SRS
Scalable Readout System

for 2015

Hans Muller CERN/RD51

(1) Electronics for R&D on detectors

- open, light and table-top
- Frontends according type of detector
- sparc protected for MPGD's
- affordable channel cost
- purchase from stock
- complete from frontend to offline
- both DAQ and Labview –like software
- standard detector plugin
- user community in RD51
- scalable from a few channels to a large system

(1) Electronics for R&D on detectors

"SRS Classic"

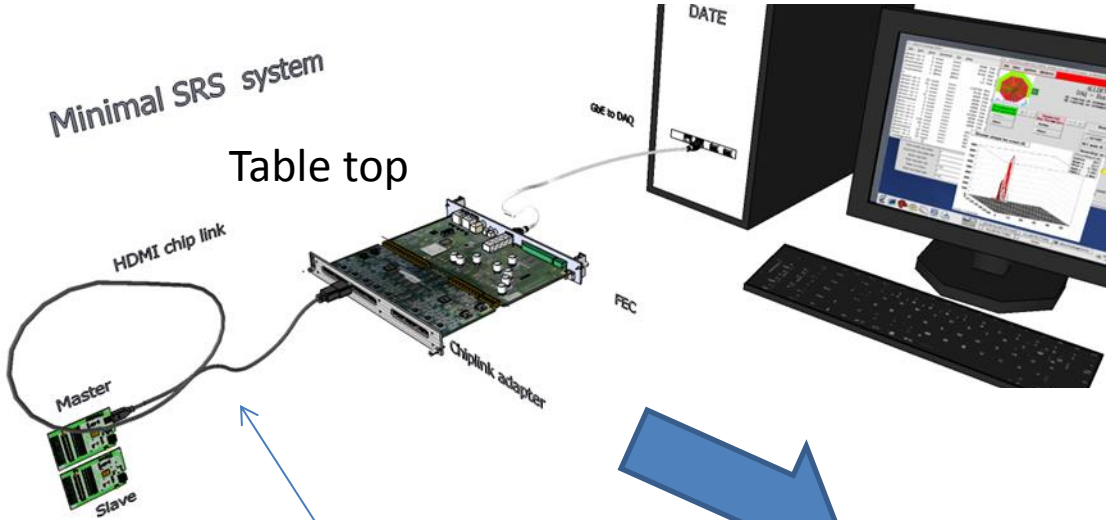


Table-top complete readout system from detector up to offline Analysis

copper cables, distance limited to max 25 m

Mini-crate SRS system

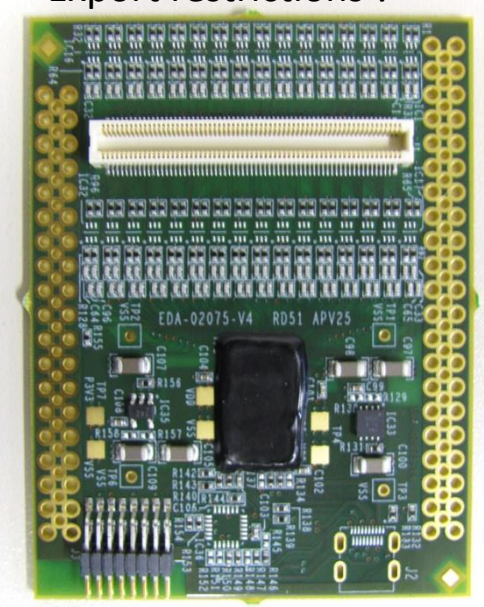
by 2014, ca 100 crate systems are in use worldwide mainly by members of the RD51 collaboration

- Hardware available via CERN store
- Firmware included
- Software via RD51

SRS frontend ASICSs

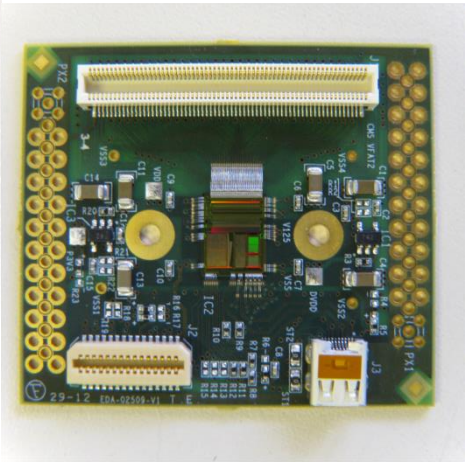
2009 → **2014**

<u>APV ,128-ch. analogue</u>
100% designed for RD51 SRS
HW and FW RD51 property
4 revisions
still going strong
about 2000 produced
distributed via CERN store
Export restrictions !

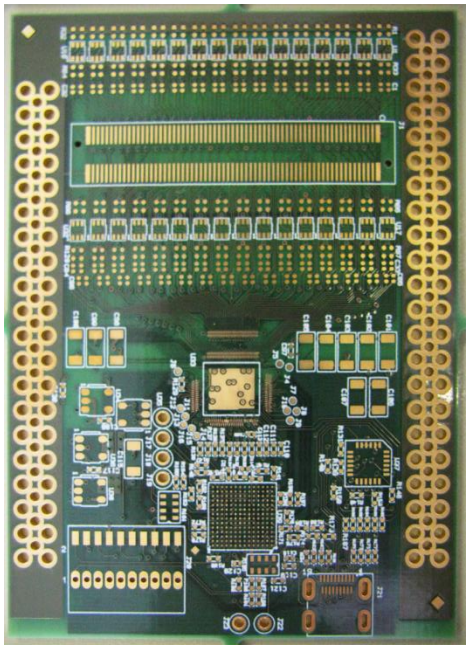


Letter of compliance reqired

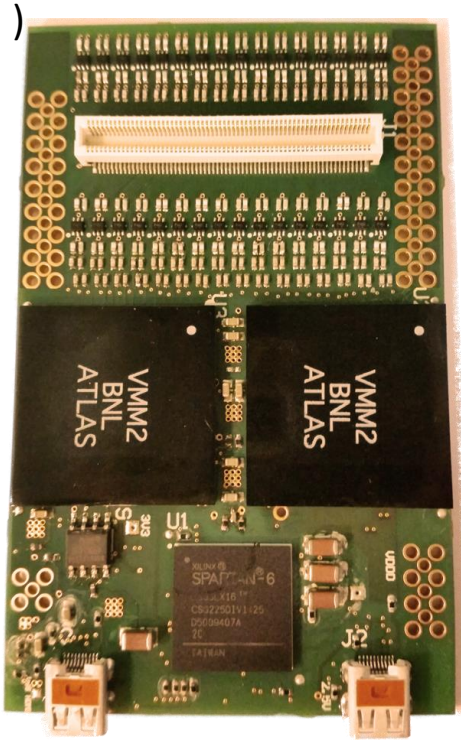
<u>VFAT,128 ch digital</u>
designed by RD51
excessive noise in V1
xferred to CMS



<u>Beetle: 128 ch analogue</u>
Design RD51/WIS
production difficulties
with 4-layer bonding
..to be continued (ALICE /Focal)



VMM-2: 2x 64 ch digital
HW and FW
Mini2 design by RD51
under test
by IFIN/ATLAS NSW
-> talk by Sorin Martoiu

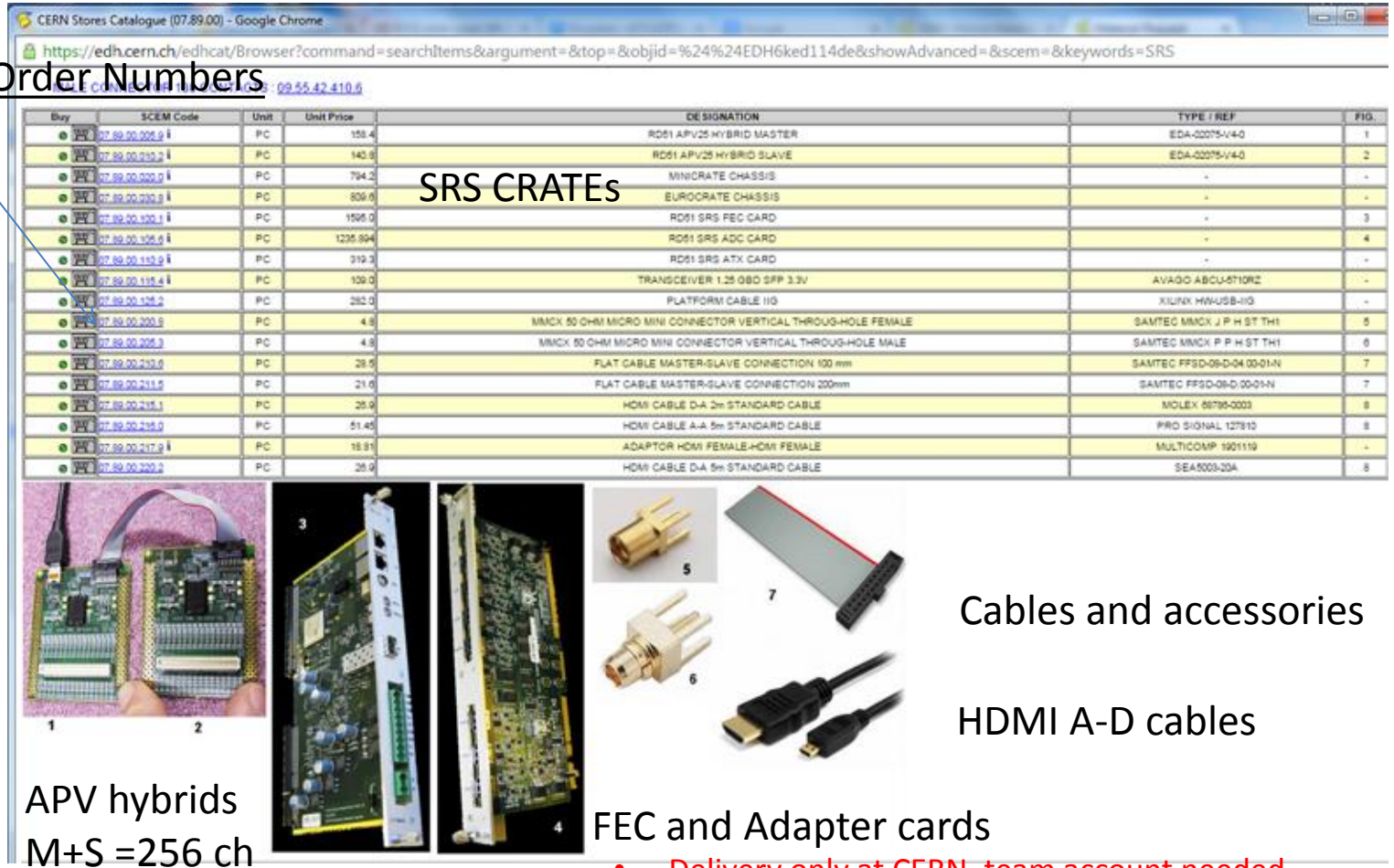


2014 SRS classic availability* at CERN

CERN store: edh.cern.ch ->stores icon -> Keyword: SRS

SCEM Order Numbers

SRS CRATEs



APV hybrids
M+S =256 ch

Cables and accessories

HDMI A-D cables

FEC and Adapter cards

- Delivery only at CERN, team account needed
- restricted access to APV hybrids (country dependent)

SRS-Classic: FEC and Adapter cards

FEC-V3
Virtex5

CERN store 2010-14

FEC-V6
Virtex6
(in production)

