



# Status of dry-run planned for the SPS

K. Li for the SPS Commissioning and Operations team

**SPS MCM**

**27. January 2020**

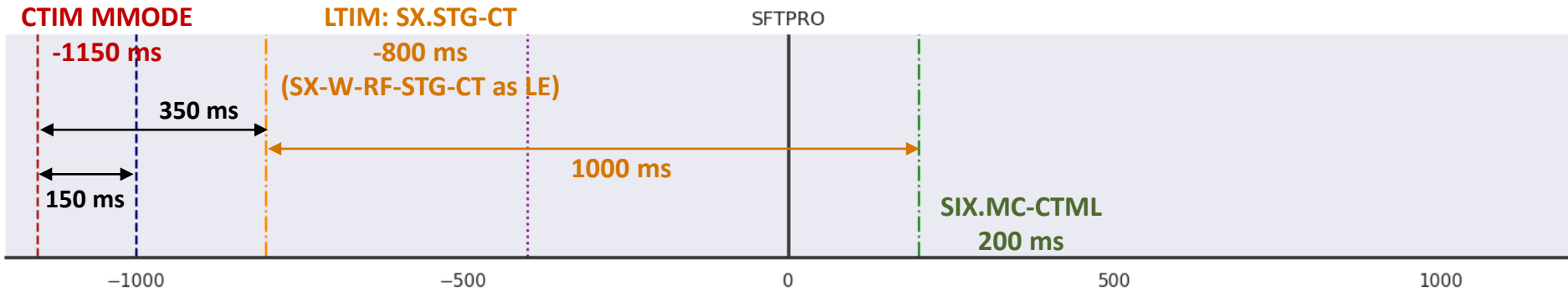


# ATIM updates

- ATIMs during coast:
  - At configuration pulse, ATIM needs to know whether next machine mode is cycling or coast - to prepare timings for next cycle!
  - Agreed with timing team to **add a new timing event at 1150 ms before start of cycle** – then next machine mode is available. This is also the event that is used as “configuration pulse” and triggers the configuration phase for the ATIMs.
  
- ATIMs start timing generator:
  - ~~Use a forewarning start cycle (FCY1K) as load event for the LTIM~~
  - ~~Trigger occurrence with respect to injection forewarning – **equivalent F1KFO; use Makerules to compute delays from FCY1K**~~
  - ~~Original plan to use a new event similar to F1KFO, occurring also in case of missed injection, brought many more complications~~
  - We got a separate configurable timing event here as well, that we can use as load event to start the timing generator – SX.RF-STG-CTML with first injection and SX.W-RF-STG-CTML currently set at 1k seconds before first injection



# ATIM cycle architecture



- New timing event at **1150 ms before start cycle** to trigger ATIM configuration and carrying machine mode
- ~~Load event forewarning **1s before start cycle** (SX.FCY1K-CT) is used for start timing generator (SX.STG-CT)~~
- SX.STG-CT now triggered directly via SX.W-RF-STG-CT – no more makerules needed here
- ~~Start timing generator delay computed to occur with forewarning **1s before first injection via Makerule**:~~
  - ~~SX.STG-CT load event = SX.FCY1K-CTML~~
  - ~~SX.STG-CT delay = **SIX.MC-CTML + SX.F1KFO-CTML - SX.FCY1K-CTML**~~
- ~~Earliest possible start timing generator can occur **150 ms after trigger ATIM configuration**~~
- ~~For SFTPRO, which is earliest possible injection time today the start timing generator occurs **350 ms after start ATIM configuration** → **well within the chosen window of 200 ms (with margins)**~~





# Last ATIM dry run done 18. December 2019

Sequence Editor: Edit BCD /Coast LHCMD1 ION 0/3/4

Type: Description Rule violations Selection

General description

Name: Coast LHCMD1 ION 0/3/4

Desc:

SPS:CTTIMINGS - SPS.USER.LHCMD1 - (INCA)

