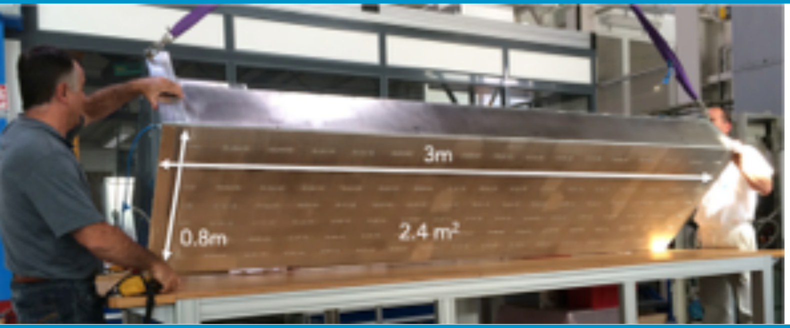
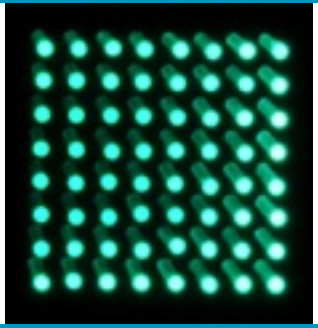
Detector Group Overview

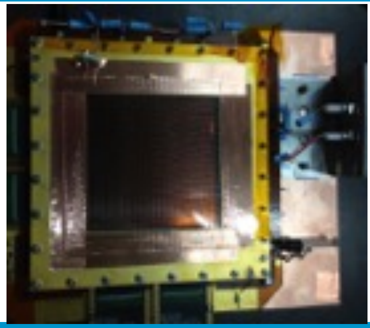
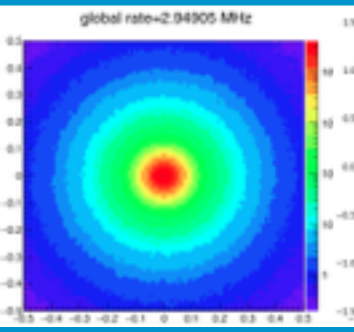
Richard Hall-Wilton
Detector Group Leader

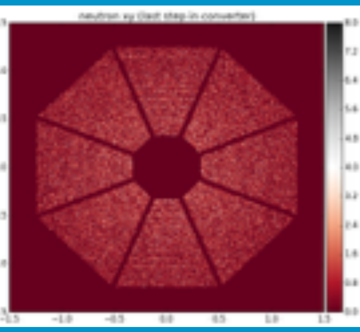
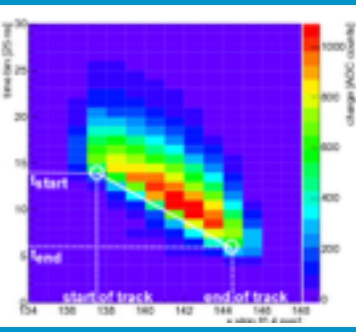
www.europeanspallationsource.se

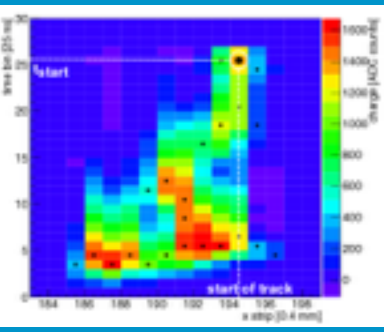
BrightnESS Task 5.1 Kickoff

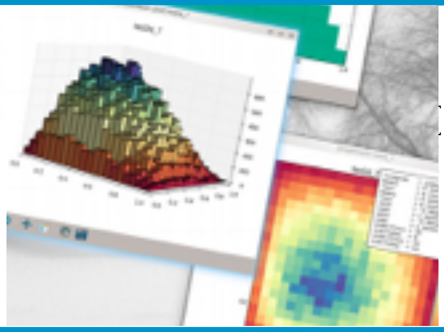
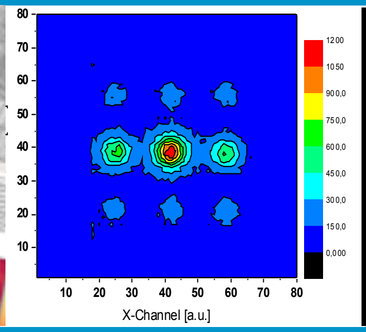


