



DECTRIS

Next Generation X-Ray Detectors

Past Present Future

New Developments and Product Extensions

Miroslav Kobas

Volker Pilipp, Peter Trueb

DECTRIS Ltd., 5400 Baden, Switzerland

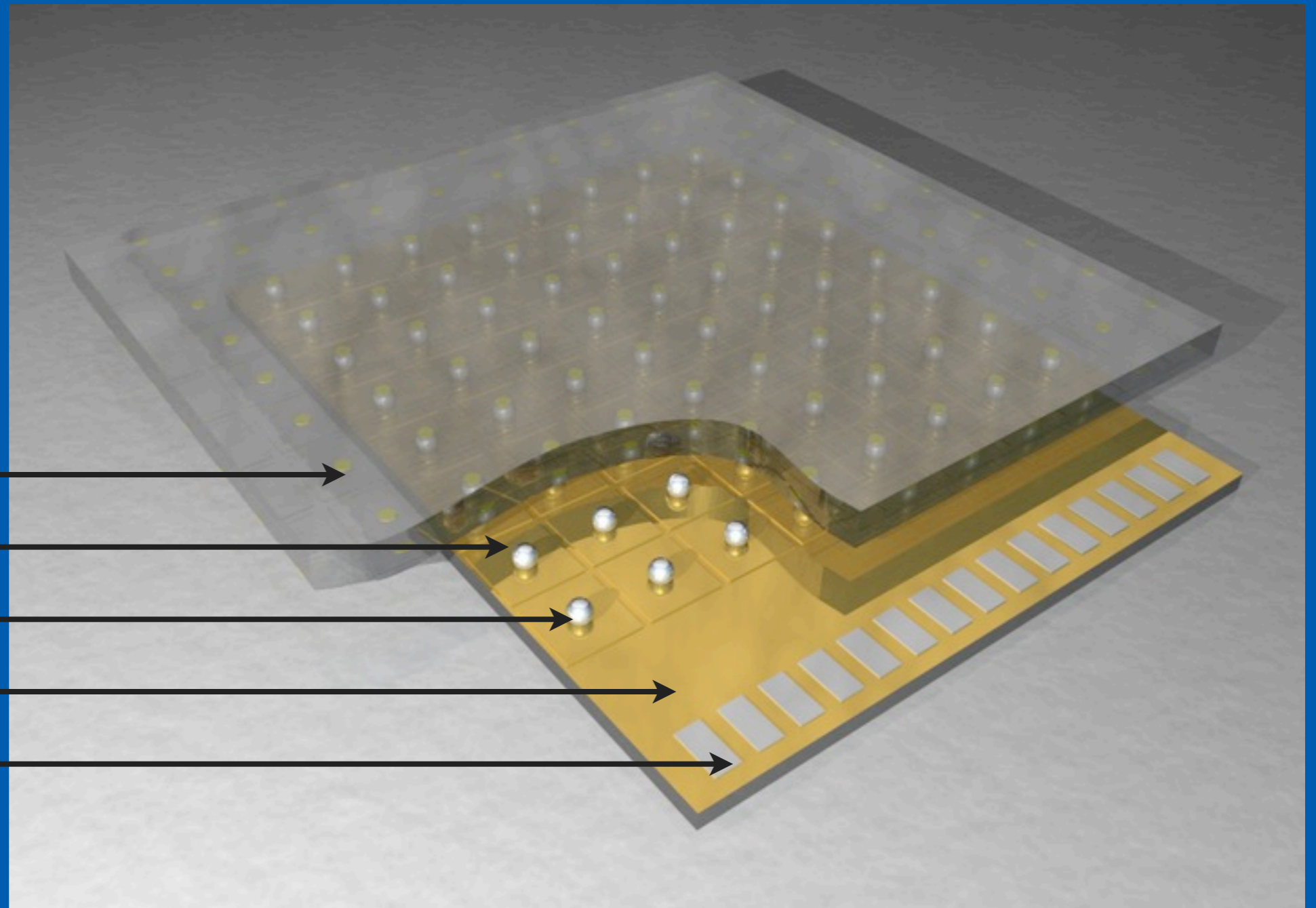
www.dectris.com

Outline

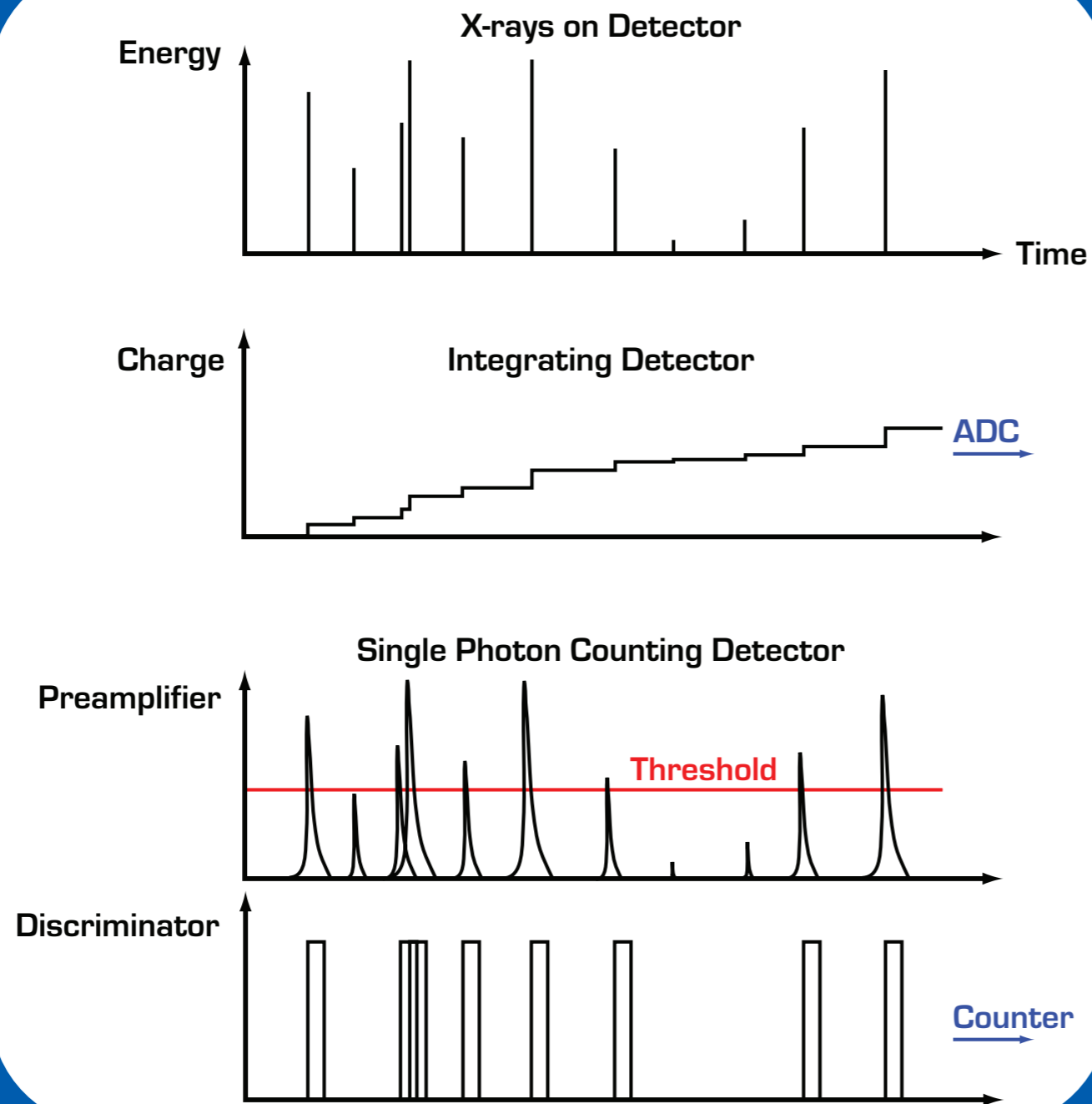
- Introduction
- **DECTRIS Detector Systems**
- New Developments
- Product Extensions
- Conclusions

Hybrid Pixel Array Detector

- Si sensor (0.320 mm)
- Pixel (0.172 mm)
- In bump-bond (0.018 mm)
- Read-out chip
- Wire-bond (\varnothing 0.025 mm)



Integrating vs. Counting Detector



Single photon counting

- No dark current
- No read-out noise
- Earliest possible digitization

DECTRIS Ltd. - Spin-Off Company of PSI

**GEWINNER
2010**



Das innovative Unternehmen

DECTRIS AG

ist Gewinner der Kategorie Hightech/Biotech
beim Swiss Economic Award, dem bedeutendsten
Jungunternehmerpreis der Schweiz

www.swisseconomic.ch/award



DECTRIS - proud winner of Swiss Economic Award 2010

PILATUS Detector Systems



Applications: materials science, surface diffraction, small-angle scattering, time-resolved studies,...

