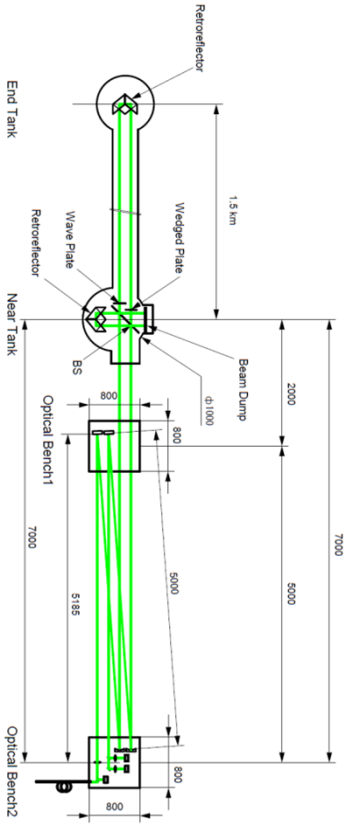
Geophysics interferometer

16 January, 2012

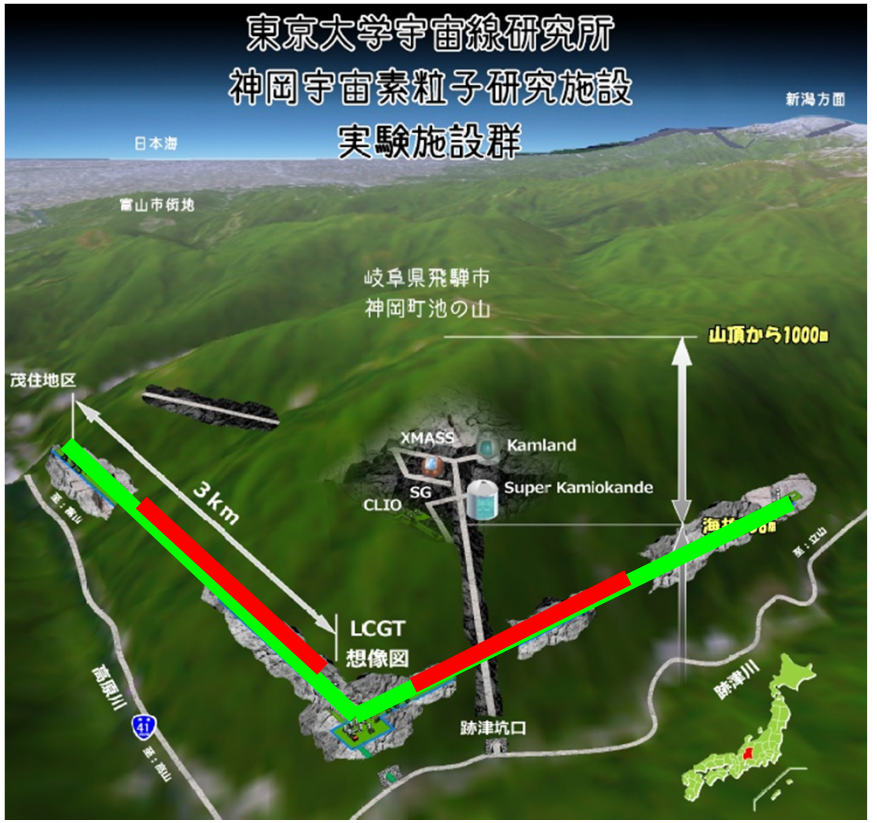
Definition

1. Construction of two baseline-monitor interferometers (1.5km) along LCGT

2. In charge of sensors and benchmarks for monitoring environmental condition



Geophysics Interferometers along LCGT



Optical layout:

Baseline 1500m

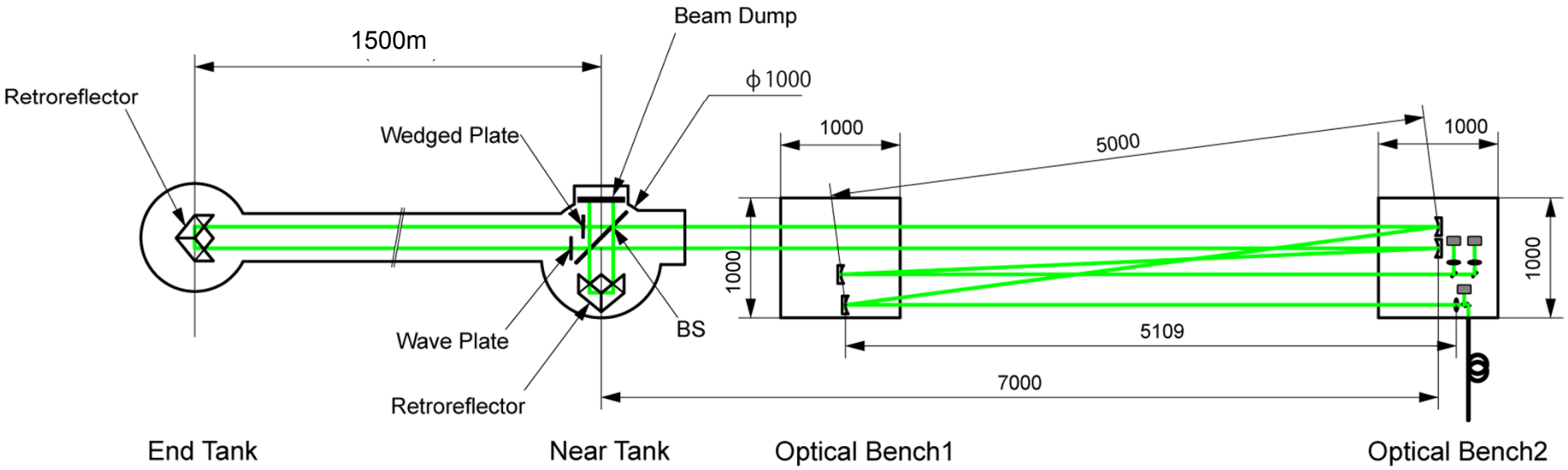
Asymmetric Michelson interferometer with two retroreflectors

