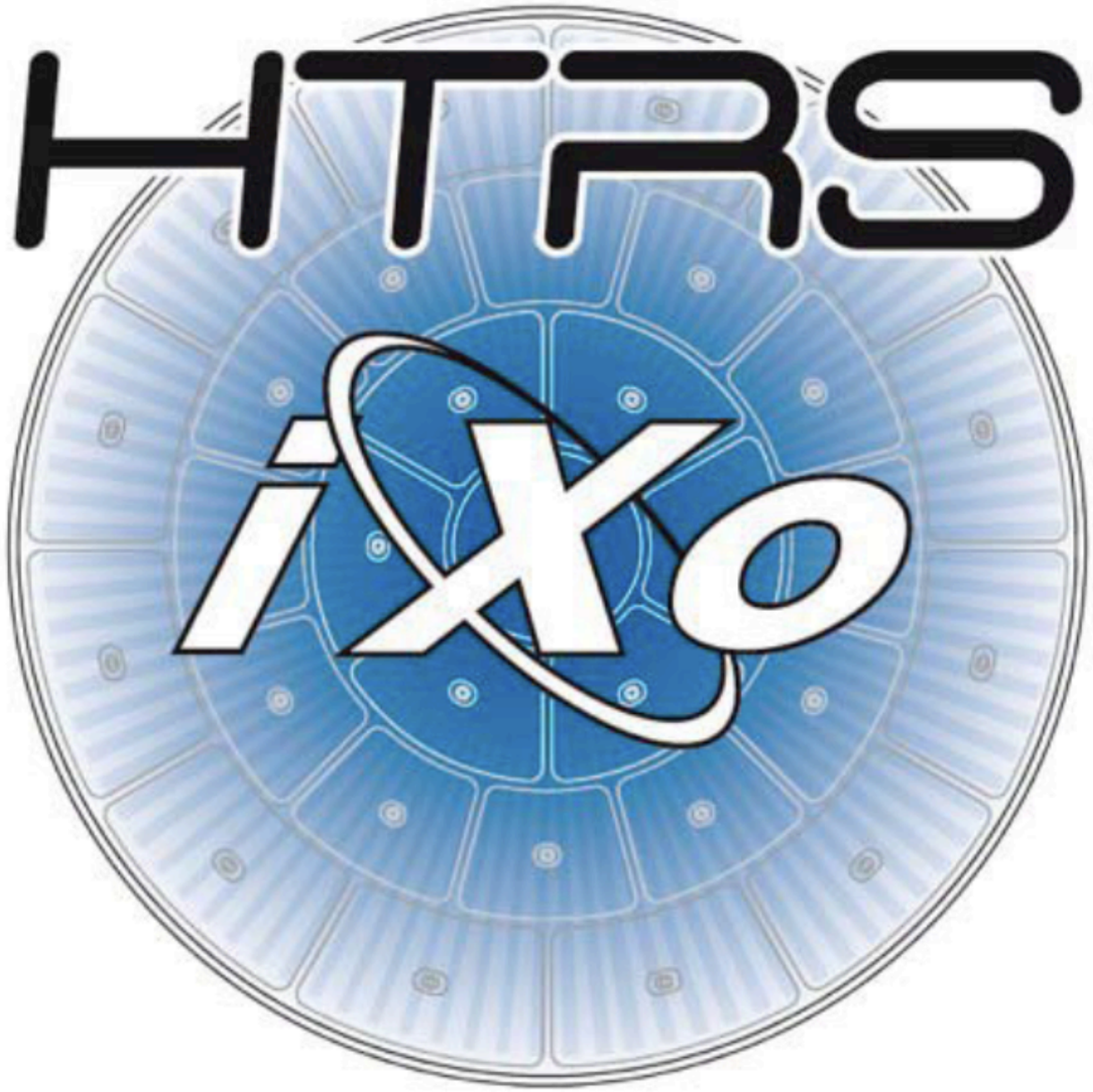
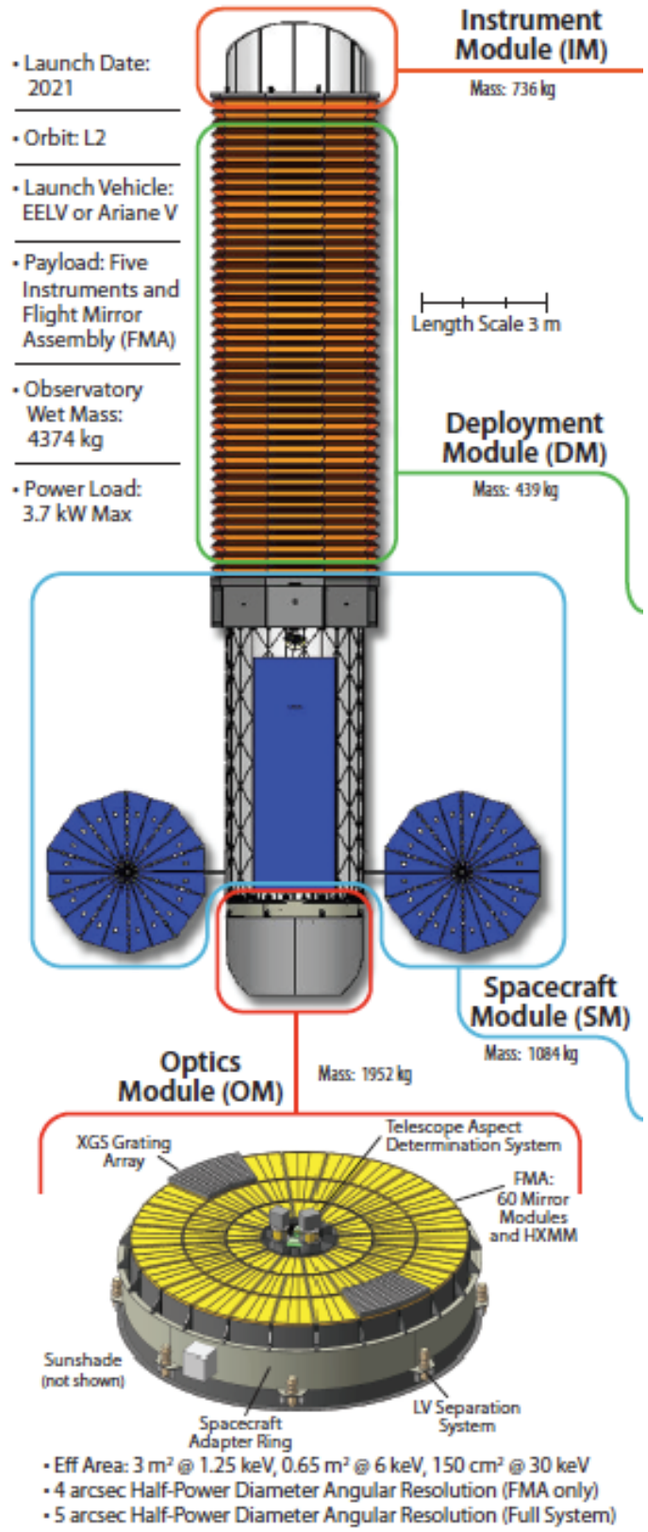
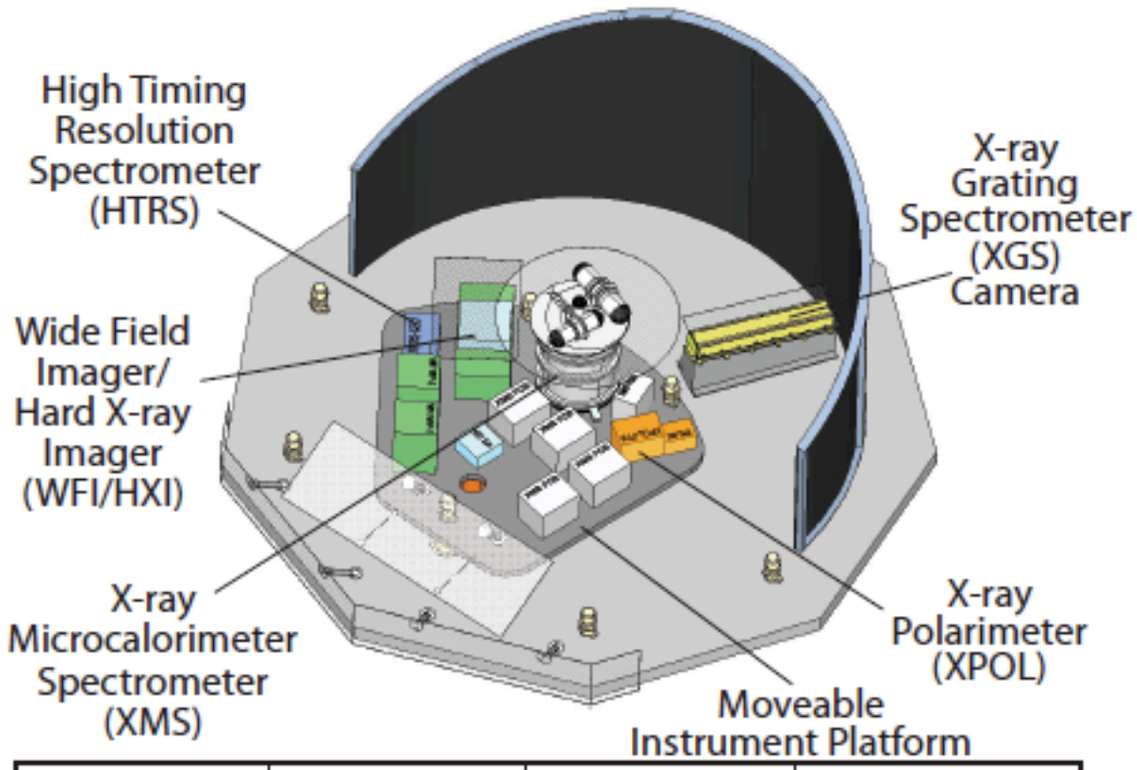
HTRS



Chris Tenzer / HTRS system team
IAAT - University of Tübingen

The International X-ray Observatory IXO

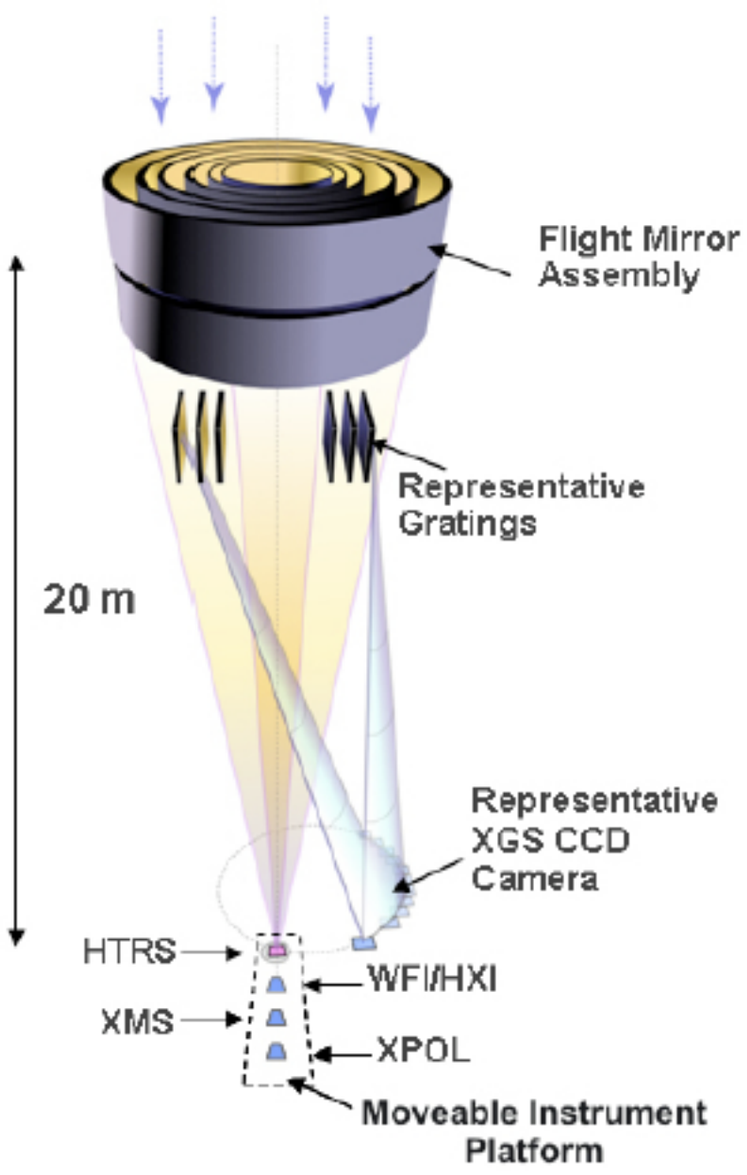


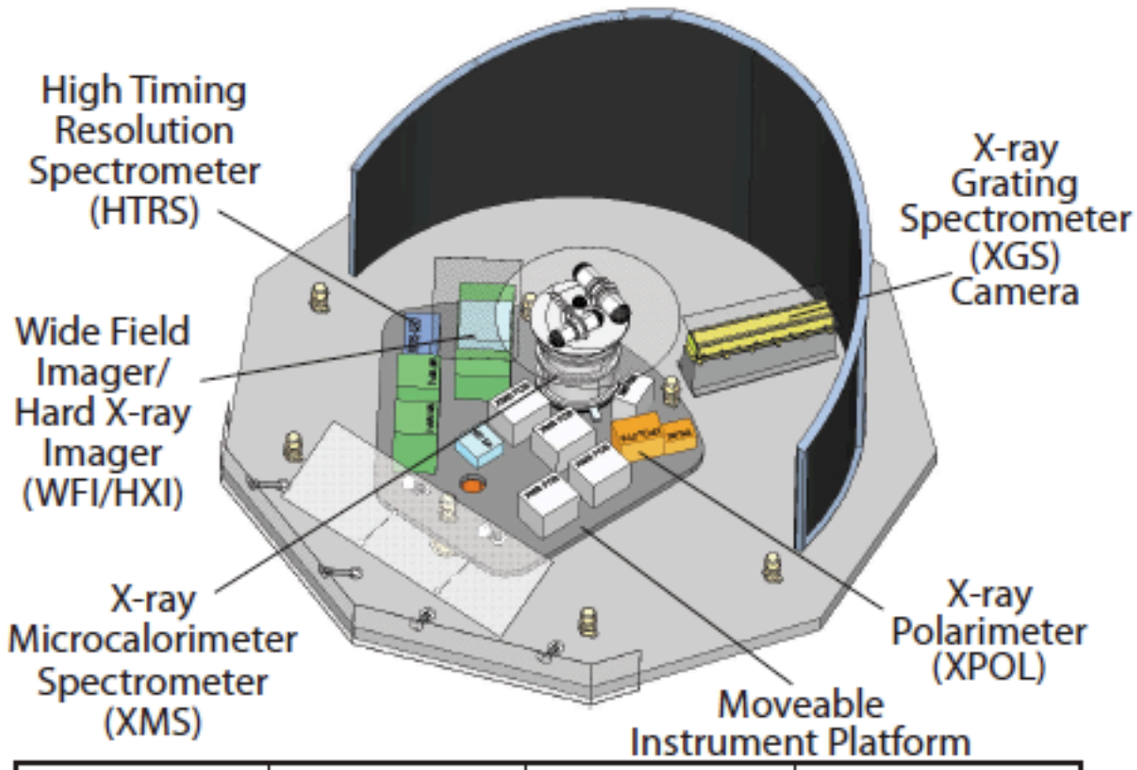


Instrument	Bandpass [keV]	FOV [arcmin]	Energy Resolution [eV@keV]
XMS core	0.3–12	2 x 2	2.5@6
XMS outer		5.4 x 5.4	10@6
WFI/HXI	0.1–15/10–40	18 diam/8 x 8	150@6/1000@30
XGS	0.3–1	N/A	E/ΔE = 3000
HTRS	0.3–10	N/A	150@6
XPOL	2–10	2.5 x 2.5	1200@6

