Whispering Gallery Mode Resonators

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College of William & Mary

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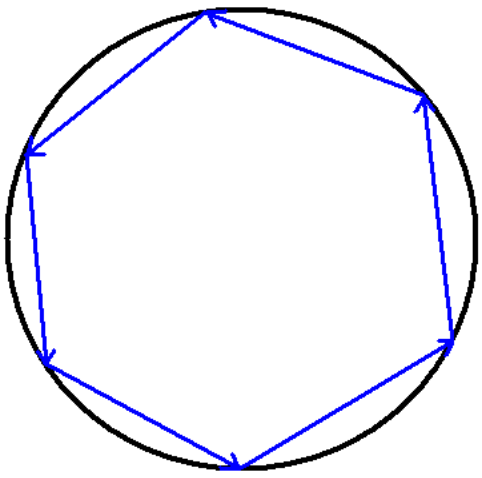
Outline

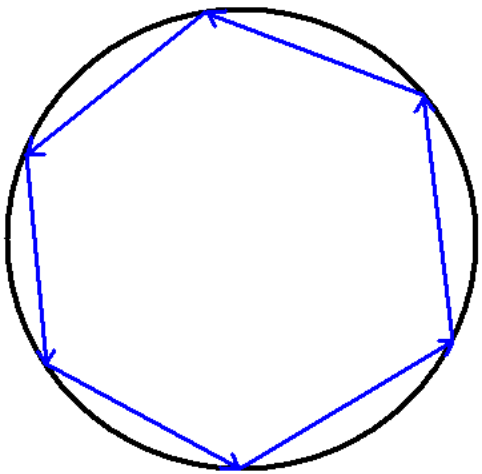
Whispering Galleries



Whispering Gallery

- St. Paul's Cathedral
  - Acoustic Waves
- Electromagnetic Waves
  - Total Internal Reflection
  - Resonant Modes
- Spheres or Disks
- WGMRs

Whispering Galleries



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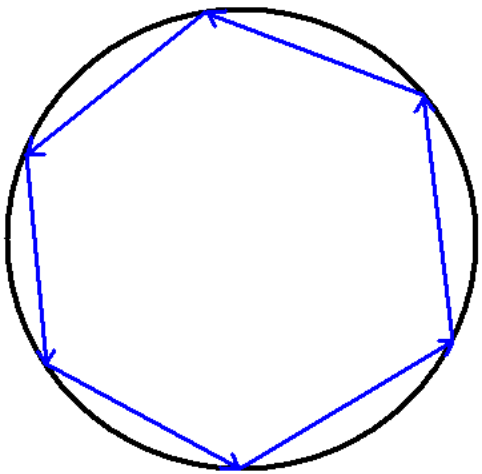

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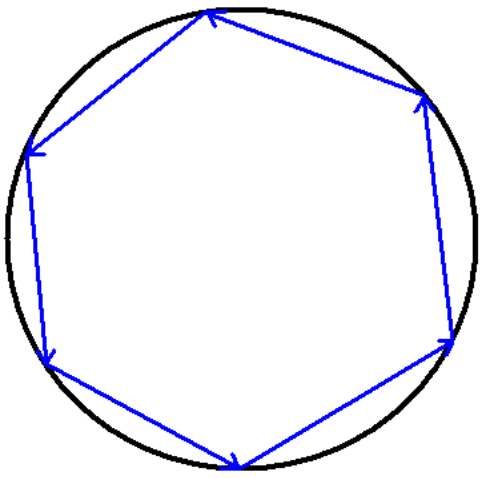

