

Electrostatically Addressable Visored Shutter Array by Electroplating for Astronomical Spectrography

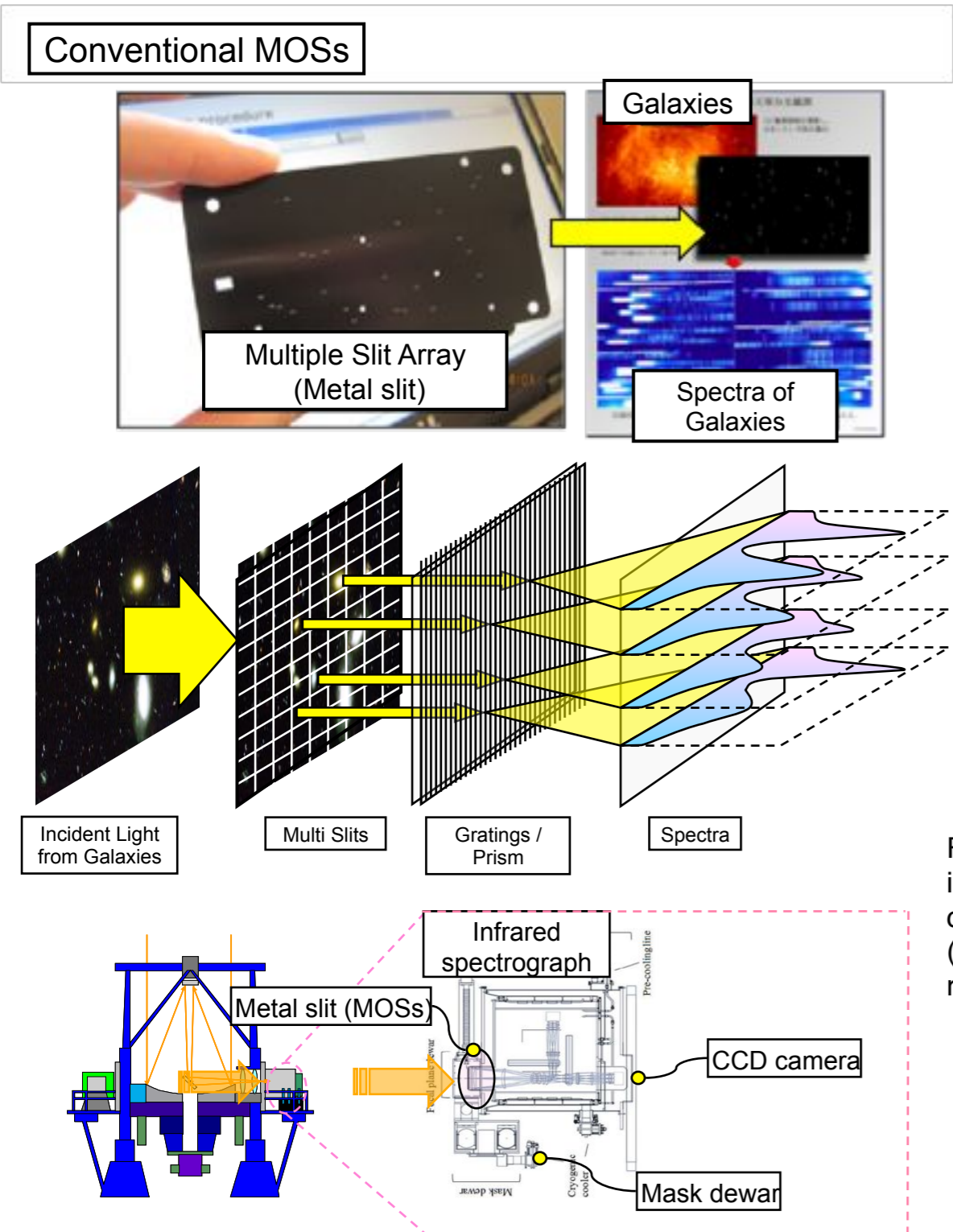
*T. Takahashi*¹, M. Mita², K. Motohara¹, N. Kobayashi¹, N. Kashikawa³,
H. Fujita¹, and H. Toshiyoshi¹

