



System Integration

E. Fagotti



Outline



- Starting status
- Interface Management Workflow & Documentation
- PBS interfaces
- Some results



Starting Status (February 2014)



Interfaces identification was spread among different people inside a WP without a clear responsible.

In some cases Interface Requirements (IR) were well defined. In some other they weren't defined in a clear way. In some cases there were lack of requirements. In rare cases requirements were completely wrong.

No interface documentation review and approval

Project Breakdown Structure (PBS) to be completed

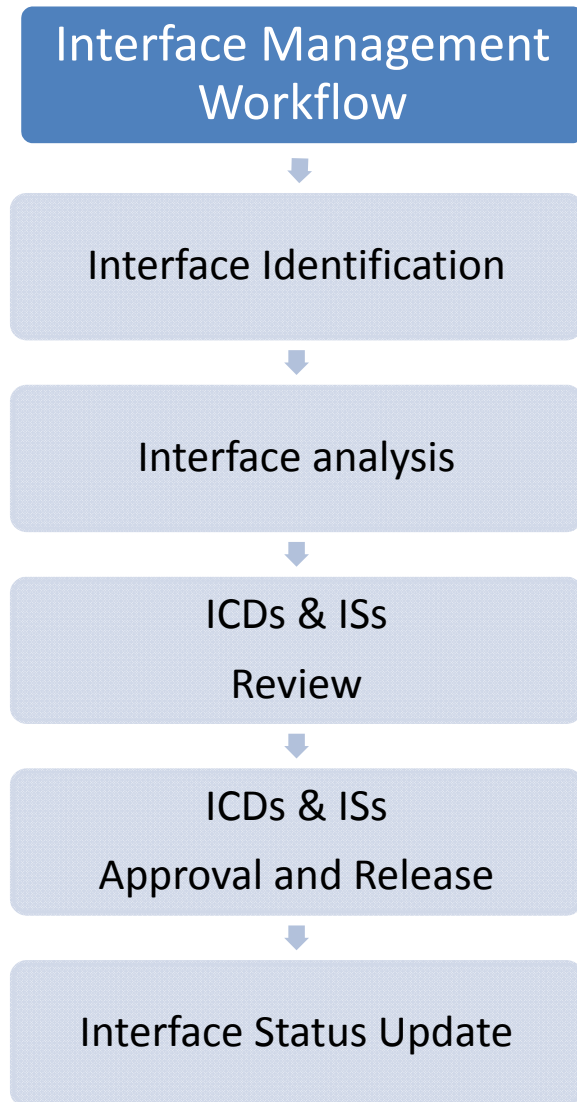
Work Breakdown Structure (WBS) to be completed



First objectives



- Define an Interface Management Workflow
- Identify a minimum number of documents to collect informations
- Starting interfaces identification using PBS levels
- Define some practical guideline to define systems limits and responsibilities



For each potential interface between their system and another system, each Work Package Responsible (WPR) shall identify whether an interface exists and if it does, define at least one Interface Control Document (ICD)

Each WPR shall

- List the constituent Interface Sheets (IS) that the interface shall be divided into
- For each IS within the ICD, define Interface Requirements (IR)

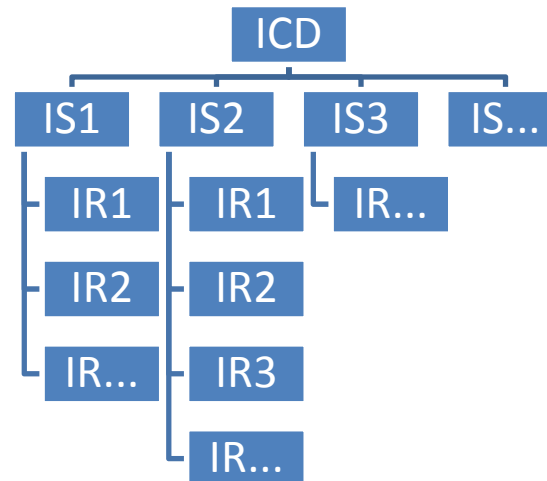
The System Integrator (SI) triggers interface meetings and performs ICDs and ISs review

Both WPRs approve the reviewed ICDs and ISs. The ICDs are then released into the project baseline.

The WPR shall, for each IS of each ICD of his system, keep track of the evolution of the interfacing systems and update accordingly the existing IRs.