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Applications

Light Storage

Laser Cavity

Non-linear Processes

- Second Harmonic Generation
- Parametric Oscillation

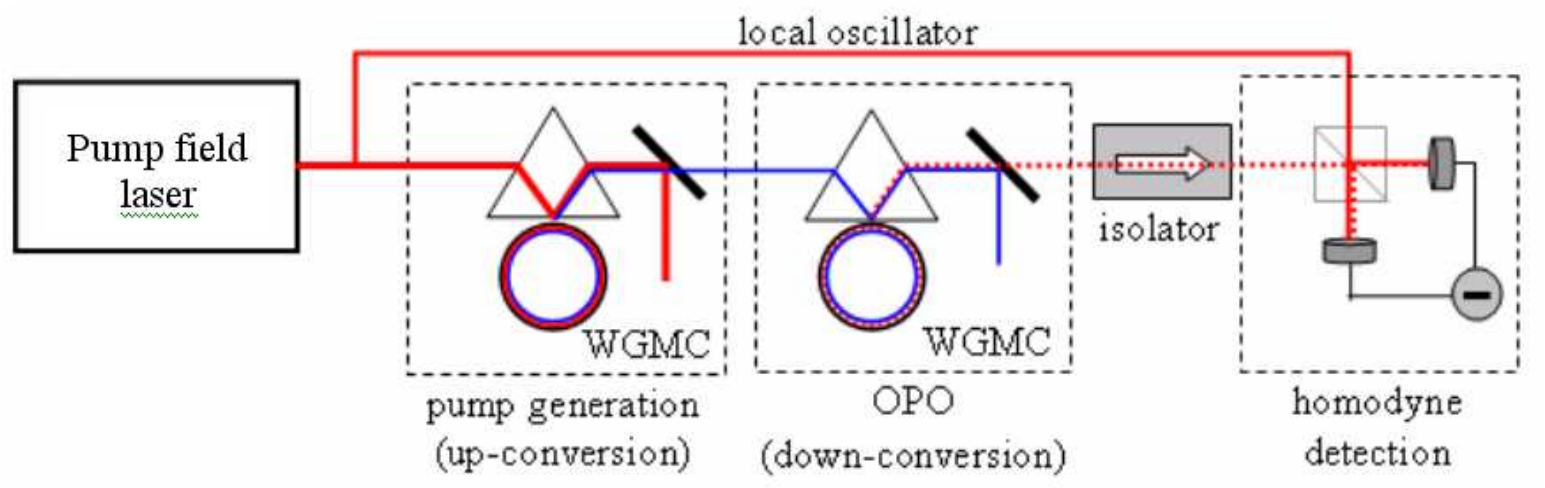

Figure: Experiment Using WGMRs

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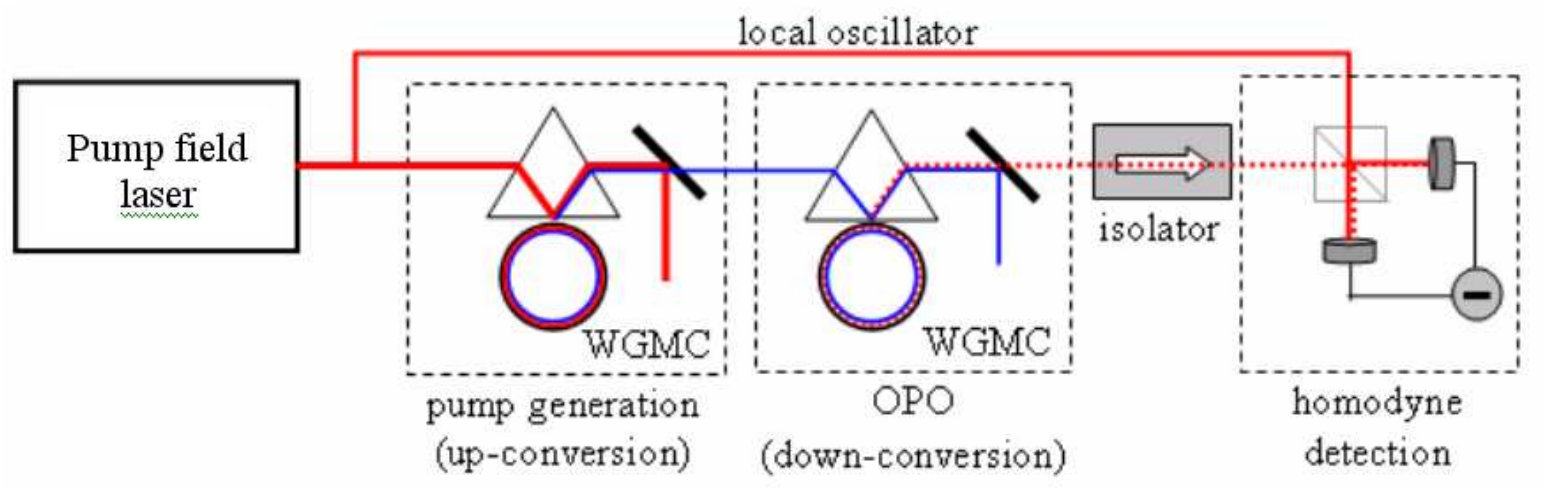