New: CERN store 2015+

ADC adapter
(16 x 12 bit ADC)
For analogue ASICs
lke APV

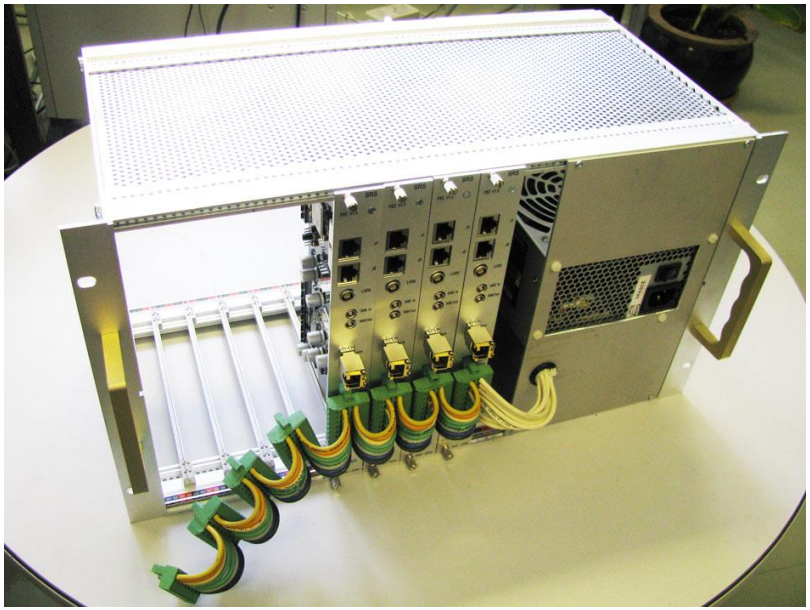
CERN store 2010-15

Digital adapter
(16 digital channels)
for digital ASICs
like VMM

New: CERN store 2015

SRS Classic crates

Minicrate AB, max 2 FEC



Eurocrate 4 or 8 FECs

Note: both crates must NOT be operated in magnetic fields
Revised versions with B-field immune bucks planned for 2015

Scalable Readout Unit (SRU)

SRU is more than an Ethernet switch:
-Low latency clock distribution (default TTC)
-slow controls fanout from Online PC
-NIM/LVDS interface for trigger, clock and Busy

Features:
Rack-mountable
24 x switch for SRS FECs
24 x DTCC (Data, trigger Clock Control)
FPGA based (Virtex-6)
10 GBE Ethernet to DATE/Online
2 GB optional Data buffer
1 TTCrx input for LHC clock and Trigger
4 NIM in / 4 NIM out
4 dfferential LVDS in/out
3 SFP ports 3Gbps
DC power from SRS-Crate
ALU chassis for use in magnetic field

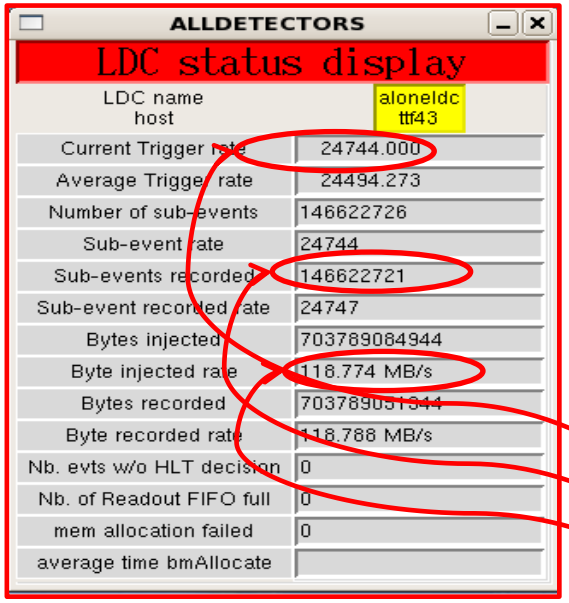
More than 60 SRU's built

Online / offline software*

DATE / SRS-amore

DATE Online system
More on DATE installation and use:

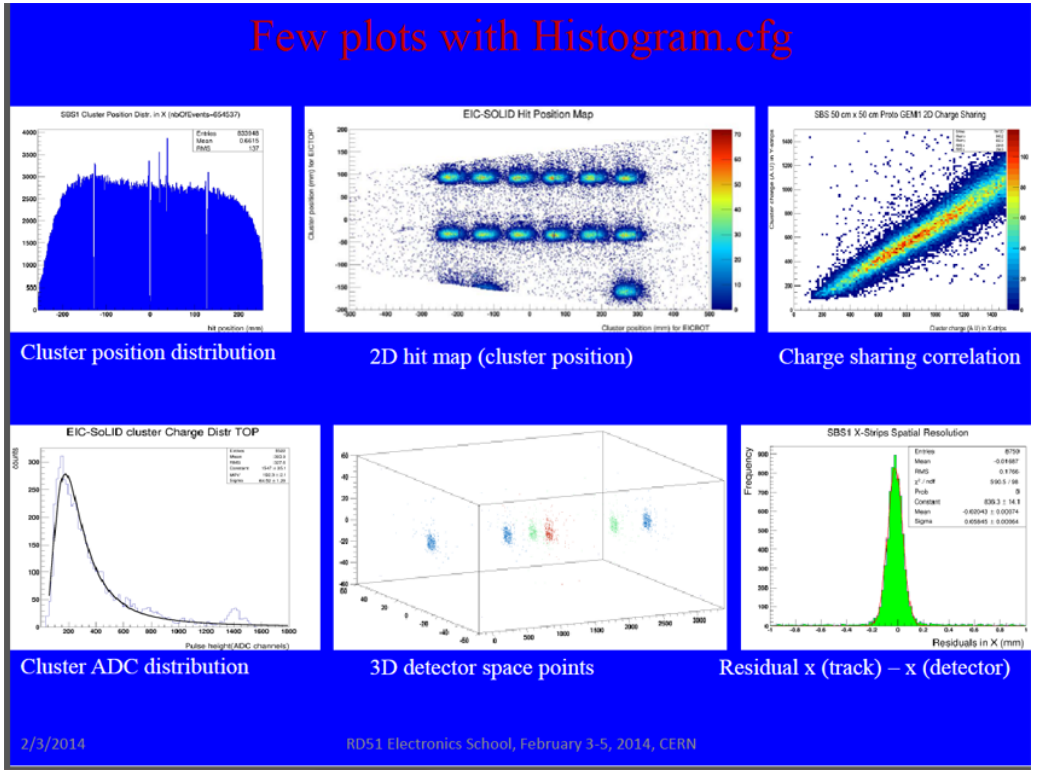
"Totem Readout using the SRS"
Adrian Fiergolski, Michele Quinto
RD51 E-School, 3rd of February 2014



- Trigger rate at flat top ~25kHz**
- Readout bandwidth close to the link limit 118MB/s
- System stability over more than 140M events
- None of the event has been lost

**this is an order of magnitude faster than the previous VME based system

More on Offline Analysis via SRSamore:
Monitoring APV25-SRS Electronics with amoreSRS *RD51 Electronics School, Feb 3-5, 2014*
Kondo Gnanvo

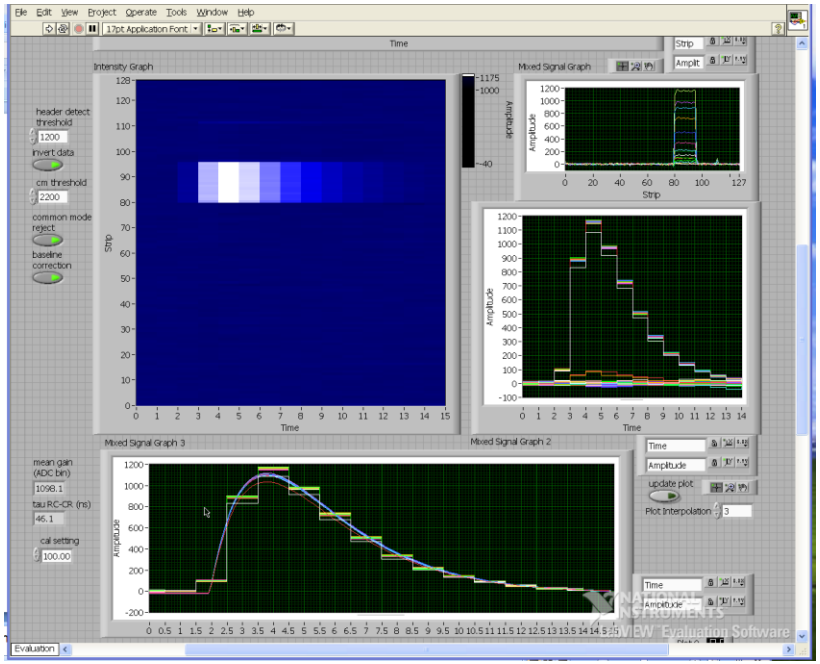


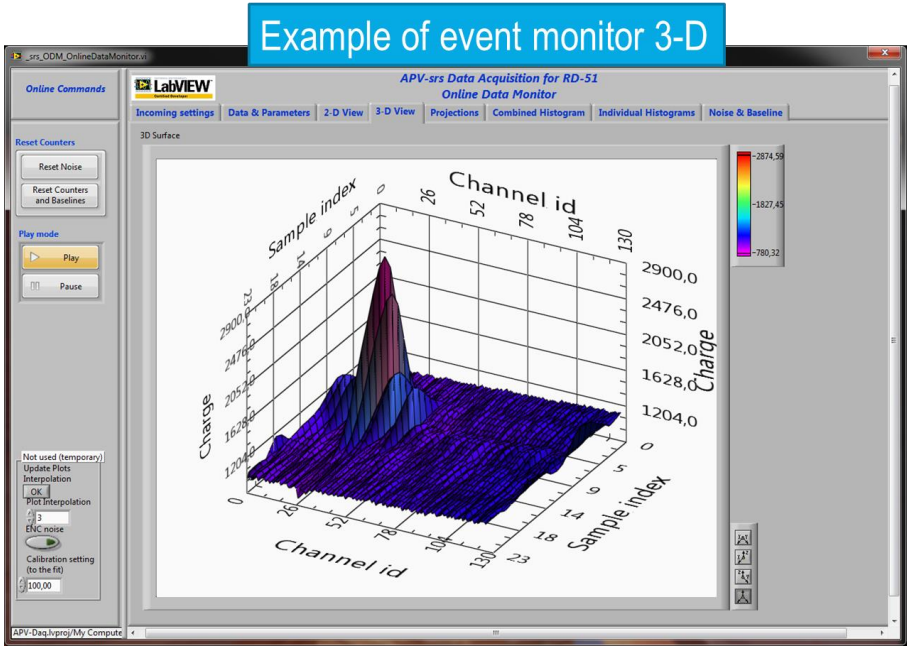
- The use of DATE by RD51 members is based on a Memorandum between ALICE DAQ team and RD51
DATE users are deemed to know and obey the content of this Memo

Labview SRS*
for small system tests

More on AVP readout via Labview DAQ
"detector signal readout with APV and SRS"
Electronics School, Feb 3-5, 2014
Sorin Martoiu

More on
LabVIEW-Based SRS Data Acquisition System
Riccardo de Asmundis
Electronics School, Feb 3-5, 2014





*RD51 electronics school 2014 http://indico.cern.ch/event/283113/

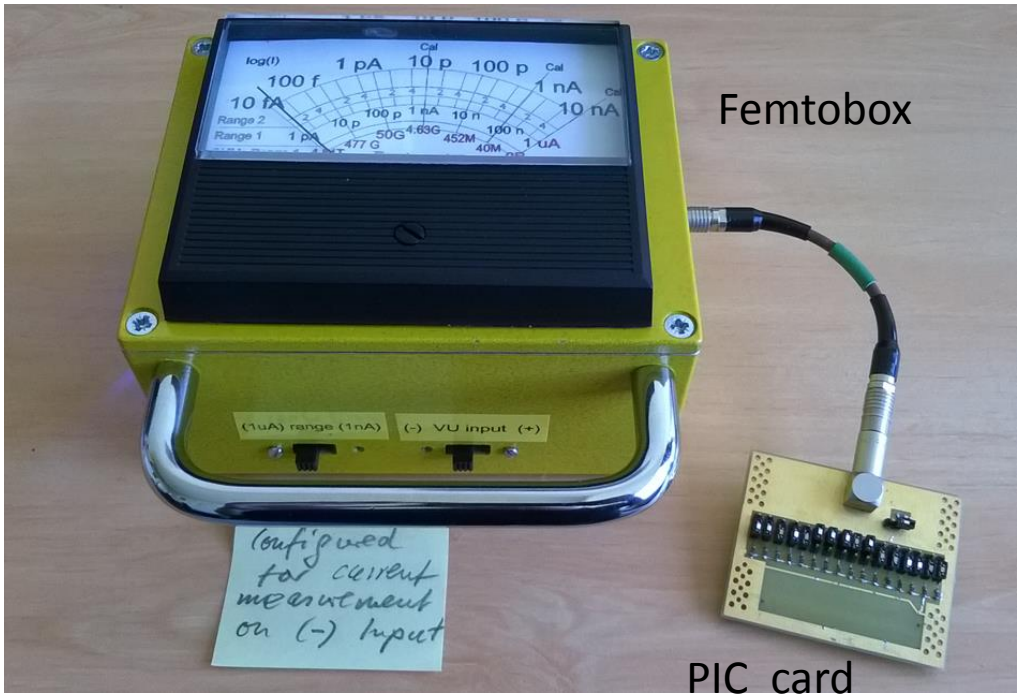
SRS laboratory peripherals

Utility devices like:

-monitoring of current, voltage, temperature , humidity, pressure
-signal pickup / trigger adapters /NIM logic
-HV generator / regulator
-Picopulser etc

Some of these work stand alone, others can be read out and controlled via remote I2C cables to SRS

Femtometer 1.2*



Femtobox

PIC card
for MPGDs

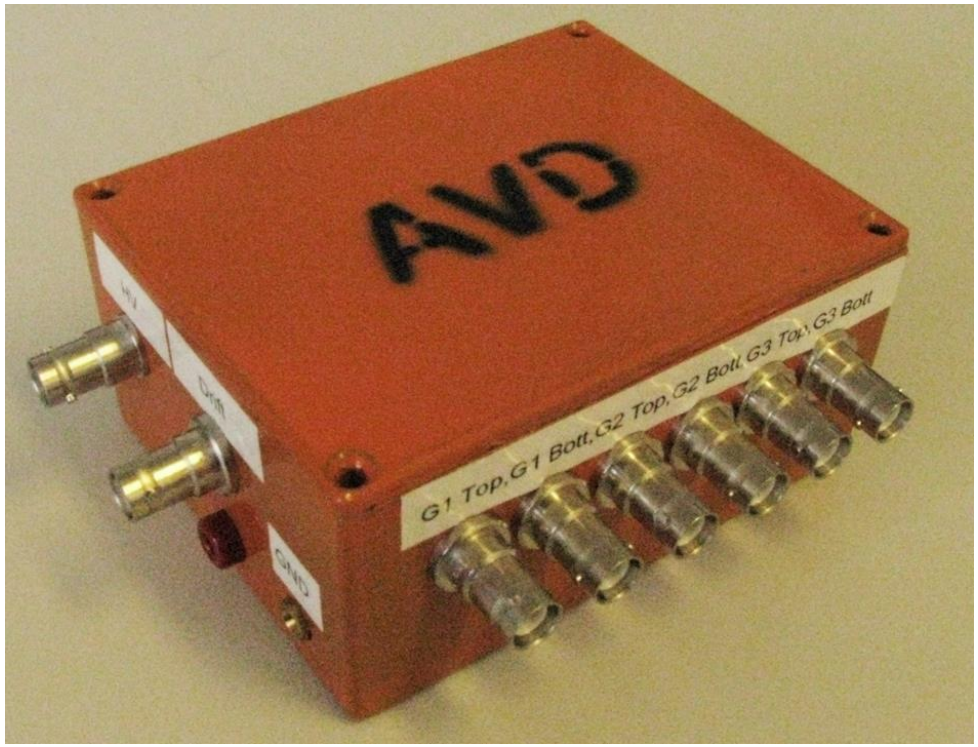
Main features

10fA – 1uA in 2 ranges
Battery powered
Moving coil or analogue output
overload protected
Internal calibration sources
(-) and (+) inputs
GigaOHM meter scale
Configurable also as CSA, electrometer and TIA

3 Femtos built so far
2015 revision to include SRS interface

*user manual: https://dl.dropboxusercontent.com/u/31352454/FEMTO%20box%20User%20manual.pdf

Active Voltage Divider for GEMs G-AVD



1 Prototybe built

Main features of prototype

"constant current" resistor divider
compensated electrode currents via active bypass
External -HV supply to deliver bypass currents
GEM fields configuarable via resistor chain as before
GEM sector short circuit safe
Prompt current monitor output
Readout via SRS cable

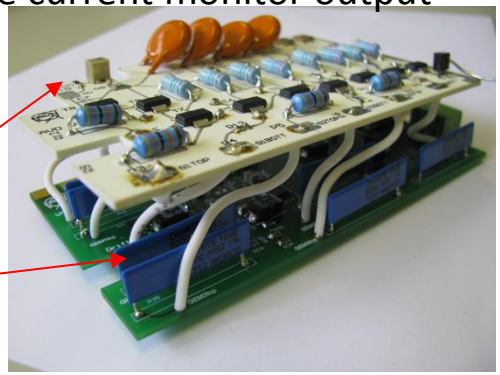
2015 Revision list :

Up to 4 GEM stack each with 4 sector outputs
up 50Watt (10 mA @ 5 kV) compensation current
GEM Voltage monitor on all top electrodes
Femto-like current monitor output " " "

Inside AVD

Top: Active Voltage Divider board

Bottom: Voltage and Current monitoring board



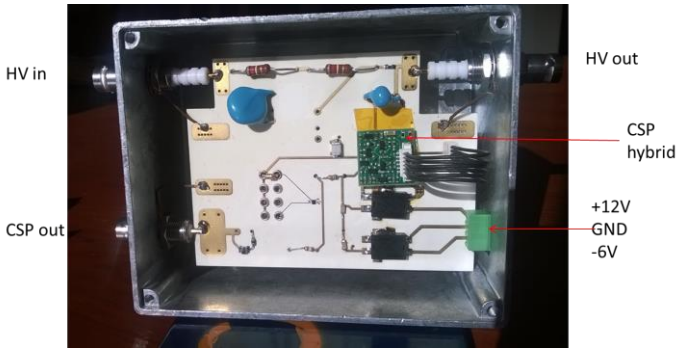
Hans.Muller@cern.ch

Trigger Pickup box (TPIC)

Feature list

pick up dQ/dt from grid or mesh
Up +/- 5 kV
amplify via a charge sensitive pream (CSP)
50 OHM Trigger/ Timing output
Overvolt / sparc protected

Inside TPIC



10 TPIC Boxes in preparation

Final commissioning going on

Some SRS based experiments

TPC readout at **NEXT**
Jose F. Toledo Alarcon, *Electronics School, Feb 3-5, 2014*

Upgrade for SBS GEM readout at **JLab**
Kondo Gnanvo
RD51 Miniweek june 2014
http://indico.cern.ch/event/323839/other-view?view=standard

ATLAS NSW MicroMega readout via SRS
Andre Zibell, *Electronics School, Feb 3-5, 2014*

Timepix readout via SRS
Michael Lupberger -> see talk today

Status of the SRS integration into the
TOTEM DAQ System
Michele Quinto et al. *RD51 Miniweek June 2014*
http://indico.cern.ch/event/323839/other-view?view=standard

Data transfer performance of SRS
(**J-PARC E16 Experiment**)
Yuhei Morino Collaboration meeting CERN Feb 2014
http://indico.cern.ch/event/283108/other-view?view=standard

Update on the **BNL SRS readout and analysis system**
M.Purschke https://indico.cern.ch/event/179611/timetable/#20121002

Plans for SRS at **ELI (Extreme Light Infrastructure)**
Sorin Maroiu Collaboration meeting CERN Feb 2014
http://indico.cern.ch/event/283108/other-view?view=standard

More ad-interim SRS users
(presentations invited)

GEMs for CMS project
T2DM2 CRNS project
…. etc

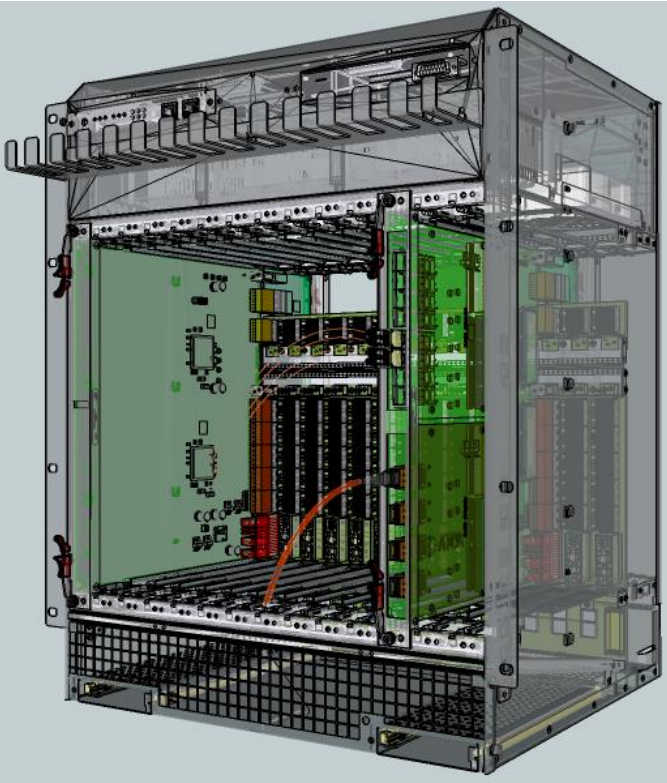
(2) Electronics for Experiments

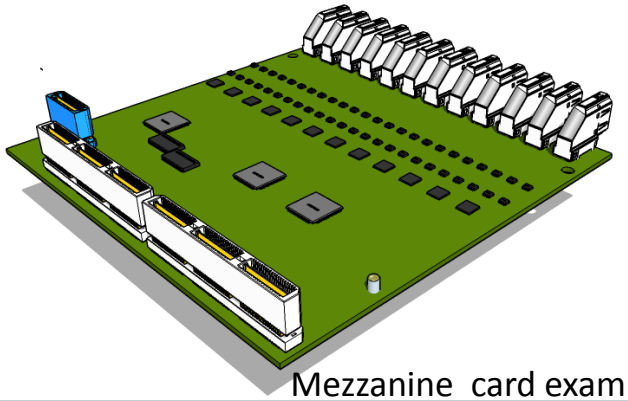
- Multichannel systems up 10^{7} ch
- Certified crate / rack standards
- Experiment-defined frontend ASICs choice
- Power from an existing DC infrastructure
- Surge, overvoltage and polarity immunity
- Electronically fused
- Operation in magnetic fields
- Radiation tolerant
- Operational in areas of limited access or partially harsh environments
- Remote reset from a safe boot device
- Data, clock and controls transmission over distance (optical fibres)
- Minimal scope of contact failures
- Full integration in standard DAQ software and offline Analysis
- Channel cost => system cost

