

INPUT OPTICS OF KAGRA

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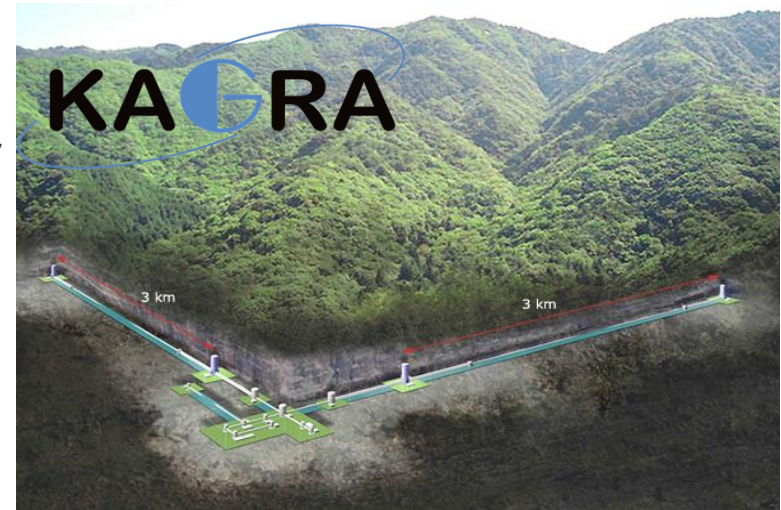
Outline

- Background and Objectives of Input Optics
- Overview
- Pre-Stabilized Laser
- Input Mode Cleaner, Input Faraday Isolator and Input Mode Matching Telescope
- Frequency Stabilization
- Future Plan

Background

KAGRA will be developed in two phases. The first phase of KAGRA is called iKAGRA (initial KAGRA), and second phase is called bKAGRA (basement KAGRA). We are developing the input optics for iKAGRA so far. iKAGRA specifications are below

- **Configuration**
 - ✓ 3 km Fabry Perot Michelson Interferometer
- **Laser Power**
 - ✓ 2W
- **Purpose**
 - ✓ To gain experience in operating a large interferometer



Objectives of Input Optics

- Provide a laser beam stable enough for locking the Fabry-Perot Michelson Interferometer stably.
 - ✓ **Frequency stability**
 - ✓ **Reduction of the beam jitter**
 - ✓ **Mode matching**

