Sub 0.1μm Track Width Measurement Using a Common Path Optical Interferometer and Artificial Neural Network.

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Talk Outline

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- Introduction
- Artificial Neural Network
- Optical System
- Results
- Discussion / Future Work

Introduction

Aim: Measure trackwidth structures down to 0.1micron

Problem: Optical system limited by diffraction limit. Using high NA and short wavelength this limit is around 250nm

Rayleigh Criterion = 0.61 lambda/NA

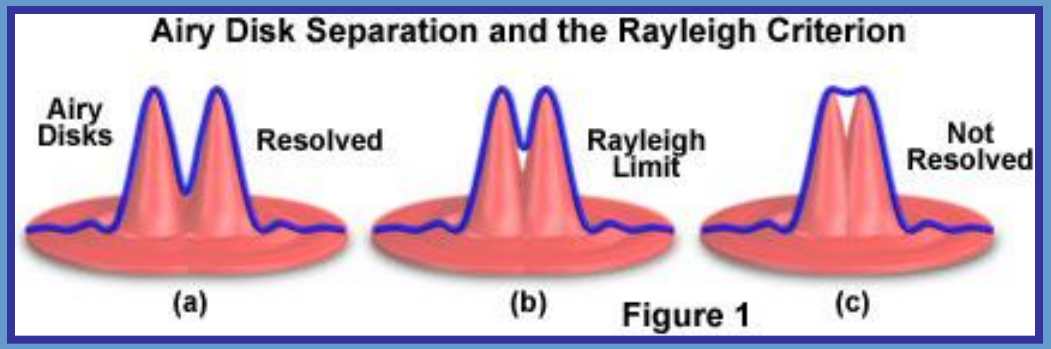

Figure 1

This means that 0.1 micron is not possible with just an optical system alone.

Introduction

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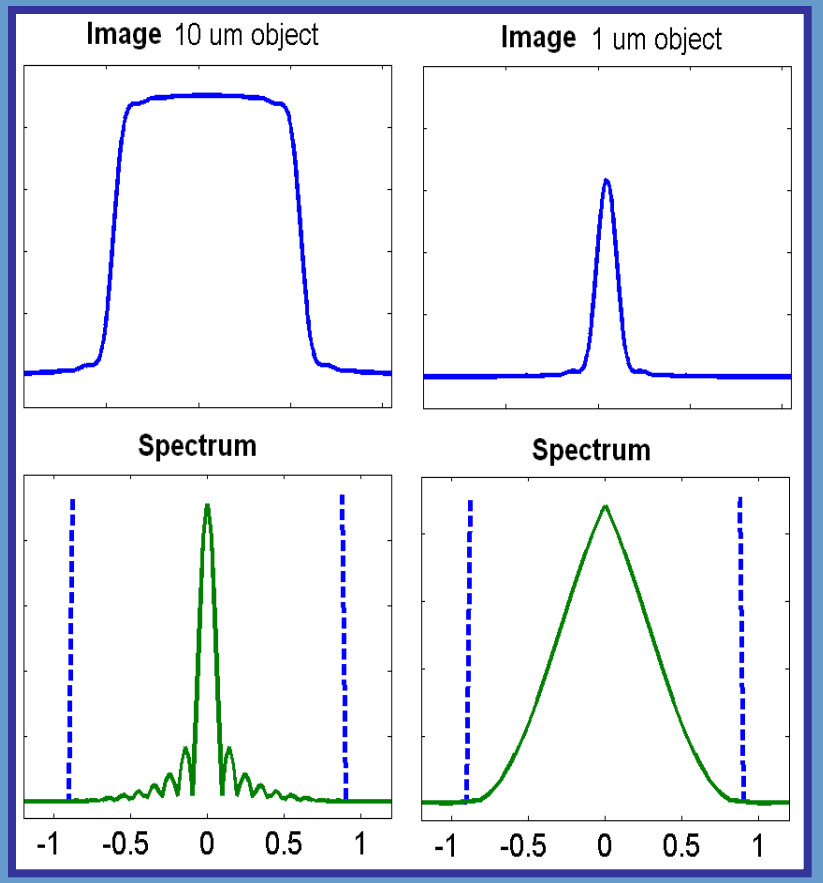
- Optical system truncates spectral components present in system
- Reconstruct spectral components to obtain a higher resolution image
- Extension limited due to SNR of real signal
- We require value of the trackwidth
- Use artificial neural network (ANN) to extract this information.
- INCREASE IN MEASUREMENT CAPABILITY NOT RESOLUTION



