Measuring the birefringence of the sapphire mirrors installed in the KAGRA detector

Research Results Presentation Meeting
of the Inter-University Research Program
for Fiscal Year 2023

February 21st , 2024

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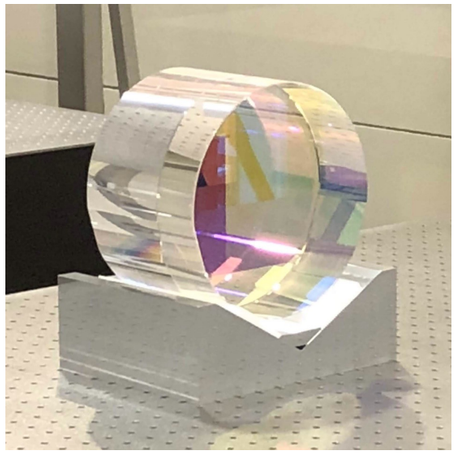
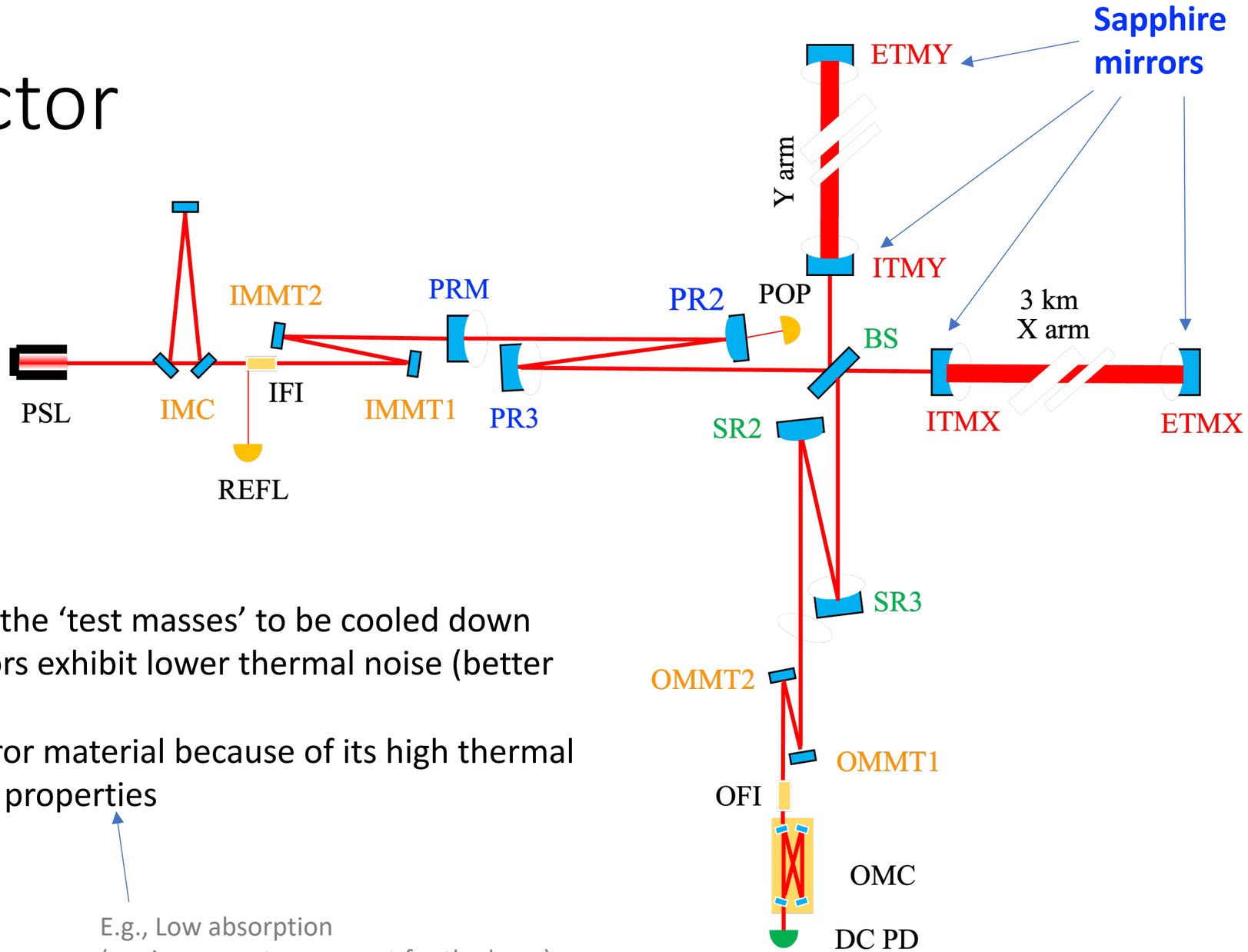
KAGRA Detector





