MicroTCA used in the Dark Matter experiment ALPS IIc

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Micro TCA Workshop

02.12.2020

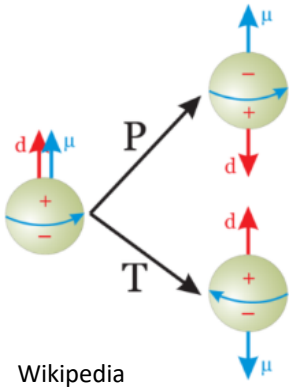
ALPS IIc
an experiment for finding Axions

the **physics** part

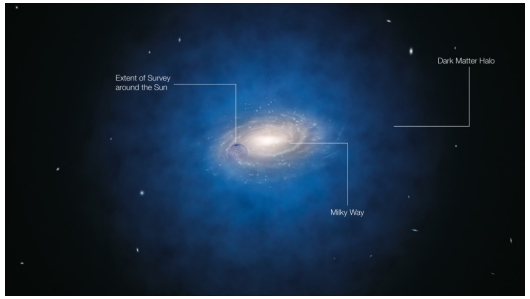
Why are we searching for Axions?

Axions

- could explain why neutrons do not show any electric dipole moment ("CP conservation in QCD") (**C**harge + **P**arity; **Q**uantum **C**hromo**D**ynamics)
- could make up the dark matter of the universe
- could even be the cause behind dark energy
- could explain strange effect in the propagation of gamma rays in the universe
- could explain strange effects in the evolution of stars
- could be the last new elementary particle to be discovered in the foreseeable future
- are predicted by string theories and other "beyond standard model" theories



