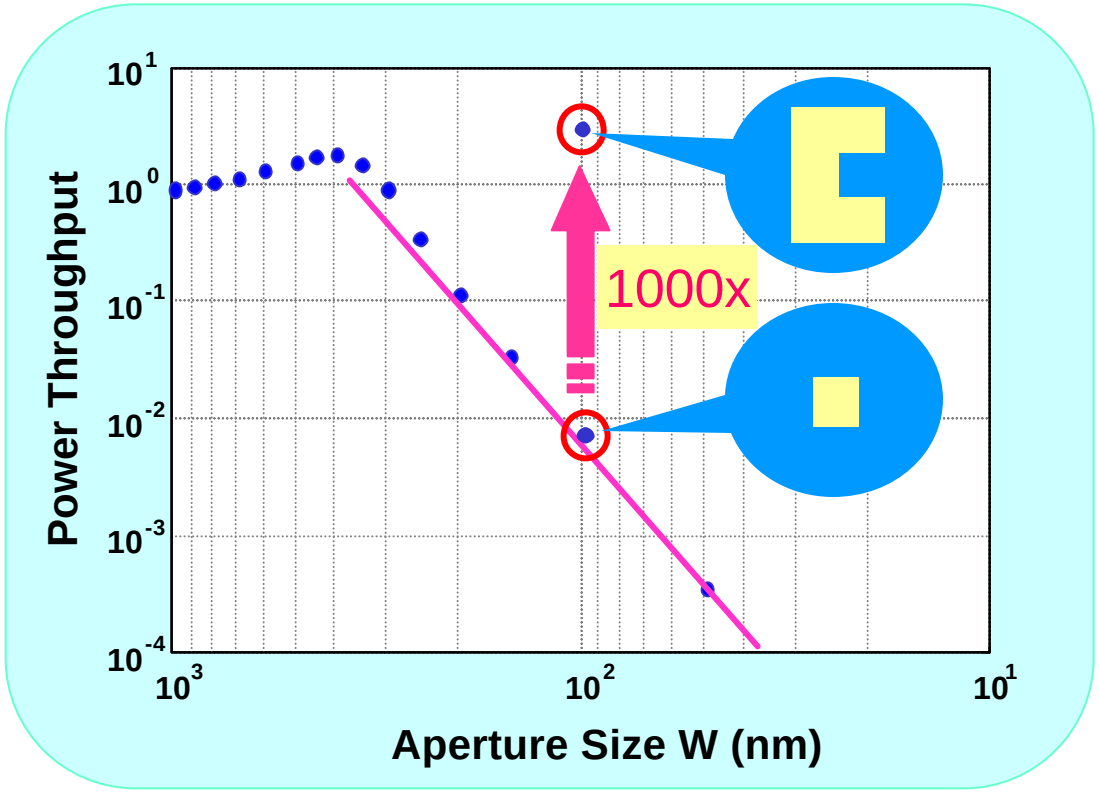
A Nano-aperture with 1000x Power Throughput Enhancement for VSAL



