

Light source stabilization system for High Accuracy Photometry Instruments in Astronomy

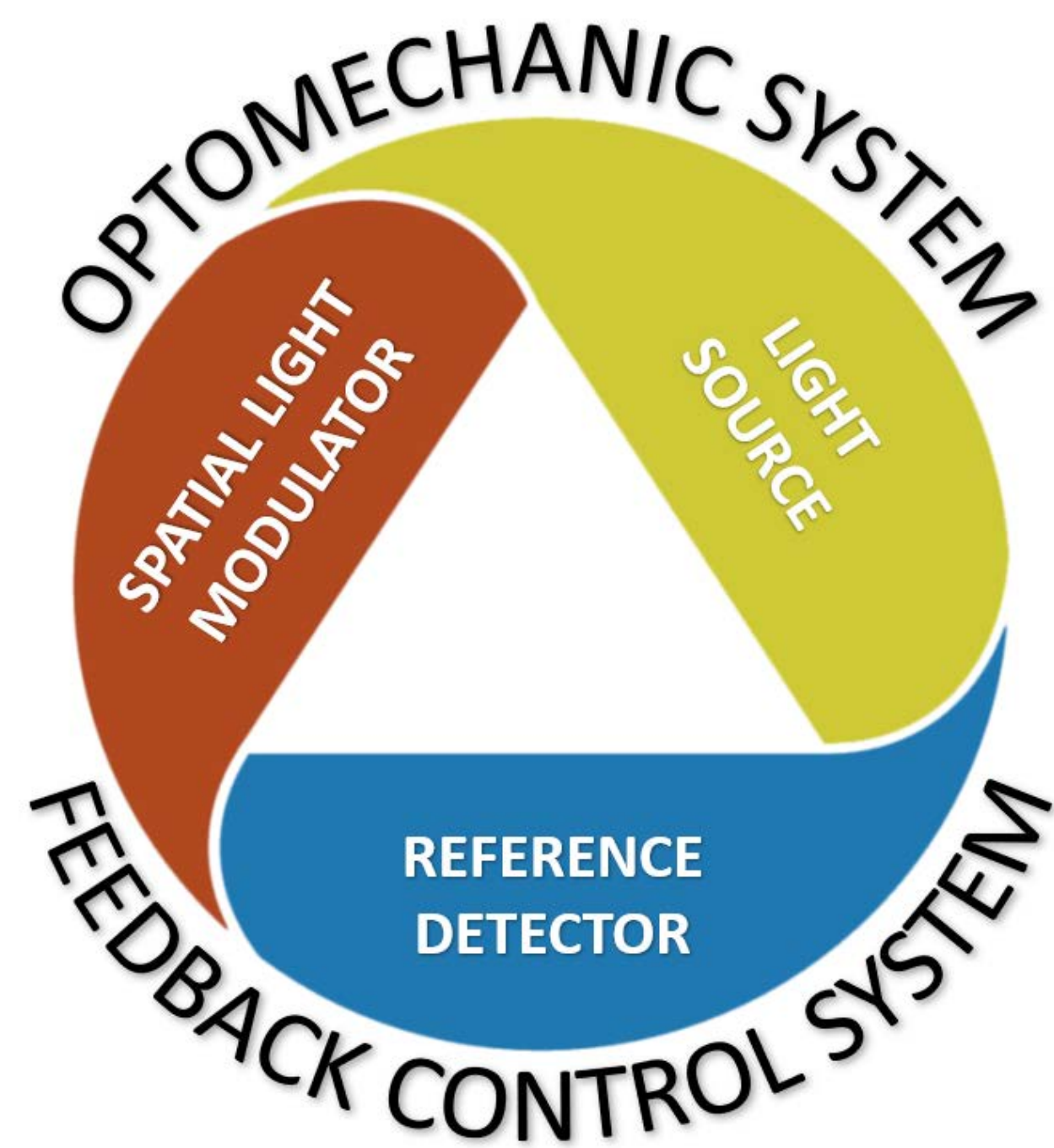
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Transit spectroscopy and multi-band photometry has been so far conducted using general-purpose, space-based instruments. These measurements however suffer from a high level of systematic error due to issues such as pointing jitter, thermal and opto-mechanical stability, wavelength and photometric calibration, and detector stability.