Artificial Neural Network

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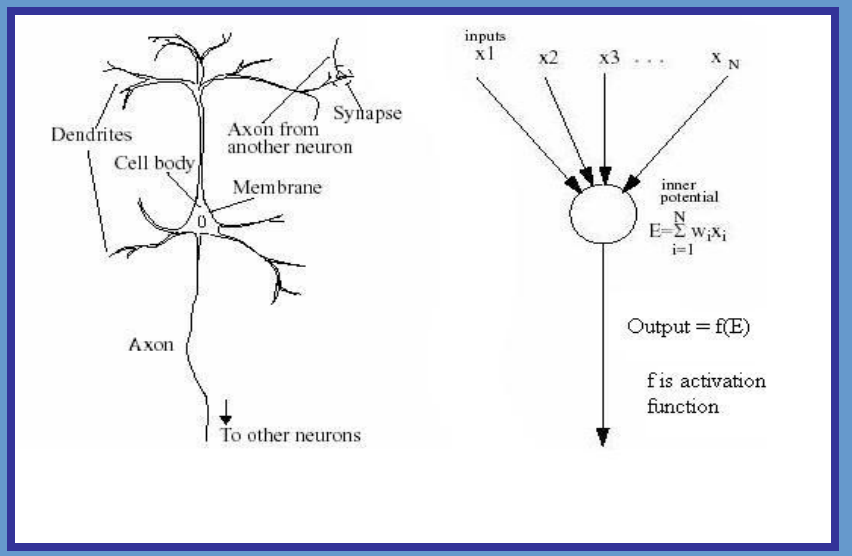
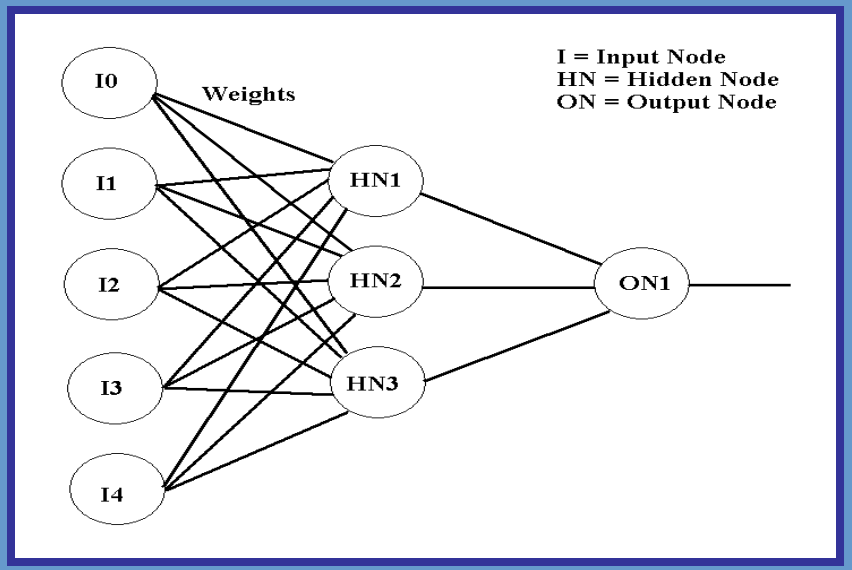
- Each node is a simple unit
- Combined into networks
- Form powerful nonlinear computational networks



- We use a Feed-forward network
- Typically: 8 inputs,5 'hidden' nodes & 1 output node