credit: ESA/NASA

IXO - position of the instruments





Instrument	Bandpass [keV]	FOV [arcmin]	Energy Resolution [eV@keV]
XMS core	0.3–12	2 x 2	2.5@6
XMS outer		5.4 x 5.4	10@6
WFI/HXI	0.1–15/10–40	18 diam/8 x 8	150@6/1000@30
XGS	0.3–1	N/A	$E/\Delta E = 3000$
HTRS	0.3–10	N/A	150@6
XPOL	2–10	2.5 x 2.5	1200@6

credit: ESA/NASA

Science Goals

- Black Holes and matter under extreme conditions:
  - extreme densities (neutron stars)
  - extreme gravity (black holes and neutron stars)
  - extreme magnetic fields (neutron stars)

- Formation and evolution of galaxies, clusters and Large Scale Structures

- Life cycles of matter and energy

Science Goals

- Black Holes and matter under extreme conditions:
  - extreme densities (neutron stars)
  - extreme gravity (black holes and neutron stars)
  - extreme magnetic fields (neutron stars)

- Formation and evolution of galaxies, clusters and Large Scale Structures

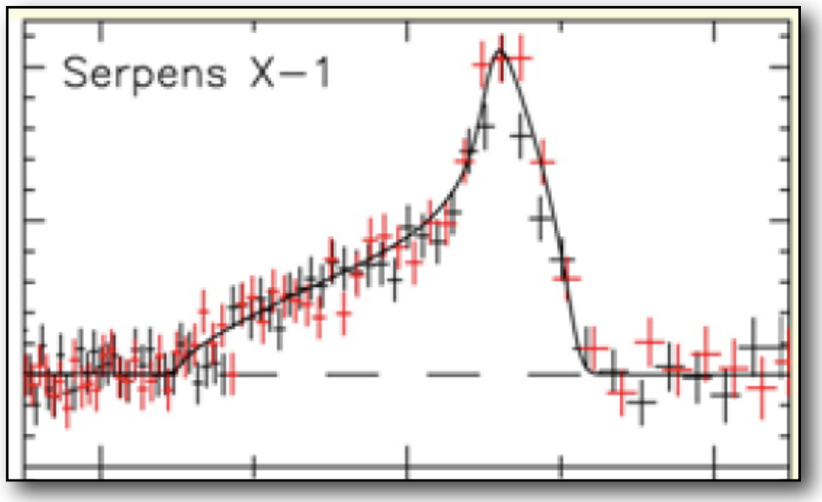
- Life cycles of matter and energy

HTRS Science Goals

Two possible ways to measure the ISCO using properties of matter in orbital motion

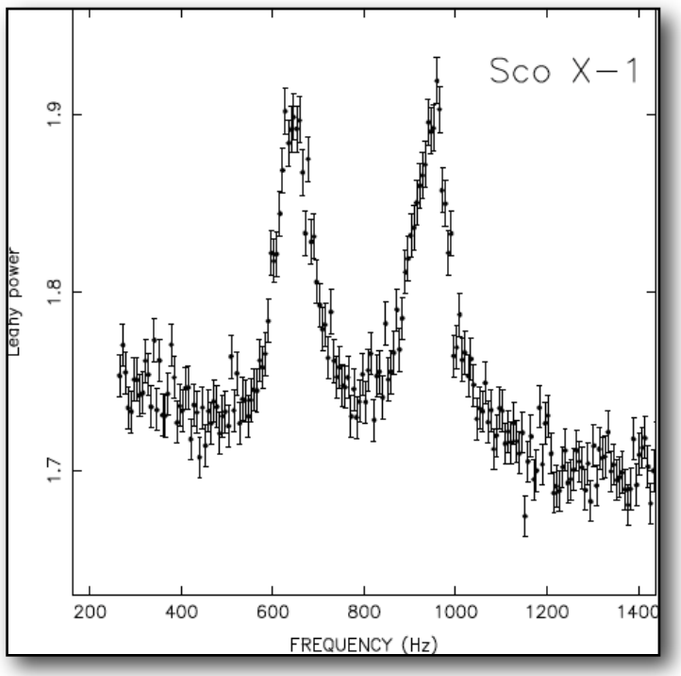
Spectroscopy

- Relativistic Iron Line

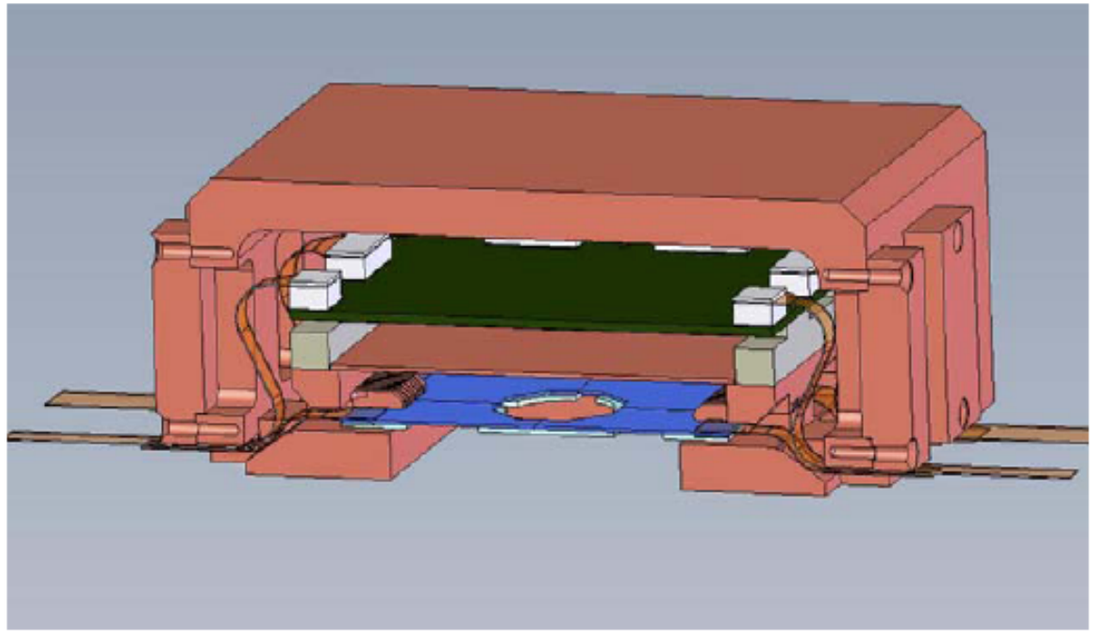


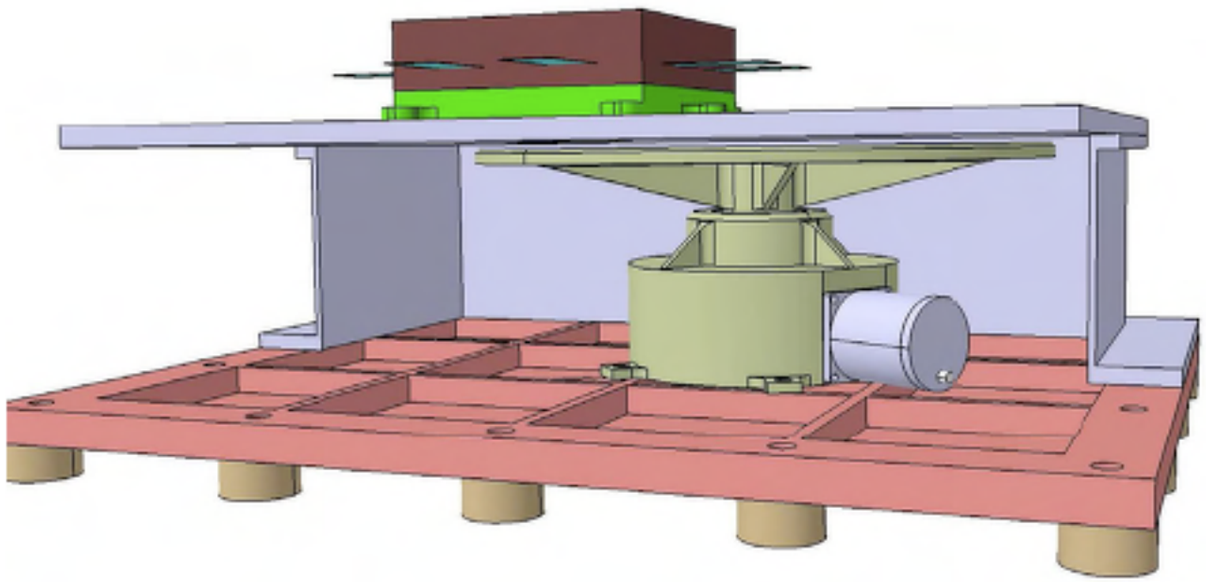
Timing

- Quasi-Periodic Oscillations



HTRS overview

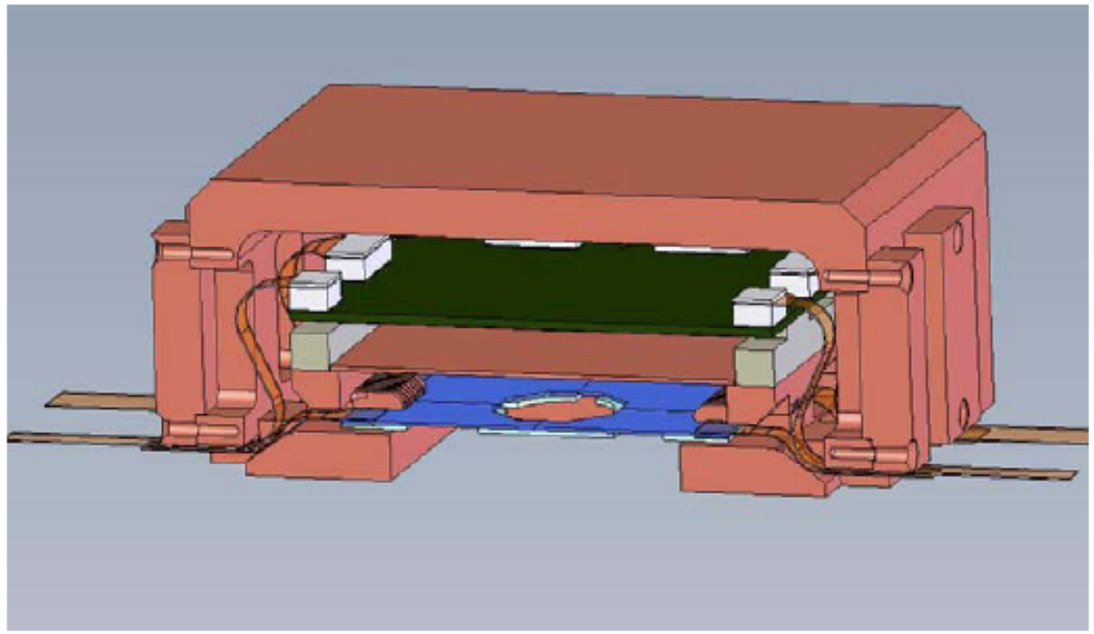


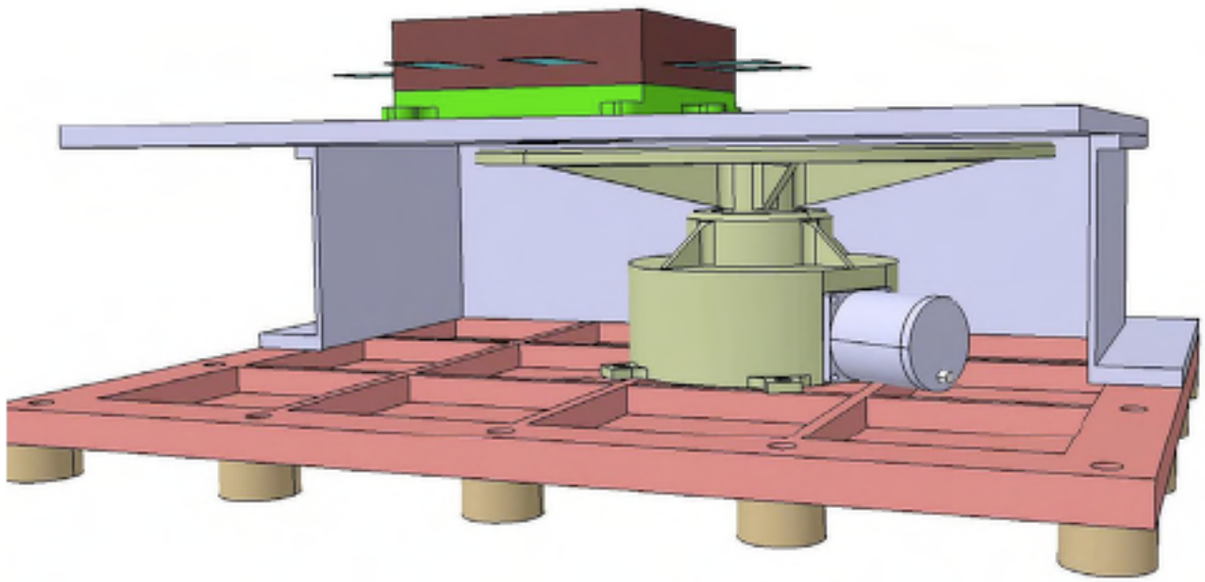


HTRS overview

HTRS science requirements:

- observe very bright sources ≥ 1 Crab without pile-up
- Energy band: 0.3 - 15 keV
- ΔE < 150 eV at 6 keV
- 10 μs time resolution, low deadtime





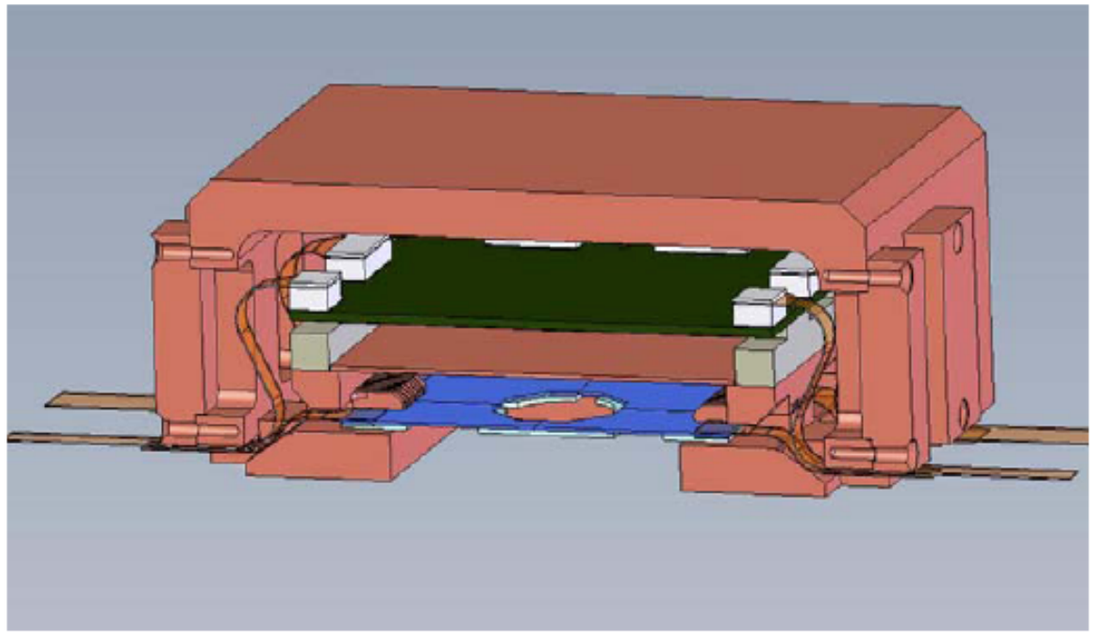
HTRS overview

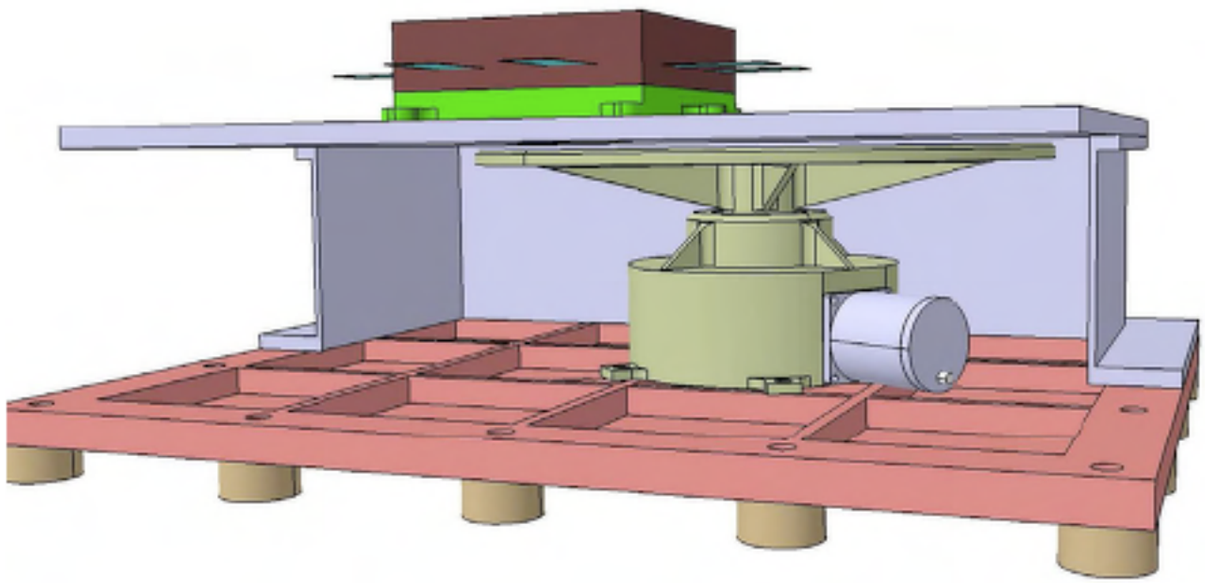
HTRS science requirements:

- observe very bright sources ≥ 1 Crab without pile-up
- Energy band: 0.3 - 15 keV
- ΔE < 150 eV at 6 keV
- 10 μs time resolution, low deadtime

HTRS detector specs:

- array of 31 Silicon Drift Detectors (SDD)
- 450 μm silicon thickness
- low leakage current
- out-of-focus position, high throughput





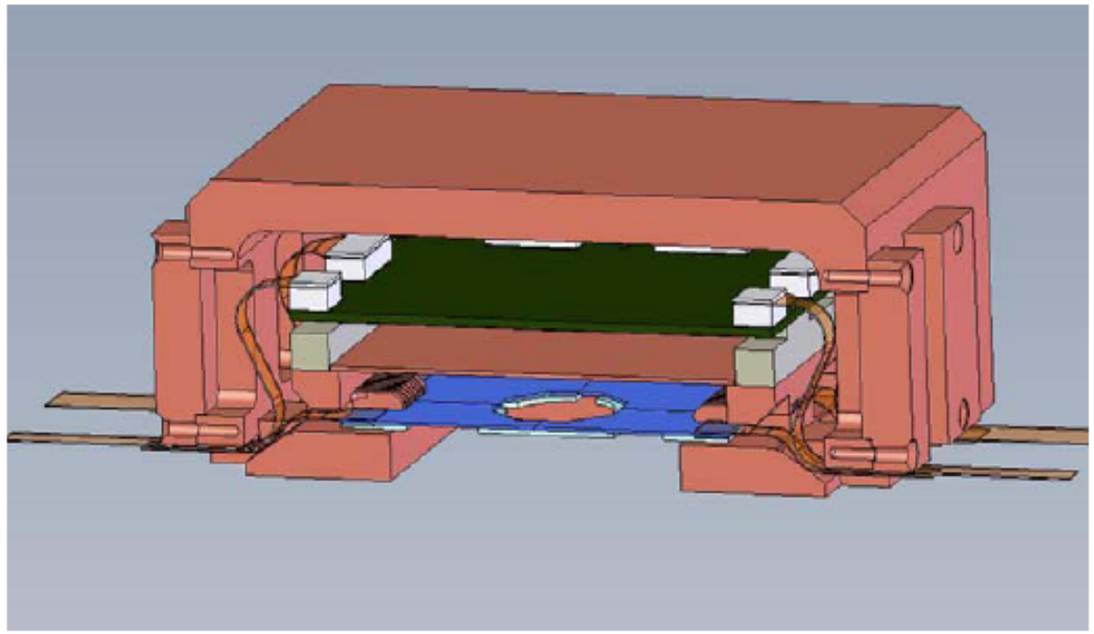
HTRS overview

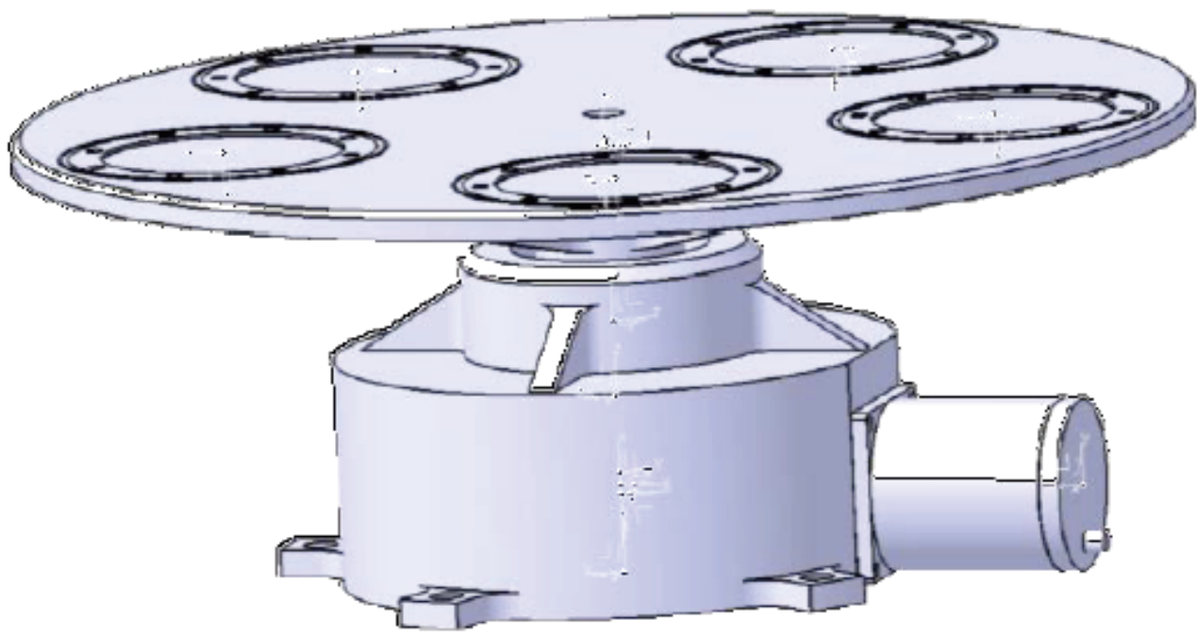
HTRS science requirements:

- observe very bright sources ≥ 1 Crab without pile-up
- Energy band: 0.3 - 15 keV
- ΔE < 150 eV at 6 keV
- 10 μs time resolution, low deadtime

HTRS detector specs:

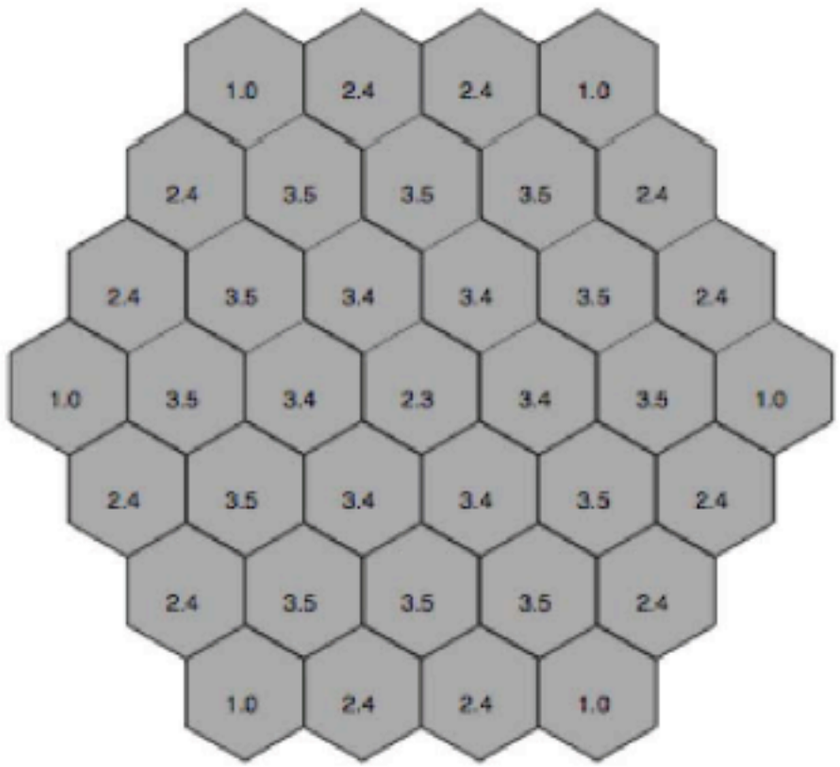
- array of 31 Silicon Drift Detectors (SDD)
- 450 μm silicon thickness
- low leakage current
- out-of-focus position, high throughput



