

Third Midas Workshop 7th August 2019

DarkSide DAQ

Pierre-André Amaudruz @ Triumf

DUNE-like cryostat

Dark Matter Search
WIMP scattering on LAr nuclei

Atmospheric LAr bath

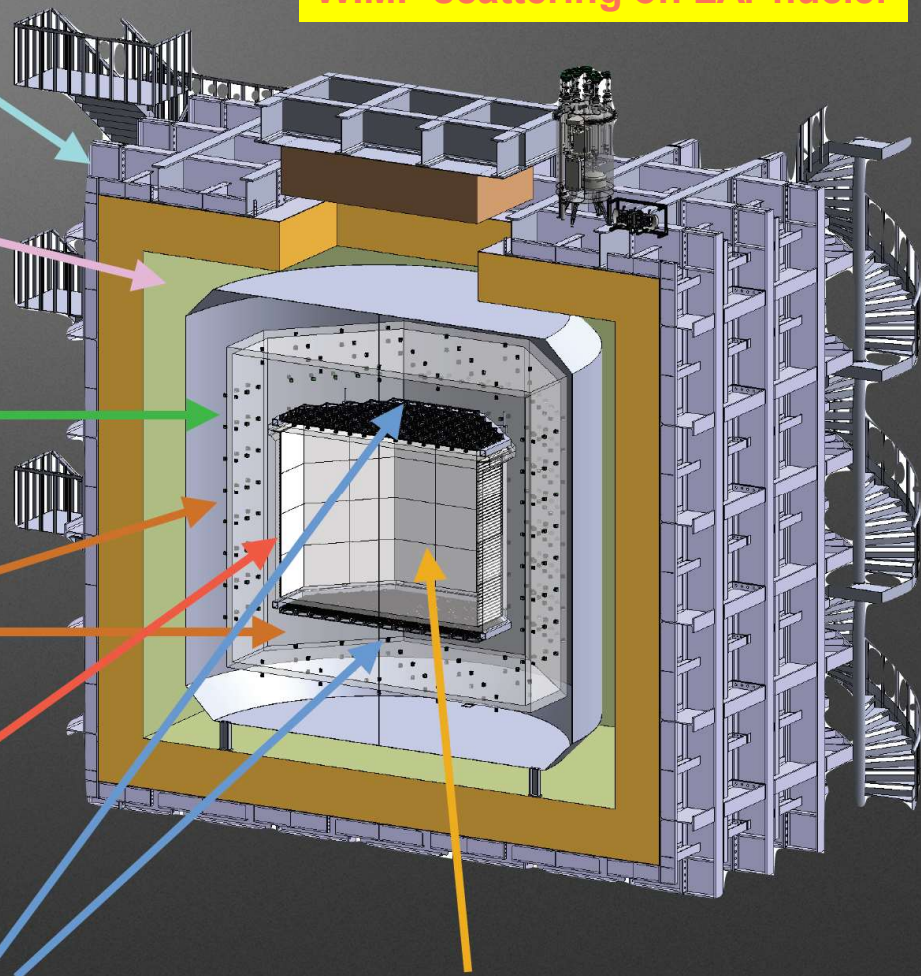
Neutron moderator
Loaded with Gd

Active LAr vetoes

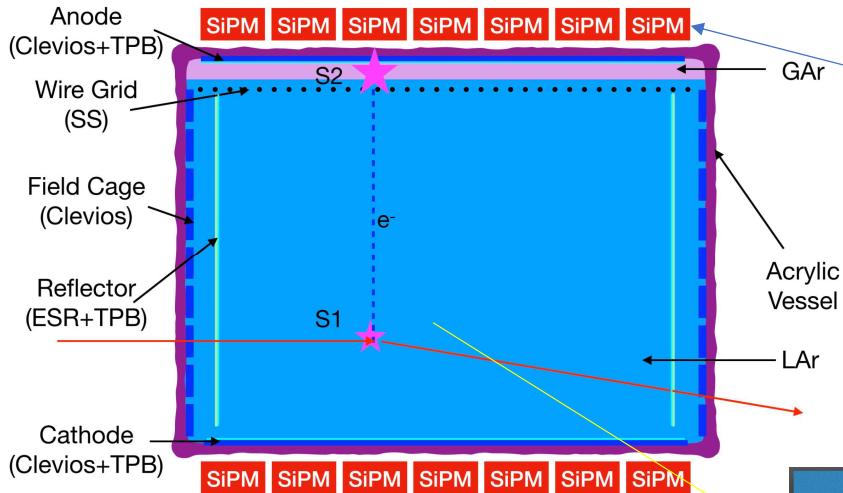
TPC in acrylic vessel

SiPMs

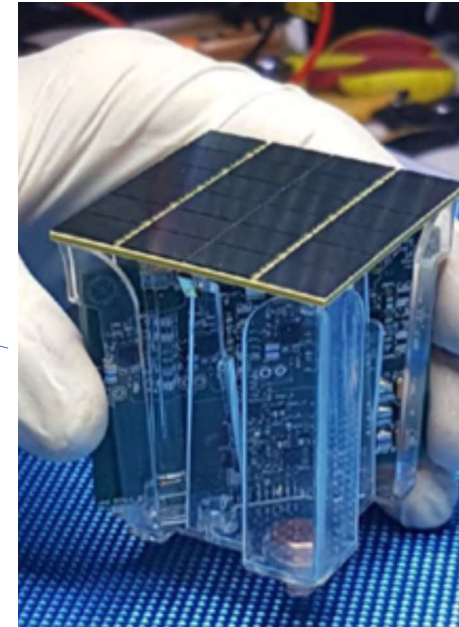
