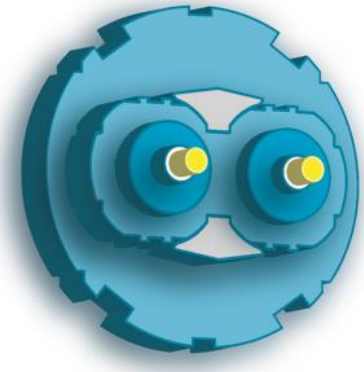


High Luminosity LHC

LIU/HL-LHC C&S Review Preparation Status

I. Bejar Alonso/I. Laugier/B. Delille

The HiLumi LHC Design Study is included in the High Luminosity LHC project and is partly funded by the European Commission within the Framework Programme 7 Capacities Specific Programme, Grant Agreement 284404.

Content

- Scope of the review
- Purpose of the review
- Programme - // Sessions – Reviewers and CERN Lead
- Presentations - Content and list of actions
- C&S review preparation with WP leaders
  - Status, global schedule
  - Key concepts and examples
- Conclusion

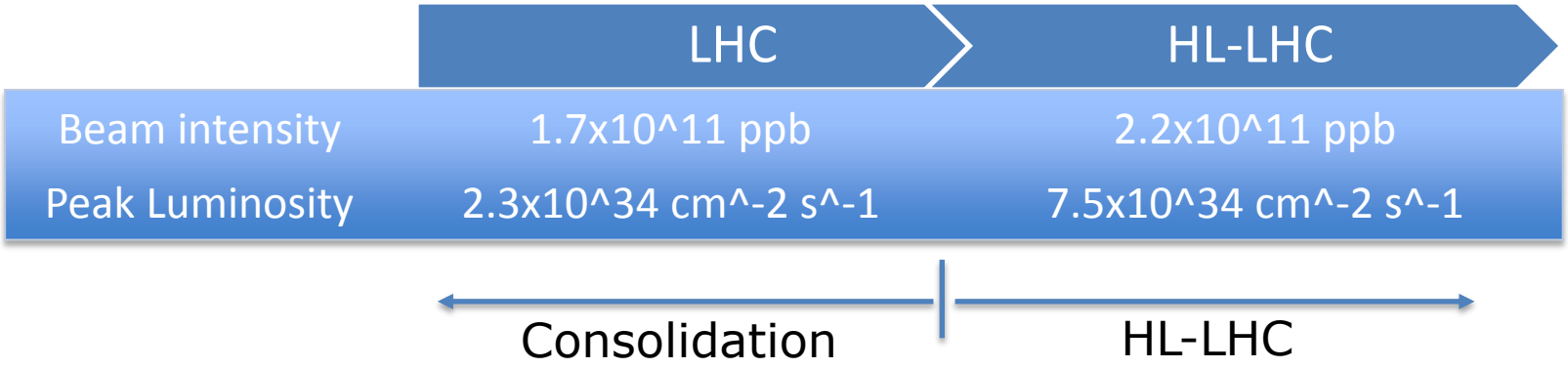
Background

- MTP 2015-2019 incorporates long-term outlook up to 2025, in line with the updated European Strategy for Particle Physics
- Integration in the MTP of the construction and commissioning of the full HL-LHC programme and the completion of the detector upgrades by the end of Long Shutdown 3 (LS3), scheduled for the years 2023 to 2025
- Driving factor for the budget cumulative deficit for the period up to 2025

→Cost and Schedule Review – 9 to 11th of March 2015

Cost & Schedule Review - Scope

- HL-LHC and LIU projects
- taking into consideration how these are linked to the **consolidation** project and the **operation** of the CERN accelerator complex



Cost & Schedule Review - Purpose

- Assess the status of the project development taking into account the technical developments that are still ongoing
- Assess the project baseline, i.e.
  - Scope
  - Resources (Material and personnel costs)
  - Schedule

  And also
  - Project Management methods
  - Risks: Evaluation and risk management

Cost & Schedule Review - 3 Days Programme

9 March 2015

- Plenary
- Breakout sessions

10 March 2015

- Breakout sessions
- Breakout sessions

11 March 2015

- Q&A session
- Recommendations and Close-out

Cost & Schedule Review – // Sessions - CERN Lead

- Session 1: LIU (CERN Lead: G. Rumolo)
- Session 2: SC Magnets and Cryogenic Systems - HL-LHC project (CERN Lead: L. Bottura)
- Session 3: SC cavities - HL-LHC project (CERN Lead: Erk Jensen)
- Session 4: Other Accelerator systems, Support and Interface Systems -HL-LHC (CERN Lead: O. Bruning)
- Session 5: Cost, Schedule, Management, Risk, Infrastructure and Integration - LIU and HL-LHC projects (CERN Leads: M. Meddahi, L. Rossi)

