

Contactless Cost-effective Polarizer for mm-Wave Dielectric Rod Waveguide

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PRINCIPLE OF
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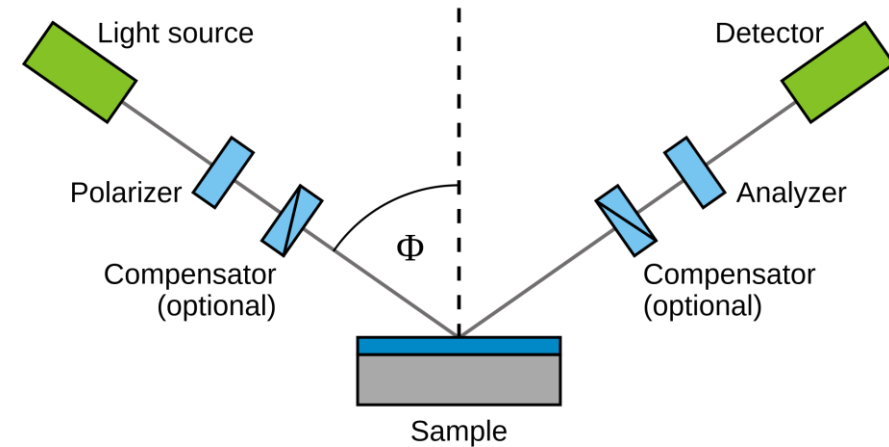
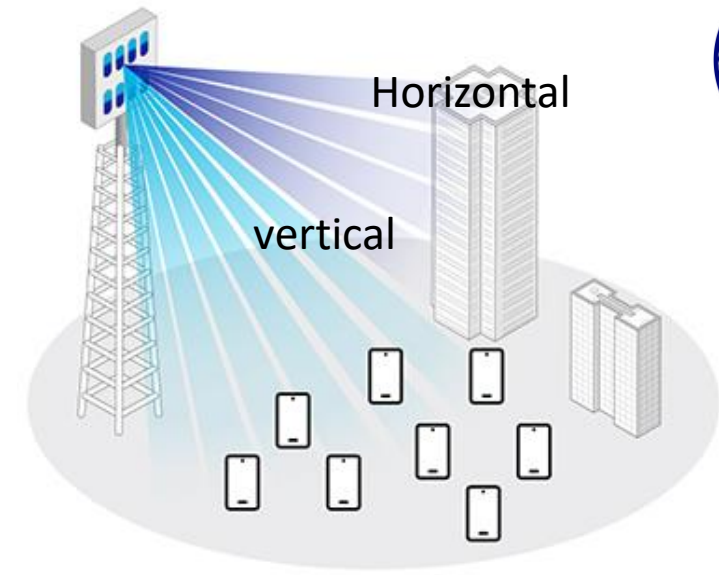
EXPERIMENT AND
RESULTS



CONCLUSION

Motivation

- Many mm-wave applications exploit polarization diversity
 - ❖ Communications for higher overall bandwidth.
 - ❖ Measurement techniques such as Ellipsometry as well.
- Require well-defined orthogonal polarizations
- Require mm-wave polarizers for signal integrity

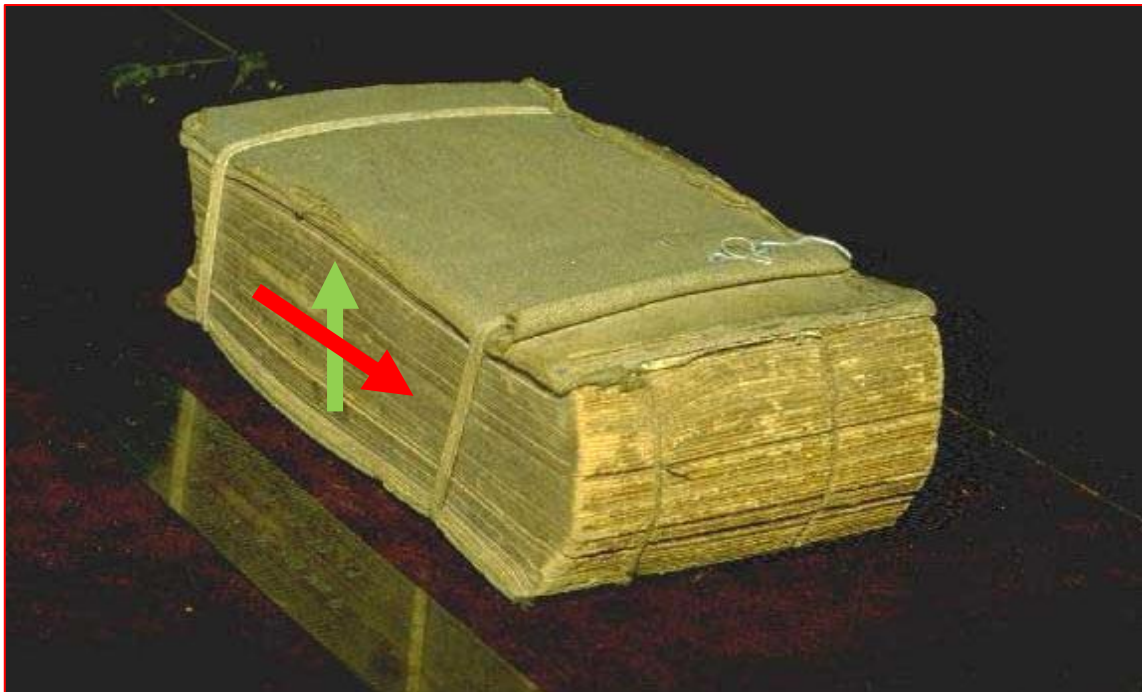


Spectroscopic Ellipsometer

[<https://cense.engr.uky.edu/>]

How did it begin

- Jagadish Chandra Bose → late 18th century
- Book pages interleaved with tinfoil → 60 GHz polarizer



Bose's polarizers with cut-off metal plate grating, consisting of a book with sheets of tinfoil interleaved in the pages.