SRS-ATCA

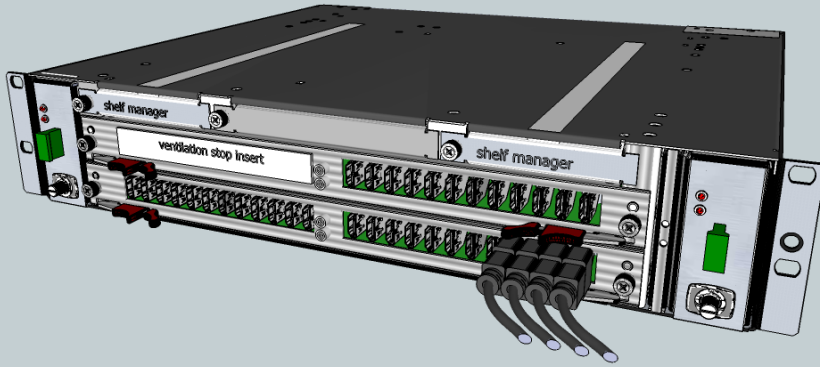
crates, blades, mezzanines and RTMs

More: see talk by Friedrich Fix Eicsys today



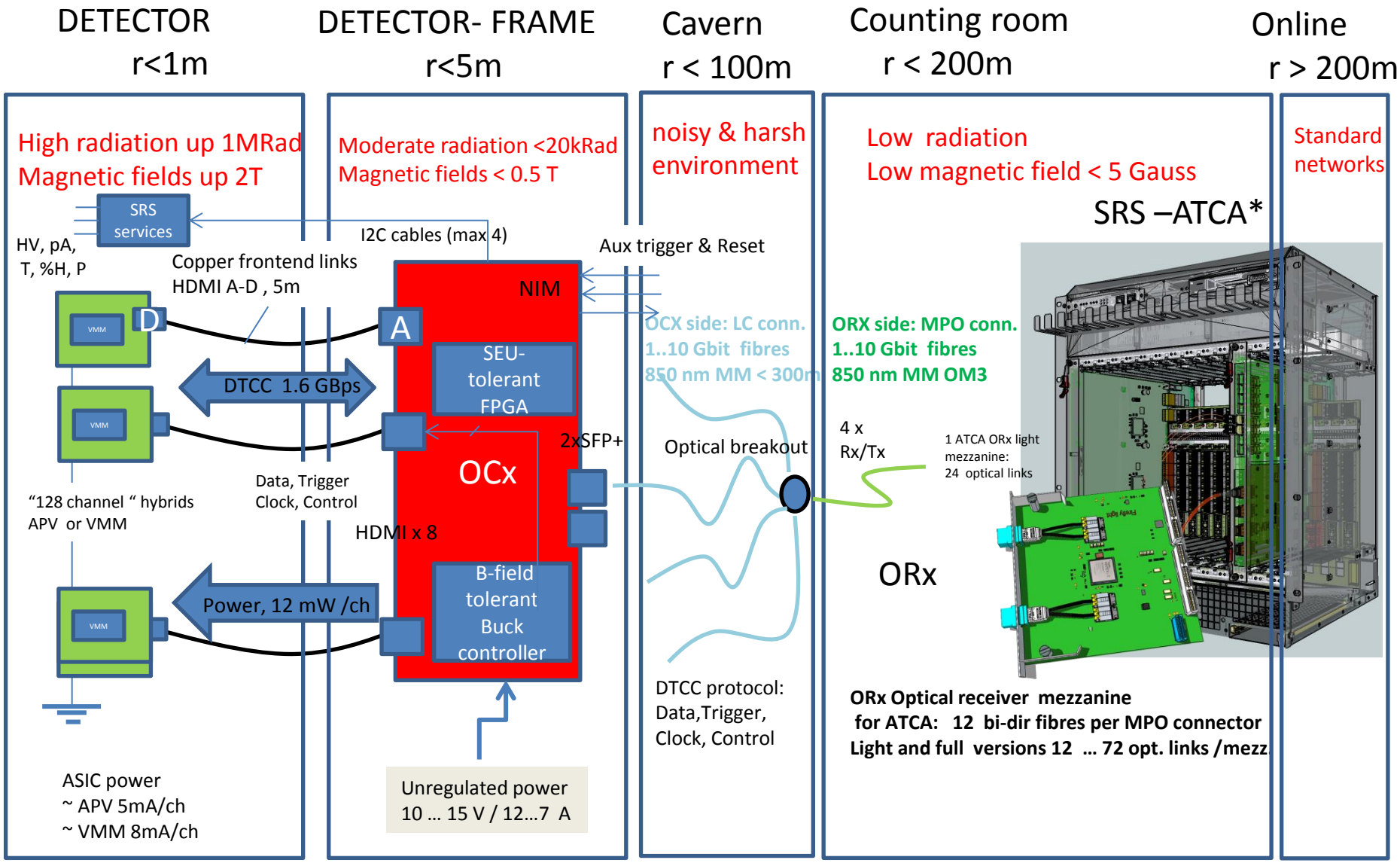


Mezzanine card example



ATCA Minicrate

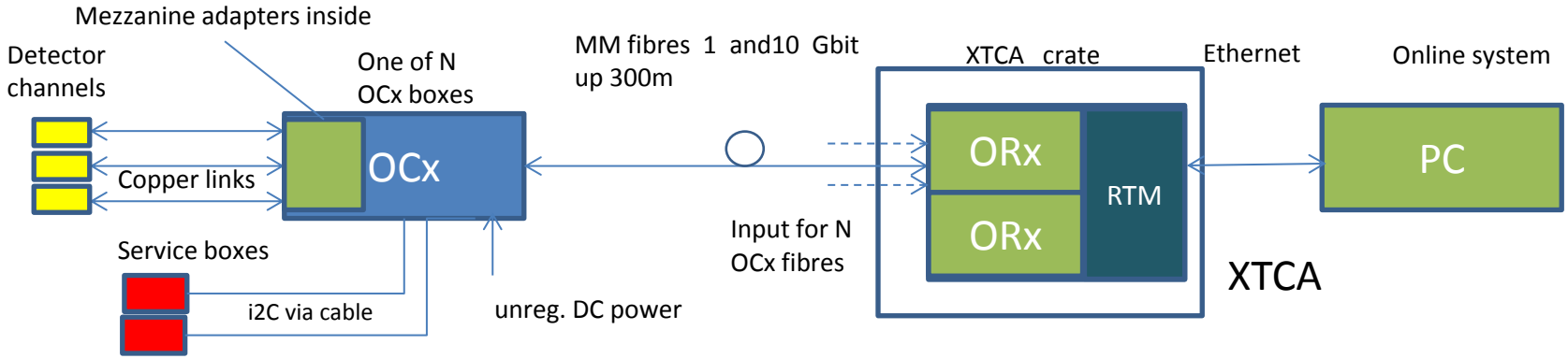
LHC experiments: from detector to counting room



Towards “Optical SRS”

OCx: **O**ptical-**C**opper Junction box for SRS frontends

ORx: **O**ptical **R**eceiver mezzanines for xTCA



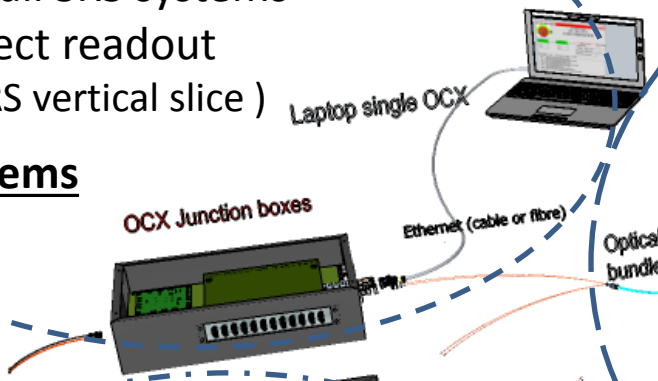
- Extension of SRS readout architecture over distance
- Readout of spatially distributed detectors
- Operation in magnetic fields
- Mezzanine adapters for OCx depending on Application (analogue, digital etc)
- Mezzanine adapters for ORx integrate fibre optics receivers
- OCx Operation close to points of high radiation (copper links to detector hybrids)
- Power via 2-wire unregulated DC 10-15 V (max 120 W)

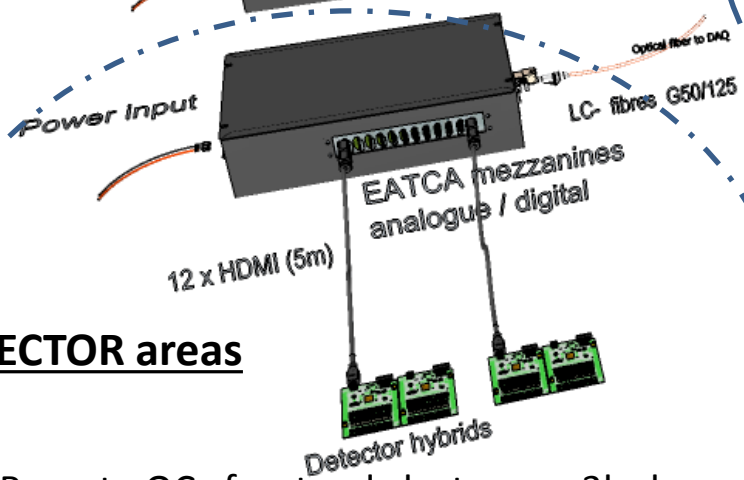
OVERVIEW

Optical SRS for distributed systems

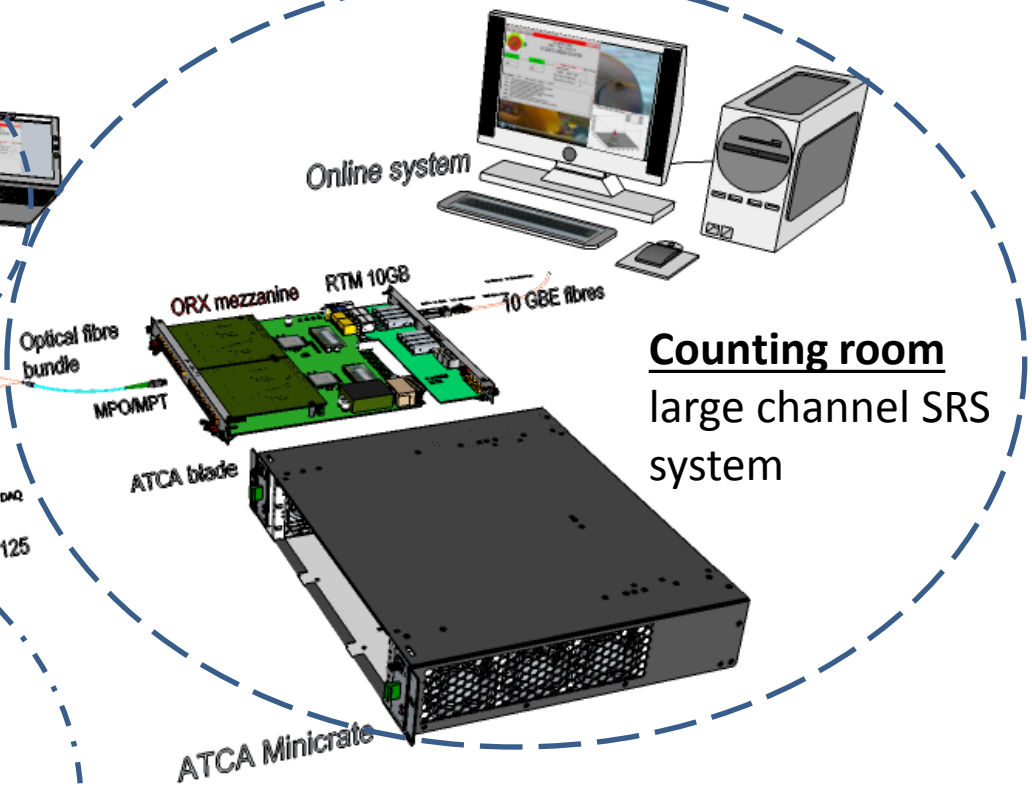
Small SRS systems
direct readout
(SRS vertical slice)