Cost & Schedule Review – Reviewers

Breakout session	Chair	Members
LIU	T. Roser	W. Fischer Q. Qin
SC Magnets and Cryosystems	S. Gourlay	P. Vedrine (CEA) B. Petersen (DESY)
SC Cavities		oto (KEK)
Other accelerator syste Support and interface systems systems (QPS, collimation, beam dumps, feedback, controls)		PSI)
Project Management, Schedule, Cost, Risk, Infrastructure and civil engineering	N. Holtkamp	K. Oide C. Neumeyer (PPPL)

CMAC Meeting #10

Cost & Schedule Review – Programme Details

- Shared on HL-LHC Collaboration Workspace
  - Cost&Schedule Review – Programme

- Indico page in preparation
  - http://indico.cern.ch/event/357610/

Presentations – Scope of WP

The Review panel has received the PDR (January 2015)

The scope shall include

- Description of the WP (from the PDR)
- Clear PBS with what is Baseline and not Baseline
- Systems architecture
- Interface specifications
- Deliverables/Milestones

Presentations - Resources

Each presentation will include

- HR effort during the full project (up to 2025) (P and M4P)
  - Associate each P and M4P WU to the top level of the PBS and the corresponding WP leader
- Material resources (including major supply contracts)
  - Associate each M WU to the level 2 (or 3 in some case) of the PBS and the technical responsible person (see again EDMS1405056)
- Collaborations

Presentations - Schedule

Each presentation will include

- Consolidated data (prepared centrally)
- List of major constrains and elements in the critical path (prepared centrally)

Presentations - Risk

Your presentation will include

- Main risks and mitigation actions (prepared centrally)

Presentations – Uncertainty

- Global uncertainty on the cost of each WP, together with list of equipment with major contribution to the level of uncertainty

List of actions to get ready for the C&S review

- Complete existing reference documents (Conceptual specifications, Interface specifications, space reservations)
- Best guess of material expenditures, split on the project phases
- Pre-strategy of supplies (amount, timing, by whom) (Industry, In-house, Collaboration)
- List of existing collaborations
- Update of HR resources presently working (next 3 years) and plan up to 2025
- M4P plan (MPA, FSUs and Industrial Services contracts)
- List of Deliverables
- Existing schedules (that will be integrated globally)
- Reflection on risks and uncertainties

Cost & Schedule Review – Preparation in practise

- 2 to 3 meetings to define and check the information
- Individual targeted meetings to obtain/complete information on scope, resources or schedule
- Rehearsal meeting (Status provided by CERN Lead) in Special TC end February 2015

Traceability via the SharePoint

https://espace2013.cern.ch/project-HL-LHC-Technical-coordination/CandS/_layouts/15/start.aspx#/

C&S Review Preparation - Global view

Week #	W6	W7	W8	W9	W10	W11
BC Structure						C&S REVIEW
APT WBS						
APT WUs						
Data P						
Data M4P						
Data M						
APT data integration						
Schedule						
Risk						
Uncertainty						

Today – TE retreat – Special TC

Milestone for bottom-up

Data on resources and schedule integrated

WP Interfaces final check
Strategic Decisions (CONS? R2E? What is on the critical path?…)

Ready for the review? Global view

&

WP	Description	Dep.	BC	APT WBS	APT wus	Data P	Data M4P	Data M	Date	Schedule	Risk	Uncertainty
2	Accelerator Physics and Performance	BE			IL	IL	IL	IL		W7		
3	Magnets for Insertion Regions	TE		BD	BD	BD	BD	BD	02-Feb	W7		
4	Crab Cavities & RF	BE		IL	IL	IL	IL	IL		W7		
5	Collimation	BE		IL	IL	IL	IL	IL		W7		
6A	Cold Powering	TE		BD	BD	BD	BD	BD	06-Feb	W8		
6B	Warm Powering	TE		IL	IL	BD	BD	BD		W8		
7	Machine Protection	TE		IL	IL	BD	BD	BD	13-Feb	W8		
8	Collider-Experiment Interface	BE		IL	IL	IB	IB	IB		W8		
9	Cryogenics	TE		IL	IL	IL	IL	IL	03-Feb	W7		
10	Energy Deposition & Absorber Coordination	EN		IL	IL	IB	IB	IB		W7		
11	11 T Dipole Two-in-One for DS	TE		BD	BD	BD	BD	BD	06-Feb	W8		
12	Vacuum	TE		IL	IL	BD	BD	BD		W8		
13	Beam Diagnostics	BE		IL	IL	IL	IL	IL		W8		
14	Beam Transfer & Kickers	TE		IL	IL	BD	BD	BD		W8		
15	Integration & (De-)Installation	EN		IL	IL	IB	IB	IB				
16	Hardware Commissioning	BE		IL	IL	IL	IL	IL		W7		
17	Infrastructure, logistics and civil engineering	EN		IB	IB	IB	IB	IB		W7		

