

# Accelerator Testing Planning

aTAC#18

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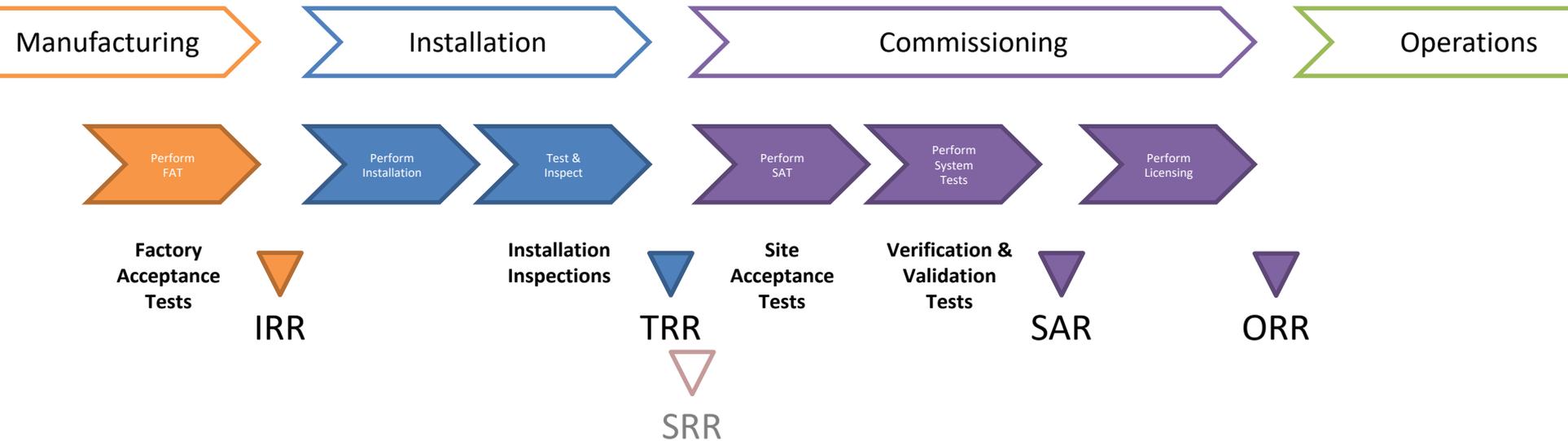
October 18, 2018

# Outline

- Strategy
- Planning
- Status
- Lessons (being) learned



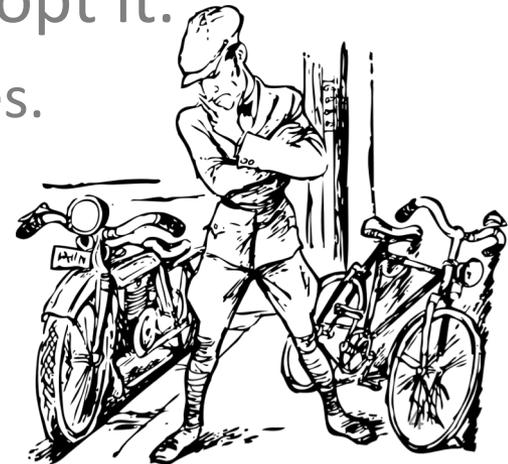
# Strategy



The main purpose of the testing activities is to verify that the systems and components meet their requirements and operational goals, i.e. they are verification and validation activities.

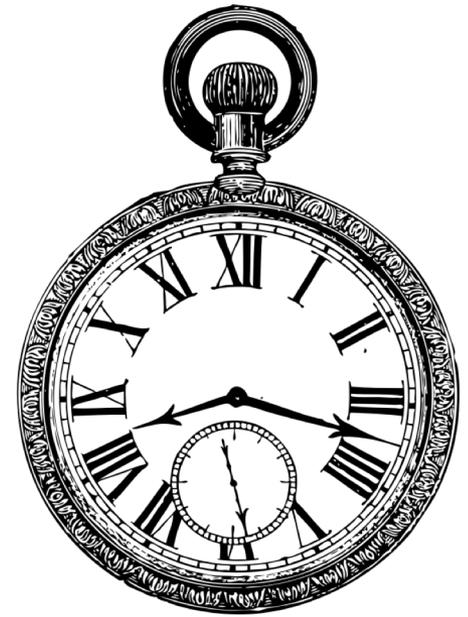
# Strategy: Pragmatic approach

- Centralize coordination to get some **consistency**, but give teams agency to use the appropriate practices for themselves.
  - We try to minimize disruptions to ongoing work.
- It is better to adopt a **good-enough** approach quickly than a perfect one eventually, but it will nonetheless require an **effort from everybody** to adopt it.
  - It is challenging with the available resources.



