Continuous scans at the chemical crystallography beamline P24 at DESY

Martin Tolkiehn

Deutsches Elektronen-Synchrotron
Ein Forschungszentrum der Helmholtz-Gemeinschaft

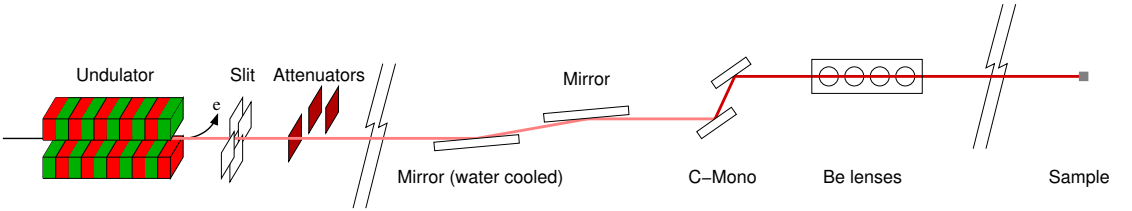
September 20, 2023

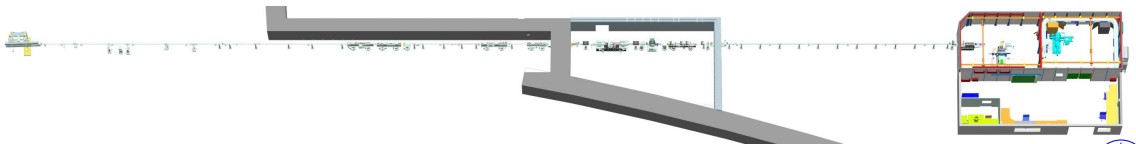
Outline

- The beamline P24
- Continuous scans
- Current implementation
- Future perspectives

Beamline P24

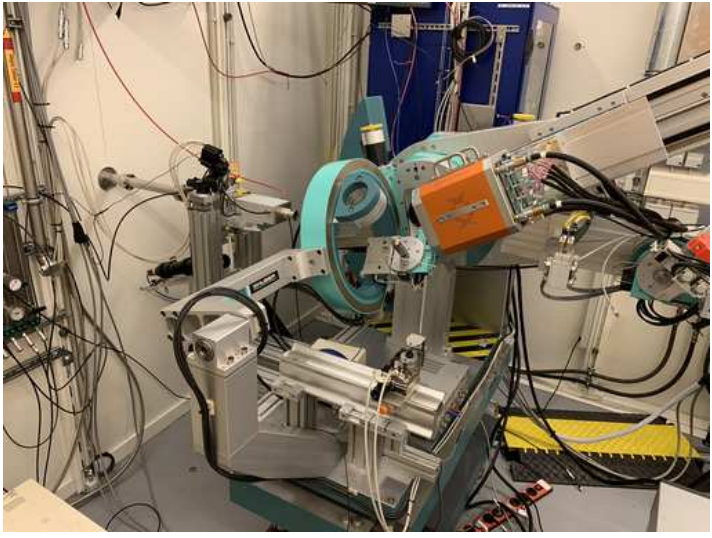
- Chemical crystallography beamline, PETRA extension
- Optical elements at 55 ± 5m
- 2 Experimental stations at 84m and 90m



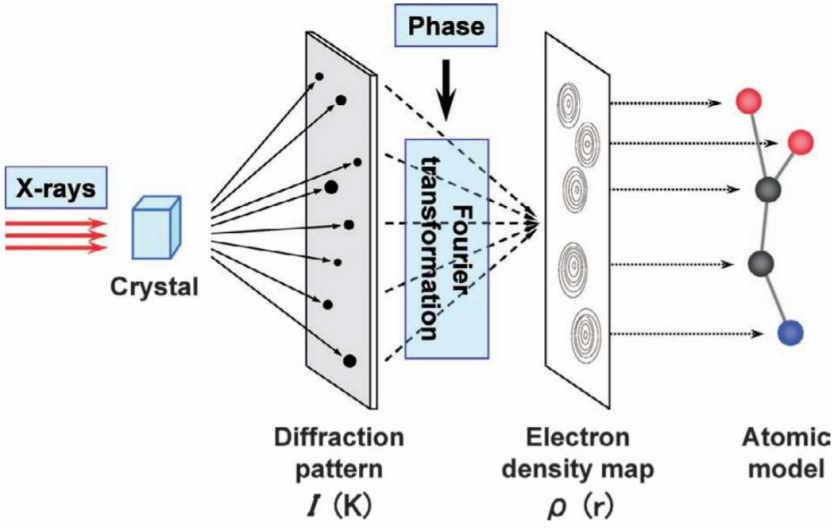


P24 under construction (in early 2017)

