



# TDR Task Force Meeting

10/11/2010



## Updated TDR schedule & resources





1) a first phase (up to 2016) focused on:

- review of the CLIC baseline design, taking into account CDR results – cost & power consumption optimization, energy staging
- technical developments & beginning of industrialization,
- exploitation and upgrade of CTF3 towards CTF3+, construction and commissioning of CLIC Zero injector,
- Technical Design (TD) and Project Implementation Plan (PIP) of CLIC Zero

This phase will culminate with a document describing the above work and proposing the next phase including the construction of something like CLIC Zero as first CLIC phase.

2) a following phase (from 2017 to 2020-22) focused on:

- finalization of the baseline design, taking into account:
  - results of technical studies done in the previous phase
  - final energy staging scenario based on the LHC Physics results, which should be fully available by the time,
- further technical developments & industrialization,
- Construction of CLIC Zero as first CLIC phase (independently of future CLIC site)
- Technical Design (TD) and Project Implementation Plan (PIP) of CLIC, following the energy staging strategy.

This phase will culminate with a document describing the above work and possibly proposing CLIC as a project to be built in phases, building up on CLIC Zero and starting with the lowest energy requested by Physics.



## The new MTP

Fact Sheet	Old fact sheet number	(in MCHF, 2010 prices, rounded off)	2010 Revised budget	2011	2012	2013	2014	2015	2011-2015 Total
		<b>Projects</b>	<b>105.2</b>	<b>134.4</b>	<b>133.4</b>	<b>123.4</b>	<b>120.9</b>	<b>98.9</b>	<b>611.0</b>
24	16.a	CLIC / Linear collider	24.2	27.0	28.7	29.9	29.9	29.9	145.4
		Personnel	12.8	14.2	11.9	11.1	10.9	10.9	58.8
		Materials	11.3	12.9	16.8	18.8	19.0	19.0	86.6

MTP August		2010	2011	2012	2013	2014	2015	2016
Yearly	Total	24.2	27	28.7	29.9	29.9	29.9	29.9
	Personnel	12.8	14.2	11.9	11.1	10.9	10.9	10.9
	Material	11.3	12.9	16.8	18.8	19	19	19
Integrated from 2011	Total		27	55.7	85.6	115.5	145.4	175.3
	Personnel		14.2	26.1	37.2	48.1	59	69.9
	Material		12.9	29.7	48.5	67.5	86.5	105.5

- What can be done until 2016 with the available resources?
  - Assume 105 MCHF integrated CERN contribution (2011-2016) for material budget
  - Assume an additional 50% from the Collaboration > total ~150 MCHF
  - Neglect Personnel budget for the moment

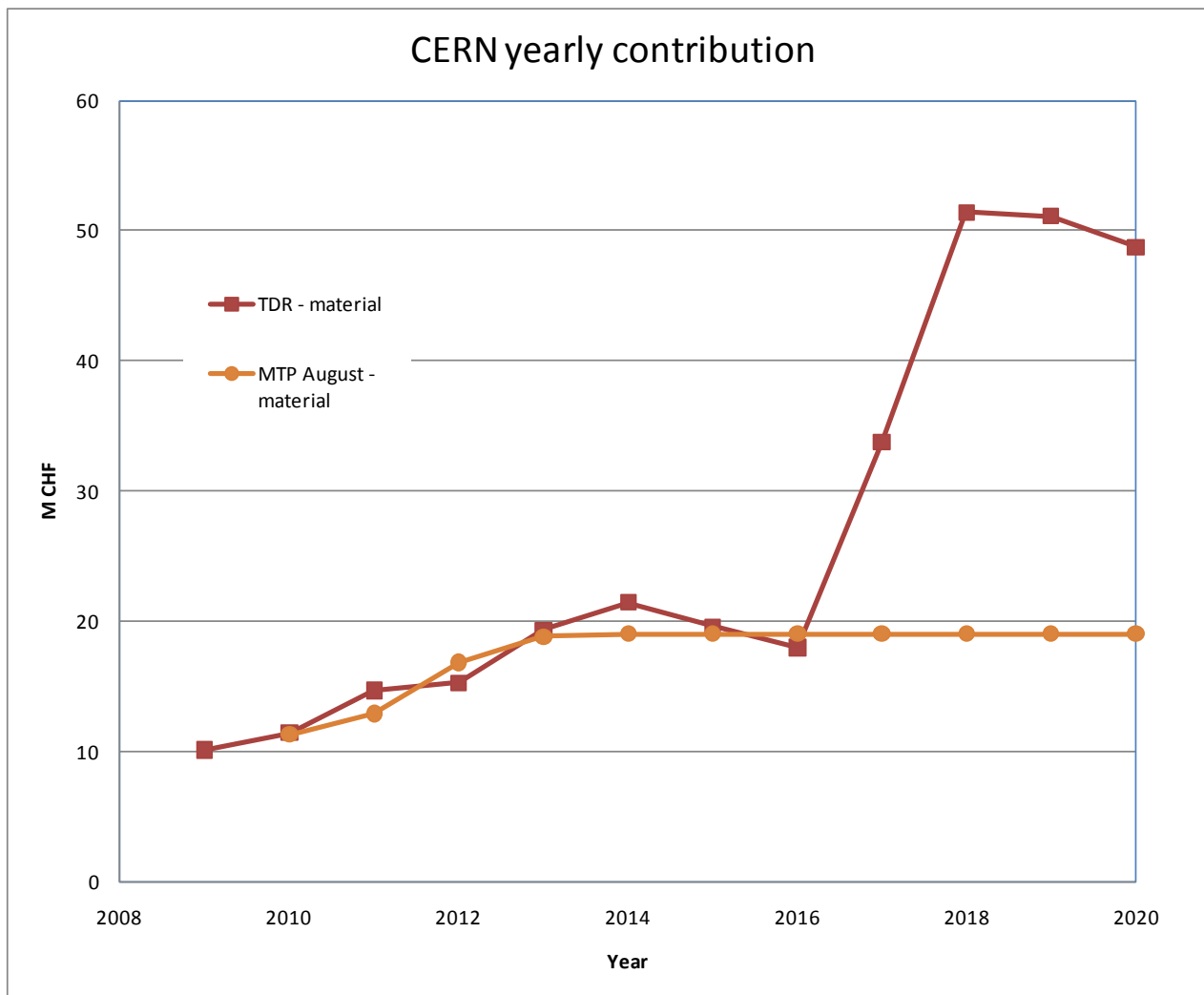


- Cannot maintain all program, even without CLIC Zero !
- Extend RF structure development, High power testing, Technical Development, Beam physics over 10 years rather than 6
- Keep Technical Development and prototypes, Cost & Civil Eng studies to lower level until 2016

