

# Phase-2 Tracker Upgrade TDR

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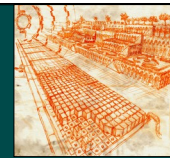
# Status Report

**Katja Klein** (Main Editor)  
*RWTH Aachen University*

Phase-2 MB, March 7th, 2017



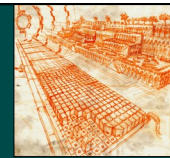
# Reminder: Structure of the TDR



- We adapt the format proposed by the USG
- **Part 1 (“Project Overview”):**
  - Represents \*the TDR\*
  - Works stand-alone, i.e. many LHCC referees will only read this
  - Provides the crucial information at a sufficiently detailed and technical level to allow judging the soundness of the project
- **Part 2 (“Technical Descriptions”):**
  - Provides material for “further reading”
  - Aspects that are highly technical or very detailed
  - Additional supportive plots, software descriptions, setups, specifications, ...
  - Most referees will read only parts of this, depending on their area of interest



# Organization & Access



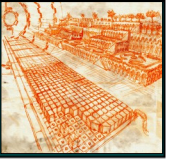
- Editorial team consists of ~28 people, mostly working group conveners
- The editorial process is documented on a Twiki:  
<https://twiki.cern.ch/twiki/bin/viewauth/CMS/Phase2TrackerTDR>
  - The access is not restricted, everybody can have a look
  - Latest version can be found at the bottom, under “Documents“
  - The document is updated ~daily (but not this week)
  - If you have comments, send them directly to me (katja.klein@cern.ch)

## Documents

- A first draft for the outline (September 2016): [TDR\\_Structure\\_Draft0\\_15092016.xlsx](#)
- Second draft for part 1 (3.10.2016, updated 14.10.2016) [TDR\\_Structure\\_Part1\\_Draft1\\_03102016.xlsx](#)
- File summarizing the content as proposed by the chapter authors during the first meeting (version of 3.10.2016, updated 14.10.2016) [pptx](#)
- Draft compiled on 21st of November [p2uTracker\\_temp.pdf](#) and section on pixel module electronics by Jorgen (not yet in SVN) [TDR\\_pixel\\_phase2\\_electronics\\_v2.pdf](#)
  - Some comments on electronics and sensors sections by Alexander [p2uTracker\\_temp\\_2016-11-25\\_aldi.pdf](#)
  - Comments on pixel electronics section by Georg [Comments\\_PixelElectronics\\_GeorgSteinbrueck.pdf](#)
  - Comments on first version by Katja [Click to open](#)
- Draft compiled on 22nd of December [p2uTracker\\_22122016.pdf](#)
  - Comments on second version by Duccio [p2uTracker\\_22122016\\_commented\\_DA.pdf](#)
  - Comments to second version by Alexander [p2uTracker\\_22122016\\_aldi.pdf](#)
  - Comments on second version by Katja [Click to open](#)
- Draft compiled on 4th of March [p2uTracker\\_04032017.pdf](#)
  - Includes editing by KK for all text. Revisiting now the remaining issues and implementing comments.



# Schedule



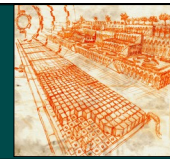
2016				2017								
Aug	Sep	Nov	Dec	Jan	Feb	March 1st	April	May 1st	June 1st	July 1st	Sep 12th	Nov
Form editorial team	Detailed outline from all authors	First internal version	Second internal version	Third internal version, editing by main editor, internal reviewing	W1-2: Editing by main editor, internal reviewing; W3: draft to TK Phase-2 MB	V1 to editorial board	Approval of performance results	V2 to critical readers	TDR to CWR, submit preview to LHCC	Submission of approved TDR to LHCC	Present TDR to LHCC, Scientific approval	Final approval
					Updating of missing results							
					Work with CMS main editor							



We are here



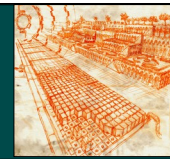
# Status Overview



- Document has now overall 262 pages
  - 237 pages of real content
  - Part 1 aka “Project Overview“ has 95 pages
  - Part 2 aka “Technical descriptions“ has 142 pages
- Draft is quite complete (> 95%), but improvements and updates of many plots required
- Internal reviewing done: every section was read by 1-2 other authors
- Draft has been sent to the Phase-2 MB (response so far: 0)
- Draft has been sent to the CMS main editor on 1st of March, as requested
  - Together with a list of items to be completed / updated
  - Comments on Chapters 1 and 2 received today



