Concept of the Real-time Monitoring System for the ESS Phase Reference Line

Dominik Sikora, K. Czuba, P. Jatczak, R. Papis - ISE, Warsaw University of Technology, Poland
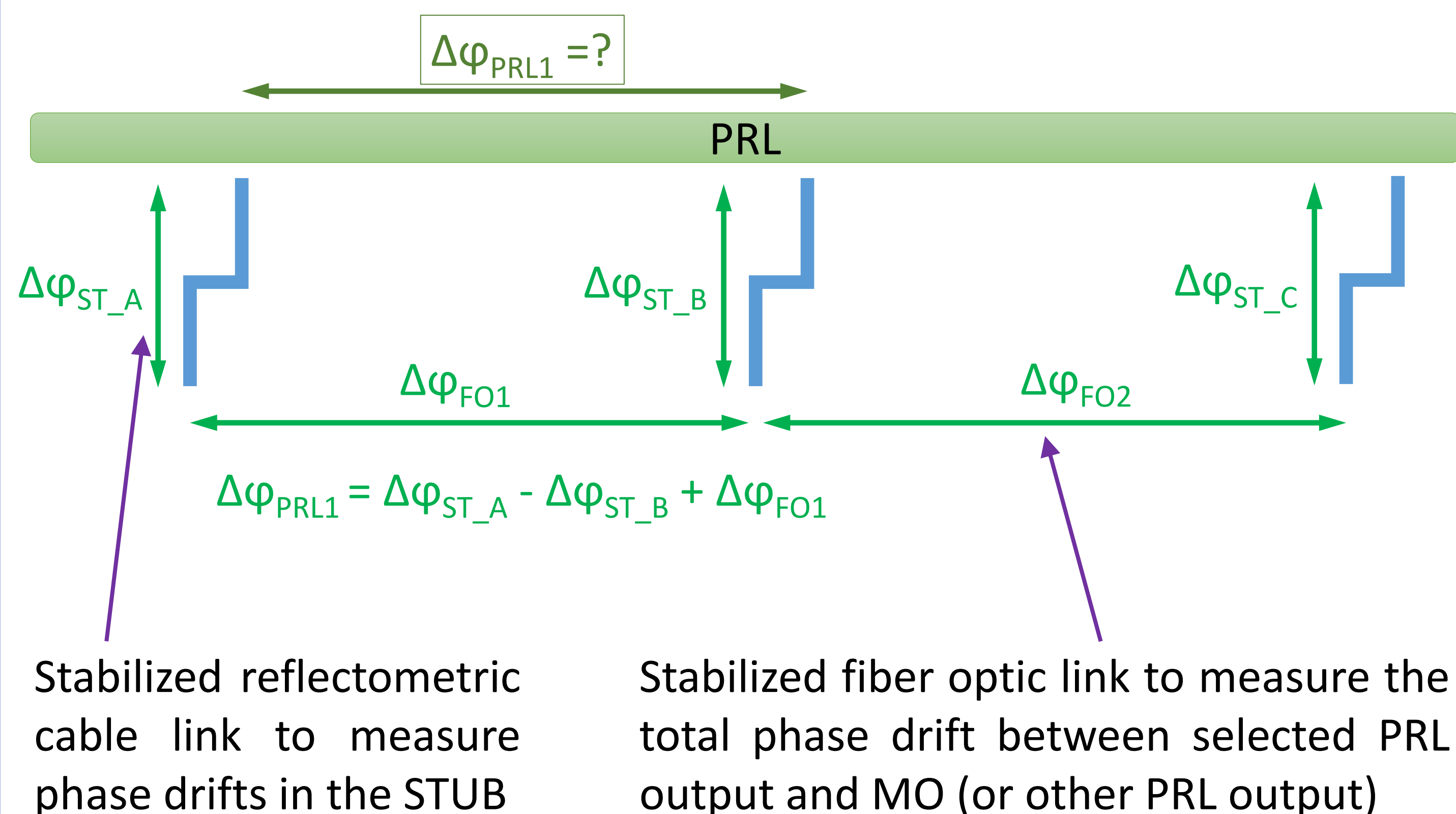M. Jensen, A. Krishna Bhattacharyya – European Spallation Source, Sweden

ABSTRACT

The Phase Reference Line (PRL) of the European Spallation Source (ESS) is a system that distributes 352.21 MHz and 704.42 MHz reference signals from Master Oscillator (MO) in Klystron Gallery (KG) to LLRF and Beam Instrumentation (BI) systems over the machine in the tunnel. It is a 580 m long system based on a 1-5/8" coaxial rigid line installed in the tunnel. Due to radiation, the system is an entirely passive structure, and possible diagnosis during the accelerator operation is an issue.