¹University of Tokyo, ²JAXA, ³National Astronomical Observatory of Japan

本研究の最終目標は、東京大学理学部天文センターが中心となって南米チリのアタカマ高地に計画している「東京大学アタカマ天文台」の6.5m級望遠鏡に搭載する近赤外分光器を「多天体分光器化」して、遠方銀河のディープサーベイを短時間に効率よく行う技術を開発することである。分光器に従来搭載されてきた金属スリットに代わるデバイスとして、本研究室ではトーシヨンミラー型静電駆動シャッタアレイを開発中であるが、今回はシャッタ上方に3次元的に庇構造を追加した新たなデバイスについて報告する。この庇構造は表面マイクロマシニング技術の電解めっきを用いて製作され、それ自体を独立した一つの電極として使用することにより、シャッタ個々に電気配線をする必要なしに任意のシャッタのON/OFF駆動と静電ラッチが可能となり、シャッタ板周囲の漏れ光対策のみならず、素子数を増やしデバイスを大面積化した際に生じる配線問題の解法としても期待できる。

Introduction

Astronomical Multi-Object Spectrographs (MOSS)



TAO 6.5m Telescope @Atakama in Chile



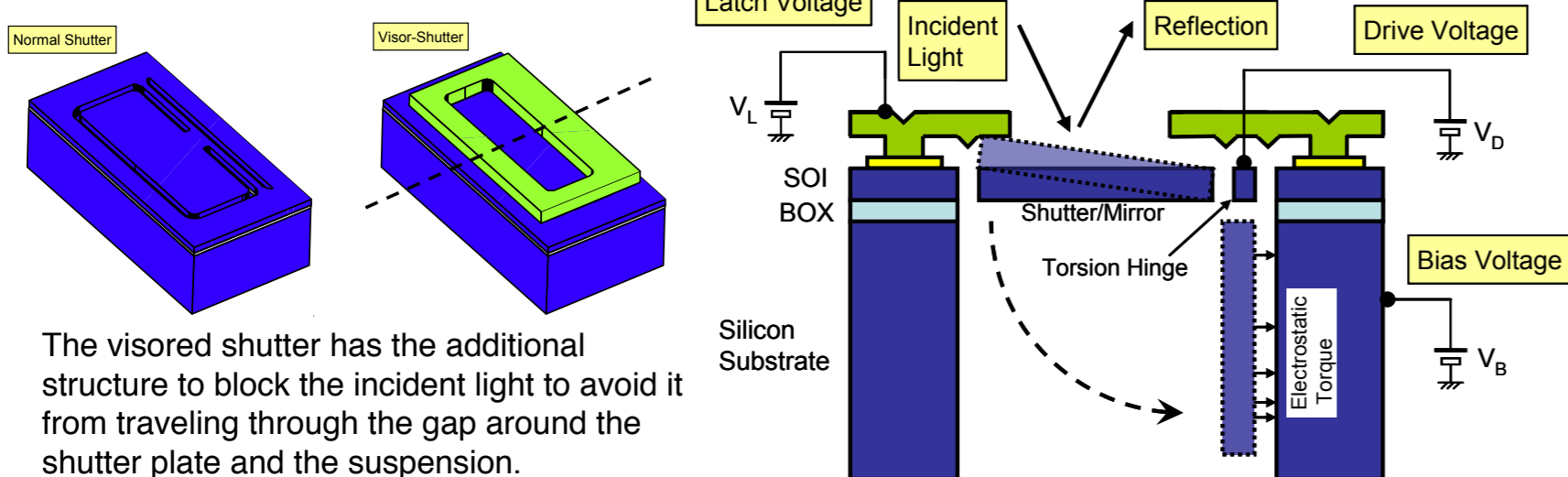
miniTAO 1.0m Telescope (installed in 2009)

Fixed metal slit-masks were inconvenient when frequently changing the target galaxies. (Time & labor consuming when replacement is needed.)

MEMS shutter array could be used to replace the fixed metal-slit mask.