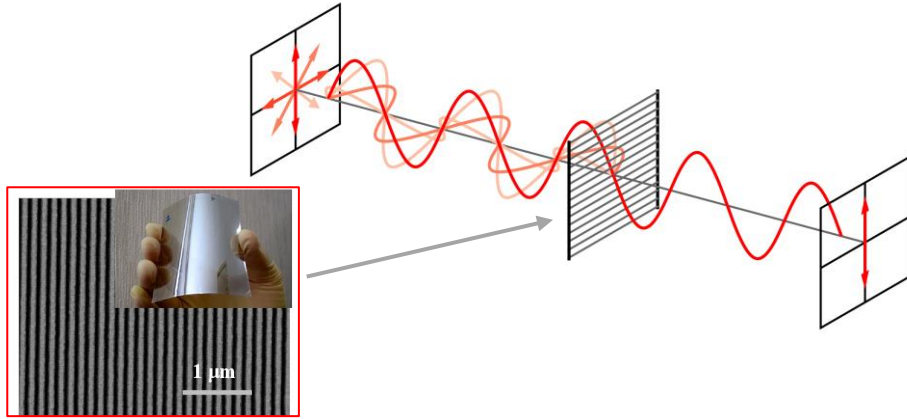


One of the twisted-jute polarizers used by Bose

[D. T. Emerson et al., IEEE Transactions on Microwave Theory and Techniques, vol. 45, no. 12, pp. 2267–2273, 199]

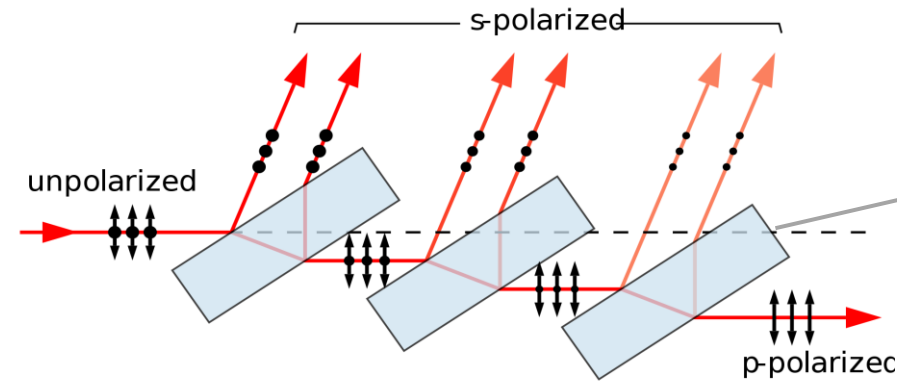
Terahertz polarizers

mm-wave and THz polarizers mainly fall in following category:



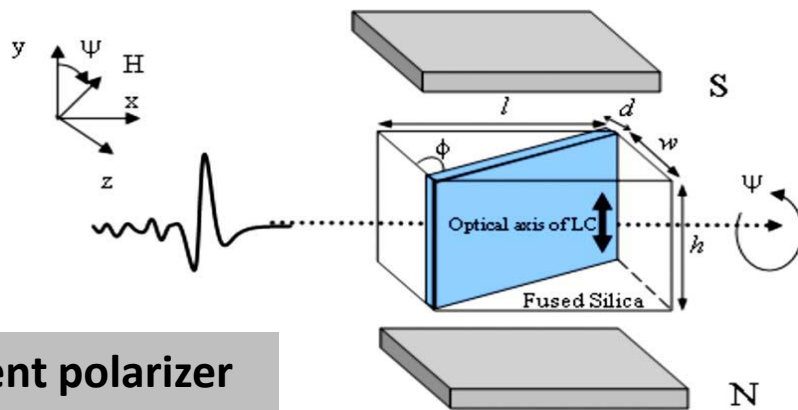
Wire grid polarizer

[Takano K et al., Opt Lett. 2011 Jul 15;36(14):2665-7]



Reflection polarizer

[A Wojdyla et al., Opt. Express 19, 14099-14107 (2011)]



