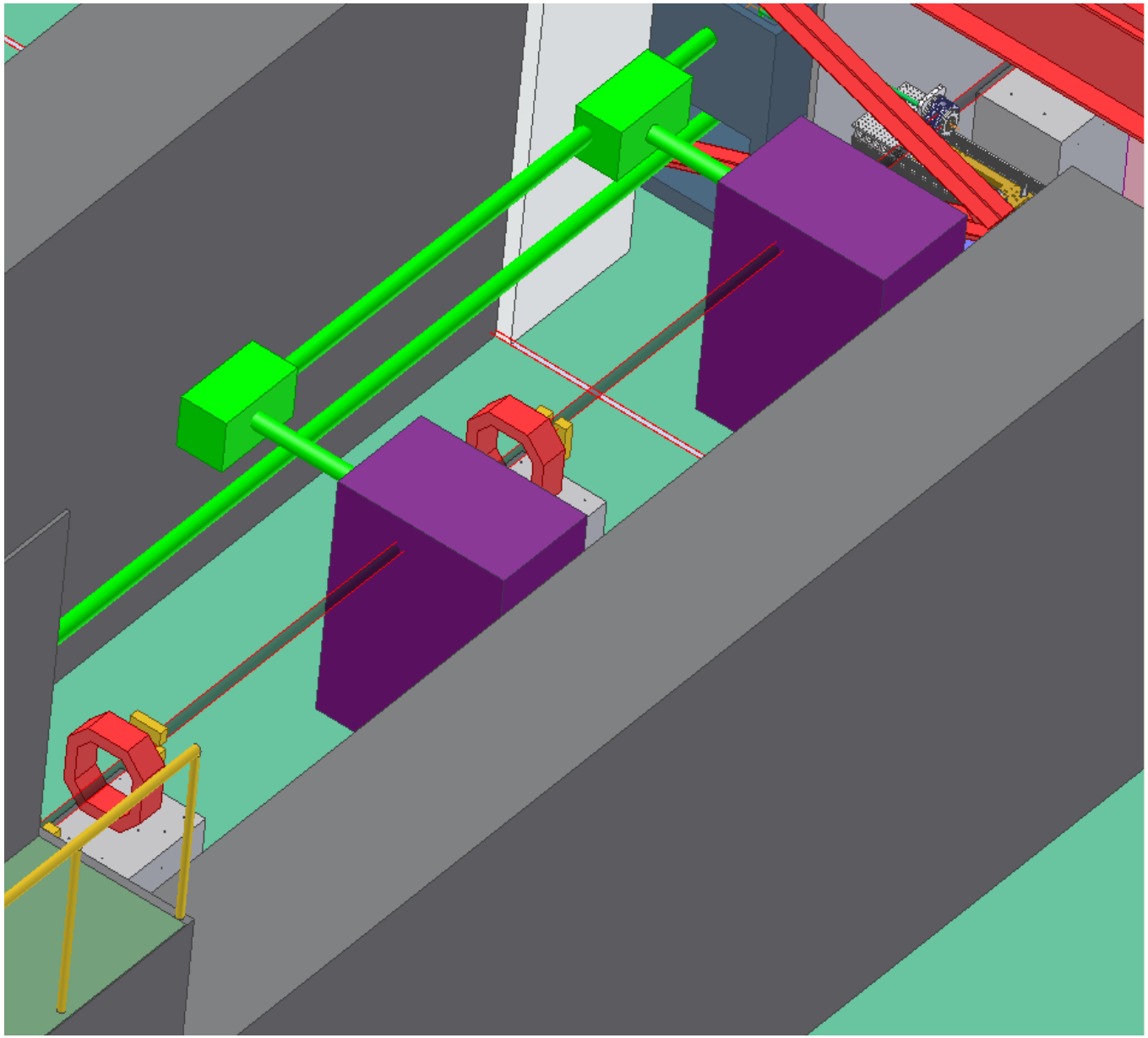
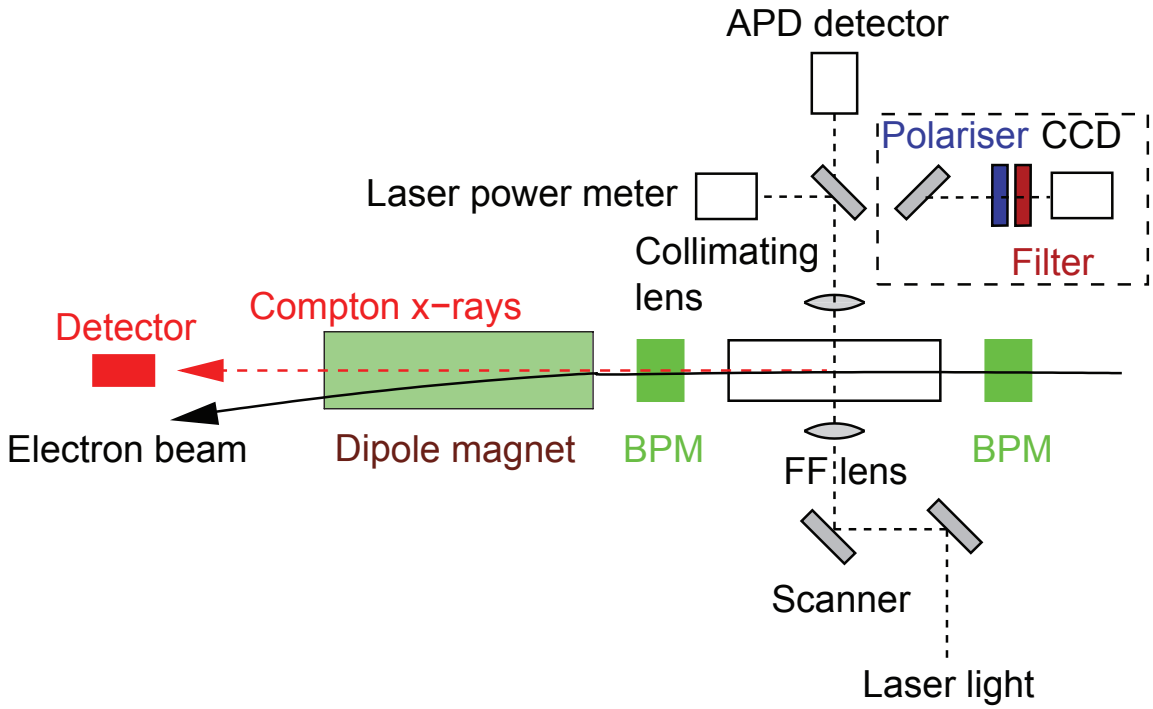


