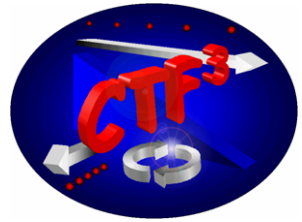
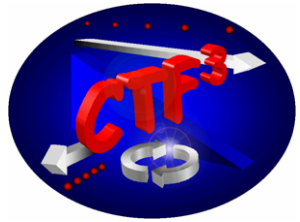


Status of CTF3

G.Geschonke
CERN/AB

Collaborating institutes



Countries	*Funding Agencies*	*Laboratory*
	CERN	CERN
FINLAND		Helsinki Inst of Phys (HIP)
FRANCE	CEA	DAPNIA Saclay
	CNRS/IN2P3	LAL
		LAPP
		LURE
INDIA*	Indian DAE	RRCAT, Indore
ITALY	INFN	LNF
PAKISTAN *	PAEC	NCP
RUSSIA		Budker Inst (BINP)
		IAP
	Dubna	JINR
SPAIN	Ministry of Education & Science (MEC)	CIEMAT
		UPC
		IFIC
SWEDEN	Swedish Research Council Wallenberg Foundation	Uppsala University
		TSL
SWITZERLAND		Paul Scherrer Inst (PSI)
TURKEY		Ankara Univ Group (2)
USA	DOE	Northwestern Univ Illinois (NWU)
		SLAC

17 members involving 22 Institutes

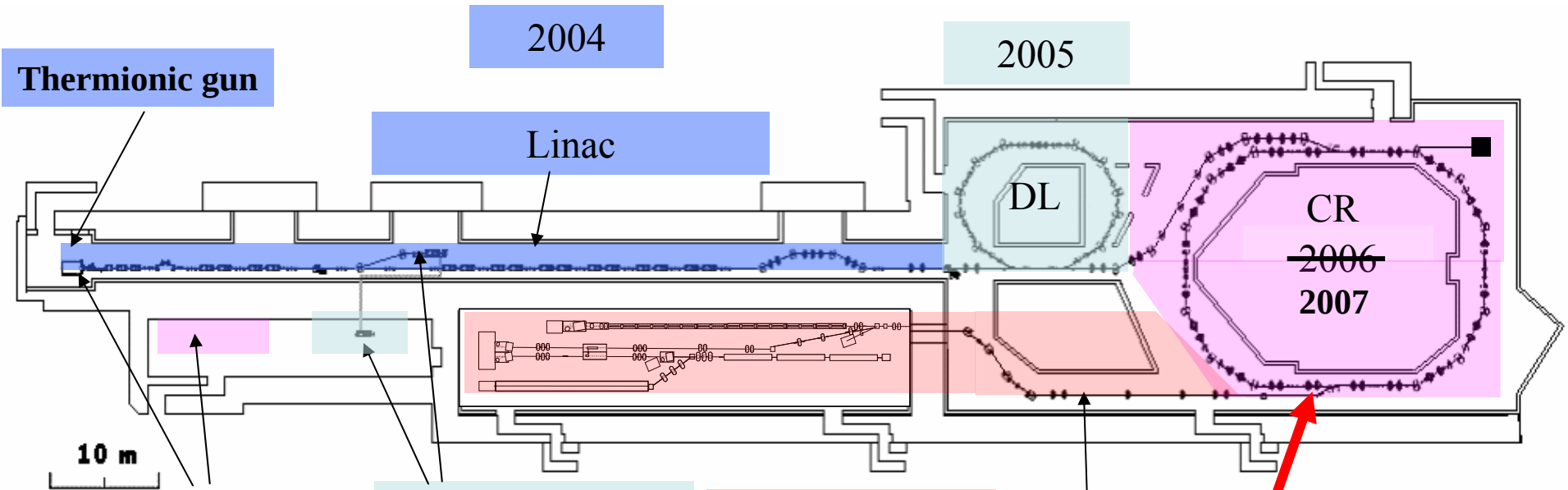
* India and Pakistan have not signed the CTF3 MoU, but have an agreement with CERN for the development of novel accelerator technologies

Draft MoU Addendum with J.Adams Institute London

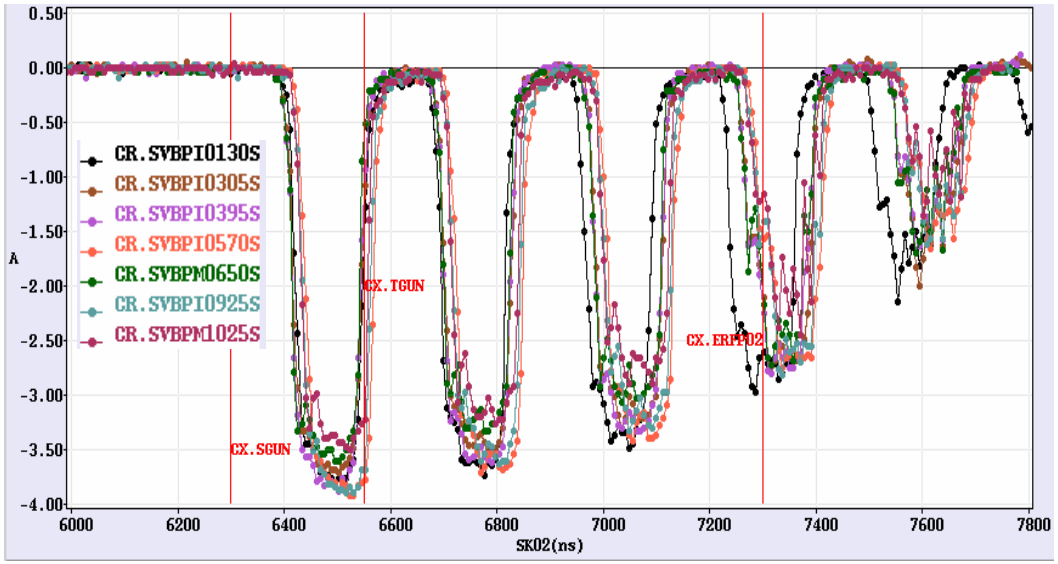
Discussions with : Iran, UK (Cockcroft Institute), JLAB, EPFL, INFN Milan

