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# SPL in SM18

## High Power RF test stand

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# Summary

- Scope of the Work Package / Prerequisites
  - Description of the work
    - Interfaces with other activities (cryogenics, electricity, water distribution,..)
    - Modulator
    - Klystron
    - RF power distribution system
    - Interlocks & controls
    - Auxiliaries
    - Installation
  - Budget
  - Conclusions
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# SPL in SM18: the framework

## □ Work package detailed in:

- 7 main tasks & several work units
  - most of which are already well defined
  - some with less constraints or less information kept longer
- the work is defined:
  - such to be ready for cryomodule tests early 2013  
*=>as a SPL “self oriented” exercise*
- resources (budget) assigned to each task

## □ With the aim of:

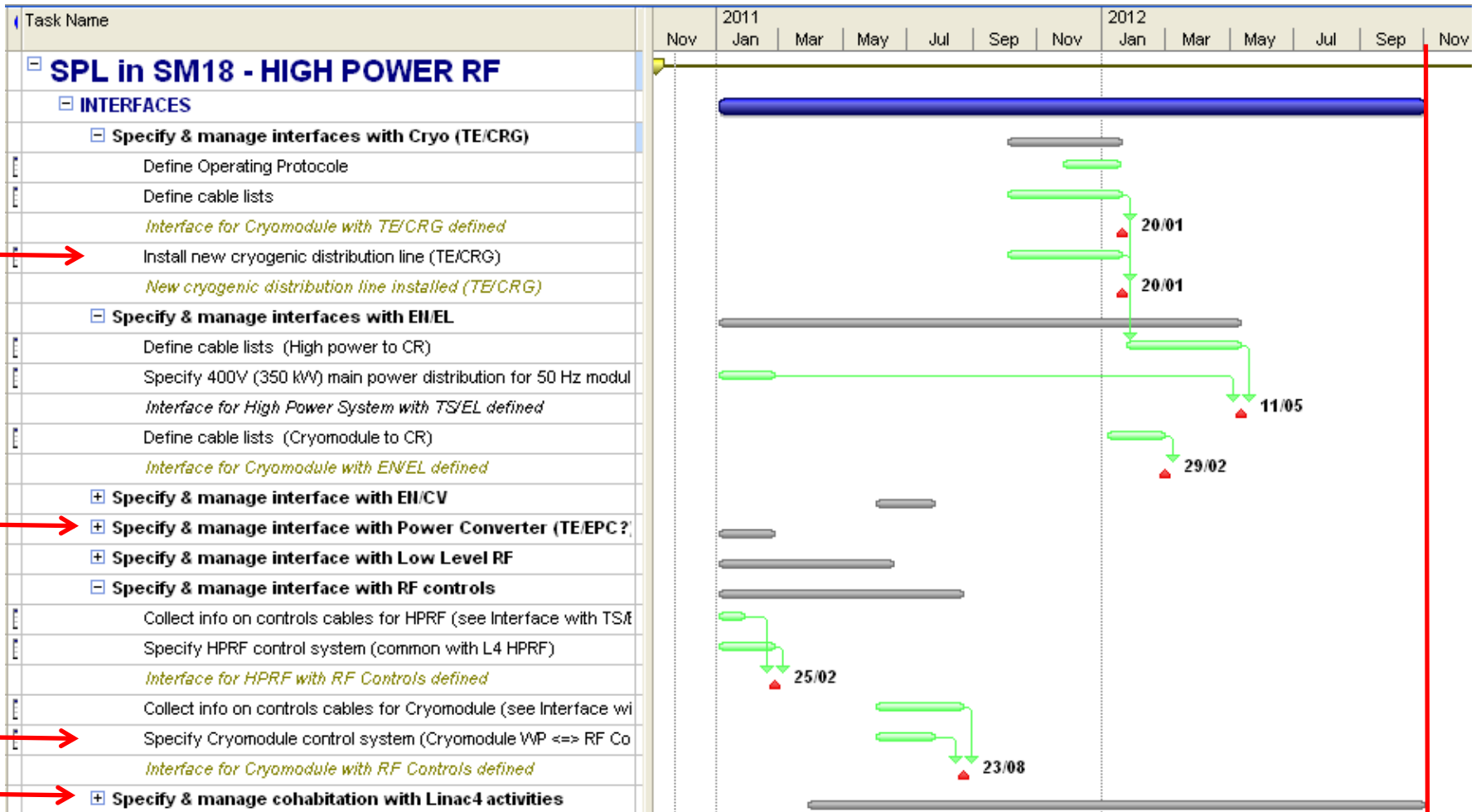
- detailing the associated work
  - defining major milestones
  - identifying possible overlap of activities in SM18
  - estimating the budget
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# Description of the work

