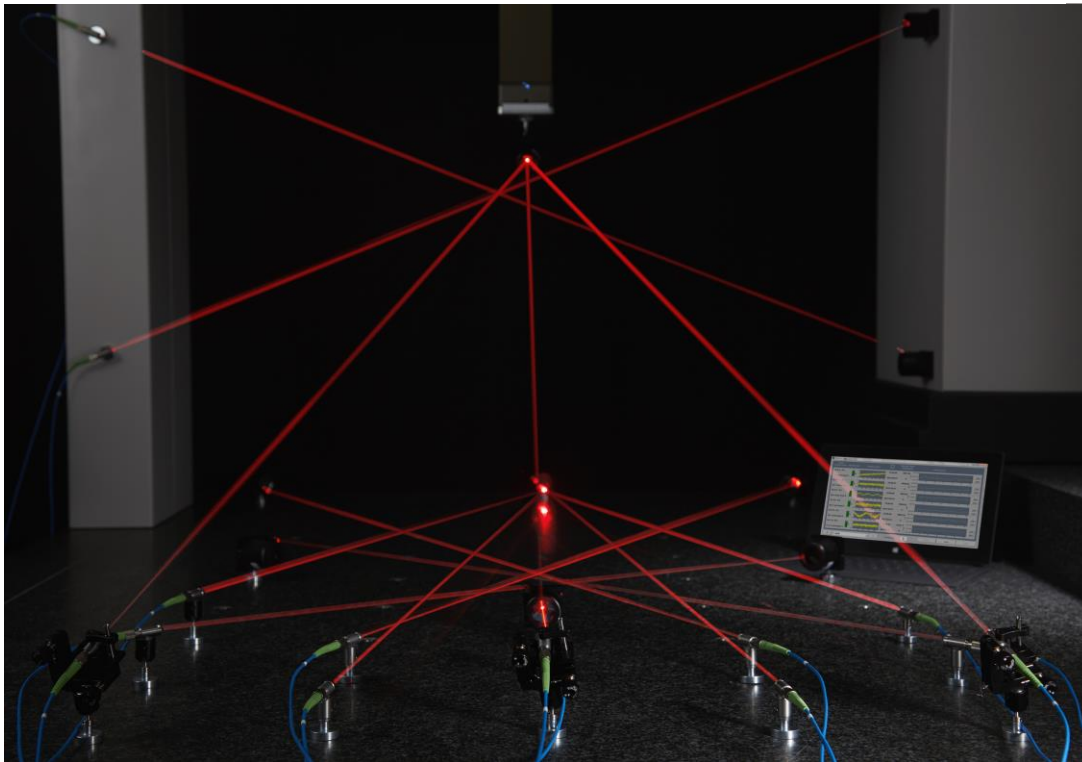


Absolute Multiline-Technology

Applications and new developments





Etalon AG

- Founded 2004 as a spin-off of PTB in Braunschweig / Germany
- Specialized in Interferometric measurement and calibration of machines and structures
- Worldwide customer base in industry and research
- Today 20 people, 70 % Master / PhD
- 2016 subsidiary in the US (Seattle) established

Etalons product line



LaserTRACER-MT

Calibration of 5 axis machine tools: Accurate, complete and fast



LaserTRACER-NG

Calibration of CMM and machine tools with sub-micron accuracy



Absolute Multiline Technology

Absolute multi-channel interferometry for monitoring and deformation analysis

Absolute Multiline[®]-Technology

- Absolute interferometer
- Central unit with up to 88 independent channels
- Measurement uncertainty (95%) : 0.5 $\mu\text{m}/\text{m}$
- Measurement length up to 20 m
- Simple measurement channel consisting only of telecom fiber, collimator and triple reflector (no electrical systems at detector)
- Almost unlimited fiber length possible (several kilometers)
- Eye save infrared radiation
- Metrological stability by gas absorption cell
- Usable in vacuum and cryogenic applications
- **No real-time capability !**



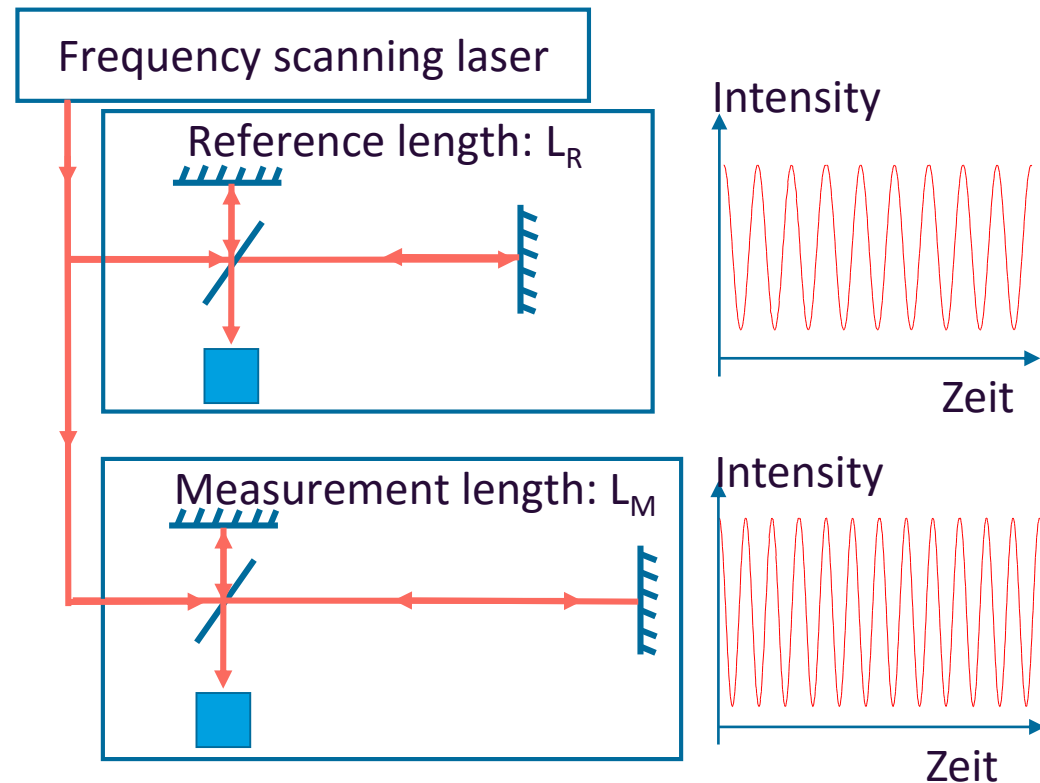
Classical “frequency scanning interferometry”

- Laser is modulating its wavelength and is generating interferences on measurement arm and reference arm.
- Number of fringe counts depends on the measured distance
- Phase of interference is evaluated

$$\frac{\Delta Phase_M}{\Delta Phase_R} = \frac{L_M}{L_R}$$

Main restrictions:

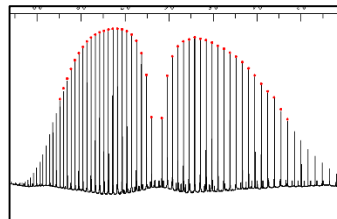
- Motion of target is degrading the measurement accuracy
- Reference length must be known and long term stable



Extensions “Absolute Multiline Technology”

1. Integration gas absorption cell

- Stable wave length reference
- Reference length can be determined
- Source of metrological traceability