Past collaboration with RAL within PHIN

Present status

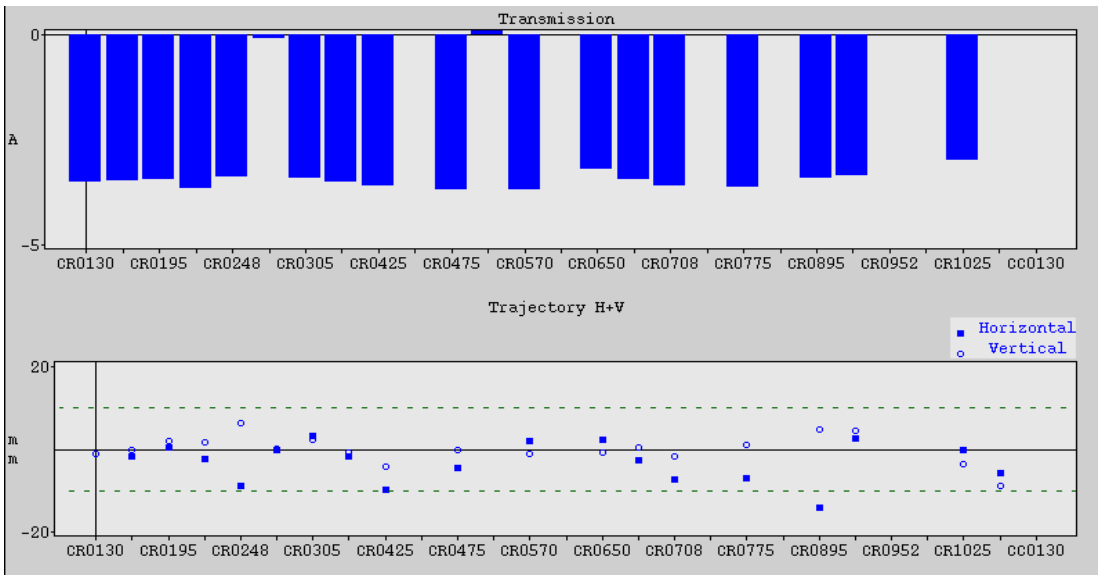


Combiner ring - latest status



We make up to a few 100 turns!

- Nominal isochronous optics
- RF injection
- short RF pulse in deflector that it's only seen by the beam at injection.

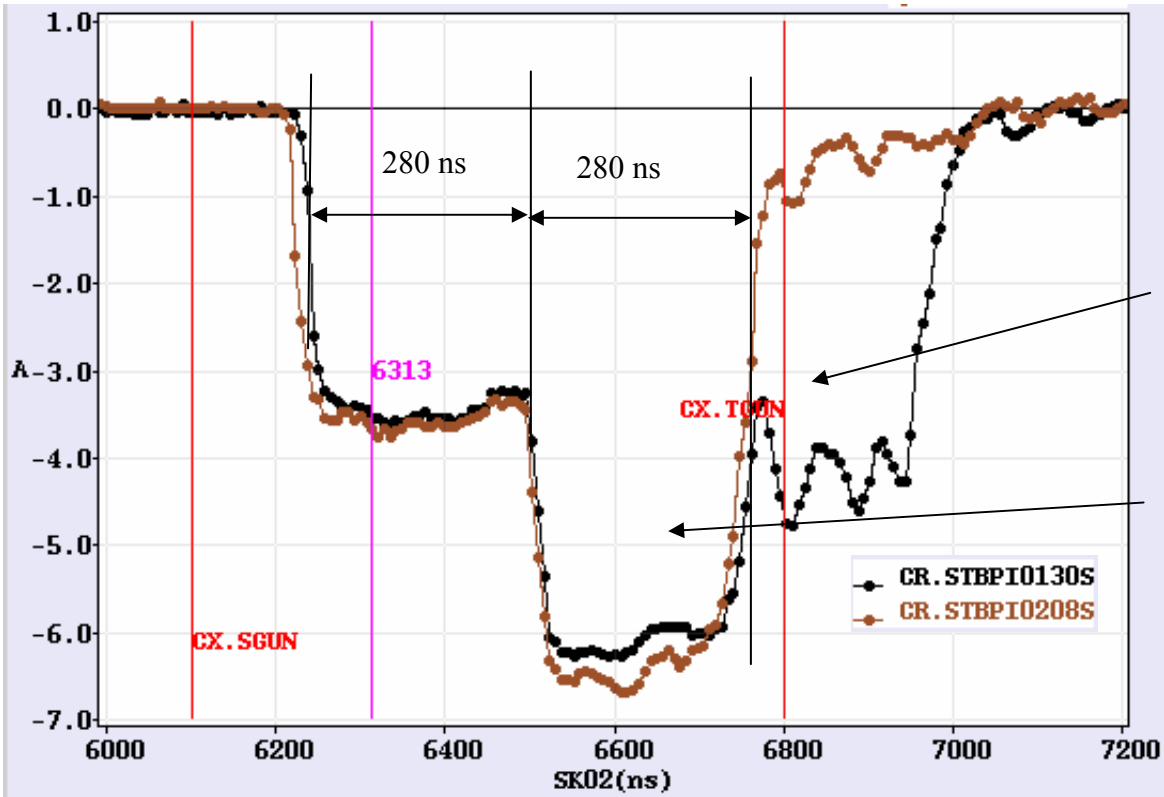


Switching on the SHBS (2 out of 3)

We got immediately the same Transmission in CR!

Combiner ring - latest status

Latest results from last week … we recombine (factor 2)!



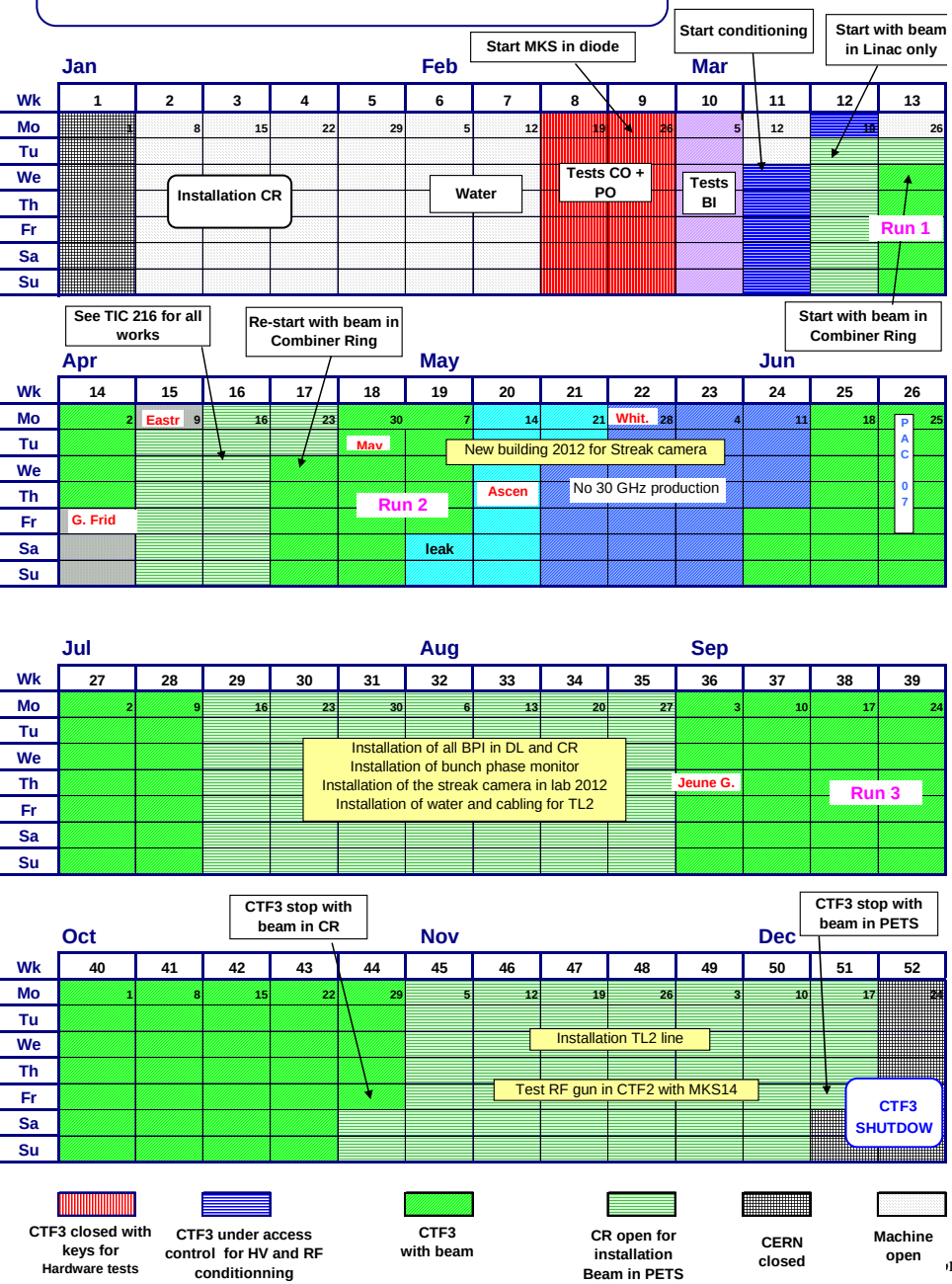
Second turn of second pulse and partly third turn of first pulse

