# Interferometer Design for bKAGRA Phase 1

Yuta Michimura

Department of Physics, University of Tokyo

for the MIF subgroup

#### **bKAGRA** Phase 1

#### Goal:

- Start observation run using 3km cryogenic interferometer by the end of March 2018
  - TM temperature should be (close to) 20 K
  - No requirement for sensitivity

#### Configuration:

- 3 km (power-recycled) Michelson
- minimum success: Michelson with LSC
- extra success: PRMI with ASC
- so, we prepare for PRMI with ASC

#### Purpose:

- Test cryopayload and cryogenic operation

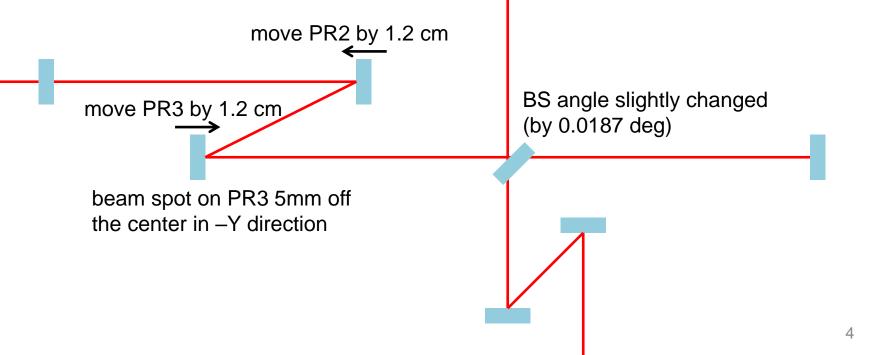
# Configuration

Every detection port listed here has both PD and QPDs (for ASC), and placed on output optics tables in air invac fixed BRT (could be on isolated table; Green lasers are also installed GPT is on output optics table in air) (but not necessary for Phase 1) No requirement for vacuum level **TRY** IMC: Type-C ETMs: Type-A + ~20 K CRYp with WFS (CRYp not final ones) POP PRM misaligned if we give up PRMI IMMT: Type-C **TRX PSL IMMT1T** 2 W BS, SRs: Type-B final PMC PRs: Type-Bp **REFL** invac fixed BRT high power EOM fIMC = 13.78 MHzf1 = 16.88 MHzfrequency stabilized with RefCav/IMC/(PRCL) invac fixed STM

intensity stabilized with PMCT and IMMT1T

## Layout

- Adjust layout slightly to compensate ITM wedge
- Move PR2 and PR3 to stabilize mode of PR cavity
- see <u>JGW-G1605199</u>
   for more detail



## Length Sensing and Control

- Only use f1 sidebands
- Sensing matrix:

[W/m]	MICH	PRCL
REFL_I	+9.92e-01	-7.48e+07
REFL_Q	+6.61e+04	-3.52e+07
AS_I	+8.97e+02	-2.23e-01
AS Q	-1.67e+06	+4.16e+02

## Alignment Sensing and Control

- Only use f1 sidebands (and TRX/Y DC)
- Sensing matrix:

```
[W/rad] COMM DIFF BS PRM PR2' PR3'

REFLA_I +4.98e+02 +2.36e-01 -4.16e+02 -8.13e+01 -2.08e-01 -1.21e+03

REFLB_I -7.01e-01 -2.91e+00 -1.93e+00 -2.10e+01 -1.70e-03 +3.47e+00

ASA_Q +9.80e-01 +1.87e+02 +1.56e+02 -1.39e-01 +1.31e-03 -2.27e+00

POPA_DC +4.04e+01 +1.49e+01 -2.41e+01 +3.91e+02 +8.07e+02 -1.57e+01

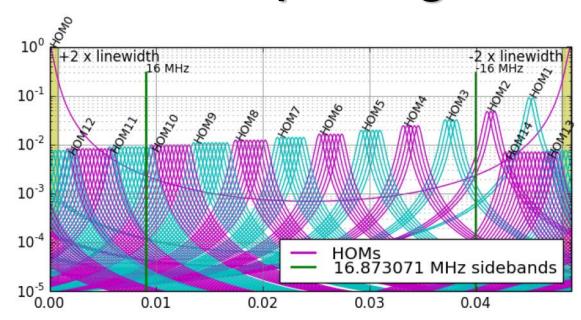
TRXA_DC +2.30e+01 +1.71e-01 +1.93e+01 -1.23e-01 -5.66e-03 -6.51e-01

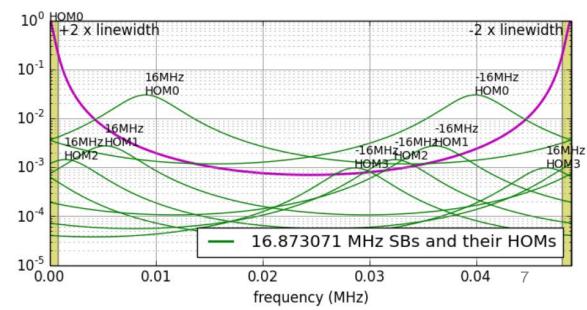
TRYA_DC -2.30e+01 +1.71e-01 -1.91e+01 -1.17e-01 -3.25e-03 -6.36e-01
```

 See <u>JGW-G1605541</u> and <u>JGW-T1605362</u> for more detail

### Transverse Mode Spacing

- g-factor
   0.8750 in pitch
   0.8958 in yaw
   (with designed
   RoCs & lengths,
   PR2-PR3 length
   shortened by
   2.4 cm)
- See
   <u>JGW-G1605541</u>
   <u>JGW-T1605362</u>
   for more detail





#### PRMI or MI

- PRMI could be unstable even if PR2-PR3 length is tuned, if combination of PR2/PR3 RoC errors is the worst case
- We don't have much time for TMS tuning
- Thus, we might have to give up PRMI Give up PRMI as a configuration for the end of March 2018 unstable unstable mode lock stable stable Try adjust Measure beam profile, Shorten PR2-PR3 mode. mode **PRMI** PR2-PR3 Try PR-ETMY cavity by 2.4 cm (max) LSC if possible stable **ETMY** ETMX lock cryopayload cryopayload installed installed Go with PRMI-