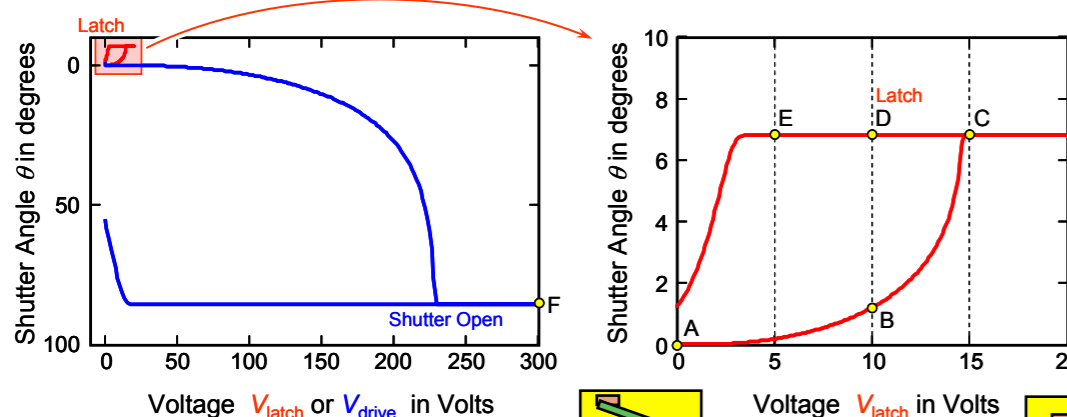
Experimental setup

Device structure



The visored shutter has the additional structure to block the incident light to avoid it from traveling through the gap around the shutter plate and the suspension.

Addressing simulation (one shutter)

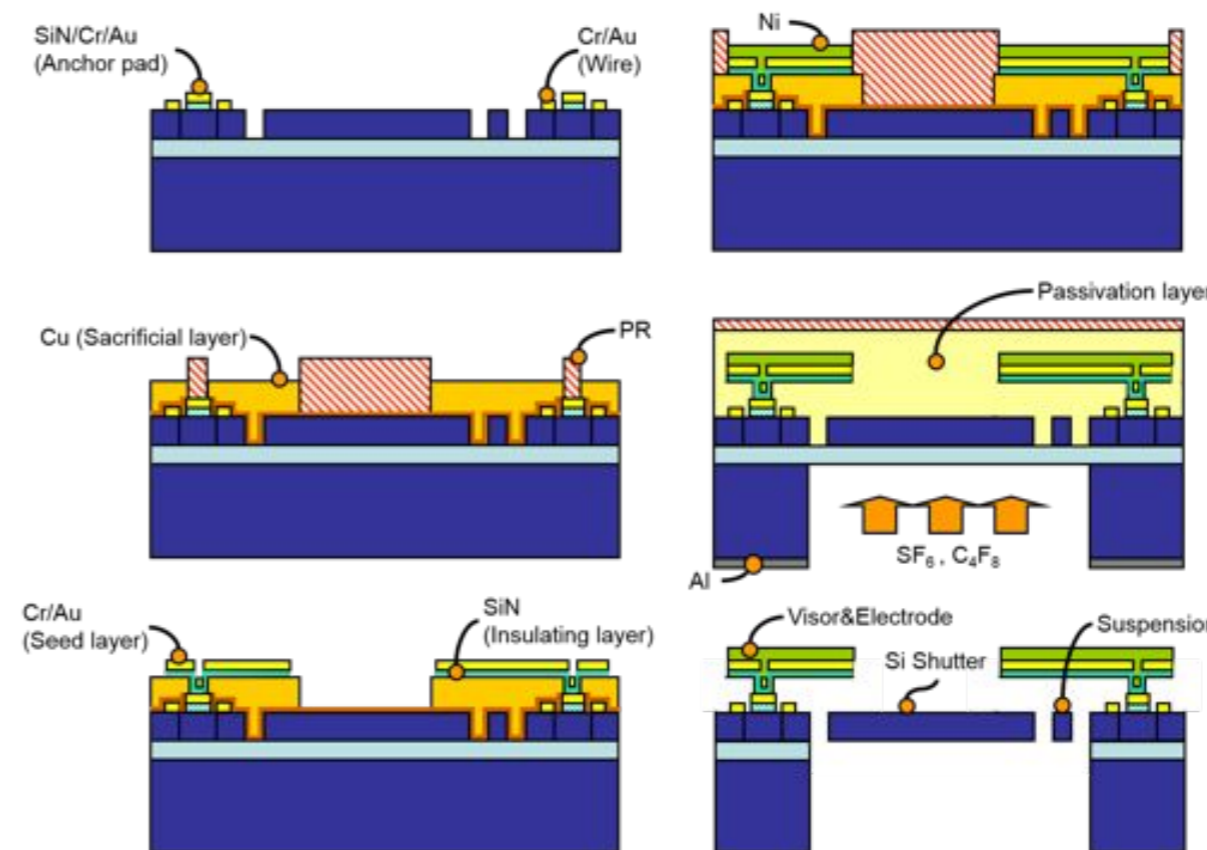


Shutter plate is electrostatically pulled inside to open 90 by degrees when a voltage is applied.

