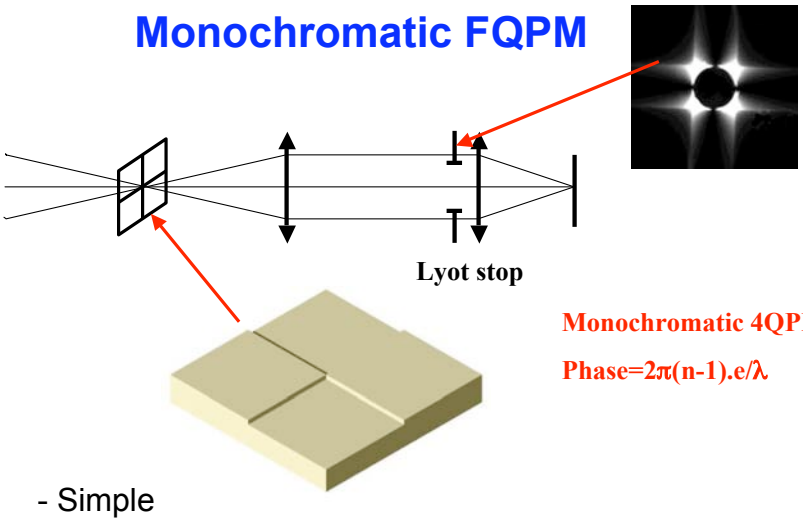
Multiple-Stage Four Quadrant Phase Mask Coronagraph

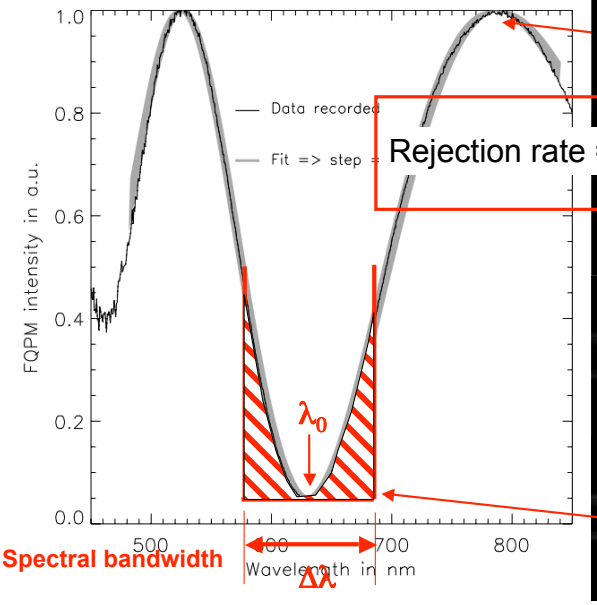
P. Baudoz, R. Galicher, A. Boccaletti,
D. Rouan, J. Baudrand

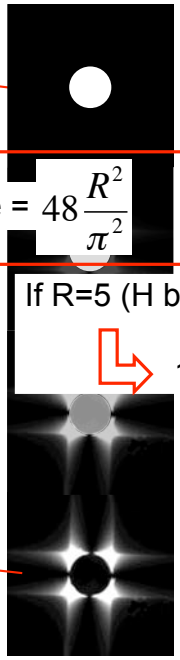
Monochromatic FQPM



- Simple
- well studied (lab, JWST, VLT-NACO)
- already built for visible, NIR,thermal IR