40 ton of UAr



DarkSide Dual phase Liquid Argon TPC

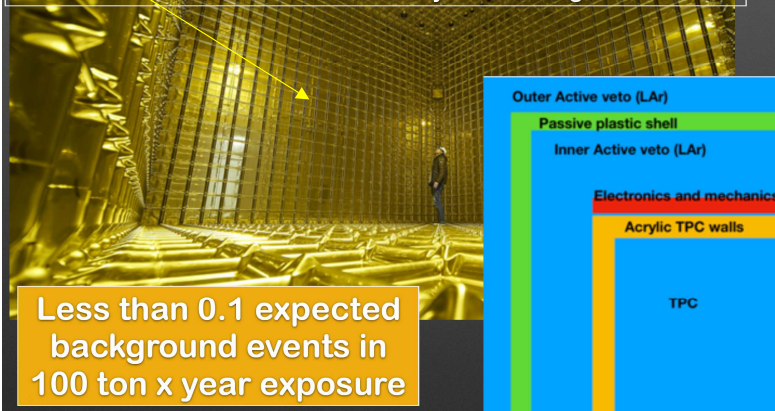


1 PDM (photo-detector module)
= 25 SiPMs each
In Series/Parallel configuration

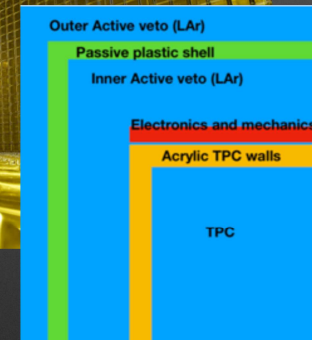


A Proto-DUNE cryostat as veto

Remove the main sources of neutron background (from PMTs and cryostat)
No need for UAr between TPC and cryostat → large active mass

