Requirements on ECAL Monitoring Laser Installation at USC55

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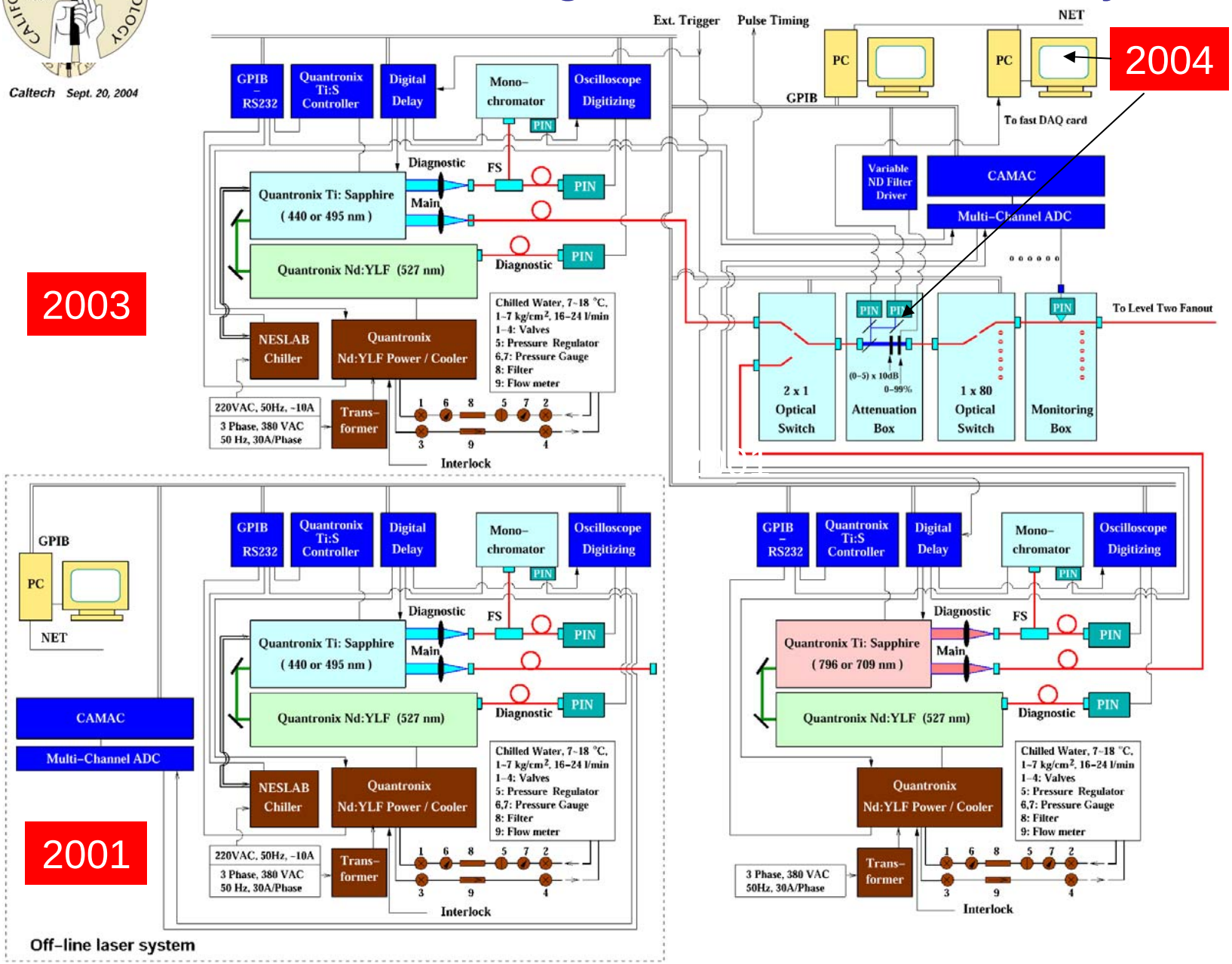
Introduction

- The ECAL Monitoring laser light source was designed and constructed at Caltech, and has been installed and commissioned at CERN.
- While laser system worked flawlessly in 2003, it experienced some degradation of performance and damaged optics in 2004, which was attributed to the instability of the temperature in laser barracks and the dirty environment at H4.