## Seven main tasks

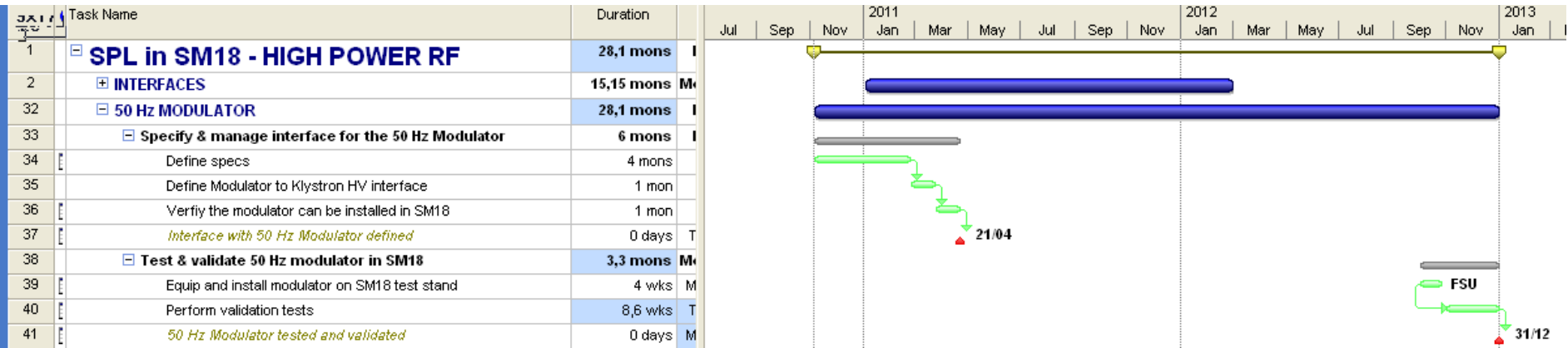
Task Name	Duration	Start	2011							2012							2013	
			Sep	Nov	Jan	Mar	May	Jul	Sep	Nov	Jan	Mar	May	Jul	Sep	Nov	Jan	
1 <b>SPL in SM18 - HIGH POWER RF</b>	28,1 mons	Fri 05/11/10	[Gantt bar spanning from Sep 2011 to Jan 2013]															
2 <b>INTERFACES</b>	23,95 mons	Mon 03/01/11	[Gantt bar from Jan 2011 to Sep 2012]															
44 <b>50 Hz MODULATOR</b>	28,1 mons	Fri 05/11/10	[Gantt bar from Sep 2011 to Sep 2012]															
54 <b>704 MHz KLYSTRON</b>	27,05 mons	Wed 01/12/10	[Gantt bar from Dec 2010 to Sep 2012]															
66 <b>RF CIRCULATORS &amp; LOADS</b>	25,95 mons	Mon 03/01/11	[Gantt bar from Mar 2011 to Sep 2012]															
78 <b>INTERLOCKS &amp; CONTROLS</b>	22,7 mons	Fri 05/11/10	[Gantt bar from May 2011 to Sep 2012]															
89 <b>AUXILIARIES</b>	23 mons	Mon 03/01/11	[Gantt bar from Mar 2011 to Sep 2012]															
146 <b>HIGH POWER SYSTEM INSTALATION</b>	26 mons	Fri 05/11/10	[Gantt bar from May 2011 to Sep 2012]															

# Interfaces:



- A Linac4 test place is now being prepared in SM18 => compatible with SPL requirements
- New helium (2K) distribution line will (might) be installed end 2011
- Need 400 V distribution line for the 50Hz modulator
- Take into account the L4 planning in SM18 (in bunker A) => (see Installation)

