The Extremely Large Telescope

- Testing concept of segmented mirrors
- An optical design concept for a 100-m telescope

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COST EFFICIENT TESTING OF SEGMENTS

- **THE PROBLEM: PRODUCTION TESTING OF OFF-AXIS SEGMENTS:**
- **Parameters to test: Radius of curvature, Asphericity, rms wavefront amplitude and slope errors.**
- **For a 100-m diameter aspheric primary: around 100 different types of segments of 2-m diameter class for a total production of about 2000 segments.**
- **The segments have asphericities varying from 1 μm to 80 μm,**

mainly represented by astigmatism : $kr^2h^2/4R^3$ where:

k conic constant (-1 for paraboloid)

r segment radius (1-m)

h segment off-axis distance (max of 50-m)

R primary mirror radius of curvature (200-m)

- **Easier to polish than Keck segments with max of 100 μm astigmatism**

Current Approaches

- **Spherical test plate with 100 different types of CGH (Jim Burge, OSC Arizona). Cost?**

- **Mechanical Profilometer (Peggs,NPL, UK): the accuracy to measure the segments wavefront errors of the order of 20 nm questionable even with a calibrated reference mirror. Contact probe more accurate but damage to polished surface?**

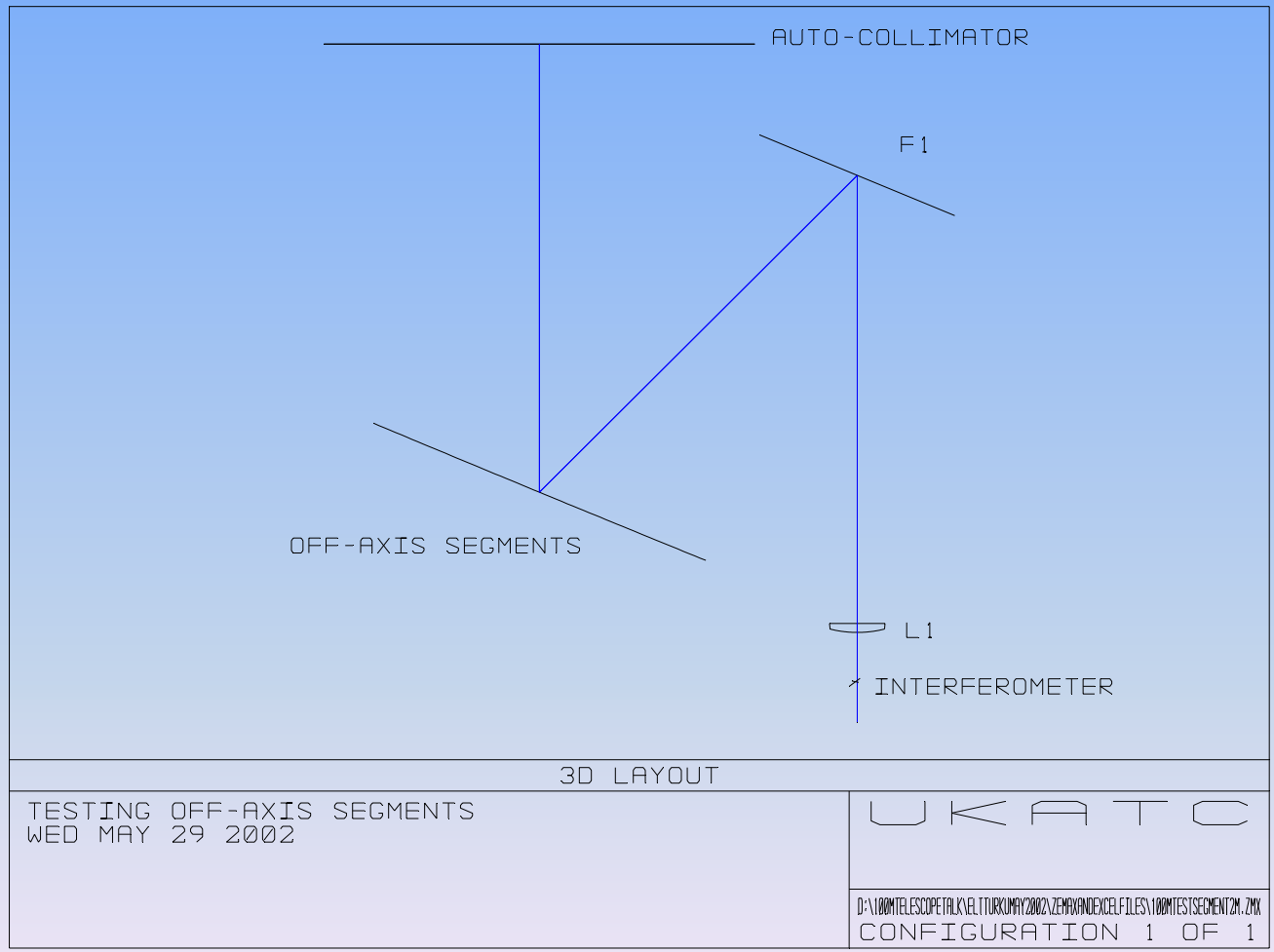
- **4-D phase-shift interferometry (WYKO): a digital interferometer provides quantitative analysis of surface shape. More info on this technique applied to the off-axis 2-m segments still to be received. Seems to be the best technique to use.**

