

Motion Control & Automation

- Update at IKON10 -

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Motion Control & Automation Group

Motion Control & Automation (MCA)

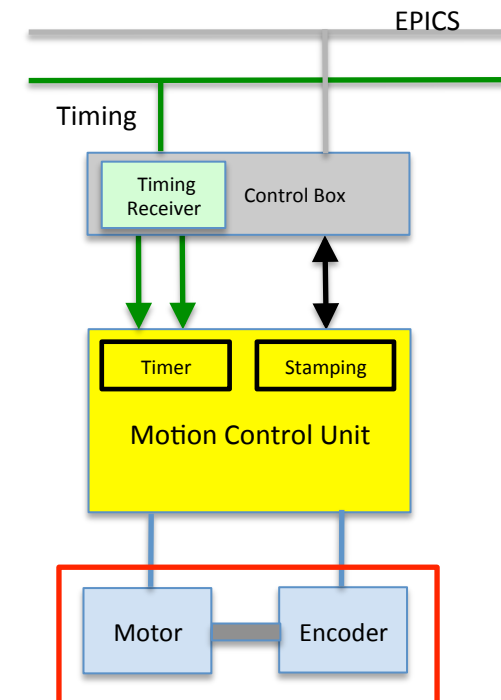
- Overview -



- 1 Evaluation for Generic Motion Control Unit in final stage
- 2 Start on identifying radiation hard components
- 3 Motion Control Components Standard issued (ESS-0037290)
- 4 Guidelines for MCA in Phase 1 issued (ESS-0049514 draft)
 - How to derive to technical solutions?
 - How to calculate budget?
 - What documentation recommended for phase 1
 - Support by ESS MCA Group: Examples of DREAM and ESTIA
 - Some handouts available

MCA Standard: Motion Control Components I (Motor, Encoder, End Switches)

- Standard v1.0 issued for NSS
- CHESS-Nr. 37290
- Actual Range
 - 2Ph. Hybrid Stepper Motors, 24/48V, max. $3.5A_{rms}$ ($5A_{pk}$), 1/64 Micro stepping
 - DC brushless, piezo (not yet specified)
 - Incremental Encoders, digital quadrature (A,B + R), RS-422 output
 - SSI absolute Encoder, max 32 Bit, 1 Mhz clock
 - BissC, Resolver, LVDT (not yet specified)
- Standard v2.0 will be issued for whole ESS by the Standardisation Subcommittee
- Will be extended after final decision on Motion Control Unit



Responsibilities

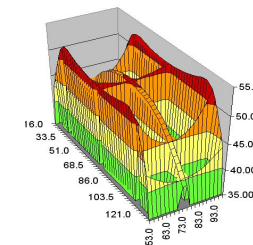
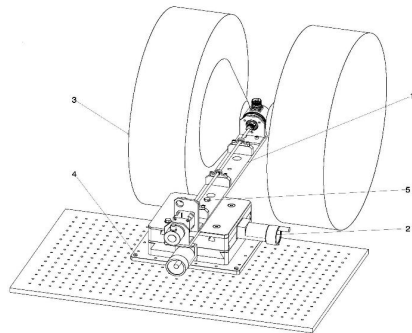
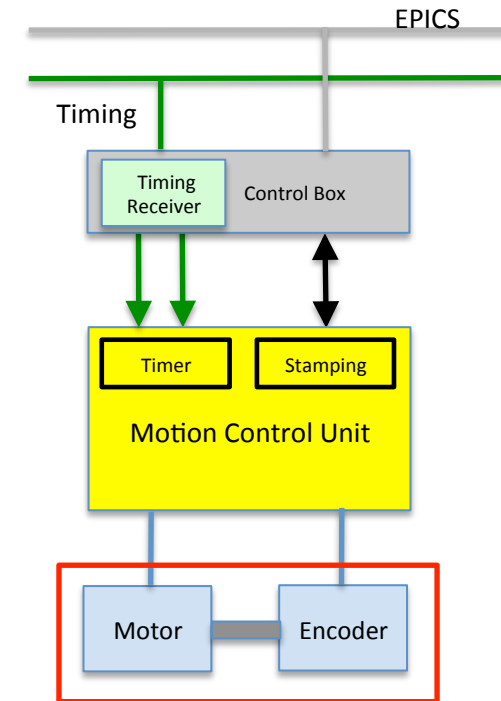
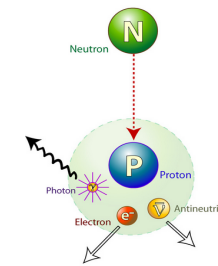
Technology: MCA

Integration: MCA/ICS

MCA Standard: Motion Control Components II

(Harsh Environment)