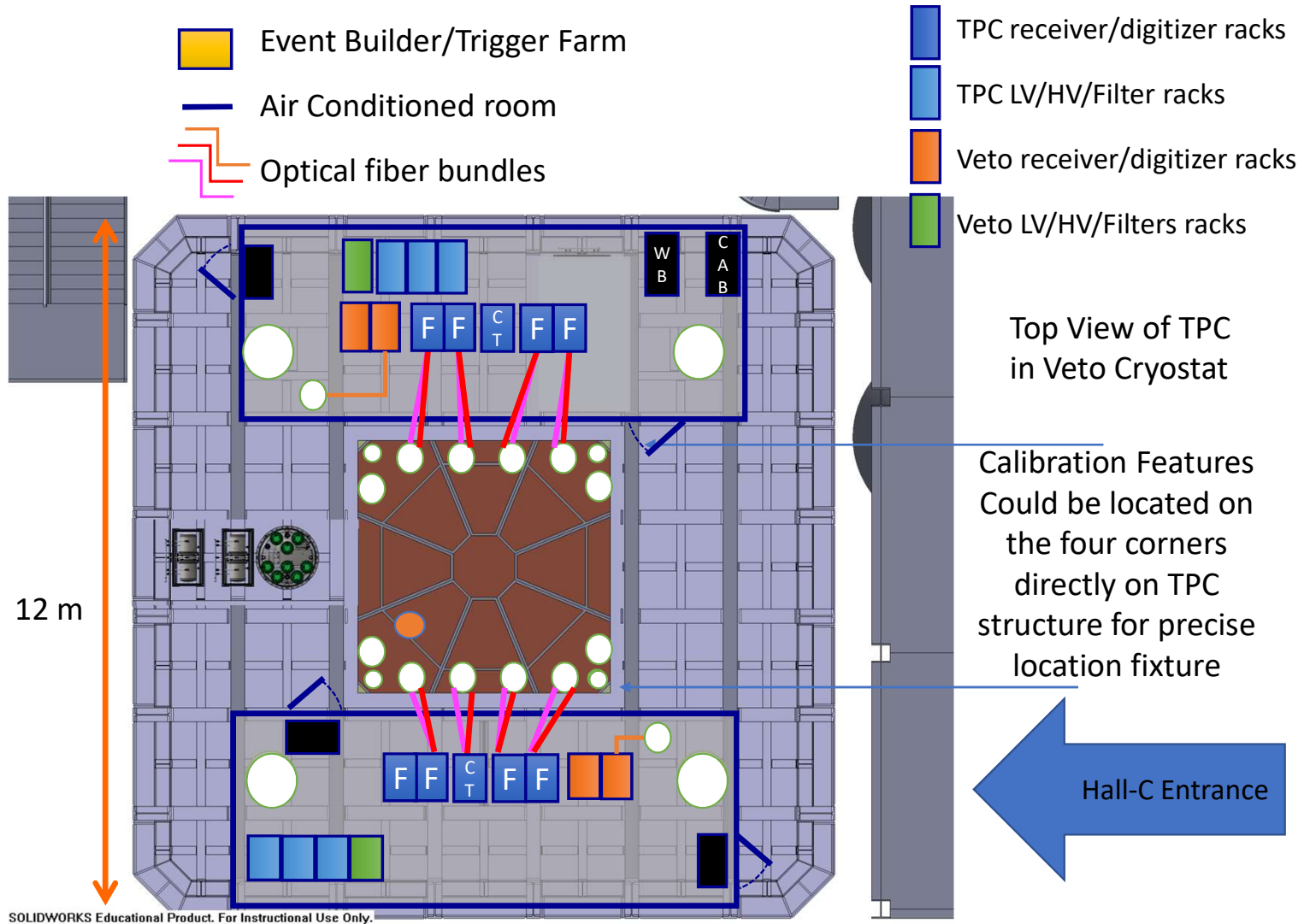


Less than 0.1 expected background events in 100 ton x year exposure



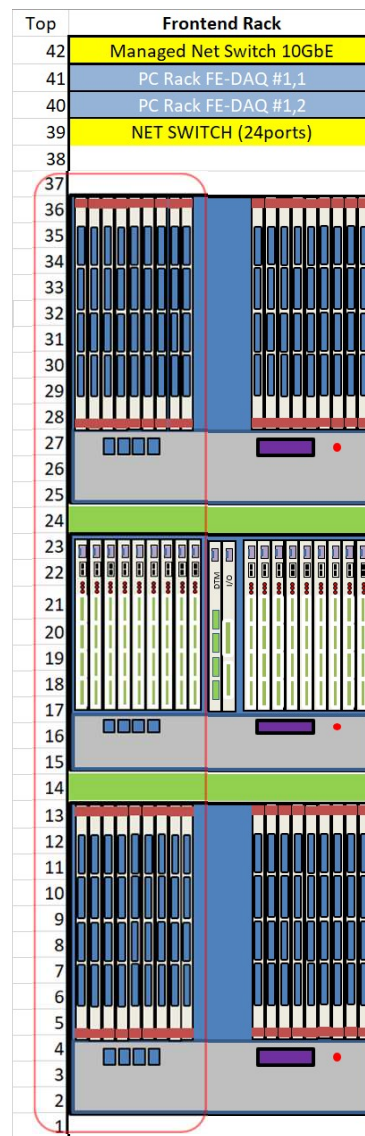
~5000 Veto PDMs

~8250 PDMs
Top and Bottom



DS-20K DAQ scheme Ver 0.3

- Vertical slice Bot+Top sectors per rack
- Triggerless and Triggered Data acquisition system
- Data Flow simulation studies
- Online data monitoring
- Semi-offline, offline, data storage infrastructure
- Slow control aspect
 - PDM control/monitoring
 - Light injection, calibration
 - Vessel monitoring
- Modular Rack system see fig.