The Proposed Optical Set-up

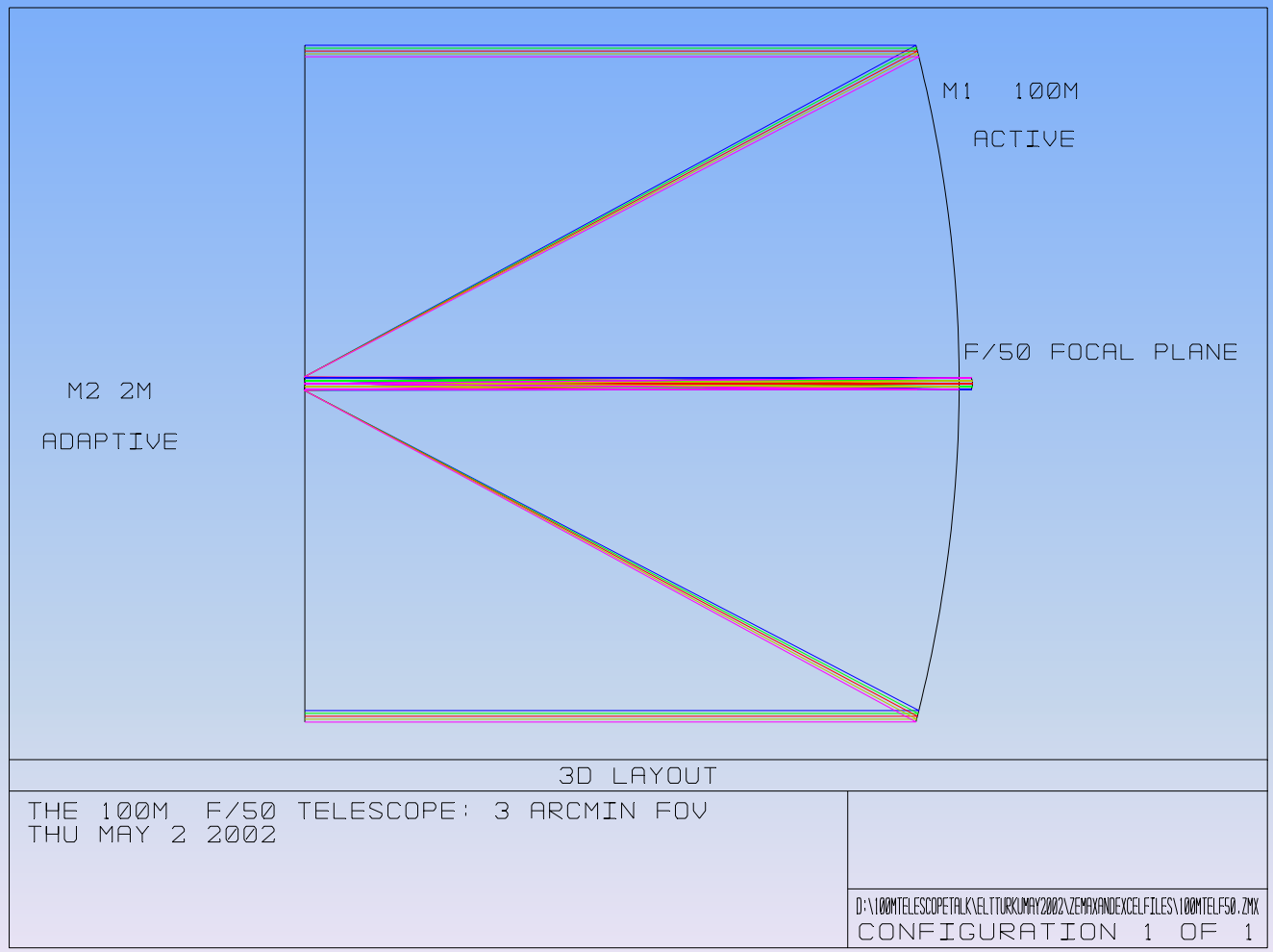
- **Simple fixed optical set-up where only the segments are replaced.**