Documents details

- **Interface Control Document (ICD):** a collection of ISs describing the interfaces for all interfacing products (any PBS item) within a system or between two systems. An ICD need not be a textual document but it may be an (evolving) table.



- **Interface Sheets (IS):** a set of interface requirements relevant to two interfacing products within a system or between two systems. An IS is a technical view. An IS need not be a textual document but it may be an (evolving) table.
- **Interface requirement (IR):** a requirement on an interface. An interface requirement can be:
 - A quantitative constraint
 - A qualitative constraint
 - A reference to a constraint



More on Role and Responsibility



Work Package Responsible (WPR)

- The WPR originate and author the ICDs and ISs (occasionally they may delegate authorship and/or assign co-authorship as appropriate)
- WPRs are also responsible for approving and releasing the ICDs and ISs for their interfacing systems. They must also ensure compliance between the IRs and the applicable information of their system.

System Integrator (SI)

- Organizes Interface Management Meeting for triggering interface identifications and analysis
- Review the ICDs and ISs
- Provide guidance on the use of the interface management procedure
- Assess the compliance of the ISs and ICDs with the interface management procedure
- Request author to correct their ISs and ICDs if needed
- Identify any conflict between authors regarding the preparation of ICDs and ISs and, if any, provide support to the author for the resolution of such conflict
- Make sure the released ICDs are updated into configuration baseline.

Tentative PBS

1	0	0	0	Scientific Support
2	0	0	0	Radioprotection and Safety
3	0	0	0	Infrastructures
4	0	0	0	Controls
5	0	0	0	Cyclotron
6	0	0	0	Exotic Beams
7	0	0	0	Beam Transport & Selection
8	0	0	0	RFQ
9	0	0	0	RNB Accelerator
10	0	0	0	Mechanics & Alignment
11	0	0	0	Vacuum System
12	0	0	0	Project Management