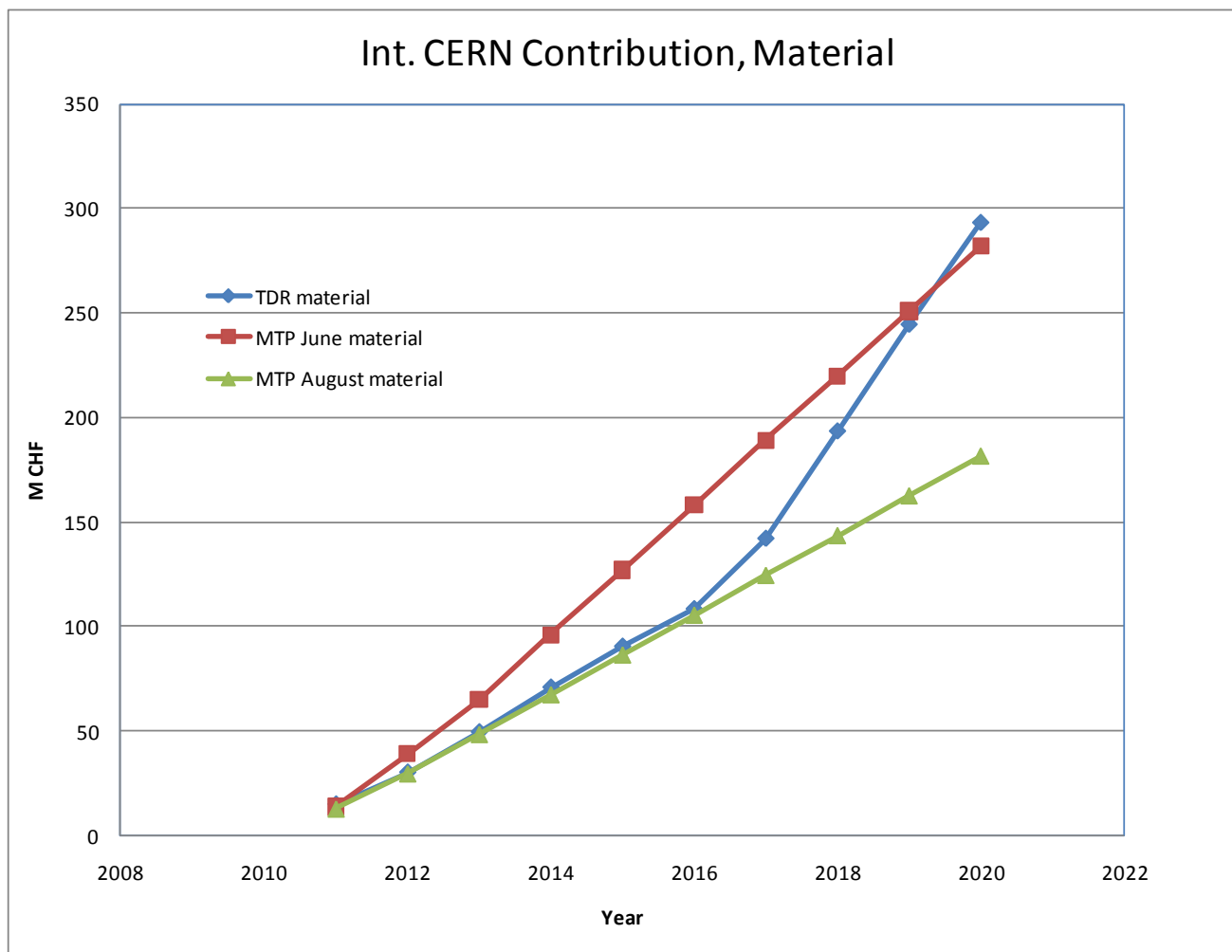
Results:	material cost (MCHF)
• CTF3++	43
• Drive Beam Injector (plus a couple of modules)	25
• RF structure development	30
• High power testing	13
• Technical Development, prototypes	30
• Cost, Civil Eng studies	4
• Beam Physics	3
• Total	~ 150 MCHF



## Tentative TDR budget profile (material)



## Tentative TDR budget profile (material)



## Review per activity - RF structure development & High power testing

Resources estimate for structures, last update 24-09-2010				
values in kCHF				
Manpower (FTEs per year over whole period, CERN and collaborators)		Period: 2011-2016		
	staff (including coll.)	fellows and students		
Design	6	10		
Production	7	7		
Test areas and testing	6	6		
Total	19	23		
Cost per year per FTE	200	125		
Cost per year	3800	2875		
<b>Sub-total over six years</b>		<b>40050</b>		
Integrated material budget				
item	Unit cost	Number	Total cost	
<b>Laboratory-based manufacturing</b>				
Machining center	1000	1	1000	
H2 diff. bonding furnace	500	1	500	
Infrastructures	1000	1	1000	
Exploitation	2000/y		12000	
<b>Accelerating structures</b>				
Baseline made by industry for test	75	100	7500	
New/alternative design	100	20	2000	
<b>PETS</b>				
New/alternative design	75	10	750	
<b>Klystron-based test areas (incl. 1 for long-running test)</b>				
Klystron	750	4	3000	
modulator	550	4	2200	
Pulse compressor, waveguide, instrumentation	1000	4	4000	
Infrastructures	1000	1	1000	
Exploitation	500/y		3000	
<b>Beam-based power sources</b>				
not included here			13200	
<b>Subtotal</b>			<b>37950</b>	
<b>Total</b>			<b>78000</b>	

structures

test areas

### Structures

- Build and test about **120** accelerating structures
- Build and test about **10** PETS prototypes (others for CTF3+, both TBL & modules)
- Establish quality control, brazing and assembly procedures for structure fabrication at CERN
- Precision machining center at CERN

### Test areas

- Four 12 GHz klystron-based RF high-power test stations, for about 8 slots, running before 2016
- Continue high-power testing at 11.4 GHz (KEK and SLAC)
- Contribution to high-power testing in CTF+ (TBL)