TEST systems





DETECTOR areas



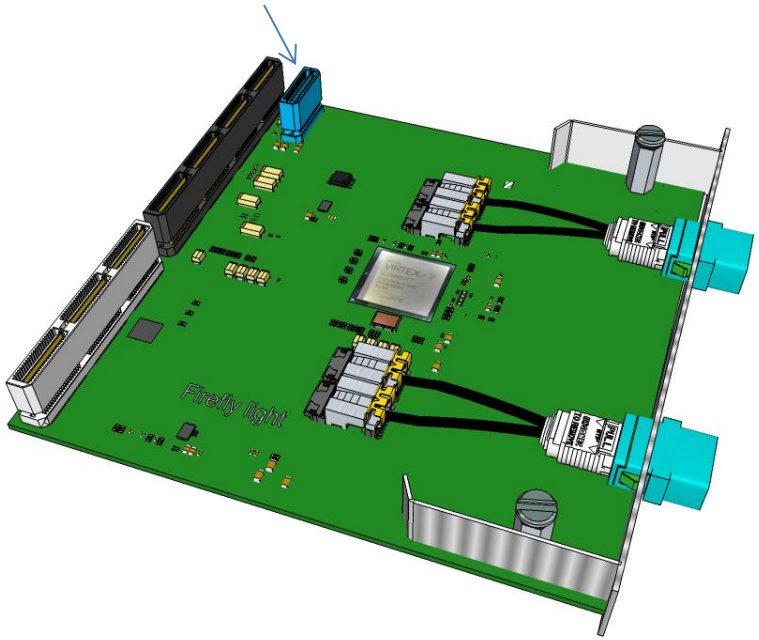
Counting room
large channel SRS system

Remote OCx frontend clusters up 3k ch
unregulated DC input power max 120W
operation in B fields
SEU auto-reboot

ORx mezzanines
ATCA Firefly **Light*** mezzanine

Note: **the Firefly connectors allow also be used for micro coax Firefly plugins**

Power connector for OCx



12 or 24 bidir. Optical links
up 3k APV channels per link

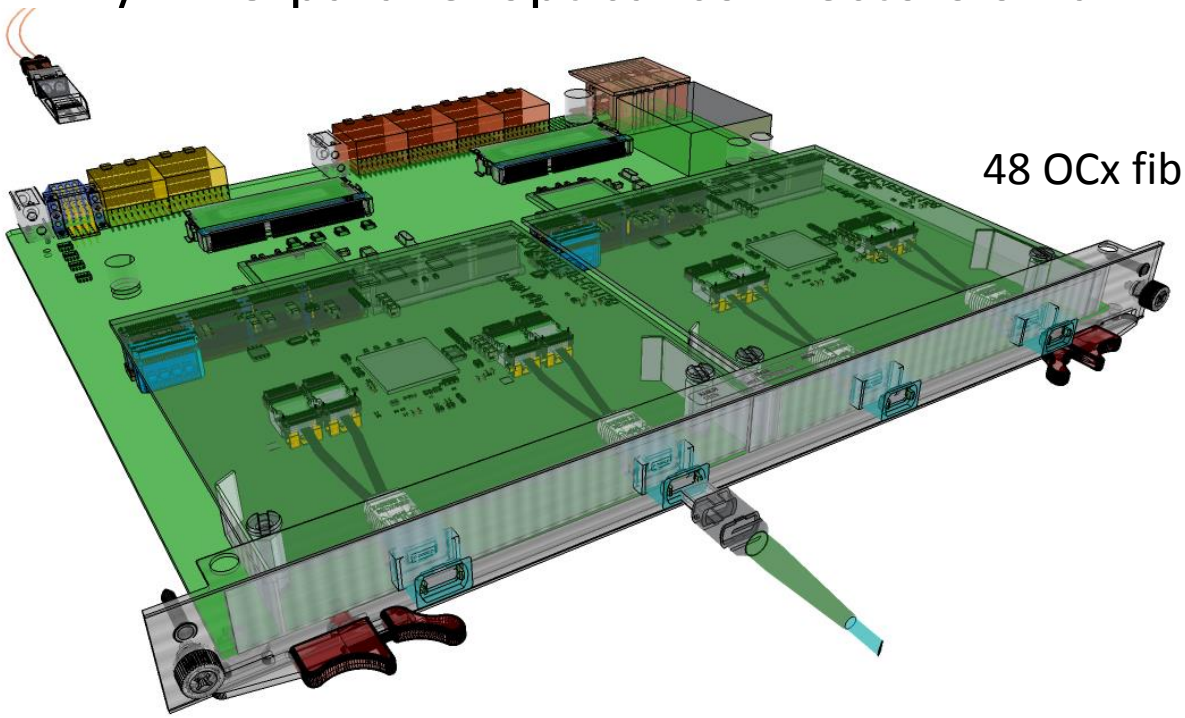
MPO / MTP on frontpanel
MM OM3 fibre
1 x FPGA

…..Looking for 2015 design resources

*High density ORx mezanine -> talk by Sorin Martoiu

Aggregation of OCx fibre links

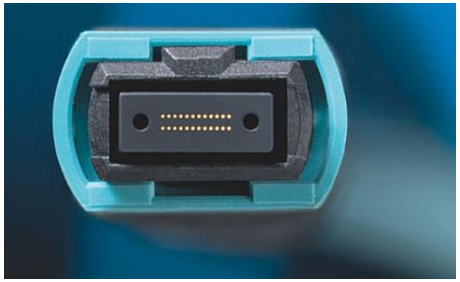
via MTP/MPO parallel optical connectors on an ATCA-ORx



