SPI boards package and applications for Beamlines

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On behalf of Electronic Control and Data Acquisition team

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- Introduction
- The requirements
- SPI Board Principle
- The developed Boards
- Application’s examples
- Conclusion

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introduction

- What is the SPI* boards package?
  - It's a set of electronic boards developped by ECA group. These boards can be connected together in daisy chain and they communicate to the embedded controller through SPI Bus.

- Objectives
  - To have platform allowing us to built specific solution with simple and opened tools.
  - To have a modular architecture
  - To provide solutions for applications which require synchronization.
  - To implement the process at low level to achieve better performance.
  - To connect easily to Soleil control network.

* Serial Peripheral Interface

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The requirements

- Development are coordinated and implemented for new requirements:
  - Upgrade of magnet insertion devices control to improve the feed-forward
  - Control of EMPHU (rapid undulator combining coils and permanent magnets)
  - Process encoder signals

* SSI:Synchronous Serial Interface

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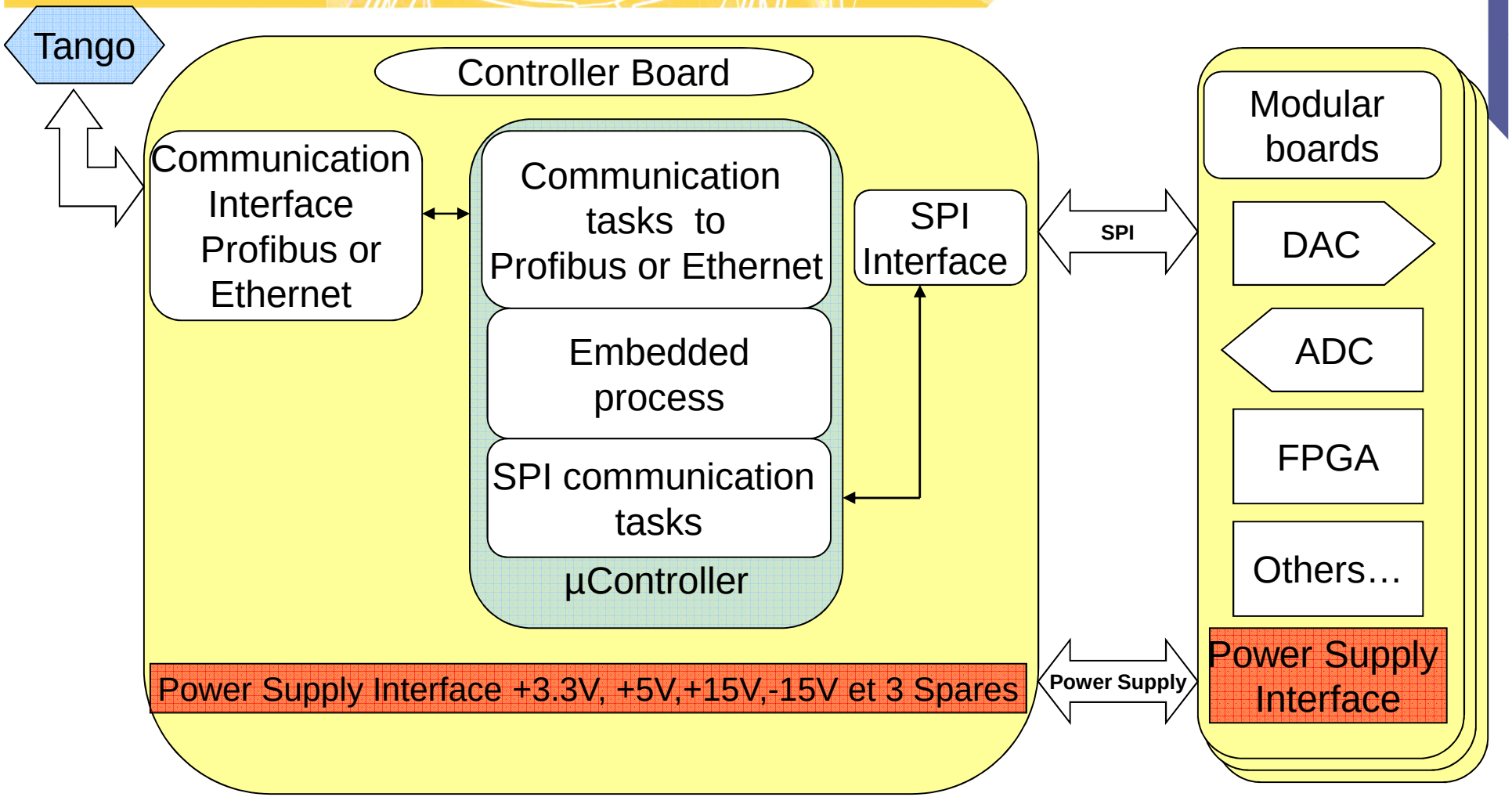
SPI package principle