# Planning: Priorities

- Realistic **time allocation** in the ITC plan
  - Add and link detailed activities in JIRA
- **Milestones** linked between JIRA & P6
- **Key dependencies**
  - Links to other Accelerator systems and other divisions (CF, ICS...)
  - Correct Gateways/Reviews (TRR, SRR...)
- **Additional support**
  - Identify relevant Permits (internal, SSM...)
  - Ensure Safety Measures (RAMS, WSCP...)



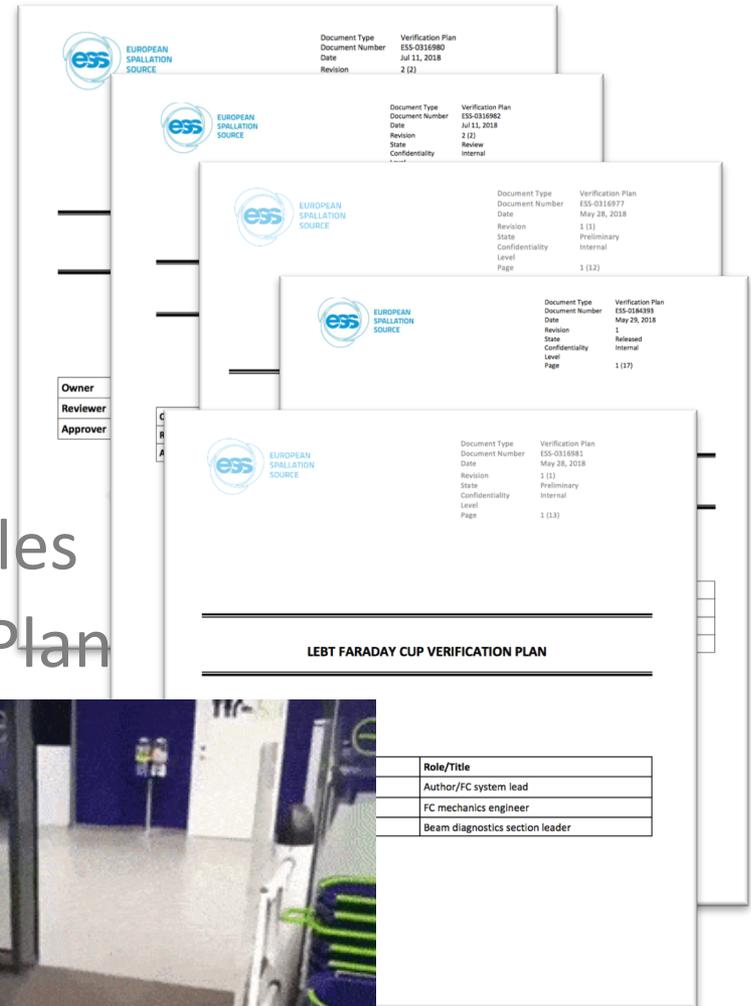
# Status: Procedures

- Use of ESS procedures to coordinate plans:
  - [Handbook for Engineering Management, ESS-0092276](#)
    - [Graphical Workflow, ESS-0093443](#)
  - [Procedure for Prepare for Installation and Installation, ESS-0102864](#)
  - [Procedure for Test, Verification and Commissioning, ESS-0102865](#)
  - [Handbook for System Verification, ESS-0117128](#)
  - [Accelerator System Verification Plan, ESS-0005458](#)



# Status: Verification Plans

- BCM verification plan
- LEBT EMU verification plan
- DPL verification plan
- LEBT NPM verification plan
- LEBT FC verification plan
- HIPOT Testing for vacuum cables
- Gamma Blockers Verification Plan
- RSMS Test Procedures
- ...



Stack of verification plan documents showing metadata and a table of roles.