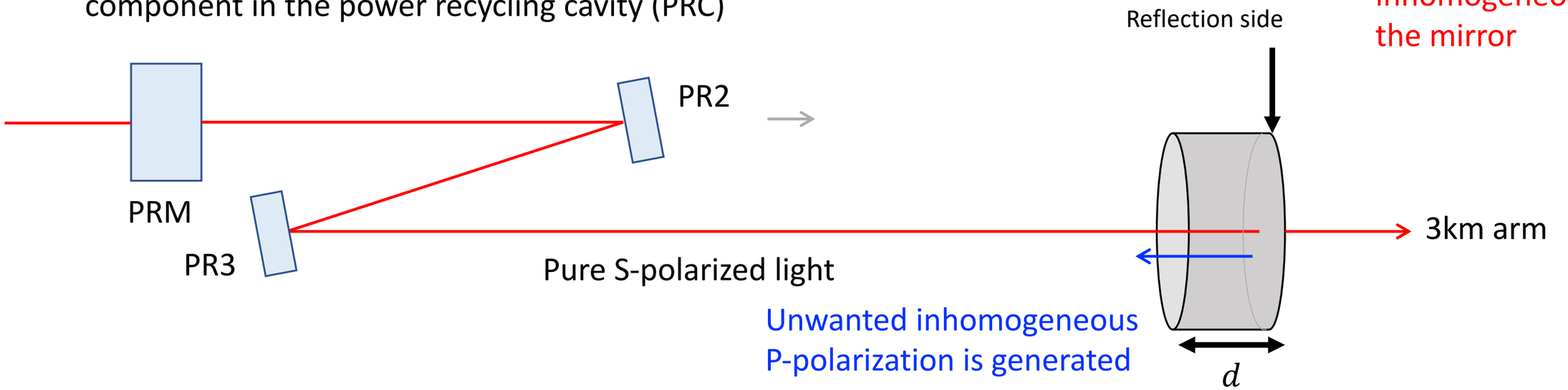
- Sapphire mirrors are used for the ‘test masses’ to be cooled down
- Lower the temperature, mirrors exhibit lower thermal noise (better sensitivity)
- Sapphire is chosen as the mirror material because of its high thermal conductivity and good optical properties

Heat induced by laser must be removed

E.g., Low absorption
(= mirrors are transparent for the laser)

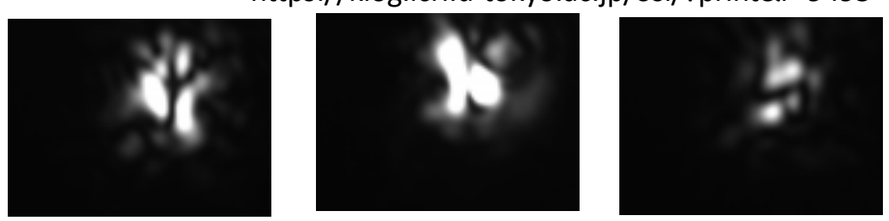
Birefringence Problems in KAGRA

Birefringent input test masses (ITMs) generate unwanted polarization component in the power recycling cavity (PRC)