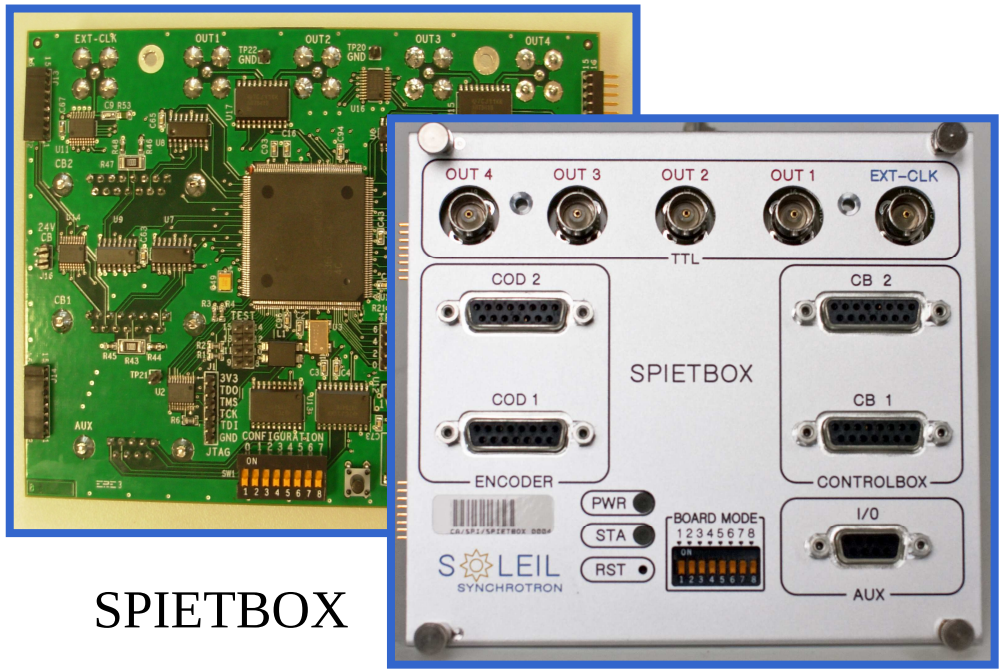


Boards

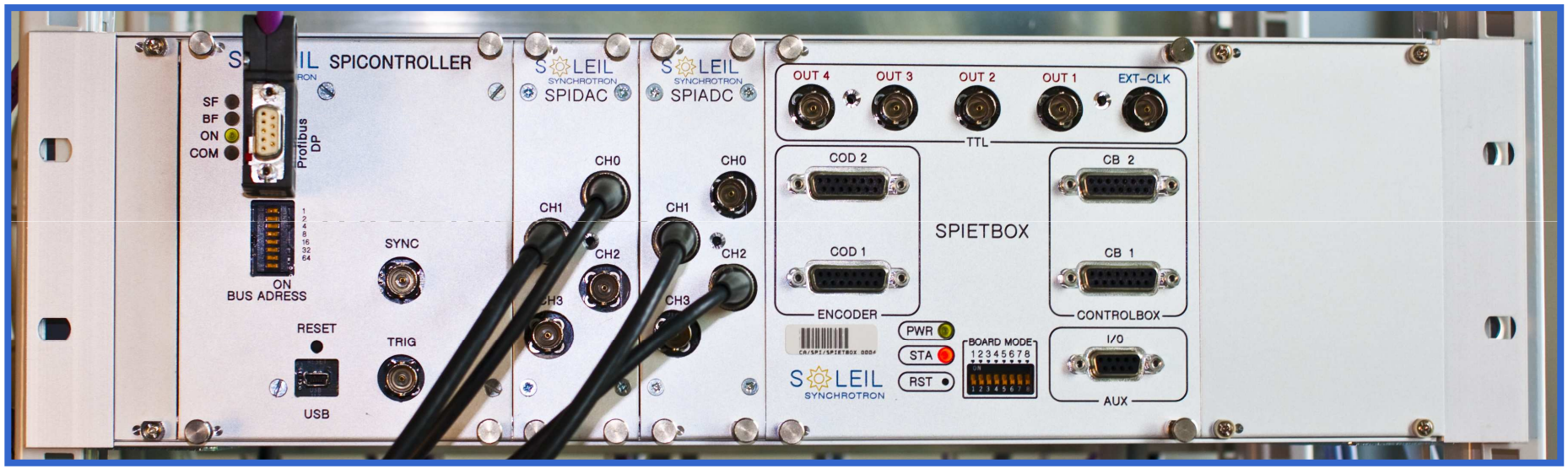
- Modular Boards:
  - SPIDAC: DAC 4 channels board, 16 bits, ±10V
  - SPIADC: ADC 4 channels board, 16 bits, ±10V
  - SPIETBOX: encoder signal processing board

SPIDAC

SPIADC



SPIETBOX


SPICONTROLLER
SPIDAC
SPIADC
SF
BF
ON
COM
Profibus DP
ON
BUS ADRESS
RESET
USB
SYNC
TRIG
CH0
CH1
CH2
CH3
OUT 4
OUT 3
OUT 2
OUT 1
EXT-CLK
TTL
COD 2
COD 1
ENCODER
SPIETBOX
CB 2
CB 1
CONTROLBOX
I/O
AUX
PWR
STA
RST
BOARD MODE

