

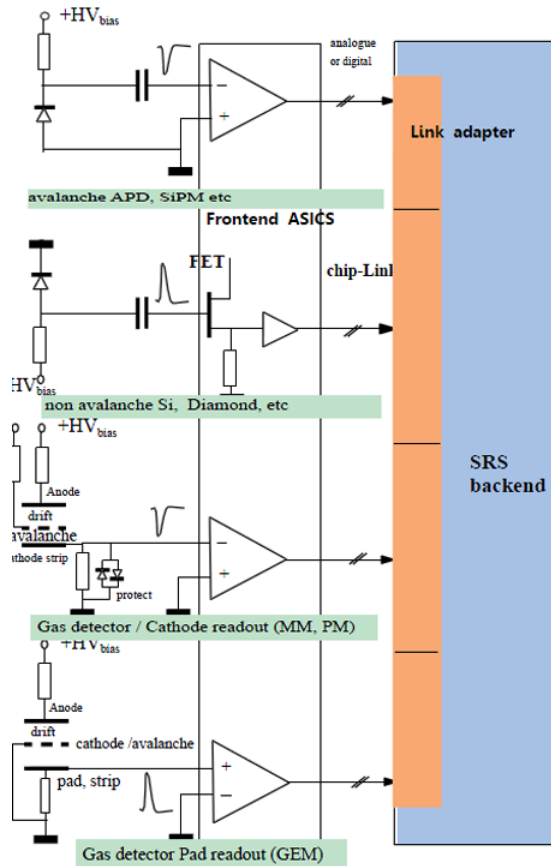
An ATCA framework project for the RD51* SRS electronics

Hans Muller, CERN PH
(Convenor of WG5 on Electronics for MPGD detectors)

* <http://rd51-public.web.cern.ch/rd51-public/>

SRS idea (RD51 collaboration)

- choose the frontend (ASIC, hybrid) that fits your detector
- provide a common readout backend with standard DAQ SW
- start from minimal systems - > scale to large systems



HOW:

- connect specific frontends via a “chip-link” (HDMI etc)
- 19” crate system
- FEC-chip link adapters for Analogue, Digital, Copper, Fiber
- FEC: an FPGA board handling Data, Trigger and Control
- Small Systems: (<2K) direct GBE link from FEC to DAQ
- Medium sized system (<16k) add Network switch
- Large systems, DTC links ->1 SRU -> 10 GBE
- Open developer concept: community-driven development
- start from 100 chann. SRS with full line systems support
- port succesful DAQ and Control SW for SRS

SRS readout architecture

DAQ/Online/Offline
Control, Trigger

Networks 1/10/48 Gbit

COMMON

Readout Units

DTC links: CAT6
Data/Trigger/Control

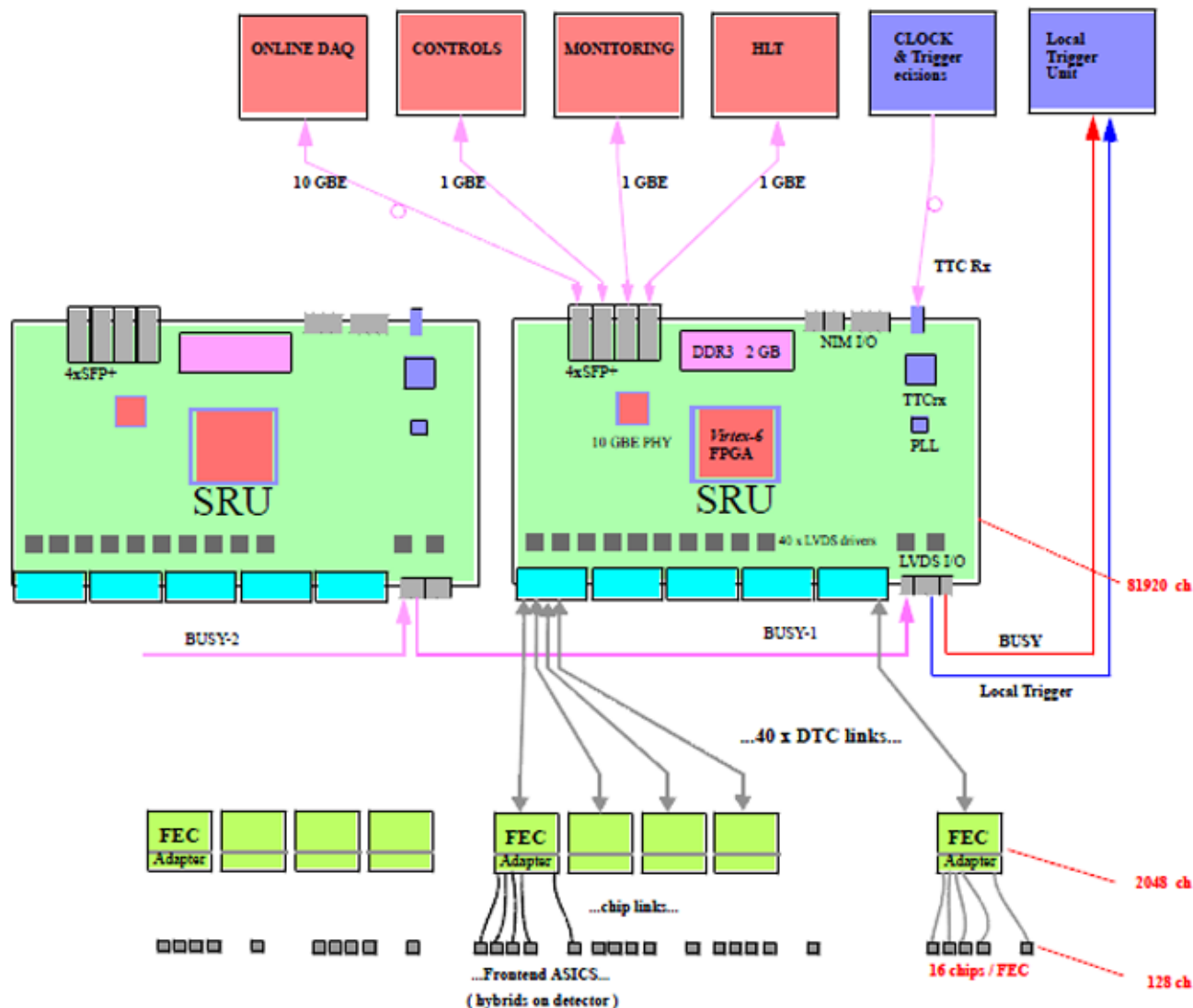
FEC cards

chip-link adapters

Chip links

Frontend ASICS/Detectors

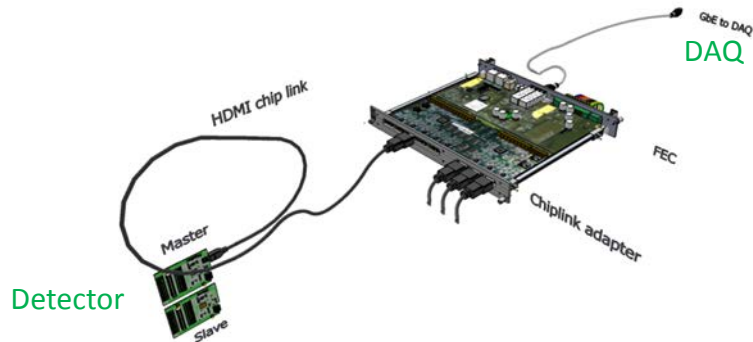
SPECIFIC



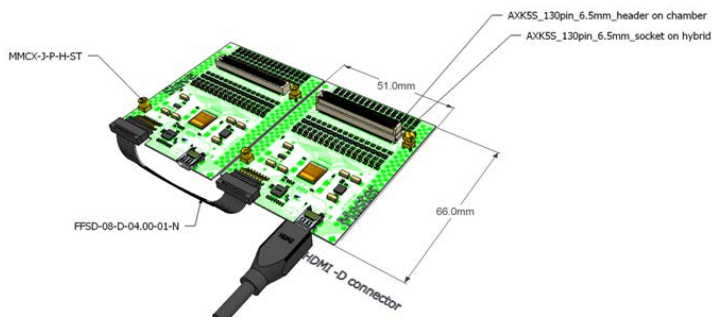
SRS “as is” implementation

BASICS:

table-top Combo = generic FEC card
+ detector-specific link adapter card



Chip link (HDMI up 25 m) between Combo and detector-resident hybrids, 8 per Combo

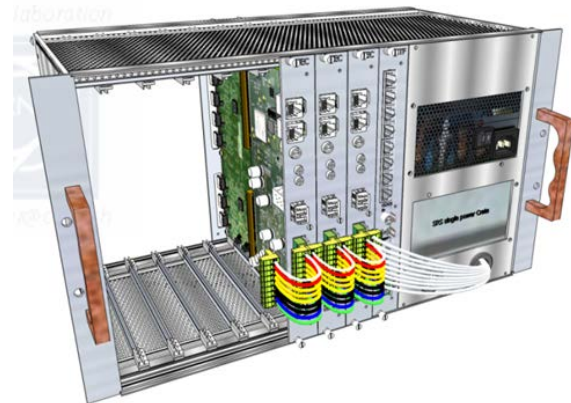


Frontend chips on MPGD carrier, sparc-protected,
powered via HDMI.

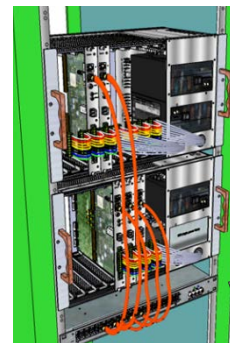
APV25, Beetle, VFAT .. more planned

Systems:

Powered SRS Crates, 6U and 3 U, up 16 k channels/crate
Commercially produced and sold via CERN store



Rack systems up 5 Crates/82 k channels, parallel FEC readout
via 1 Gb DTC links (Data-Trigger-Control)