- Radiation Environment (Gamma, Neutrons)
 - Identify and evaluate motors and encoders
 - Integrate components into motion control unit
 - Test in radiation environment if necessary
- High Magnetic Field (DC)
 - Identify and evaluate motors and encoders
 - Integrate components into motion control unit
 - Single components test in magnetic field (1,5T)



Responsibilities
Technology: MCA
Integration: MCA

- Will be issued end 2016

Motion Control & Automation (MCA)

- Technical Solution -



- Table of Motion Axes

- Complete list/description of axes
- Accuracy, range, environment etc.
- Support from MCA PoC



Generic Purpose Motion Control

> 90%

Special Purpose Motion Control

Robotics / Piezo actuators

Equipment requirements

Racks/Controllers/Power/Cooling

Preliminary cabinet / cabling layout

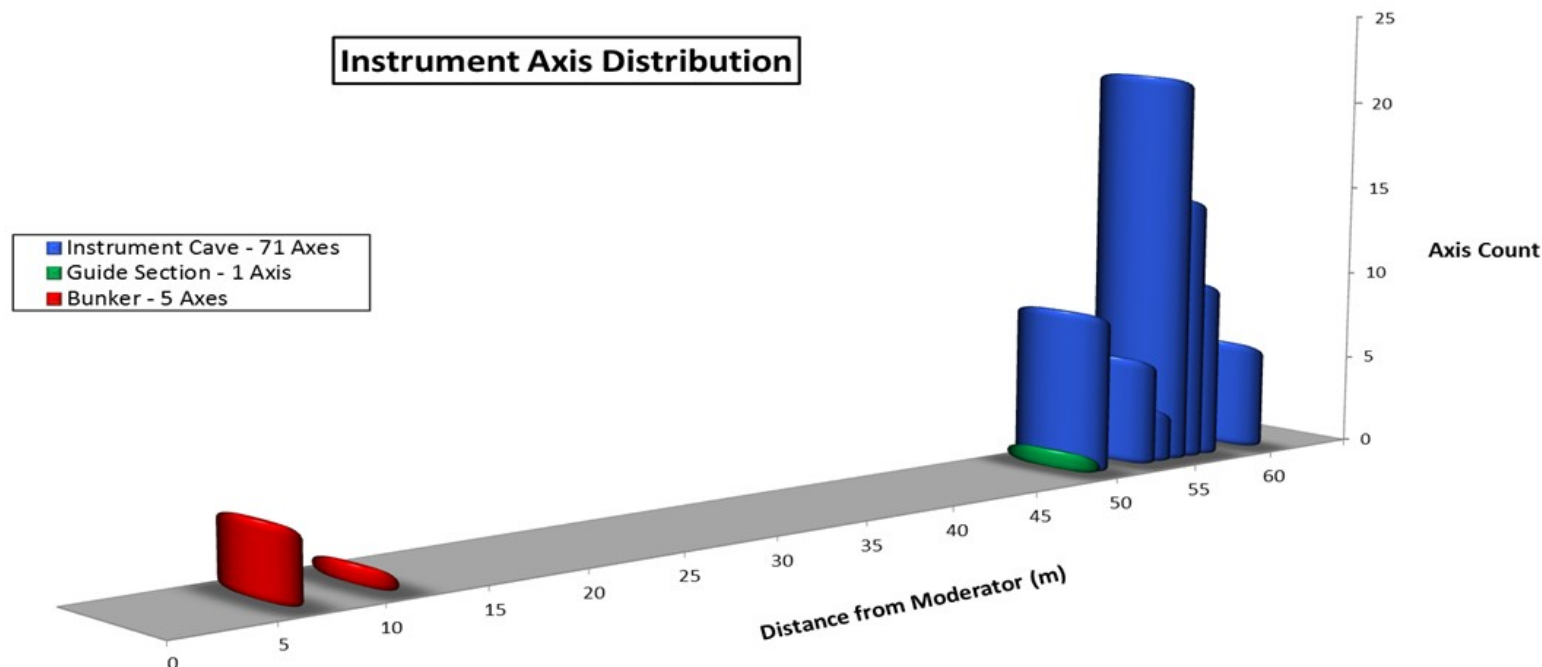
Instrument Name		ODIN												
Rev.	A													
MOTION CONTROL														
Axis Number	Device Description	Deliverable	Custom / Off The Shelf	Axis description	Motion Type	Actuator Type	Range (mm/*)	Accuracy (mm/*)	Precision / Repeatability (mm/*)	Encoder Type	Synch' with other axis	Synch' with signals / sensors	Load (Kg)	Force Torque
1	Pulse Shaping Chopper Unit 1	13.6.5.12.1.1.1 MCI – PSC Motion	Custom	X	Linear	Electrical	200	0.1	0.1	Absolute	No	No	800	Mediu
2	Pulse Shaping Chopper Unit 1	13.6.5.12.1.1.1 MCI – PSC Motion	Custom	X	Linear	Electrical	200	0.1	0.1	Absolute	No	No	800	Mediu
3	Pulse Shaping Chopper Unit 2	13.6.5.12.1.1.1 MCI – PSC Motion	Custom	X	Linear	Electrical	200	0.1	0.1	Absolute	No	No	800	Mediu