Recombination – factor 2

- nominal isochronous optics
- energy ~ 115 MeV
- RF injection (2nd RF deflector off – so far)
- set up of the path length in CR with wiggler

2007 - CTF 3 - Schedule

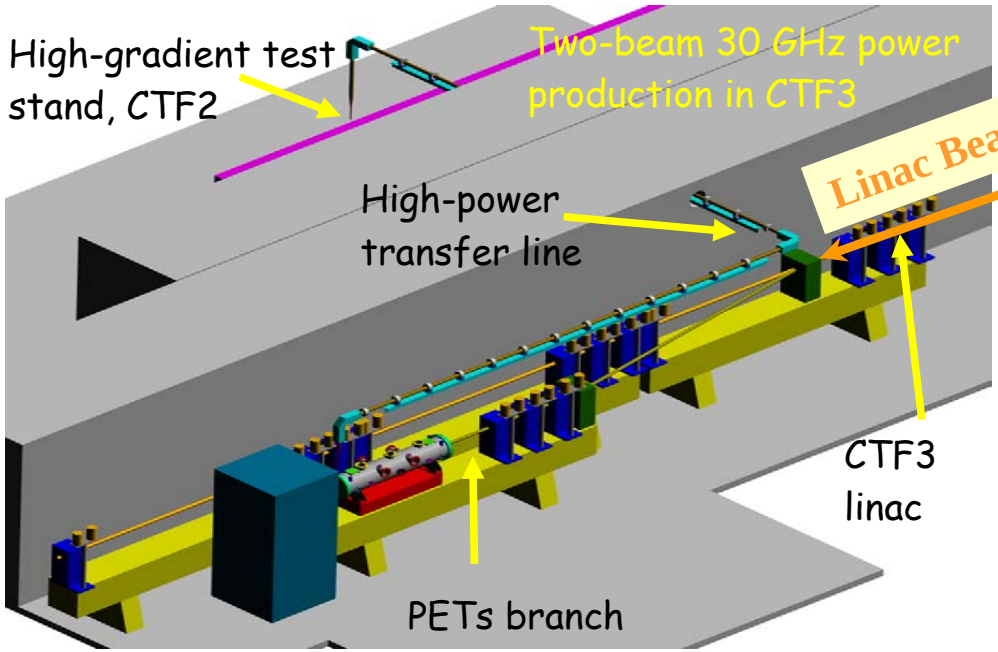
15th May 2007



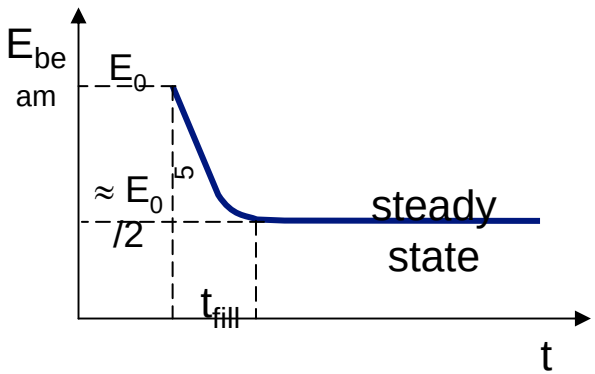
start according to schedule,
many operational problems.
(controls, magnets,.....).

Beam circulated in CR, injected with RF,
no recombination yet

30 GHz RF production

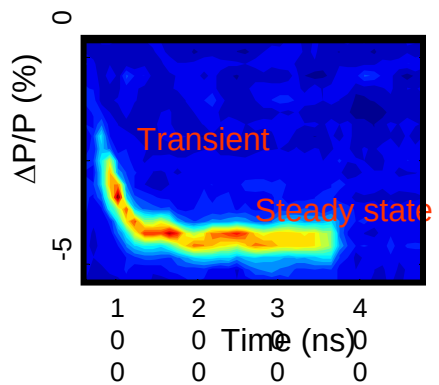


operation for 30 GHz now routine, largely automatic.
Supervision from CCC
24 hour operation / night operation

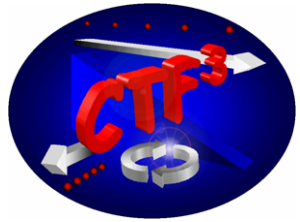


2007:

- 30 GHz conditioning has started as foreseen.
- 12. May Vacuum leak in PETS line.
- Repaired successfully, operation resumed on 23. May.
  PETS was not allowed by safety.
- 30 GHz operation Resumed Friday 15.6
- operate with 5 Hz, then gradually increase f_{rep}



Present status



Combiner Ring finished, Commissioning in progress.

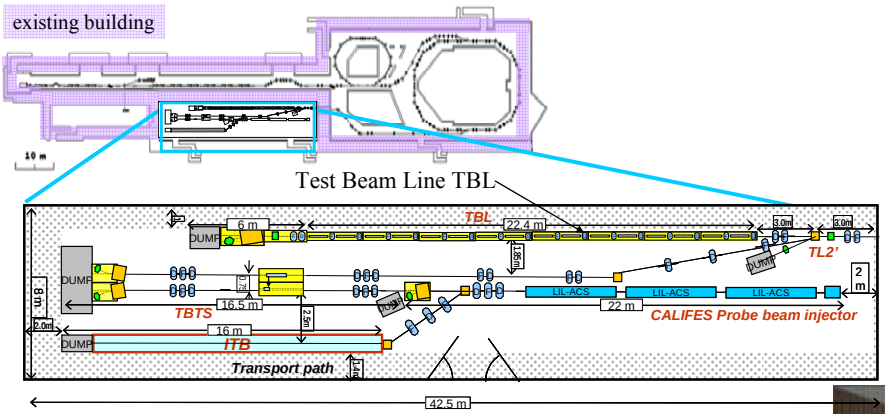
Preparations for TL2 and TL2'

- Optics finished, detailed layout close to completion
- Procurement of components has started:
  - support infrastructure, vacuum chambers (India, industry), power supplies,
  - magnets (available/Lure/Celsius/Ciemat),
  - beam diagnostic equipment (CERN, INFN, LAPP)
  - tail clipper (CIEMAT,CERN)

Installation in July, August and from November onwards.

