

ADAPTIVE OPTICS

Together, we will change the way you see Light

高速変形ミラー Hi-Speed deformable mirrors

F. Rooms

アルパオ社

July 2011

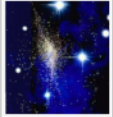
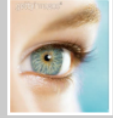


トピック

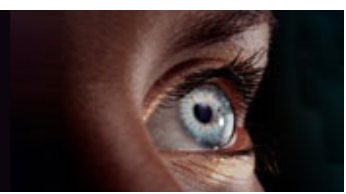
1. 会社紹介

2. アダプティブミラーの用途

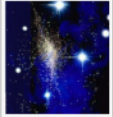
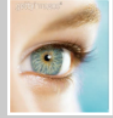
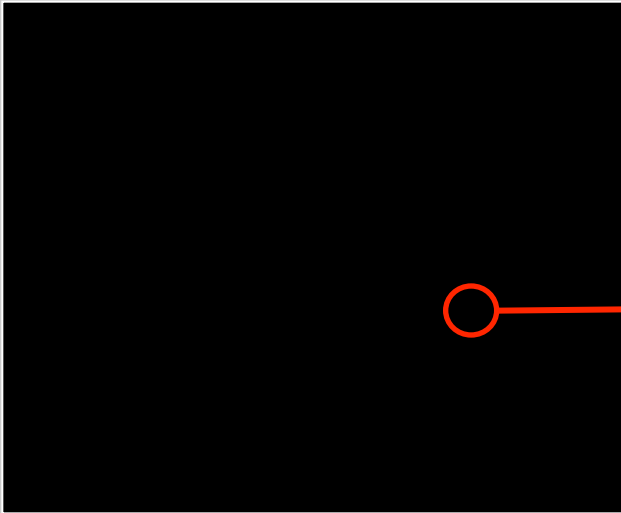
3. アルパオ 高速 DM97-15



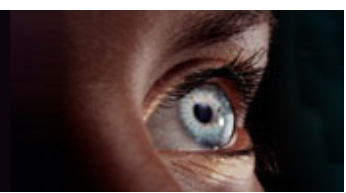
ALPAO社について



•ALPAOの意味 **ALP**ES **A**daptive **O**ptics



アルパオ社について

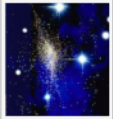
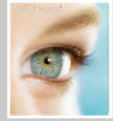


• 会社のゴール **Goals of the company:**

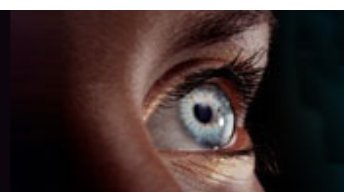
- 堅牢で使いやすい製品を紹介 to commercialize robust and easy to use products
 - イメージの品質を高める to increase the image quality
 - オプティカルベーム無形式最適化 to optimize the optical beam shape

• デザイナーと生産 **Designer & manufacturer**

- 社内で製造 In-house manufacturing capabilities
- 銃牛押印は10名 10 people
- 会社創立後3年 3 years old



What is adaptive optics ?



• オプティカルな異常が起こったときの解決法 A solution to increase image quality when there are optical aberrations

ダイナミック Dynamic

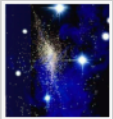
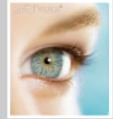
- エア Air (天文学 e.g. astronomy)
- 組織 Tissue (e.g. vision science)
- 液体 (顕微鏡 e.g. microscopy)

スタティティック Static

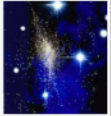
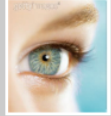
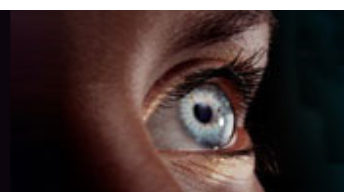
- 悪いレンズ Bad optics
- 形が有効でない Shape not available

• 光学的な異常 Optical Phase noise ns = 雑音 noise

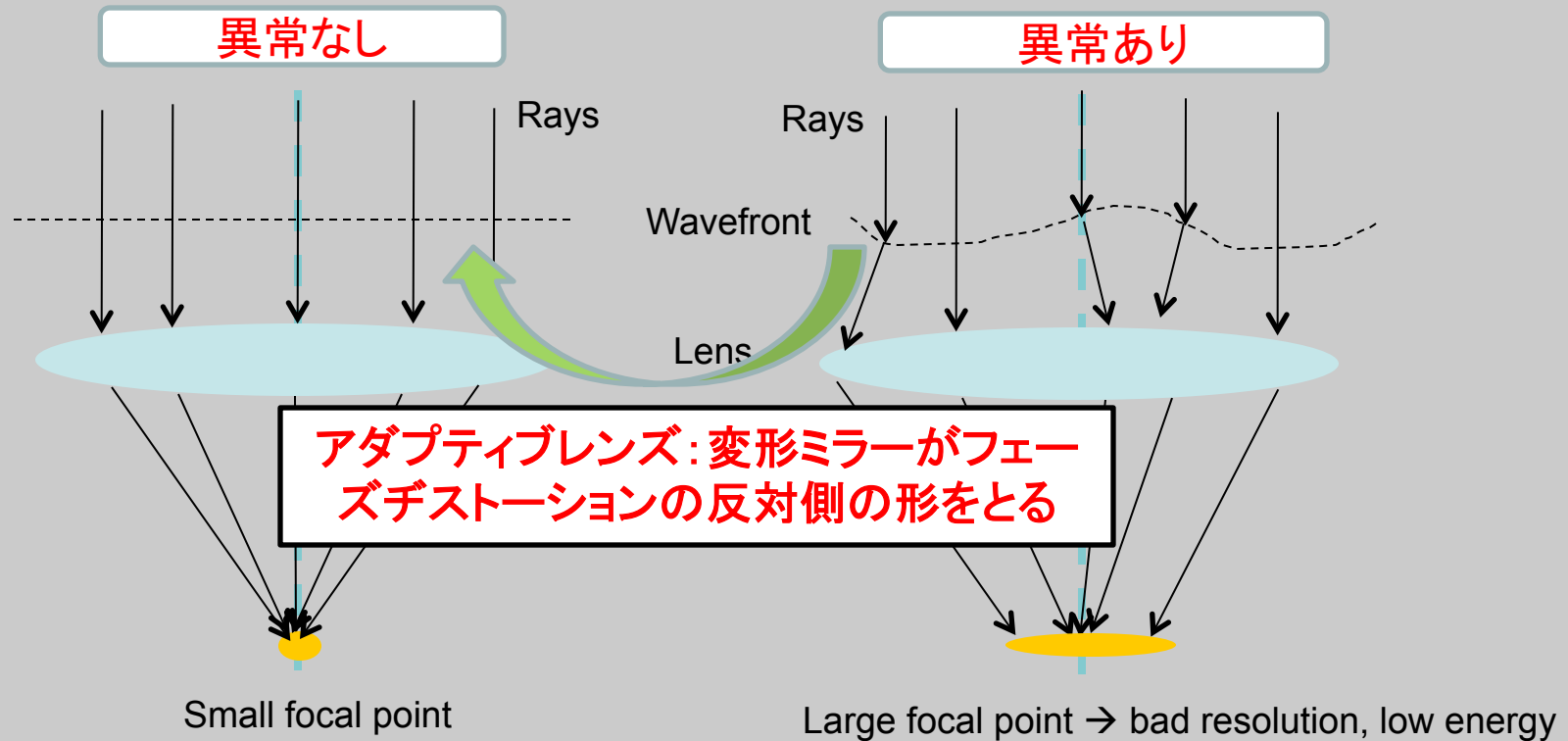
→ アダプティブオプティックはアクティブなノイズキャンセレーションをします。
adaptive optics is an active noise cancellation system



