Timing calibration in NEMO

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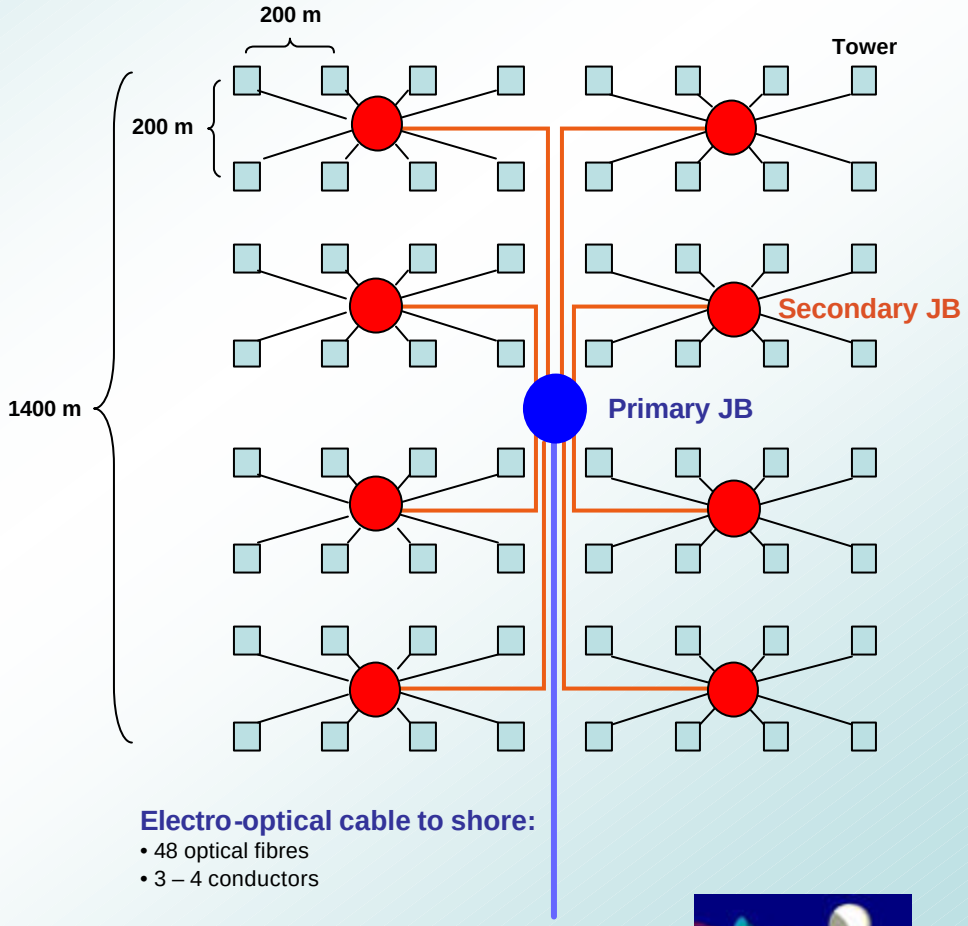
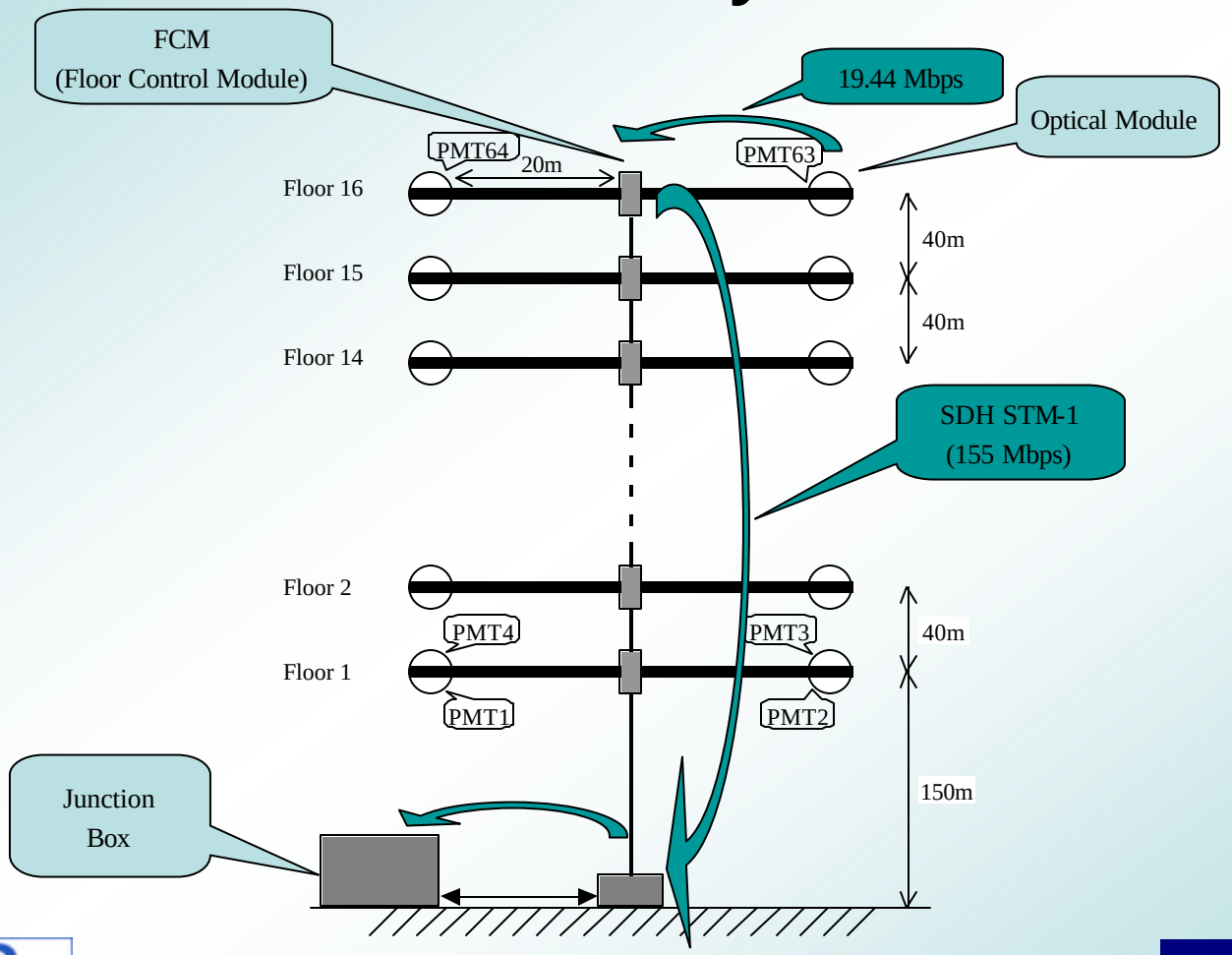
on behalf of the NEMO Collaboration

NEMO Telescope layout

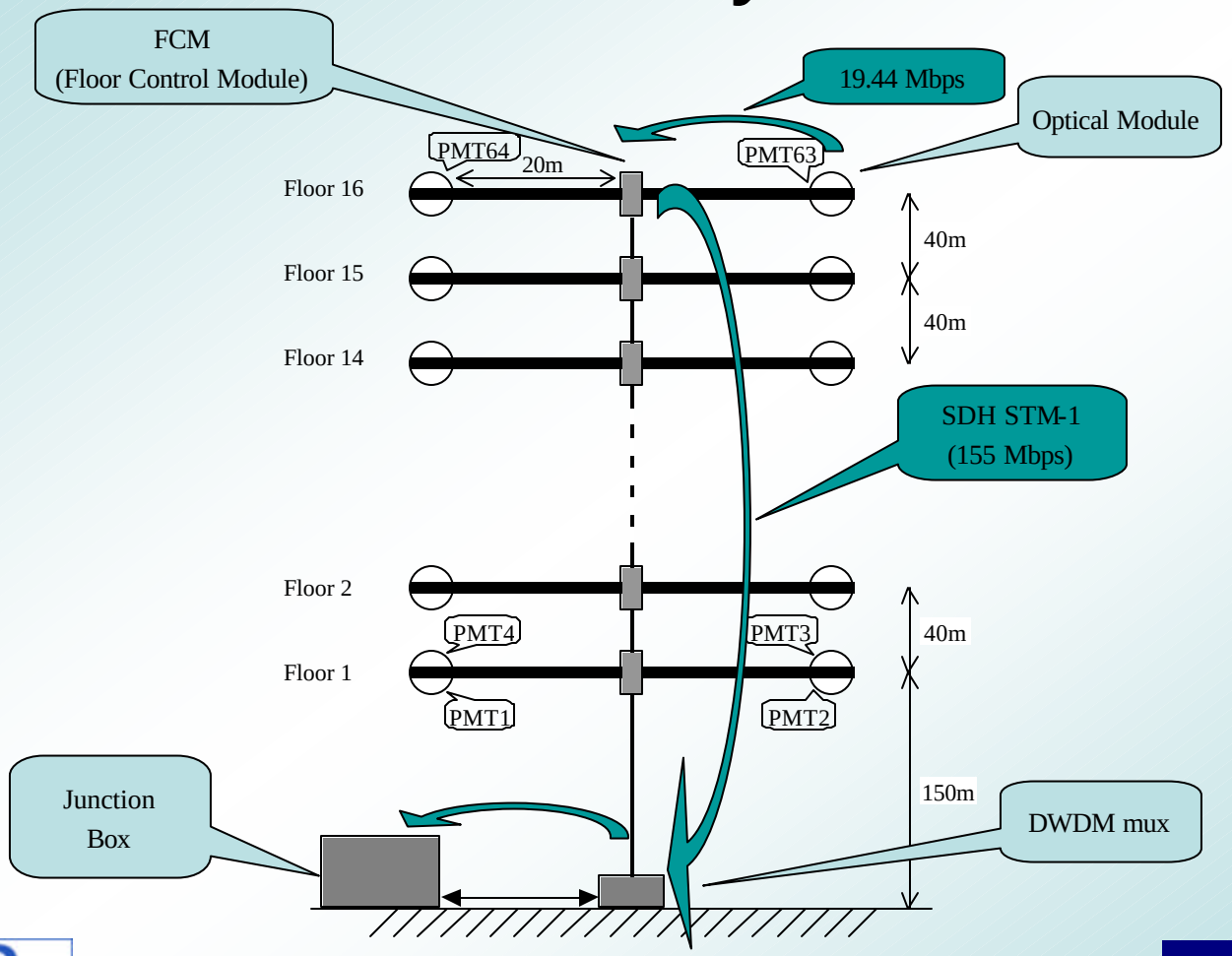
- 1 primary Junction Box
- 8 secondary Junction Boxes
- 64 towers
- 200 m grid pitch
- 64 PMT on each tower
- 4096 PMT in total