Target to send beam into CLEX after winter shut-down ~ April 2008

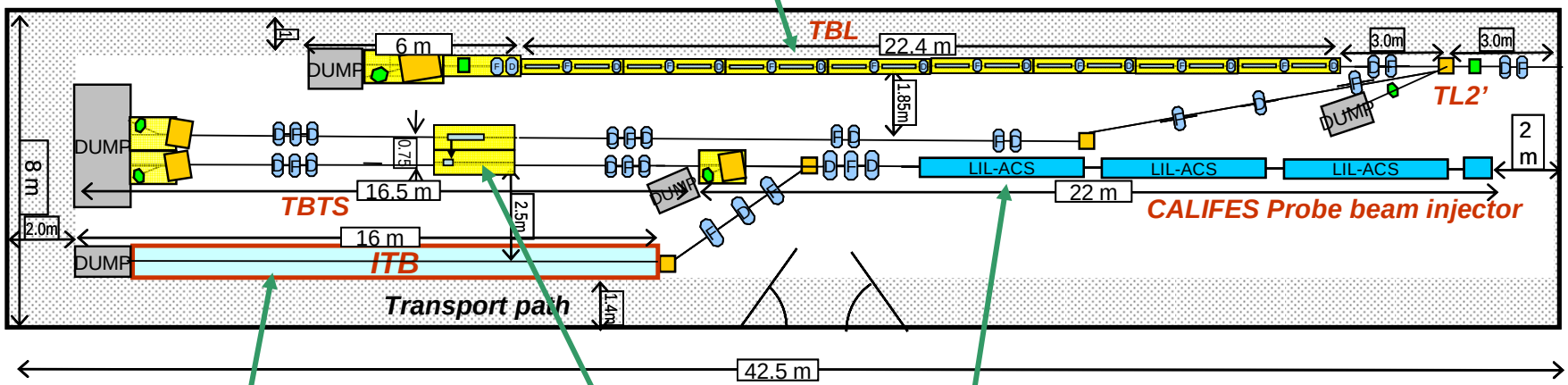
CLEX building



Construction on schedule, lower level finished, equipment is being installed.
klystron gallery will be finished in a few weeks.
Full electrical power will only be available from end October ,
meanwhile provisional installation with limited power

Ongoing work for CLEX

CIEMAT magnet movers, PETS prototype,(+ series ????), PETS tank (series ???)
UPC & IFIC : BPM development + electronics (series ???)
CERN overall responsibility, optics, RF equipment, diagnostics, infrastructure, quadrupoles ???



Instrumentation Test Beam Line
not presently funded
(FP7 GADGET proposal)

Uppsala University Two Beam Test Stand
CERN PETS and Accelerating structure

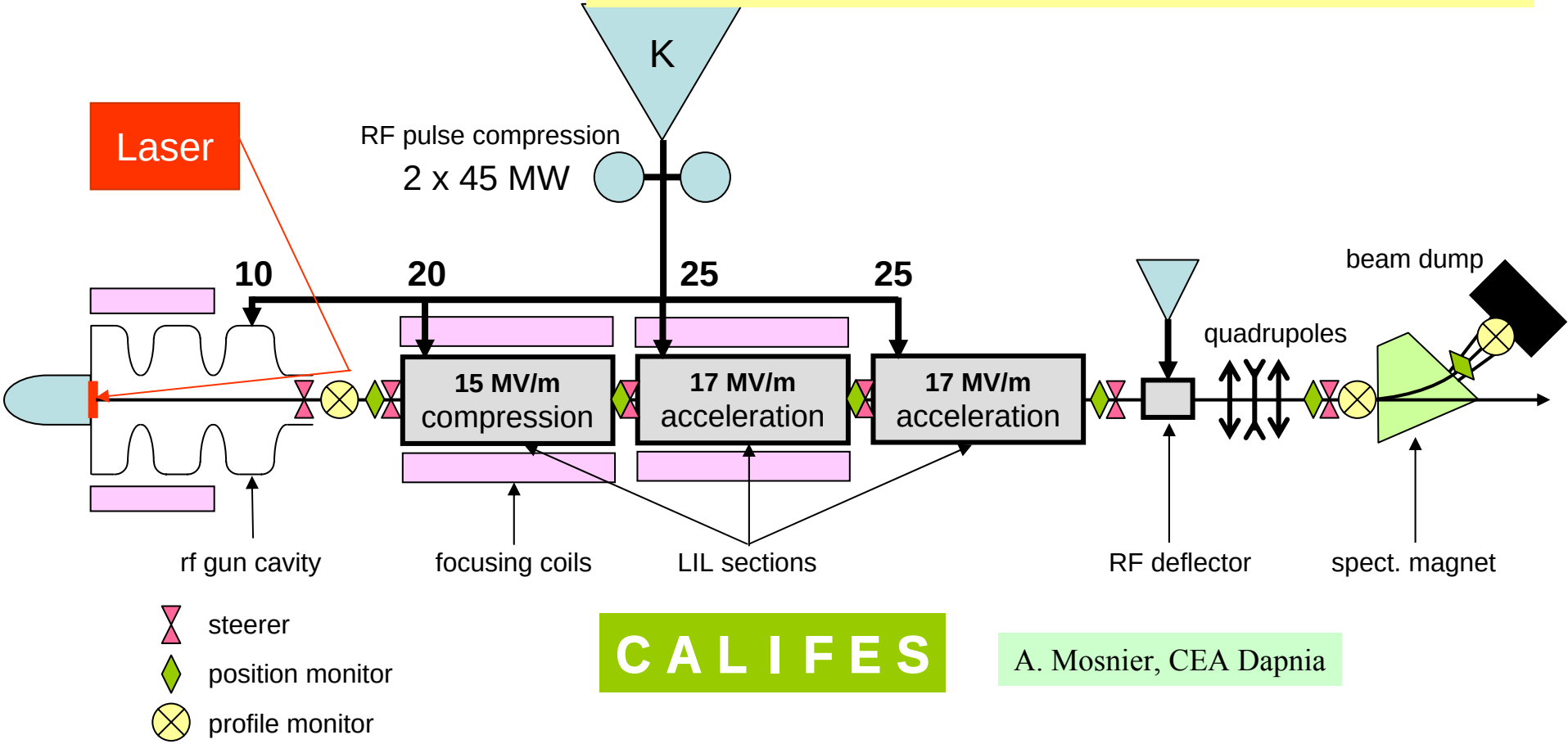
CEA Dapnia Saclay overall responsibility
CERN
CEA laser beam line, laser beam conditioning
LAL RF gun for photo injector

Pakistan: stainless steel vacuum components + ???
Iran: RF + Beam dynamics simulations

Probe Beam

200 MeV
bunch charge 0.5 nC
number of bunches 1 - 64

Planning foresees everything to be installed by April 2008
one LIL section radioactive
waveguide components missing