# Top Level To-do List



- New OT geometry: additional ring in TBPS, possibly new TEDD module arrangement
  - Affects several figures (layout, material budget) and tables
- System test and test beam: very few results are ready; several measurements and test beam analysis efforts ongoing, but many difficulties to get correct and robust results
- IT modules + mechanics – effort on module mechanics and TBPX started recently
  - All figures need to be updated with a consistent CAD model
- Local reconstruction + tracking
  - All plots need to be redone for the new geometry (12 IT discs + new OT geometry)
  - Several things not well understood
- Physics performance (Upgrade Performance WG) - this is still in a very early stage
- List of institutes + institutional interests: here YOU can help – please answer Salvatores e-mails
- Finalization of cost estimate, overhaul of schedule
- Text to be completed on DAQ, luminosity measurement, system test, physics performance...



# Report of the Resources Manager

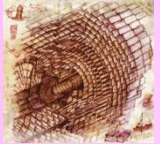


# Evolution of the TK Ph2 Construction Cost Book (1)



- ❖ The **Ph2 TK Construction Cost Book** was “born” in Oct 2016 from the ashes of the Outer Tracker (OT) & Inner Tracker (IT) — ex’ Pixel’ — TP cost-estimate files.
- ❖ Following agreement reached in Ph2 MB, also some non-TK systems were included in it, as a strategy to reduce the serious overfunding of the TK upgrade (and relieving the underfunding in other systems) by adding costs to the TK rather than having funds - and groups along with the funds - taken away from the TK community.
- ❖ However, while inclusion of **beam pipe** and **YB0 shared services** was welcomed, inclusion of **HGCAL Cooling and Power** does not seem to be accepted by CMS Upgrade Management - on the contrary, a campaign to divert funds from TK to underfunded projects has started.
  - Migration of funds seems at this point unavoidable, and migration of people/groups unfortunately too
  - Sufficient funding for the TK does not seem to be in jeopardy, though
  - **But we (you) all should be vigilant that the TK does not become under-covered in terms of construction work commitments!**
- HGCAL’s Cooling and Power cost are not yet formally removed from the Cost Book *file* - but they might be doomed.







## ❖ Continuous updating:

- ❖ Guesses replaced with engineering estimates, estimates with vendor quotes...
- ❖ Just a few examples:
  - ❖ Have long-awaited reliable quotes for major cost driver items: sensors (OT & IT), OT Front-end Hybrids. Power System (OT & IT)
  - ❖ Have well defined design of IT+OT common Cooling System, with a well understood cost
- ❖ It's reassuring that these do not imply significant cost increase wrt older estimates

## ❖ Adopts partition terminology agreed for TDR:

- ❖ OT  TBPS, TB2S, TEDDs
- ❖ IT  TBPX, TFPXs, TEPXs

## ❖ A long process of **Cost Review** ahead...

- ❖ Already went through a couple of reviews
- ❖ Another one this Friday...

## ❖ Discussion about cost sharing of individual items have started in the Ph2MB level and, especiall for IT, have already made good progress

## ❖ At least it seems possible to cover all IT items financially

- ❖ Still some work needed to reshuffle overfunding
- ❖ As for Phase-1, cost sharing **will not be in TDR**, but in **MoUs** to be issued later

# Cost Summary Tables (in kCHF)



## Cost to aim for

There is an expectation in CMS that cost evolution for the various system should not lead to a total new cost higher than in the TP.

With the current Cost Book structure this means:

OT's TP cost	89087
Pixel's TP cost	23174
BRIL-LUMI's TP cost (*)	1400
Beam Pipe's TP cost	1'700
Beam piper extra cost	1'200
HGCAL Cooling	4'220
HGCAL Power	3'150
Shared Services	1'000
<b>TDR Cost Target</b>	<b>124931</b>

(\*) 1930 in TP includes 530 BE to be left in BRIL's Cost Book

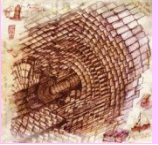
During **cost review** phase, forced to switch back to 2014 exchange rates, so that reviewers can effortlessly compare with TP estimates, factorizing out actual changes of the *estimates* from variations of *currency exchange rates*