光学的異常の効果 Effect of optical aberrations



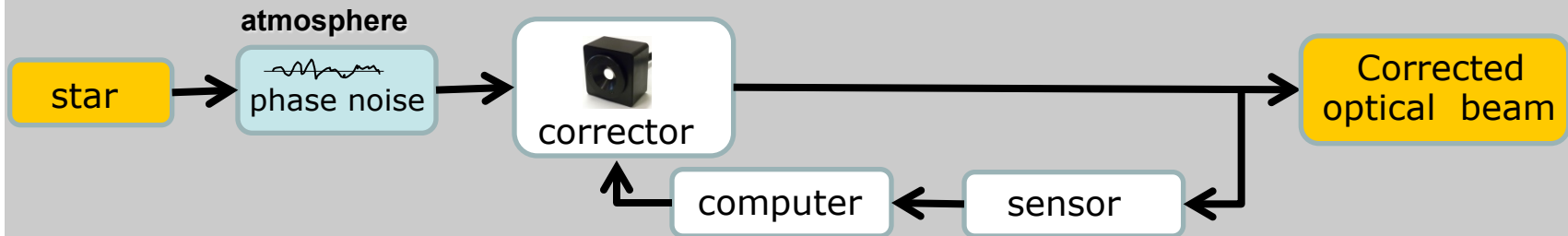
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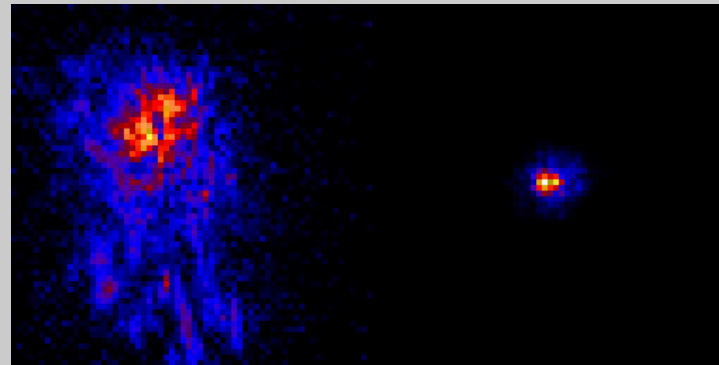
光学的な変形はイメージの解像度とS/Nを減らす。Optical aberrations reduce the imaging resolution and the signal-to-noise ratio.

天文学: 空気のゆらぎをキャンセル Astronomy: cancelling air movements

- おおきな望遠鏡では空気のランダムなゆらぎが発生する。The random movement of the air blurs the images taken with large telescopes:



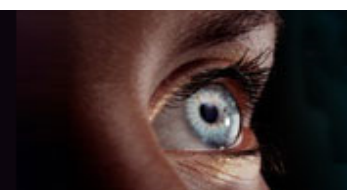
Courtesy of the CFAO



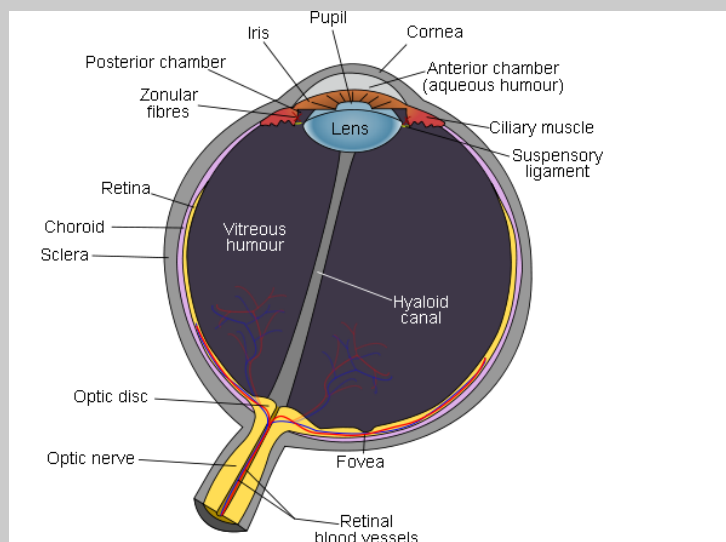
Adaptive Optics OFF

Adaptive Optics On

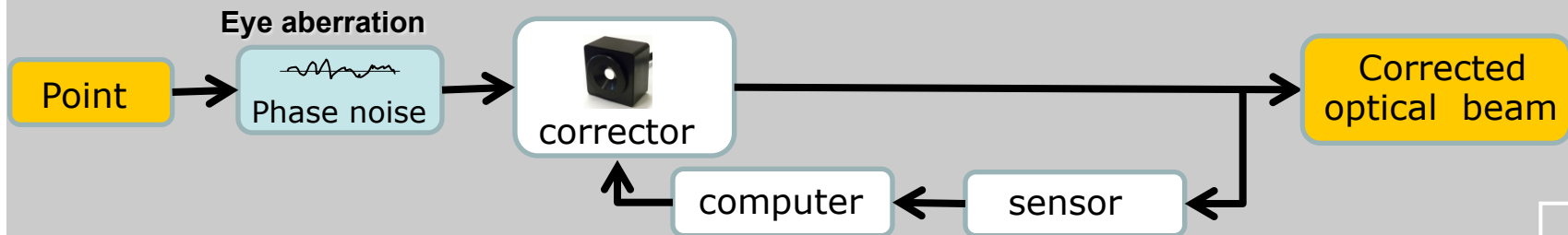
ビジョンサイエンス: 目の異常をキャンセルできる Vision science: cancelling eye aberrations



- ランダムな目の変形は虹彩のイメージ品質を落とし、OCTの装置や、スキャニングレーザーオプタルモなど。
- 小さな目のパターンでは見えない

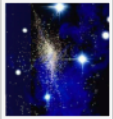
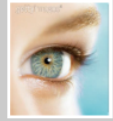


Source: Wikipedia

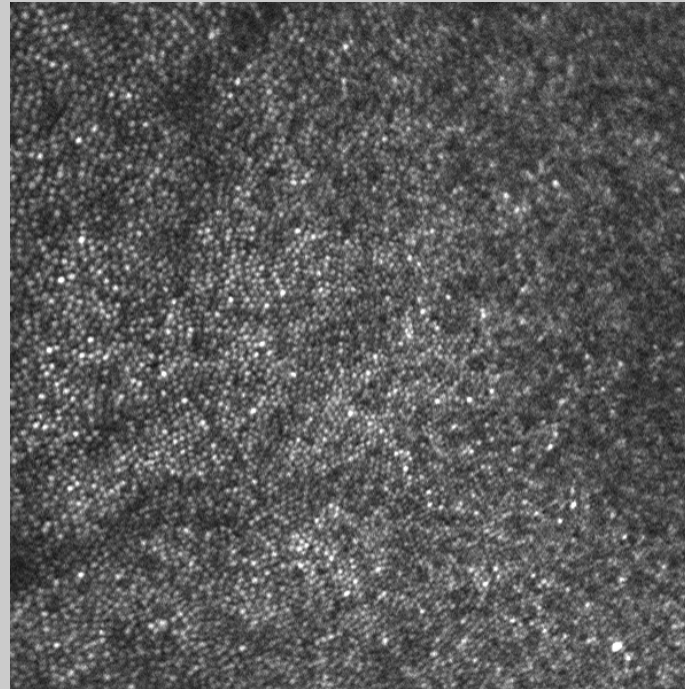


AO(アダプティブオプティック)を使っての高解像度イメージの例

Example of high resolution images using AO



Man, 34 years old, 2.0D hyperope



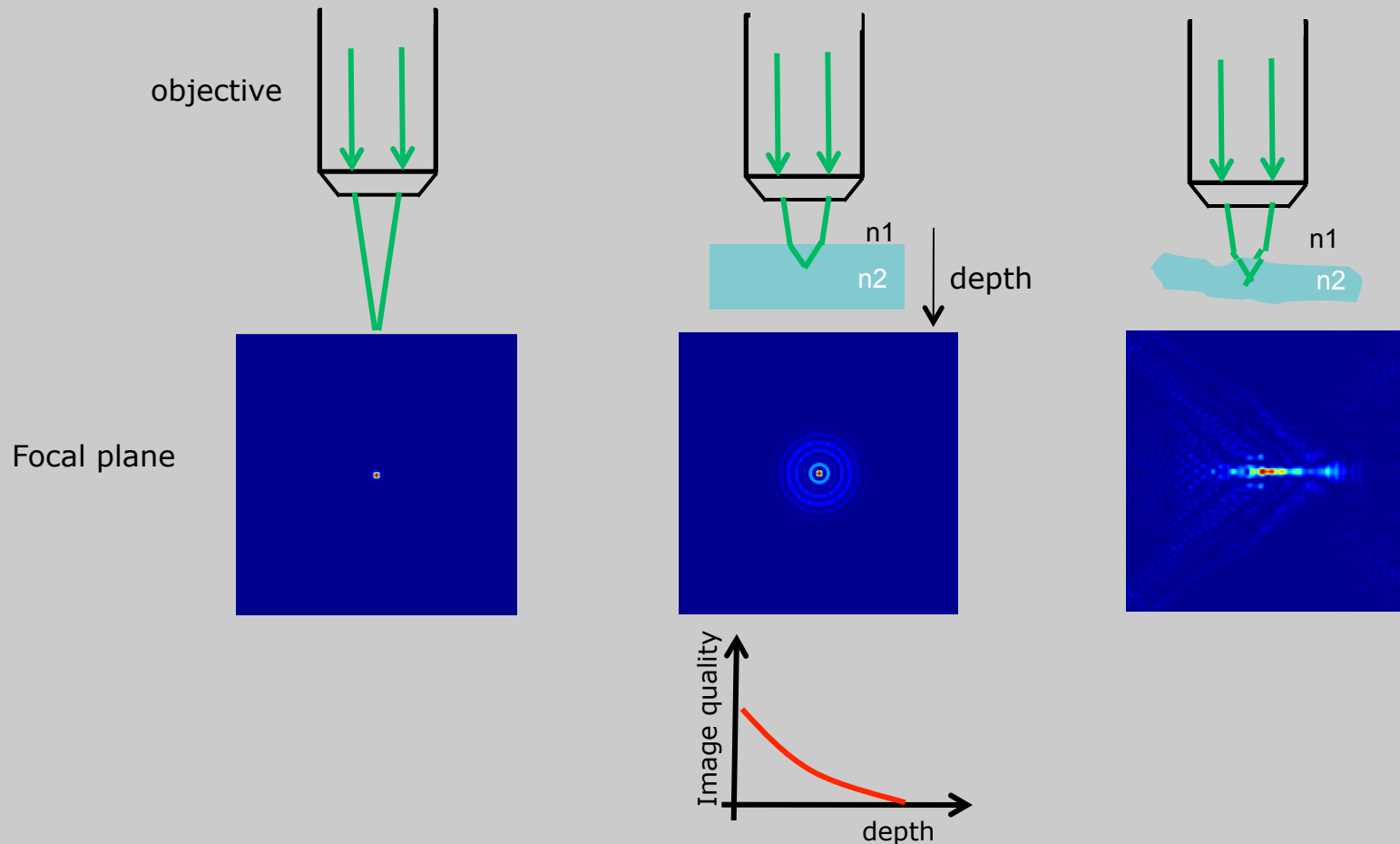
Courtesy of Alfredo Dubra, University of Rochester Eye Institute
Video obtained with the deformable mirror Hi-Speed DM97-15 from ALPAO