4	Pulse Shaping Chopper Unit 2	13.6.5.12.1.1.1 MCI – PSC Motion	Custom	X	Linear	Electrical	200	0.1	0.1	Absolute	No	No	800	Mediu
5	Heavy Shutter	13.6.5.12.1.1.2 MCI – Heavy Shutter Motion	Custom	Yaw	Rotary	Electrical	90	0.05	0.05	Absolute	No	No	1000	Mediu
6	Secondary Shutter	13.6.5.12.1.1.3 MCI – Secondary Shutter Motion	Custom	Z	Linear	Pneumatic	120	1	1	Absolute	No	No	5	Low
7	Variable Pinhole System	13.6.5.12.1.1.5 MCI – Variable Pinhole System	Custom	Y	Linear	Electrical	200	0.01	0.01	Absolute	No	No	5	Low
8	Variable Pinhole System	13.6.5.12.1.1.5 MCI – Variable Pinhole System	Custom	Y	Linear	Electrical	200	0.01	0.01	Absolute	No	No	5	Low
9	Variable Pinhole System	13.6.5.12.1.1.5 MCI – Variable Pinhole System	Custom	Y	Linear	Electrical	200	0.01	0.01	Absolute	No	No	5	Low
10	Variable Pinhole System	13.6.5.12.1.1.5 MCI – Variable Pinhole System	Custom	Y	Linear	Electrical	200	0.01	0.01	Absolute	No	No	5	Low
11	Variable Pinhole System	13.6.5.12.1.1.5 MCI – Variable Pinhole System	Custom	Z	Linear	Electrical	200	0.01	0.01	Absolute	No	No	5	Low
12	Variable Pinhole System	13.6.5.12.1.1.5 MCI – Variable Pinhole System	Custom	Z	Linear	Electrical	200	0.01	0.01	Absolute	No	No	5	Low
13	Variable Pinhole System	13.6.5.12.1.1.5 MCI – Variable Pinhole System	Custom	Z	Linear	Electrical	200	0.01	0.01	Absolute	No	No	5	Low
14	Variable Pinhole System	13.6.5.12.1.1.5 MCI – Variable Pinhole System	Custom	Z	Linear	Electrical	200	0.01	0.01	Absolute	No	No	5	Low
15	Heavy Aperture Wheel	13.6.5.12.1.1.6 MCI – Heavy Aperture Exchange Wheel Motion	Custom	Yaw	Rotary	Electrical	360	0.1	0.1	Absolute	No	No	500	Mediu