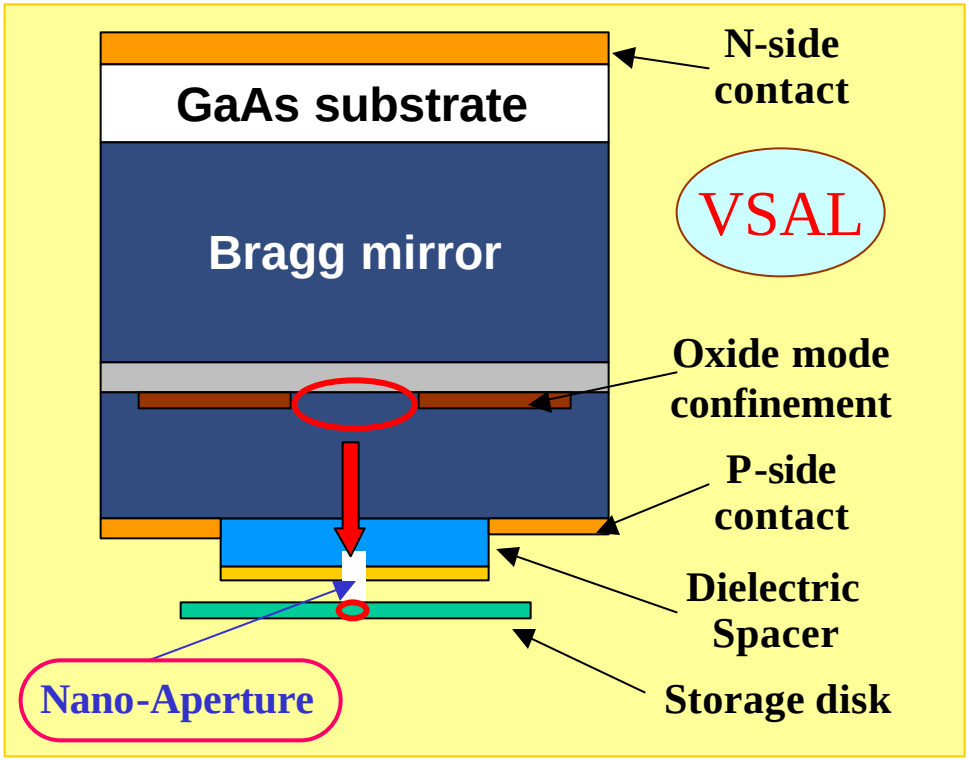
Xiaolei Shi, Robert L. Thornton, Lambertus Hesselink

Contact: xiaolei@stanford.edu

siros technologies

Introduction: VSAL

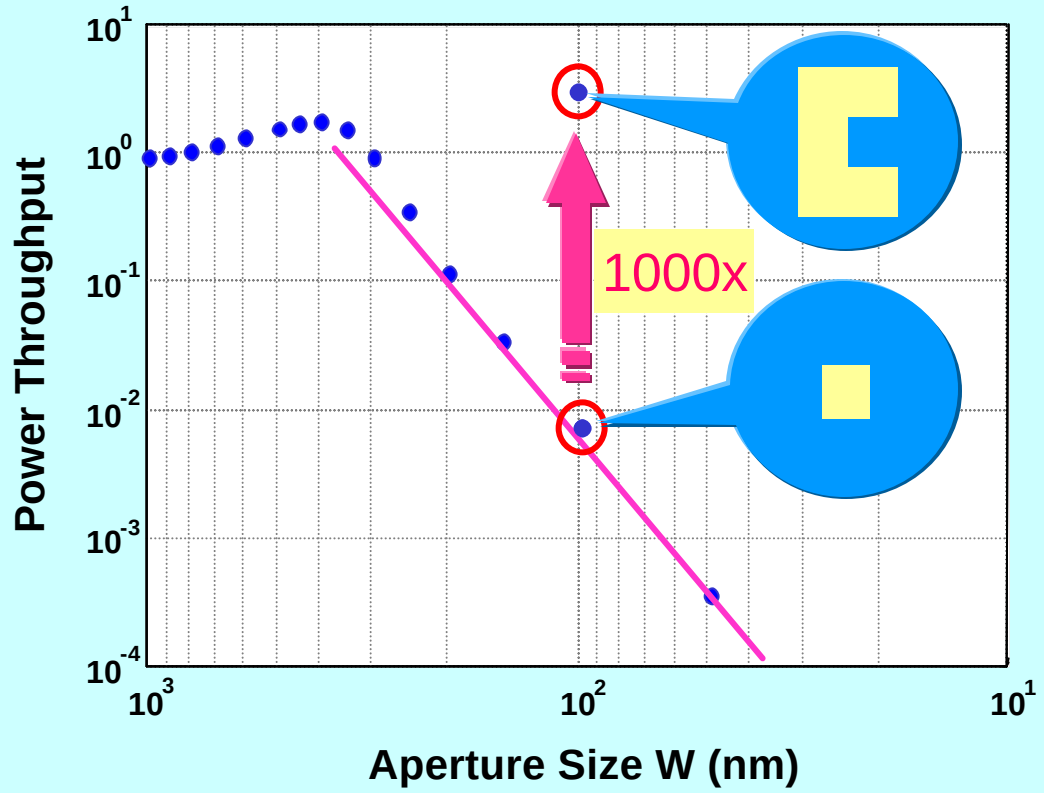
- VSAL:Very Small Aperture Laser system
- Near field optical data storage
- the minimum spot size is determined by the aperture size