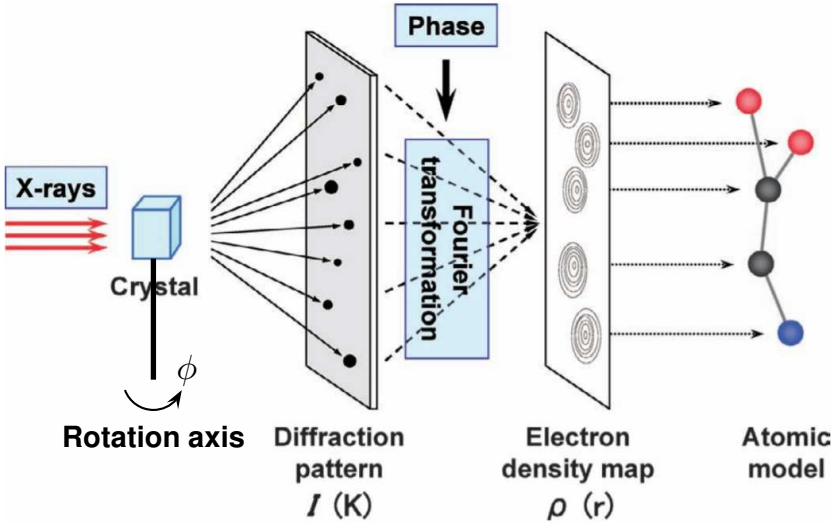
Four circle diffractometer in EH2



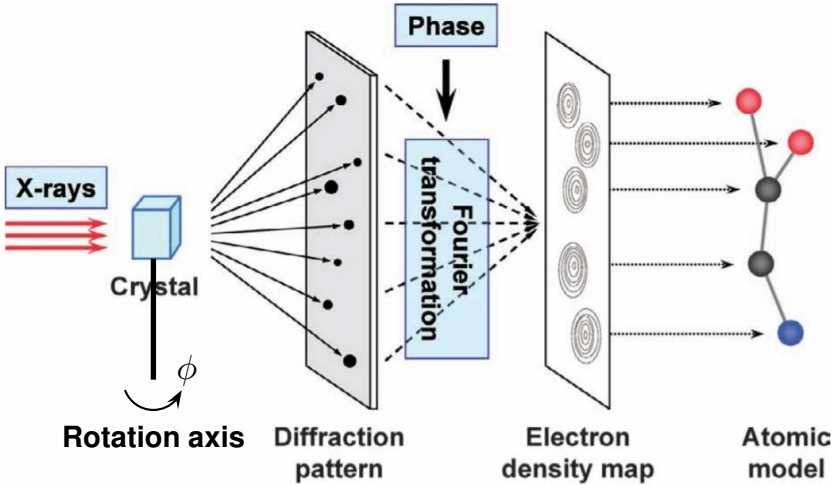
Single crystal diffraction



Single crystal diffraction



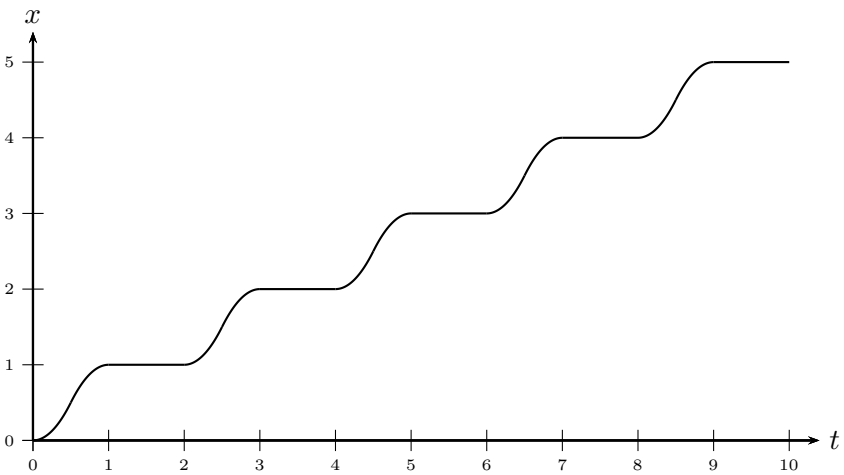
Single crystal diffraction



$$I_{\text{int}} = \int_{\phi_0}^{\phi_0+\Delta\phi} I \, d\phi = \int I \, \omega \, dt$$