Area: 1475 x 195 pixels
253.7 x 33.5 mm²

Pixel size: 172 x 172 μm²

Frame rate: up to 200 Hz

Readout time: 2.2 ms

487 x 619 pixels
83.8 x 106.5 mm²

172 x 172 μm²

up to 200 Hz

2.2 ms

487 x 195 pixels
83.8 x 33.5 mm²

172 x 172 μm²

300 Hz

2.2 ms

PILATUS Detector Systems



Applications: x-ray diffraction, macromolecular crystallography, time-resolved studies,...

Area:	2463 x 2527 pixels 423.6 x 434.6 mm ²	1475 x 1679 pixels 253.7 x 288.8 mm ²	981 x 1043 pixels 168.7 x 179.4 mm ²
Pixel size:	172 x 172 μm ²	172 x 172 μm ²	172 x 172 μm ²
Frame rate:	up to 12.5 Hz	up to 30 Hz	up to 100 Hz
Readout time:	2.2 ms	2.2 ms	2.2 ms

MYTHEN Detector Systems



Applications: powder diffraction, stress analysis, texture analysis, kinetic experiments,...

Area: 1280 strips
8 x 64 mm
Strip size: 50 μ m
Frame rate: 25 - 600 Hz
Readout time: 0.3 ms

6x 1280 strips
8 x 384 mm²
50 μ m
25 - 250 Hz
0.3 ms

Current Readout Technology

Current technology: DCB based

- Readout time 2.28 ms
- Communication detector-server based on GigaStar (1 Gbit/s)
- 1 DBC supports 1 MCB or 1 BCB

Past: Data Rates

Detector System	Maximum Frame Rate	Maximum Data Rate Uncompressed	Maximum Date Rate Compressed	Availability
100K	300 Hz	120 MB/s	30 MB/s	available
300K	200 Hz	240 MB/s	60 MB/s	available
1M	30 Hz	120 MB/s	30 MB/s	available
2M	30 Hz	288 MB/s	72 MB/s	available
6M	12.5 Hz	300 MB/s	75 MB/s	available

Present: Data Rates

Detector System	Maximum Frame Rate	Maximum Data Rate Uncompressed	Maximum Date Rate Compressed	Availability
100K	300 Hz	120 MB/s	30 MB/s	available
300K	200 Hz	240 MB/s	60 MB/s	available
1M	30 Hz	120 MB/s	30 MB/s	available
1M-F	135 Hz	540 MB/s	135 MB/s	new
2M	30 Hz	288 MB/s	72 MB/s	available
2M-F	55 Hz	528 MB/s	132 MB/s	new
6M	12.5 Hz	300 MB/s	75 MB/s	available
6M-F	22 Hz	528 MB/s	132 MB/s	new

Successor Readout Technology

Current technology: DCB based

- Readout time 2.28 ms
- Communication detector-server based on GigaStar (1Gbit/s)
- 1 DBC supports 1 MCB or 1 BCB

Successor technology: DCBe based

- Readout time 1.48 ms
- Communication detector-server based on standard 10 GBaseT (2x 10Gbit/s)
- 1 DCBe supports 3 MCB or 3 BCB

—> simpler, faster, more reliable data readout !!!

Future: Data Rates

Detector System	Maximum Frame Rate	Maximum Data Rate Uncompressed	Maximum Date Rate Compressed	Availability
100Ke ?	350 Hz	140 MB/s	35 MB/s	2012?
300Ke ?	350 Hz	420 MB/s	105 MB/s	2012?
1Me ?	350 Hz	1400 MB/s	350 MB/s	2012?
2Me ?	350 Hz	3360 MB/s	840 MB/s	2012/2013 ?
6Me ?	200 Hz	4800 MB/s	1200 MB/s	2012/2013?
6Me-F ?	350 Hz	8400 MB/s	2100 MB/s	2012/2013 ?