Motion Control & Automation (MCA)

- Technical Solution -

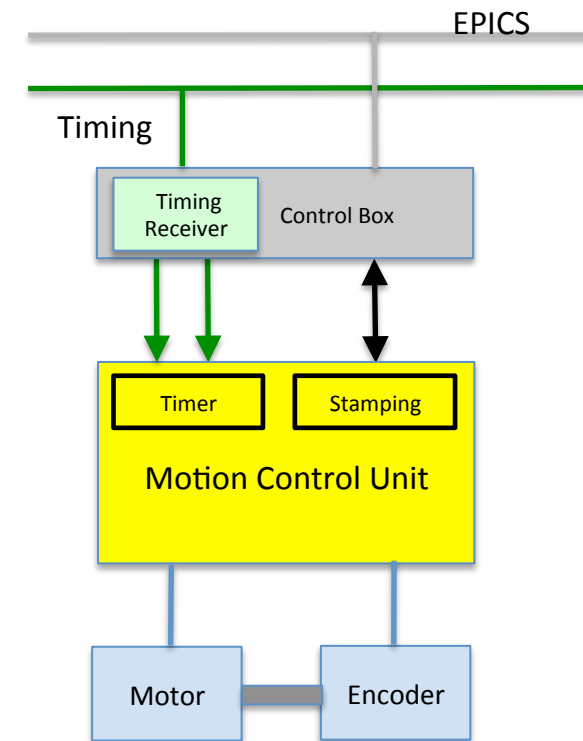
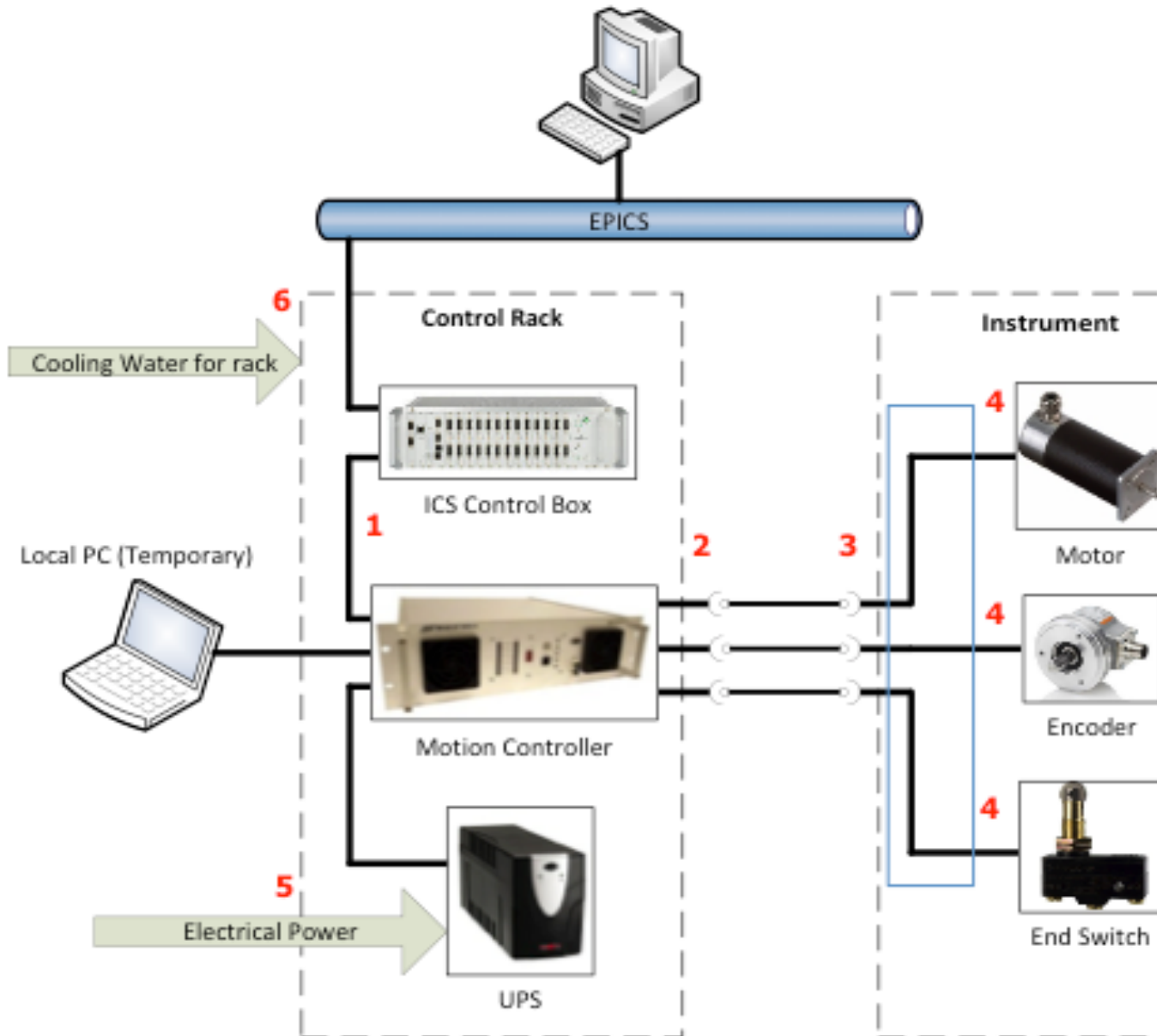


- Local Distribution of Motion Axes
 - First indications on electrical cabinets and cabling layout