Lasers and High-level Distribution System

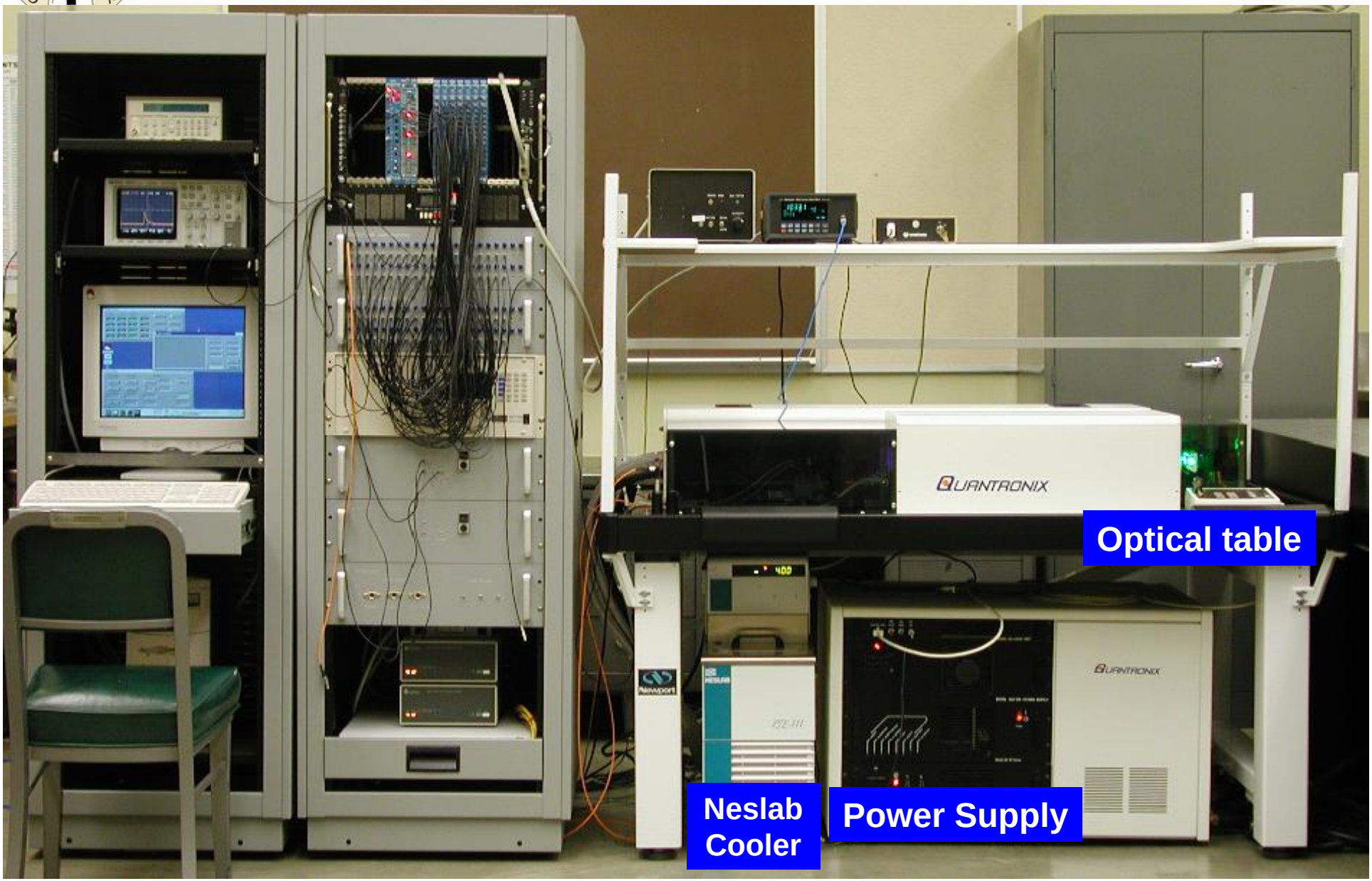
Caltech Sept. 20, 2004



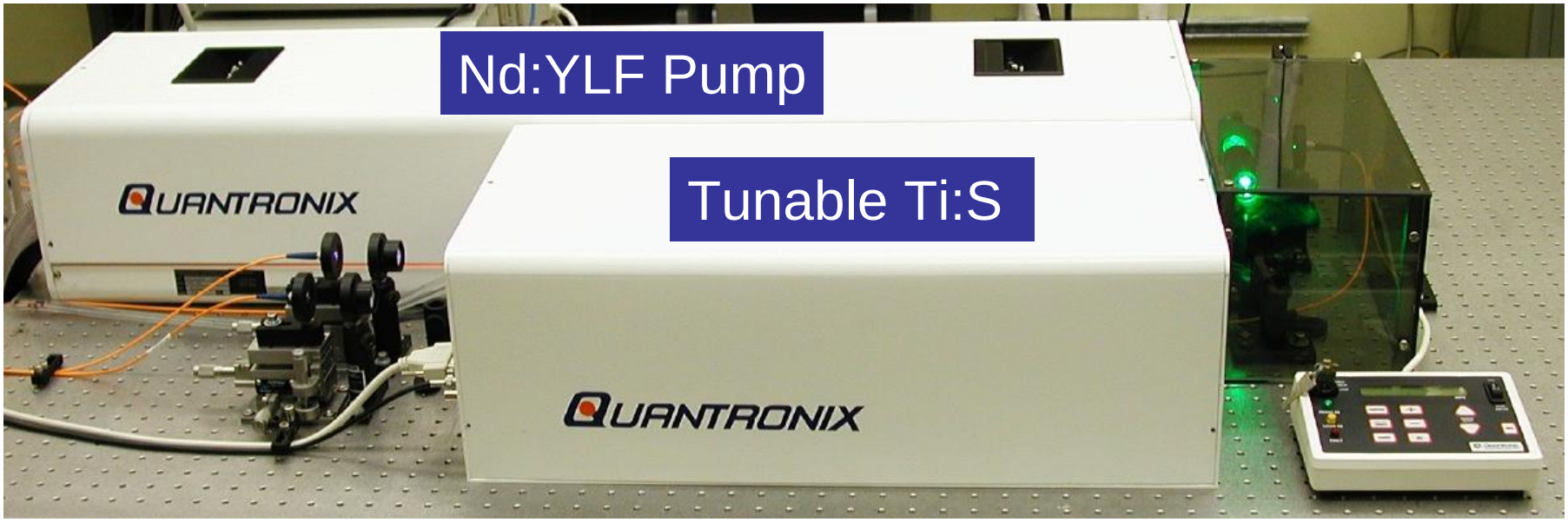
The 1st laser system was Installed in 2001, and used in 2002 beam test.

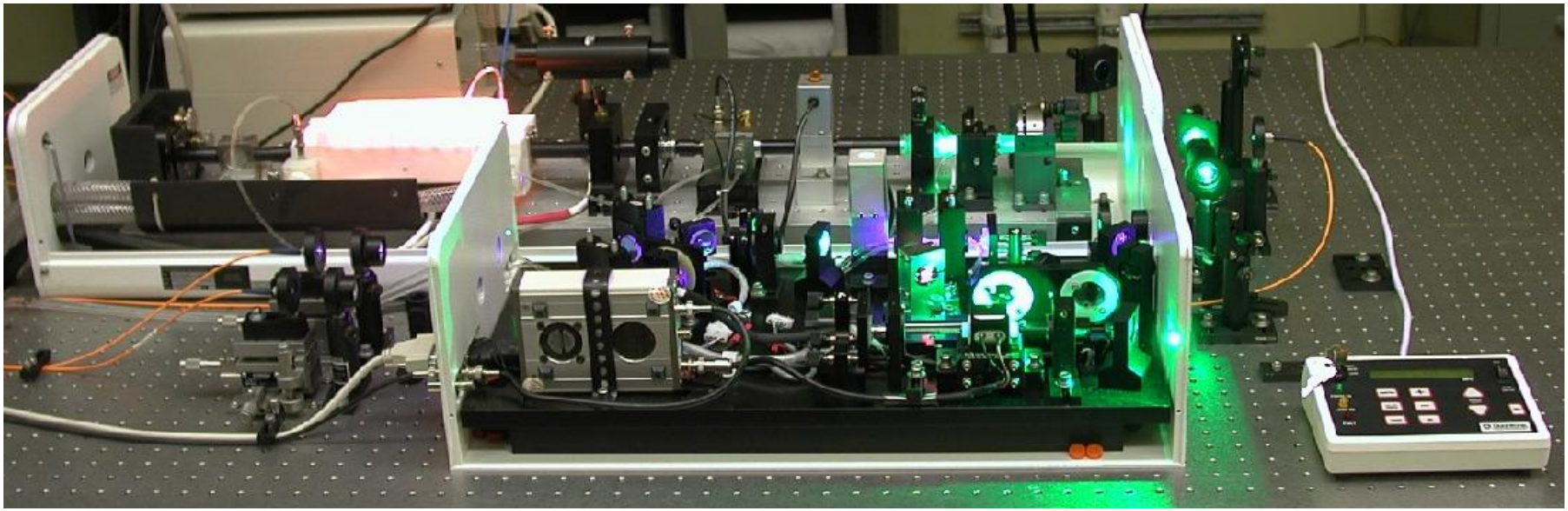
The 2nd and 3rd laser systems installed at CERN in August, 2003.