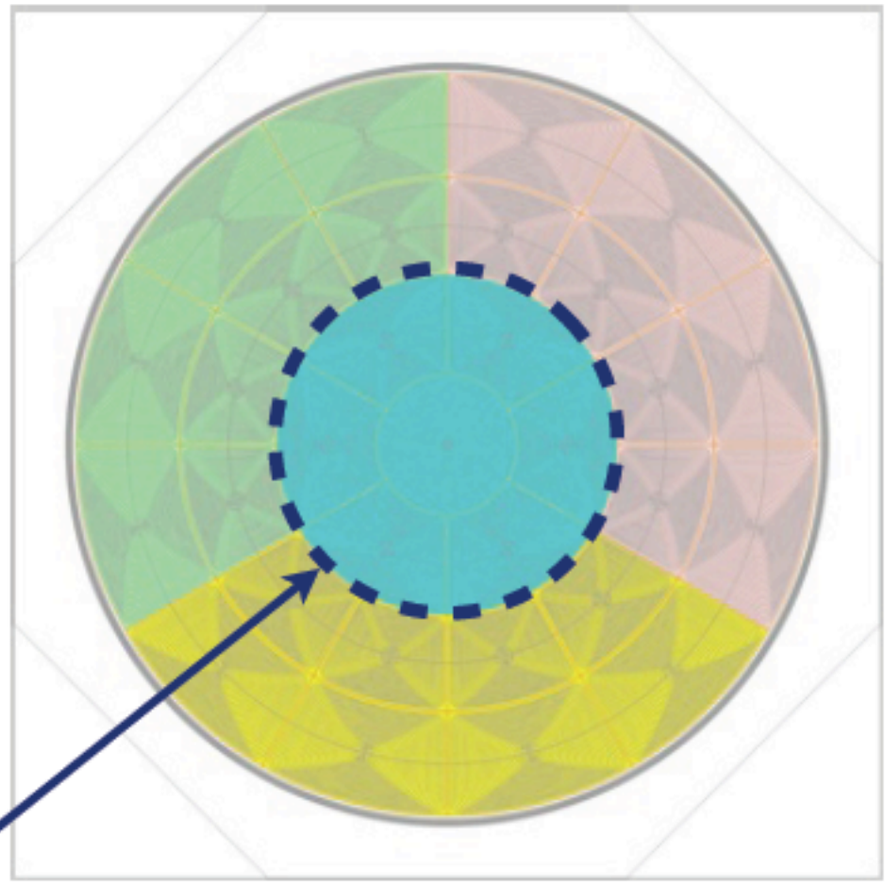


Detector array topology

Hexagonal, 37 diodes (design presented in PDD)

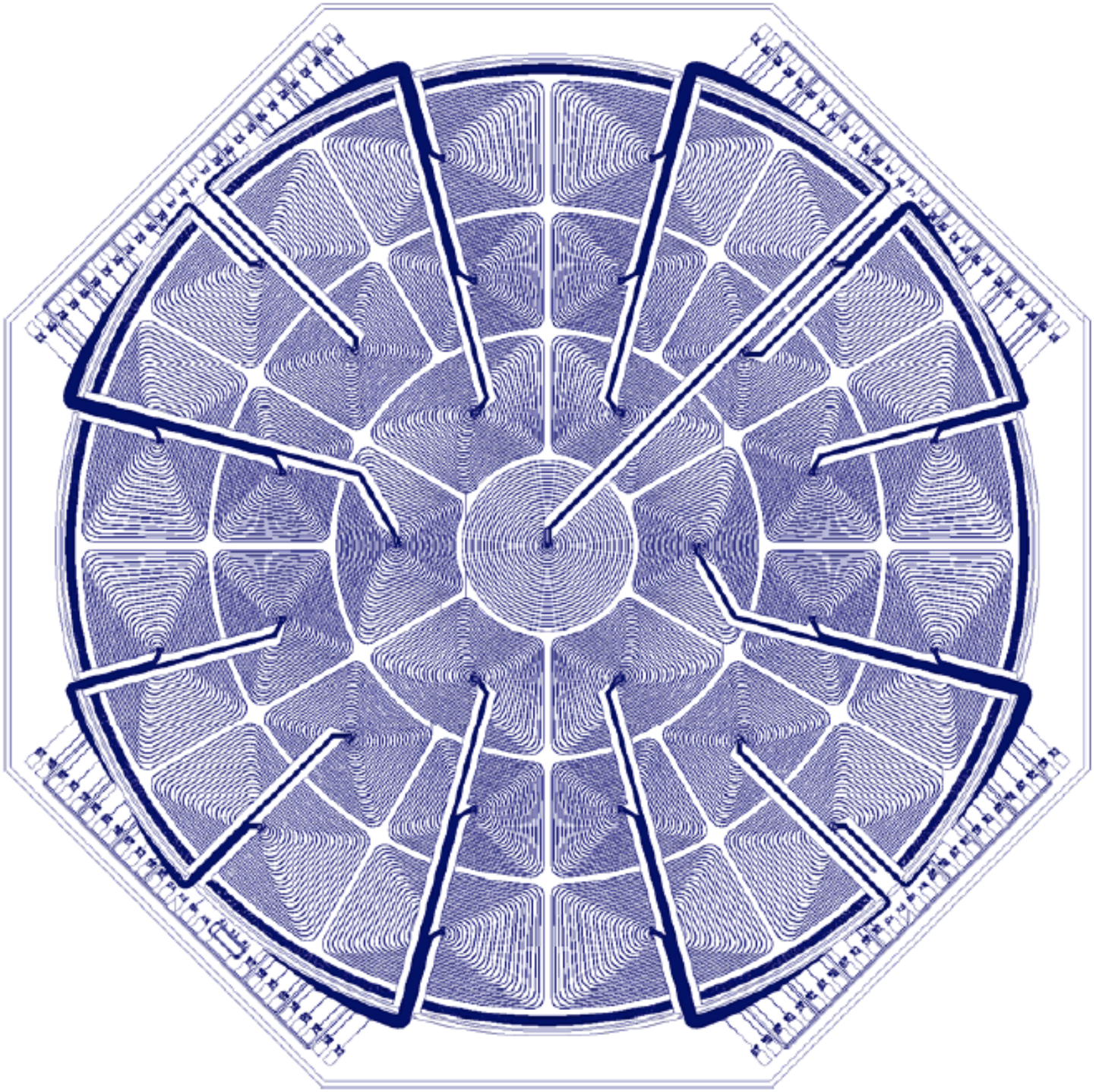


Circular, 31 diodes (design presented at IDR)