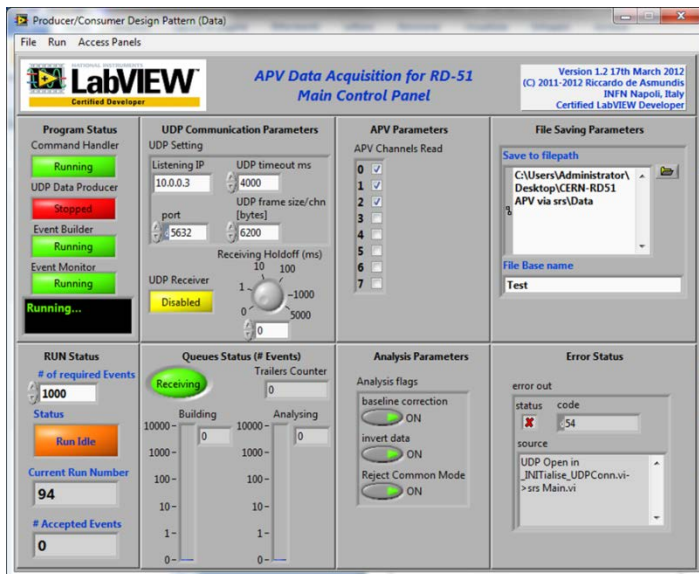


1 SRU cluster concentrator / Rack
40 DTC links input, 10 Gb to DAQ
1 Gb Slow Controls, 1 Gb Monitoring
1 TTC for trigger

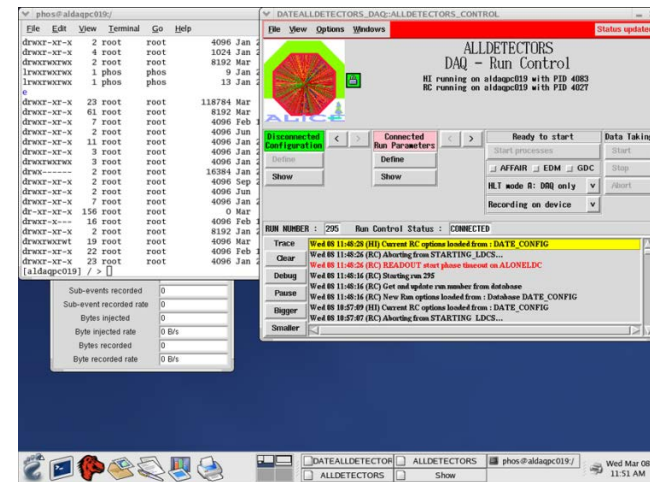


Online software for SRS

SRS-Labview

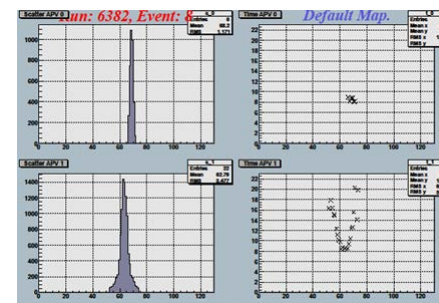
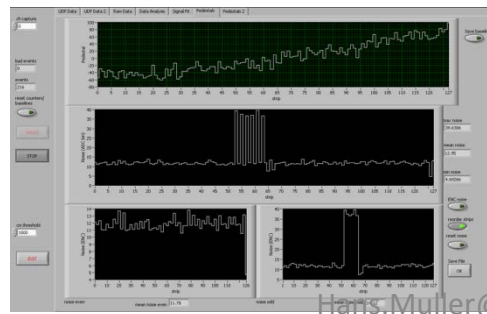
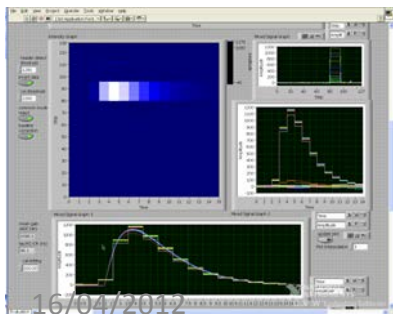


DATE, MMDAQ, RCDAQ (Linux based)



Root Analysis: Event statistics, distributions, cuts and fits

Online Monitoring: pulse-shape, x-y plots, pedestals, noise



Charge sharing with 11616 good events

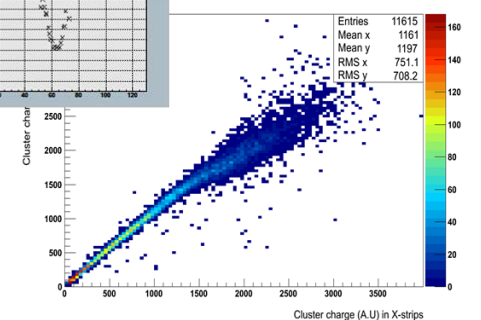


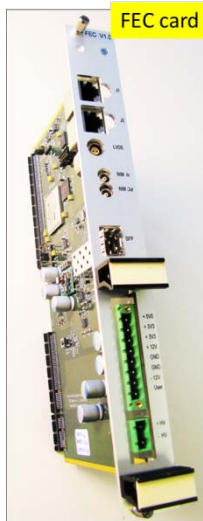
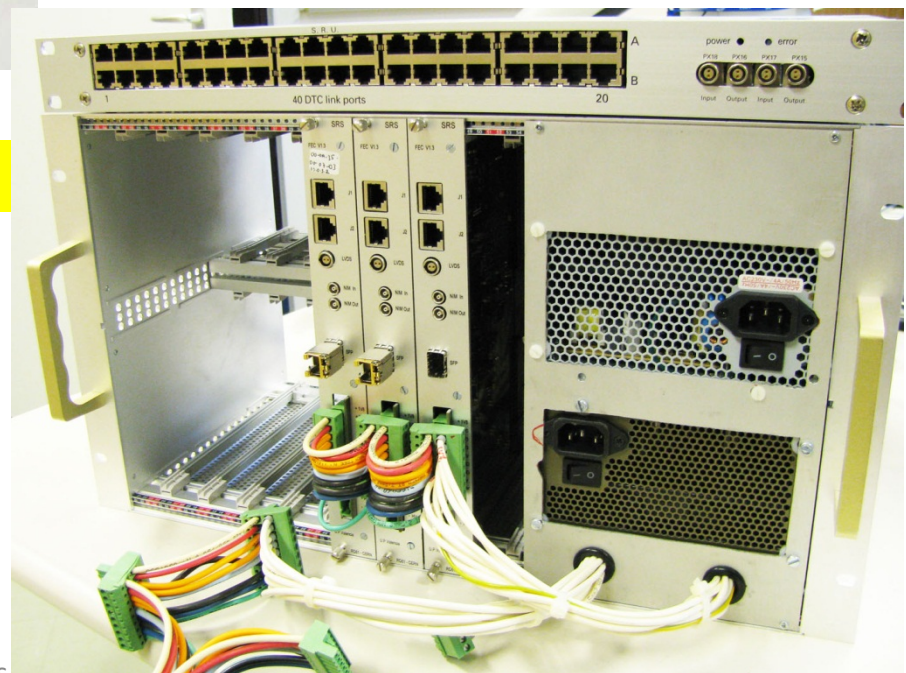
Photo of SRS 19"

Minicrate, 5kG, up 4 k channels



SRS sales via CERN store
production via PRISMA

Eurocrate with SRU on top
up 5 crates / rack



FEC card



12 bit Digitizer
16 channels

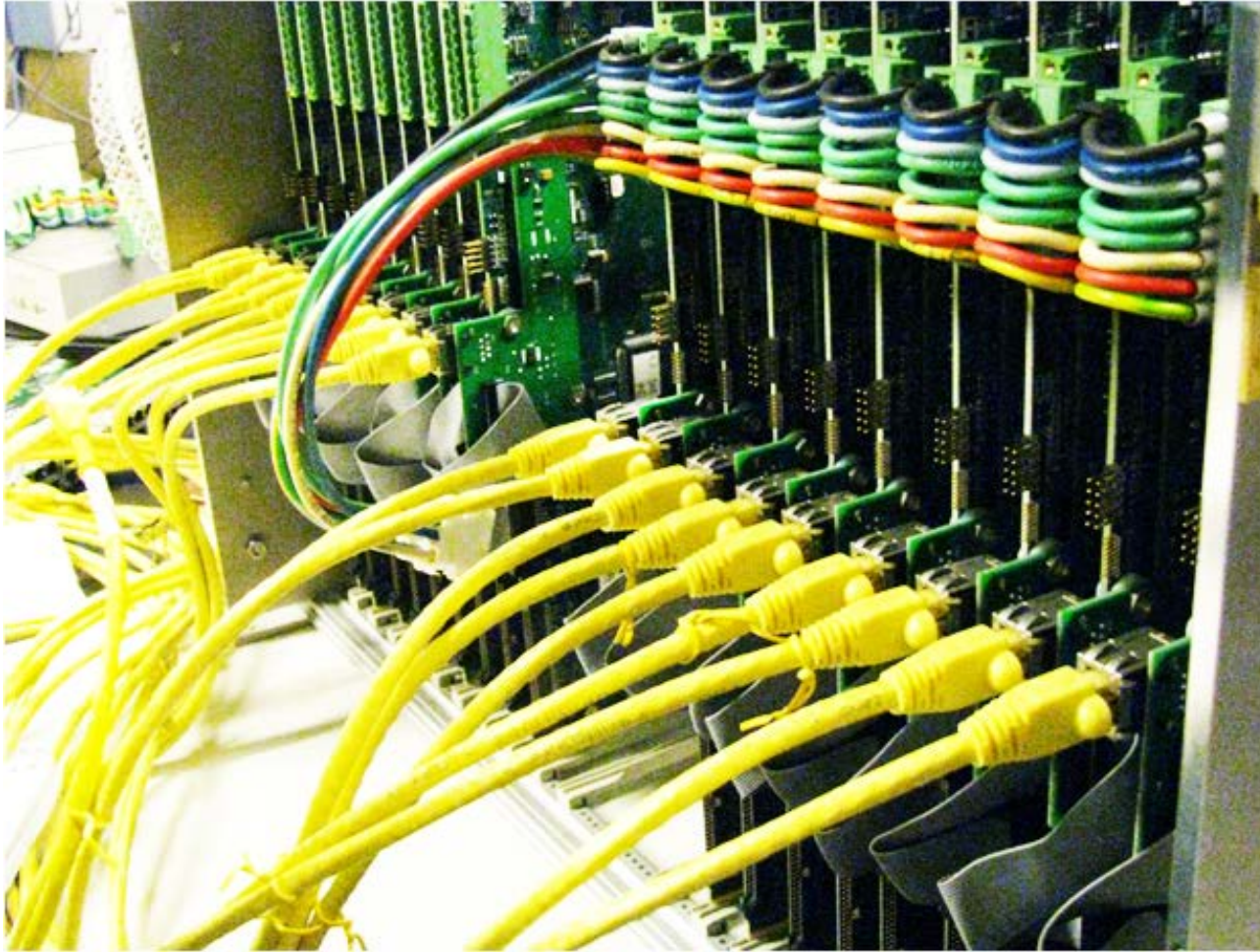


CTF Clock Trigger
Fanout

16/04/2012

Hans.Mueller@cern.ch

Photo DTC link readout (ALICE EMCaL)



SRS User Status 4/2012*

CERN experiments

- ATLAS CSC upgrade MMegas (8kch APV-SRS systems, 1st SRS testbeams, MMDAQ developer)
- ATLAS CSC upgrade MMegas, (VMM1 readout chip developer, SRS Adapter by Arizona Univ, MMDAQ)
- ALICE EMCal + FOCAL, SRU-based backend (50 kHz upgrade via SRS, DATE, new: Focal readout via SRS-Beetle ?)
- ALICE TPC upgrade, SRS readout electronics with DATE backend ?
- NA62 ref. tracker with Micro-Megas (1kCH-SRS Minicrate, MMDAQ)
- CMS high Eta GEM collaboration (VFAT hybrid and VFAT SRS adapter, in prep.)
- Totem upgrade R&D , SRS VFAT readout, DATE ?



SRS Minicrate up 4k ch.

HEP experiments

- NEXT Coll., dual Beta decay, SiPM, PM (Collaboration on SRS HW & FW, FEC cards, DATE)
- BNL GEM detector readout (2kCH. APV Minicrate, PHENIX SRDAQ porting to SRS)
- Jeff. Lab Virginia Univ. GEM prototyping, (Minicrate , Offline Data evaluation via AMORE + DATE)

Applications with Cosmic Tomography

- FIT Florida, Muon Tomography for homeland security, GEMs (1st 16K SRS application, DATE)
- Geosciences CRNS- Waterquality in Rocks, MMegas (5kCh SRS Crate , DATE , Labview)

R&D with MPGD's (small systems)

- Bonn/Mainz Univ, Timepix readout (SRS- Timepix adapter card)
- Helsinki HIP, GEM-MMega (SRS evaluation, Trigger pickup box via CSP)
- MEXICO UNAM, THGEM 2x (SRS Minicrate, DATE)
- C.E. Saclay, Micromegas (2k Ch SRS Minicrate , MMDAQ)
- WIS Israel, THGEM 3x (Minicrate, Beetle hybrid, SRS- Labview Beta tester
- INFN Naples (Minicrate, Labview for SRS developer, CTF card , Zero-suppression code



SRS crate 16k ch.

