Light collection system for ICARUS-T600

Gian Luca Raselli

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Present W.G.: M. Babicz, V. Bellini, M. Bonesini, T. Cervi, A. Falcone, C. Montanari, F. Pietropaolo, G.L. Raselli, A. Rappoldi, M. Rossella, M. Spanu, M. Torti, F. Tortorici, C. Vignoli, A. Zani.

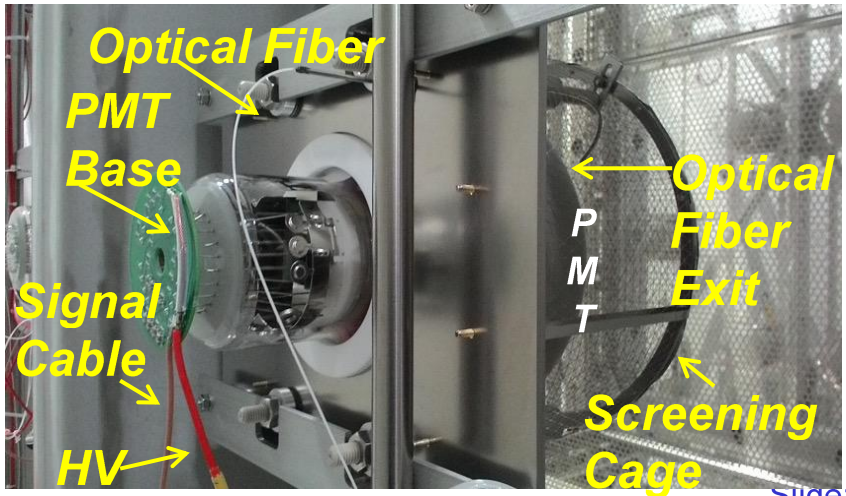
… more people welcome!

Upgrade of the light collection system

- The refurbished light collection system consists of 90 PMT 8" HAMAMATSU R5912-MOD for TPC, installed behind each wire planes (360 PMT in the whole T600);
- This configuration allows for a photo-cathode coverage of 5% of the wire plane area and a light collection of 15 phe/MeV;
- Monte Carlo simulations demonstrate that this PMT deployment permits to trigger low energy events (<100 MeV) with fairly high threshold/multiplicity. It offers an event longitudinal localization better than 0.5 m and allows an initial classification of different interaction topologies (μ-tracks vs e.m. showers).

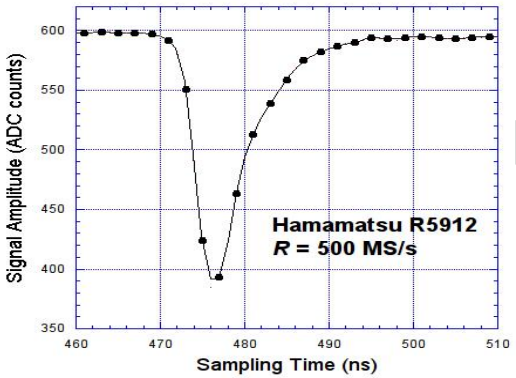
Preparation and test of the light collection devices at CERN

- A total of 400 PMTs, delivered by Hamamatsu at CERN, were equipped with a customized cryogenic base.
- All PMT's were tested at room temperature; 60 units directly in a LAr bath to evaluate the change at cryo temperature of gain, linearity & dark counts.
- *All PMTs were rated compliant with requirements for installation in T600.*
- 360 PMTs were uniformly coated by evaporation with ~200 $\mu g/cm^2$ of Tetra-Phenyl-Butadiene (TPB) to detect the λ = 128 nm LAr scintillation light.
- New mechanical supports for the PMT installation were prepared. Each device is set inside a wire screening cage to prevent induction of PMT pulses on the facing TPC Collection wire planes.
- The PMT timing/gain equalization is performed by using light pulses from a Laser source (Hamamatsu PLP10, λ=405 nm, FWHM <100 ps, peak power ~400 mW). For each PMT, a 50 μm optical fiber allows the illumination of the photocathode.



PMT DAQ Electronics

- The scintillation light data acquisition and recording is equivalent to an oscilloscope channel for each PMT.
- This is performed by means of CAEN V1730B (500MS/s, 14-bit). Recorded signals will be available through optical links (A3818 board).
- Moreover the V1730B boards will generate a set of discriminated output signals (LVDS) which will be available for triggering purposes.