## Review per activity – CTF3 +

			2011	2012	2013	2014	2015	2016		tot
Operation, consol, upgrade	material		2000	2000	3000	3000	3000	3000		16000
	manpower		3000	3000	3000	3000	3000	3000		18000
	total		5000	5000	6000	6000	6000	6000		34000
TBL+	material		0	1000	1000	1000	1000	0		4000
	manpower		0	1000	1000	1000	1000	500		4500
	total		0	2000	2000	2000	2000	500		8500
Phase feedback	material		0	1000	1000	1000	0	0		3000
	manpower		500	500	500	500	500	500		3000
	total		500	1500	1500	1500	500	500		6000
TBL	material		2000							2000
	manpower		600							600
	total		2600	0	0	0	0	0		2600
Modules CTF3	material		1500	2500	4500	4000	4000	1500		18000
	manpower		500	1000	1000	1000	1000	0		4500
	total		2000	3500	5500	5000	5000	1500		22500
			2011	2012	2013	2014	2015	2016		tot
ALL	material		5500	6500	9500	9000	8000	4500		43000
	manpower		4600	5500	5500	5500	5500	4000		30600
	total		10100	12000	15000	14500	13500	8500		73600

- Consolidation and upgrade (higher energy – three more MKS, rep. rate, stability, reliability)
- Drive beam phase feed-forward experiments (phase monitor - EU7, kickers, amplifiers...)
- Upgrade and operate TBL as 12 GHz power production facility (up to 8 testing slots, increased rep. rate)
- Operation with beam of a *long string* of CLIC two-beam modules

Main question during discussion: what is the added value of a long module string in CTF3?

Comparison of resources between minimum and maximum scenario ( N.B.: about 850 kCHF per module – G. Riddone 20 May 2010)

Present program (up to 6 modules)	material	4750	5750	3875	3875	2875	1875		23000
	manpower	3475	4375	3375	3375	3375	2875		20850
	total	8225	10125	7250	7250	6250	4750		43850
Addition for up to 20 modules	material	750	750	5625	5125	5125	2625		20000
	manpower	1125	1125	2125	2125	2125	1125		9750
	total	1875	1875	7750	7250	7250	3750		29750



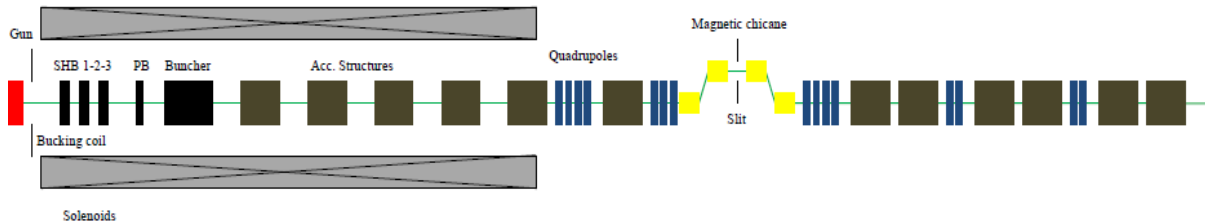


## Review per activity – CLIC Zero Injector

Reviewed cost and manpower after discussion, taking into account recent injector design & comments

Injector		
Energy	30 MeV	
Current	4 A	
Power	120 MW	
Total P.	133 MW	
Unit power	15 MW	
N. Units	12	
cost/RF unit	1300 kSfr	
total cost RF	15600	
N. structures	6	
cost/structure	200 kSfr	
structures	1200	
add. Equipment cost	8400	
total injector	25200	
construction		
Manpower/year	12 FTE	
Duration	5 years	
Cost/FTE	150 kSfr	
manpower cost /year	1800	
manpower (constr. only)	9000	
operation		
Manpower/year	5 FTE	
Duration	5 years	
Cost/FTE	150 kSfr	
manpower cost /year	750	
manpower (op. only)	3750	
<b>total inj mat.</b>	<b>28116.67</b>	
total inj constr.	37116.67	
total inj manpow	12750	

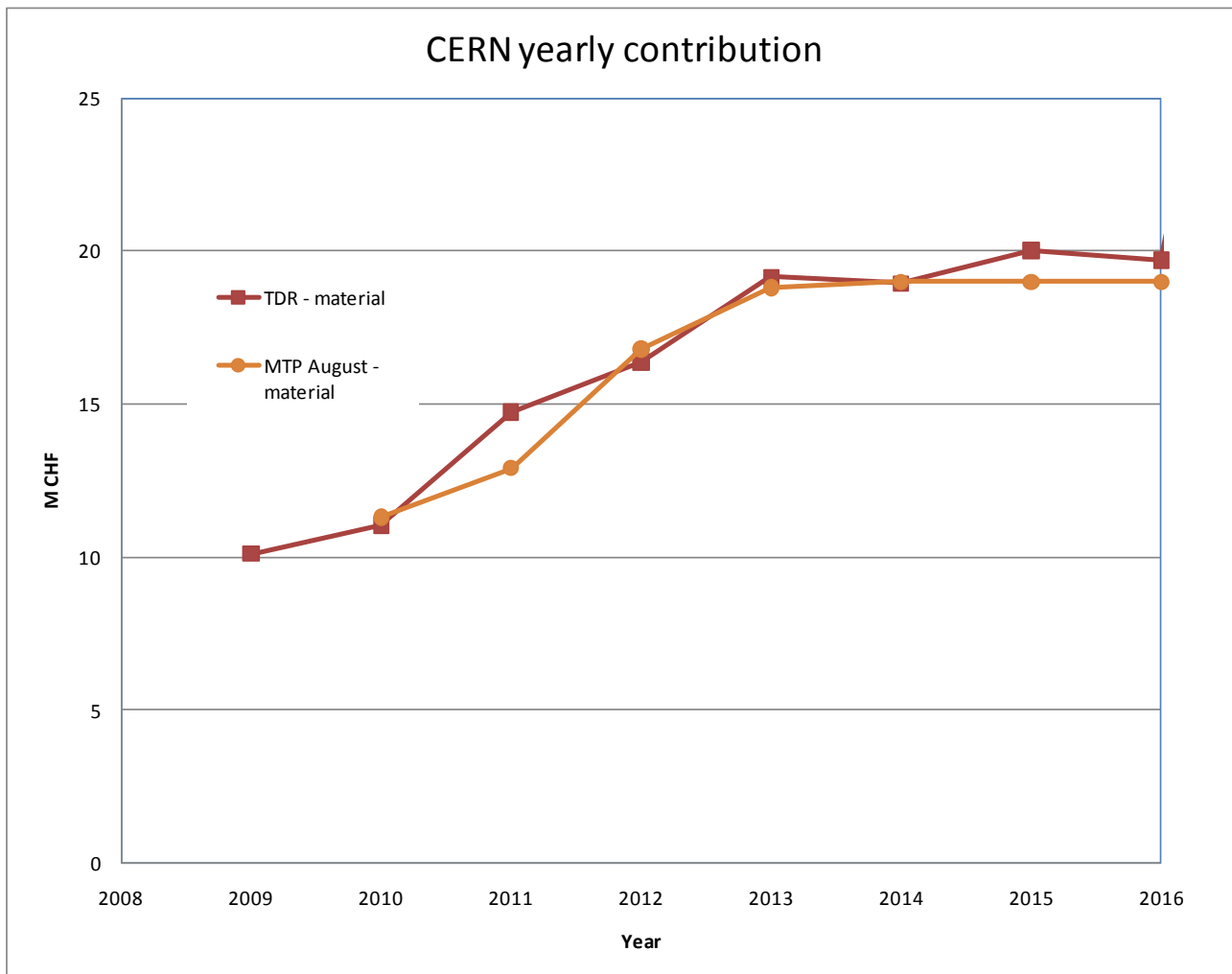
- Build and commission 30 MeV Drive Beam Injector with nominal CLIC parameters
- Build and commission a few (2 to 4) Drive Beam accelerator nominal modules
- Start construction of DBA linac (mainly civ. eng.)
- Participation to Technical Design of full CLIC Zero facility



