

Annual report@ICRR
18-December, 2010

LCGT 関連の共同利用研究報告
Report of Researches related with
LCGT in FY 2010

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ICRR



平成22年度共同利用研究題目(LCGT関連)

Subjects related to LCGT in FY 2010

- 大型低温重力波望遠鏡の開発・設計(XII)
R&D and Design of large-scale cryogenic gravitational wave telescope (XII)
研究代表: 黒田和明 予算: 100千円(旅費100)
- LCGTのための単結晶サファイア鏡懸架の開発(VI)
Development of suspension system for single crystal sapphire mirror
研究代表: 鈴木敏一 予算 210千円(旅費50)
- LCGTクライオスタットの超高真空対応化への研究
Study of a LCGT cryostat toward ultra-high vacuum operation
研究代表: 高橋竜太郎 予算 260千円(旅費40)
- CLIO干渉計高出力光源の強度安定化装置の開発
Development of an intensity stabilization system for a high-power laser for CLIO
研究代表: 三尾典克 予算 400千円(旅費0)
- 重力波検出器のための低振動地下施設の研究
Seismic classification of underground facilities for low frequency ground based gravitational wave detectors)
研究代表: 黒田和明 予算30千円(旅費30)

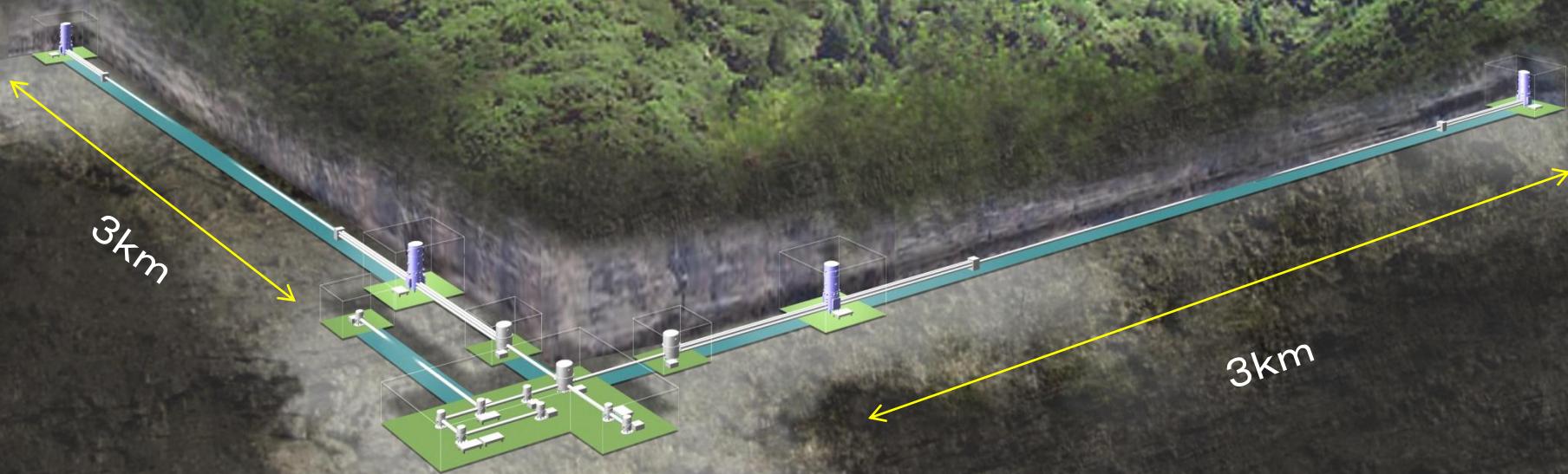
LCGT予算化に伴う変化

Change by LCGT funding

- PIの創設(計画から事業へ)
- 海外LCGT Collaboration memberの共同利用
研究者としての参加・authorization
 - 海外の参加者開拓中
- 計画プロジェクトの学術学会での公表
- 広報活動の強化
 - 名前募集中

LCGTの目的

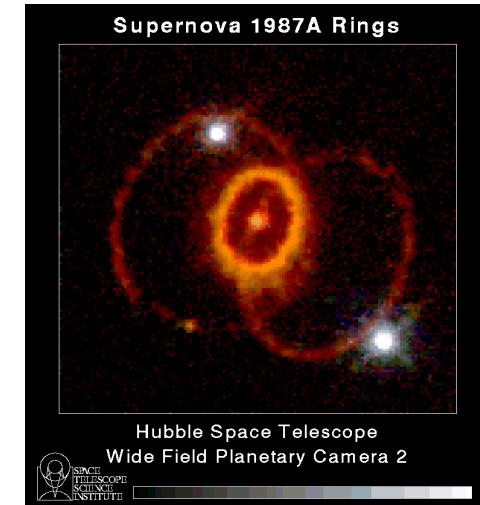
- 1) 世界に先駆け重力波の発見
- 2) 重力波天文学の創生と展開



Target GW Sources of LCGT

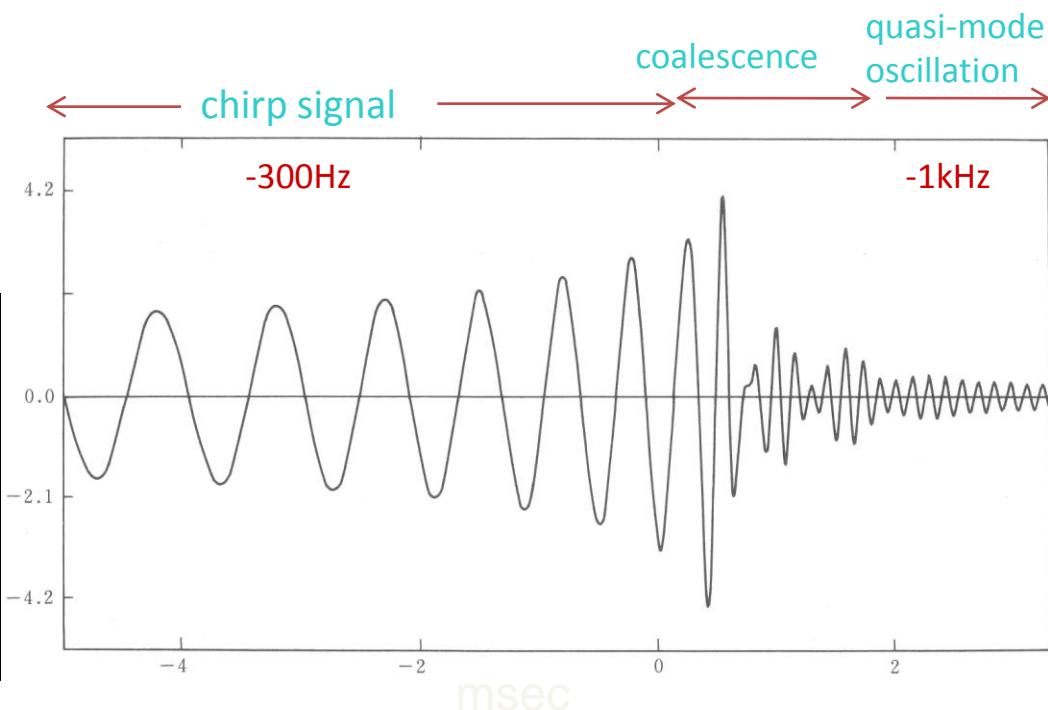
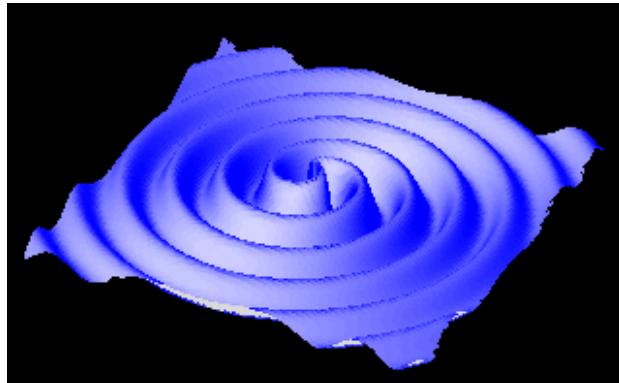
Higher priority

1. Coalescence of neutron star binaries
2. Coalescence of black hole binaries
3. Core collapse of massive stars
4. Rotation of pulsar