Spot size & Field Intensity

siros technologies

Overview

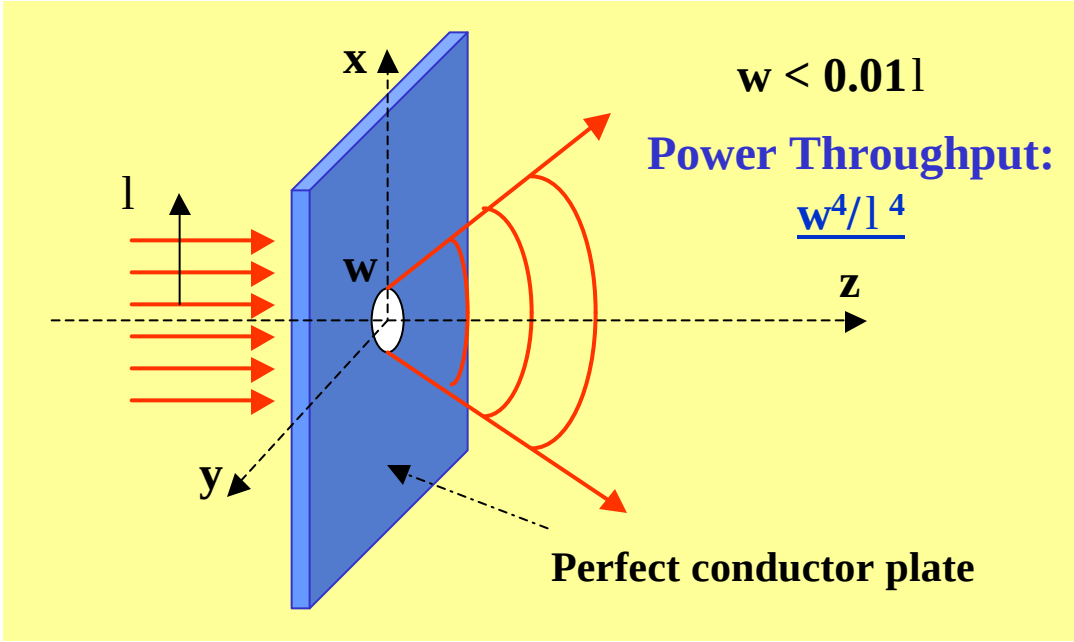


- Problem:
  Power throughput scales: ~ $(W/\lambda)^4$
- Solution:
  C-aperture, ~1000× enhancement
- Physics:
  Polarization & resonance effects