Artificial Neural Network

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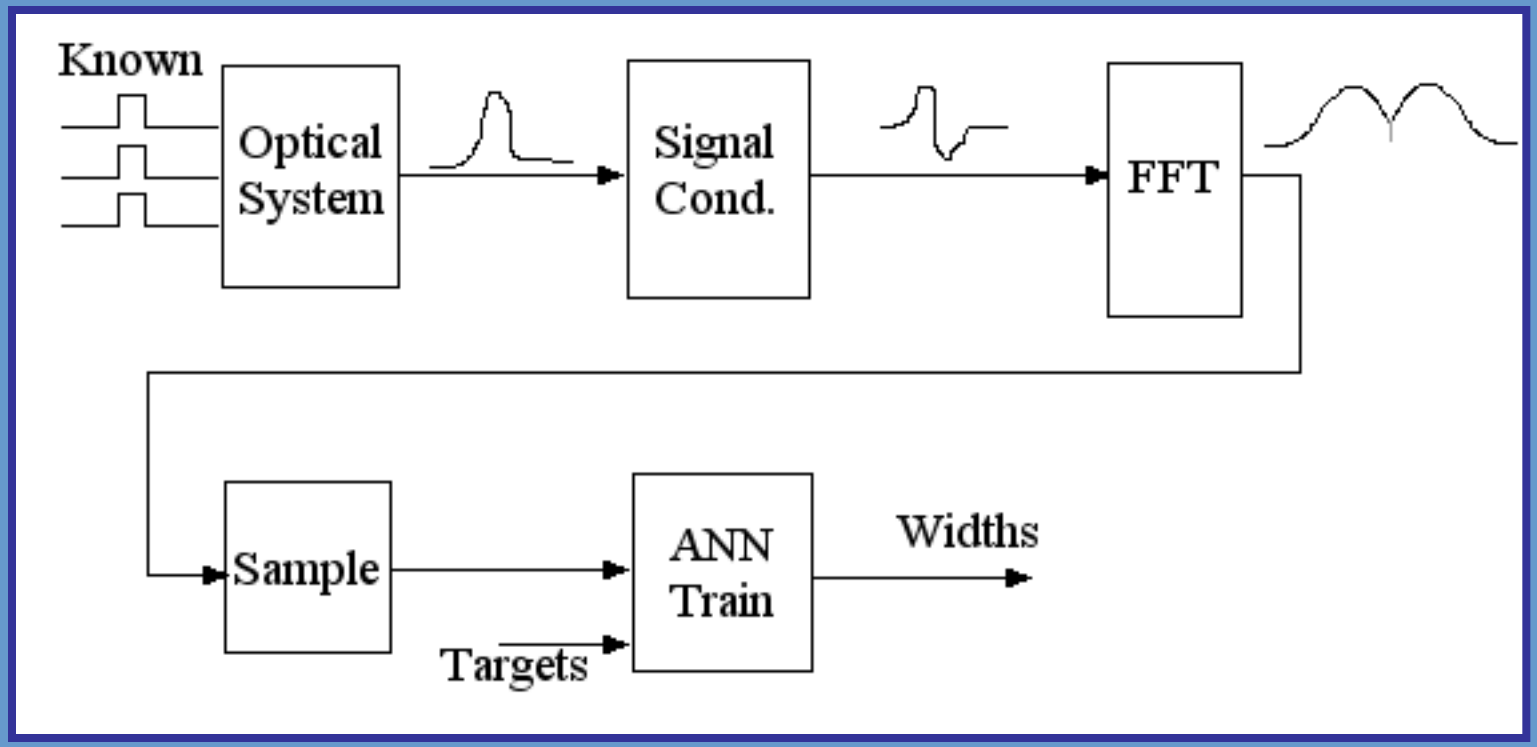
The Training Process



Optical System

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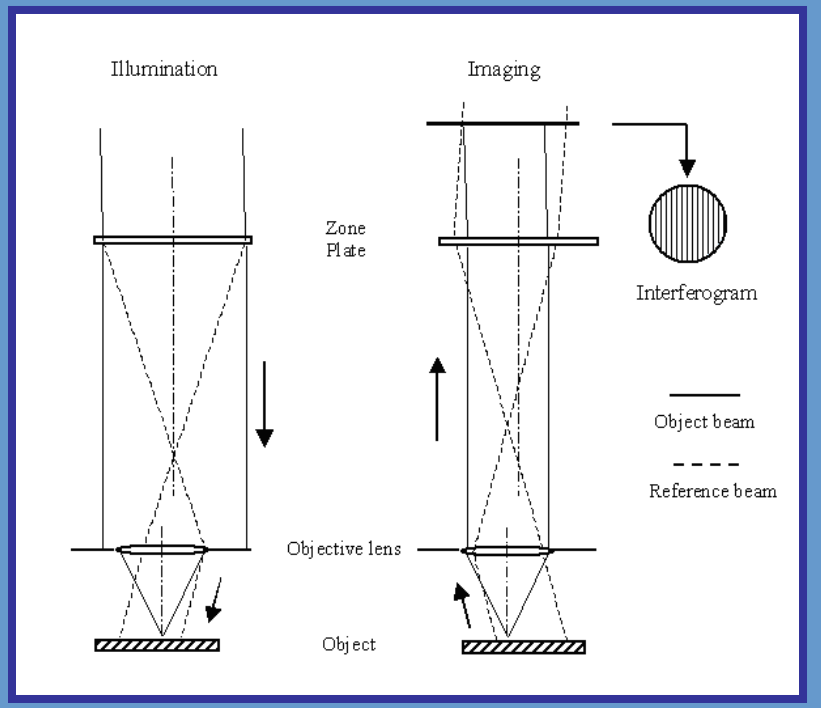
Common path scanning optical interferometer