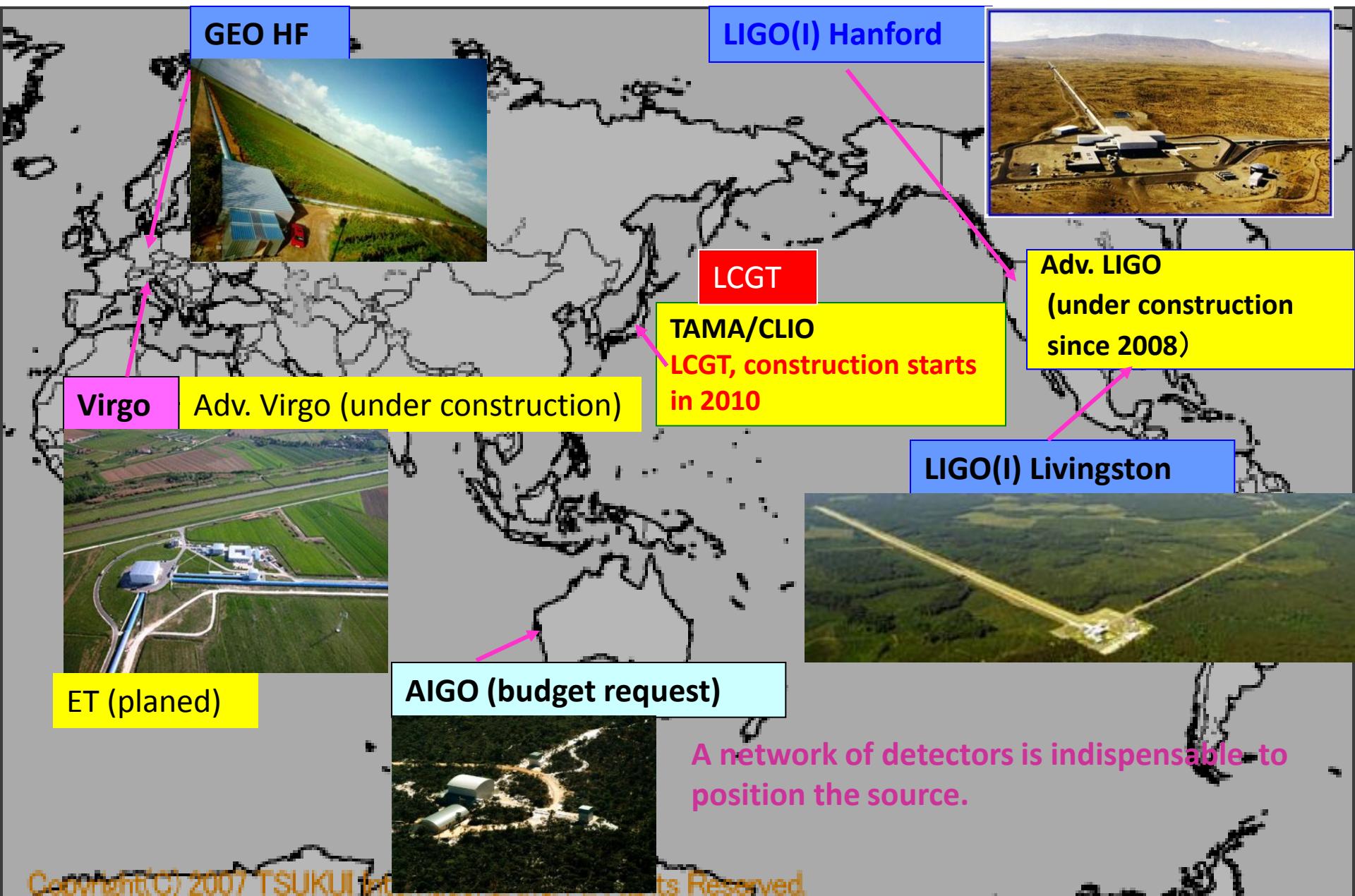
Existing neutron star binaries in our Galaxy

- PSR B1913+16
- PSR B1534+12
- PSR J0737-3039
- PSR J1756-2251
- PSR J1906+0746





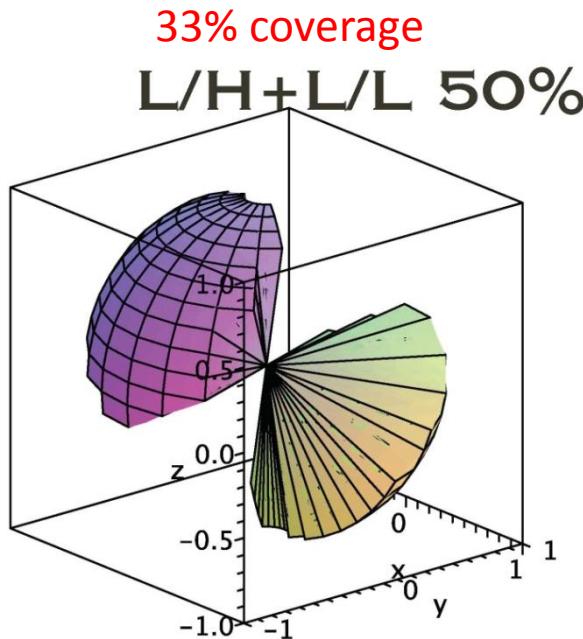
Detectors in the world



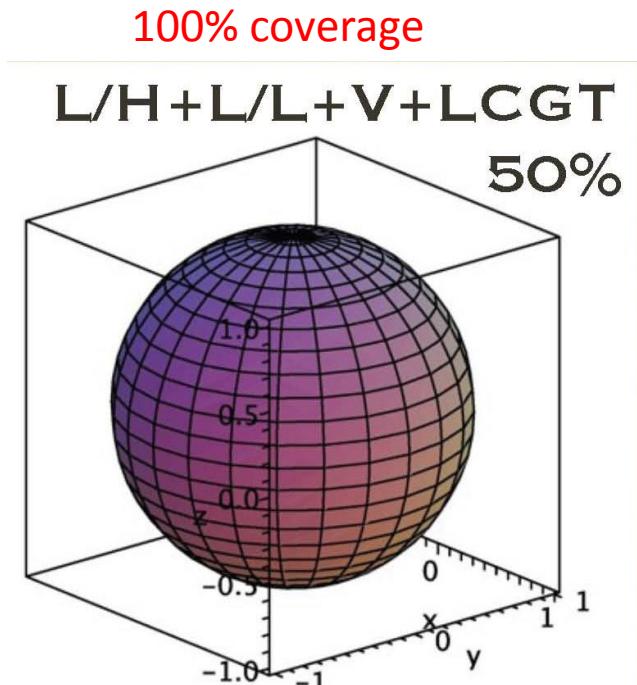
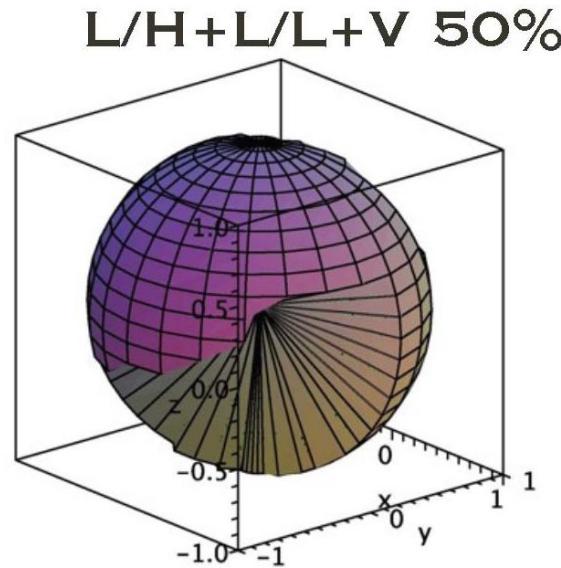
LCGT in World-wide GW Network

- 1) Increase the large baseline length (20 ms time flight among North America, Europe and Asia)
- 2) Widen the sensitivity pattern

Adding LCGT to L/H-L/L-Virgo, the whole sky coverage is realized

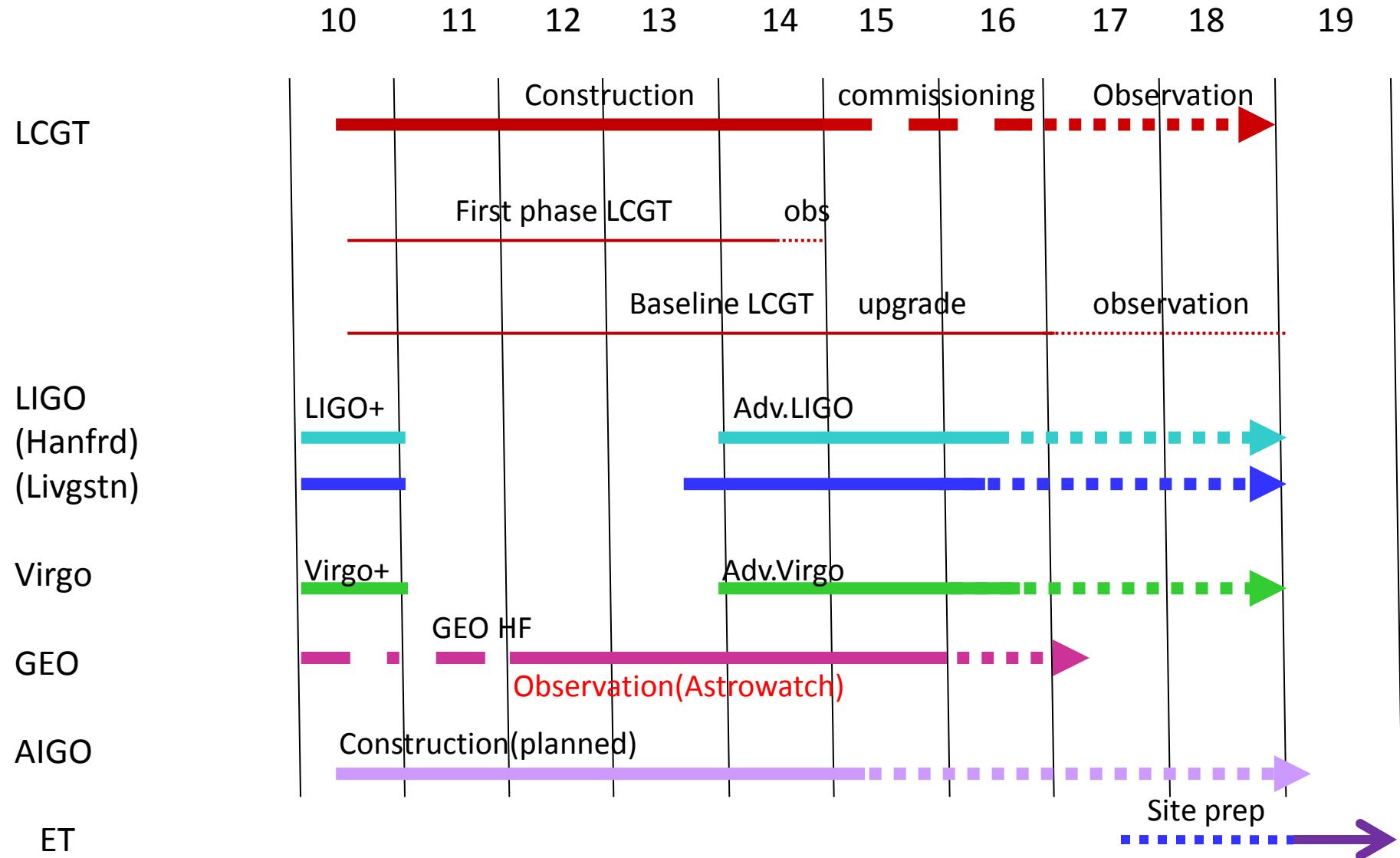


By global network





LCGTプロジェクトの建設・観測スケジュール



LCGT: Time line (Budget)