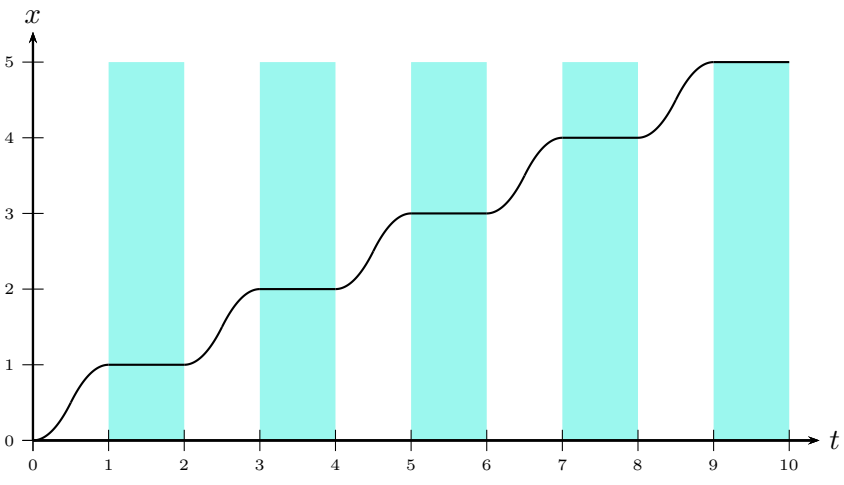
Different scan types

Step scan



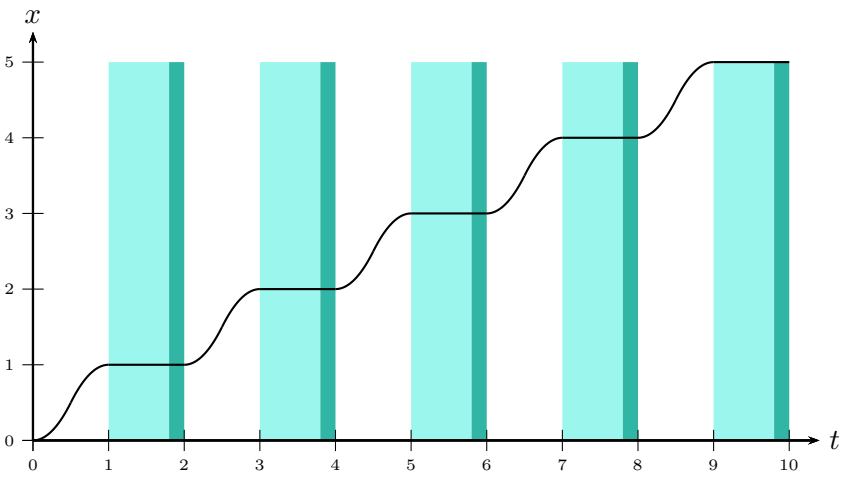
Different scan types

Step scan



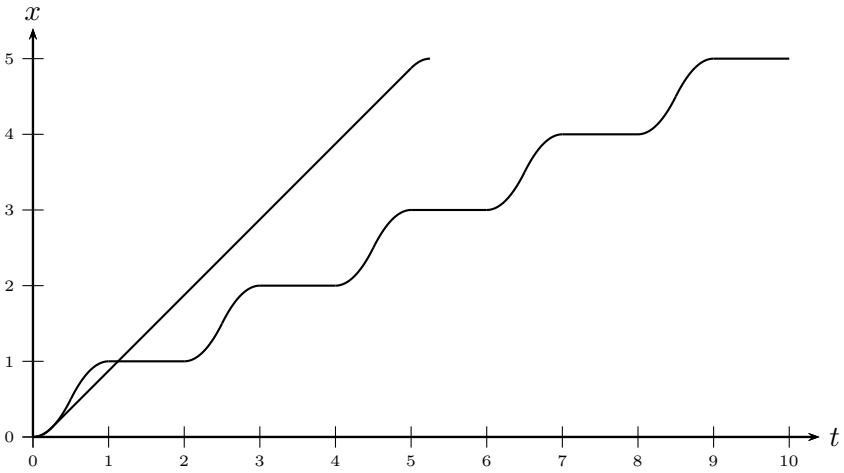
Different scan types

Step scan



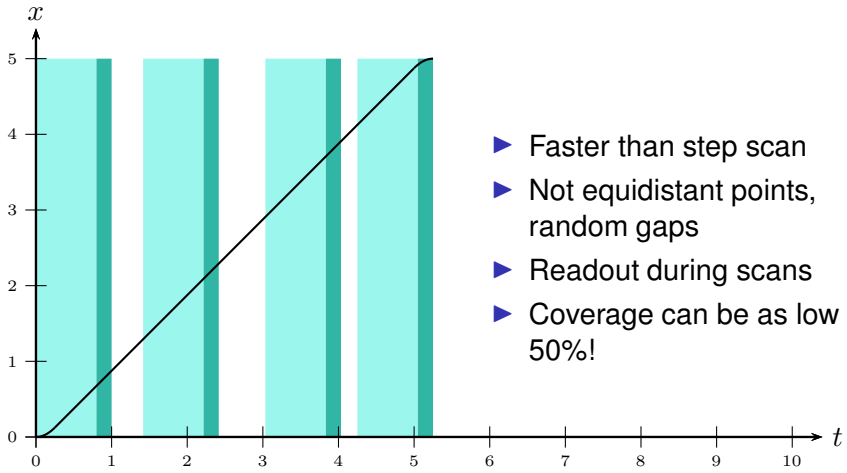
Different scan types

Continuous scan



Different scan types

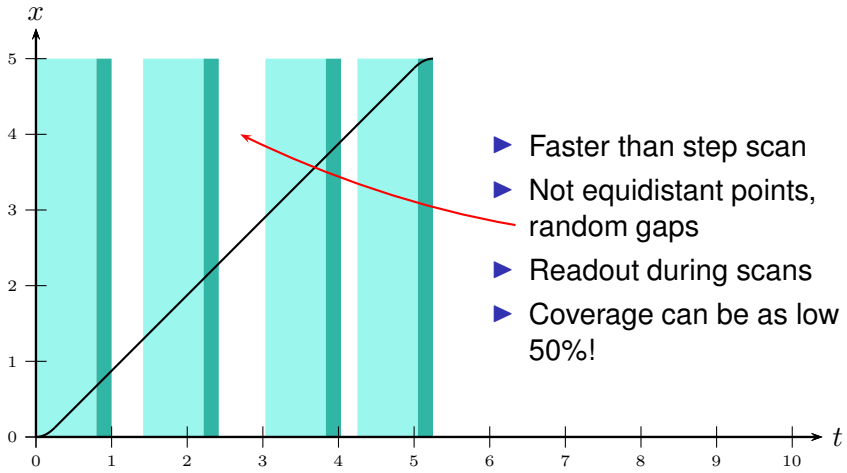