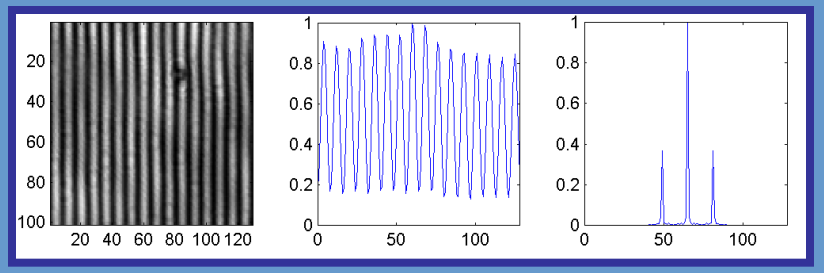
Uses hologram as beam splitter which produces two beams

- One focused beam on sample surface
- One collimated beam on sample surface

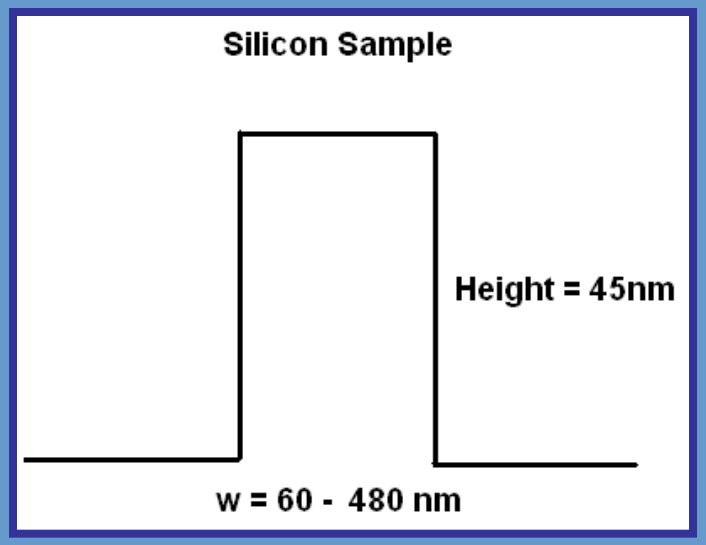
On reverse path beams recombine and interfere

The two beams traverse similar paths, providing a common path and stable configuration