	2010	2011	2012	2013	2014	2015	2016
inj		0.05	0.1	0.2	0.3	0.35	
civ. eng.lin		0.04	0.06	0.04	0.03	0.05	0.42
linac					0.01	0.01	0.05
	2010	2011	2012	2013	2014	2015	2016
material	0	1960	3570	5740	8925	10535	11549
manpower	0	863	1313	2438	3225	2963	4200



## Situation (material) after these reviews

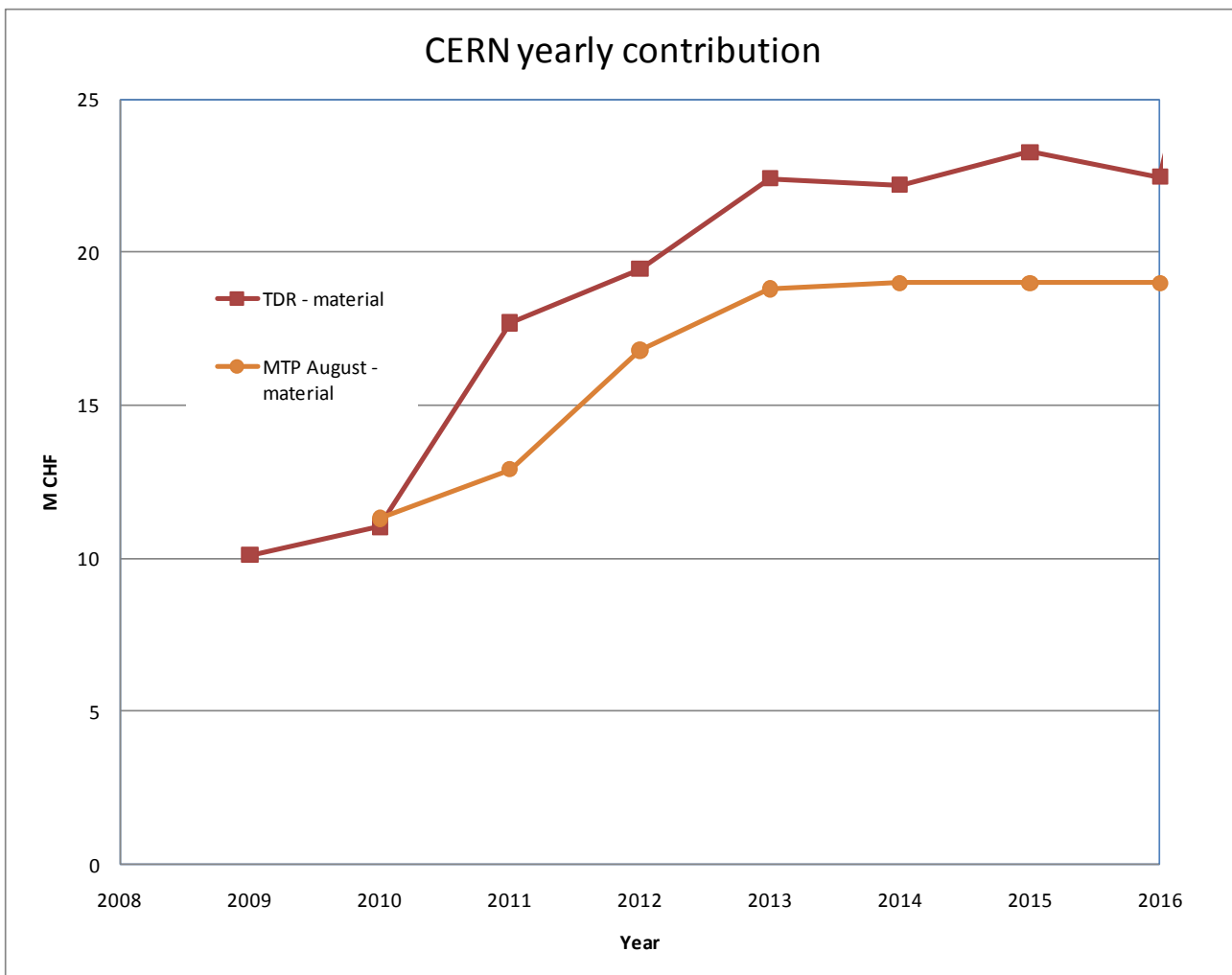


## Review per activity – CTC, prototyping – Hermann’s evaluation

CTC driven technical development		year	2010	2011	2012	2013	2014	2015	2016
domain	deliverable								
development of 15 MW 1 GHZ MBK	2 x 3 working prototypes			160	1500	1500	1500	1500	1500
development of modulators for above	prototypes for all MBKs			250	1000	1000	1000	1000	1000
prototypes of stabilized MB quads	at least one T1, T2, T3, T4			750	750	100	100	100	750
alignment system	400m working demonstrator in TZ32			1000	1000	100	100	100	1000
alternative alignment system	prototypes			300	300	800	800	800	300
prototype for FF quad (including stabilization)	Short and long prototype			500	500	1000	1000	1000	500
Validation of quad stability through beam experiments	validation			200	200	200	200	200	200
Prototypes of critical beam instruments	experimental validation; BPMs, ODR			800	800	800	800	800	800
Prototype installation of fs timing system	24 km transport of 10 fs timing reference			200	200	500	500	500	200
prototypes of fast kickers	10-4 jitter kicker in lab; beam tests			400	400	400	400	400	400