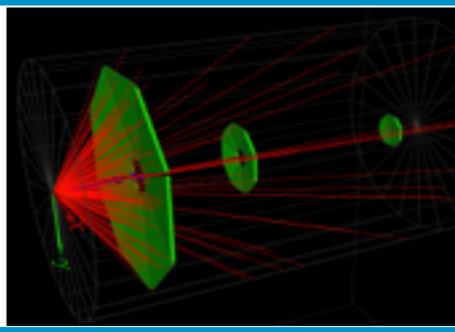


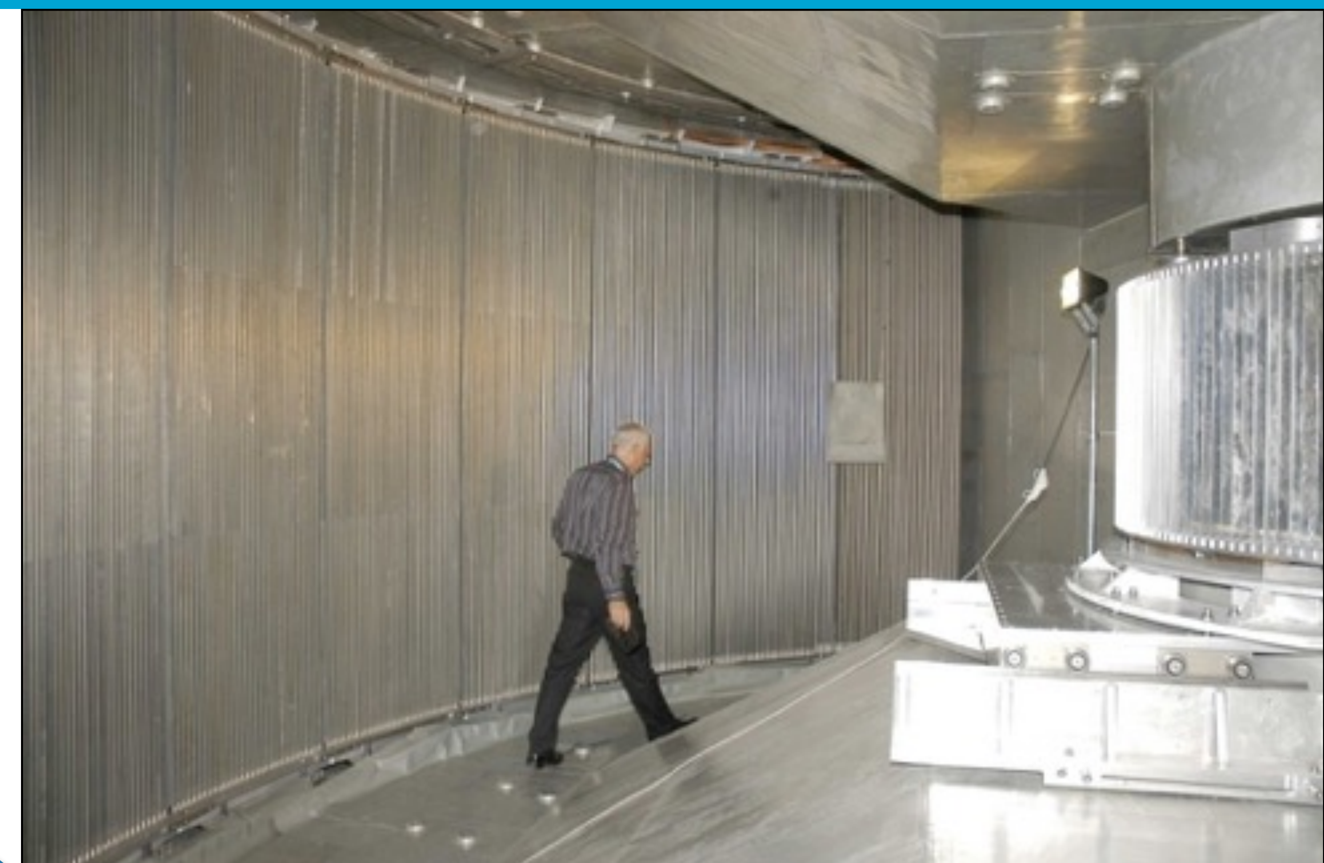


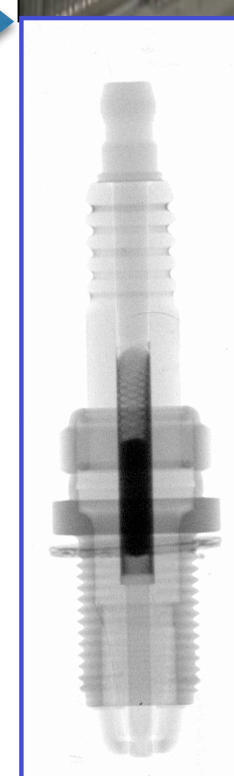



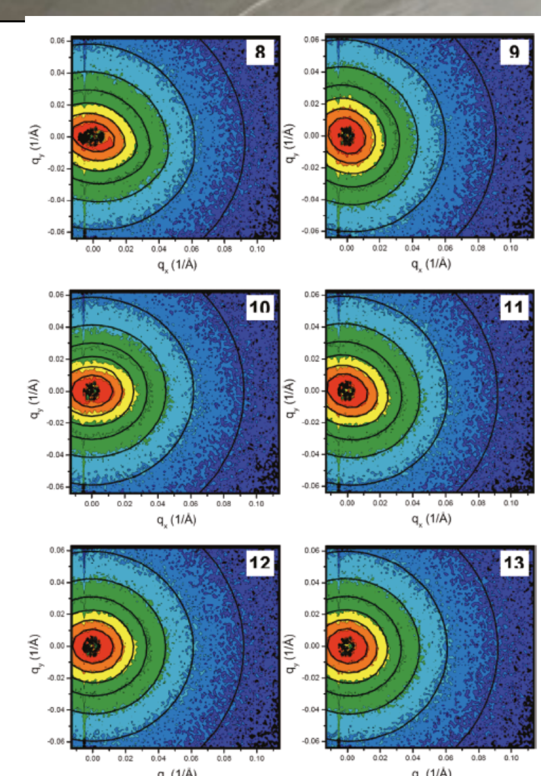


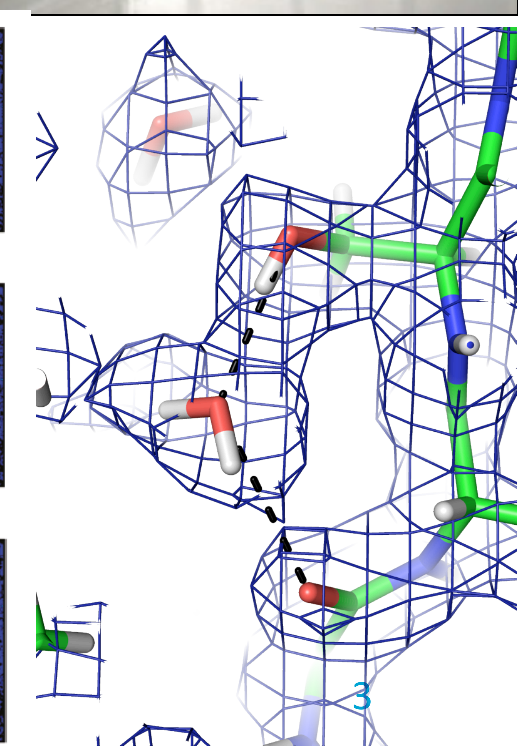
SCOPE

Detector Strategy:
how we get from here to there









Scope

- Support and facilitate partners to be able to deliver performant detectors for world class instruments
- Act as a host institute to assist and enable in-kind partners to deliver where requested
- Facilitate installation and Commission detectors
- Operate and maintain detectors throughout their lifetime

- Interface management for in-kind partners with other parts of NSS and ESS and other in-kind partners
- Integrate detectors into a homogeneous ESS instruments suite
- Where necessary, assist in the design and development of detectors with partners for partners
- A technology service group capable of long term support

What can be done with ESS brightness?

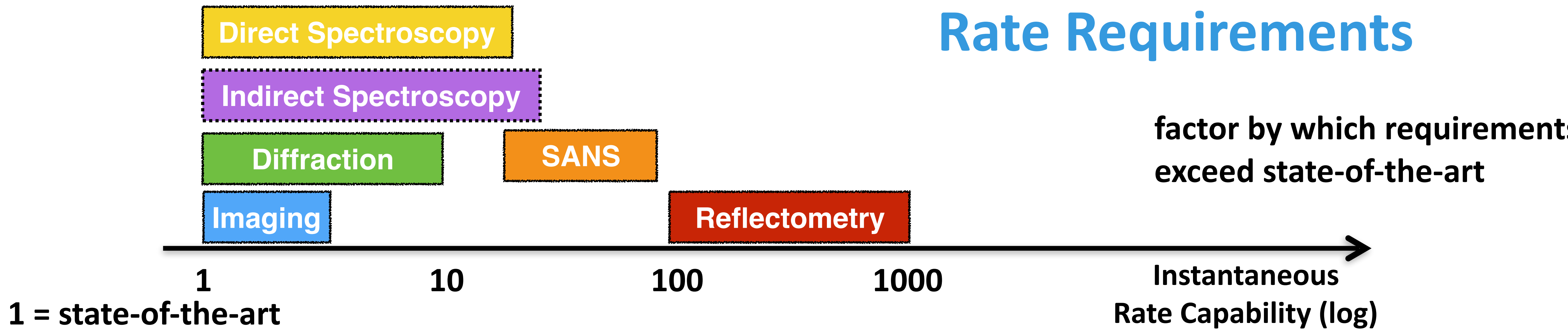
Instrument Design	Implications for Detectors
Smaller samples	Better Resolution (position and time) Channel count
Higher flux, shorter experiments	Rate capability and data volume
More detailed studies	Lower background, lower S:B Larger dynamic range
Multiple methods on 1 instrument Larger solid angle coverage	Larger area coverage Lower cost of detectors

Also: scarcity of Helium-3 …

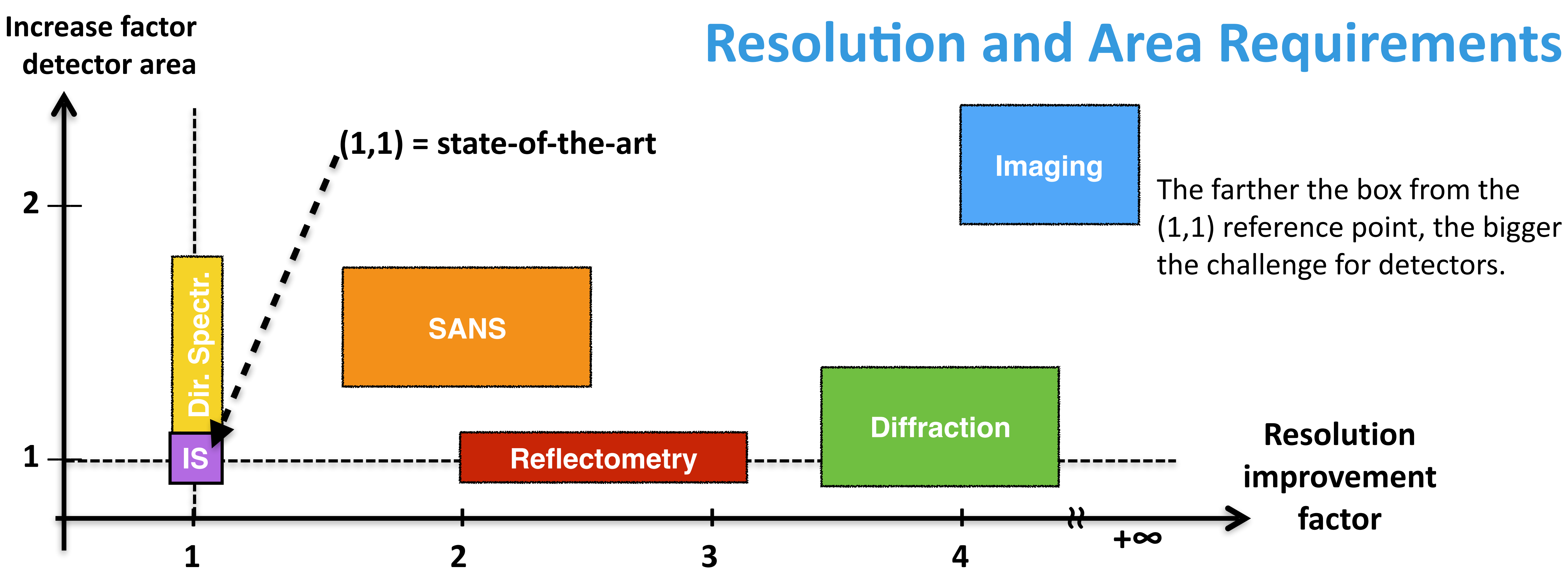
Developments required for detectors for new Instruments

Requirements Challenge for Detectors for ESS:
beyond detector present state-of-the art

Rate Requirements



Resolution and Area Requirements



STRATEGY

- Involve in-kind partners and solve problems together
- Modularisation to tackle interfaces and integration
- Instrument baselines, detector design, design teams and build teams identified
- Close working collaborative relationships to mitigate risks
- Mitigation plan identified