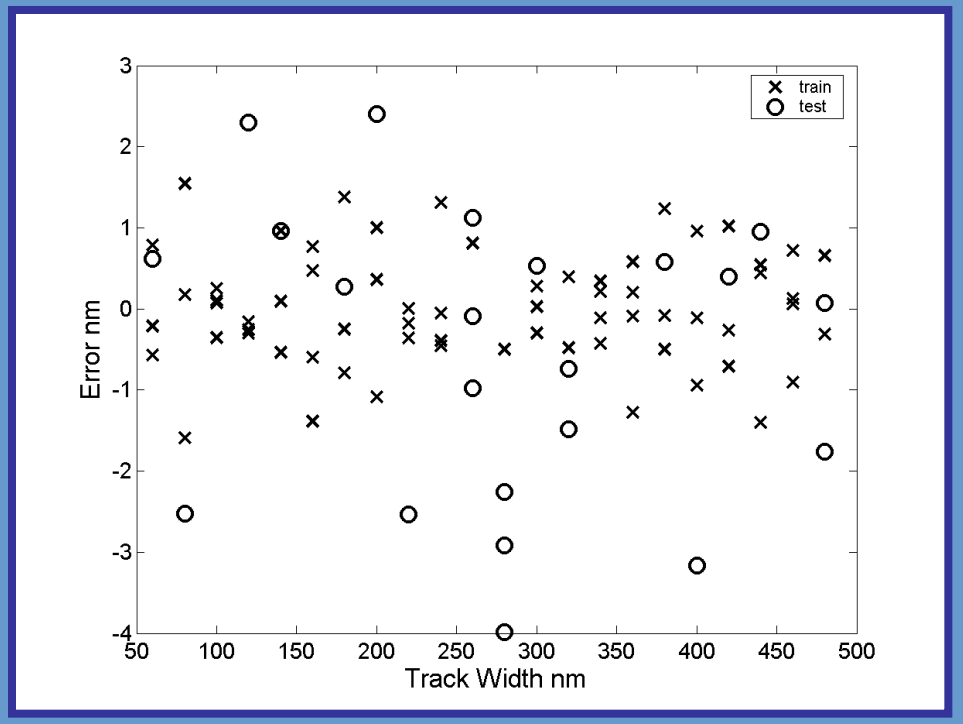




Experimental Results



- **λ=633**nm **NA = 0.3**
- Deviation between targets and ANN response approx. **2nm**
- Smallest track is **1/46th** of the optical spot size



Experimental Results

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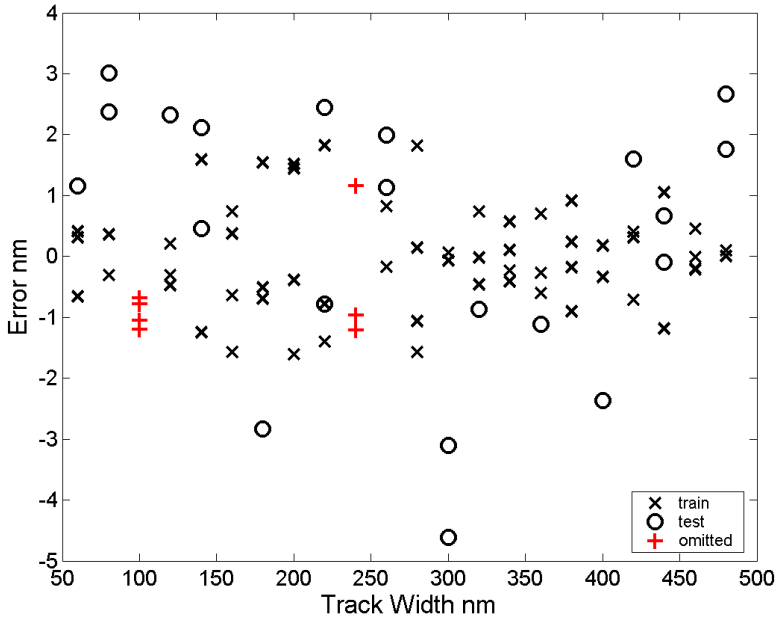
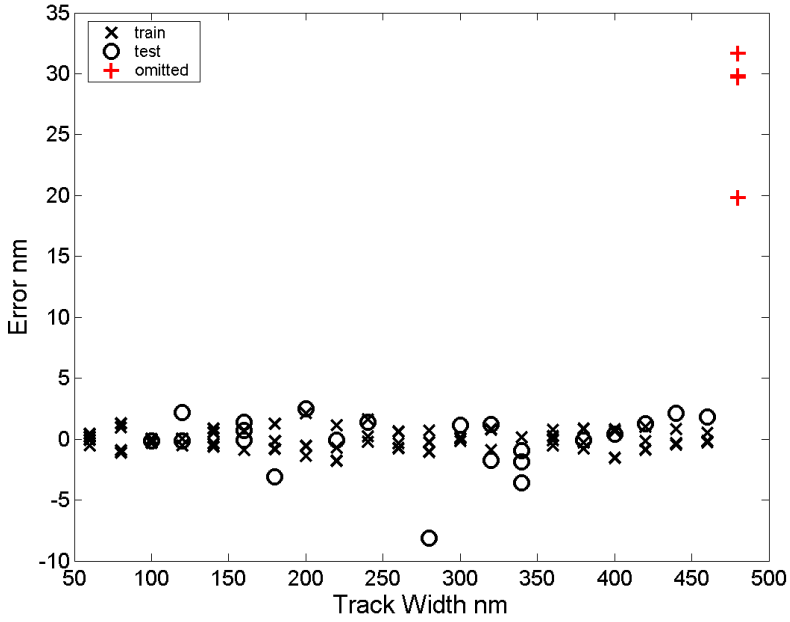
General result



