Thèse Futur & Ruptures

Modeling, design and fabrication of wide-angle diffraction Diffractive Optical Elements

Giang-Nam NGUYEN[1], *Kevin HEGGARTY*[1], *Philippe GERARD*[2], *Patrick MEYRUEIS*[2]

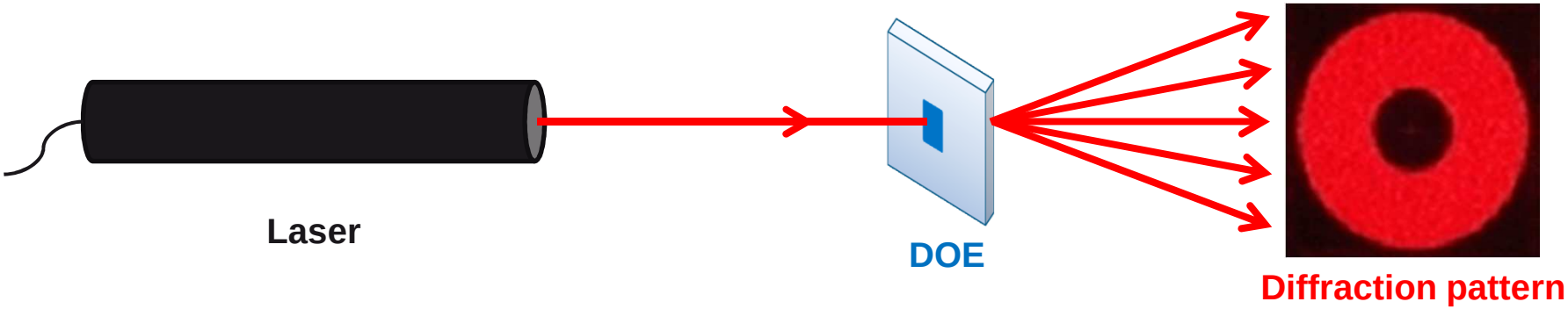
[1] Optics Department, TELECOM Bretagne, France

[2] Lab ICube, TELECOM Physique Strasbourg, France

Introduction to Diffractive Optical Elements

What is a Diffractive Optical Element (DOE)?

- Micro/nano structures which diffract light into almost any desired pattern



What are DOEs used for?