Testing and calibration of high precision photometers for the detection of planetary transits requires a light source which photometric stability must be better than the goal stability of the photometer to be tested. In case test, integration and calibration of these sensors, it will be required highly radiometrically stable light sources, both in flux and spectra.

The proposed project aims to research and develop a device that senses the light source fluctuations and modulates the beam, both in flux and in spectra, to produce a sufficiently stable source, a truly impressive challenge when stabilization levels of few ppm are required up to several hours of observation.



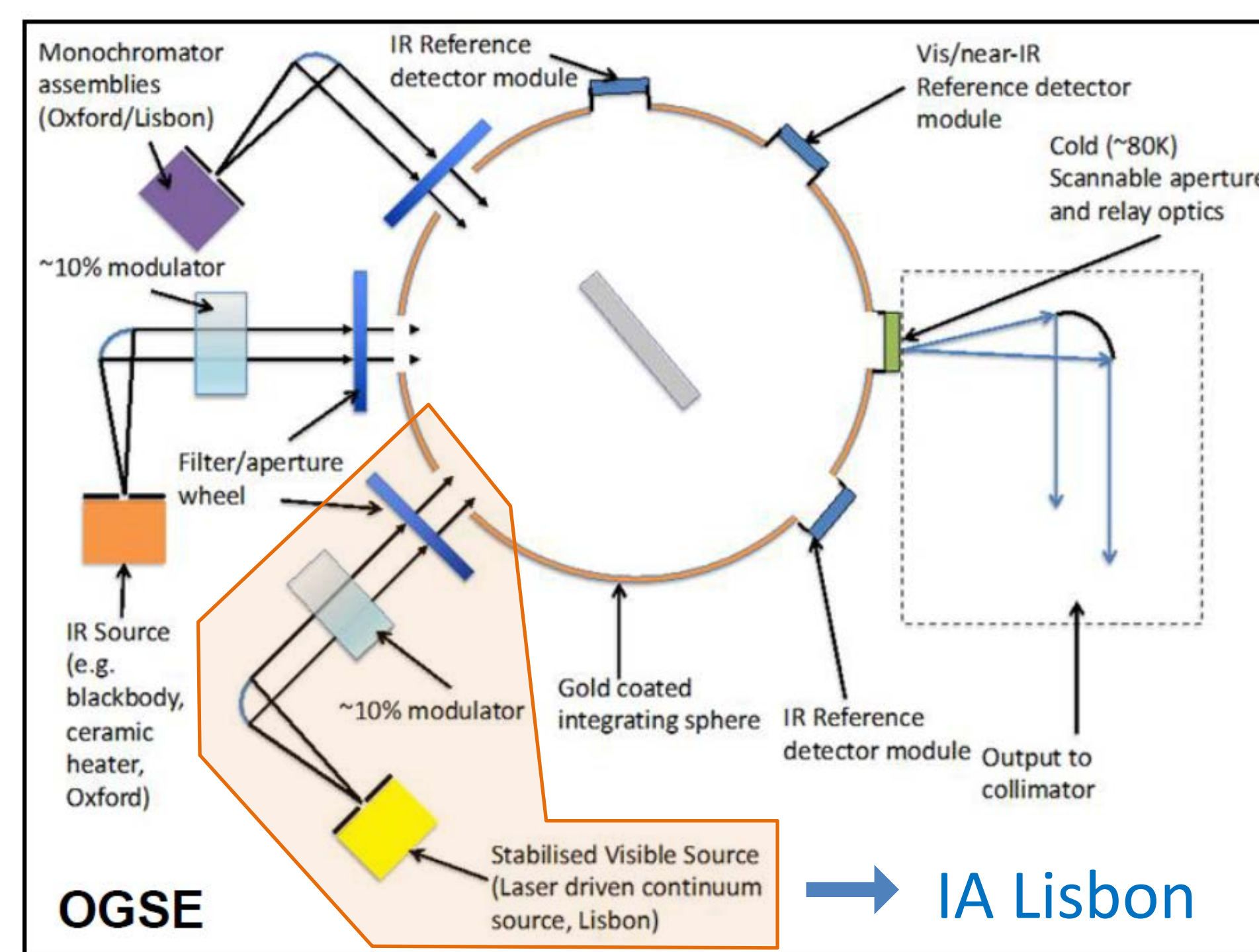
State of Art: Photometric Precision

| Space Mission | Photometric Precision | |
|---------------|-----------------------|--------------|
| Hubble | 30 ppm | @ 4 hours |
| Spitzer | 30-100 ppm | @ 8-24 hours |
| Corot | 700 ppm | @ 6 hours |
| Kepler/K2 | 30-200 ppm | @ 6 hours |
| Gaia | 100 ppm | @ 4 hours |
| Tess | 60 ppm | @ 6 hours |
| Cheops | 20 ppm | @ 6 hours |
| JWST | 20 ppm | @ 6-12 hours |
| Plato | 30 ppm | @ 1 hour |
| Ariel | 10-100 ppm | @ 10 hours |

ARIEL OGSE Collaboration

ARIEL Space Mission

- 4-year space mission to study and characterize exoplanets
- 4 instruments:
 - AIRS
 - NIRSpec
 - FGS
 - VISPhoT