Out of Range



Target Errors

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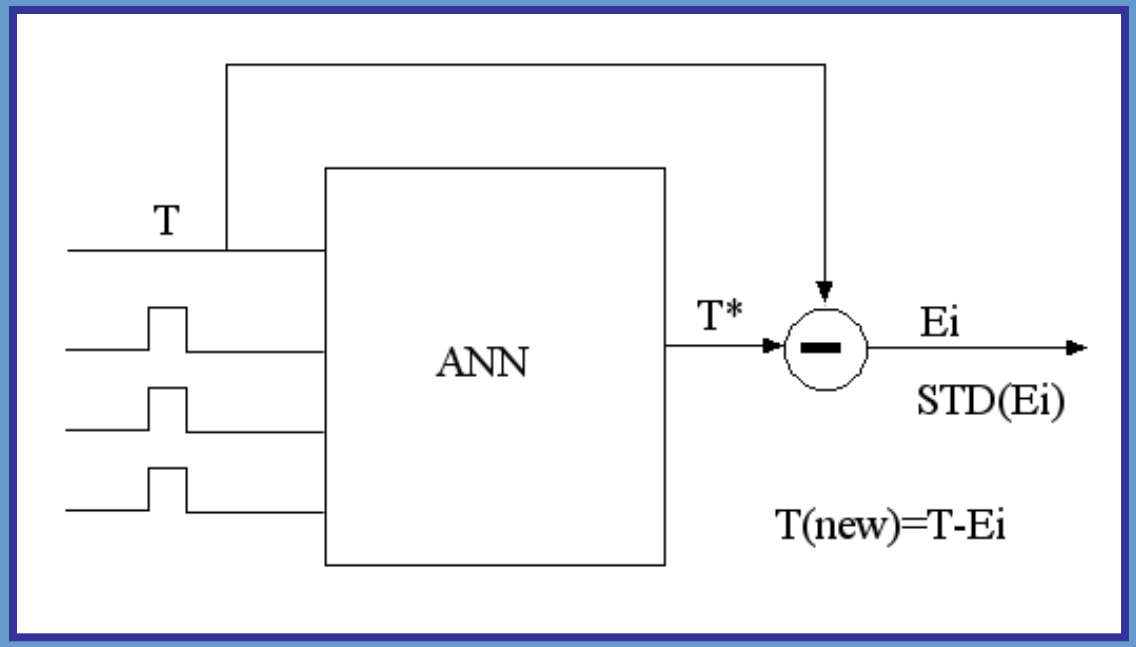
- Can network correct for incorrect targets when training?



- Update targets and retrain to correct target error
- Repeat until update is small

Target Errors

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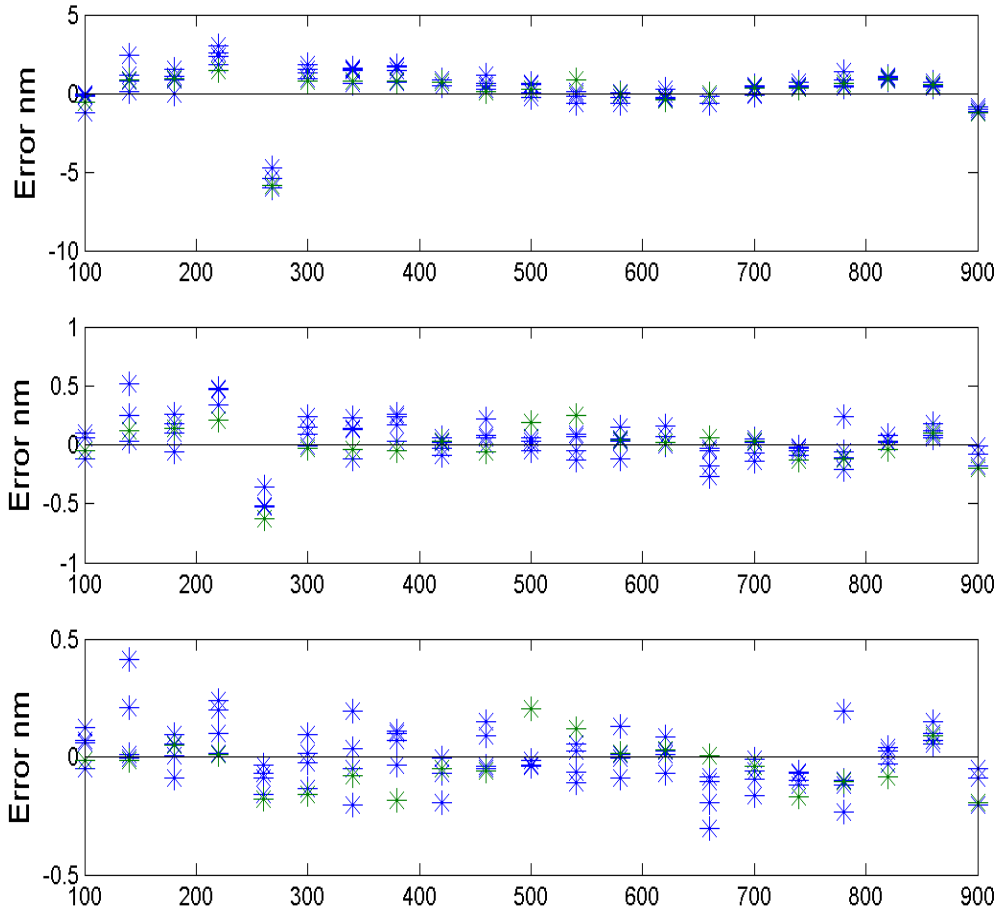
Simulation