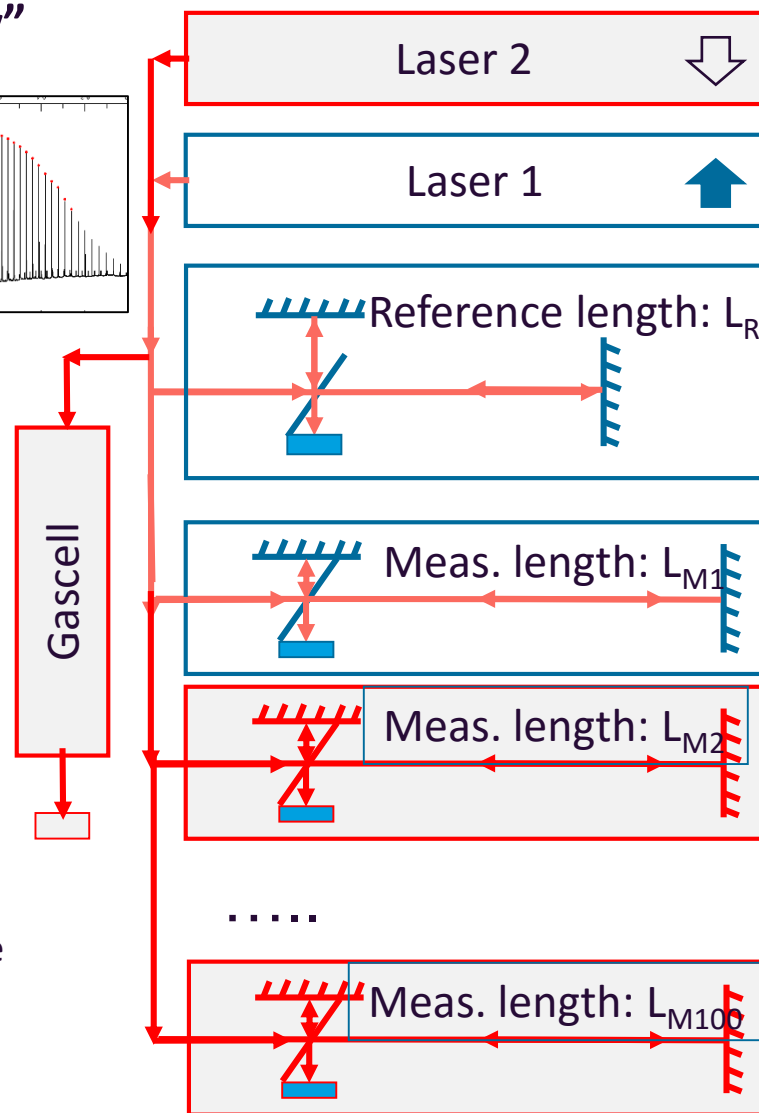


2. Second Laser with inversed scanning direction

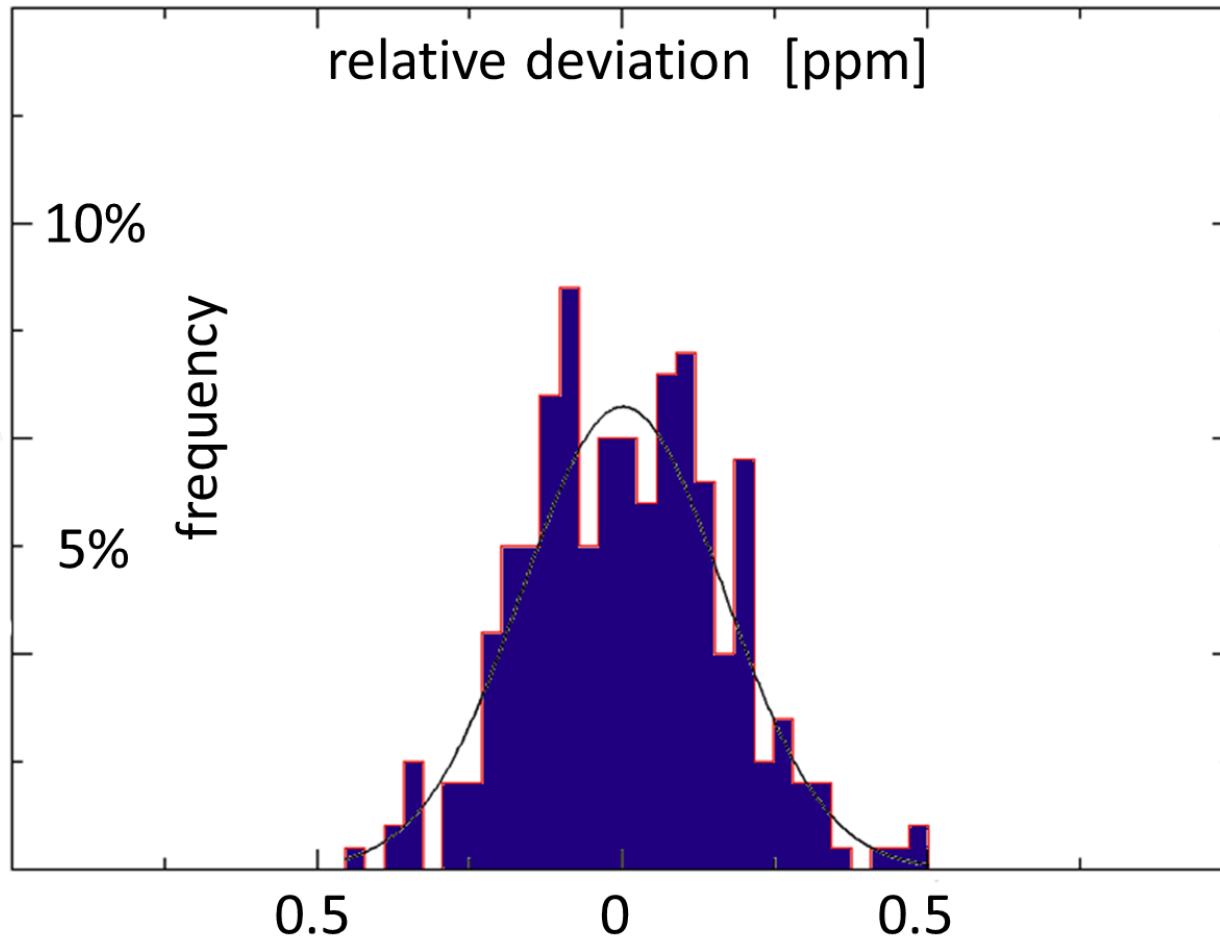
- Motion of target during the shot can be measured -> Motion of target does not degrade measurement accuracy

3. Integration of an optical signal distribution

- Distribution of the signal to multiple measurement lines
- Simultaneous measurements on all channels possible
- Telcom Technology