PILATUS Detector System

Basic Configuration

Detector Unit

PILATUS Server

- 8 - 16 Cores
- 32 - 64 GB RAM

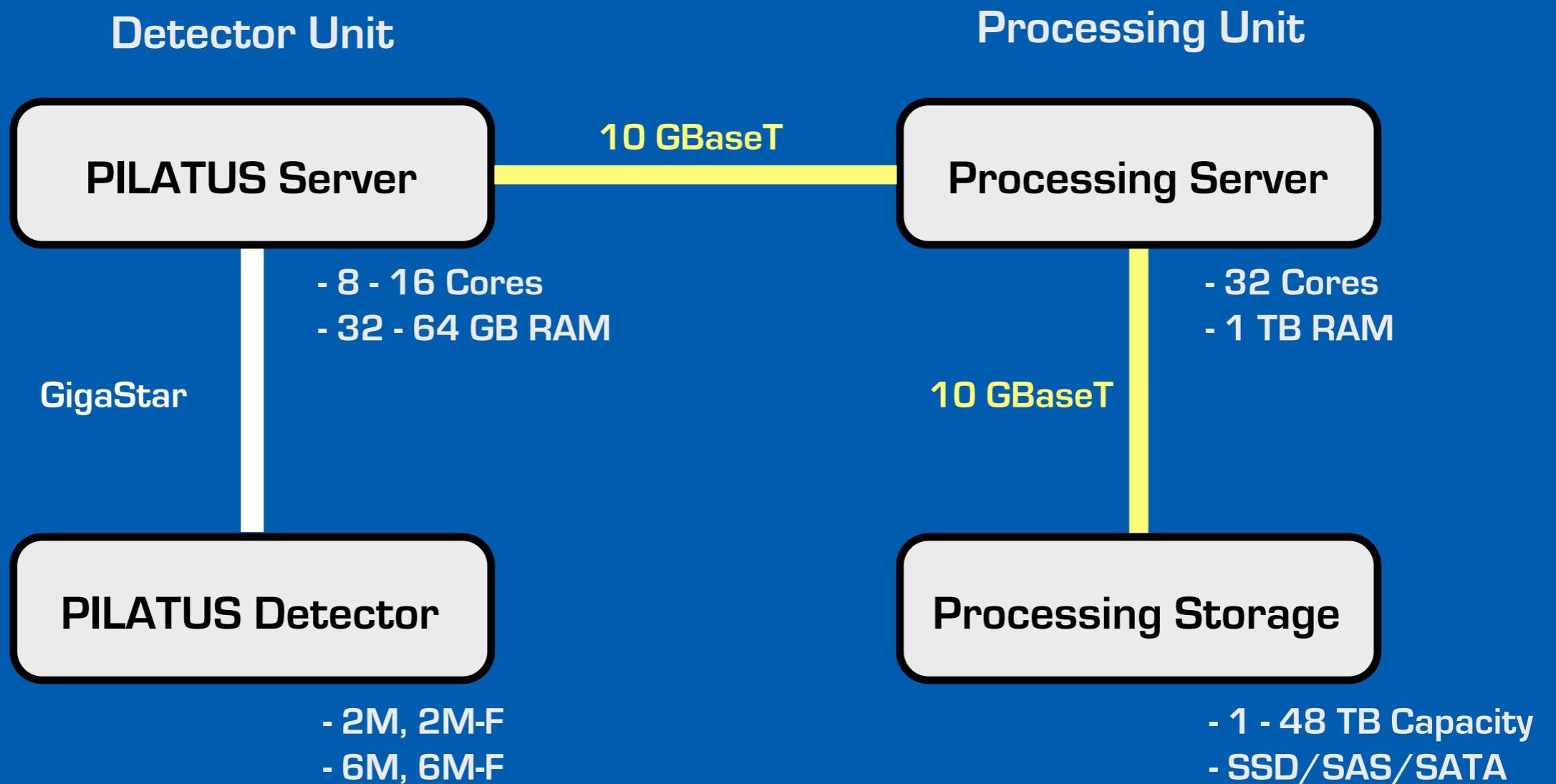
GigaStar

PILATUS Detector

- 2M, 2M-F
- 6M, 6M-F

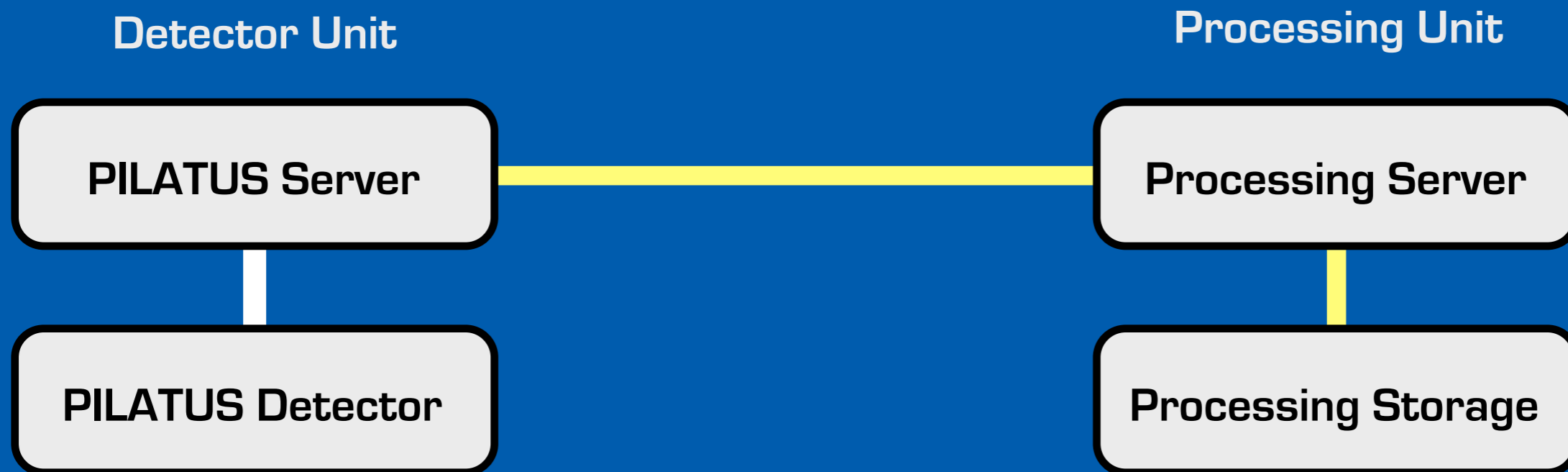
Product Extension - Processing Unit