Frontend rack

1 Rack power management

18 WFD64 slots (1152ch.)

36 OptRec slots (1152ch.)

1 Clock Dist. Slots (1->24)

1 Trigger I/O

2 Net switches (24ports)

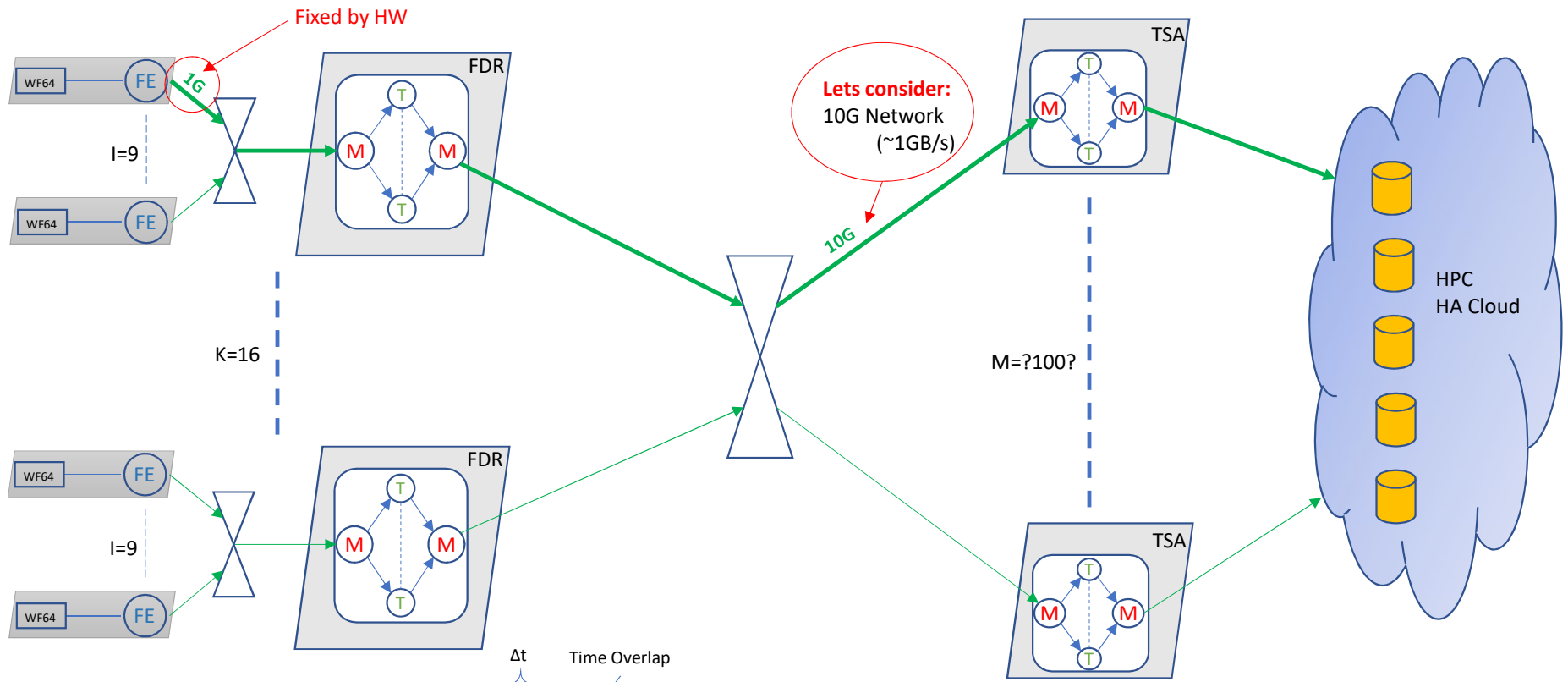
1 9U VME crates (networked)

2 12U crates

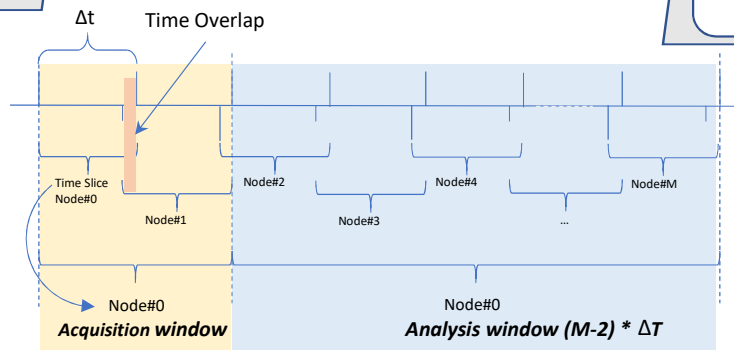
8 FE Racks (9216 channels)