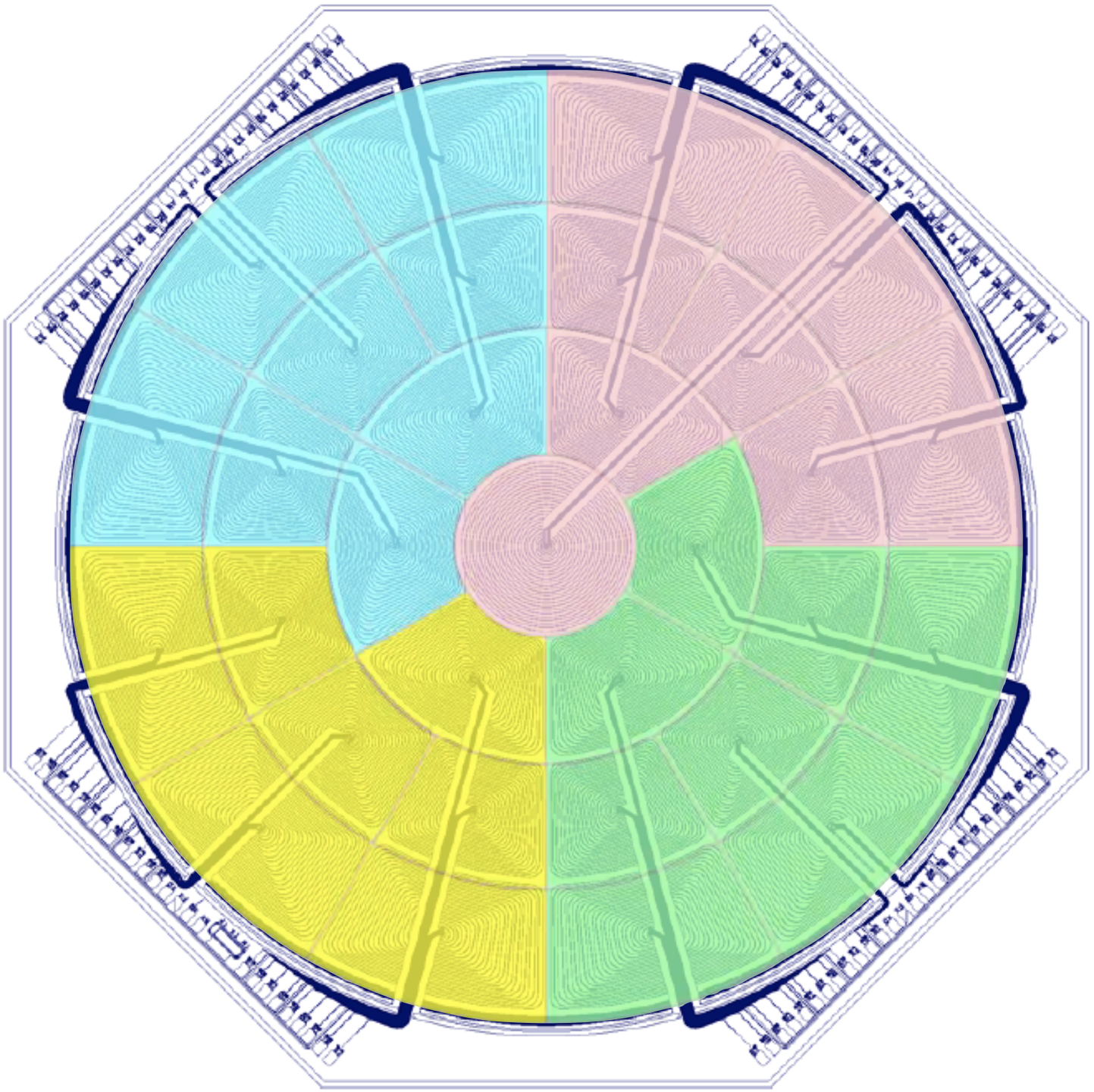
Phase A development

HTRS detector



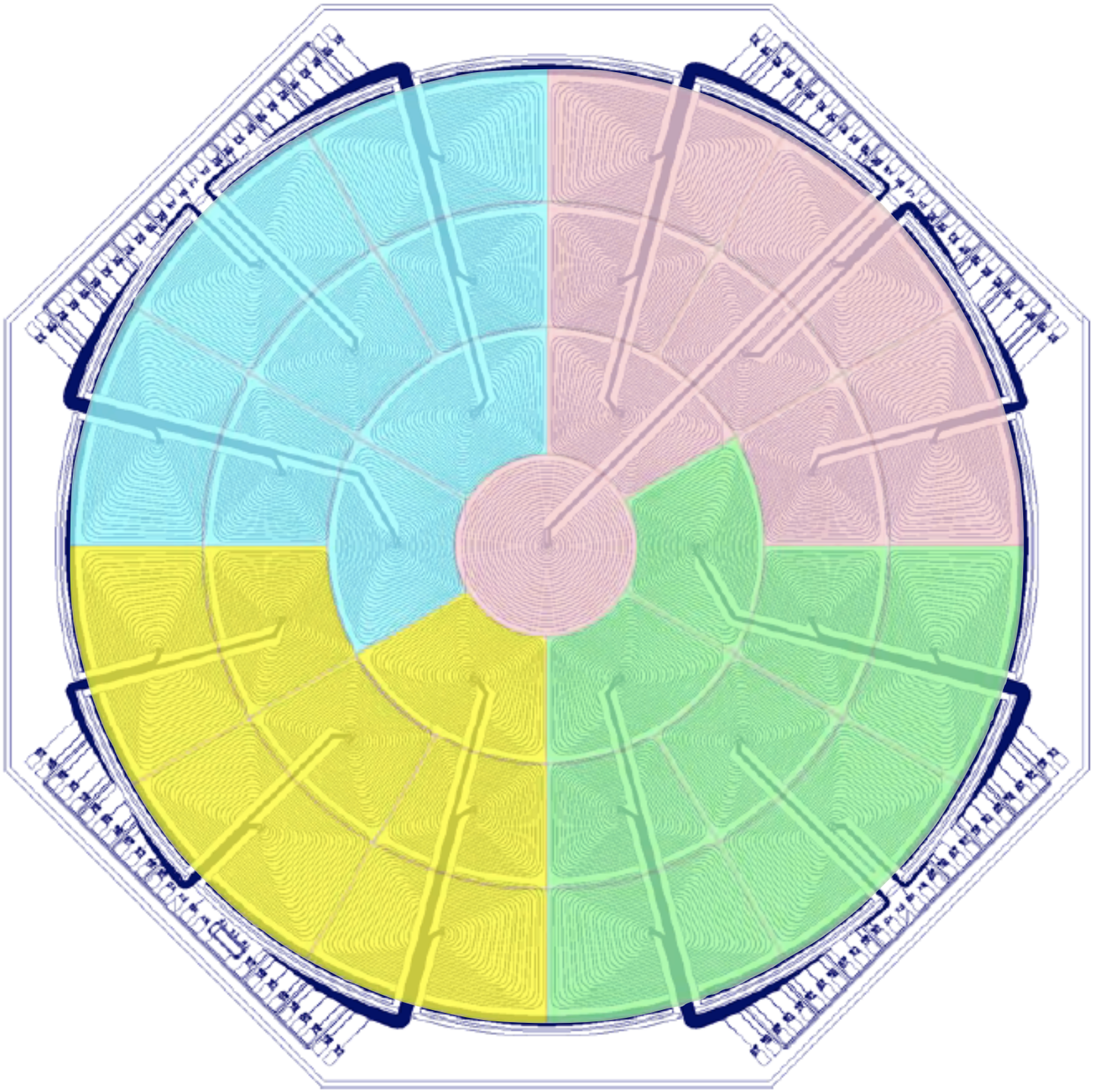
images: Peter Lechner, HLL

HTRS detector



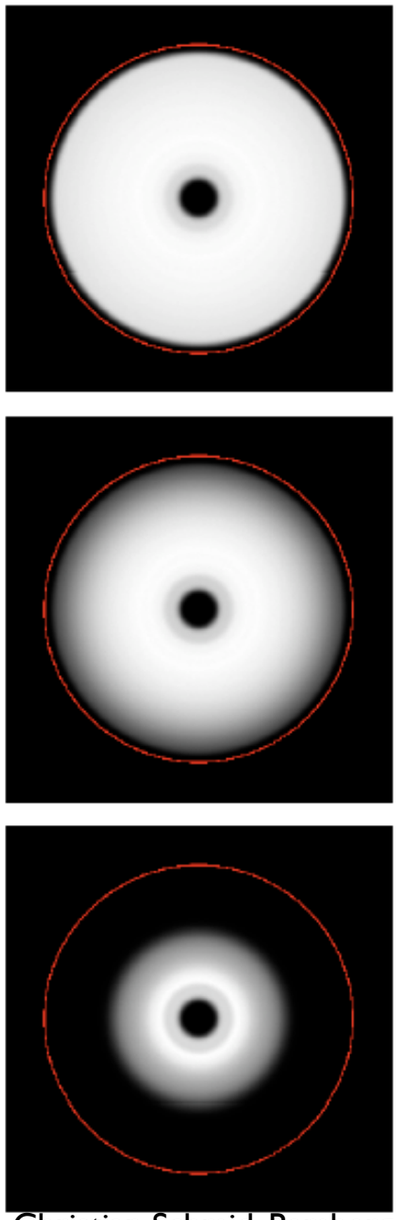
images: Peter Lechner, HLL

HTRS detector



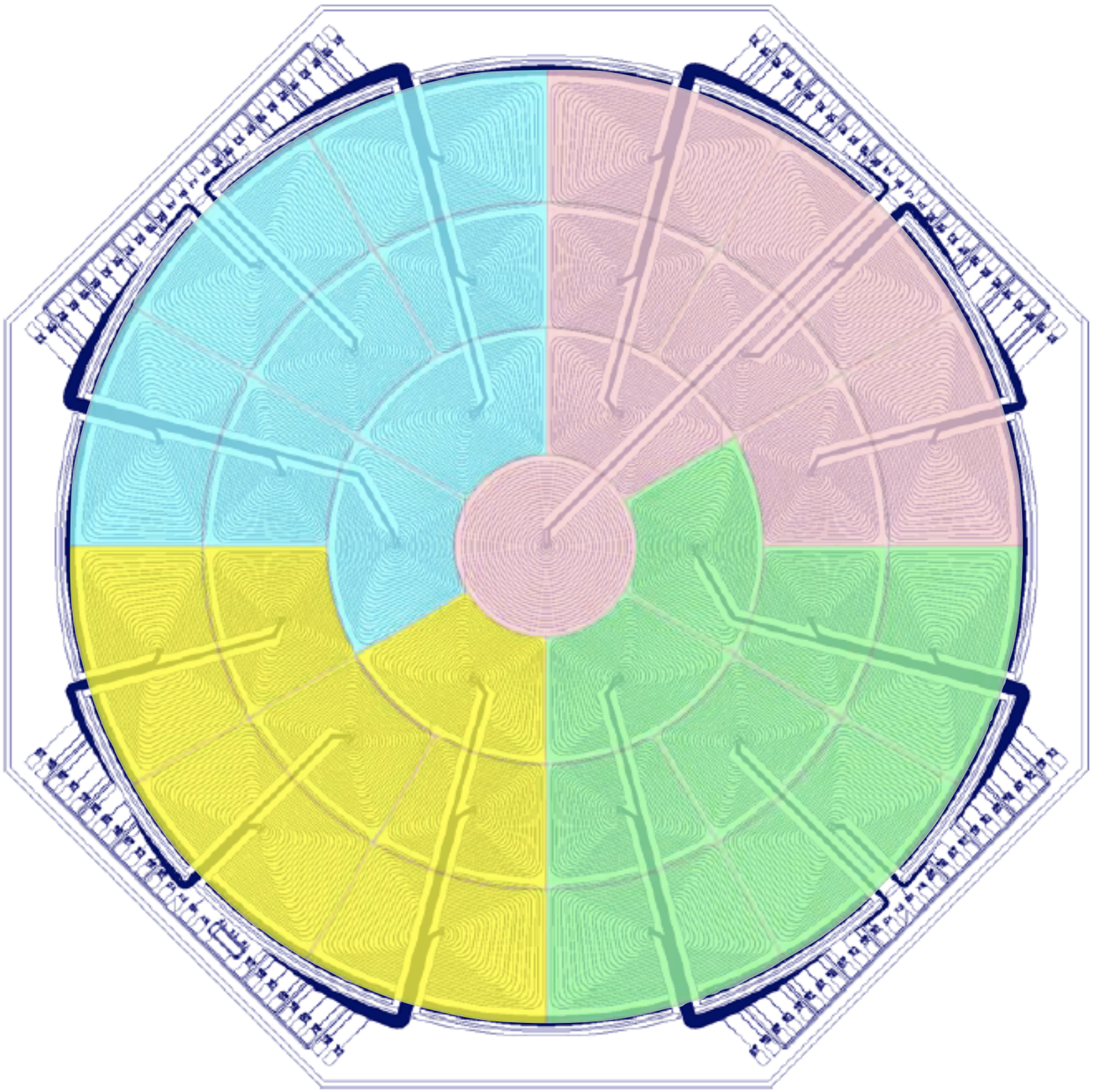
images: Peter Lechner, HLL

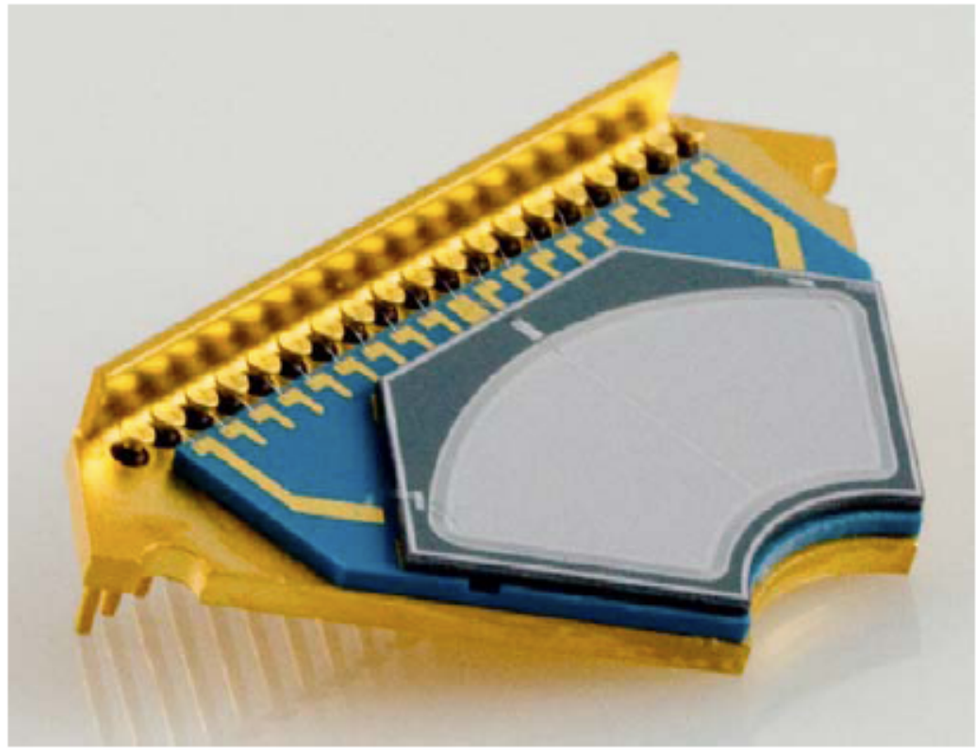
Photon distribution for 12 cm out-of-focus position at 1 keV, 2 keV and 6 keV



Christian Schmid, Bamberg

HTRS detector



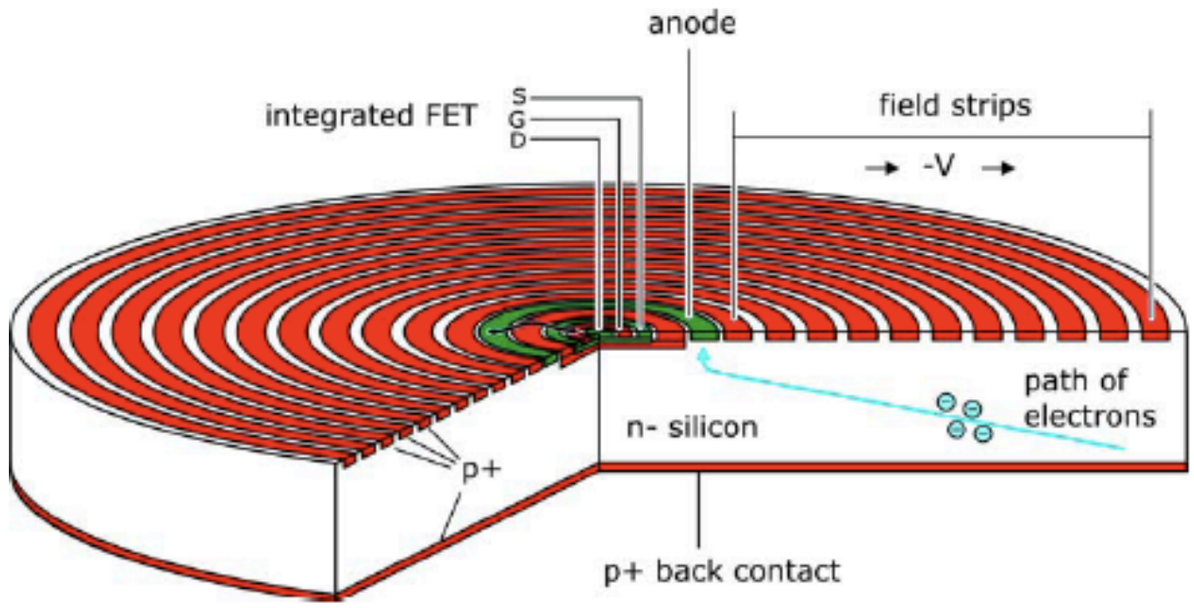


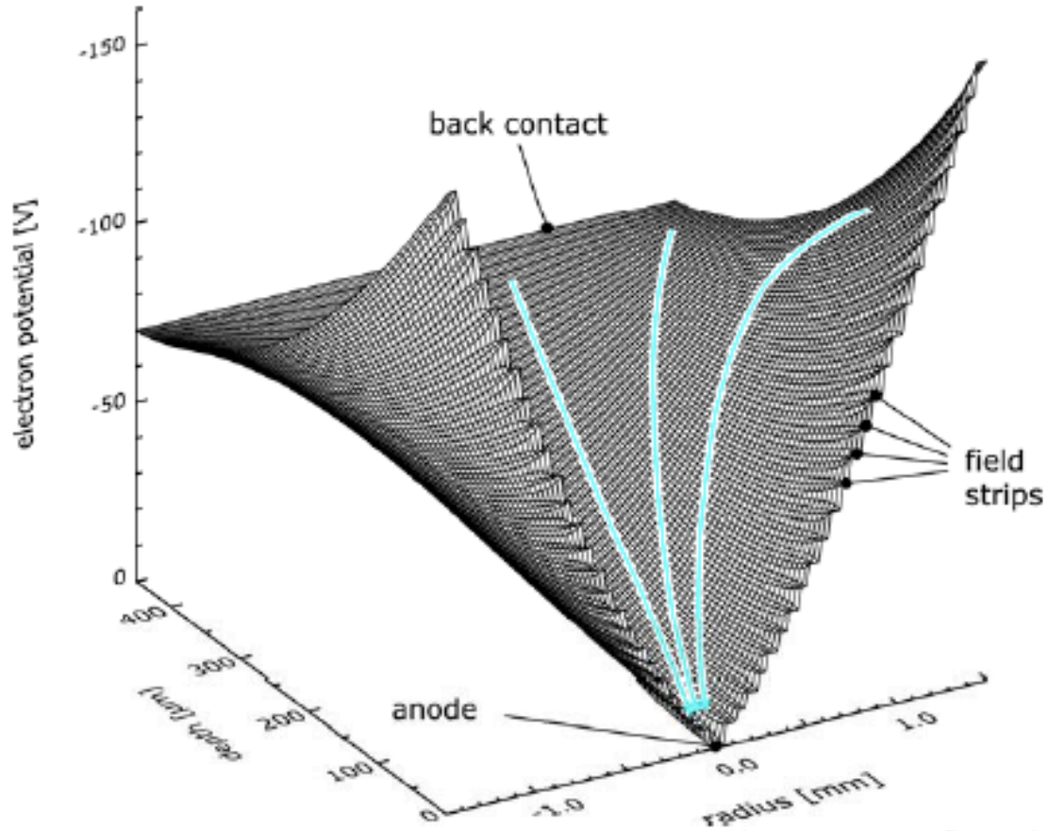
ring sector shaped SDD for the ExoMars Moessbauer spectrometer (2 x 45 mm²)

