

# Recent New Ideas and Directions for Space-based Nulling Interferometry

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TPF SWG meeting  
October 2004

## Motivation

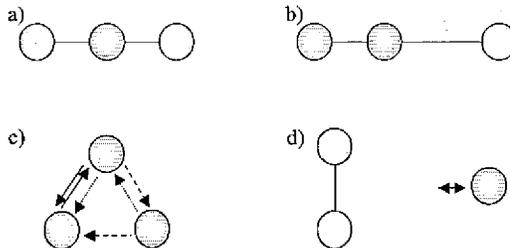
- New ideas have emerged from here & there
- Goal: where are we (nulling interferometry in space) compared to a year or so ago?

## $\theta^4$ or $\theta^2$ nulls?

- $\theta^4$  nulls not necessarily required
  - $\theta^2$  nulls largely sufficient
  - simpler configurations

## Smallest possible TPF: 3 Telescopes

- Three telescopes provide an interesting “smallest possible TPF” option:
  - Formation flying easier
  - Complexity minimal



- a) Can have same chopped response as dual-Bracewell
- b) High null leakage due to longer baseline
- c) Only three spacecraft needed for formation flying
- d) Only two spacecraft

## Pupil configurations

- Current configuration trade space is already reduced (“down selected”):
  - Only options with  $\leq 4$  telescopes are being considered
  - $\leq 5$  spacecraft
  - System less complex
  - Formation flying less complex

## Flexible Beamcombiners

- A single BC for 3 **or** 4 telescopes
- Graceful degradation (from 4 to 3)
- $\theta^2$  or  $\theta^4$  nulls at different outputs of BC
- Virtual telescope arrays defined by BC
- Phased array beamcombiners
- Different algorithms for different BC outputs

## Fiber Nullers

- New beamcombiner approach:
  - Fiber nuller: no beamsplitter
  - N beams combined at once
  - Experimental results (100,000:1) in hand

## MIR fibers are becoming a reality

- First deliveries from Israel & Europe
- NRL: new potential source

## Definition of a Configuration

- Formation flying is inherently flexible – can it allow for more than one pupil geometry?
- What are the hardware differences between configurations?
- Classes of configurations:
  - 4T, 5S
  - 4T, 4S
  - 3T, 4S
  - 3T, 3S

## Summary

- Our understanding compared to a year or so ago:
  - Simpler options identified
  - A degree of flexibility is possible (BC & pupil), allowing switching (or degradation) between some options
  - Not necessary to define every component to the exclusion of all other possibilities
  - MIR fibers are becoming a reality
- Of course SNR is still the main driver
  - No escape!

# The Fiber Nuller

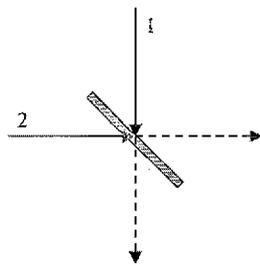
Gene Serabyn & Pierre Haguenaer

TPF SWG

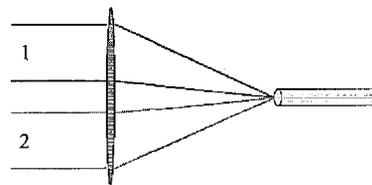
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## The Idea