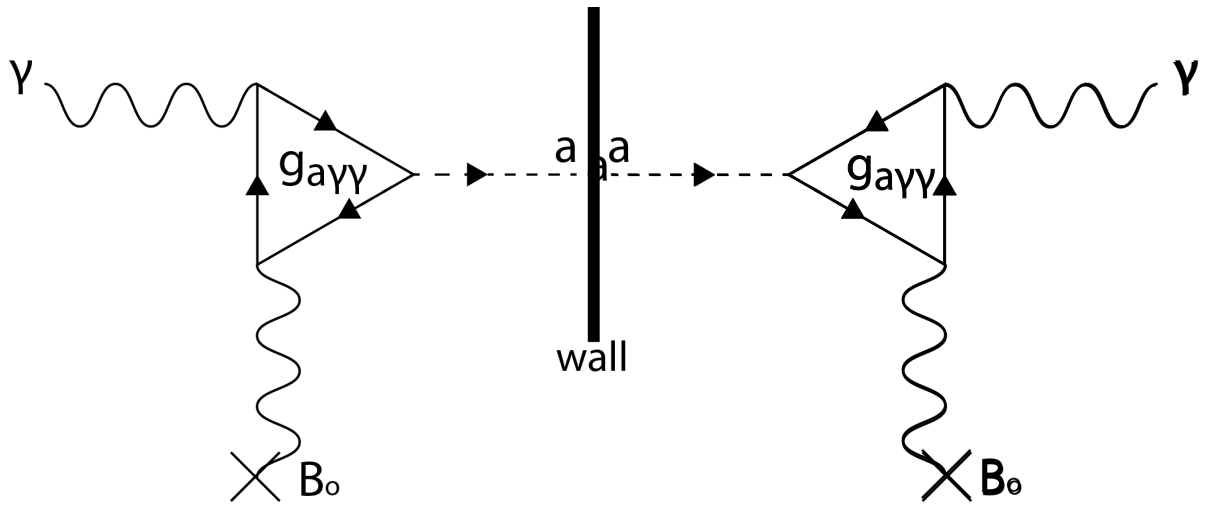
Wikipedia



https://www.eso.org/public/news/eso1217/

courtesy of Axel Lindner

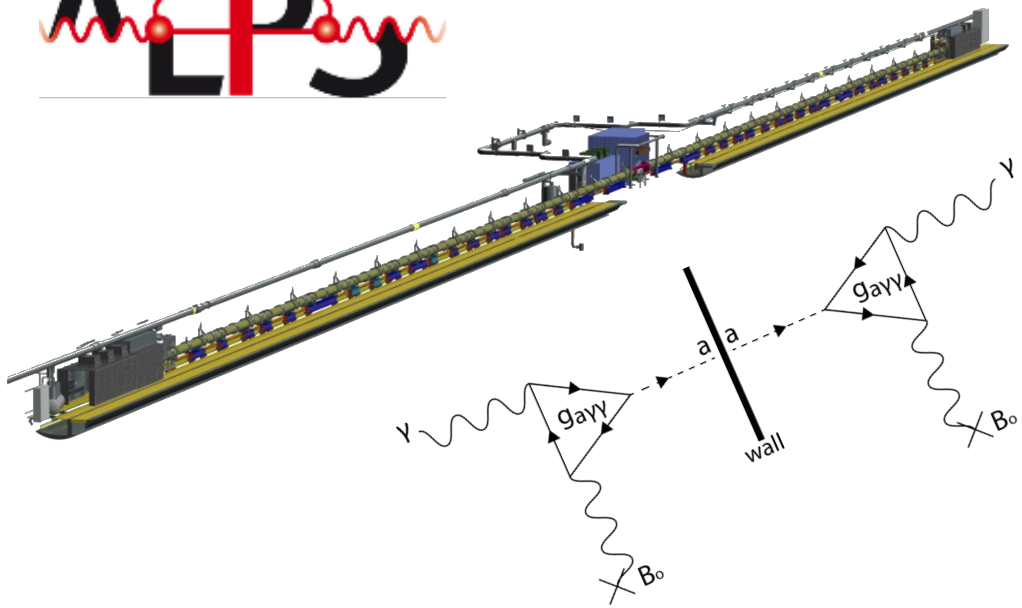
Axion detection method

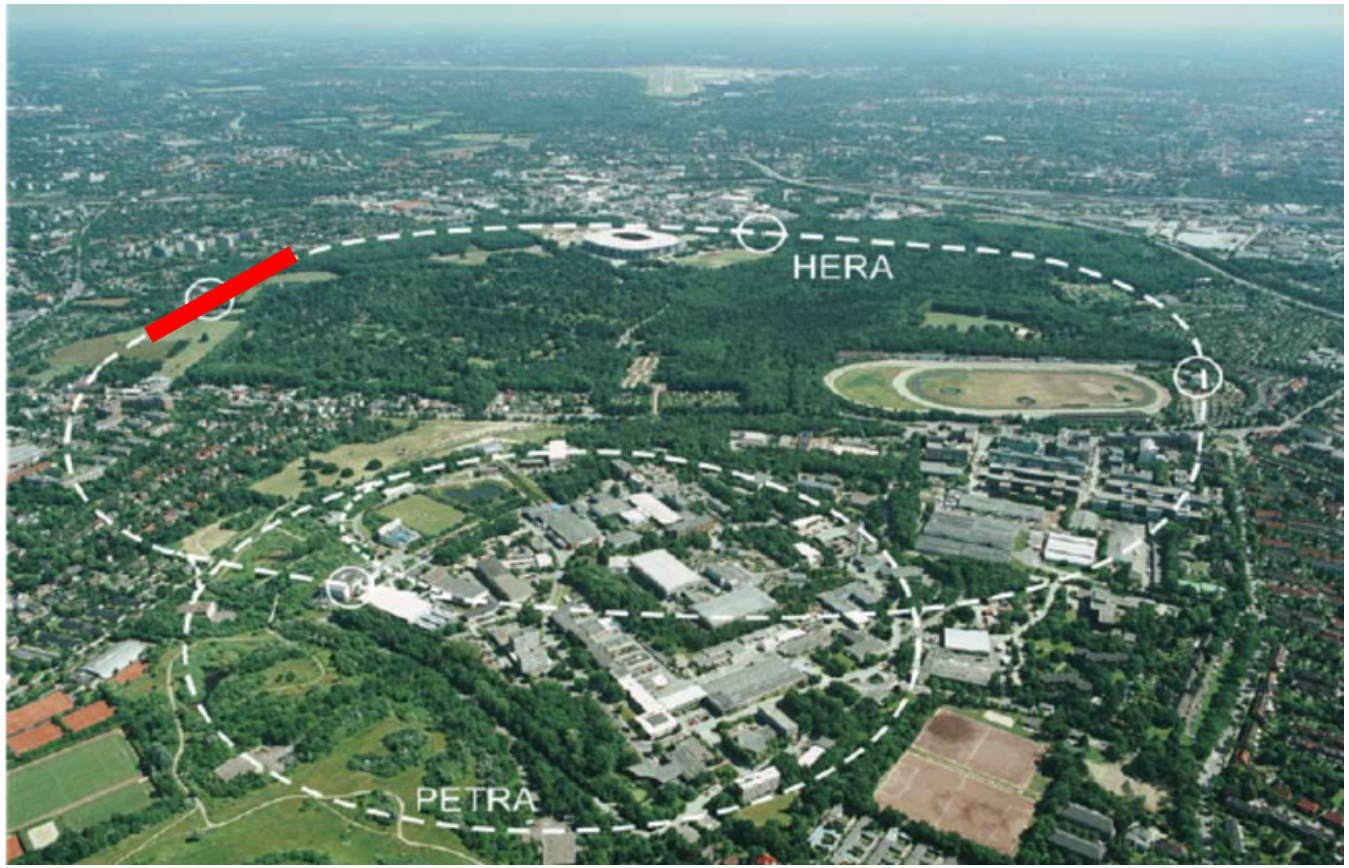


a = Axion
B_0 = magnetic field
γ = Photon
g = interaction coupling constant

About ALPS IIc

Light Through The Wall experiment



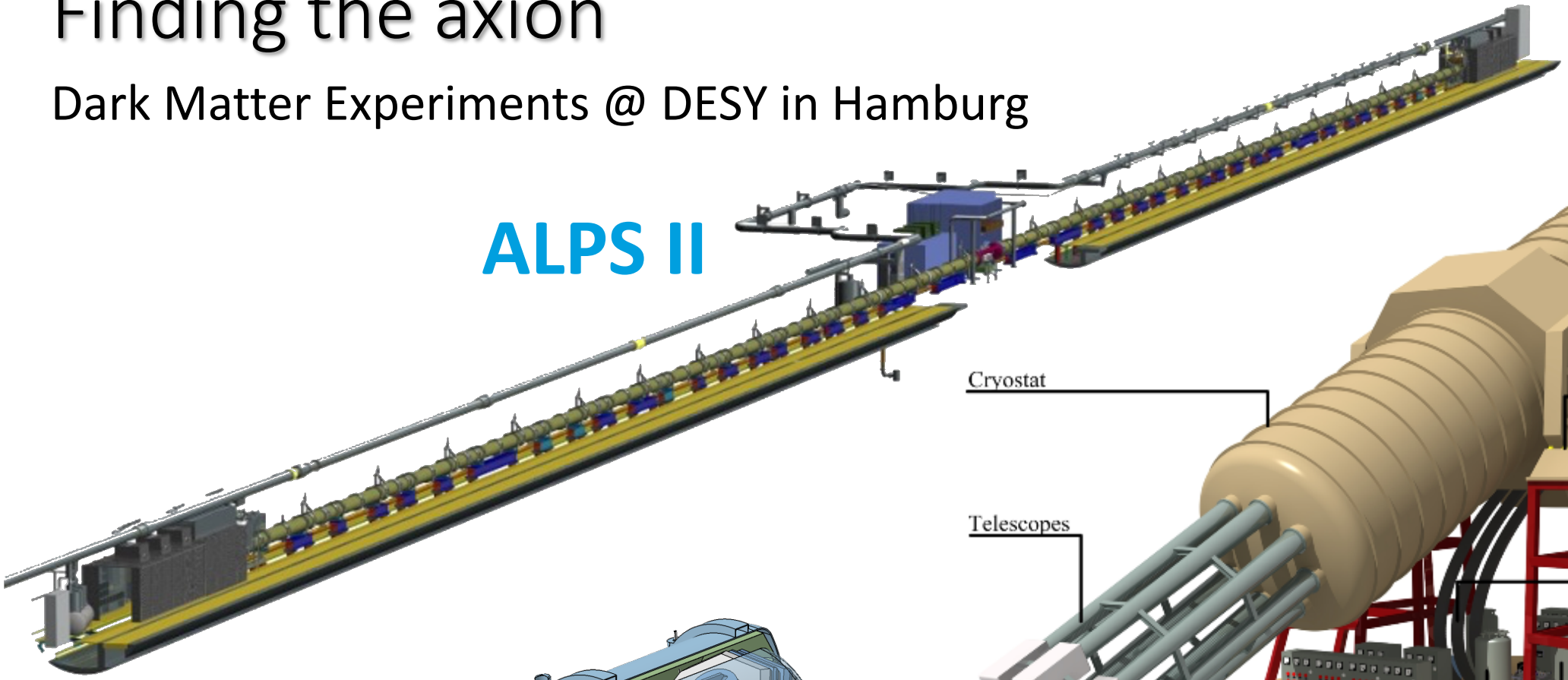


Location: HERA North