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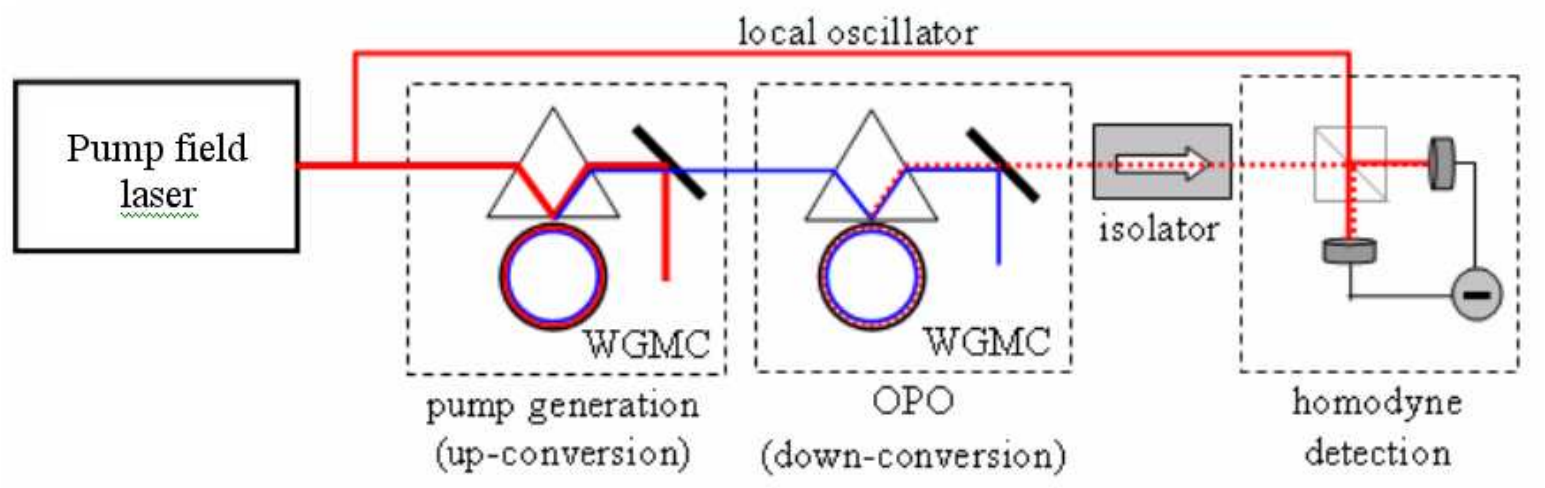

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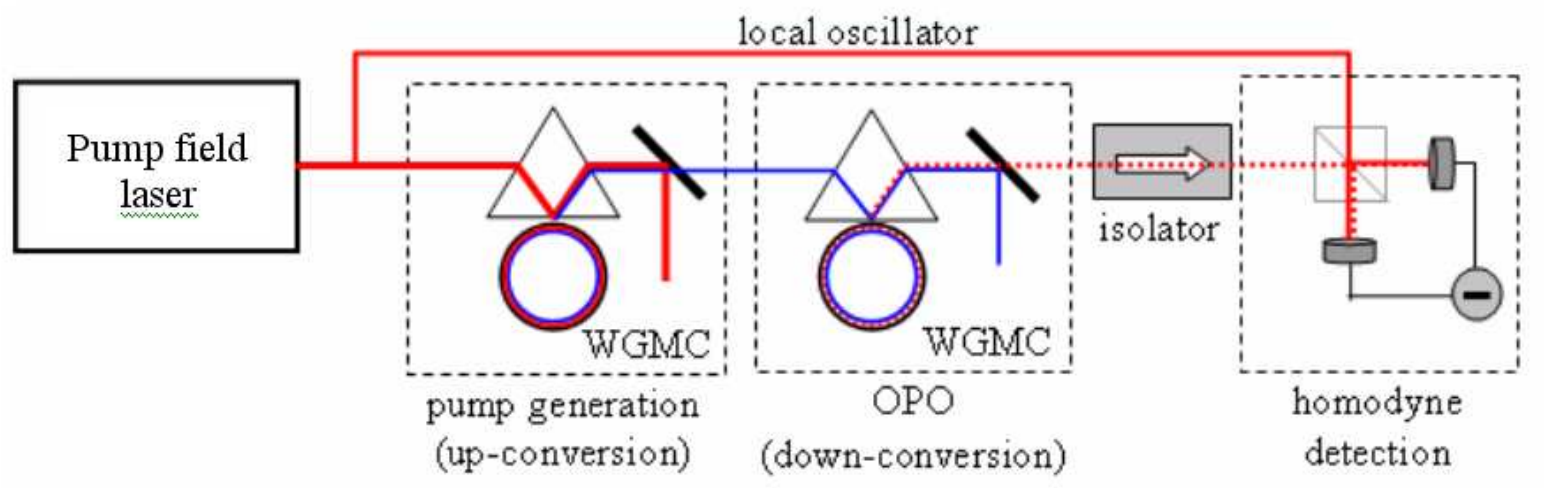