Document Type	Verification Plan
Document Number	ESS-0316980
Date	Jul 11, 2018
Revision	2 (2)

Document Type	Verification Plan
Document Number	ESS-0316982
Date	Jul 11, 2018
Revision	2 (2)
State	Review
Confidentiality	Internal

Document Type	Verification Plan
Document Number	ESS-0316977
Date	May 26, 2018
Revision	1 (1)
State	Preliminary
Confidentiality	Internal
Level	1 (12)
Page	1 (12)

Document Type	Verification Plan
Document Number	ESS-0316993
Date	May 29, 2018
Revision	1
State	Released
Confidentiality	Internal
Level	1 (17)
Page	1 (17)

Document Type	Verification Plan
Document Number	ESS-0316981
Date	May 26, 2018
Revision	1 (1)
State	Preliminary
Confidentiality	Internal
Level	1 (13)
Page	1 (13)

**LEBT FARADAY CUP VERIFICATION PLAN**

Role/Title
Author/FC system lead
FC mechanics engineer
Beam diagnostics section leader



# Status: Planned activities (NC Linac)

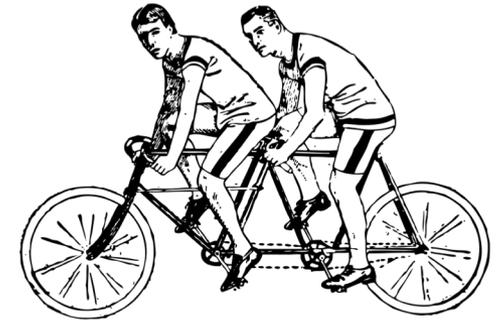
System	Local tests	Integrated tests
RFQ Cooling Water		<a href="#">PLC comm. w/ controls</a> , <a href="#">Closed loop test (dry run)</a>
RFQ Vacuum	<a href="#">Leak tests</a>	
RFQ EMR	<a href="#">RFQ tuning</a>	
RFQ		<a href="#">Test comm. w/ LLRF</a>
MEBT Cooling Water	<a href="#">Manifold inst.</a>	
MEBT Vacuum	<a href="#">Leak tests</a>	<a href="#">Integrated tests</a>
MEBT EMR	<a href="#">Buncher tuning</a>	<a href="#">Controls tests</a> , <a href="#">Tuner comm. w/ LLRF</a> , <a href="#">RF conditioning</a>
MEBT Bilbao rack equipment	<a href="#">Local tests</a>	
MEBT Beam Instrumentation		<a href="#">Tests w/o beam</a> (x9)
MEBT Magnets		<a href="#">Integrated tests</a>
MEBT Chopper		<a href="#">Integrated tests</a>
MEBT MPS		<a href="#">Tests</a>
MEBT		<a href="#">Dry run</a>
DTL EMR		RF conditioning <a href="#">1</a> , <a href="#">2-4</a> , <a href="#">5</a>
DTL	Local HW tests: <a href="#">1</a> , <a href="#">2</a> , <a href="#">3</a> , <a href="#">4</a> , <a href="#">5</a>	Dry run: <a href="#">1</a> , <a href="#">2</a> , <a href="#">3</a> , <a href="#">4</a> , <a href="#">5</a> , <a href="#">HW verification w/ beam</a>

# ISrc & LEBT Testing and Commissioning Lessons Learned

- Session held 2018/10/12
- Worked well:
  - PSS is working great
  - Weekly meeting to organise the SRR was very useful
  - Vacuum documentation was excellent from the controls point of view
  - Good team building experience
  - Great support from technicians and Area Coordinators
- To be improved:
  - Changing conditions lead to need for re-testing
  - **FAT documentation** lacking
  - **Sequence** of tests (PSS...) needs to be more explicit
  - Management disconnect, lack of engagement
  - **Quality inspections** for all installations, make no assumptions
  - **Verification plans** missing (sometimes), and they should also include integration tests
  - Cramming activities to meet “arbitrary” deadlines leads to inefficiencies
  - Infrastructure plan still under development, coordination needed
  - **TRR was too weak**
- Suggestions:
  - Clear checklists
  - Clarify the **safety responsibility** during testing
  - Balance the paperwork vs hands-on work
  - SRR ≠ Beam RR, minimalistic and focused on safety
  - **Dry runs**
- Report in preparation