Introduction: Nano-apertures

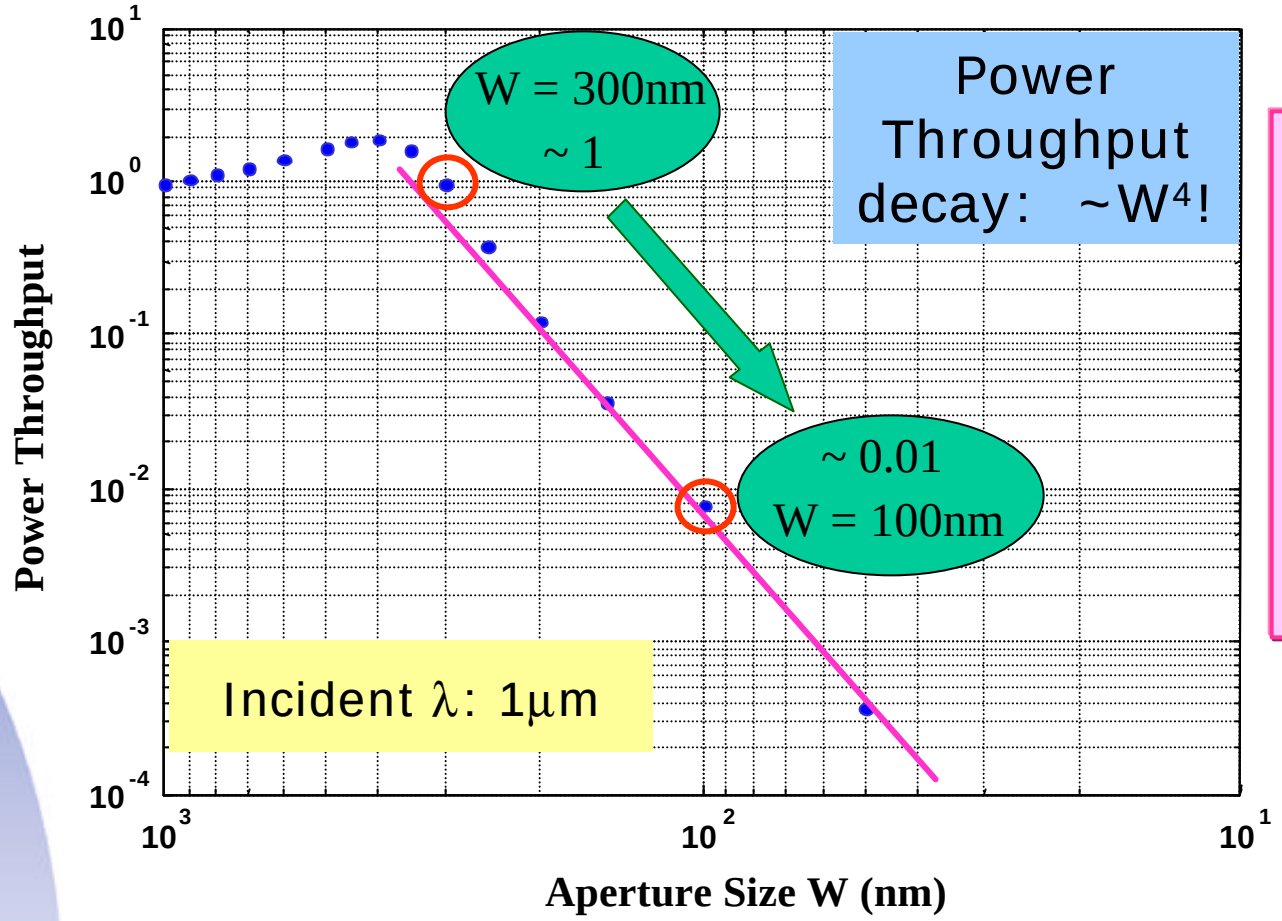
- Bethe theory (1944) : radiation through circular aperture in perfect conducting plate

H.A. Bethe
1967 Nobel Prize laureate in Physics.



$$PowerThrou\ ghput = \frac{TotalTrans\ mittedPowe\ r}{IncidentPo\ werOverApe\ rtureArea}$$