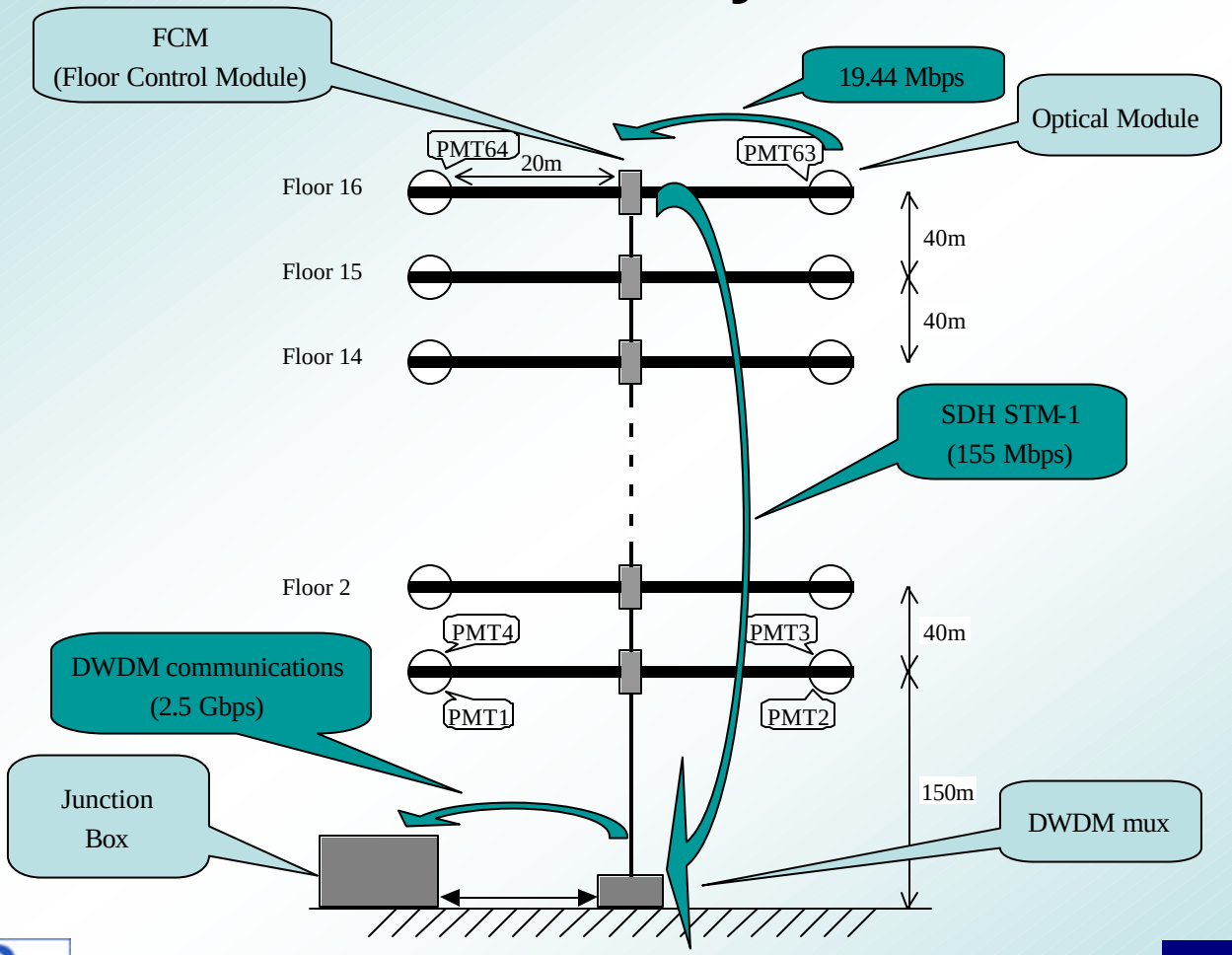
Tower Layout



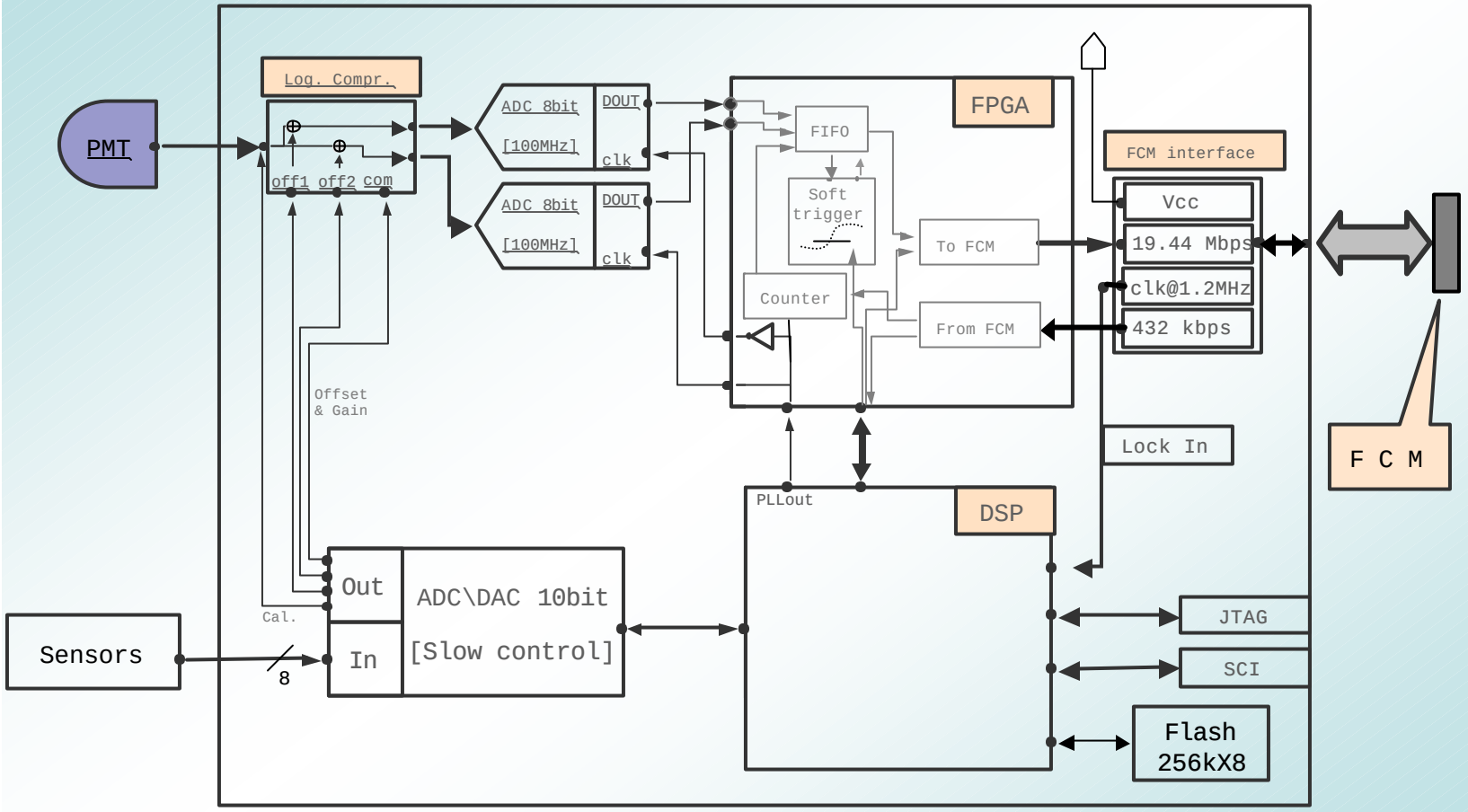
Tower Layout



Tower Layout



Front-end electronics (inside the Optical Modules)



