# DETECTING EXO-SOLAR SYSTEMS

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# Imaging system

- ELT
- High Strehl Adaptive Optics
- Rotation shearing coronograph
- Imaging & Differential imaging

# Limiting noises

- Speckle noise
- Star photon noise
- Planet photon noise
- Readout noise

# Speckle noise

- Without adaptative system: pure speckle noise ($\sigma2 = I2$, Dainty – 1974)

- With partial adaptative correction

  (Canales & Gagigal, 1999)

- Experimental approach (Racine et al.1999)

- Non stationnary phase structure fonction with spatial & spectral correlations

  (Chelli & Tatulli, in preparation)

# Signal to noise ratio

$$SNR \approx \frac{f\overline{K}\Delta\lambda S Q_1}{\sqrt{4\overline{K}^2\Delta\lambda^2\frac{\tau}{T}(1-\mathcal{S})^2 g^2\left(\frac{r_0}{D}\right)^4\left(\frac{4}{\pi}\right)^2 L^2(\gamma,\overline{\lambda})Q_2^2 + 2\overline{K}(1-\mathcal{S})g\Delta\lambda c^2\left(\frac{r_0}{D}\right)^2 L(\gamma,\overline{\lambda}) + f\overline{K}\Delta\lambda S Q_1 + \sigma^2}}$$

$$SNR \approx\approx \frac{f}{2}\frac{\mathcal{S}}{1-\mathcal{S}}\left(\frac{D}{r_0}\right)^2\frac{1}{L(\gamma,\overline{\lambda})}\frac{Q_1}{Q_2}\sqrt{\frac{T}{\tau}}$$

# Differential imaging

- Scaling

  - If $\beta\Delta\lambda/\lambda > 1$ then the 2 contributions of the planet are fully separated

- Weighting

SPECKLE SNR AS A FUNCTION OF THE INTEGRATION FIELD

SAMPLING=0.5"