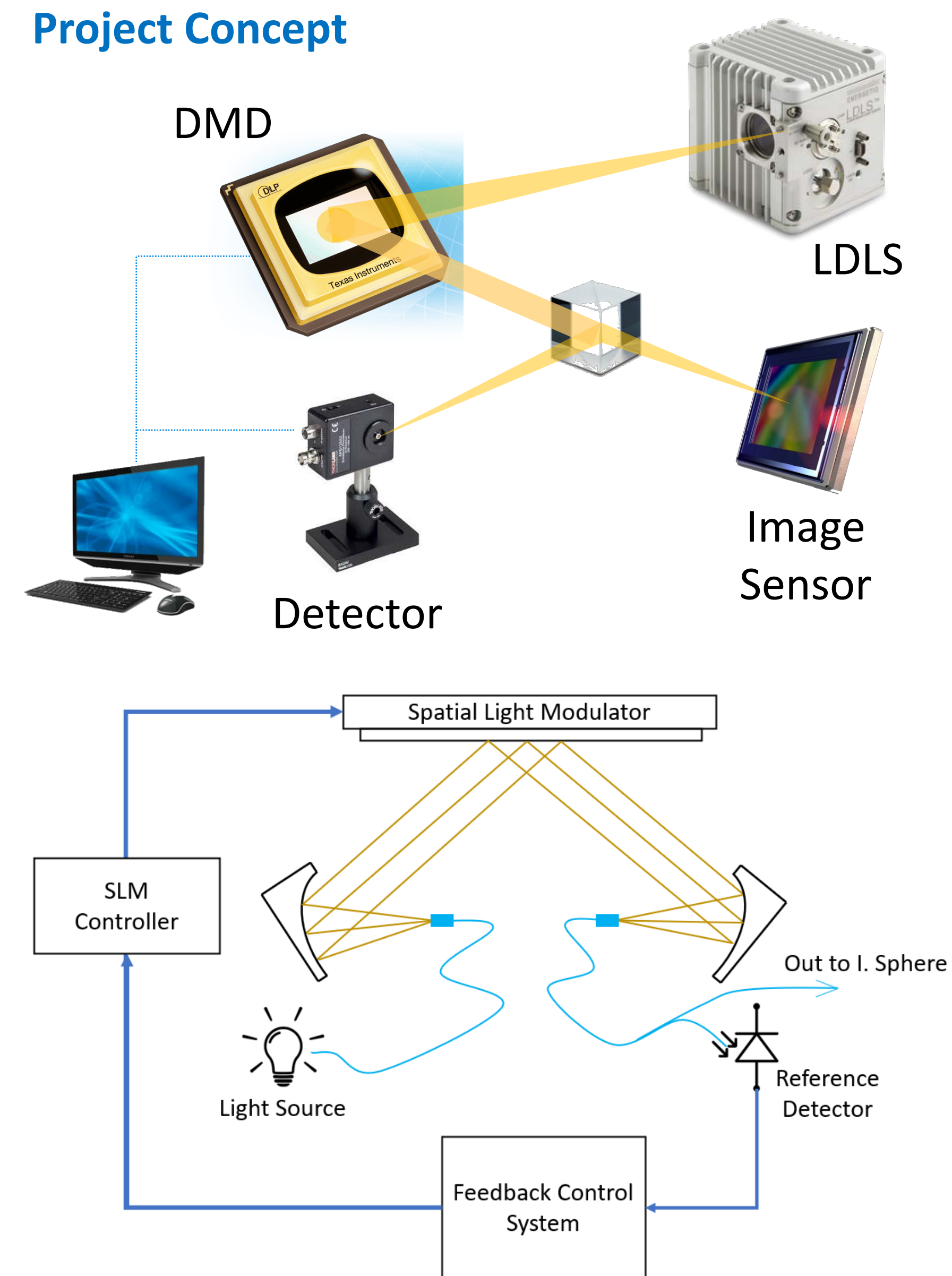


PhD Project Solution

Requirements

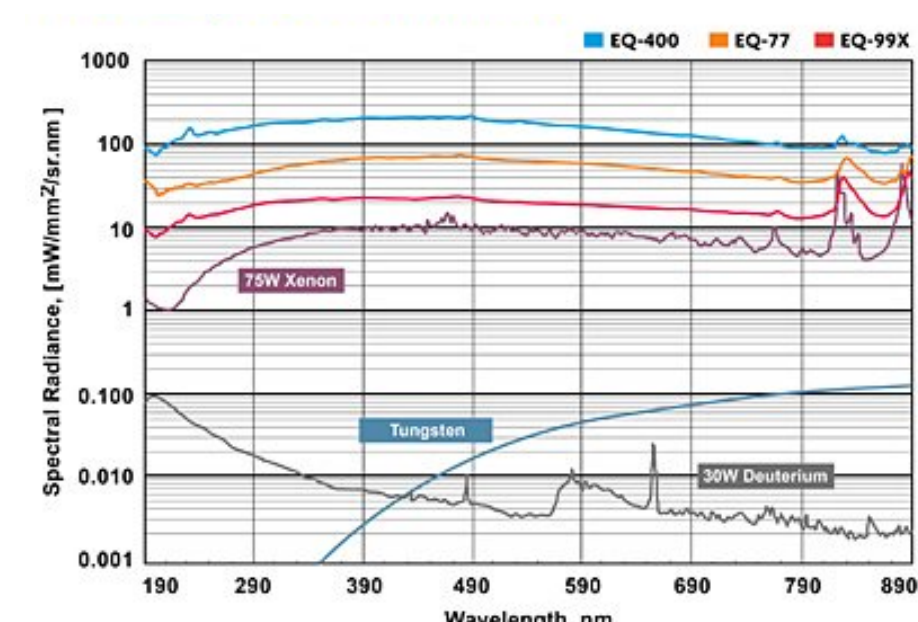
- Modulation for different intensity levels
- Stability level less than 20 ppm @ 10 hours
- Wavelength range from 0.5 μm to 1.95 μm