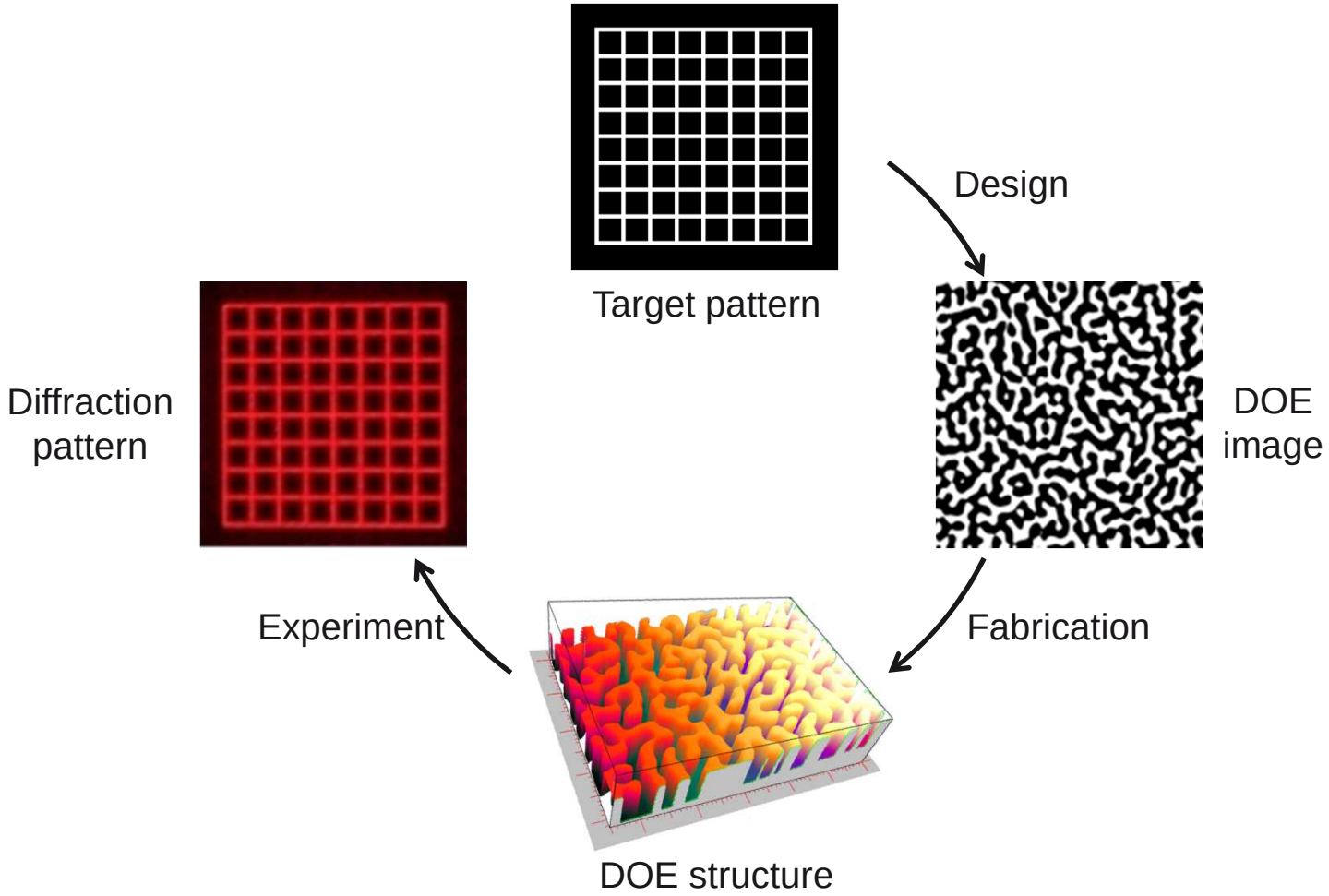
Data storage

Bar-code reader

Laser cutting

Security devices

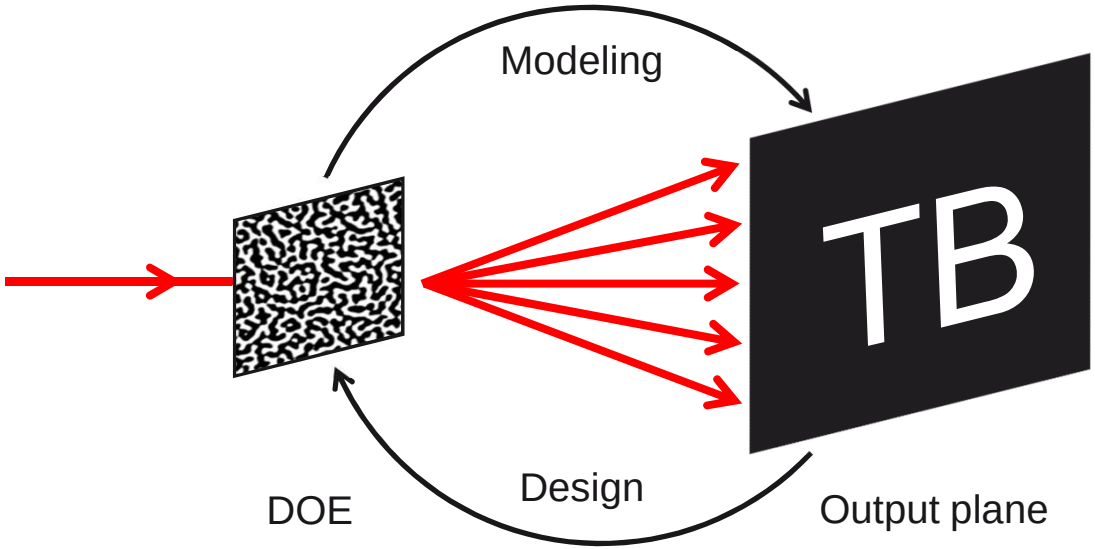
DOE design and fabrication process



- **Typical DOE size:** total size ~cm^2, ~µm/pixel

Thesis problem formulation

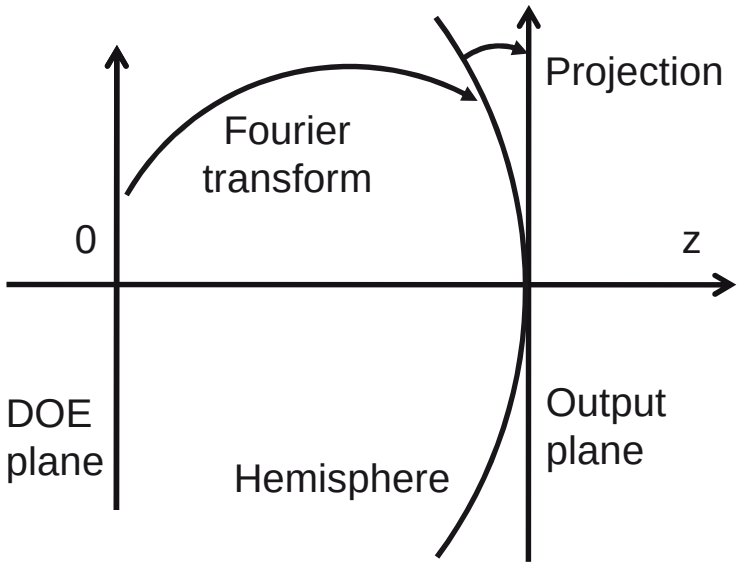
- **DOE design:** model the diffraction of light
  - **Simple model:** diffraction angle < 10° → small output patterns
  - **Complex models:** any angle but huge calculation time