Figure: Experiment Using WGMRs

Production

Figure: WGMR Disk

Materials

- Glass
- $LiNbO_3$
- $LiTaO_3$, Silica, CaF_2

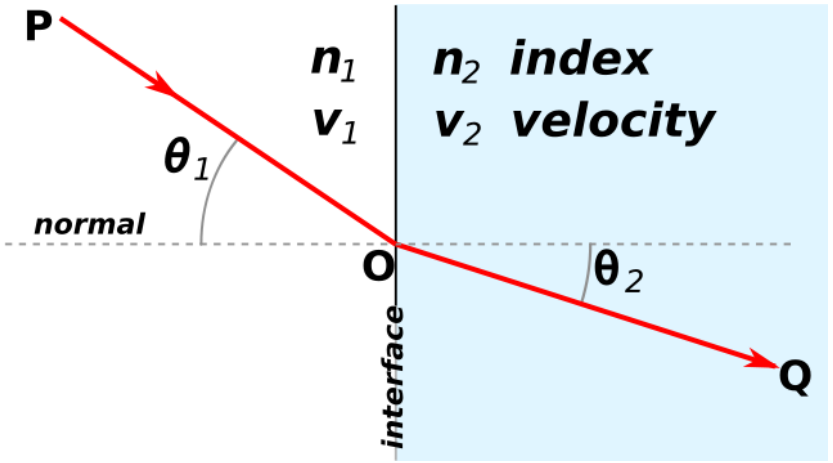
Production

Figure: WGMR on Post

1. Rough-cut Disks from Material
   - Diamond-Tipped Drill Bits
2. Attach to Post for Lathing
   - Heat-Activated Clamp
3. Sand and Polish
   - Lathe
   - Diamond Grit Sandpaper

How to Couple Light Into WGMR

Light Entering Disk Must Refract 90°



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- For $n_1 > n_2$:
  θ_1 Required Will Result in Total Internal Reflection

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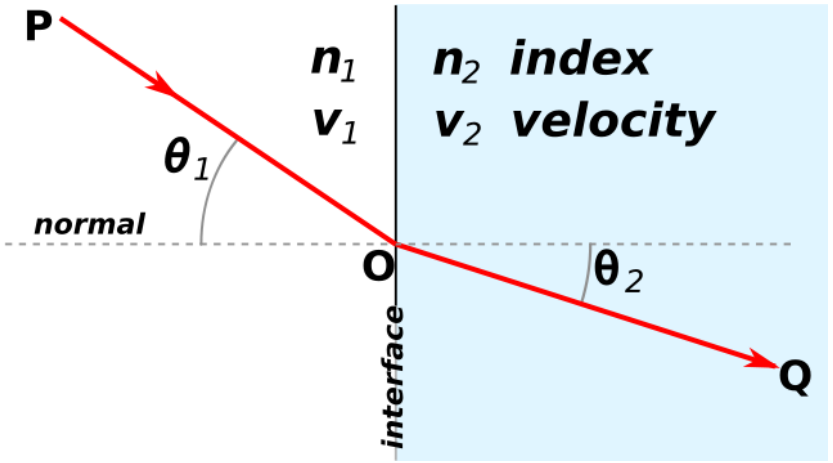

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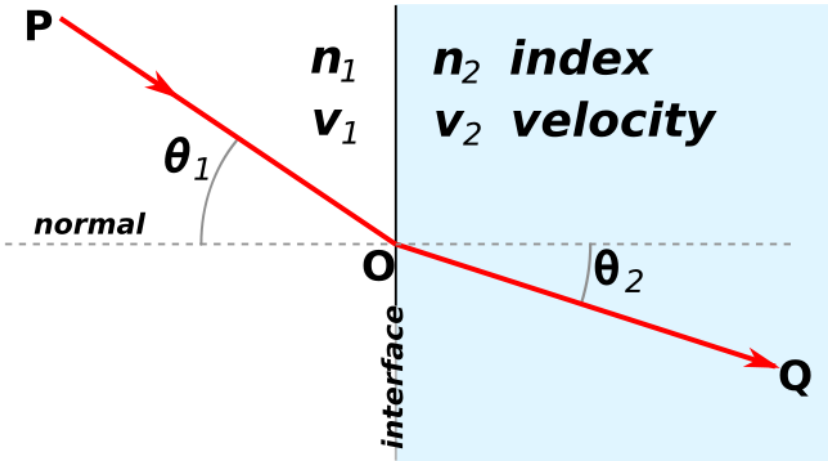