A 5-m input baseline

Iodine-stabilized 532nm laser

φ400mm vacuum pipe

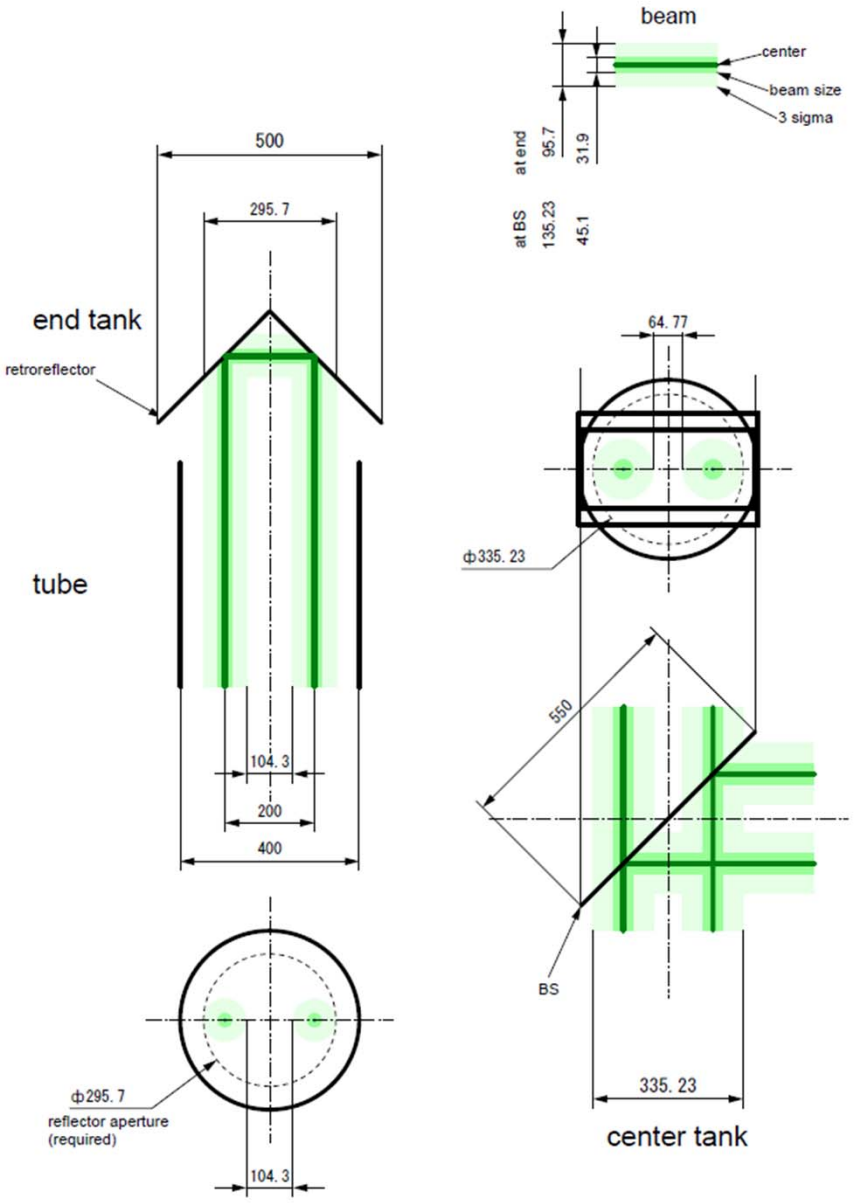
Essentially based on the current 100-m system.



Optical layout

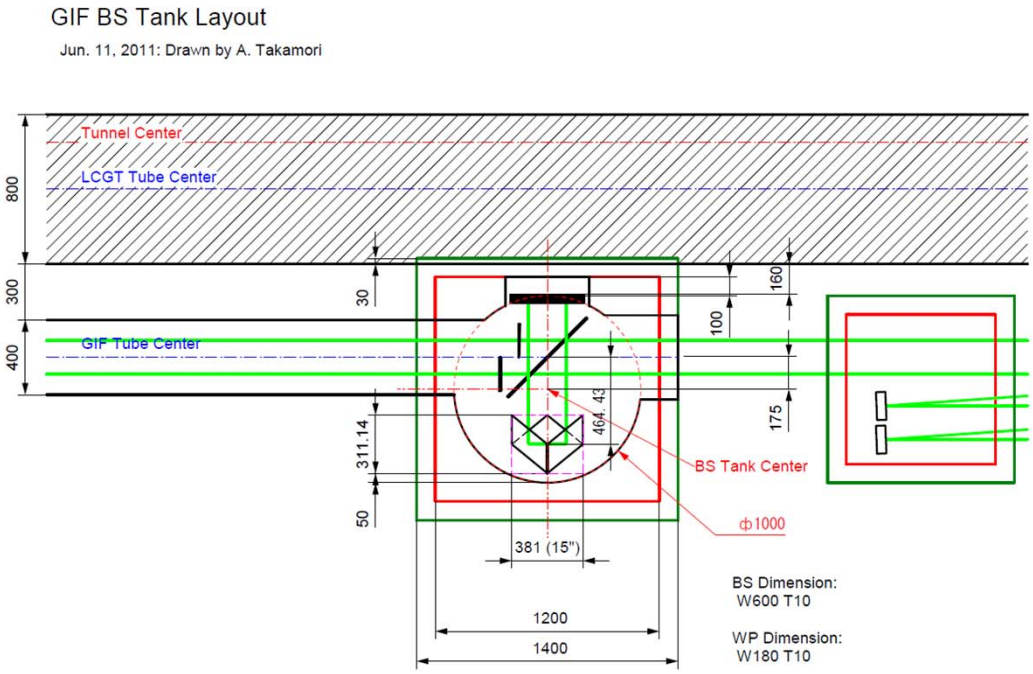
Optical parameters for
1500m baseline:
Beam diameter (waist) 32mm
Beam diameter (max.) 45mm
Visibility 0.7