...... INF SAM / W

– – INF SAM / UW

A. Chelli -- Florence ELT meeting, November 8-10 2004

SPECKLE SNR AS A FUNCTION OF THE ANGULAR DISTANCE

RESOLUTIONS: 5, 10, 25, 100, 5000

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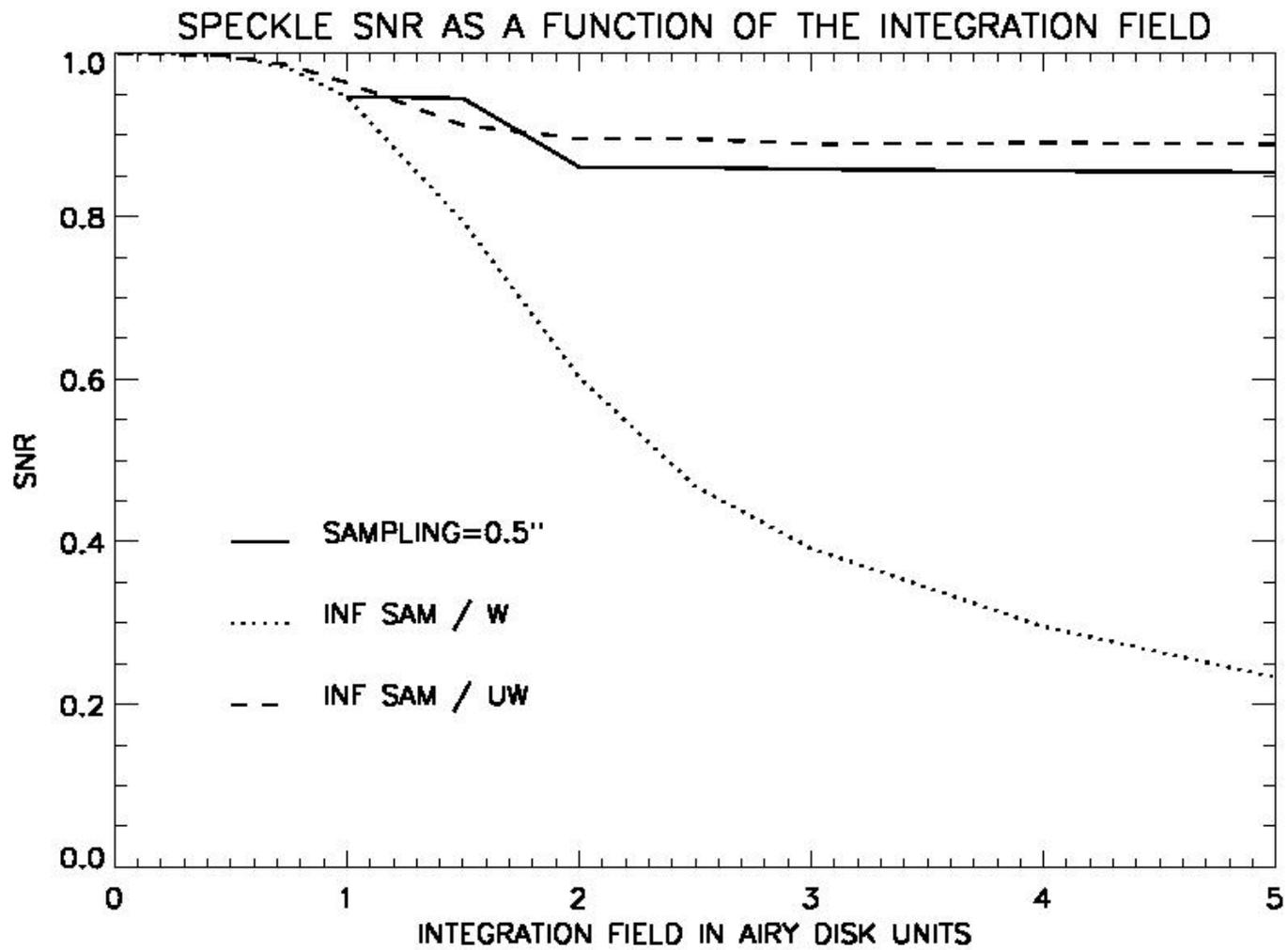