Optical Link

V1730

PMT Trigger

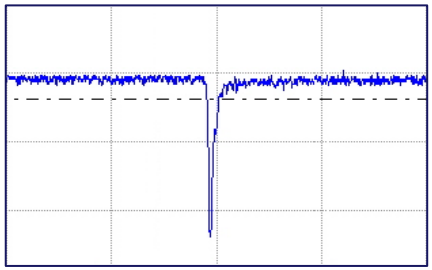
PMT Trigger Logic

To Global Trigger

LVDS

A3818

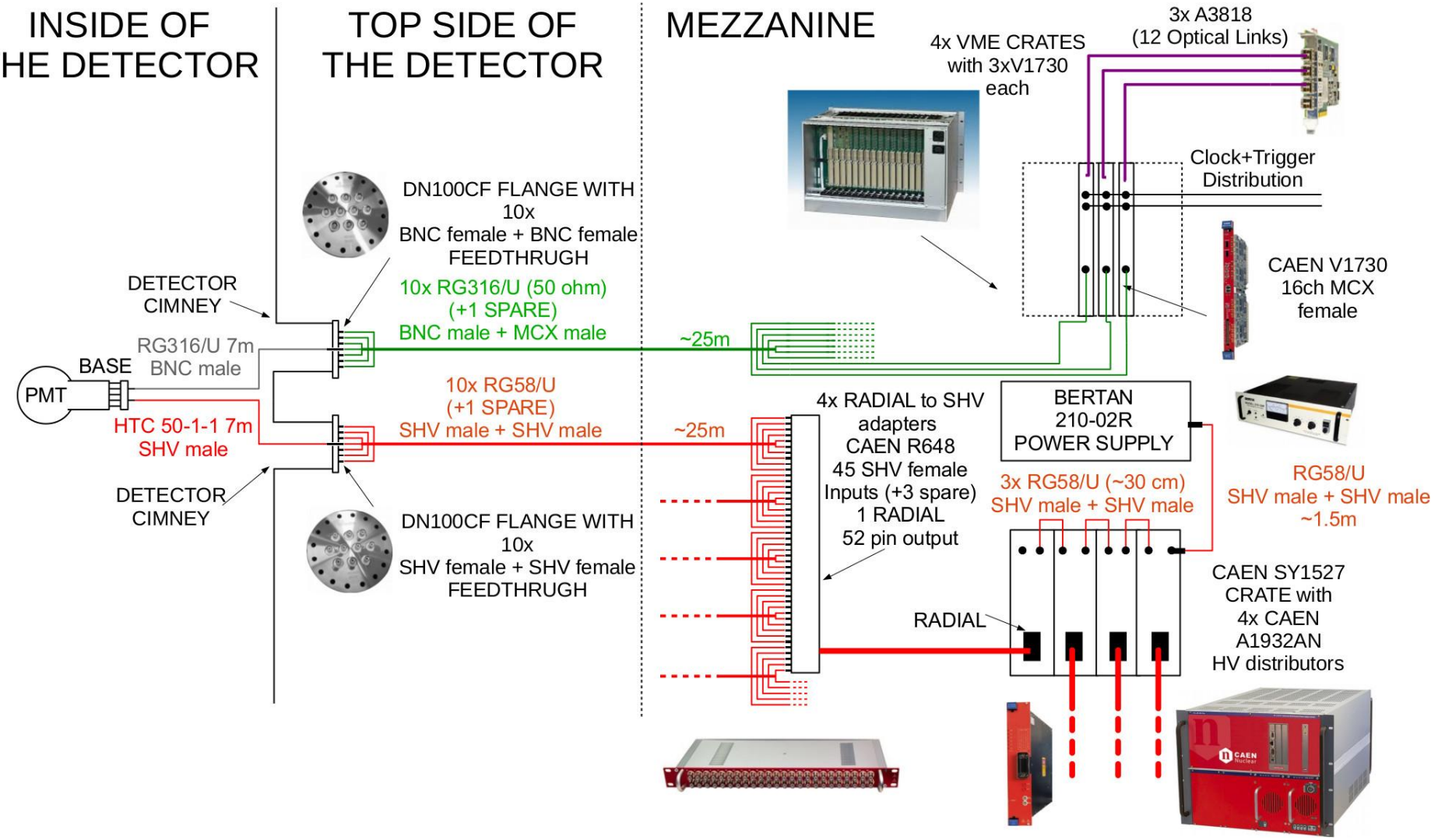
Data Recording



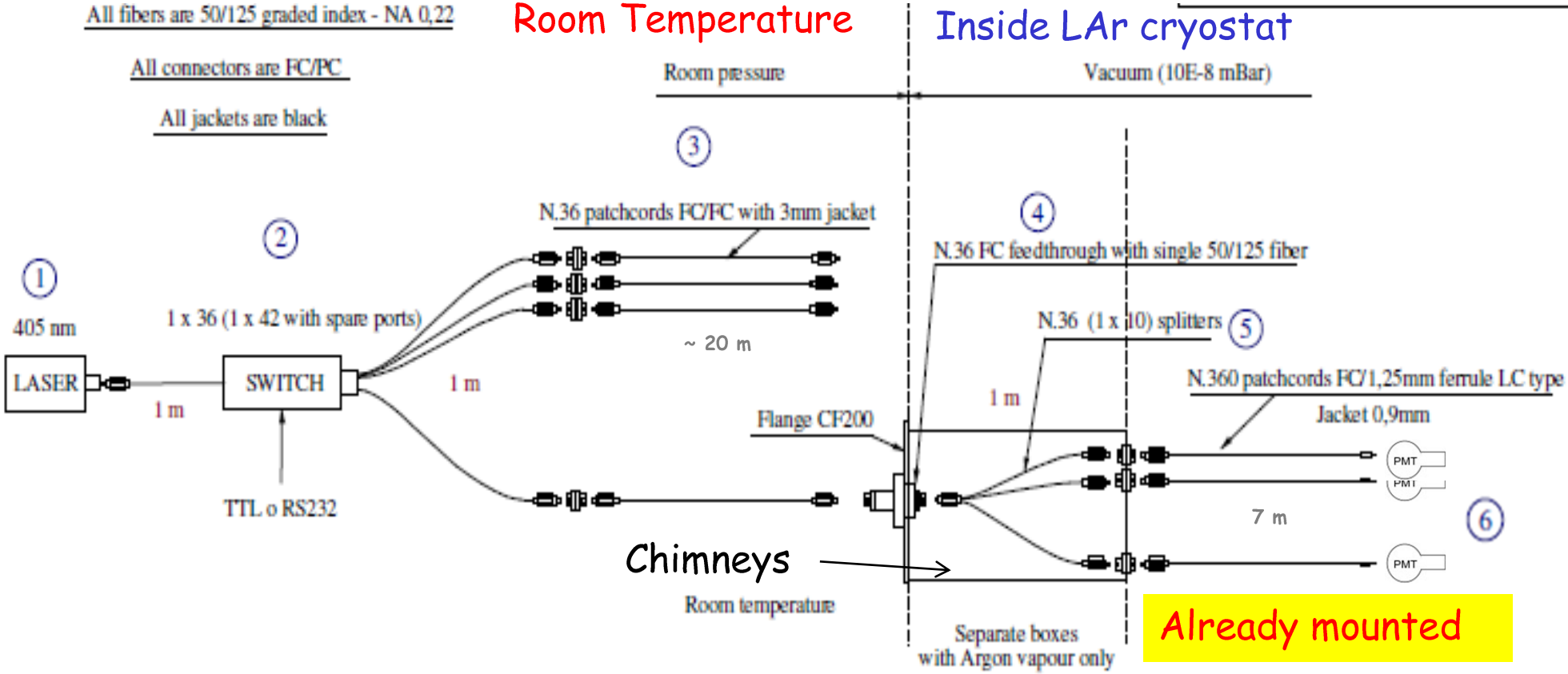
See next trigger presentation for details

Light detection system deployment

- For each T300 module the following instrumentation deployment has to be accomplished.



Layout of the laser calibration system



1. 405 nm Laser [1]
2. Magic box: 1x42 optical switch [1] or 1x42 passive splitter [1]
3. ~15 m long armed FC/FC patchcords [36]
4. FC/FC UHV feedtrough [36] on CF40 flange, mounted on a CF200 flange
5. 1x10 fused fiber splitters [36]
6. 7m FC/ferrule injection patch fiber from 1x10 splitter to PMT [360]