Continuous scan – software controlled



- Faster than step scan
- Not equidistant points, random gaps
- Readout during scans
- Coverage can be as low as 50%!

Different scan types

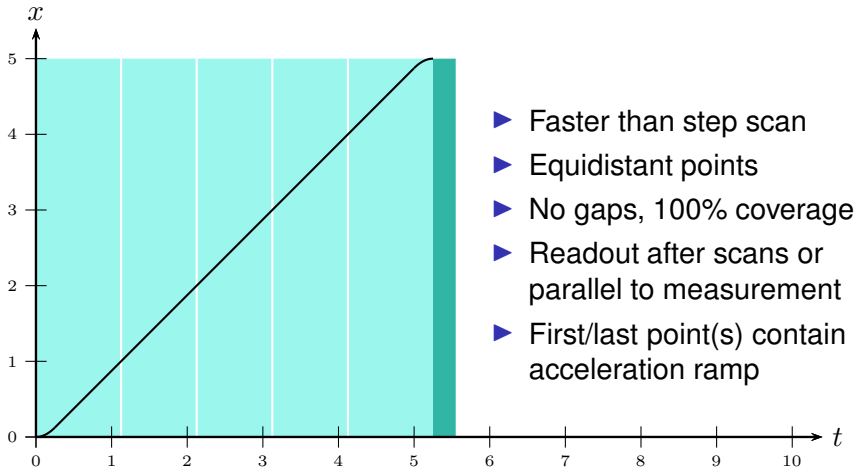
Continuous scan – software controlled



- Faster than step scan
- Not equidistant points, random gaps
- Readout during scans
- Coverage can be as low as 50%!