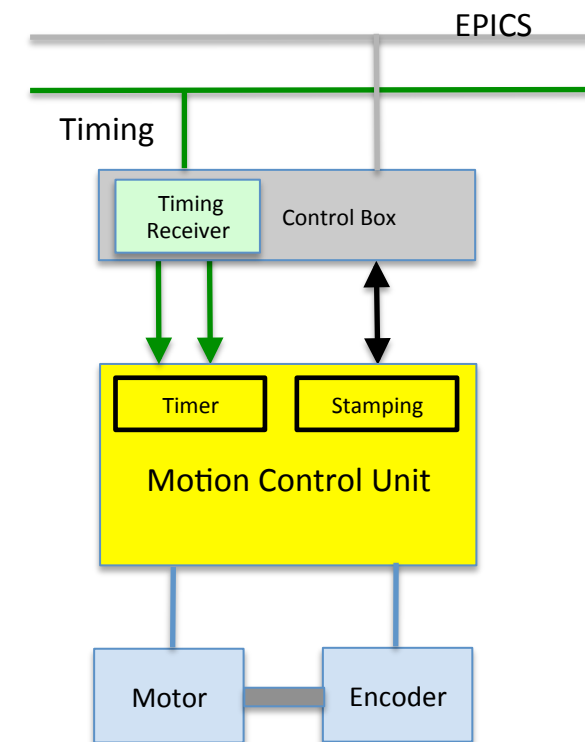
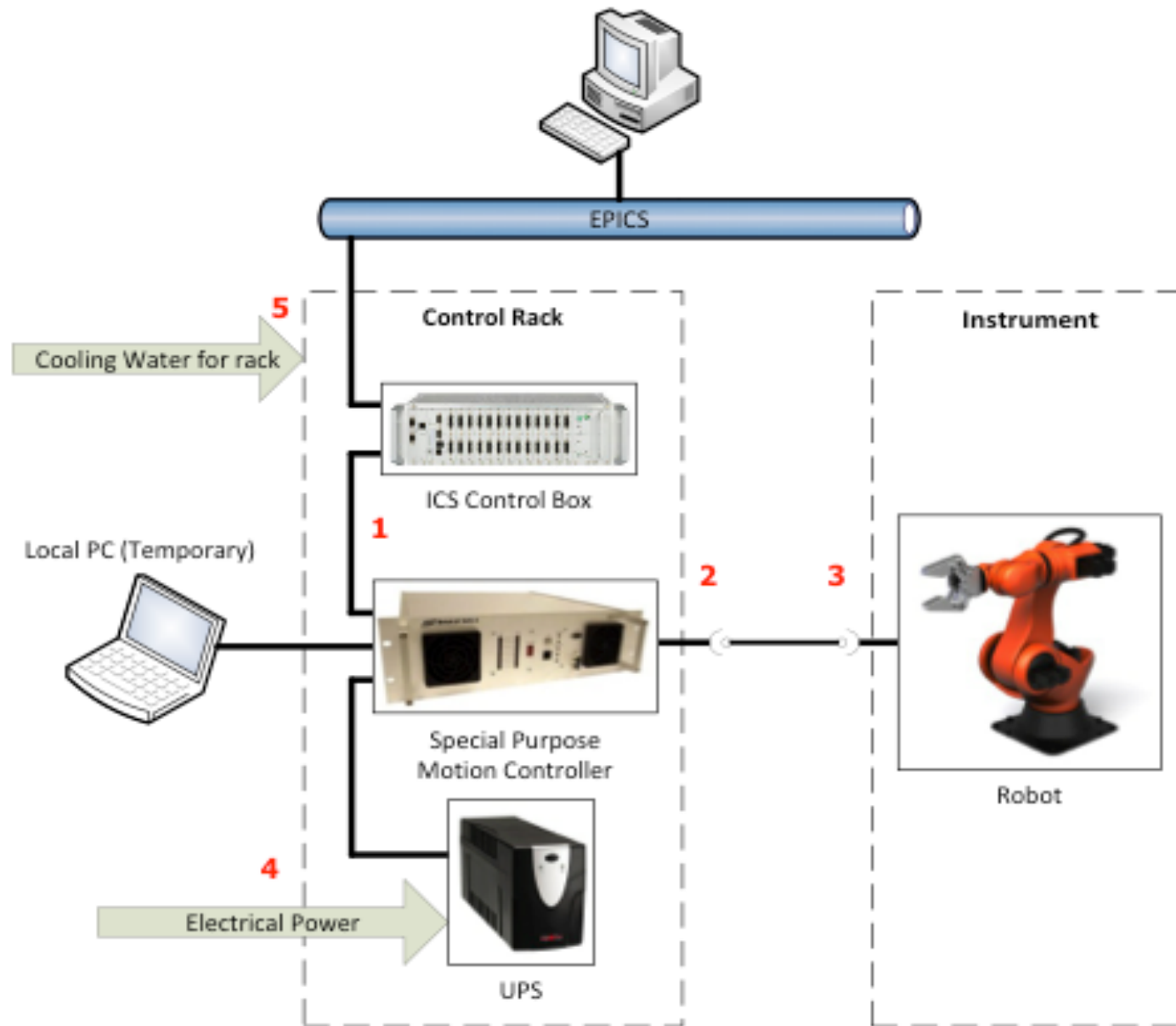
Motion Control & Automation (MCA)