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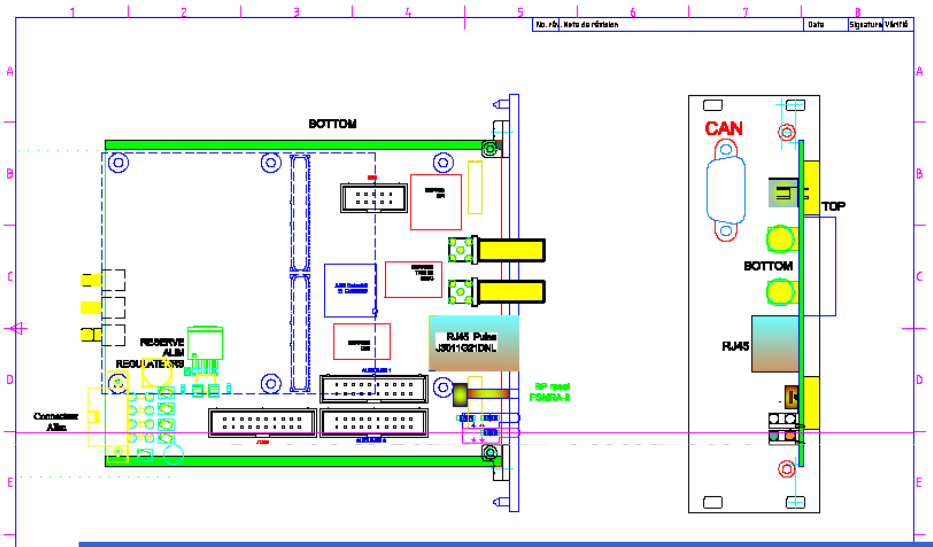
SPICONTROLER

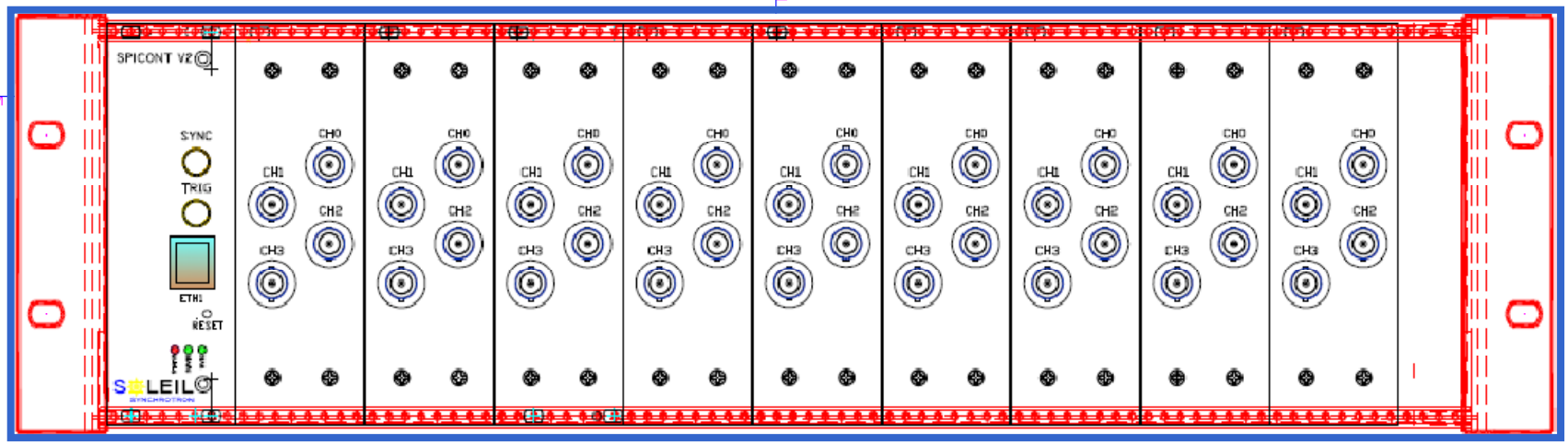
SPICONTROLER

This board manage the communication with control system and the embedded process.

- ✓First version available with a Profibus interface (Profichip VPC3 ASIC) and the old 8051 microcontroller from Intel

- ✓Second version (in development) based on ARM Cortex M3 microcontroller which integrate the Ethernet interface
  - ➔Board in design: first prototype planed for end of Q1/2011