images: Peter Lechner, HLL

Silicon Drift Detectors

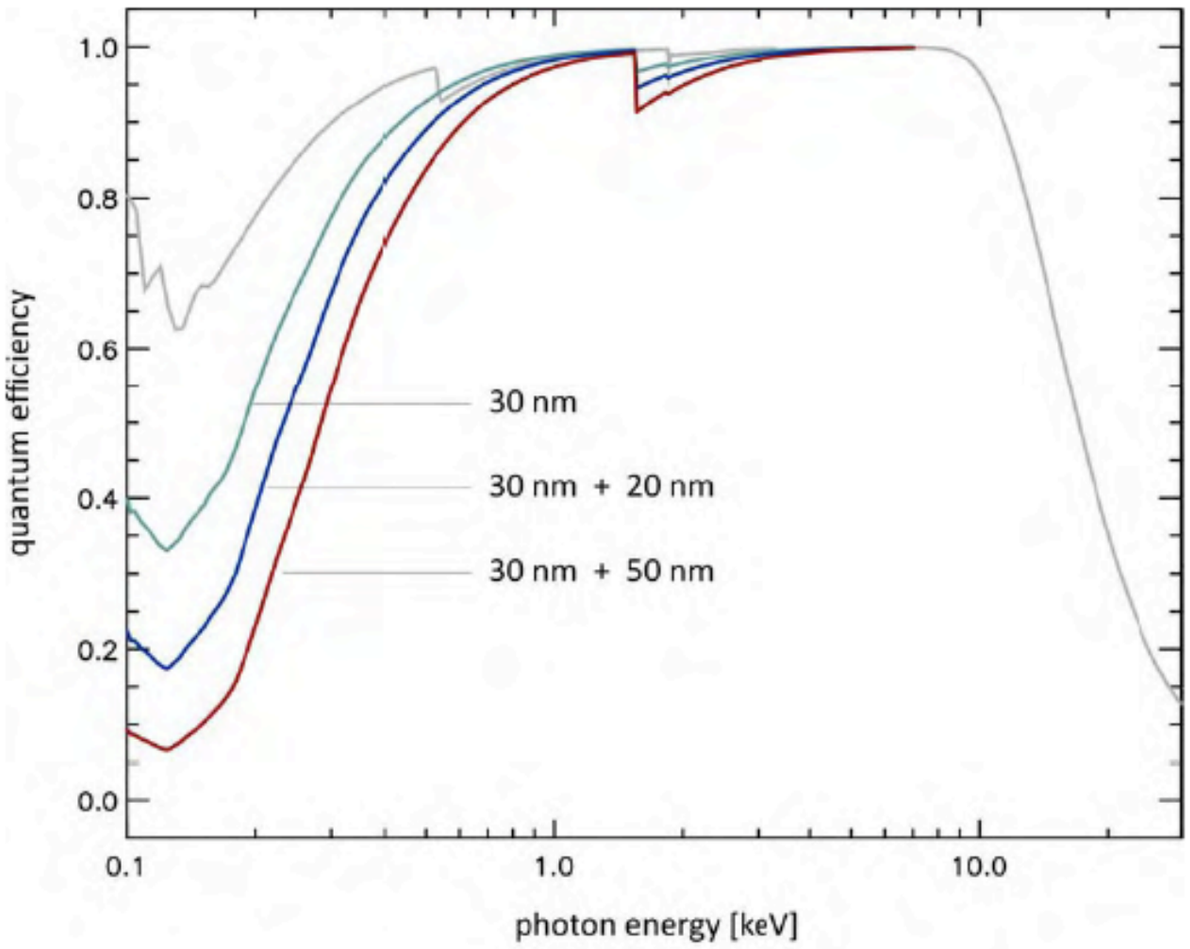
- Large sensitive area
- Small capacitance + integrated FET
  - Low electronics noise
  - Insensitive to pickup
  - High count rate
- Low leakage current level
  - Operation at room temperature or at moderate cooling
- Homogeneous entrance window
  - Backside illumination
- Flexible in shape and size