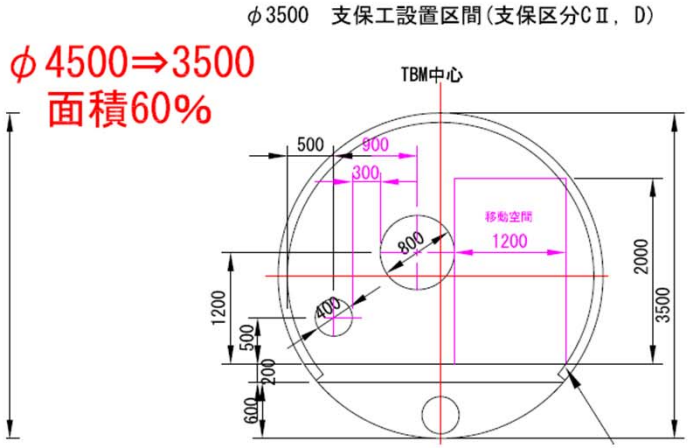
Diameter of 400mm is required for vacuum tubes.



Optical layout around the front chamber

Compatible with the TBM φ3500~4500 tunnel ->
should be redesigned for NATM tunnel



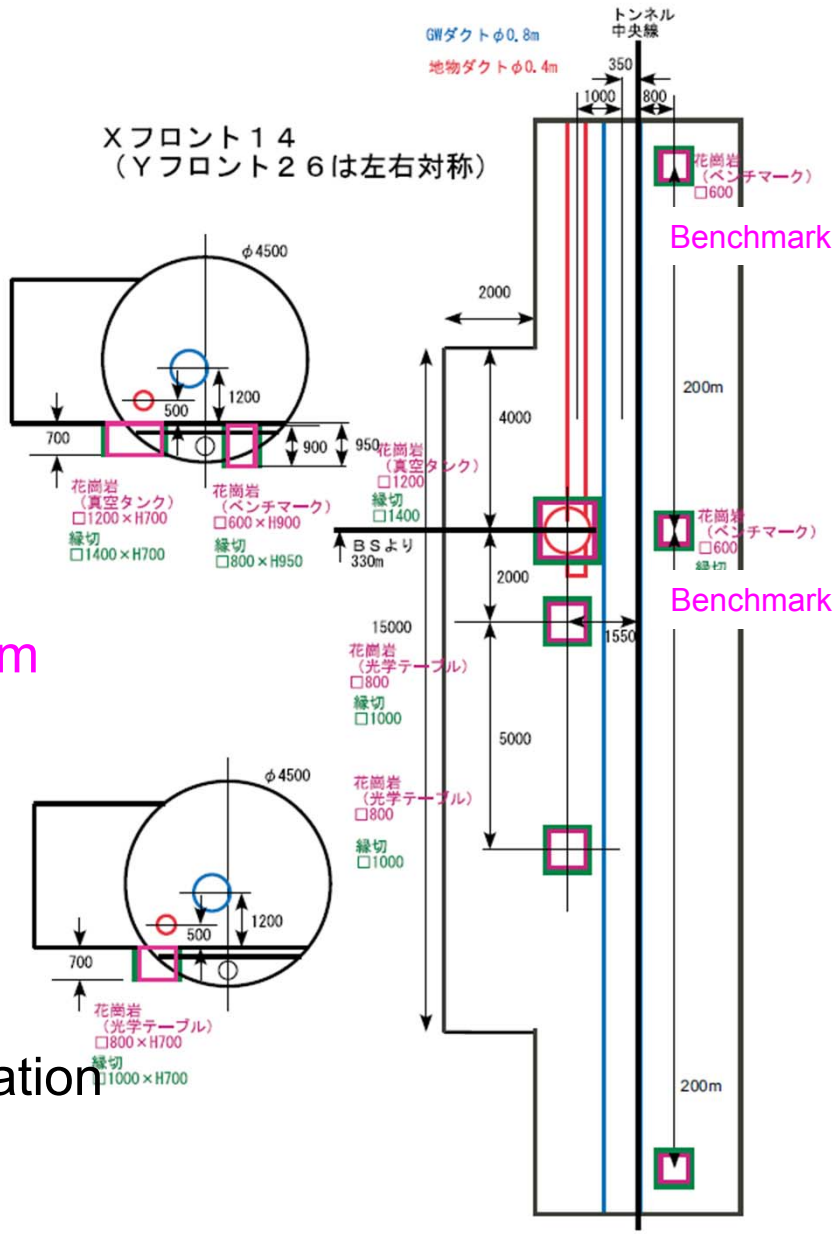


Layout of vacuum system and benchmarks

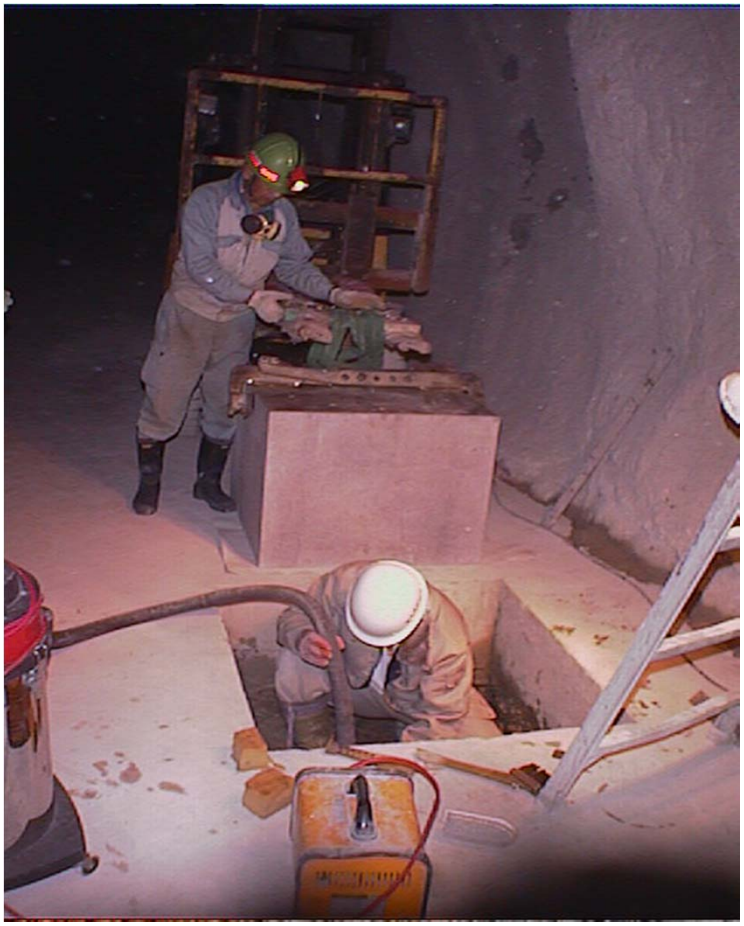
Strain sensitivity ~10^{-12}
Baseline 1.5km