Overall length: ~280m

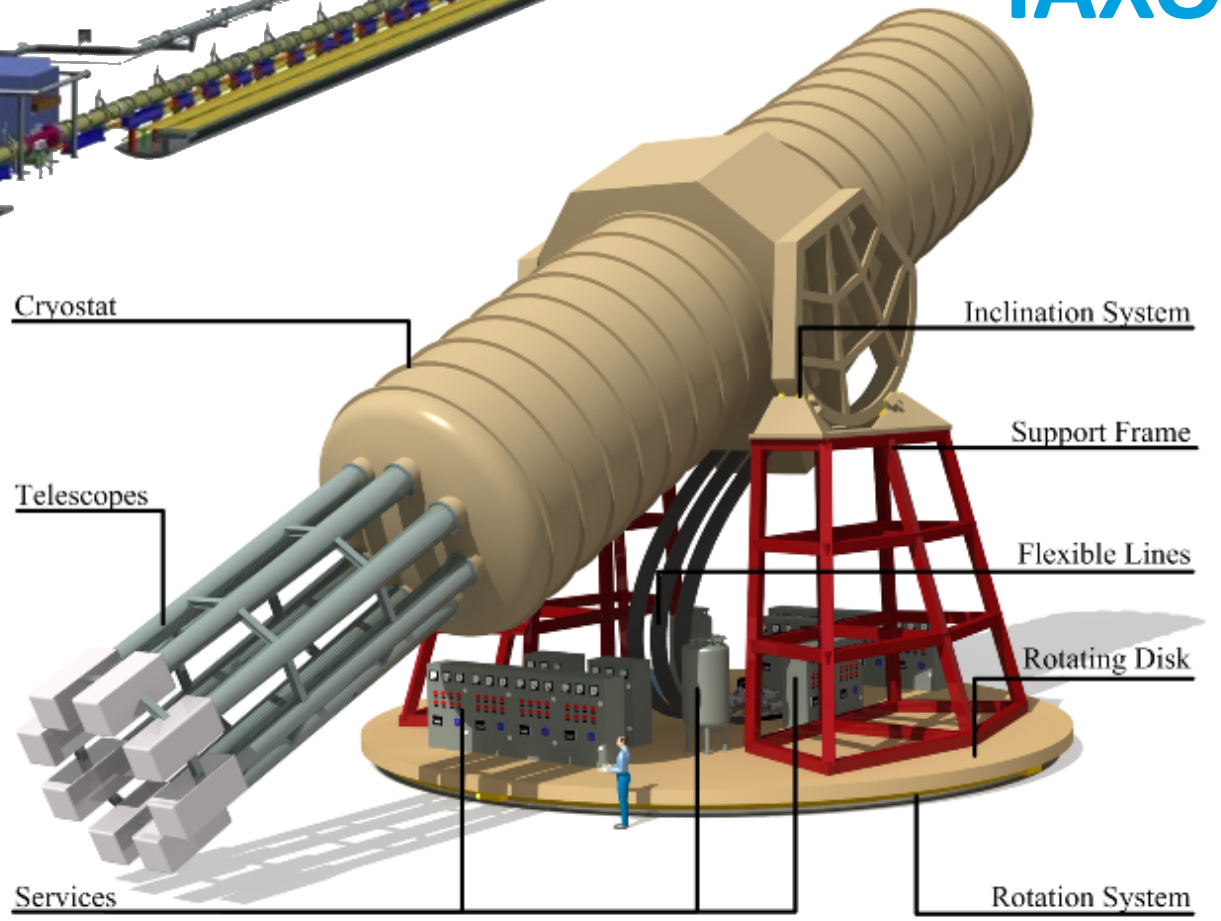
Finding the axion

Dark Matter Experiments @ DESY in Hamburg

ALPS II

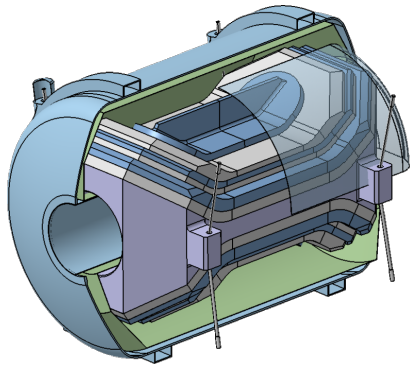


IAXO



courtesy of Axel Lindner

MADMAX



Three kinds of light-shining-through-walls @ DESY

Axion-photon mixing in magnetic fields

- Purely laboratory experiments, “light-shining-through-walls”, microwaves, optical photons (ALPS)
  model independent axion results