Budget Structure

EXAMPLE

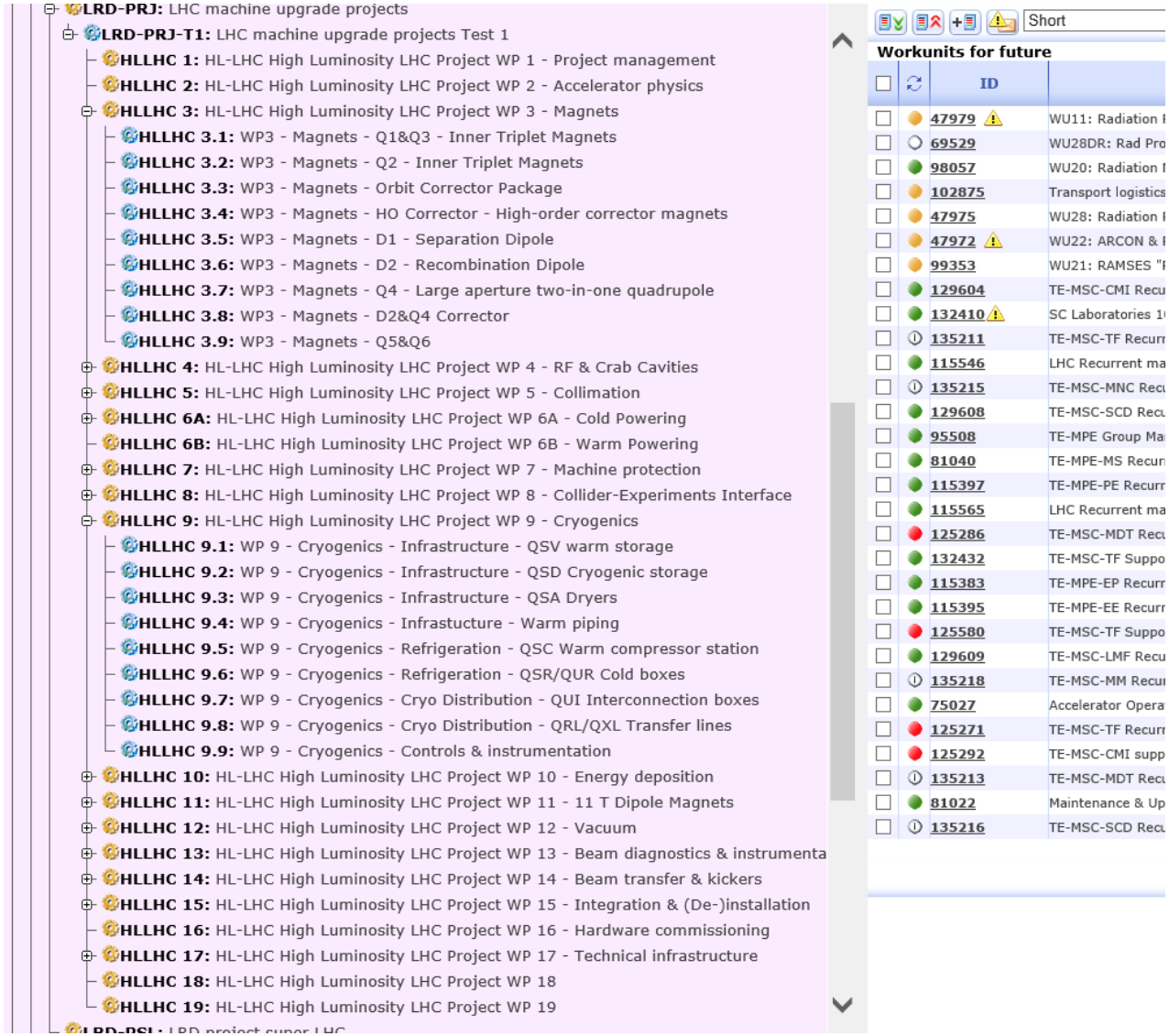
WP3- Budget Codes		BUDGET CODES		
	Section	Description	Material BC	Personnel BC
Cable	SCD	HL-LHC WP03-Cable-Q1/Q3 cable	92530	HL-LHC WP03 Cable (Personnel) Code 92500
		HL-LHC WP03-Q2 cable	92531	
		HL-LHC WP03-D1 D2 Q4 cable	92532	
		HL-LHC WP03-superferric cable	92533	
		HL-LHC WP03-corrector cable	92534	
Model	MI	HL-LHC WP03-Q1/Q3 model	92535	HL-LHC WP03 Model (Personnel) Code 92501
		HL-LHC WP03-Q2 model	92536	