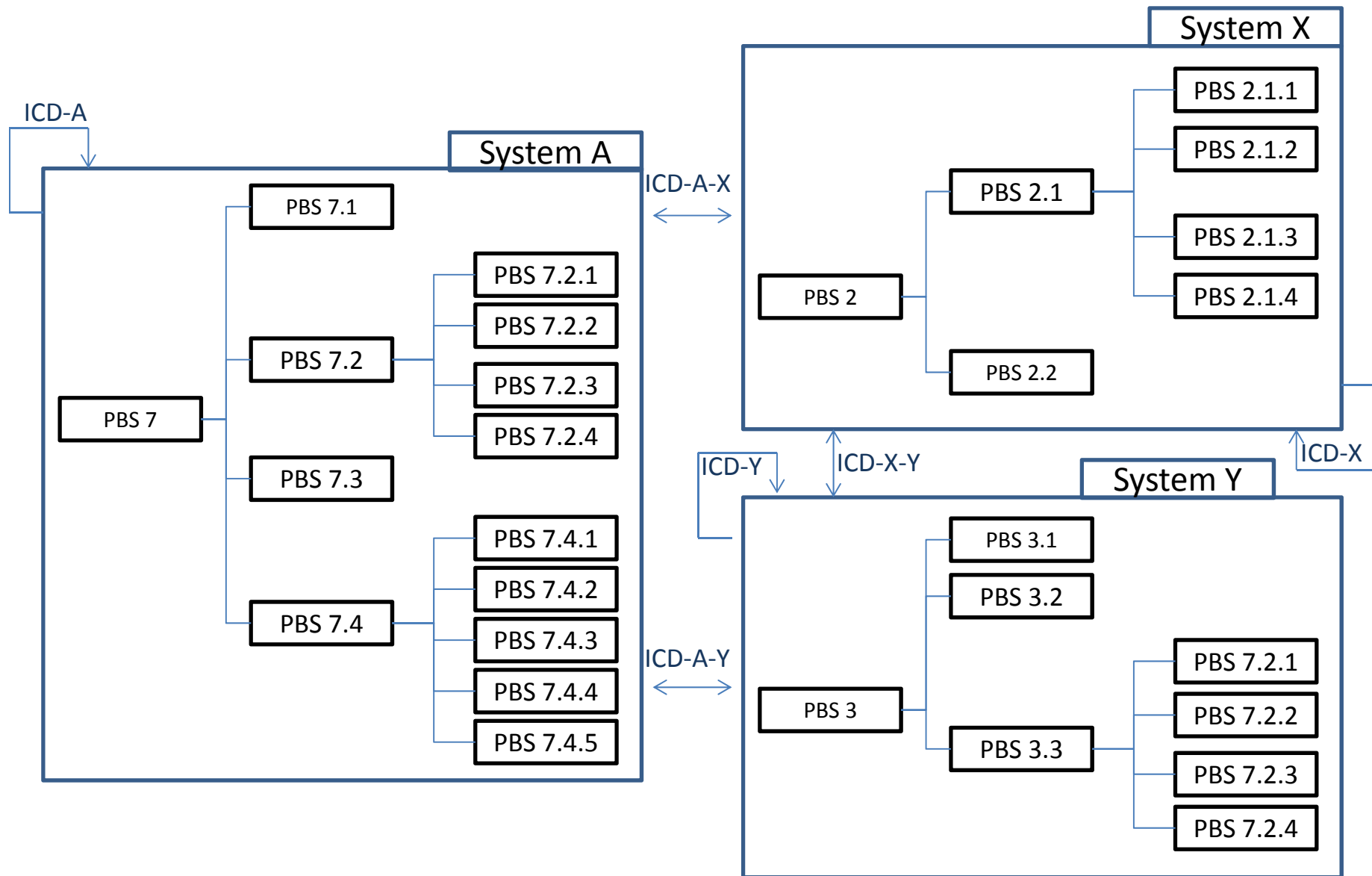
1° Level PBS:WP

1	0	0	0	Scientific Support
1	0	0	0	Nuclear Instrumentation and Measurements
2	0	0	0	SPES web site
2	0	0	0	Radioprotection and Safety
1	0	0	0	Radioprotection
2	0	0	0	Safety
3	0	0	0	Infrastructures
1	0	0	0	Building
2	0	0	0	Plants for the building
3	0	0	0	Plants for SPES
4	0	0	0	Controls
1	0	0	0	Machine Control System
2	0	0	0	Machine Protection System
3	0	0	0	Person Protection System
5	0	0	0	Cyclotron
1	0	0	0	Cyclotron Accelerator
2	0	0	0	Transfer Lines
3	0	0	0	Beam Dump
6	0	0	0	Exotic Beams
1	0	0	0	Target Material and Ucx Production
2	0	0	0	Target Ion Source Complex
3	0	0	0	Laser System
4	0	0	0	ISOL Front End
5	0	0	0	Handling

2° Level PBS

7	0	0	0	Beam Transport & Selection
1	0	0	0	Beam Dynamics
2	0	0	0	RIBS Beam Lines
3	0	0	0	RNB Diagnostics
4	0	0	0	Selection
8	0	0	0	RFQ
1	0	0	0	Cavity
2	0	0	0	RF
3	0	0	0	Cooling/Tuning System
4	0	0	0	LCS
5	0	0	0	LLRF
6	0	0	0	Vacuum System
9	0	0	0	RNB Accelerator
1	0	0	0	Charge Breeder
2	0	0	0	Cryogenics
3	0	0	0	Cryostats & Cavities
4	0	0	0	Bunchers and Chopper
10	0	0	0	Mechanics
1	0	0	0	Beam Pipes
2	0	0	0	Supports
3	0	0	0	Alignment
11	0	0	0	Vacuum System
1	0	0	0	Conventional Vacuum
2	0	0	0	High contaminants Vacuum System
3	0	0	0	Hot Areas Exhaust
4	0	0	0	Maintenance Area
12	0	0	0	Project Management
1	0	0	0	Management & Administration
2	0	0	0	Environment, Safety and Health doc
3	0	0	0	Quality Assurance

ICD example



Ownership

- When a product is a service line (supplier) connected to another product (consumer), unless formally defined otherwise, the service line and its end connector belongs to the service line supplier and the socket in which the connector is plugged belongs to the consumer.
- A penetration in a wall belongs to the building, or room, to which the wall belongs. A service line penetrating a wall belongs to the service line supplier.

Geographical interfaces

- A product that has one single geographical location has one interface with the room in which it is located. A product that has several geographical locations has one interface per adjacent geographical location.