Teams waiting for commercial SRS delivery (orders via CERN store)

- RD51 lab, Radcore, WIS, USTC, SAHA, INFN Bari, INFN Naples, Stony Brook, Freiburg Univ
- Yale Univ, J-Parc-RIKEN, East Carol. Univ., Jeff-Lab, Tsinghua Univ, Univ Texas,

* in red: SRS developers in green: to be confirmed in blue: USER

SRS price/channel Gas detectors

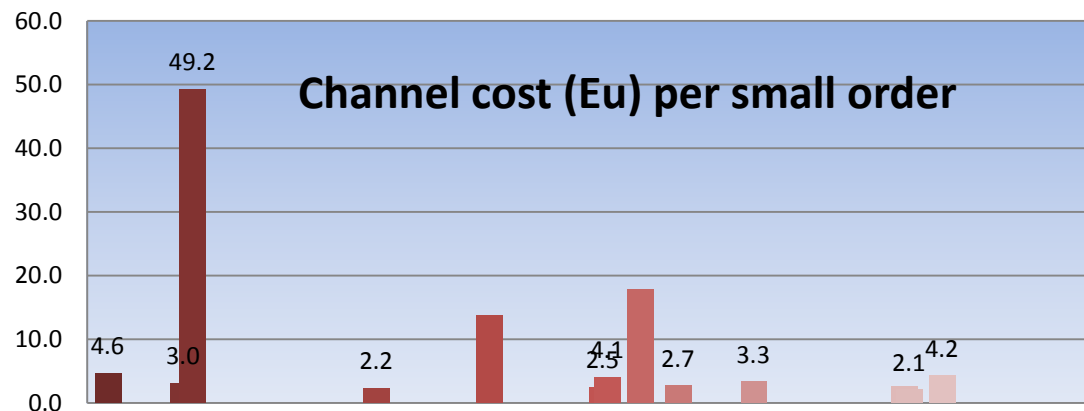
Example: 82k channel SRS system (1 Rack, 5 crates, 1 SRU)

640 hybrids	~ 65 k
5 Crates full power	~ 6 k
1 SRU in Alu box	~ 3 k
40 FEC + ADC cards	~ 83 k
320 cables (HDMI+Flat)	~ 6 k

hybrids	34%
electronics + cables	66%

Total 163 kEu

Channel cost (82 k) ~ 1.98 Eu



Project*: re-map SRS in ATCA

- 1.) higher channel integration => reduce cost/channel for large systems
- 2.) certified crate standard
- 3.) replace DTC cables by backplane

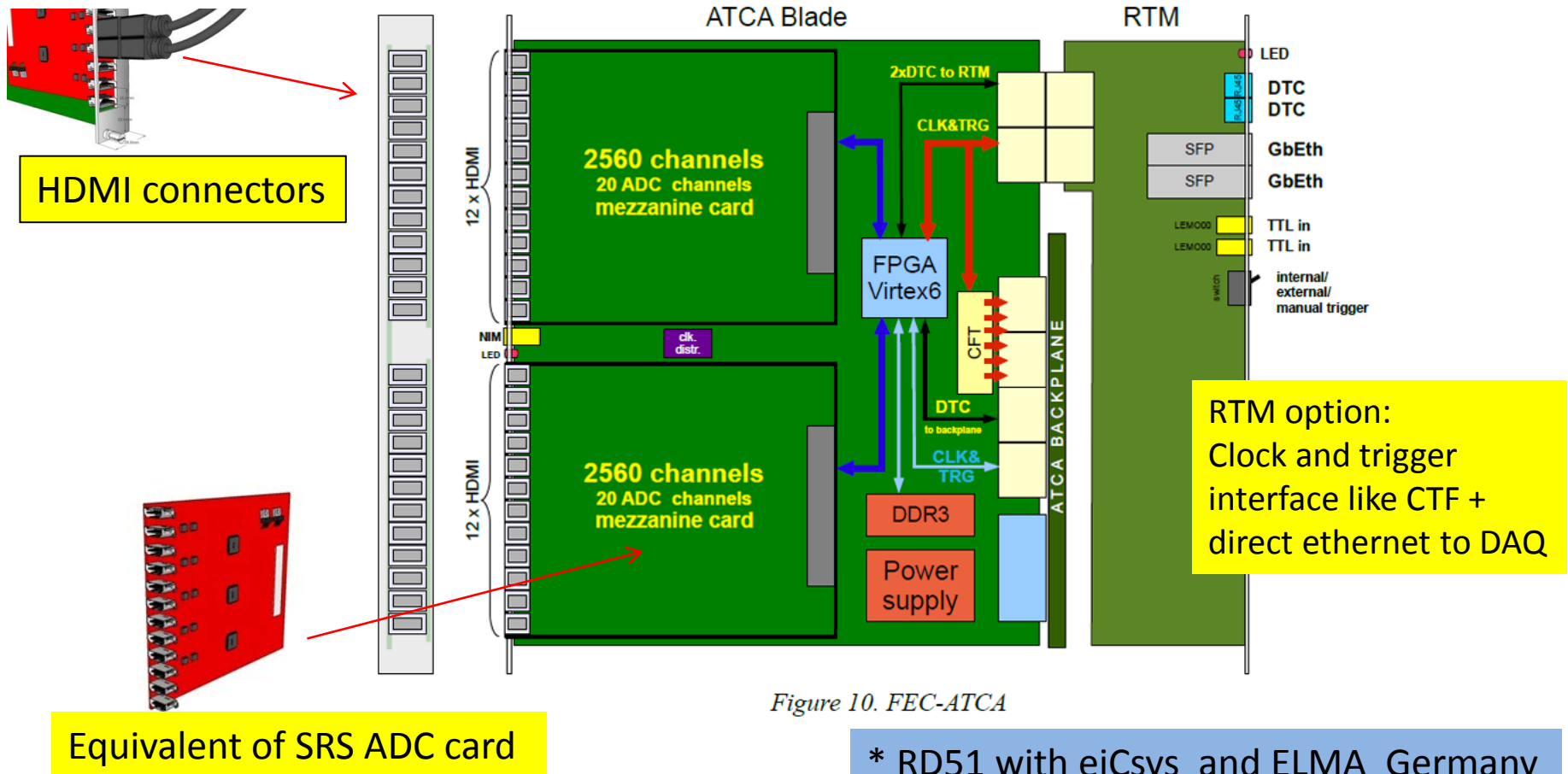
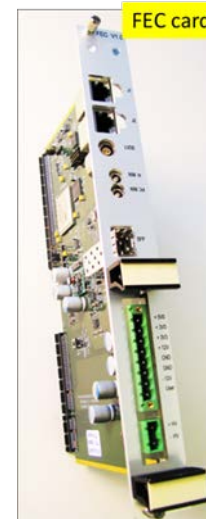
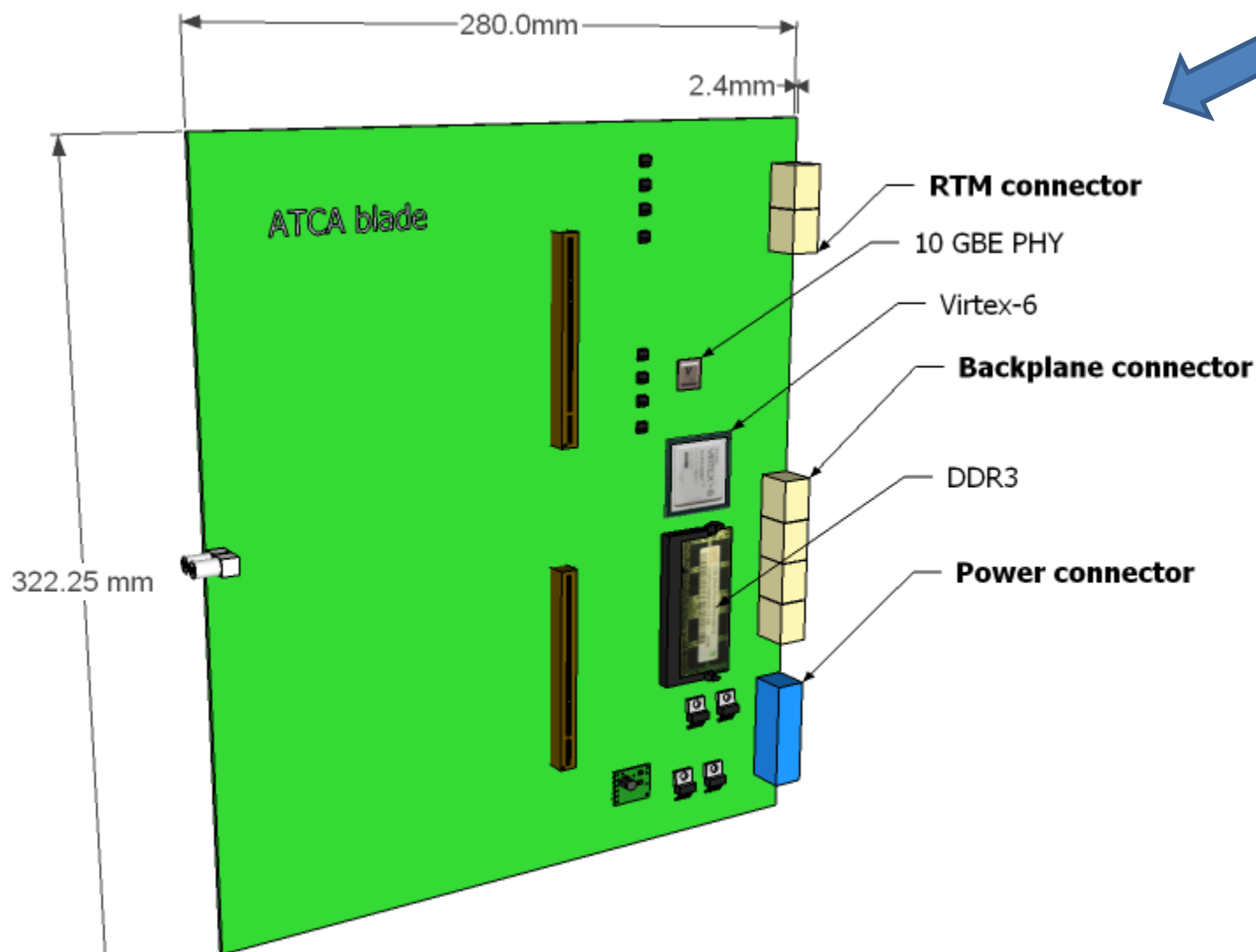