- Helioscopes (IAXO)
  ALPs emitted by the sun, X-rays
  slightly model dependent axion results.

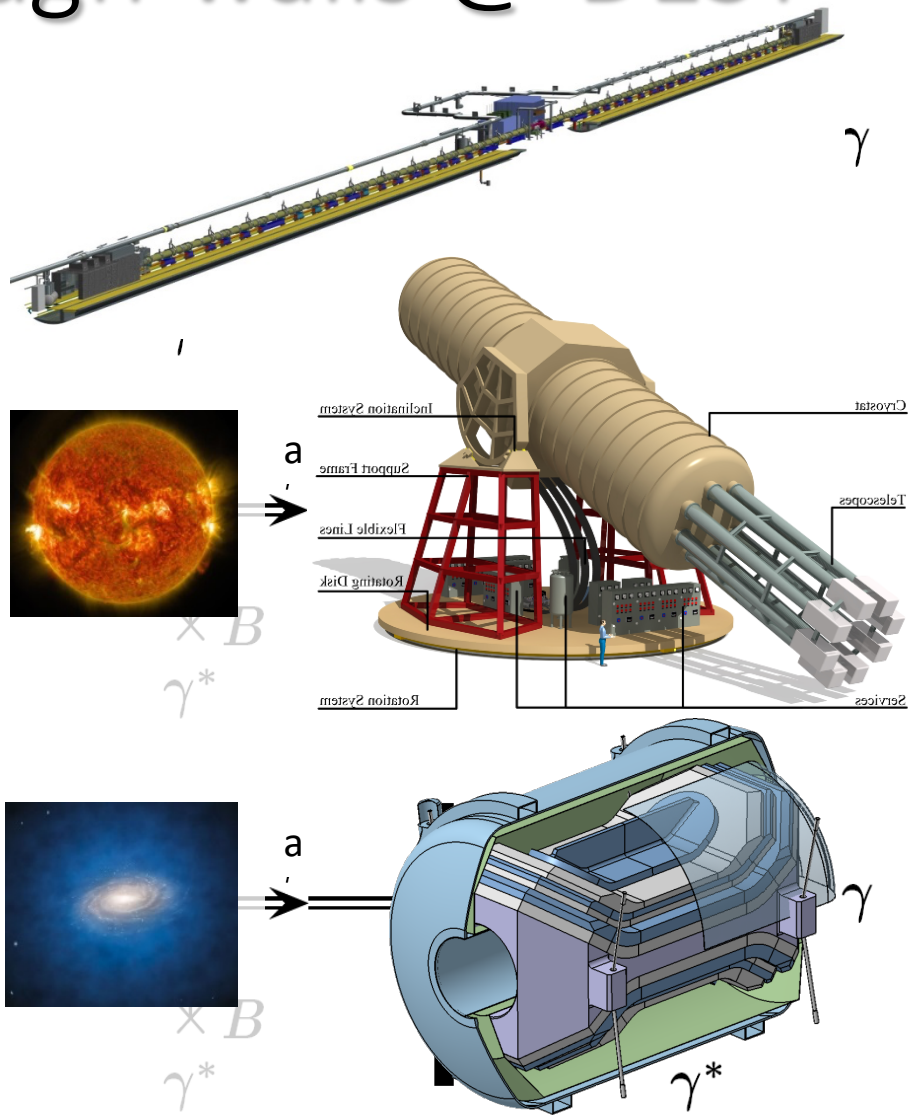
- Haloscopes (MADMAX)
  looking for dark matter constituents, microwaves
  model dependent axion results.