Aim is to be able to x-check expenses 'easily'

WP9-Budget Codes			S	
Workunits			Material BC	Personnel BC
Infrastructure - QSV warm storage			92705	HL-LHC WP09 (Personnel) code 92700
Infrastructure - QSD Cryogenic storage				
Infrastructure - QSA Dryers				
Infrastucture - Warm piping				
Refrigeration - QSC Warm compressor station			92706	
Refrigeration - QSR/QUR Cold boxes				
Refrigeration - QSC Warm compressor station	TE-CRG-ML	HL-LHC WP09-Refrigeration@P1/P5	92707	
Refrigeration - QSR/QUR Cold boxes				
Cryo Distribution - QUI Interconnection boxes	TE-CRG-ML	HL-LHC WP09-Cryo Distribution@P4	92708	
Cryo Distribution - QRL/QXL cryo lines				
Cryo Distribution - QUI Interconnection boxes	TE-CRG-ML	HL-LHC WP09-Cryo Distribution@P1/P5	92709	
Cryo Distribution - QRL/QXL cryo lines				
Controls & instrumentation	TE-CRG-ML	HL-LHC WP09-Controls & Instrumentation	92710	

APT WBS & WUs

EXAMPLE



Resources P and M4P – Key Concepts

P Work Units

- One WU will be created yearly for each WP for personnel purposes.
- Staff and fellows (existing) are included in P WUs.
- for the first 3 years must be nominative (it is mandatory for APT for 2 years). From the 4th year onwards until 2025, general needs are expressed.
- All corrections or changes will be made in collaboration between HL-LHC team and the DPO, with the responsibility of the information kept by the DPO.

Resources P and M4P – Key Concepts

M4P Work Units

- One WU will be created yearly for each WP for M4P purposes.
- M4P includes MPA, FSU and service contracts.
  - **MPAs**
    - covers all requests for TRNE, STUD, DOCT, ADMI, TECH, COAS, PJAS **AND** FELLOW-GET
    - at a general cost od 67.2kCHF per person per year – PJAS subsistence + 12kCHF/year for the institute. Trade-off between students, PJAs and fellows (some covered by the departments as DGP).
    - All existing MPA for the first 3 years must be nominative. For the future MPA and from the 4th year onwards until 2025, general needs are expressed.
  - **FSUs**
    - cost expressed in CHF and based on present FSU contracts. The average cost to be used is 110 kCHF/year. This cost includes the margin for the replacement of the resources during holidays, maternity, etc.
  - **Service contracts – Industrial services**
    - Values for service contracts will be expressed in CHF and based on previous service contracts used for the construction of the LHC (indexed) or on currently existing service contracts.
- A maximum amount of 2000 CHF will be assigned per person per year for integration of personnel, conferences, travel and/or training expenses.

Resources P and M4P - APT numbers – WP14

EXAMPLE

HL-LHC WP14 Budget Estimate

Unit: KCHF

Summary per budget code

	Dept/Group	Responsible	Description
Absorbers	EN-STI	R.Losito	New absorbers
Beam Instrumentation	BE-BI	B.Dehning	Beam Instrumentaion for injection absorbers
Vacuum	TE-VSC-absorber	V.Baglin	Vacuum for absorbers
	TE-VSC-kicker		Vacuum for kickers
Kickers	TE-ABT	L.Ducimetiere	Kickers FPS
		E.Carlier	Kickers EC
WP-office	TE-ABT-BTP	J.Uythoven	Studies, fellows, integration, travel etc.

