B2C Performance Trades

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Study inputs

- Three science cases
  - KBO: 10% sky, 0 Dec, 300 sec
  - Nearby BH Kinematics: 30% sky, 30 zen, 600 sec
  - Galaxy-Galaxy Lensing: 30% sky (nominal), 30 zen, 1200 sec
- Three seeing conditions
  - 25% best: r_0 = 20 cm
  - 50%: r_0 = 16 cm
  - 75%: r_0 = 12 cm

Assumptions

- Lasers
  - Center-launched
  - "SOR-like" return: 150 ph/cm^2/sec/W in mesosphere
  - Column density: 3x10^9 atoms/cm^2
- Transmissions
  - LGSF: 0.75
  - Atm: 0.90 (at zenith)
  - HOWFS: 0.19
  - LOWFS: 0.22
  - Narrow field science path (BTW): 0.25
- LOWFS
  - 2 TT + 1 TTFA
  - MOAO-sharpened, J+H band, no ADC, FoR diameter: 120"
  - 32 x 32 MEMS DM
  - H2RG (4.5e- RON, 0.85 QE_J)
- HOWFS
  - 4x4 pix/subap
  - CCID56 (1.6 e- RON, 0.80 QE_{589} , dark: 400 cnt/sec, 0.25 pix charge diffusion)
  - 50% moon, some fratricide

Baseline system for this study

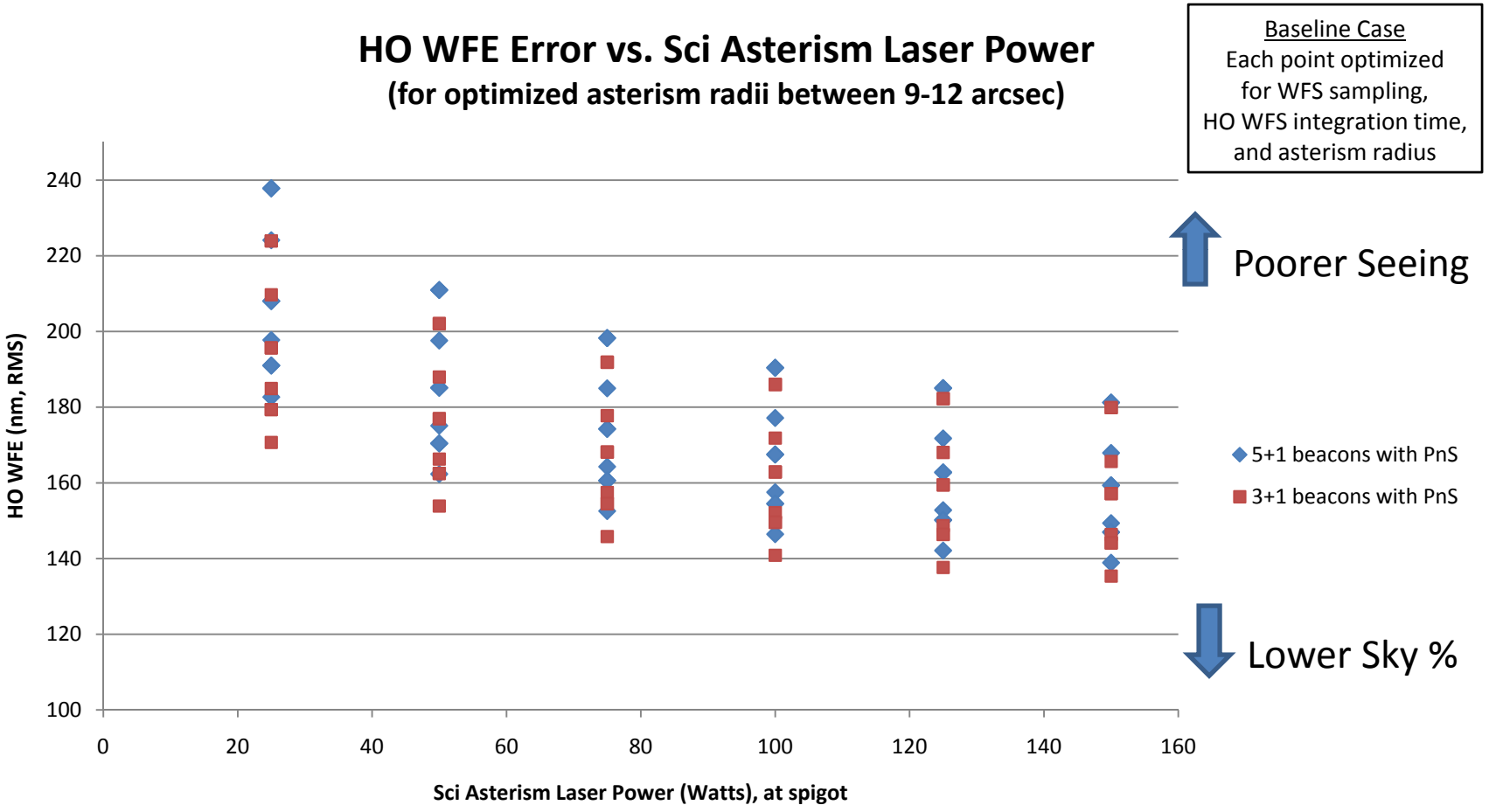
- Fixed Science Asterism with Point and Shoot (PnS)
  - 7 LGS beacons in all
  - Science Asterism
    - 50W divided into a regular 3+1 “Tetrad”
      - 12.5W per beacon
    - With PnS typical optimized radius is 10”
  - Point and Shoot (PnS)
    - 25 W divided into 3 patrolling beacons
      - 8.3 W per beacon
    - Independently optimized HO integration time for PnS LGS
      - Typically ~600 Hz in median seeing
    - Max patrol range: 60”
    - Tomography error heuristically transitions from sci asterism ‘interior’ error to single LGS FA error, depending on PnS location
      - Deserves more investigation