Item	Japanese FY					
	2010	2011	2012	2013	2014	2015
Excavation						
vacuum system						
Optical system						
laser system						
suspension / Cryogenic						
Vibration isolation						
2nd phase (Cryogenic system)						
Geophysics interferometer						
Digital system						
control room (building)						

 Project for the promotion of advanced researches (Granted)

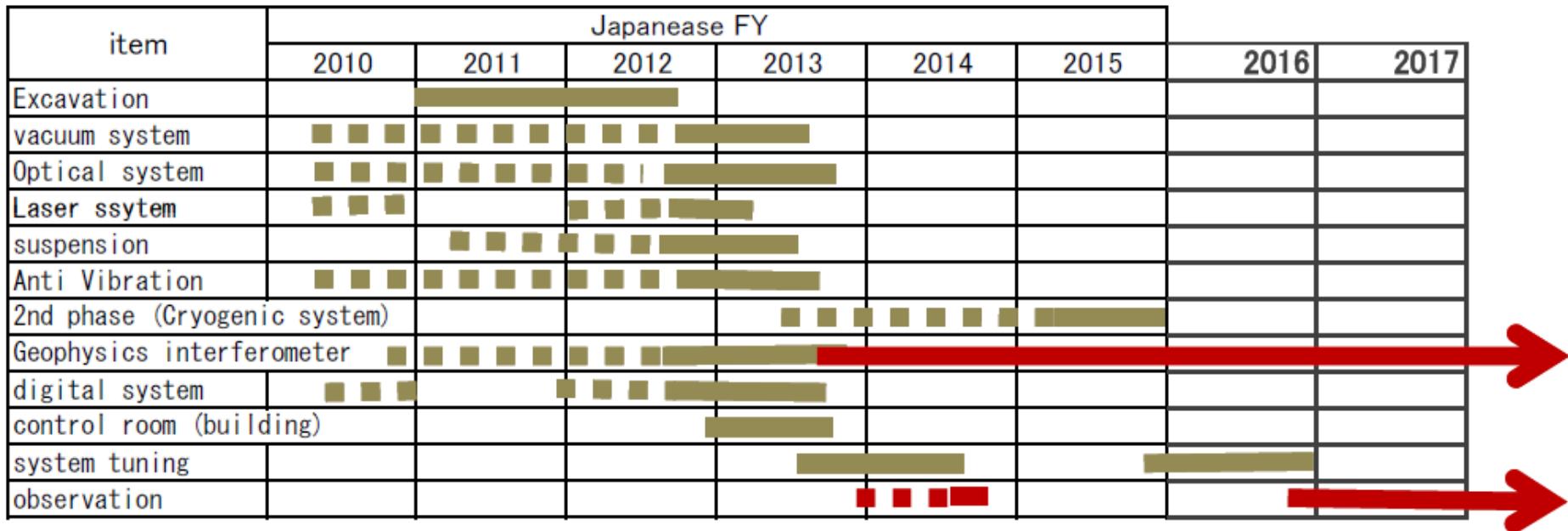
 Budget request (MEXT to Ministry of Finance)

 To be requested



We will hear the final decision at the end of 2010.

LCGT: Time line (Construction/Observation)



 construction (off-site)
 construction (on-site)
 observation

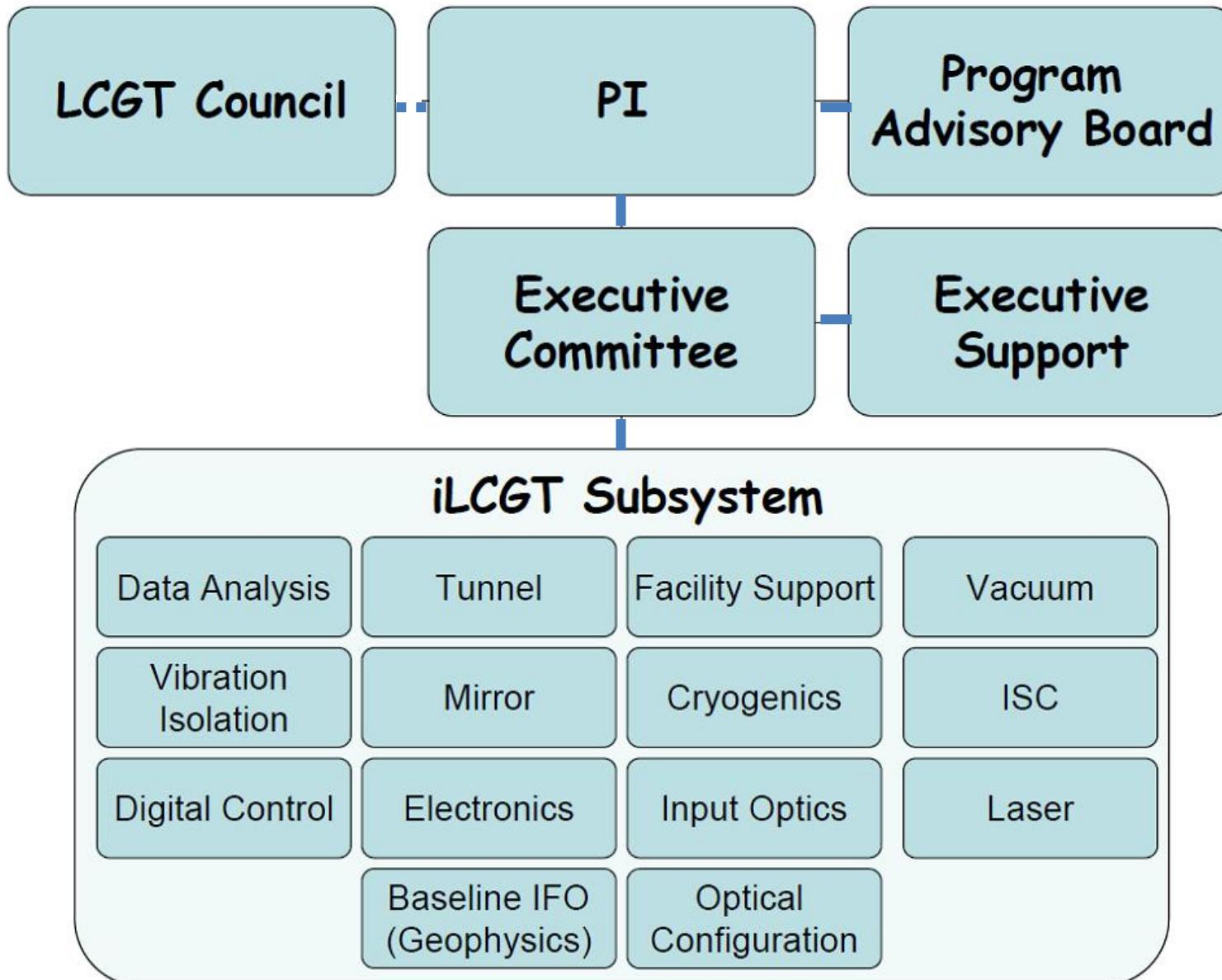
The construction/observation plan is in 2 stages:

In 2014, non-cryogenic observation.