File Edit View References Archives Commands Control Programs Help

18 Dec 2019 09:15:19 SPS - 11 LHCMD1 | MD\_ION\_4inj\_FT2073\_27... 11/22

JAPC view

SCV	CCV	AQN	Occurrence	
SX.FCY1K1-NBM-CTML	-1100	-1100	0	
SCV	Pulse	CCV		
SX.V-SCY-CTML	true		0	
SCV	CCV	AQN	Occurrence	
SX.APEC0-QW-CTML	1199	1199	0	
SX.FCY-MMODE-CTML	-1150	-1150	0	
SX.SCY-CTML	0	0	0	
SX.FCY1K-CTML	-1000	-1000	0	
SX.FCY2500-CTML	-2500	-2500	1	
SX.FGC-TT10-CTML	-2899	-2899	0	
SX.FGC-TT10-D-CTML	-2898	-2898	0	
SX.FGC-RING-CTML	-1199	-1199	0	
SX.FGC-RING-D-CTML	-1198	-1198	0	
SBP	Pulse	CCV		
SX.V-SBP-CTML	true		0	
SBP	CCV	AQN	Occurrence	
SX.RPL5-CTML	-1	-1	0	
SX.SBP-CTML	0	0	0	
SX.APPACQ-CTML	1100	1100	0	
INJ	Pulse	CCV	Rpt	Delay
SIX.MC-CTML	true	725	3	3600
INJ	CCV	AQN	Occurrence	Delay
SIX.AMC-CTML	0	725	1	0
SIX.AMCF0-CTML	0	11525	1	0
SIX.AMCL0-CTML	0	10525	1	0
SIX.W20-CTML	-20	11505	0	0
SIX.W20-CTML	-20	11505	0	0
SIX.F1KDF0-CTML	-1001	-276	1	0
SIX.F1KL0-CTML	-1000	10525	-1	0
SIX.F1KF0-CTML	-1000	-275	1	0
SIX.DRESET-CTML	-250	11275	0	0
PREPARE LLRF	Pulse	CCV		
SX.RF-STG-CTML	true		725	
PREPARE LLRF	CCV	AQN	Occurrence	
SX.W-RF-STG-CTML	-1000	-275	0	
RAMP	Pulse	CCV		
SX.ST-RAMP-CTML	true		12145	
RAMP	CCV	AQN	Occurrence	
SX.S-RAMP-CTML	0	12145	0	
SX.S-F2K-CTML	1000	11145	0	

RES

5	6	7	8	9	10	11	12	13	14	15
LHCMD1 COASTABL										
LHCMD1 COASTABL										
LHCMD1 COASTABL										
6	7	8	9	10	11	12	13	14	15	
LHC4			LHC4			EAST1				
LHC4			LHC4			EAST1				
9	10	11	12	13	14	15				
MHRS NORMHRS NORMHRS NORMHRS NORMHRS NORMHRS NORMHRS										
Dose LIN3MEAS LIN3MEAS LIN3MEAS LIN3MEAS LIN3MEAS LIN3MEAS										
9	10	11	12	13	14	15				
LIN3MEAS LIN3MEAS			NOMINAL			LIN3MEAS				
LIN3MEAS LIN3MEAS			NOMINAL			LIN3MEAS				

• ATIM dry run for testing functionality during COAST with all new timing system features

Machine Mode now correctly read 0- ATIMs behave as desired – mimicking well the LTIMs (in software)

behav

PREPARE LLRF	Pulse	CCV	Occurrence
SX.RF-STG-CTML	true		1015
PREPARE LLRF	CCV	AQN	Occurrence
SX.W-RF-STG-CTML	-1000	15	0
RAMP	Pulse	CCV	
SX.ST-RAMP-CTML	true		12115
RAMP	CCV	AQN	Occurrence
SX.S-RAMP-CTML	0	12115	0
SX.S-F2K-CTML	-1000	11115	0
SFT	Pulse	CCV	
SX.S-FTOP-CTML	true		23311
SFT	CCV	AQN	Occurrence

No Exception to display...