Different scan types

Continuous scan – hardware controlled



- Faster than step scan
- Equidistant points
- No gaps, 100% coverage
- Readout after scans or parallel to measurement
- First/last point(s) contain acceleration ramp

Multi axis motor controller

OMS MAXv

- 8 axis controller
- Stepper or servo motors
- Step/Direction output or analog output
- 10 encoder inputs,
- Limit and home switch inputs
- GPIO

Multi axis motor controller

OMS MAXv

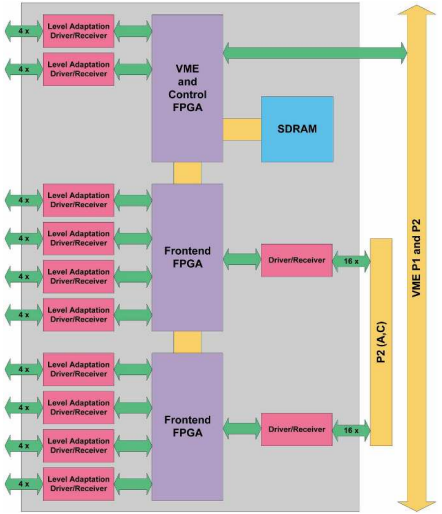
- 8 axis controller
- Stepper or servo motors
- Step/Direction output or analog output
- 10 encoder inputs,
- Limit and home switch inputs
- GPIO

Step signal can be used for synchronization with special RTM

Multi channel scaler (MCS)

Struck SIS3820:

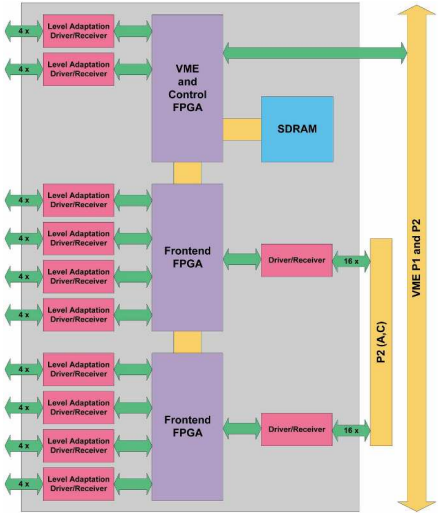
- 32 channel, 32 bit counter
- 960ns min. dwell time
- 64MB on board SDRAM
- 80MB/s readout



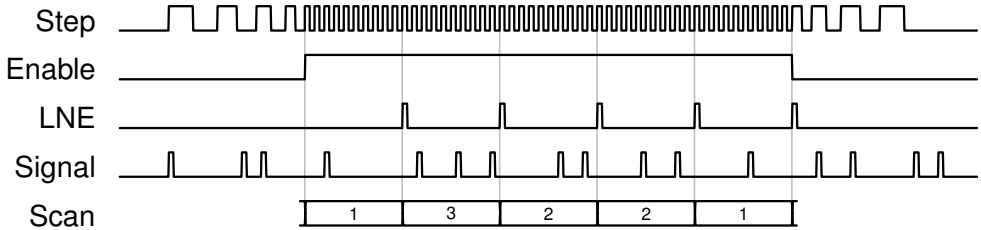
Multi channel scaler (MCS)

Struck SIS3820:

- 32 channel, 32 bit counter
- 960ns min. dwell time
- 64MB on board SDRAM
- 80MB/s readout
- Synchronization with motor controller:
  - Step signal
  - Quadrature encoder
- Sync. outputs for other devices

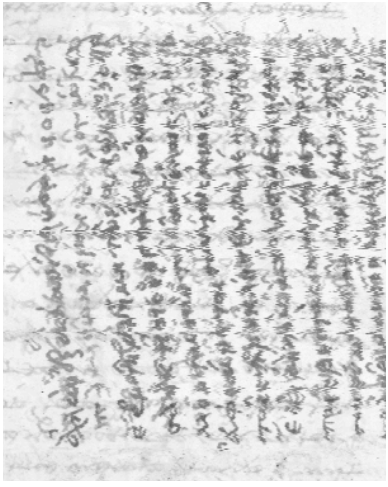


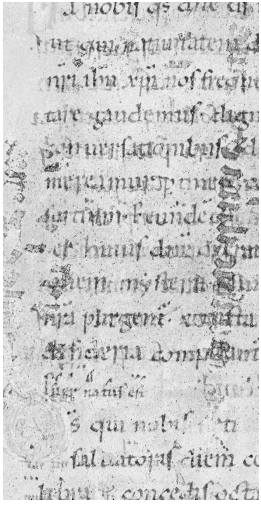
Continuous scans with the SIS3820



- Motor step signal is connected to one of the counter channels
- Enable and LNE signals are available at the front panel
- Synchronization with other devices is possible (e.g. SIS3302, LAMBDA, . . .)
- Supported by spec (`flyscan`)