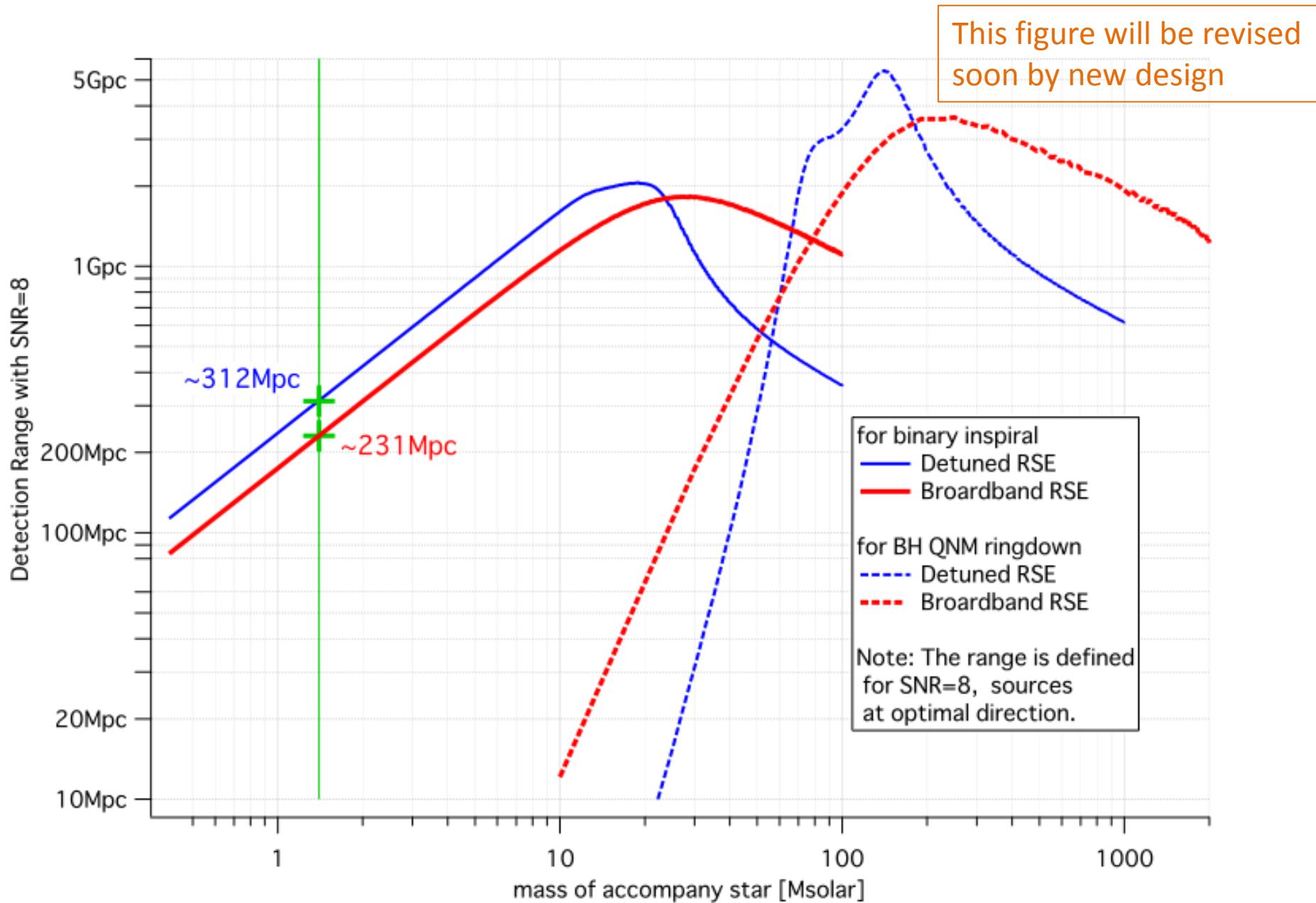
Full observation with the cryogenic system, at the beginning of 2017.