Fabio, Stephane, Orson

Kevin Li



# LSA RF preparations – 27. January 2020

- **LSA RF clean-up implemented – some minor items still to be checked**
- High level parameters for cavity control mostly in LSA
- LQR beam control partly in LSA
- RF synchro in LSA and ready with value generators
- ATIMs value generators in the making



# Two dry runs foreseen for execution

- **Week 5 RF: LHC cycle generation:**
  - **Cavity control:**
    - High level settings (bucket area, synchrotron tune)
    - Total voltage generation and propagation
    - Missing: dpOverP, full links to 800 phase offset
  - **Beam control:**
    - LQR for radial and synchro loops
  - **RF synchro:**
    - Cleaned up – value generators ready for test
  - **Timing:**
    - Value generators in the making – FESA classes subset ready for deployment
  - **Re-phasing:**
    - Value generators ready on paper – wait for FESA class



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# Two dry runs foreseen for execution

- **Week 4 ALPS:**
  - BA3 FIFO
  - BA3 Orbit
  - BA3 Injection trajectory
- **Status → moved to Thursday, 6 February (FESA classes still needed some final works)**
  - FESA classes are now ready
  - All features implemented in YASP (Jorg):
    - First turn: choice of
      - FIFO
      - any injection (1-16)
    - Orbit: choice of
      - triggered single acquisition available shortly after the selected cycle time
      - cycle acquisition (at the end of the cycle), either for a single selected time or the evolution along the cycle
    - Settings can also be configured from YASP
  - Ready for dry run on ...
- **Next:**
  - Monday March 2: Multi-turn (simulating a BST triggered oscillation on the simulated position), logging depending on what is there
  - Tuesday May 12: Test interlocks algorithms - Validation of the algorithm via emulated bumps and oscillations
  - Week 24: BIS checks - Andrea to see with Ivan Ramirez





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# Overview

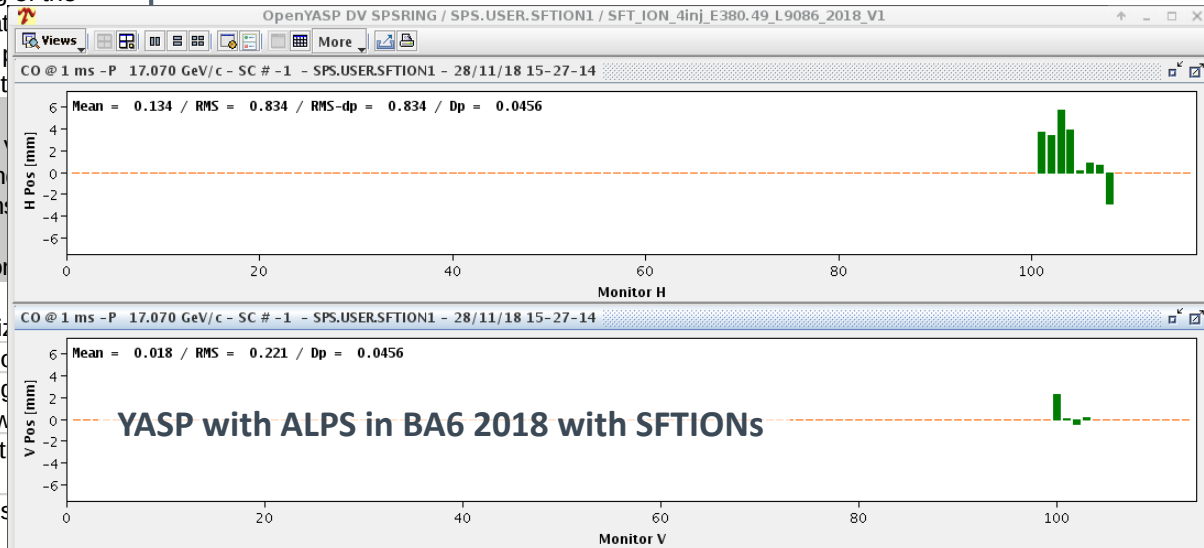
- **Dry run: full (sub-)system functionality tests in operational conditions**
- Plan and schedule tests per equipment or system ideally **from highest level (application)** through LSA/INCA and FESA **down to hardware**
- Identified different groups of tests – established a list of tests and an idea of when to schedule these
- Tests will start early next year (February 2020)
- Not all tests can be done immediately full vertical slice; we will **need to go staged tests** – as far up and as far down as we can go; we will show an example for the RF tests