Project Concept

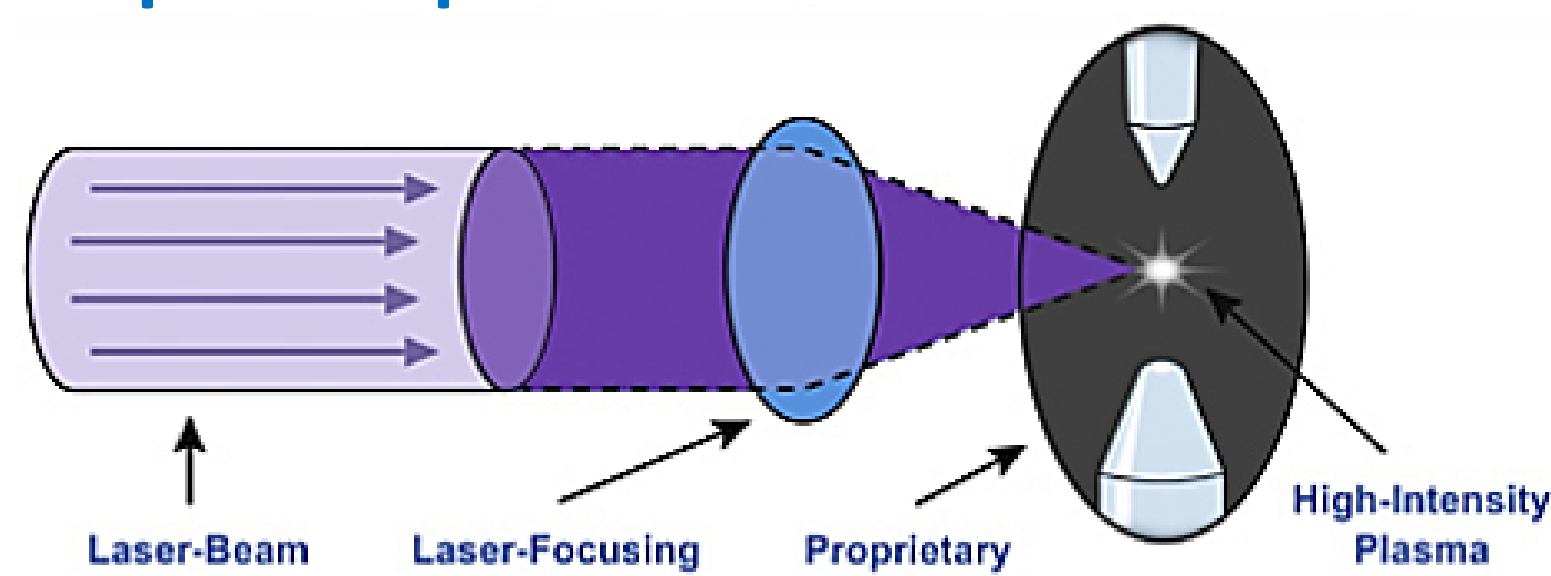


Laser-Driven Light Source (LDLS)

Spectral Radiance



Principle of Operation



Stability Level

- 1'000 ppm @ seconds to hours and 10'000 ppm @ 1000h (Kerber 2014).
- 10'000 to 30'000 ppm range @ 6 hours (B. Chazelas 2016).

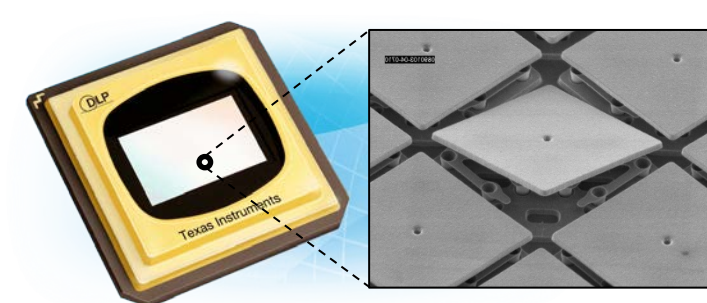
Advantages

- High brightness
- Broadband spectrum
- Excellent spatial stability
- Electrodeless operation