# Testing-related learned lessons from other projects

- Lessons learned in different topics:
  - Leadership
  - Planning
  - Communication
  - Documentation
  - Control systems
- Collected from the proceedings of several conferences, as well as during the workshop held on Tuesday:
  - NuMI Lessons to Learn, S. Childress, Fermilab, 29 Sep 2008
  - Overview and Lessons Learned of the Jefferson Lab Cryomodule Production for the CEBAF 12 GeV Upgrade, North American PAC 29 September–04 October 2013 (WEZAA2)
  - The Spallation Neutron Source Beam Commissioning and Initial Operations, ORNL/TM-2015/321
  - ProtoDUNE - lesson learned, D. Mladenov CERN EP/NU, LBNF Cryostat final design review, SURF 21-22 August 2017
  - MAX IV Laboratory, Milestones and Lessons Learned Vincent Hardion on behalf of KITS Group, MAXIV ICALEPCS 2015
  - MAXIV STATUS, KITS MAXIV, 29th Tango meeting, Krakow
  - Workshop on Testing and Commissioning, ESS, Lund, 16 Oct 2018 ([link](#))
    - Diamond Commissioning, Mark Heron
    - SNS Commissioning, Mike Plum
    - RF commissioning at XFEL, Julien Branlard



# Testing-related learned lessons from other projects

- Leadership
  - *“While our reviews are essential, many times they do not go into enough depth to really find many more subtle but major problems. For any challenging technical project, it is essential to have broad based lead **technical experience at a decision making level.**”*
  - *“Better/Faster way to **resolve disputes**, or ideally avoid them altogether.”*
  - *“**Changing** an established organisation is extremely **difficult.**”*

# Testing-related learned lessons from other projects

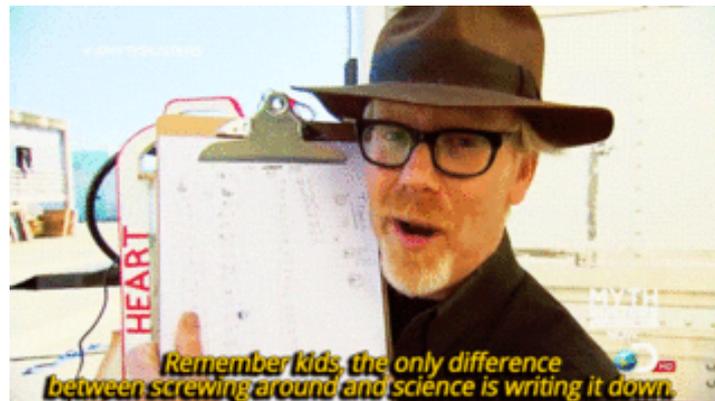
- Planning
  - “Some tests fail, allow for plenty of **time** for testing.”
  - “More time to evaluate/trade-off installation/operation impacts.”
  - “**Integrate** detailed schedule of activities including **resources** and **interdependencies** (Civil, beam transport, cryogenics, high power-rf, instrumentation, controls & safety)”
  - “Early operation of the frontend at SNS provided an opportunity for **integrated tests** of most of the basic accelerator systems, e.g. the control system, timing, machine protection, RF, vacuum and high level software.”
  - “Be prepared to take out installed equipment (storage, maintenance, documentation, testing, training, etc).”
  - “Commissioning a large accelerator facility necessitates **parallel Hardware and Beam commissioning.**”
  - “**Parallelising** activities has **limits.**”
  - “**Deep system test** of each device, from hardware to the synoptic (~fully operational for the commissioning).”
  - “Large part of the project was spent on the **subsystems tests** (SST): the goal was to deliver the system ready for the commissioning with the fewest experienced defects. The SST helped to discover the discrepancy in the connection chain. For example the steering and the protection system of every single magnet has been all tested from the power supply to the report of the correct field of the magnet on the synoptic GUI.”
  - “**Expect surprises:** even the best checklist won't catch everything.”
  - “Start tests as **soon** as the kit is ready for test, not to some arbitrary schedule.”