## Arranged by System

CBS N.	Cost Item Name	kCHF 2014
	8224 2S modules	28'218
	5332 PS modules	18'158
	Mechanics	7'171
	DAQ	5'784
	Dry gas system	50
	Safety system	600
	Services	5'635
	Infrastructures, logistics, work	3'610
	Track Trigger	6'618
<b>1.1</b>	<b>Outer Tracker</b>	<b>75'845</b>
	Costs common to different modules: 3D/Si sensor masks, ROC submission	1'122
	428 Inner Modules 1x2 with 3D sensors	1'833
	1532 Inner Modules 1x2 with planar sensors	2'940
	2392 Outer Modules 2x2	7'193
	Service Electronics	302
	Barrel Mechanics	1'400
	Forward Mechanics	1'353
	Endcap Mechanics	1'209
	DAQ	1'122
	Beam Pipe	2'900
	Safety system	263
	Services	1'572
	Infrastructures, logistics, work	2'905
<b>1.2</b>	<b>Inner Tracker</b>	<b>26'113</b>
2.1	Cooling	12'200
2.2	Power Systems	13'045
2.3	Shared Services	1'100
<b>2</b>	<b>CMS Si-Detectors Shared Systems</b>	<b>26'345</b>
<b>OTK TDR total cost</b>		<b>128'303</b>

## Arranged by Partition

CBS N.	Cost Item Name	kCHF 2014
	<b>TBPS</b>	15'220
	<b>TB2S</b>	22'746
	<b>TEDD</b>	31'260
	Track Trigger	6'618
<b>1.1</b>	<b>Outer Tracker</b>	<b>75'845</b>
	<b>TBPX</b>	6'336
	<b>TFPX</b>	10'250
	<b>TEPX</b>	9'527
<b>1.2</b>	<b>Inner Tracker</b>	<b>26'113</b>
<b>1</b>	<b>Phase-2 Tracker</b>	<b>101'958</b>
<b>2.1</b>	<b>CMS Si-Detectors Cooling</b>	12'200
<b>2.2</b>	<b>CMS Si-Detectors Power Systems</b>	13'045
<b>2.3</b>	<b>Shared Services</b>	1'100
<b>2</b>	<b>CMS Si-Detectors Shared Systems</b>	<b>26'345</b>
<b>0</b>	<b>TK TDR total cost</b>	<b>128'303</b>



- ❖ The last chapter of both Part 1 and Part 2 describe “**Project Organisation, Responsibilities, Planning and Cost**” and include:
  - a **list of Participating Institutes and Collaborators**
  - a **table of Institutional Interests for construction tasks** in the section on construction workload sharing
- I’m in the process of collecting from Ph2MB and TIB members data for these two sections



- ❖ Process to collect names very slow
- ❖ Still missing or not-yet-confirmed info for:

## ❖ **7 USA Institutes**

1. **Florida State University, Tallahassee, Florida, USA**
  2. **University of Florida, Gainesville, Florida, USA**
  3. **Northwestern University, Evanston, Illinois, USA**
  4. **Purdue University, West Lafayette, Indiana, USA**
  5. **Massachusetts Institute of Technology, Cambridge, Massachusetts, USA**
  6. **University of Mississippi, Oxford, Mississippi, USA**
  7. **Cornell University, Ithaca, New York, USA**
- 
- ❖ **If an (USA) Institute is not involved, an explicit statement would be appreciated – and the Institute will be removed from the list**

# Table of Institutional Interests



	<b>Task 1</b>	<b>Task 2</b>	<b>Task 3</b>	<b>Task 4</b>	<b>...</b>
<b>Institute 1</b>		X			X
<b>Institute 2</b>			X		
<b>...</b>		X		X	

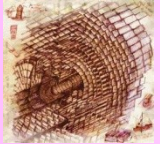


# Tasks to indicate Interest for

Not too detailed, to avoid it becoming binding, as the workload sharing is not perfectly defined yet

Sensor QC	ASICs QC	FE Hybrid QC	Bump bonding QC	On-detector Service Electronics	Module production	Module burn-in	Integration of sub-assemblies	Mechanics	Beam pipe	Optical Data links	DAQ hw	DAQ sw	Track trigger	Dry gas system	Safety system	Cooling system	Power system	Power cables	Commissioning	Installation	Construction database
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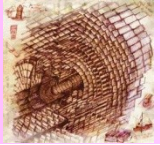
# Partitions for which Interest can be expressed