This contribution covers the design concept of a real-time PRL performance monitoring system. The system will base on active optic links measuring PRL phase performance with the assistance of reflectometer links. Reflectometers with Ethernet interface for real-time phase change measurements in cables routed through STUBs. Active optical links for PRL performance monitoring in the ESS Klystron Gallery. The assumed measurement accuracy is better than 0.1 degrees

BACKGROUND

- **PRL phase performance tests** with temporary optic links in the tunnel before the beam operation
- Fiber optic diagnostics **can not be installed permanently** in the tunnel, due to radiation

Monitoring concept:

$$\Delta\varphi_{PRL1} = \Delta\varphi_{ST\_A} - \Delta\varphi_{ST\_B} + \Delta\varphi_{FO1}$$

Stabilized reflectometric cable link to measure phase drifts in the STUB

Stabilized fiber optic link to measure the total phase drift between selected PRL output and MO (or other PRL output)

RF REFLECTOMETER IN STUB

- RF reflectometers with Ethernet for real-time measurements of phase changes in additional, same type STUB cables to estimate phase drifts of reference signals in STUBs
- Permanent installation in 3 places (close to the beginning, middle and to the end of the tunnel)
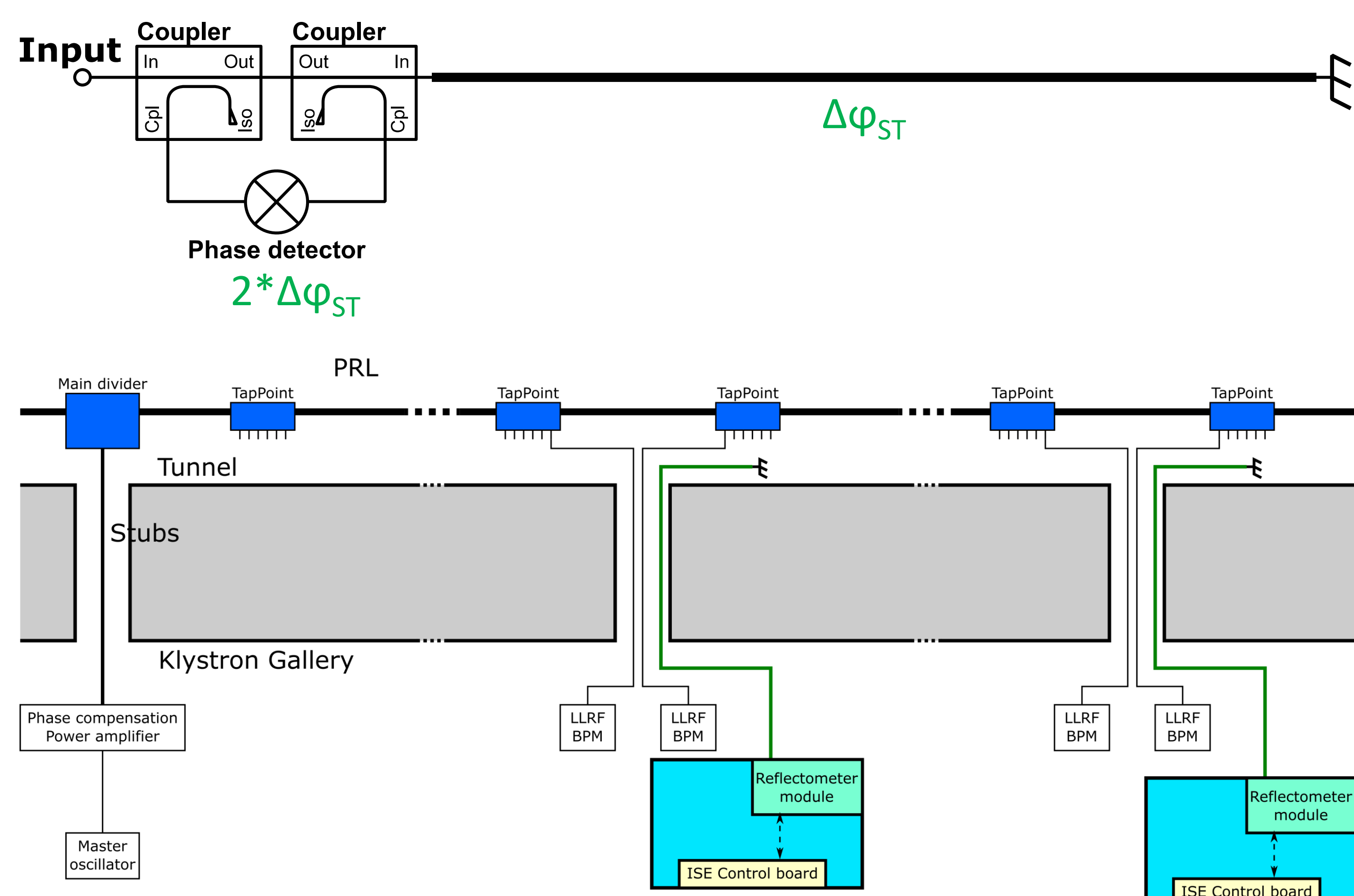

