ÖAW ÖSTERREICHISCHE AKADEMIE DER WISSENSCHAFTEN

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METIS FDR WFSensing strategy: status and challenges

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WFS in the VLT/ELT era V

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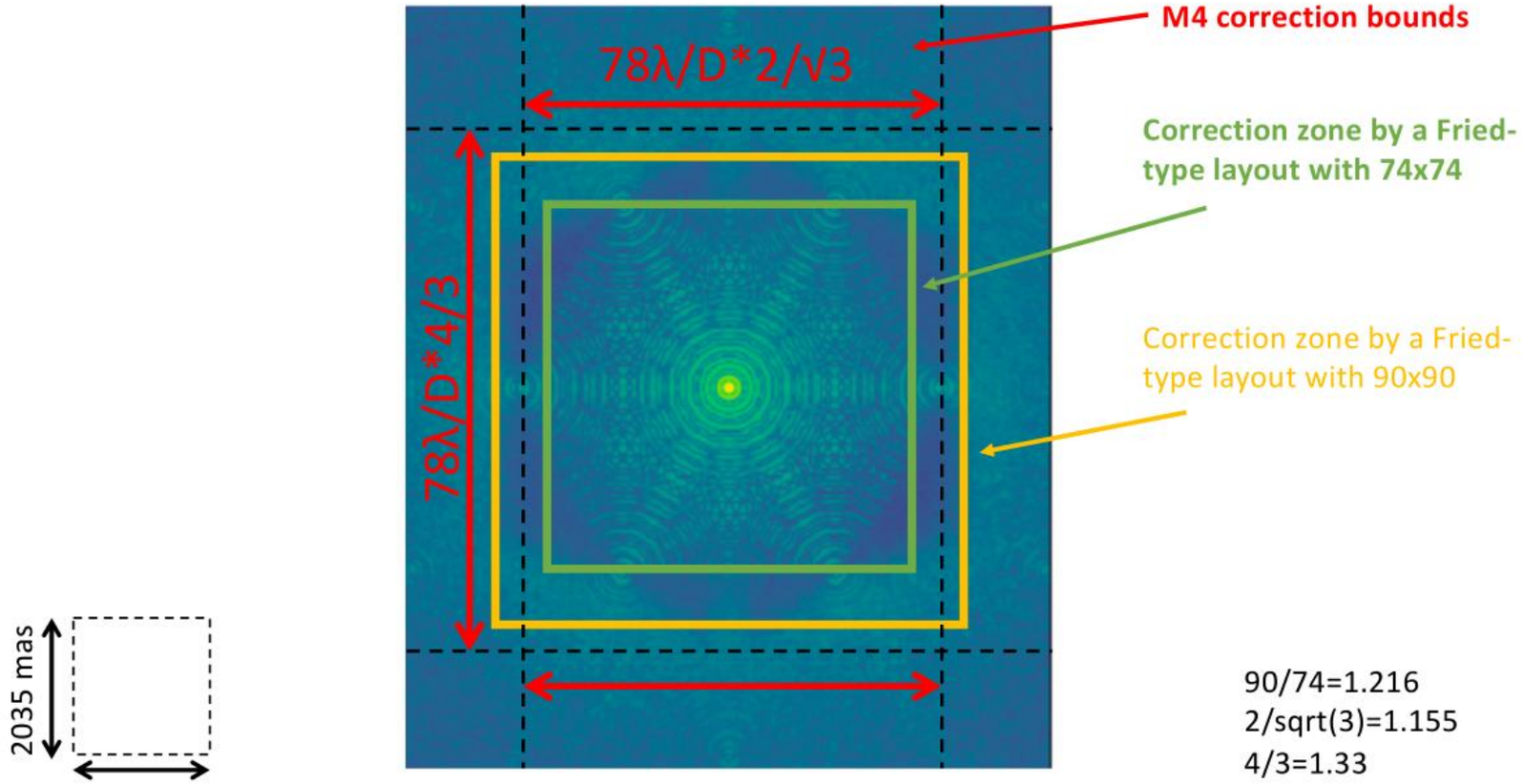
Utilise M4 correcting cabapilities

- PDR: 74pixels/subapertures for Pyramid, 50cm (projected) subaperture size
- FDR: new baseline → 90pixels
- Better coverage of the M4 frequency range with a comparable Fried DM



Credit: C. Correia

Wavefront Reconstruction

- P Φ = S, where Φ is the residual wavefront (continuous)
- Discretise $\Phi \cong \sum a_i z_i$, choose z_i suited

  → use Finite Element Ansatz for the residual wavefront („zonal“)
- invert (discretised) Pyramid Operator using Tikhonov/MMSE