FQPM chromaticity



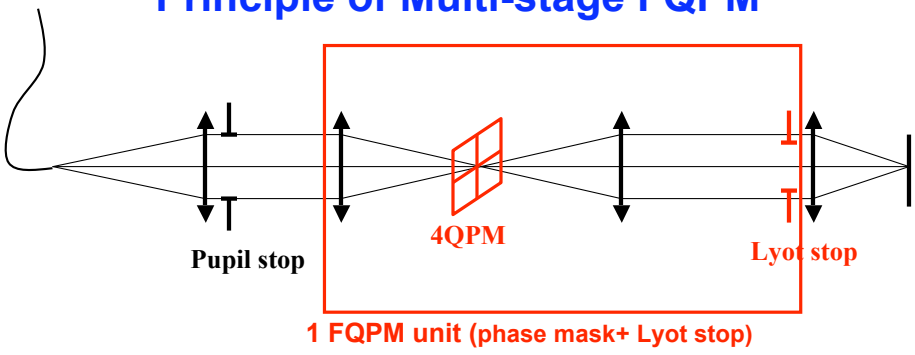


Rejection rate = $48\frac{R^2}{\pi^2}$ $R = \frac{\lambda}{\Delta\lambda}$

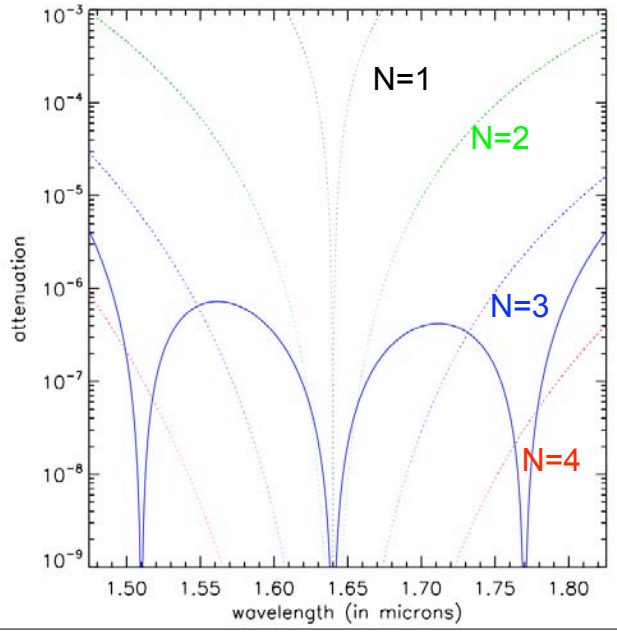
If R=5 (H band)

120

Principle of Multi-stage FQPM

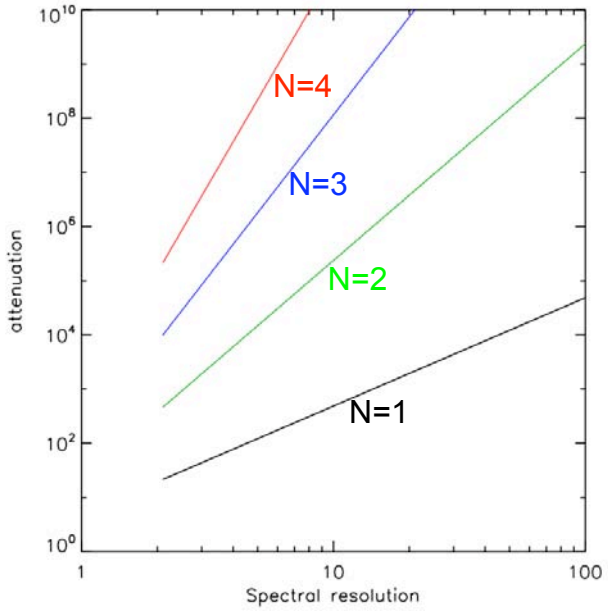


Multi-stage FQPM chromaticity (H Band)