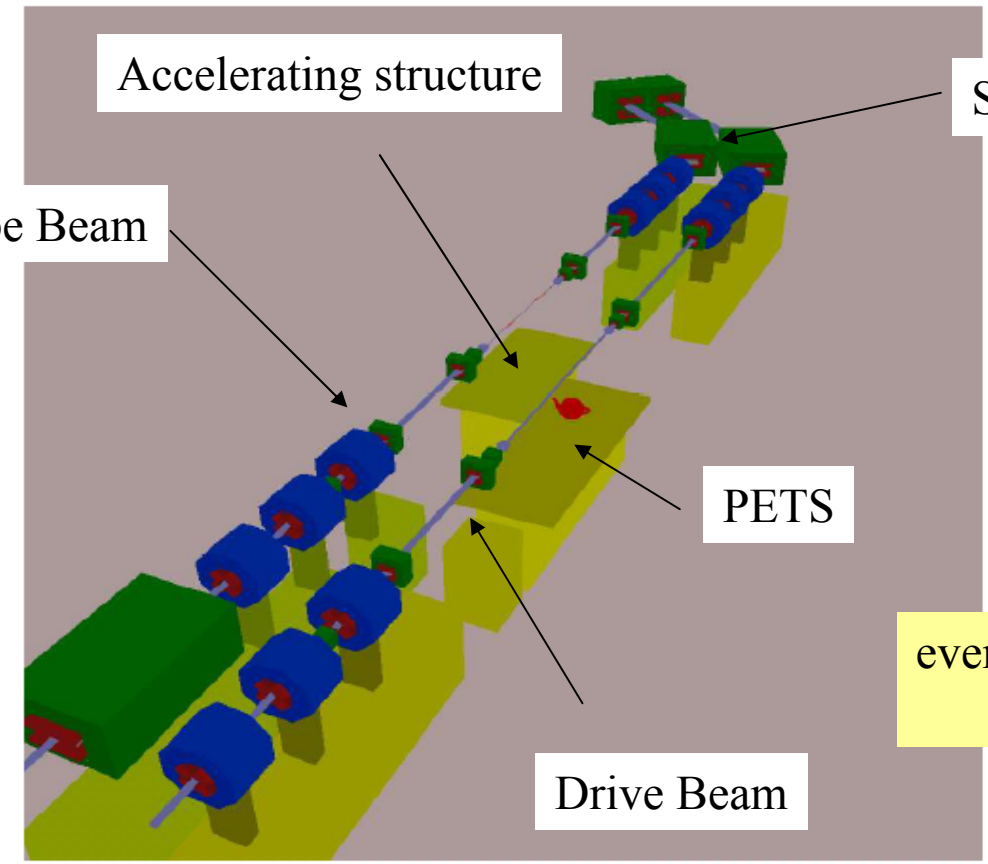


CALIFES

A. Mosnier, CEA Dapnia

Two Beam Test Stand

Accelerate Probe Beam with 30 GHz power from Drive Beam

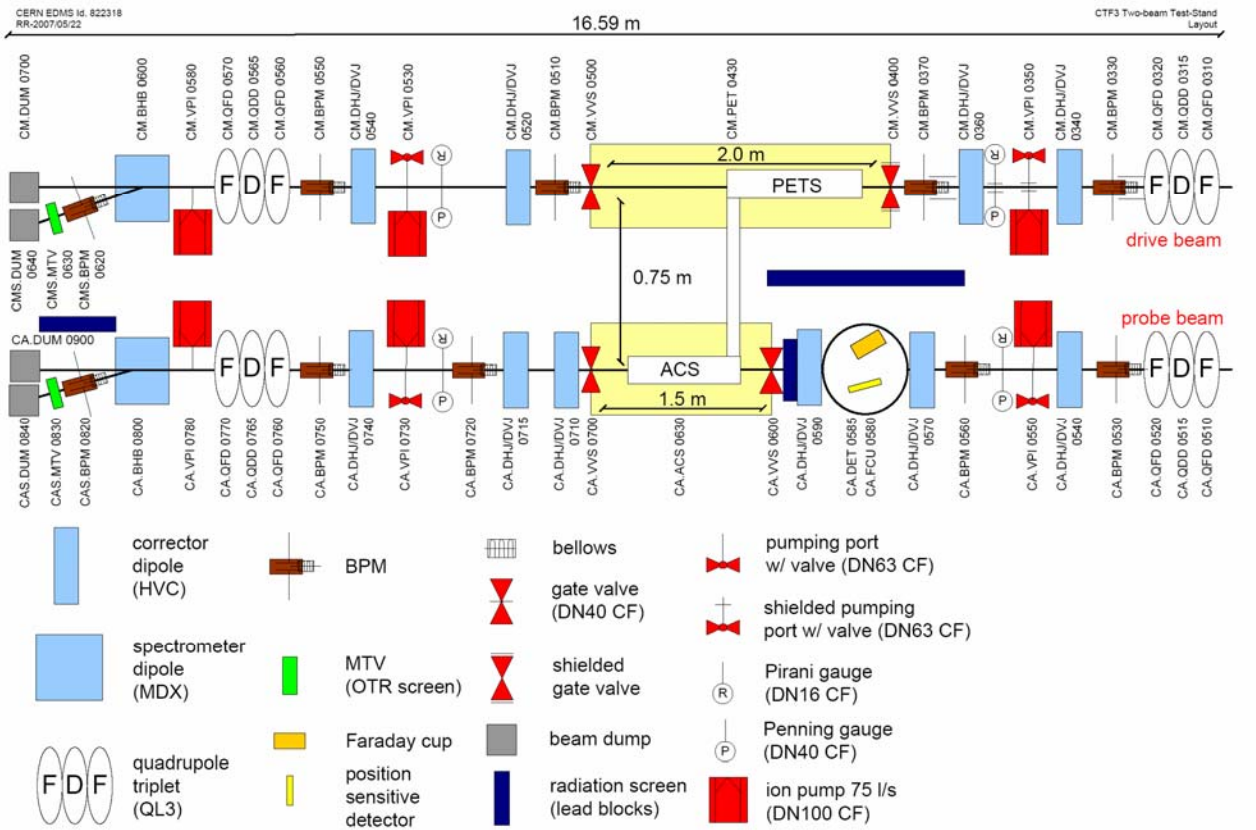


Diagnostics for energy, transverse kick due to RF breakdown

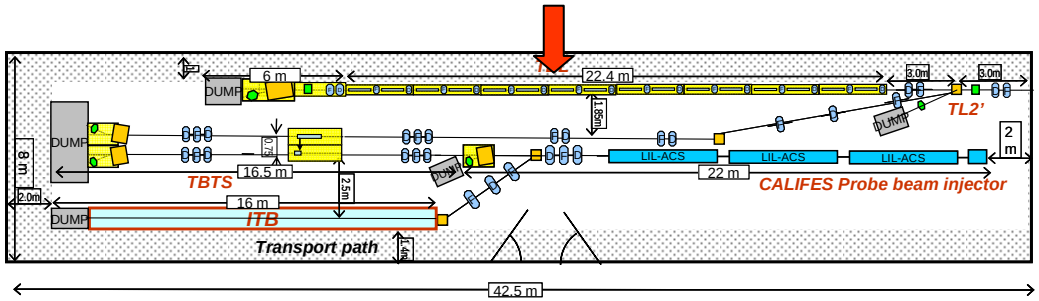
everything to be installed by April 2008