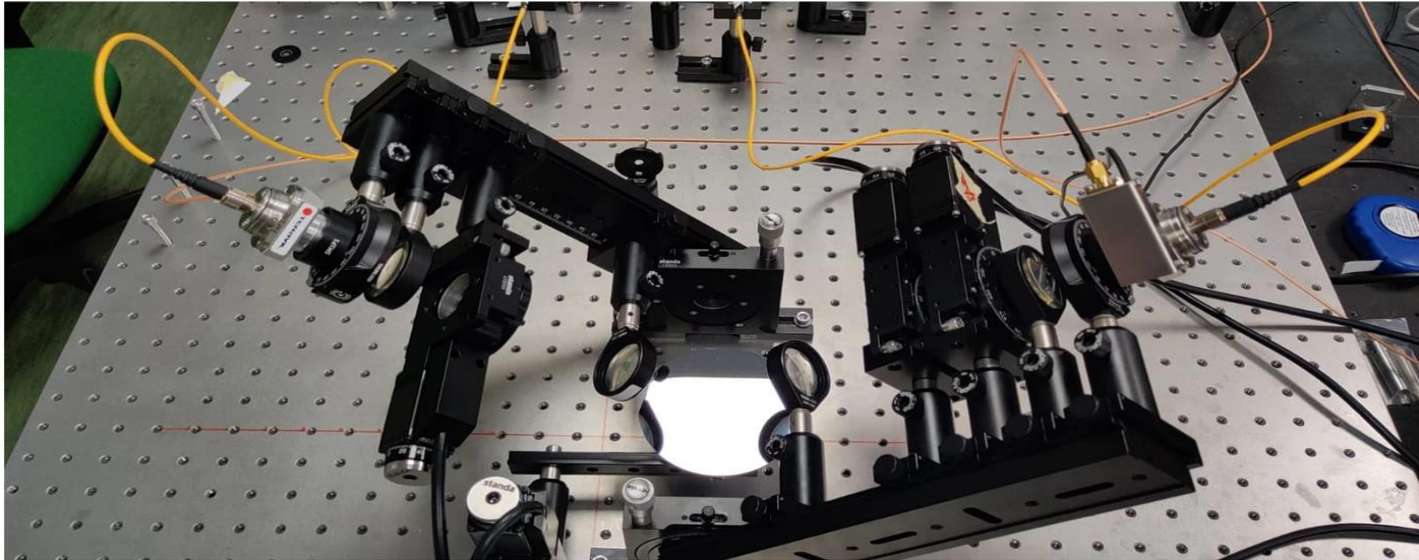
Birefringent polarizer

[Cho-Fan Hsieh et al., Opt. Lett. 33, 1174-1176 (2008)]

➤ Reconfigurable

➤ Bulky free space

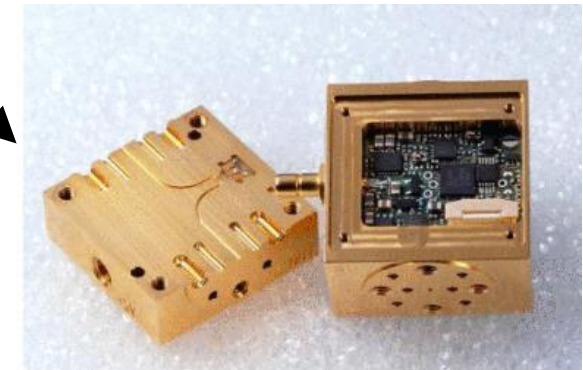
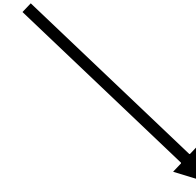
Guided waveguide



Free space setup

[Mazaheri, Z et al., *Sci Rep* **12**, 7342 (2022)]

Miniaturization of system

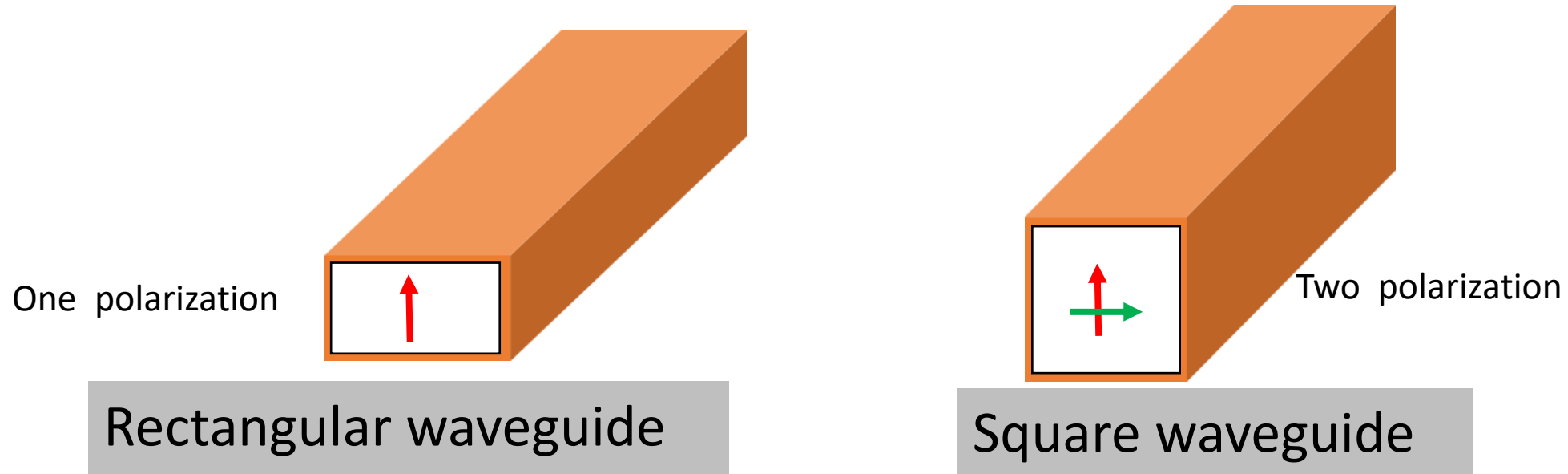


Guided waveguide setup

[H. -J. Song et al., *Proceedings of the IEEE*, vol. 105, no. 6, pp. 1121-1138]