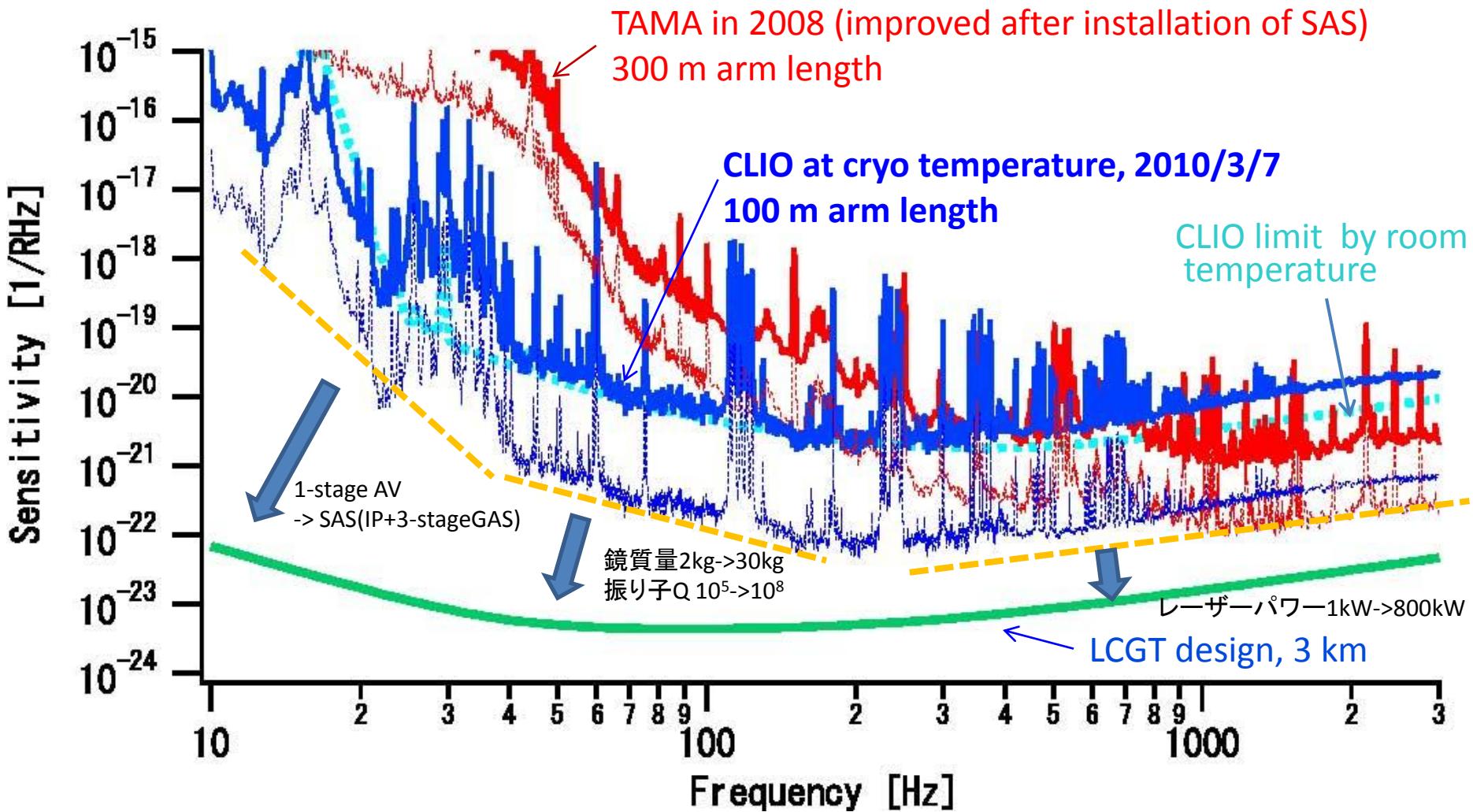
LCGT Organization for Construction



Sensitivity of LCGT and future improvement

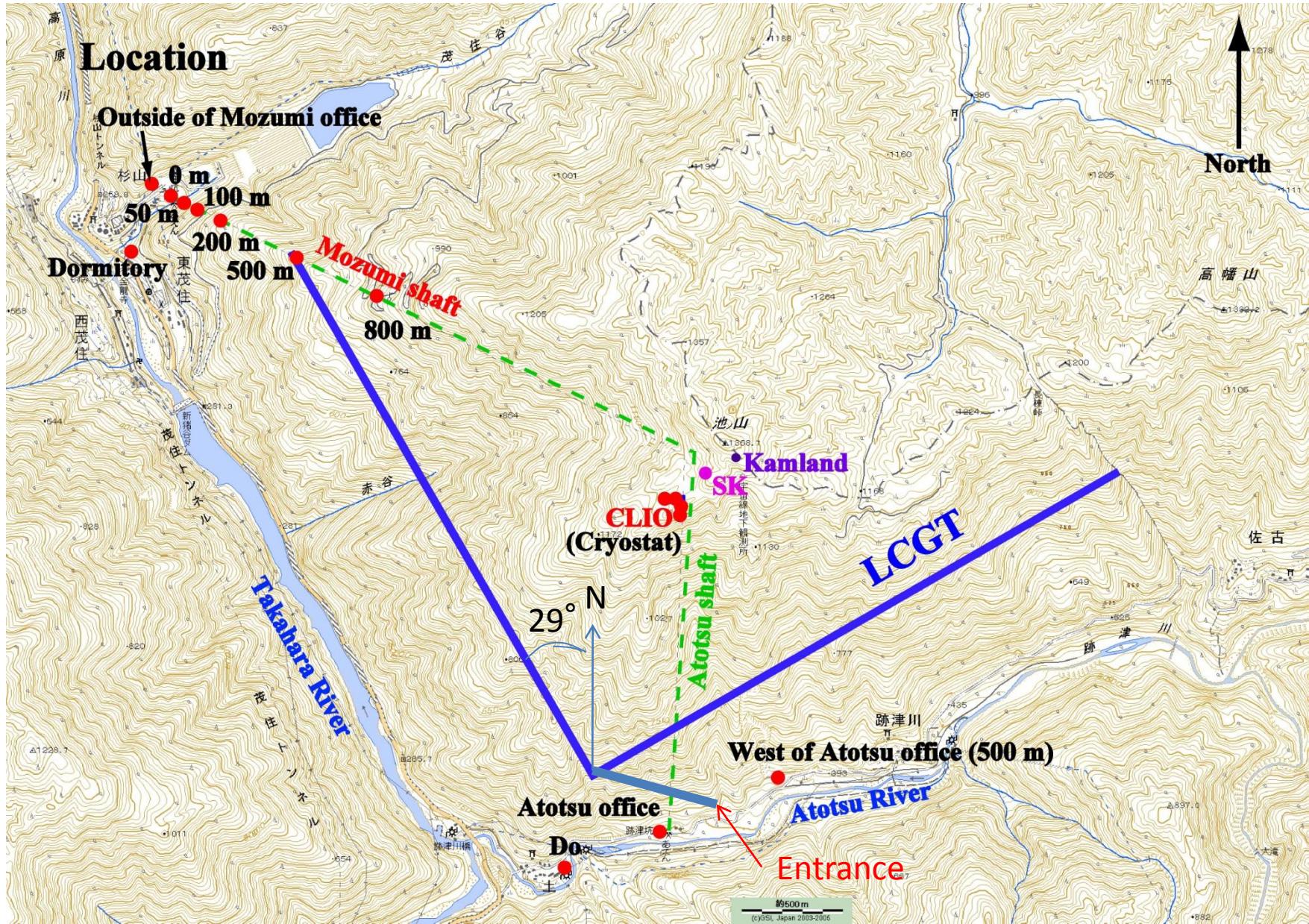


LCGT実現に向けた感度向上

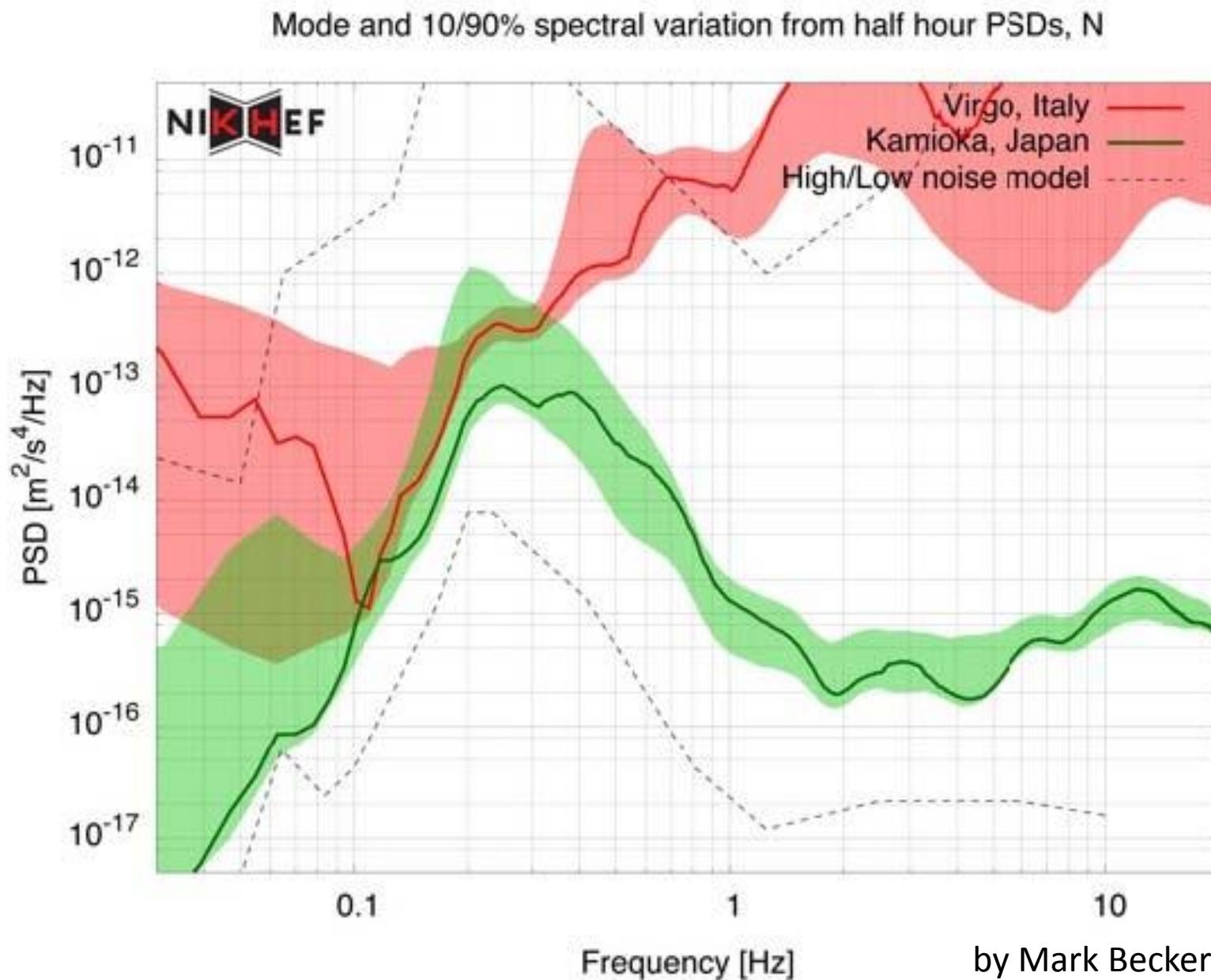




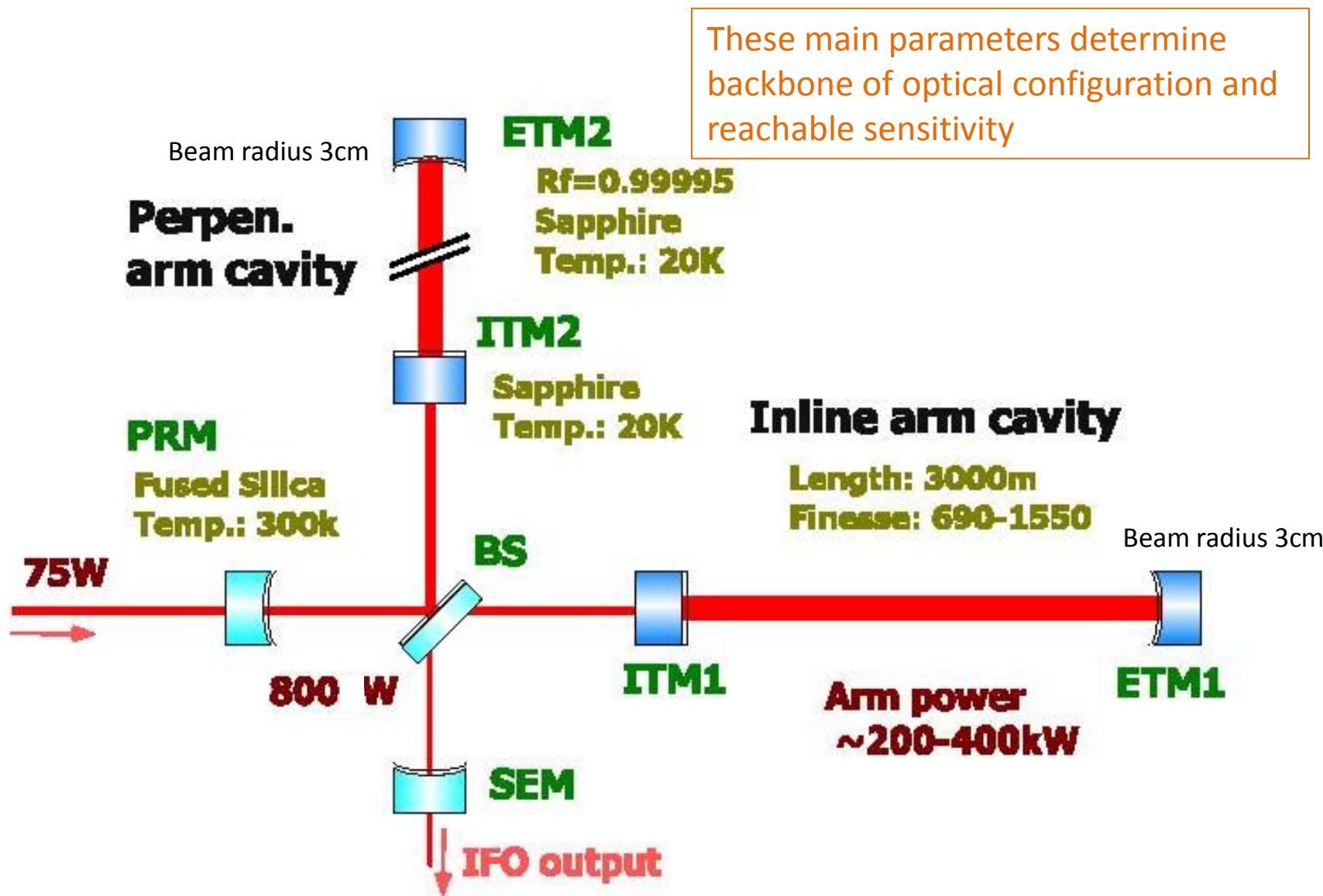
LCGTトンネル位置



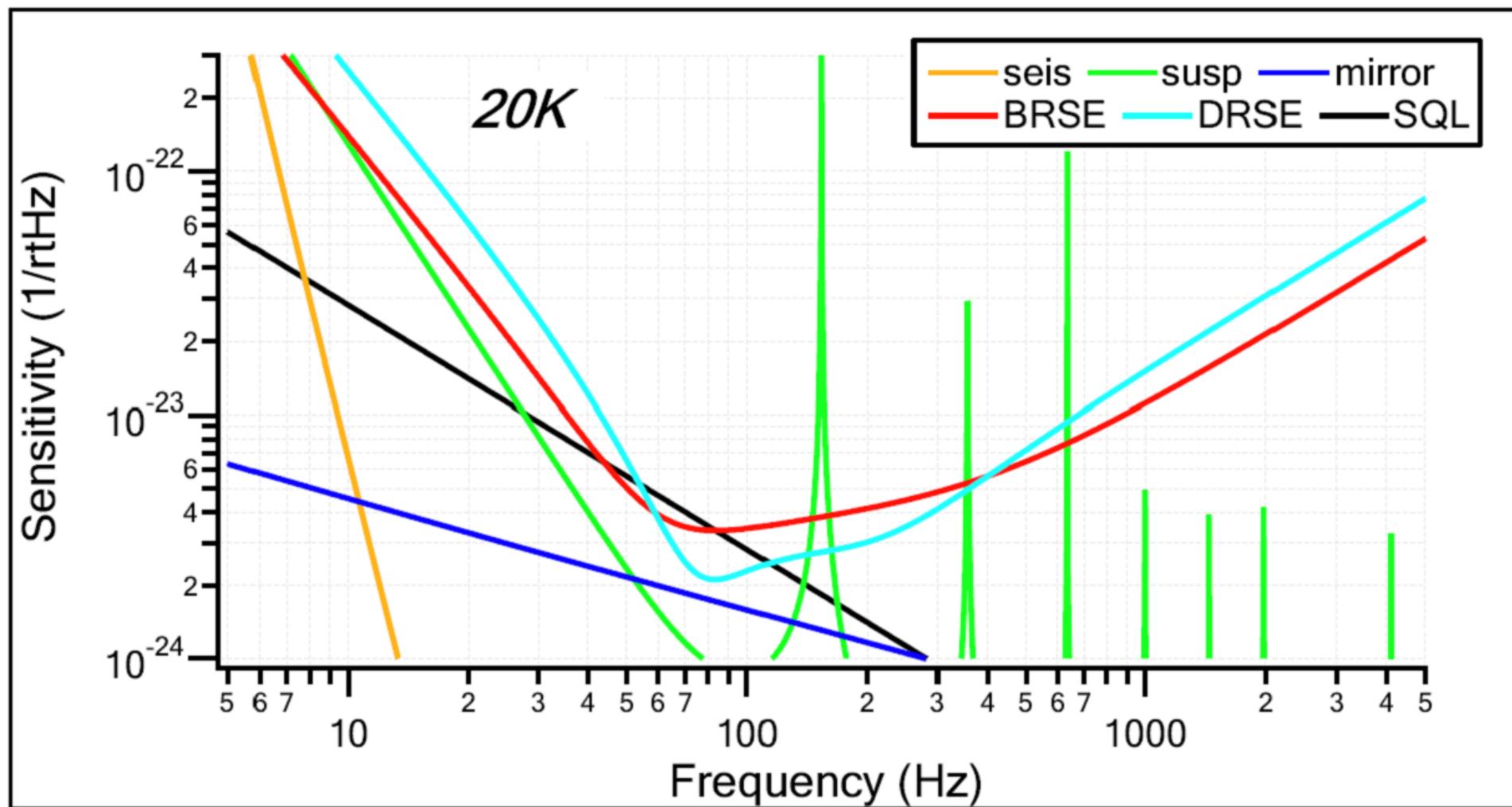
R&D: Seismic vibration compared with Virgo



Optical design of LCGT (main part)