# Testing-related learned lessons from other projects

- Communication
  - *“Diligent communication between **all relevant stakeholders** is essential to deliver an optimal solution”*
  - *“Good communication & **cross functional coordination** is critical to success”*
  - *“Group should have established a **rapport with safety officers.**”*
  - *“Have an **Electronic Log Book** system up and running from day one”*
  - *“Tools will never solve any organisational communication issue”*
  - *“Operators working with and **learning from other groups** is invaluable experience and proves immensely helpful back in the control room”*
  - *“**Accelerator scientists in the control room** makes operators better: Questions are answered, issues are approached together, learning happens”*

# Testing-related learned lessons from other projects

- Documentation
  - “*Procedure documentation, operation training, and testing are **time consuming but essential.***”
  - “***Configuration Management:** define the source and format of information.*”
  - “*A **calibration plan** should be developed.*”
  - “*Information gathered early is vital. **Document** as you go along”*”
  - “*Design and follow **checklists**”*”



# Testing-related learned lessons from other projects

- Control systems
  - *“Software needs to be ready before beam commissioning, and should be **tested in advance**.”*
  - *“All subsystem had to include the Control System in their test suites. The tests included the access to the functionalities but also the **performance** and the **quality** of the responses. The improvement in the configuration management allowed a very **fast reconfiguration** without regression for all the different subsystems.”*

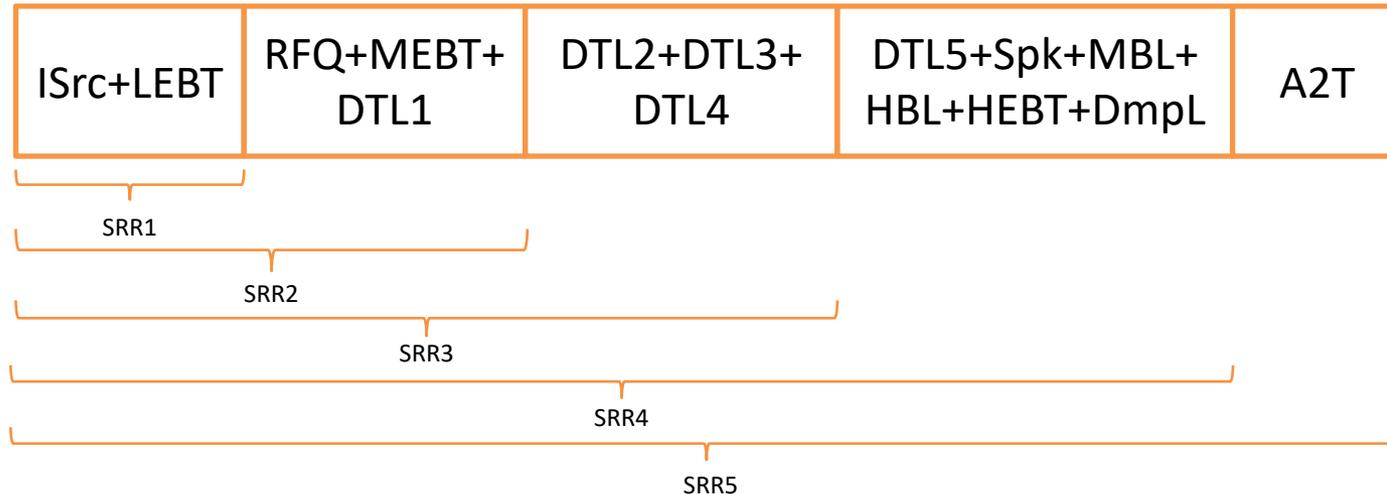
# Summary

- Short term goals:
  - Identify missing activities and V&V plans
  - Update the JIRA plan with milestones linked to Primavera
- Medium term goals:
  - Help producing the missing documentation
  - Support the preparation of TRRs and SRRs
  - Organise dry runs
- Long term goals:
  - Make sure the commissioning team gets the hardware they need, reliably tested and on time

Thank you for your attention

# Commissioning vs Beam Commissioning

- In the context of the Handbook for Engineering Management, “Commissioning” is used for the Verification and Validation phase of all systems, independently of the use of the proton beam.
- To show to that the systems are ready from a safety point of view to start “Beam Commissioning” part of the accelerator, 5 separate **Safety Readiness Reviews (SRR)** will be held.