The visor structure provides it with another electrostatic drive port that could be used to latch the shutter plate keep it at the close-position against the drive torque from the substrate part.

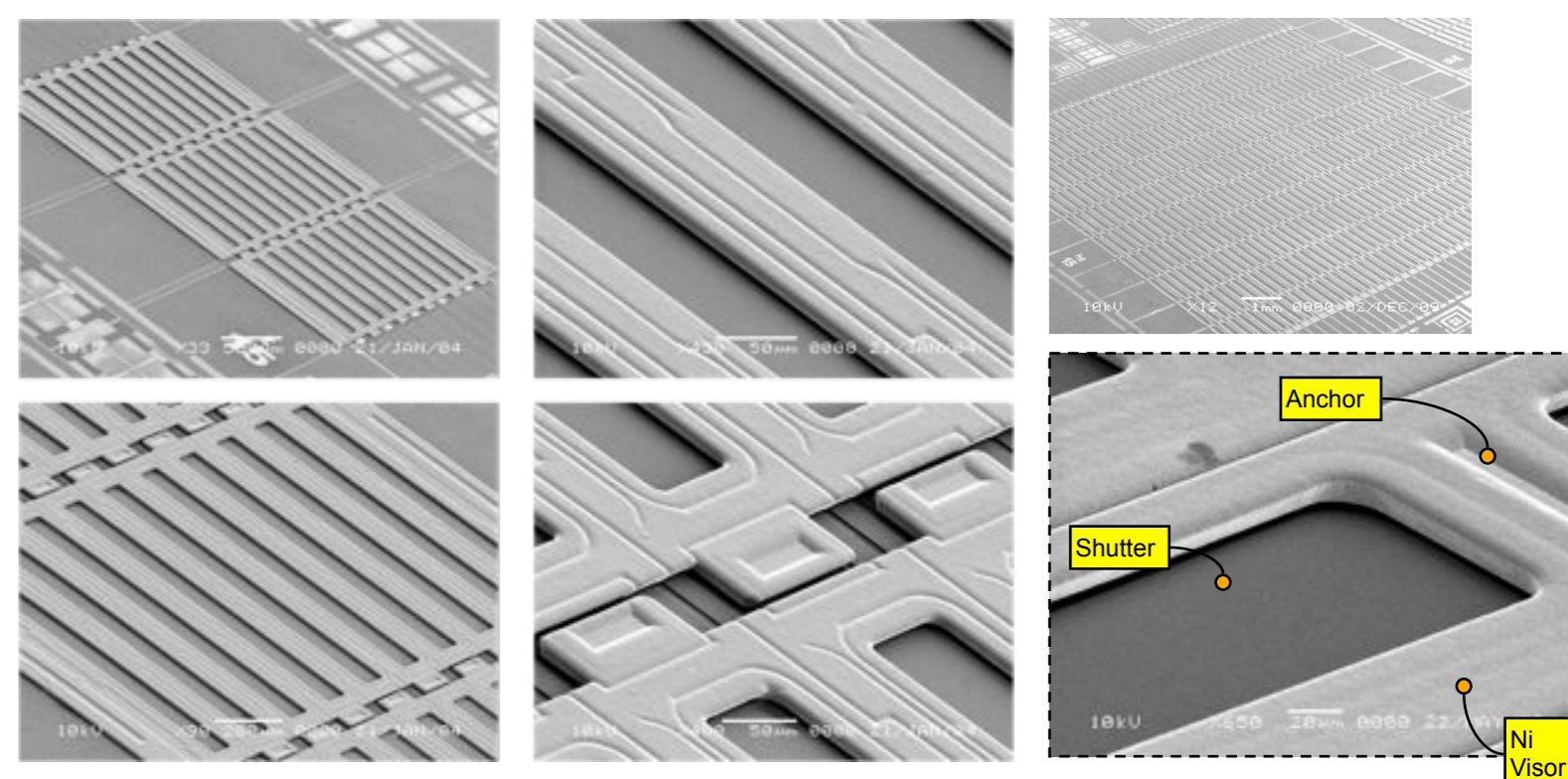
The timing chart to control the voltages to the shutter, the visor, and to the substrate to choose arbitrary combination of shutters at the latch position.