Hollow waveguides

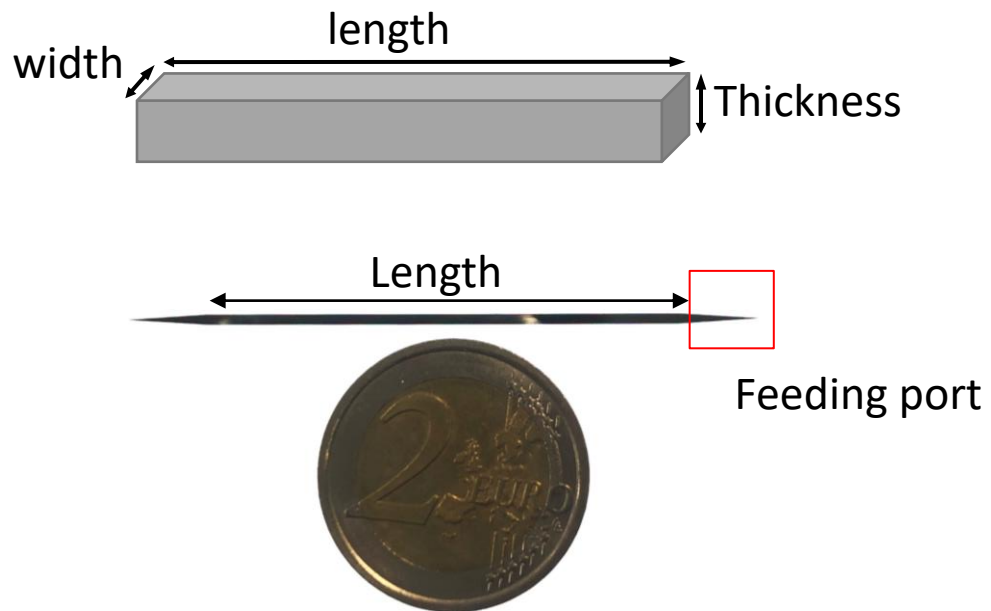
- Compact, hand-held systems
- Innate control over polarization via guide dimensions



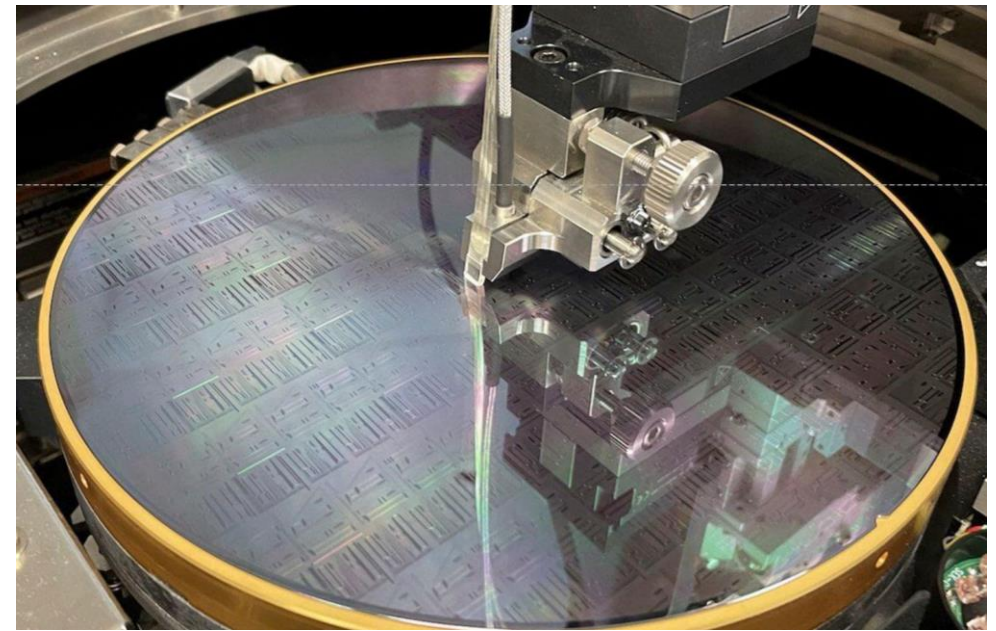
➤ Not adjustable /reconfigurable

Silicon waveguides

- Emerging low-loss mm-wave and terahertz platform
- Foundry process (deep reactive ion etching) → Scalable manufacture
- Always supports two polarizations → **polarization diversity**



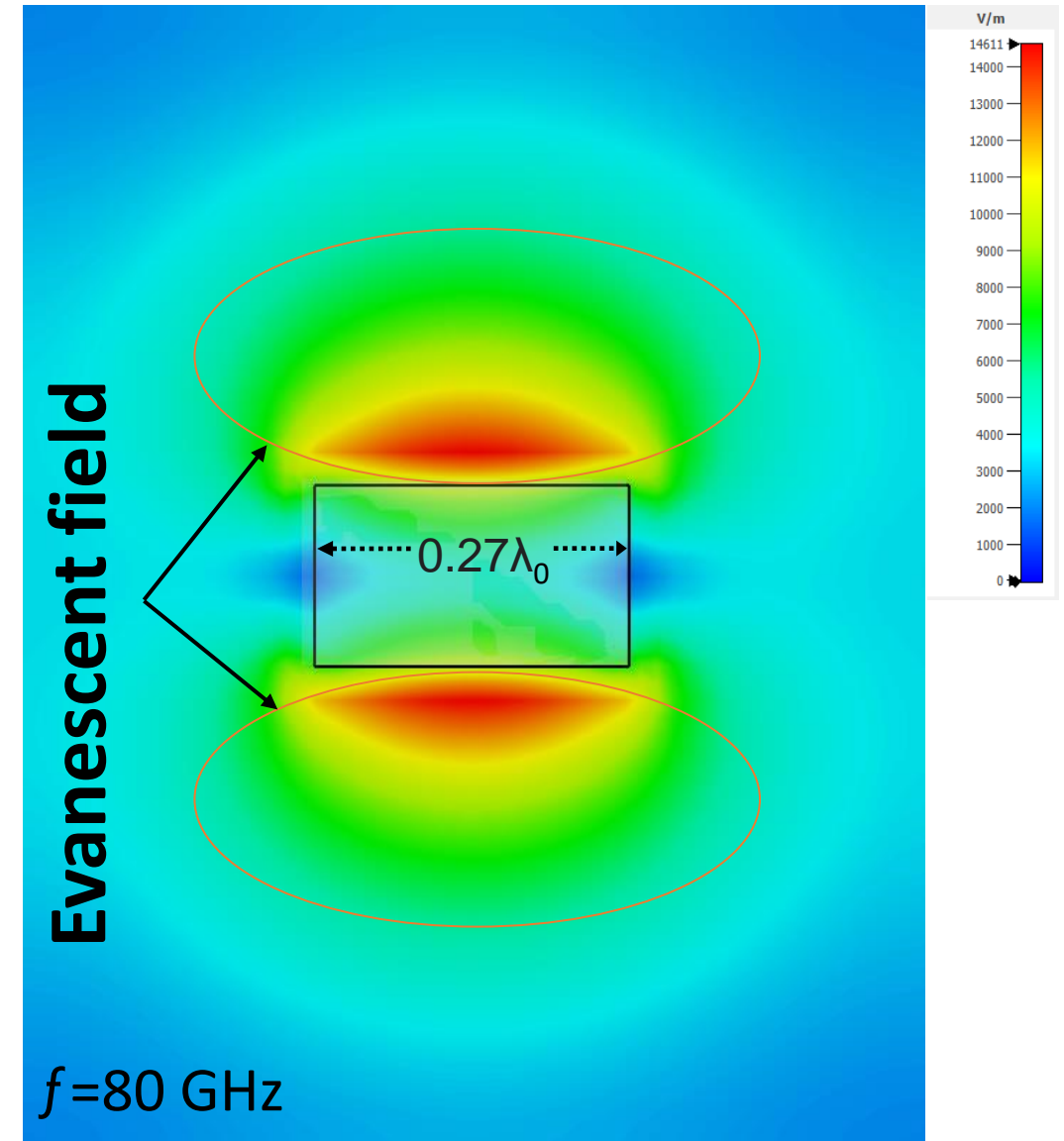
Dielectric rod waveguide (DRW)