# Tests list – BI ALPS

Name	Week	Description
BA6 – FIFO mode		Sending on selected channels (BPMs) N calibration pulses
BA6 – Injection trajectory	DR 1	Using a BST controlled start for the calibration pulses
BA6 – orbit		Simulating bumps with a specified pattern
BA6 – trajectory		Simulating a BST triggered oscillation on the simulated position
BA6 – logging		Monitoring of the logged data extended 9 cycle orbit
Interlocks tests – algorithms		Validation algorithm bumps and oscillations
Interlock tests – BIS		Validation connection
Full ring tests		Points synchronization
Full ring logging		Full data logging
Ring interlock tests		Check ring interlocks – with new
Extraction interlock tests		Check extraction interlocks
Post mortem push		Check post mortem push
Final YASP integration checks		Check new system with ALPS

- YASP as was connected to BA6 crate – new:
  - Expert mode for orbit acquisition
  - Slightly modified FESA API
  - Injection oscillations
  - FIFO operation mode
  - Q26, Q20 optics with post-LS2 sequence





# Tests list – EPC

Name	Week	Description
FGC interfaces	Check	FGC interface available
LSA integration	10	Check settings generation and management in LSA complete
FGC tests	DR 1 14	Simulation tests for state control, interlock, acquisition, pc check,...
Economy modes, COAST etc.	14	Test FGCs in special machine modes
FEI tests	22	FEI tests in TT10 and after fast extraction
FEI tests		FEI in TT10 with BHZ during HWC

- FGC dry run in simulation mode (new mains and cods):
  - All applications
  - State control
  - Acquisition
  - SIS
  - Different modes, coast economy,...
- FEI dry runs:
  - For given BI node can set converters to test mode, will drive A channel to true and can read channel
  - Real interlock functionality check is taken out of chain in simulation mode
- BHZ dry runs – when ready to test? Comments from David:
  - Preconditions: gateway and BIS in place, need to be able to drive permit out of interlock system; also need to be able to mask all inputs, all functions set up for TT10 for TT10 PC giving FEI conditions to true; check different energy levels prepare different cycles. Dry run to check permits come in.
  - We cannot run TT10 PCs just in simulation mode, thus, we will need to do a full dry run of the BHZ only during the HWC period.
  - Running in simulation mode, one could however still run it through the FEI application and check at least the anticipated results. (Actual result will always be false as we are in simulation) – run FEI app in a couple of scenarios – this is already planned.
  - David recommends to target the first week of August for the BHZ dry run; that would fit with the PS schedule. To be negotiated with the PS. He also recommends the first things to drive and check TT10 settings – try several attempts first August to mid September.



# Tests list – EPC

Operational Configuration: SPS0P

Thursday, 14 November 2019 13:39

Context: 2: SPS.USER.MD1 29 | PC

File Control Favorites Timing General CO Diag EDUMP Reset WorkingSet Screenshot Print... Active Tasks

SPS Beam Control  
 SPS Beam Measurements  
 SPS Equipment Control  
 SPS Beam Interlocks  
 SPS Fixed Displays  
 SPS Experiments  
 SPS Logging  
 Alarms  
 General Services  
 Radiation Services

