

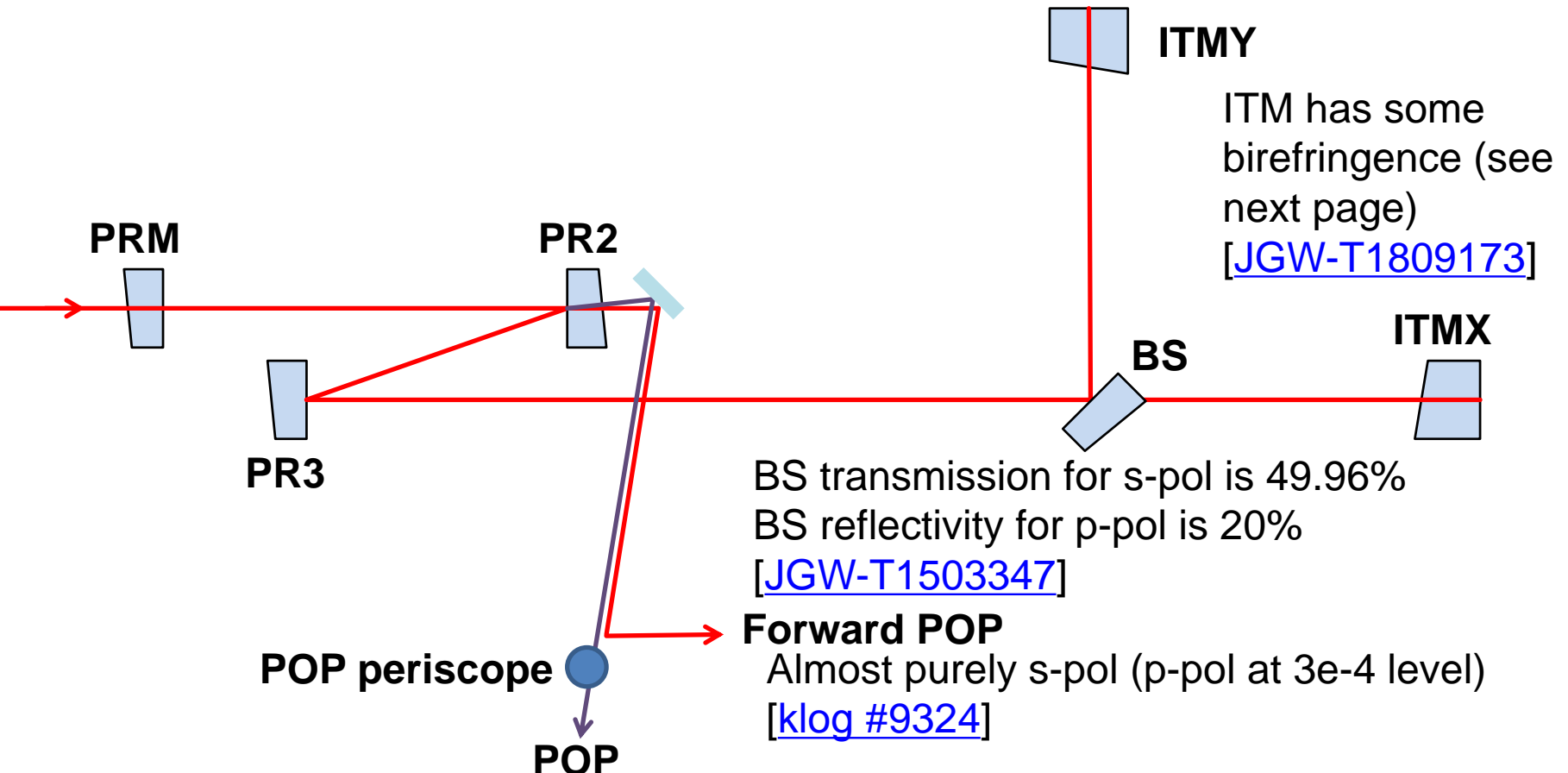
# Discussion on Interferometer Configuration for O3 with Birefringent ITMs