The crystal axis was found to be inhomogeneous over the mirror

https://klog.icrr.u-tokyo.ac.jp/osl/?print&r=9495



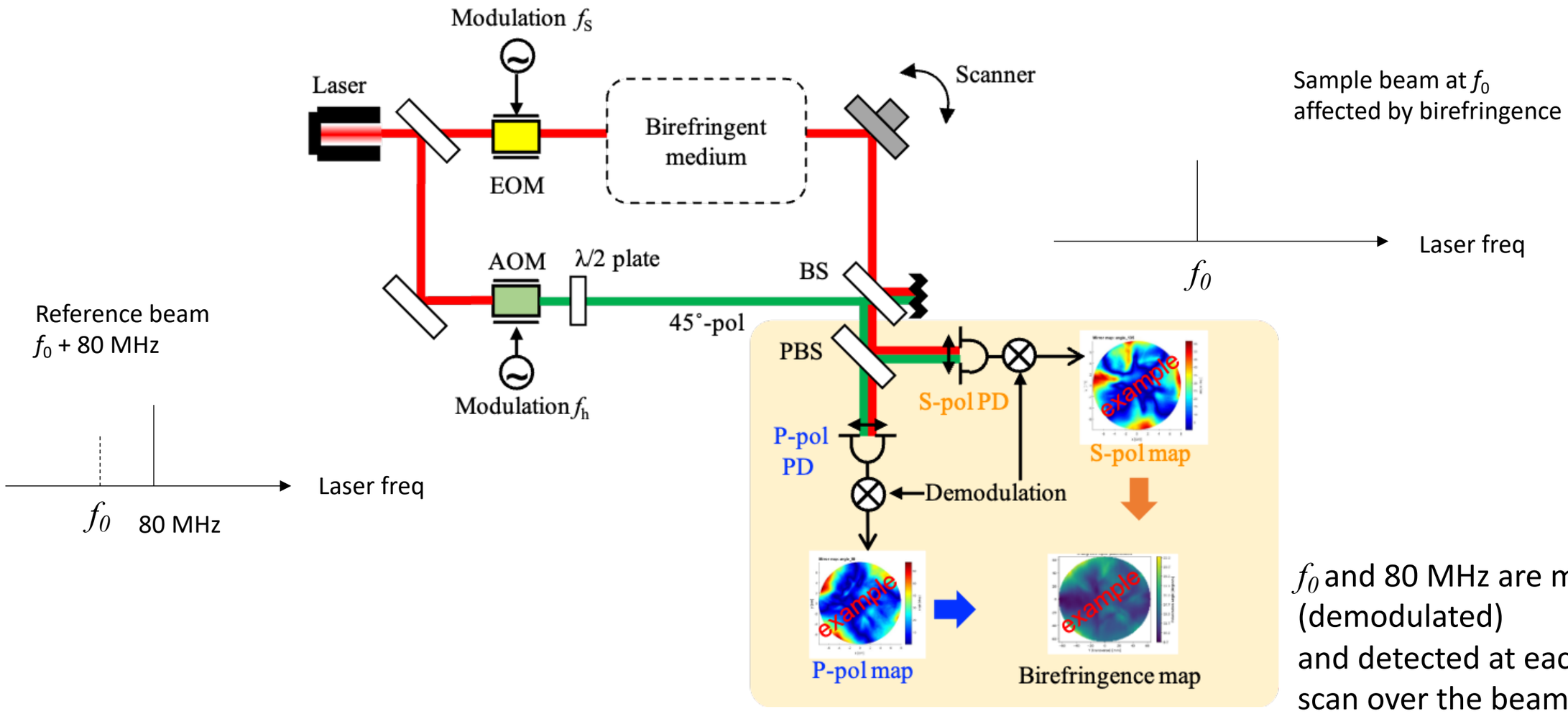
→ Transmitted beam of PR2 in the unwanted polarization

Resulted in

- Laser power loss
- Unstable error signals for the cavity length and angular controls