- ❖ Table could be filled with just with crosses, to express interest for a task
- ❖ **We would like to do it with the next level of detail, as in the Phase-1 TDR, giving the possibility to express the interests for specific partitions of the detector**
- ❖ **Not too detailed though, to avoid it becoming binding, as the workload sharing is not perfectly defined yet**

(OK to say “I plan to build modules for the TEDDs”, but not “2000 PS modules for TEDD”)

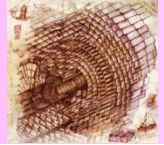
Possible entries:
<b>X = interest in this item (<i>without specifying partition</i>)</b>
<b>OT = interest in this item for the entire OT</b>
<b>TBPS = interest in this item for the TBPS</b>
<b>TB2S = interest in this item for the TB2S</b>
<b>TEDD = interest in this item for the TEDDs</b>
<b>IT = interest in this item for the entire IT</b>
<b>TBPX = interest in this item for the TBPX</b>
<b>TFPX = interest in this item for the TFPXs</b>
<b>TEPX = interest in this item for the TEPXs</b>



- ❖ **In order to speed up the collection process, two passes**
- ❖ First pass: collect from Ph2MB members, representing whole Funding Agencies
- ❖ Input received from:
  - ❖ Austria, Belgium, Finland, France, Germany (BMBF & DESY), Greece, Hungary, Italy, Spain, CERN, Switzerland
  - ❖ **Missing input from:**
    - ❖ India, Pakistan, UK, USA
- ❖ Second pass: collect from TIB members, representing the individual Institutes
- ❖ **Table in present status shown in next slide**
  - **Will email it to all Institute Reps in TIB**
  - **Institute Reps: check entries for your Institute, correct or add entries as appropriate – if in doubt, discuss with the Ph2MB member for your FA**