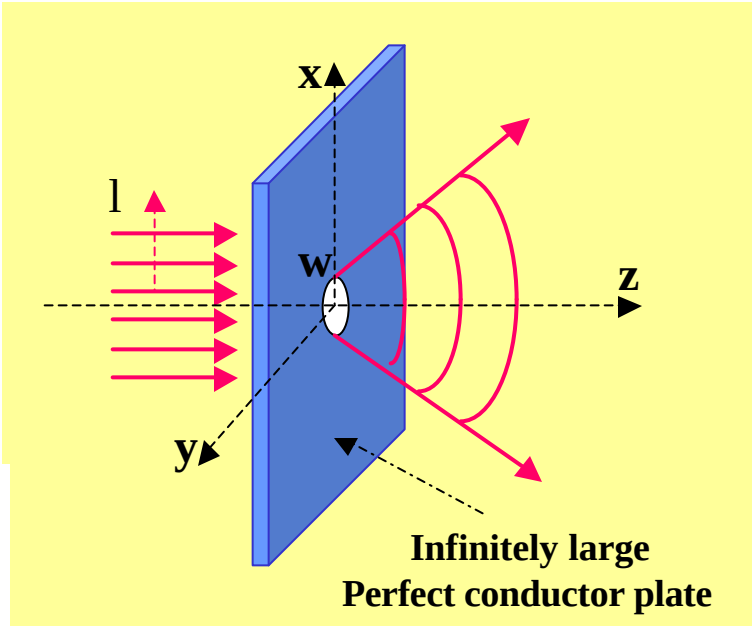
Introduction: Nano-Apertures

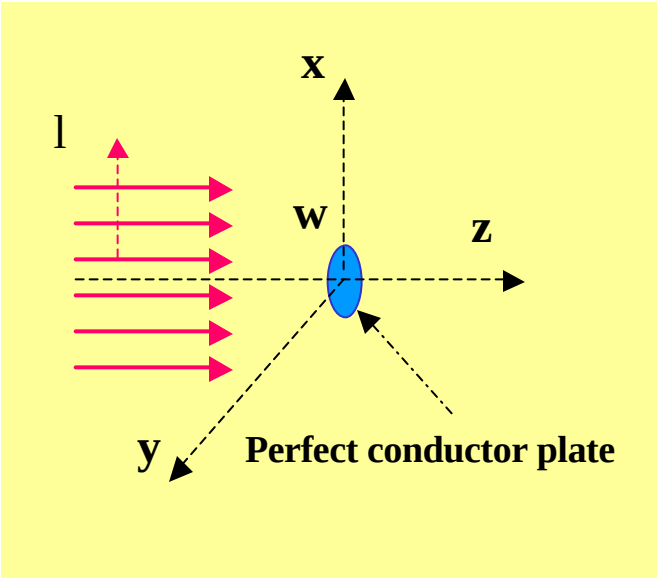


Need new aperture design to enhance power throughput!!

siros technologies

Simulation Setup



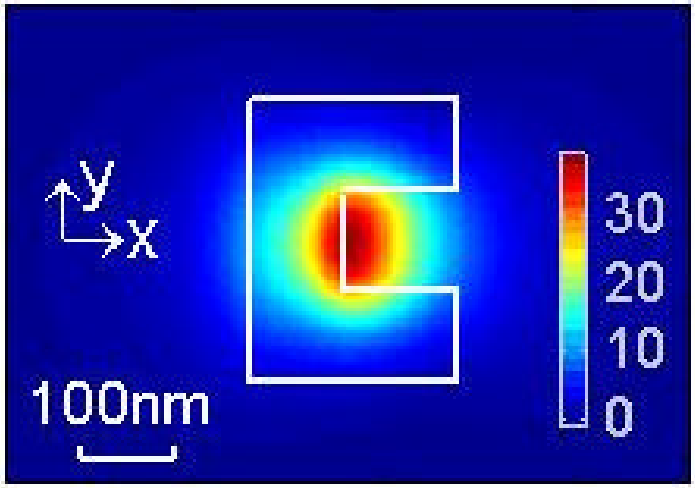


- XFDTD simulation
- Babinet's principle

- incident $\lambda = 1\mu m$ (geometry scales with λ)
- linearly polarized planewave
- aperture in perfect conductor plate