顕微鏡: 異常のキャンセル cancelling aberrations introduced by the sample

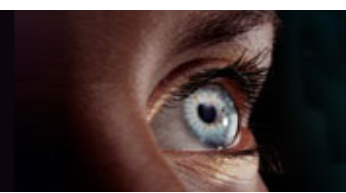


- フォーカスを深くするとイメージの解像度が落ちる

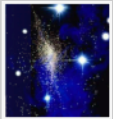
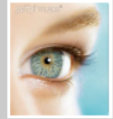
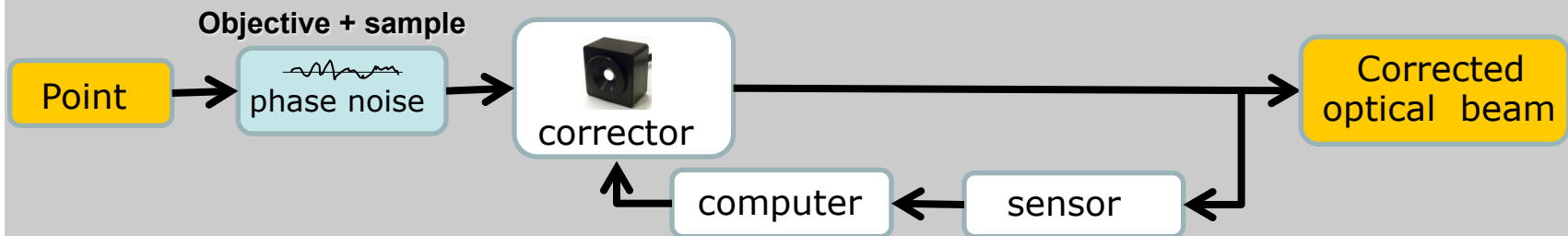
→ 小さなパターンが見えない



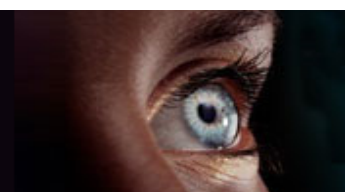
顕微鏡 Microscopy: 異常のキャン背レーション



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与えられたシェープを発生 Generating a given shape

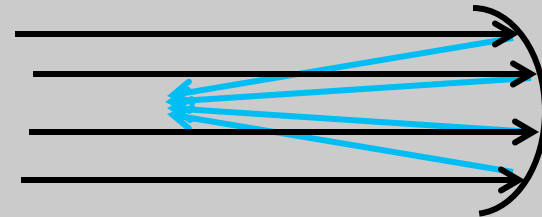


ユーザーはカスタムでデフォーミブルミラーをコントロールできます。.

- Ex: controlling the focal length



Deformable mirror
Focal length: infinity



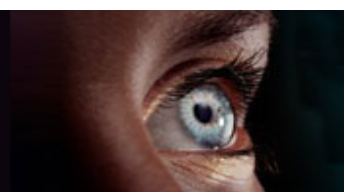
Deformable mirror:
Focal length: a few cm.

- Ex: creating a profile that cannot be manufactured or expensive



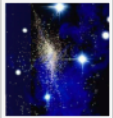
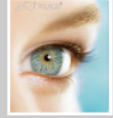
Aspheric shape achievable with a deformable mirror

どうやってよりよい補正を行うのか？



• より良いWavefront補正は次のときに行われます：

- 変形ミラーは大きな異常のときに有効です。the deformable mirror can compensate for large aberrations
→ おおきなストロークが必要 **large strokes needed.**
- 変形ミラーは正確に異常を再現できます the deformable mirror accurately reproduce the aberration
→ 正確な数のアクチュエーター **right number of actuators.**
- 変形ミラーはひとつの場所から他の場所へ短い時間で行くことができます。
• the deformable mirror goes from one position to the other one in a short time
→ おおきなバンド幅/高速セッティング時間 **large bandwidth/fast settling time.**
- 変形ミラーはあなたが期待するところにいくことができます。the deformable mirror goes where you expect it
→ リニアリティー **linearity.**
- 変形ミラーは光の効率を反射します。the deformable mirror reflects the light efficiently
→ パワーを反射する **power reflectivity.**

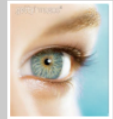


Topics

1. Introduce the company

2. Applications of adaptive optics

3. アルパオの高速変形ミラー ALPAO Hi-Speed Deformable mirrors



ALPAO 高速変形ミラー

- 在庫してあるものとカスタム製品 **Off-the-shelf and custom products**

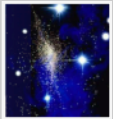
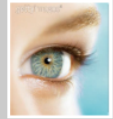