OPTIC LINK IN KLYSTRON GALLERY

- Optic link based on standard bidirectional optical RFoF transceivers
- Delay Locked Loop (DLL) applied to stabilize output phase at the STUB location with accuracy much better than 0.1 degree
- Optical link operates at 352.21 MHz and 704.42 MHz simultaneously
- FO links located in KG, due to radiation in the tunnel
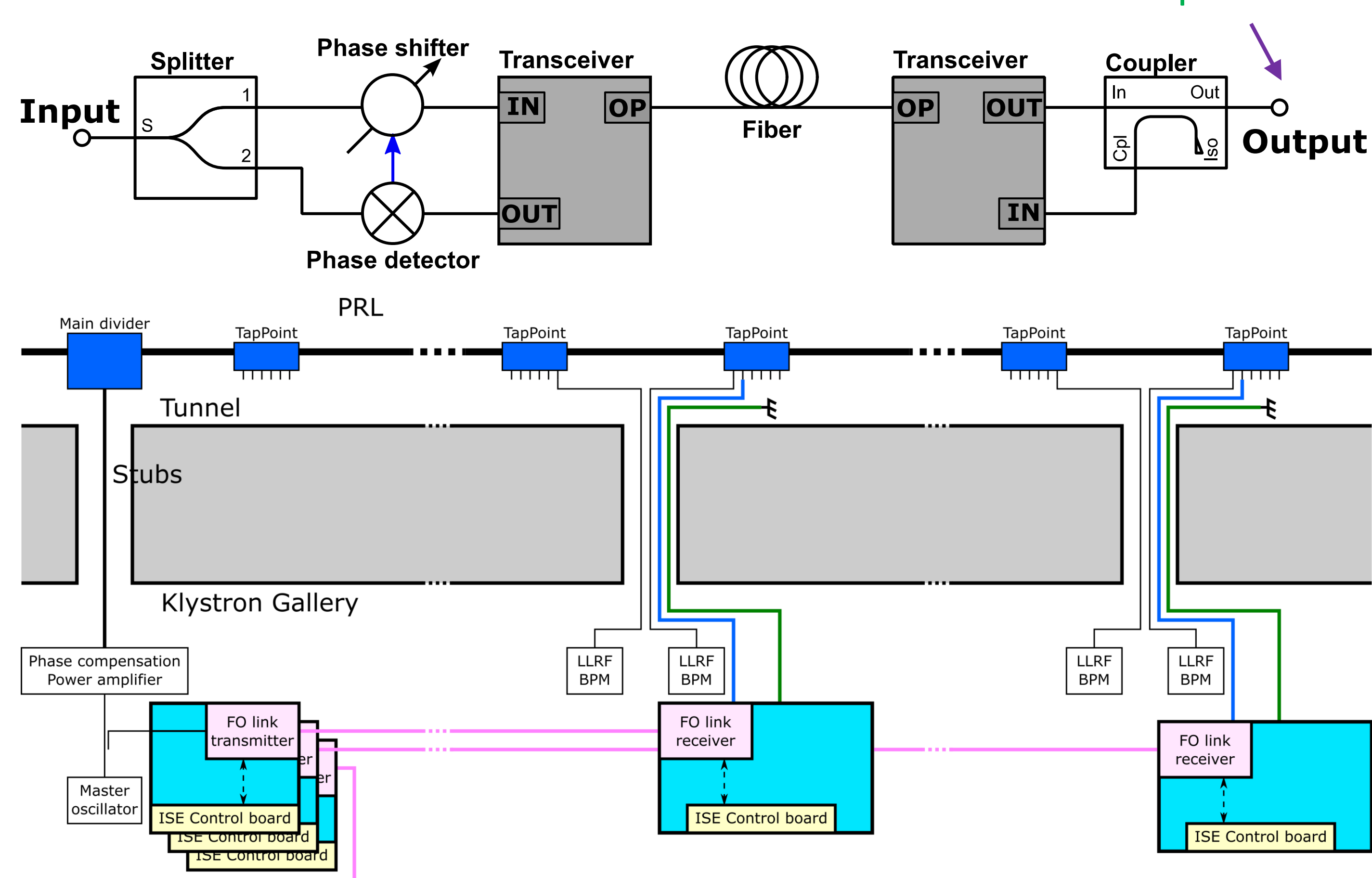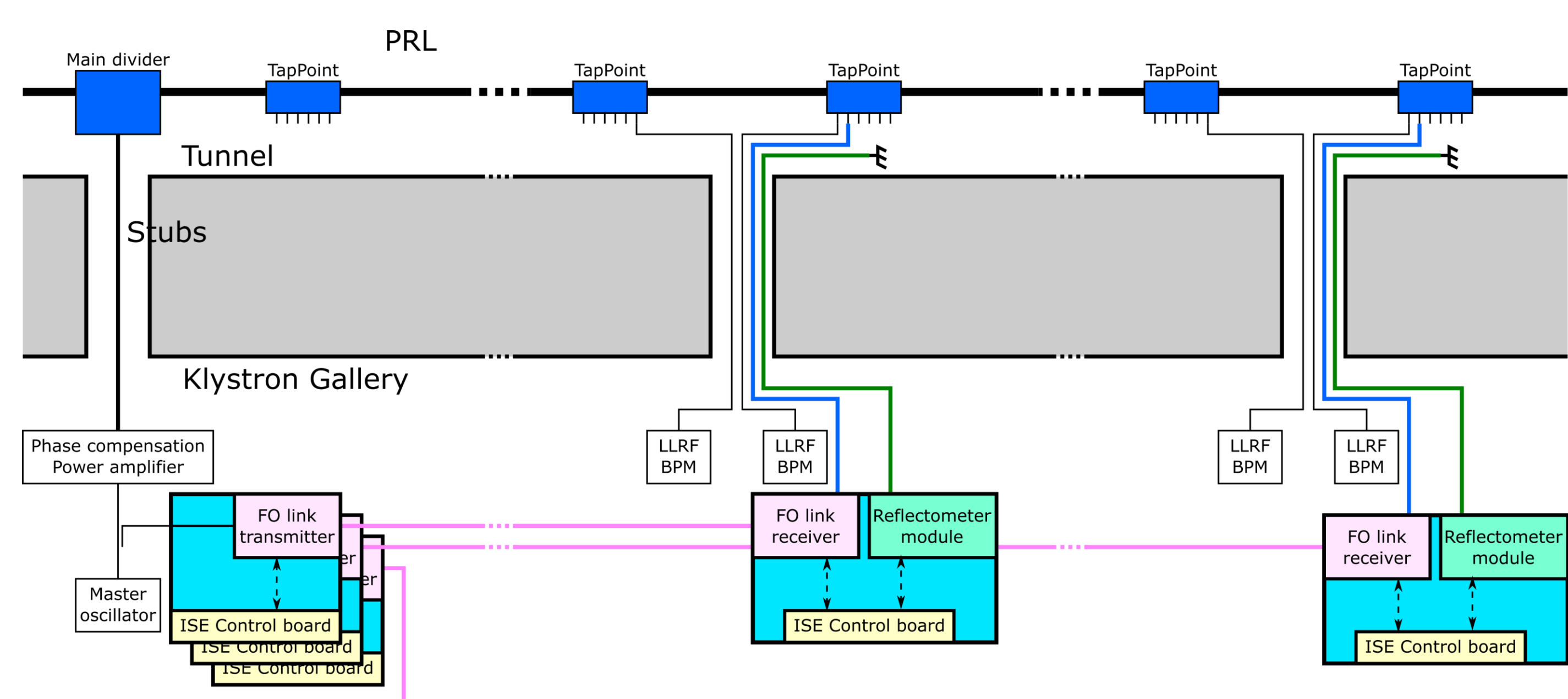