Study of Optical Design

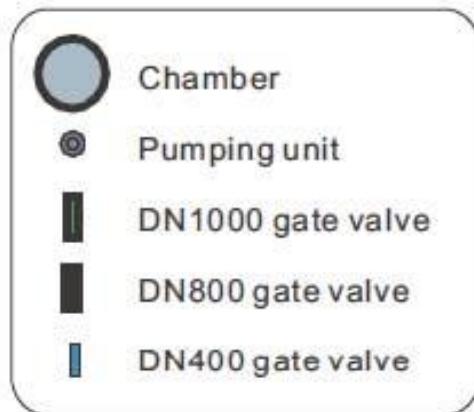


LCGT Vacuum System

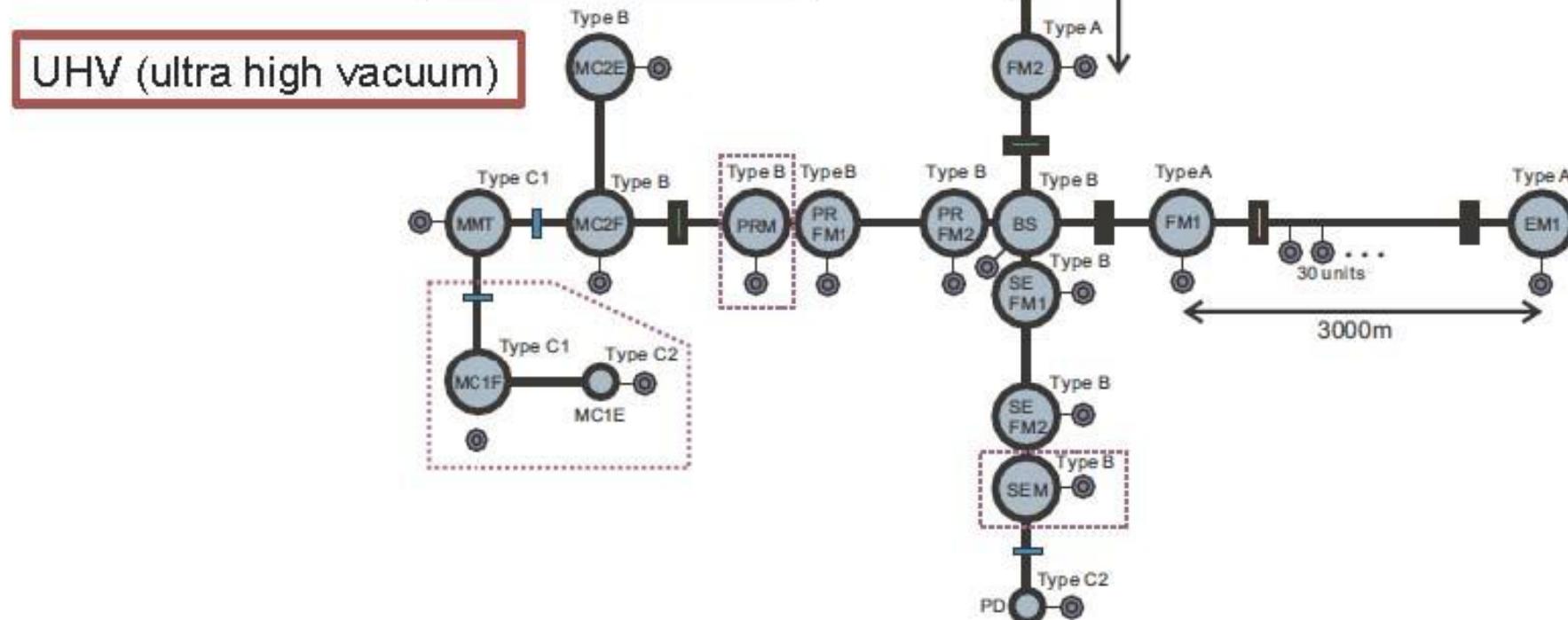


** for reducing noise due to a residual gas effect

** for maintenance minimizing



EM: End Mirror
FM: Front Mirror
BS: Beam Splitter
MC: Mode Cleaner
PRM: Power Recycling Mirror
SEM: Signal Extraction Mirror
MMT: Mode Matching Telescope
PD: Photo Detector