Hi-Speed DM37-15

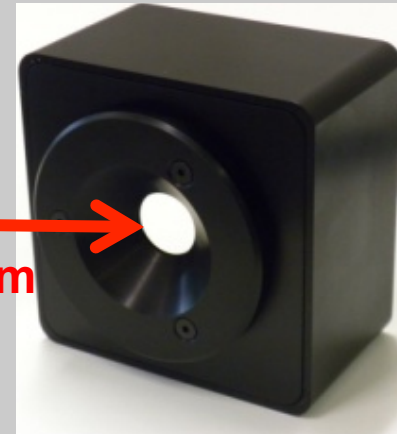
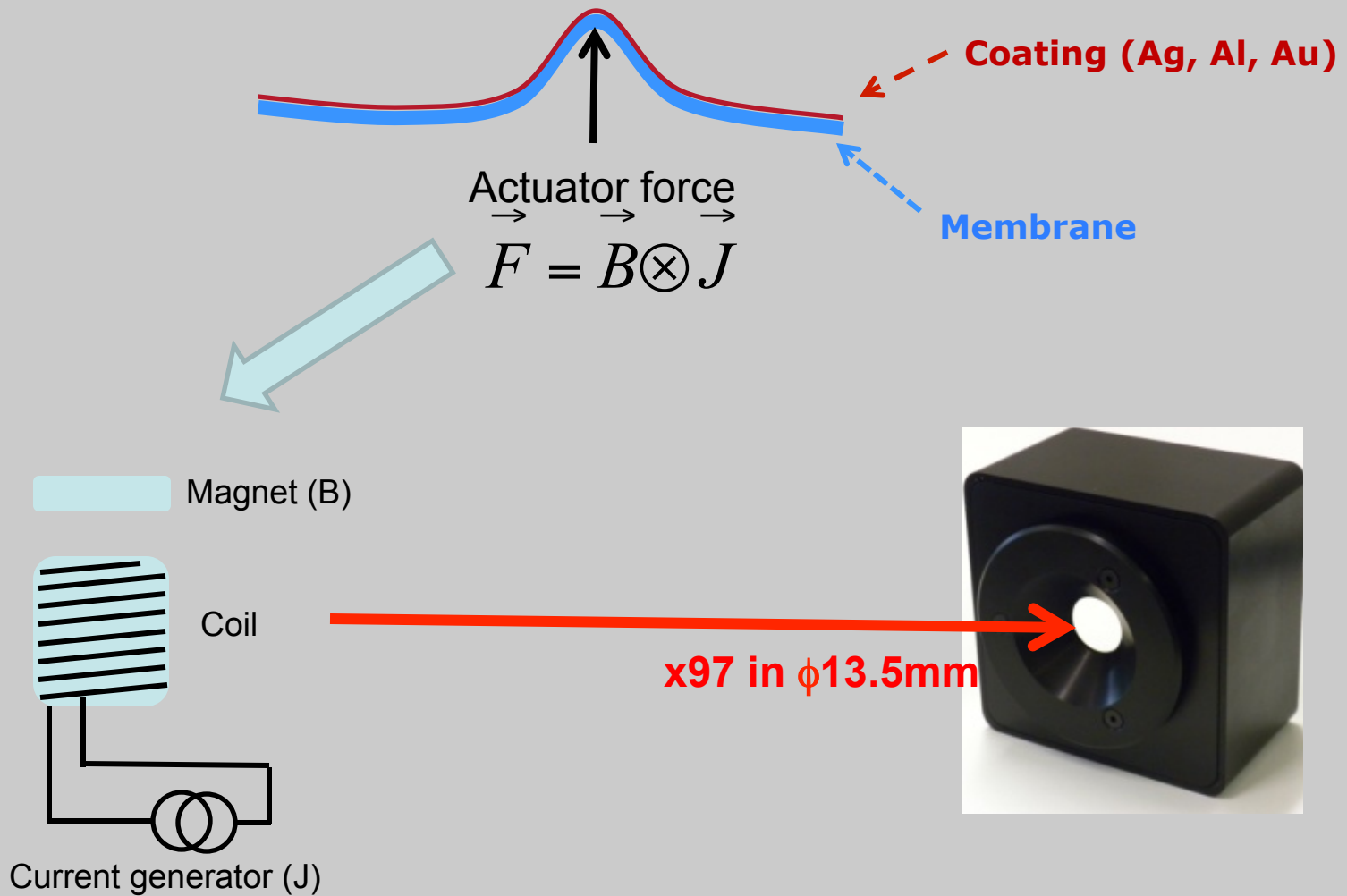
- 有効直径 7.5mm to 40.0mm
- 2つのアクチュエーの距離: 1.5 to 3.0mm
- 低電圧電源
- 堅牢
- OEM タイプもある

もしカタログの中によいミラーが見つからなければ、弊社にコンタクトしてください。If you do not find the right mirror in our catalog, please contact us.

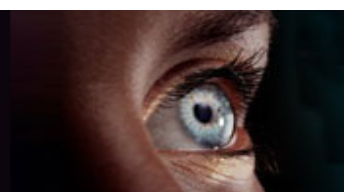
変形の基本 Principle of deformation



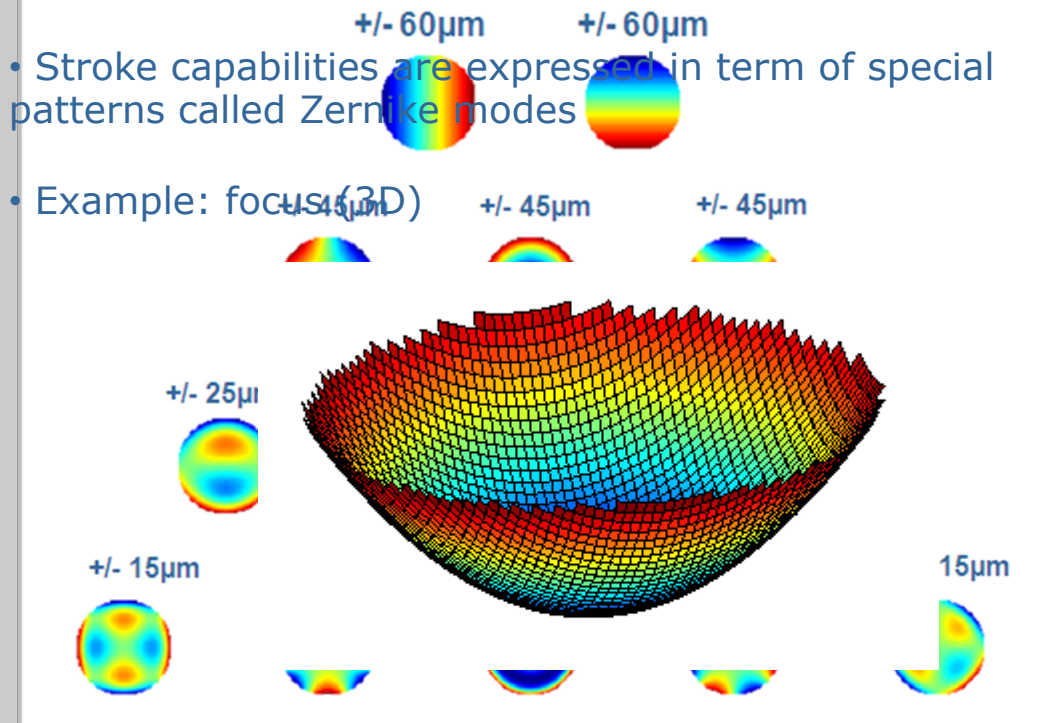
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ストロークの可能性 (i)