Some results: SPES parameters

Reference	A/Q													
Cyclotron	1													
RIB source	140													
RFQ cooler	140													
Charge Breeder	7.5													
	Cyclotron Extraction	Cyclotron line	RIB Source	Q=1 transp.	RFQ Cooler	HMRS	Charge Breeder	Q>1 transp.	MMRS	RFQ	ALPI L.B.	ALPI M.B.	ALPI H.B.	Unit
Equivalent Voltage	70	0	0.0429	0	0.0428	-0.2670	0.0428	0	-0.1286	5.4098	15.51	30.89	14.82	MV
Center energy	-	-	-	-	0.0000007	0.0022	0	-	0.0228	-	-	-	-	MeV/u
Output Energy	70	70	0.00031	0.00031	0.00031	0.00031	0.0057	0.0057	0.0057	0.727	2.795	6.913	8.889	MeV/u
Center Beta	-	-	-	-	0.000039	0.0022	0	-	0.0070	-	-	-	-	
Output Beta	0.3662	0.3662	0.00081	0.00081	0.00081	0.00081	0.0035	0.0035	0.0035	0.0393	0.0770	0.1207	0.1367	
Transmission (acceptance value)	9.3	99.0	100.0	95.0	80.0	95.0	5.0	95.0	95.0	85.0	80.0	80.0	90.0	%
Transmission (cumulative)	9.3	9.2	100.0	95.0	76.0	72.2	3.6	3.4	3.3	2.8	2.2	1.8	1.6	%
Resolving Power	-	-	-	200	-	10000	-	-	1000	-	-	-	-	
Output H emittance (norm., rms)	-	-	0.007	0.00735	0.000735	0.00077175	0.080	0.080	0.080	0.084	0.088	0.093	0.097	mm-mrad
Output V emittance (norm., rms)	-	-	0.007	0.00735	0.000735	0.00077175	0.080	0.080	0.080	0.084	0.088	0.093	0.097	mm-mrad
Output longitudinal rms emittance	-	-	-	-	-	-	-	-	-	5.0	5.3	5.5	5.8	deg-KeV/u
Energy Spread	560000	560000	20	20	5	5	5	5	5	-	-	-	-	eV
Energy Spread	0.8	0.8	0.04667	0.04667	0.01167	0.01167	0.00063	0.00063	0.00063					%
Controlled beam loss, expected	-	0.5		0.5	15	0.5	80	0.5	0.5	5	5	5	2	%
Uncontrolled beam loss; expected	-	0.5		4.5	5	4.5	10	4.5	4.5	10	15	15	8	%
Output H emittance increase	-	-	-	5	-90	5	-	0		5	5	5	5	%
Output V emittance increase	-	-	-	5	-90	5	-	0		5	5	5	5	%
Output L emittance increase	-	-	-	-	-	-	-	-	-	-	5	5	5	%
Interface Sheet	IS-5.1-5.2-1	IS-5.2-6.1-1	IS-6.2-7.1-1	IS-7.2.1-7.1-1	IS-7.4.2-7.1-1	IS-7.4.3-7.1-1	IS-9.1-7.1-1	IS-7.2.3-7.1-1	IS-7.4.4-7.1-1	IS-8.1-7.1-1	IS-7.2.4-7.1-1			



Some results: Tender for magnets ISs to insert in ICD-12.1-7.2



- Technical Specification standardization (IS-12.1.1-7.2.3-1):

- Format
- Documents to require
- Aspects and costs to include
- Technical documents to require
- Control meetings organization
- Requirements for stocking, packaging and handling
- Requirements for health, safety and environment
- Specific requirements
- Quality control
- Non conformity management
- Conformity verification
- Penalty clauses
- Etc.

7	0	0	0	Beam Transport & Selection
1	0	0	0	Beam Dynamics
2	0	0	0	RIBS Beam Lines
	1	0	0	TIS extraction
	2	0	1+	Transport Line up to CB
		1		Electrostatic Lenses
		2		Dipoles
		3		Power Supplies
	3	0	n+	Transport Lines from CB to RFQ
		1		Magnets
		2		Electrostatic Lenses
		3		Dipoles
		4		Power Supplies

12	0	0	0	Project Management
1	0	0	0	Management and Administration
	1	0	0	Administration
		1	0	Tenders
		2	0	Business Travels
		3	0	Orders

- Contractual Conditions standardization (IS-12.1.1-7.2.3-2).



System Integration Organization



- Up to now system integration activity was limited due to limited FTE.
- With the beginning of next year management group devoted to system integration will be consolidated.

Next future

- Next Interface Management Meetings will be focused on PBS 5.0 (Cyclotron) interfaces and in particular with:
 - PBS 2.0 (Radioprotection and Safety)
 - PBS 3.0 (Infrastructure)
 - PBS 4.0 (Controls)
 - PBS 6.0 (Exotic beams)
 - PBS 10.0 (Mechanics & Alignment)

Schedule Cyclotron Interfaces