# Modulator:

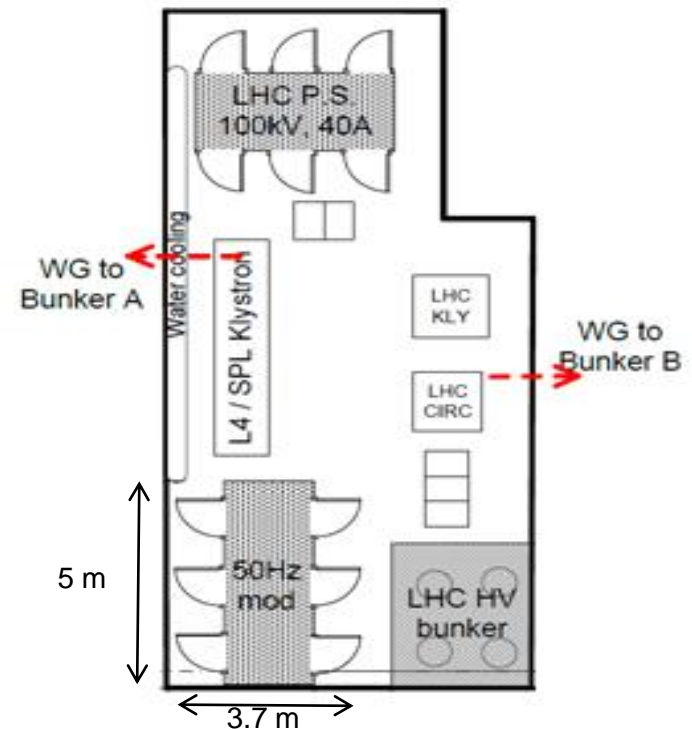


❑ In January the SM18 will be modified in view of the 50 Hz modulator installation

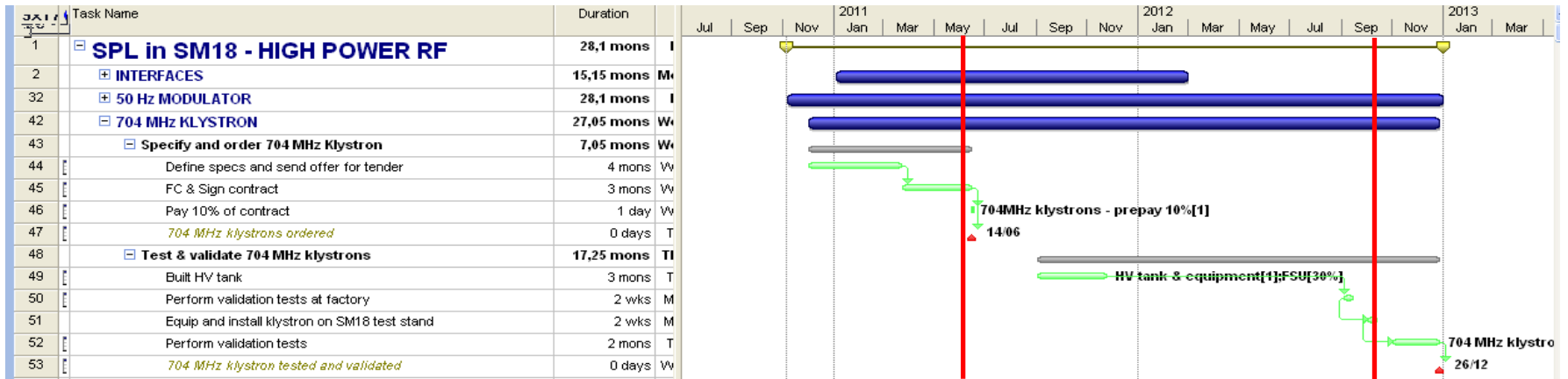
- ❑ LHC bunker will be dismantled and moved
- ❑ 5 m x 3.7 m area for the pulsed modulator

❑ **urgent:**

- ❑ Enough space for the modulator? Footprint?
- ❑ HV connections to klystron
- ❑ Connection to main (400 V)
- ❑ Interlock & controls
- ❑ Water cooling requirements