ESS Partners on Detectors
Solve problems together

EUROPEAN SPALLATION SOURCE

ILL NEUTRONS FOR SCIENCE

CERN

SNS SPALLATION NEUTRON SOURCE

LUNDS UNIVERSITET

LiU LINKÖPING UNIVERSITY

Science & Technology Facilities Council

BNC Budapest Neutron Centre

UNIVERSITÀ DEGLI STUDI DI MILANO BICOCCA

DTU

Mittuniversitetet MID SWEDEN UNIVERSITY

Science & Technology Facilities Council ISIS

Wigner

Consiglio Nazionale Ricerche

TUM Technische Universität München

UNIVERSITAS BERGENSIS

JÜLICH FORSCHUNGSZENTRUM

IFP

TU Delft

PAUL SCHERRER INSTITUT PSI

Helmholtz-Zentrum Geesthacht
Zentrum für Material- und Küstenforschung

UNIVERSITY OF MALTA
L-Università ta' Malta

INFN Istituto Nazionale di Fisica Nucleare

FZÚ

ESS Bilbao

IFE Institute for Energy Technology

COSYLAB

DENEX
Detektoren für Neutronen GmbH
Stöteroggestraße 71 | 21339 Lüneburg
Tel.: +49 (0) 4131/248932

ideas

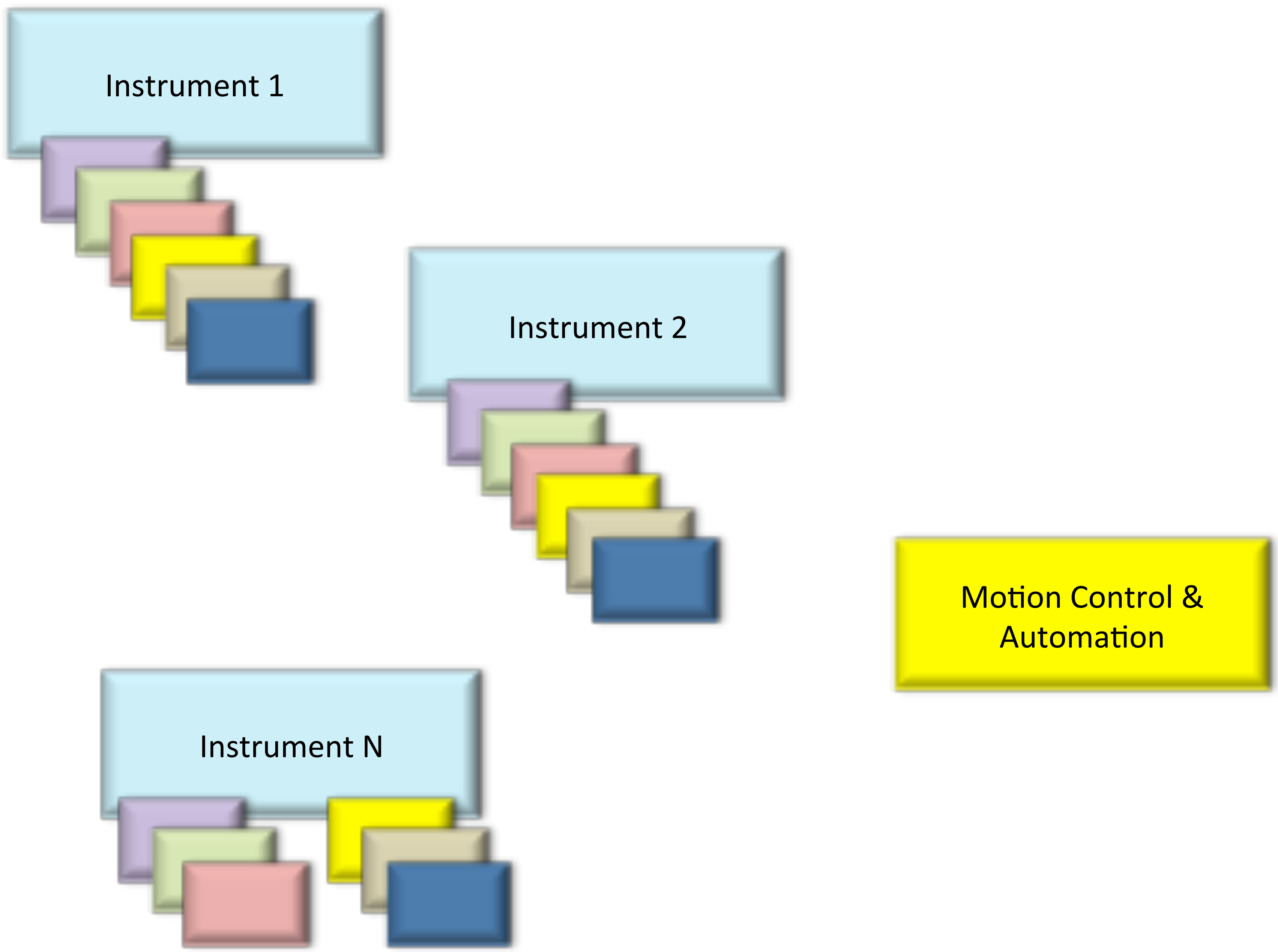
CDT GmbH
CASCADE Detector Technologies

icnd.org { ILL NEUTRONS FOR SCIENCE, ess, FRM II Forschungs-Neutronenquelle Heinz Maier-Leibnitz, HZB Helmholtz Zentrum Berlin, ISIS, J-PARC, NIST, Oak Ridge National Laboratory NEUTRON SCIENCES }

INTERNATIONAL COLLABORATION FOR THE DEVELOPMENT OF NEUTRON DETECTORS

NSS – Functional decomposition

from Oliver



Functional decomposition facilitates to identify common / similar requirements

Create centralised workpackage to avoid recurring engineering cost in individual instrument projects; minimise risk

Ensure proper integration

Provide solution to instrument projects

Schedule is the driver

Neutron Detectors

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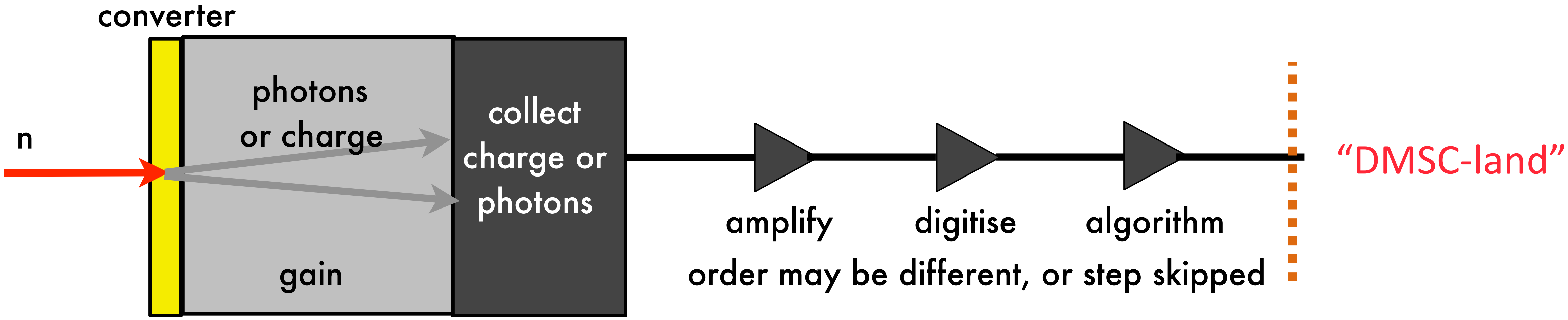
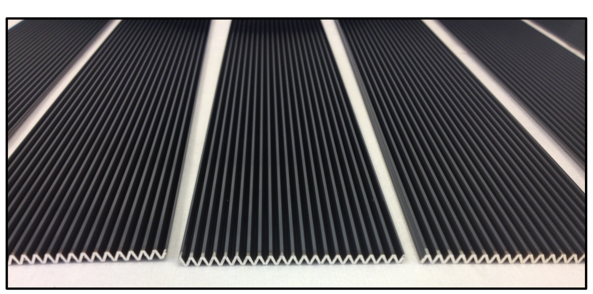
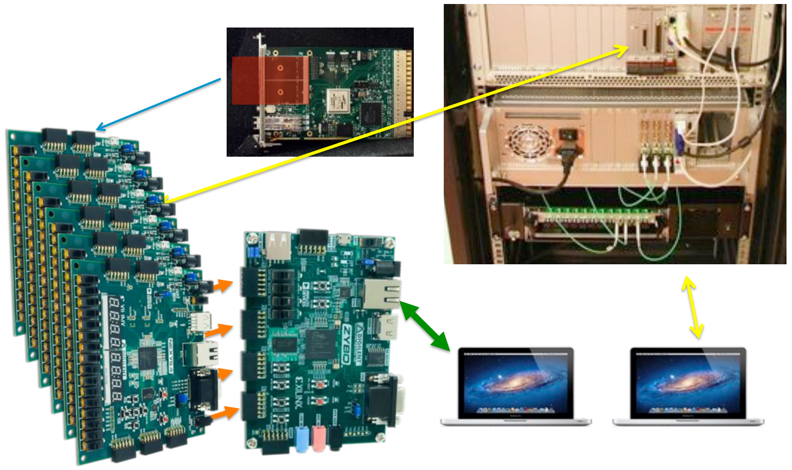
Modularisation to tackle interfaces