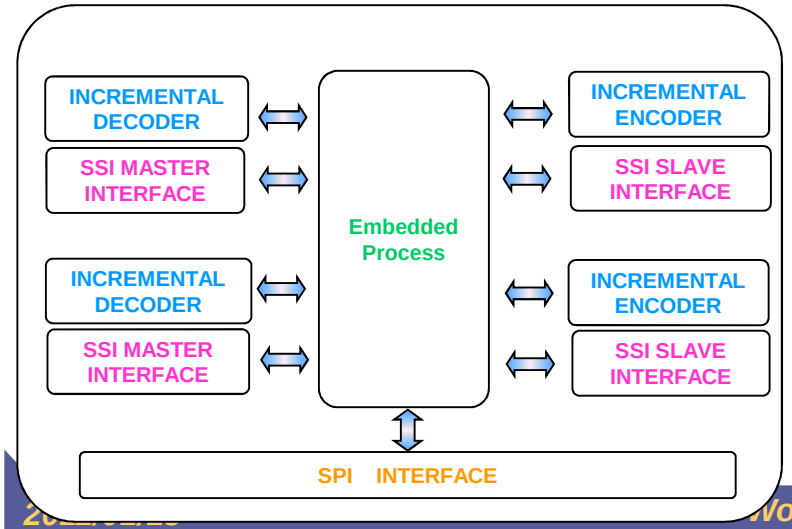

BOTTOM
CAN
TOP
BOTTOM
RJ45

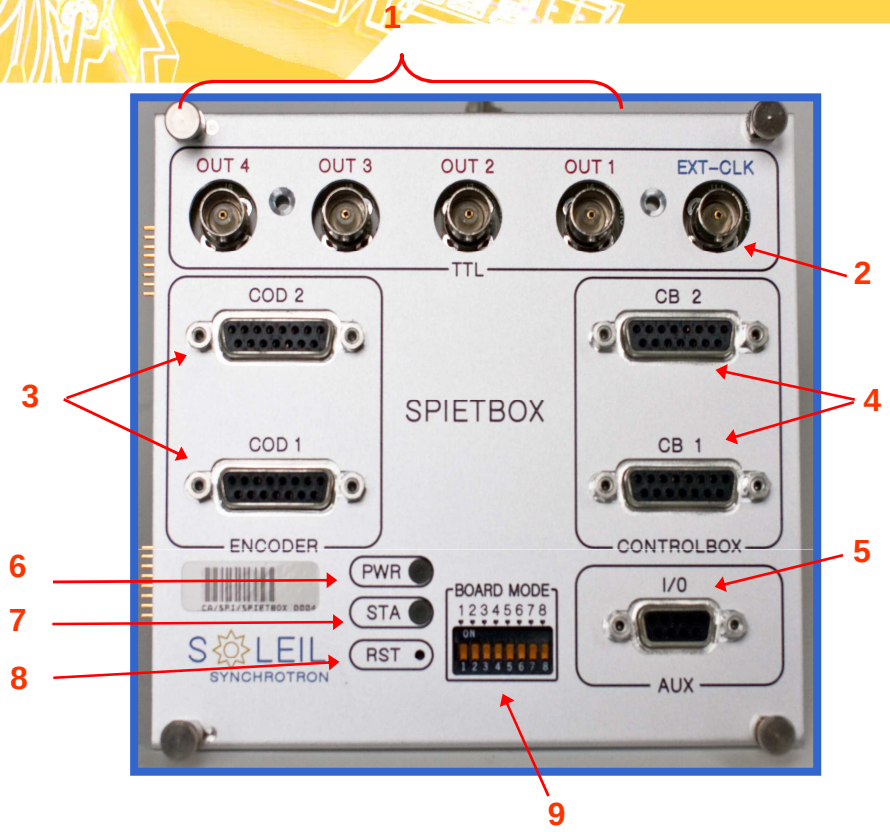

SPICONT V2
SYNC
TRIG
ETH1
RESET
CH0
CH1
CH2
CH3

SPIETBOX

SPIETBOX

1. 4 TTL Output
2. 1 TTL Input
3. 2 Soleil standard Encoder Input
4. 2 Soleil standard Encoder Output
5. Aux Port : 4TTL Output / 4 TTL Input
6. Power Supply Led
7. Status Led
8. Reset Botton
9. 8 Switches for Board standalone configuration





Based on a SPARTAN 3 FPGA

Works in standalone or connected to SPICONTROLLER

Functionalities

- ✓ Encoder signals duplication
- ✓ Interfacing incremental encoder signals to our standard counter board
- ✓ Protocol Converting
  - ➔ incremental encoder signal in « PULSE » and « DIR »
  - ➔ single turn absolute encoder to multiturn absolute encoder…
- ✓ Calculation on multiple encoders
- ✓ Fly-scan: Generation of Trigger depending on time or encoder position