various magnet prototypes with power supplies	preparation of industrial production			800	800	800	800	800	800
Critical equipment for DRs: vacuum, SC wiggler	prototypes, verification in light sources			1500	500	500	500	500	500
dump, masks	studies, designs, material tests			700	700	700	700	700	700
general				500	500	1500	1500	1500	500
<b>part of CTF3+ program</b>									
complete and fully integrated 2 beam modules	part of CTF3+ program								
prototyping for phase measurement and feed-forward	part of CTF3+ program								
Prototype of machine protection system	part of CTF3+ program								
	<b>total M:</b>			8060	9150	9900	9900	9900	9150
	<b>CERN M:</b>			6000	6200	6600	6800	6800	6800



## Situation (material) after Hermann's input

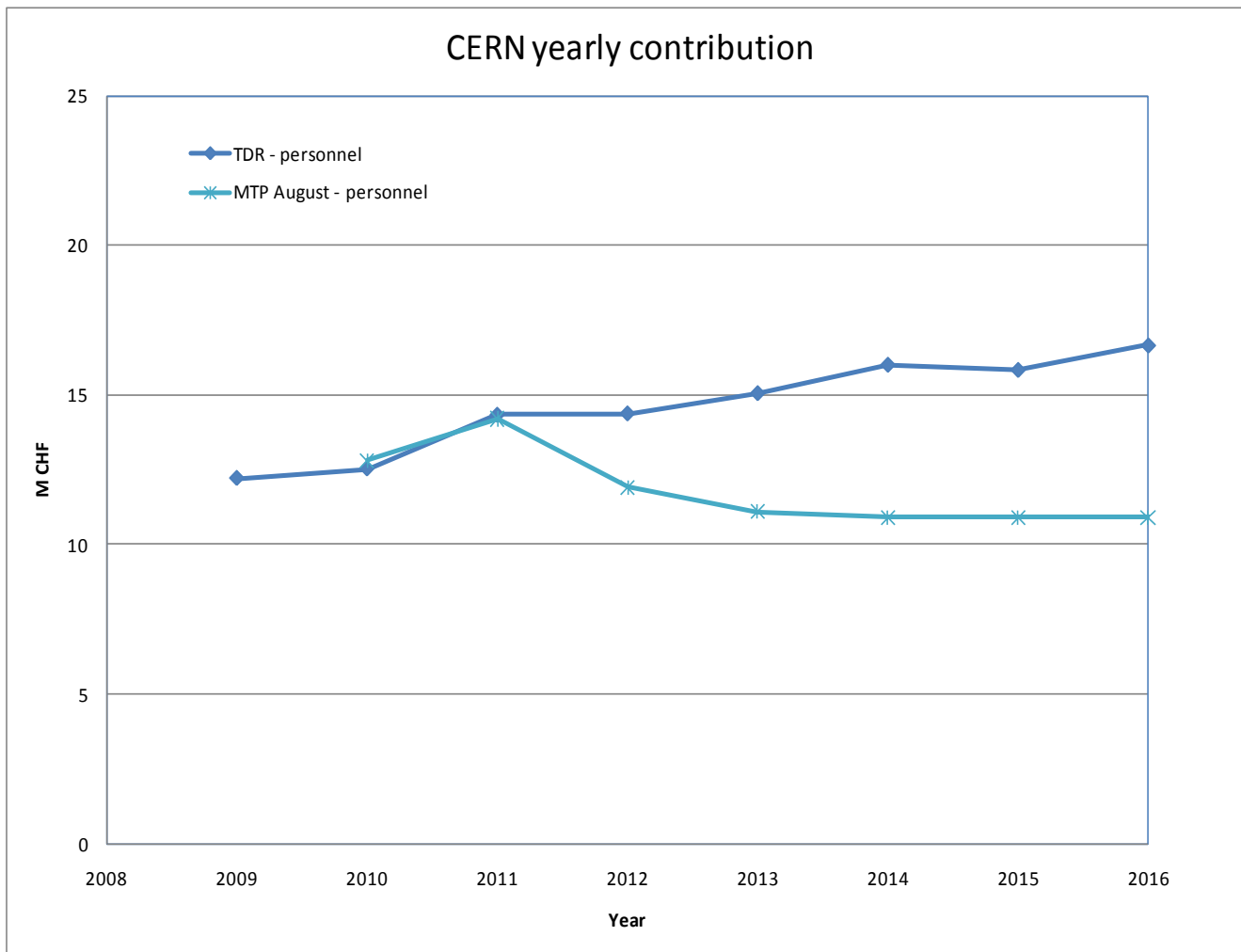


## Distribution (integrated) of material budget (CERN & collaborators)

material, integrated by activity	2010	2011	2012	2013	2014	2015	2016
CTF3 upgrade and operation		5500	13000	22000	29500	37000	43000
CLIC ZERO		1960	5530	11270	20195	30730	42279
RF structures construction		4500	9000	13500	18000	22500	27000
RF test infrastructure		3000	6500	10000	11000	12000	13000
Prototypes of critical components		8060	17210	27110	37010	46910	56060
Cost studies, Civil Engineering, Proj. Impl		403	861	1361	2361	3361	4361
Beam physics studies		480	980	1480	1980	2480	2980