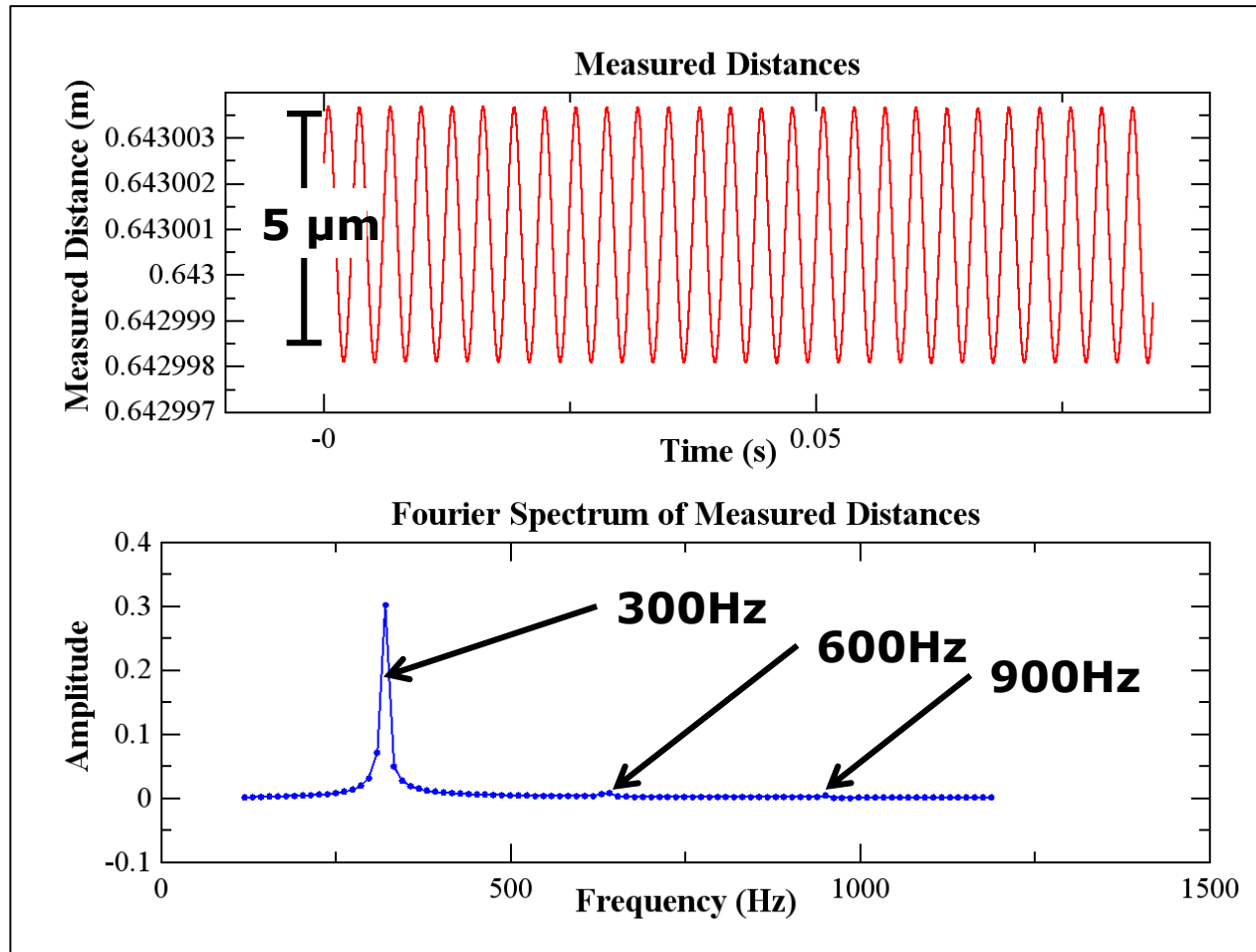


Relative deviation between 0.2 m and 20 m



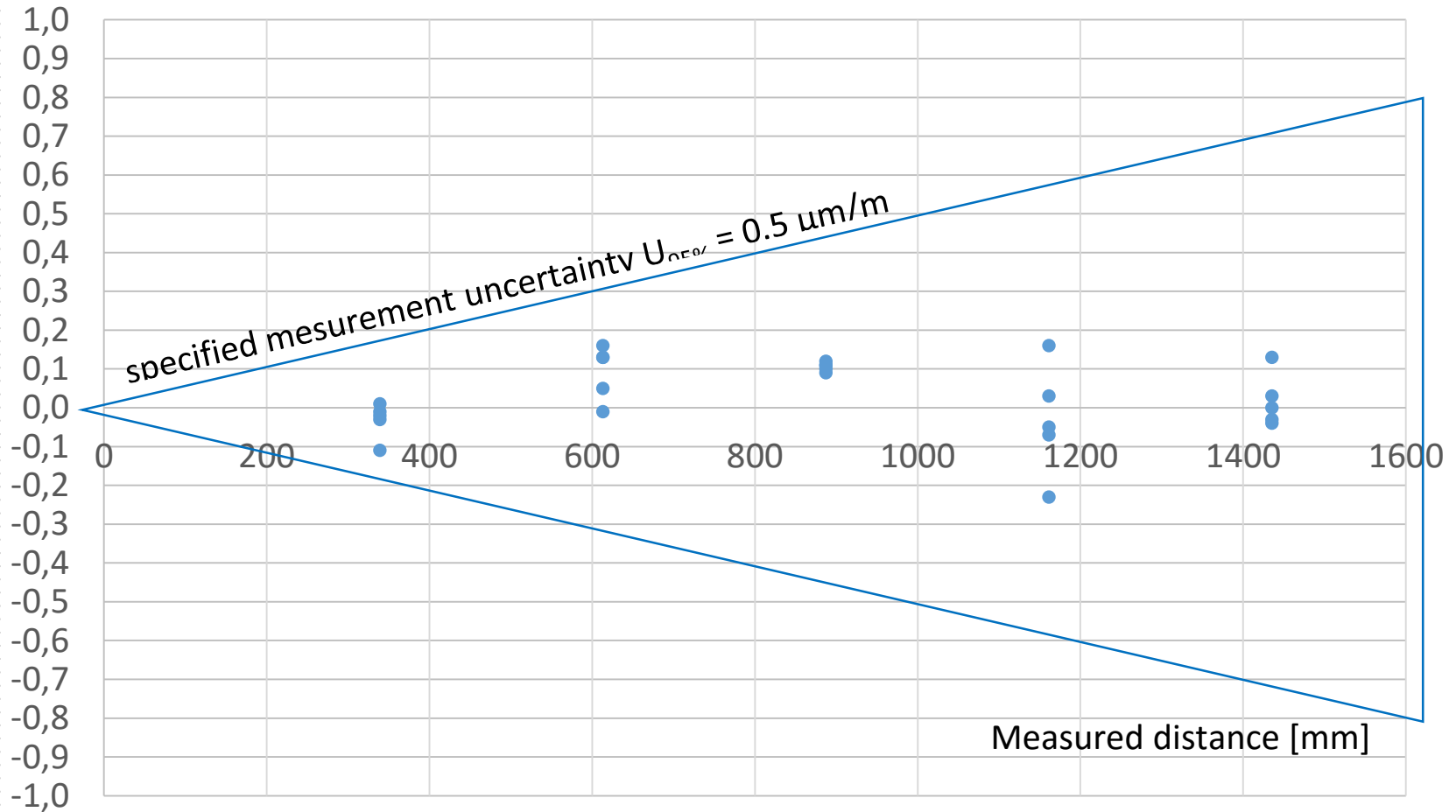
Relative standard deviation = 0.17 ppm

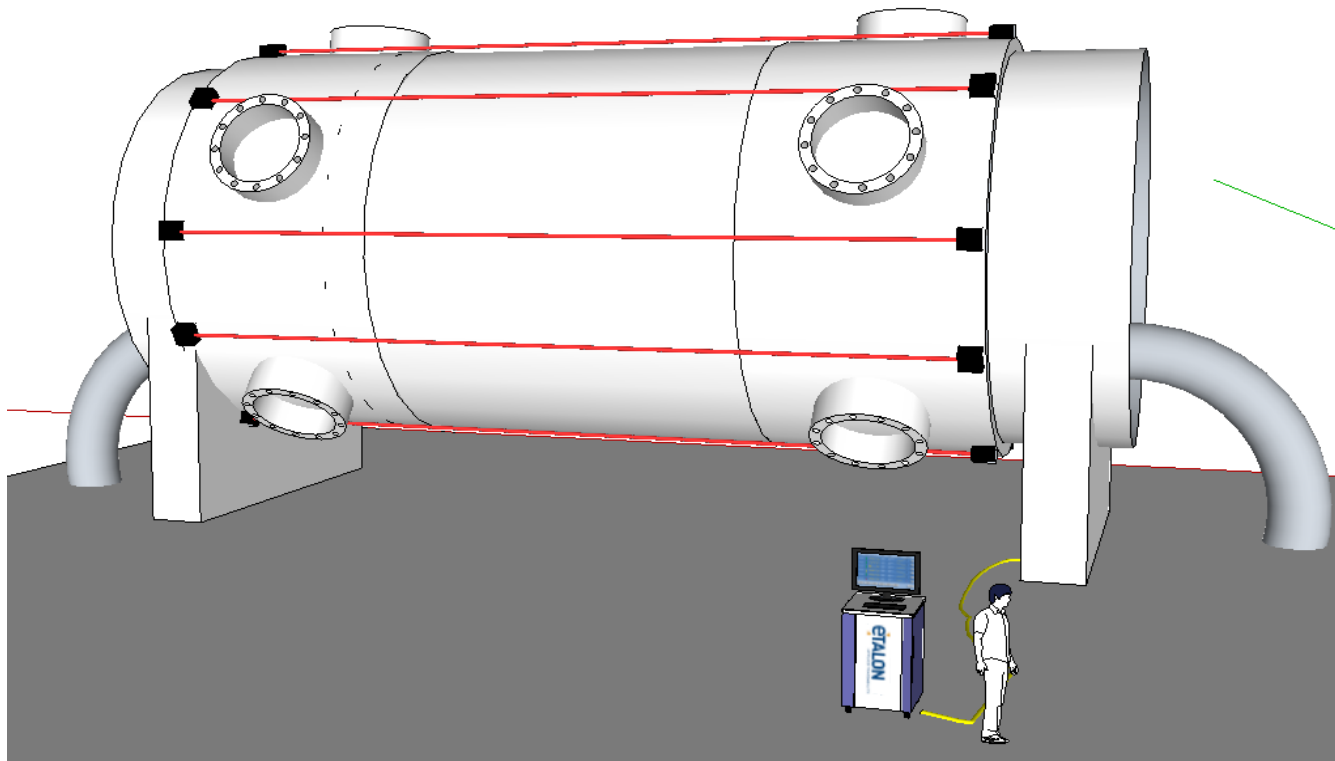