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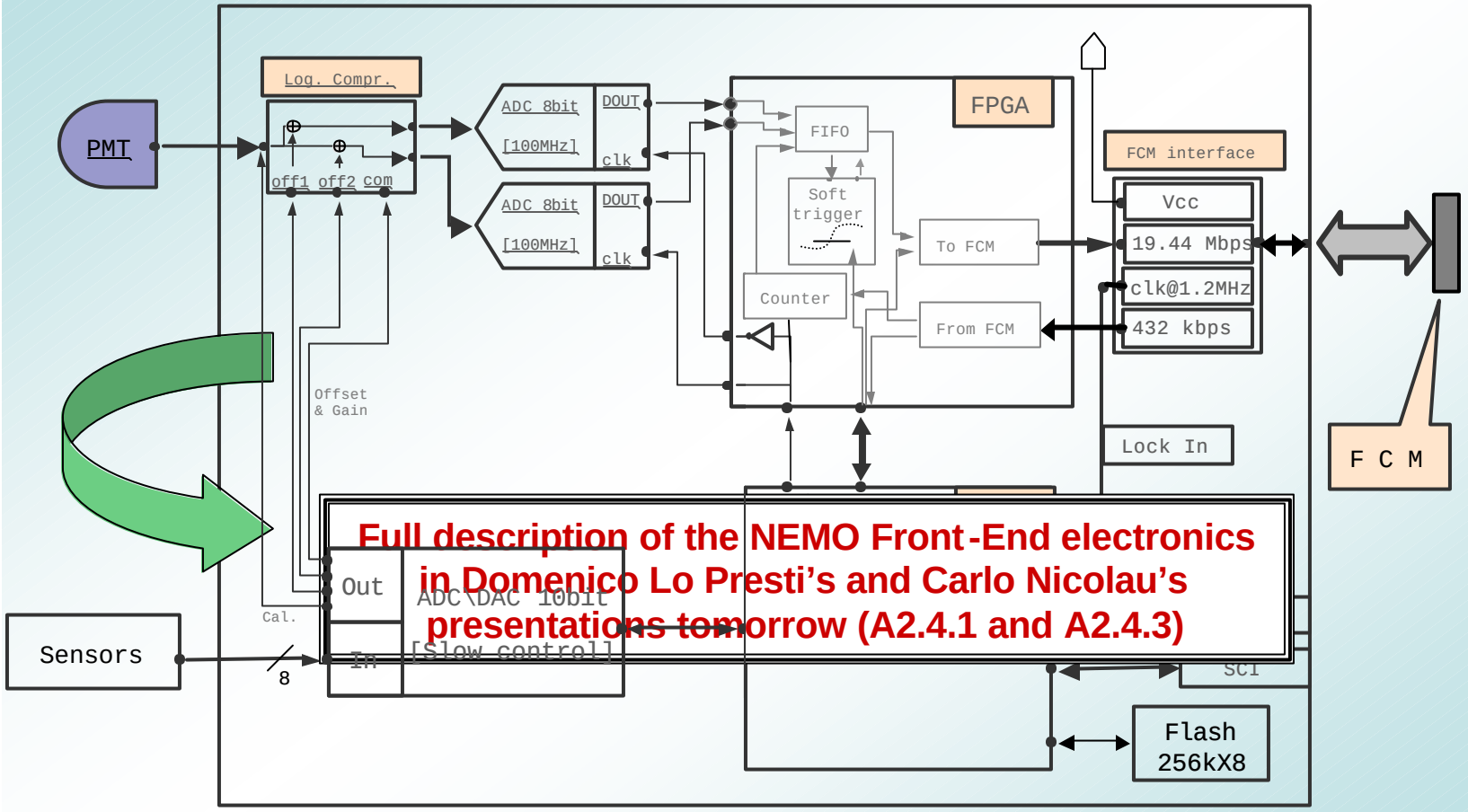
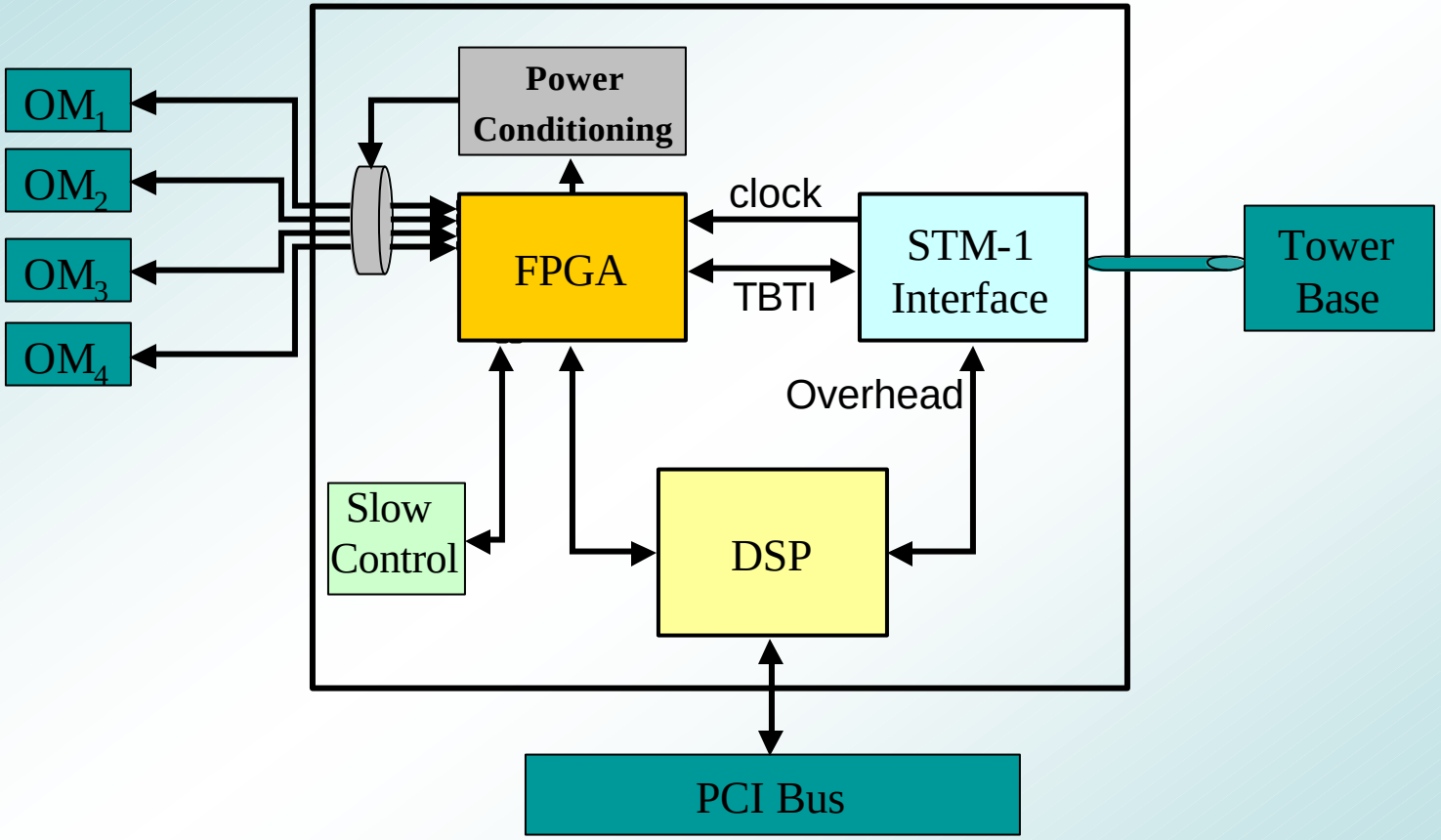
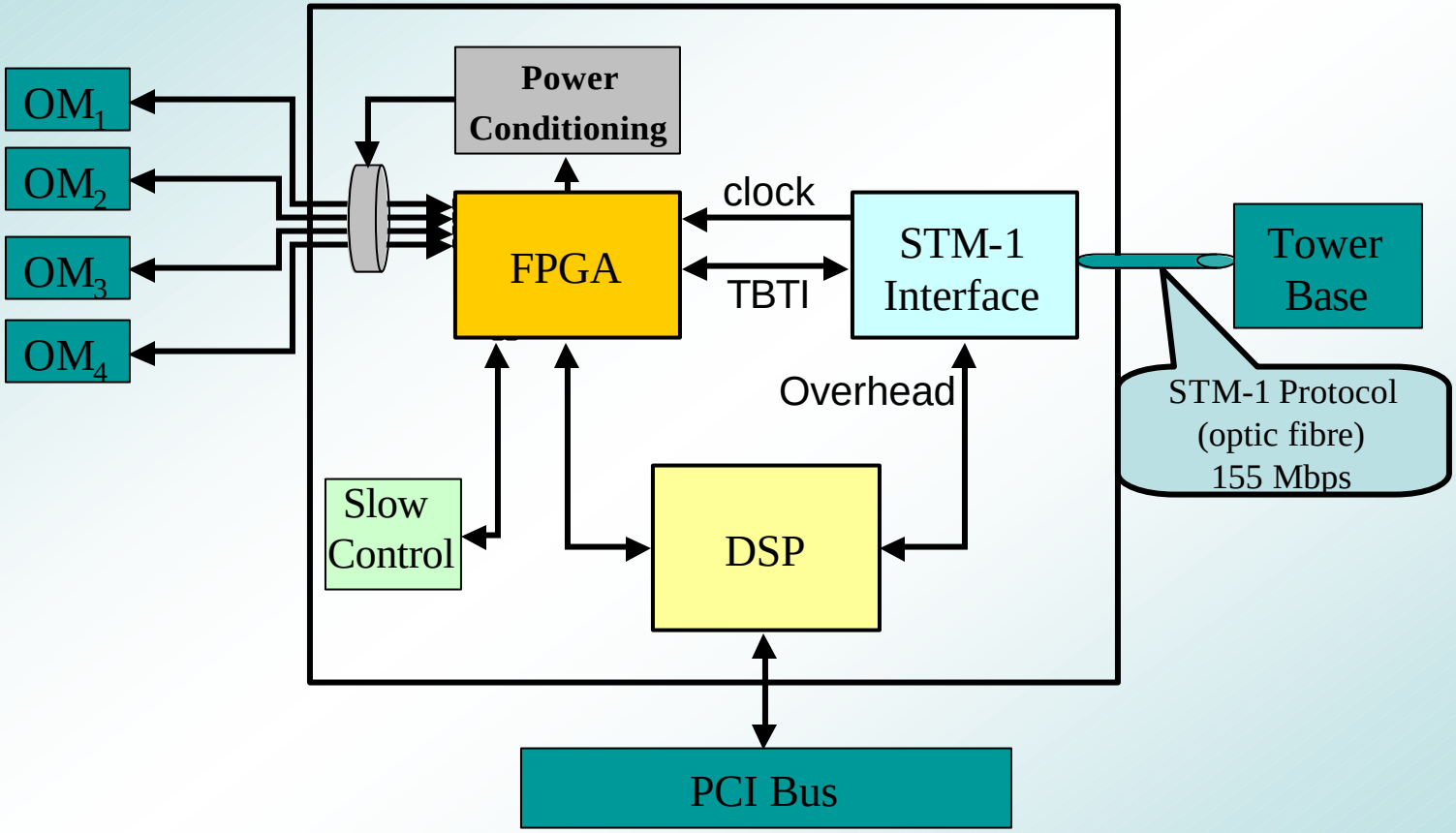


Full description of the NEMO Front-End electronics in Domenico Lo Presti's and Carlo Nicolau's presentations tomorrow (A2.4.1 and A2.4.3)