Target sensitivity

1 photon/day
exploit resonant detection

1 photon/year

10^{-22} W
exploit resonant detection



courtesy of Axel Lindner

DESY. HELMHOLTZ RESEARCH FOR GRAND CHALLENGES

How to realize ADC measurements

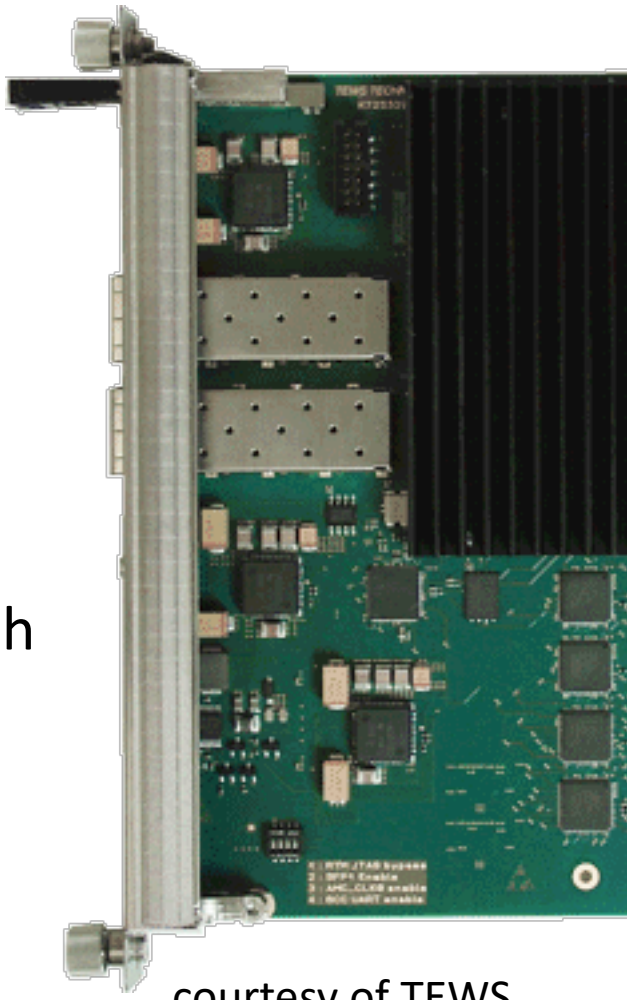
The **MicroTCA** part

The problem per ADC

- 32 analog channels
- Triggered with 16 kHz
- 16 ADC values / trigger / channel
- Permanent measurements over at least 6 Months
- High accurate trigger without any time shift over the whole measurement period
- ~32.8 Mbyte/sec (2.8 Tbyte / 24h)

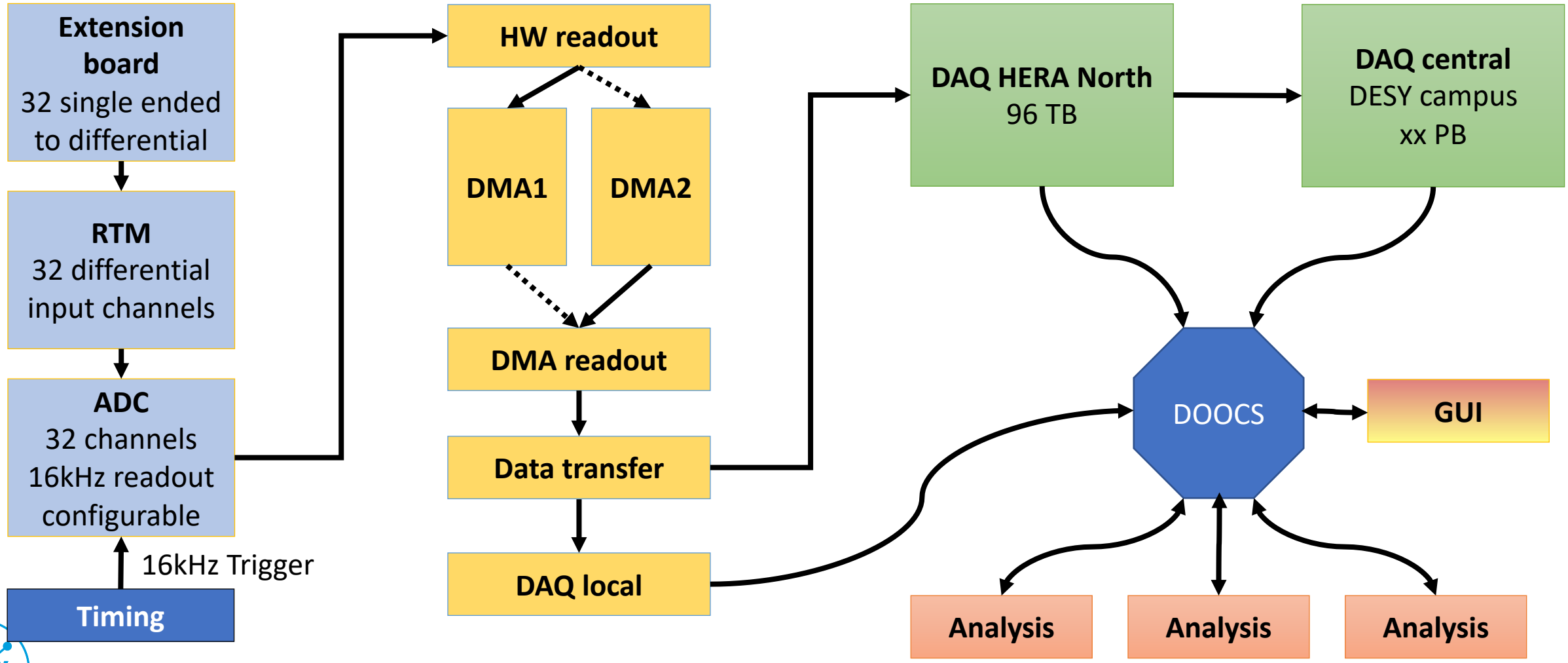
ADC

- TEWS TAMC 532
  - 32x Analog Input MTCA.4 RTM
  - 32 x 14 Bit
  - 50 MS/s / channel
  - ±1V analog inputs
  - 2 x DDR3 memory, 32 bit data bus width each, 256 MByte each