Monitoring of a vibrating target



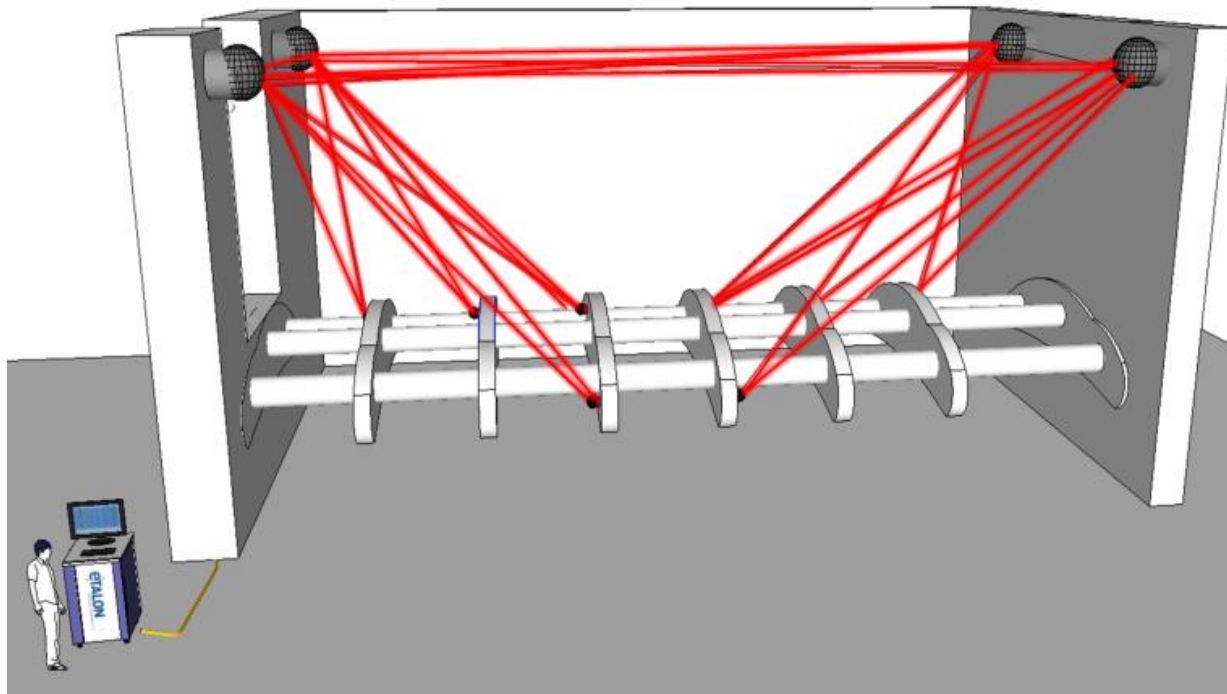
Deviation [μm]

Deviation to reference interferometer

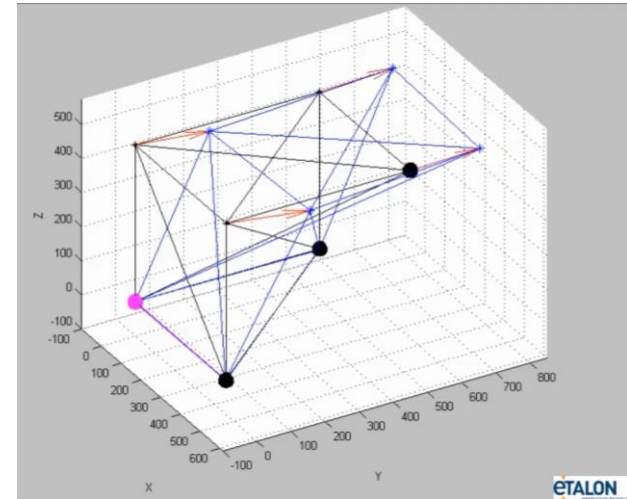
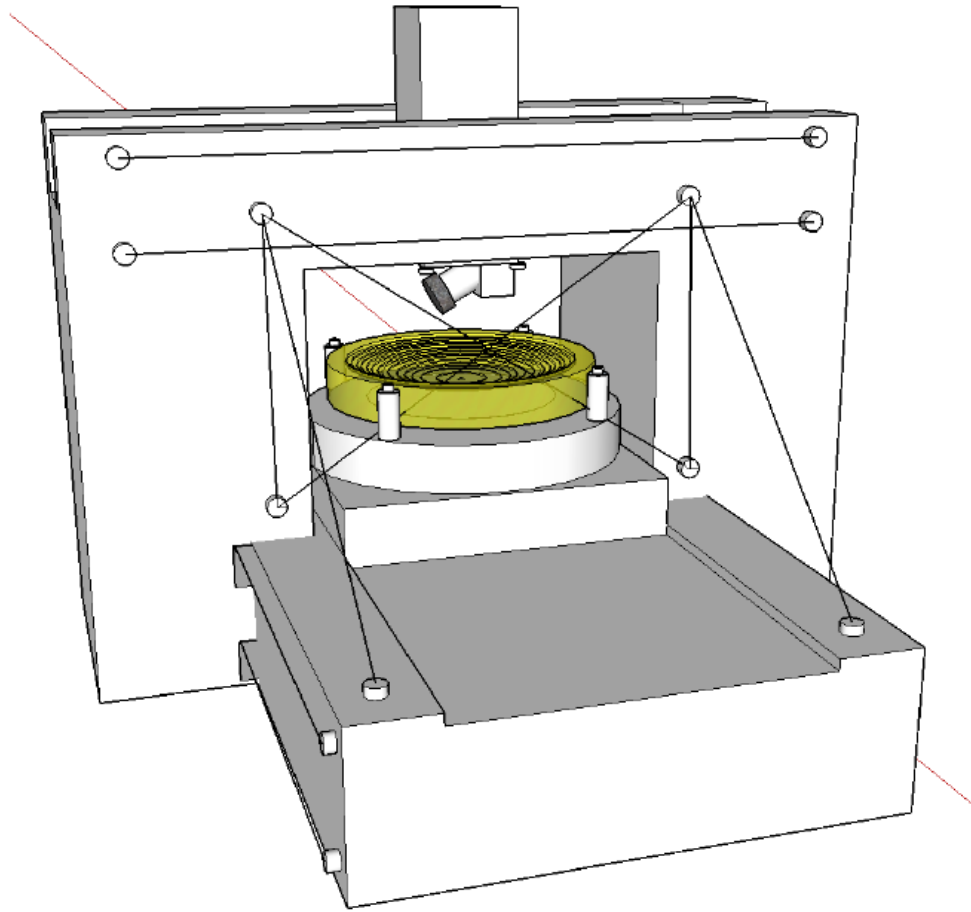