ISE CONTROL BOARD

Universal control and monitoring board:

- Linux SBC: Toradex Verdin iMX8 SOM
- 16 channels 24-bit ADC
- 8 channels 16-bit DAC
- 2 channels 20-bit DAC,
- 24x GPIO (3,3V or 5V)
- FAN/Relay control using PWM and open drain outputs
- 2x Ethernet
- RS485, SPI, I2C, UARTs,
- SD card slot
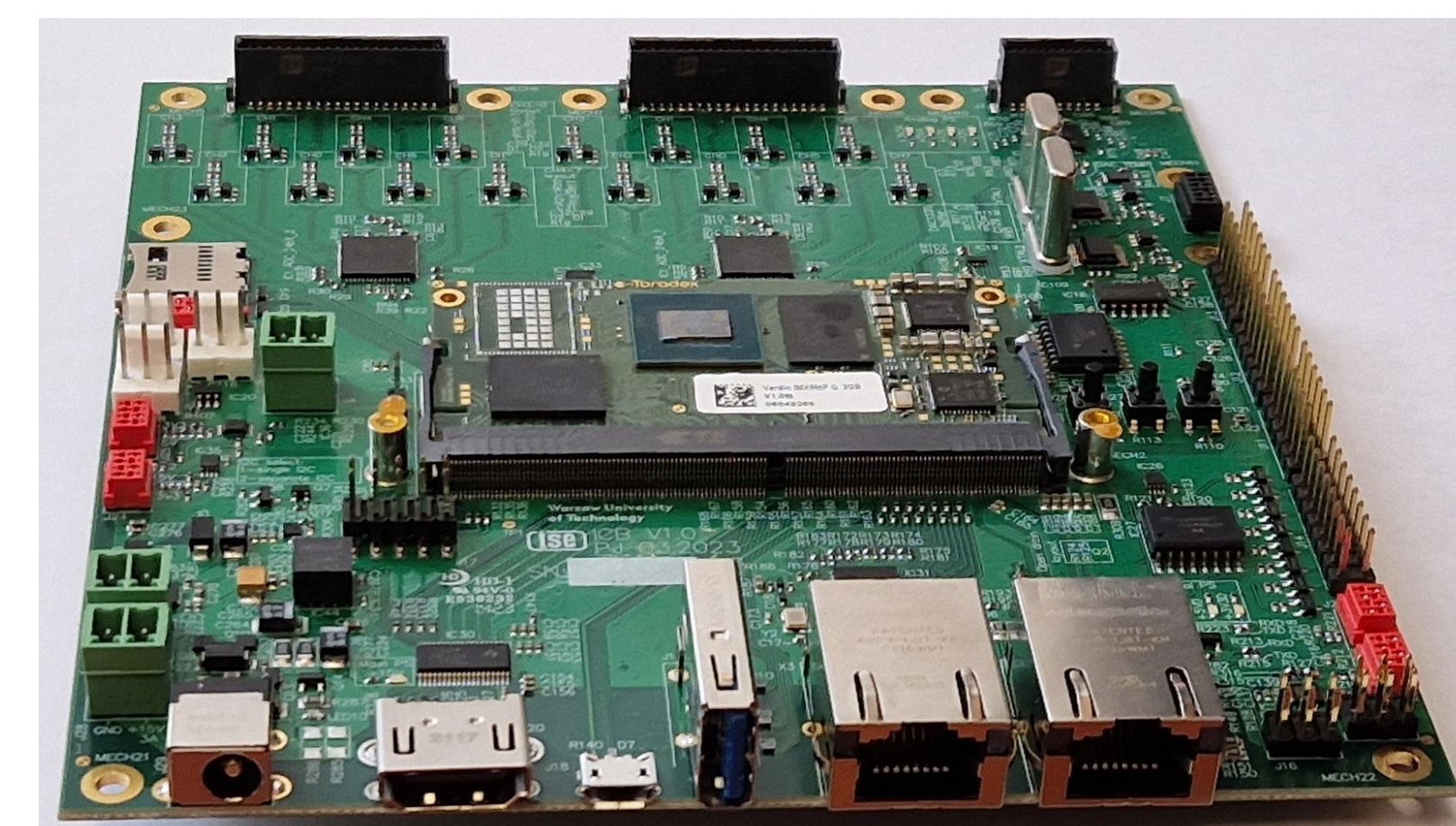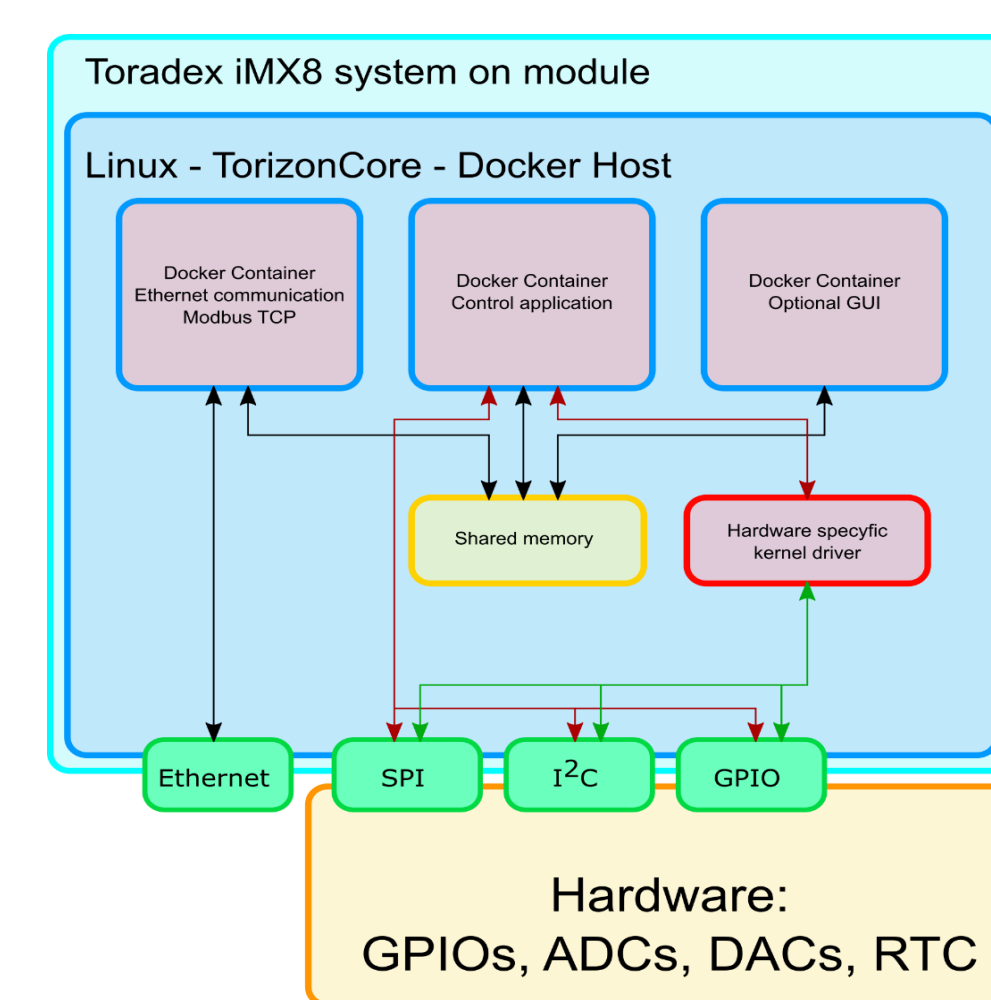
PRL MONITORING SYSTEM

- Total phase drift measurements with assumed accuracy better than 0.1 degrees
- Software to estimate PRL phase drifts between two points based on reflectometer measurements

CONTACT

Dominik.Sikora@pw.edu.pl

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