Example: Fluorescence mapping of old handwritings





Left: Continuos scans with ONLINE software Right: Continuos scans with SIS3820

Future perspective

Challenges:

- OMS MAXv and SIS3820 are VME bus cards $\Rightarrow$ Technology from last century!
- SIS3820 is based on obsolete Spartan 2 FPGAs. (Only few boards are still in stock)
- Needs cable connections. (Scalability?)

Future perspective

Challenges:

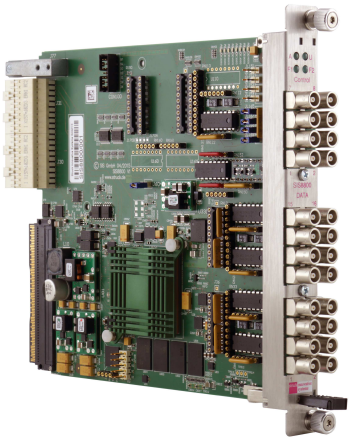
- OMS MAXv and SIS3820 are VME bus cards ⇒ Technology from last century!
- SIS3820 is based on obsolete Spartan 2 FPGAs. (Only few boards are still in stock)
- Needs cable connections. (Scalability?)

Solution:

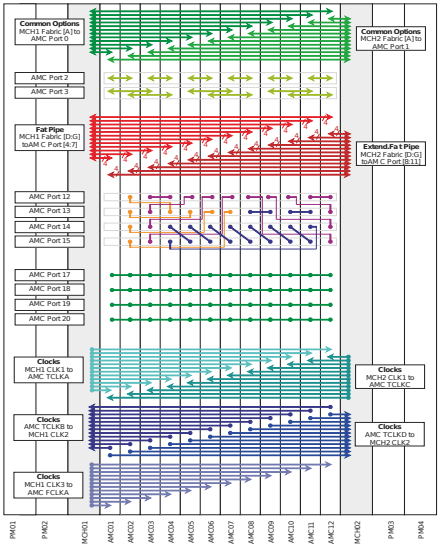
Replace VME by a more modern standard like MTCA

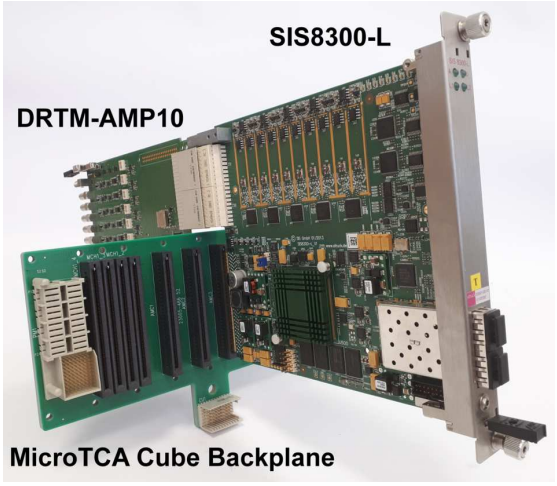
Replacement: Struck SIS8800

- Similar features as SIS3820, but MTCA.4
- 16 channels on front panel
- 16 channels via RTM
- Synchronization with other devices via backplane