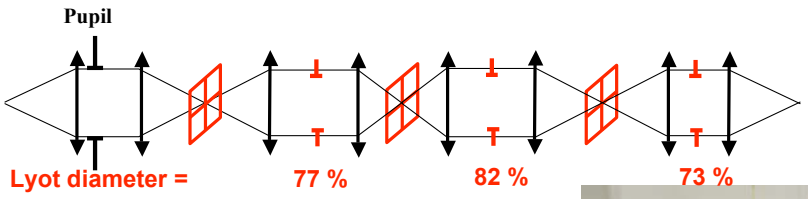
$$\left(48\frac{R^2}{\pi^2}\right)^N$$

General Multi-stage FQPM chromaticity



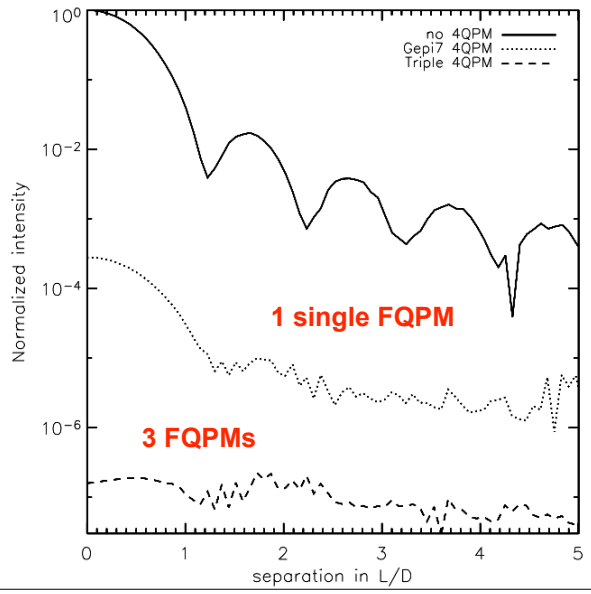
$$\left(48\frac{R^2}{\pi^2}\right)^N$$

Laboratory tests : set-up



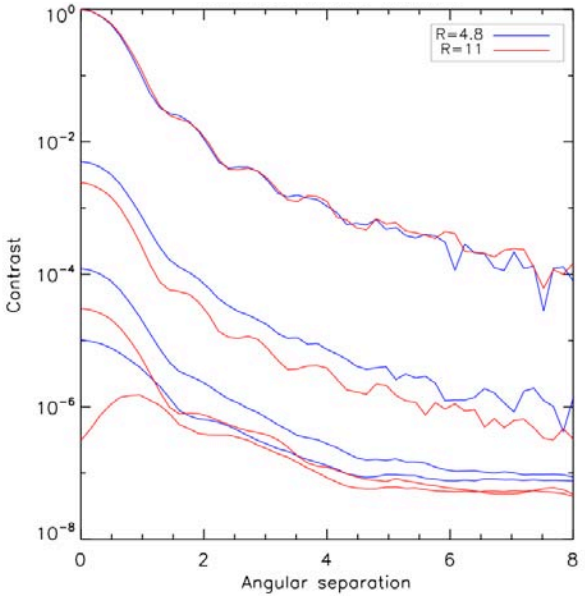
- Super-luminous source
- 3 monochromatic FQPMs optimized for:
  - 623 nm
  - 633 nm
  - 641 nm
- Standard lenses
- Entrance pupil : 1.78 mm (chromaticity, sphericity)