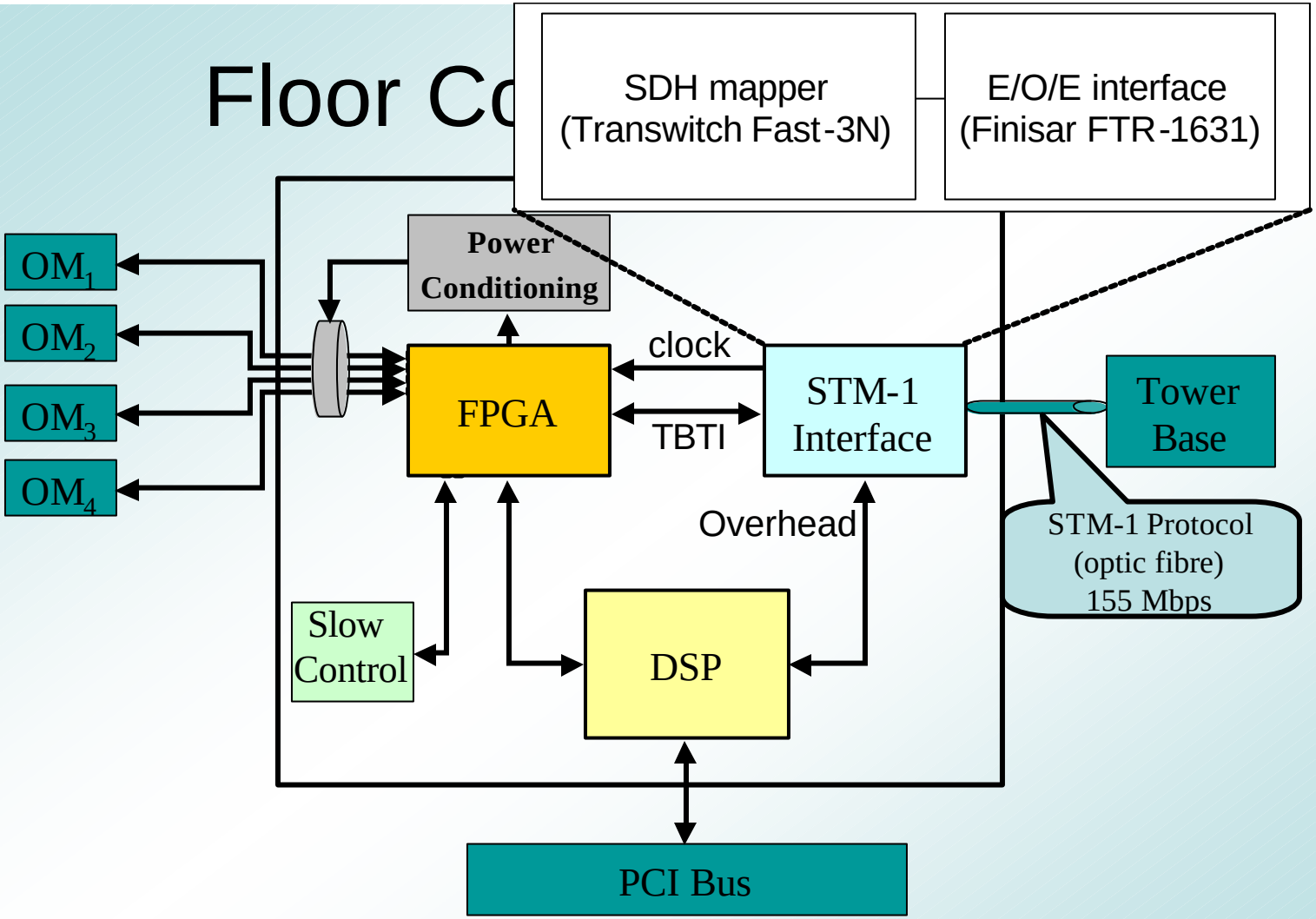
Floor Control Module



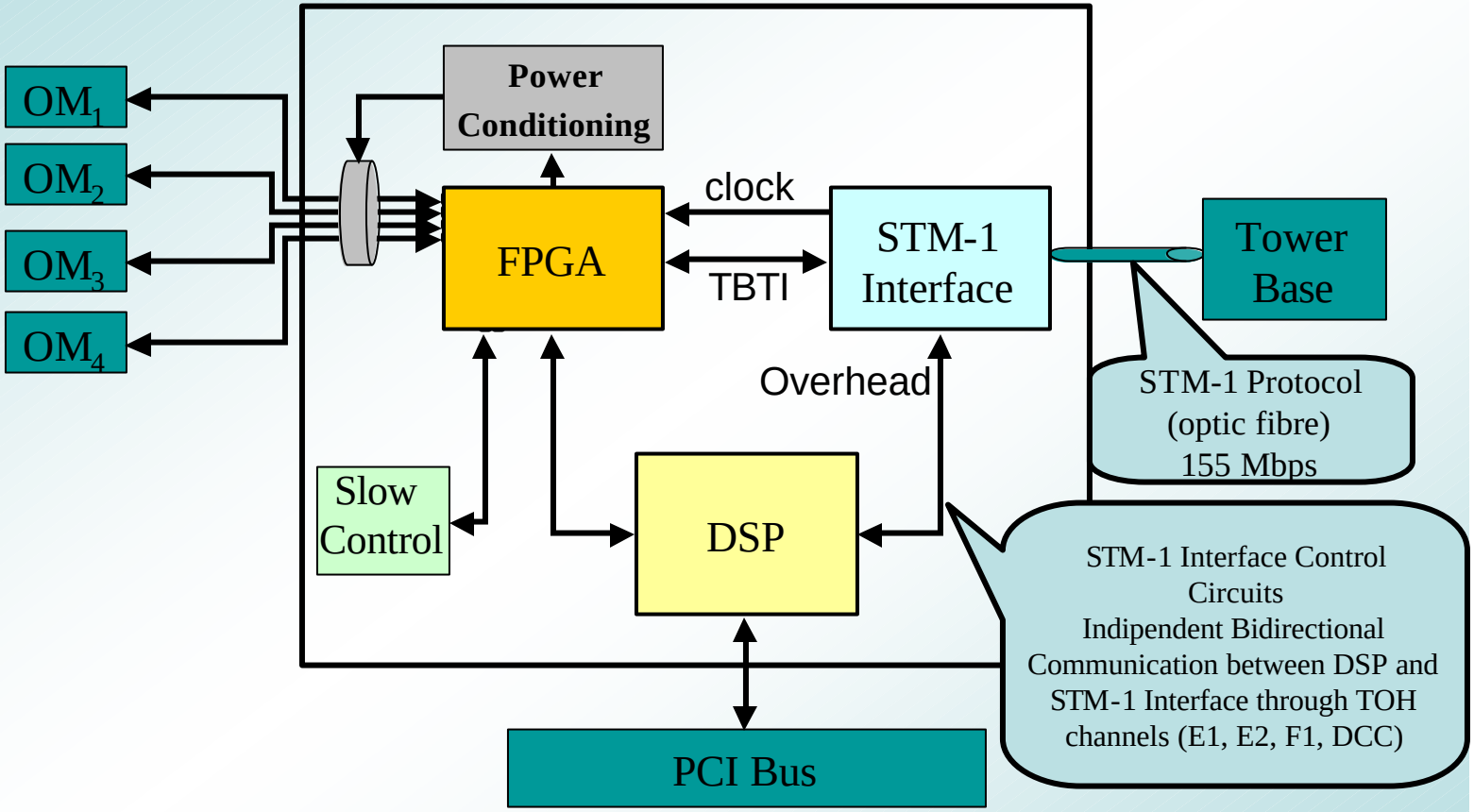
Floor Control Module



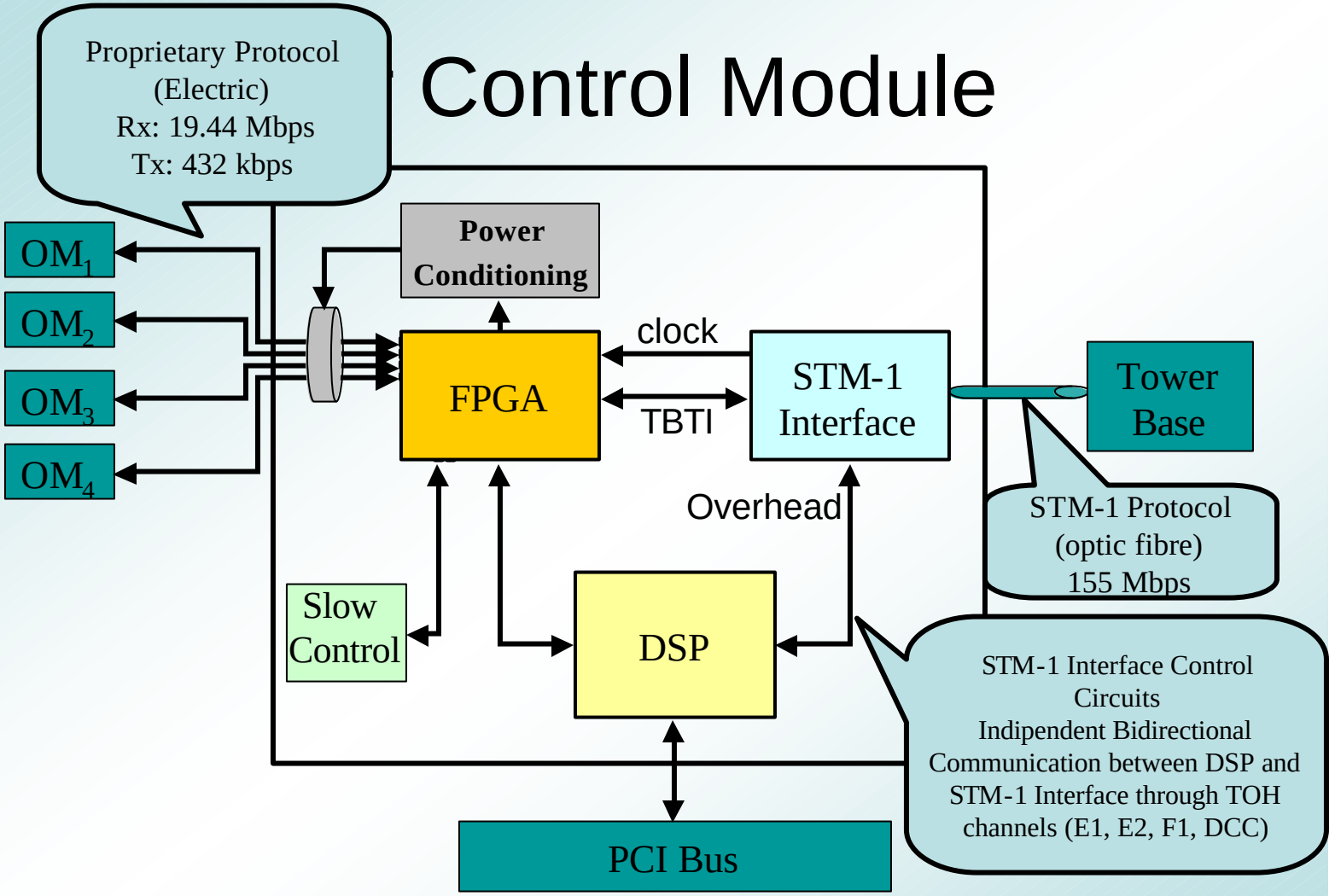
Floor Co


SDH mapper
(Transwitch Fast-3N)
E/O/E interface
(Finisar FTR-1631)
Power
Conditioning
OM1
OM2
OM3
OM4
FPGA
clock
TBTI
STM-1
Interface
Tower
Base
Overhead
STM-1 Protocol
(optic fibre)
155 Mbps
Slow
Control
DSP
PCI Bus