Extended Configuration



Product Extension - Software Packages

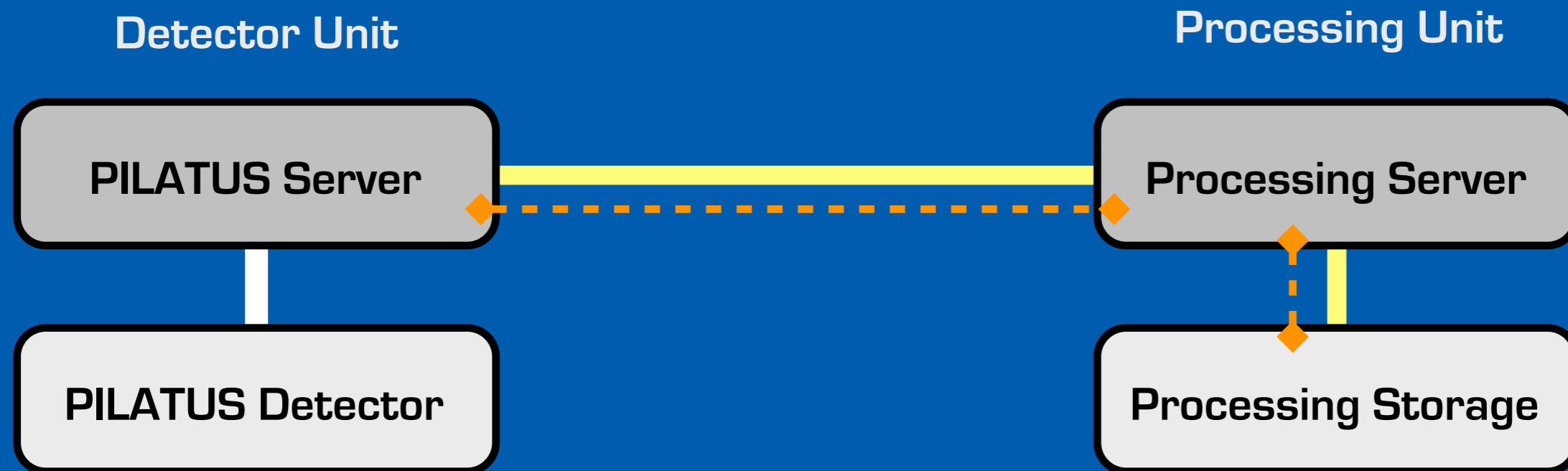
Value Adding Software Packages



- Data synchronization software
- Data visualization software
- Count-rate strategy software
- Crystallographic data processing software XDS