ATF2 study plan

- Continue study of laser-wire
  - Implementation (DAQ, operation, etc)
- Study of various systematic effects (see paper I. Agapov at al.)
  - Beam jitter (laser and electron beams)
  - Optics calibration
    - Impact of non-perfect lens and laser
- ILC performance requirements
  - Fast laser scanners
  - Laser systems
  - Light transport and control

Laserwire/Optical Diffraction

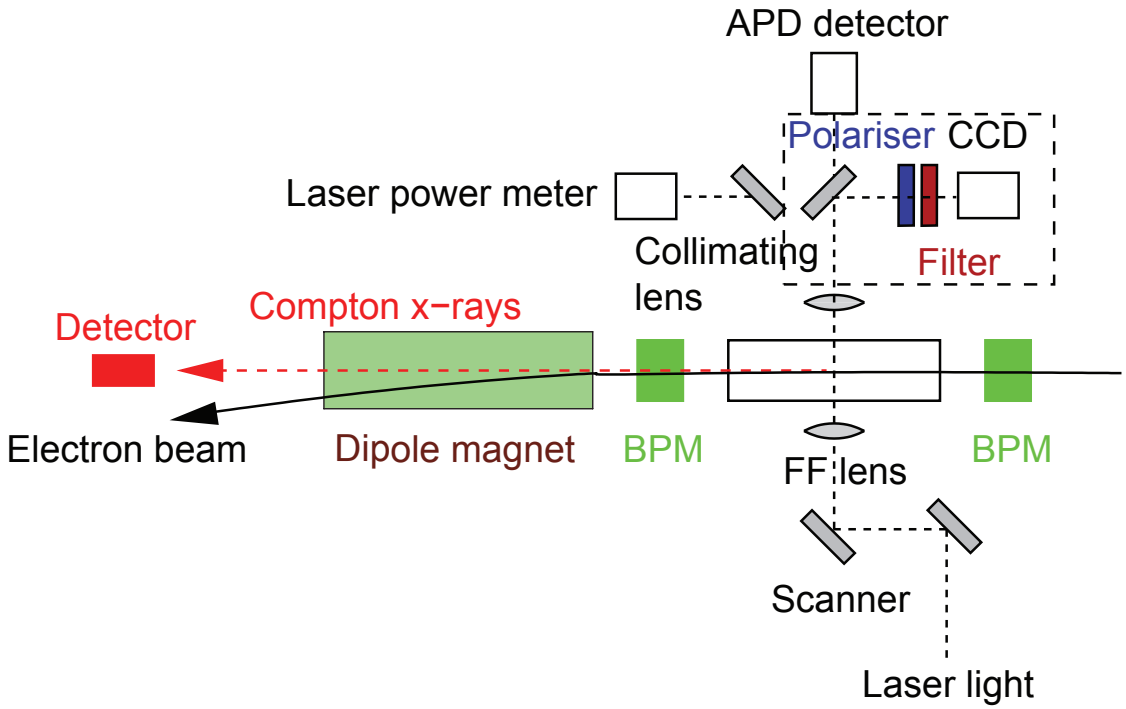
- Target manipulation excellent for ODR/OTR studies
  - ODR can measure down to 20 micro beam sizes
- Plan to integrate laserwire and ODR diagnostics together
  - General ILC beam diagnostic
  - Wakefield kicks etc



See talk of P. Karataev in ATF TB meeting

Laserwire/Optical Diffraction

- Target manipulation excellent for ODR/OTR studies
  - ODR can measure down to 20 micro beam sizes
- Plan to integrate laserwire and ODR diagnostics together
  - General ILC beam diagnostic
  - Wakefield kicks etc



See talk of P. Karataev in ATF TB meeting

Summary

- Good progress with laser-wire system
  - Hopefully have one micron collisions by end of ATF1 operation
- Move existing laser-wire system to location at end of the extraction system
  - Continue development of transmissive optics
  - Test developments in scanning technology (electro-optics)
  - Laser systems
  - Systematics studies
- Develop multiple axis system for ATF2
  - 2-3 axis (vertical, horizontal, small angle)
  - Roll angles (alignment with respect to quads etc)