Light detection system: installation tasks

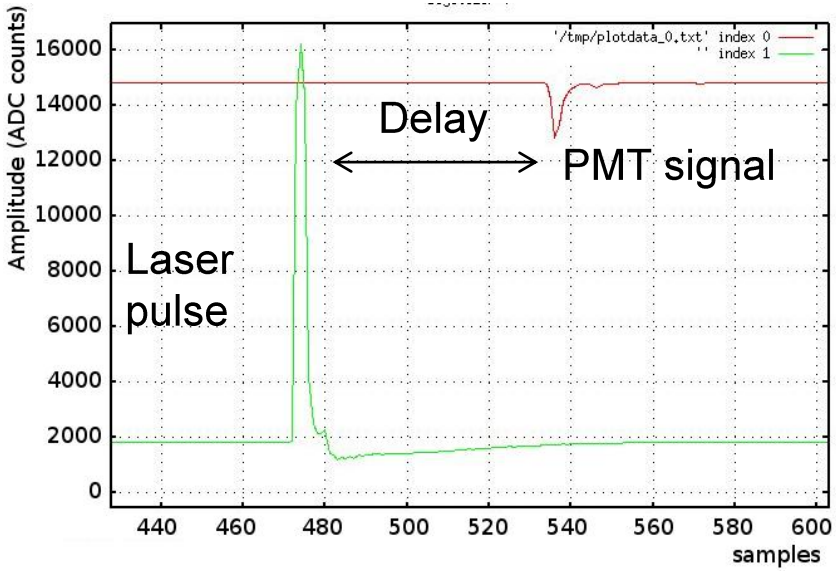
- Internal part of T600 light detection system and the laser calibration system have been completed before the detector shipping to FNAL.
- The following installation tasks will be carried out at FNAL:
  - Signal cables and optical fibers recovering from the TOP flanges.
  - Signal cables and optical fibers deployment and fastening along the TOP chimneys and in the upper crosses.
  - Installation of internal optical splitters and optical feed-through flanges.
  - Signal cables and optical fibers mounting on the feed-through flanges.
  - Connection to external cabling and optical fibers.
  - Installation of HV power supply system.
  - Installation of the PMT DAQ system: VME crates, digitizers, optical links, cabling.
  - Installation of the timing calibration system: Laser, optical switch.

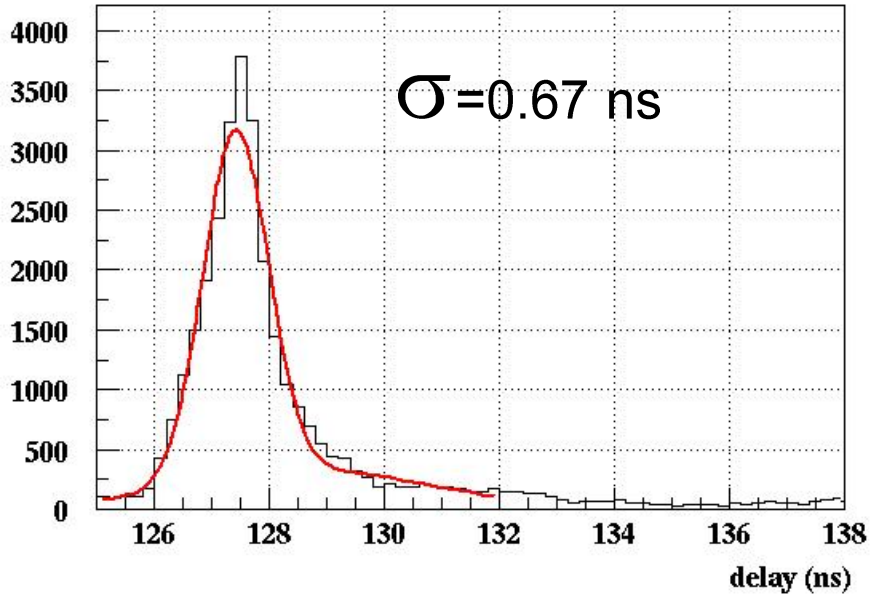
Light detection system: online, software & slow control tasks

- Other important activities concern:
  - Development of software for the PMT signal recording and integration on the detector DAQ system (see presentations on DAQ and Trigger);
  - Development of software for PMT signal analysis (see presentation on software);
  - Development of the light detection system calibration and monitoring (procedure, signal reconstruction algorithm…).
  - Deployment of the light detection system slow control (see presentation on slow control).
- In addition a number of tests are being performed to improve the performance of the light detection system and to get familiar with the different subsystems before operating at FNAL:
  - Study of the synchronization between different boards;
  - Study of the Laser calibration protocol finalized to a precise PMT signal synchronization.

PMT DAQ Tests

- On going tests on PMT DAQ electronics are mainly focused on the timing characteristics of the system.





Example of measured time delay distribution between the PMT response to laser illumination and the Laser pulse, simulating a laser calibration procedure. Thanks to the multiple sampling of the input pulses, it is possible to reconstruct the leading edge of the signals and evaluate the time response at 50% of their amplitude. The resolution resulting from a Gaussian fit $(\sigma^2_{Laser}+\sigma^2_{PMT})^{1/2}=0.67ns$ is better than digitizer sampling time (2 ns). This work is in progress to better reconstruct the signal time response and refine the attainable resolution.