Product Extension - Software Packages

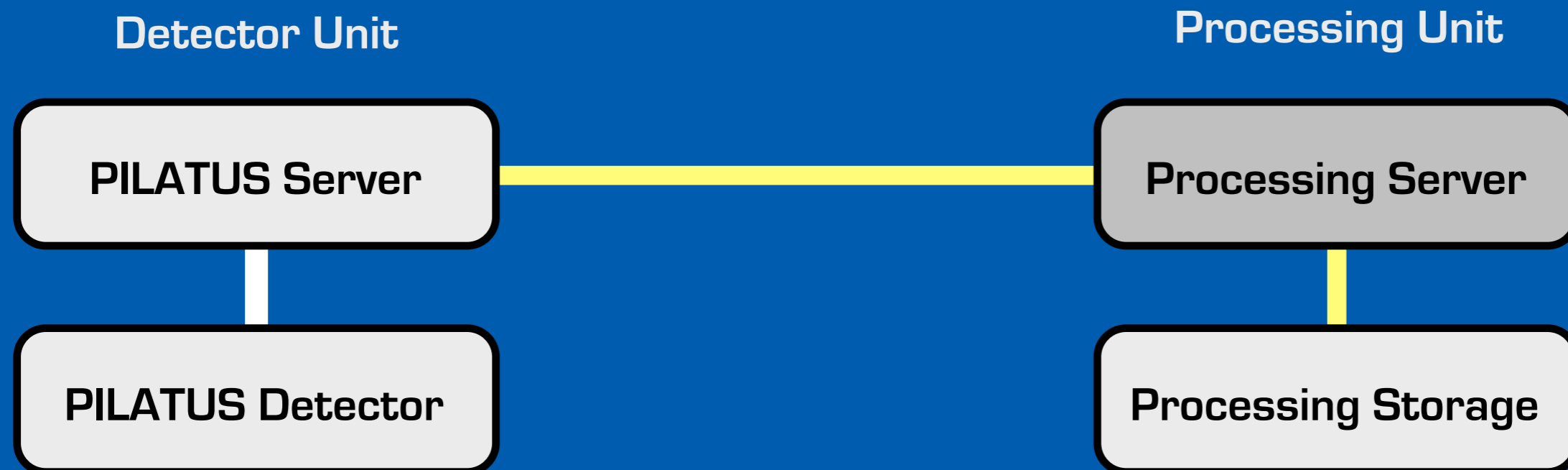
Data Synchronization Software



- RAM (PILATUS server) to RAM (Processing server) synchronization of data
>1000 MB/s performance. Performance keeps up with fast versions of current PILATUS detectors.
- RAM (Processing server) to storage synchronization of data
>250 MB/s performance.