- Generic Motion Control-



Motion Control & Automation (MCA)

- Special Purpose Motion Control-



Motion Control & Automation (MCA)

- Budget -



Budget

- Format
 - Cost per WBS element
 - Further detailed breakdown by device
- Process
 - Custom / Off-The-Shelf
 - Economy of Scale
 - Complexity

Excluded (to be discussed)

- Cables/Connectors
 - Materials cost
 - Cost for installation
- Motors/Encoders/Switches
 - Materials cost
 - Cost for cabling inside the WBS element

		Technical Group Design Document LoKI					WBS Cost Breakdown		
Generic Motion Control - 13.6.5.12.1.1		PROJECT SECTIONS / SUB-SECTIONS					Labour (hrs)	FTE	Equ (k€)
Instrument Device	WBS Element	2 Project management / meetings	3 Support and Review of Mechanical Design	4 Support of Procurement	4 Factory Acceptance Tests	5 Site Acceptance & Commissioning			
	13.6.5.12.1.1 - Generic Motion Control						4206	2.34	0.
	13.6.5.12.1.1.1 MCI – PSC Motion						127	0.07	-
	13.6.5.12.1.1.2 MCI – Heavy Shutter Motion						80	0.04	-
	13.6.5.12.1.1.3 MCI – Secondary Shutter Motion						77	0.04	-
	13.6.5.12.1.1.4 MCI – Slit Package 1,2,3,4						691	0.38	-
	13.6.5.12.1.1.5 MCI – Variable Pinhole System						638	0.35	-
	13.6.5.12.1.1.7 MCI – Beam Monitors						159	0.09	-
	13.6.5.12.1.1.8 MCI – Sample Positioning Stage 1,2,3						943	0.52	-
	13.6.5.12.1.1.9 MCI – Detector Positioning Stage 1,2						375	0.21	-
	13.6.5.12.1.1.10 MCI – Ancillary Stages						282	0.16	-
	13.6.5.12.1.1.11 MCI – Camera Optics Motor						125	0.07	-
	13.6.5.12.1.1.12 MCI – Phase and Analyser Gratings						182	0.10	-
	13.6.5.12.1.1.13 MCI – Polarizer Analysers						280	0.16	-
	13.6.5.12.1.1.14 MCI – Source Grating						248	0.14	-
Pulse Shaping Chopper Unit 1	13.6.5.12.1.1.1 MCI – PSC Motion	3	5	3	6				
Pulse Shaping Chopper Unit 2	13.6.5.12.1.1.1 MCI – PSC Motion	3	5	3	6				
Heavy Shutter	13.6.5.12.1.1.2 MCI – Heavy Shutter Motion	3	6	3	8				
Secondary Shutter	13.6.5.12.1.1.3 MCI – Secondary Shutter Motion	3	6	3	7				

Motion Control & Automation (MCA)

- Phase 1: Recommended Documentation -



Documentation

- New document based on experience from first 3 instruments
 - Draft document ESS-0049514 issued
 - Feedback from teams welcome
- Templates available (xls-sheets)
 - Table of Motion Axes
 - Axes Distribution
 - Task list

Content

- Technical solution (Input to Prelim. Design)
 - Table-of-Axes
 - Detailed description of Special Purpose solutions
 - Layout and distribution of cabinets
- Project description (Input to WP Spec.)
 - Task list/project plan/milestones/interfaces
 - Costs labor/non-labour
 - How to cover MCA manpower?

		Technical Group Design Document LoKI					WBS Cost Breakdown		
Generic Motion Control - 13.6.5.12.1.1		PROJECT SECTIONS / SUB-SECTIONS					Labour (hrs)	FTE	Equ (k€)
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	13.6.5.12.1.1 - Generic Motion Control						4206	2.34	0.
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	13.6.5.12.1.1.2 MCI – Heavy Shutter Motion						80	0.04	-
	13.6.5.12.1.1.3 MCI – Secondary Shutter Motion						77	0.04	-
	13.6.5.12.1.1.4 MCI – Slit Package 1,2,3,4						691	0.38	-
	13.6.5.12.1.1.5 MCI – Variable Pinhole System						638	0.35	-
	13.6.5.12.1.1.7 MCI – Beam Monitors						159	0.09	-
	13.6.5.12.1.1.8 MCI – Sample Positioning Stage 1,2,3						943	0.52	-
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	13.6.5.12.1.1.11 MCI – Camera Optics Motor						125	0.07	-
	13.6.5.12.1.1.12 MCI – Phase and Analyser Gratings						182	0.10	-
	13.6.5.12.1.1.13 MCI – Polarizer Analysers						280	0.16	-
	13.6.5.12.1.1.14 MCI – Source Grating						248	0.14	-
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Pulse Shaping Chopper Unit 2	13.6.5.12.1.1.1 MCI – PSC Motion	3	5	3	6				
Heavy Shutter	13.6.5.12.1.1.2 MCI – Heavy Shutter Motion	3	6	3	8				
Secondary Shutter	13.6.5.12.1.1.3 MCI – Secondary Shutter Motion	3	6	3	7				