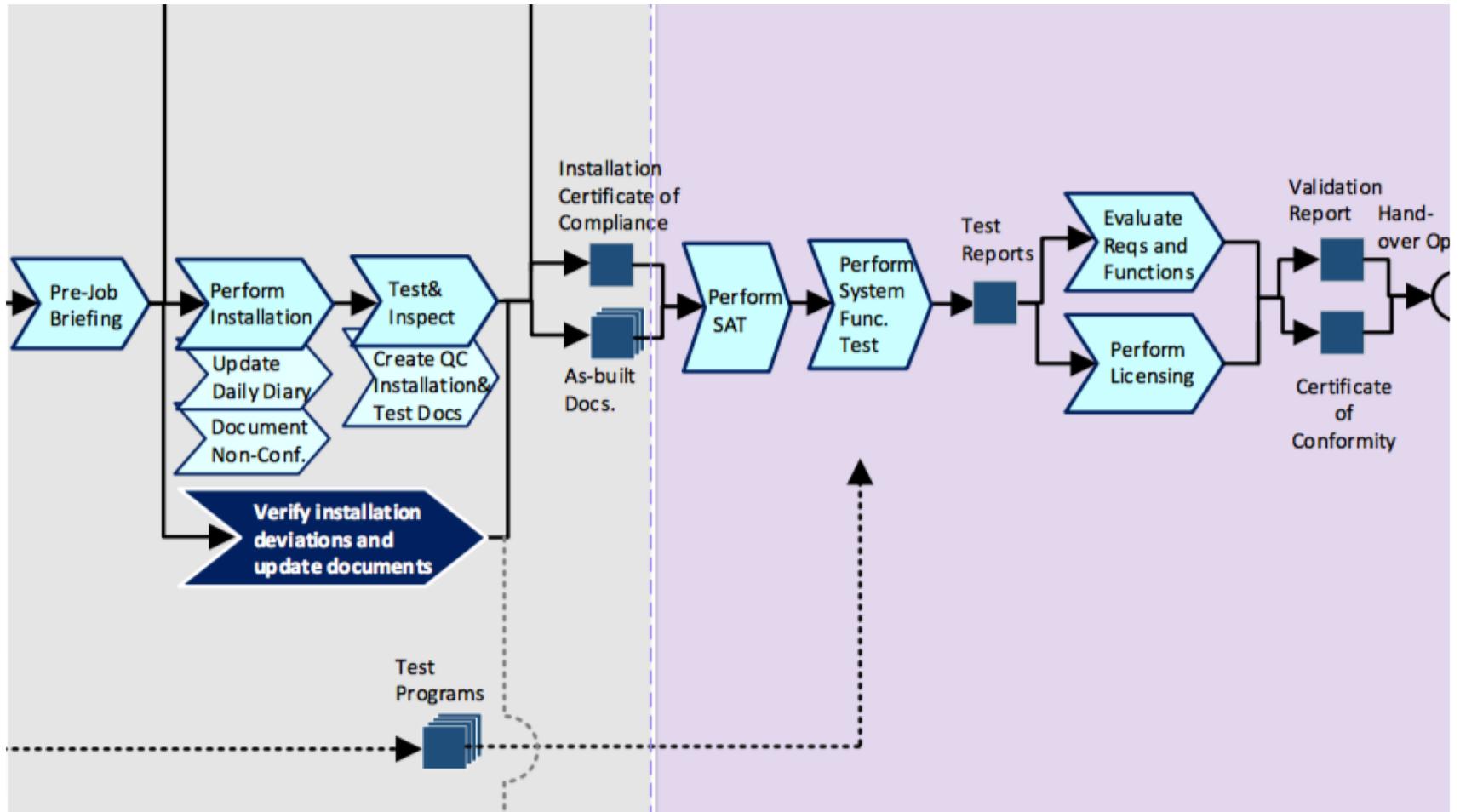


# Status: Planned activities (NC Linac)

+	NCLIN	testing milestones relating to other projects - Summary of	Inigo Alonso	TO DO	2019-Mar-08	2020-Oct-01	Mileston	
✓	NCLIN	RFQ cooling system ready	Janet Schmidt	TO DO	2019-Mar-08	2019-Mar-08	Mileston	
✓	NCLIN	LLRF input signal to SKID controls available - As we discuss	Anders J Johansson	TO DO	2019-Mar-08	2019-Mar-08	LLRF	
✓	NCLIN	RFQ controls operational - milestone for ICS	Thomas Fay	TO DO	2019-Mar-08	2019-Mar-08	ICS	
+	NCLIN	MEBT racks powered up and handed over	Olle Lagerblad	TO DO	2019-Apr-26	2019-Apr-26	Mileston	
✓	NCLIN	MEBT controls operational - milestone	Joao Paulo Martins	TO DO	2019-May-10	2019-May-10	Mileston	
✓	NCLIN	DTL cooling system operational - milestone	Anton Lundmark	TO DO	2019-May-27	2019-May-27	Mileston	
✓	NCLIN	DTL4 control system operational	Thomas Fay	TO DO	2019-May-27	2019-May-27	DTL	
✓	NCLIN	PSS1 ready for operation - milestone to tick off when PSS1	Morteza Mansouri	TO DO	2019-Jul-01	2019-Jul-01	Mileston	
✓	NCLIN	DTL1 control system operational	Thomas Fay	TO DO	2019-Jul-08	2019-Jul-08	DTL	
✓	NCLIN	RF system for RFQ and DTL1 operational - This is a milest	Morten Rostrup For	TO DO	2019-Jul-12	2019-Jul-12	Mileston	
✓	NCLIN	MEBT RF system operational - This is a milestone for the f	Morten Rostrup For	TO DO	2019-Jul-12	2019-Jul-12	Mileston	
✓	NCLIN	SSM licence released for cavity conditioning		TO DO	2019-Sep-13	2019-Sep-13	Mileston	
✓	NCLIN	DTL3 control system operational	Thomas Fay	TO DO	2019-Nov-22	2019-Nov-22	DTL	
✓	NCLIN	RF system for DTL2 - DTL5 ready	Morten Rostrup For	TO DO	2020-Jan-03	2020-Jan-03	Mileston	
✓	NCLIN	DTL2 control system operational	Thomas Fay	TO DO	2020-Jan-06	2020-Jan-06	DTL	