Yoichi Aso

Yuta Michimura

# The Situation

- ITM reflection has some p-pol, while forward beam is almost purely s-pol



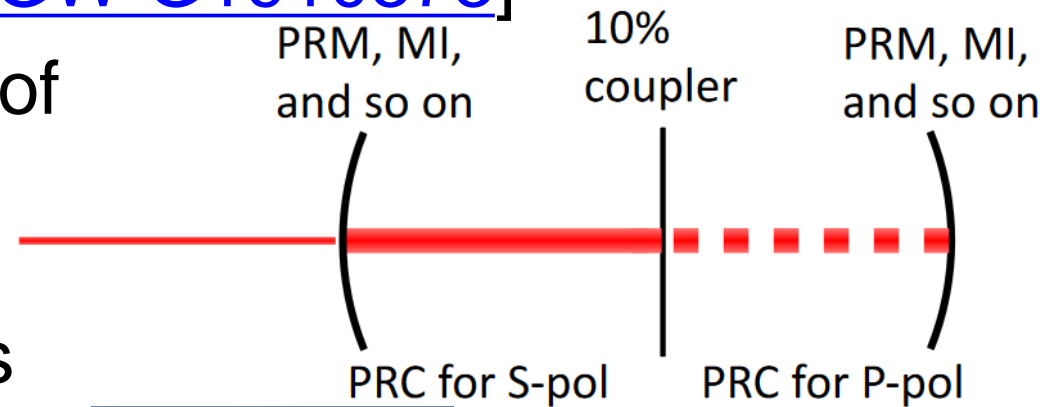
9.4 % p-pol from ITMX single bounce

4.6 % p-pol from ITMY single bounce [\[klog #9314\]](#)

# The Situation

- Amount of p-pol generated with ITM single bounce seems to be explainable with inhomogeneous birefringence [[JGW-G19010369](#)]
- Loss as DRMI will be dependent on interference conditions for p-pol, and this is not controlled → sloshing issue [[JGW-G1910373](#)]

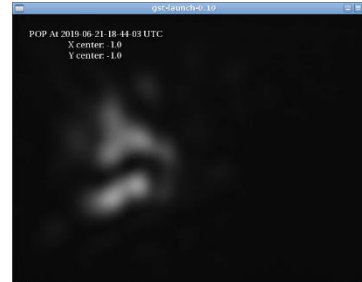
- Amount and phase of p-pol generated is dependent on beam spot positions