- Stroke capabilities are expressed in term of special patterns called Zernike modes
- Example: focus (3D)



- Peak-to-Valley: 45μm
- Wavefront peak-to-valley amplitude (Hi-Speed DM97-15)

Vision science:

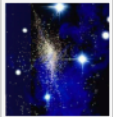
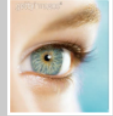
- correction distortions in bad eyes

Microscopy:

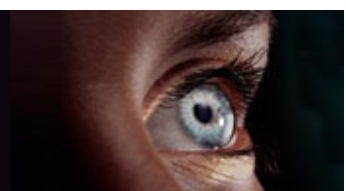
- high quality in deep samples (spherical capabilities)

Static aberrations:

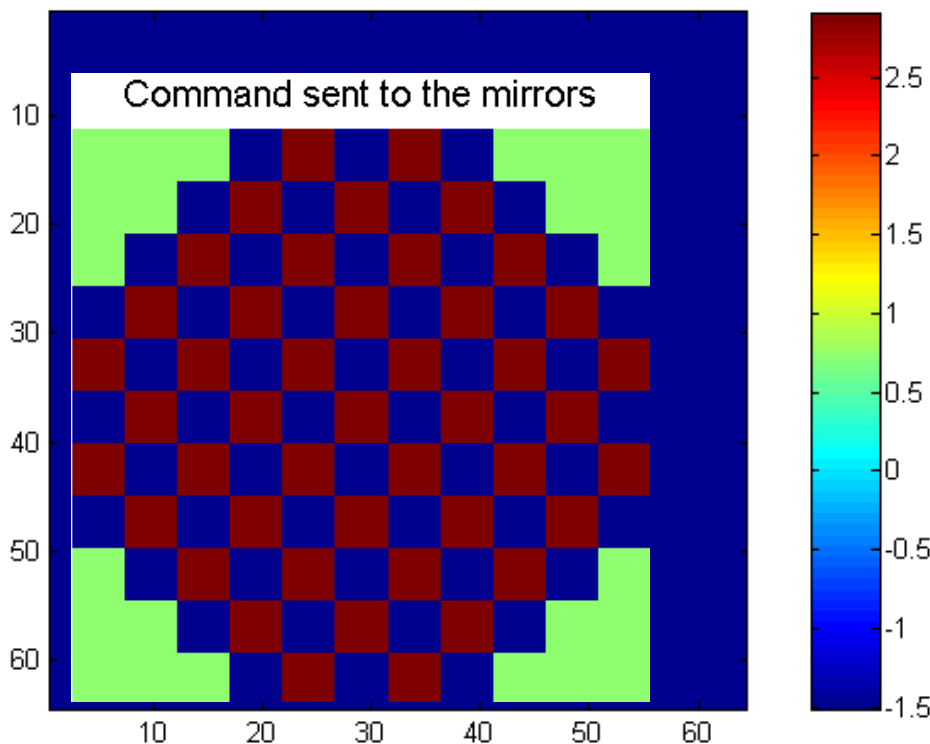
- large aspheric shapes



ストロークの可能性 (ii)



すべてのアクチュエーターを押して引っ張る



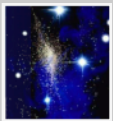
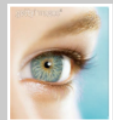
Wavefront peak-to-valley amplitude (Hi-Speed DM97-15)

天文学とスペース用
オプティック

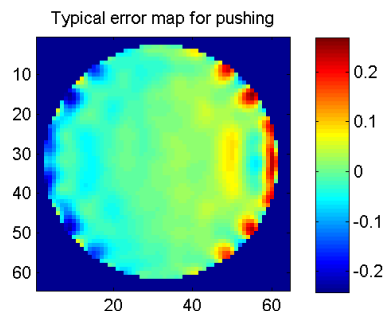
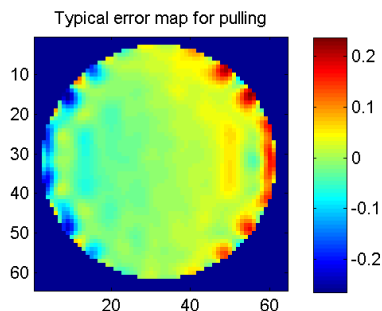
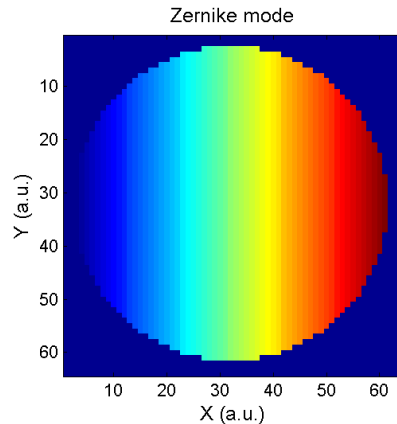
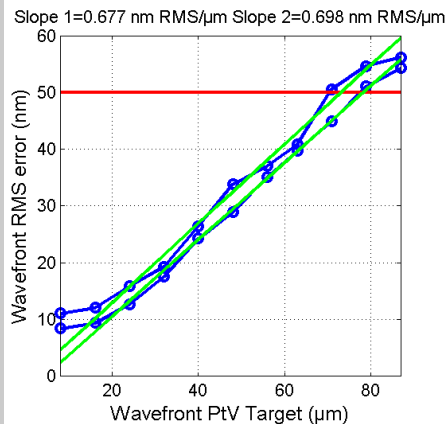
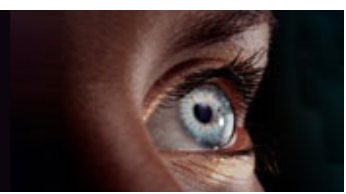
- correction of strong turbulence (small Fried's parameter)