✓	NCLIN	DTL5 control system operational	Thomas Fay	TO DO	2020-Aug-17	2020-Aug-17	DTL	
✓	NCLIN	PSS for DTL5 operation ready - a milestone like NCLIN-45	Morteza Mansouri	TO DO	2020-Oct-01	2020-Oct-01	Mileston	
✓	NCLIN	MEBT cooling system operational - milestone	Anton Lundmark	TO DO	2019-May-10	2019-May-10	Mileston	
+	NCLIN	DTL4 Beam Stop Installation	Thomas Shea	TO DO	2019-May-20	2019-May-31	P6	
+	NCLIN	Temporary Shielding Installation	Håkan Danared	IN PROGRESS	2019-Jun-03	2019-Jun-14	P6	
+	NCLIN	Full PSS 1 Validation by ICS		TO DO	2020-Feb-03	2020-Feb-14	P6	
+	NCLIN	Partially PSS 1 Validation by ICS (Iscr, LEBT, RFQ, DTL1)	Stuart Birch	TO DO	2020-Feb-03	2020-Feb-14	P6	
+	NCLIN	Safety Readiness Review (SRR2) - ISrc - DTL1	Edgar Sargsyan	TO DO	2019-Nov-01	2019-Nov-01	P6	Re
+	NCLIN	SRR preparation - Prepare according to: ESS-0123091 - I	Edgar Sargsyan	TO DO	2018-Jun-20	2018-Jun-20		
+	NCLIN	Safety Readiness Review (SRR3) - Front End + DTL1,2,3,4	Edgar Sargsyan	TO DO	2018-Jun-20	2018-Jun-20	P6	Re
+	NCLIN	SRR preparation - Prepare according to: ESS-0123091 - I	Edgar Sargsyan	DONE	2018-Jun-20	2018-Jun-20		
+	NCLIN	ISrc - DTL1 Beam Commissioning - h5. Ref * ESS-0157170	Ryoichi Miyamoto	TO DO	2020-Jan-06	2020-Mar-27	BeamC	
+	NCLIN	ISrc - DTL4 Beam Commissioning	Ryoichi Miyamoto	TO DO	2020-Apr-27	2020-Jul-17	P6	
+	NCLIN	DTL4 Beam Stop Removal	Thomas Shea	TO DO	2020-Jul-20	2020-Jul-24	P6	
+	NCLIN	Temporary Shielding Removal	Håkan Danared	TO DO	2020-Jul-20	2020-Jul-24	P6	



# Handbook of Engineering Management



# Requirements Engineering

- Quality: “Conformance to requirements”
- Good requirements engineering practices are a prerequisite to deliver systems that fulfil the Operations needs