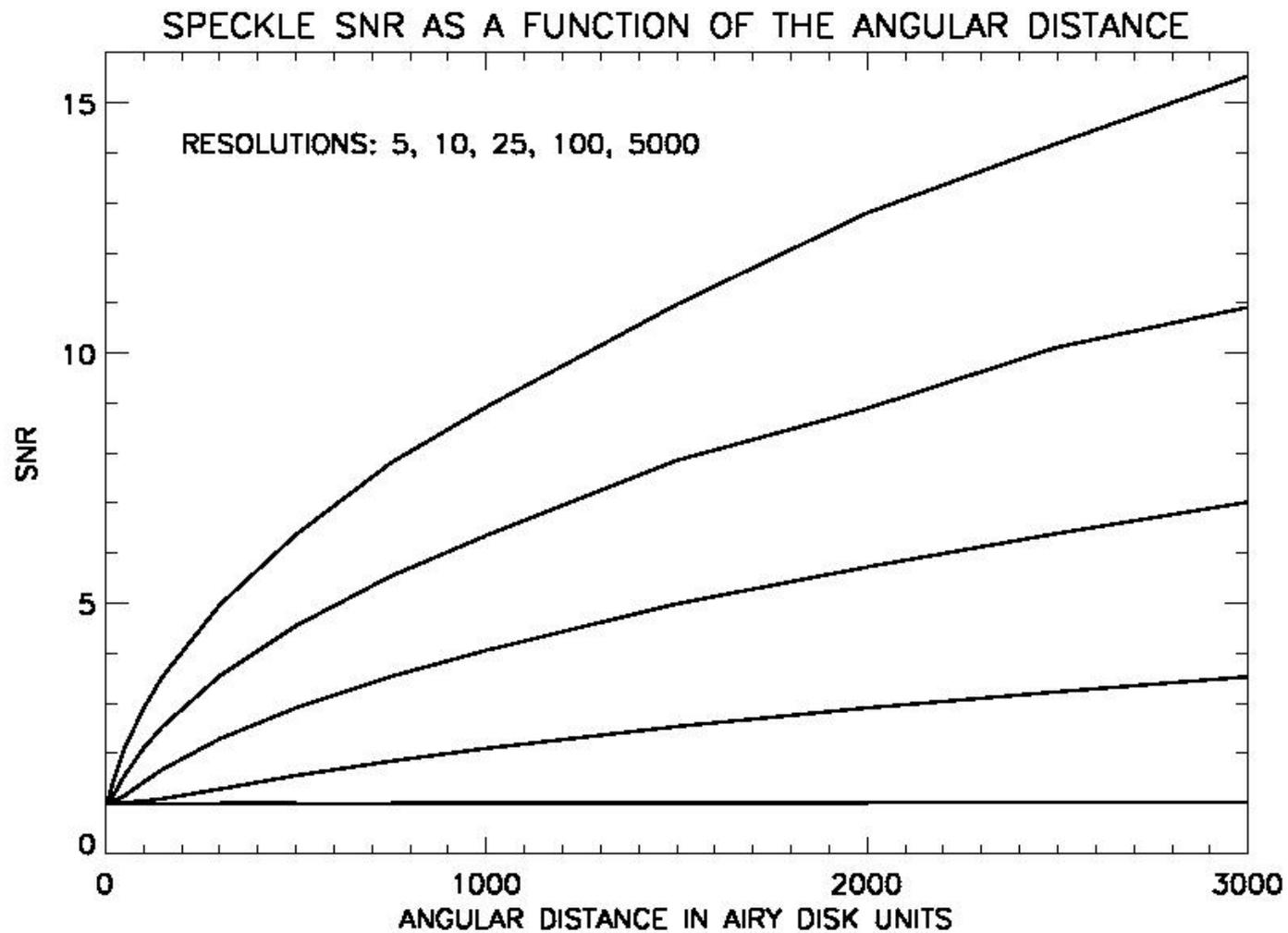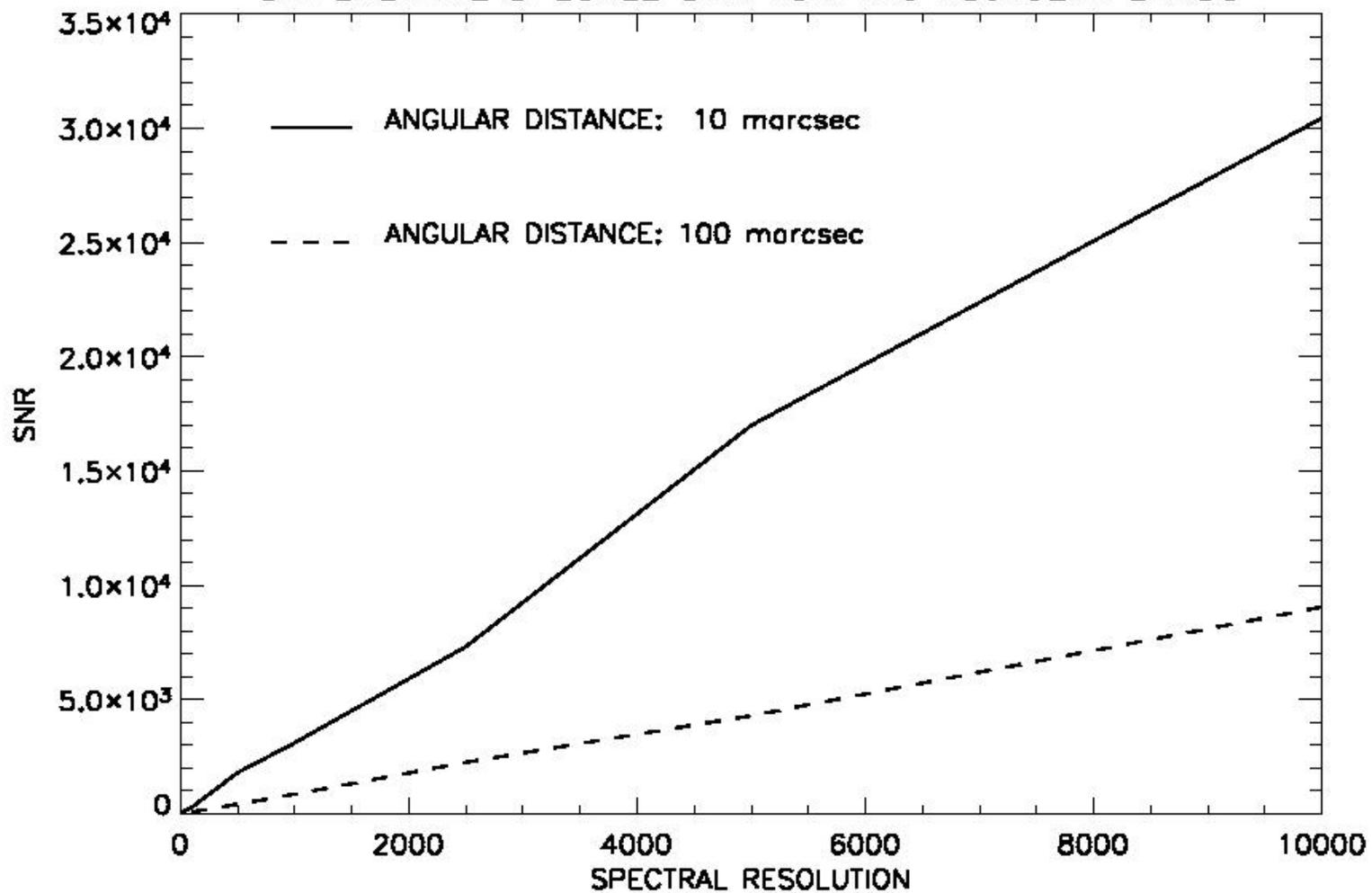
SNR FOR THE SUN/JUPITER SYSTEM IN H BAND