The 1st Monitoring Laser System

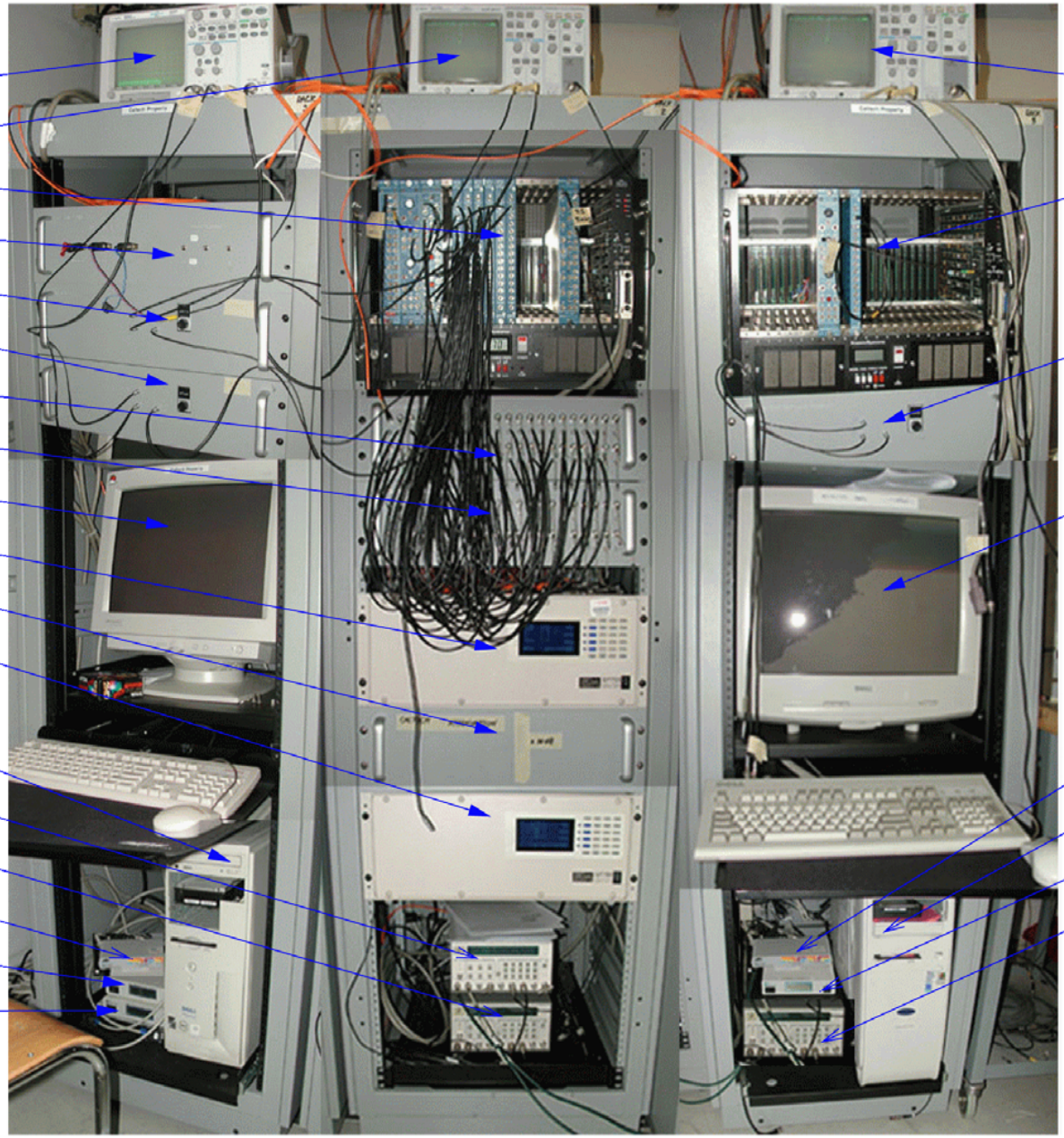


Ti:Sapphire Laser with Two Wavelengths





Laser Monitors, DAQ and Distribution System



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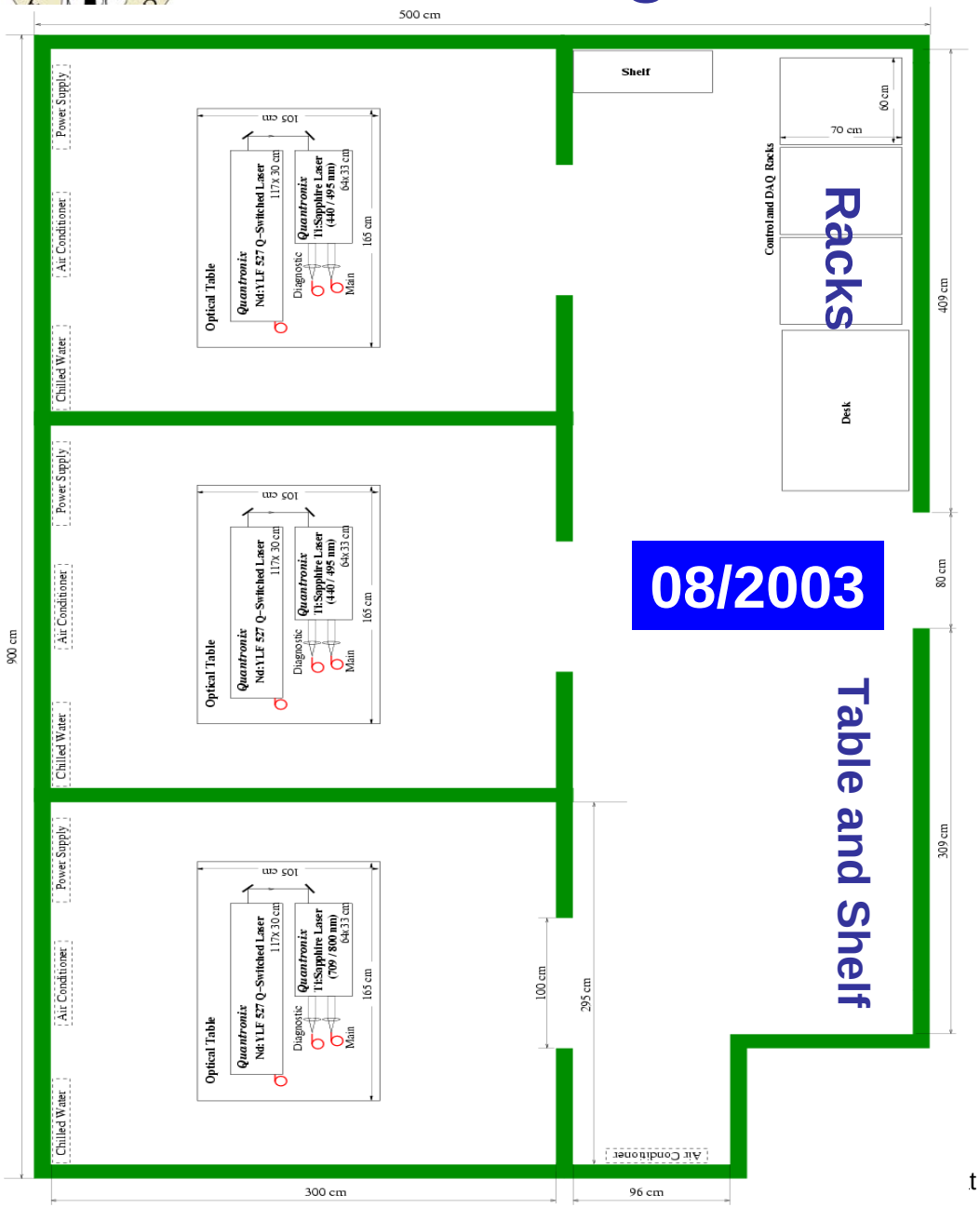
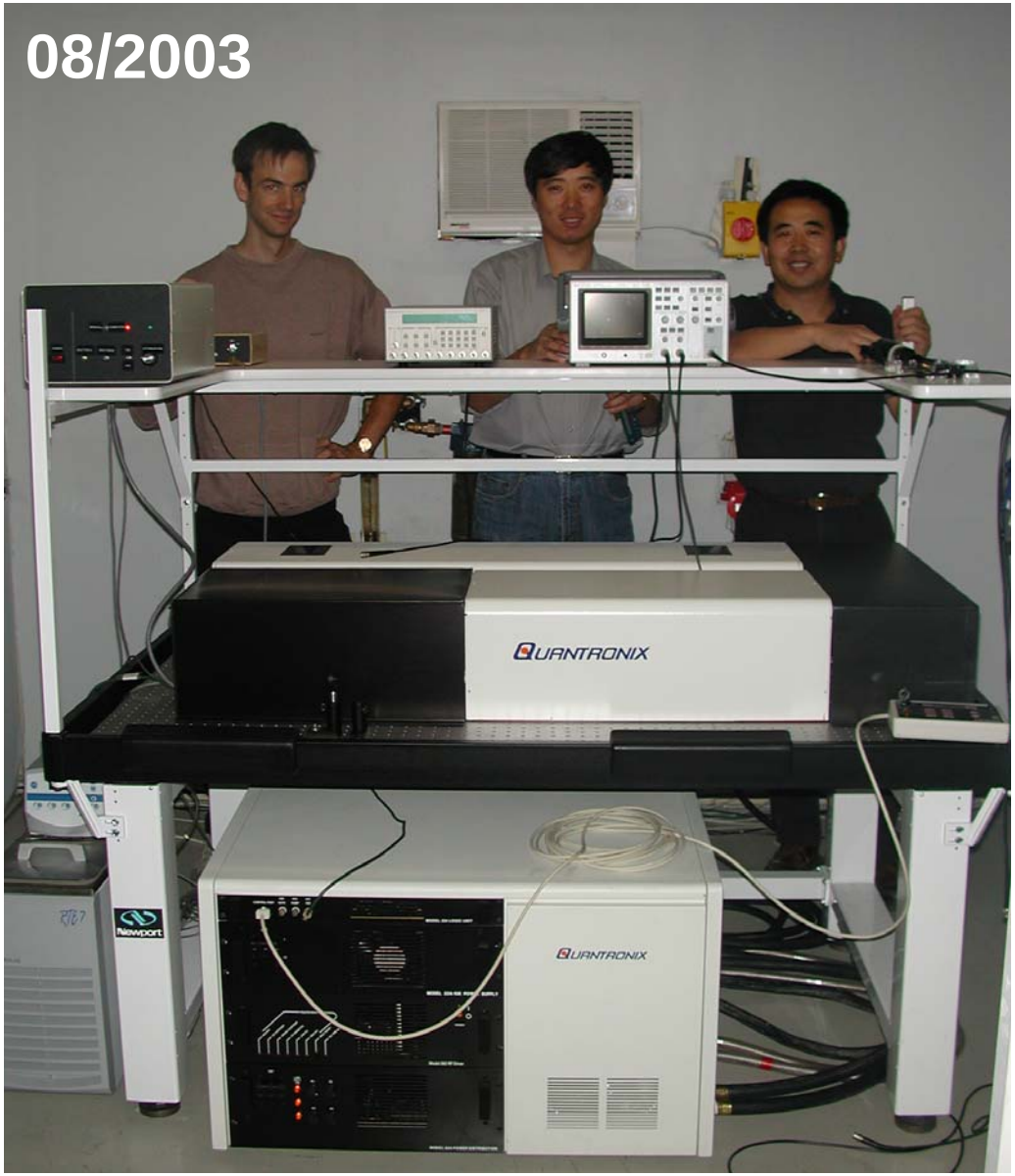
Space & Safety Requirements