Trades performed

- Baseline system as function of laser power
  - Assumption: PnS power allocation is always 50% the allocation made to the Sci Asterism
- Compare 3+1 PnS and 5+1 PnS with same power
- Performance loss with fixed WFS sampling
- Compare EE for 3+1 PnS and 5+1 no PnS
  - With 5+1 30” fixed radius
  - With 5+1 50” fixed radius
  - Compare also with no MOAO

- Asymmetric fixed asterism without PnS study not complete
  - LAOS issues and need to interate with Lianqi

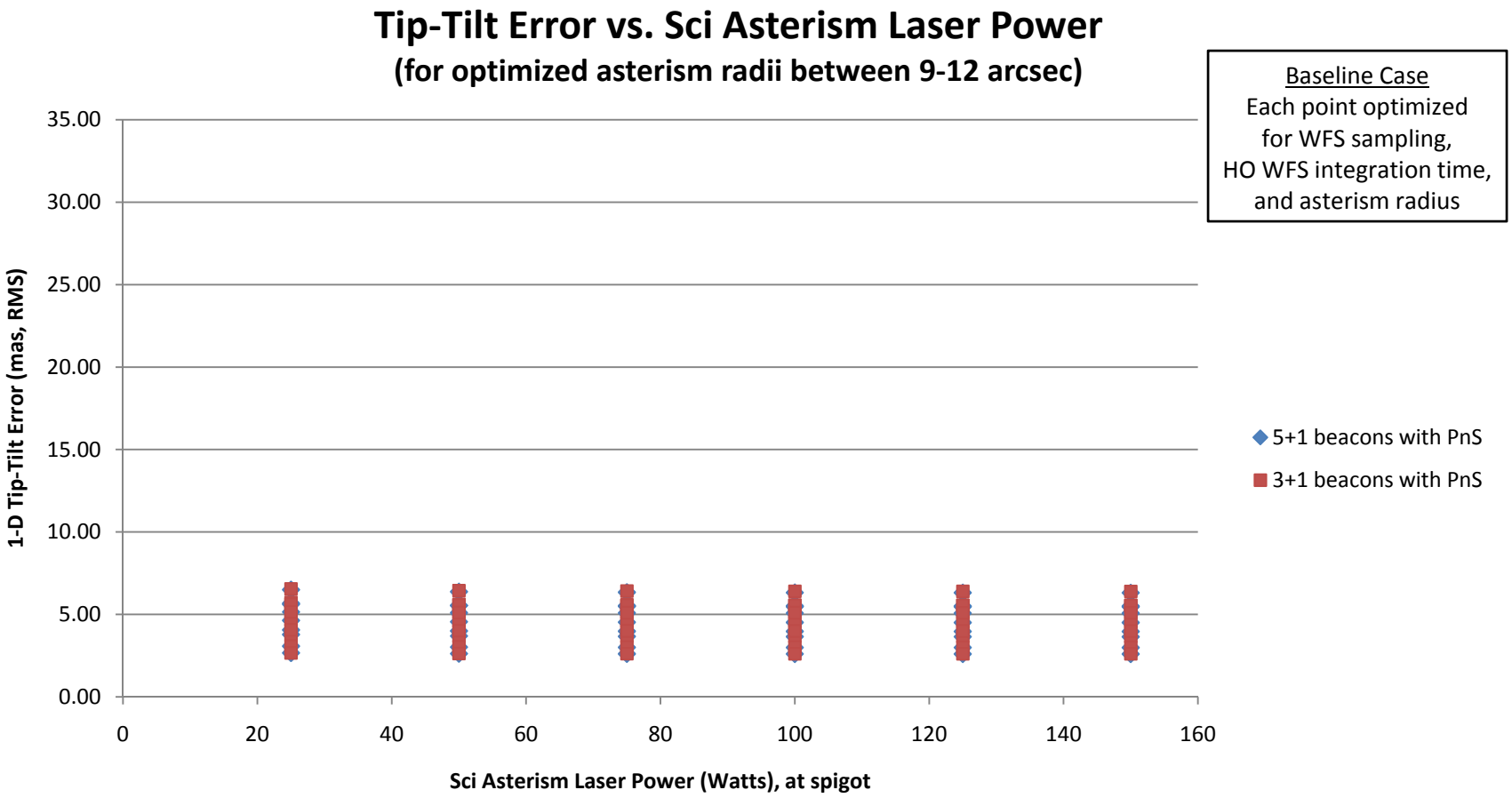
50W of Sci Asterism Laser Power is at Performance 'Knee'
(3+1 asterism generally superior to 5+1)