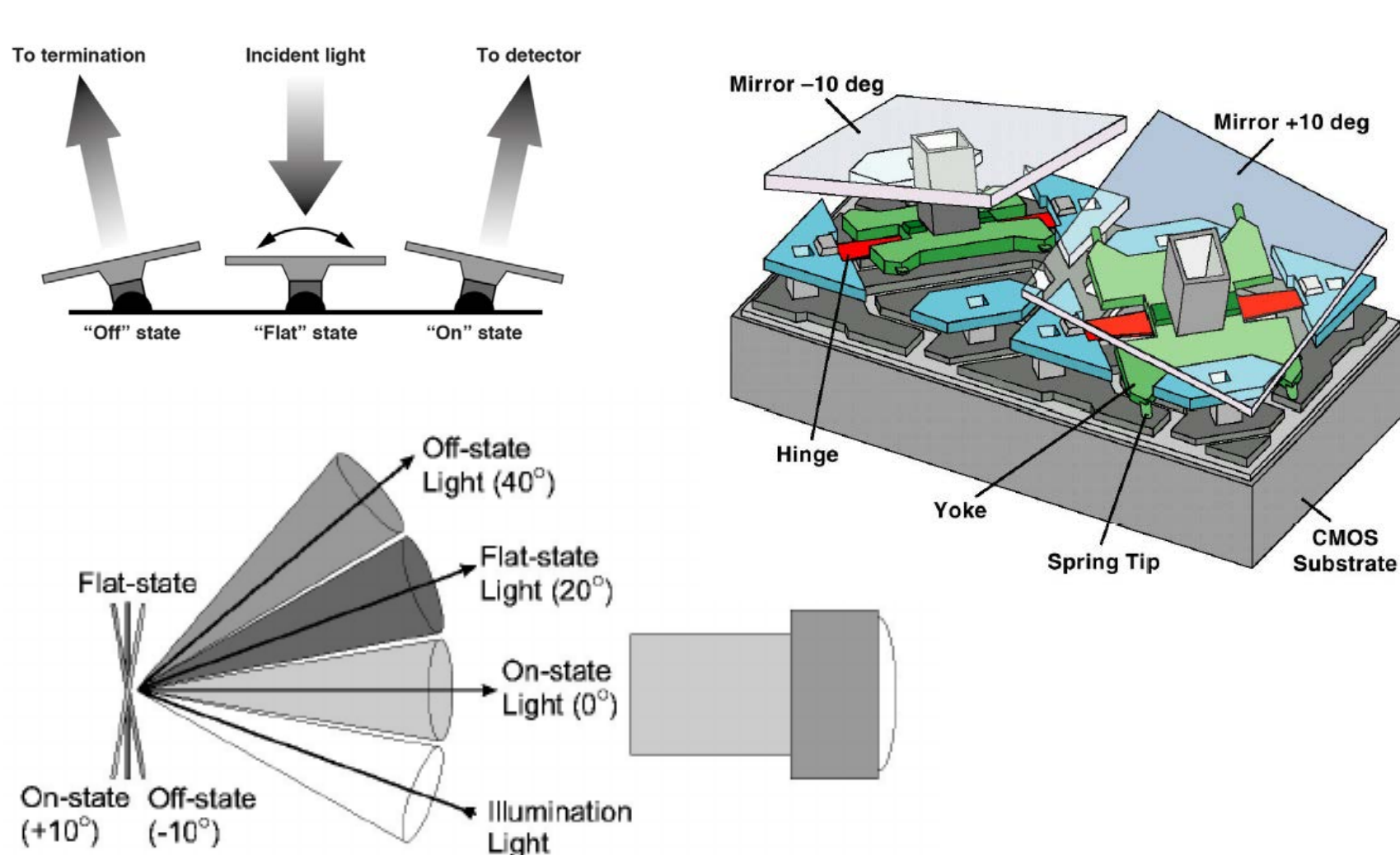
Digital Micromirror Devices (DMD)

DMD

- MOEMS System
- Digital Light Processing
- Chip with millions of microscopically small moving mirrors
- Each micromirror is addressable and can be tilted between two positions
- Spectral window from 0.4 to 2.5 μm



Principle of Operation



Advantages

- Faster modulation rates
- Capable of flux and spectral modulation
- Good beam shaping fidelity
- Small "pixels" (5.4 to 13,68 μm)
- Extended working spectral range