V.Ziemann, Uppsala University

Two Beam Test Stand

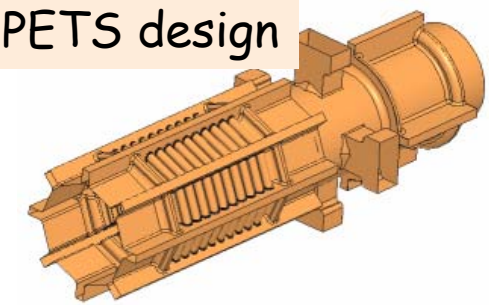


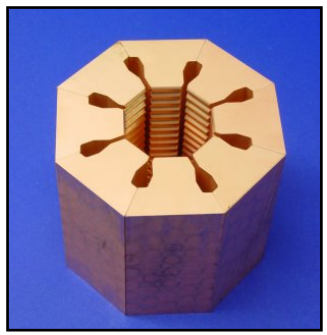
Test Beam Line TBL



Demonstrate beam stability under deceleration

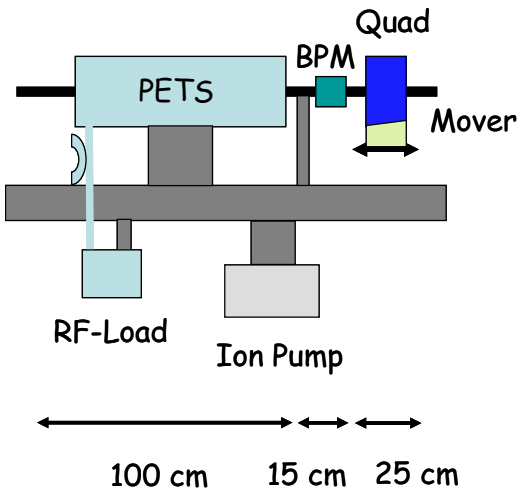
PETS design





5 MV/m deceleration (35 A)

165 MV output Power



standard cell, 16 total

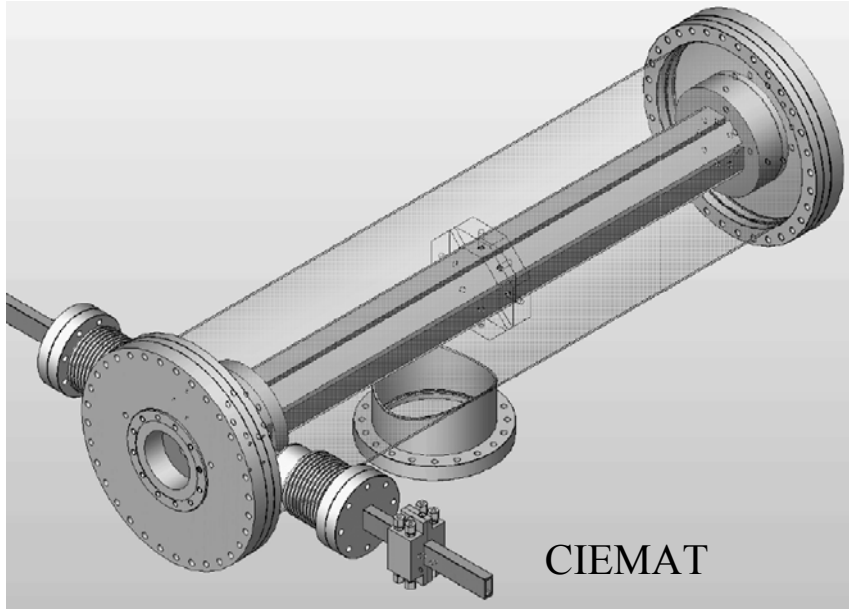
Decelerate to about 50 % beam energy
Total power produced in 16 PETS: 2.5 GW

S. Doebert, CERN

TBL

Concept clear now.

Spain is working on:
- PETS prototype incl. vacuum tank (CIEMAT)
- Beam position monitors (IFIC Vaencia)
- BPM electronics (UPC)



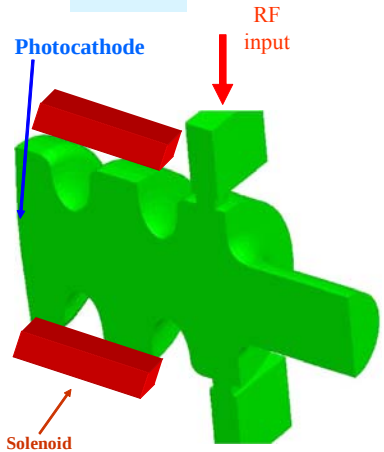
In 2008 only one PETS will be installed.
Series in 2009

still open: Series production of PETS (16 in total)
and BPM + electronics

Photo Injector

smaller emittance, faster phase coding, no "satellite bunches"

LAL

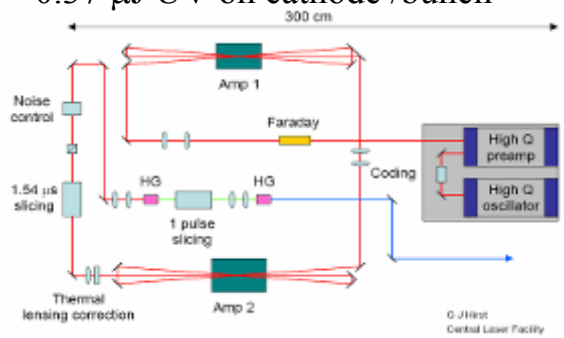


CERN

Cs_2Te photo cathode
3% QE
40 hours life time
pulse train: 1.5 μs,
charge per bunch: 2.33 nC
bunch spacing 0.67 ns
number of bunches: 2332

RAL

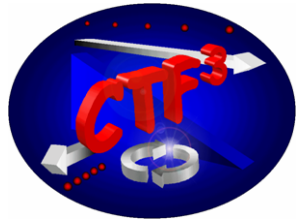
diode pumped Nd:YLF laser
10 μJ IR / bunch
0.37 μJ UV on cathode /bunch



Phase 1:
off-line testing from 2007

Phase 2:
Gun in CTF3: earliest spring 2008 ?????

Photo Injector



Present status:

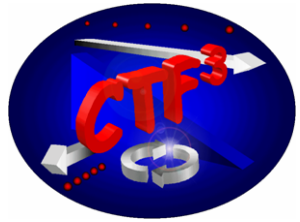
RF gun being built, ready end 2007 ??

Laser at CERN, needs to be finished
(full system has never worked, no phase coding, no control system, no feedbacks.....)

RAL does not collaborate any more
strong involvement from CERN, INFN Frascati and Milan

Laser is needed also for CALIFES injector !