SPS RF  
 SPS Power Supplies/Converters  
 SPS Beam Instrumentation  
 SPS Beam Obstacles  
 SPS BT  
 SPS Vacuum  
 Equip State  
 Autotrim  
 FMCM Control  
 NOBEAM

Super Cycle I Load  
 FGC Status  
 FGC Check  
 FGC PC Fixed Display  
 FGC Mains Survey  
 Inspector PCs NA  
 FGC Run+  
 FGC Spy  
 FGC Post Mortem  
 SPY-SPS-MAIN  
 SPS Power for ECO

Dynamic Destination: SPS\_DUMP  
 Machine Mode: FULLECO

Time [ms]

Time [ms]

FGC (Log I Meas - Ref Log I Meas)  
 FGC Log I Meas - LSA Function  
 FGC (Log I Meas - Ref Log I Meas)

Injection

Intl. Failed to con...  
 Op. Pc. Failed to con...

RING

Main Bends: Failed to con...  
 Main Quads: Failed to con...  
 Sextupoles: UNKNOWN  
 Octupoles: UNKNOWN  
 Operational PC: Failed to con...  
 Servo Spill: Failed to con...  
 Sqew Quad.: UNKNOWN  
 Special Magnets: UNKNOWN  
 Lattice Meas.: Failed to con...  
 Not Used PC: Failed to con...  
 Operational RF: Failed to con...

North

Intl. UNKNOWN  
 Op. Pc. Failed to con...

West Extraction

Intl. UNKNOWN  
 Op. Pc. UNKNOWN

LHC B1 Transfer

Intl. Failed to con...  
 Op. Pc. Failed to con...  
 Intl. LHC UNKNOWN

HirRadMat Transfer

East Extraction

Intl. UN...  
 Op. Pc. Fai...

SPS Super Cycle Load v1.0.24 - February 2019

Select Cycles  
 Cycle Filter

SFT\_PRO\_MTE\_L4780\_roman\_V1 (0->10800)  
 SFT\_PRO\_MTE\_L4830\_2014\_V1 (0->10800)  
 SFT\_PRO\_MTE\_L4830\_2017\_V1 (0->10800)  
 SHIP\_L1230\_2015\_V1 (0->7200)  
 SHIP\_L1230\_2017\_V1 (0->7200)  
 SPS\_TIMING\_2018\_V1 (0->1200) [ZERO]  
 ZERO\_1200\_2012\_V1 (0->1200)  
 Zero\_economy (0->0)

Super Cycle to compute  
 LHCBCMS\_3Inj\_Q20\_2018\_V1 (0->19200)  
 SFT\_PRO\_MTE\_L4830\_2017\_V1 (0->10800)  
 SHIP\_L1230\_2017\_V1 (0->7200)

Add selected Clear Resident ONLY Delete selected Delete All

Start Monitoring Stop

Eta > 0: SFT\_PRO\_MTE\_L4780\_2018\_V1  
 [-3.455751918948773, -3.35420548974183, -3.2526590605346873, -3.1511...]  
 [-2.8927627750830474, -2.909611384865803, -2.9191861329247493, -2.9...

Super Cycle Preview  
 I for selected cycles

6000  
 5000  
 4000  
 3000  
 2000  
 1000  
 0

0 5000 10000 15000 20000 25000 30000 35000

Compute Dipoles P Max : 37.9 MW Mains P Max : 44.0 MW

Power converter	I RMS (Amps)	Power (M Watts)
Dipoles	2,918.42	29.13
Quads	1,978.45	3.13
Dipoles and Quads	4,896.87	32.26



# Tests list – EPC

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- FGC dry run in simulation mode (new mains and cods):
  - All applications
  - State control
  - Acquisition
  - SIS
  - Different modes, coast economy,...