Total per year

cons	0

Details per budget code

Absorbers

Absorbers (EN dep)	**no absorbers**
TDIS HL	
TDIS CONS	
TCLIA, TCLIB	
TCDD	
TCLIM	
TCDS (TE-ABT & EN-STI)	
Design office	
3 fellows (one per section)	

Absorbers in D1 crysostat IP2 & IP8

To be checked with H.Prin - instead of TCDD, similar

Vacuum (TE-dep)

Absorbers vacuum TDIS HL	
Absorbers vacuum TDIS CONS	
Absorbers vacuum TCLIA/TCLIB	
Absorbers vacuum TCDD/TCLIM	
Absorber vacuum TCDS	
MKI vacuum (added, reduced from kicker budget)	
MKB vacuum new system (tbc)	
MKB vacuum consolidation (tbc, new request)	

BPMs and cables (BE-dep)

BPMs for TDIS	10	750	
BPMs for TCLIA	2	300	
Diamond BLMs for injection region		0	10
Fellow / student		160	6

Kickers

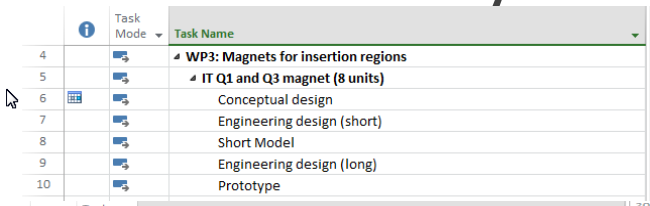
Kickers TE-dep			
MKI-studies		135	20
MKI-proto-type		400	50
MKI-series		3500	350
MKI controls			25
MKI-controls		250	
MKI consolidation already requested (T.Fowler)		0	29
MKI-student/fellow power		1150	120
MKB magnets & generators		10000	1000
MKB controls		1250	125
LBDS MKD power trigger			95
LBDS re-trigger			45
LBDS consolidation			115
Fellow ABT-EC for work LBDS			60
LBDS MKD power trigger		750	

n	MPA	30		D4	MPA for Kickers	40000	67200	CHF			
n	MPA	40		D4	MPA for WP office	40000	33600	CHF			
n	OTHERS	50		D4	Integration of personnel, conferences, travels	70000	20000	CHF			
n	wu			PL	HL-LHC-WP14-M4P-BeamTransfer&Kickers	HLLHC 14	jan.uythoven@cern.ch			1-Jan-2016	31-Dec-2016
n	INDSERV	10		D4	Design Office for Absorbers (TDIS, TCDD, TCDS)	40000	200000	CHF			
n	MPA	20		D4	MPA for Absorbers (TDIS, TCDD, TCDS)	40000	201600	CHF			
n	MPA	30		D4	MPA for Kickers	40000	67200	CHF			
n	MPA	40		D4	MPA for Diamond BLM for injection region	40000	33600	CHF			
n	MPA	50		D4	MPA for WP office	40000	67200	CHF			
n	OTHERS	60		D4	Integration of personnel, conferences, travels	70000	20000	CHF			
n	wu			PL	HL-LHC-WP14-M4P-BeamTransfer&Kickers	HLLHC 14	jan.uythoven@cern.ch			1-Jan-2017	31-Dec-2017
n	INDSERV	10		D4	Design Office for Absorbers (TDIS, TCDD, TCDS)	40000	200000	CHF			
n	MPA	20		D4	MPA for Absorbers (TDIS, TCDD, TCDS)	40000	201600	CHF			
n	MPA	30		D4	MPA for Kickers	40000	67200	CHF			
n	MPA	40		D4	MPA for Diamond BLM for injection region	40000	33600	CHF			
n	MPA	50		D4	MPA for WP office	40000	67200	CHF			
n	OTHERS	60		D4	Integration of personnel, conferences, travels	70000	20000	CHF			
n	wu			PL	HL-LHC-WP14-M4P-BeamTransfer&Kickers	HLLHC 14	jan.uythoven@cern.ch			1-Jan-2018	31-Dec-2018
n	wu			PL	HL-LHC-WP14-M4P-BeamTransfer&Kickers	HLLHC 14	jan.uythoven@cern.ch			1-Jan-2023	31-Dec-2023
n	MPA	30		D4	MPA for Kickers	40000	67200	CHF			
n	MPA	60		D4	MPA for WP office	40000	67200	CHF			
n	OTHERS	80		D4	Integration of personnel, conferences, travels	70000	20000	CHF			
n	wu			PL	HL-LHC-WP14-M4P-BeamTransfer&Kickers	HLLHC 14	jan.uythoven@cern.ch			1-Jan-2024	31-Dec-2024
n	MPA	30		D4	MPA for Kickers	40000	67200	CHF			
n	MPA	60		D4	MPA for WP office	40000	67200	CHF			
n	OTHERS	80		D4	Integration of personnel, conferences, travels	70000	20000	CHF			
n	wu			PL	HL-LHC-WP14-M4P-BeamTransfer&Kickers	HLLHC 14	jan.uythoven@cern.ch			1-Jan-2025	31-Dec-2025
n	MPA	10		D4	MPA for WP office	40000	67200	CHF			
n	OTHERS	80		D4	Integration of personnel, conferences, travels	70000	20000	CHF			
n	wu			PL	HL-LHC-WP14-M-InjectionSystem-TDIS	HLLHC 14.1.1	jan.uythoven@cern.ch			1-Jan-2015	31-Dec-2015
n	GOODS	10		D4	TDIS	63118	680000	CHF			
n	GOODS	20		D5	TDIS-CONS	10000	-453000	CHF			
n	GOODS	30		D4	TDIS - vacuum	91703	62000	CHF			
n	GOODS	40		D5	TDIS - vacuum - CONS	10000	-41000	CHF			
n	wu			PL	HL-LHC-WP14-M-InjectionSystem-TDIS	HLLHC 14.1.1	jan.uythoven@cern.ch			1-Jan-2016	31-Dec-2016
n	GOODS	10		D4	TDIS	63118	1360000	CHF			
n	GOODS	20		D5	TDIS-CONS	10000	-907000	CHF			
n	GOODS	30		D4	TDIS - vacuum	91703	62000	CHF			
n	GOODS	40		D5	TDIS - vacuum - CONS	10000	-41000	CHF			
n	wu			PL	HL-LHC-WP14-M-InjectionSystem-TDIS	HLLHC 14.1.1	jan.uythoven@cern.ch			1-Jan-2017	31-Dec-2017
n	GOODS	10		D4	TDIS	63118	1700000	CHF			
n	GOODS	20		D5	TDIS-CONS	10000	-1088000	CHF			
n	GOODS	30		D4	TDIS - vacuum	91703	186000	CHF			
n	GOODS	40		D5	TDIS - vacuum - CONS	10000	-124000	CHF			
n	wu			PL	HL-LHC-WP14-M-InjectionSystem-TDIS	HLLHC 14.1.1	jan.uythoven@cern.ch			1-Jan-2018	31-Dec-2018