12 GHz



Decision to change CLIC structure development from 30 GHz to 12 GHz

Effect on CTF3: For 30 GHz: bunch repetition frequency in Linac: 1.5 GHz
increase by x2 in DL
x5 in CR ➔ 15 GHz
For 12 GHz: bunch repetition frequency in Linac: 1.5 GHz
increase by x2 in DL
x4 in CR ➔ 12 GHz

small circumference change in CR can be accomplished with wiggler

smaller nominal beam current: can be increased by higher current in linac and higher RF power (shorter pulse)

➔ **no effect on hardware**

➔ 30 GHz structure programme continues for the moment
➔ 12 GHz PETS in TBL
➔ 12 GHz PETS and accelerating structures in Two Beam Test Stand

Future Testing Program (S.Doebert)

2007: Study Parameter Space at 30 GHz and testing of real structures at 11 GHz (focus on copper structures)

2008: Focus on two main geometries, develop damping, optimize structure

2009: CLIC prototype structure

2010: Longer term testing and better statistics

Number of tests (optimistic)

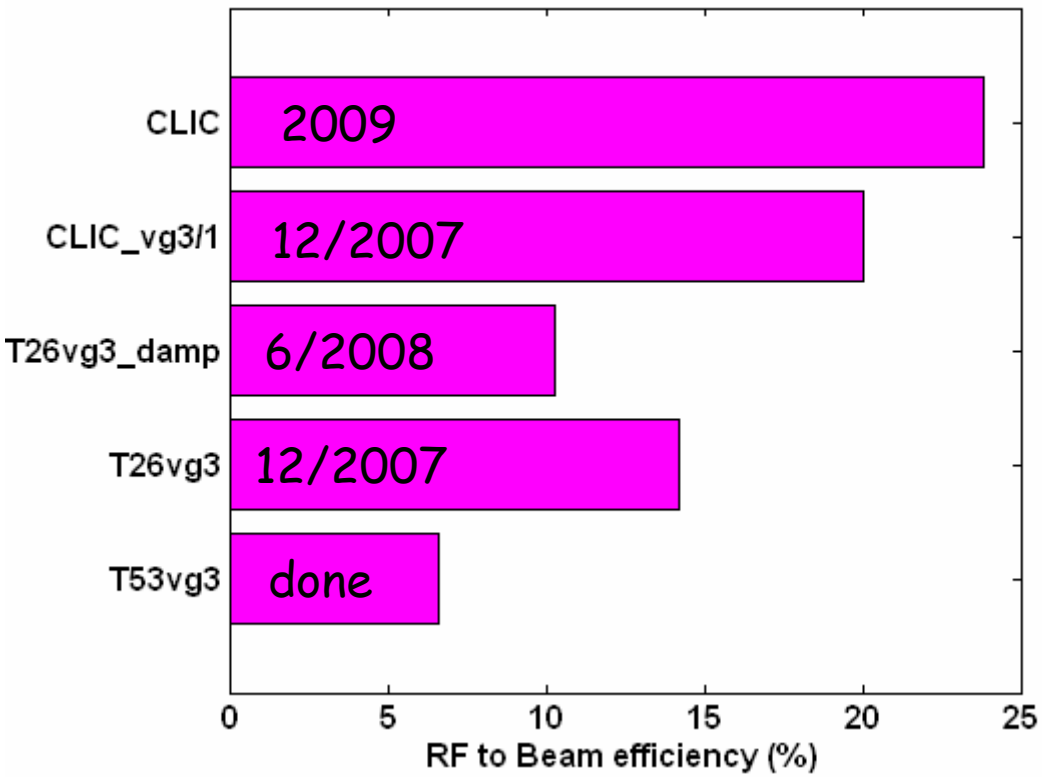
	2007	2008	2009	2010	sum
30 GHz	5	3	0	0	8
12 GHz	0	1	4	4	9
11.4 GHz	2	4	4	4	14
Stand alone at CERN	0	0	8	8	16
sum	7	8	16	16	47

Tentative CERN x-band R&D program

(S.Doebert)

When	Structure	Technology	Lab
Dec 2007	CLIC_vg1	quadrants, damped	CERN
	T26vg3MC	disks, brazed, undamped	SLAC/KEK
March 2008	CLIC_vg1	quadrants, undamped	CERN
	T26vg3MC	quadrants, undamped	CERN/SLAC/KEK
June 2008	CLIC_vg1	disks, brazed, undamped	CERN
	T26vg3MC	disks, brazed, damped	CERN/SLAC/KEK
2009	CLIC prototype	fully featured, best technology	CERN/SLAC/KEK

Efficiency milestones (S.Doebert)



P = 65 MW; 297 ns ⇔ nb = 311

P = 70 MW; 295 ns ⇔ nb = 359

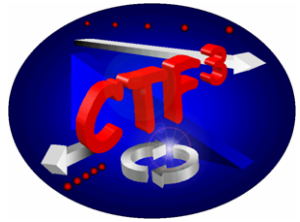
P = 111 MW; 102 ns ⇔ nb = 66

P = 102 MW; 113 ns ⇔ nb = 93

P = 134 MW; 104 ns ⇔ nb = 27

100 MV/m loaded, 10^{-6} break down rate, qb=$4*10^9$,
8 rf period bunch spacing, P*pl/C = 18 Wue

Structure testing



30 GHz testing at CERN will continue for a while.

CTF3 can only produce 12 GHz.
Test of PETS only possible at CTF3 (Two Beam Test Stand)

Collaboration with SLAC and KEK on structure development / fabrication as well as testing at x-band (11.4 GHz).

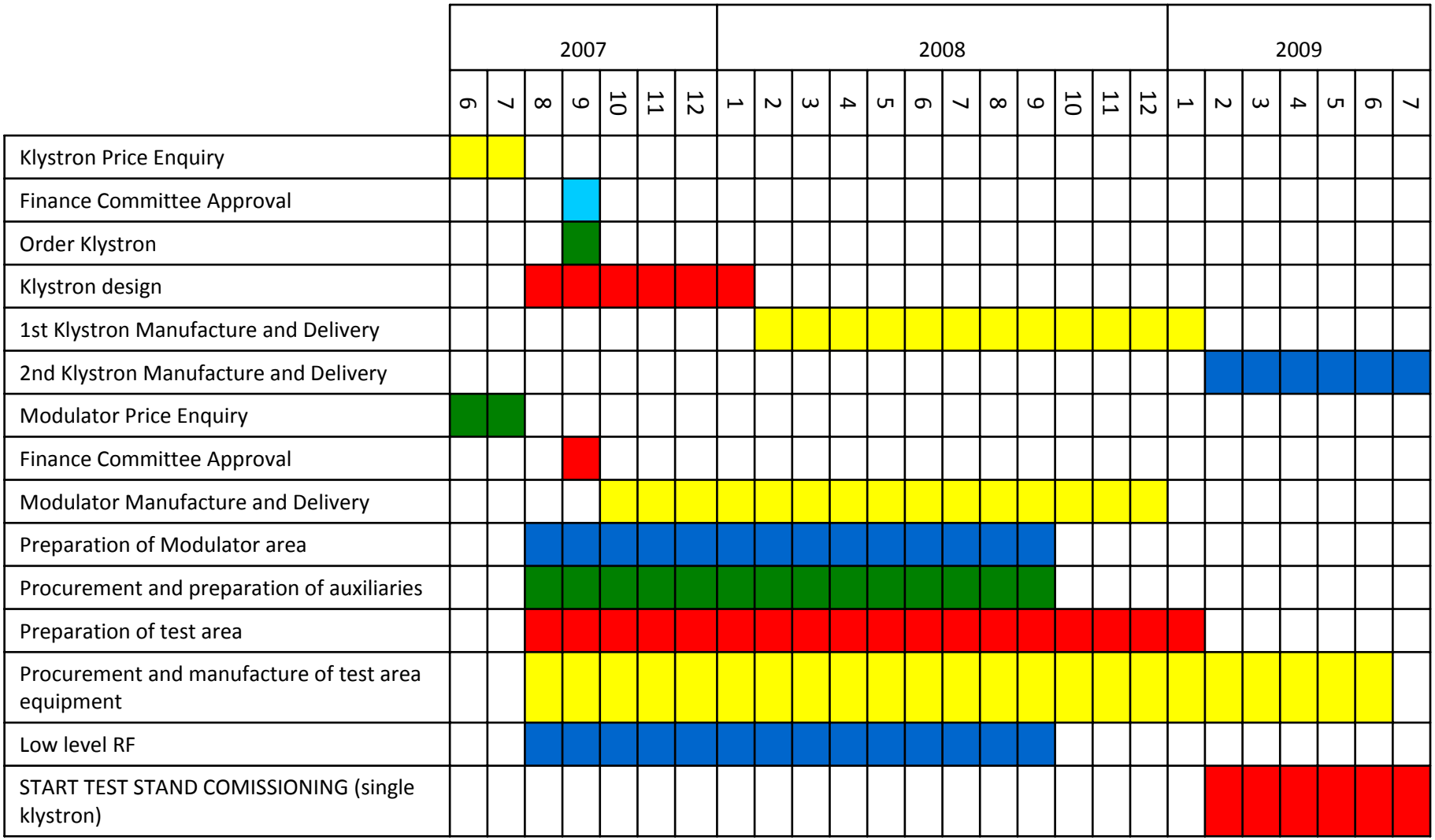
Stand-alone RF source at 12 GHz at CERN is mandatory.