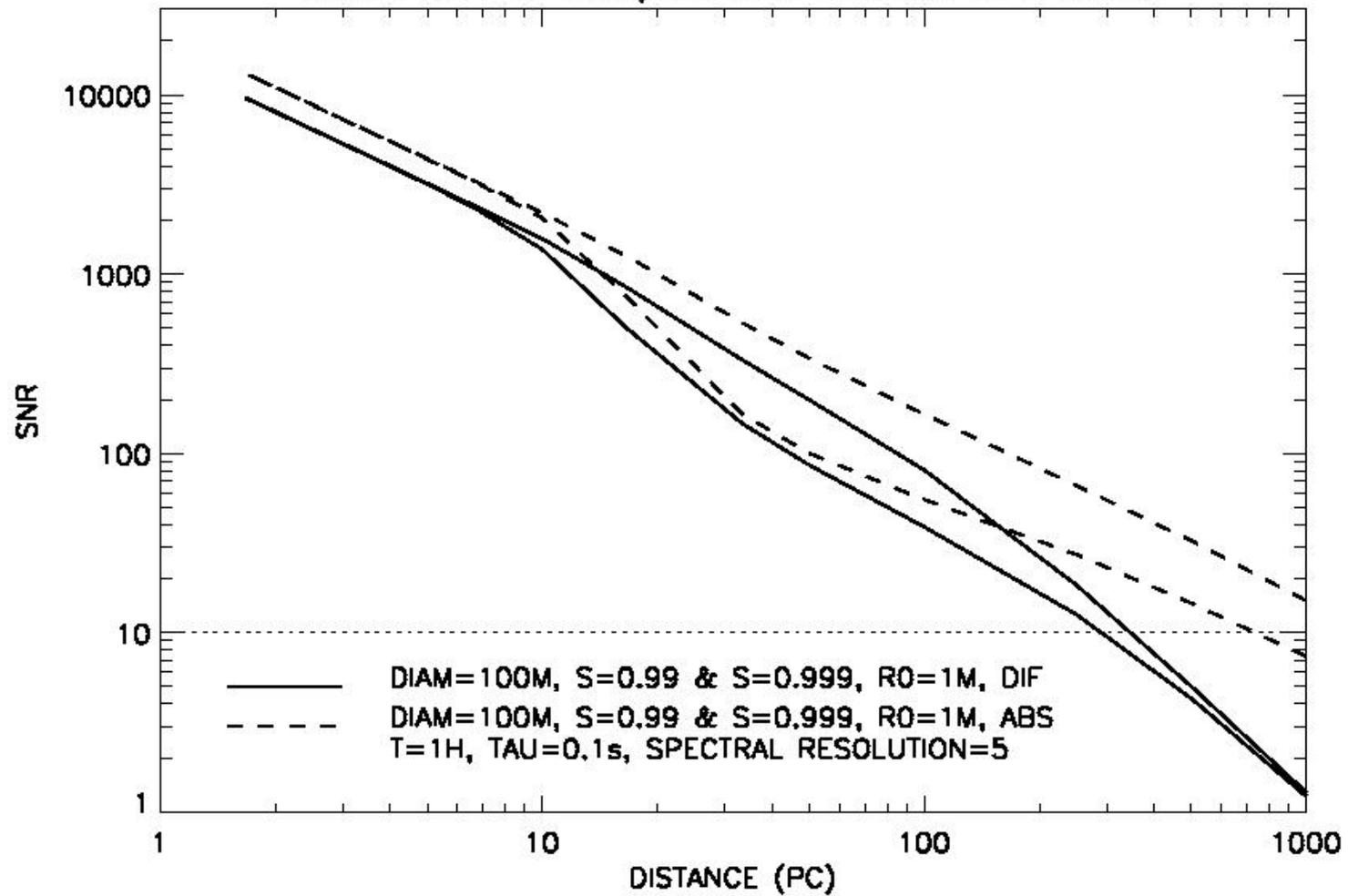
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SNR FOR THE SUN/EARTH SYSTEM IN THE VISIBLE