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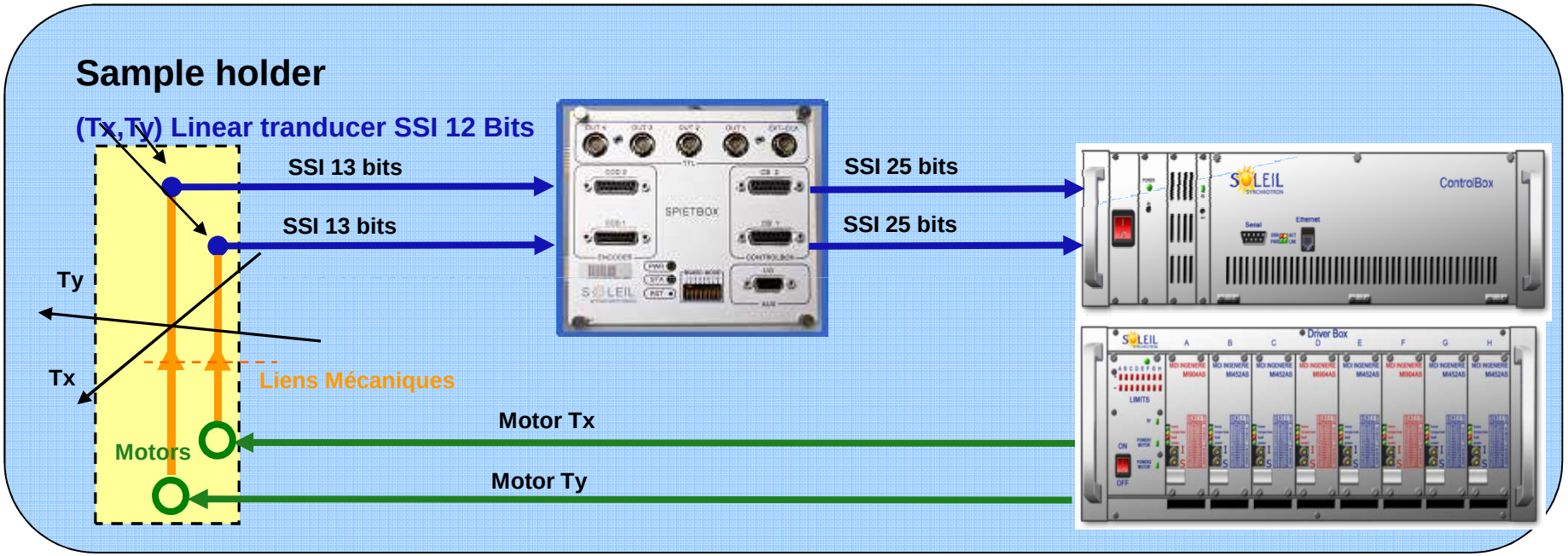
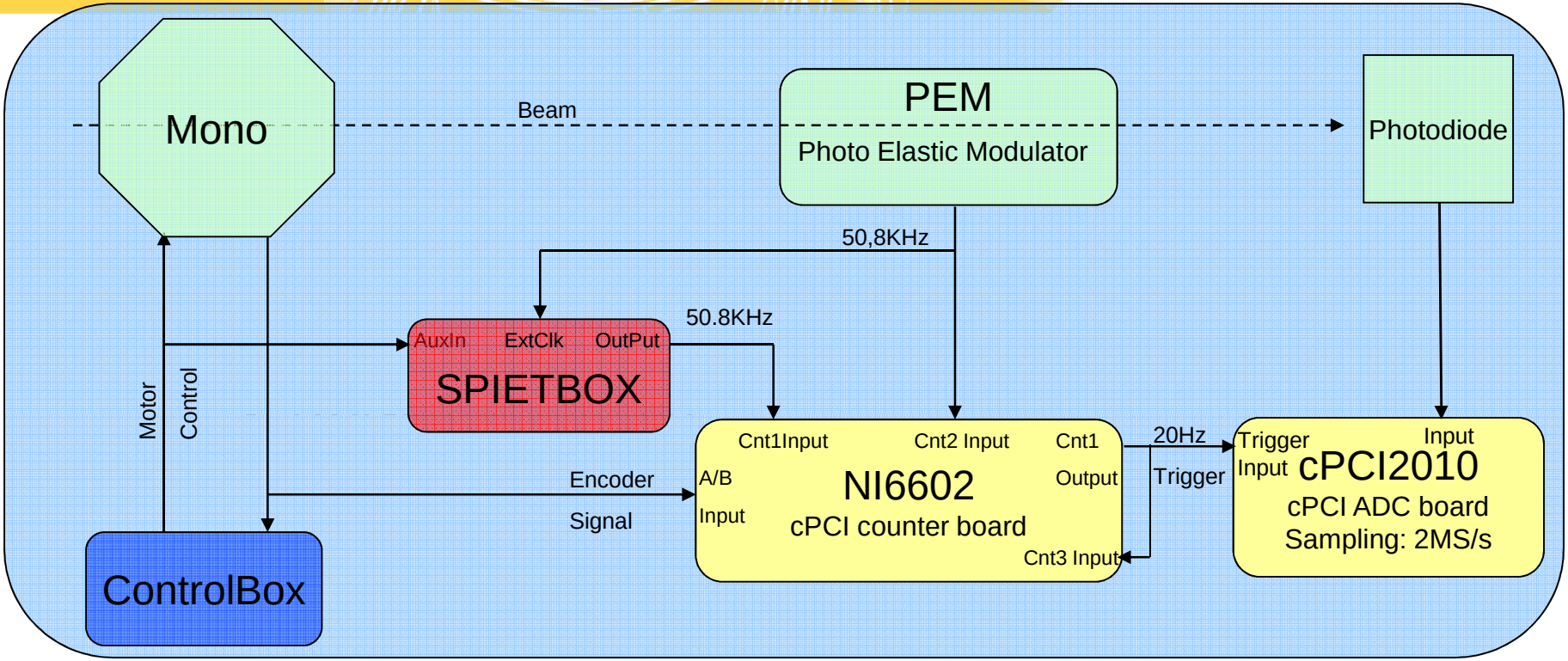
Tempo beamline: SSI Protocole Translation