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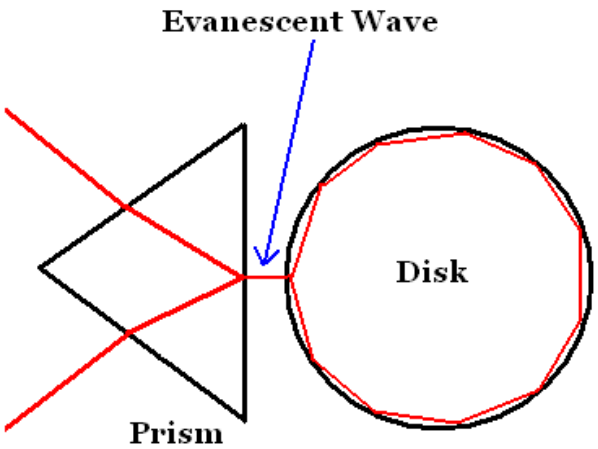

Figure: Coupling

Solution:

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- Disk Must Be Within Range of Evanescent Wave

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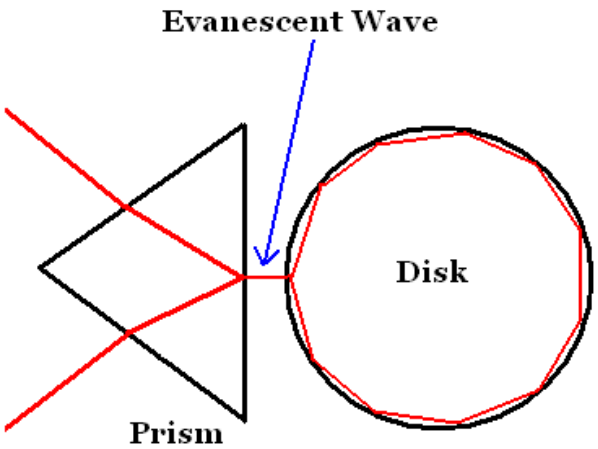

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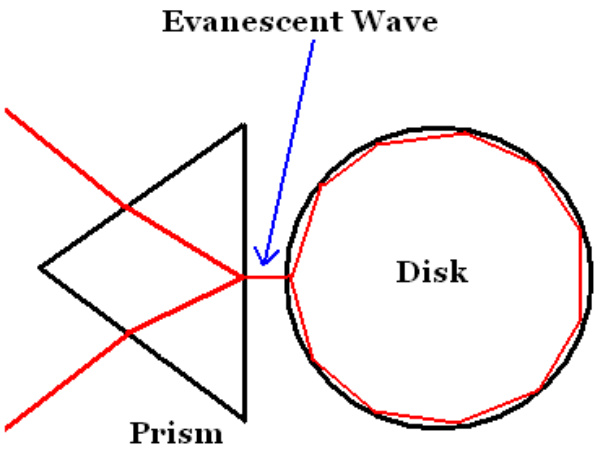

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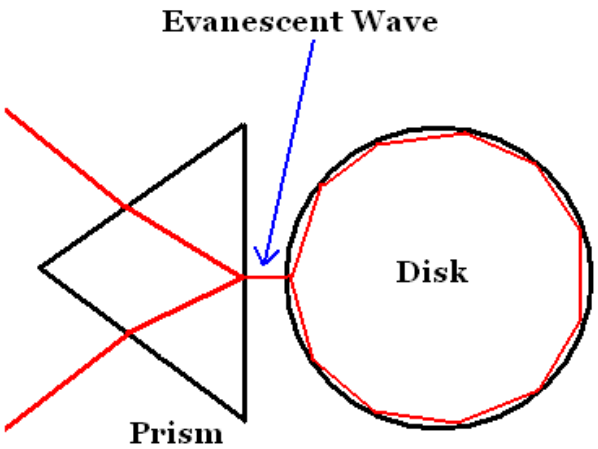