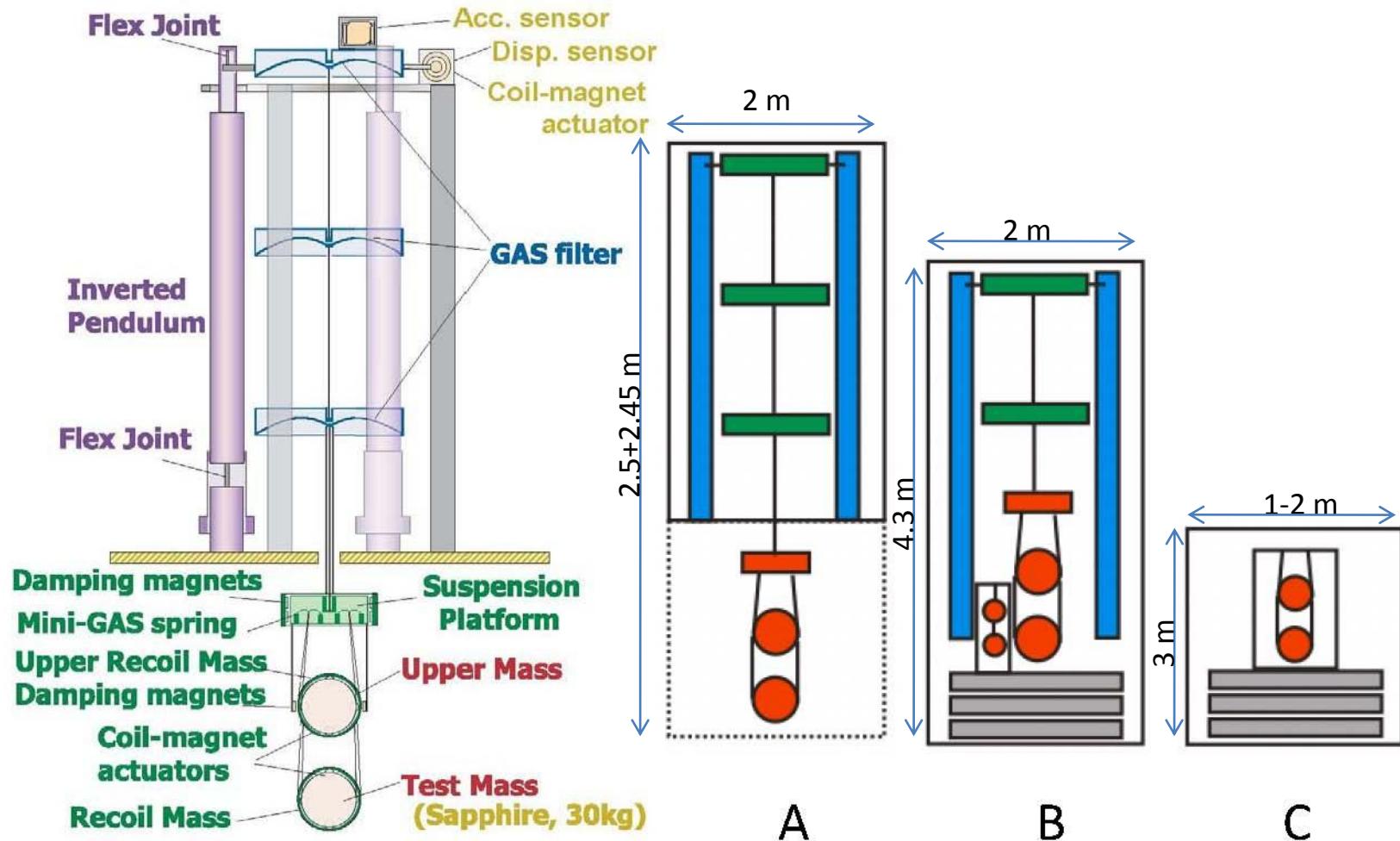


Three types of anti-vibration system

Type A) SAS(GASF 3stage)+cryo-sus: ITMX, ITMY, ETMX, ETMY

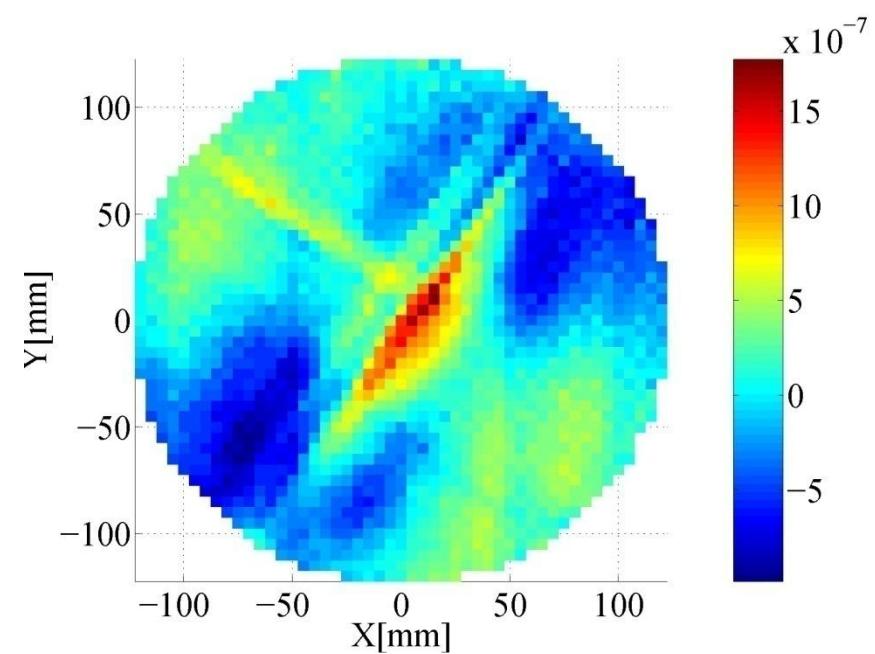
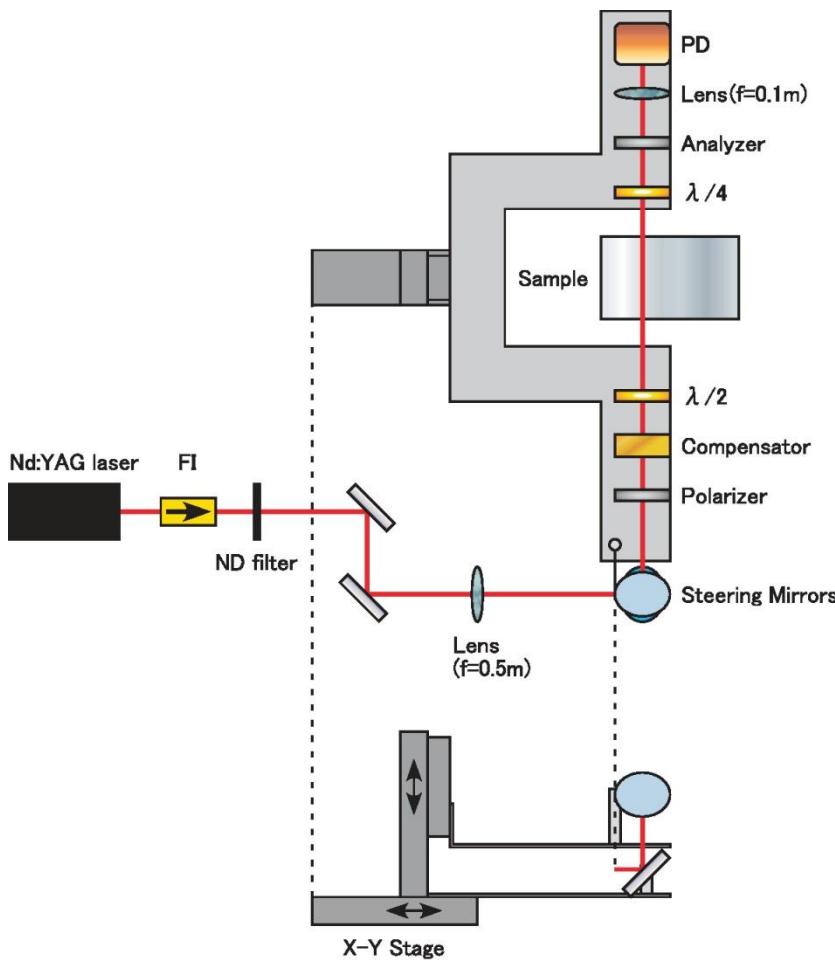
Type B) SAS(GASF 2stage)+non-cryo: BS, PR2, PR3, SR2, SR3, MC2F, MC2E

Type C) STACK+2stages:
MC1F, MC1E, MMT, PD



Quality selection machine of sapphire substrate

In order to select appropriate sapphire substrate, quality selection of sapphire pieces was developed.



LIGO sapphire sample 250mm in diameter
20kg lent by the courtesy of LIGO.
The optical quality was a few times less than required for LCGT specification

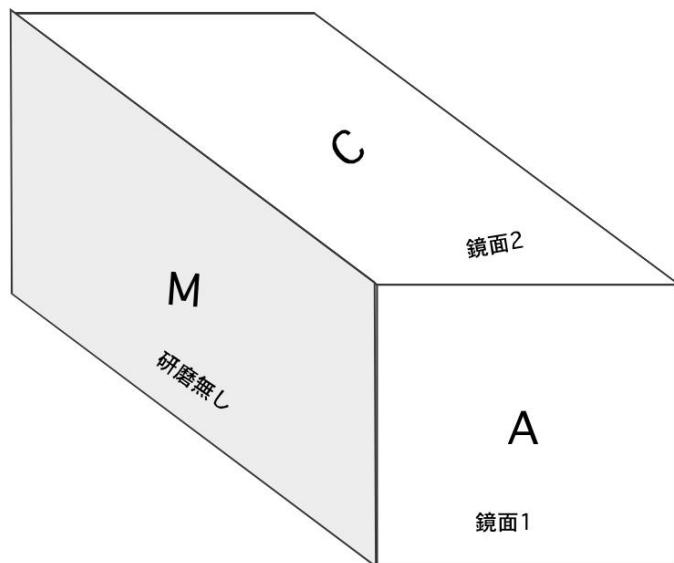
Auto scanning birefringence device

サファイア接合試験

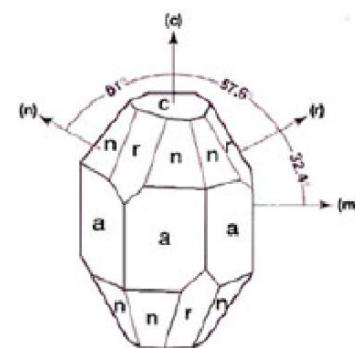
今年度の予算使途

- サファイア $5 \times 5 \times 10$ ブロック購入
京セラEFG法 Lot# 4141, 4142
- 5×5 面をオプティカルコンタクト可能なレベルの精密研磨
ジャパンセルに研磨依頼 20本
比較のため拡散接合サンプル2組を製作

製品名：サファイアブロック(TS-10097)
材質：SA100 ロットNo. 4141(16個), 4142(4個)
出荷日：2010.04.14
図番：TS-10097
注番：20040703
寸法：5mm x 5mm x 10mm