Chamber diameter 1.0m
Chamber height 1.0m
installed on a granite base 1.2m x 1.2m
Vacuum pressure ~10^{-4}Pa

Granite benchmarks 0.6m x 0.6m,
200-m separation used for
1. reference of vacuum system installation
2. monitoring tunnel deformation
3. research on standard of length

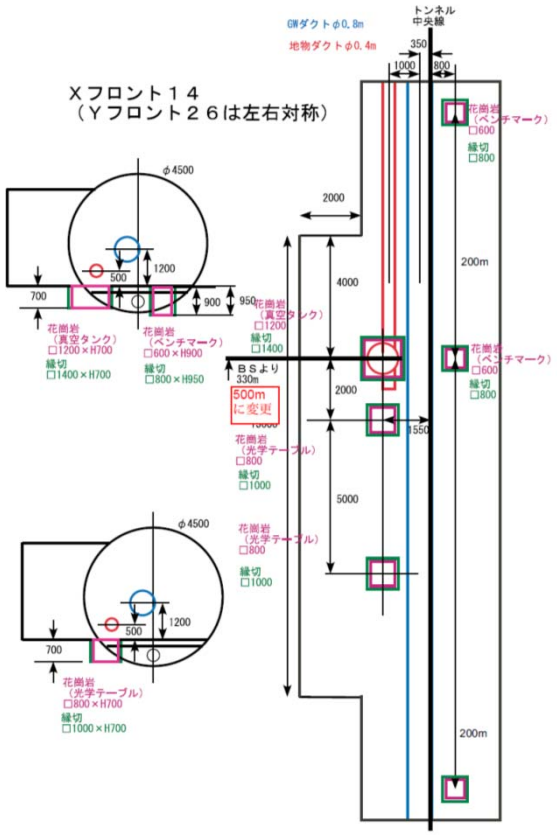


Granite base of the 100-m IFO

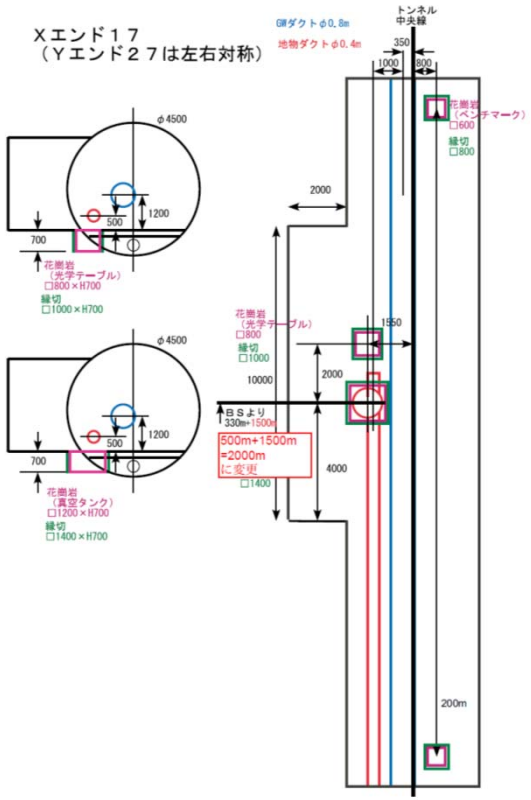


Layout of vacuum system and benchmarks

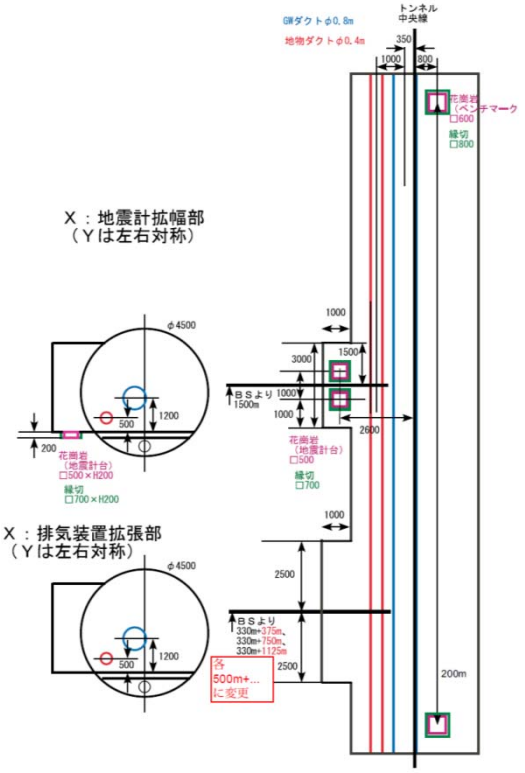
X-Front (input)



X-End (reflector)



X-Middle (seismometer)



Data acquisition system for GIF(geophysics interferometer) and EM (environmental monitor)

1. GIF-DAQ (two PXI systems) acquires GIF signals and stores the data on RAIDs through LAN. A/Ds are 24-bit 50kS/s, and are synchronized with GPS. The system also includes relay switches for controlling laser locking, etc.

2. EM-DAQ (cRIO systems) acquires EM signals and stores the data on RAIDs through LAN. The system accepts voltage and serial (RS232c) signals. Typical configuration of a cRIO system includes A/Ds (24-bit 12.5kS/s), thermo-couple modules, and a serial module. The modules may be changed upon request. The cRIO systems are planned to be arranged on 9-10 locations in the tunnel, including center/end rooms.