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Apparatus

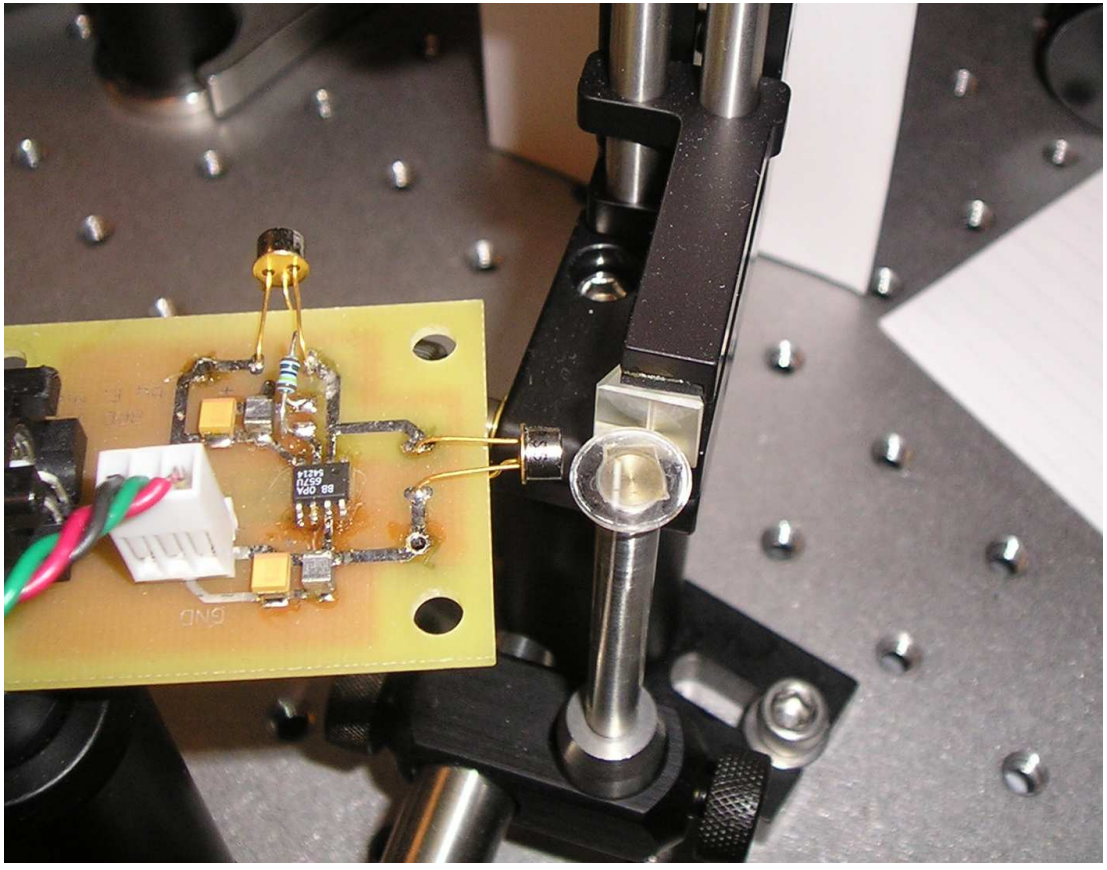


Figure: Our Current Apparatus

Apparatus

Photodetector Placement

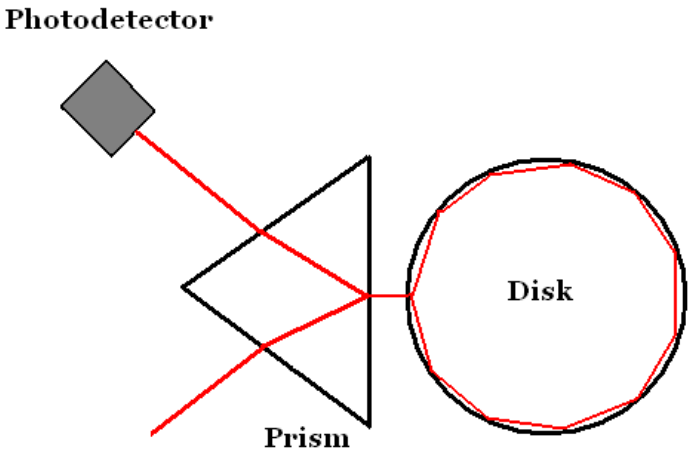


Figure: Desired

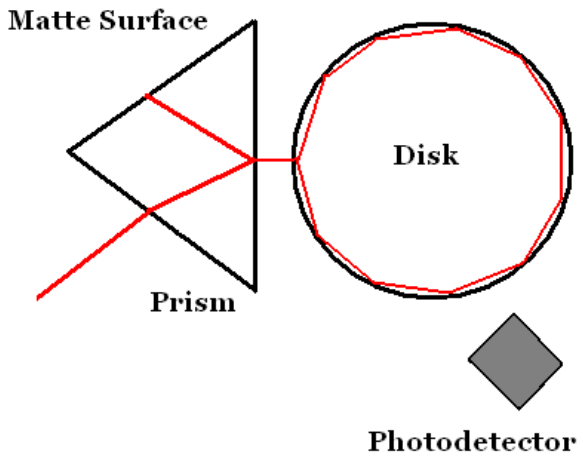
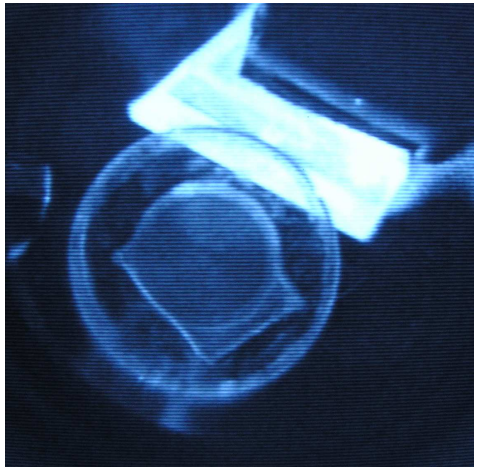
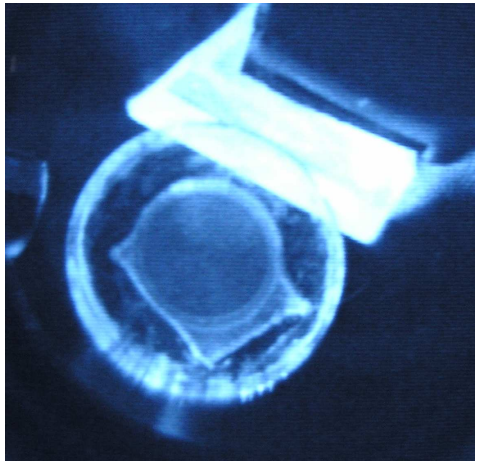