Floor Control Module



Control Module



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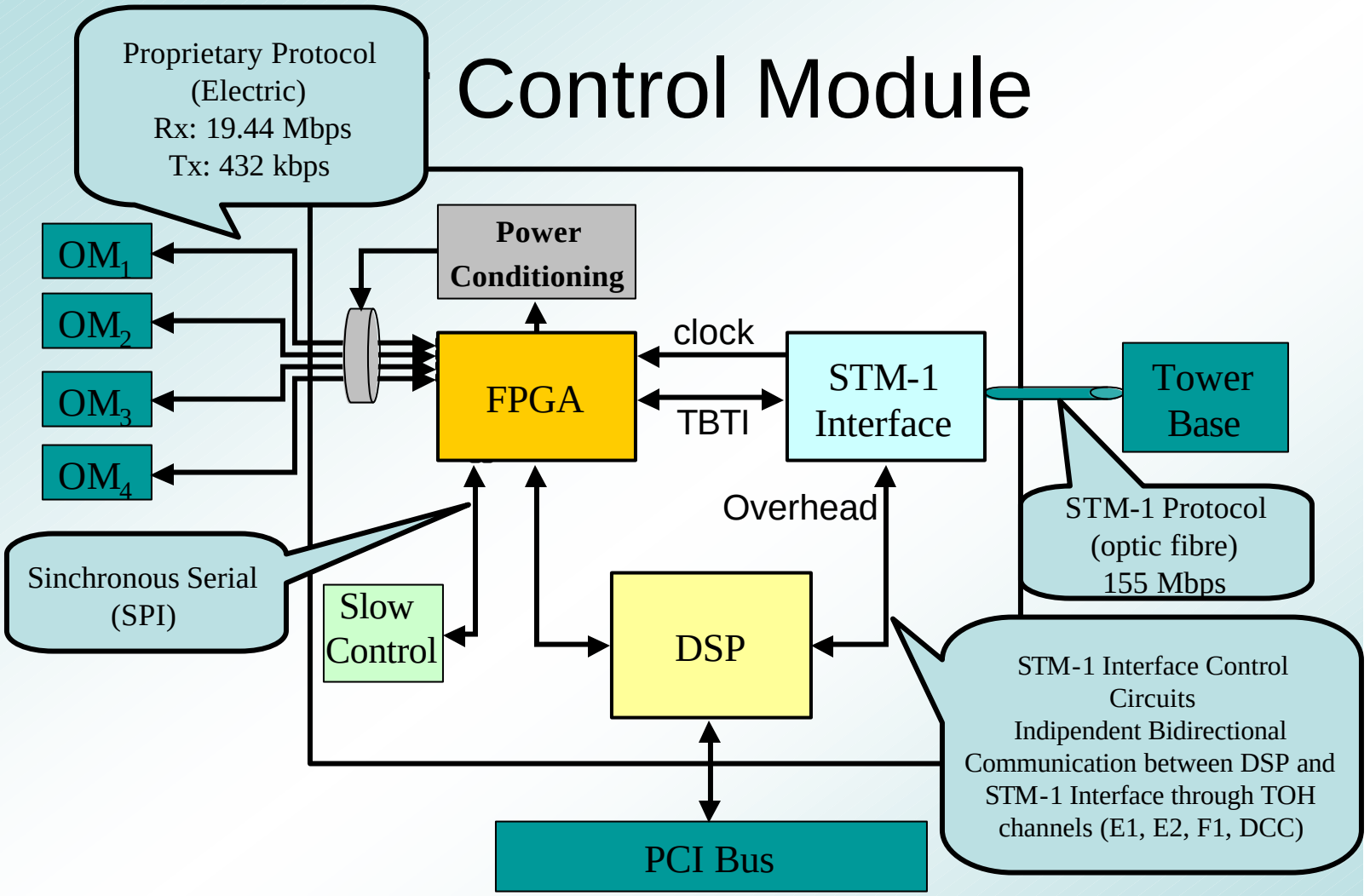
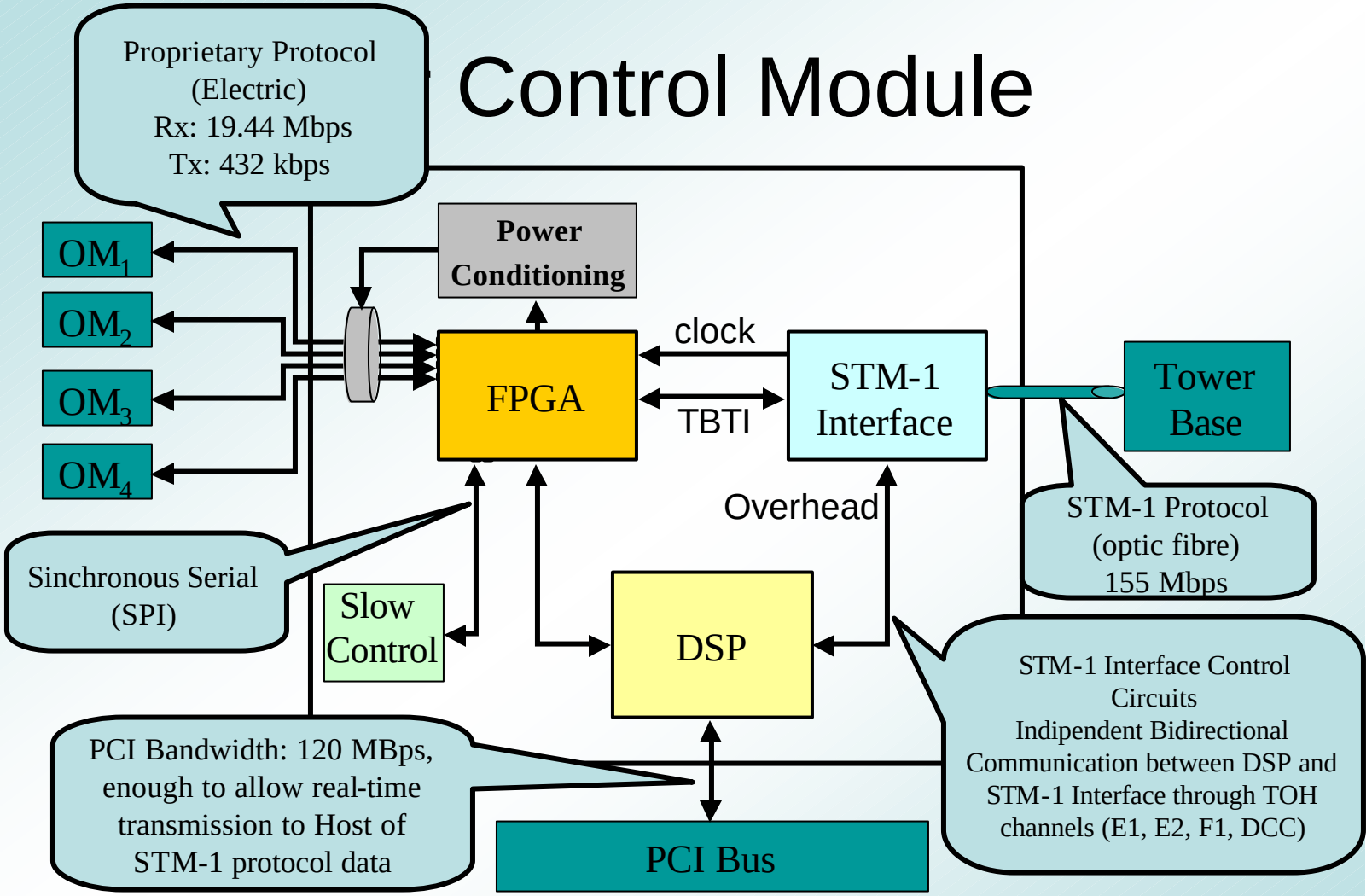
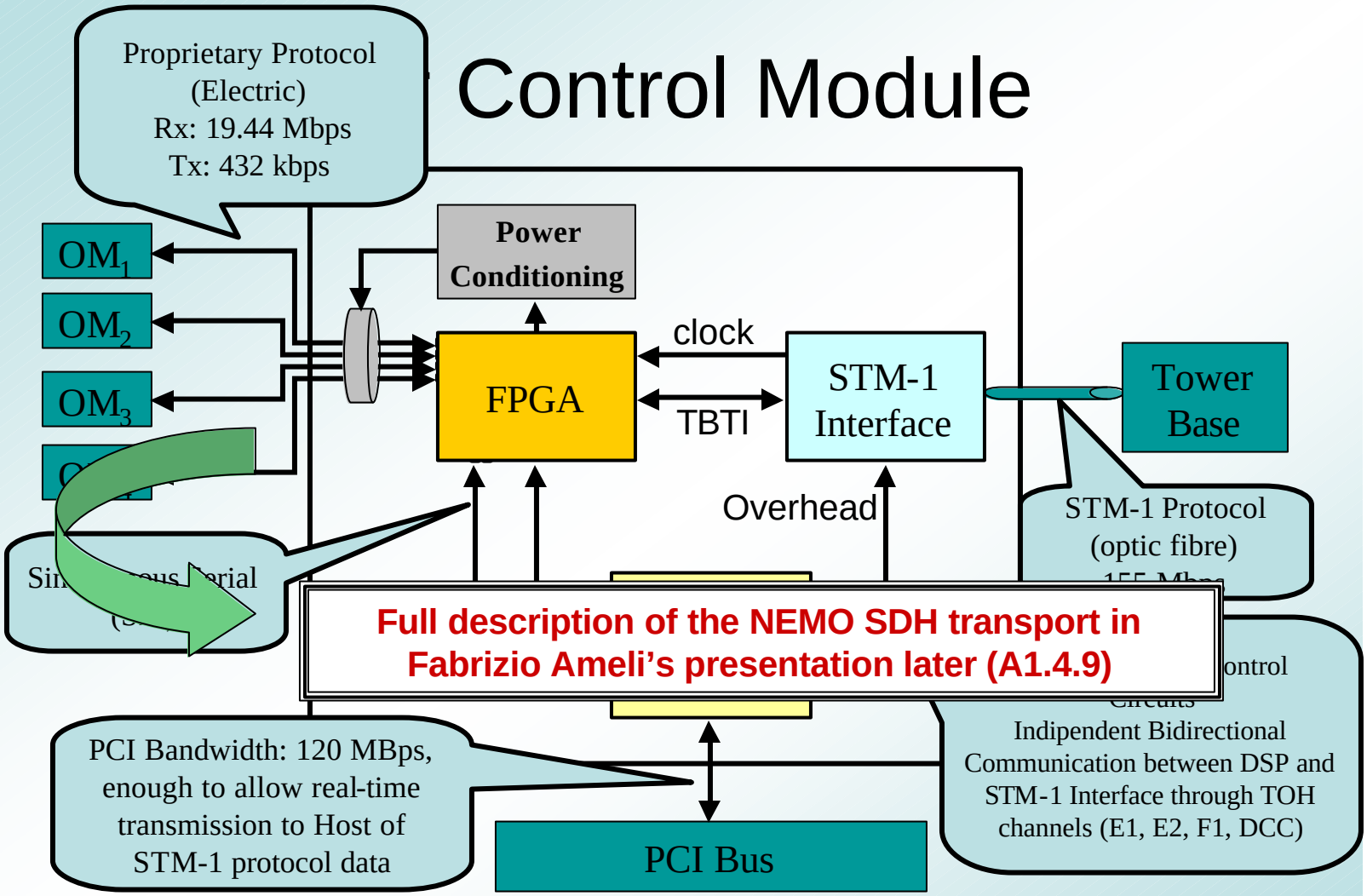