FEI SPS Application V5.9.0

LHC\_ION\_1Inj\_Nominal\_Pb82\_Q26\_2018\_V2 (LHC-IONS\_L16700 with 17.07 gev F.B.)  
SPS.USER.LHCION4

CURRENT ROLE: NONE "Current [A]" measured at 6549ms from start cycle

DRIVE LHC B1 DRIVE LHC B2

RBAC Role Picker

Select Roles You Want To Use:

- LSA-HYPERCYCLE-KICKERS
- MCS-BLM-IQC
- MCS-BLMuser
- MCS-SMP
- MCS-SPS-SIS
- MCS-SPSOP
- MCS-SPSOP-BI
- MCS-SPSOP-EXPERT
- MCS-SPSOP-GURU
- MCS-Test

Clear Revert All Cancel Done

PC name	FEI Enabled		FEI Referen	
	HW	LSA	HW	
MSE8183M	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	20218.7	2
MST6177M	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	5672.5	
MPLH6199	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	102.08	
MPSHG140	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	-18.42	
MPLH6165	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	133.42	
MPSHG219	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	81.94	
MPSV6130	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	-54.61	
MPSV6150	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	124.48	
MPSV6210	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	77.78	
MPSV6230	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	-111.84	
BA6.R8IH.610337	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	-13.15	

setting	FEI BIC Output		I Max [A]	Required role	OP mode
	HW	LSA			
218.7	1	1	24000.0	MCS-SPSOP-EXPERT	NORMAL
72.5	1	1	7500.0	MCS-SPSOP-EXPERT	NORMAL
2.08	1	1	400.0	MCS-SPSOP-EXPERT	NORMAL
8.42	1	1	400.0	MCS-SPSOP-EXPERT	NORMAL
3.42	1	1	400.0	MCS-SPSOP-EXPERT	NORMAL
1.94	1	1	400.0	MCS-SPSOP-EXPERT	NORMAL
4.61	1	1	125.0	MCS-SPSOP-EXPERT	NORMAL
4.48	1	1	125.0	MCS-SPSOP-EXPERT	NORMAL
7.78	1	1	125.0	MCS-SPSOP-EXPERT	NORMAL
11.84	1	1	125.0	MCS-SPSOP-EXPERT	NORMAL
3.15	1	1	400.0	MCS-SPSOP	NORMAL

## FEI application (screenshot)

- 3 test cycles with different references (14 GeV, 26 GeV, Ions, HiRadMat, AWAKE)



# Tests list – SBDS

Name	Week	Description
TIDVG FESA classes		Test individual TIDVG sensors readings that will go into the SIS; SIS and TIDVG monitoring application
SBDS individual FESA classes		Signals, post-mortem push
SBDS		Verify arming sequence of SBDS alone
SBDS + f_rev + injection + BIS		Verify arming sequence of SBDS with RF and BIS
SBDS TSU, MKD, BIS	DR 1	measurements of delays, validate time between dump request and pulse
SBDS + f_rev + injection + BIS		Test of SBDS arming and pulsing with different SC configurations (very important to test all possible configurations)
SBDS PM bins, SBDS and TIDVG FESA classes		Test of individual interlocks, test of analysis, test of python server for BTV

F. Velotti

- Different steps of what needs to be tested here
- Systems dry runs will be done already before as system test
- Injection tests:
  - BIS loop must be closed as of week 42.
  - Check the events for injection BIS; timing distribution which will be used by FGCs on BHZ – check with Stephane whether this is already part of HWC.
- TIDVG FESA classes as soon as it is ready – week 24 (application dry run)
  - Erik and Yannick to prepare SIS and TIDGV monitoring application
  - Can test TIDVG in signals → check whether we will get some simulated data... (temperature, cooling, LVTD... tbd)
- Test of individual classes for the SBDS – week 32 (PM beans which could come later):
  - Kickers, TSUs, check signals, post-mortem push
  - Not much needed around this inter terms of applications etc.