Figure 10. FEC-ATCA

* RD51 with eiCsys and ELMA Germany

ATCA implementation draft

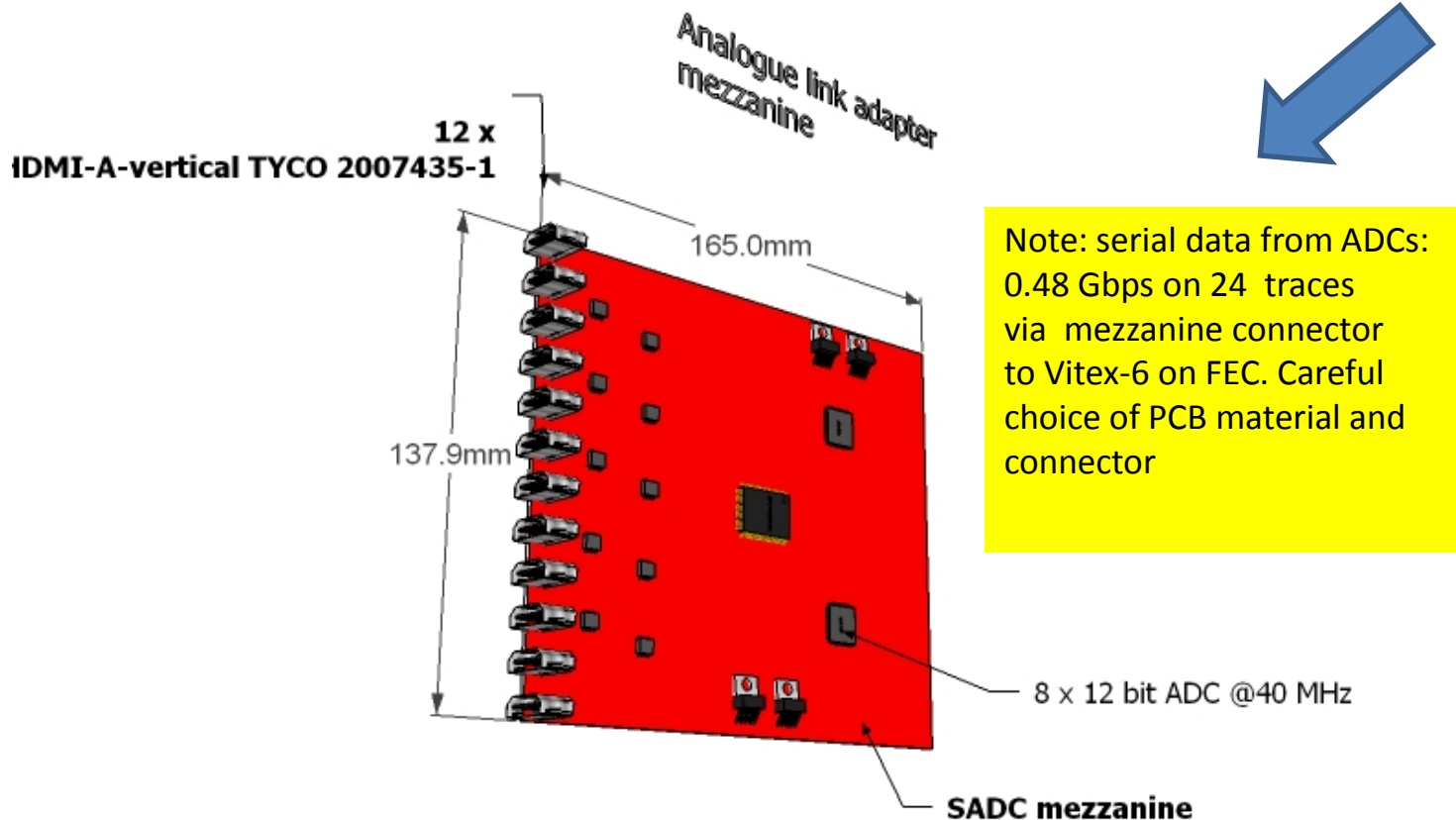
ATCA blade = FEC equivalent



SRS FEC card:
Virtex 5, DDR2
1 Gbit SFP

SADC adapter mezzanine

=equivalent of ADC adapter

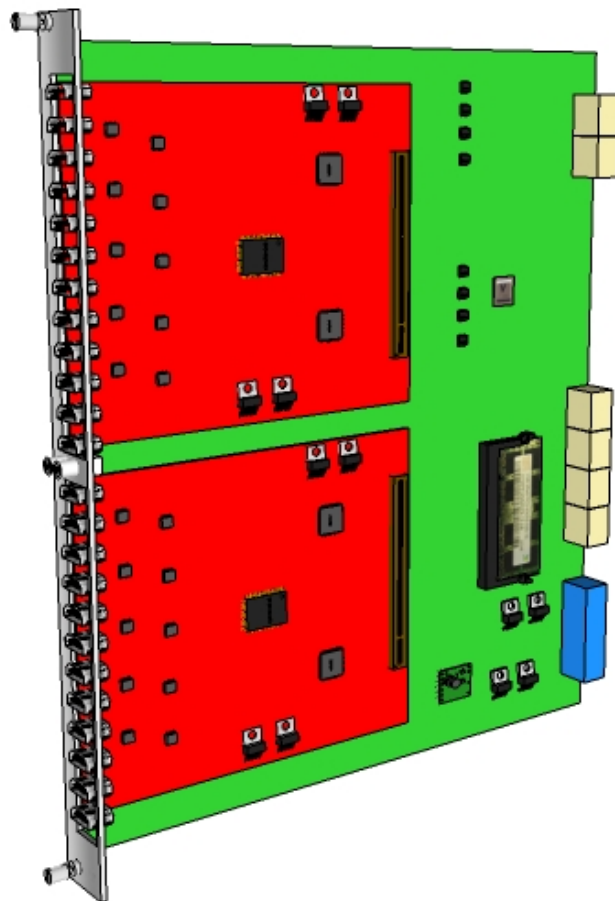


SRS ADC card
8 HDMI ports
16 x ADC 12bit@40 MHz

ATCA Blade with SADC adapter

= equivalent of SRS combo (FEC+ADC)

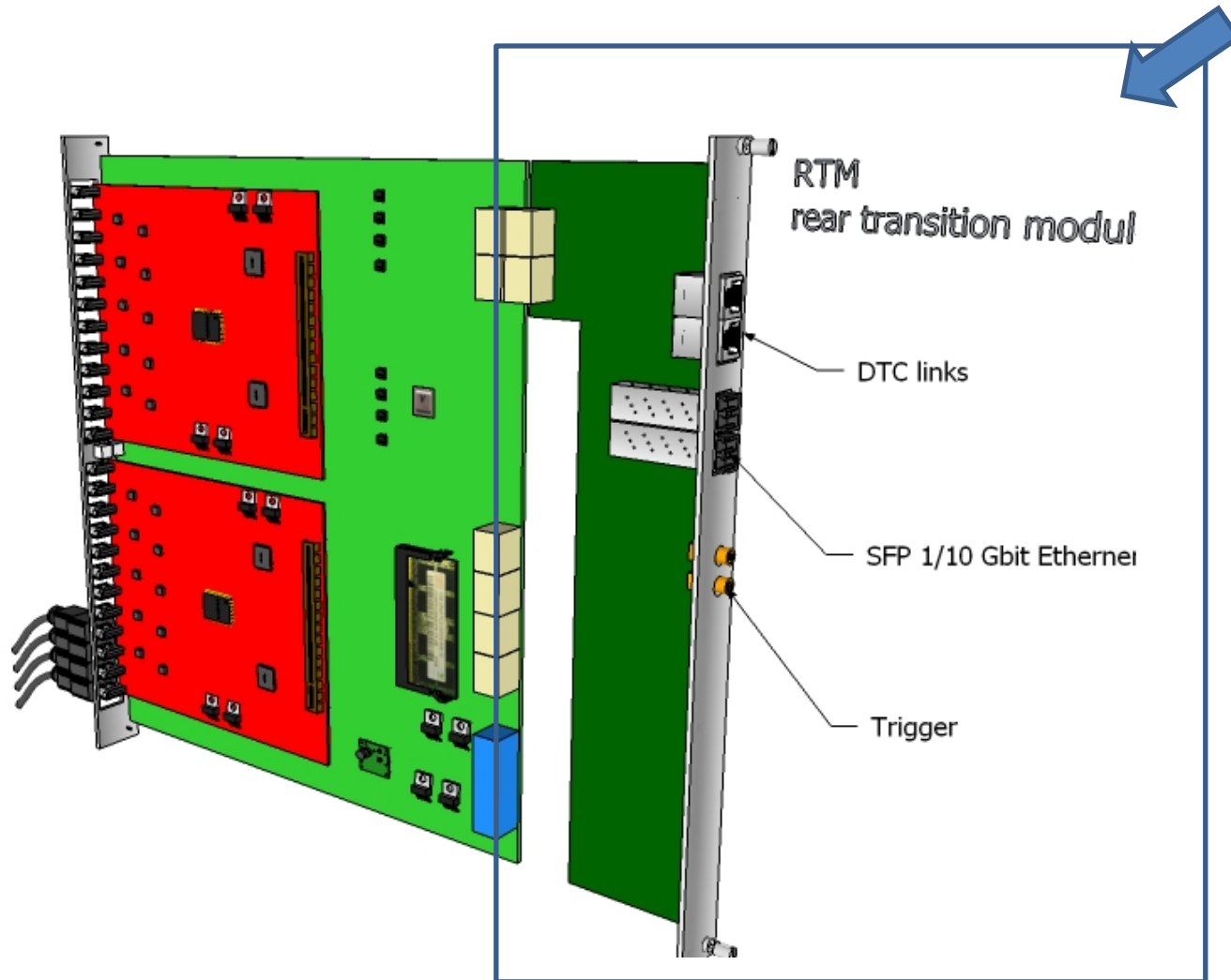
24 HDMI ports
= 48 hybrids 128 ch.
= 6144 channels