Simulation Results

C - aperture

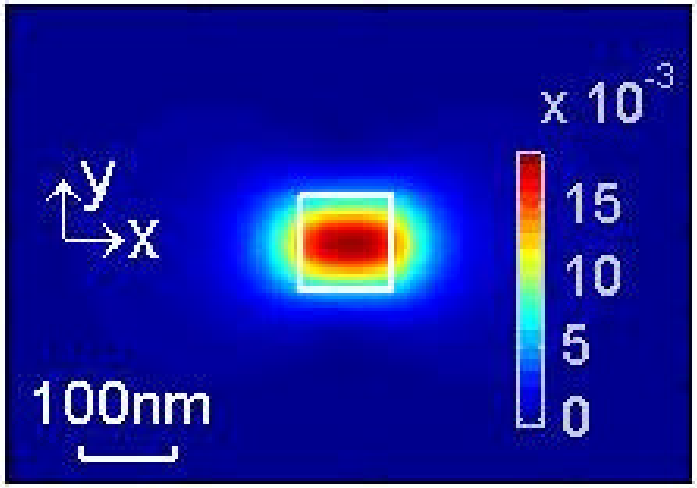


Peak Intensity at 48nm: 36

Power throughput: 4.41

Spot Size (FWHM):128nm ´ 136nm*

100nm Square aperture



Peak Intensity at 48nm: 0.019

Power throughput: 0.0078

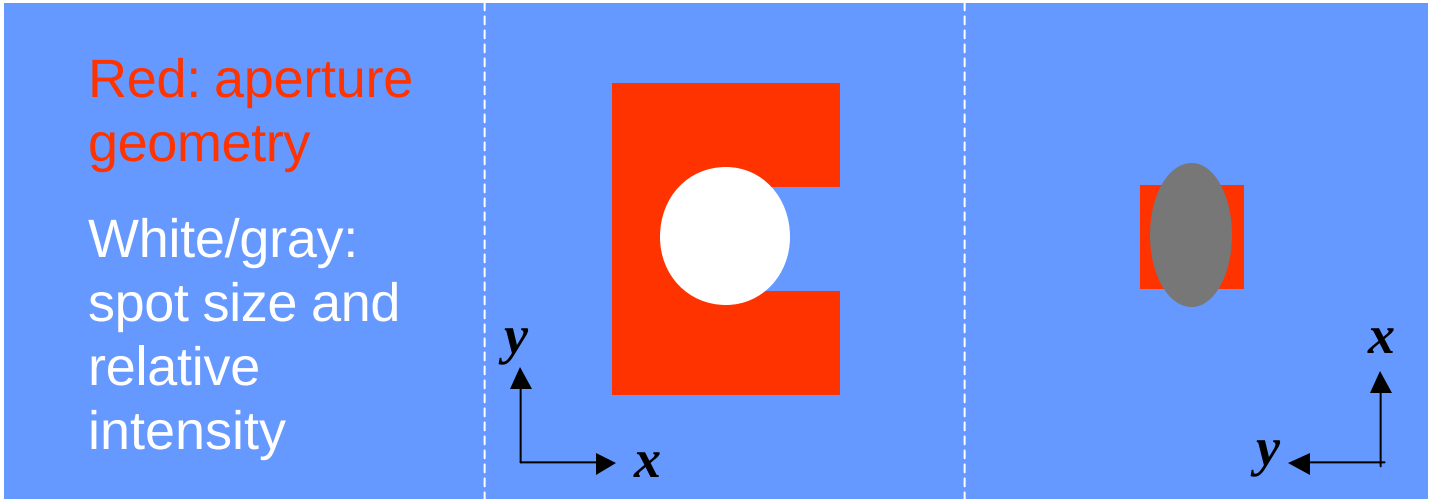
Spot Size (FWHM): 140nm ´ 80nm

Incident light polarized in x direction, λ = 1μm

*Spot size can be smaller

siros technologies

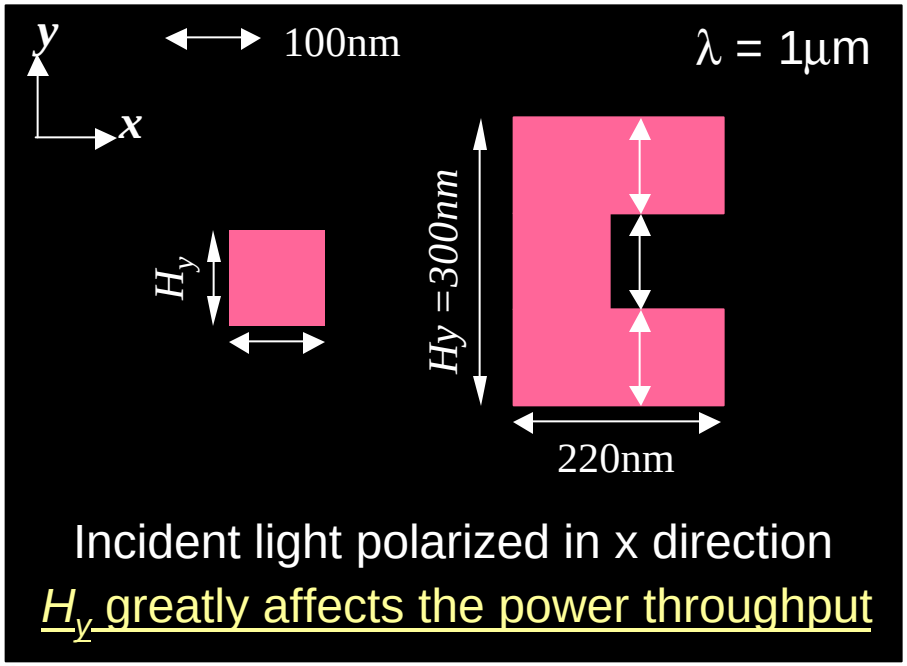
C-aperture vs.100nm square aperture



