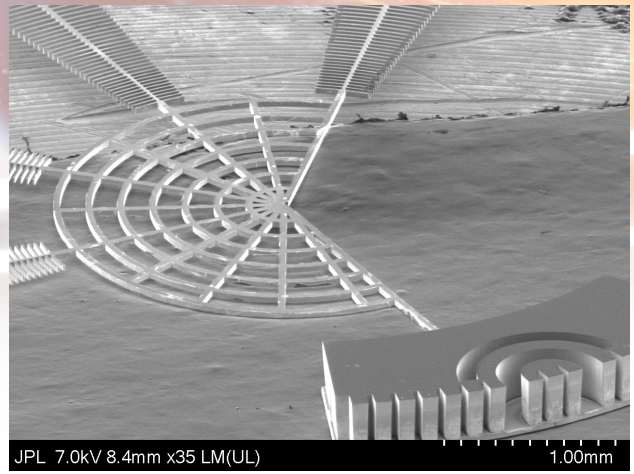
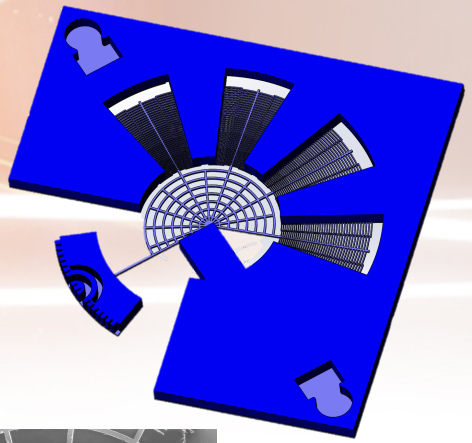
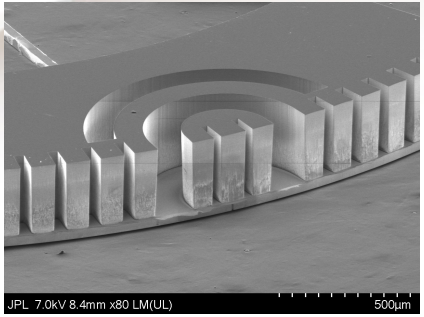
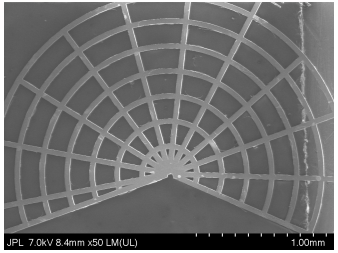
RPC 2020









Virtual Research Presentation Conference

CONTACTLESS ROTATING MEMS SWITCH FOR WATER DETECTION AT 557 GHz AND 752 GHz

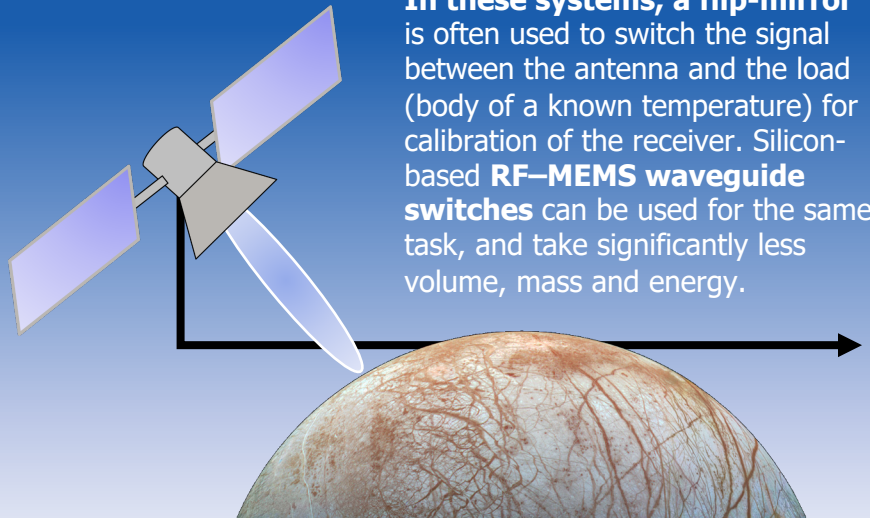
Principal Investigator: Cecile Jung-Kubiak (389)
Co-Is: Sofia Rahiminejad (Presenter, 389), Robert Lin (386), Alex Peralta (386)
Program: Innovative Spontaneous Concept