Fabrication

Contactless manipulation

- Unshielded → evanescent fields
- Interfere with evanescent fields
→ influence propagating waves
- No modification to DRW →
reconfigurable, contactless
manipulation



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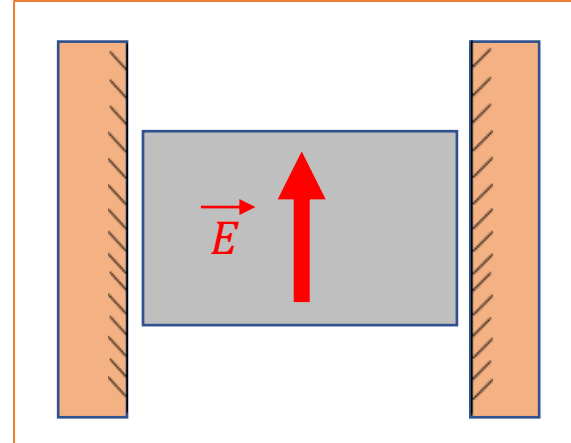
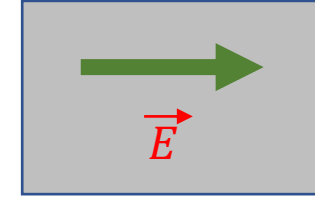
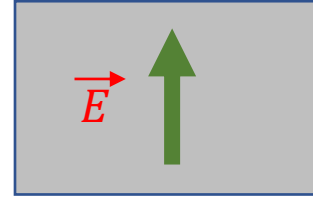
EXPERIMENT AND
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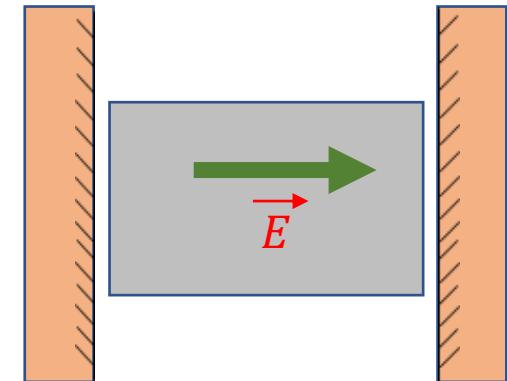
CONCLUSION

Principle of operation

- Sandwich DRW between metal
- Tangential E-field vanishes
- Suppress vertical polarization