SRS FEC + ADC
max 8 HDMI ports
per Combo

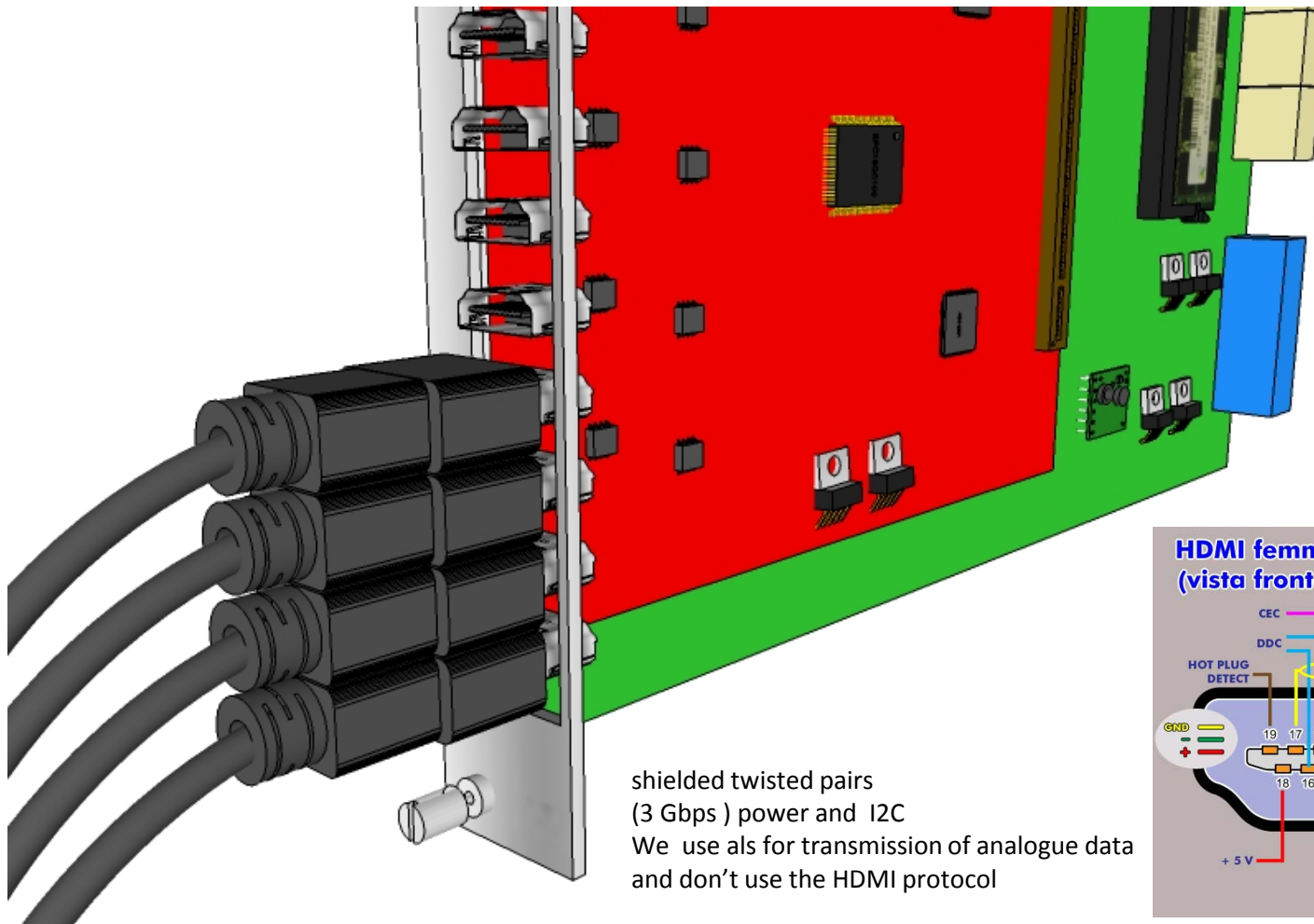
ATCA blade and RTM

= similar CTF for local I/O and trigger options

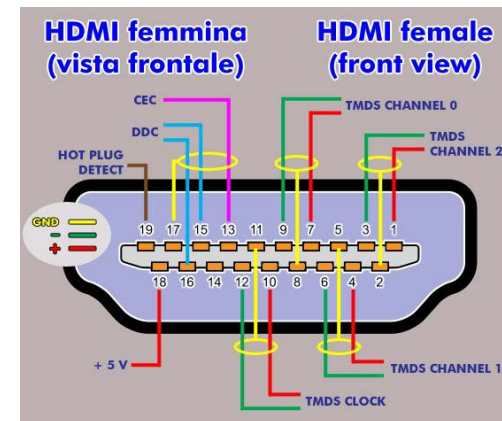


SRS: CTF card
Clock, Trigger
and IO

HDMI- chiplink to Frontend



shielded twisted pairs
(3 Gbps) power and I2C
We use als for transmission of analogue data
and don't use the HDMI protocol



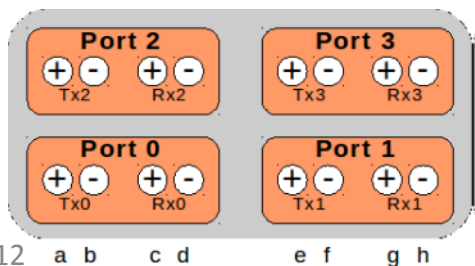
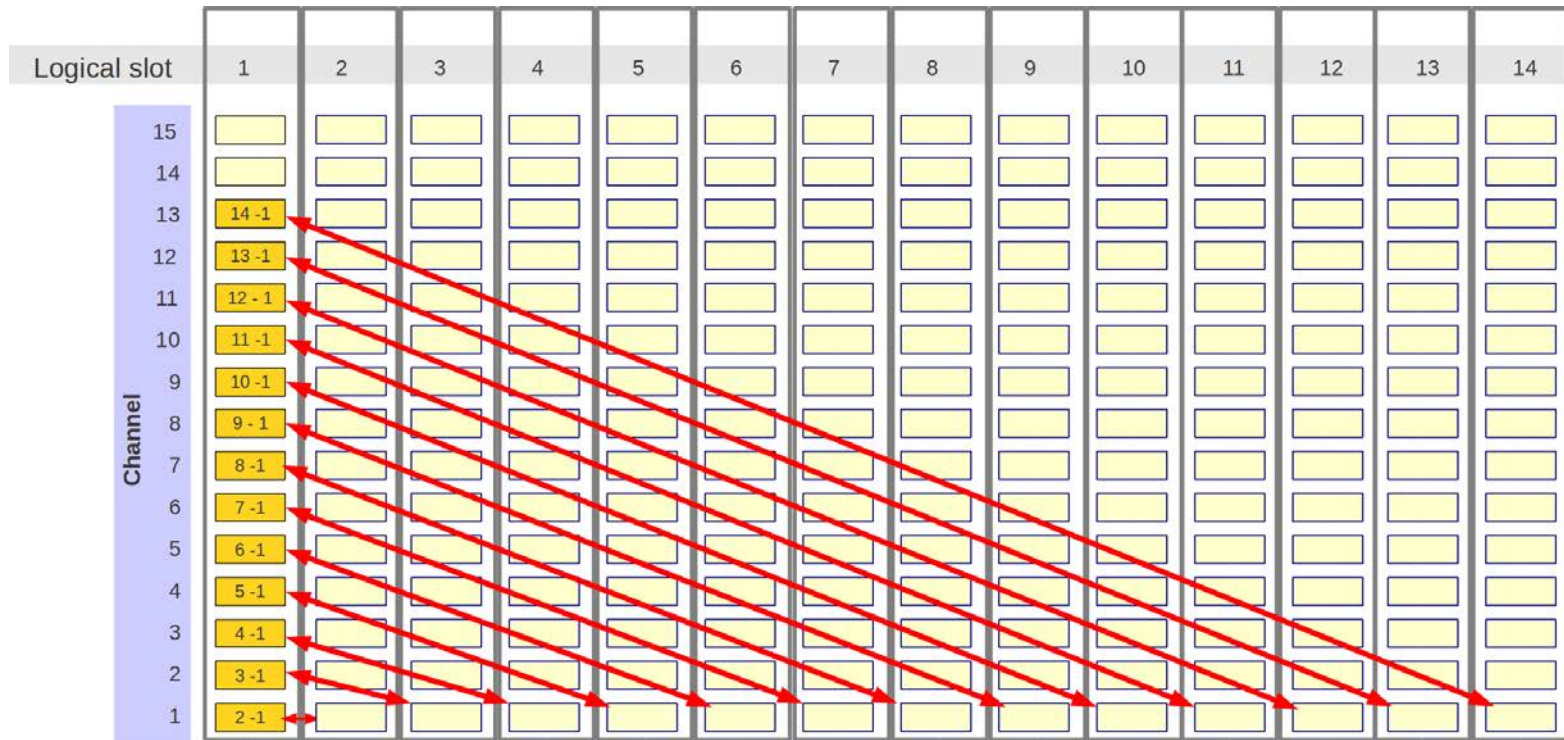
=> power and DTC link via fabric

[illegible]

Star-connected Data links to slot-1

Power

ATCA: -integrated p-p STAR technology

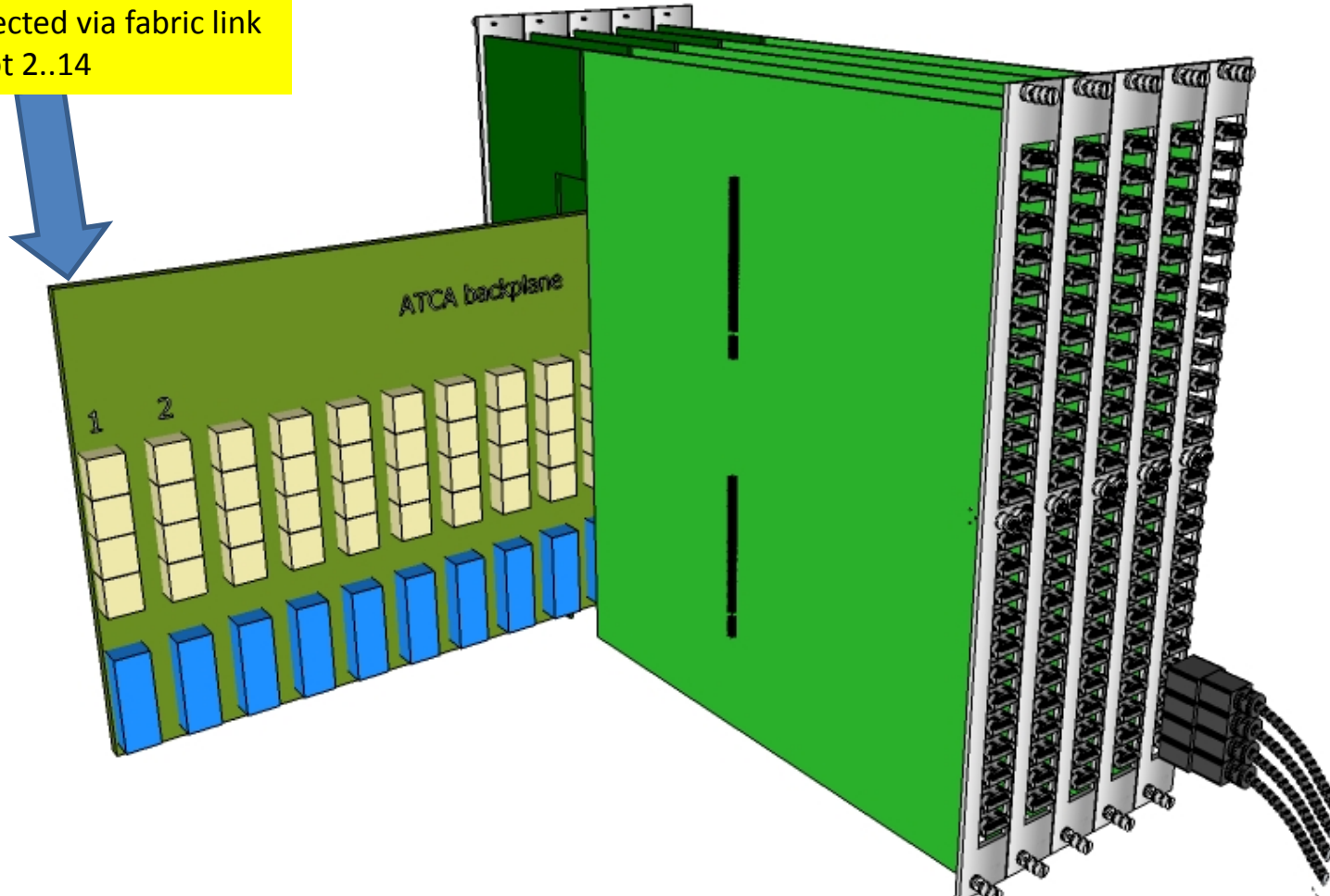


Slot 1 has 8 differential pairs to ALL 13 right-hand slots with clock capability 6 GHz