- **Where is the problem?**
  - Wide diffraction angle → big pattern, compact system
  - Fast calculation time

Work results

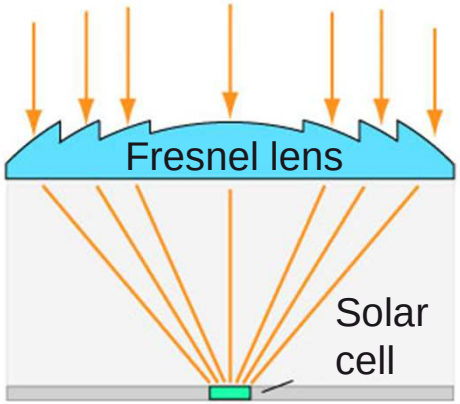
- **Wide-angle diffraction model**



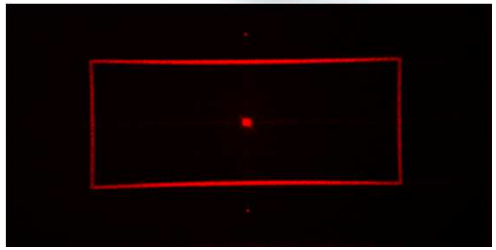
  - **Accurate and 10^4 faster** than the complex model!
- **Iterative algorithm for wide-angle diffraction DOEs**
  - Diffraction angle: **10°** → **20°** → **45°**
    initial — Telecom Bretagne — Karlsruhe Institute of Technology
- **Investigate the design and fabrication of thicker (~5µm) DOEs**
  - Even more applications!

Conclusion

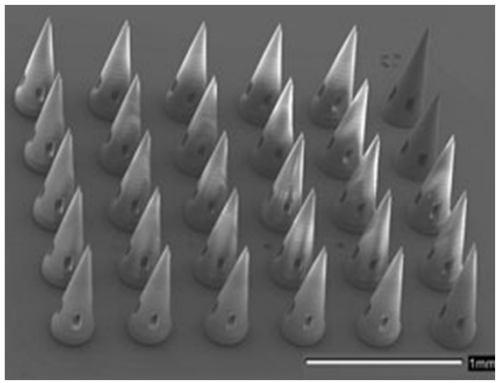
- Expand the DOE application domain: wide-angle diffraction
- Fully use of our current DOE fabrication facilities
- Real-world applications: academic & industrial partners



Fresnel lens DOEs for solar cells (with Telecom Physique Strasbourg)



Wide-angle diffraction DOEs (for an international microscope manufacturer)



3D nano-printer of medical devices (with Joseph Fourier University in Grenoble)

Publications and Reference

Conferences:

1. **G. N. Nguyen**, K. Heggarty, P. Gérard, and P. Meyrueis, “Iterative scalar algorithm for the rapid design of wide-angle diffraction Fourier elements”, 3rd EOS Conference on Manufacturing of Optical Components, 13-15 May 2013, Munich, Germany.

Journals:

1. **G. N. Nguyen**, K. Heggarty, P. Gérard, B. Serio, and P. Meyrueis, “Computationally efficient scalar non-paraxial modelling of optical wave propagation in the far-field”, *Applied Optics*, Vol. 53, Issue 10, pp. 2196-2205, Mar. 2014.
2. **G. N. Nguyen**, K. Heggarty, A. Bacher, P. J. Jakobs, D. Häringer, P. Gérard, P. Pfeiffer, and P. Meyrueis, “Iterative scalar non-paraxial algorithm for the design of Fourier phase elements”, *Optics Letters*, Vol. 39, Issue 19, pp. 5551- 5554, Sept. 2014.
3. **G. N. Nguyen**, K. Heggarty, K. Chikha, P. Gérard, and P. Meyrueis, “Diffraction symmetry of binary Fourier elements with feature sizes on the order of the illumination wavelength and effect of fabrication errors”, *to be submitted to Optics Letters*.
4. A. Liu, **G. N. Nguyen**, K. Heggarty, and P. Baldeck, “Fabrication of microscale medical devices by parallel two-photon polymerization using Dammann gratings”, *to be submitted to Optics Express*.
5. A. Albarazanchi, P. Gérard, **G. N. Nguyen**, K. Heggarty, P. Pfeiffer, P. Ambs, and P. Meyrueis, “Design and fabrication of Fresnel lens diffractive optical elements for spectrum splitting and beam concentration”, *to be submitted to Applied Optics*.

Transfer of technology to startup: http://www.holotetrix.com/