Figure: Current

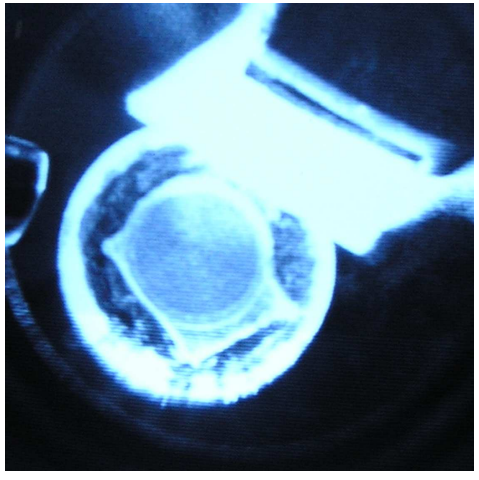
Results



Uncoupled Disk

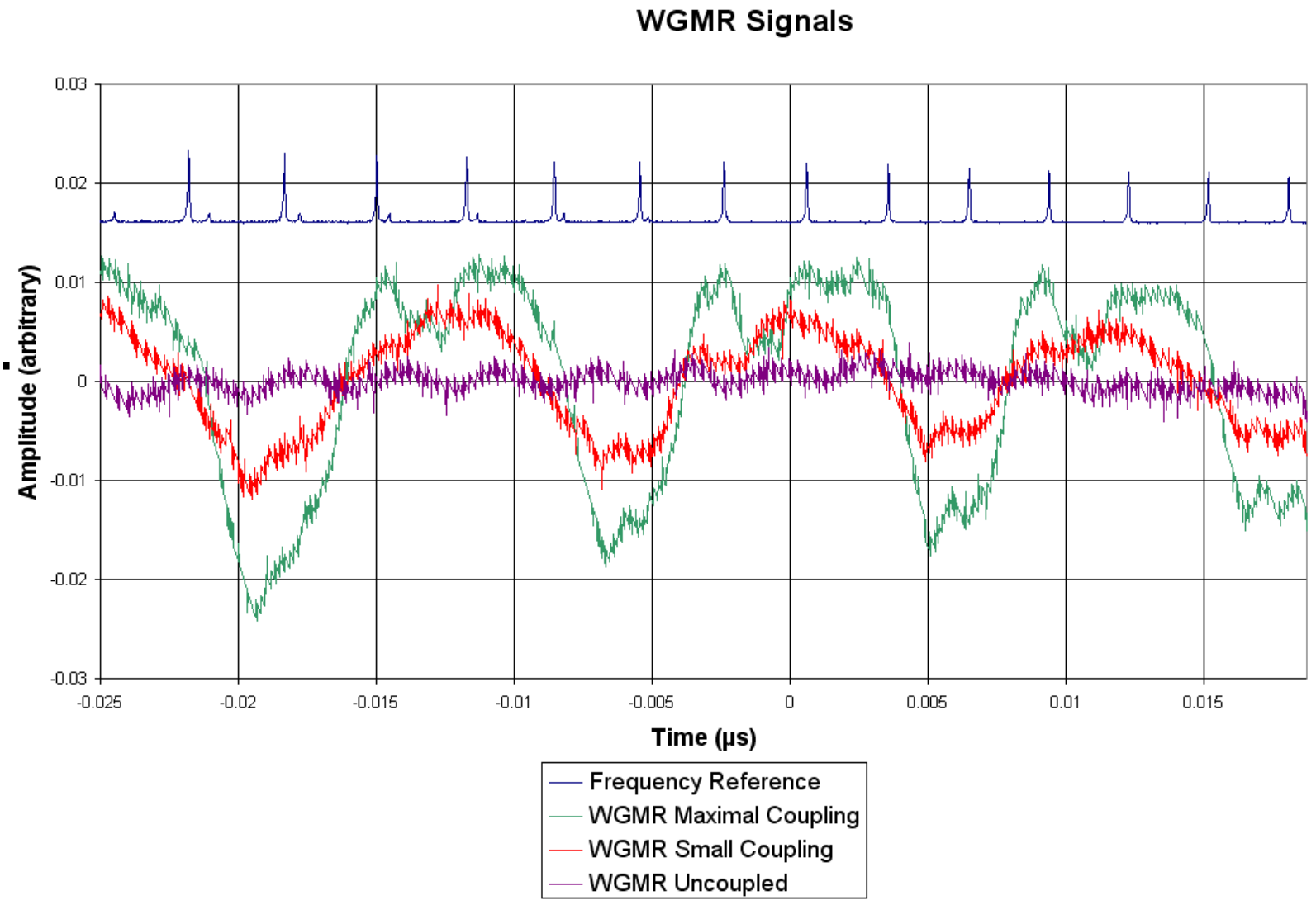


Coupled Disk



More Coupling!

Results


WGMR Signals
Amplitude (arbitrary)
0.03
0.02
0.01
0
-0.01
-0.02
-0.03
-0.025
-0.02
-0.015
-0.01
-0.005
0
0.005
0.01
0.015
Time (µs)
Frequency Reference
WGMR Maximal Coupling