From ITMX

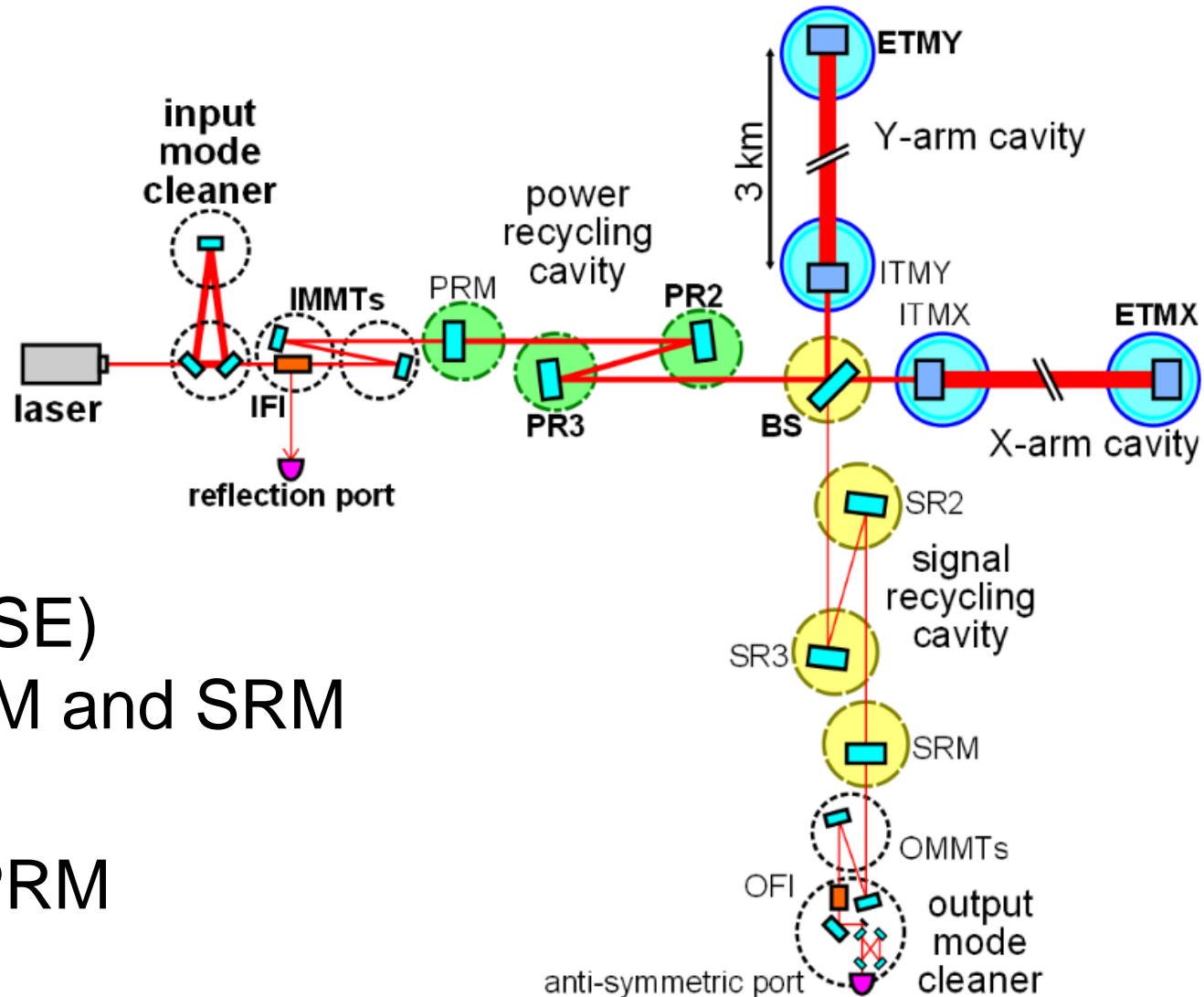


From ITMY



# Options for the Configurations

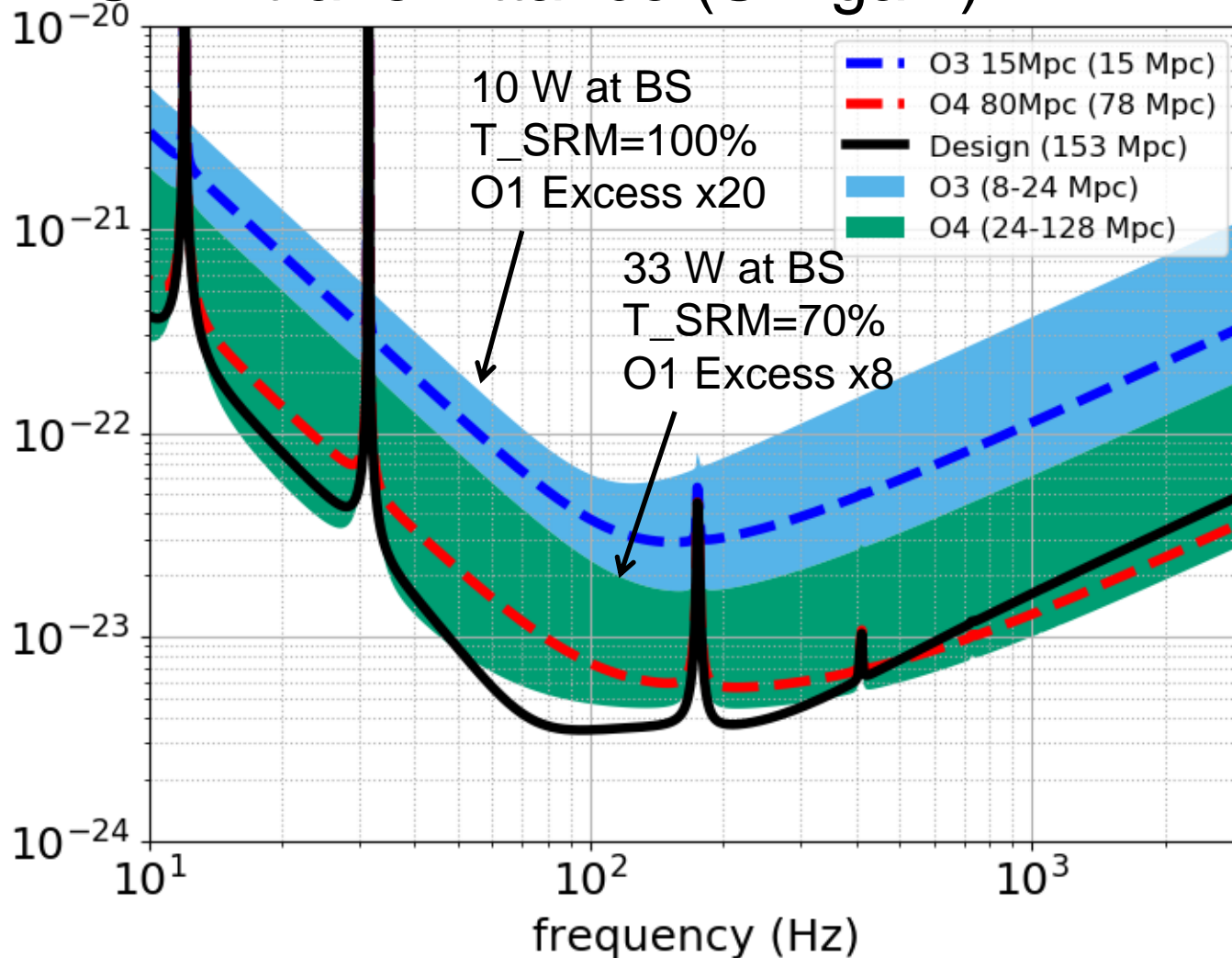
- Maximum PRM input:  
~20 W



- DRFPMI (RSE)
  - Keep PRM and SRM
- SRFPMI
  - Pull out PRM
- FPMI
  - Pull out PRM and SRM (replace with blank)