1 Global DAQ racks

N Rack Backend PCs

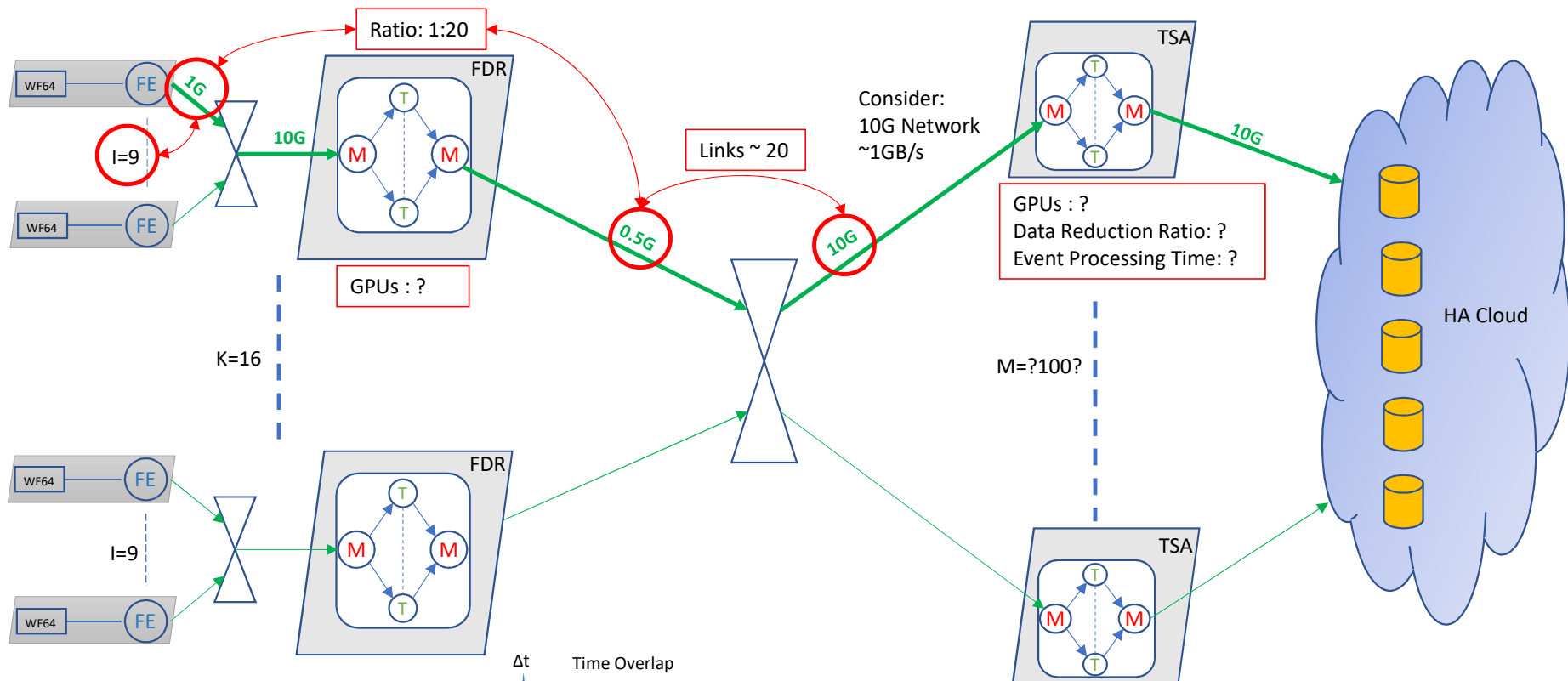


FE : Front End
 FDR: FrontEnd Data Reducer
 TSA: Time Slice Analyser
 Time Overlap : 1..2 Drift time (5..10ms)
 Δt : Analysis Time slice (?100..1000ms?)
 K: Number of DAQ fragment
 M : Number of Analysis Core
 Ratio: Data Reduction factor for max data throughput