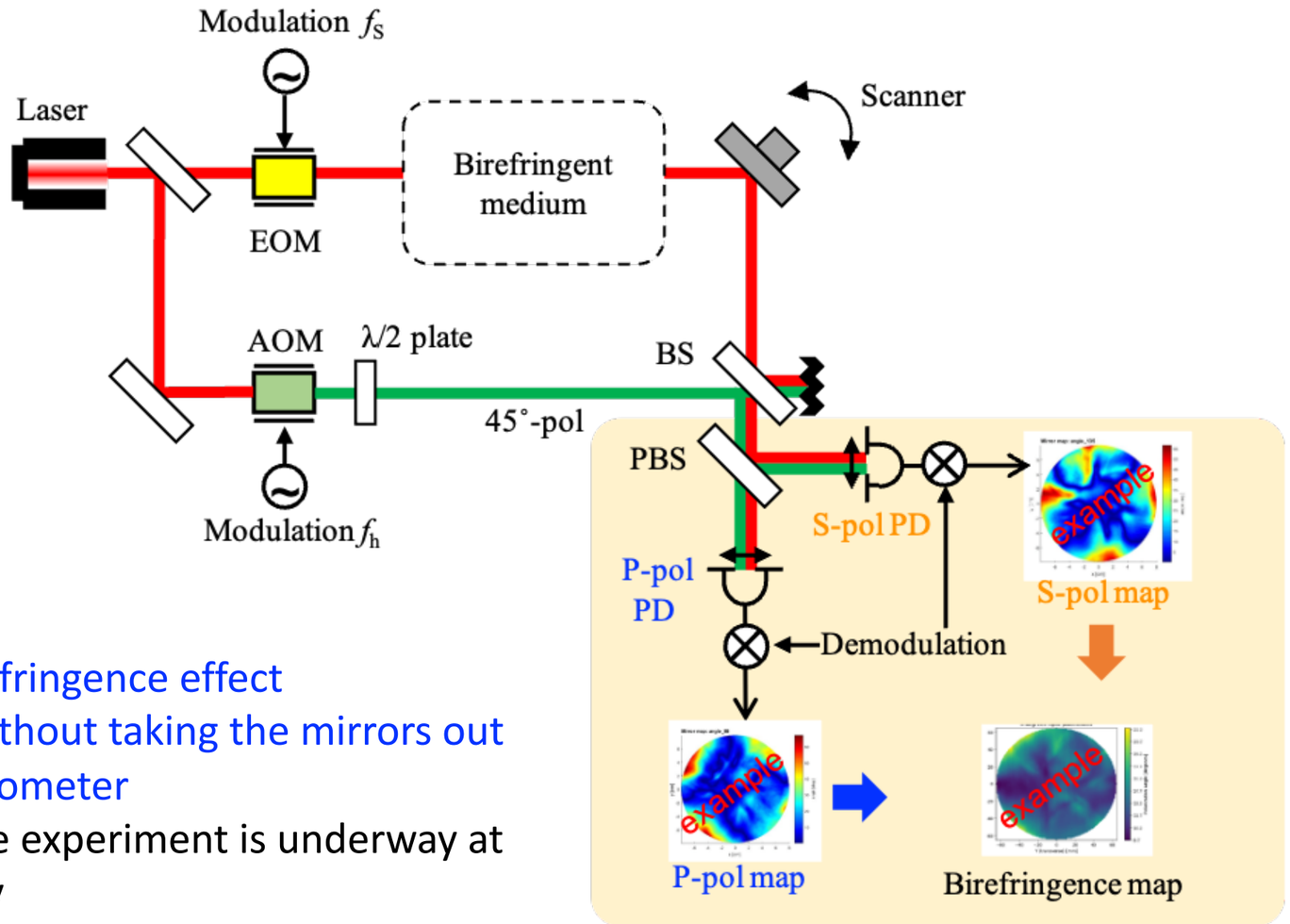
→ Lower duty factor of the observation

Principle of the polarized phase camera