48 OCx fibres per ATCA blade

ORX (FireFly) mezzanines on ATCA blade:
24 optical channels per mezzanine

up to 12 bidir optical fibres

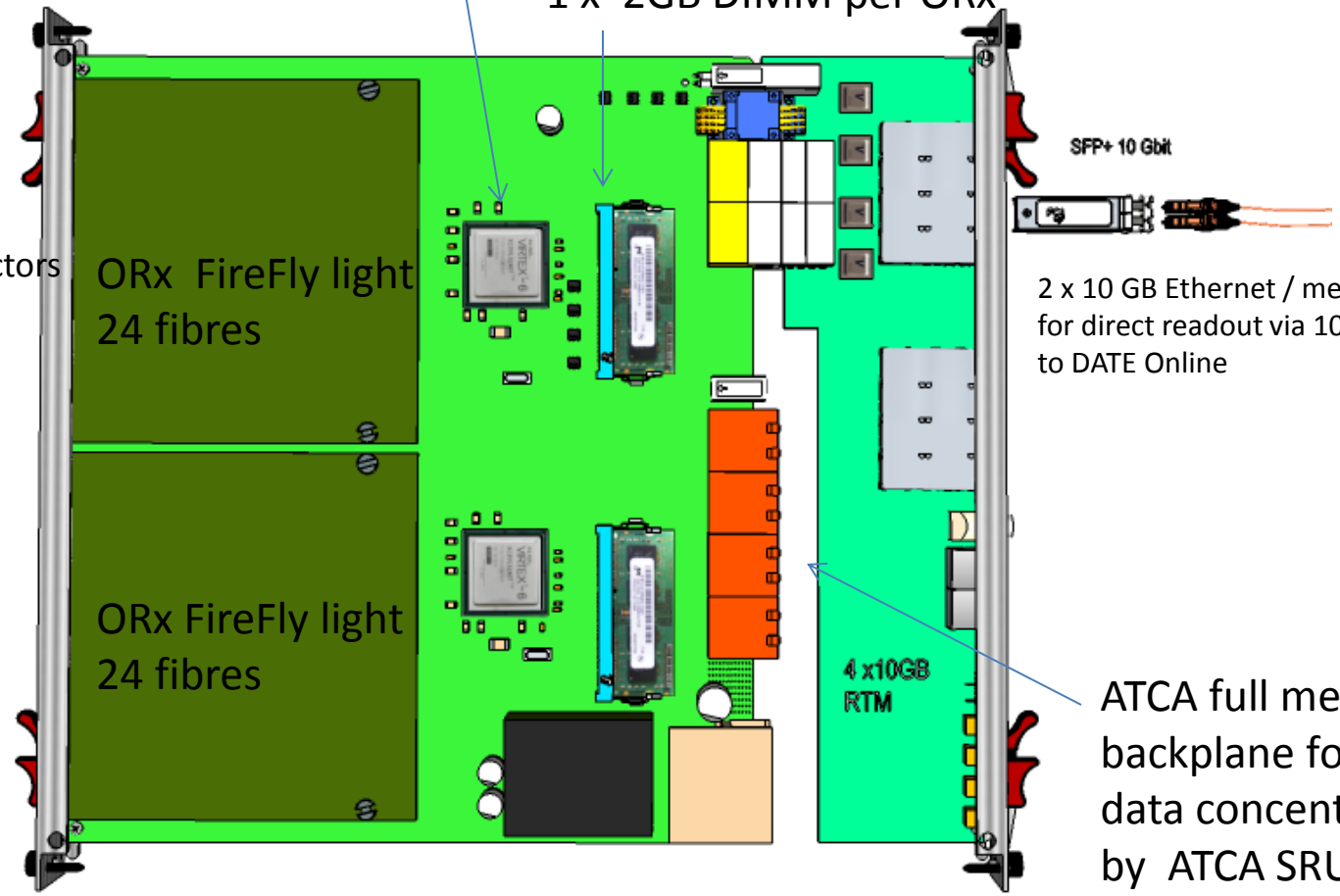


MTP is like MPO but more reliable

ATCA blade with 24 fibre concentrator*

1 Virtex 6 dedicated to 1 ORx mezzanine

1 x 2GB DIMM per ORx



12 MTP/MPO connectors per mezzanine

2 x 10 GB Ethernet / mezzanine for direct readout via 10 GBE /UDP to DATE Online

ATCA full mesh backplane for data concentration by ATCA SRU

* ~75k APV channels

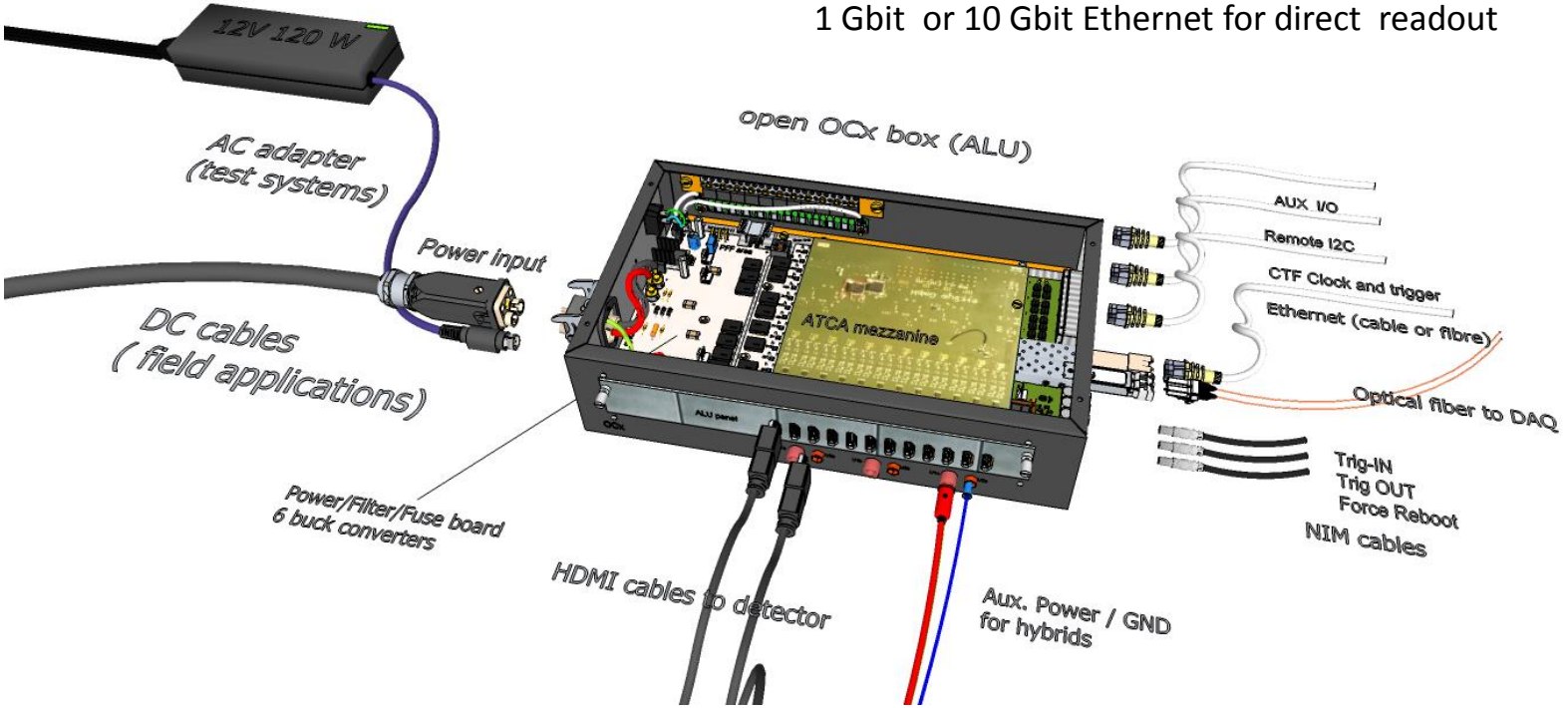
OCx: Optical-Copper Junction box

remote SRS readout and power

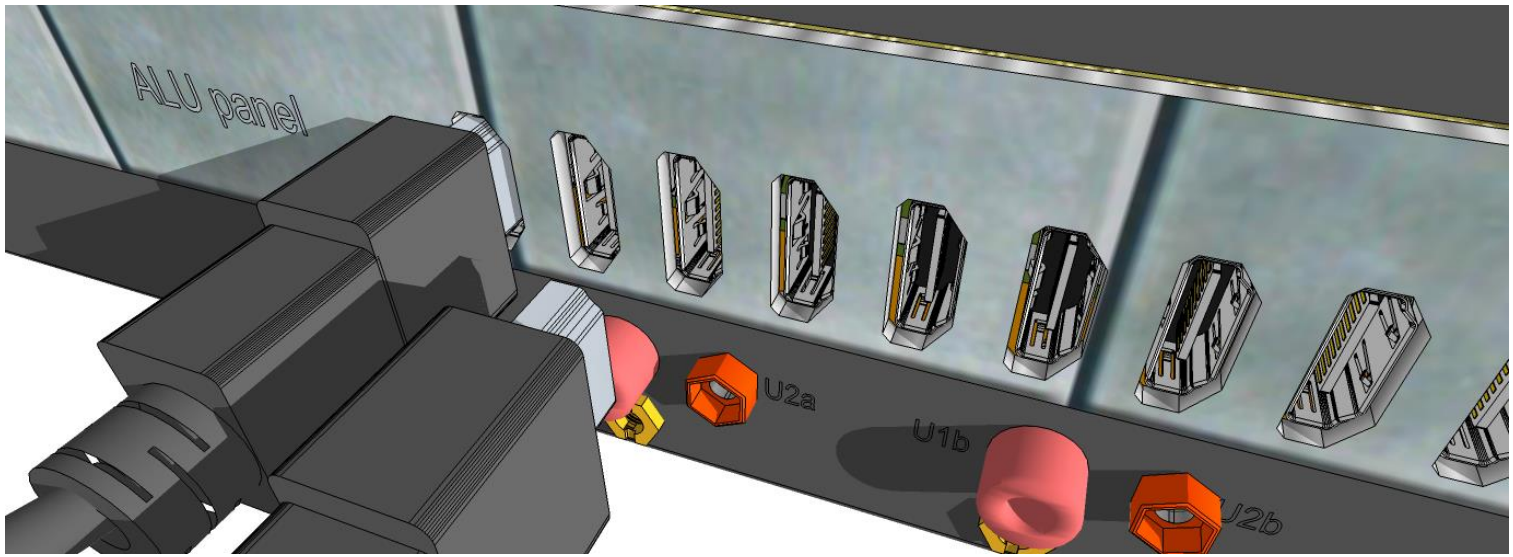
via fibre or copper

OCx be used stand –alone with
a Laptop connected via GBEthernet

OCx box works in moderate magnetic fields < 0.5 T
Powers up to 3 k channels (APV or VMM chips on detectors)
Implements safe boot from backed- up Flash
Accepts ATCA mezzanines with copper links to frontend
Accepts SRS classic mezzanines (ADC-DCARD) via adapter
Transmits and receives data via DTCC protocol
1 Gbit or 10 Gbit Ethernet for direct readout



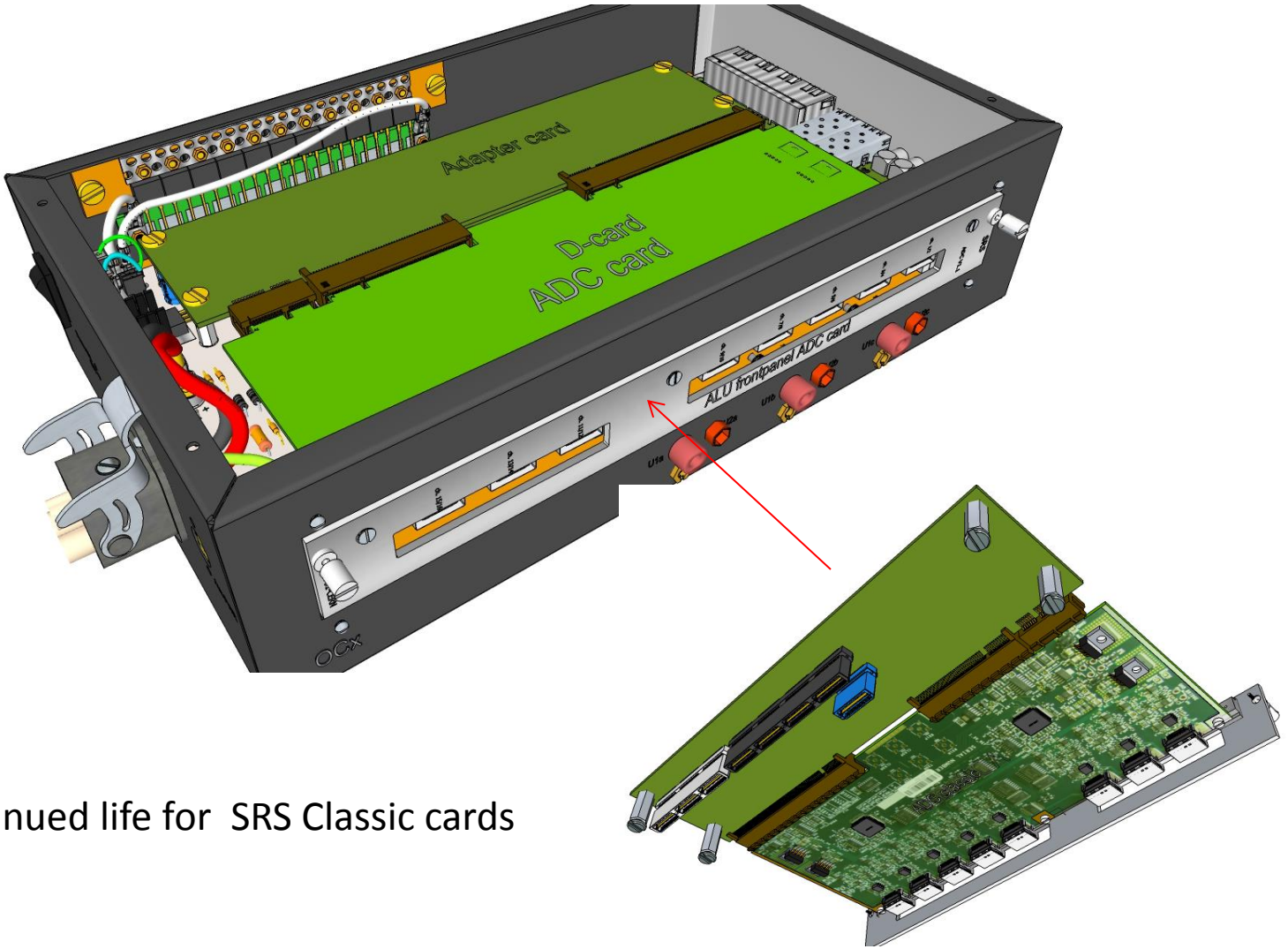
Frontside HDMI connections



HDMI plugs
-connect directly to Frontend hybrids
-power for hybrids included as before

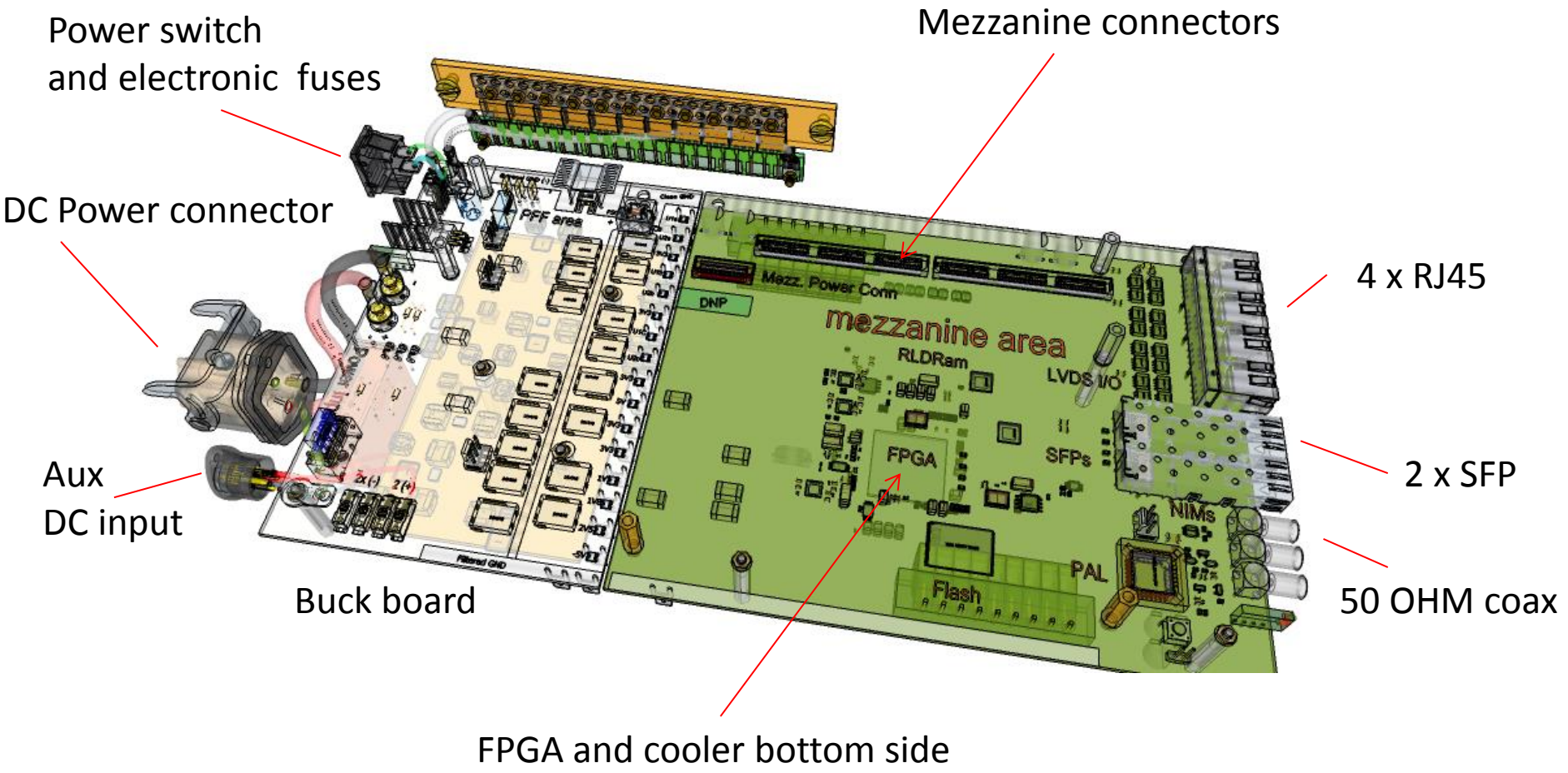
Banana plugs 3 Power Groups a,b,c
GND: cable to detector hybrids
U1: 4 mm Banana plugs, fused
U2: 2 mm Banana plugs, fused