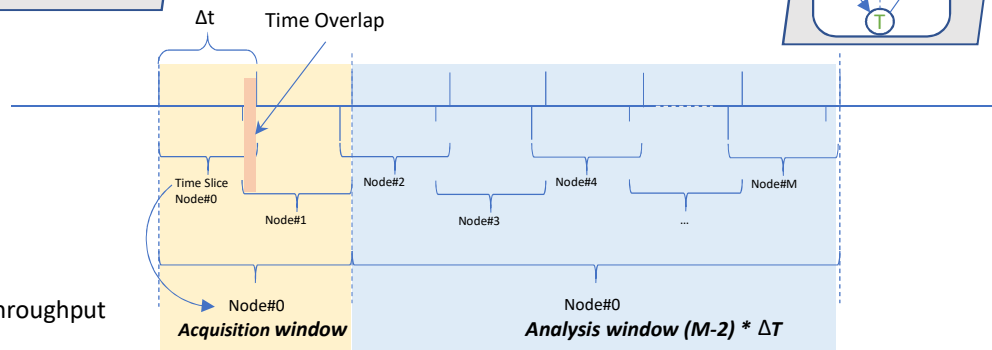


Estimate of the # of TSA cores: Use HEP-SPEC06
 Average value for today's good PC: 15/core

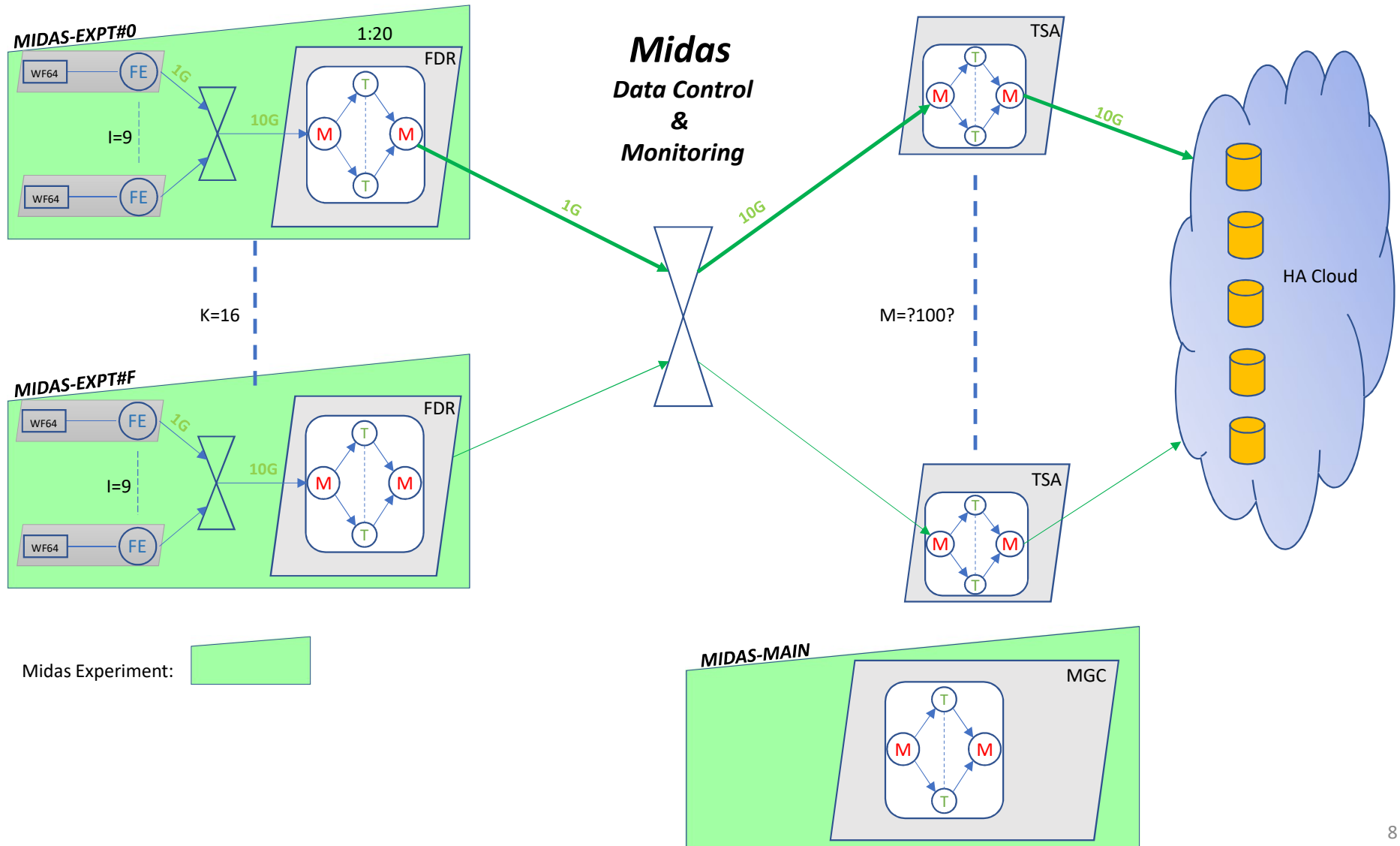
Ex: Intel Xeon 8160 24 core HT/off : 21 HS06/core
 ATLAS Event analysis: 230 HS06 / event

