Development of CoRDIA: a detector for diffraction-limited SRs and CW FELs

A. Marras[1,2], A. Klyuev[1,2], T. Laurus[1,2], D. Pennicard[1,2], U. Trunk[1,2], C.B. Wunderer[1,2], T. Hemperek[3], T. Kamilaris[3], H. Krueger[3], T. Wang[3] and H. Graafsma[1,2,4]

1) Deutsches Elektronen-Synchrotron (DESY), Hamburg, Germany
2) Center for Free Electron Laser Science (CFEL), Hamburg, Germany
3) University of Bonn, Bonn, Germany
4) Mid Sweden University, Sundsvall, Sweden

CoRDIA

BONN

DESY.

coming upgrades of X-ray sources

CoRDIA

SRs becoming diffraction-limited

expect brilliance increment O(2)
~continuous frame rate

high-brill. FELs considering CW operation

expect ~continuous operation in the 100kHz + range, no time gaps
exp. pulse intensity ~ today

common need emerging

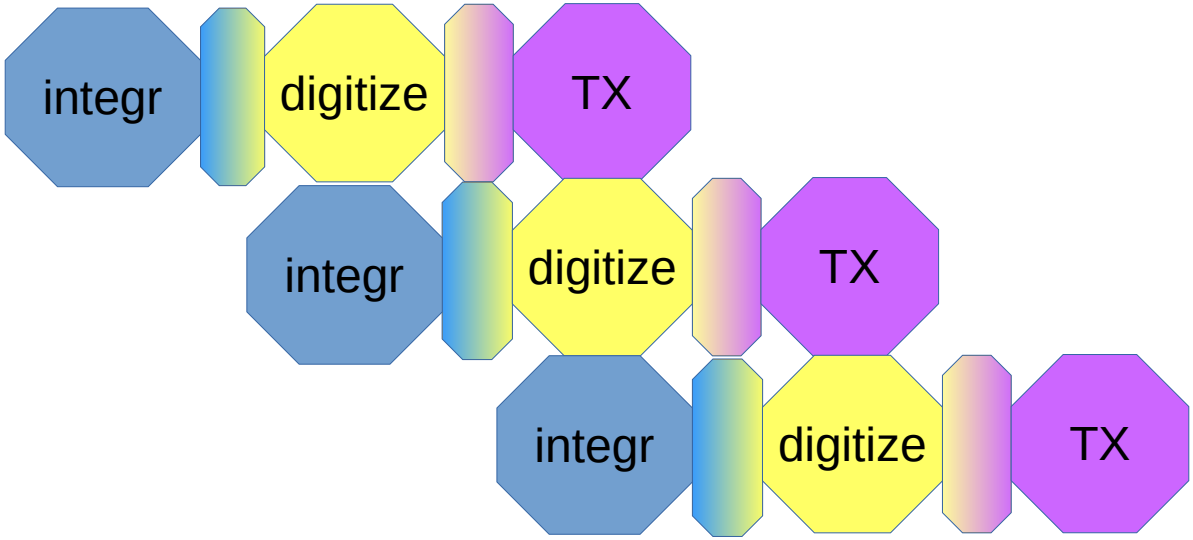
our goals

- > 100 kHz, continuous
- 100 µm pixel size
- minimal dead area
- charge integrating
- 1-photon sens. 12 keV
- 10k ph/pix/img (or more)
- compatible with HZ & internal-ampl. sensors

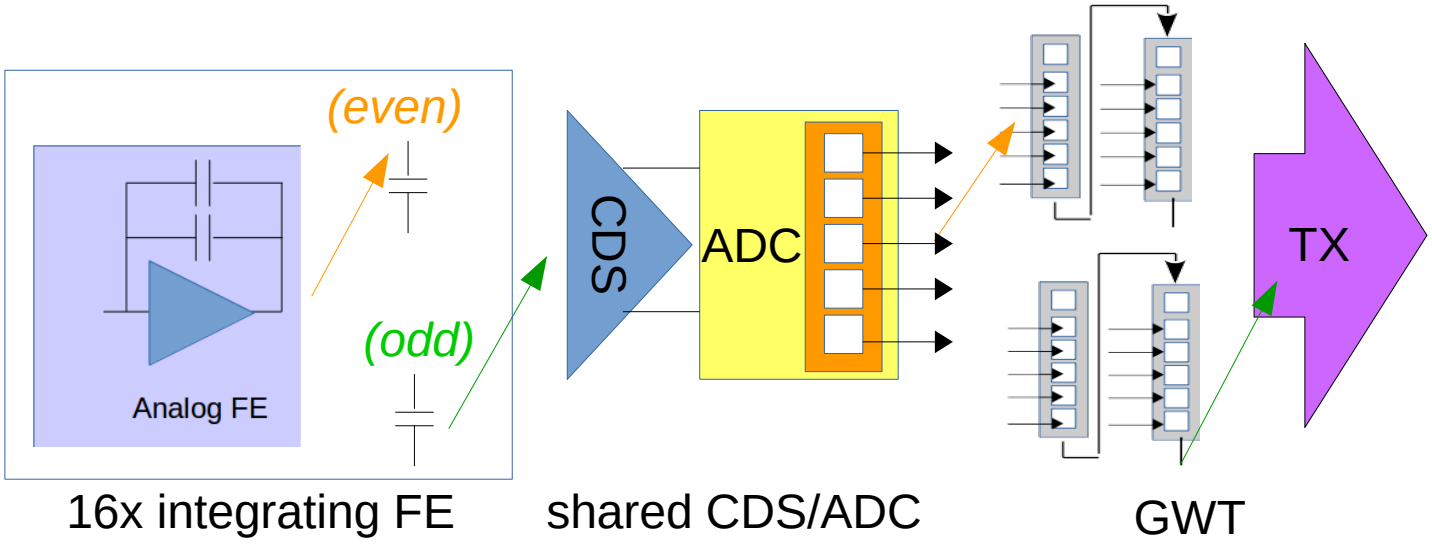
BONN DESY.