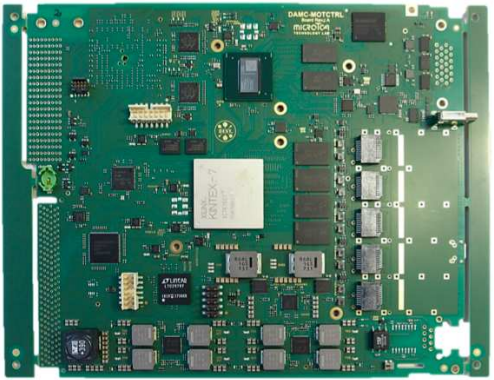
MTCA.4

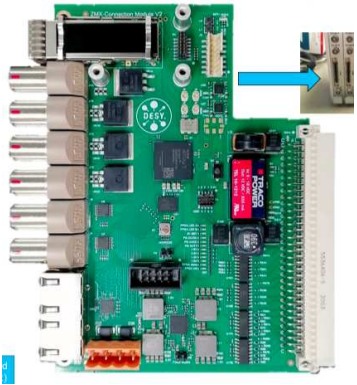

Common Options
MCH1 Fabric [A] to AMC Port 0
Common Options
MCH2 Fabric [A] to AMC Port 1
AMC Port 2
AMC Port 3
Fat Pipe
MCH1 Fabric [D:G] to AMC Port [4:7]
Extend.Fa t Pipe
MCH2 Fabric [D:G] to AMC Port [8:11]
AMC Port 12
AMC Port 13
AMC Port 14
AMC Port 15
AMC Port 17
AMC Port 18
AMC Port 19
AMC Port 20
Clocks
MCH1 CLK1 to AMC TCLKA
Clocks
MCH2 CLK1 to AMC TCLKC
Clocks
AMC TCLKB to MCH1 CLK2
Clocks
AMC TCLKD to MCH2 CLK2
Clocks
MCH1 CLK3 to AMC FCLKA
PM01
PM02
MCH01
AMC01
AMC02
AMC03
AMC04
AMC05
AMC06
AMC07
AMC08
AMC09
AMC10
AMC11
AMC12
MCH02
PM03
PM04


SIS8300-L
DRTM-AMP10
MicroTCA Cube Backplane

New motion controller

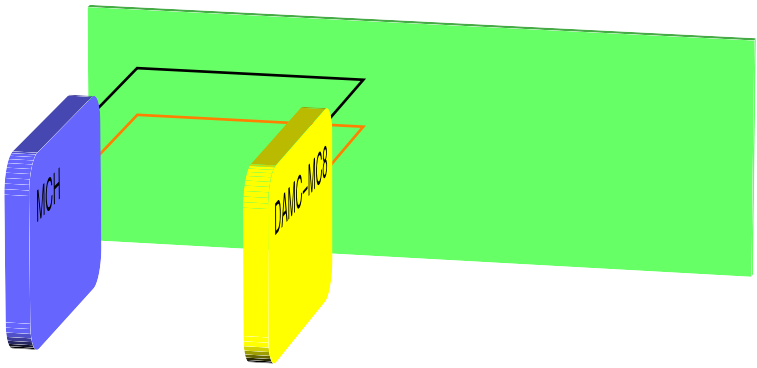
MTCA.4 based motion controller for 16 axes:



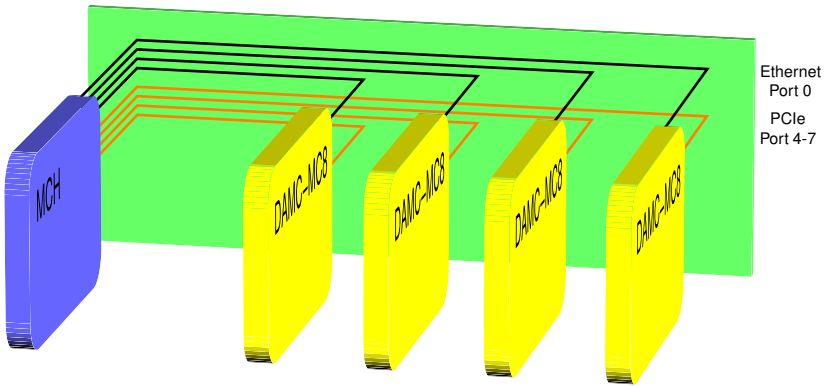


DESY-ITT funded project in collaboration with MSK (N. Radakovic, M. Fenner et al.)