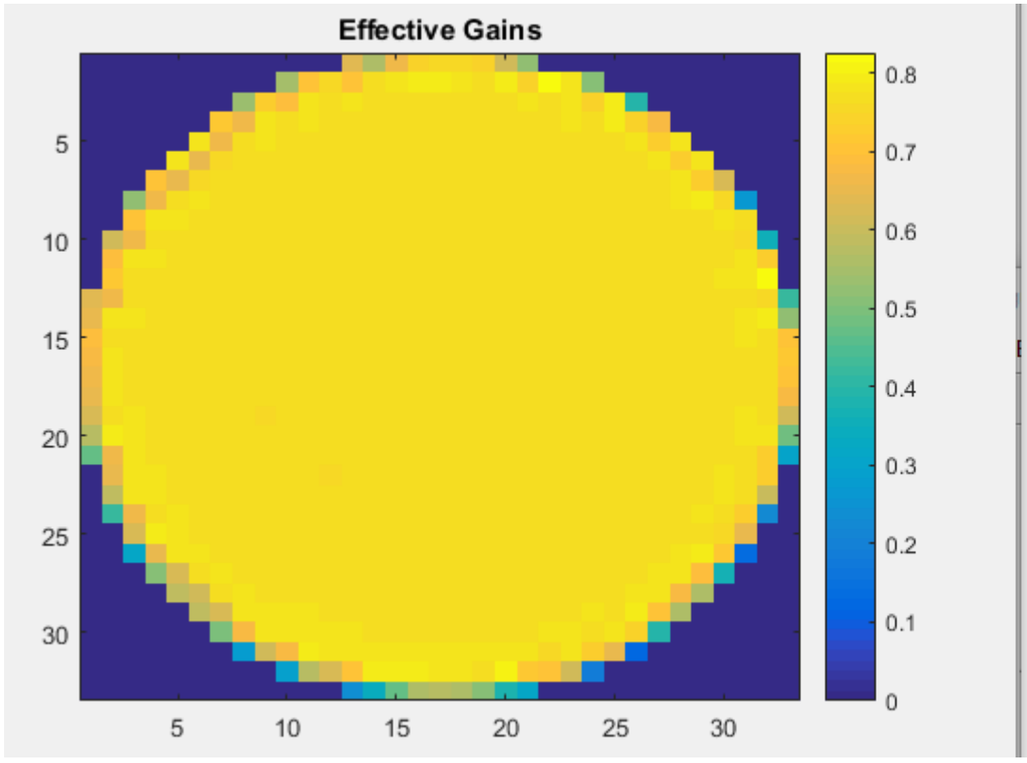
$$R = (P^T P + \alpha \triangle^2)^{-1} P^T$$

  → Laplacian squared approximates atmospheric covariance (Ellerbroek, 2004)

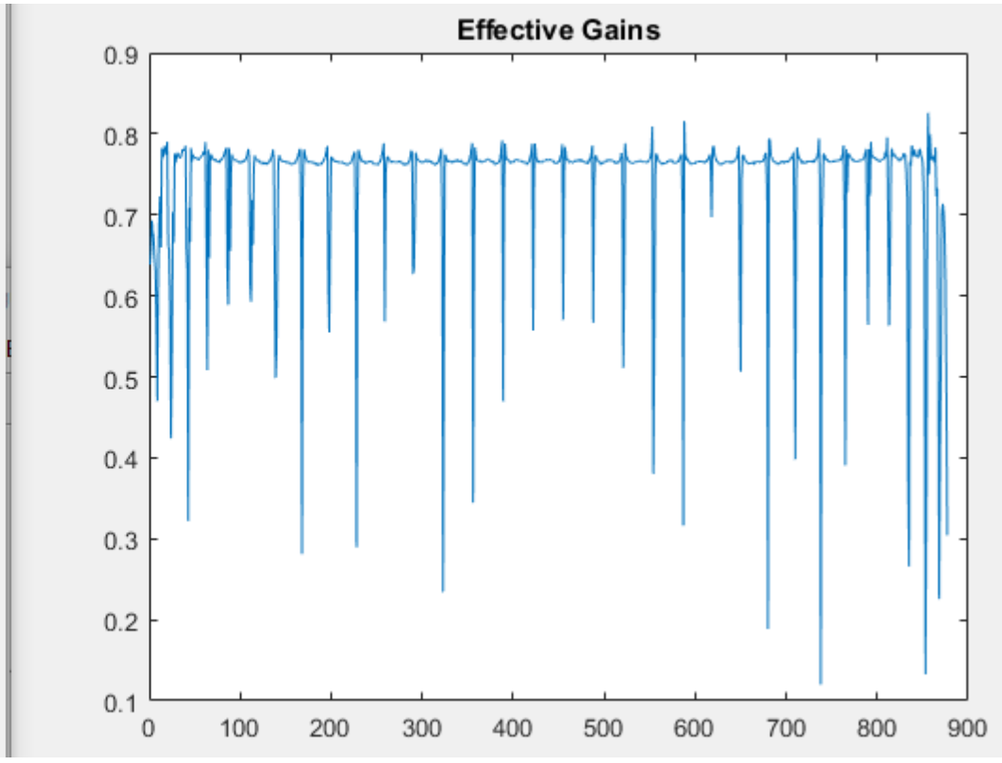
Remarks:

- Additional frequency control possible (and studied), e.g. Gauss kernel smoothing
- P does not depend on M4 (and most other telescope peculiarities)
- Optical gains are (almost) constant for FE Ansatz (zonal)

Effective gains – optical gains



over pupil position



over mode index

Well know result → different visualisation

METIS: Full Control Scheme

- A) Wavefront reconstruction with „optimal“ basis (i.e. good enough)
- B) Temporal control: (lossless?) projection on suitable control basis
- C) apply desired DM shape using „the“ M4 basis/modes

Remarks:

- Full scheme not yet fixed for METIS
- Handles petal piston, atmospheric conditions (optical gains), …
- Note: sensing in K-Band
- Use subapertures with low illumination (!)
- Alternative: use the same basis/modes for all three steps

Ongoing/Future Work

- How to properly generate the Poke Matrix? (FFT)

  (system matrix, forward matrix, interaction matrix,… legionem est nomen eius…)

- high numerical precision/resolution necessary to describe the Pyramid

  (glass imperfections, position of pupil images on sensor, …)

- Impact of different basis/modes
- Optical gain studies
- Non-linear reconstruction

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