Product Extension - Software Packages

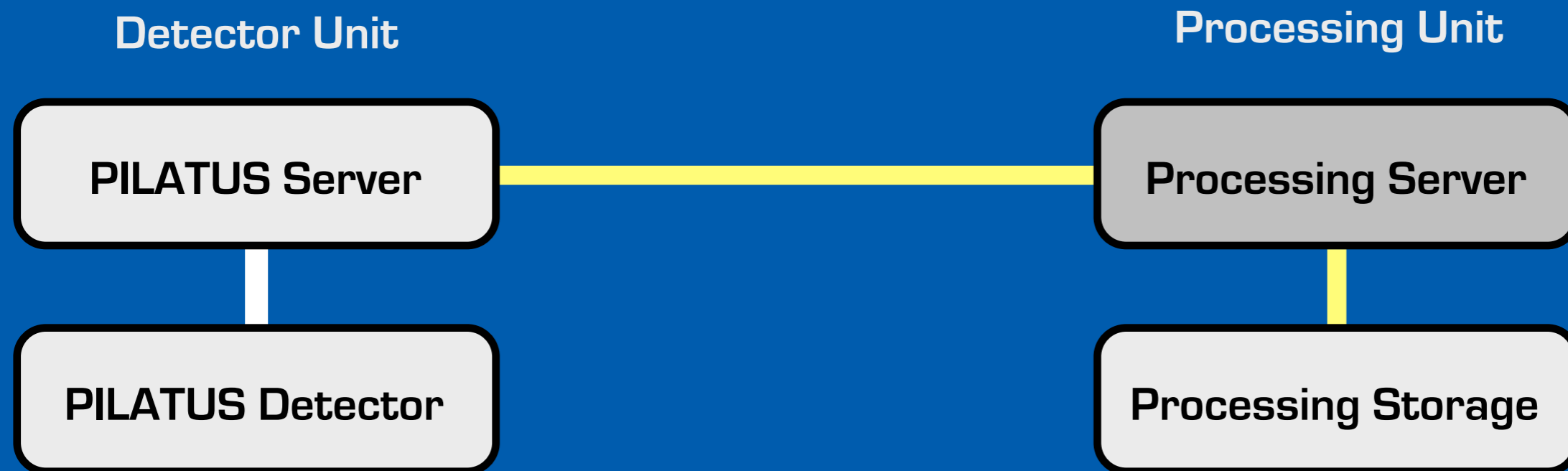
Data Visualization Software



- Online visualization of detector data (cbf- or tif-file format)
- Basic tools for image analysis, manipulation (crystallographic requirements)
- Basic tools for data manipulation (addition, subtraction, multiplication, division of image files)
- PILATUS specific correction routines (flat-field, efficiency and parallax correction)