➔ This fabric is superior to CAT6 based DTC link cables

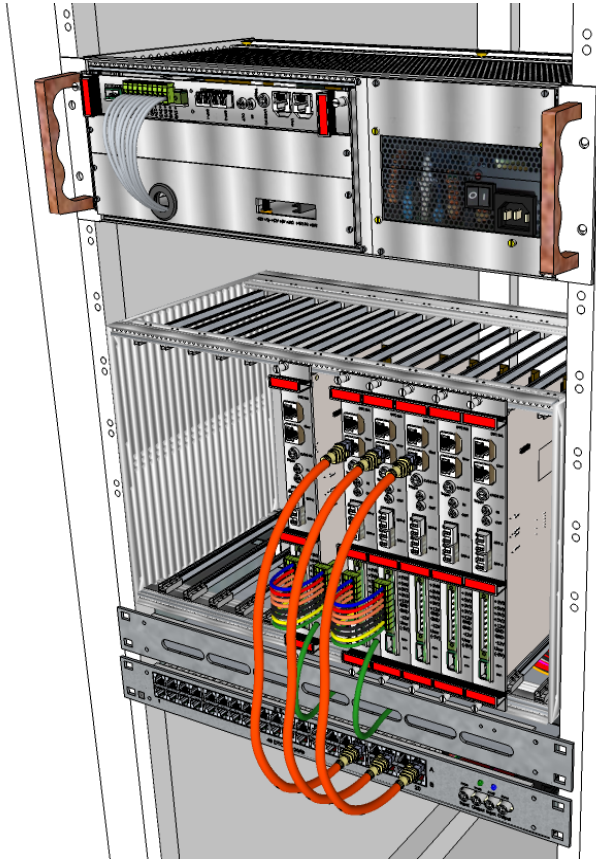
SRS-ATAC blades stack

SLOT 1
Connected via fabric link
to slot 2..14



11 Slots a 6144 channels ~ 67 k channels in one Crate

SRS Crate/Rack environments “as is”



← SRS 3U Minicrate: portable,
rack-mountable, Max 4k channels

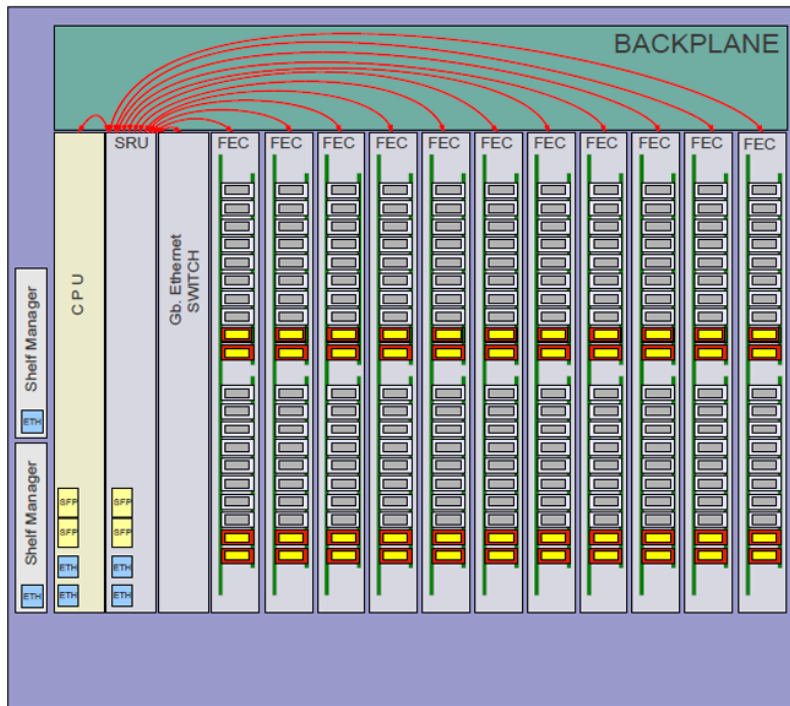
← SRS 6U Eurocrate, rack-mountable
Max 16k channels/crate

← DTC links (CAT6) 1 Gbit/s
40 FEC -> 1 SRU

← SRU 1U Readout Unit
up to 40 FEC's in 5 crates = 1 Rack
Max 92 k channels / Rack

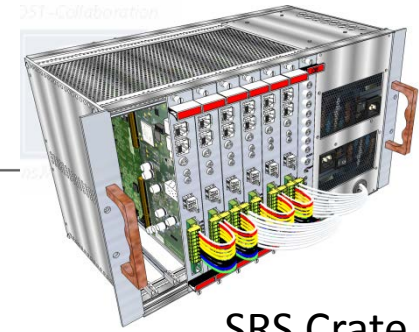
ATCA equivalent SRS Eurocrate

ATCA 14 slots Crate – SRS



- 11 FEC-ATCA blades
- 64 ADC ch. per FEC board
- 704 ADC channels in shelf
- ~~90412~~ channels per shelf
- 1 SRU blade in the shelf
- remote programming
- optional CPU in the shelf

+ 2 FEC-ATCA in no
CPU&Switch

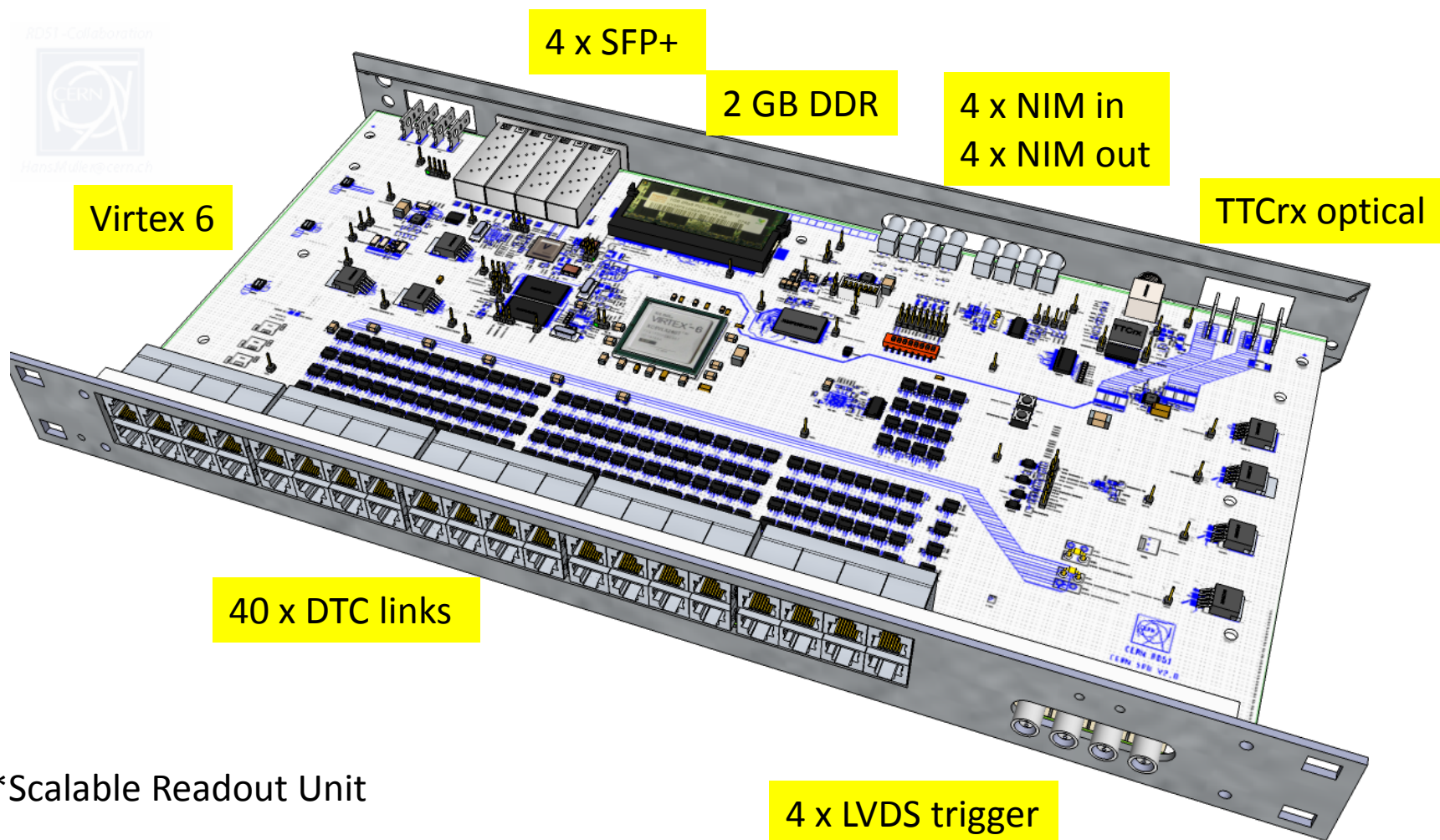


SRS Crate



67 k channel/crate

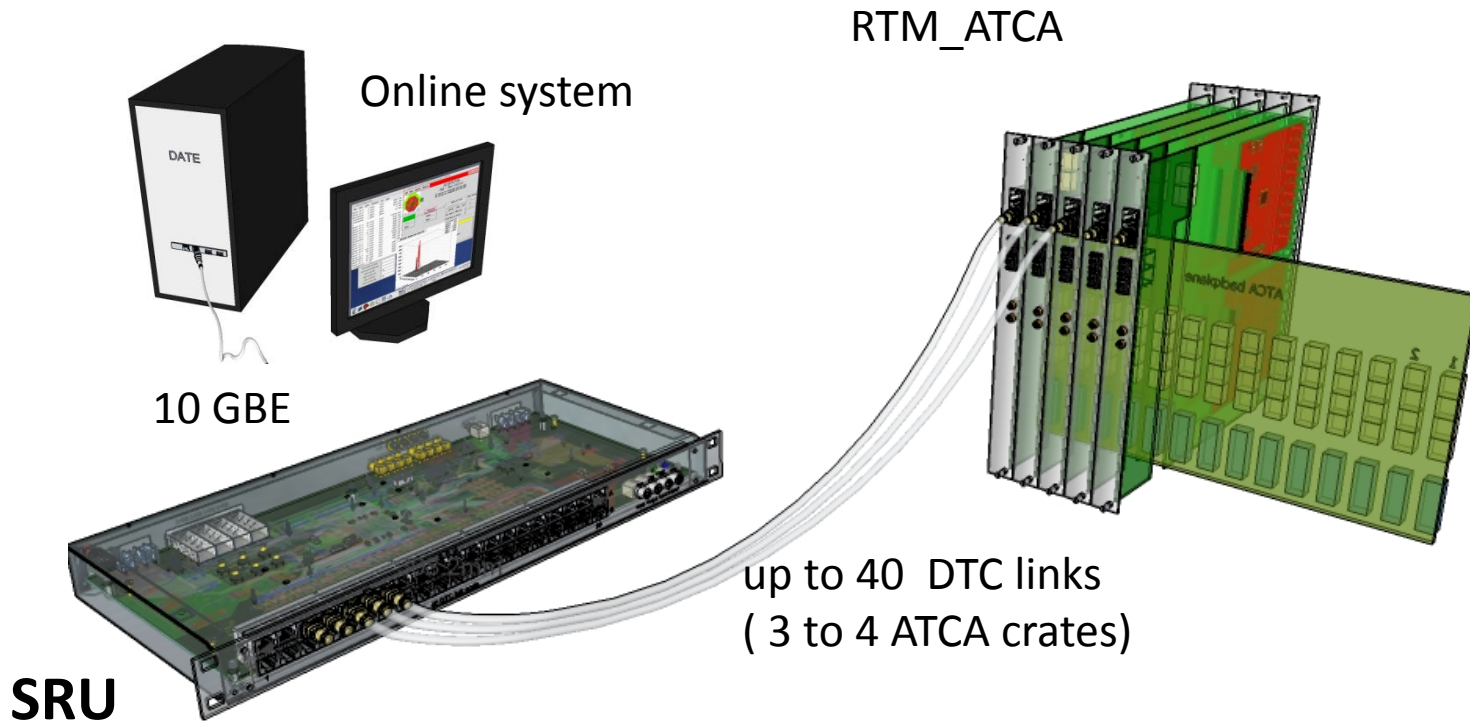
SRU* “as is”