Device Fabrications



The visor structure is formed by the two-step electroplating processes onto the shutter pattern to cover the gap.

The final sacrificial release is performed by the buried oxide of CHF₃ to minimize the risk of device rupturing and the in-process stiction.



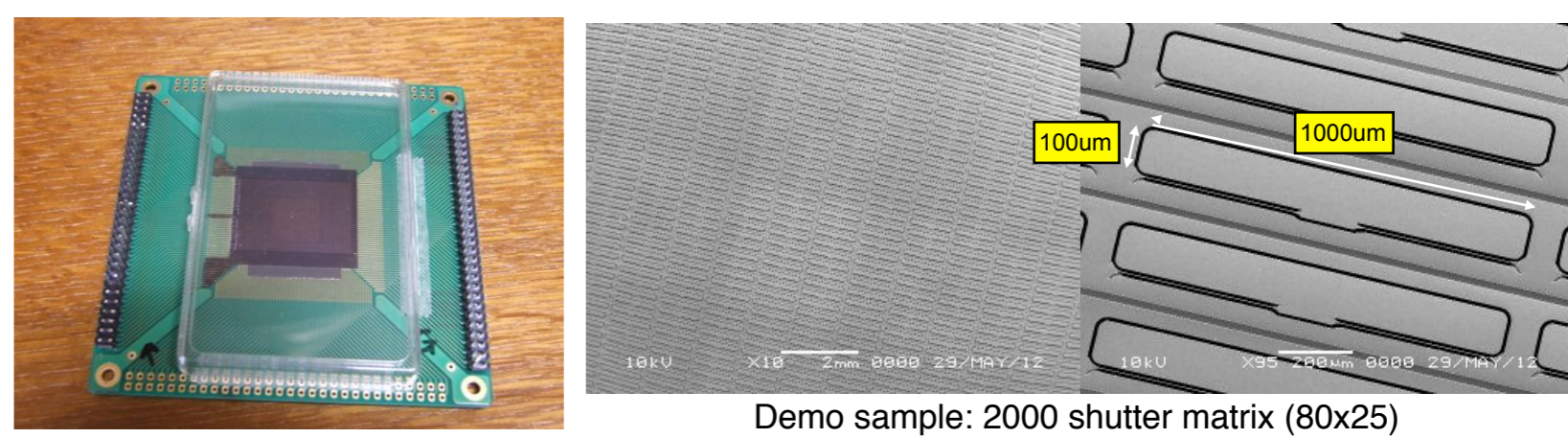
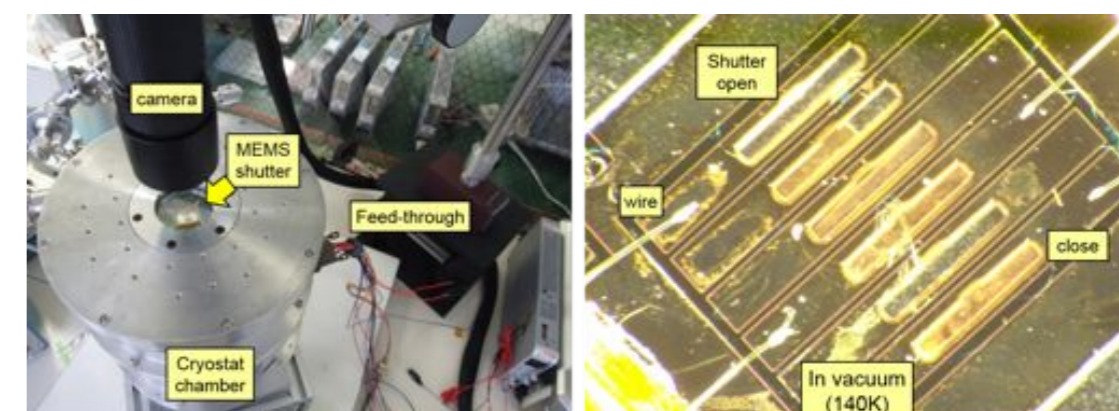
Recent Works

ATAKAMA tour in Chile



Cryogenic operation

The selected shutter was fully opened at 120V. (140K)



Contact: takuya@iis.u-tokyo.ac.jp