Control Module

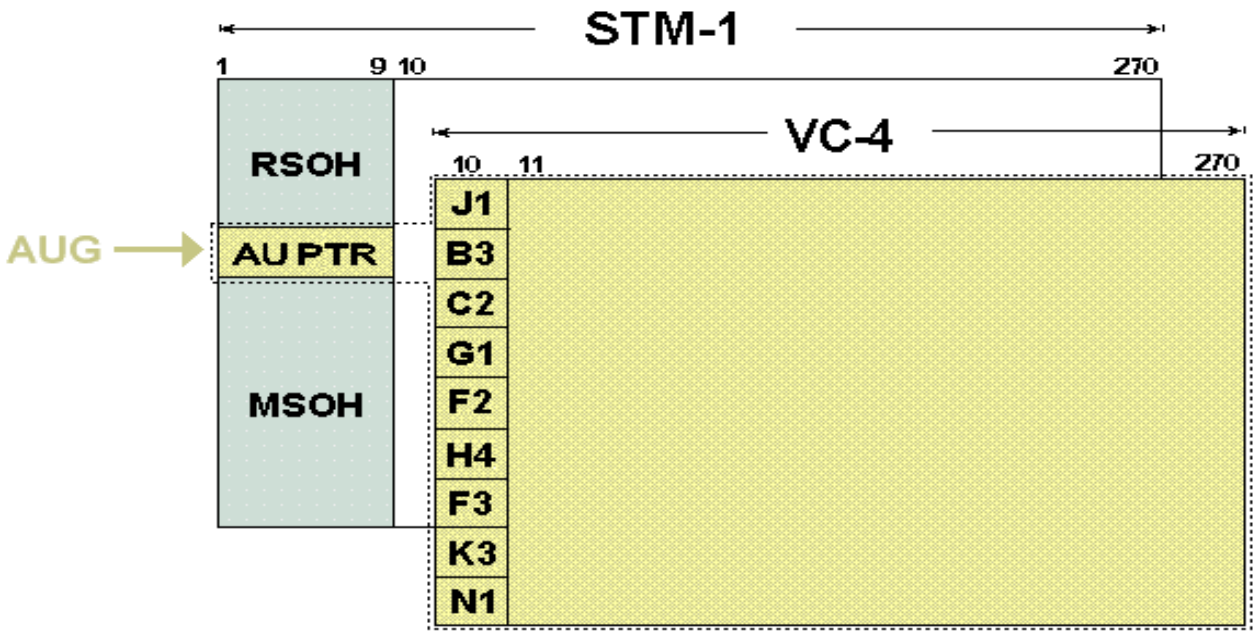


Control Module



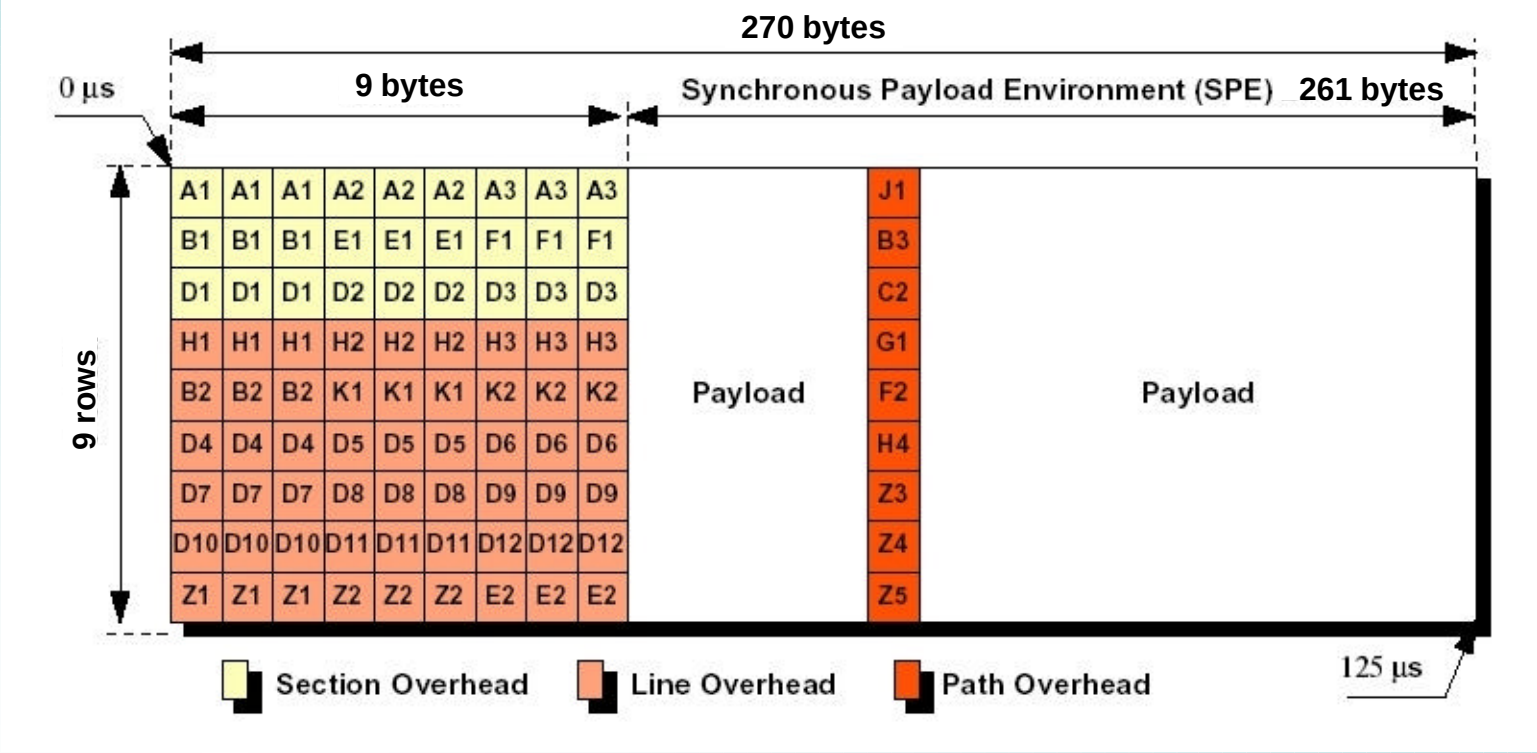
STM-1 Payload

SYNCHRONOUS TRANSPORT MODULE - 1

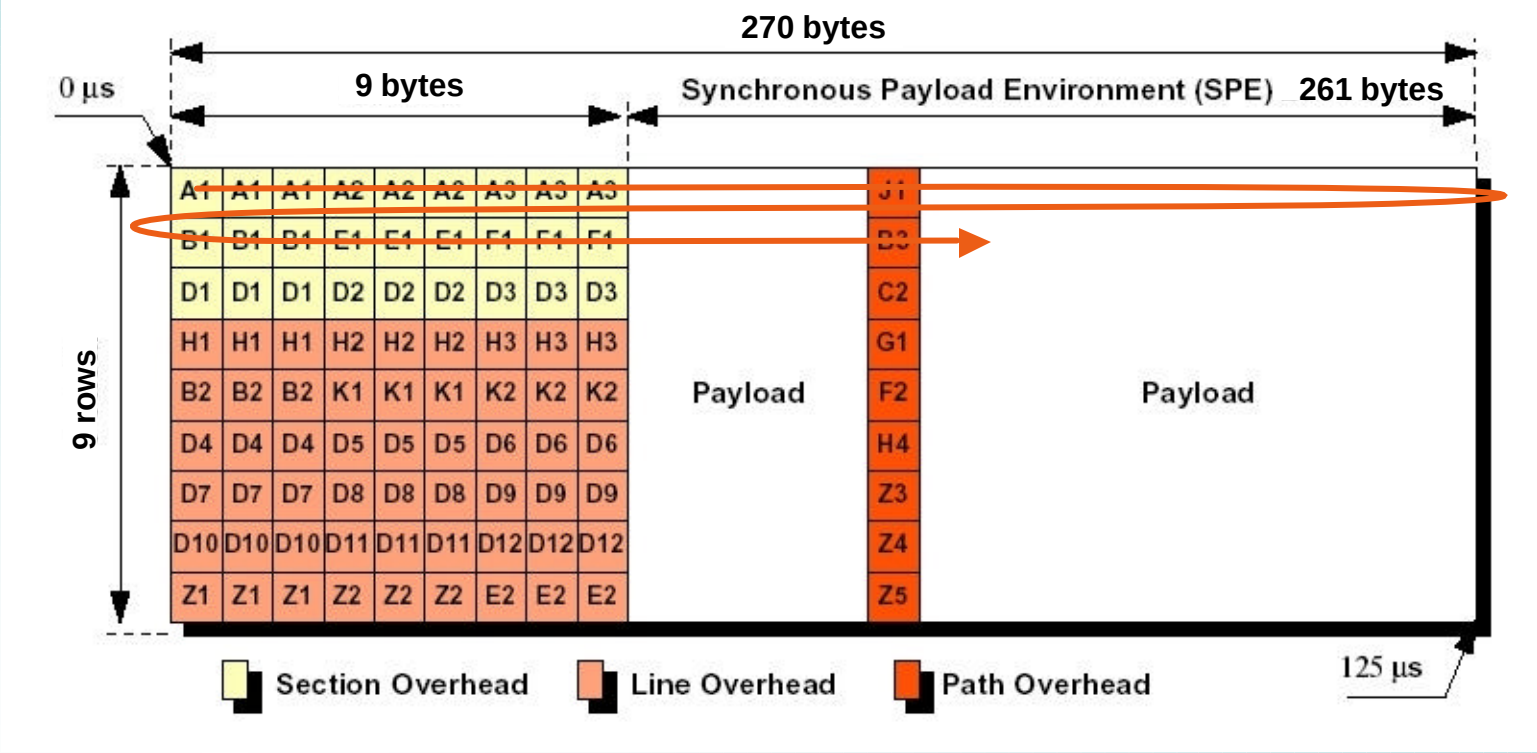


RSOH: Regenerator Section Overhead.
MSOH: Multiplexer Section Overhead.

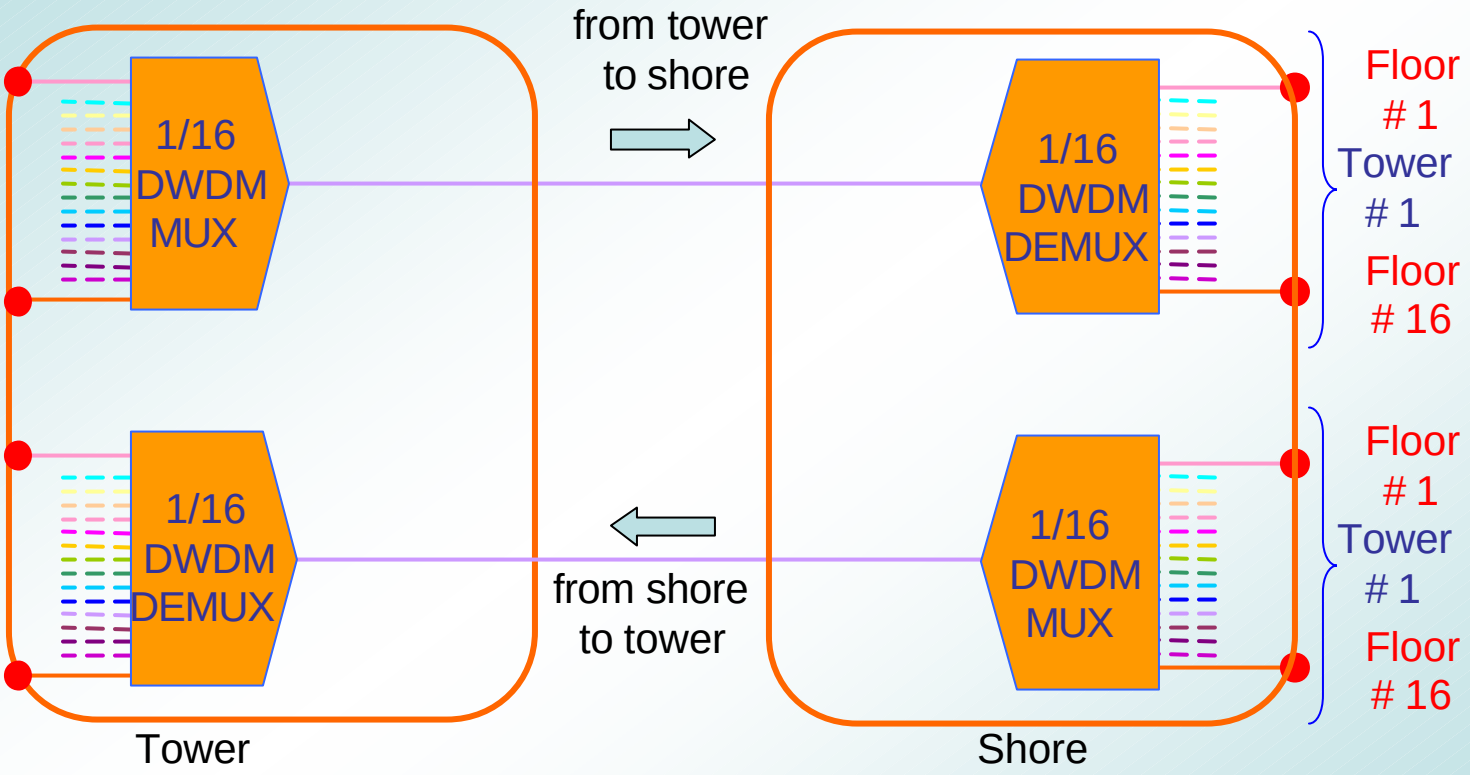
SDH STM-1 data frame



SDH STM-1 data frame



(DWDM) DATA TRANSPORT in NEMO



One colour per floor (50 GHz spacing)

Time measurements in NEMO

1. The signals from the Optical Modules are continuously sampled at 200 MHz (by means of two 'staggered' ADC's)

2. When a threshold value (remotely programmable through slow control) is met, the over-threshold samples, plus a fixed number of pre-trigger samples, are stored in a FIFO for transmission to shore

3. The readout at the trigger time of a 16-bit 100 MHz counter is stored together with the sampled signals

Synchronization in NEMO

1. The clock signal is recovered offshore (in each Floor Control Module) from the SDH frames received from the onshore station

2. The SDH mapper inside the FCM recovers a low-jitter 19.44 MHz clock (also used to clock out the 'payload' data received in the SDH data frames)

3. A 1.215 MHz clock is delivered from the FCM to the Optical Modules

4. This 1.215 MHz clock is fed to a PLL to give rise to the 100 MHz clock used for all front-end operations

Timing calibration in NEMO

Two different problems:

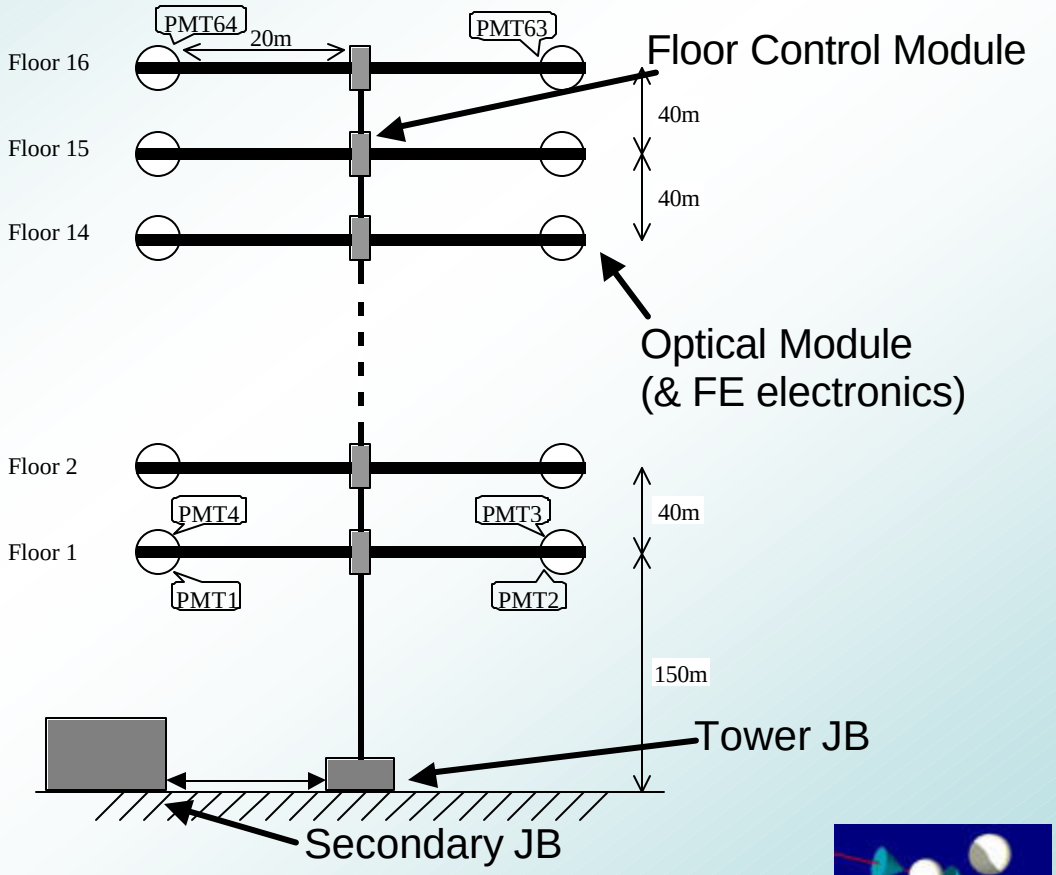
- **Compare the time measured in the apparatus with UTC time ("absolute" timing calibration)**