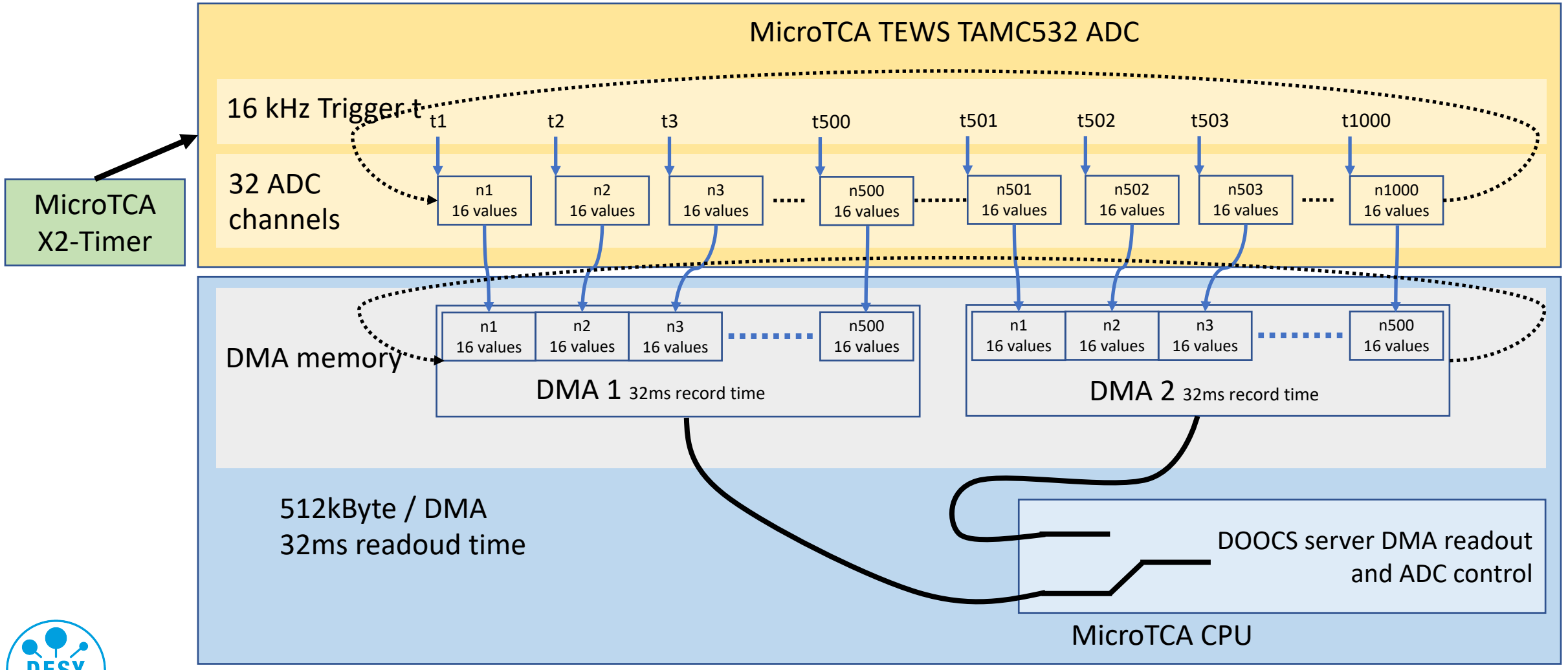


courtesy of TEWS

TEWS TAMC532 32channel ADC data flow

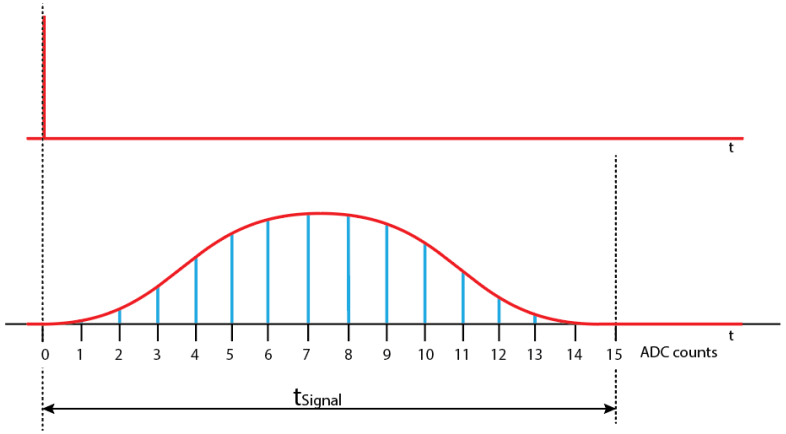


permanent ADC measurements

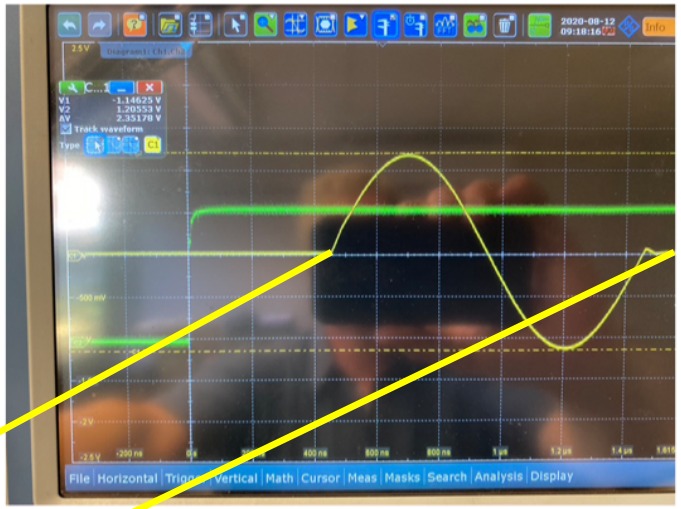