DIAM=50M, S=0.99 & S=0.999, R0=30CM, DIF
DIAM=50M, S=0.99 & S=0.999, R0=30CM, ABS
T=1H, TAU=0.03s, SPECTRAL RESOLUTION=5

SNR FOR THE SUN/EARTH SYSTEM IN THE VISIBLE

DIAM=100M, S=0.99 & S=0.999, R0=30CM, DIF
DIAM=100M, S=0.99 & S=0.999, R0=30CM, ABS
T=1H, TAU=0.03s, SPECTRAL RESOLUTION=5
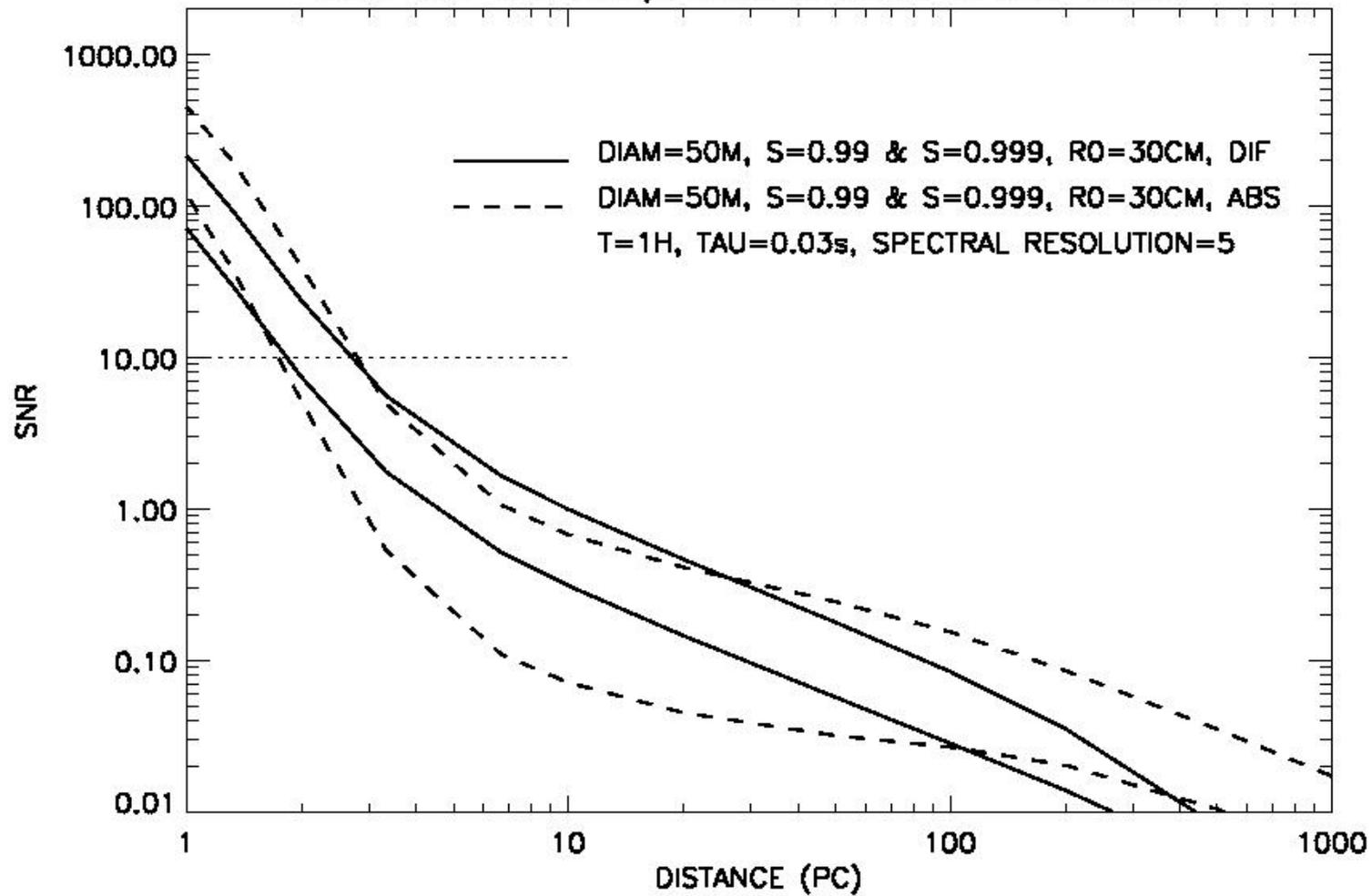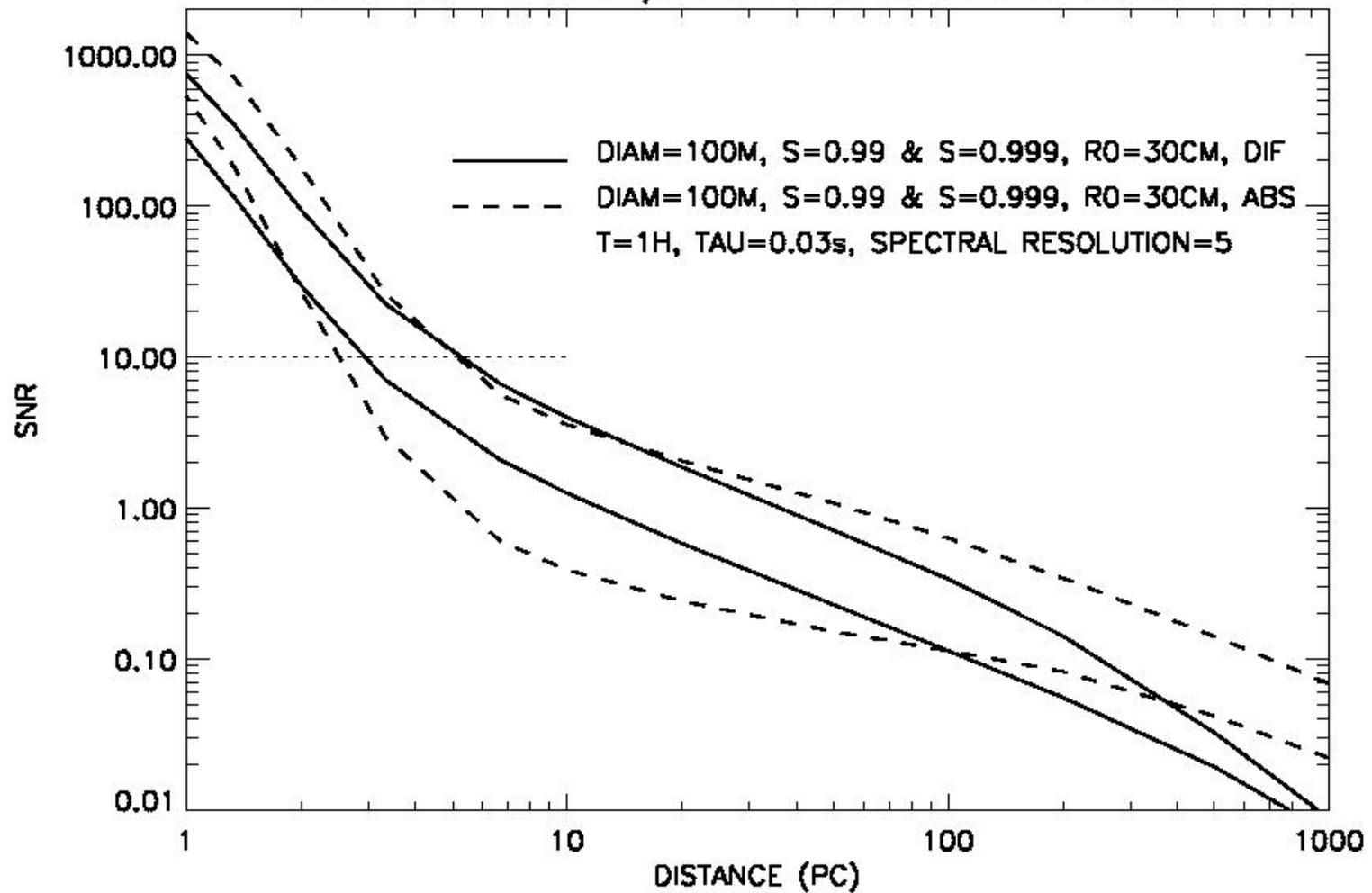
SUN/JUPITER & EARTH SYSTEM IN H & V BAND

