NGAO Photometric Accuracy Budget Strategy

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Outline

- Photometry Science
- ELT Simulations
- Photometric Variance Sources
- Performance Budget Strategy
  - Analytic Expressions
  - Numerical Investigations
    - Simulations
    - Data Analysis
- Outstanding Issues
- Discussion

Photometric Error Sources

Noise Processes

- Photon Noise
  - Source photon noise
  - Imperfect background subtraction
- Detector Issues
  - Noise
    - Read Noise
    - Fixed-Pattern Noise
    - Dark Current
    - Popcorn Noise (rapid level shifts)
  - Residual flat-fielding errors (linear, but wrong constant)
  - Detector non-linear response
  - Few/Single pixel errors
    - Cosmic rays / hot pixels / dead pixels
  - Quantum efficiency variations

PSF Uncertainties

- On-axis
  - Time-Variability of AO Performance
  - Telescope Vibrations
  - Saturation
- Off-axis
  - Residual angular anisoplanatism
    - Passive PSF estimation
      - DIMM θ_0 errors
      - Wind-induced anisoplanatism
      - Telemetry noise
    - Active PSF shaping
      - MCAO residuals
  - Optics
    - Residual field dependent aberrations (esp. field curvature)
    - Variable transmission (coating degradation)
    - Field dependent transmission (beamwalk)

Source Uncertainties

- Stellar
  - Star variability
  - Time-variable chromatic emmissions (variable color)
  - Maculation (sunspots)
- Extrastellar
  - Crowding
  - Differential interstellar extinction