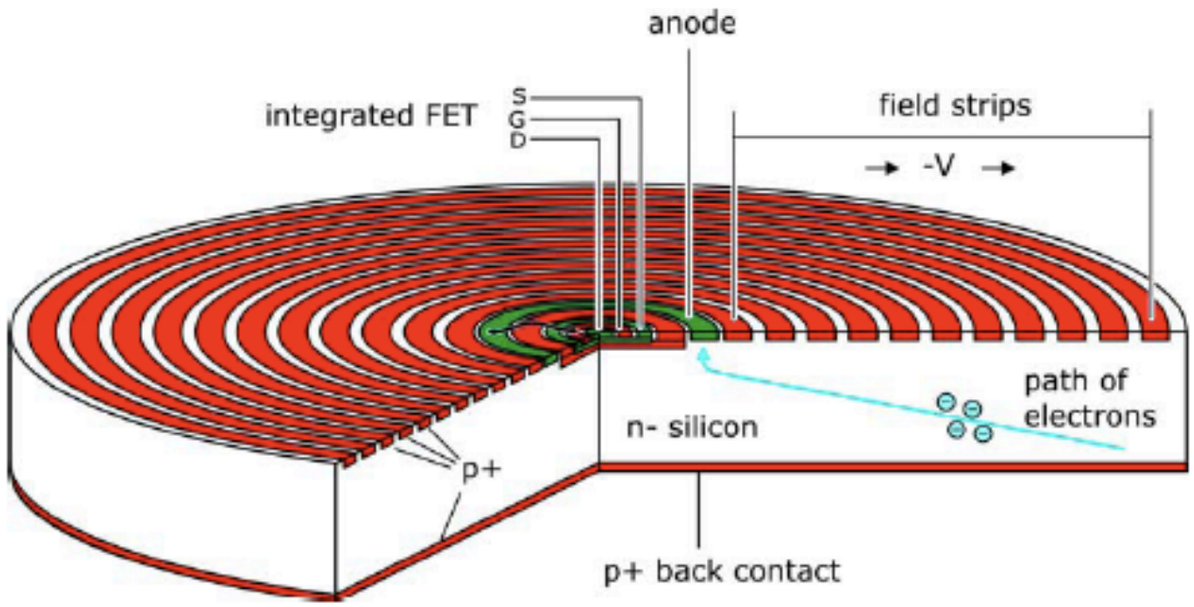


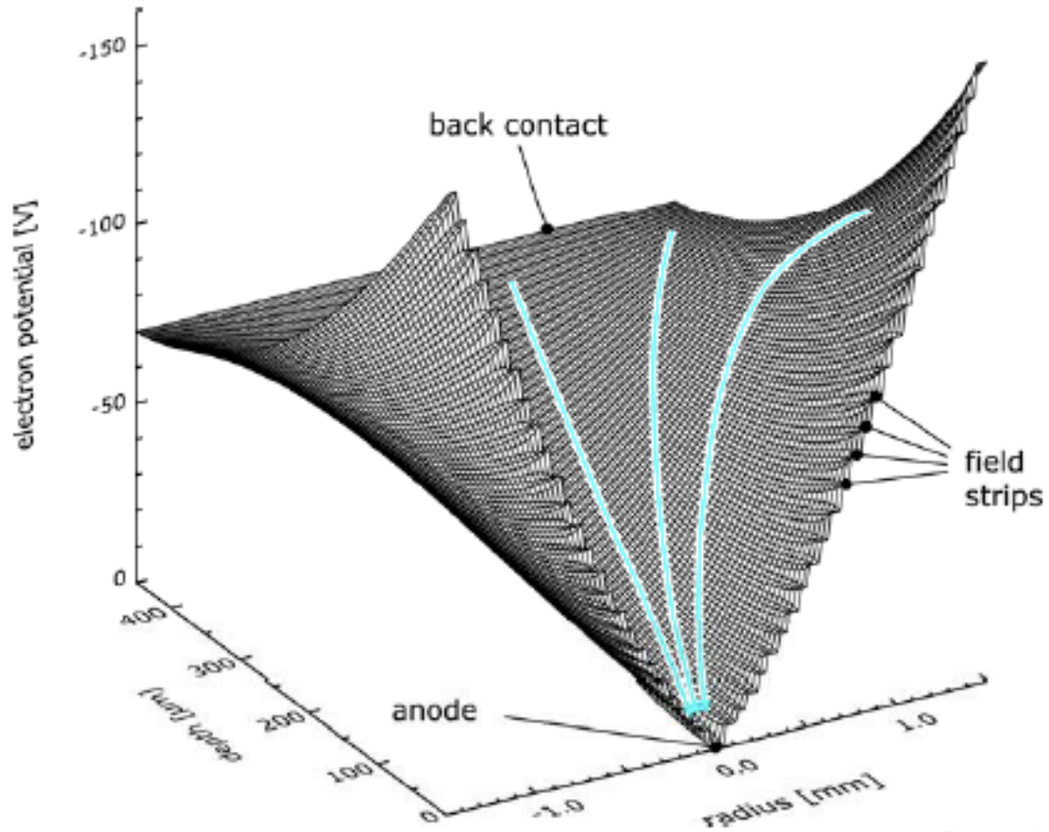


plots + images: Peter Lechner, HLL

Silicon Drift Detectors

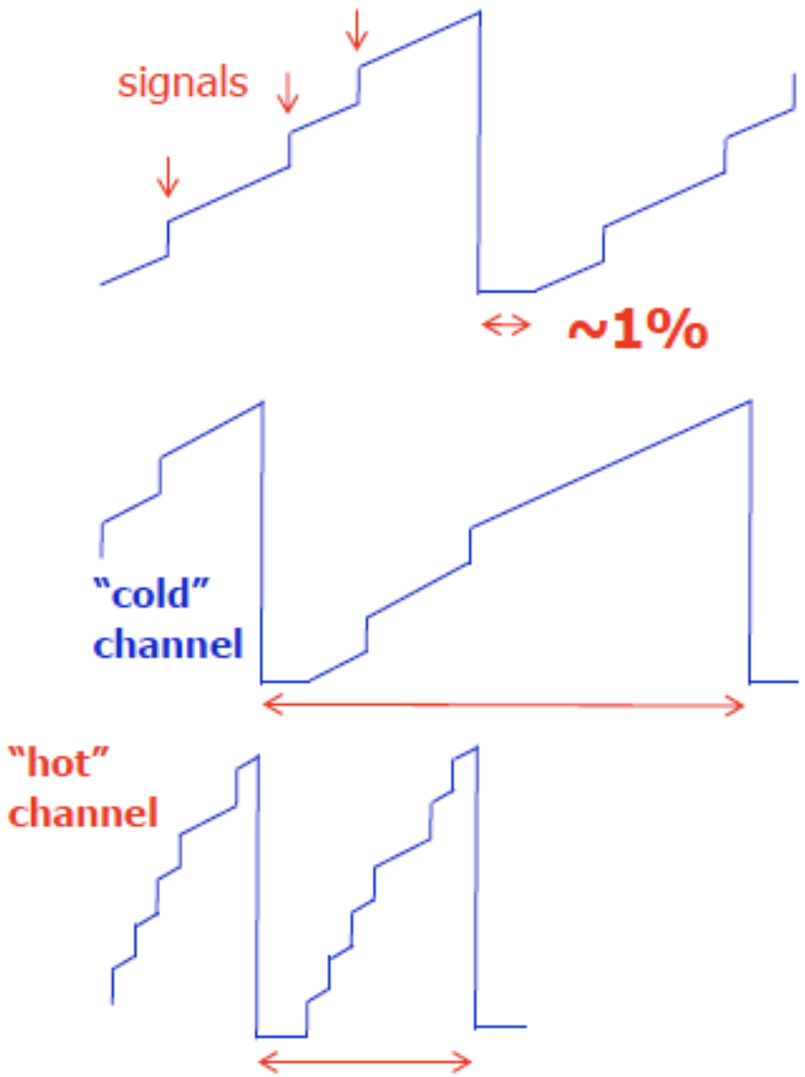






plots + images: Peter Lechner, HLL

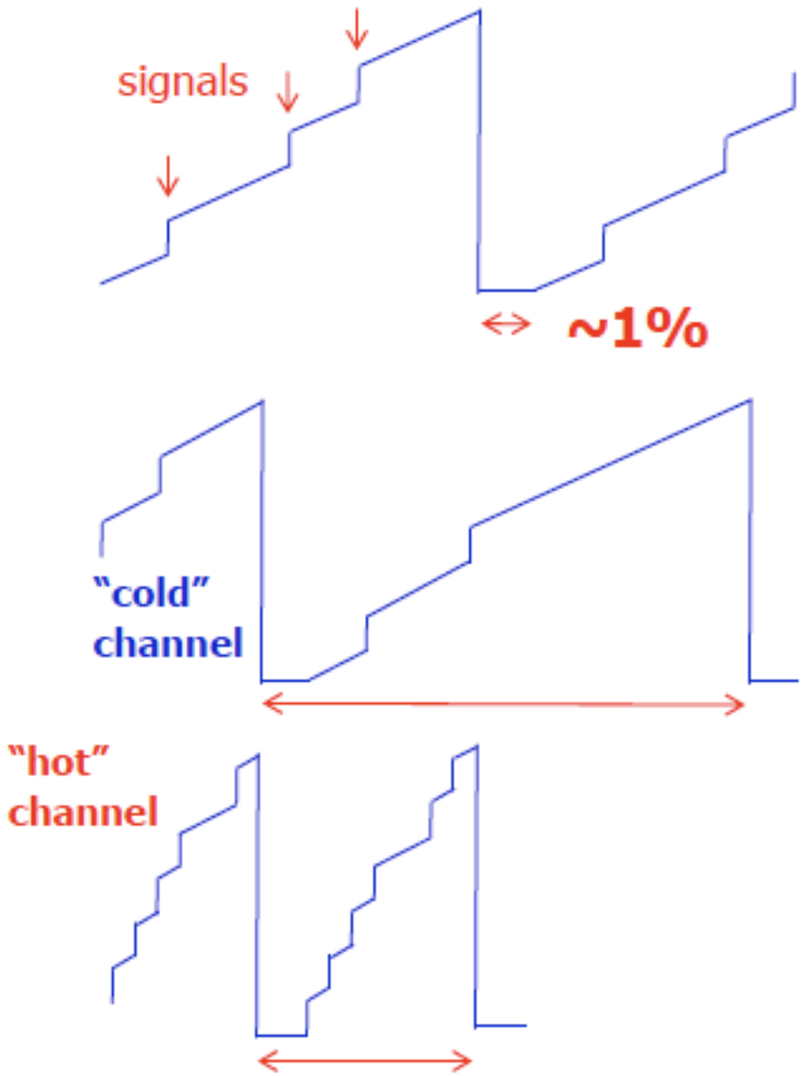
HTRS characteristics



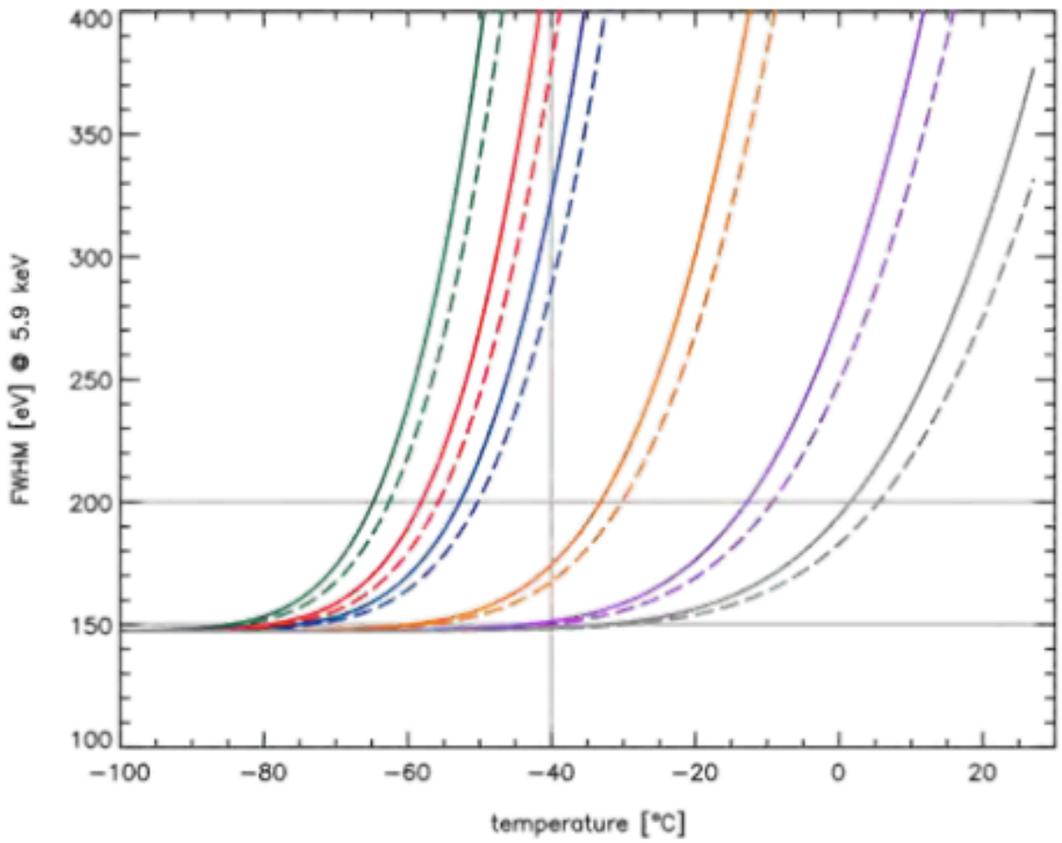
signal and thermal noise integration in one pixel over time, adaptive charge clearing

plots + images: Peter Lechner, HLL

HTRS characteristics



signal and thermal noise integration in one pixel over time, adaptive charge clearing



assumptions

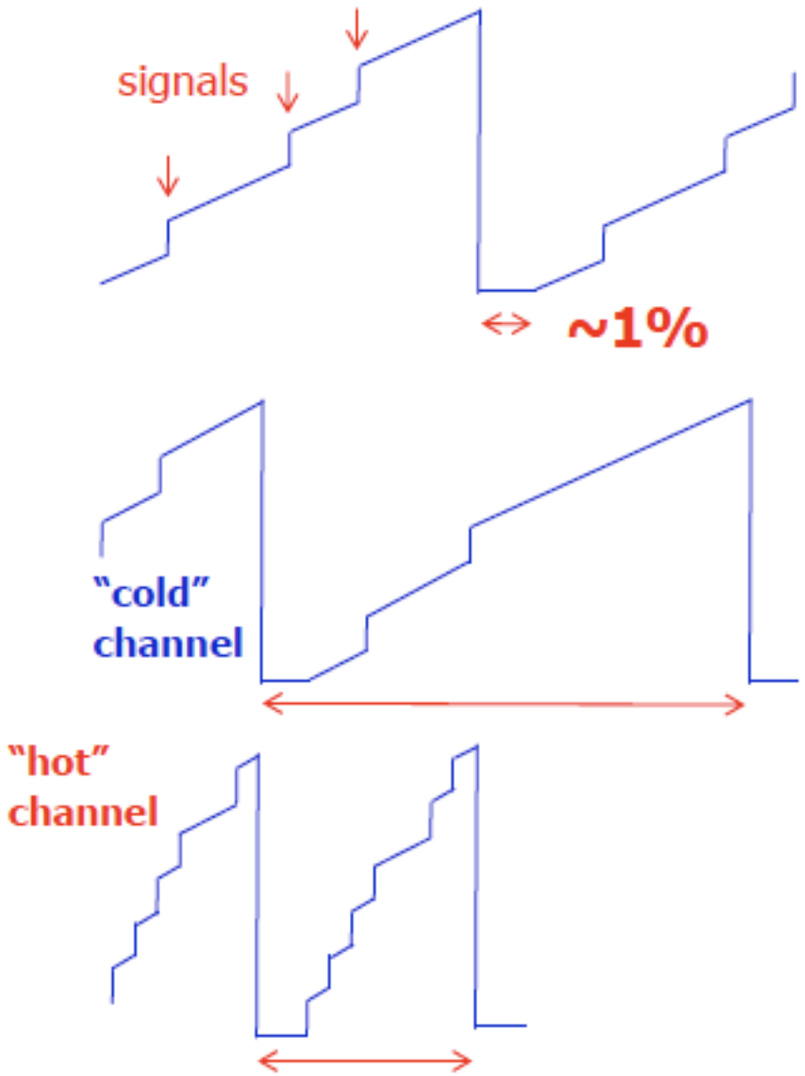
signal integration time	600 nsec
proton effect	2.43e-17 A/p(10 MeV eq.) @ room temperature
noise (white & 1/f)	10 el. r.m.s. equivalent noise charge
leakage current	1 nA/cm² @ room temperature

parameter variations

proton flux	0 p/cm² | 1.e08 p/cm² | 1.e09 p/cm² | 1.e10 p/cm² | 2.e10 p/cm² | 5.e10 p/cm²
largest SDD cell	17.2 mm² ———
smallest SDD cell	12.6 mm² – – – –

plots + images: Peter Lechner, HLL

HTRS characteristics

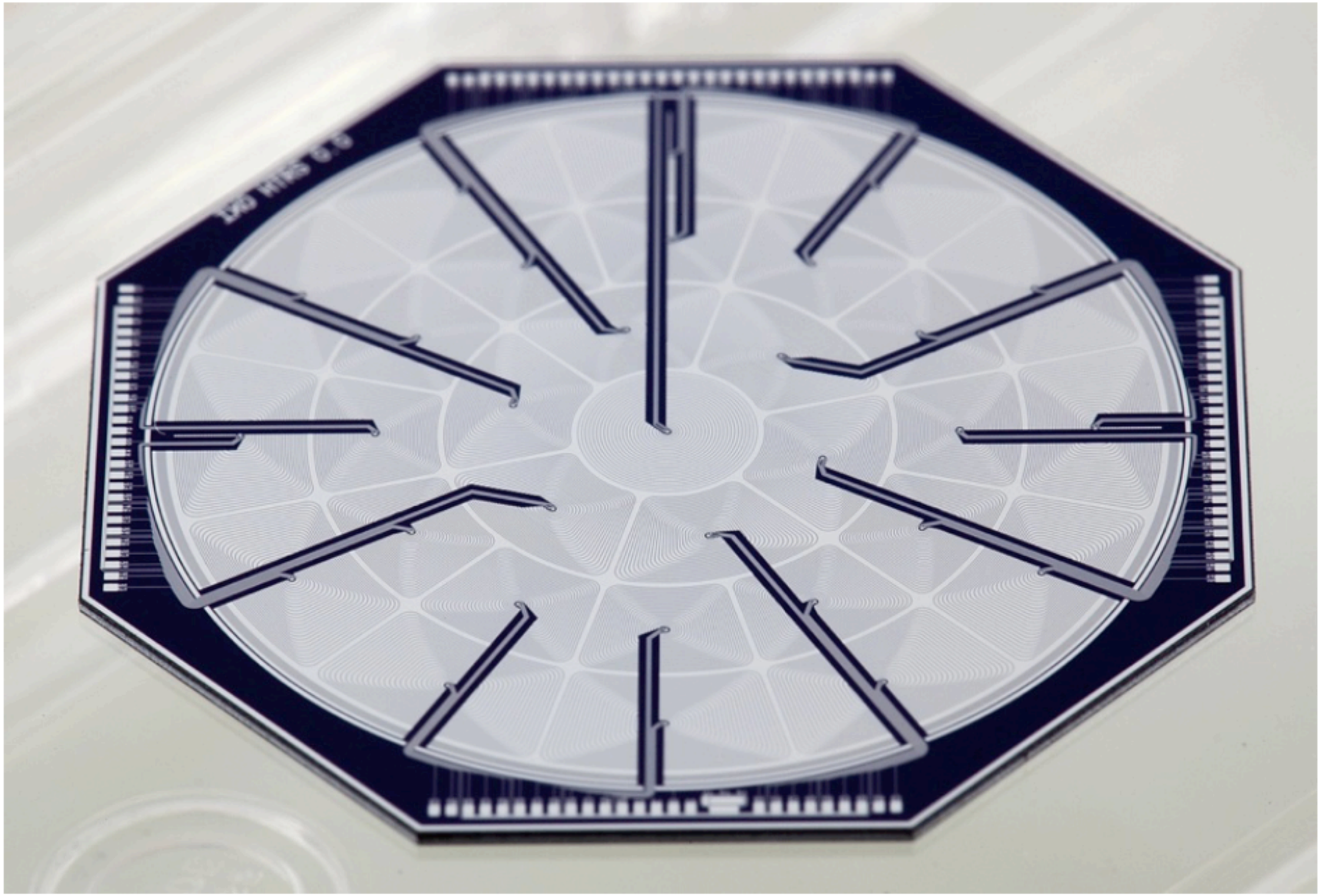


signal and thermal noise integration in one pixel over time, adaptive charge clearing

spider web structure to cover pixel boundaries in order to avoid split events

plots + images: Peter Lechner, HLL

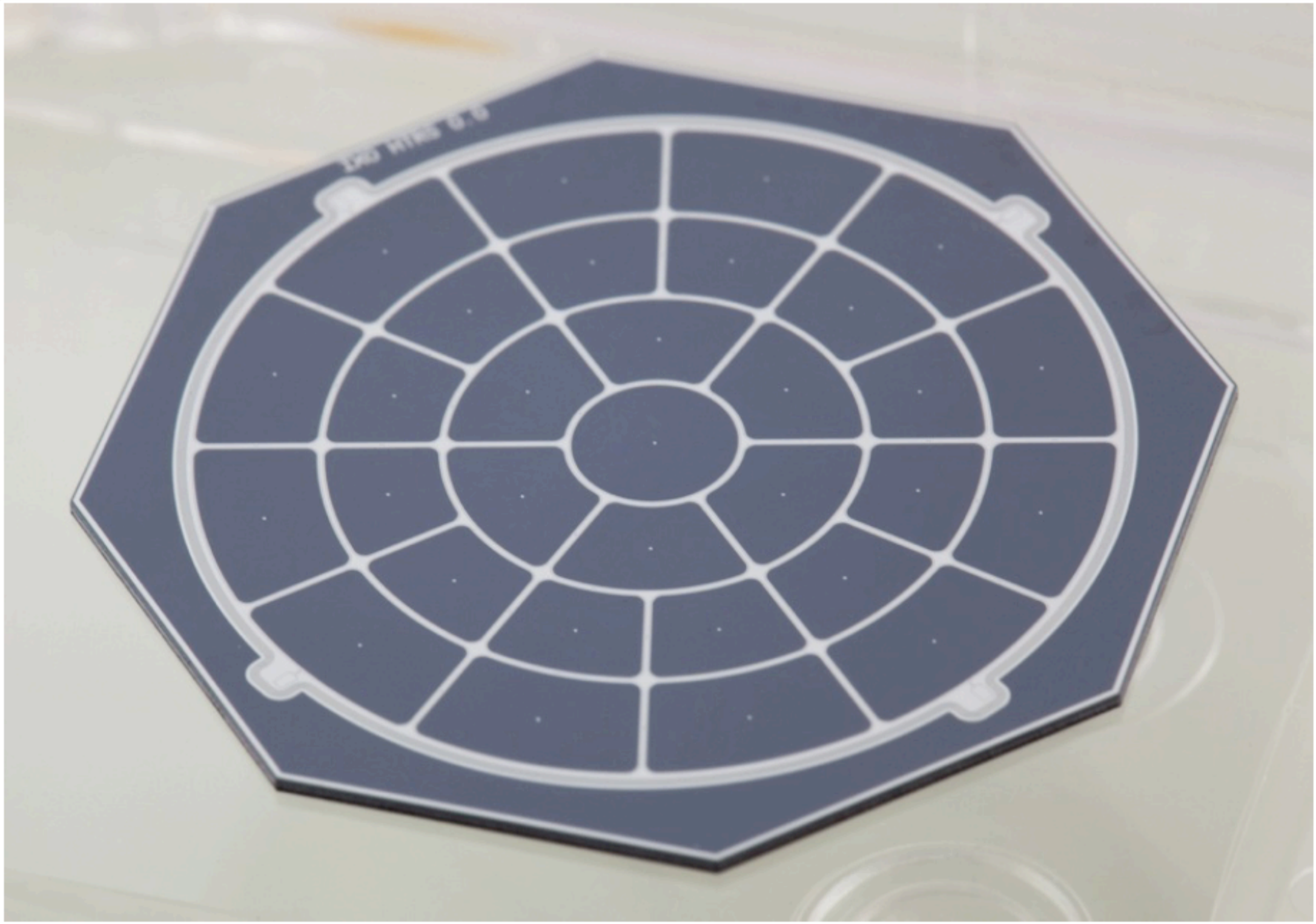
HTRS



(Photography of dummy array - readout side)

(Courtesy of Peter Lechner)