Experimental

	Target	Update
Pass One	206	-3.43
Pass Two	202.56	-1.299
Final	201.27	

Discussion/Future Work

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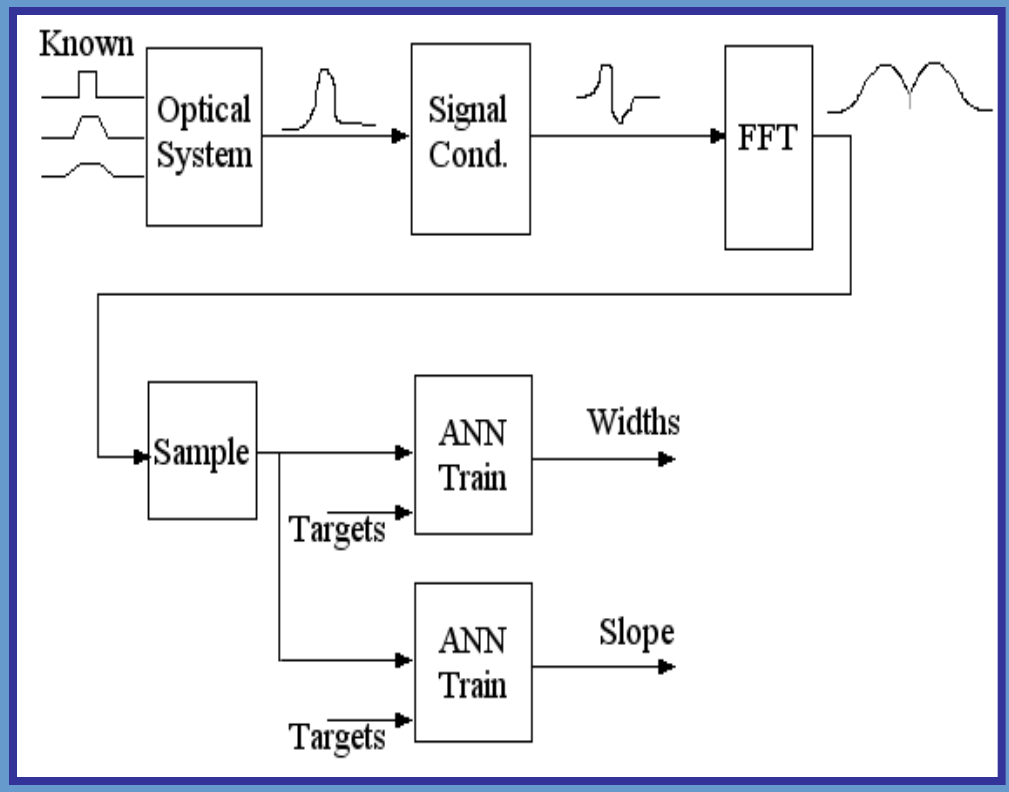
- Capability of system
  - 10nm is a strong possibility
- Areas under investigation
  - Effect of track shape
  - Apply to other structures
  - Importance of input points
  - Optical system design



Conclusion

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- Have combined an ANN and optical system to measure track widths down to 60nm with 0.3NA and wavelength of 633nm
- Which is **1/46th** of the optical spot size
- Network produces general results but only for the range of tracks that the network was trained for
- System is able to correct for small training target errors

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Acknowledgements

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Questions?

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