# Tests list – RF

Name	Week	Description
LHC generation	5	Test LSA generation for LHC type cycle with RF synchro, RF loops, RF cavity control & timings
Radial steering SPS2PS Synchro	8	Test settings for radial steering on synchro and radial loop
Synchro & phase loop diagnostics	10	Test synchro
Cavity control loops	13	Test acquisition and display of synchro and phase errors using simulated data
SFTPRO generation	16	Test generation and settings of full cavity control loops – with comb filters
Phase & position diagnostics	22	Test LSA generation for SFTPRO type cycle of RF synchro, RF loops, RF cavity control & timings
Diagnostics test	25	Test acquisition and display of phase and position using simulated data
800 MHz	27	Test what can be tested from diagnostics not tested so far
FFA generation	29	Verify settings in 800 MHz; improve generation using new functions for voltage ratio, add harmonic ratio, add offset
Longitudinal damper	31	Generate ion cycle with FFA – all settings; also synchro
RF gymnastics	33	Interface and settings for longitudinal damper ready for testing
Longitudinal blow-up	36	Interface and settings for RF gymnastics ready for testing
AWAKE and LHC rephasing	39	Interface and settings for longitudinal blow-up ready for testing
Slip stacking application	40	Generation and settings with tests for rephasing
	44	Slip stacking application ready with preparation of functions for settings

- Staged tests

- HW **not available from start of tests – test as far vertical as possible**, coming from both sides



- Requirements

- Test crate on TN trusted
  - HW progressively coming in





# Tests list – RF

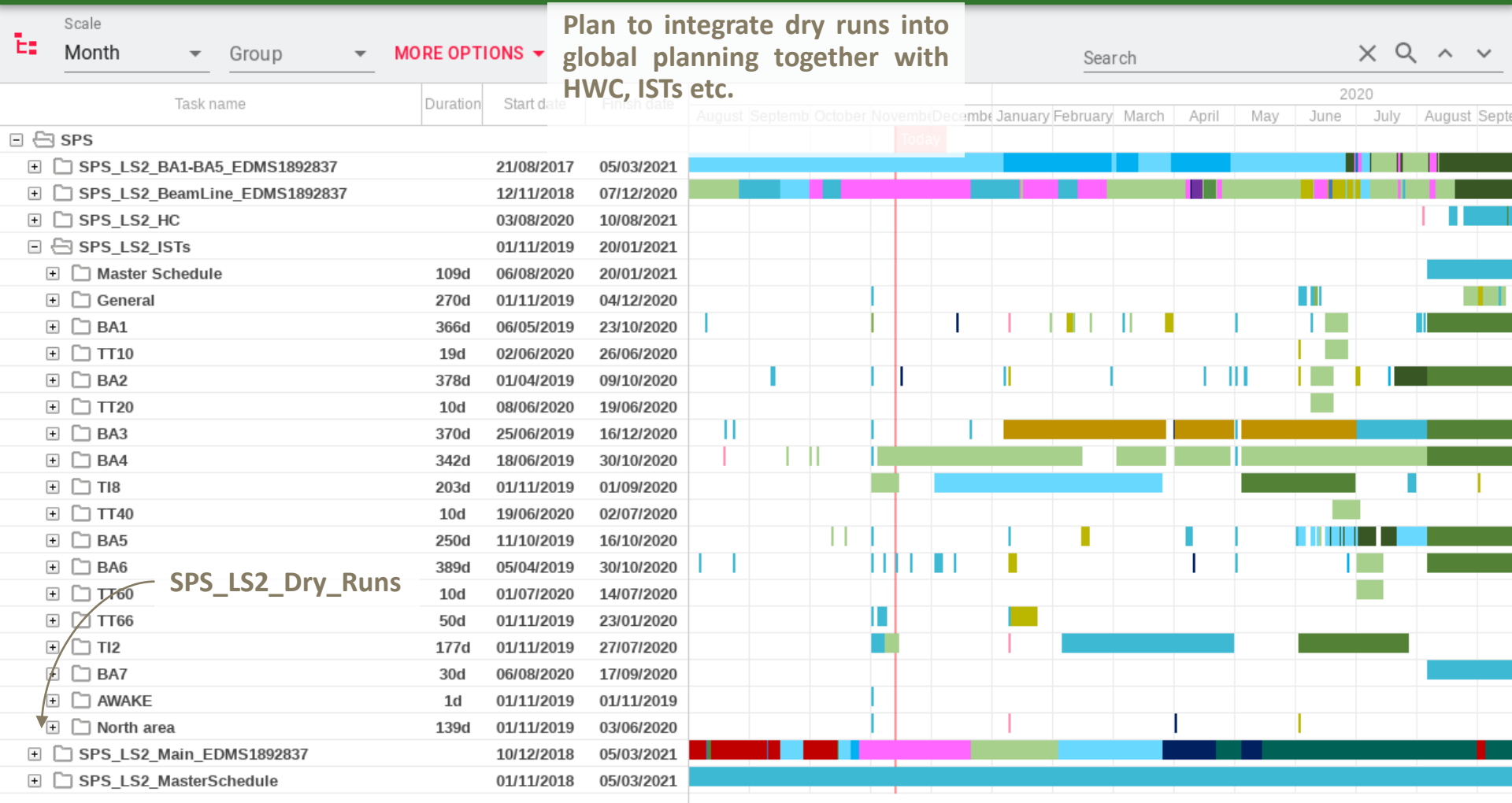
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Slip stacking application	44	Slip stacking application ready with preparation of functions for settings