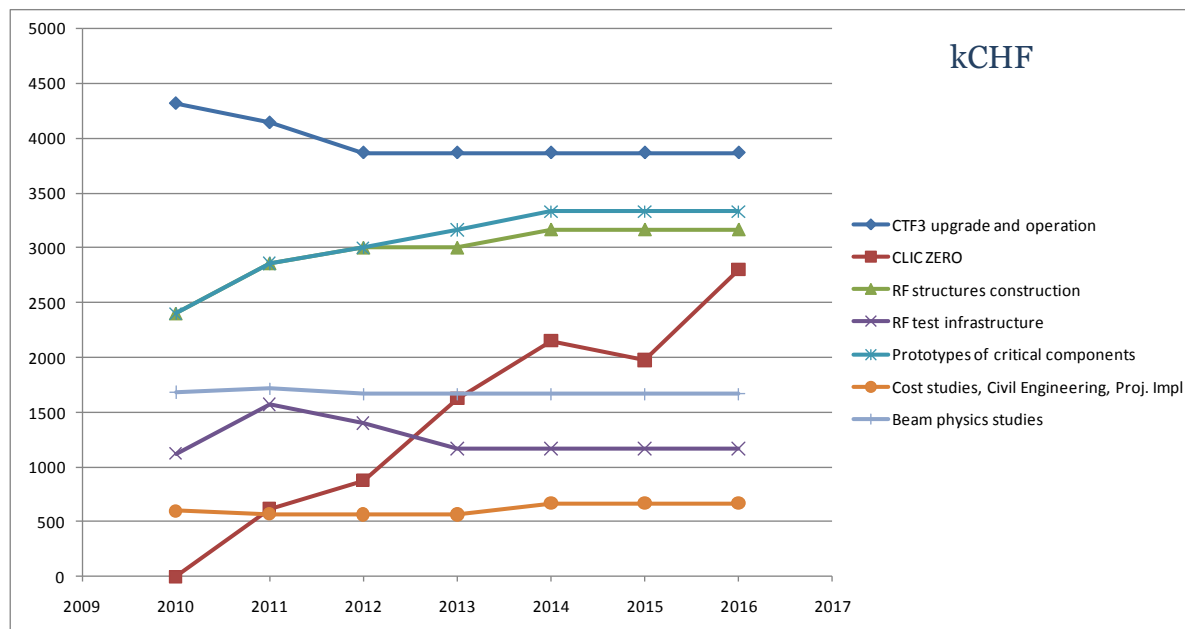


## Personnel, preliminary analysis for sector MPP



## Personnel, CERN, by activity - preliminary

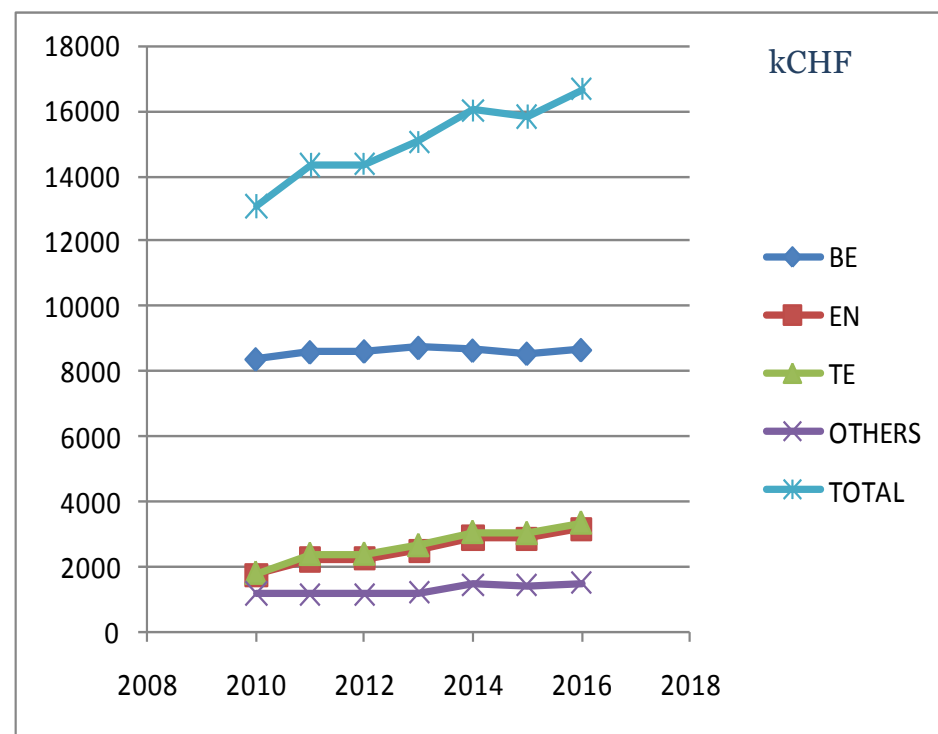
kCHF	personnel, CERN							
	2010	2011	2012	2013	2014	2015	2016	
CTF3 upgrade and operation	4320	4143	3867	3867	3867	3867	3867	
CLIC ZERO	0	616	875	1625	2150	1975	2800	
RF structures construction	2400	2857	3000	3000	3167	3167	3167	
RF test infrastructure	1120	1571	1400	1167	1167	1167	1167	
Prototypes of critical components	2400	2857	3000	3167	3333	3333	3333	
Cost studies, Civil Engineering, Proj. Impl	600	571	567	567	667	667	667	
Beam physics studies	1680	1714	1667	1667	1667	1667	1667	
<b>Total</b>	<b>12520</b>	<b>14330</b>	<b>14375</b>	<b>15058</b>	<b>16017</b>	<b>15842</b>	<b>16667</b>	