- Three independent rooms of 3 x 3 m^2 each for three lasers.
  - ➢ to enable safety interlocks.
  - ➢ to allow 60 cm free space on each side of the optical table for services on lasers sitting on the optical table and laser power supply and Neslab cooler unit, which are under the optical table.
- Solid floor to support the 3'x5'x2" optical table (300 kg) and laser power supply/coller (160 kg), and to isolate vibration.
- Double door required by TIS to eliminate risk of laser beam being seen by outsider.

Monitoring Laser Barracks at H4



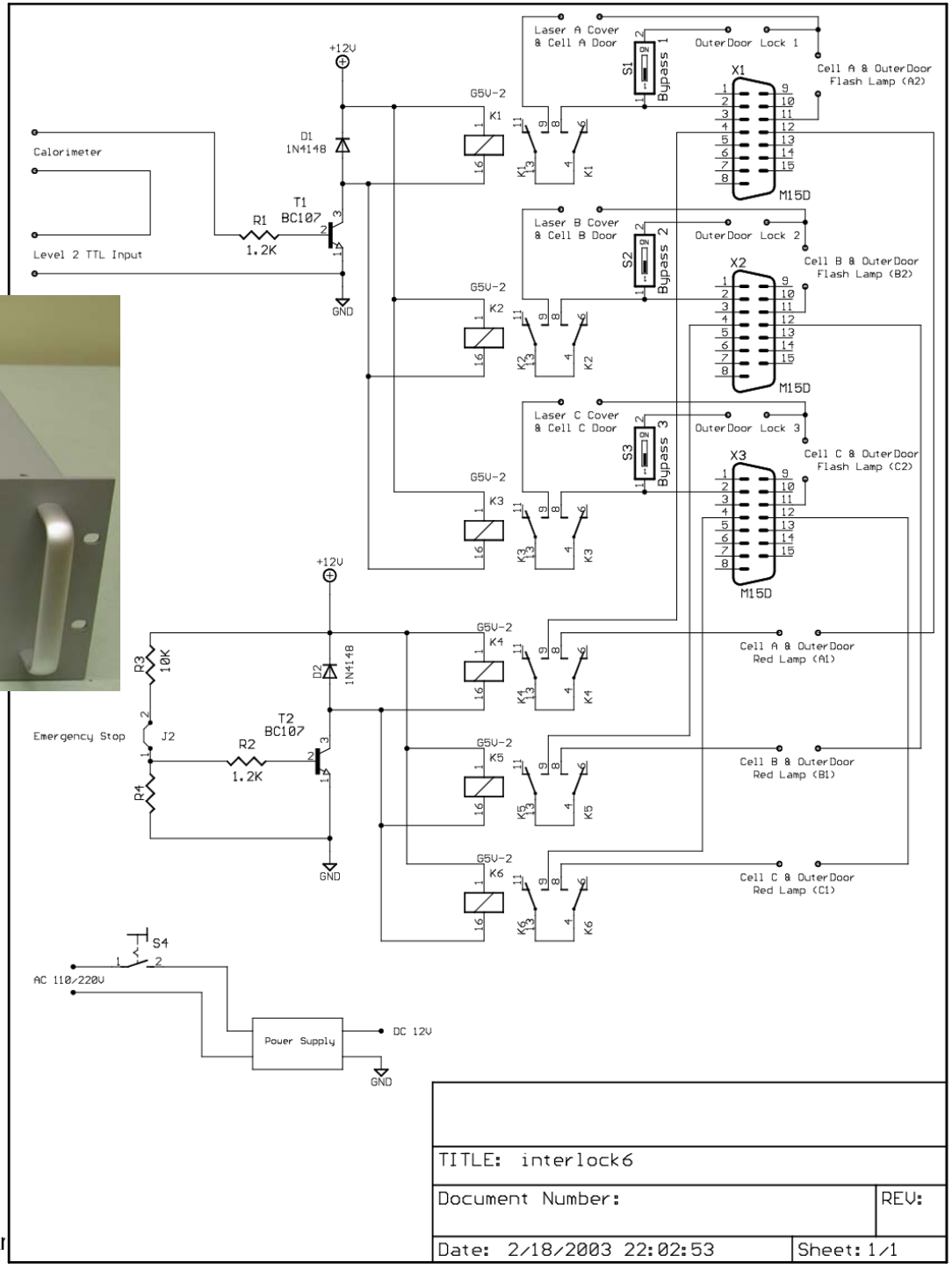
Installation and Commission at H4



Safety

3 Class 4 Lasers

- Interlocks: 3 inner doors, 3 laser covers, level 2 and calorimeter.
- Maintenance interlock: bypassing inner door and laser cover by adding outer door interlock.
- Emergency stop.