- More about software readiness, OP integration with application – **HW readiness dates still need confirmation:**
  - Settings integrated, value generators and makerules prepared – LSA trim editor to test trims
  - Appall (RF application) – trim and monitor functions from application; trim and monitor timings from application
  - Other specific applications – trim and monitor from application (requires also better Python integration!)
- Cycles:
  - LHC, SFTPRO-type cycles
- Services:
  - LSA
  - FESA
  - Timing
- Periphery:
  - TN trusted test crate
  - Python deployment



# Integration of dry runs in general planning tool

## EN-ACE Scheduling Tool - Gantt View





# Integration of dry runs in general planning tool

## EN-ACE Scheduling Tool - Gantt View

Scale: Month | Group: | MORE OPTIONS

Plan to global p  
HWC, IS

Task name	Duration	Start date	Finish date
SPS			
SPS_LS2_BA1-BA5_EDMS1892837		21/08/2017	05/03/20
SPS_LS2_BeamLine_EDMS1892837		12/11/2018	07/12/20
SPS_LS2_HC		03/08/2020	10/08/20
SPS_LS2_ISTs		01/11/2019	20/01/20
Master Schedule	109d	06/08/2020	20/01/20
General	270d	01/11/2019	04/12/20
BA1	366d	06/05/2019	23/10/20
TT10	19d	02/06/2020	26/06/20
BA2	378d	01/04/2019	09/10/20
TT20	10d	08/06/2020	19/06/20
BA3	370d	25/06/2019	16/12/20
BA4	342d	18/06/2019	30/10/20
TI8	203d	01/11/2019	01/09/20
TT40	10d	19/06/2020	02/07/20
BA5	250d	11/10/2019	16/10/20
BA6	389d	05/04/2019	30/10/20
TT60	10d	01/07/2020	14/07/20
TT66	50d	01/11/2019	23/01/20
TI2	177d	01/11/2019	27/07/20
BA7	30d	06/08/2020	17/09/20
AWAKE	1d	01/11/2019	01/11/20
North area	139d	01/11/2019	03/06/20
SPS_LS2_Main_EDMS1892837		10/12/2018	05/03/20
SPS_LS2_MasterSchedule		01/11/2018	05/03/20

SPS\_LS2\_Dry\_Runs

- Ideally as **common tool**:

- with information on pre-requisites as controls components, dry-run tests results, etc.
- as well as the ability to **access all information from a central place** (e.g., click on a dry-run from the scheduling tool and expanding the info via an URL for example...)



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