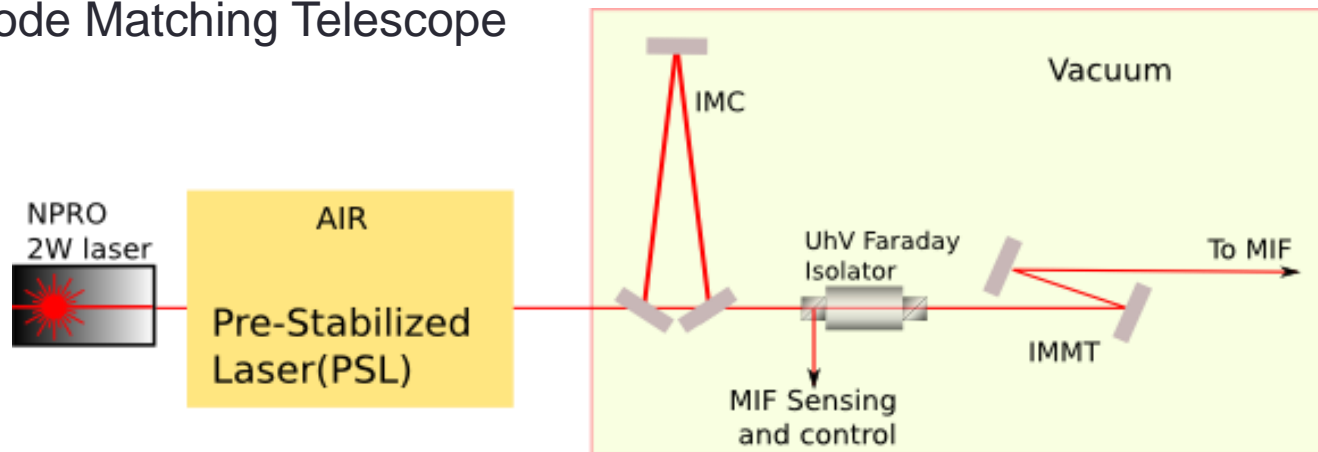
Overview of iKAGRA input optics

- **In-air optics**

- ✓ A Laser Source
- ✓ EOMs for IMC and MIF control
- ✓ Steering mirrors (SMs) for align the beam
- ✓ The frequency stabilization system with FRC
- ✓ IMC mode matching lenses

- **In-vacuum optics**

- ✓ 53 m long Input Mode Cleaner (IMC)
- ✓ A vacuum compatible high power faraday isolator
- ✓ An Input Mode Matching Telescope



Pre-Stabilized Laser (PSL)

- Laser Source
 - ✓ A monolithic Nd:YAG crystal NPRO (Non-Planar Ring Oscillator) laser.
 - ✓ The power is 2 W
- Pre-mode cleaner (PMC)
 - ✓ The cavity length will be controlled with a PZT on the end mirror by Pound-Driver Hall signal.
 - ✓ 40 cm long triangular cavity.

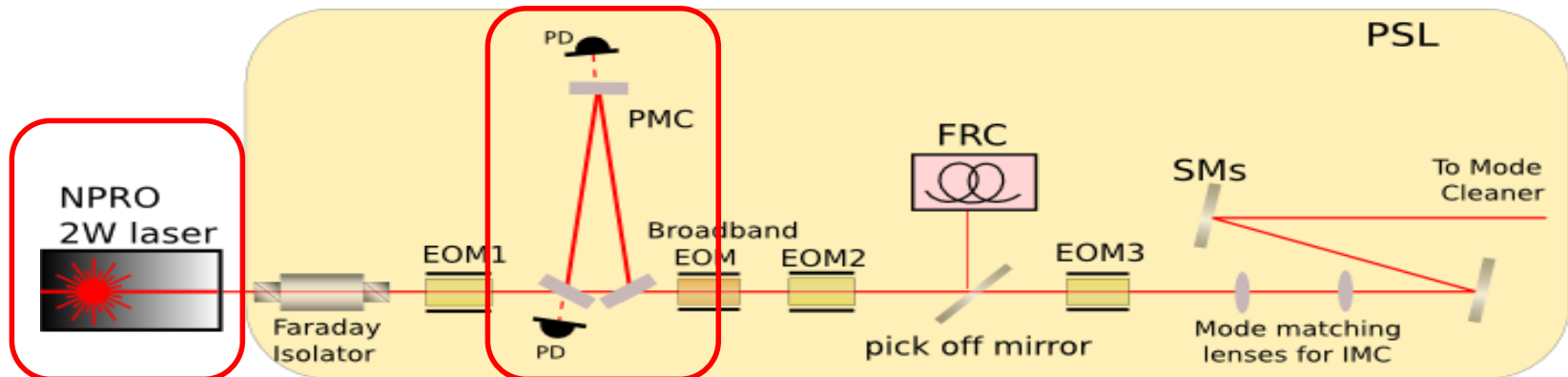


Fig.2 Pre-Stabilized Laser

Pre-Stabilized Laser (PSL)

- Electro-optic Modulators (EOMs)
 - ✓ Providing the phase modulations for each cavity length control
 - EOM1 : For PMC
 - EOM2 : For FRC and IMC
 - EOM3 : For main interferometer
 - Broadband EOM : For frequency stabilization
- Fiber Ring Cavity (FRC)
 - ✓ Used for frequency stabilization as a reference cavity.

