Electrostatically Addressable Visored Shutter Array by Electroplating for Astronomical Spectrography

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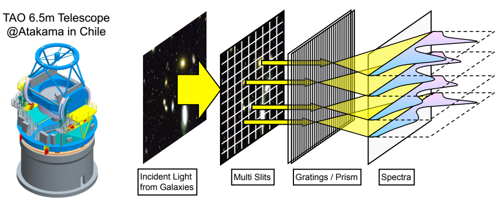
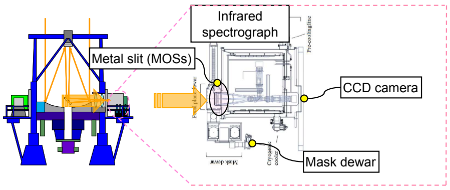
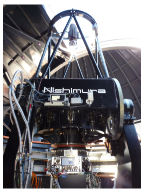
本研究の最終目標は，東京大学理学部天文センターが中心となって南米チリのアタカマ高地に計画している「東京大学アタカマ天文台」の６．５m級望遠鏡に搭載する近赤外分光器を「多天体分光器化」して，遠方銀河のディープサーベイを短時間に効率よく行う技術を開発することである．分光器に従来搭載されてきた金属スリットに代わるデバイスとして，本研究室ではトーションミラー型静電駆動シャッタアレイを開発中であるが，今回はシャッタ上方に３次元的に庇構造を追加した新たなデバイスについて報告する．この庇構造は表面マイクロマシニング技術の電解めっきを用いて製作され，それ自体を独立した電極として使用する。シャッタ個々に電気配線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

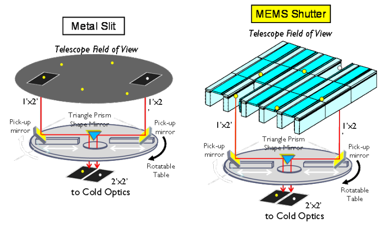
Astronomical Multi-Object Spectrographs (MOSs)







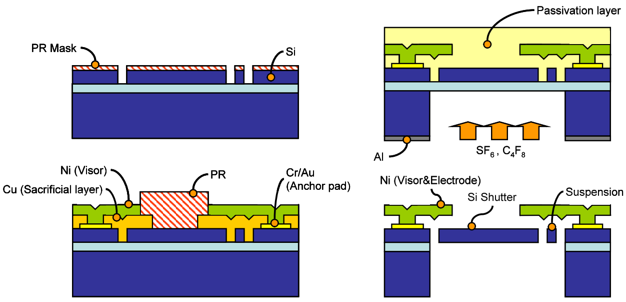
miniTAO 1.0m Telescope (installed in 2009)

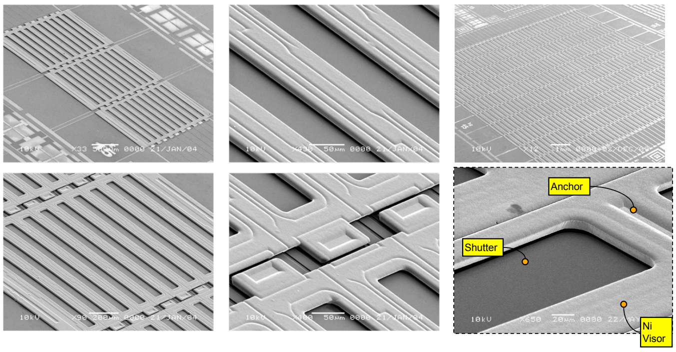


Fixed metal slit-masks were inconvenient when frequently changing the target galaxies. (Time & labor consuming when replacement is needed.)

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

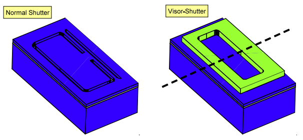
Device Fabrications



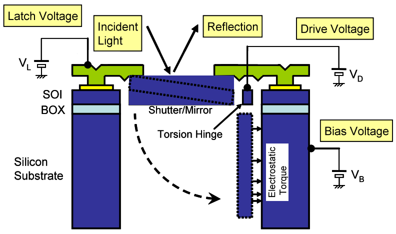


Experimental setup

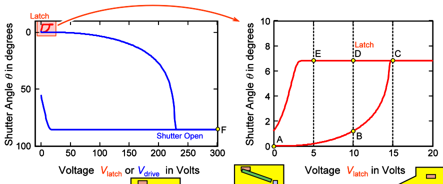
Device structure



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.

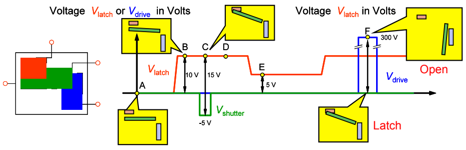


Addressing simulation (one shutter)



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

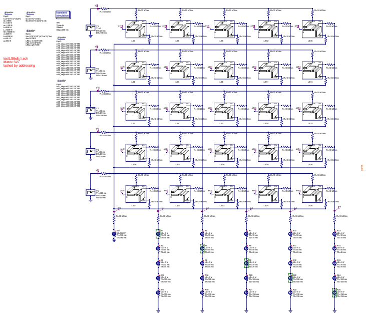
The visor structure provides it with another electrostatic drive port that could be used to latch the shutter plate keep it at the close-position against the drive torzque from the substrate part.

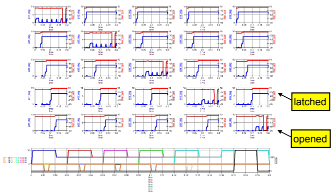


The timing chart to control the voltages to the shutter, the visor, and to the substrate to choose arbitrary combination of shutters at the latch position.

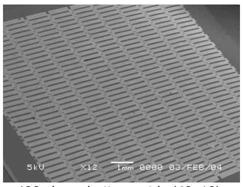
Recent Works

Addressing Simulation (5x5 shutter matrix)

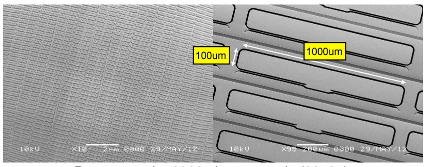




5x5 matrix visor-shutter was individually operated by the Qucs simulation.
5 shutters were full opened (rotated 90 degree) at drive voltages of 200V or higher, and the others were electrically latched with the visor.



400 visor-shutter matrix (40x10)



Demo sample: 2000 shutter matrix (80x25)

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