WGMR Small Coupling
WGMR Uncoupled

Future Work

- $LiNbO_3$
- Diamond Prism
- New Mounting System

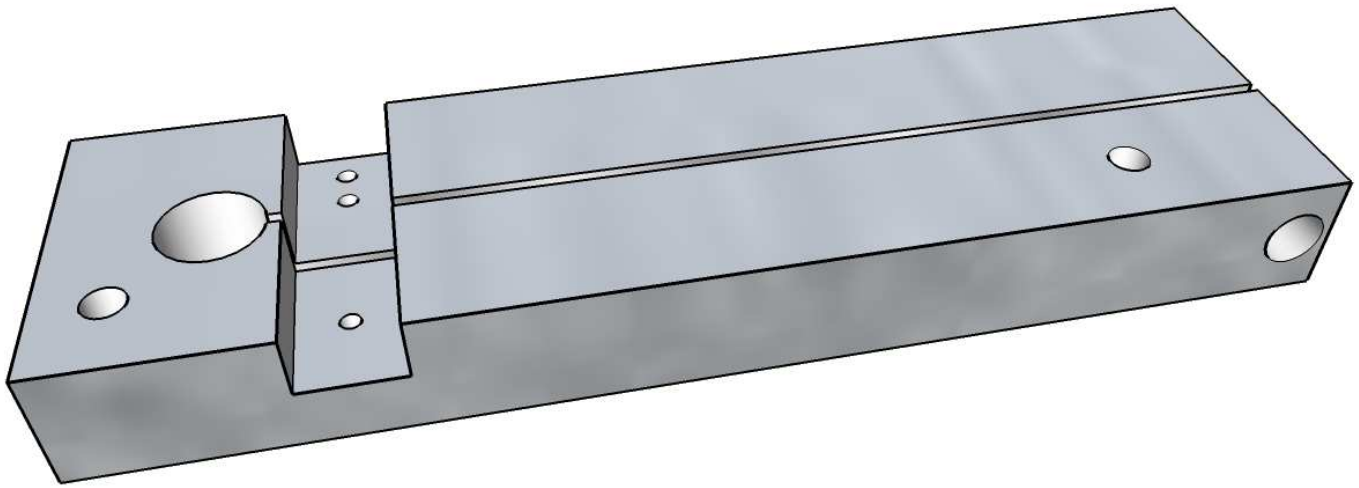


Figure: Mount Prototype

Summary

- Have Built WGMRs and Achieved Coupling
- Understand the Techniques Behind Construction
- Non-Linear Media and Future Experiments
  - $LiNbO_3$
  - New Mount Design

THE END