他の用途:

- Possibility to correct for steep aberrations



正確さ / フィッティングエラー



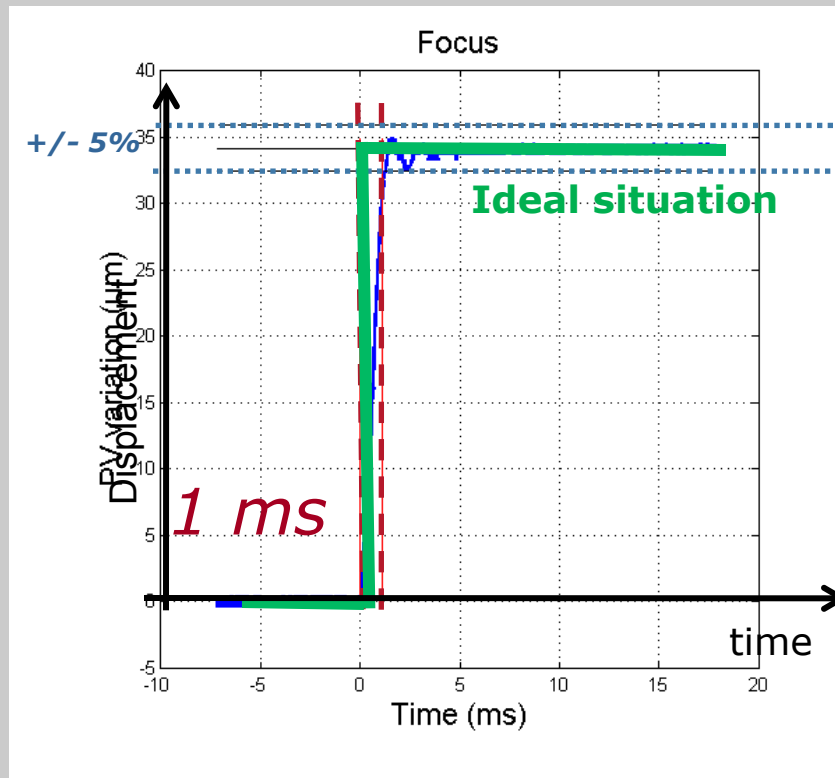
ALPAO manufactures
a large panel of
deformable mirror
with different
number of actuators.

User benefits:

Accurate and good
image quality

- The accuracy depends on the number of actuators

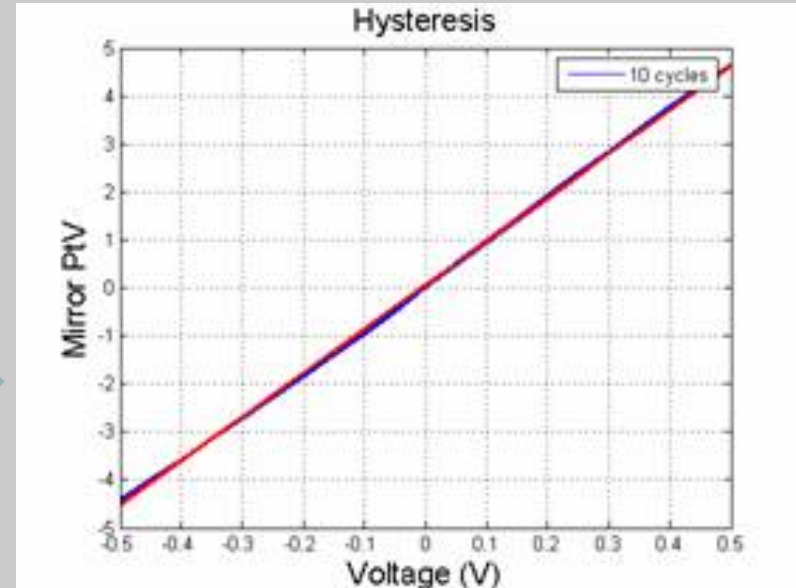
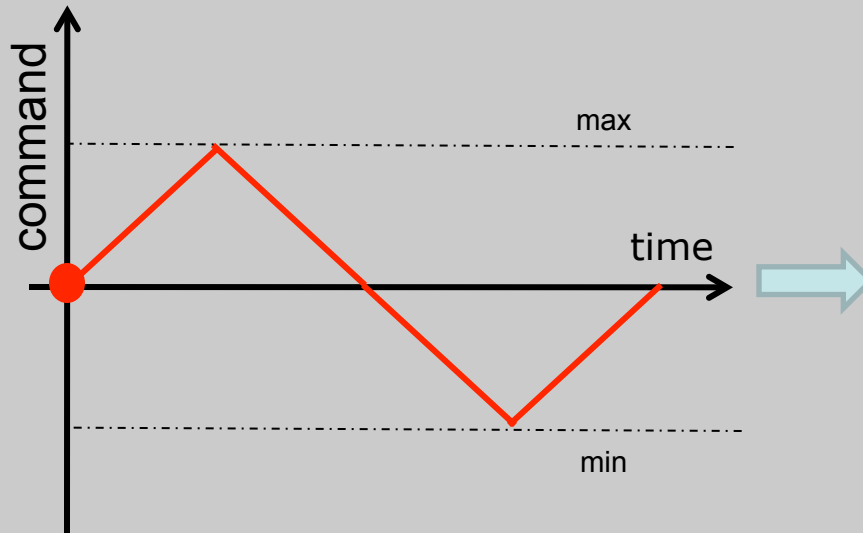
高速DM



User benefits:

- correction of fast turbulence
- changing from one shape to the other one in a short time
- precision of the measurement and the image