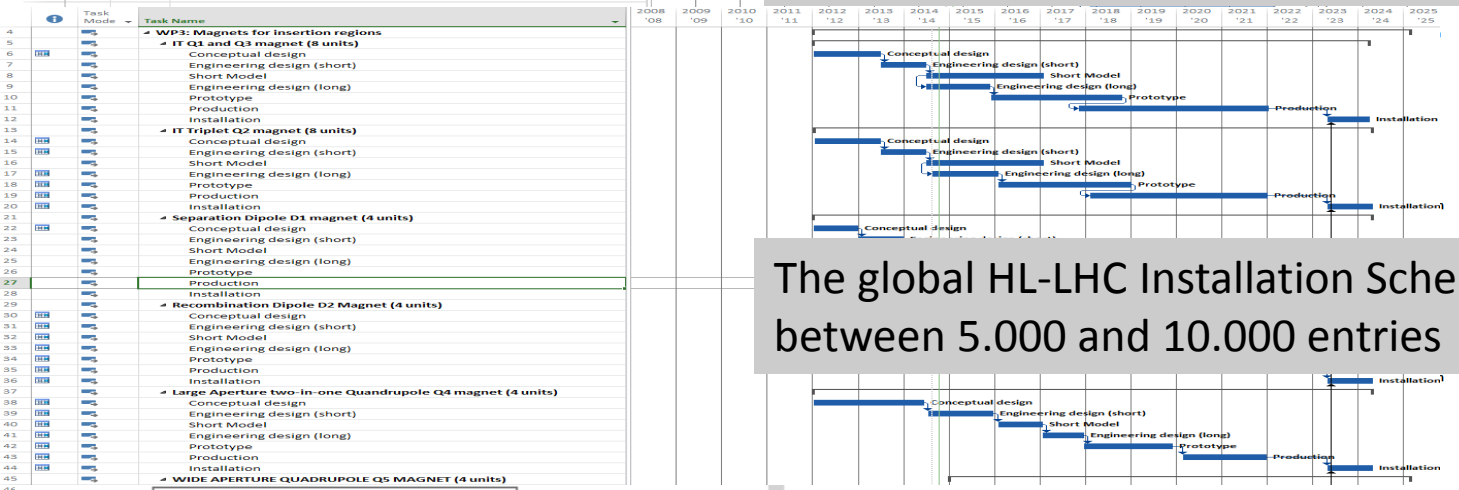
Your Excel file is fine for us, as long as we can easily:

- Identify M4P from pure M expenses
- Identify M expenses w.r.t. the PBS

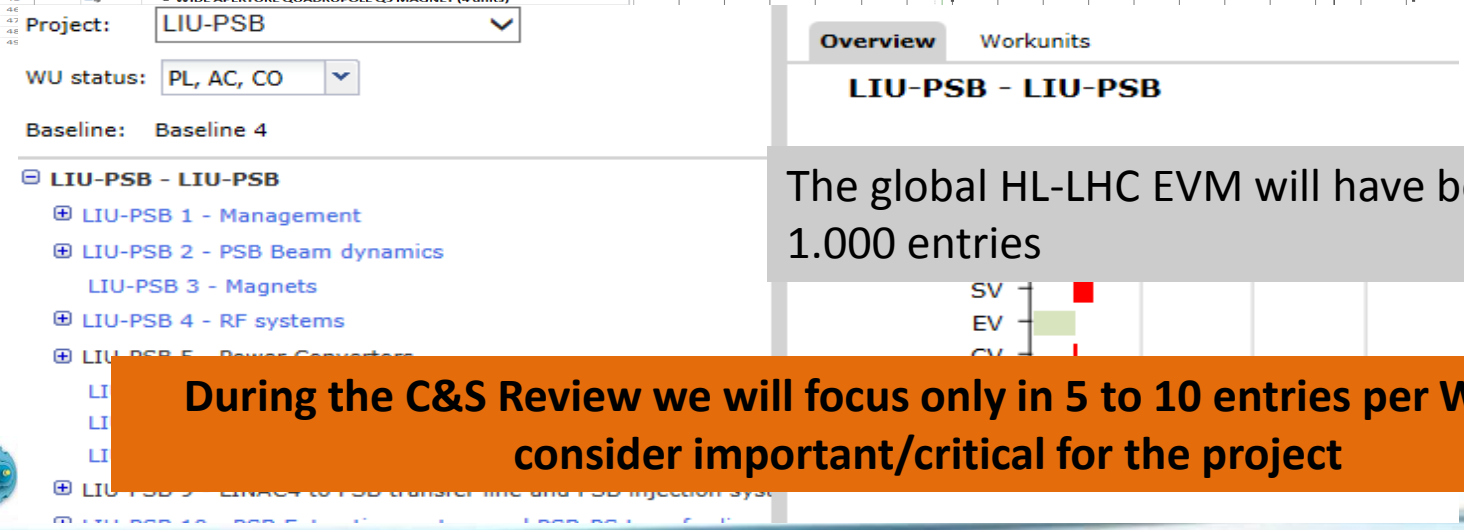
Schedule – Key concepts



The global HL-LHC Project Schedule will have between 50.000 and 100.000 entries



The global HL-LHC Installation Schedule will have between 5.000 and 10.000 entries



The global HL-LHC EVM will have between 500 and 1.000 entries

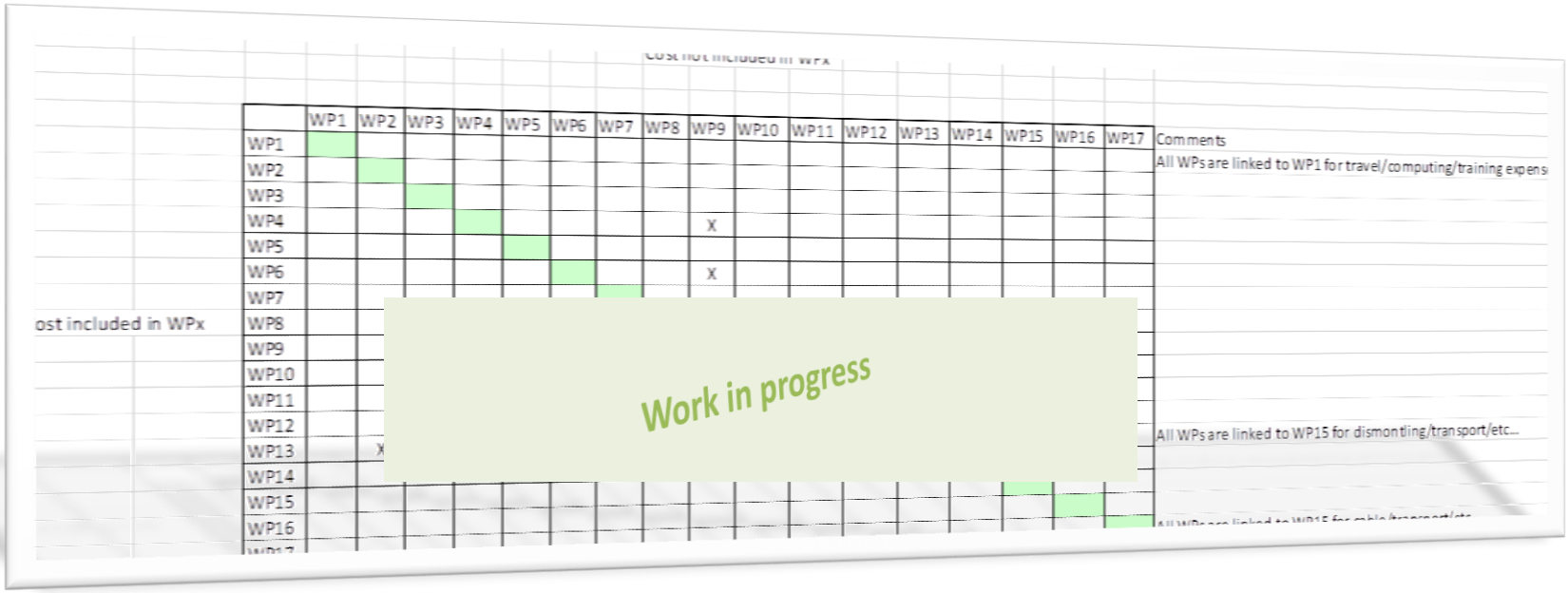
During the C&S Review we will focus only in 5 to 10 entries per WP that we consider important/critical for the project