Application : Deformations and vibration on mechanical systems



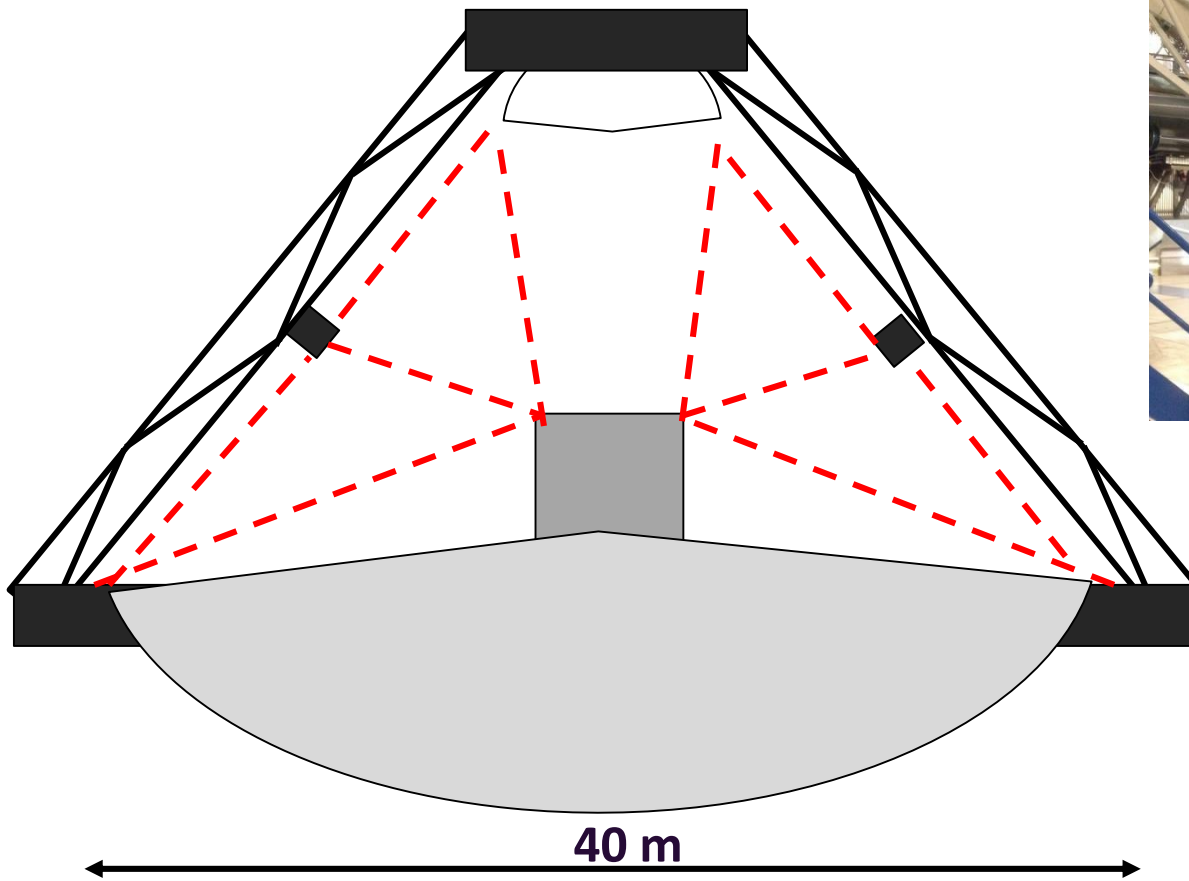
Application: Geometrical control of rigs and fixtures



Application: monitoring of machine deformations

(a) while machine development and testing

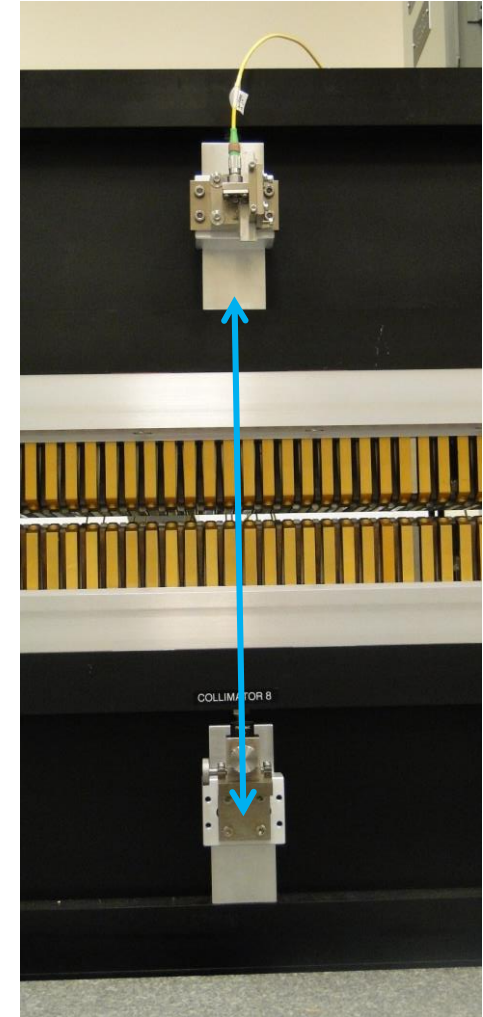
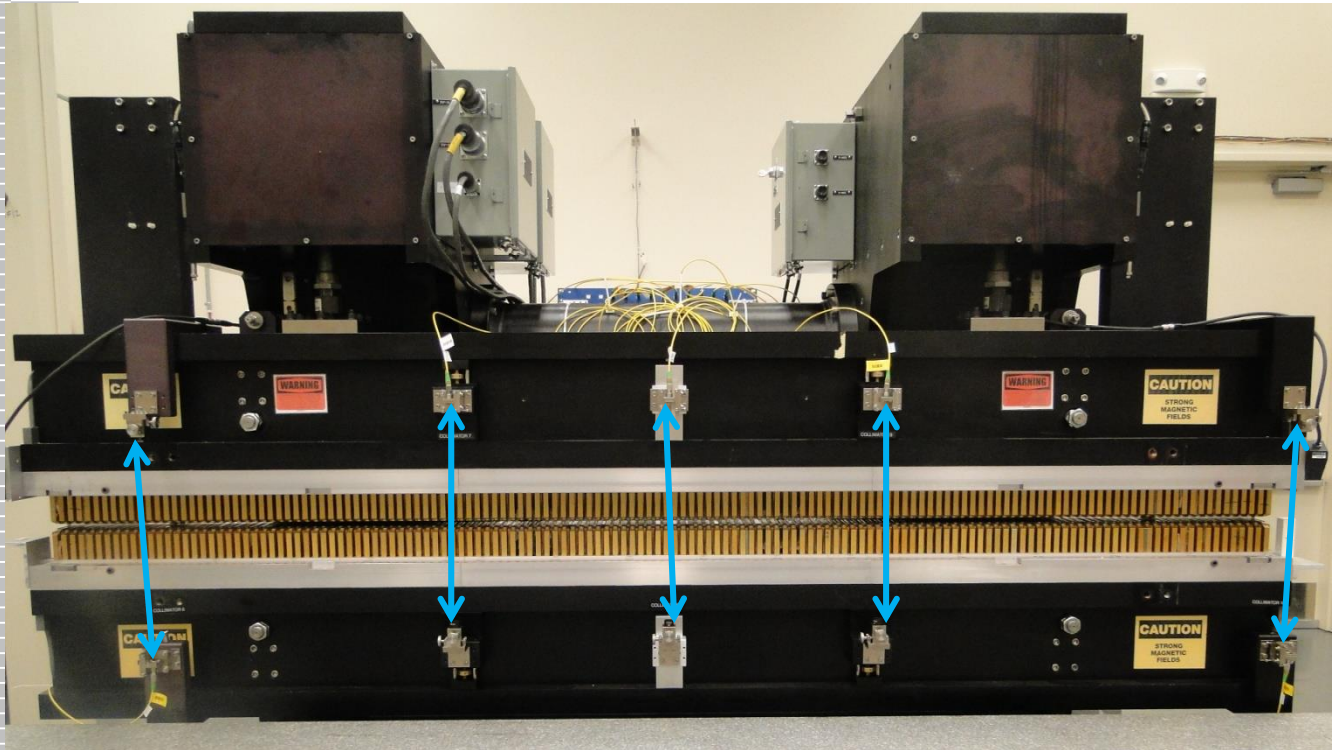
(b) constantly integrated in machine structure