Same problem for all neutrino telescopes

- **Determine the offsets in local time measurements ("relative" timing calibration), i.e. the propagation time of commands and clock signals from onshore to offshore**

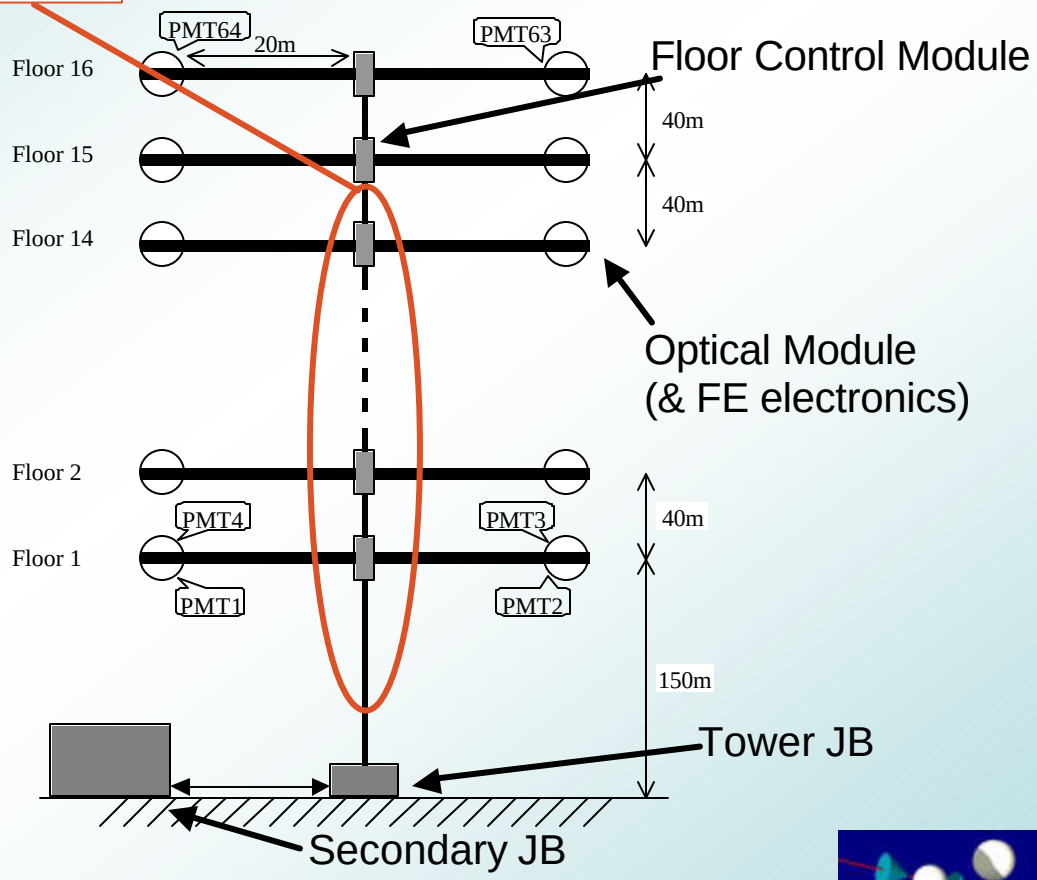
Same problem for all neutrino telescopes if the digitization and time measurements are performed offshore

Time calibration in NEMO (the approach)



Time calibration in NEMO (the approach)

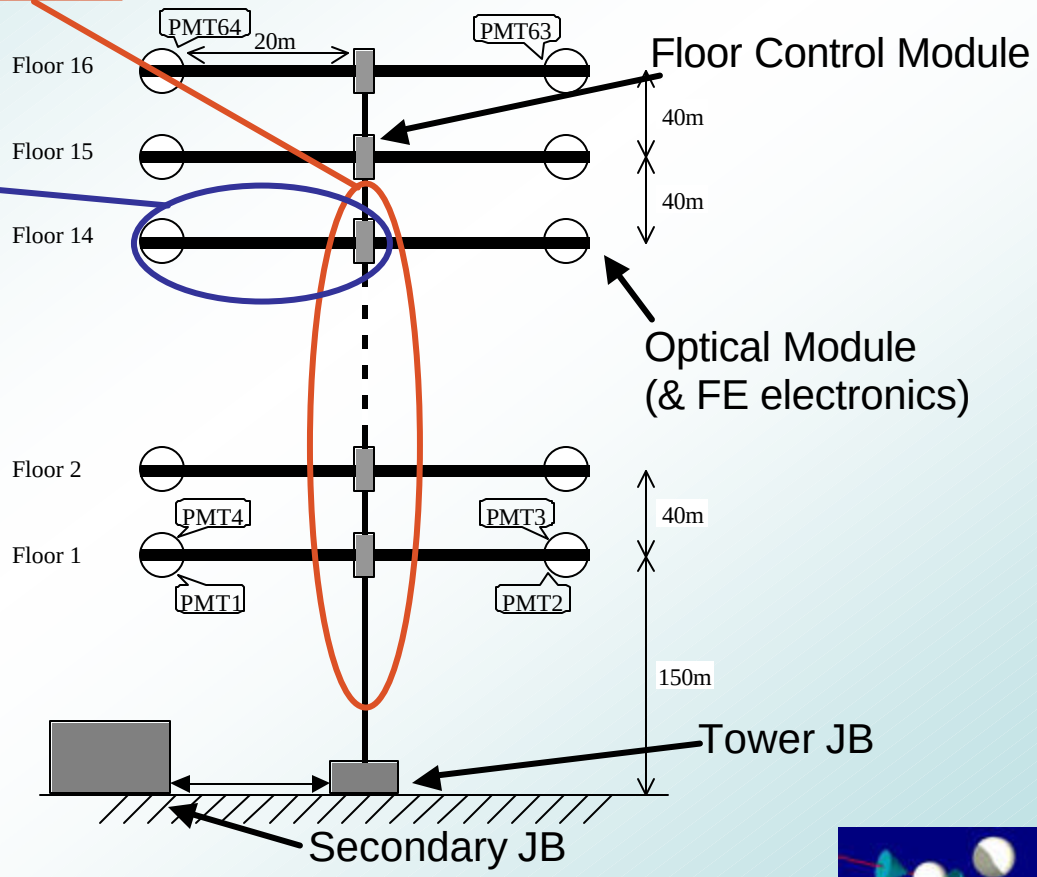
I. SDH “echo” calibration



Time calibration in NEMO (the approach)

I. SDH "echo" calibration

II. Optical calibration

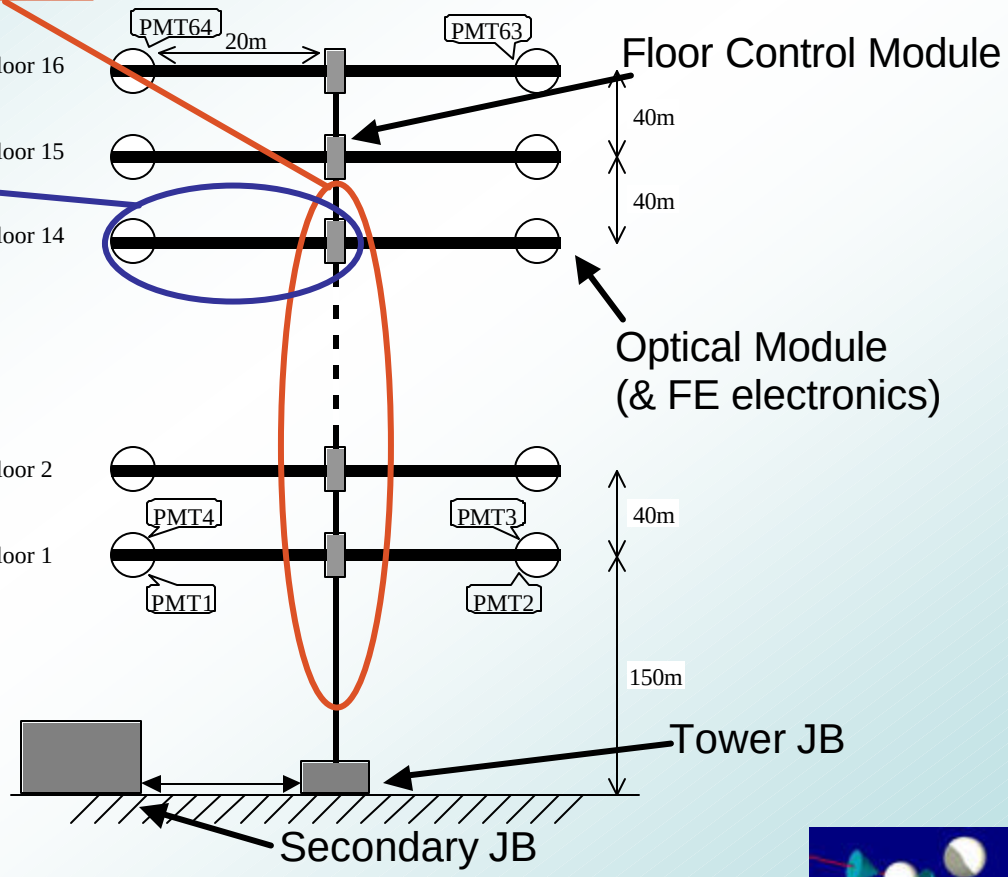


Time calibration in NEMO (the approach)