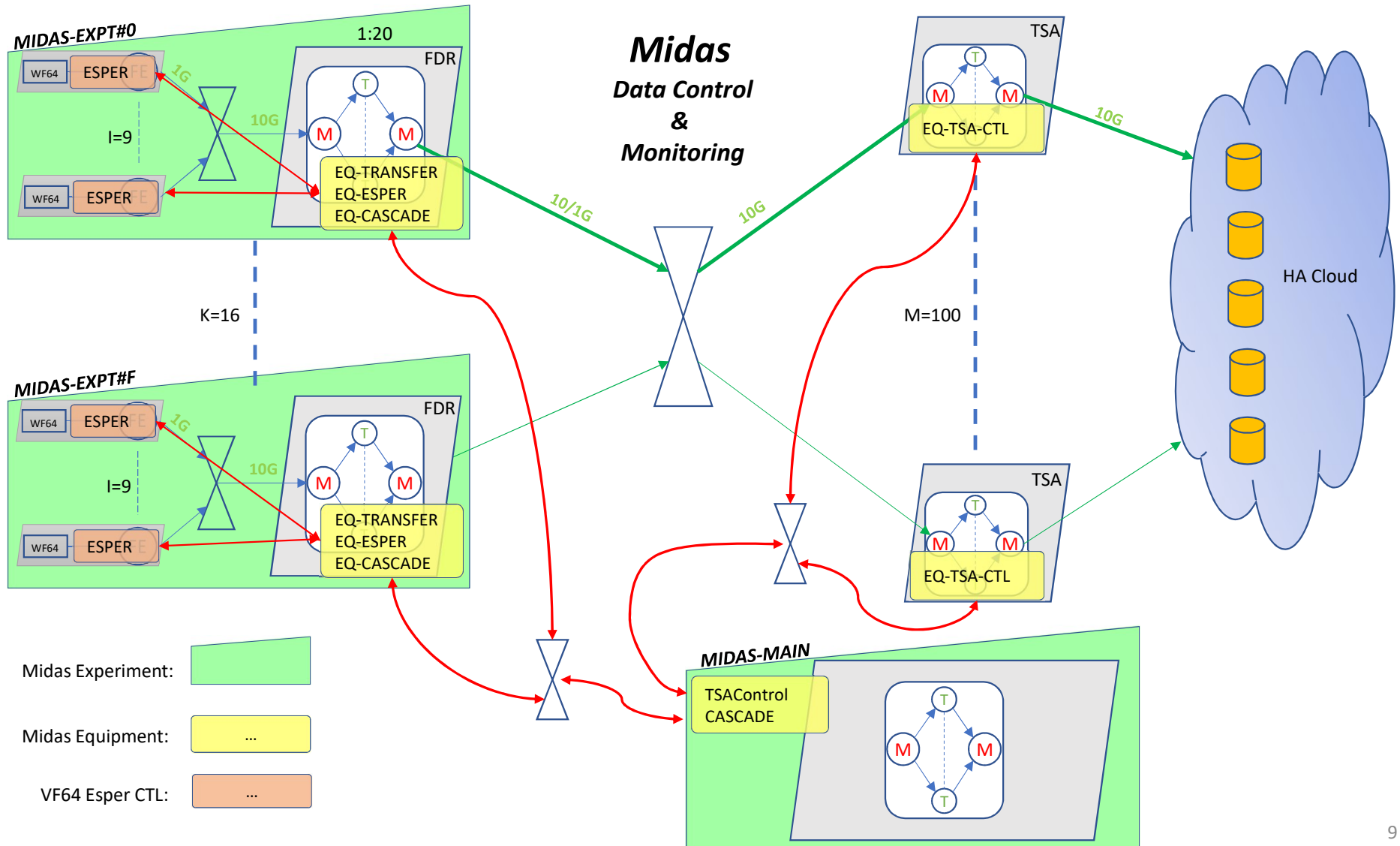


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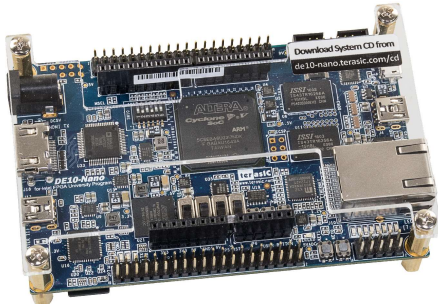
Estimated data rate
 3.3GBytes (without Veto data)
 250 Hz dark rate + 50 Hz physics (S1/S2=1)
 16 bit, S1 (S2):125 (12.5) MS/s, 7 (20) μ s window
 8280 PDM, UAr