# Klystrons:



## Option 1:

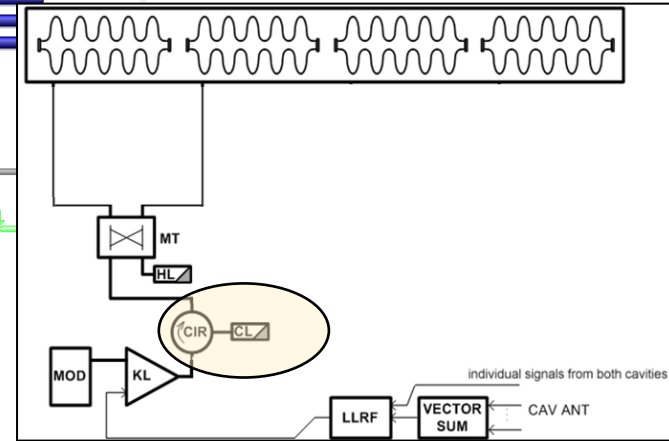
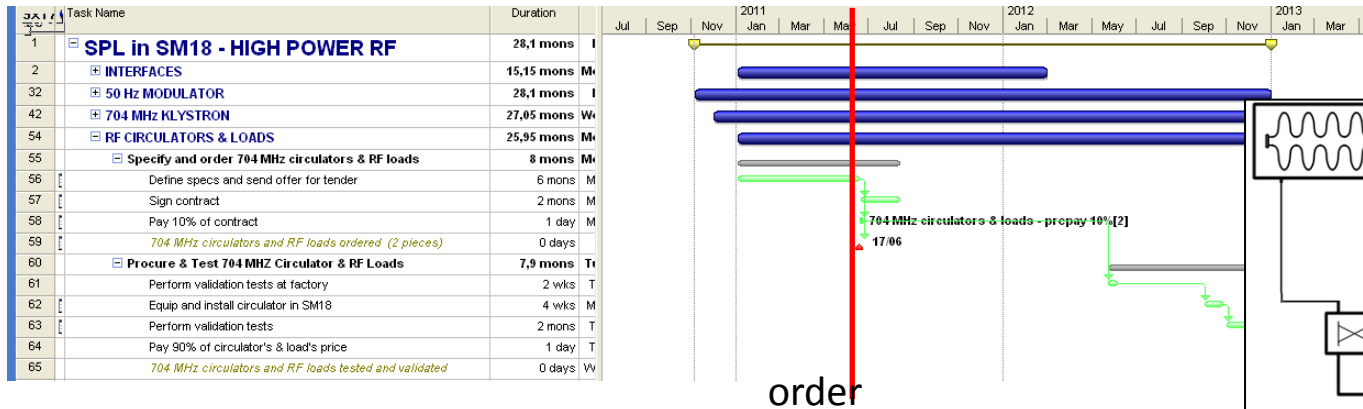
- 1 MW 704 MHz tube based on CPI specs
  - Specs ready (except HV interface to modulator)
- Pros:
  - The tube exists. No development costs
- Cons:
  - Specs do NOT include LLRF requirements

## Option 2:

- ≈ 3 MW 704 MHz tube including LLRF specifications
- Pros:
  - Allows for full SPL (ESS?) RF power system distribution validation (incl. LLRF)
- Cons:
  - More expensive! ( ≈ + 1.5 MCHF )
  - Bigger modulator !? Feasible?

=> Need decision as soon as possible

# RF power distribution:

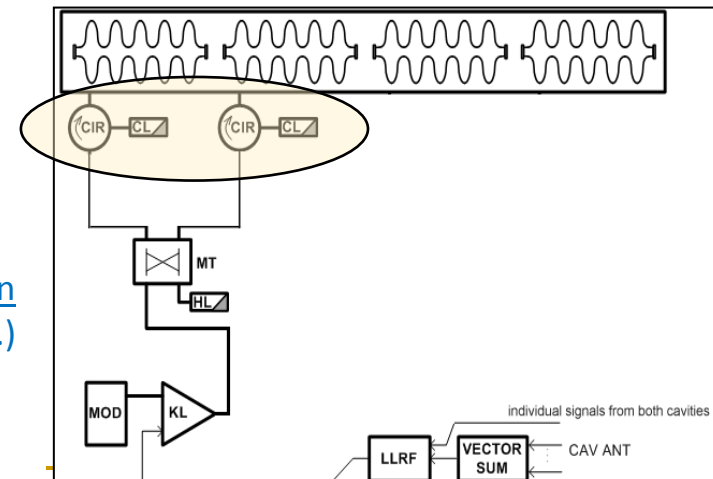


- ❑ Circulators and RF loads specs 80% ready
- ❑ Option1:

- ❑ 1 circulator and 2 RF loads
  - Cheapest solution
  - Impact on  $Q_{ext}$  & phase and power quality (crosstalk,...) will be studied (N. Schwerg)

- ❑ Option 2:

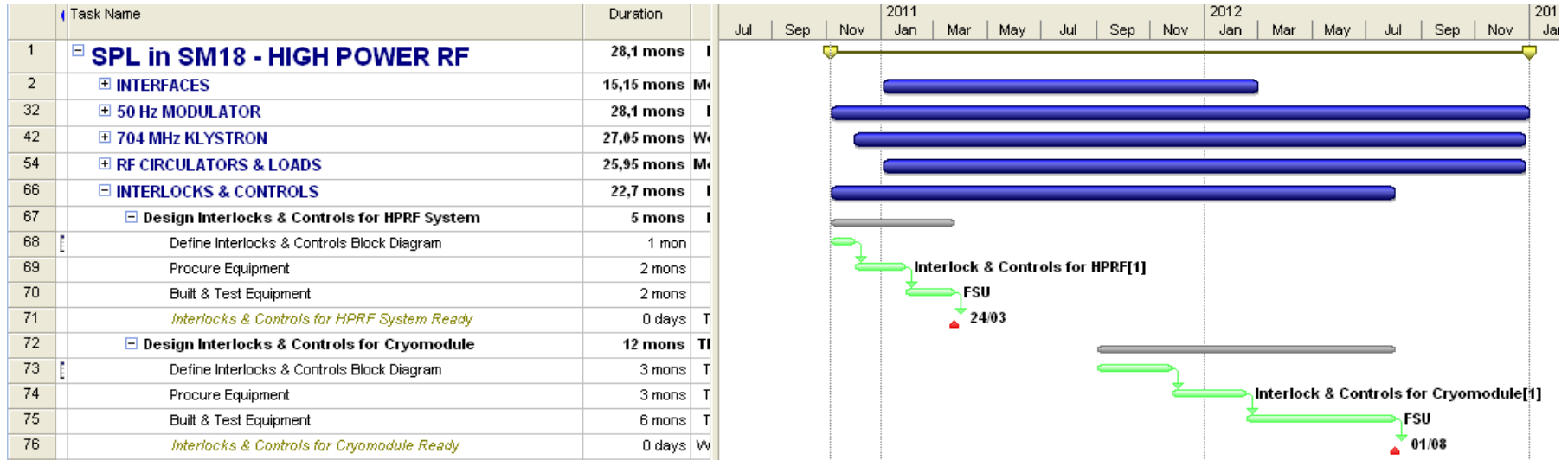
- ❑ 2 circulators and 3 RF loads
  - [Allows for full SPL \(ESS?\) RF power system distribution validation](#)
  - More expensive (+ 1 circulator + 1 magic T + 2 RF loads + WG +..)



=> Decision required by Spring 2011



# Interlock & controls:



□ Shall be built in two steps:

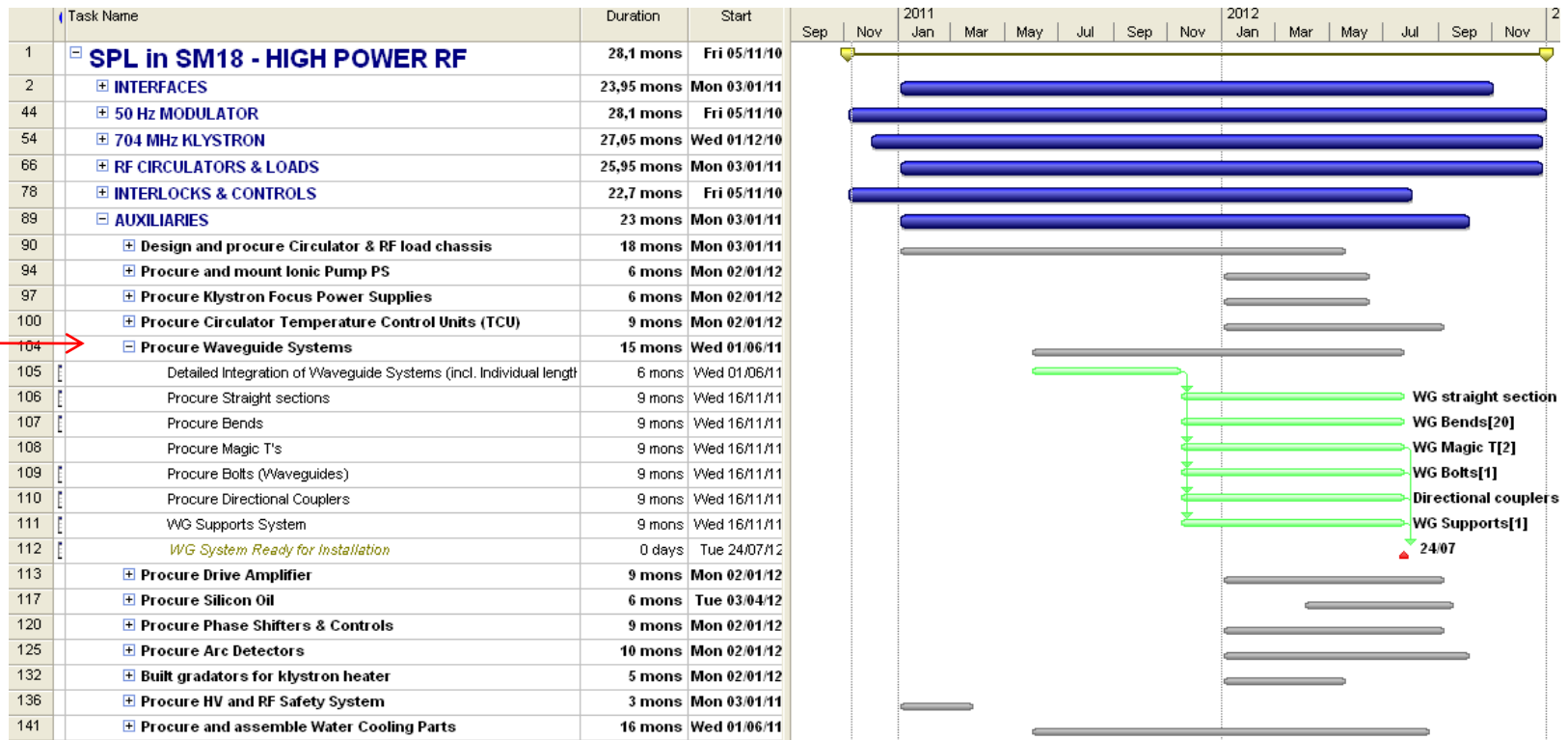
□ Interlock & controls for HPRF

- will re-use what is being prepared for the L4 test place
- implementation: Spring 2011
- adapted to 50 Hz modulator in 2012