Caveat: This is using my original KAON 429 tomography model: under review

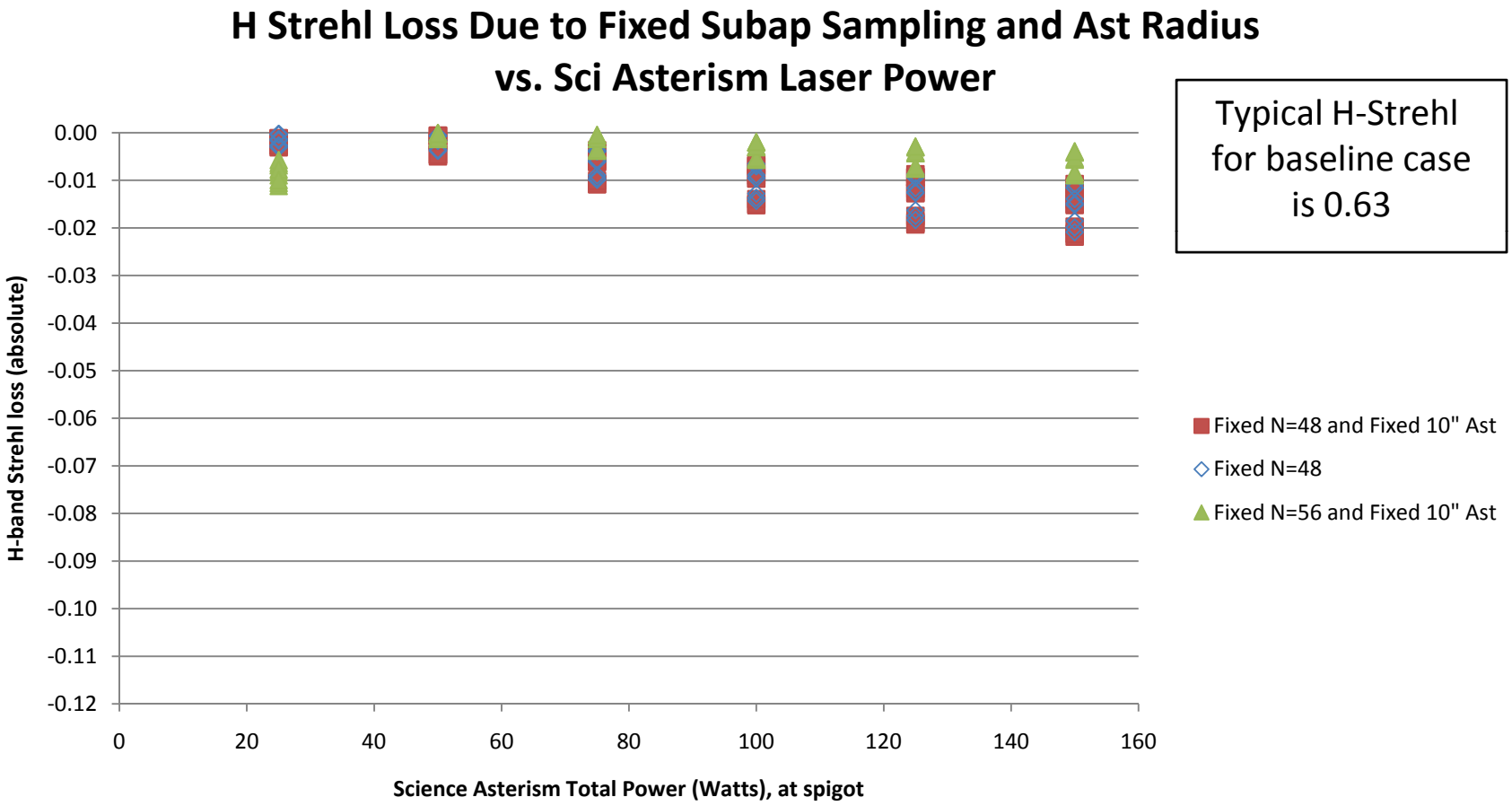
TT Error has little dependence on laser power

(indicating we may be able to use less power in the PnS beacons?)