Data Acquisition system (GIF-DAQ)

Requirements:

>>Two systems for both interferometers

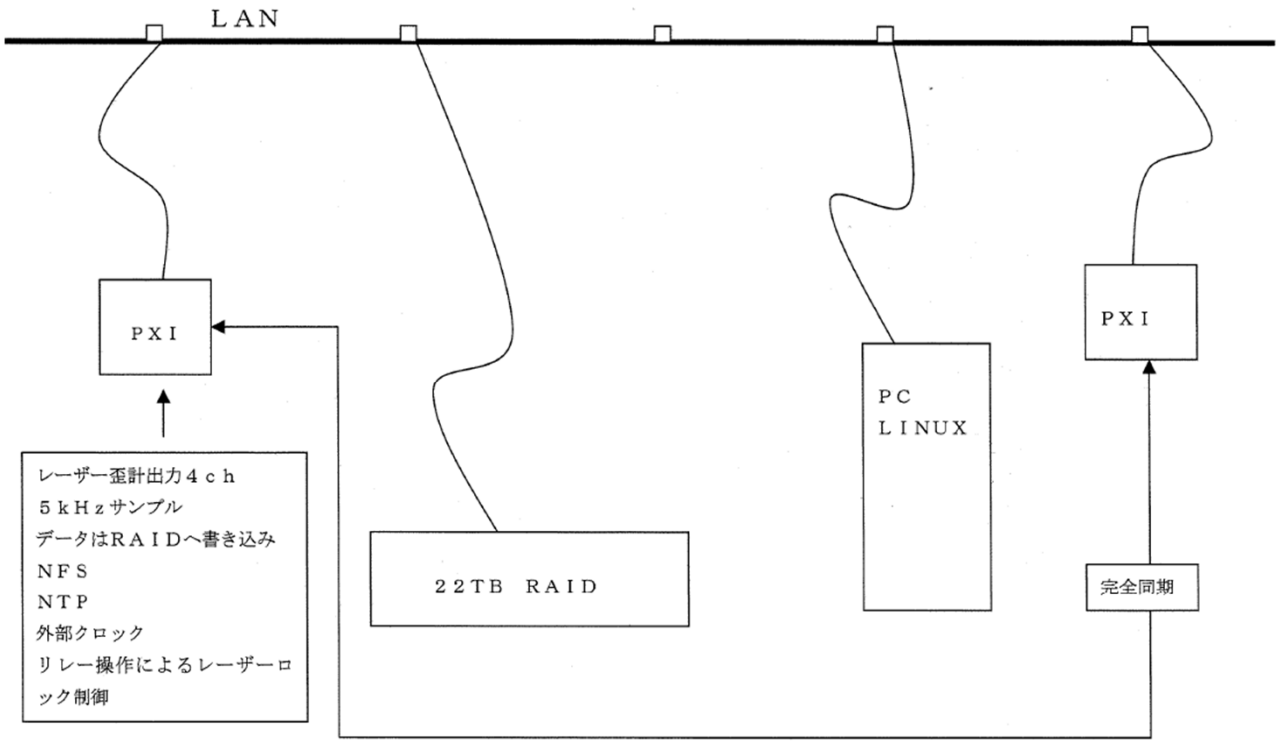
>>Synchronized sampling and time stamps
(Standard time, 1PPS, 10MHz clock)

Functions:

>>Fringe data acquisition (5kHz x 4ch for each IF)
>>Laser stabilization control (relock, remote control)
>>Data acquisition of environment-monitor sensors
>>Data sharing

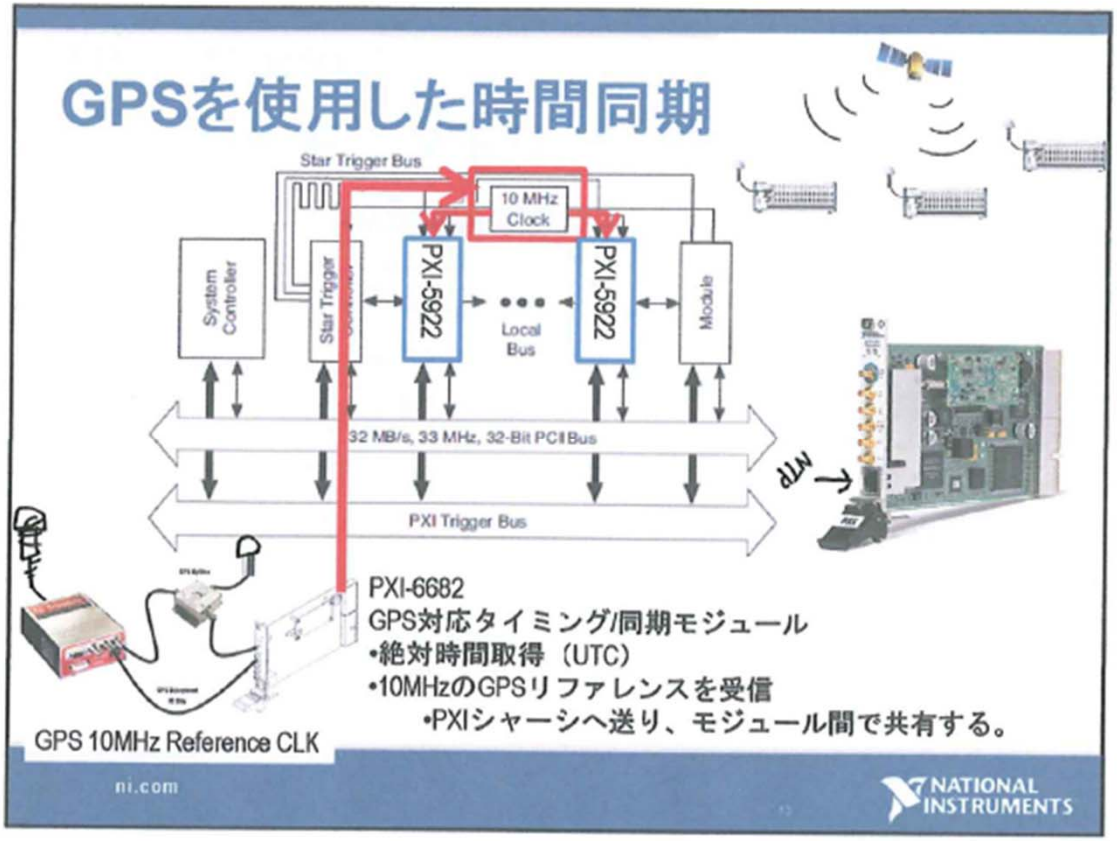
GIF-DAQ

GIF data are acquired by PXIs and stored on RAIDs through LAN.
Two PXIs are synchronized with the GPS clock.