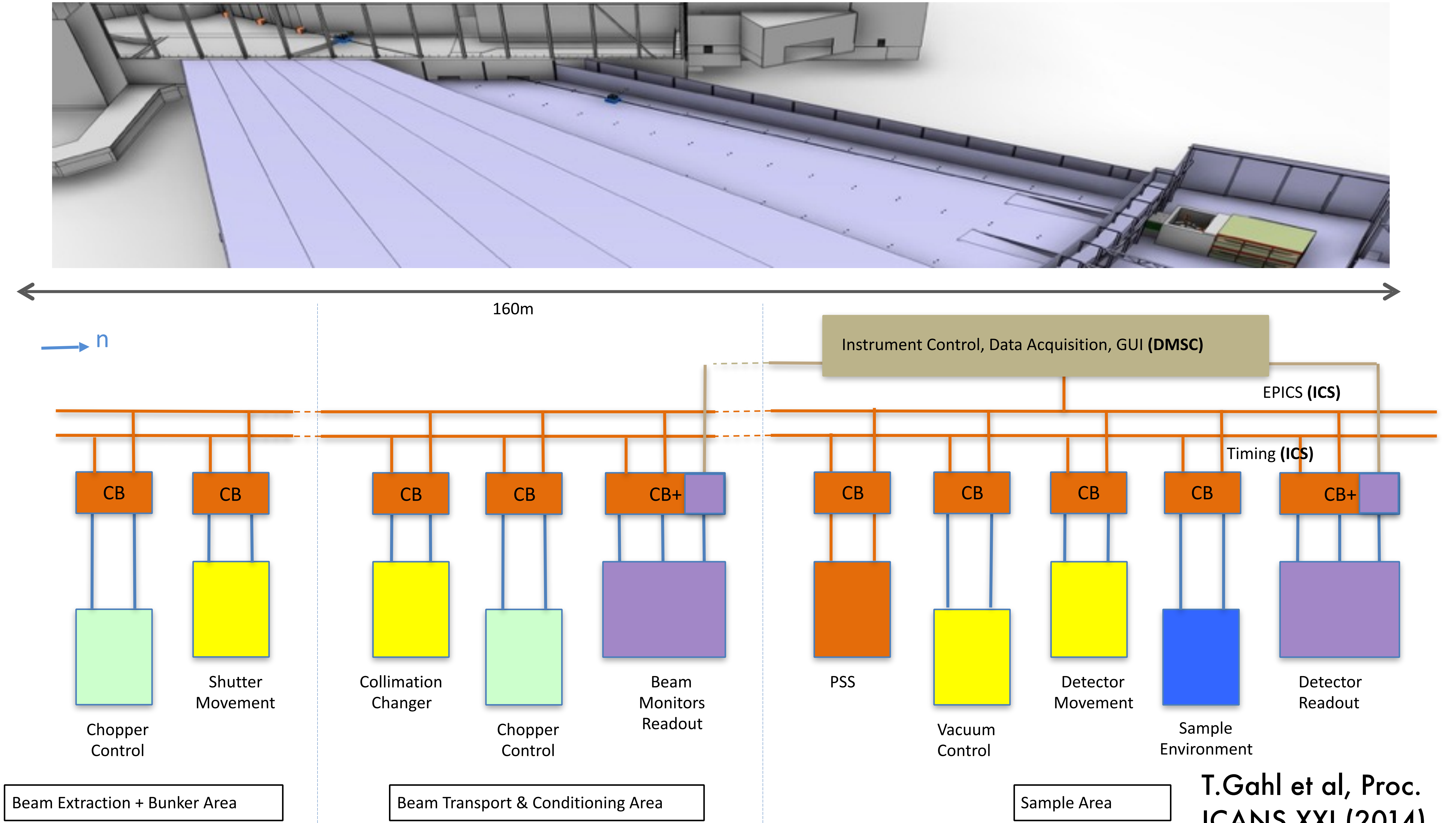


“Converter” “Detector” “Electronics”