Assigned Presentation # RPC-214

Jet Propulsion Laboratory
California Institute of Technology

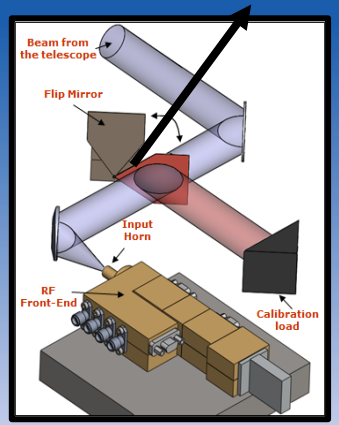
Tutorial Introduction

Today high-resolution heterodyne spectrometers suited for space missions are used to detect unique molecular signatures, such as **water molecules**, with a high spectral resolution over a wide range of wavelengths. **The radar and its antennas form a significant part of the system**.



In these systems, a flip-mirror is often used to switch the signal between the antenna and the load (body of a known temperature) for calibration of the receiver. Silicon-based **RF–MEMS waveguide switches** can be used for the same task, and take significantly less volume, mass and energy.

Flip mirror: to optically redirect the radiometer to its calibration target

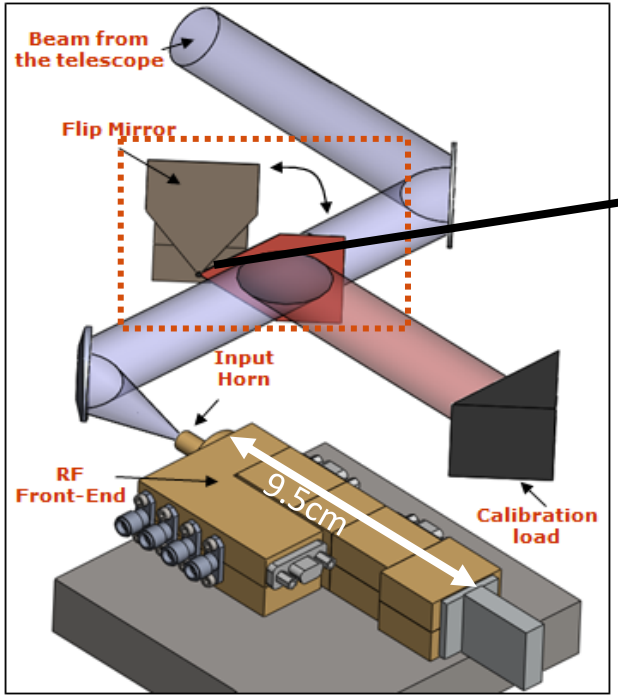


State of the art beam steering system with calibration mirror

All of the MEMS waveguide switches developed to date need electrical and mechanical contacts to block the wave, creating issues such as mechanical stress/stiction, and if cycled many times, problems with ohmic contact resistance can arise.

A contactless in-plane MEMS waveguide switch would therefore be greatly beneficial for THz applications.

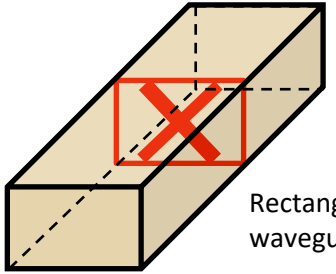
Problem Description



State of the art system, similar to what was used on MIRO

Flip mirror: to optically redirect the radiometer to its calibration target

Most waveguide switches need electrical and mechanical contact to block the incoming wave.