# Personnel, CERN, by Department - preliminary

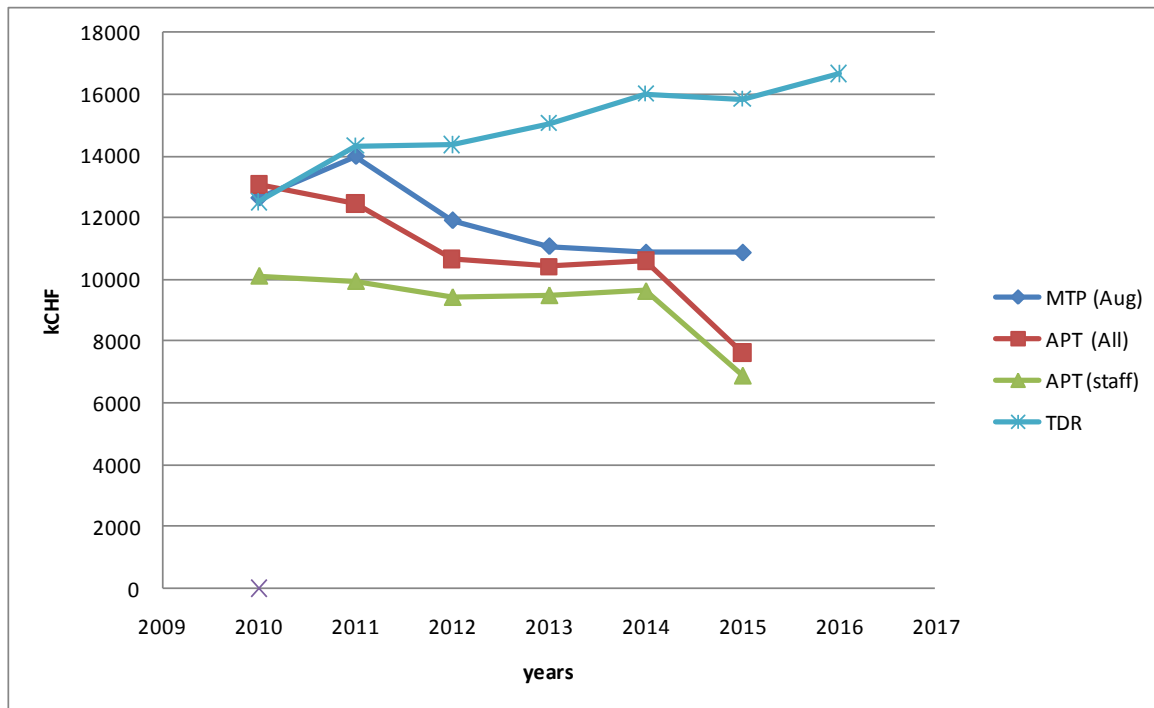
kCHF	2010	2011	2012	2013	2014	2015	2016
BE	8380	8598	8625	8734	8649	8555	8667
EN	1735	2221	2228	2485	2883	2852	3167
TE	1782	2365	2372	2635	3043	3010	3333
OTHERS	1181	1146	1150	1205	1442	1426	1500
TOTAL	13078	14330	14375	15058	16017	15842	16667

kCHF	2010	2011	2012	2013	2014	2015	2016
BE	64.1%	60.0%	60.0%	58.0%	54.0%	54.0%	52.0%
EN	13.3%	15.5%	15.5%	16.5%	18.0%	18.0%	19.0%
TE	13.6%	16.5%	16.5%	17.5%	19.0%	19.0%	20.0%
OTHERS	9.0%	8.0%	8.0%	8.0%	9.0%	9.0%	9.0%





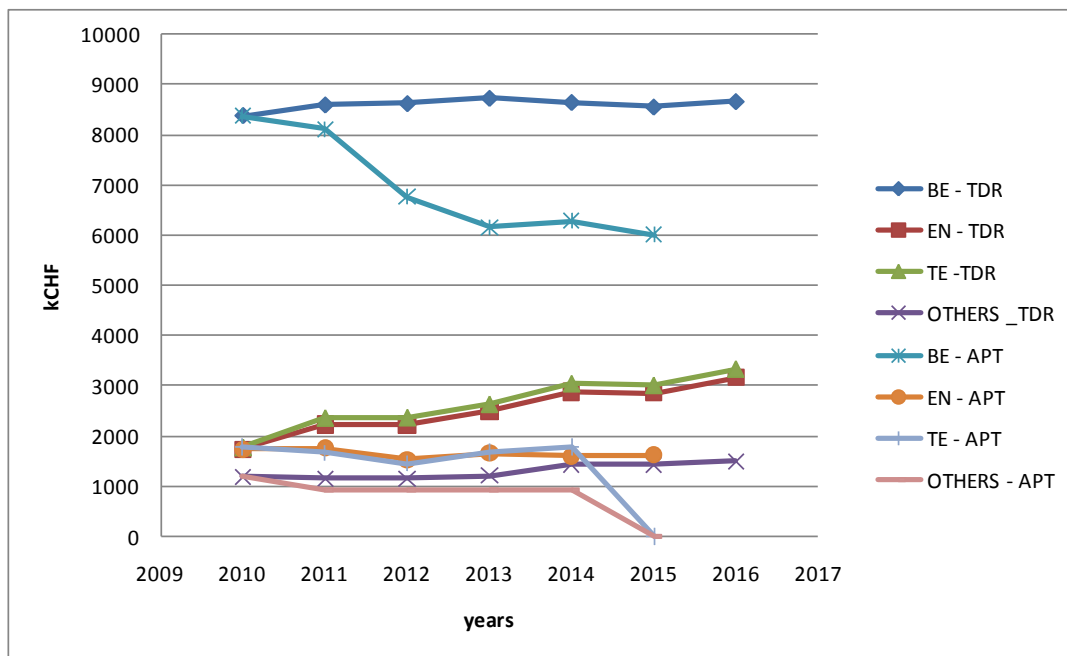
## Personnel, CERN, comparison with MTP & APT



	2010	2011	2012	2013	2014	2015	2016
MTP (Aug)	12643	13995	11915	11074	10866	10866	
APT (All)	13079	12456	10671	10417	10605	7633	
APT (staff)	10128	9958	9441	9499	9636	6905	
TDR	12520	14330	14375	15058	16017	15842	16667



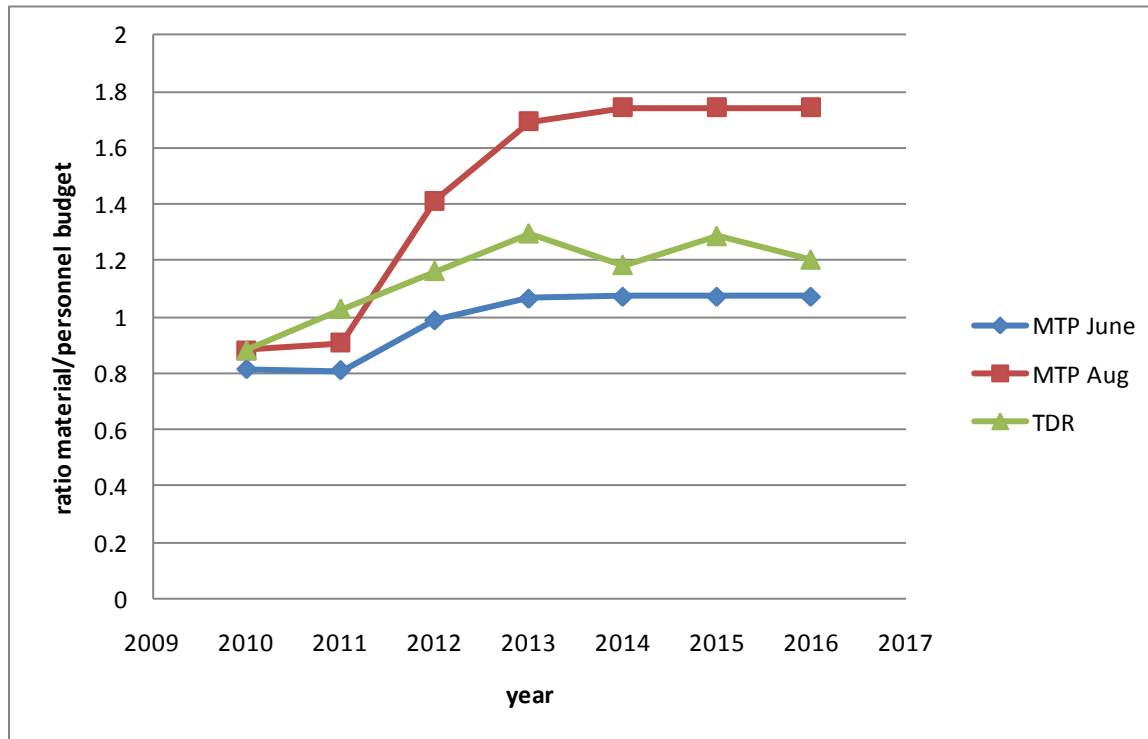
## Personnel, CERN, comparison with APT, by Dept.