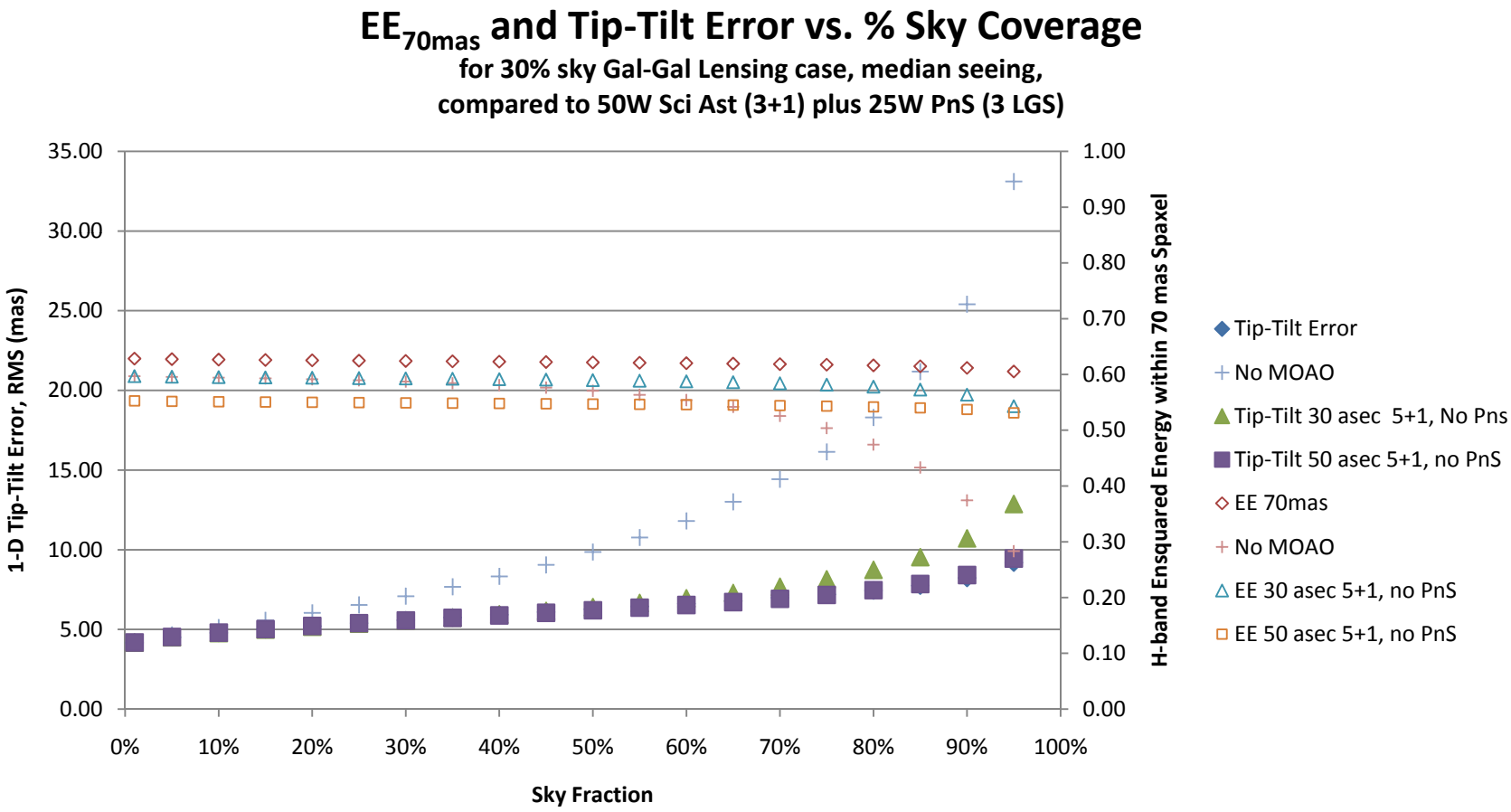
Fixed WFS sampling has little impact

(using ‘continuous’ reoptimization of integration time)



Typical H-Strehl for baseline case is 0.63

PnS Improves on-axis EE, extends sky coverage for large % fraction



For this case, science requirement 50% EE in 70 mas over 30% sky met w/o MOAO

Conclusions

- 50W Sci 3+1 and 25W PnS 3 LGS generally meets the science goals
- Cost benefit of PnS is still not clear
  - 75W 5+1 on a 30” or 50” radius may remain competitive
- Fixed asymmetric asterism still needs to be evaluated