Adapter for “Classic SRS” card

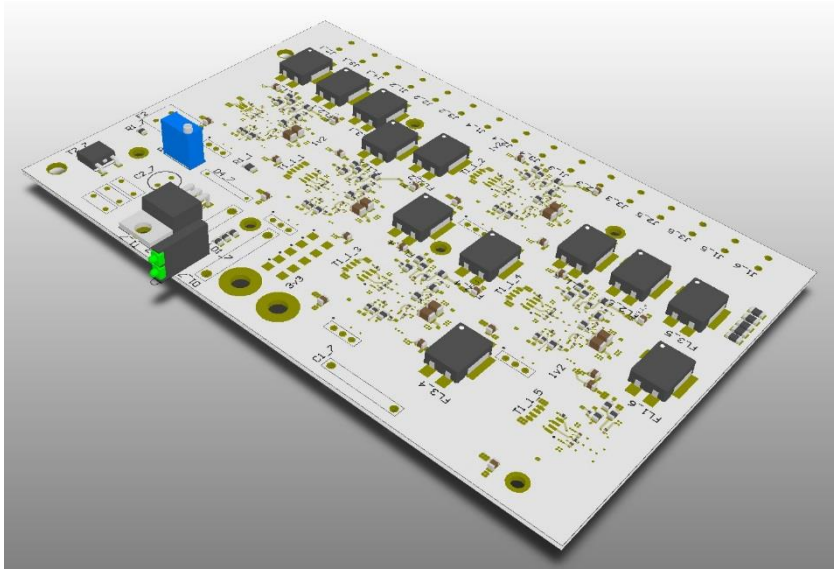


…continued life for SRS Classic cards

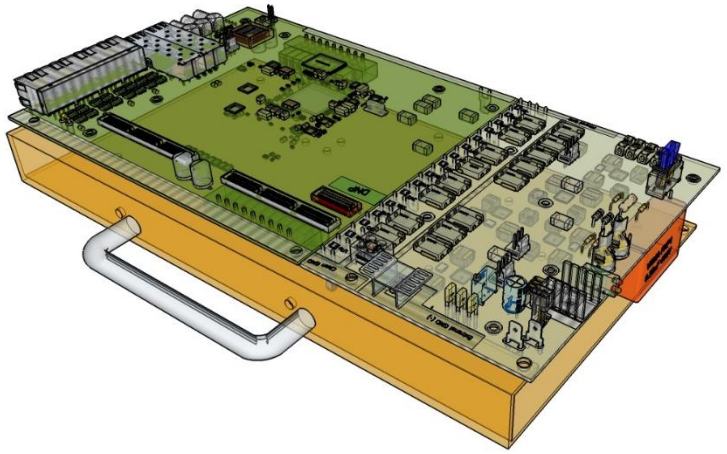
OCx internal



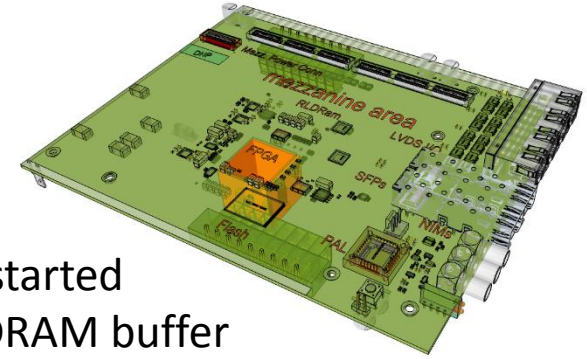
Status OCx



Hex Buck board , Altium design finalizing
(Alexandru Rusu)

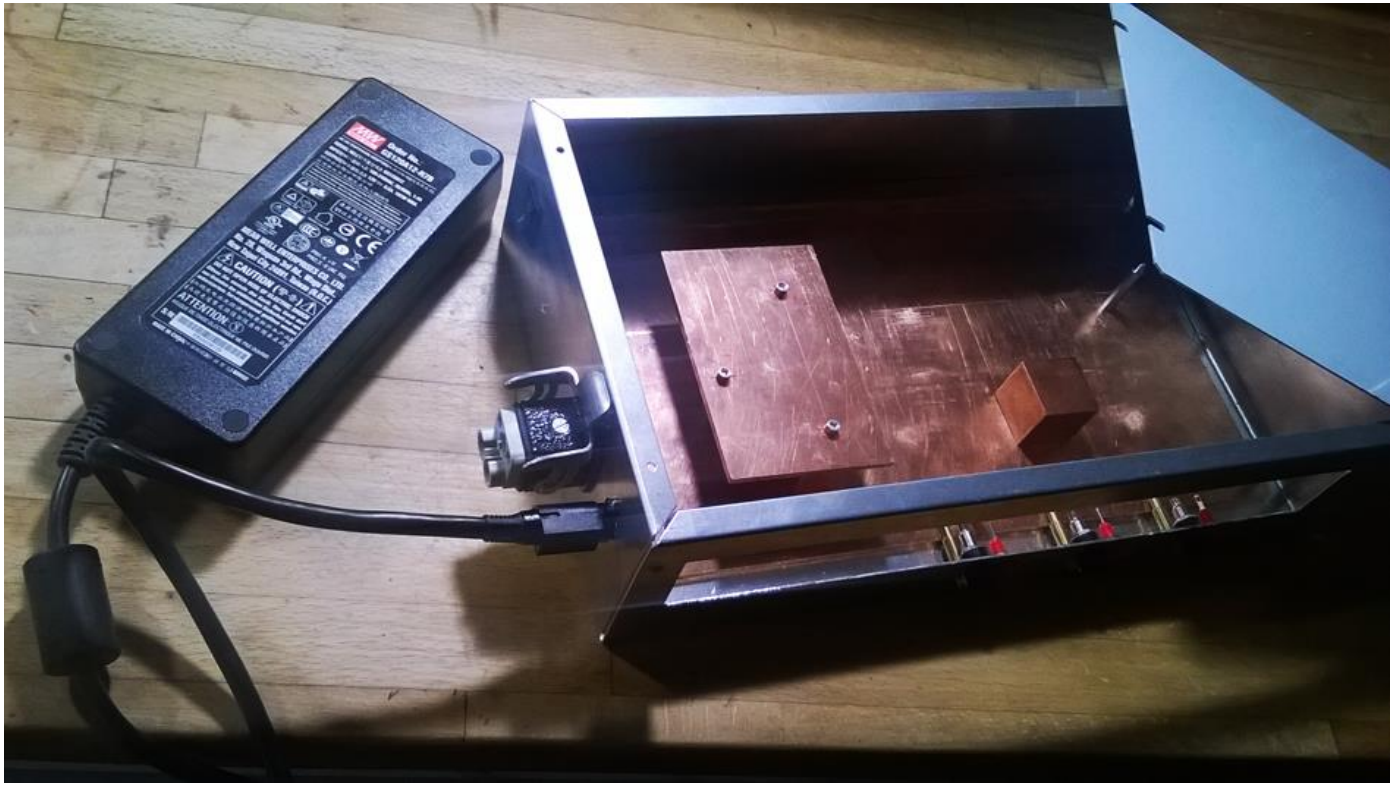


Inner Frame 3D assembly and partlist (final)
(Hans Muller)



FPGA board and thermal studies
1.) Base board 1 Gbit , schematics started
2.) High end board 10 Gbit and RLDRAM buffer
(Jose Toledo)

OCx prototyping

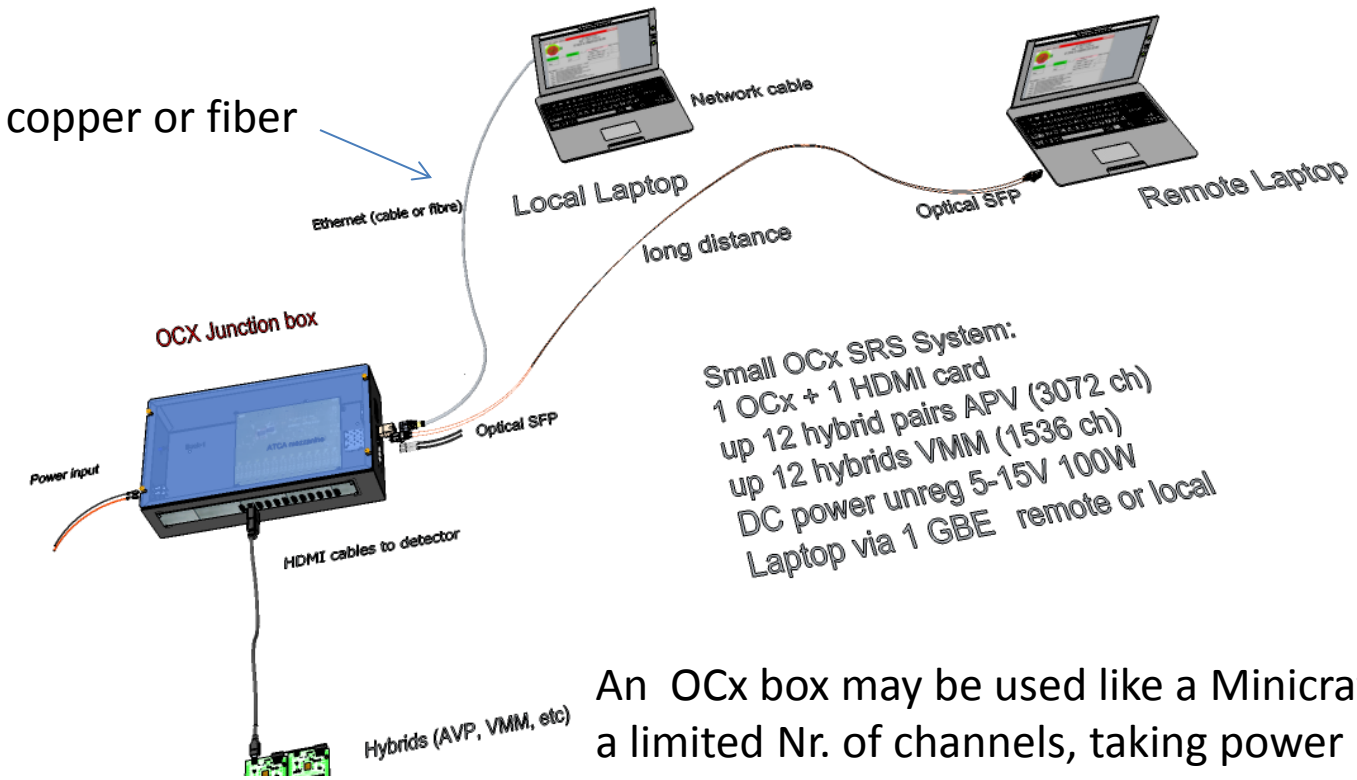


- 10 OCx box Prototypes by February
- Green light for Box cutouts and inner frame production
- Component purchase well advanced
- Buck PCB order next week
- FPGA base board tbd

(3) Electronics for Research + Industry

- Complete solutions for labs or field environments
- Standard link interfaces (SFP, RJ45)
- Plug-in adapters for analogue and / or digital frontends
- Confirmed device features for target application
- Temperature and humidity control
- Electronically fused, short circuit safe
- Clear status indicators
- Solid and portable casings
- Battery- or ACDC power packs
- Industry-standard connectors / cables
- Verified / reliable user manuals
- Stand-alone operation
- Labview-like software
- Modular Firmware cores with custom extensions

Portable stand -alone systems

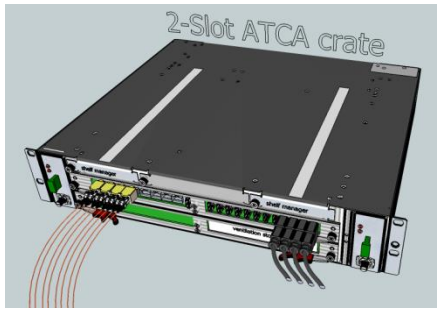


An OCx box may be used like a Minicrate for a limited Nr. of channels, taking power from an unregulated 12V DC line, and connected to a local or remote Laptop via fibre or network cable Labview or Online software