Utility Requirements

- Electricity for each laser system: **X3**
  - 208 +-10% (volt), 50/60 Hz, 3 phase, 50A/phase, which is provided through a 3 phase transformer from 380V, 50 Hz, 30A/phase at H4.
  - Neslab cooler and a He-Ne laser for alignment: 220V, 50 Hz, 10A.
  - Miscellaneous electronics: 110V, 50 Hz, 20A.
- Chilled water for each laser system: **X3**
  - Temperature: 7 to 18^{o}C, Pressure: 1 to 7 kg/cm^{2}, Fluence: 16 to 24 l/min.
- Heat load on air: 2.5 kW per room, total: 10 kW.
- Racks:
  - Three water cooled racks for power electronics and PC;
  - Two regular racks for optics: no heat.
- Internet for DAQ and communication.
- Telephone for calling laser service.

Four Transformers for Electricity

Nominal power: 10 KVA/each
Heat dissipation: <500W/each
May be eliminated if centralized power supply is provided

A Clean Chilled Water is Required

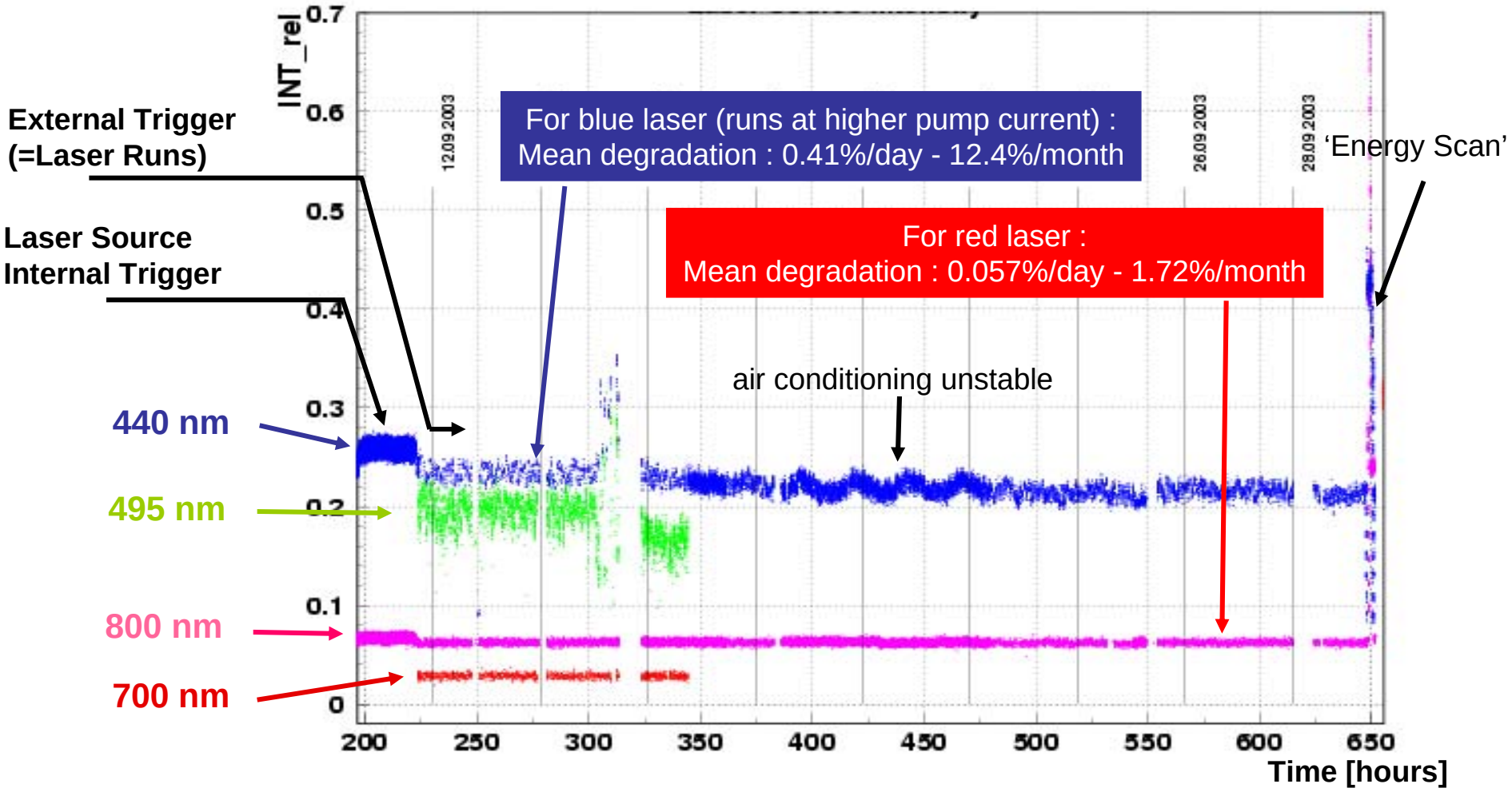
CERN water is dirty

Chilled water for lasers is now clean at H4

A heat exchanger Installed in 2002

Laser Performance in 2003 Beam Test

Typical ‘stable’ operation during 2003 beam test at CERN :



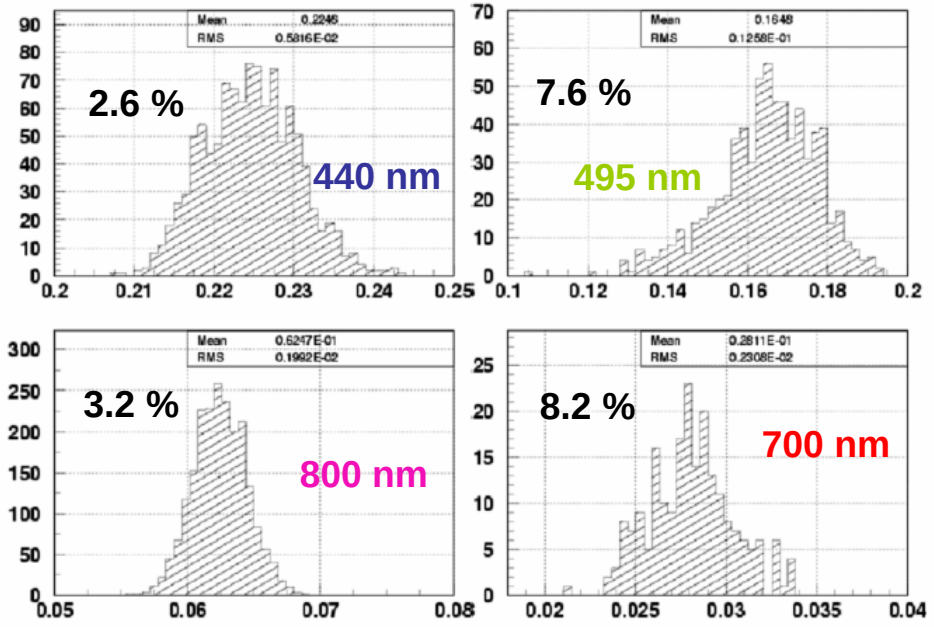
⇒ **In total more than 1200 hours of operation in 2003 beam test**