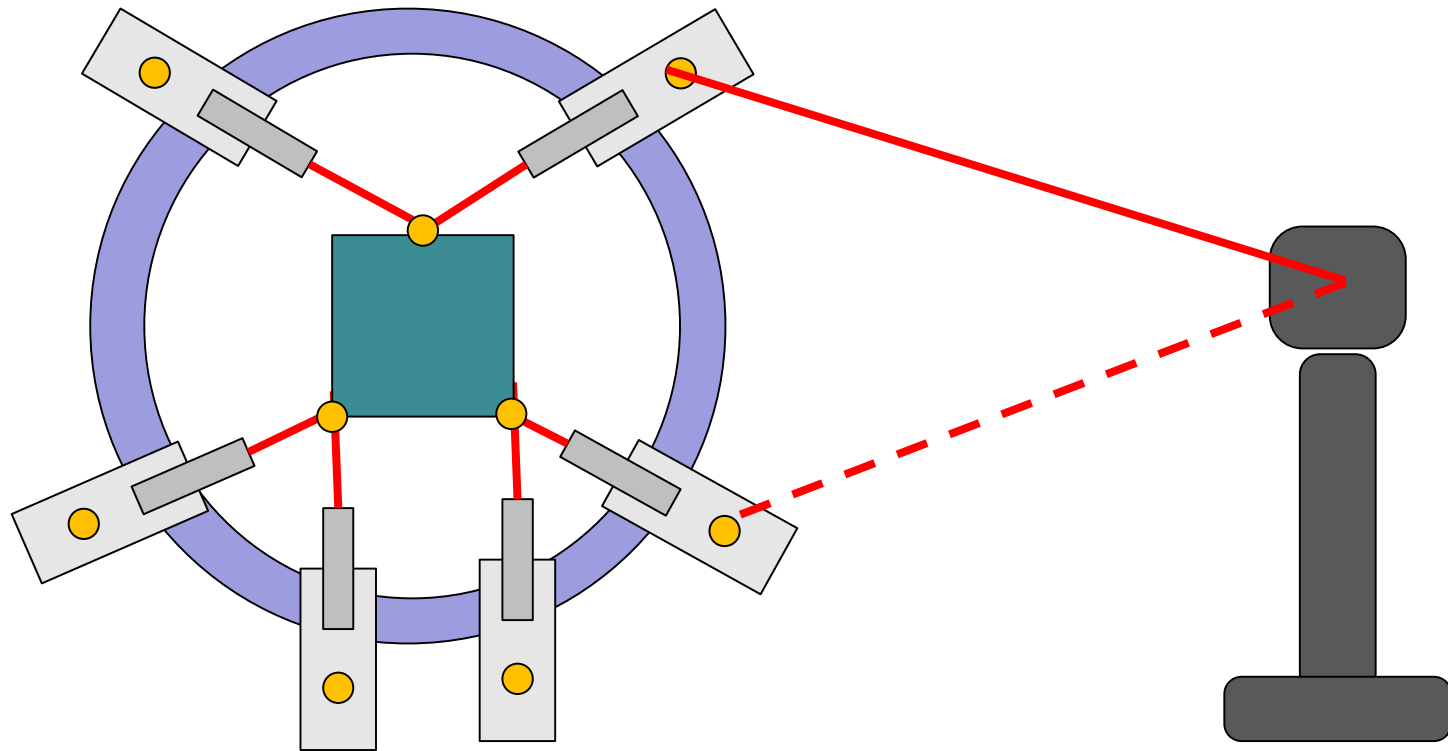
Application: Alignment and monitoring of Telescope structures



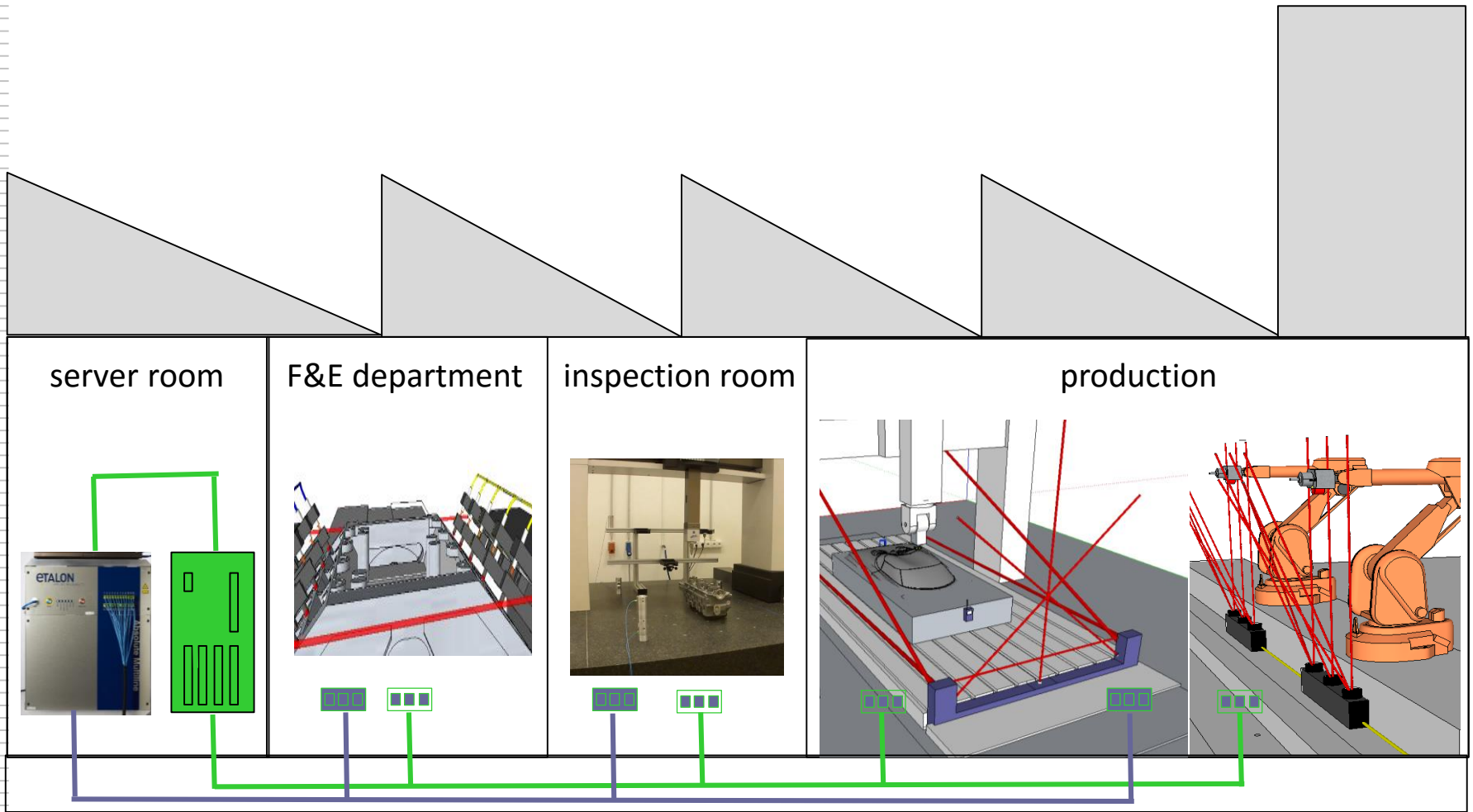
LCLS Variable Gap Undulator



Application: Deformation measurement on undulator (SLAC)