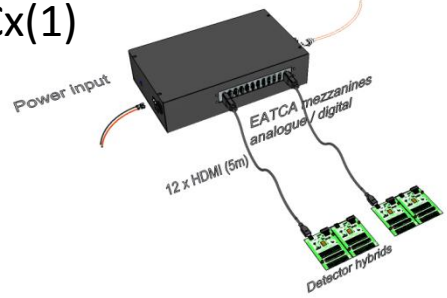
Spatially distributed detectors

Online system
for all detector channels
PC in counting house

Concentrator
crate for
optical fibres
(ATCA)



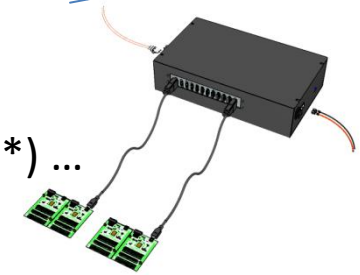
OCx(1)



n optical fibres up 300m

….distance (10 .. 200m*) …

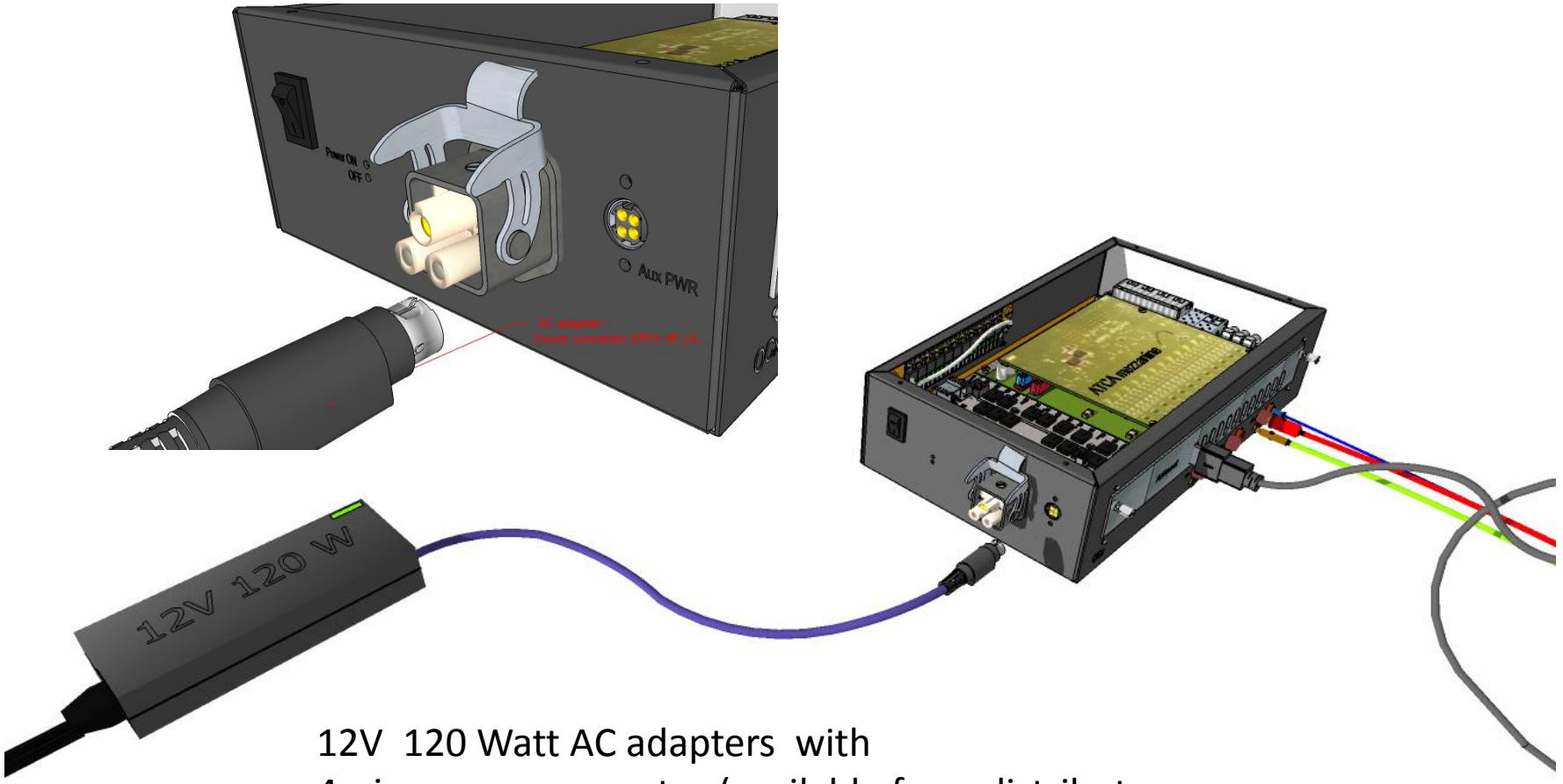
OCx(n)



up 3k frontend channels

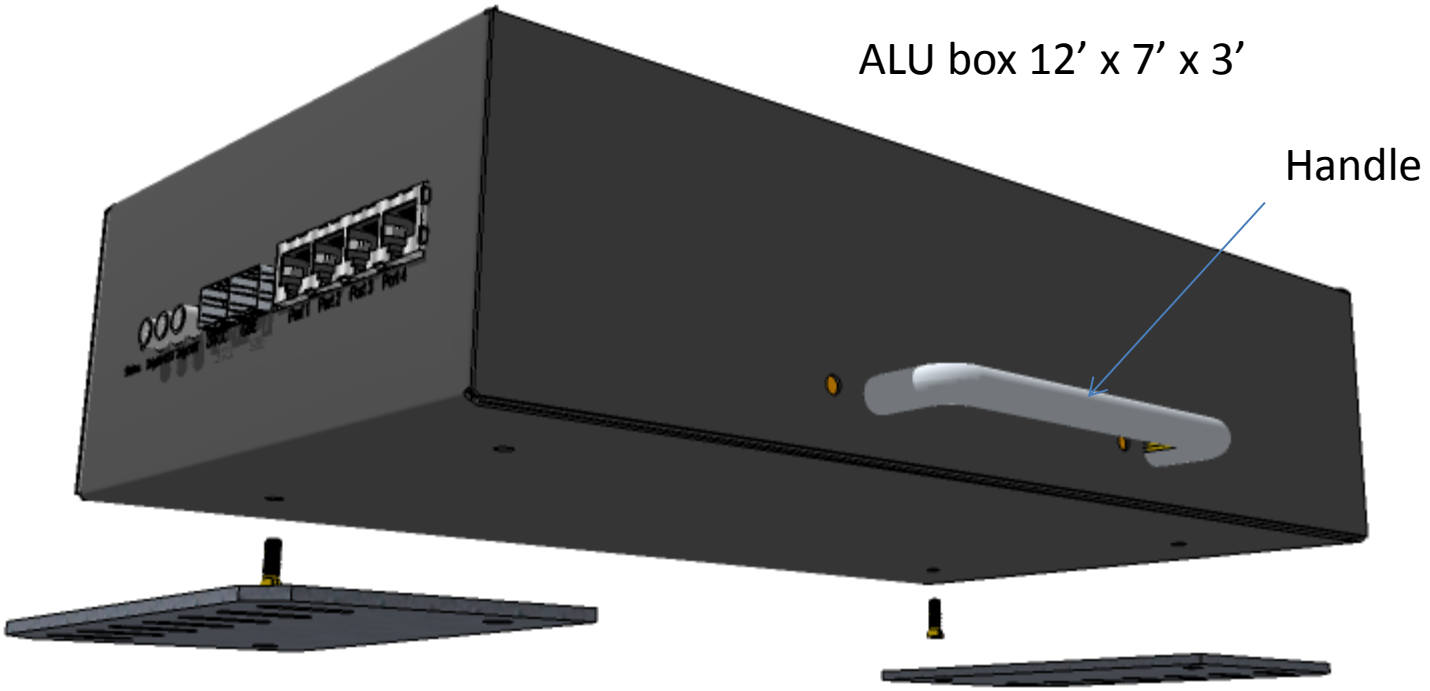
* extendible distance with optical mezzanines like Firefly

Stand alone adapter power



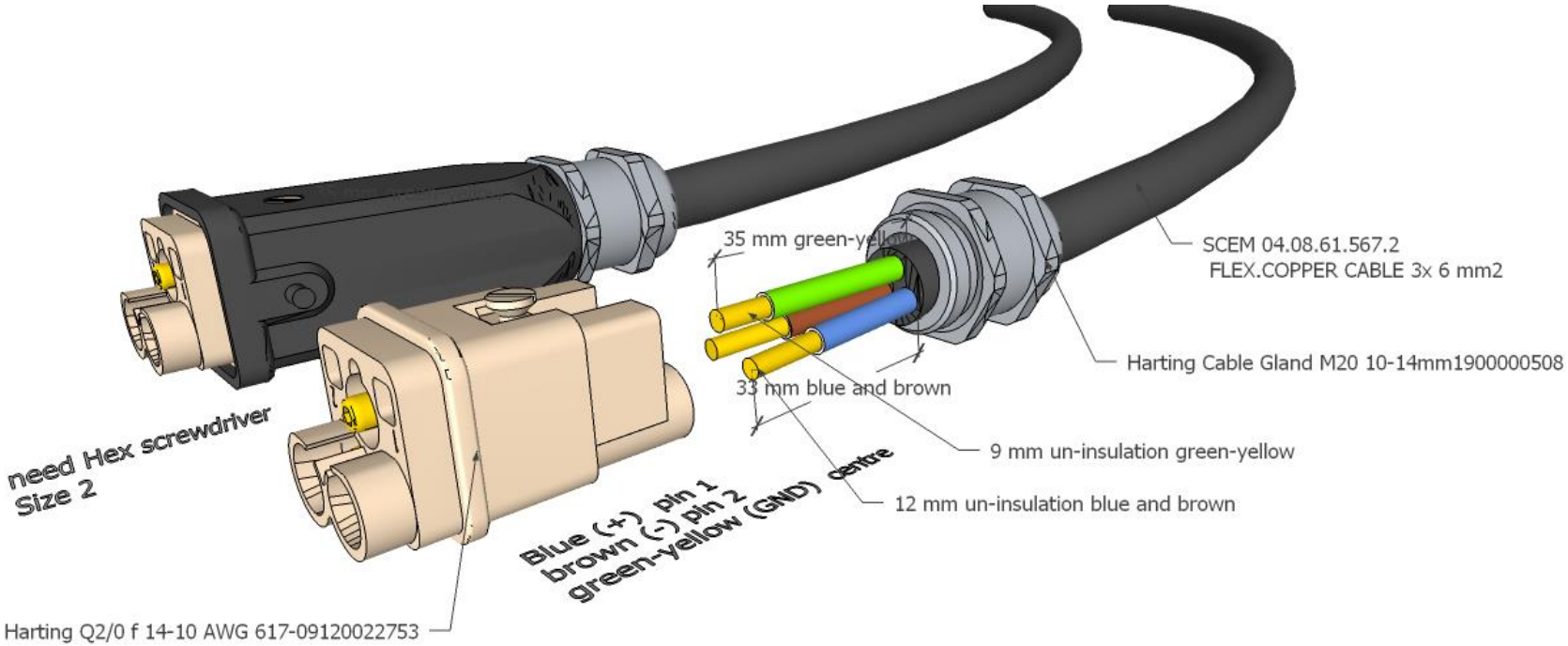
12V 120 Watt AC adapters with
4-pin power connector (available from distributors for medical applications)

Portable Box and flanch fixation



Bottom mounting flanch
M4 screws for heat extraction from inner frame

Rugged power



SRS roadmap

Upgrade path, common HW and SW

(1) SRS for R&D on detectors: 90% done

SRS classic, Femtometer, TPIC, AVD, new & faster Frontends

2009-2015

(2) SRS for Experiments: 60% done

ATCA-based SRS, SRU, new mezzanines

2014-2015

(3) SRS for Research in Industry: 25% done

spatially distributed, locally powered OCxboxes

existing and new peripherals

2015 +

Continued support by the RD51 community is needed