- Combine beams in a fiber instead of at a beamsplitter

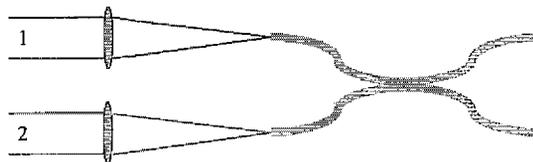


A: Two free-space fields combine at interface



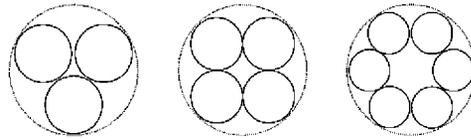
B: Fields combine in fiber

can combine n beams; coupling issues



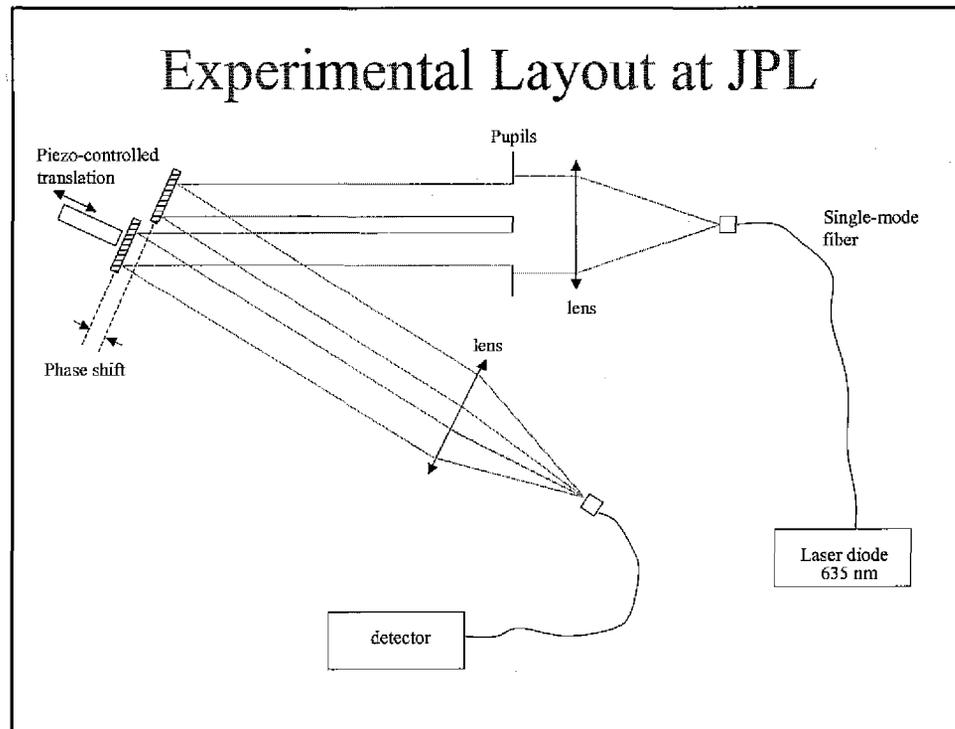
C: Full fiber combiner: has fiber length, dispersion, and polarization-matching issues

## Multi-axial single-mode beam recombination

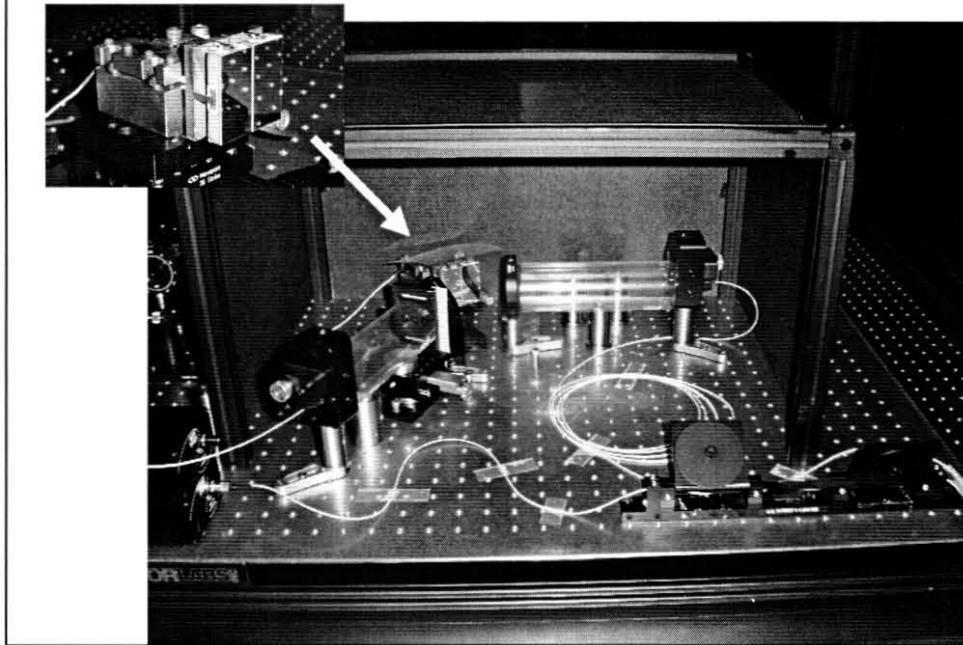


- Wallner et al. & Karlsson et al. in SPIE 2004

## Experimental Layout at JPL

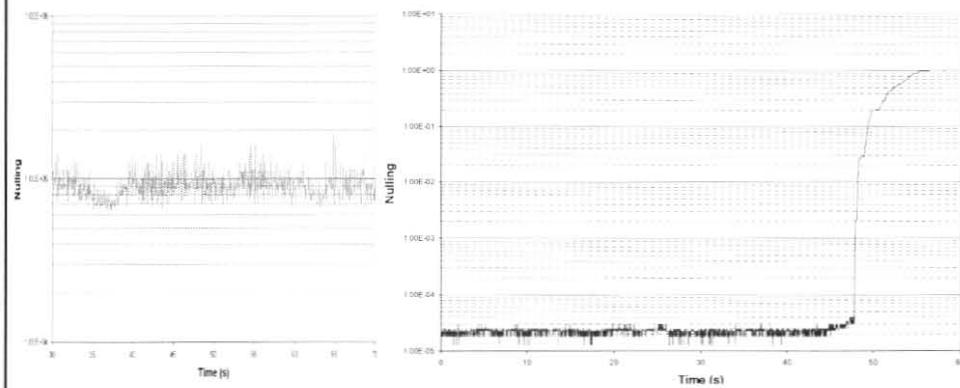


## The fiber nuller experiment



## Results

- Measured rejection of visible laser: 100,000:1
- Basic principle of fiber nulling demonstrated



- The future:
  - broadband light
  - move to the infrared
  - try it out on a telescope