*Scalable Readout Unit

1st Step

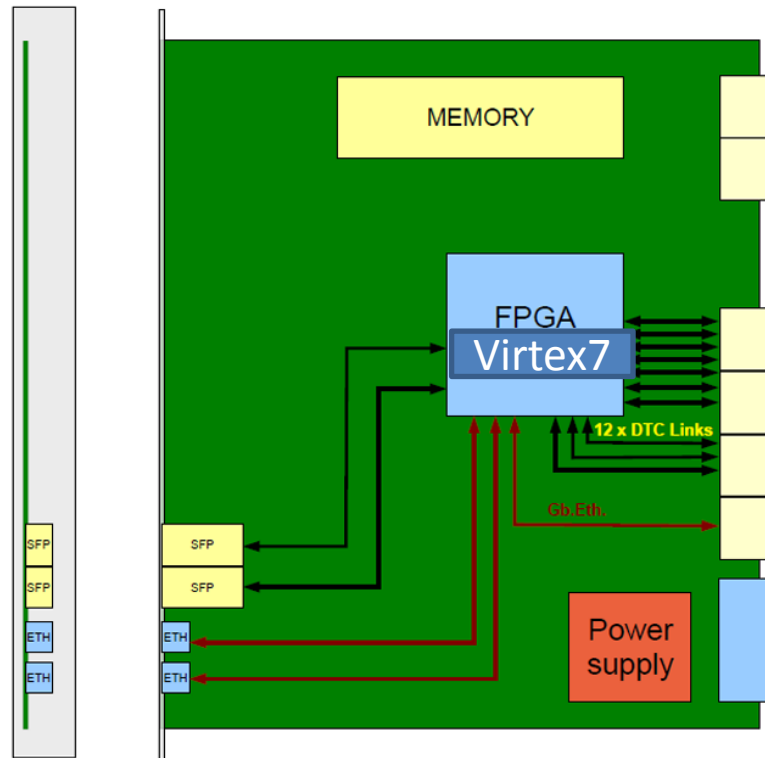
connect existing SRS module via DTC links to RTMs



2nd step: Implement SRU for Slot 1

SRU-ATCA

aim for 48 Gbit/s
optical links to DAQ



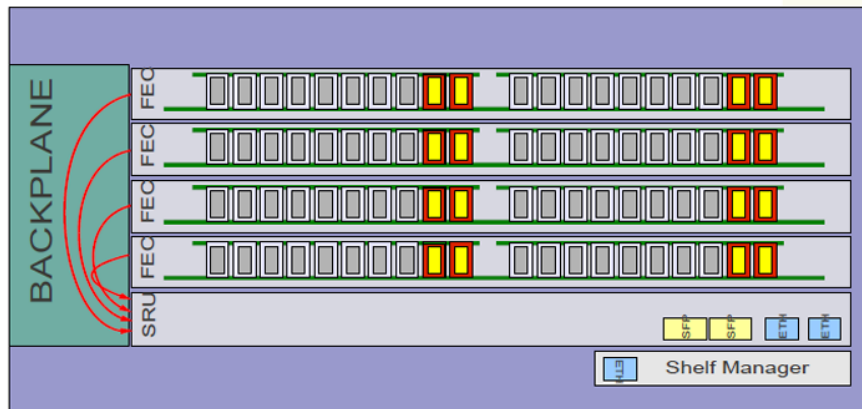
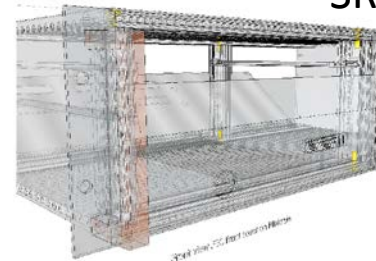
aim for 10 Gbit/s
DTC links via Fabric

ATCS equivalent for SRS Minicrate

ATCA 5 slot – solution for a small system

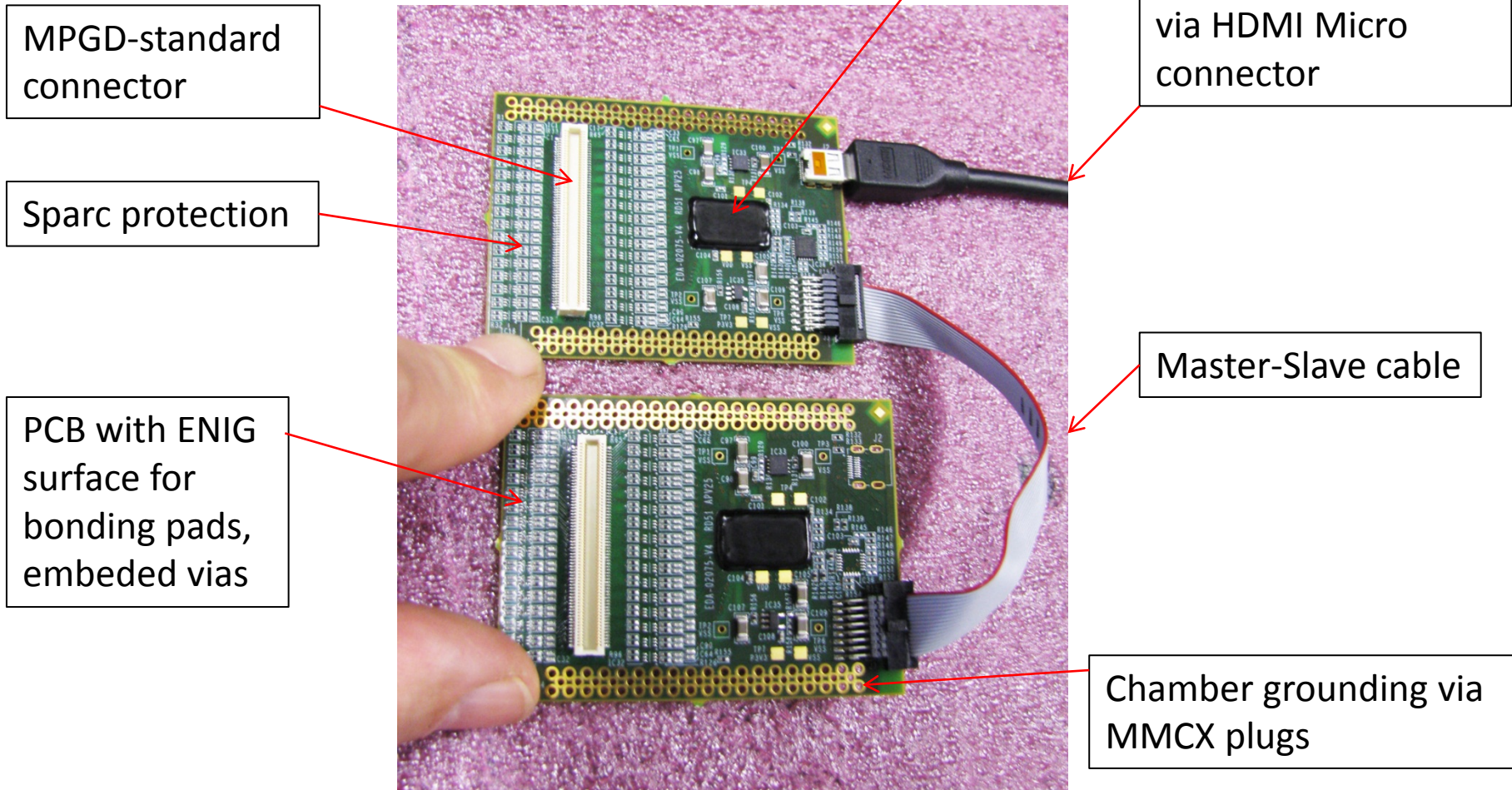
- 4 FEC-ATCA blades
- 256 ADC channels in shelf
- 32768 channels per shelf
- 1 SRU blade in the shelf

SRS Minicrate



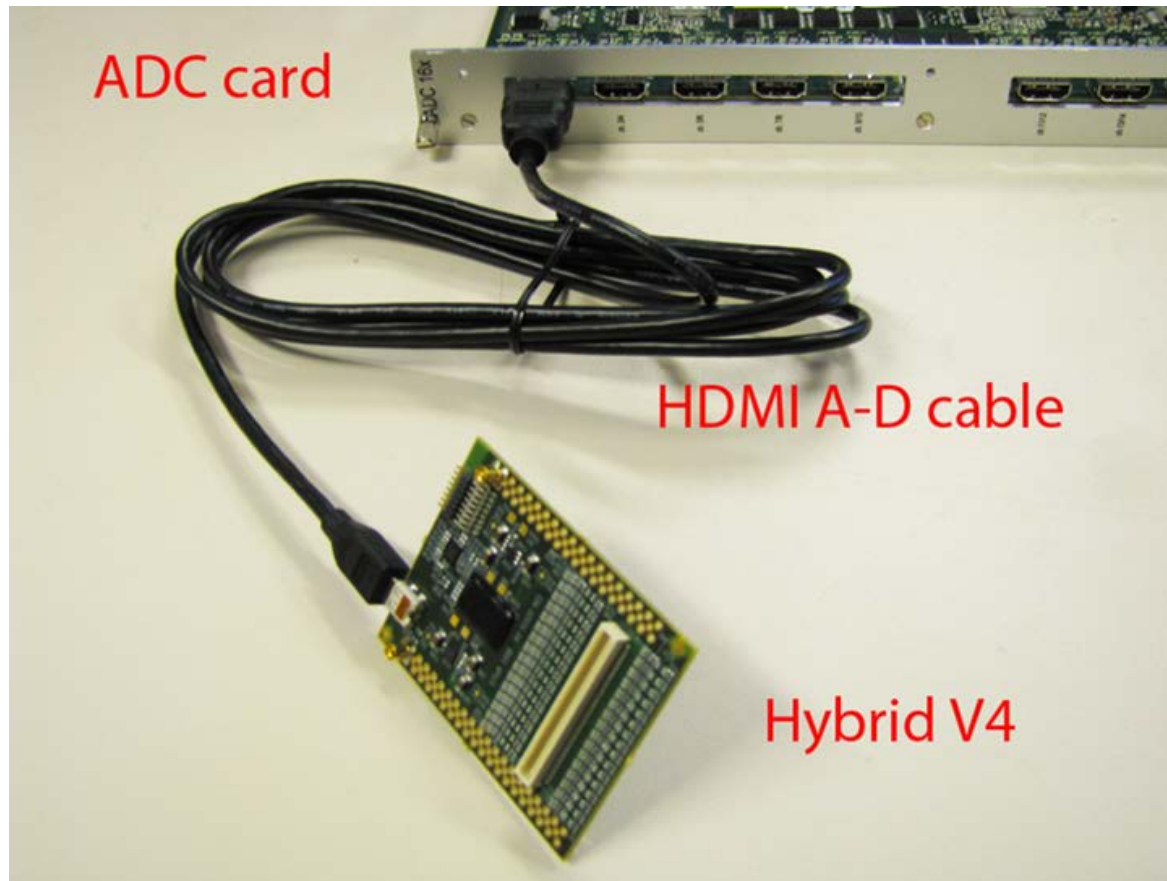
SRS frontend Hybrids

1st version uses 128 channel APV chip
Alu-wire bonded, topglobbed)



SRS ad-hoc chip-link: HDMI

Ad-hoc: cheap, v. high quality , 3Gbit/s, power, works very well



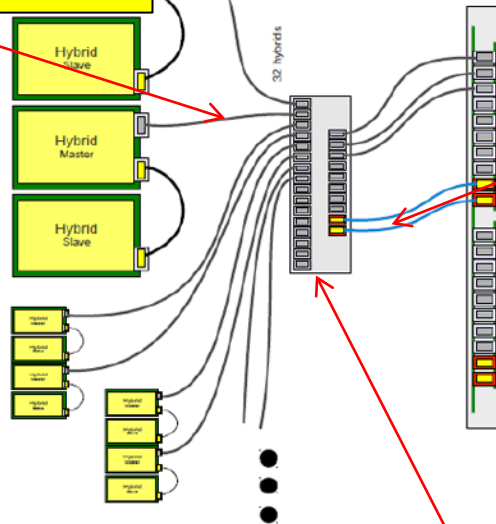
Max distance ca 30 m

Upgrade plans for frontend

SRS architecture (Hybrid <=> ADC)

Copper
From detector to "Box"

Fiber from "Box
to SRS_ATCA



To maintain compatibility with existing hybrids "redistribution box" is needed

- CLK, TRG&PWR are spitted in the box
- "redistribution box" is much cheaper than ADC/FEC board

No hybrids modification,
but additional box needed

eicSys GmbH
Embedded Integrated Control Systems

Scalable Readout System in an ATCA – February 20, 2012, CERN

10/26

SRS
electronics
within
ATCA crate
framework

Implement long distance SRS chip-link via "Intermediate BOX"

- 1: Frontend side link: short copper, O(2 m @ 1 Gbit) in radiation exposed zones
- 2: FEC side: long fiber O(50m @ 10 Gbit) to ATCA-SRS crate
- 3: provide power to ASICS a la HDMI ?