Service of ESS MCA Group to DREAM

Phase 1



- Issue standards and templates (free of charge)
 - Motion Control Components Standard (ESS-0037290)
 - MCA at ESS Neutron Instruments - Definition of Tasks and Technologies (ESS-0049514)
 - Table-of-Axes + distribution of axes template
 - Task list template
- Support in filling Table-of-Axes (free of charge)
- Review phase 1 documents (free of charge)
 - Filled Table-of-Axes
 - Technical documentation
 - Project documentation

- For our internal planning: Total estimated MCA Group manpower for phase 1:
180 h = 0,1 FTE

Service of ESS MCA Group to ESTIA

Phase 1



- Issue standards and templates (free of charge)
 - Motion Control Components Standard (ESS-0037290)
 - MCA at ESS Neutron Instruments - Definition of Tasks and Technologies (ESS-0049514)
 - Table-of-Axes + distribution of axes template
 - Task list template
- Support in filling Table-of-Axes (free of charge)
- Evaluation of technical solutions for single axes (special requirements, special purpose)
- Define layout and distribution of cabinets
- Calculate MCA budget
- Compile MCA technical documentation
- Compile MCA project documentation
- Review phase 1 documents (free of charge)
 - Filled Table-of-Axes
 - Technical documentation
 - Project documentation
- Total estimated manpower for phase 1 charged to ESTIA: **440 h = 0,24 FTE**

Motion Control & Automation Group

- Key Contact for Instrument Projects -



- | | | |
|-----|----------|--------------------|
| 1. | LOKI | Anders Sandström |
| 2. | NMX | Paul Barron |
| 3. | ODIN | David Fitzgerald |
| 4. | BEER | Paul Barron |
| 5. | DREAM | Anders Sandström |
| 6. | SKADI | Anders Sandström |
| 7. | C-SPEC | David Fitzgerald |
| 8. | ESTIA | David Fitzgerald |
| 9. | T-REX | Anders Sandström |
| 10. | FREIA | Thomas Gahl (com.) |
| 11. | BIFROST | Thomas Gahl (com.) |
| 12. | HEIMDAL | Thomas Gahl (com.) |
| 13. | MAGIC | Thomas Gahl (com.) |
| 14. | MIRACLES | Thomas Gahl (com.) |
| 15. | VESPA | Thomas Gahl (com.) |



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Service of ESS MCA Group

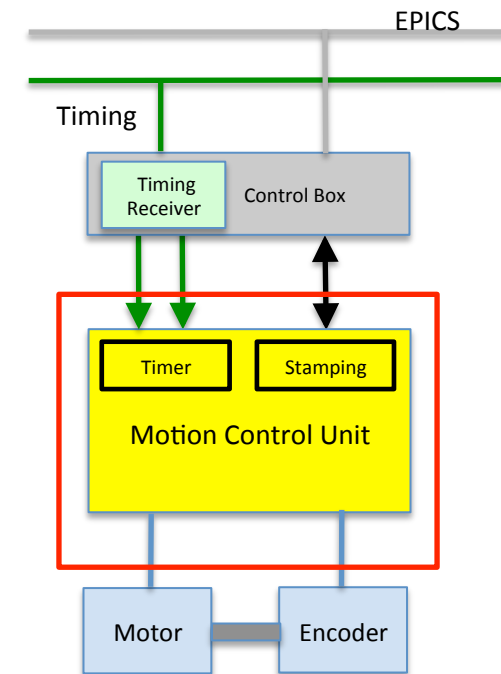
Phase 1



Questions?

MCA Standard: Generic Motion Control Unit

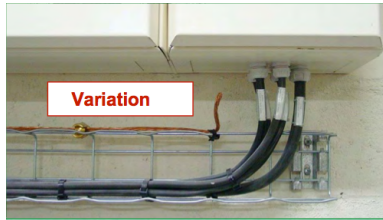
- Standardised Motion Control Unit for most of the ESS applications
- Scope of standardisation:
 - Control Hardware (controller, driver, I/O, power supply, control panel etc.)
 - Control Software (controller firmware, EPICS IOC)
 - Cables, connectors, distribution boxes, field busses
 - Prototypes for different mechanical and electrical format factors (19" box, DIN-rail, 8-axes, 2-axes etc.)
 - Test environments (Control unit + EPICS)
 - Integration workflow
- Workshop 2nd half 2015, decision end 2015
- Deployment of fully tested system mid 2016