	2010	2011	2012	2013	2014	2015	2016
BE - TDR	8380	8598	8625	8734	8649	8555	8667
EN - TDR	1735	2221	2228	2485	2883	2852	3167
TE - TDR	1782	2365	2372	2635	3043	3010	3333
OTHERS - TDR	1181	1146	1150	1205	1442	1426	1500
BE - APT	8380	8111	6760	6162	6289	6012	
EN - APT	1735	1759	1528	1655	1602	1621	
TE - APT	1782	1664	1449	1673	1777		
OTHERS - APT	1181	922	934	927	937		



## Ratio material/personnel budget, for TDR & MTP



## Personnel - Repartition by activity

	2010	2011	2012	2013	2014	2015	2016
CTF3 upgrade and operation	3280	3714	3600	3600	3600	3600	3333
CLIC ZERO	0	625	875	1542	2000	2000	3200
RF structures construction	3200	3036	3167	3000	3333	3333	3333
RF test infrastructure	1200	1643	1467	1200	1200	1200	1200
Prototypes of critical components	3200	3286	3333	3333	3333	3333	3333
Cost studies, Civil Engineering, Proj. Impl	400	357	333	333	500	500	500
Beam physics studies	1440	1500	1333	1333	1333	1333	1333



Activity	Description	Deliverables (2016)	Total budget (P+M)
CTF3 +	CTF3 consolidation and upgrade	<ul style="list-style-type: none"> <li>Consolidation and upgrade (higher energy, stability, reliability)</li> <li>Drive beam phase feed-forward experiments</li> <li>Upgrade and operate TBL as 12 GHz power production facility</li> <li>Operation with beam of a long string of CLIC two-beam modules</li> </ul>	77800 kCHF
CLIC Zero	CLIC drive beam generation complex (480 MeV), 10% of a full decelerator sector	<ul style="list-style-type: none"> <li>Build and commission 30 MeV Drive Beam injector with nominal CLIC parameters</li> <li>Build and commission a few Drive Beam accelerator nominal modules</li> <li>Participation to Technical Design of full CLIC Zero facility</li> </ul>	57300 kCHF
RF Structures	design and fabrication of 12 GHz accelerating structures & PETS and associated R&D	<ul style="list-style-type: none"> <li>Build and test about 120 accelerating structures</li> <li>Build and test about 10 PETS prototype</li> <li>Establish quality control, brazing and assembly procedures for structure fabrication at CERN</li> <li>Precision machining center at CERN</li> </ul>	56300 kCHF
RF test infrastructure	Building, commissioning and operation of high-power RF test stands	<ul style="list-style-type: none"> <li>Four 12 GHz klystron-based RF high-power test stations, for about 8 slots, running before 2016</li> <li>Continue high-power testing at 11.4 GHz (KEK and SLAC)</li> <li>Contribution to high-power testing in CTF+ (TBL)</li> </ul>	24300 kCHF
Prototypes of critical components	Technical R&D – design, build and test prototypes of CLIC critical components	<ul style="list-style-type: none"> <li>R&amp;D and prototypes of two-beam modules alignment and stabilization systems</li> <li>Prototype of final focus QD) quadrupole and stabilization system</li> <li>Several nominal CLIC two-beam modules, mechanically tested, possibly beam tested</li> <li>R&amp;D and prototyping of critical beam instrumentation</li> <li>Design and studies of machine protection system</li> <li>DR superconducting wiggler prototypes, test with beam</li> <li>DR extraction kickers prototypes</li> <li>Dynamic vacuum assessment</li> <li>Contribution to the CLIC Zero TDR</li> <li>...</li> </ul>	57300 kCHF
Cost studies, Civil engineering, Proj, Implementation	Update and improve CLIC cost model & civil engineering studies	<ul style="list-style-type: none"> <li>Technical Design (TD) and Project Implementation Plan (PIP) of CLIC Zero</li> <li>Improved cost model, feedback to CLIC baseline review</li> </ul>	9500 kCHF
Beam physics studies	Beam physics and overall design	<ul style="list-style-type: none"> <li>Review of the CLIC baseline design</li> <li>Contribution to the TDR of CLIC Zero</li> </ul>	17900 kCHF



Activity	Description	Total budget P	Total budget M	CERN budget P	CERN budget M
CTF3 +	CTF3 consolidation and upgrade	34800 kCHF	43000 kCHF	23500 kCHF	28900 kCHF
CLIC Zero	CLIC drive beam generation complex (480 MeV), 10% of a full decelerator sector	15000 kCHF	42300 kCHF	10000 kCHF	28300 kCHF
RF Structures	design and fabrication of 12 GHz accelerating structures & PETS and associated R&D	27300 kCHF	29000 kCHF	18400 kCHF	19500 kCHF
RF test infrastructure	Building, commissioning and operation of high-power RF test stands	11300 kCHF	13000 kCHF	7600 kCHF	8800 kCHF
Prototypes of critical components	Technical R&D – design, build and test prototypes of CLIC critical components	28300 kCHF	29000 kCHF	19000 kCHF	19500 kCHF
Cost studies, Civil engineering, Proj, Implementation	Update and improve CLIC cost model & civil engineering studies	5500 kCHF	4000 kCHF	3700 kCHF	2600 kCHF
Beam physics studies	Beam physics and overall design	14900 kCHF	3000 kCHF	10000 kCHF	2000 kCHF