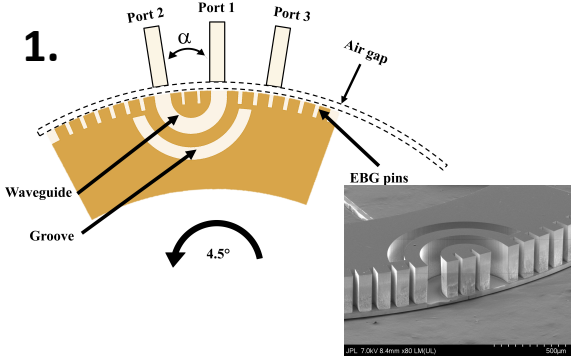
Solution

A contactless in-plane MEMS waveguide switch

- By replacing the flip mirror with a MEMS component will significantly reduce volume and mass of the system.
- By designing the MEMS switch to be contactless, using electromagnetic bandgap surfaces, the common issues of MEMS switches can be avoided.

Methodology

1.

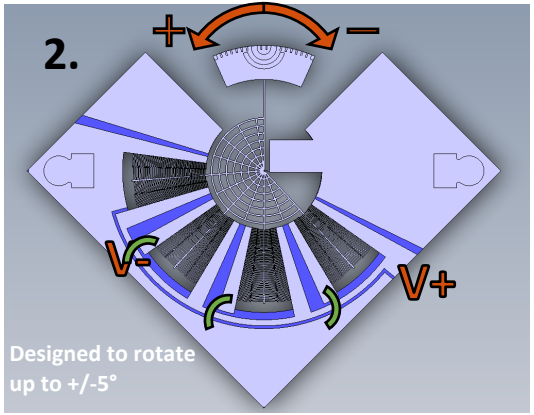


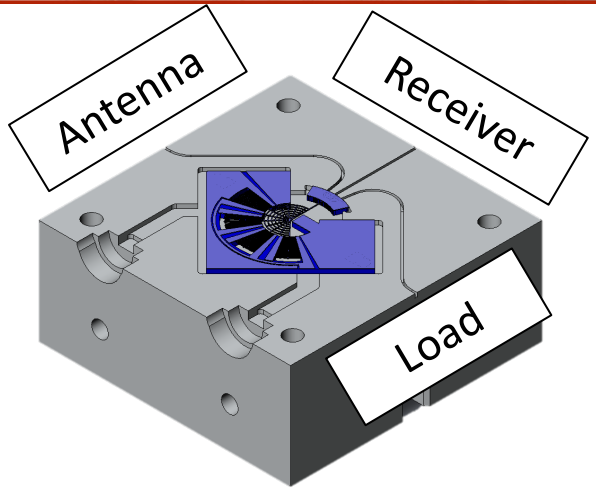
a) Designed a U-bend waveguide that connects two waveguide ports.

b) Surround the U-bend opening with an EBG surface to avoid leakage even though there is a gap.

c) Designed the angular spacing between the waveguide ports to so that the U-bend only needs to rotate +/- 4.5°.

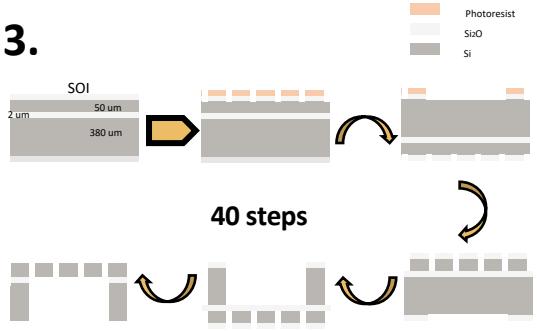
2.



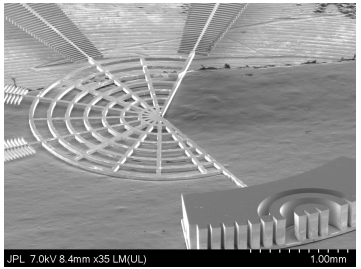


Designed a rotating MEMS motor that can rotate +/- 5° and a brass block to connect the waveguides.