Pulse Energy Stability

t_{ref} : 330 - 355 h

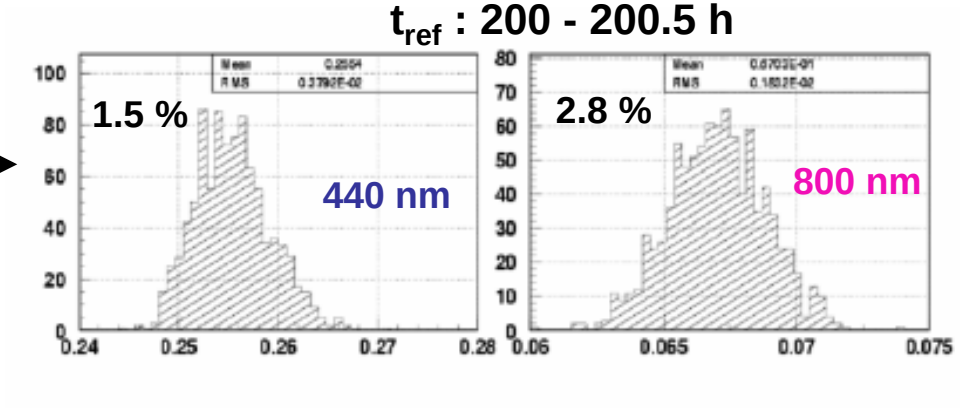
Stability over 25 h

Very good performance exceeds requirements !



t_{ref} : 200 - 200.5 h

Typical 'Laser Run' in test beam mode takes 10 - 30 minutes.



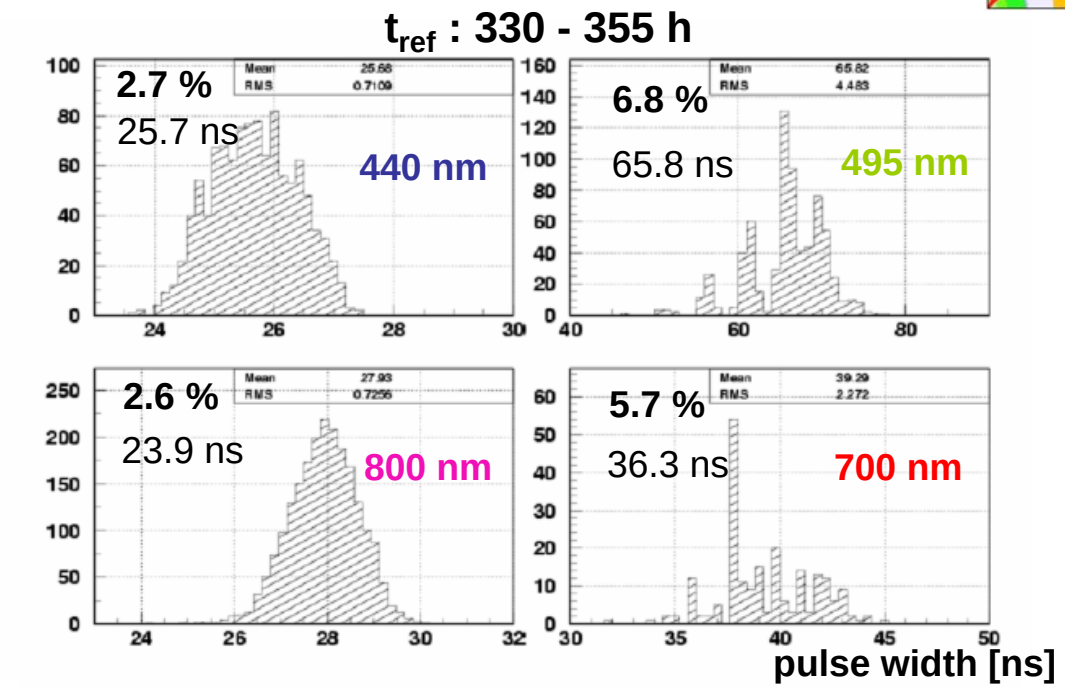
Pulse Width and Timing Jitter Stability

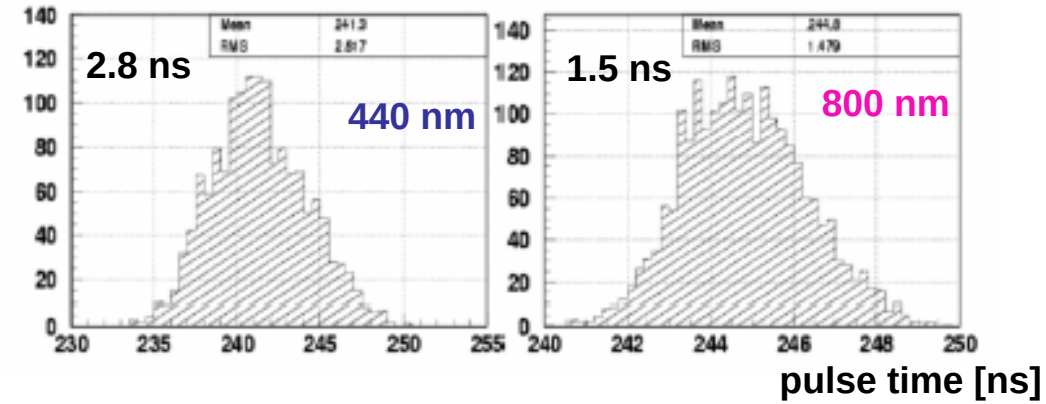
Stability over 25 h

⇒Very good performance.

⇒ In general 440nm/800nm better than 495nm/700nm.

⇒Pulse timing jitter is anti-correlated to the pulse energy variations !