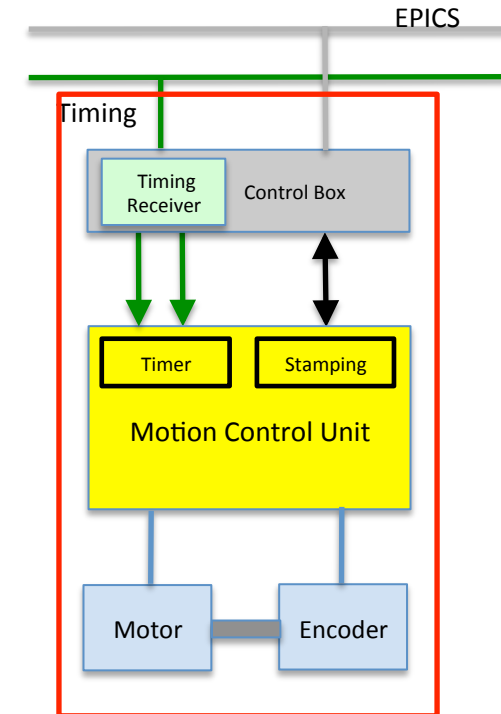
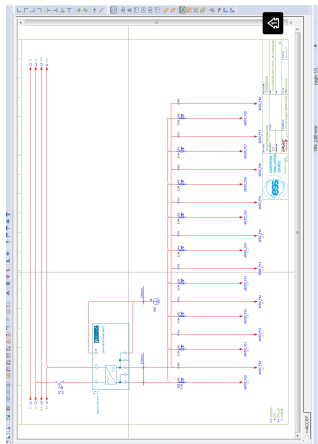
Responsibilities

Technology: MCA
Integration: MCA/ICS

General Electrical Standards



- Power Distribution
 - Following CF standard
- Electrical Installation
 - Cable routing, cable naming etc.
 - Following ESS standard, adapted to NSS needs
- ECAD
- Racks, Electrical Cabinets
 - 19" racks (cooling, UPS, EMC, power)
 - Electrical cabinets
- EMC, Earthing, Grounding
 - Scott's talk tomorrow



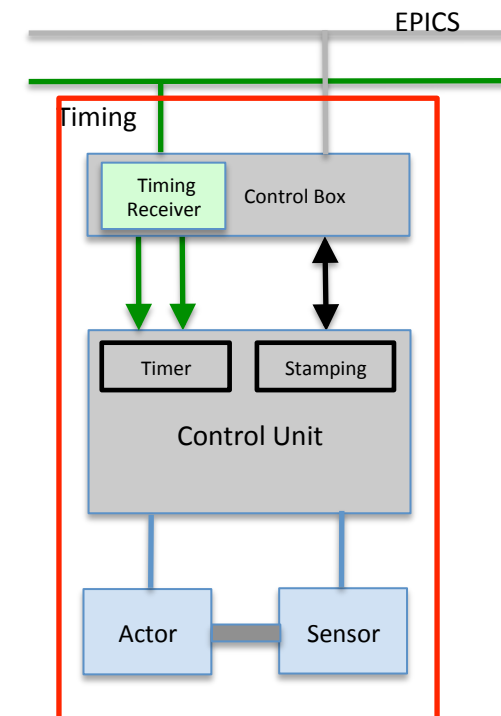
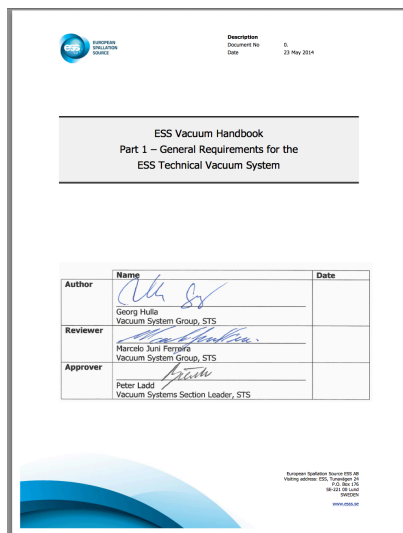
Responsibilities

Technology: MCA/E&IS

Integration: NSS

General control standards

- Vacuum
 - Vacuum handbook by Vacuum Group
 - PLC control by ICS
- Cooling
 - PLC control by ICS
- Power Monitoring
 - Monitoring by CF
 - Integration into EPICS by ICS
- Personnel Safety Systems
 - Done by ICS



Responsibilities

Technology: ICS

Integration: ICS