- **Main items in the double-pass optical path:**
  1. **Phase-shift interferometer, output placed at focal plane of off-axis paraboloid.**
  2. **Tip-tilt Flat fold mirror**
  3. **Parabolic off-axis segments**
  4. **2-m diameter flat auto-collimator mirror, calibrated in terms of wavefront errors**

Optical layout



The 100m f/50 design: 2 aspheres



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The f/50 design: 2 aspheric mirrors; fov: 3 arcmin

Mirrors	R	Separation	Clear aperture	K
	(m)	(m)	(m)	
M1	200	98	100	-1.00019
M2	4.081	100	2	-1.084307
Focal Plane	4.1		1.7	

Primary Mirror: M1

- **Aperture: 100 m (FWHM of 2 marcsec at 1 μm wavelength)**

- **Paraboloid :**

  ·No major increase of cost compared to spherical primary

  · Simplification of the optical design

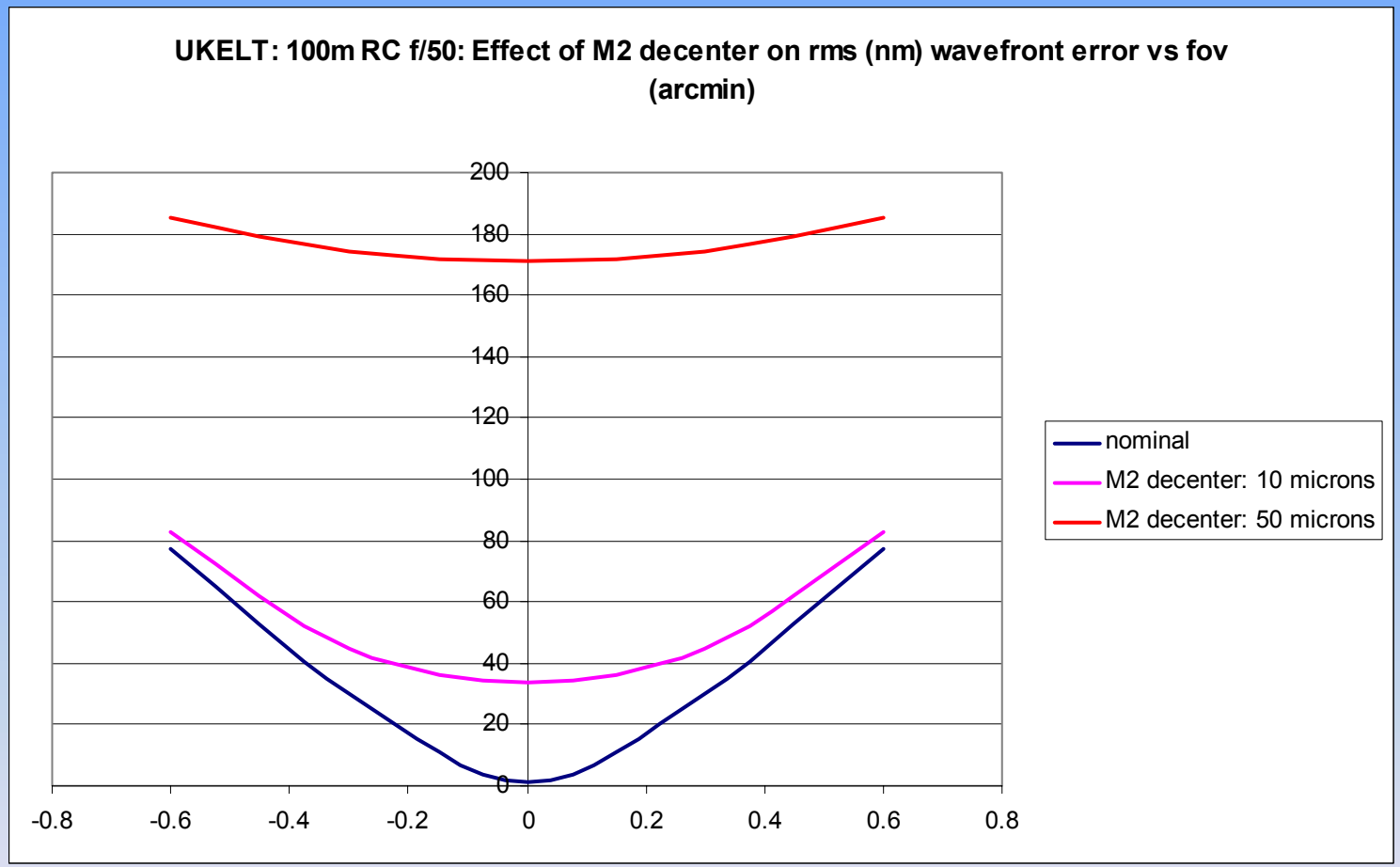
  . 2-m active segments (the actuators will be used for a first and rough alignement of the 2000 segments).