□ Interlock & controls for Cryomodule

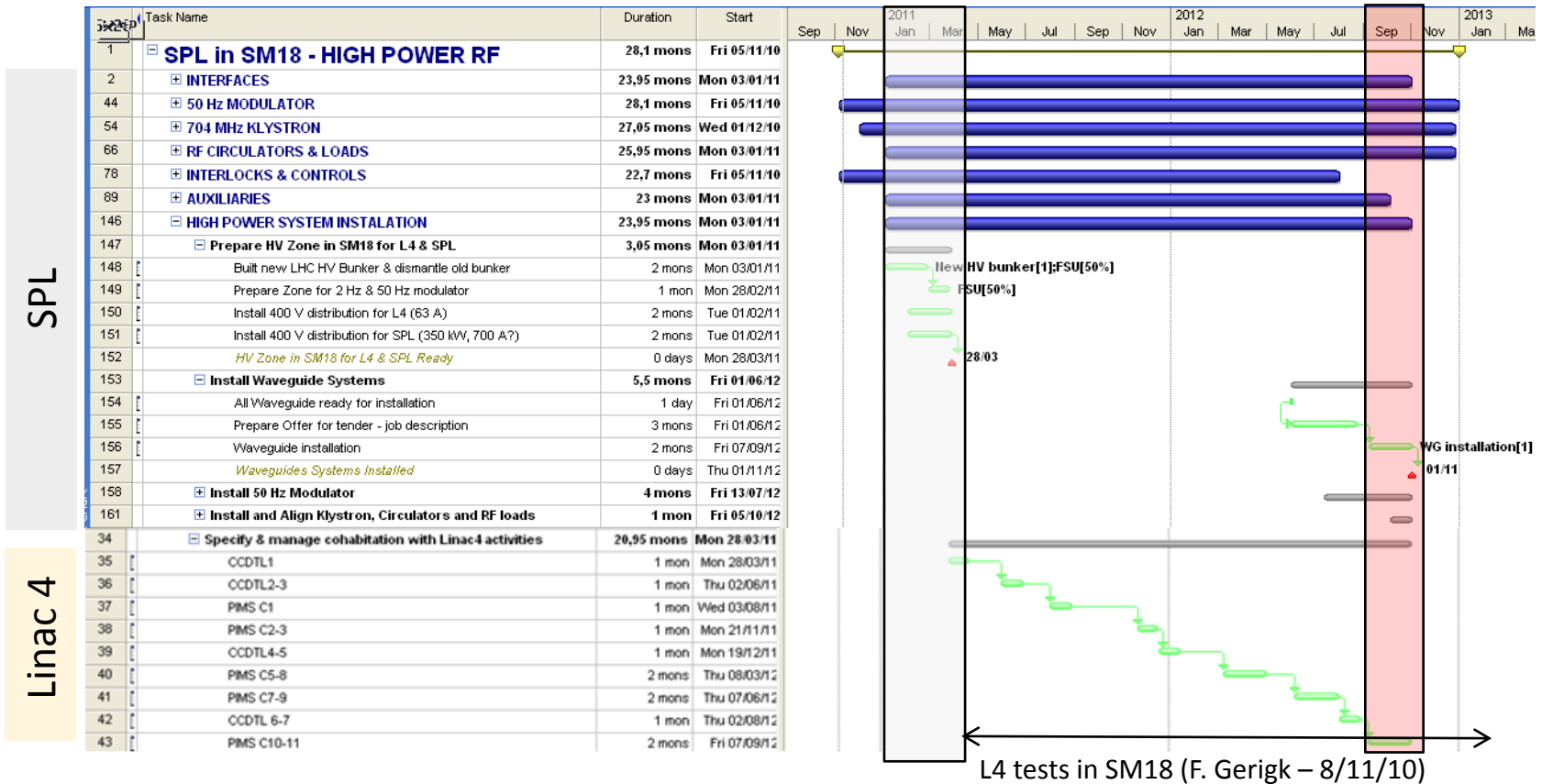
- requires well defined interface with cryo system and cryomodule (deadline: third quarter 2011)

# Auxiliaries:



- ❑ Long list of auxiliaries to be ordered or built (drive amplifier, power supplies...)
- ❑ Waveguide network to be designed
  - ❑ depends on which RF power distribution scheme is chosen
  - ❑ detailed implementation in SM18 required *(Sept'11 at the latest)*

# Test stand installation & commissioning



key dates to be ready for cryomodule tests in January 2013:

- Linac4 PIMS CW RF tests must be finished by end 2010 at the latest
- installation of L4 test place in SM18: January – March 2011
- L4 tests: April 2011 – November 2012
- installation: September - October 2012
- 704 MHz equipment tests: November – December 2012

} 2 months overlap !!!

# Preliminary Budget (1)

	Task Name	Total Cost	2011	2012
1	[-] SPL in SM18 - HIGH POWER RF	SFr. 1 876 380,00	384 kCHF	1'493' kCHF
2	[+] IINTERFACES	SFr. 0,00		
44	[+] 50 Hz MODULATOR	SFr. 16 000,00		
54	[+] 704 MHz KLYSTRON	SFr. 834 400,00		
66	[+] RF CIRCULATORS & LOADS	SFr. 320 000,00		
78	[+] IINTERLOCKS & CONTROLS	SFr. 203 000,00		
89	[+] AUXILIARIES	SFr. 370 980,00		
146	[+] HIGH POWER SYSTEM INSTALATION	SFr. 132 000,00		

1 1MW klystron, 2 circulators, 3 RF loads, WG, + FSU work...