# Sensitivity

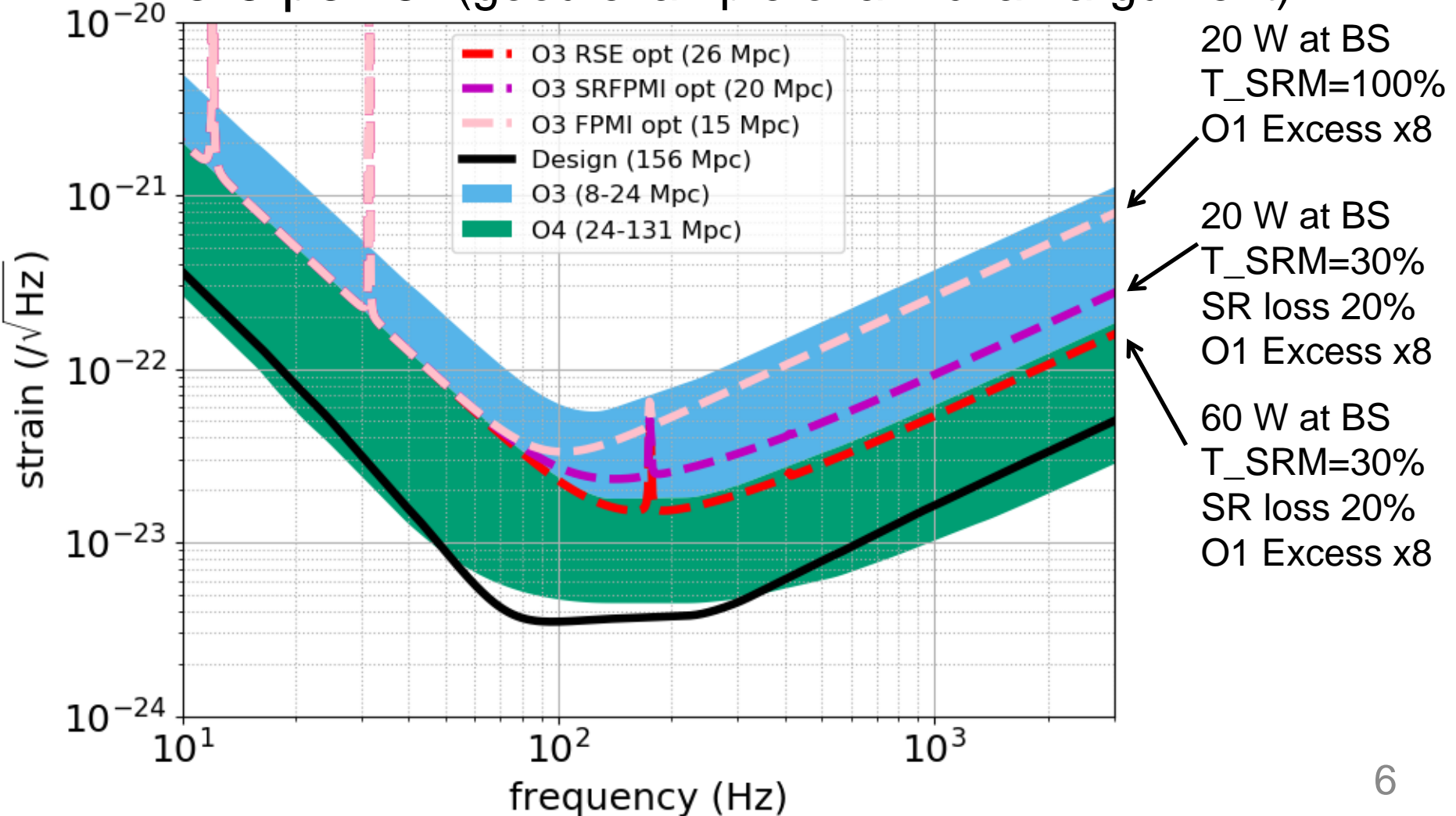
- Sensitivity is determined with power at BS and SRM transmittance (SR gain)



[JGW-T1809078](#)

# Sensitivity

- In principle, we still have some margin if we can put more power (good example of armchair argument)



# DRFPMI

- Are there mirrors for replacing ITMs?
  - Sapphire?
  - Fused silica?
- How to control the loss?
  - Fix the beam positions on ITMs
    - Rough estimate gives  $\sim 0.1$   $\mu\text{m}$  PRX length change for p-pol per ITMX 1  $\mu\text{rad}$   
( $\sim 10$  nrad should be possible with proper WFS)
  - Somehow do something with arm transmission?
- ASC possible with distorted beams?

# SRFPMI

- Increasing PRM input power by x3 sounds easier than locking PRC with PR gain  $\sim 3$
- Frequency/Intensity noise coupling will be x10 higher at high frequencies
- How to keep PR mode-matching?
  - Fixed 2-inch blank mirror? (scattering...)
  - Tune IMMT positions?



# FPMI

- Narrow bandwidth due to no signal extraction
- Frequency/Intensity noise coupling will be x10 higher at high frequencies
- How to keep PR and SR mode-matching?
  - 2-inch blank mirror for SRM
  - Tune IMMT positions?

# Others

- We should confirm if it is really from ITM substrate birefringence (e.g. ITM frosting? ITM coating?)
- This is a serious failure of the project. ***The cause must be investigated and reported.***
  - What was the requirement?
  - What was the process for the procurement?
  - What was the specs to be inspected?
  - What was the acceptance process?
  - etc...