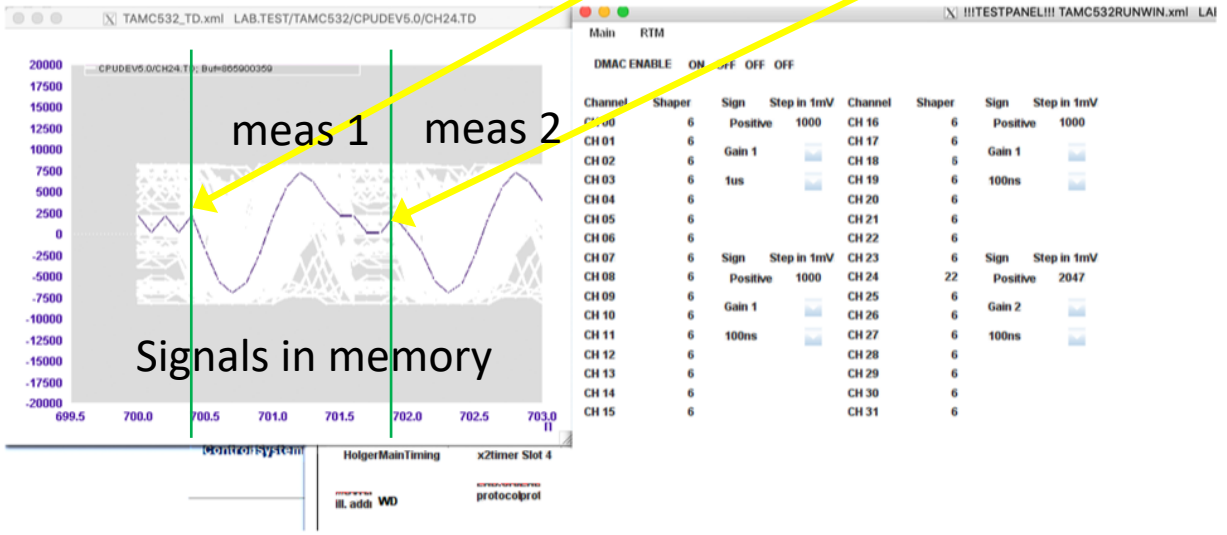
Theory and Practice

Signal: 900kHz sine
Trigger: 16kHz

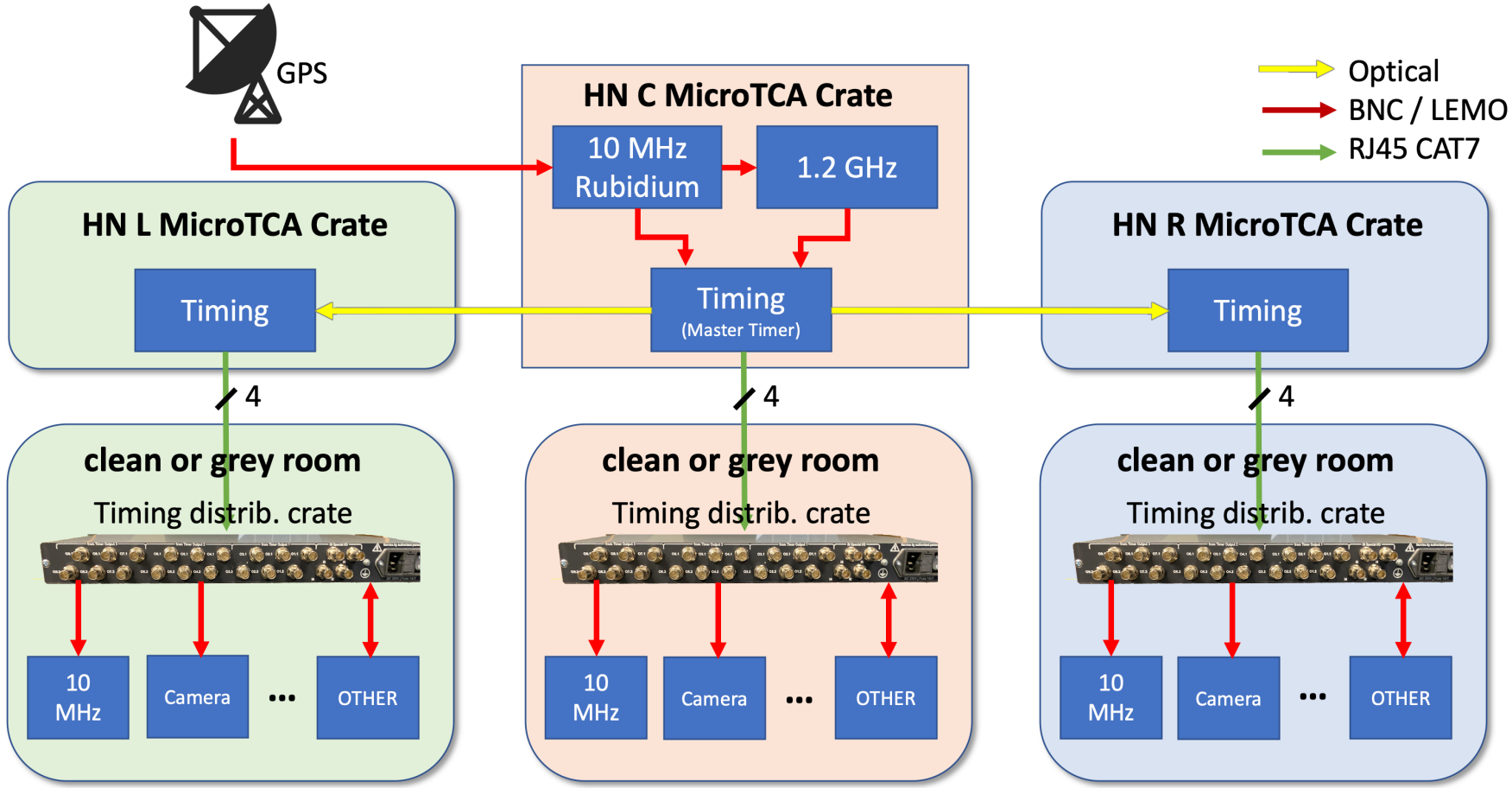


ADC counts	0-15	16-31	32-47	48-63	...	7984 - 7999
ADC block	n=0	n=1	n=2	n=3	...	n=499