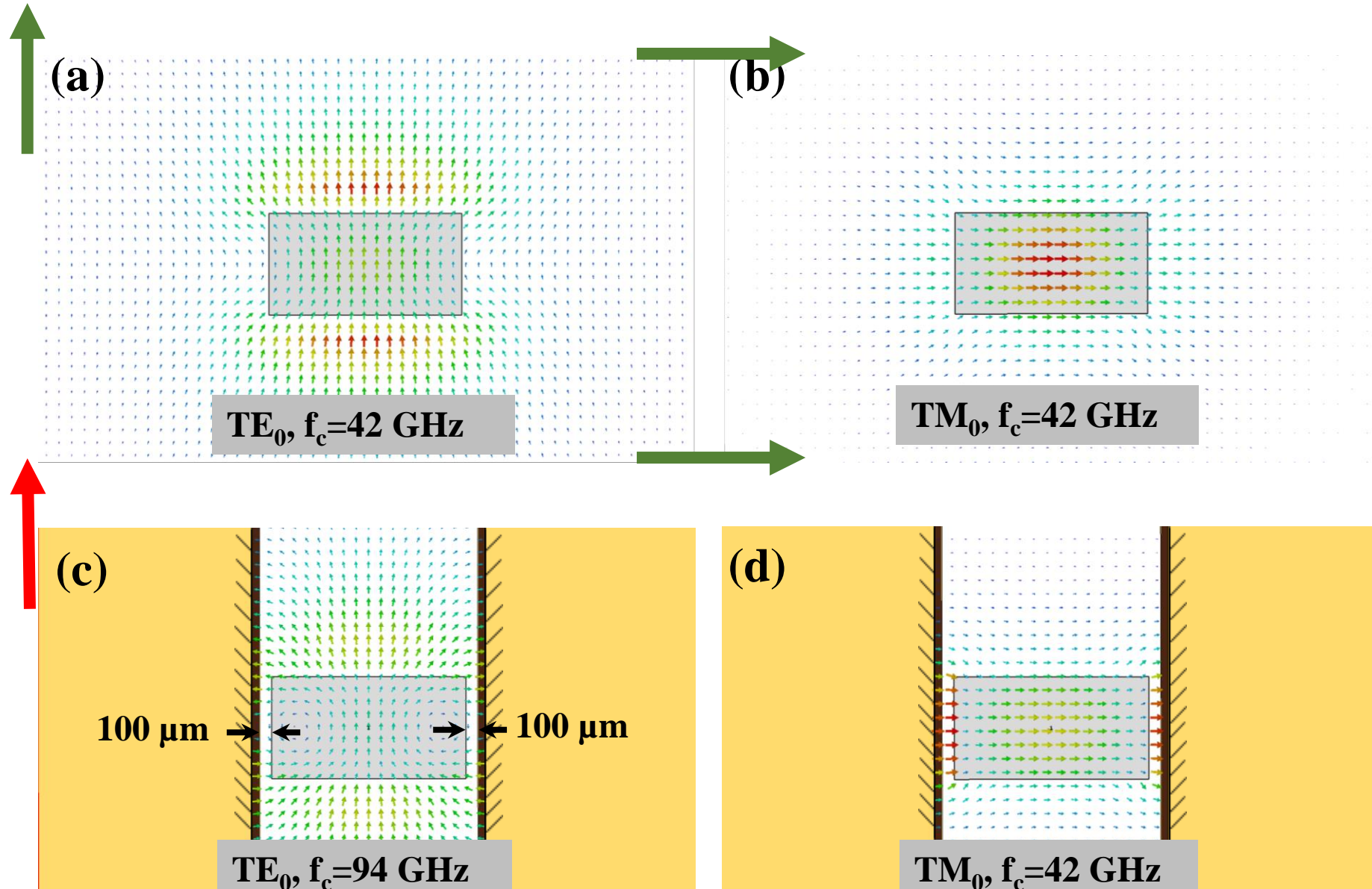


Vertical polarization



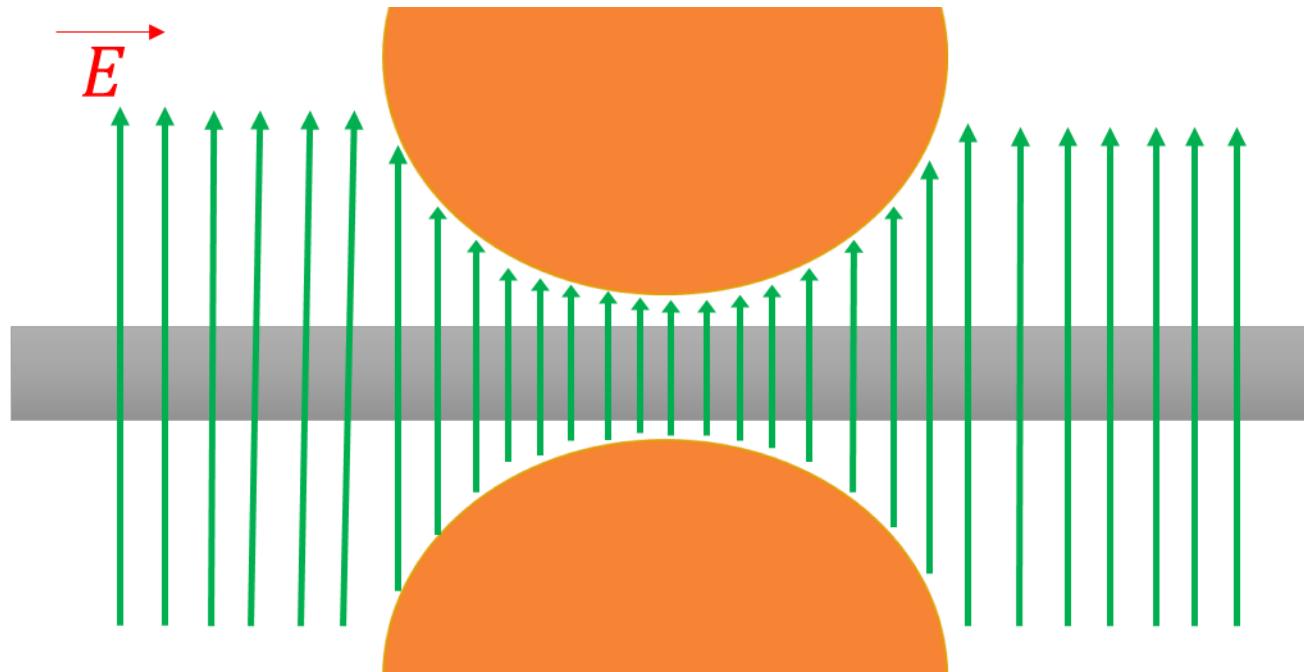
Horizontal polarization

Modal analysis

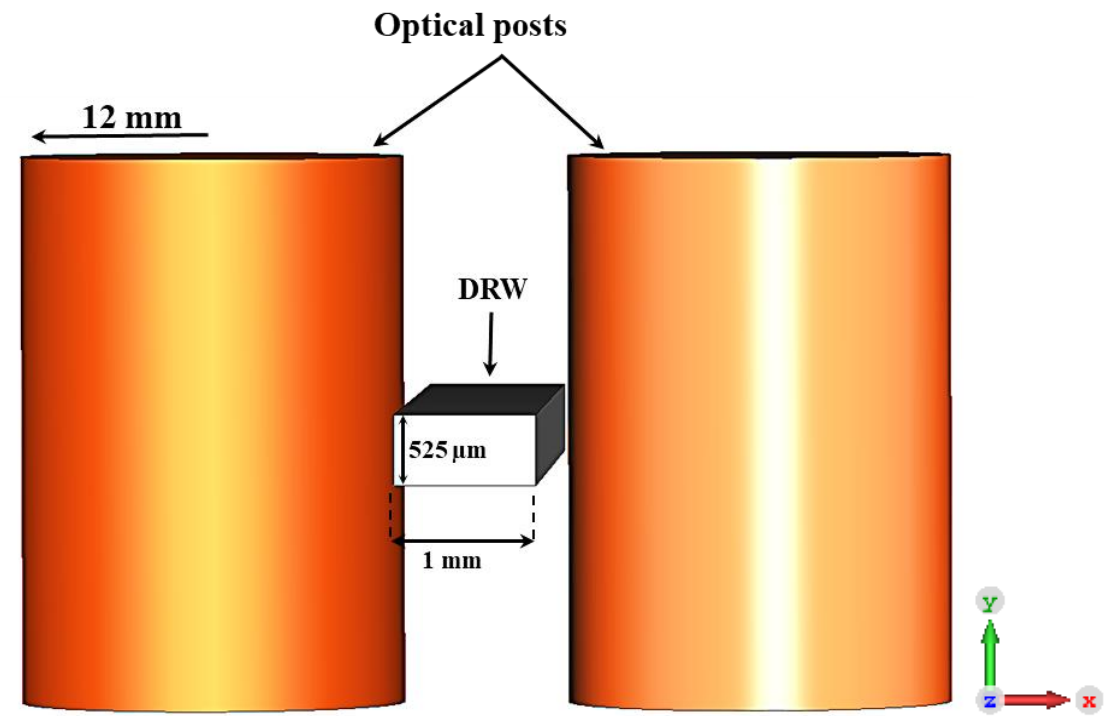


Progressive matching structure