Uncertainty – Key concepts

- Allows to put a level of risk on the overall project.
- Documents where the estimate comes.
- Allows to judge whether the cost estimates provided are within 20%, 50% or a factor of 2 …
- Basic principle is : The more you know what needs to be done, the more precise can you give a price for it.

Cost Estimate Classification	Primary Characteristics		Secondary Characteristic	
	Level of Definition (% of Complete Definition)	Typical Estimating Technique of the Cost	Typical purpose of estimate	Expected accuracy range - Variation in low and high ranges
Class 5, Concept Screening	0% to 2%	Capacity factored, Stochastic, most Parametric models, judgement or analogy	Concept screening	L: -20% to -50% H: +30% to +100%
Class 4, Study or Feasibility	1% to 15%	Equipment factored, more Parametric models	Study or feasibility	L: -15% to -30% H: +20% to +50%
Class 3, Preliminary, Budget Authorization	10% to 40%	Semi-detailed unit costs with assembly level line items, cost estimating technique includes the combinations of various techniques (detailed, unit-cost, or activity-based; parametric; specific analogy; expert opinion; trend analysis)	Budget authorization or control	L: -10% to -20% H: +10% to +30%
Class 2, Control or Bid/Tender	30% to 70%	Detailed unit cost, cost estimating technique includes the combinations of various techniques (detailed, unit-cost, or activity-based; expert opinion; learning curve)	Control or bid/tender	L: -5% to -15% H: +5% to +20%
Class 1, Check Estimate or Bid/Tender	50% to 100%	Deterministic, most definitive cost estimation	Check estimate or bid/tender	L: -3% to -10% H: +3% to +15%

Interfaces Identification



ost included in WPx

	WP1	WP2	WP3	WP4	WP5	WP6	WP7	WP8	WP9	WP10	WP11	WP12	WP13	WP14	WP15	WP16	WP17	Comments
WP1																		All WPs are linked to WP1 for travel/computing/training expens
WP2																		
WP3																		
WP4									X									
WP5																		
WP6									X									
WP7																		
WP8																		
WP9																		
WP10																		
WP11																		
WP12																		
WP13		X																All WPs are linked to WP15 for dismontling/transport/etc...
WP14																		
WP15																		
WP16																		All WPs are linked to WP15 for public transport/etc
WP17																		

Work in progress

Conclusion

- Schedule to get ready for the C&S review is tight, we need schedule and resources data (P, M4P, M) ready by end of next week (W8)
  - → leaving 2 weeks to prepare risks, uncertainty, interfaces identification …
- P resources to be uploaded in APT (in the WUs proposed by the project team)
- Interfaces – to be discussed in the TC of this afternoon
  - WP6A-WP6B-WP9
  - WP9-WP4 for SPS infrastructure
  - WP12 with almost all others
  - WP3-WP11-WP15 Interconnections
  - …
- Last 2 weeks to look for global consistency, chase up interfaces issues, reflect on risks and uncertainty

Thank you for your attention