GIF-DAQ

Synchronization with the GPS clock by PXI-5922.



GIF-DAQ

PXI modules

NI PXI-5922、可変分解能デジタイザ、2ch、32MB/ch、スペクトル計測ツールキット付

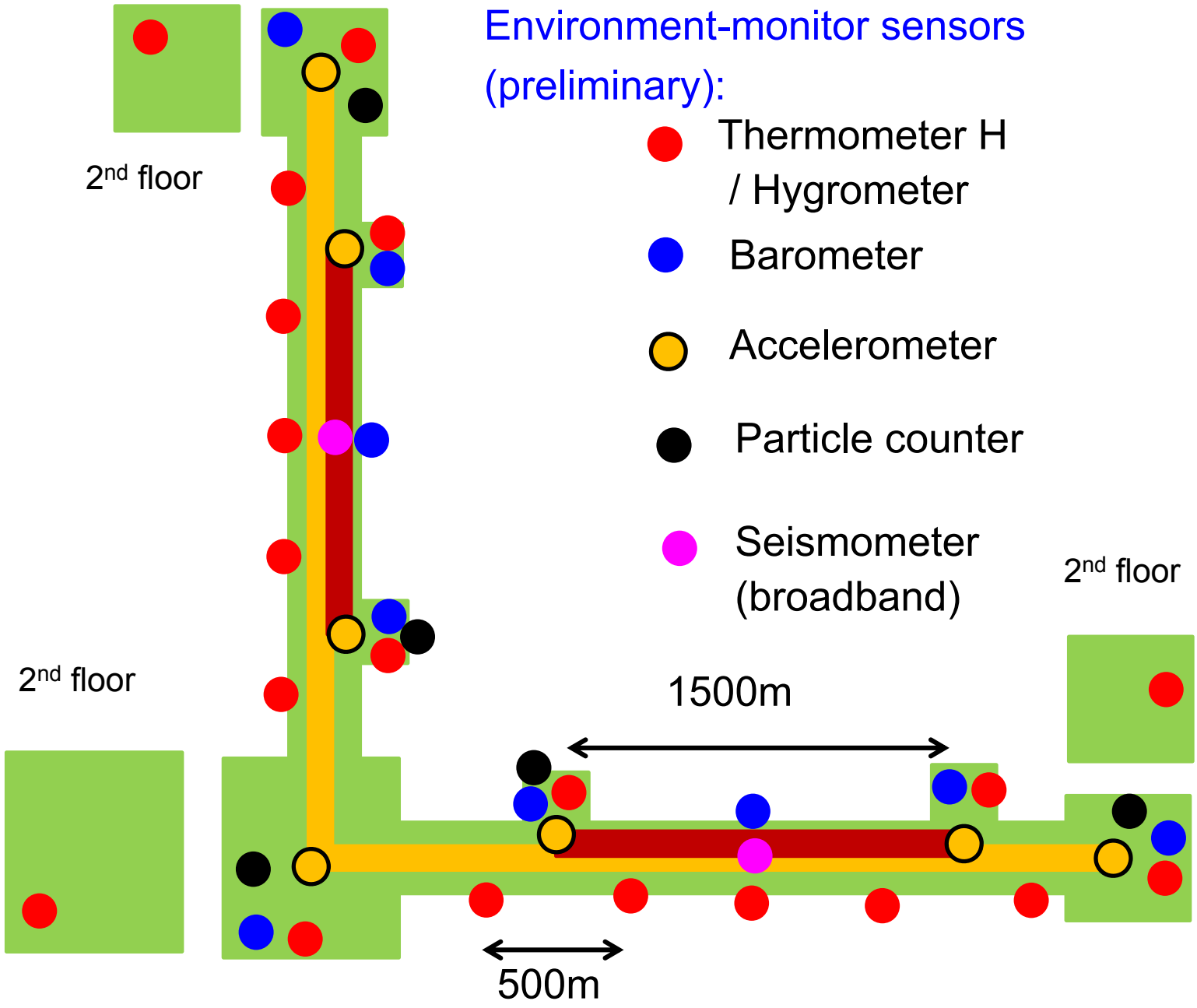
779153-02

- 24ビット（50 kS/秒）～16ビット（15 MS/秒）の範囲の分解能
- 2つの同時サンプリングチャンネル
- -120 dBFS rmsのノイズ
- 50Ω または1MΩ ソフトウェアによって選択可能な入力インピーダンス
- 全サンプリングレートに対するアンチエイリアス機能搭載
- 32MBオンボードメモリを搭載
- 最大-114 dBcのSFDR（スプリアスフリーダイナミックレンジ）

NI PXI-6682H GPS、同期/タイミングモジュール、IRIG-B および IEEE 1588 対応、TCXO

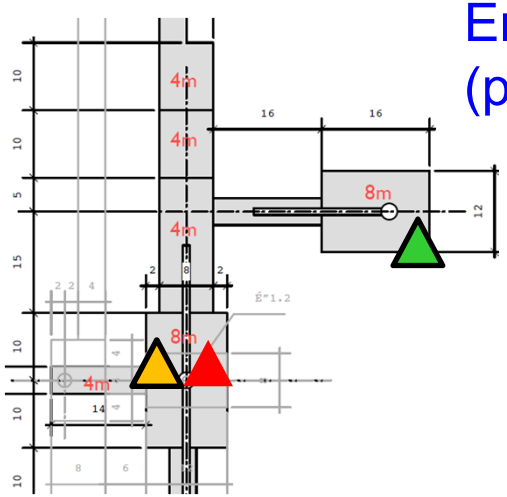
781059-01

•GPS、IEEE 1588-2008（IEC 61588:2009）、またはIRIG-Bを用いたPXIシステムの同期
•内部/外部クロックとトリガ信号をオンボードでルーティング
•アクティブGPSアンテナに対応