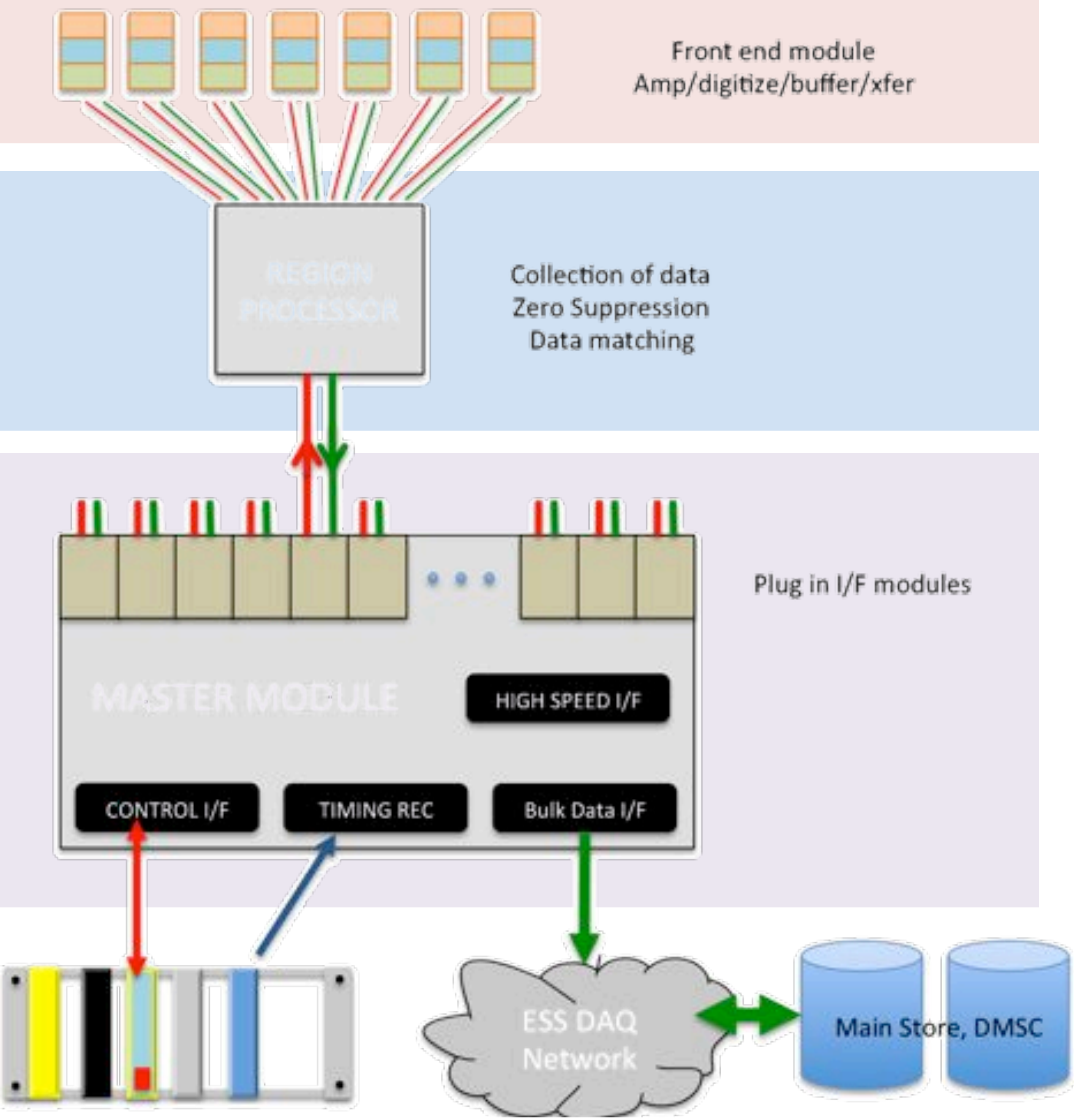
Modular Instrument Control Concept



- Modularisation to manage key interface

T.Gahl et al, Proc. ICANS XXI (2014)
arXiv: 1507.01838

Modularisation for Detector Electronics

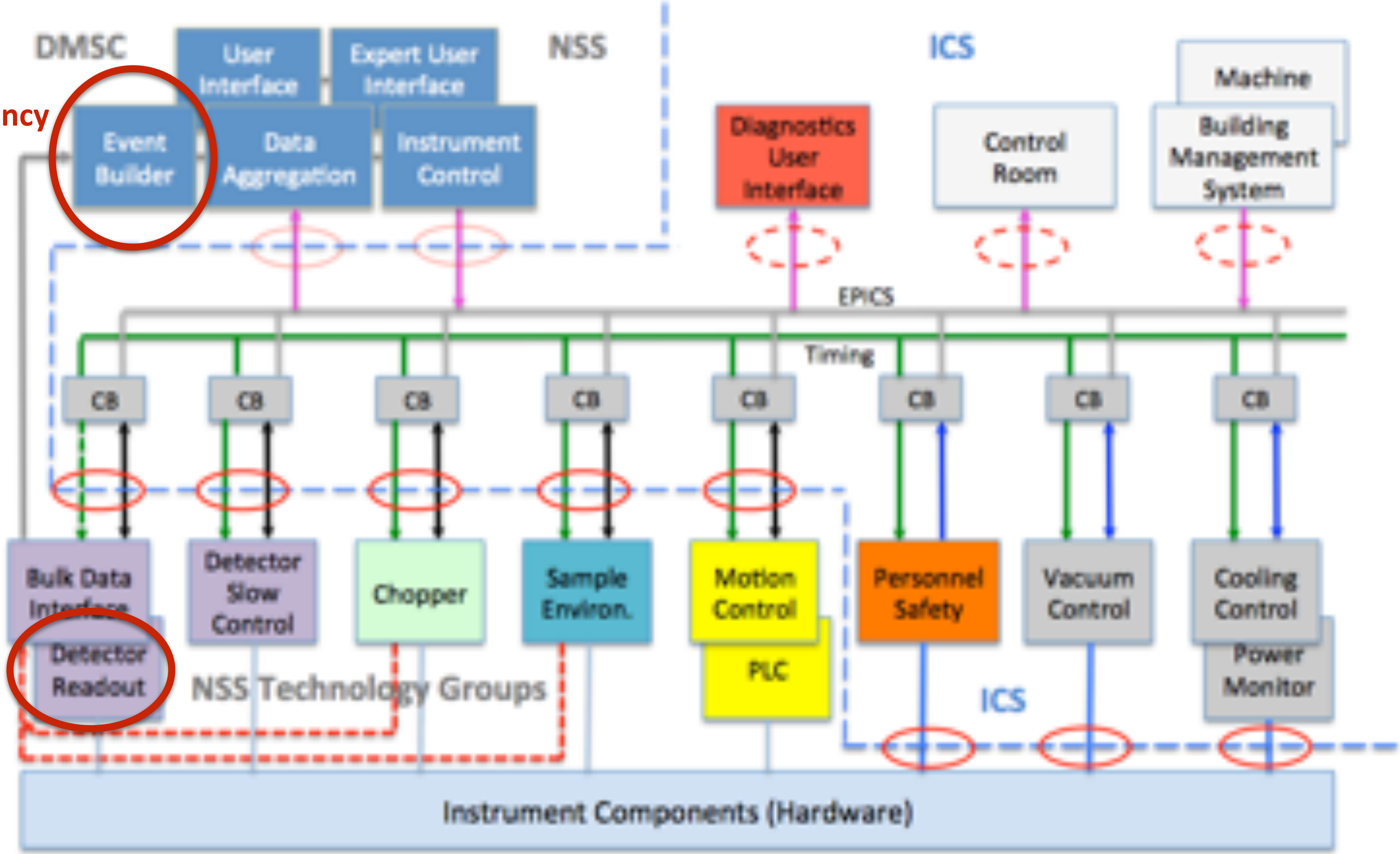


- Modularisation to manage key interface
- Single in-kind partner (STFC, UK) for backend readout
- Example of synergy with existing European expertise to reduce developments needed by ESS
- Adapting rather than developing

Detector - DMSC Interface

- DG- DMSC interface ..
- Covered by Brightness (Tasks 5.1 and 4.4)

tency



Detectors for ESS: strategy update for 16 instruments

Instrument class	Instrument sub-class	Instrument	Key requirements for detectors	Preferred detector technology	Ongoing developments (funding source)
Large-scale structures	Small Angle Scattering	SKADI	Pixel size, count-rate	Scintillators	SonDe (EU SonDe)
		LOKI		10B-based	BandGem
	Reflectometry	FREIA	Pixel size, count-rate	10B-based	MultiBlade (EU BrightnESS)
		ESTIA			
Diffraction	Powder diffraction	DREAM	Pixel size, count-rate	10B-based	Jalousie
		HEIMDAL		Scintillators	
	Single-crystal diffraction	MAGIC	Pixel size, count-rate	10B-based	Jalousie
		NMX	Pixel size, large area	Gd-based	GdGEM uTPC (EU
Engineering	Strain scanning	BEER	Pixel size, count-rate	10B-based	AmCLD, A1CLD
	Imaging and tomography	ODIN	Pixel size	Scintillators, MCP, wire chambers	
Spectroscopy	Direct geometry	C-SPEC	Large area (^{3}He-gas unaffordable)	10B-based	MultiGrid (EU BrightnESS)
		T-REX			
		VOR			
	Indirect geometry	BIFROST	Count-rate	3He-based	
		MIRACLES			
		VESPA	Count-rate	3He-based	
SPIN-ECHO	Spin-echo	tbd	tbd	3He-based/10B-based	

Detectors for ESS instruments: establish a baseline (1/2)

EUROPEAN SPALLATION SOURCE

Instrument	Detector Design	Design Teams	Build Teams	Technical Risks	Schedule Risks
LOKI	BandGEM	Milan-Biccoca/CNR/INFN/ESS (2011-…)	Milan-Biccoca/CNR/INFN/ESS	Medium/ Low	Low
SKADI	Pixelated Scintillator (SoNDe)	SoNDe: FZJ/LLB/IDEAS/LU/ESS (2011-…)	SoNDe: FZJ/LLB/IDEAS/LU/ESS	Low	Low
NMX	Gd-GEM	BrightnESS:ESS/CERN (2014-…)	BrightnESS:ESS/CERN U. Bergen and/or Wigner / ESS	Medium *	Low
ODIN	Misc: MCP, Scintillator, Semiconductor	Various: PSI, Berkeley, ISIS … BrightnESS: IAEP, MiUN, ESS …	PSI	Low	Low
DREAM	Jalousie	POWTEX: FZJ/CDT	FZJ POWTEX	Low	Medium
BEER	A1CLD AmCLD	HZG/DENEX (2011-…)	HZG/DENEX	Low	Medium (ik start delay)
FREIA	Multi-Blade	BrigthnESS: ESS/LU/Wigner (2013-…)	ISIS/ESS/LU/Wigner	Medium	Low
ESTIA	Multi-Blade	BrigthnESS: ESS/LU/Wigner (2013-…)	PSI/ESS/LU/Wigner	Medium	Low

Baselines, detector design, design teams and build teams identified

Detectors for ESS instruments: establish a baseline (2/2)

Instrument	Detector Design	Design Teams	Build Teams	Technology Risks	Schedule Risks
VOR	Multi-Grid	CRISP: ESS/ILL Linköping Univ. BrightnESS: ESS/ILL (2009-…)	ESS/Wigner? *	Low	Low
C-SPEC	Multi-Grid	CRISP: ESS/ILL Linköping Univ. BrightnESS: ESS/ILL (2009-…)	ESS/TUM/LLB? *	Low	Low
T-REX	Multi-Grid	CRISP: ESS/ILL Linköping Univ. BrightnESS: ESS/ILL (2009-…)	ESS/FZJ? *	Low	Low
BIFROST	Helium-3 (tubes)	PSI	PSI	High: Inst. Rate Req.?	Low
HEIMDAL	WLS Scintillator ? (SANS: BANDGEM imaging: Timepix options)	Workshop 14-15 March	DK/PSI/NO SANS:CNR	High (medium?)	unknown
MAGIC	Jalousie	POWTEX: FZJ/CDT (2012/3-…)	FZJ/CDT/LLB	Low	Medium
MIRACLES	Helium-3 PSD tubes	N/A	NBI. ESS-B?	Low	Low
VESPA	Helium-3 PSD tubes	N/A	CNR? ISIS?	Low/Medium Availability?	Low
SPIN-ECHO	3He-based/10B-based			Low	Low