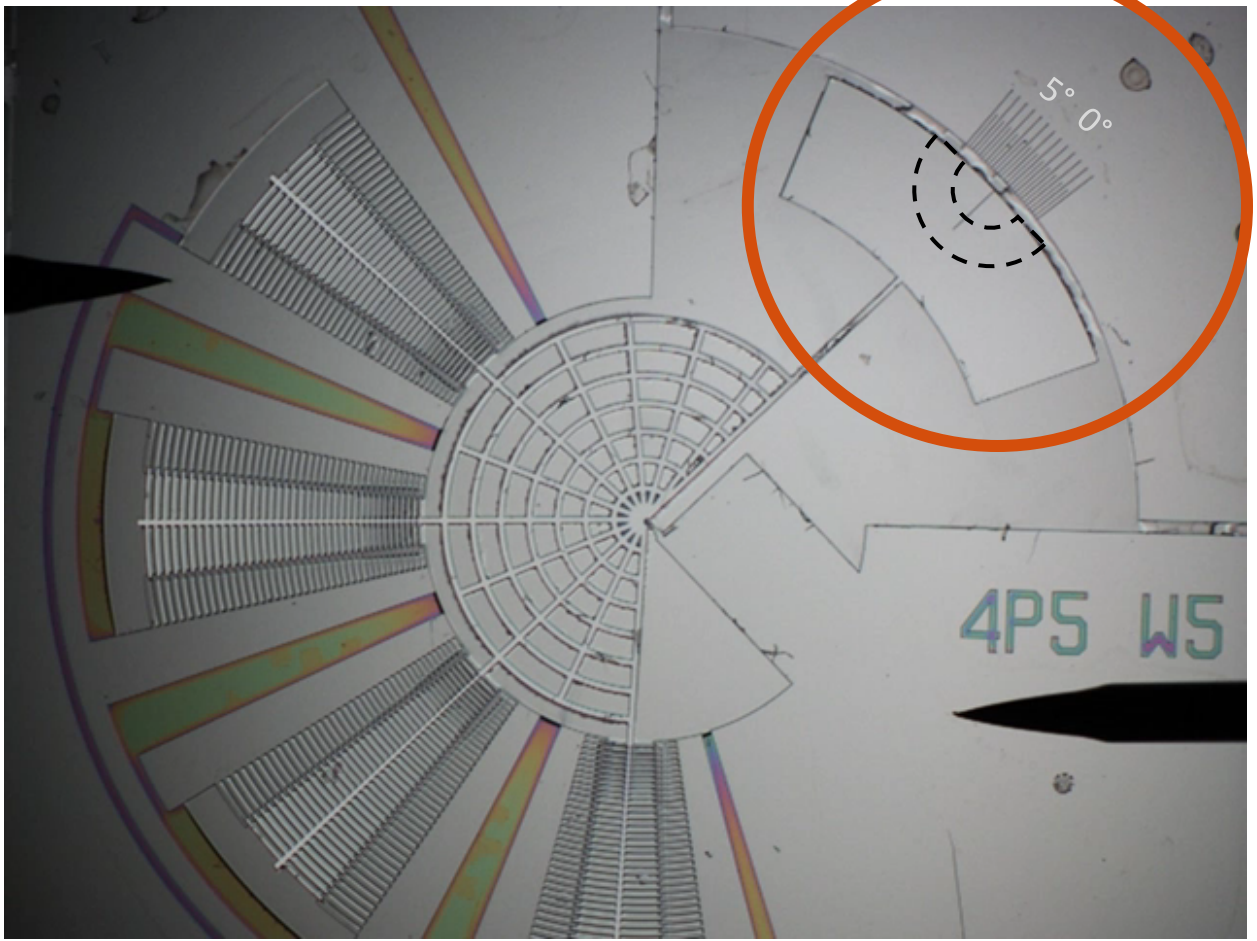
3.



Developed a fabrication process and then fabricated the contactless rotating waveguide switch using SOI wafers in the MDL cleanroom at JPL.



Results



Click on the video to play if it does not start !

Publications and References

S. Rahiminejad, C. Jung-Kubiak, M. Rais-Zadeh and G. Chattopadhyay, "*Contactless rotating MEMS waveguide switch for water detection at 557 GHz*" 31st IEEE International Symposium On Space Terahertz Technology (ISSTT), Tempe, AZ, 2020.