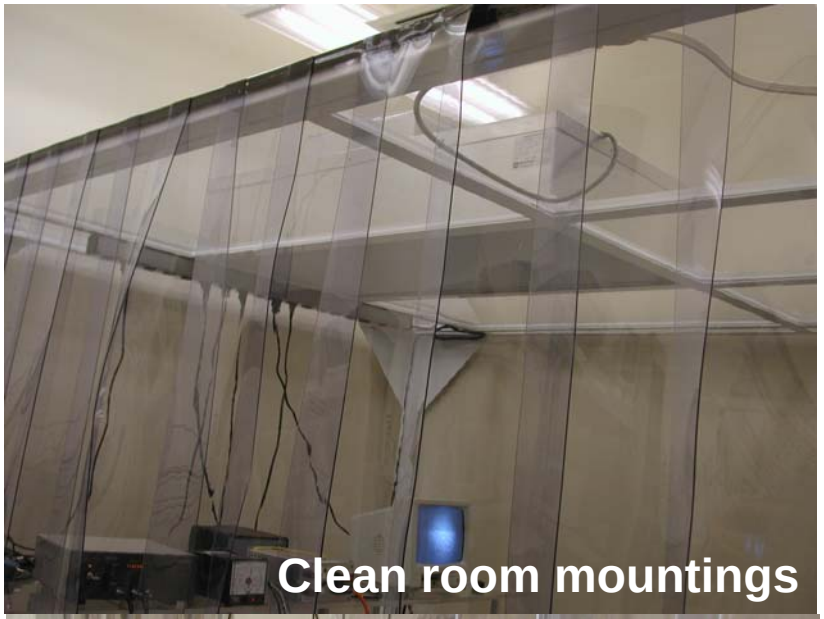


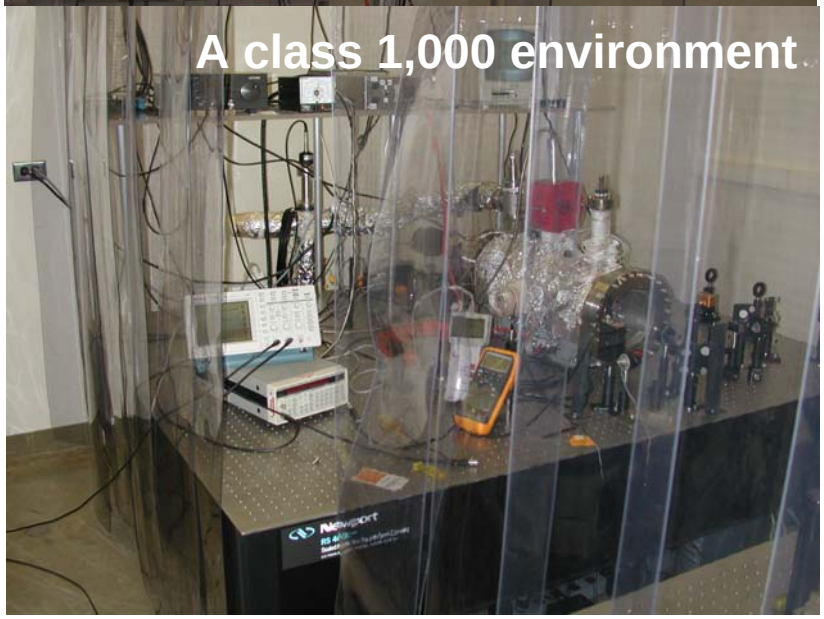
Laser Stability in 2004 Beam Test

Laser system experienced significant degradation (few %/day) in 2004 beam test when running at 100 Hz, which was caused by some damaged optics because of the dirty environment inside the laser barracks at H4, CERN.

Quantronix engineer recommended a class 10,000 clean environment.

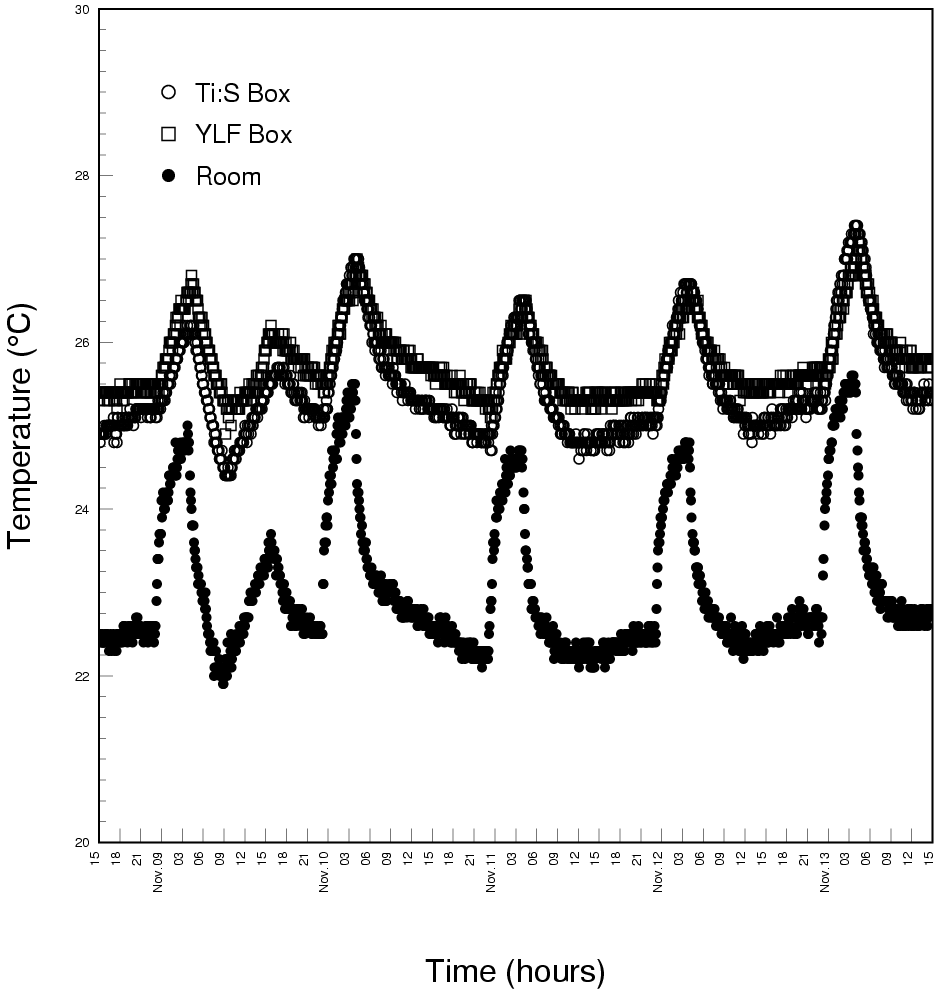
Our solution is to install portable clean room facilities for all three lasers at CERN, which may provide a clean environment with reasonable cost ($10k/set).

