Synchronization between Detector and Motion in a Neutron Instrument

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Abstract: The single crystal hot neutron diffractometer HEiDi is operated by Forschungszentrum Jülich at the research reactor FRM II in Garching. Core of the instrument is the 4-circle diffractometer, consisting of an Eulerian cradle for the sample and the detector arm. The detector of HEiDi is a single a ^{3}He detector tube. In classical scans, in each step the axes of the 4-circle diffractometer are moved to the desired position and then the measurement is started. A reduction of measurement time can be achieved by measuring also during movement. The necessary synchronization between the motion subsystem and the detector is being implemented. The motion subsystem is based on a Siemens S7-1500 PLC and the synchronization uses its cam track technology objects.

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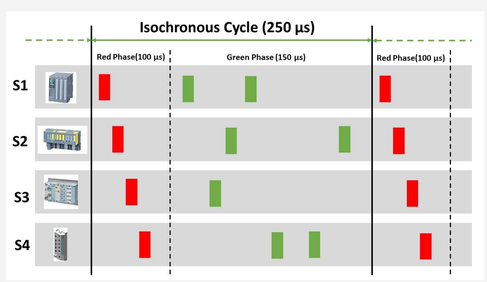
Hot Single Crystal Diffractometer HEiDi

- Studies on structural and magnetic properties of single crystals using thermal and epithermal neutrons
- Located in the experimental hall of research reactor FRM II in Garching
- Operated by the Institute of Crystallography, RWTH Aachen University, and JCNS, Forschungszentrum Jülich
- Electronics: Siemens S7-1500 + ET200S
- Software: DIF4N + Tango
- Detector: HE-3 proportional counting tube
- Goal: measurement during movement in scan

Toolbox

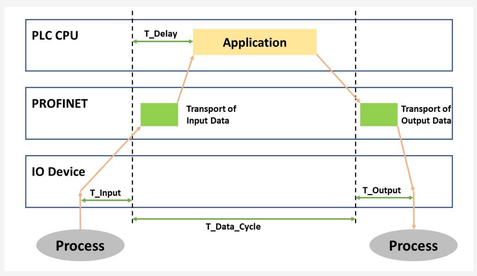
PROFINET IRT

- Time synchronization of Profinet stations with PTP
- Fixed cycle duration
- Scheduled transmission times
- Precision: < 1 µs



S7-1500 Isochronous Mode

- Constant application SW cycle synchronized with Profinet cycle
- IO-Devices also synchronized with Profinet cycle



Time Based IO

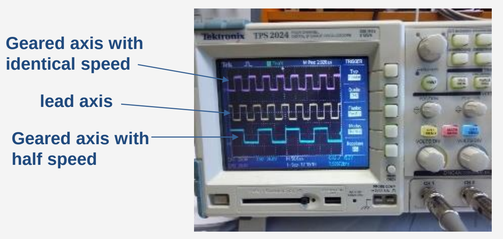
- Precise scheduling of output pulses
- Precise measurement of input pulses
- Hardware-supported

⇒Independent of application cycle

- Only supported by TM Timer DIDQ

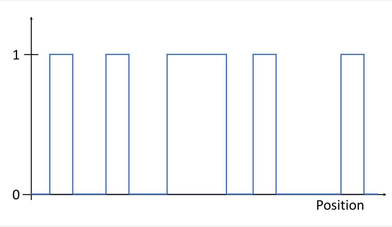
Electronic Gearing

- Velocity synchronization between Euler cradle axes ω,χ,φ,θ
- Standard PLCopen motion function block MC_GearIn: $v_x = k * v_z$



Motion Technology Objects Measuring Input and CAM Track

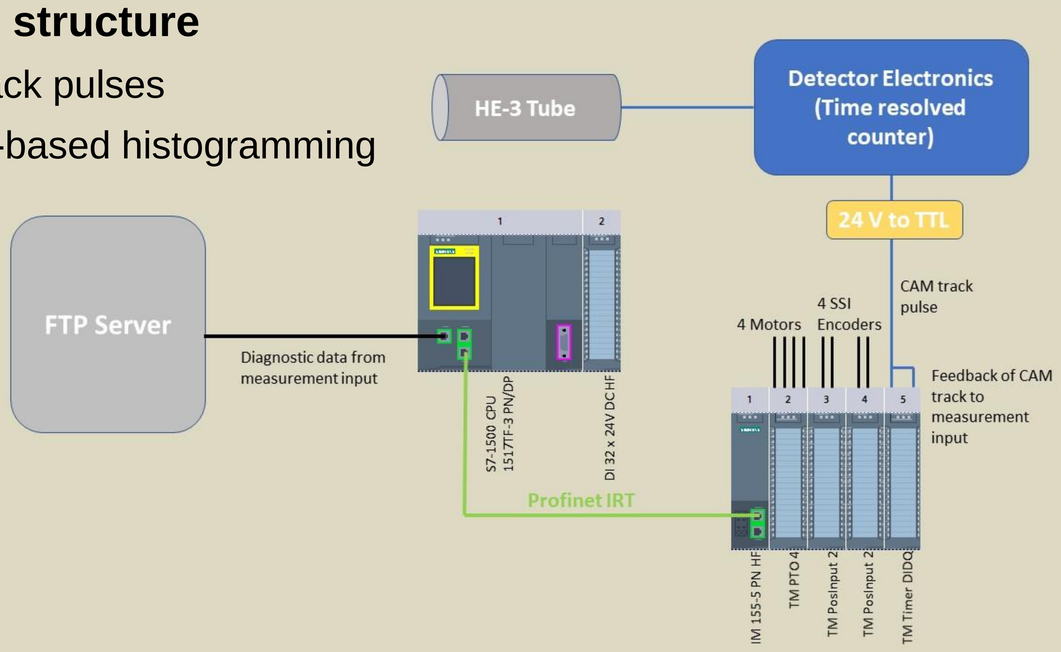
- Measuring Input: precise position reading on pulse edges
- CAM Track: output of position-dependent pulse sequences



Hardware structure

- CAM Track pulses

⇒Position-based histogramming



Status and Outlook

- Ongoing tests in lab
- Evaluation of synchronization quality
- Next steps: installation at HEiDi and integration into HEiDi SW
- Next goal: automatic scan in reciprocal space executed on the S7-1500 PLC