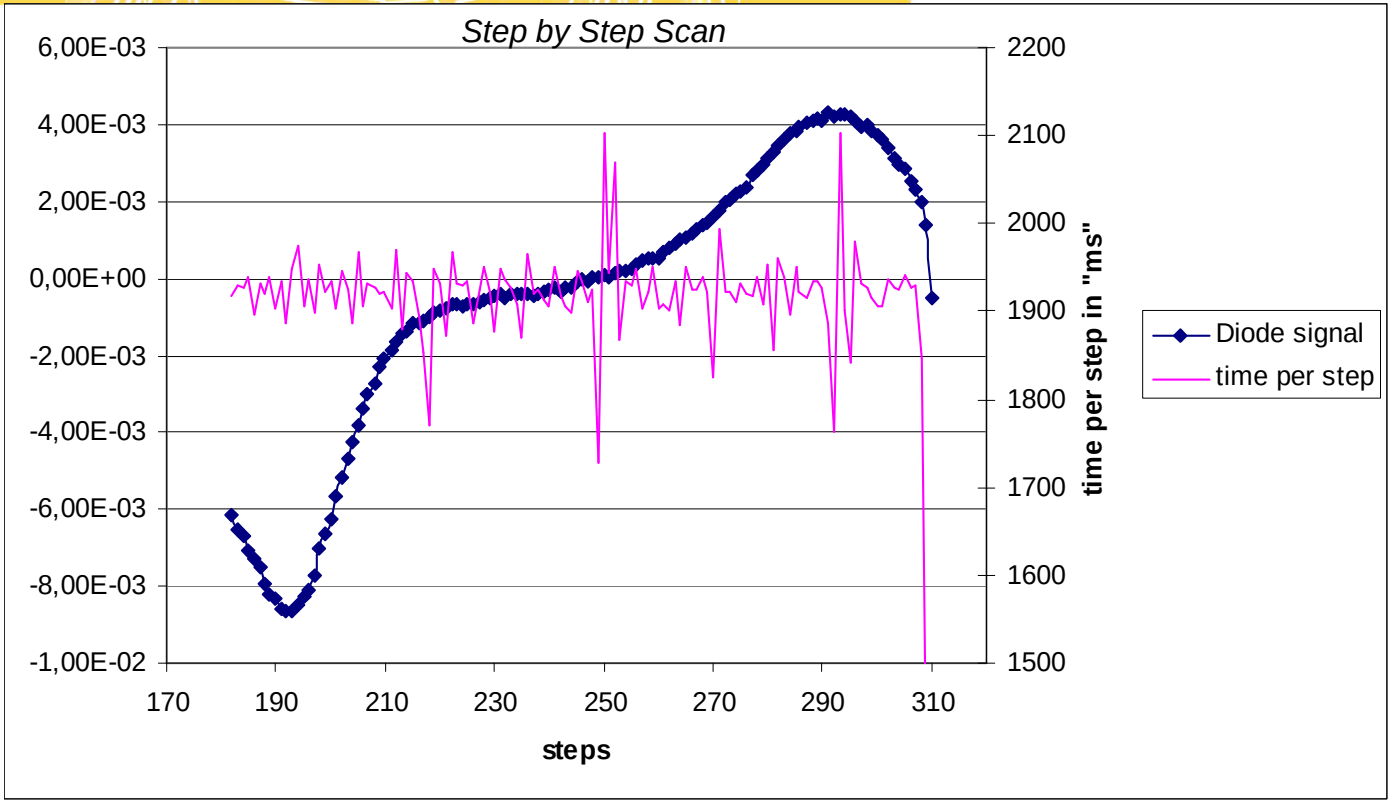
DISCO beamline: SRCD experiment



The SPIETBOX is used to synchronize ADC and Counter data acquisitions. It delivers the 50.8KHz frequency only when a monochromator movement is detected.
This architecture enables us to be locked on the PEM frequency and to acquire synchronously the following Data:

- ✓PEM Frequency
- ✓encoder position (Giving the beam Energy)
- ✓intensity delivered by the photodiode