- Broadband transition between unclad and metal-enclosed DRWs
- Exploit innate curvature of cylindrical metallic optical posts



Progressive matching



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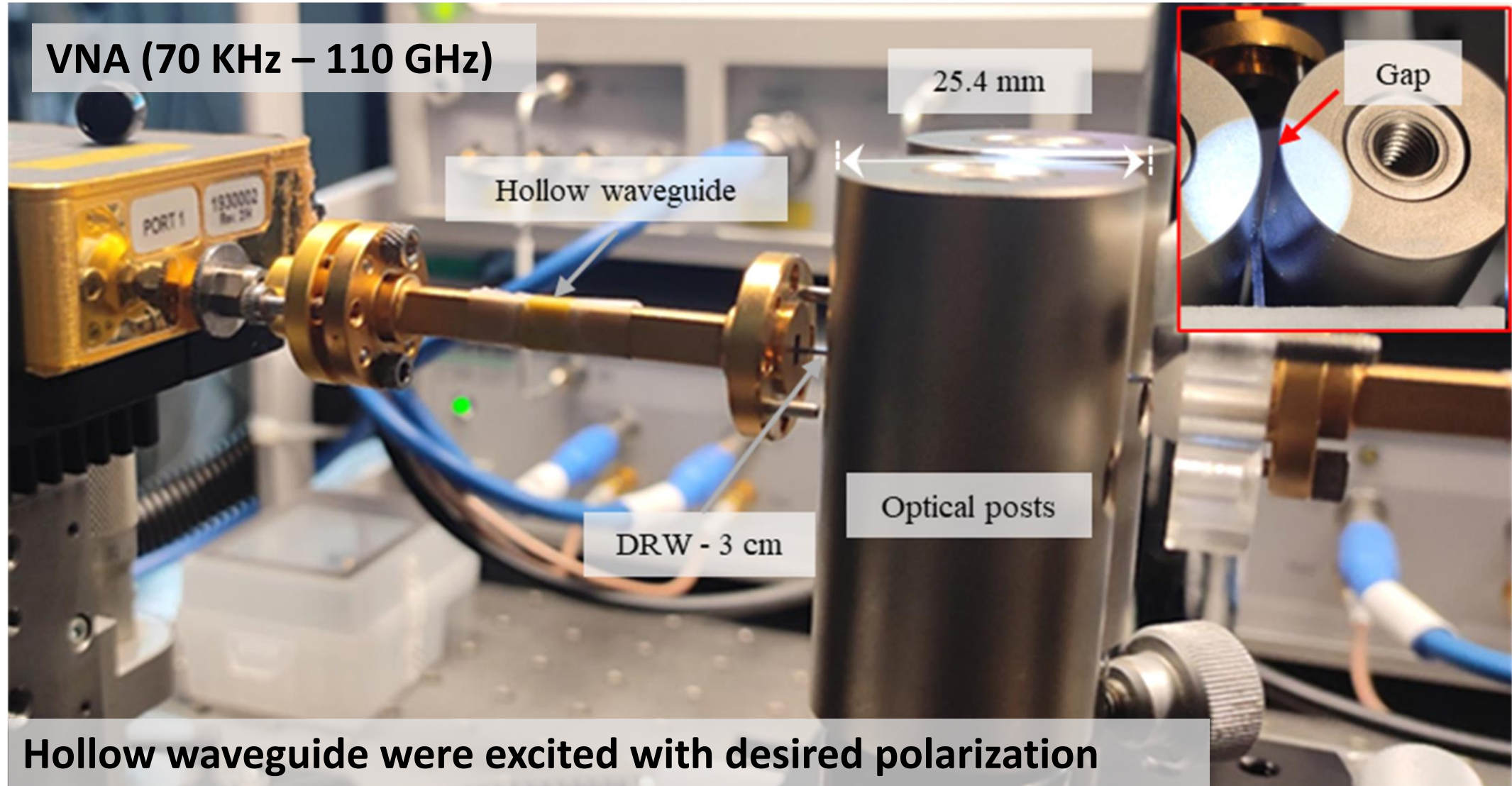