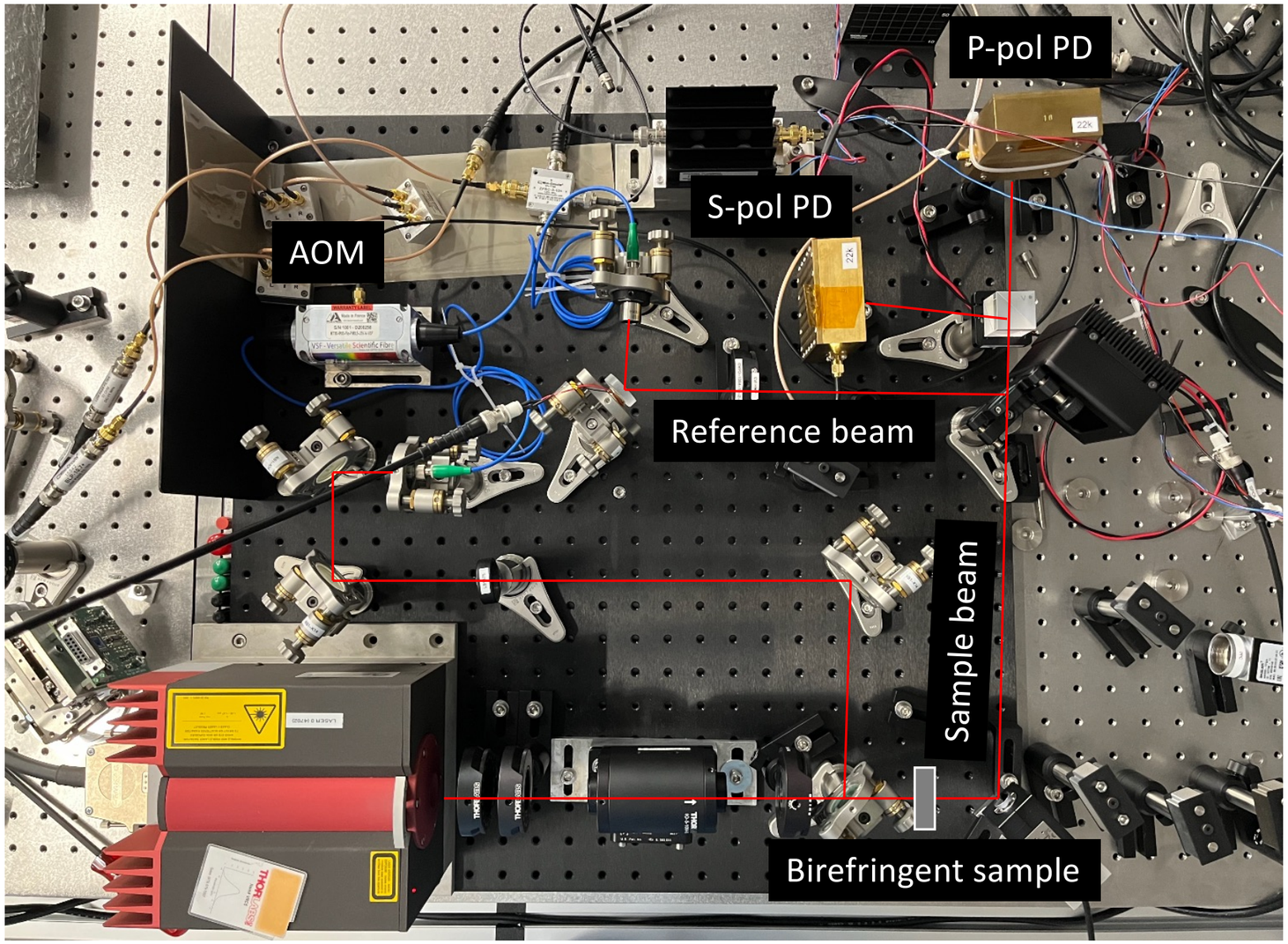
f_0 and 80 MHz are mixed (demodulated) and detected at each pixel scan over the beam