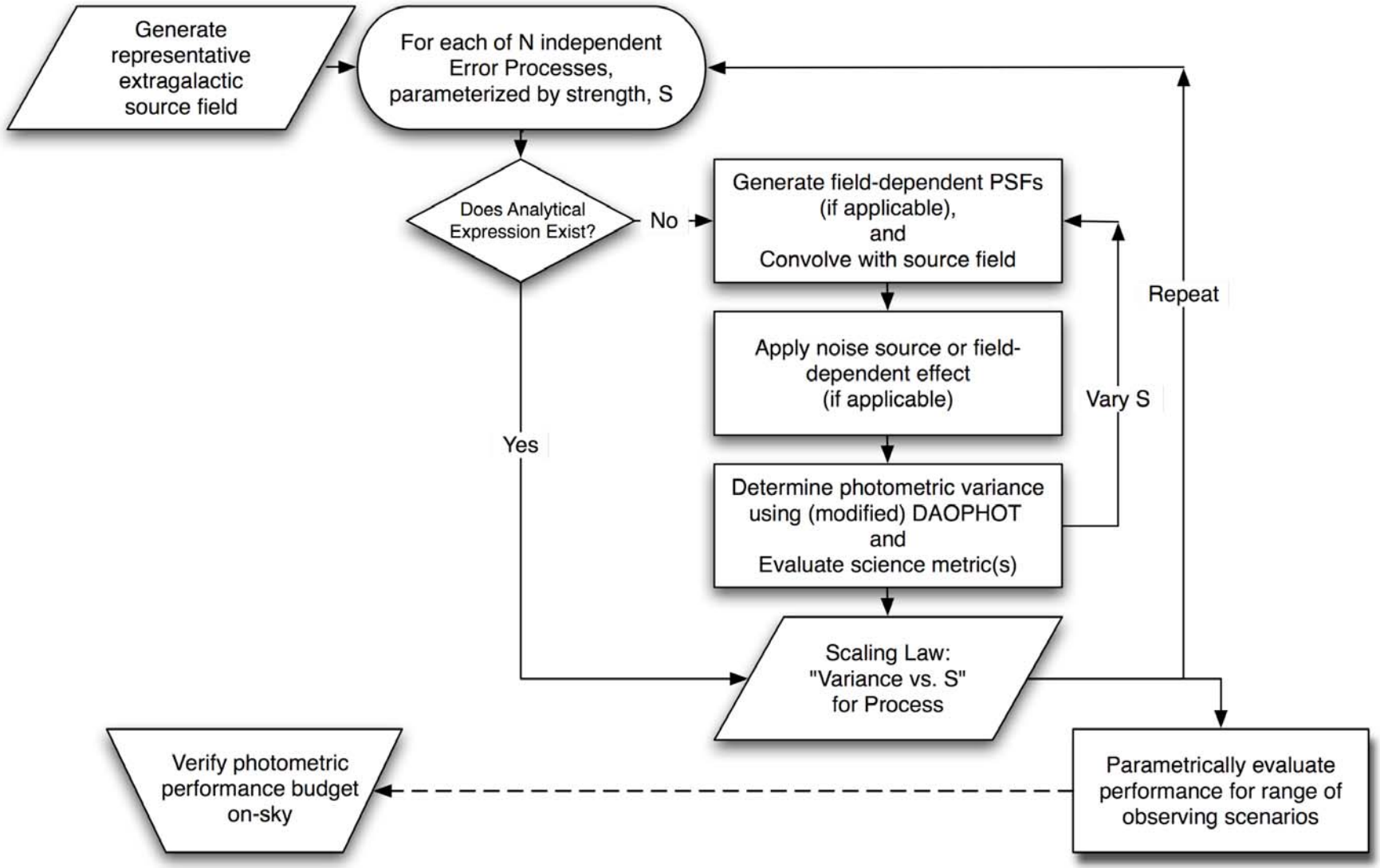
Environmental

- Atmospheric scintillation
- Variable extinction
  - Scatter
  - Transparency waves
  - Airmass variation across FoV
  - Heterochromatic extinction