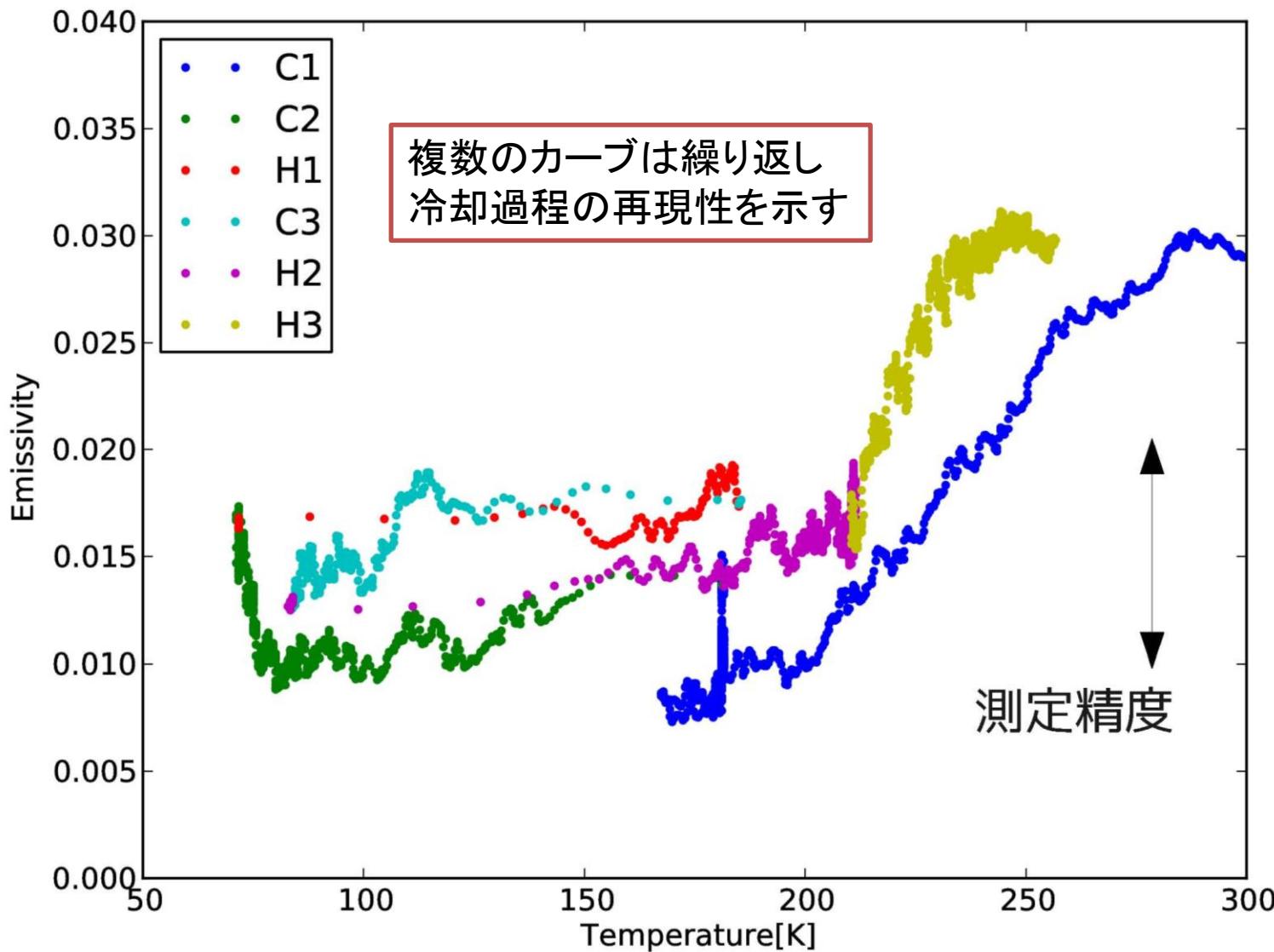
面方位：ACM面
面仕上：4面鏡面



- FUJINONによる測定
 - 抜き取り ブロック5本分(10面)
 - 波長674.4nmの単色光干渉
 - 波長単位の表示
- Zygo New Viewによる測定
 - 阪大 打越研に依頼した
 - ブロック16本(32面)
 - 白色光干渉

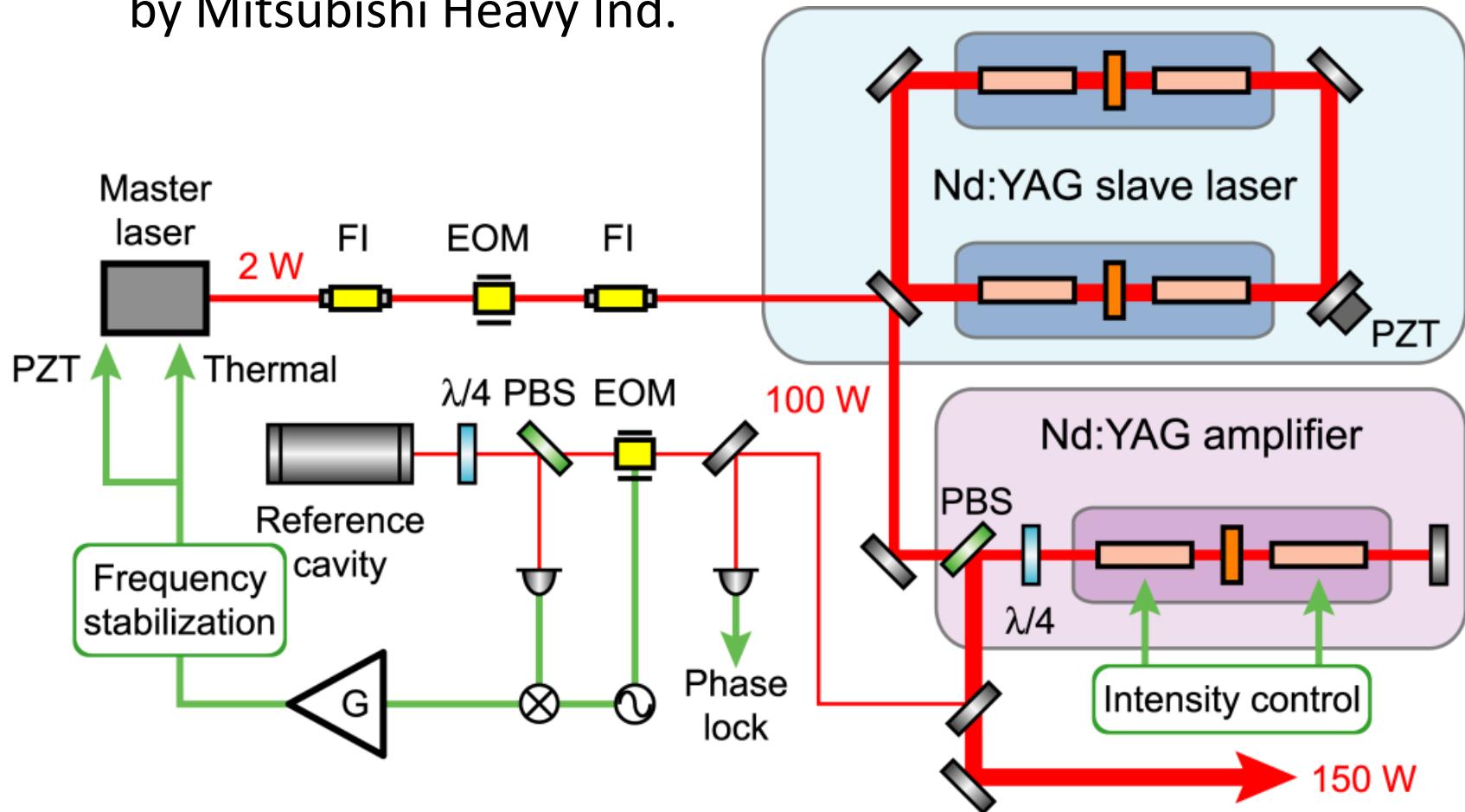
R&D: 低温クライオスタットの輻射シールド材

クリーンな輻射シールド材として、熱放射率の小さい材料が必要
銅サンプルの測定でLCGTの要求値(<0.07)を満たしている。



Laser

Laser diode pumped injection locking laser system
by Mitsubishi Heavy Ind.





Data Analysis

- It is difficult to detect burst wave events by a single detector
- Coherent observation gives more fruitful result
- It is natural to promote data-sharing in the world-wide GW observation network
- We have experienced data taking & analysis by TAMA and CLIO
- We collaborate with LIGO-Virgo project for developing techniques for analysis



国内機関との協力

- KEKとの共同研究覚え書き締結
- 国立天文台からのスタッフの合流(在籍出向)
- 共同利用研究者としての参加促進



International collaborations with other projects

- Attachment agreed under existing MOU between ICRR (represents LCGT Collaboration) and LIGO laboratory
 - Manpower, software & technique exchanged
- MOU with Attachment between EGO + Virgo Collaboration and ICRR is now on process to be signed
- MOU between ICRR and SUCA in Shanghai Normal University is now on process to be signed
- MOU between ICRR and GEO people is also conceived



Summary

- LCGT has been partially funded (June, 2010) to promote fundamental physics by GW detection
- We keep high competitiveness with other GW projects in the world for the detection of GW
- Playing a key role in the worldwide GW network with adv. LIGO, adv. Virgo and possible other observatories
- Thanks for supports by both ICRR and CRC