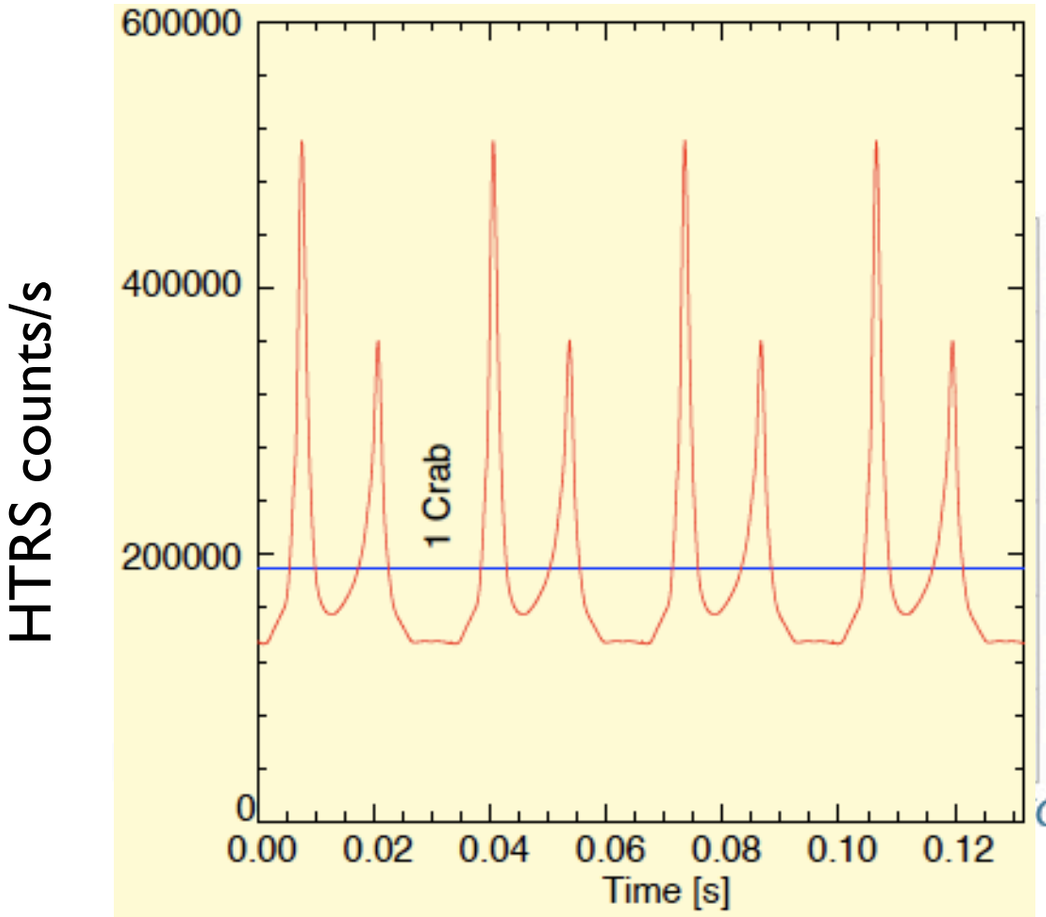
HTRS



(Photography of dummy array - entrance window side)

(Courtesy of Peter Lechner)

Data rates



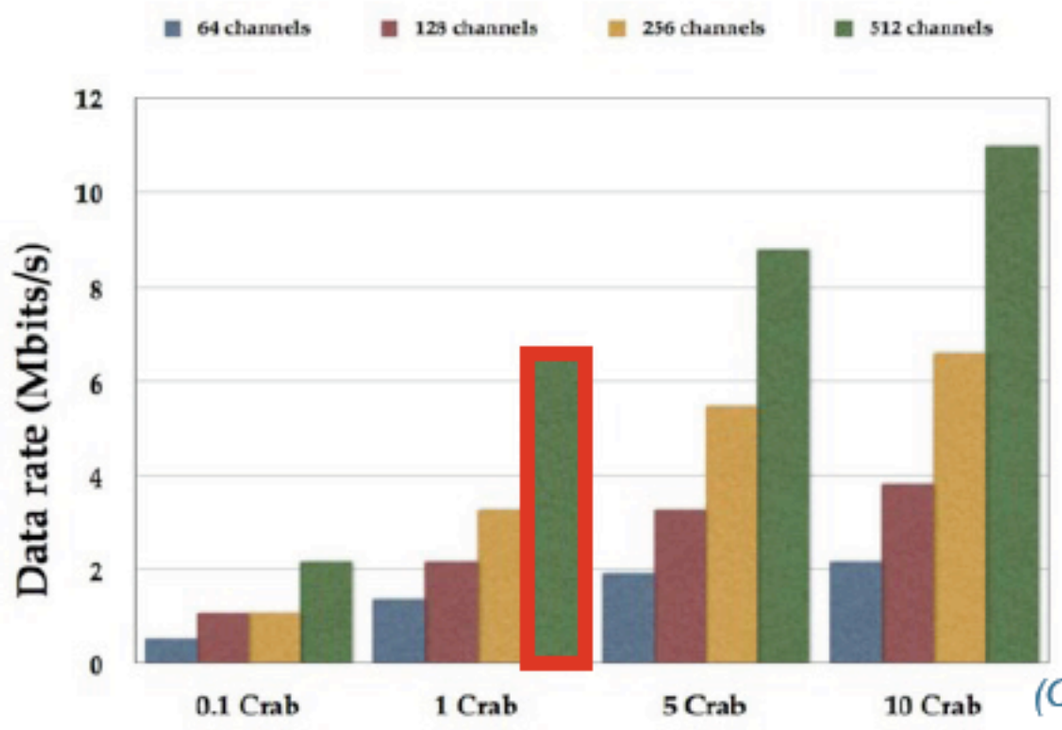
- Raw data rate: 6.6 Mbits/s @ 1 crab / full resolution
- TM allocation: 0.84 Mbits/s when in // with XGS
- Need for an internal Mass Memory
- Can the HTRS rely on additional TM allocation to download the data from its MM?

Courtesy of Joern Wilms & Didier Barret)

We are defining Data modes in order to comply with the TM constraints whatever the event rate is and evaluating the impact on the HTRS science:

- Science event mode (transmit E, t for each event)
- Engineering event mode (transmit E, t and the pixel reference for each event)
- Binned data mode (accumulate the events in one spectrum for a given Δt)
- Standard modes (permanent, reduced size, e.g. low resolution light curves)
- Engineering housekeepings (temperatures, voltages, current, status)

Data rates



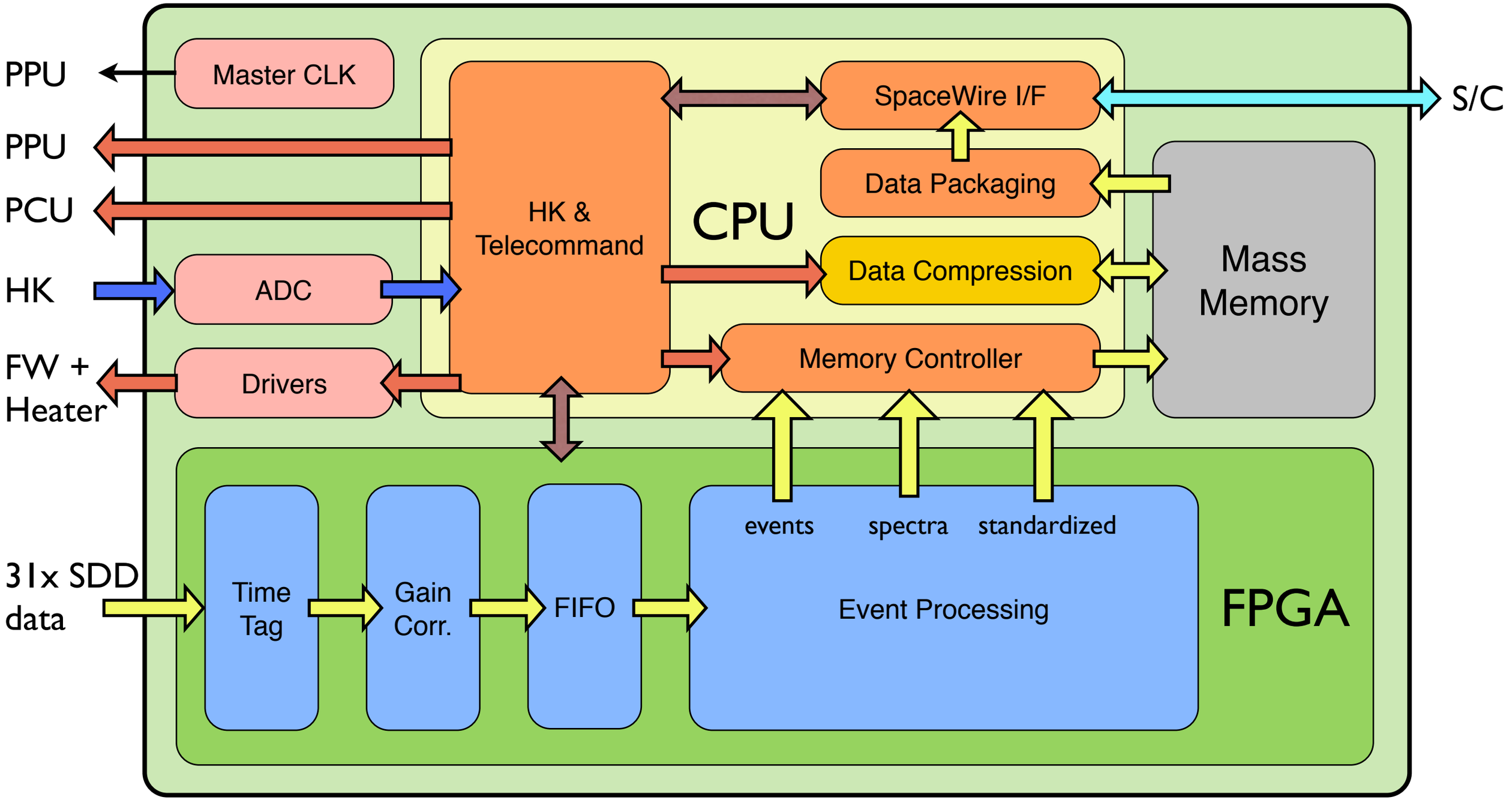
(Courtesy of Joern Wilms & Didier Barret)

- Raw data rate: 6.6 Mbits/s @ 1 crab / full resolution
- TM allocation: 0.84 Mbits/s when in // with XGS
- Need for an internal Mass Memory
- Can the HTRS rely on additional TM allocation to download the data from its MM?

We are defining Data modes in order to comply with the TM constraints whatever the event rate is and evaluating the impact on the HTRS science:

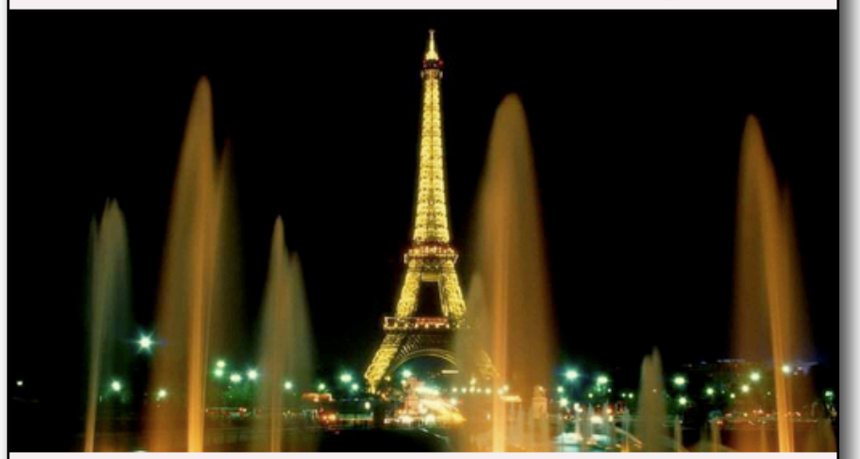
- Science event mode (transmit E, t for each event)
- Engineering event mode (transmit E, t and the pixel reference for each event)
- Binned data mode (accumulate the events in one spectrum for a given Δt)
- Standard modes (permanent, reduced size, e.g. low resolution light curves)
- Engineering housekeepings (temperatures, voltages, current, status)

IAAT hardware contribution for HTRS



Digital Data Processing Unit

IXO Science Meeting

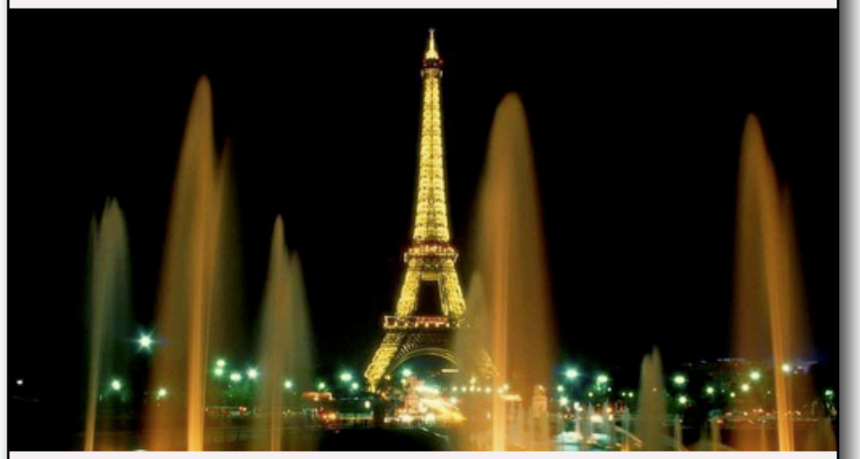


IXO Science definition team meeting
April 27th, 2010 (morning)

IXO general meeting
April 27th (afternoon) - April 29th, 2010 (up to around 4 pm)

Cité Universitaire Paris
Avenue Rockefeller
75014 Paris, France

IXO Science Meeting



IXO Science definition team meeting
April 27th, 2010 (morning)

IXO general meeting
April 27th (afternoon) - April 29th, 2010 (up to around 4 pm)

Cité Universitaire Paris
Avenue Rockefeller
75014 Paris, France