Disco Result

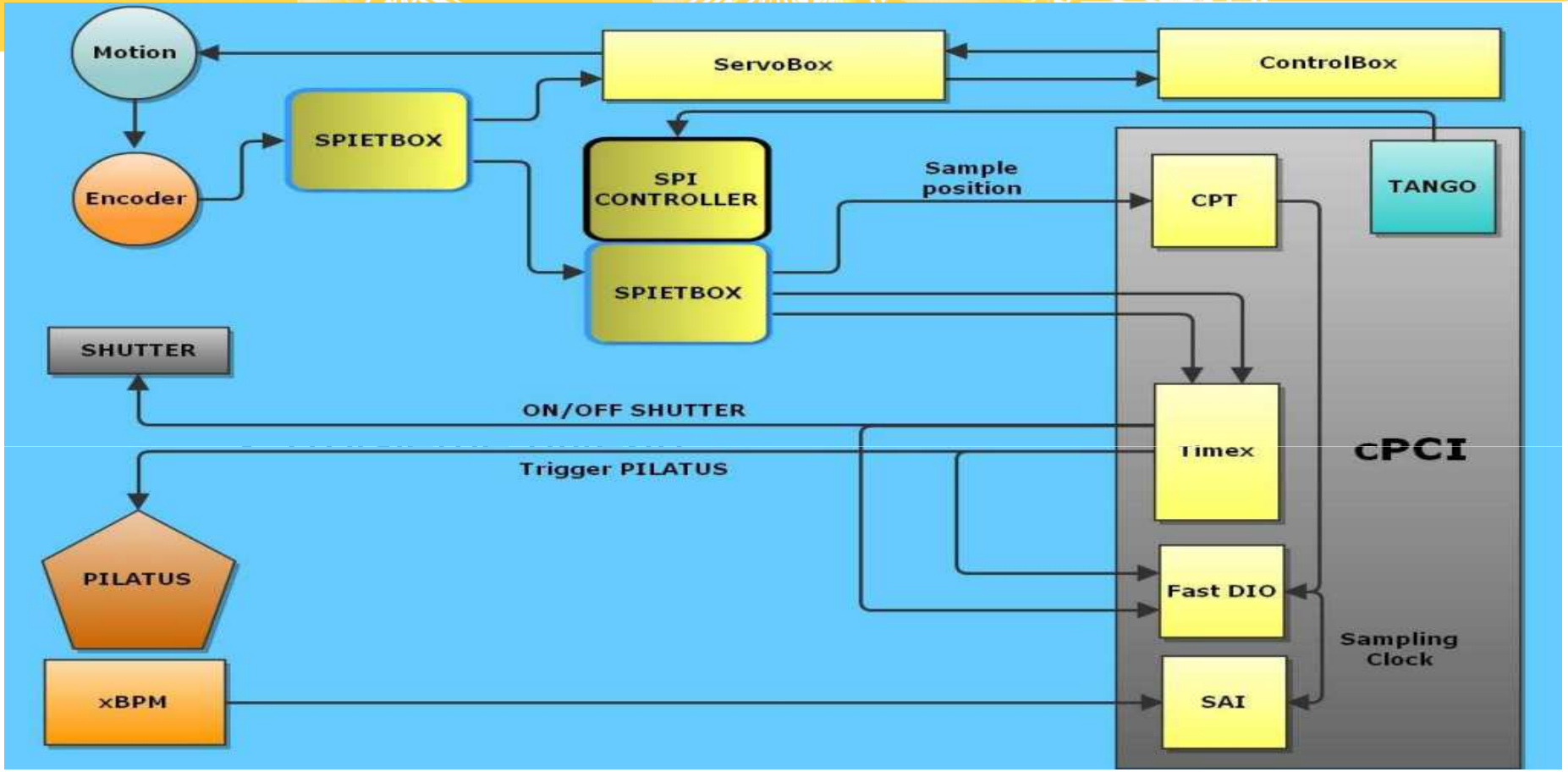


save time between Step by step and continuous scan!

Step by Step Scan : About 2 seconds per step 130 steps -> 4 min

Continuous Scan : About 1 second per step 130 steps -> 2 min

Hardware sequencer for fly scan (PX1 beam line pilatus detector exemple)

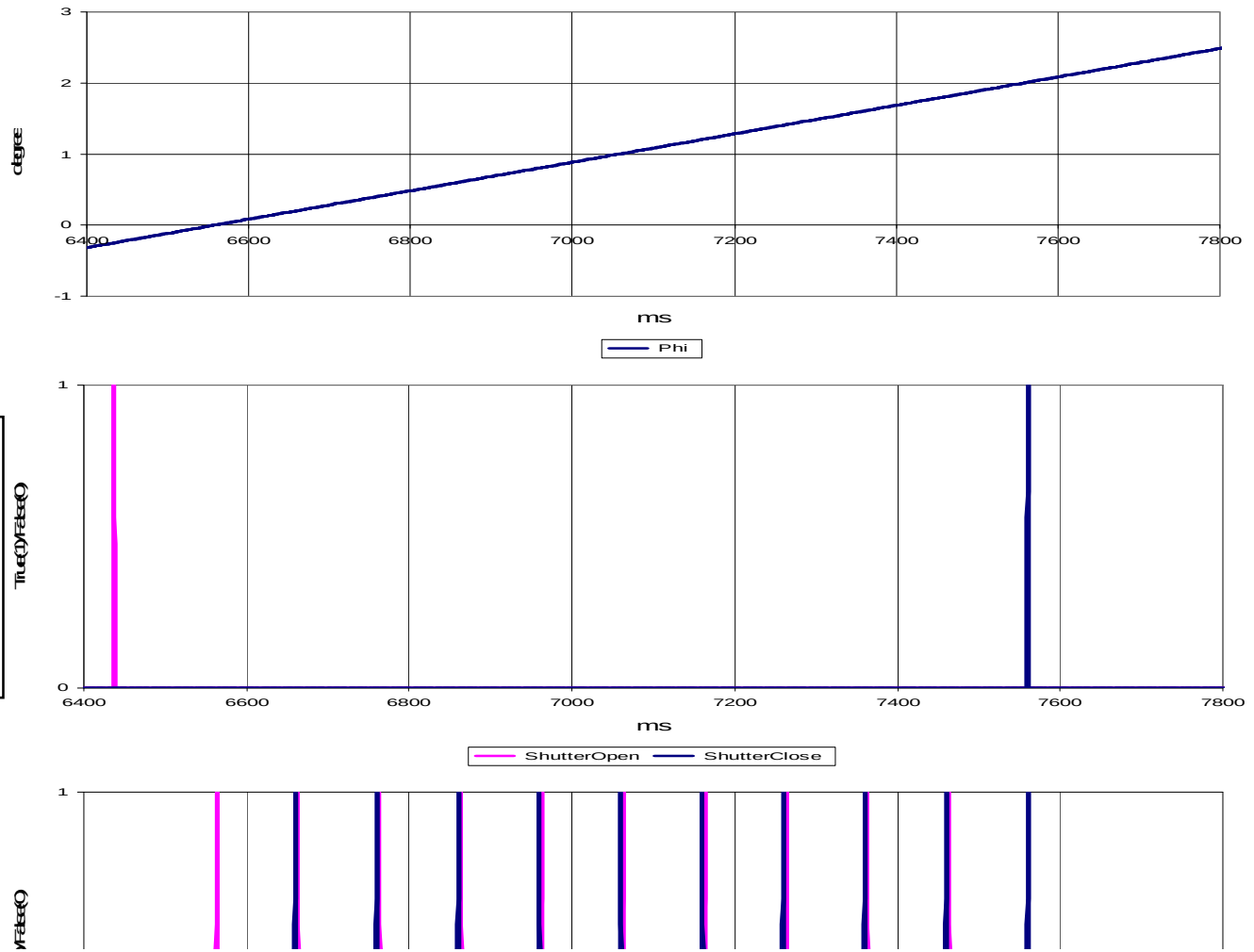


The Spietbox which is configured through the SPICONTROLER

- copy in real time the encoder position of the diffractometer
- open and close the shutter when the diffractometer moves at constant speed
- Trig the Pilatus detector on a regular basis depending on a regular period or a regular position vari