Close working collaborative relationships to mitigate risks

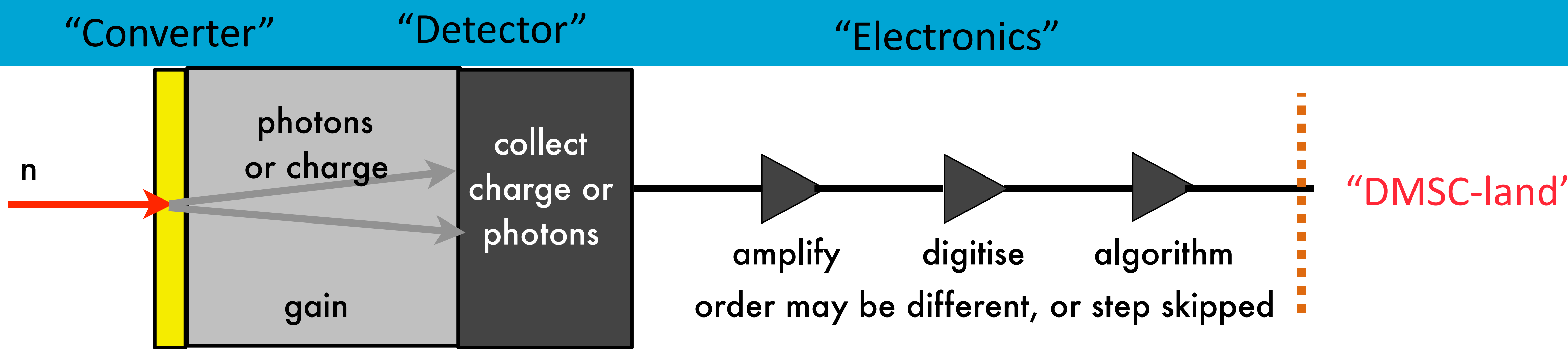
Mitigation Plan

Instrument	Primary Detector Technology	Critical decision dates	Backup Detector Technology	Cost Backup Detector Technology (EUR)	Critical decision dates for Day 1 Option	Secondary backup Detector Technology (Day 1 configuration)	Cost of secondary Day 1 option to contingency (EUR)
LOKI	BandGEM	17Q1/2: final technology decision	SONDE	7 M	2019 Q2	He-3 PSD MWPC	500 k
ODIN	Misc: MCP, Scintillator, Semiconductor, …	2018	Several Technologies already involved	N/A	2019 Q2	Scintillator+CCD	100 k
BEER	AmCLD/A1CLD	2018 Q1	Jalousie	3 M	2020 Q1	He-3 PSD MWPC	500 k
C-SPEC	Multi-Grid	Technology Decision 2017Q4	He-3 Tubes	>10 M	2020 Q1	MultiGrid Prototypes	200 k
ESTIA	Multi-Blade	Technology decision (17Q4?)	SINE2020	750 k	2020 Q1	He-3 8mm PSD Tubes	500 k
DREAM	Jalousie	TG3: 17Q4?	AmCLD/A1CLD	2.5 M	2020 Q1	He-3 PSD MWPC	500 k
MAGIC	Jalousie	TG3: 18Q2?	AmCLD/A1CLD	2.5 M	2020 Q1	He-3 PSD MWPC	500 k
BIFROST	He-3 Tubes	TG3: 19Q1?	Helium-3 Pixels	1,5 M	N/A	N/A	0

Risk exposure (delta): >15 MEUR

Risk exposure: 2.8 MEUR

Schedule of Key Activities



2011	2012	2013	2014	2015	2016	2017
Coatings	Detector Conceptual Designs	Detector Prototype Designs	Strategy for Instruments, Instrument Designs	People, workshops and facilities, Instrument Designs	Electronics	Instrument Detector Design
					ICS/DMSC interface	Electronics
					Instrument conceptual design	ICS/DMSC interface
						Construction

2018	2019	2020	2021	2022	2023	2024	2025
Electronics /ICS/DMSC	Design	Construction	Construction	Construction	Installation	Installation	Installation
Design	Construction	Installation	Installation	Installation	Commissioning	Commissioning	Commissioning
Construction	Installation	Commissioning	Commissioning	Commissioning	Operation	Operation	Operation

Key Activities for Coming Year

- Support phase 1 work for all instruments
- Detailed design work for LOKI and NMX
- Brightness, SINE2020 and SoNDE design work for ESS Instruments

- Baseline for detector electronics
- Definition of DG-DMSC and DG-ICS interfaces

- Finalise detector systems in-kind and successful launch of all in-kind work
- Strengthen collaborations for delivering detectors for ESS instruments

Within BrightnESS Task4

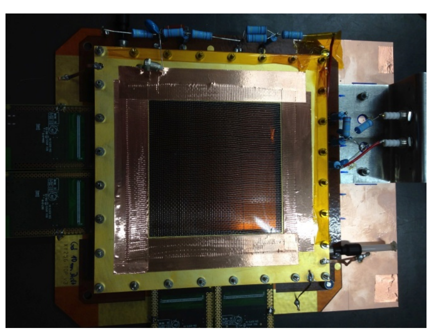
Grants turning developments into design

Helps partners to be involved
Mitigating risk for ESS project on critical items …
Use grants to enhance scope of NSS

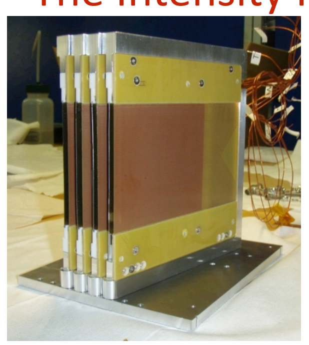
Move beyond R+D: work moved into detector design phase

BrightnESS

Task 4.1
"The Resolution Challenge"

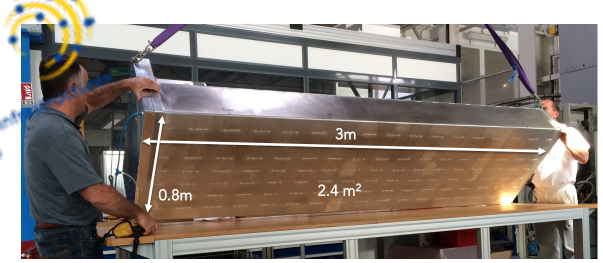


Task 4.2
"The Intensity Frontier"

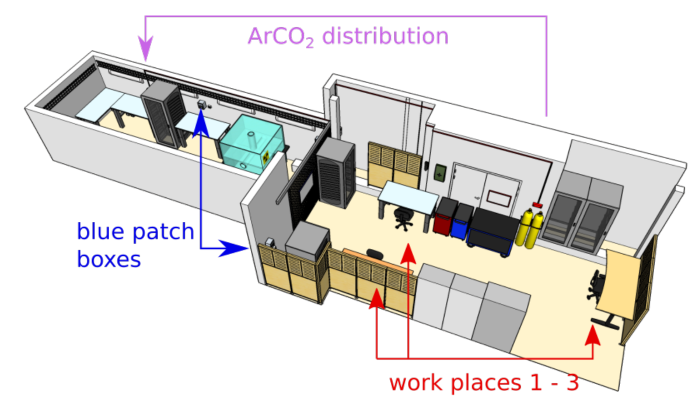


Task 4.3
"Realising Large Area Detectors"

CRISP The Cluster of Research Infrastructures for Synergies in Physics



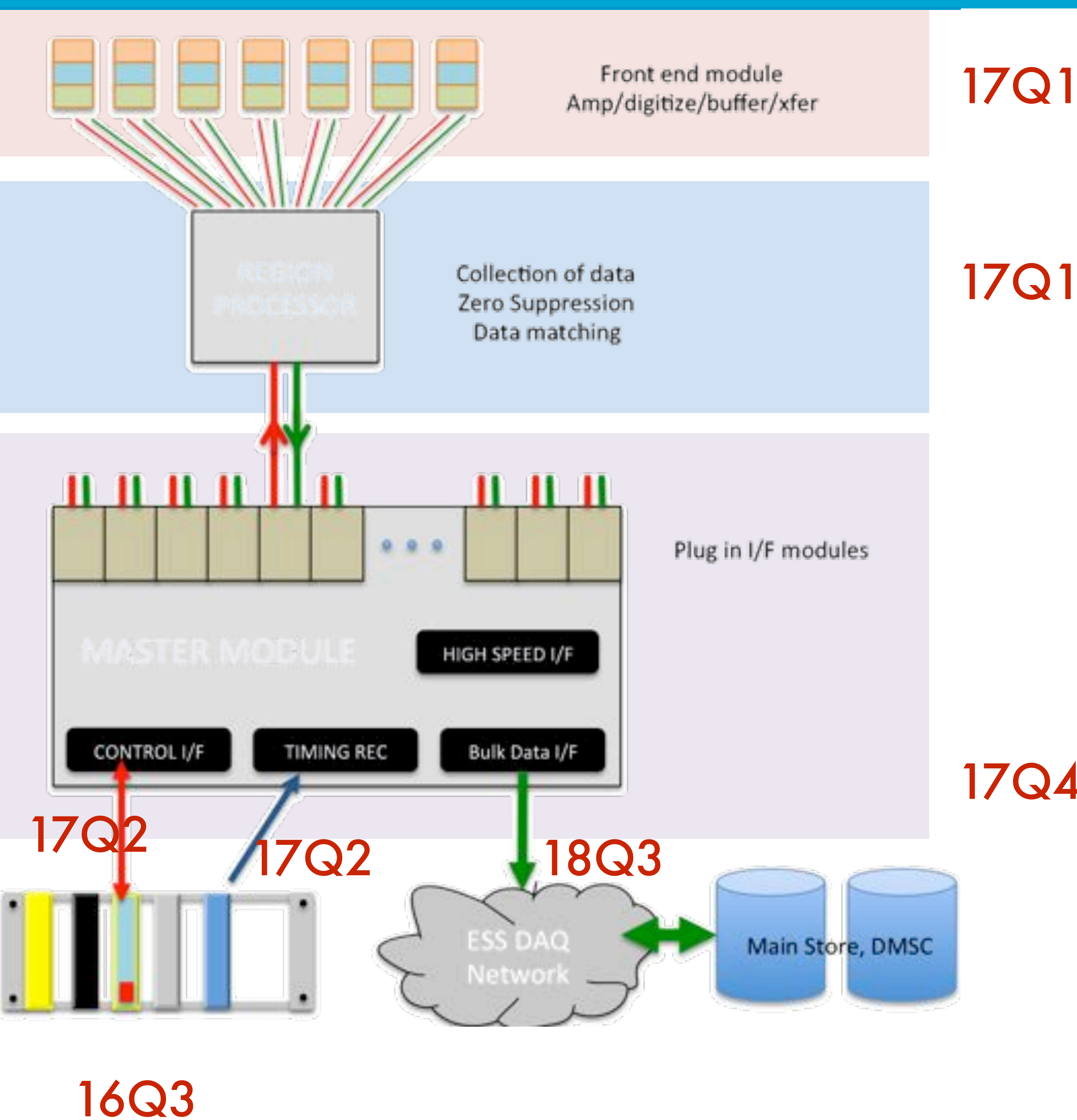
Task 4.4
"Detector Realisation"