ChronoBox

DE10 nano (CycloneV)
Sdcard, ETH 1G, Serial



ZeroMQ <http://zero.mq> (Pieter Hintjen)

Embeddable networking library

Low level API are in C, Lightweight

Alternate Tool: Kafka, RabbitMQ, ActiveMQ

Used by: AT&T, Cisco, EA, Los Alamos Labs, NASA, Weta Digital, Zynga, Spotify, Samsung Electronics Microsoft, and CERN.

mzmq data publisher running in the ChronoBox

- On Trigger generate data block
 - TimeStamp of Trigger
 - Accepted/Missed Trigger counter
 - Trigger Mask, etc...

```
└─ TDM
  └─ docs
  └─ linux
    └─ buildroot
      └─ config
        └─ buildroot
          └─ overlay
            └─ tree
              └─ configs
                └─ package
                  └─ esper
                    └─ mzmq
                      └─ local
                        └─ build
                          └─ src
                            └─ fezmq.c
                              └─ CMakeLists.txt
                                └─ Config.in
                                  └─ mzmq.mk
                                    └─ Config.in
                                      └─ external.desc
                                        └─ external.mk
                                          └─ kernel
                                            └─ keys
                                              └─ uboot
                                                └─ gcc-linaro-arm-linux-gnueabi-4.8-2014.04_linux
                                                  └─ image
                                                    └─ chronobox.img
                                                      └─ linux-socfpga
                                                        └─ u-boot-socfpga
                                                          └─ Makefile
                                                            └─ quartus
                                                              └─ bin
                                                                └─ hdl
                                                                  └─ chronobox
                                                                    └─ db
                                                                      └─ hps_isw_handoff
                                                                        └─ incremental_db
                                                                          └─ ip
                                                                            └─ mf
                                                                              └─ qsys_headers
                                                                                └─ soc_system
                                                                                  └─ software
                                                                                    └─ c5_pin_model_dump.txt
                                                                                      └─ chronobox_assignment_defaults.qdf
                                                                                        └─ chronobox_top.v
                                                                                          └─ chronobox.qdf
                                                                                            └─ chronobox.qpf
                                                                                              └─ chronobox.qsf
                                                                                                └─ chronobox.sdc
                                                                                                  └─ chronobox.srf
                                                                                                    └─ hps_common_board_info.xml
                                                                                                      └─ hps_sdram_p0_summary.csv
                                                                                                        └─ new_rtl_netlist
                                                                                                          └─ old_rtl_netlist
                                                                                                            └─ soc_system_board_info.xml
                                                                                                              └─ soc_system.qsys
                                                                                                                └─ soc_system.sopcinfo
                                                                                                                  └─ timestamp.v
                                                                                                                    └─ scripts
                                                                                                                      └─ sim
                                                                                                                        └─ Makefile
                                                                                                                          └─ .gitignore
                                                                                                                            └─ README.md
```

DS-Proto DAQ – Current Status

Midas Frontend (feov1725.cxx)

- Main readout function
 - Read ChronoBox data block
 - Read all four V1725 (Thread per module)
- Serial Number check
- Time Stamp check (checked @ BOR only)

```
INT read_event_from_ring_bufs(char *pevent, INT off) {
...
    sn = SERIAL_NUMBER(pevent);
    bk_init32(pevent);
    //
    // Get the ChronoBox data and make the bank
    bk_create(pevent, "ZMQ0", TID_DWORD, (void **)&pdata);
    int stat = zmq_recv (subscriber, pdata, 1000, ZMQ_DONTWAIT);
    if (stat > 0) {
        pdata += stat/sizeof(uint32_t);
        bk_close(pevent, pdata);
    }
    //
    // Get the V1725
    for (itv1725 = ov1725.begin(); itv1725 != ov1725.end(); ++itv1725) {
        if (! itv1725->IsConnected()) continue; // Skip unconnected board
        itv1725->FillEventBank(pevent); // Fill Event bank
    }
    INT ev_size = bk_size(pevent);
    return ev_size;
}
```

DAQ Architecture proposal for DS-20K