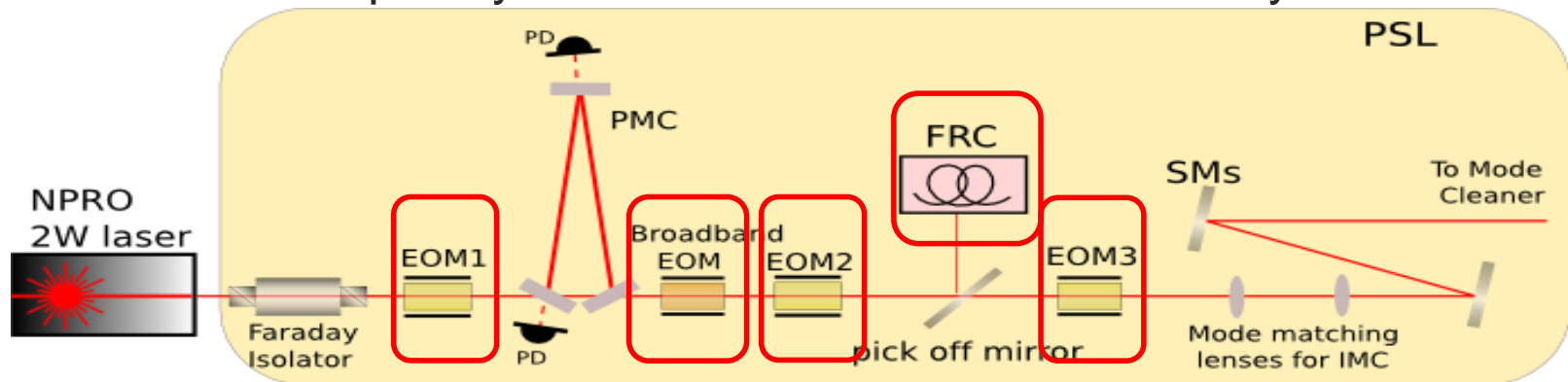
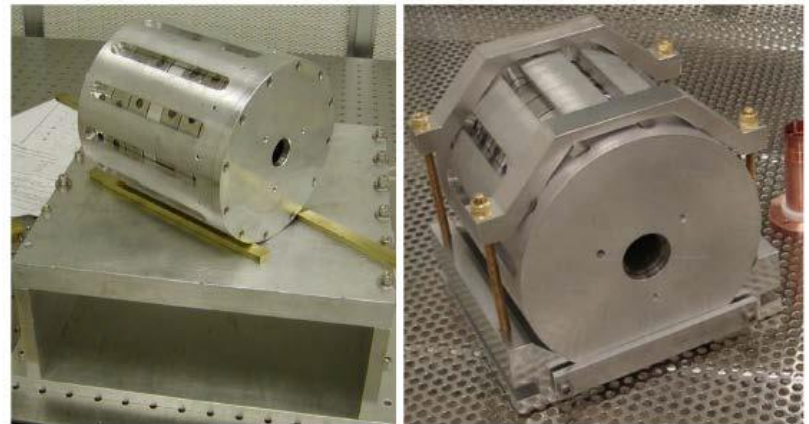