Result of PX1 test stand– Timing mode

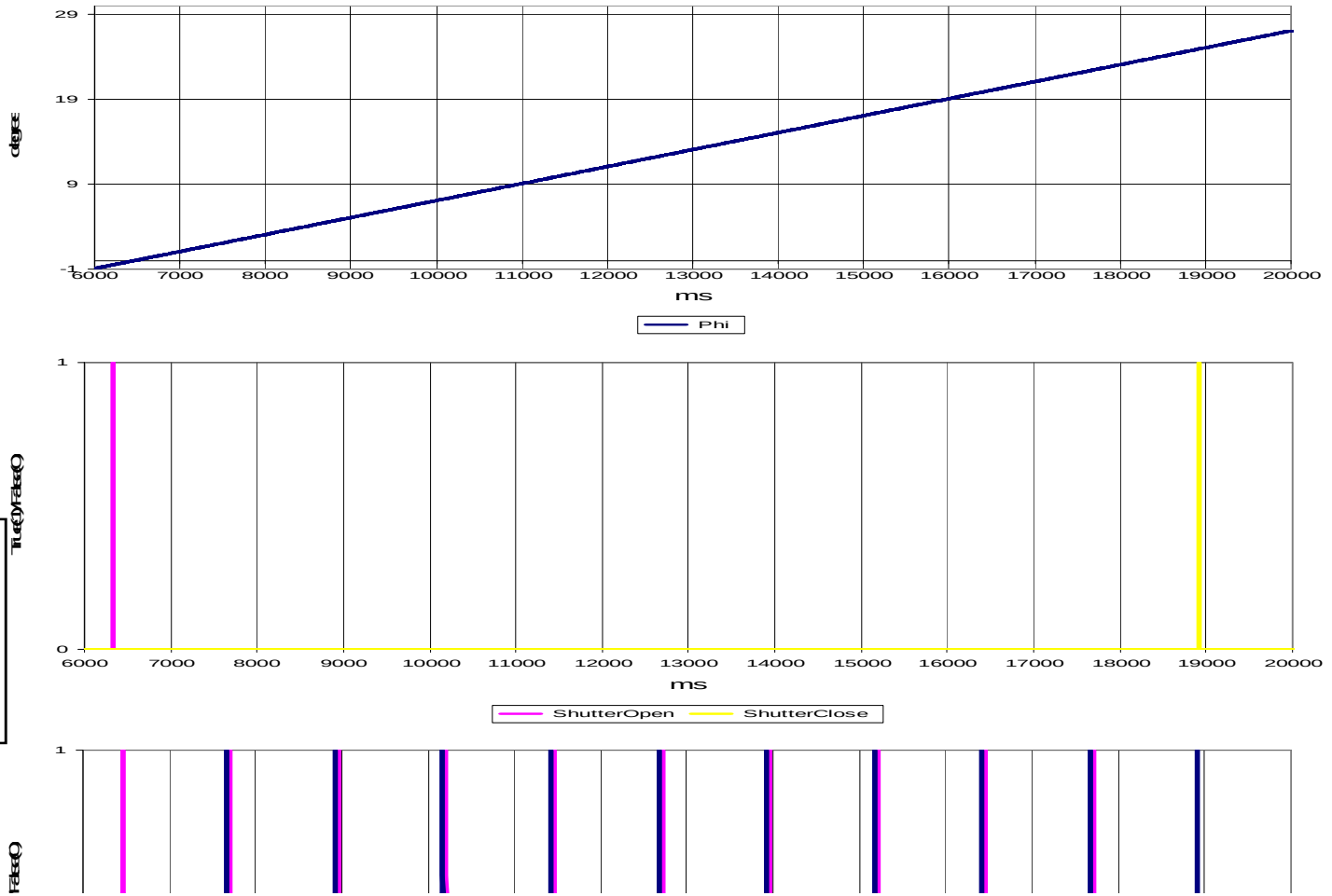
Speed	2°/s
angle BeforeExpo	1°
angleShutterDelay	0,02°
numberOfImages	10
timeExpoPeriod	0,1s
timeReadOut	0,003s



➔**One image every 100ms**

Result of PX1 test stand – Position mode

Speed	2°/s
angle BeforeExpo	1°
angleShutterDelay	0,02°
numberOfImages	10
angleExpoPeriod	0,2°
angleReadOut (3ms)	0,006°



➔**One image every 2,5°**

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- SPI Platform give us
  - Solution for synchronized process.
  - Flexibility for embedding specific process.
  - Basis for developing dedicated SPI daughter boards.
  - Simple boards and process which is important for maintenance.
- SPIETBOX scheme and gerber files will be soon available on the open hardware repository
- Perspectives
  - Continuous Scan with SSI encoder (feasibility?)
  - Open for other idea
  - Looking for possible help or collaboration!

Thanks for your attention