SoNDe Solid-State Neutron Detector

SINE 2020

Detector Electronics and Interfaces to DMSC and ICS

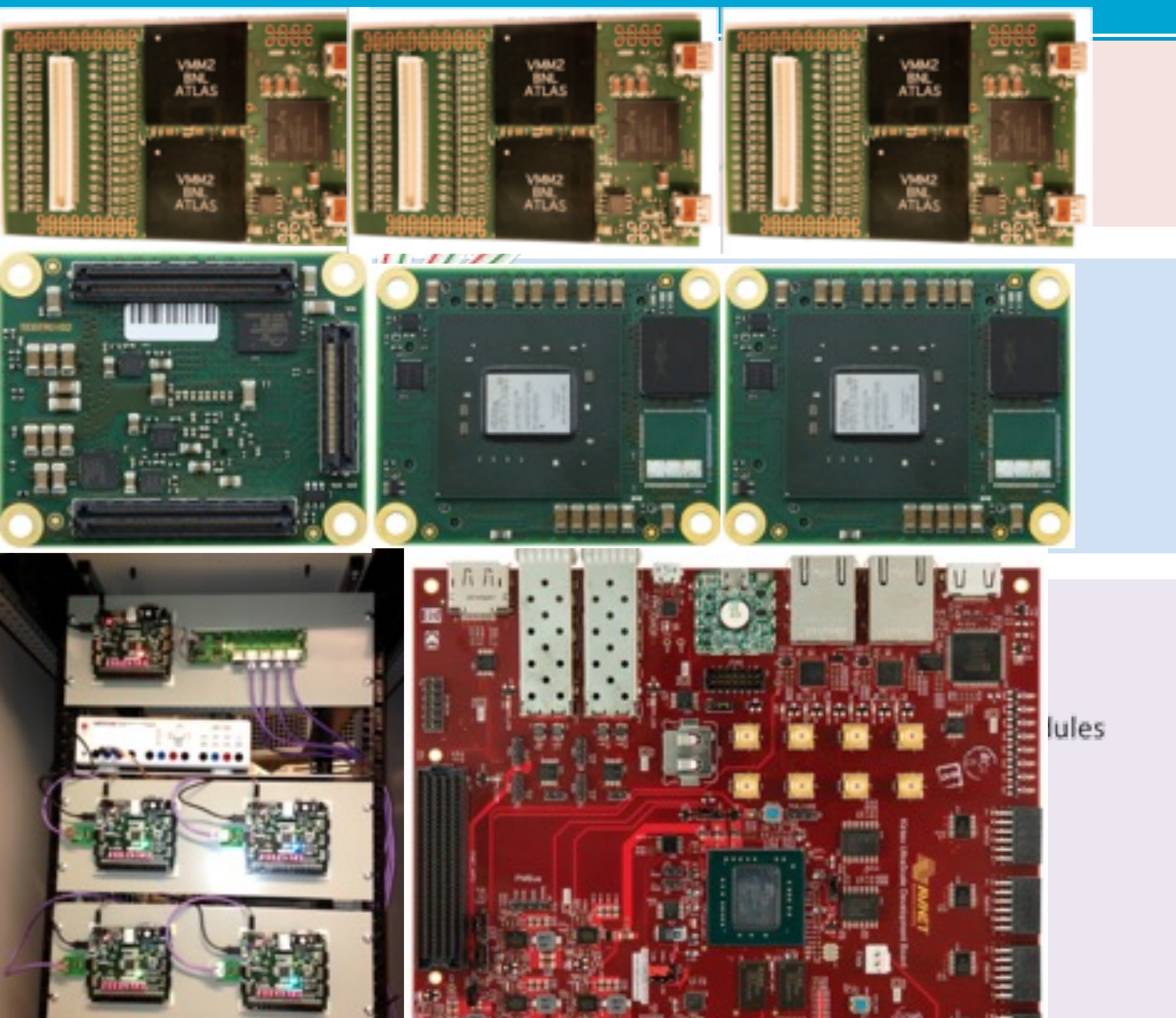


- Design underway for all aspects
- Modularisation to manage key interface
- Single in-kind partner (STFC, UK) for backend readout
- Example of synergy with existing European expertise to reduce developments needed by ESS
- Adapting rather than developing

- ICS interface design and prototyping underway
- Design model: arXiv: 1507.01838

- DG-DMSC interface covered by BrightnESS task 5.1 and 4.4
- Resources in place: work started

Detector Electronics and Interfaces to DMSC and ICS



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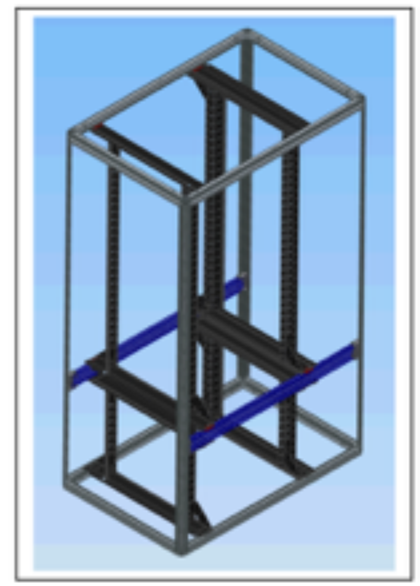
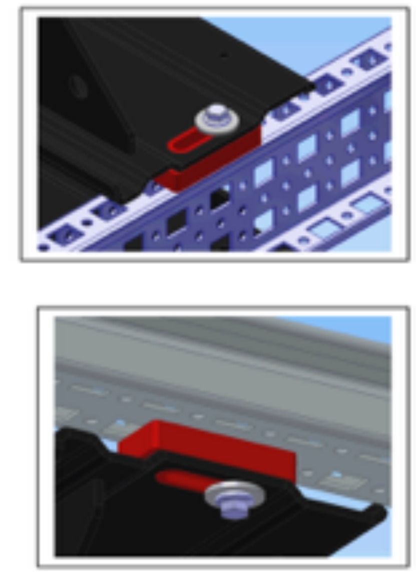
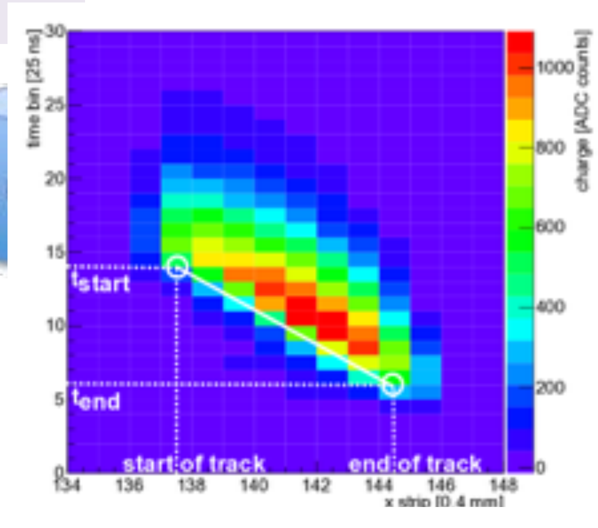
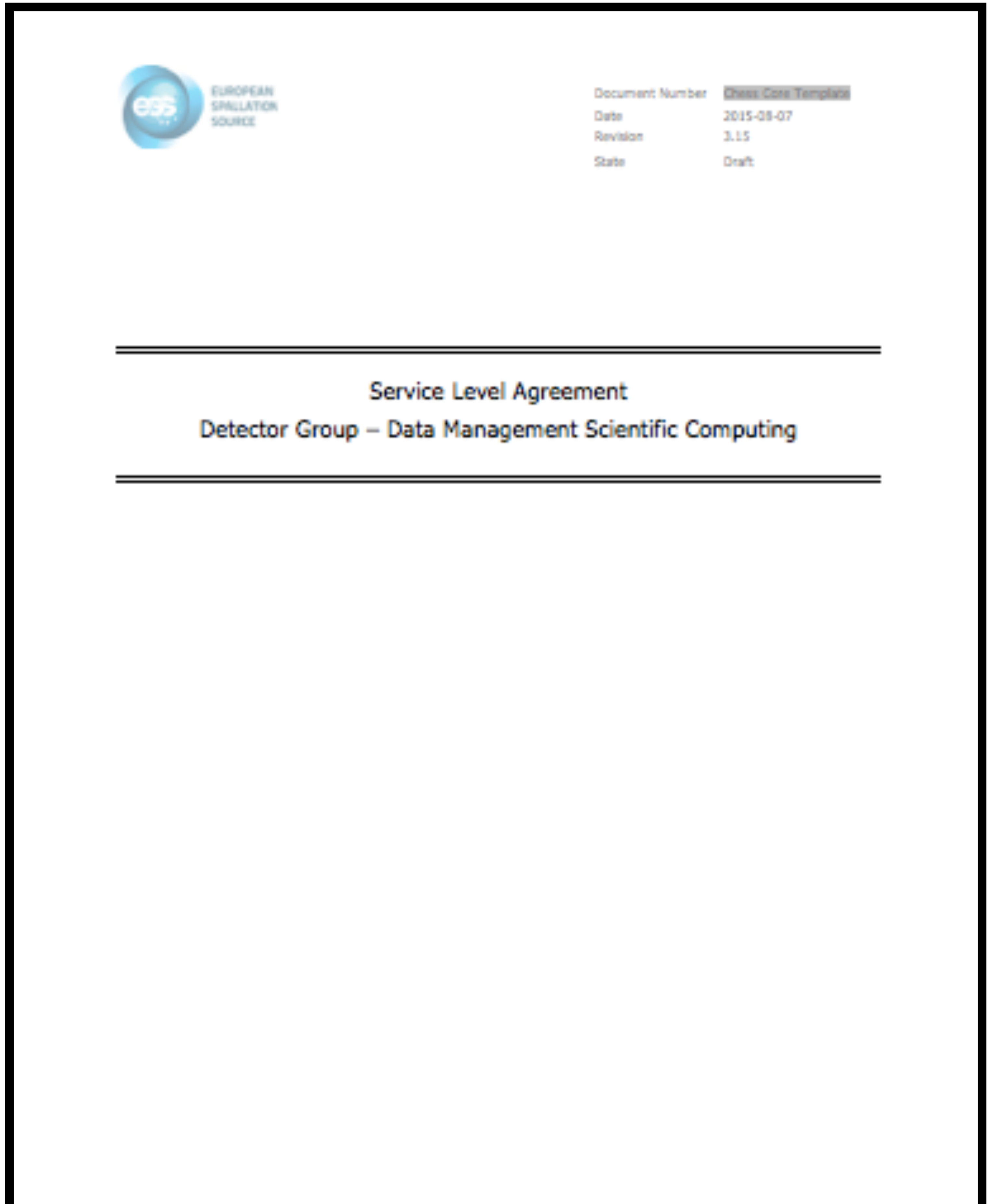