COntinuous **R**eadout **D**igitising **I**mager **A**rray

CoRDIA



CWR scheme
using pipelined
signal-process chain



AdGn FE adapt.
from AGIPD

on-chip ADC
developed by
Bonn University

adopt. Timepix4
GWT developed
by Nikhef

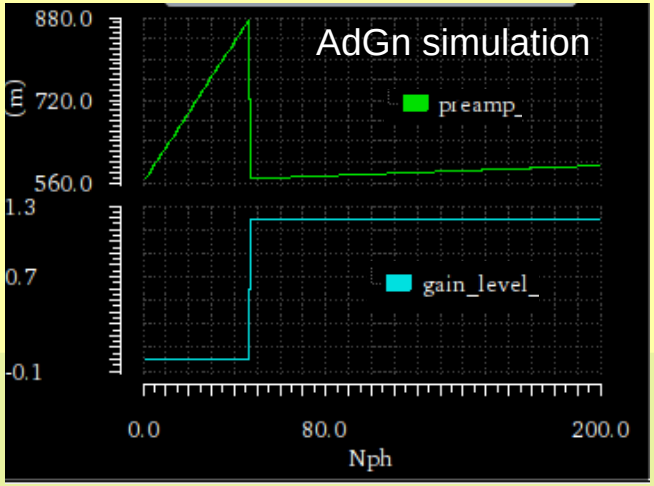
a glimpse at the (ASIC) project flow

CoRDIA

validation of individual circuit blocks

Analog FE & ADC | design | manufacture | test → miniasic

digital streamout | Tpix4 corr | adapt | manufacture | test



validation of individual circuit blocks → validation of circuit chain as a pixel array → validation as a component of the overall detector system

explor. MPW (TSMC65) this year

expansion to full-scale ASIC → 1st gen ASIC

performance improvement study

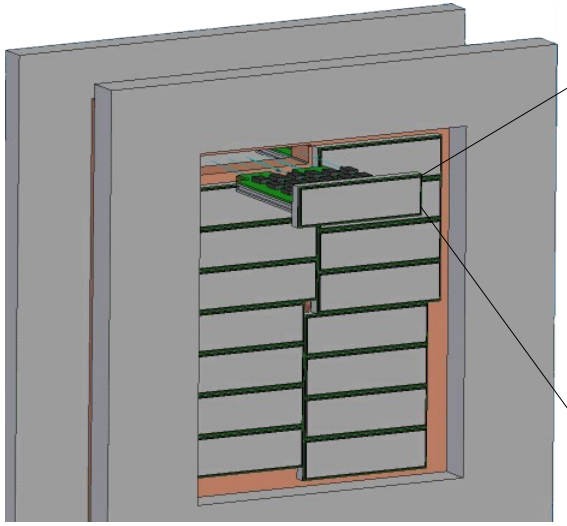
moderate performances will target pixel pitch, cont. readout >100KHz

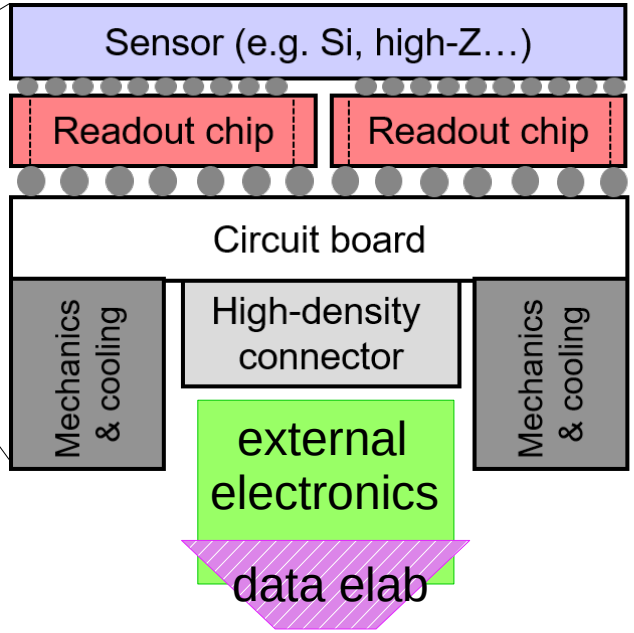
performance improved ASIC → 2nd gen ASIC

improved performance extend dynamic range, reduce noise, minimize blind areas

other aspects

CoRDIA





compatiblility with e-collecting sensors:
- n-on-p Si (~12keV)
- high-Z (hard X-rays)
- sensors with built-in amplification (soft X-rays)

plan to use TSVs to minimize dead/blind space between modules

also, beware of the DataApocalypse

1Mpix x 14bit/pix x 100kframe/s = 1.4Tb/s = 175GByte/s

or worse, as: larger array desirable | encoding, redundancy | >100kframe/s

we plan to address the issue:

On Silicon
- on-chip digitization through parallel ADCs
- high speed drivers

Out-of-Silicon:
- Serialization on high-perform. FPGA
- high-speed optical links

data reduct./compress.: (under consideration)
- preproc. hardware to reduce data volume