Environment-monitor sensors
(preliminary):
Thermometer H
/ Hygrometer
Barometer
Accelerometer
Particle counter
Seismometer
(broadband)
2nd floor
2nd floor
2nd floor
1500m
500m

Environment-monitor sensors (preliminary):

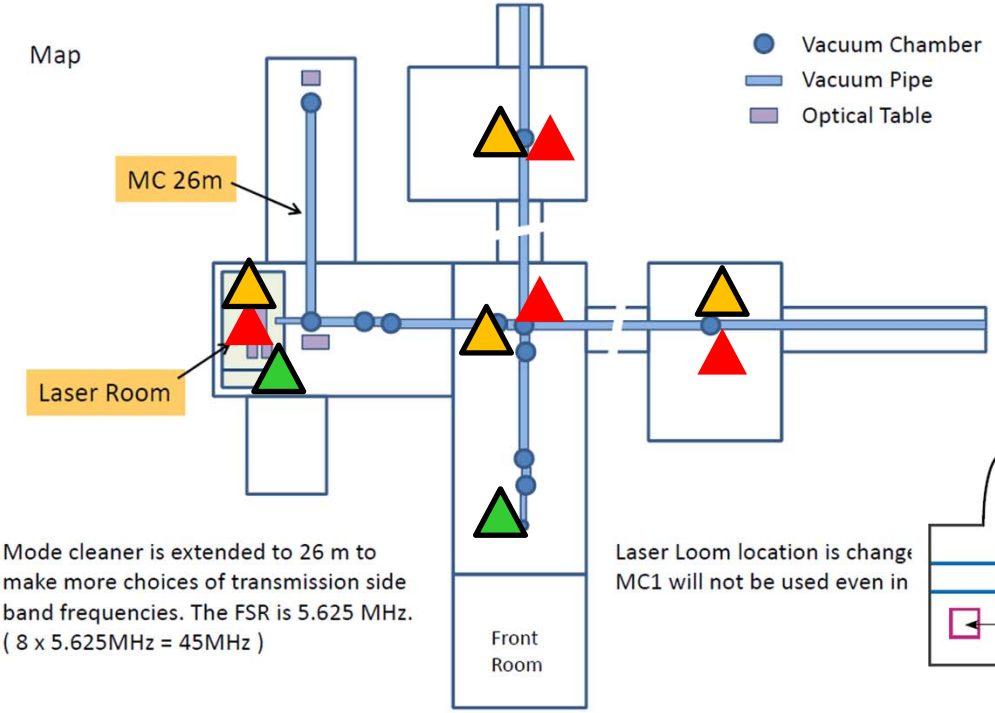
End room



Thermometer L

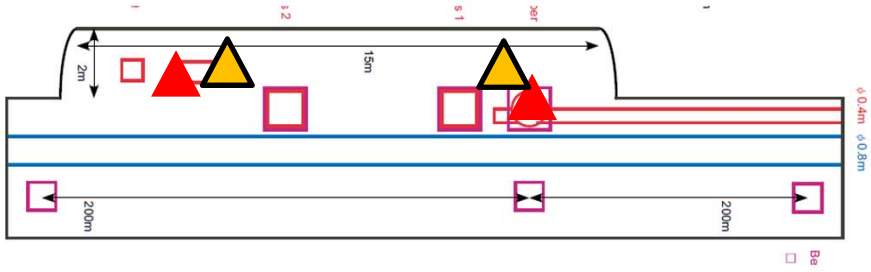
Accelerometer L

Center room



Microphone, EM sensor

Geo area



High end (absolute) Low end (relative, low resolution)

Thermometer δt~ 0.1deg

voltage

USB

δt~ 1deg

voltage

Barometer

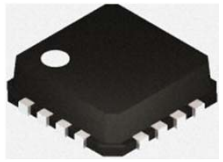
δp~ 0.1hPa

voltage/RS232c

δp~ 1hPa

voltage

Accelerometer



ICD parameters (preliminary)

Sensor	range	resolution	response
Thermometer(abs.)	-50–50deg.	0.15deg.	DC-0.1Hz
Thermometer(rel.)	-50–100 deg.	1deg.	DC-0.1Hz
Hygrometer	0-100%	3%	DC-0.1Hz
Barometer (abs.)	500–1300hPa	0.15hPa	DC-0.1Hz
Barometer (rel.)	TBD	TBD	TBD
Accelerometer (abs.)	-20-20m/s^2	1.e-5m/s^2	DC-500Hz
Accelerometer (rel.)	-50-50m/s^2	1.e-2m/s^2	1-5kHz
Seismometer	1.5e-2m/s	1.e-9m/s	4m-200Hz
Particlemeter	TBD	TBD	TBD
Microphone	TBD	TBD	TBD
EM sensor	TBD	TBD	TBD

				TU	FA	VA	VI	MI	CR	IF	DG	EL	IO	LA	AO	GI	DA
barometer	TBD		barometer resolution		FA	VA	VI			IF	DG					GI	DA
hygrometer	TBD		hygrometer resolutio		FA	VA	VI			IF	DG					GI	DA
thermometer	TBD		thermometer resoluti		FA		VI			IF	DG					GI	DA
microphone	TBD		microphone resolutio		FA		VI			IF	DG					GI	DA
particlemeter	TBD		particle meter resol	TU	FA	VA	VI			IF	DG					GI	DA
accelerometer	TBD		accelerometer resolu				VI			IF	DG					GI	DA
seismometer	TBD		seismometer resoluti	TU	FA		VI			IF	DG					GI	DA

EM-DAQ

cRIO modules (example)