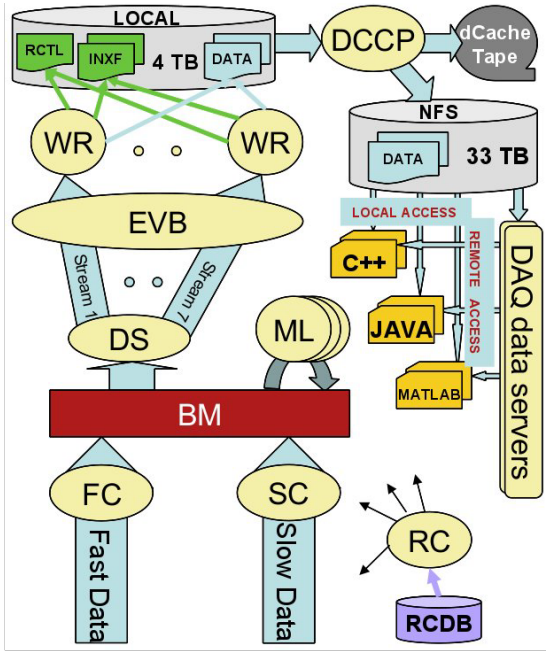


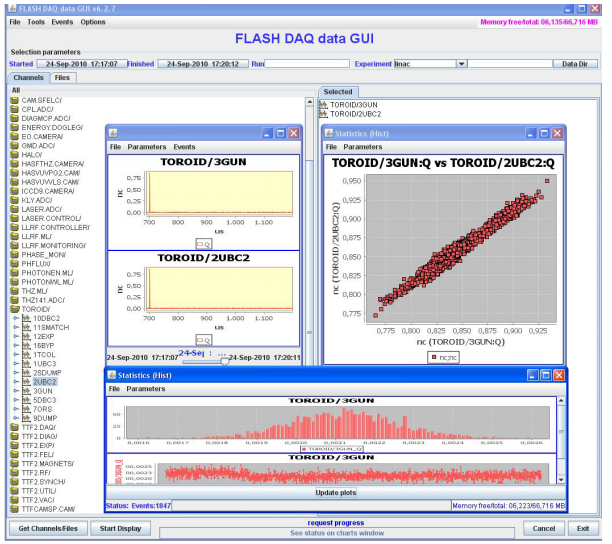
ALPS IIc Timing System Structure



DAQ – Data AQuisition

- Intel Xeon Gold 6126 2,6GHz, 12Kernels/24Threads, **10,4GTransfers/s**
- **4 x 10GBit** ethernet ports for fast data saving
- 12 Hot-Plug-Harddisks
- **96 TByte diskspace**
- RAID array
- DESY campus 60 PByte

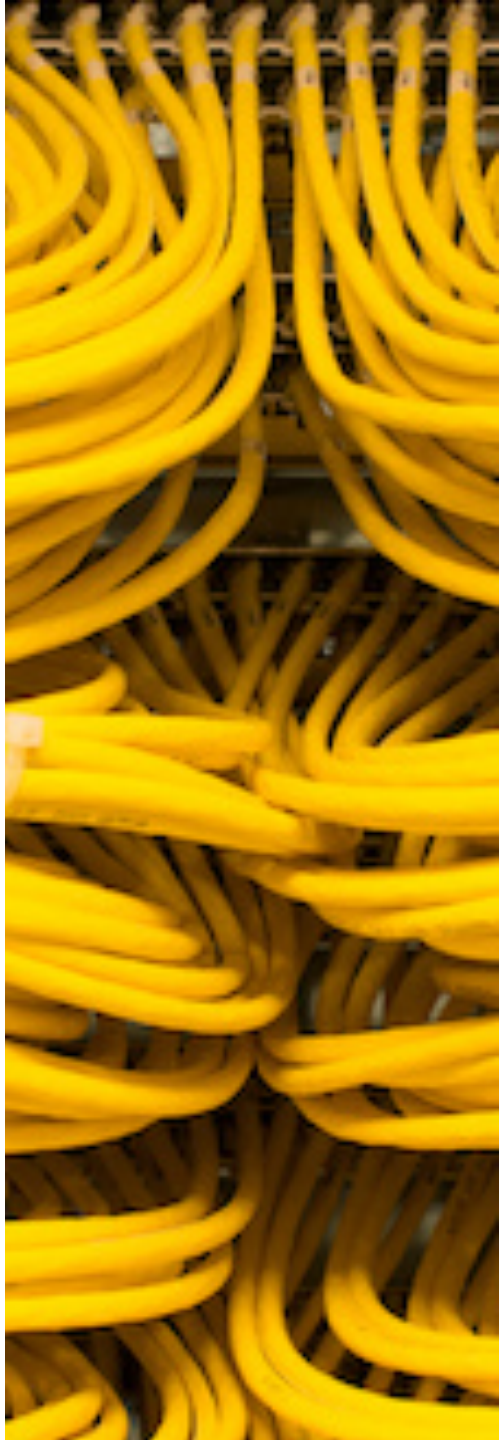




DESY. HELMHOLTZ RESEARCH FOR GRAND CHALLENGES

Network

- 10 Gbit Ethernet
- Multiple DAQ connections for fast data storage



Involved colleagues

- Ludwig Petrosyan, MCS4, server programming
- Holger Kay, MCS4, timing
- Vladimir Rybnikov, FTX-AST, DAQ integration
- Tim Wilksen, MCS4, overall support
- Axel Lindner, ALPS, ALPS information
- Gerrit Hesse & Co, TEWS, firmware support

Thanks for your !