DIAM=50M & 100M, S=0.99, R0=1M, 1.65um
DIAM=50M & 100M, S=0.99, R0=1M, 0.55um
T=1H, SPECTRAL RESOLUTION=5
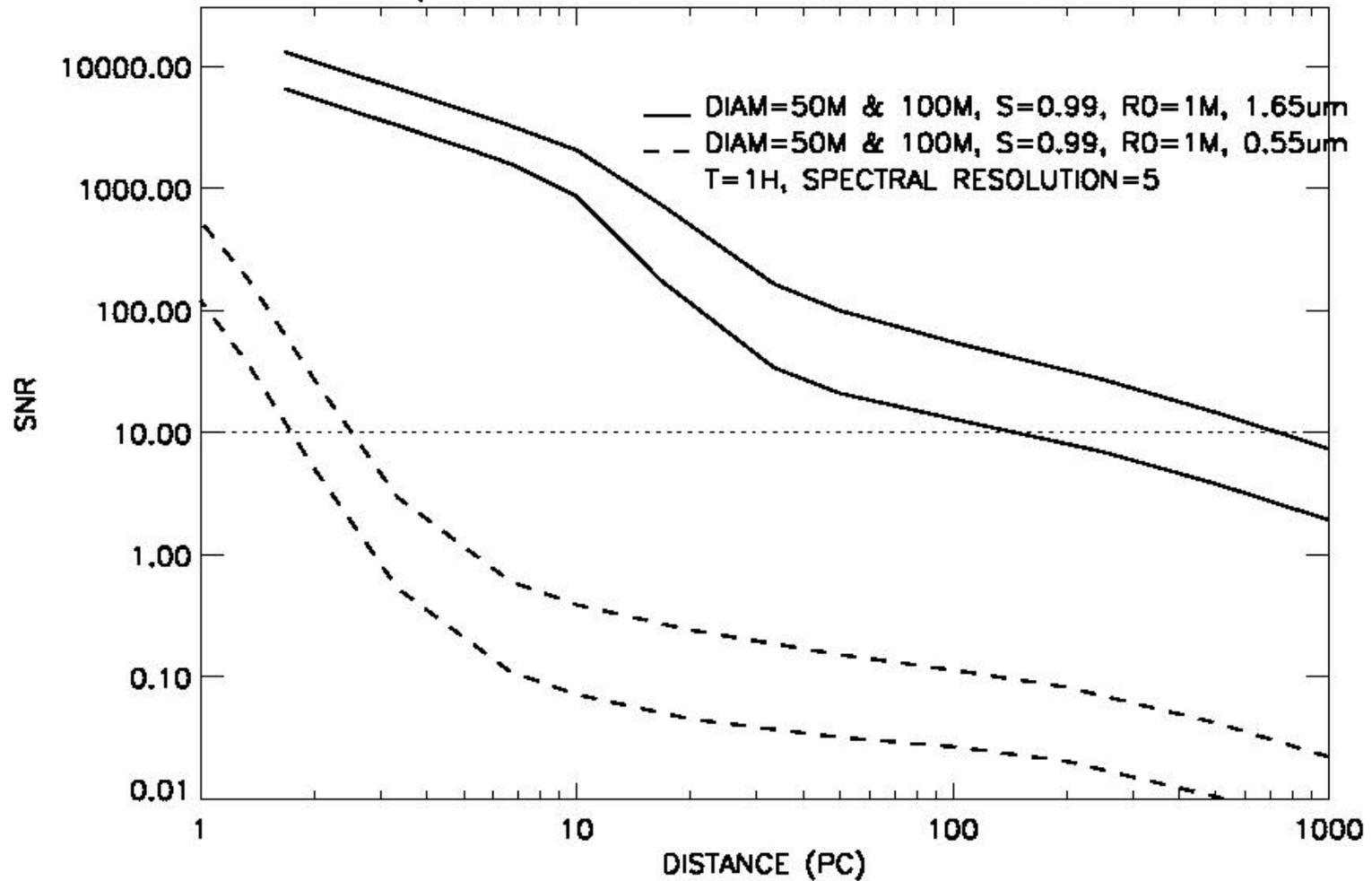
# Conclusions

- Rigorous & complete treatment of speckle noise
- Science cases:
  - Absolute magnitude
  - Flux ratio
  - Separation
- SNR on absolute & differential detection