## □ still important unknowns

- do we stick to 1 MW or do we go for more power?
- very rough price estimates for klystron, circulator(s), RF loads...
- RF power distribution network to be detailed

# Preliminary Budget (2)

	2011	2012	Total
FSU	SFr. 78 400,00	SFr. 182 400,00	SFr. 260 800,00
704MHz klystrons - prepay 10%	SFr. 80 000,00		SFr. 80 000,00
704 MHz klystrons - 90%		SFr. 720 000,00	SFr. 720 000,00
HV tank & equipment	SFr. 20 000,00		SFr. 20 000,00
704 MHz circulator - prepay 10%	SFr. 20 000,00		SFr. 20 000,00
704 MHz circulator - 90%		SFr. 180 000,00	SFr. 180 000,00
Circulator chassis			
RF Load chassis	SFr. 11 666,67	SFr. 8 333,33	SFr. 20 000,00
Ionic pump PS		SFr. 13 080,00	SFr. 13 080,00
Focus PS		SFr. 60 000,00	SFr. 60 000,00
Circulator TCU		SFr. 3 400,00	SFr. 3 400,00
W G straight section (per meter)	SFr. 11 000,00	SFr. 49 000,00	SFr. 60 000,00
W G Magic T	SFr. 2 933,33	SFr. 13 066,67	SFr. 16 000,00
W G Bends	SFr. 9 166,67	SFr. 40 833,33	SFr. 50 000,00
W G Bolts	SFr. 3 666,67	SFr. 16 333,33	SFr. 20 000,00
W G Supports	SFr. 1 100,00	SFr. 4 900,00	SFr. 6 000,00
Drive amplifier - 200W amplifier		SFr. 16 000,00	SFr. 16 000,00
Power meter			
Silicon oil		SFr. 6 000,00	SFr. 6 000,00
Phase shifter - mechanics		SFr. 8 000,00	SFr. 8 000,00
Phase shifter - controls		SFr. 3 000,00	SFr. 3 000,00
Arc detector - electronics		SFr. 2 650,00	SFr. 2 650,00
Arc detector - optical fibers		SFr. 1 400,00	SFr. 1 400,00
Arc detector - mechanics		SFr. 550,00	SFr. 550,00
Gradator		SFr. 2 000,00	SFr. 2 000,00
RF monitoring system	SFr. 11 000,00		SFr. 11 000,00
Flashing light	SFr. 500,00		SFr. 500,00
Water cooling - missing part...	SFr. 6 083,33	SFr. 3 916,67	SFr. 10 000,00
Interlock & Controls for HPRF	SFr. 25 000,00		SFr. 25 000,00
Interlock & Controls for Cryomodule	SFr. 22 500,00	SFr. 27 500,00	SFr. 50 000,00
Directional couplers	SFr. 2 750,00	SFr. 12 250,00	SFr. 15 000,00
HV Cables & connectors			
W G installation		SFr. 10 000,00	SFr. 10 000,00
New HV bunker	SFr. 10 000,00		SFr. 10 000,00
704 MHz RF load - prepay 10%	SFr. 12 000,00		SFr. 12 000,00
704 MHz RF load - 90%		SFr. 108 000,00	SFr. 108 000,00
400 V for Linac 4	SFr. 6 000,00		SFr. 6 000,00
400 V for SPL	SFr. 50 000,00		SFr. 50 000,00
<b>Total</b>	<b>SFr. 383 766,67</b>	<b>SFr. 1 492 613,33</b>	<b>SFr. 1 876 380,00</b>

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# Conclusions

- ❑ WU, milestones and deliverables have been defined such to be ready for January 2013
  - ❑ relevant issues have been raised:
    - ❑ specs of new klystrons, RF power distribution network
    - ❑ impact of the installation of the new 2K cryo-line on the L4/SPL planning ?
    - ❑ overlap of Linac4 and SPL activities => to be followed up
  - ❑ the budget is very preliminary (still needs inputs)
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