  . Material for the 2-m segments: Zerodur, Sital or ULE fused silica, SiC, Carbon fibre composite (CFC)

Secondary Mirror: M2

- **Diameter: 2- m**
- **Convex hyperboloid or general asphere**
- **Material: lightweighted Zerodur, CVD SiC, Sital, CFC**
- **Manufacture and testing possible using CGH or Matrix Lens**
- **5 degrees of freedom platform similar to the tolerances in VLT and VISTA: focus maintained at a level of 1μm**
  decenter : 10 μm
  tilt: 1-2 arcsec

Sensitivity to M1/M2 decenter errors



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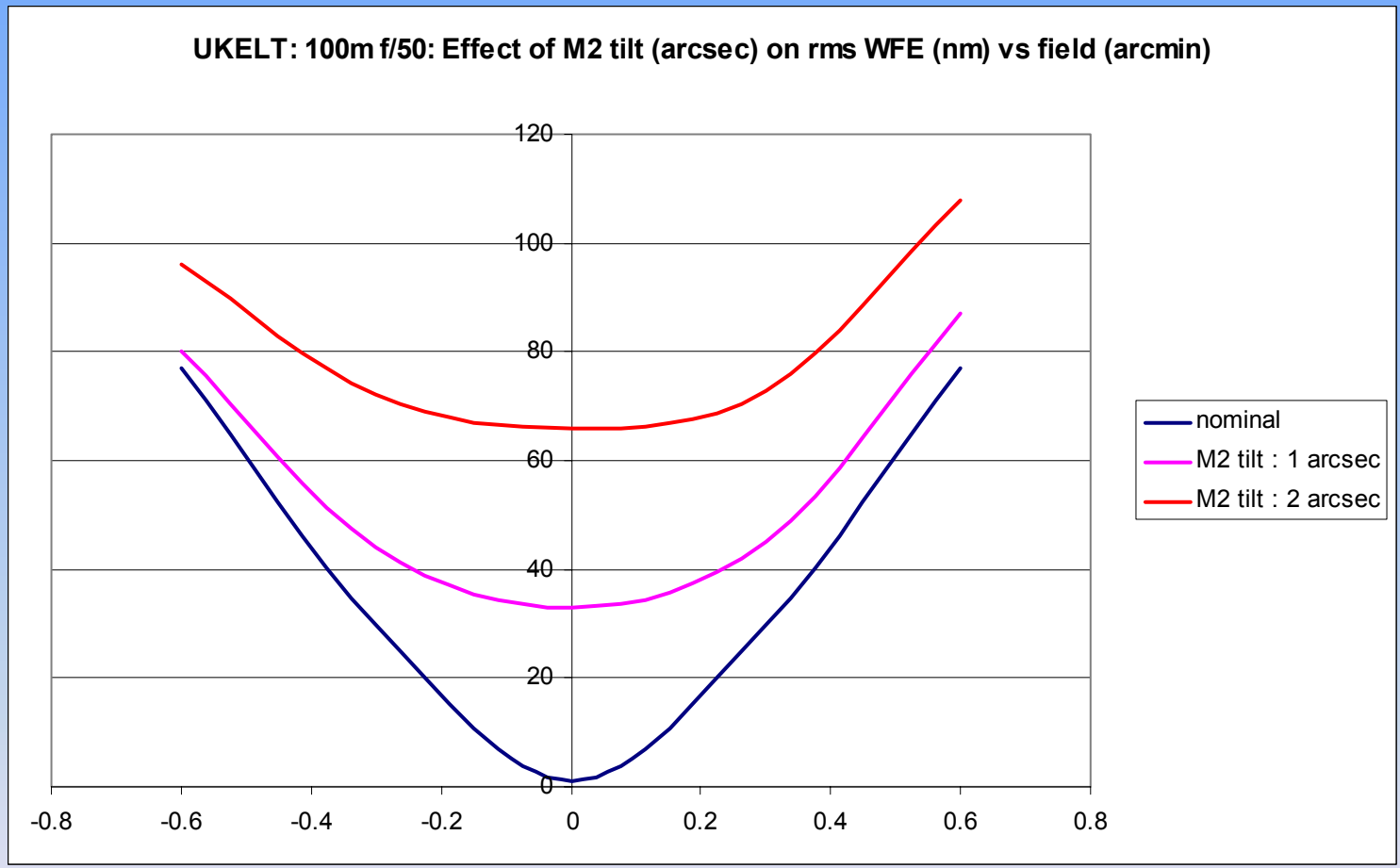
Sensitivity to M1/M2 Tilt errors



Sensitivity of M1/M2 focus errors