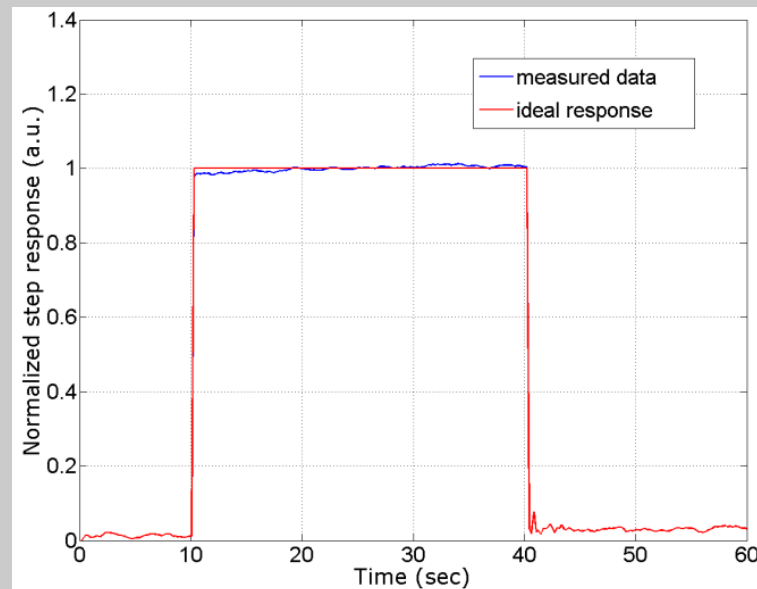
リニアリティー (i)



User benefits:

- Non linearity errors <5%
 - Easy control
- Optimal strategy

リニアリティー(ii)

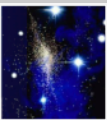


Stability: $\pm 1\%$ over 30 sec!

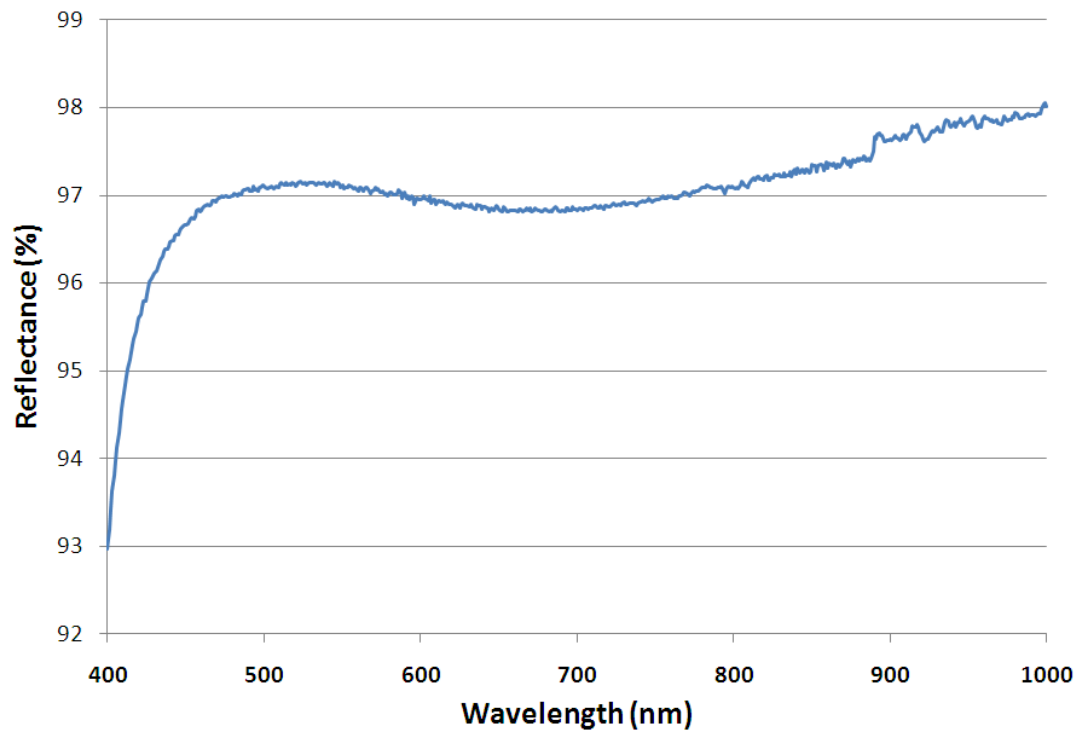
User benefits:

- Easy control

- 
- A close-up photograph of a person's eye, showing a contact lens. The lens has a light blue or green tint. The person's iris is visible through the lens. The image is part of an advertisement for contact lenses.

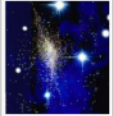
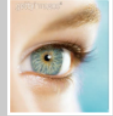
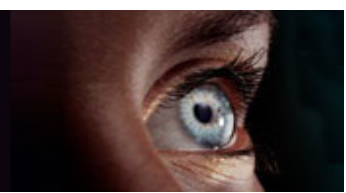


コーティング



User benefits: low photon loss

変形ミラーの製品リスト



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	Hi-Speed DM37-15	Hi-Speed DM52-15	Hi-Speed DM69-15	Hi-Speed DM97-15	Hi-Speed DM52-25	Hi-Speed DM88-25
Pitch	1.5 mm				2.5 mm	
Number of actuators	37	52	69	97	52	88
Pupil diameter	7.5 mm	9.0 mm	10.5 mm	13.5 mm	15 mm	20 mm
Mirror best flat	7 nm RMS				7 nm RMS	
Wavefront tip/tilt stroke	+/- 60 μ m				+/- 20 μ m	
Wavefront inter-actuator stroke	> 3 μ m				> 3 μ m	
Wavefront 3x3 stroke	> 30 μ m				> 14 μ m	
Bandwidth	> 750 Hz				> 750 Hz	
Non-linearity error	< 3%				< 3%	
Hysteresis error	< 1%				< 1%	
Coating	Protected Silver				Protected Silver	
Operating temperature	10 to 35 °C				10 to 35 °C	
Dimensions	68x68x49 mm				78x60x22 mm	
Weight	600 g				200 g	

If you do not find the right mirror in our catalog, please contact us.



Arigatô

QUESTIONS ?

- Adaptive optics for Extremely Large Telescopes (Canada)
- Frontiers in optics 2011 (U.S.A.)