HEP requirement to a commercial crate standard

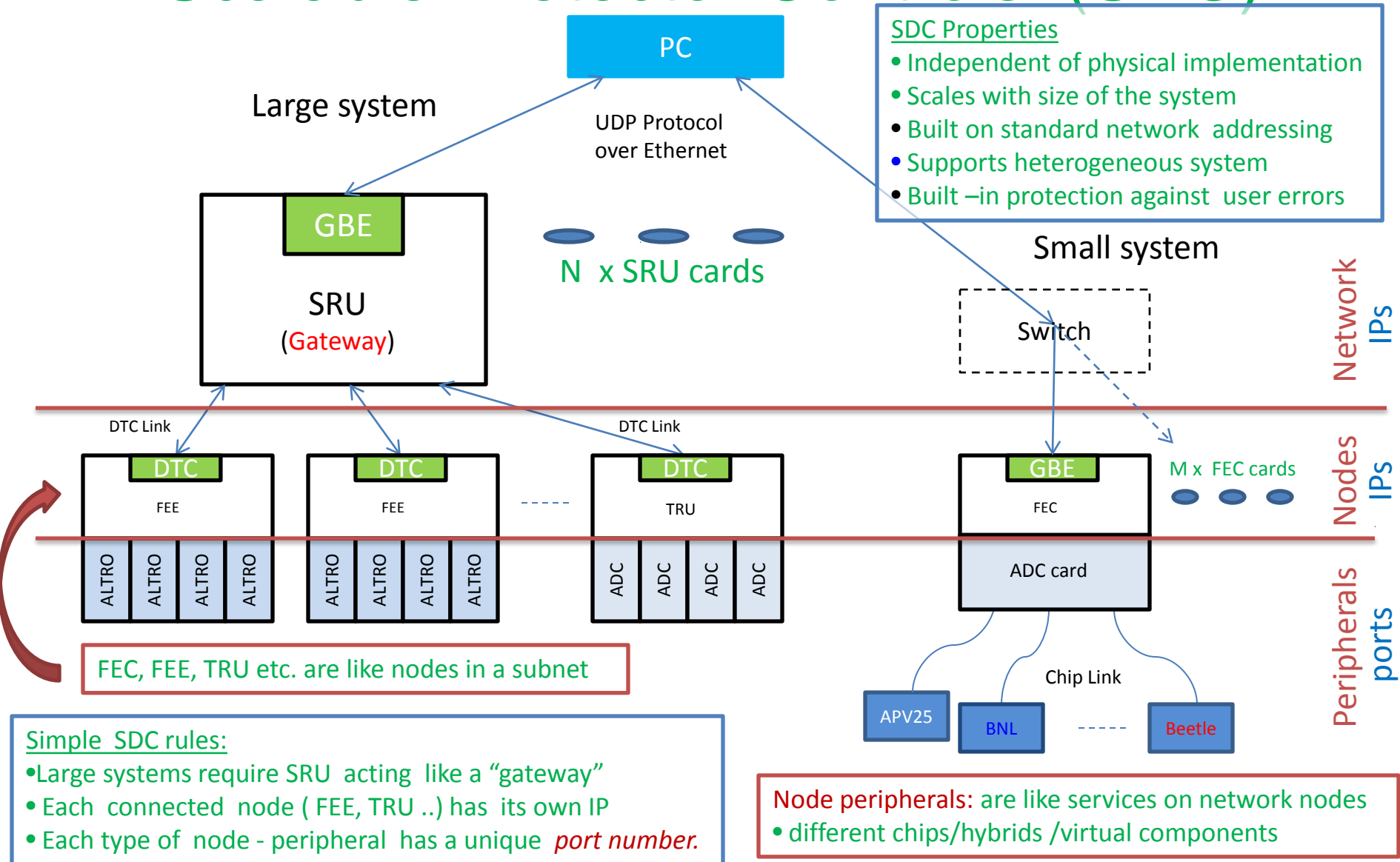
- Operation in Magnetic fields (up 10 Gauss , no Ventilators, no Ferrite DC-DC, no magnetic Materials)
- Real-time re-configuration (SEU tolerant systems, Cavern ~ 10 kRAD, Racks up to 50 kRAD)
- Ground-loop avoidance (good filters on PWR, GND, Signals and Network)
- Immunity to HV discharge transients (ESD protection on all signal inputs)

Message to the XTCA community

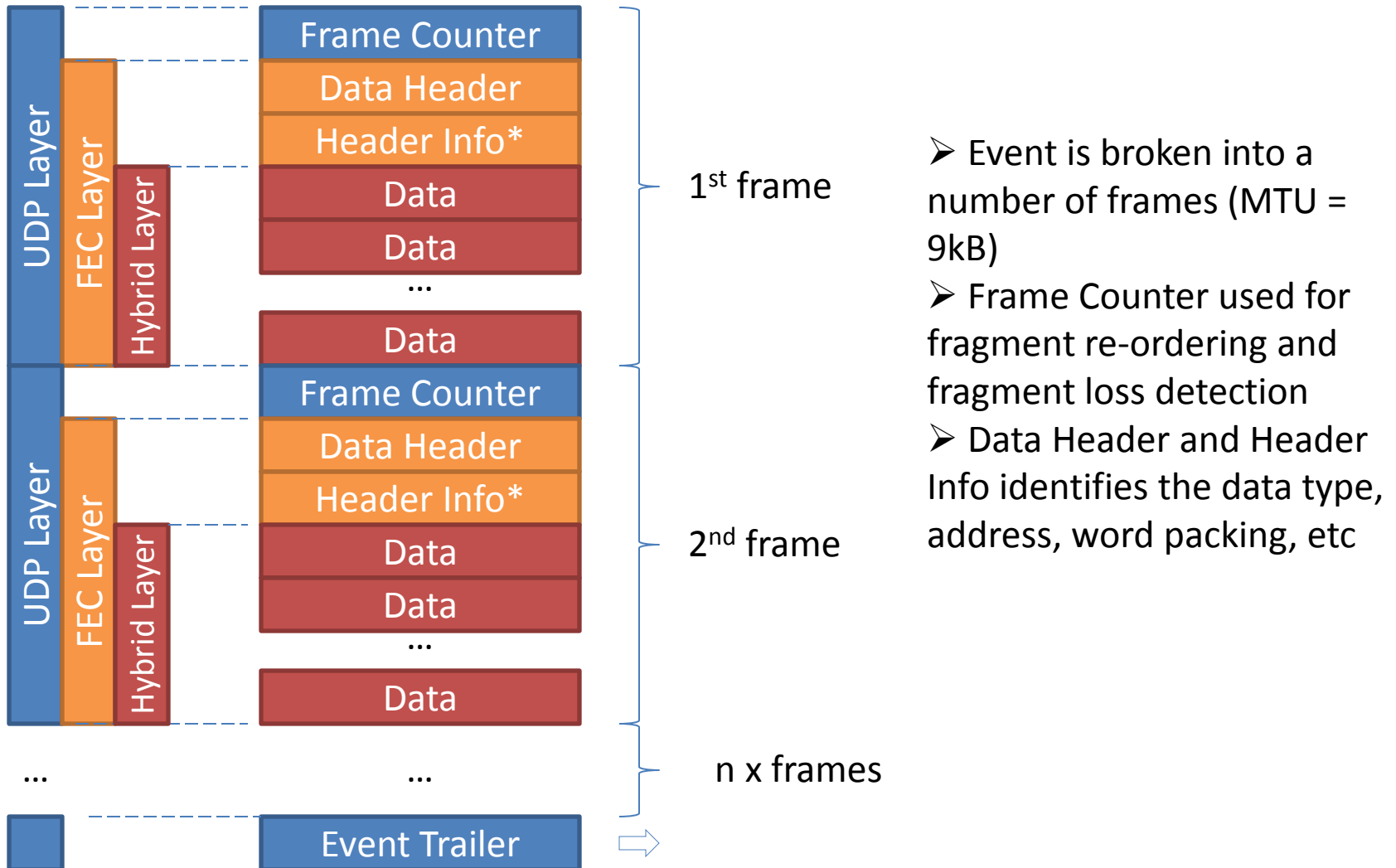
- SRS is established in the MPGD detector community but does not exclude other detector communities
- A significant SRS user-base ready adopt XTCA for large system plans
- SRS includes: Hybrids, DAQ Software, Slow Controls
- SRS could be a motor for xTCA-based systems
- Joining SRS means joining ~ 30 teams : WELCOME

Backups

Scalable Detector Controls (SDC)



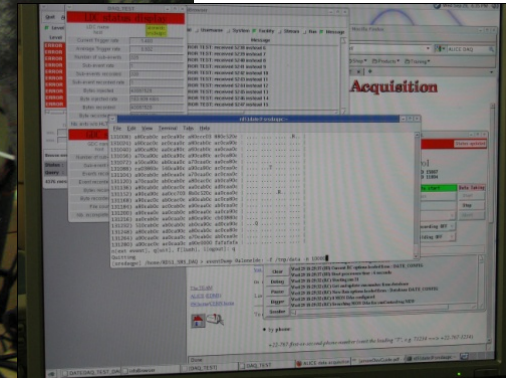
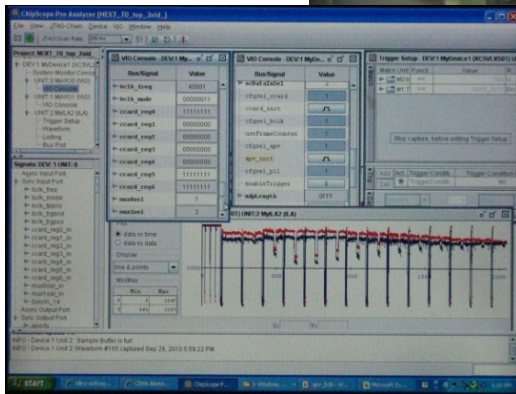
SRS UDP data protocol



SRS users

Event display and controls

DATE Online system of ALICE
-> offline Analysis via Root



Online, Monitoring and Control systems on a Laptop