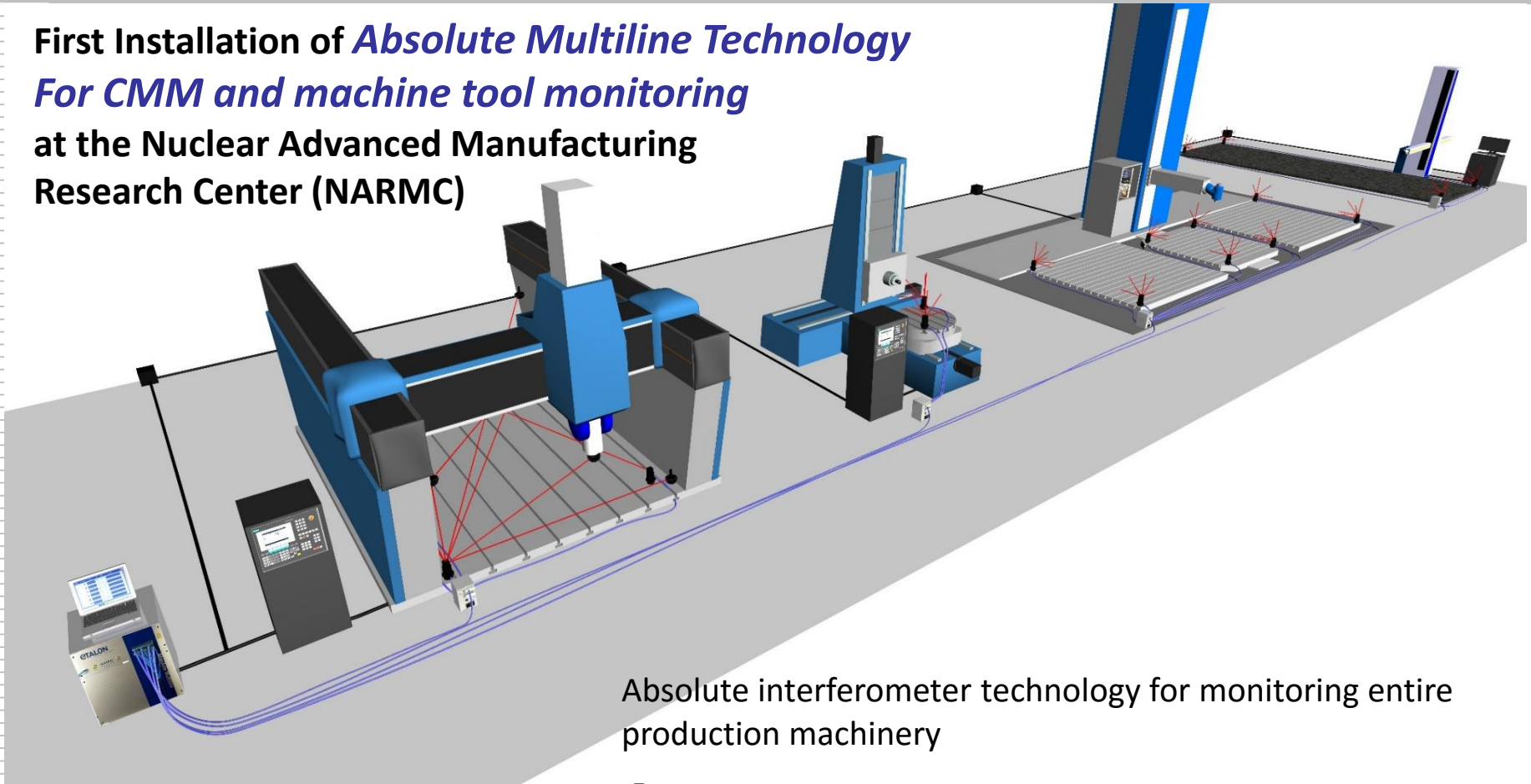


**Application: Alignment and monitoring of components in vacuum/
cryogenic/radioactive environment**



Application: Facility wide metrology system for central traceability in all areas

First Installation of *Absolute Multiline Technology*
For CMM and machine tool monitoring
at the Nuclear Advanced Manufacturing
Research Center (NARMC)