Near field spot size is comparable

Power throughput is enhanced by ~1000 times

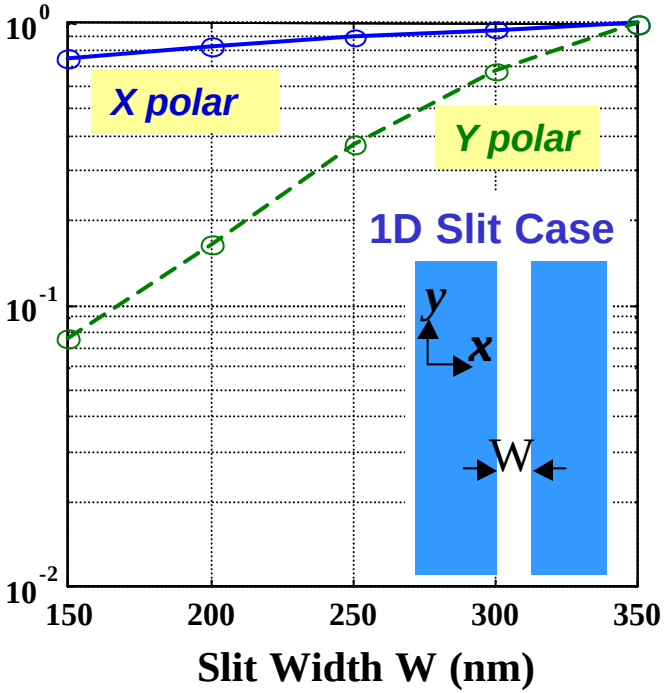
Polarization Effect



Incident light polarized in x direction

H_y greatly affects the power throughput

Power Throughput vs. Slit width



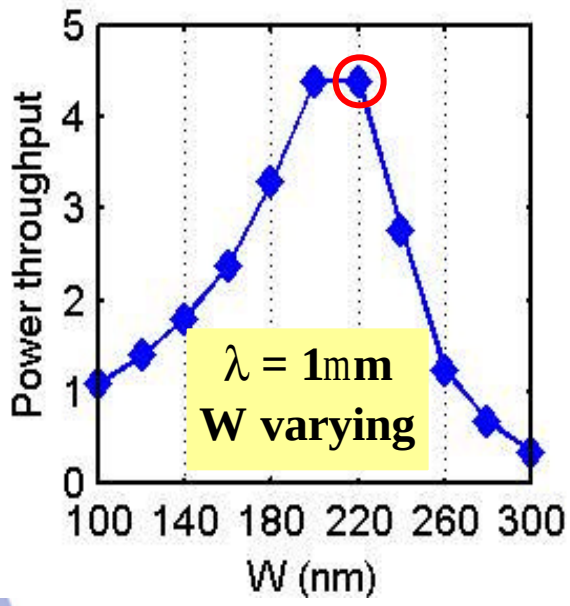
Polarization effect:

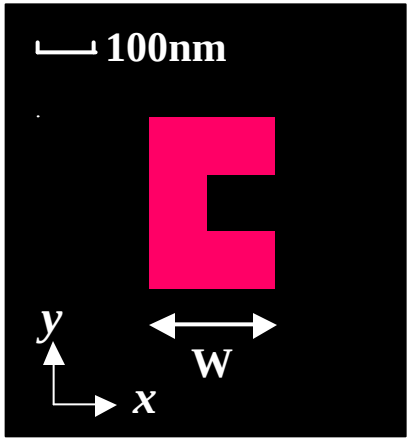
Aperture size in the direction that perpendicular to the incident polarization direction greatly affects the power throughput.