Calibration

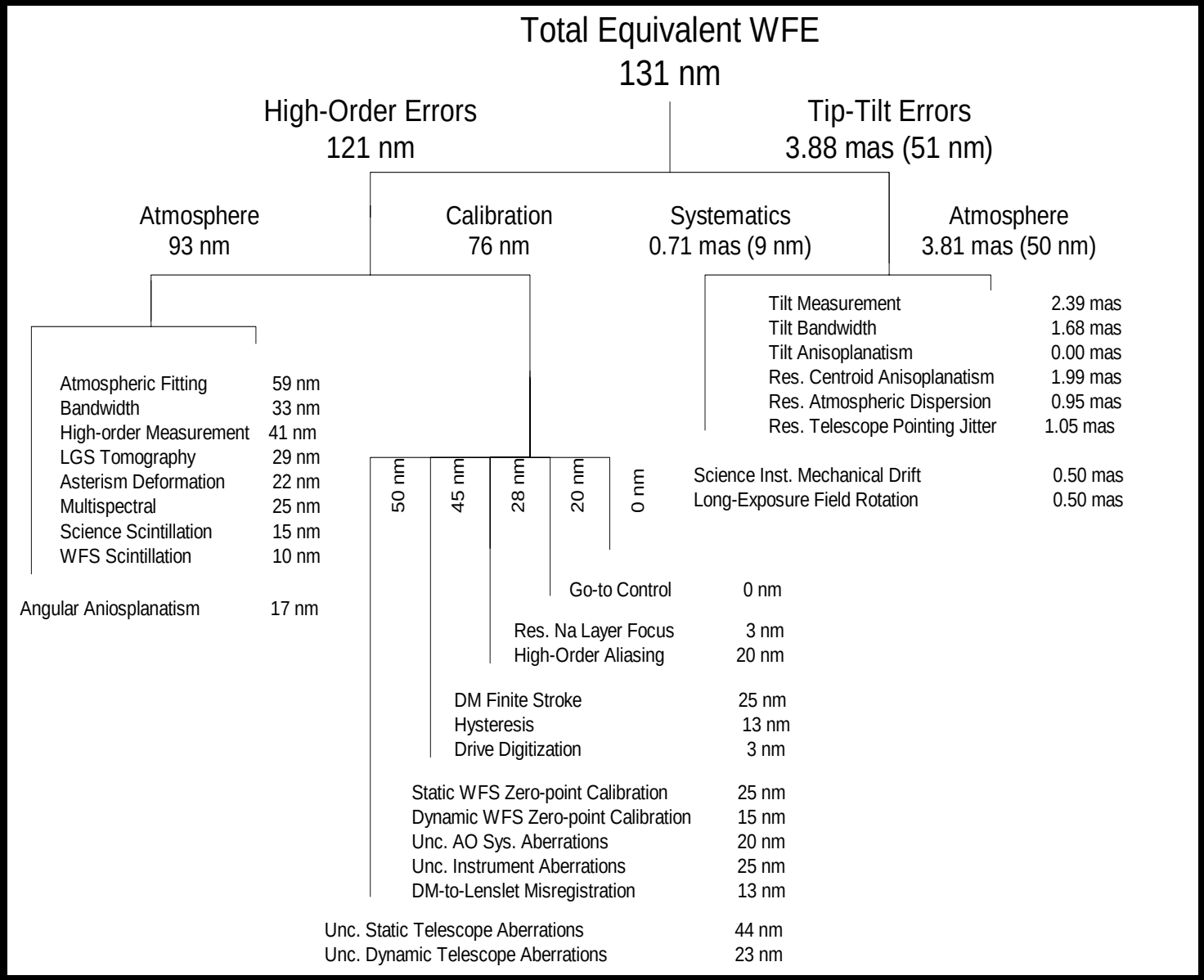
- Filter
  - Bandpass uncertainties

Proposed Performance Budget Strategy



NGAO Error Budget

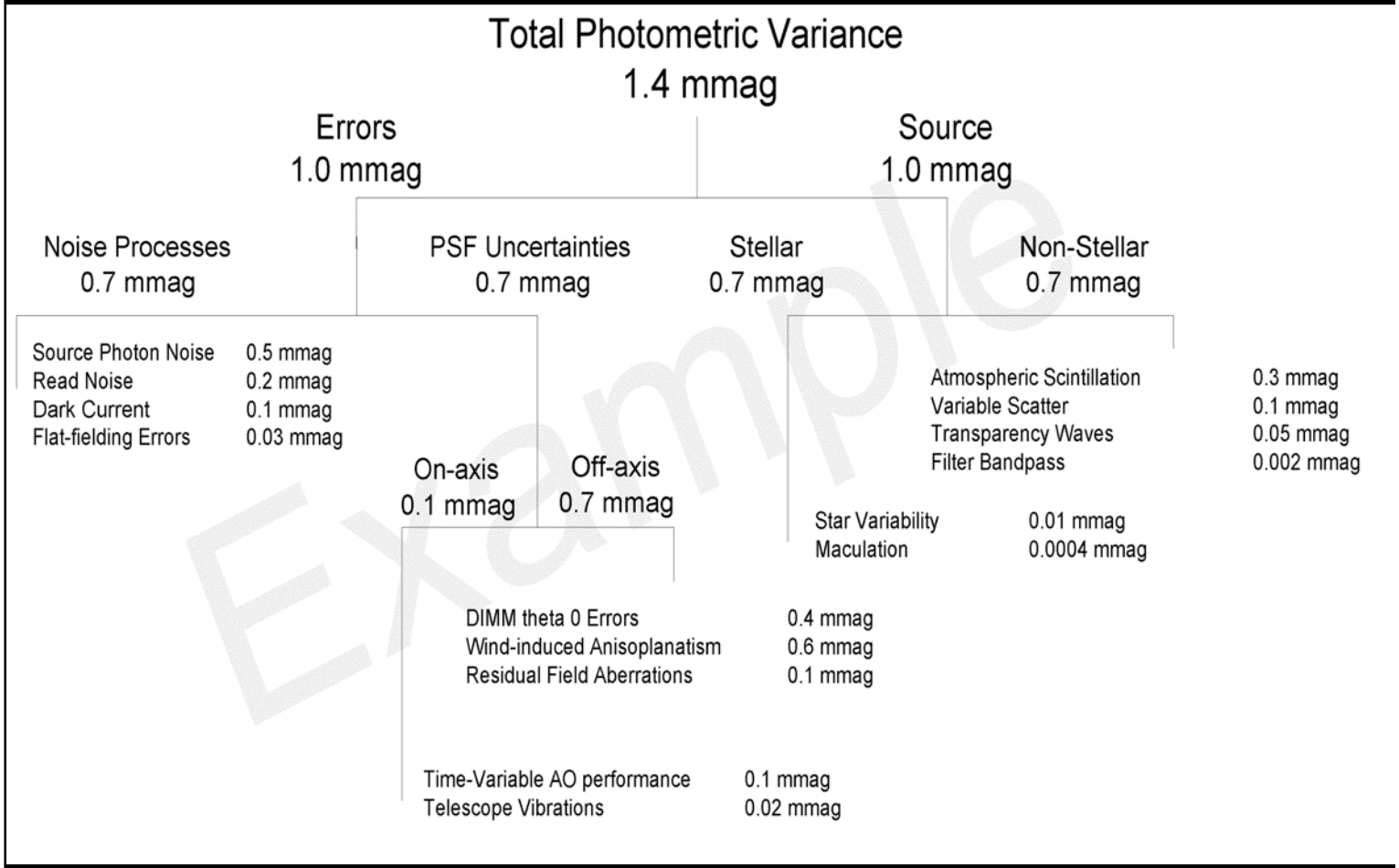
KBO imaging scenario



Based on Lick, Palomar & Keck experience

NGAO Photometry Budget

M31 Bulge Scenario

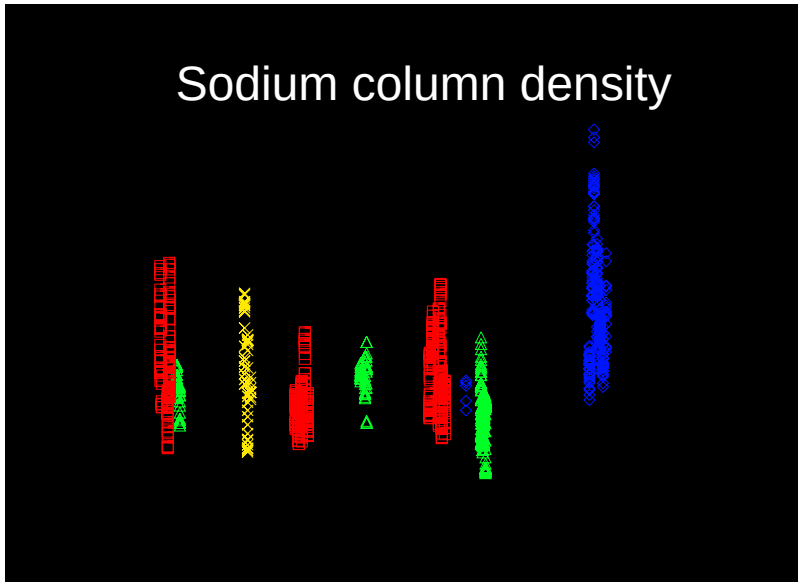


Input Assumption - Site Data

Mauna Kea median seeing conditions at $\lambda = 0.5\ \mu m$:

- $r_0 = 18$ cm. $\sigma = 3$ cm. $L_0 = 75$ m.
- $\theta_0 = 2.5$ arcsec
- $f_G = 39$ Hz
- $L_0 = 75$ m
- C_n^2 profile from data

Altitude (km)	Fractional C_n^2	Wind Speed (m/s)
0.0	0.471	6.7
2.1	0.184	13.9
4.1	0.107	20.8
6.5	0.085	29.0
9.0	0.038	29.0
12.0	0.093	29.0
14.8	0.023	29.0



Median sodium density = 4×10^9 atoms/cm^2

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