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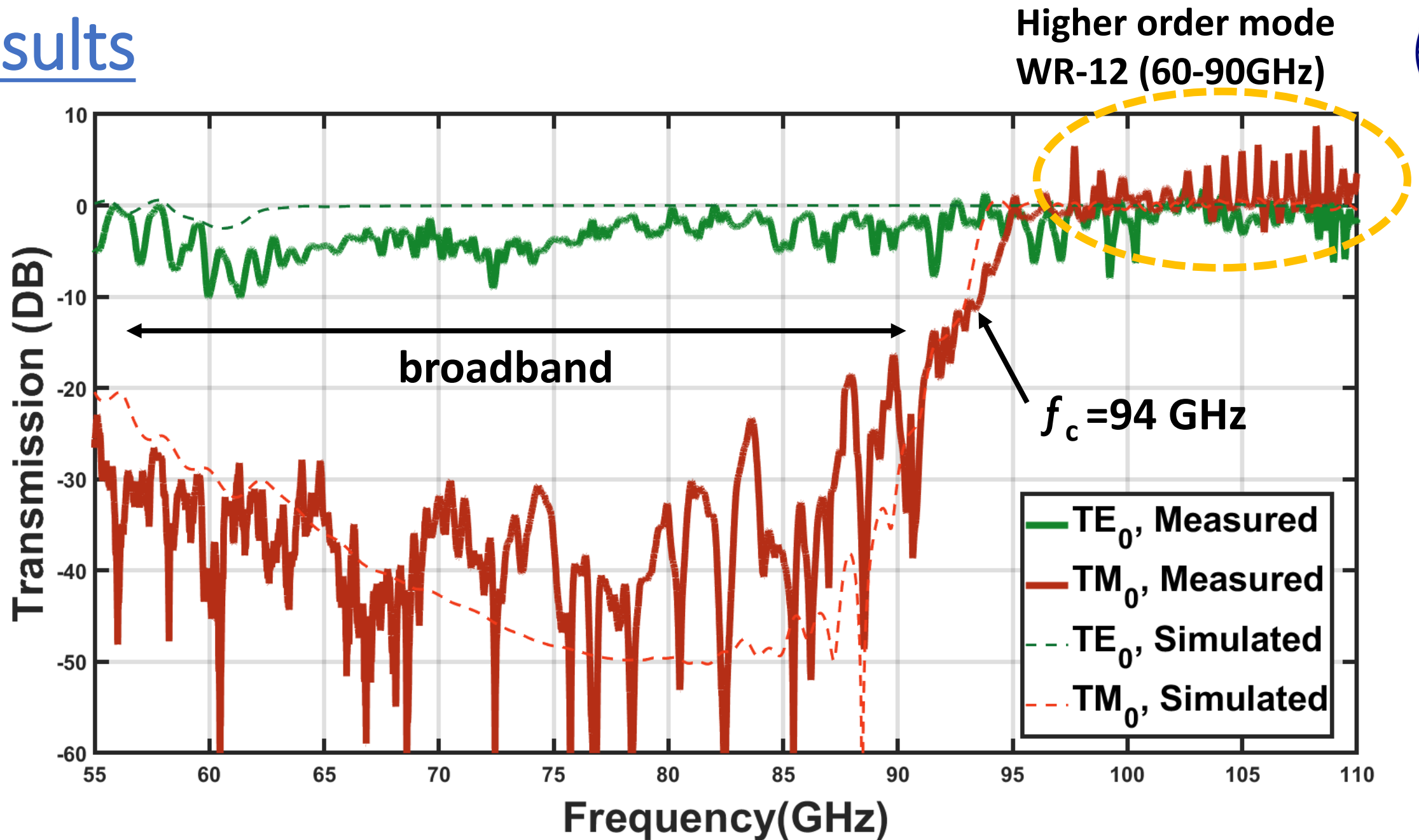
CONCLUSION

Experimental setup



VNA port 1 → W1coax → WR12 → foam → DRW → WR12 → w1coax → VNA port 2

Results



Increase of cutoff \rightarrow vertical polarization \rightarrow working polarizer

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Conclusion

- Polarization purity critical in polarization-diverse applications
- Inexpensive optical posts operate as mm-wave polarizer for DRW
- Evanescent manipulation -> Contactless and reconfigurable

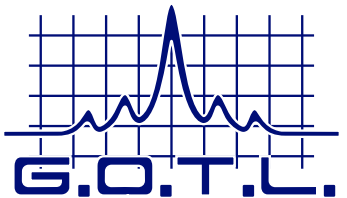
Further work

- Potential to realize **arbitrary polarization conversion and control**
- Motorized control, MEMS

Acknowledgement

We acknowledge support from the following Grants:

- **TERAOPTICS** project (Grant No: 956857) and **TERAWAY** project (Grant No: 871668) funded from the European Union's research and innovation program.
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That's all for now!

Thank you for your attention

Are there any question ?

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