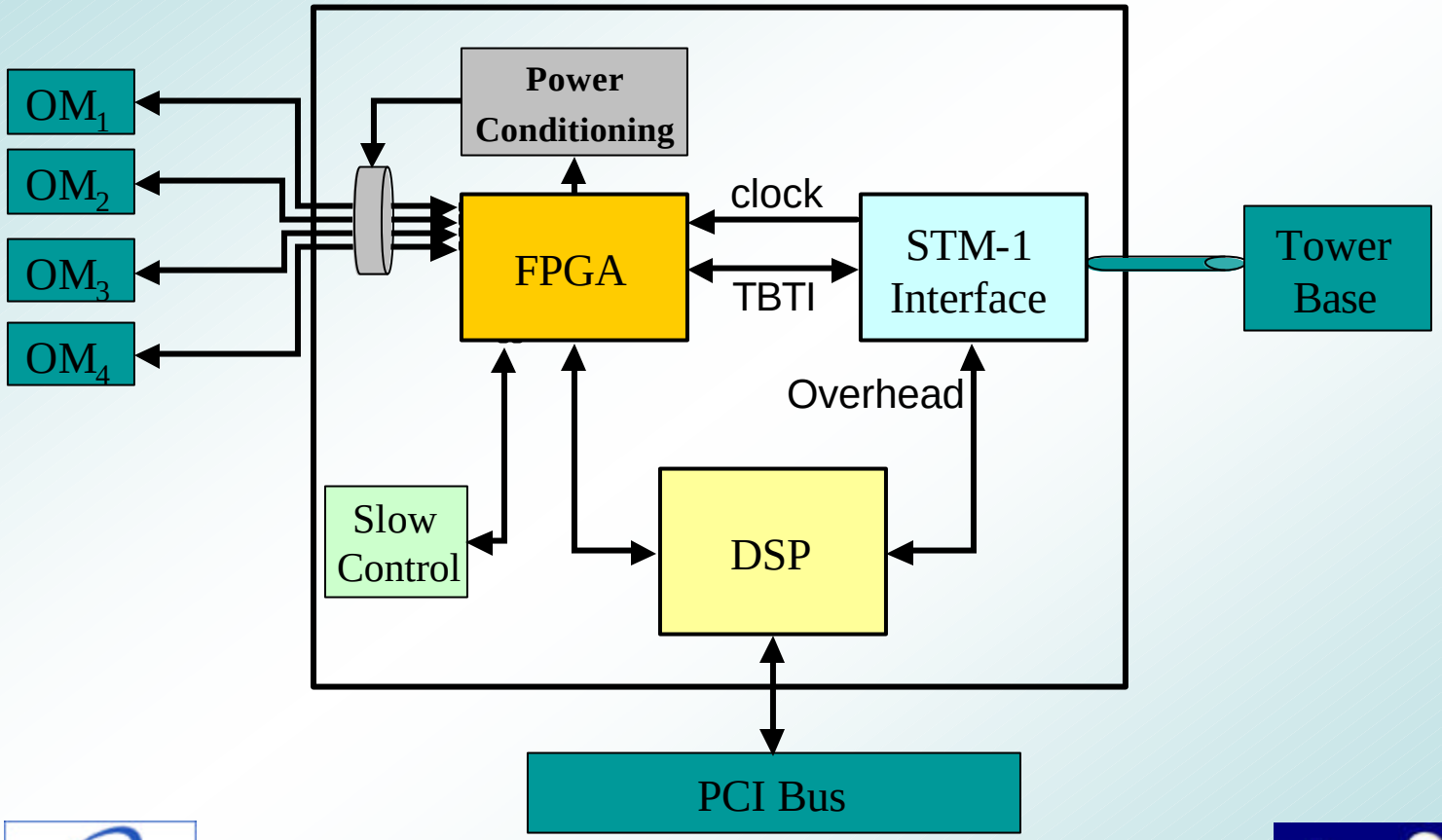
I. SDH “echo” calibration

II. Optical calibration

III. Shore station:
It will be equipped for the SDH “echo” time measurements and with GPS



The FCM interface to the timing calibration system



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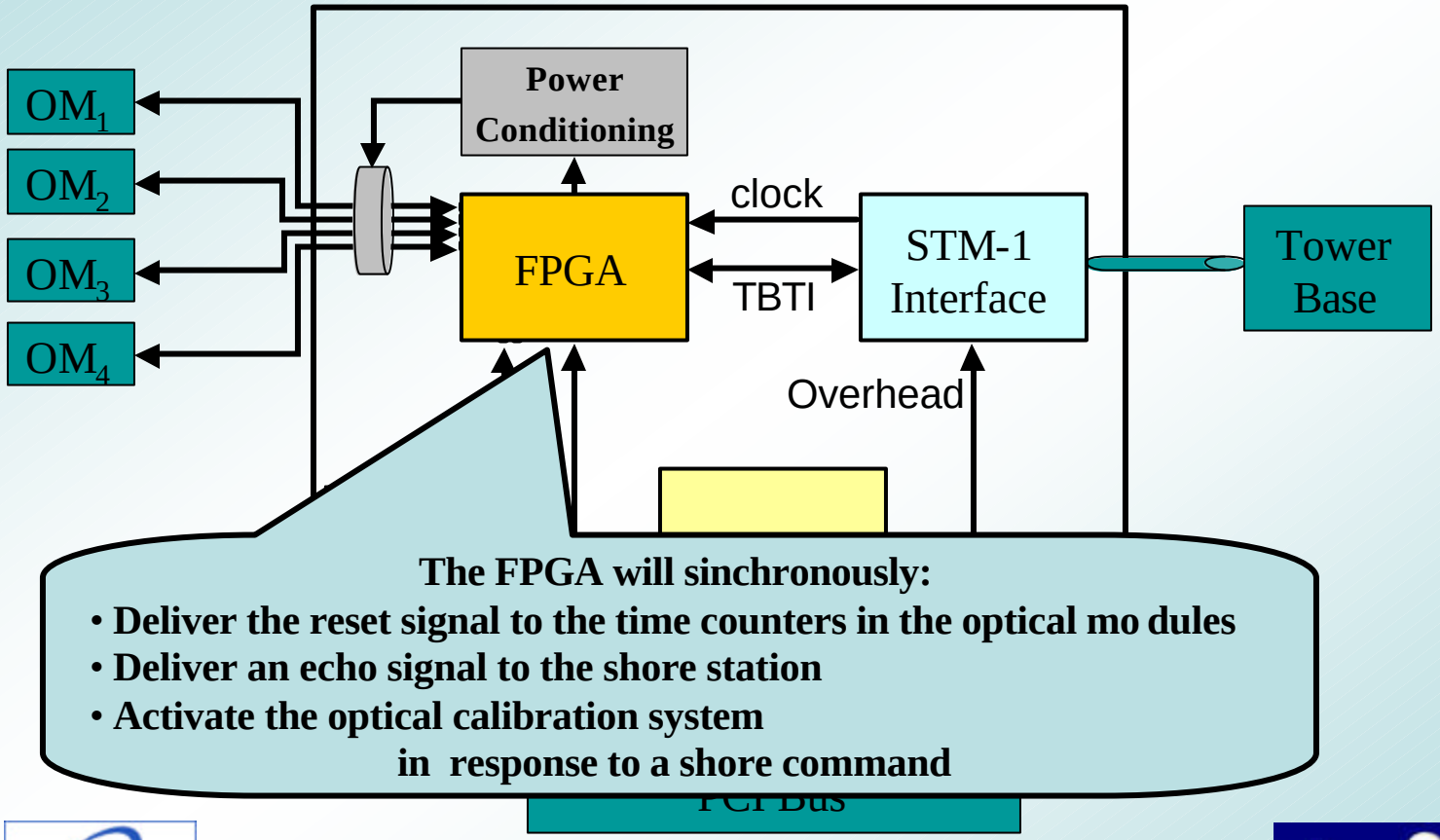
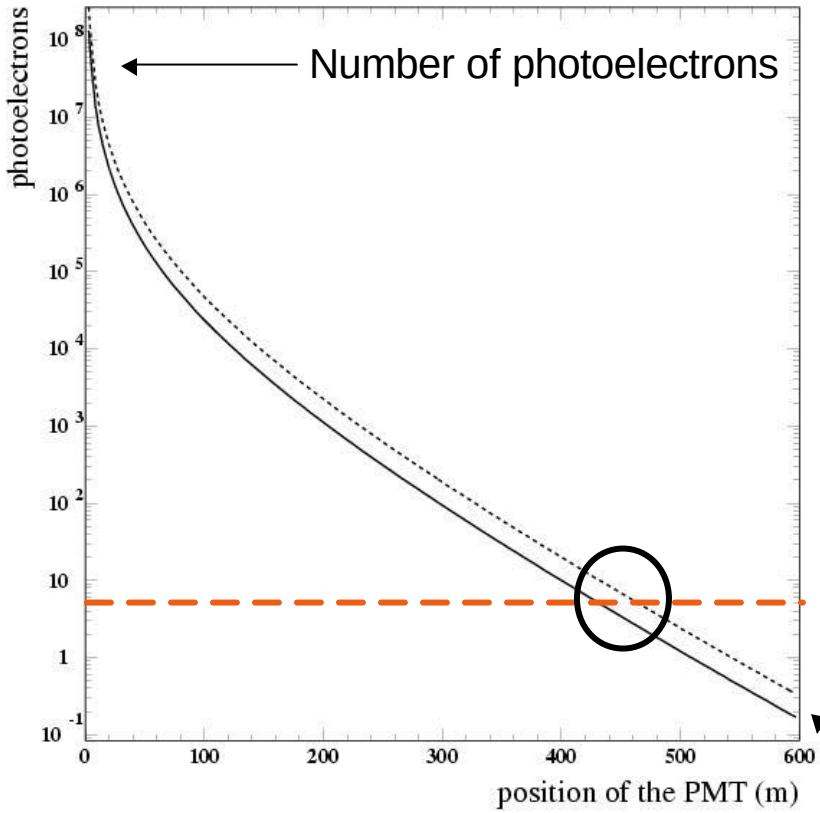


The FPGA will sinchronously:

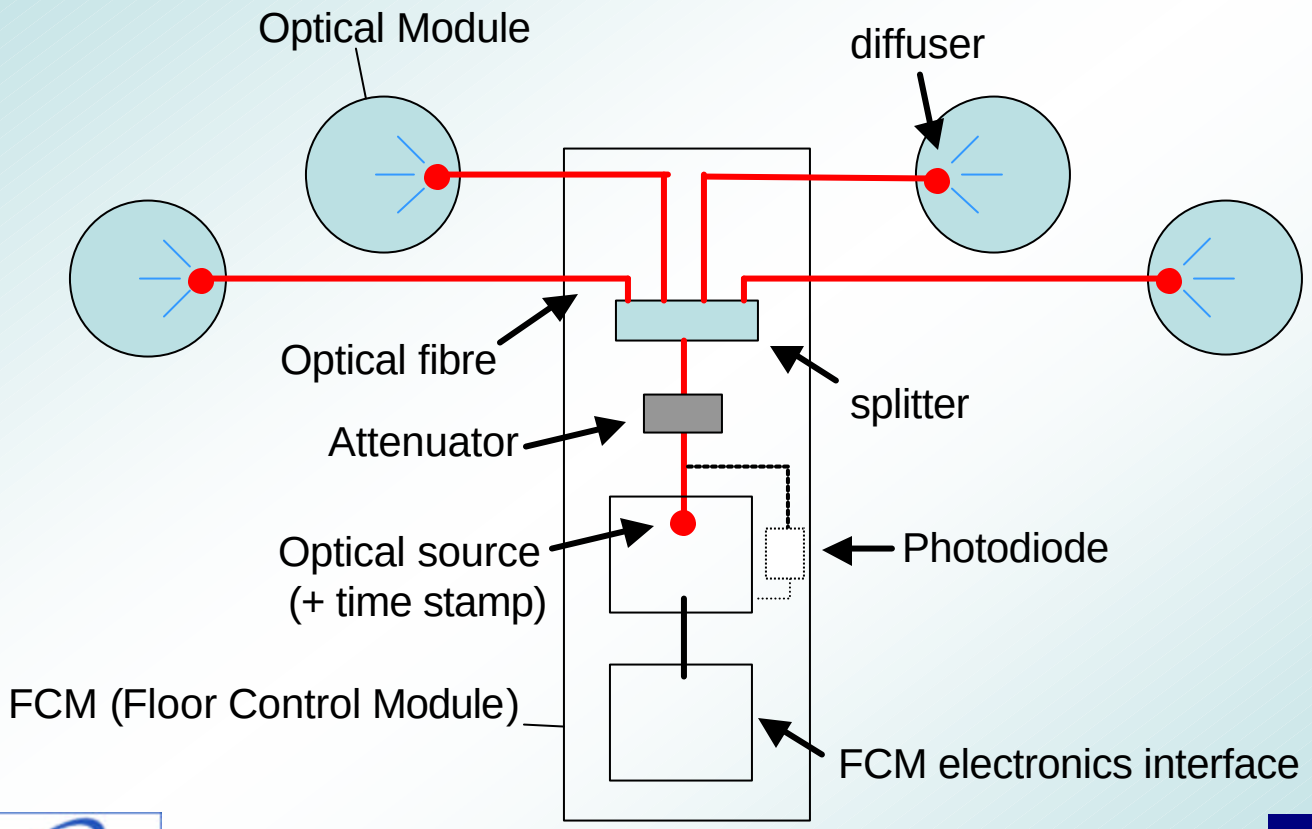
- **Deliver the reset signal to the time counters in the optical mo dules**
- **Deliver an echo signal to the shore station**
- **Activate the optical calibration system in response to a shore command**

Optical beacons are ineffective for km^3-scale detectors!



M. Circella and the NEMO Coll., Timing Calibration in NEMO
VLVnT workshop, Amsterdam, October 2003

Optical calibration system



Timing calibration in NEMO: conclusions and perspectives

- The relative timing calibration will be performed by means of a SDH "echo" measurement and an optical calibration system
- Interface with the data trasport system under definition
- Different choices under study for the optical calibration system