Principle of the polarized phase camera

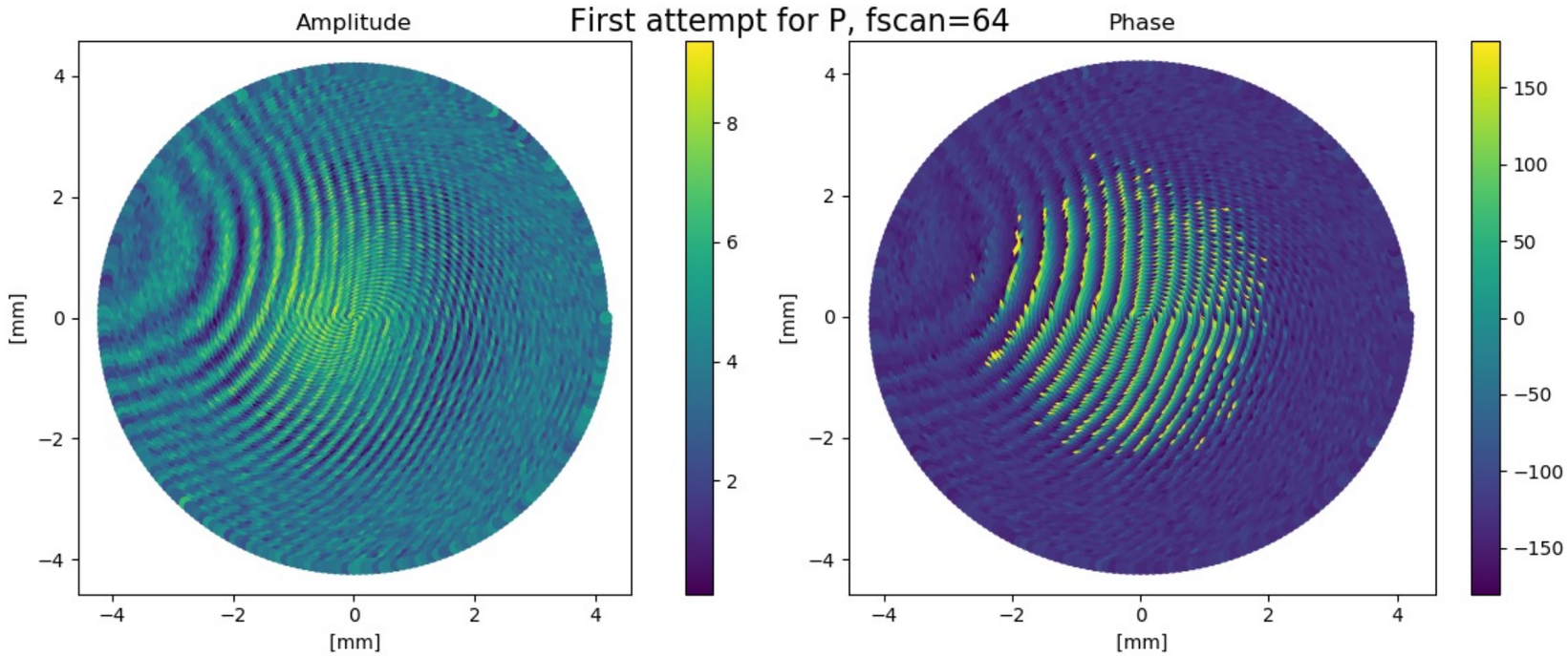


- Enabling the birefringence effect measurement without taking the mirrors out from the interferometer
- Proof-of-principle experiment is underway at Cardiff University