環境測定装置一式

構成 ID：CR2514449 （www.ni.com/advisor/retrieve の構成内容を表示）

NI cRIO-9022、Real-Time PowerPC コントローラ、cRIO 用、533 MHz、2 GB ストレージ、256 MB DRAM

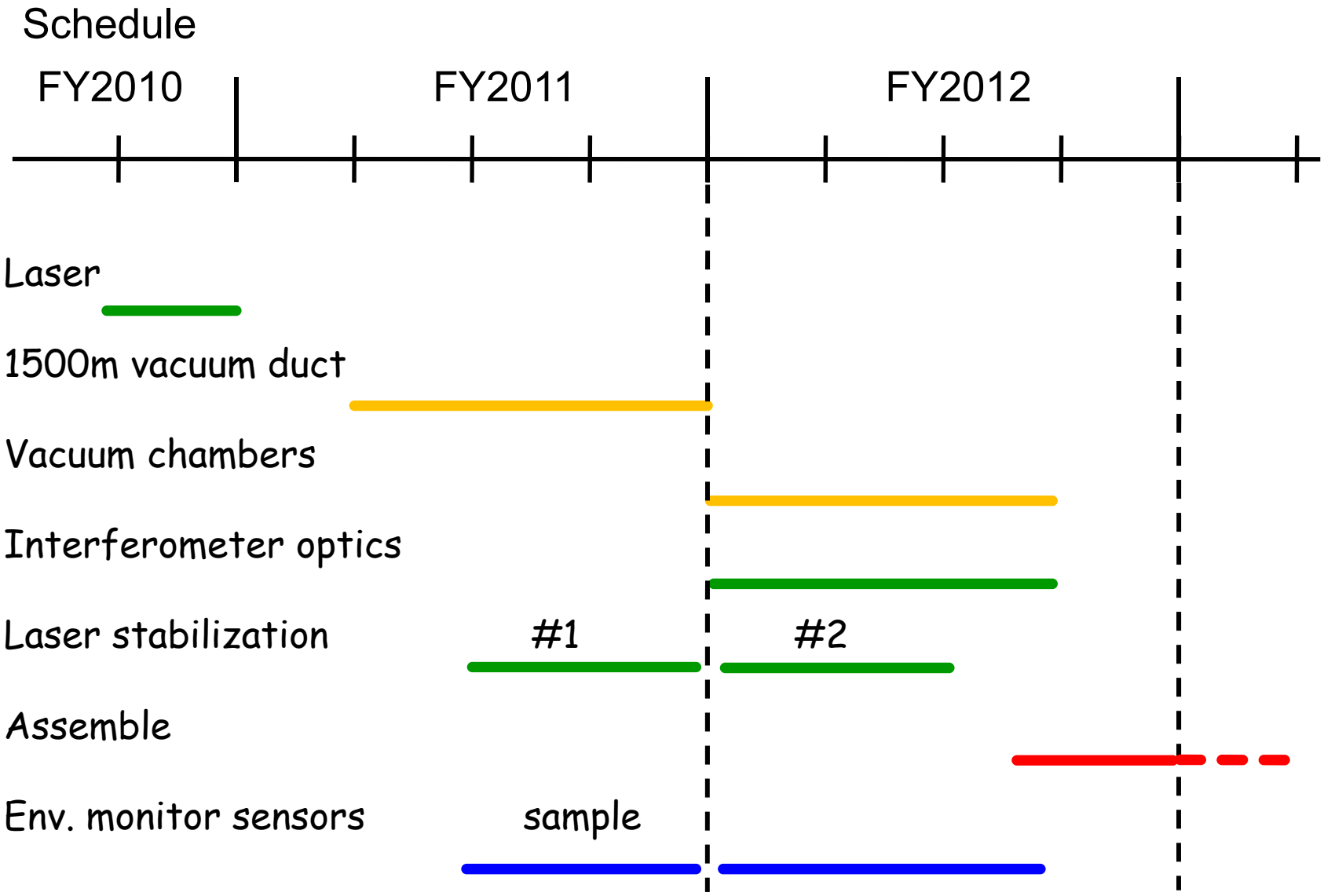
780718-01

- LabVIEW Real-TimeOSを使用し、確定性に優れた制御、データロギング、解析が可能な組込コントローラ
- 533 MHzプロセッサ、2 GB不揮発性ストレージ、256 MB DDR2メモリを搭載
デュアルEthernetポート、リモートユーザインタフェースに使用できる組込Web/ファイルサーバ
- USBフラッシュおよびメモリデバイスとの接続のためのHi-Speed USBホストポートを搭載
- 周辺デバイス接続用のRS232シリアルポート、9～35 VDCデュアル電源入力
- 動作温度範囲：-20～55ºC

NI 9239、絶縁アナログ入力モジュール、[4ch、±10 V、 50 kS/S/ch、24ビット]

779593-01

- 250 V（実効値）チャンネル間絶縁
- 50 kS/秒/chの同時サンプリング入力
- アンチエイリアスフィルタ搭載
- ±10 Vの入力範囲


Schedule
FY2010
FY2011
FY2012
Laser
1500m vacuum duct
Vacuum chambers
Interferometer optics
Laser stabilization
#1
#2
Assemble
Env. monitor sensors
sample

Φ400-mm vacuum pipes are in production

Milestones (Geophysics interferometer)

		related sub-groups
2012.3	vacuum pipes delivery	Vacuum
	optics final design	Tunnel
	EM sensor determination	Det Char
2012.9	vacuum valves / pumps delivery	Vacuum
	infra specification (clean booth, LAN)	Fac. Sup.
2013.3	optical components delivery	
	vacuum components delivery	Vacuum
	EM sensors delivery	Det Char
(2014.3)	tunnel excavated	Tunnel
2014.6	vacuum & granite base installation	Vacuum/ Fac. Sup.
2014.12	vacuum installation	Vacuum
2015.3	optics installation	
	EM-DAQ operation	Det Char
2015.6	test observation start	
	safety management	Fac. Sup.
2015.9	observation & maintenance	
(2018.3)	bLCGT	