Laboratory tests :monochromatic

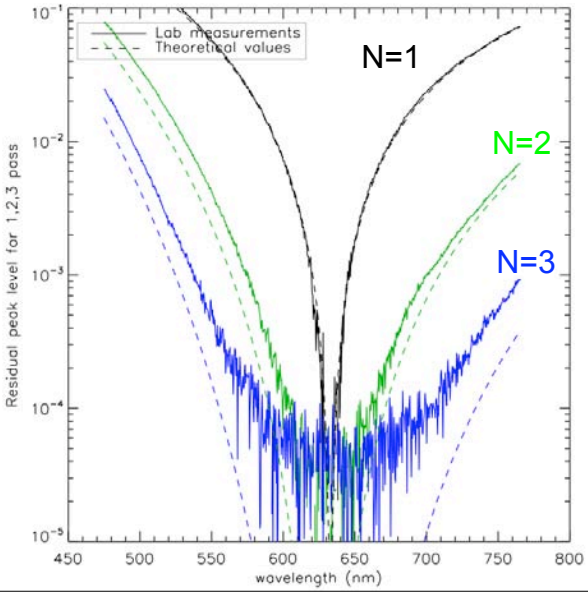


Profiles for Multiple Stage FQPMs

- N=1, 2 and 3
- Spectral bandwidth
  R=λ/Δλ=4.8 and 11



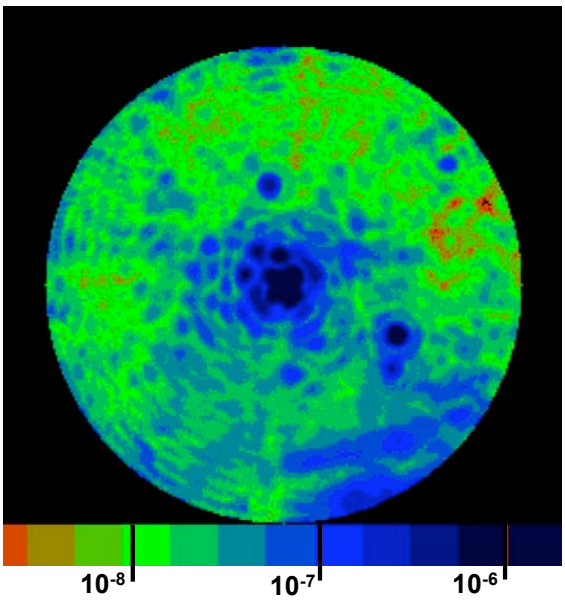
Laboratory tests : spectroscopy



Laboratory results R=λ/Δλ=11

3 FQPM

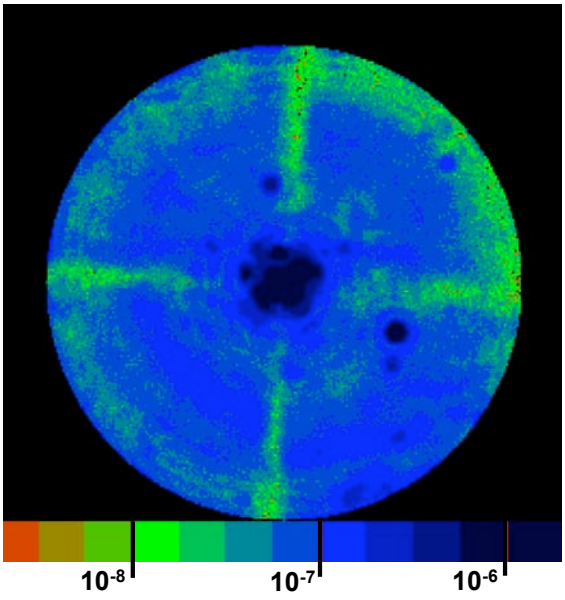
35 λ/D



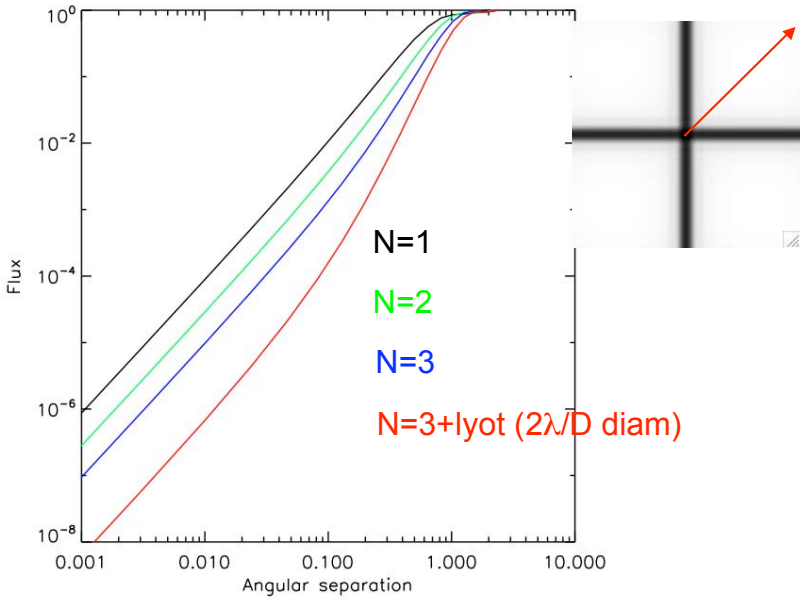
Laboratory results R=λ/Δλ=4.8

3 FQPM

35 λ/D

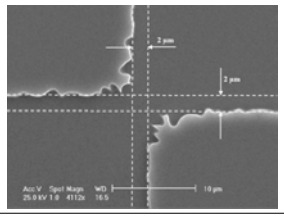


Multi-stage IWA



Advantages of Multiple-stage

- Based on well known technologies
- Small Inner Working Angle (<1.5 λ/D)
- But relaxed stellar size issue
- Relaxed central obscuration issue
- Relaxed fabrication specification



Conclusion

Theoretically:

with 3 FQPMs well optimized > 10^6 rejection rate

Laboratory test :

10^7 @ 4 λ/D for typical astronomical bandwidth
$R=\lambda/\Delta\lambda = 5$

To be done :

- full evaluation of performances with ground-based XAO

- design and build compact version with FQPM optimized for large spectral bandwidths.