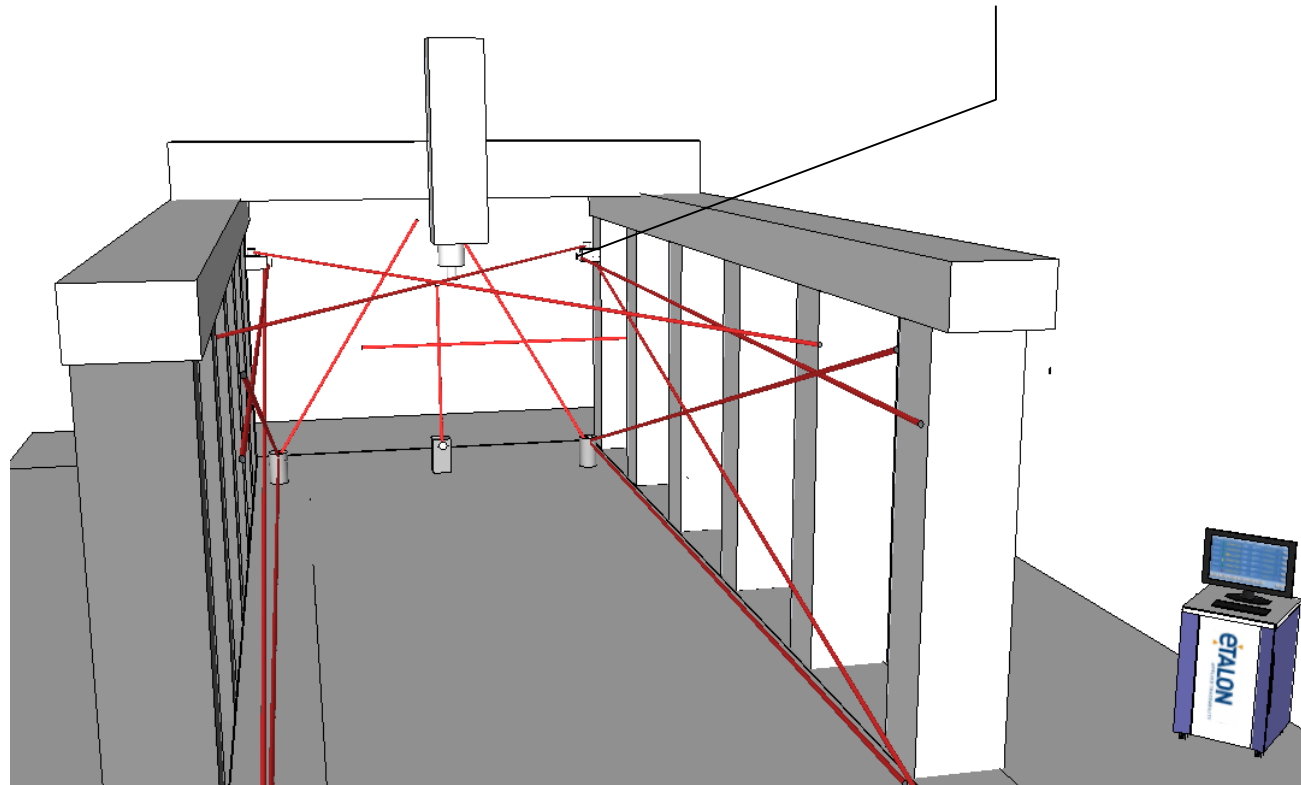


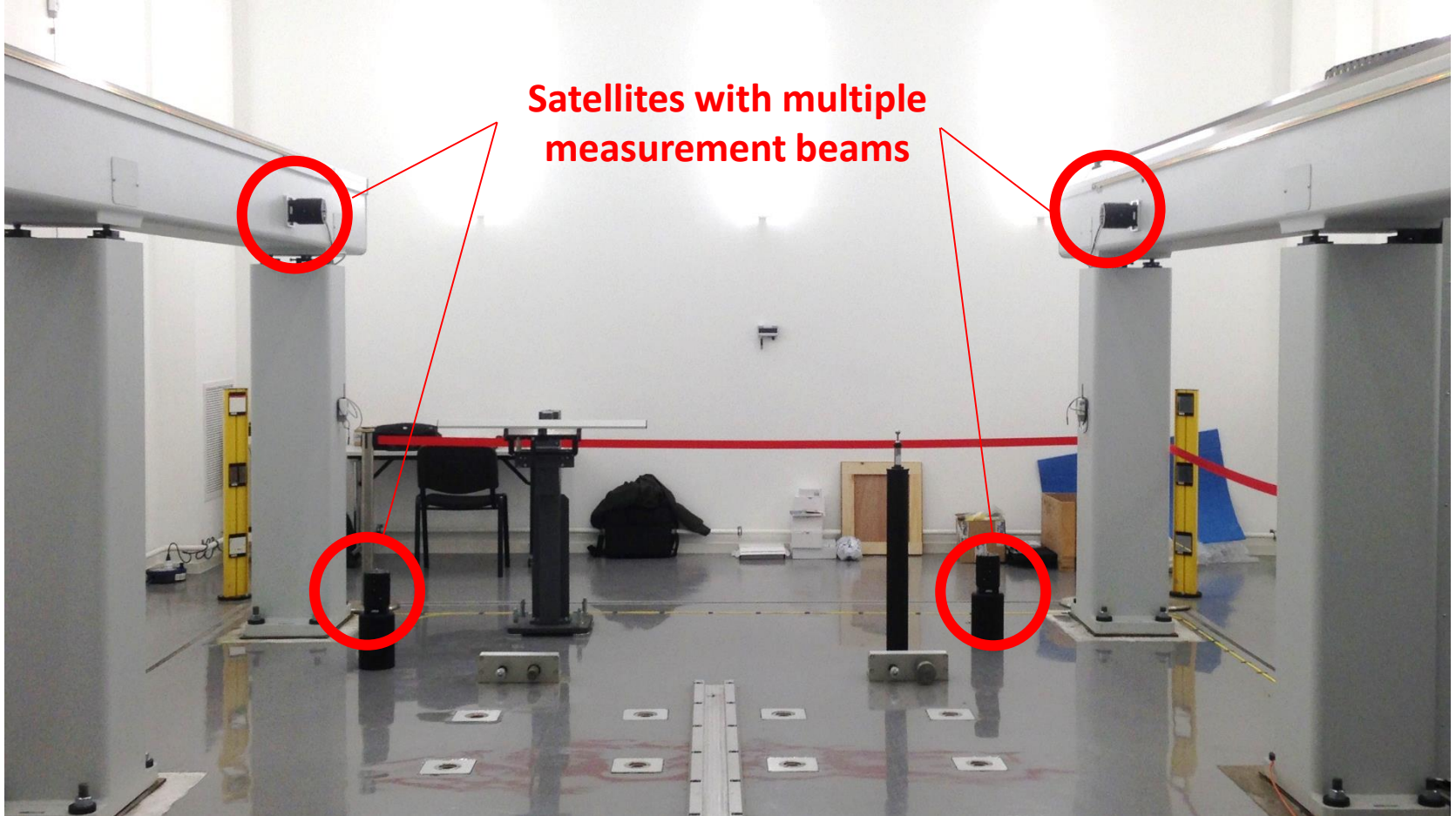
Absolute interferometer technology for monitoring entire production machinery

- ➔ Geometry of all machines under control (CMM and MT)
- ➔ Reliability of production increased
- ➔ **Quality inspection of parts can be done on machine tool**

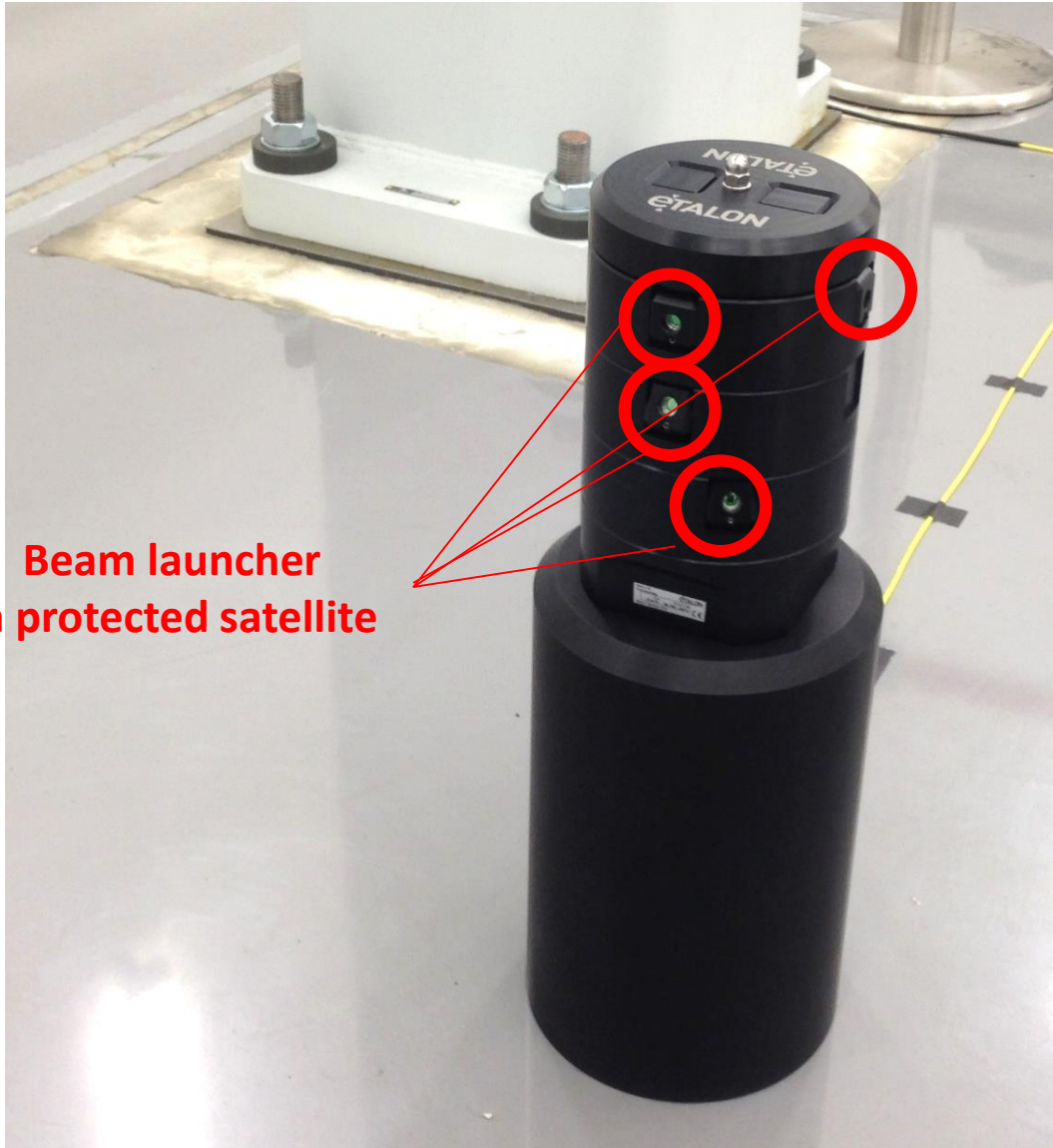
Example: Monitoring of a bridge type machine

Permanently mounted
beam launchers





Satellites with multiple measurement beams



**Beam launcher
In protected satellite**

Features of the 2nd generation Absolute Multiline System

Characteristic	1st generation	2nd generation
Sampling electronics	custom build	μTCA with custom build analogue RTM
Sampling rate	2.7 MHz	125 MHz
Data transfer	USB 2	10 Gbit Ethernet
Uncertainty	U(95%)= 0.5 ppm	U(95%)= 0.3 ppm
Channels per extension board	16	12
Maximum distance	20 m	> 30 m
Maximum measurement channels	88	124
Measurement and Evaluation	sequential	parallel

Summary

- Etalons Absolute Multiline Technology offers unique possibilities for monitoring and alignment tasks in physics and precision engineering
- Various applications have been identified and presented
- Facility wide networks of interferometer channels including TCP/IP controlled switches are possible
- 2nd generation will introduce new performance specifications



**Business
Partner**

Solution Partner

Automation

SIEMENS