The DMSC-DG Interface (BrightnESS Task5.1)

Draft Started



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Document Number	Chess Core Template
Date	2015-08-07
Revision	3.15
State	Draft

Service Level Agreement

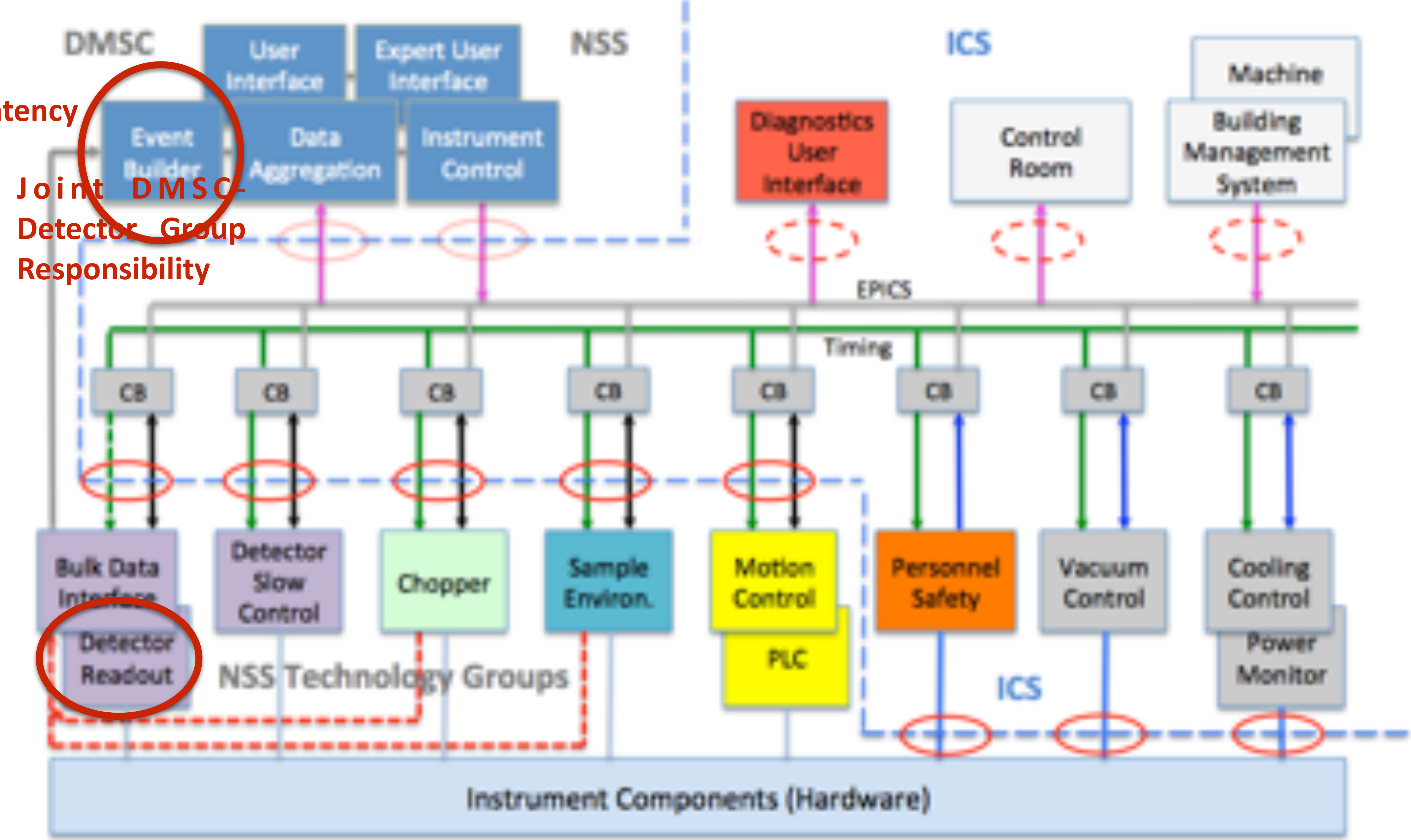
Detector Group – Data Management Scientific Computing

Where do we do the various stages of processing?

Need to understand levels of algorithms and advantages of doing it in different places

Need to understand what data we will actually get

Latency is an issue: need to understand limitations here.



Processing Topics

- Note that a data simulation and expectation is important to be able to make progress on several crucial parts of the design
- Different implications of running in various modes

- Local clustering
- Inter-Chip clustering
- uTPC algorithm
- Data re-packaging: event-like into histogram-like (pixel ID)

- EVENT BUILDER is a JOINT DMSC/DG responsibility
- It must work
- This is the primary deliverable of BrightnESS task 5.1

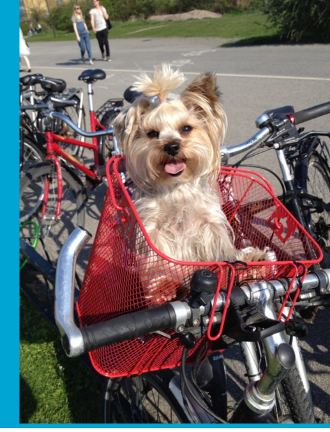
Where do I get information?

- DG Atlassian. This is our working area.
  - https://ess-ics.atlassian.net/wiki/display/DG/Detector+Group
- There is a detector area on Indico. We use this rigorously:
  - https://indico.esss.lu.se/category/2/

- Specific Links:

- NMX detector event processing
  - https://indico.esss.lu.se/event/497/
- Workshop on Neutron Instrument Architecture for Data Acquisition, Instrument Control, & Data Storage
  - https://indico.esss.lu.se/event/110/
- T.Gahl et al, Proc. ICANS XXI (2014) arXiv: 1507.01838

Jamboree Aim



- Get to know who-is-who
- Where the DMSC offices are

- Expand work for WP5 from Gd-GEM for NMX to include MultiGrid And MultiBlade designs
- CSPEC, ESTIA, TREX, FREIA

- Start discussion and brainstorm on what the data mode should be for Beam Monitors (event vs histo vs ..)

- Compilation and consolidation work on the Rates for instruments

- Brainstorm on how to make this work, and commission …

- This has to do with the software and data aspects: there will be a follow up meeting on the hardware aspects in 17Q1.

Summary

- ESS will provide increased neutron brightness
- Novel instrument designs push requirements for detectors well beyond current day state-of-the-art

- Detector systems project in good shape, and running at full speed
- Baseline detector designs exist
- Set of design and build partners identified and available
- Very much an open collaboration of groups across (mostly) Europe

- Detector work now very much design, and not R&D
- Schedule and budget: make the detectors affordable and on time
- Enable partners