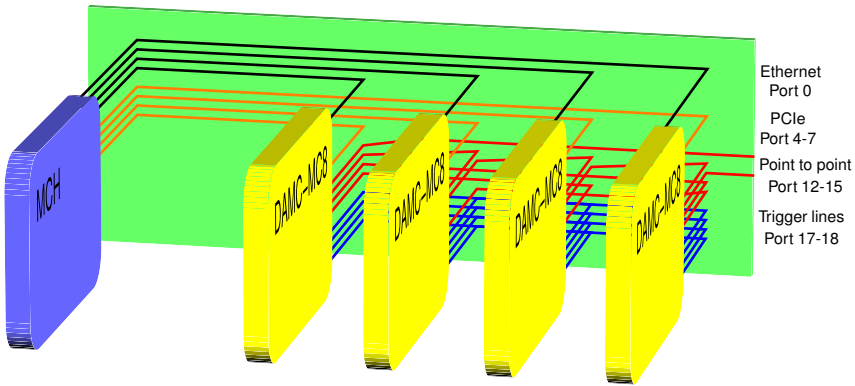
Synchronization



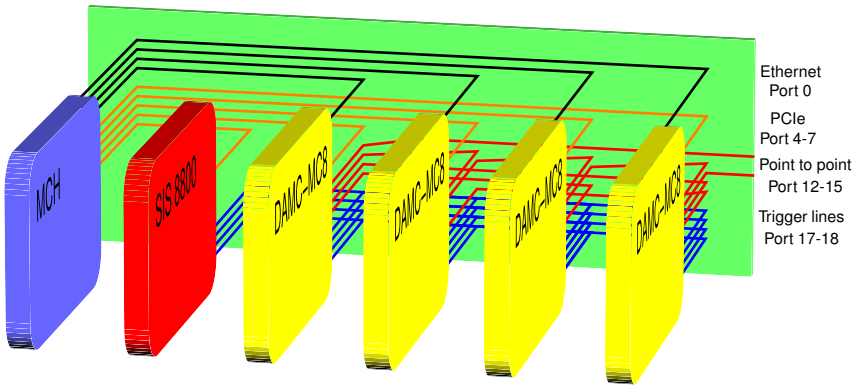
Synchronization



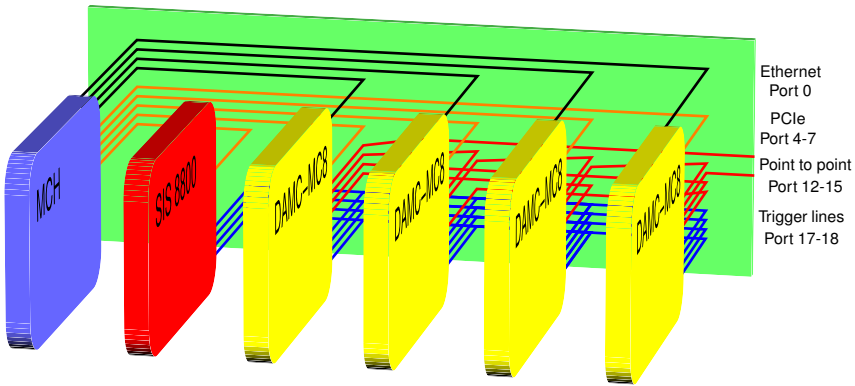
Synchronization



Synchronization



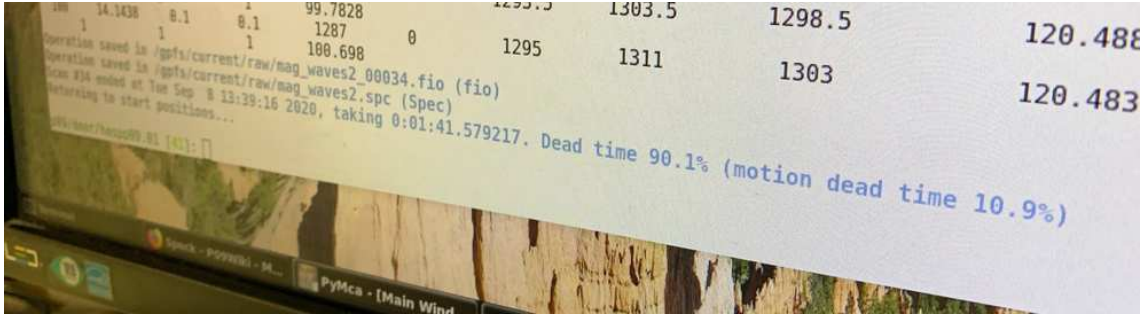
Synchronization



- Synchronization of many motion controllers will be possible
- Controllers can be in different crates (optical fiber)
- Continuous scans, synchronization with detectors

Thank you for your attention!

Slow scans


99.7828
1287
100.698
1295
1303.5
1311
1298.5
1303
120.488
120.483
/gpfs/current/raw/mag_waves2_00034.fio (fio)
/gpfs/current/raw/mag_waves2.spc (Spec)
2020, taking 0:01:41.579217. Dead time 90.1% (motion dead time 10.9%)
PyMca - [Main Wind