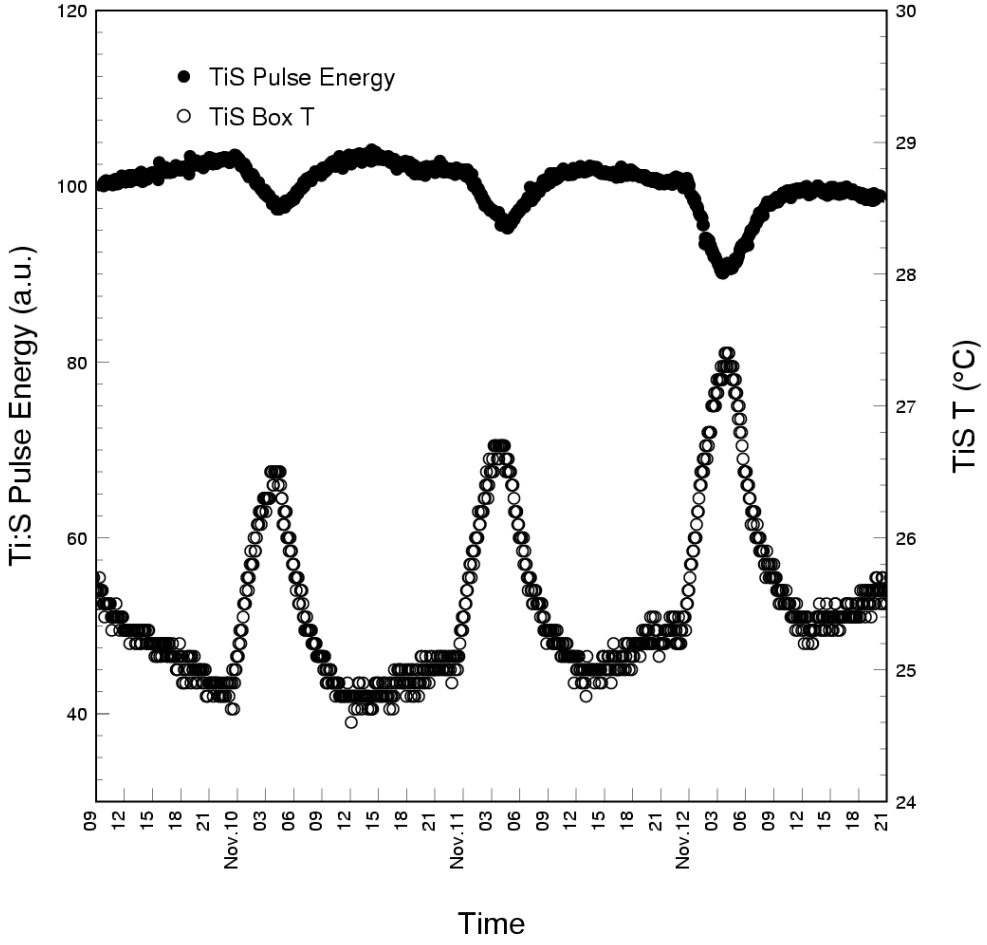




A Study on Temperature Effect

Room T Variations in 5 Days

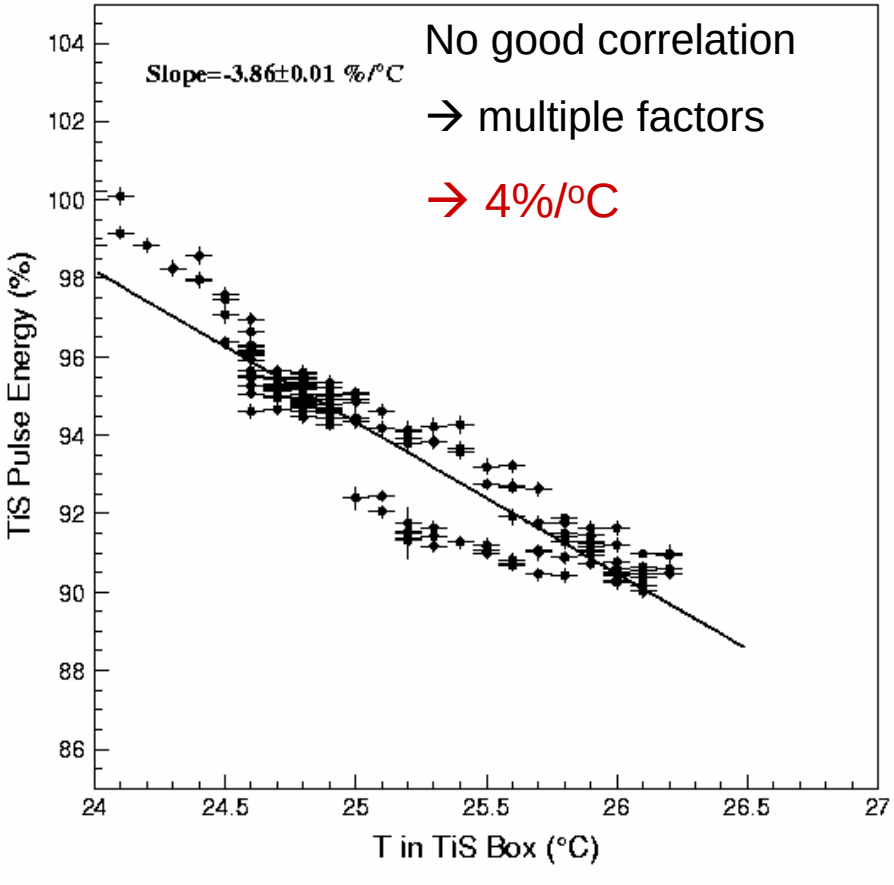




Ti:S Pulse Energy and T

Laser Temperature Dependence

ECAL monitoring electronics requires stable laser pulses



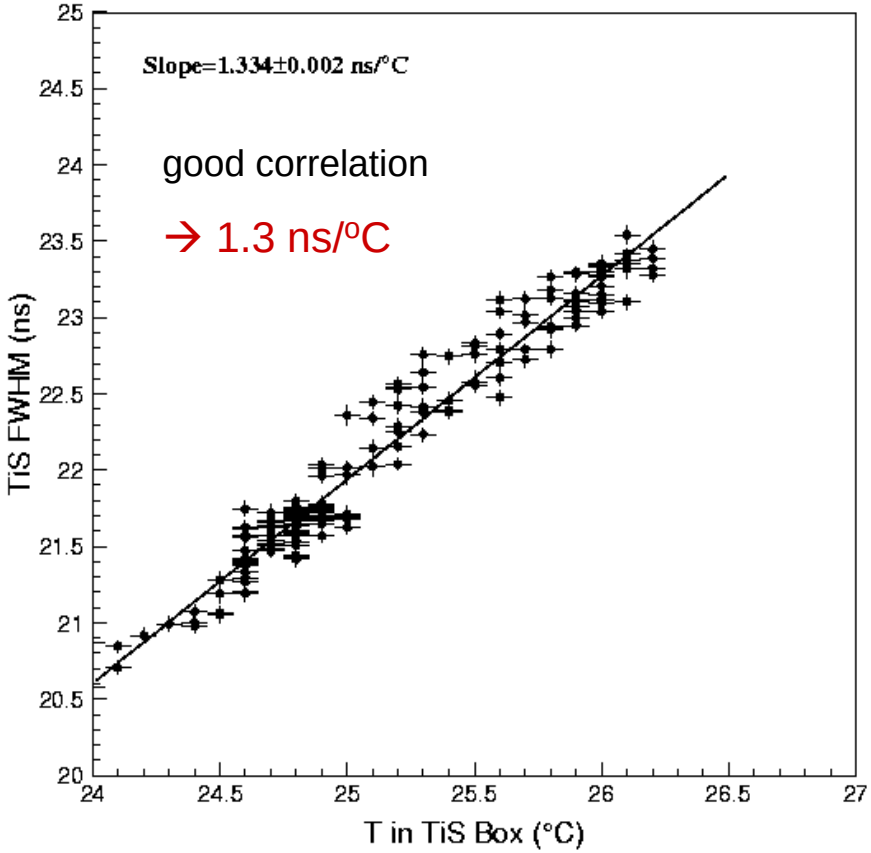
No good correlation

→ multiple factors

→ 4%/°C

Ti:S Pulse Energy versus T

Ti:S Pulse FWHM versus T



good correlation

→ 1.3 ns/°C

Summary

- Since its installation and commission, the performance of the ECAL monitoring light source at CERN reached or exceeded the original design specifications.
- Based upon 2004 test beam experience we impose the following requirements for the laser environment at USC55:
  - Temperature stabilized to ± 0.5 °C;
  - Humidity < 60%;
  - Significant air currents should be avoided;
  - Dust and particulate matter should be minimized: Class 10,000.
- David Bailleux will explain our portable sofwall clean room approach to achieve these goals.