Fig.2 Pre-Stabilized Laser

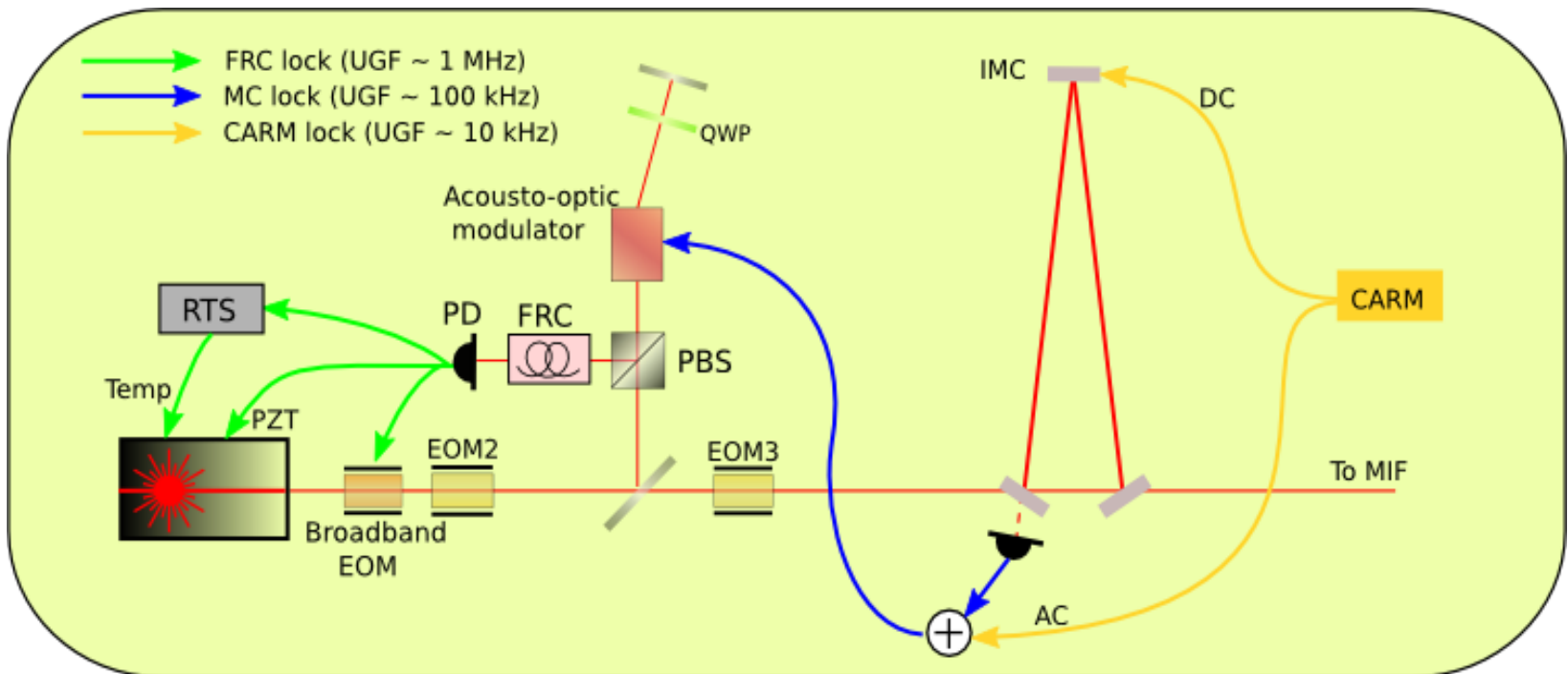
IMC, IFI, IMMT

- Input Mode Cleaner (IMC)
 - ✓ A triangular cavity with suspended mirrors.
 - ✓ Round trip length is 53 m, Finesse is 500, FSR is 5.625 MHz
 - ✓ Use the Wave Front Sensing technique for alignment control
- Input Faraday Isolator (IFI)
 - ✓ Vacuum compatible high isolation ratio.
 - ✓ We don't have to suspend it in the sense of phase noise caused by back scattered light
 - ✓ We ordered to Florida University.
- Mode Matching Telescope
 - ✓ We don't need any curved mirrors or lenses for mode matching for the FPMI.
 - ✓ We just use flat mirrors for the mode matching telescope.



Frequency Stabilization

- The frequency noise stabilization servo will be a multiple loop system.
- Using the Fiber Ring Cavity as a reference cavity
 - ✓ FRC is easy to use and the alignment is stable.



Frequency Stabilization Servo Topology

Future Plans

- Start the test for input optics in ICRR (Kashiwa).
 - ✓ Development of frequency stabilization system with FRC
 - ✓ Measurement of the beam profile
 - ✓ Check of isolation factor
 - ✓ Check of phase modulation
 - ✓ Characterization of injection points
 - ✓ Lock with dummy signals
- The schedule for installation is below

2014	Oct.	Installation of optical table and optics on it
	Nov.	Check the PSL performance including frequency stabilization
	Dec.	Alignment of beam to the IMC
2015	Jan.	The IMC locking
	Feb.	The IMC alignment control
	Mar.	Integration IMC and alignment of beam to MMT