Product Extension - Software Packages

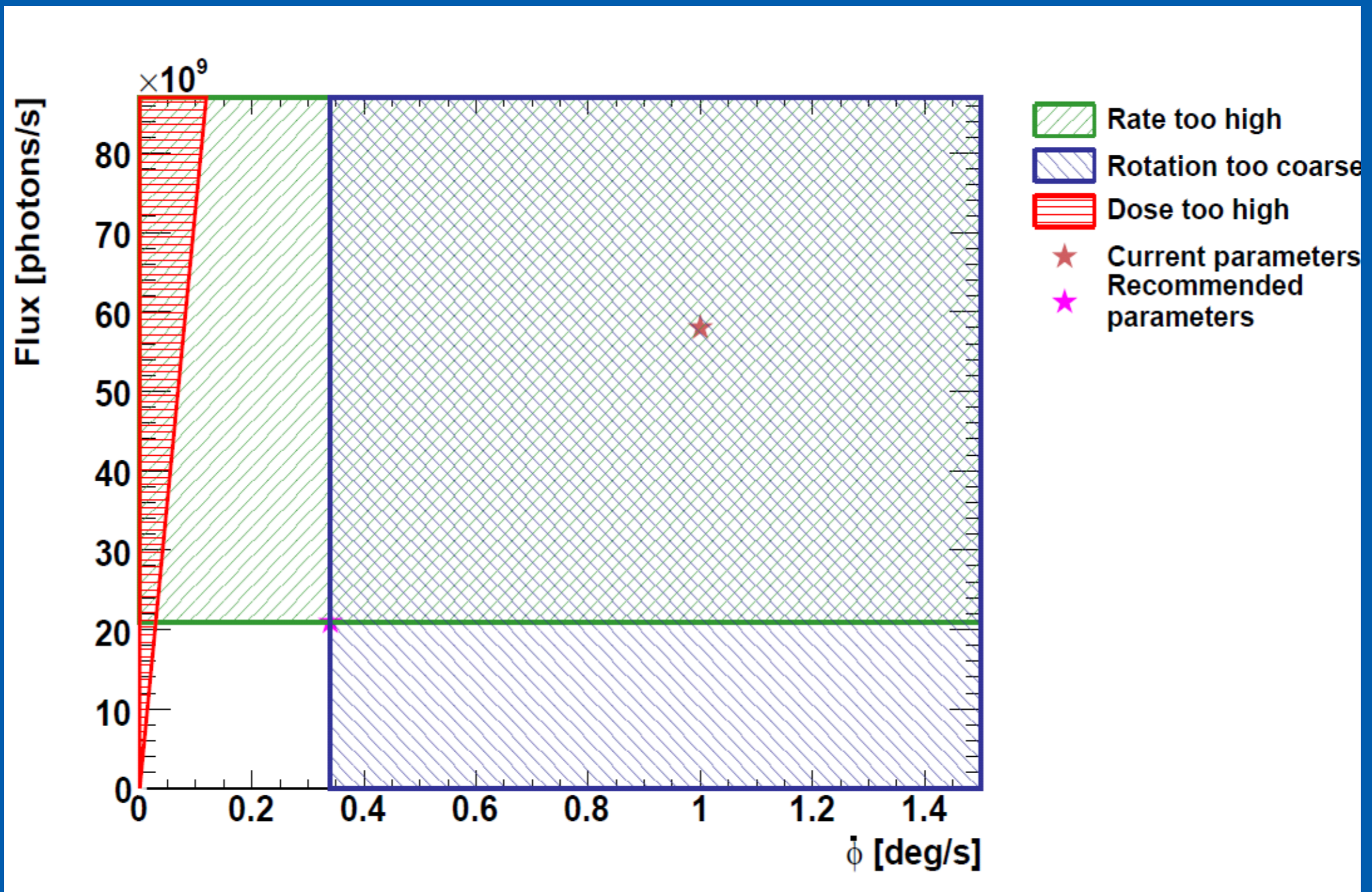
Count-Rate Strategy Software



Goal: maximize precision of count-rate correction and minimize radiation damage

- Propose initial parameters for low-dose crystallographic dataset
- Process low-dose dataset and compute optimal beam flux and rotation increment
- Feedback to beamline control software for optimal beam flux and rotation increment
- Data collection with optimal parameters
- All computation done in RAM

Product Extension - Software Packages



Product Extension - Software Packages

Crystallographic Data Processing Software



Goal: data processing equally fast as data collection

- All computation done in RAM (image files, results, temporary files,...)
- Data continuously synchronized to storage and after calculations finish, deleted from RAM
- Recommended software package XDS due to parallel computing

Conclusions

- DCBe based PILATUS detectors will generate massive data rates
100Ke to 6Me-F: 140 - 8400 MB/s
- Product extensions to our detector systems: processing unit
Our value proposition is:
 - Better data quality due to optimal data collection: count-rate strategy software
 - Online data visualization and manipulation: data visualization software
 - No missing images due to data transfer issues: data synchronization software
 - Fast crystallographic data reduction: processing server using XDS
 - Storage capacity for up to 4 months regular user operation: processing storage

Are you ready for the future ???

DECTRIS is...

DECTRIS Ltd., Switzerland: D. Barrowman, S. Brandstetter, Ch. Broennimann, C. Buechli, S. Commichau, T. Donath, E.F. Eikenberry, A. Gyueruesi, Ch. Hoermann, F. Hunziker, M. Kobas, T. Loeliger, B. Luethi, C. Mathis, I. Mathys, M. Ming, D. Musarra, M. Naef, G. Palminteri, V. Pilipp, T. Sakhelashvili, M. Schneebeili, R. Schnyder, S. Schwegler, M. Spieser, R. Theiler, P. Trueb, C. Umbricht

SLS Detector Group, PSI, Switzerland: A. Bergamaschi, R. Dinapoli, B. Henrich, P. Kraft, H. Rickert, B. Schmitt

CMS Pixel Group, PSI, Switzerland: R. Horisberger, H.K. Kaestli, B. Meier, S. Streuli

PX Group, SLS, PSI, Switzerland: J. Diez, M. Mueller, E. Panepucci, A. Pauluhn C., Schulze-Briese, T. Tomizaki

Coherent Scattering Group, SLS, PSI, Switzerland: M. Brecht, O. Bunk, F. Pfeiffer

Laboratory of Crystallography, ETH Zurich, Switzerland: L. Massueger, W. Steurer, Th. Weber

Nanometallurgy, ETH Zurich, Switzerland: R. Spolenak, R. Nyilas

Laboratory of Crystallography, EPFL Lausanne, Switzerland: G. Chapuis, P. Pattison, M. Schiltz

Novartis Institutes for BioMedical Research, Basel, Switzerland: T. Wagner

JASRI, SPring-8, Japan: H. Toyokawa

Nuclear Engineering, University of Tokyo, Japan: H. Niko

Physics Department, The University of Melbourne, Australia: R. Rassool, B. Sobott, J. Winton

Max-Planck-Institut für Medizinische Forschung, Heidelberg, Germany: W. Kabsch

MRC Laboratory of Molecular Biology, Cambridge, United Kingdom: A. Leslie, H. Powell

Dowling College, Kramer Science Center, U.S.A.: H. Bernstein

The Sripps Research Institute, U.S.A.: A. Arvai