Local Development at Cardiff University

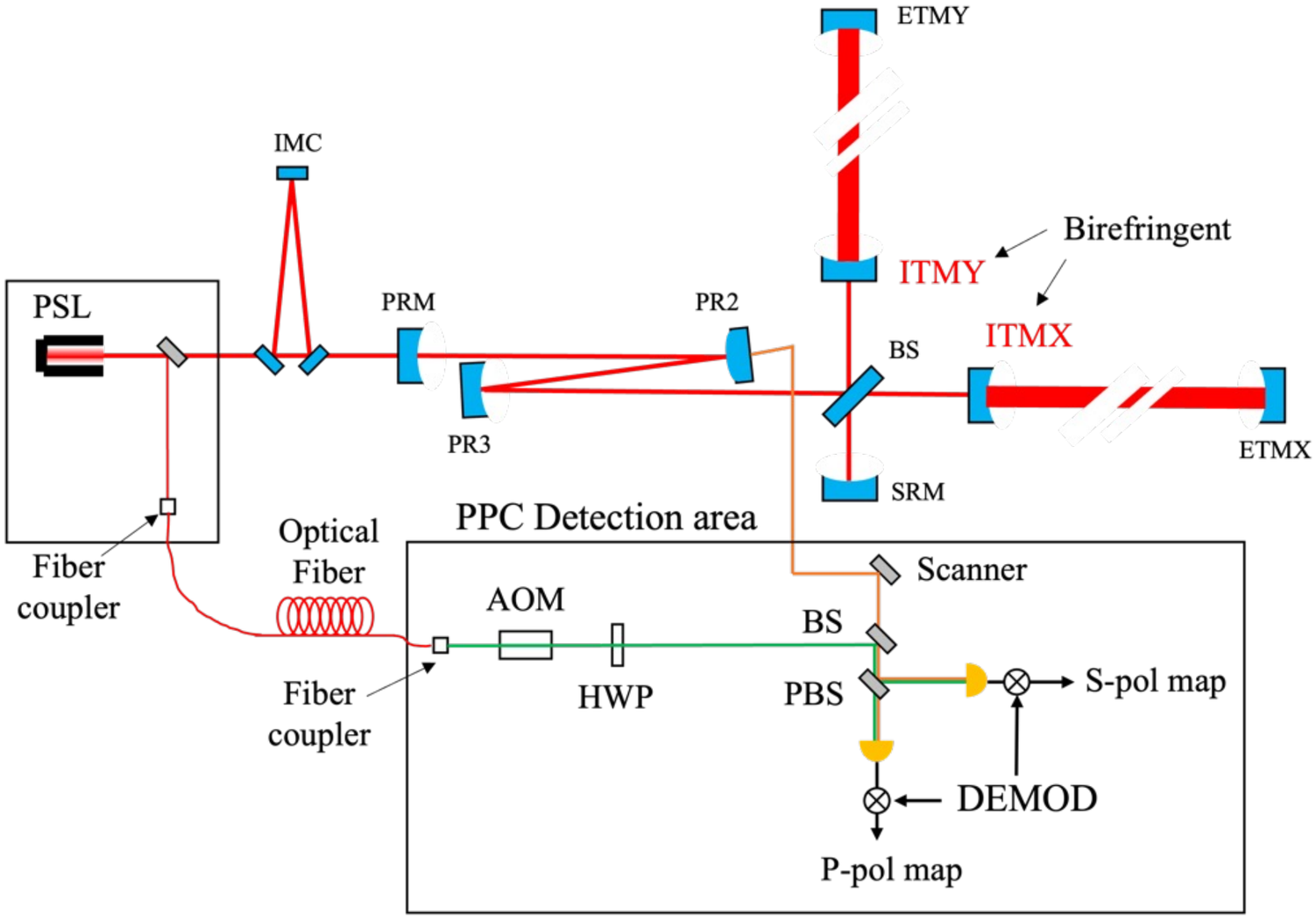


Obtaining P-pol Camera Image



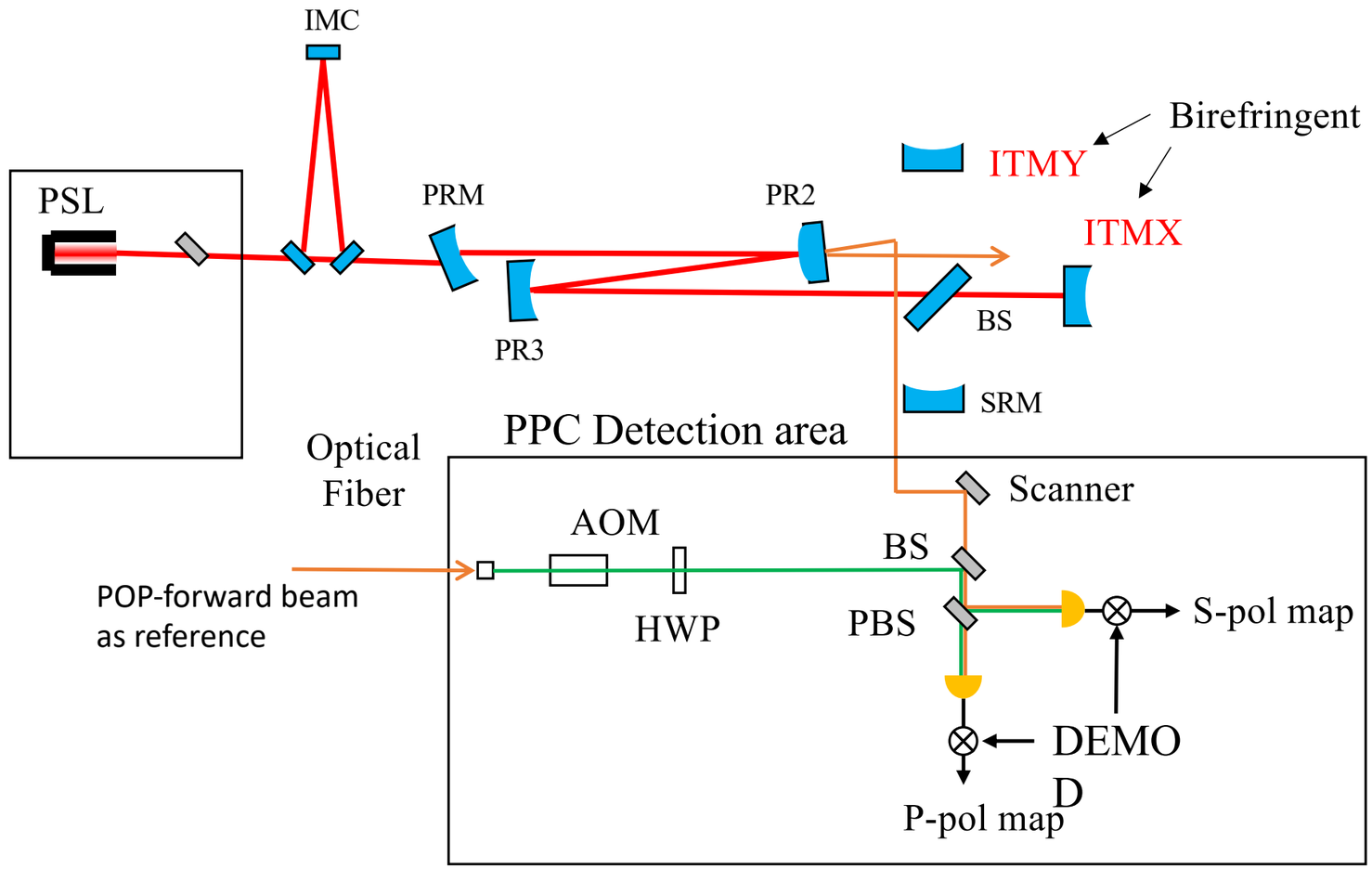
Mapping calculation ongoing

Possible Application for KAGRA 1



Alternative Application

No need to install the fiber, and can measure only the single-bounce



Procurement of FSY2023

- Approved: JPY 250k (+ carry over JPY 100k from 2022)
- Used: JPY 150k
  - Domestic Travel for the collaboration meeting and discussions at Kamioka

Plans for FSY2024

- Finish the local development
- Consider the measurement at KAGRA