# Table of Institutional Interests



Possible entries:	Sensor QC	ASICs QC	FE Hybrid QC	Bump bonding QC	On-detector Service Electronics	Module production	Module burn-in	Integration of sub-assemblies	Mechanics	Beam pipe	Optical Data Links	DAQ hw	DAQ sw	Track trigger	Dry gas system	Safety system	Cooling system	Power system	Power cables	Commissioning	Installation	Construction database
Institut f. Teilchenphysik der OAW Wien, AUSTRIA	OT																					
Universiteit Antwerpen, Antwerpen, BELGIUM																						
Universiteit [c] Libre de Bruxelles, Brussels, BELGIUM																						
Vrije Universiteit Brussel, Brussels, BELGIUM																						
Universiteit [c] Catholique de Louvain, Louvain-la-Neuve, BELGIUM																						
Department of Physics, University of Helsinki, Helsinki, FINLAND																						
Helsinki Institute of Physics, FINLAND																						
Lappeenranta University of Technology, Lappeenranta, FINLAND																						
Universit[et] de Lyon, Universit[et] [c] Claude Bernard Lyon 1, CNRS-IN2P3, Institut de Physique Nuel [c] Jean de Lyon, Villeurbanne, FRANCE	OT																					
Universit[et] [c] de Strasbourg, CNRS, IPHC UMR 7173, Strasbourg, FRANCE																						
RWTH Aachen University, I. Physikalisches Institut, Aachen, GERMANY					OT																	
RWTH Aachen University, II. Physikalisches Institut B, Aachen, GERMANY																						
Deutsches Elektronen-Synchrotron, Hamburg, GERMANY																						
University of Hamburg, Hamburg, GERMANY	IT		IT	IT																		
Institut f. Teilchenphysik, Karlsruhe, GERMANY	OT																					
Institute of Nuclear and Particle Physics (INPP), NCSR Demokritos, Aghia Paraskevi, GREECE	OT	OT	OT																			
Wigner Research Centre for Physics, Budapest, HUNGARY																						
Indian Institute of Science, Bangalore, INDIA																						
National Institute of Science Education and Research, Bhubaneswar, INDIA																						
Punjabi University Chandigarh, INDIA																						
University of Delhi, Delhi, INDIA																						
Saha Institute of Nuclear Physics, Kolkata, INDIA																						
Indian Institute of Technology, Madras, INDIA																						
Tata Institute of Fundamental Research, Mumbai, INDIA																						
Massachusetts Institute of Technology, Cambridge, MA, USA																						
INFN Sezione di Bari and Universit[et] [c] di Bari, Bari, ITALY																						
INFN Sezione di Catania and Universit[et] [c] di Catania, Catania, ITALY																						
INFN Sezione di Firenze and Universit[et] [c] di Firenze, Firenze, ITALY																						
INFN Sezione di Genova and Universit[et] [c] di Genova, Genova, ITALY																						
INFN Sezione di Milano-Bicocca and Universit[et] [c] di Milano-Bicocca, Milano, ITALY																						
INFN Sezione di Padova and Universit[et] [c] di Padova, Padova, ITALY																						
INFN Sezione di Pavia, Universit[et] [c] di Pavia and Universit[et] [c] di Bergamo, Pavia, ITALY																						
INFN Sezione di Perugia and Universit[et] [c] di Perugia, Perugia, ITALY	OT	X	OT																			
INFN Sezione di Pisa, Universit[et] [c] di Pisa and Scuola Normale Superiore di Pisa, Pisa, ITALY	IT																					
INFN Sezione di Torino, Universit[et] [c] di Torino and Politecnico di Torino, Torino, ITALY																						
INFN Sezione di Trieste and Universit[et] [c] di Trieste, Trieste, ITALY																						
National Centre for Physics, Quaid-i-Azam University, Islamabad, PAKISTAN																						
Instituto de Fisica de Cantabria (IFCA), CSIC-Universidad de Cantabria, Santander, SPAIN	OT																					
Instituto Tecnol[og]ico de Arago (ITAN) (IN2P3), Zaragoza, SPAIN																						
Grupo de Ingenieria Electronica de la Universidad de Sevilla (GIE-US), Sevilla, SPAIN	IT																					
ETH, European Organization for Nuclear Research, Gen[ev]e, SWITZERLAND																						
Institute for Particle Physics, ETH Z[ur]ich, Z[ur]ich, SWITZERLAND	OT																					
Universit[et] [c] Z[ur]ich, Z[ur]ich, SWITZERLAND	IT																					
Paul Scherrer Institut, Villigen, SWITZERLAND	IT	IT	IT																			
University of Bristol, Bristol, UNITED KINGDOM																						
Imperial College London, UNITED KINGDOM																						
University of California at Davis, Davis, California, USA																						
University of California at Riverside, Riverside, California, USA																						
University of California at San Diego, La Jolla, California, USA																						
University of California at Boulder, Boulder, Colorado, USA																						
The Catholic University of America, Washington, DC, USA																						
Florida State University, Tallahassee, Florida, USA																						
University of Florida, Gainesville, Florida, USA																						
Fermi National Accelerator Laboratory (FNAL), Batavia, Illinois, USA																						
University of Illinois at Chicago (UIC), Chicago, Illinois, USA																						
Northwestern University, Evanston, Illinois, USA																						
Purdue University Northwest, Hammond, Indiana, USA																						
Purdue University, West Lafayette, Indiana, USA																						
University of Iowa, Iowa City, Iowa, USA																						
The University of Kansas, Lawrence, Kansas, USA																						
Kansas State University, Manhattan, Kansas, USA																						
Johns Hopkins University, Baltimore, Maryland, USA																						
Massachusetts Institute of Technology, Cambridge, Massachusetts, USA																						
University of Mississippi, Oxford, Mississippi, USA																						
University of Nebraska, Lincoln, Nebraska, USA																						
Rutgers, The State University of New Jersey, Piscataway, New Jersey, USA																						
Princeton University, Princeton, New Jersey, USA																						
State University of New York, Buffalo, New York, USA																						
Cornell University, Ithaca, New York, USA																						
University of Rochester, Rochester, New York, USA																						
The Ohio State University, Columbus, Ohio, USA																						
University of Puerto Rico, Mayaguez, Puerto Rico, USA																						
Brown University, Providence, Rhode Island, USA																						
Texas A&M University, College Station, Texas, USA																						
Vanderbilt University, Nashville, Tennessee, USA																						
Rice University, Houston, Texas, USA																						

- ## TIB members tasks:
- Check existing entries for your Institute, correct them as appropriate
  - Add missing entries for your Institute
  - If in doubt, discuss with the Ph2MB member for your FA