siros technologies

Resonance Effect

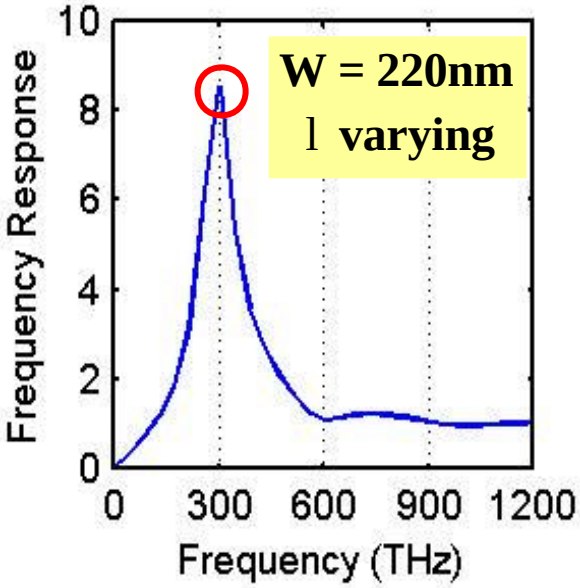
Experiment 1





Incident light:
x polarized,
wavelength λ

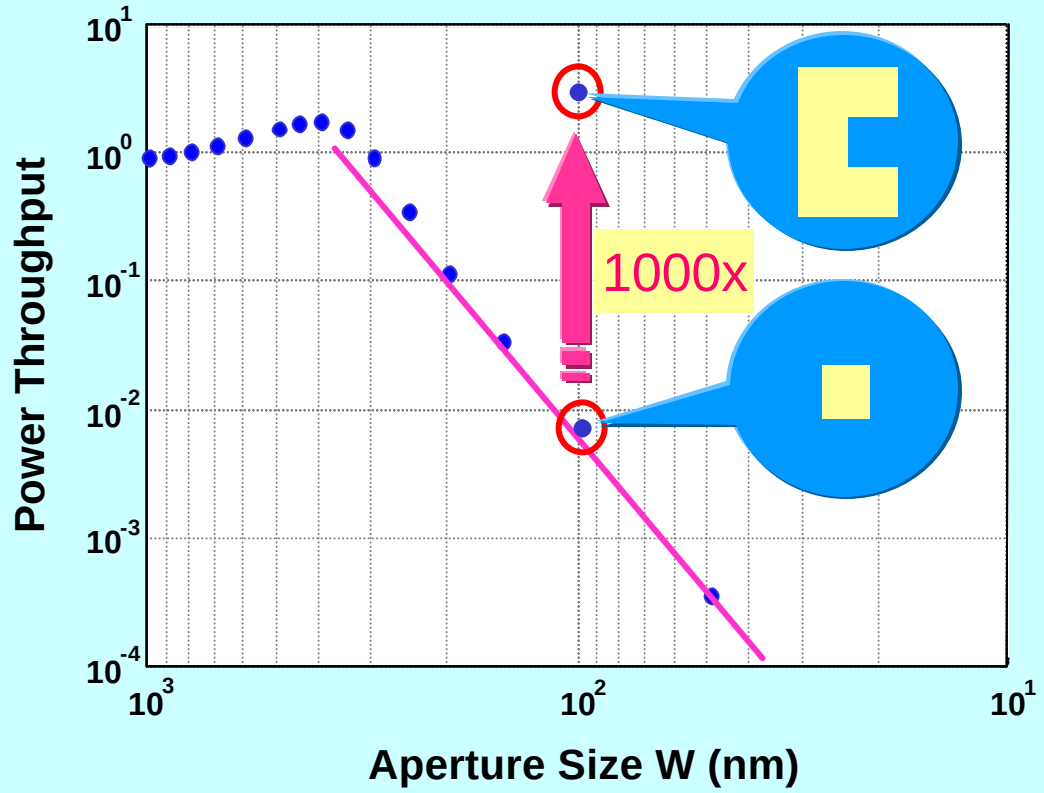
Experiment 2



Numerical tests show the existence of resonance

siros technologies

Summary



- Problem:
  Power throughput scales: ~ $(W/\lambda)^4$
- Solution:
  C-aperture, ~1000× enhancement
- Physics:
  Polarization & resonance effects

Contact: xiaolei@stanford.edu

siros technologies