Several labs in Europe interested as well (PSI, INFN, Elettra)

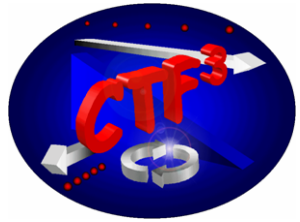
11.9942 GHz, 50 MW peak, 1.5 μs, 50 Hz

Budget: 3.5 MSFr, could be operational in 2009

A possible schedule

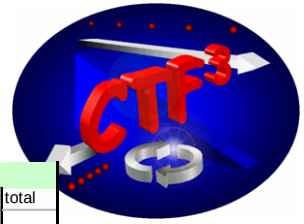


CLIC resources from CERN



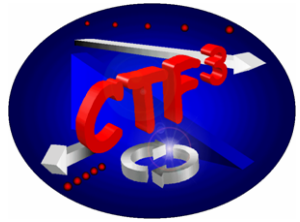
		2008	2009	2010	Total
Material budget (kCHF)	Present MTP	3485	3485	3485	10455
	Additional LTP (CLIC-PLO/06-17 and White Paper)	4000	4000	4000	12000
	12 GHz power test stand and structure tests	1050	1850	600	3500
	Total additional (to present MTP plans) resources	5050	5850	4600	15500
	Total needed resources (to be included in future MTP)	8535	9335	8085	25955
Man-Power (FTE)	Present MTP	30.5	28	26.5	85
	Additional LTP (CLIC-PLO/06-17 and White Paper)	20	20	20	60
	12 GHz power test stand and structure tests	3	3	3	9
	Total additional (to present MTP plans) resources	23	23	23	69
	Total needed resources (to be included in future MTP)	53.5	51	49.5	154

Status of contributions



15/12/2006		spent up to end 2004		pledged for 2005-2009		totals<2004+pledged		2005				2006			
		manpower my	cost kSFr	manpower my	cost kSFr	manpower	cost	m*y	m*y [k CHF]	material	total	m*y	m*y [CHF]	material	total
Addendum signed / Protocol with CERN*															
CERN	*totals*	*100.00*	*56,000*	*125.00*	*14,815*	*225.00*	*70,815*	*29*		*3,225*		*36.0*		4,314	
Helsinki Institute of Physics (HIP)	specialist in micro machining technologies for CLIC structure developments			3.00		*3.00*						*1.3*	45		
	establish dedicated project for development of technology with industrial and academic partners														
CEA	Probe Beam linac			30.00	1,950	*30.00*	*1,950*								
CNRS IN3P3						*23.00*	*450*								
	LURE 32 quadrupoles														
	LAL														
	Thermionic guns (15 my = 2.25 MCHF)	15.00													
	probe beam photo gun			3.00	300										
	LAPP BPM read-out electronics			5.00	150							*4.8*		63	
India *	TL2 design,												6		
	Alu vac chambers for TL2														
	Dipole magnets for TL2														
INFN	Delay Loop	25.00	4,000			*33.00*	*4,900*	*7*		*568*		*7.0*		1,190	
	vacuum chamber TL1 and CR			4.00	900										
	CTF3 commissioning, operation			4.00											
Pakistan NCP *					800										
Budker institute of Nuclear Physics (BINP) Novosibirsk	11 quadrupoles, 26 sextupoles				270		*270*								
	future: more magnets as required according to the same conditions.														
IAP	30 GHz power source				1,024	*0.00*	*1,024*								
	Manpower and material , ISTC 227k$ included														
JINR Dubna	Manpower for automatic conditioning		114				*114*								
Spain Ciemat	15 qadrupoles for TBL + precision tables					*4.00*	*2,000*						272	840	
	2 Septa for CR														
	Extraction kicker for CR														
	HV pulser for kicker														
	32 corrector magnets for CR														
	PETS design														
UPC / IFIC	Contribution to BPM design for TBL			4.00	2,000										
Sweden Uppsala Univ.	Preliminary phase participation	1.50				*3.00*	*2,650*					*1.3*		107	
	Phase monitor	1.50	150												
	Phase monitor cont.				200										
	Two Beam Test Stand				2,300										
TSL	Celsius magnets				150									150	
PSI	Modulator components				200		*200*							200	
Ankara University	manpower for CTF3 operation	0.25		5.00		*5.25*		*0.5*				*1.0*			
Northwestern University Illinois	one accelerating structure		100			*3.00*	*350*								
	beam loss monitor		100		50										
	total manpower	2.00		1.00											
	RF pick-up for bunch length				100										
SLAC	electron gun triode (long term loan)		320			*3.00*	*320*								
	injector design and commissioning	3.00													

Open work packages for CTF3



1. RF equipment for Probe Beam (Califes)

1.1 klystron for Califes
3 GHz, 45 MW, pulse length 5.5 ms

1.2 waveguide components for Califes:
WR 284, LIL-type flanges, peak power 100 MW, pulse length 5.5 ms

1.2.1.various line components: straight lines, bends, directional couplers, RF loads, operation under UH Vacuum

1.2.2.special waveguide components:
one 4.5/1.9 dB splitter
one variable waveguide attenuator, 0.5 to 20 dB attenuation,
peak power 10 MW, operation under SF6

(Being ordered by CERN)

2. RF equipment for CTF3 operation

The 3 GHz klystrons which reach the end of their lifetime have to be repaired or eventually replaced by new ones if they cannot be repaired any more. We estimate that on average 1.5 to two klystrons need to be replaced every year. The klystrons are rated at 45 MW peak power at an RF pulse length of 5.5 ms and a repetition rate of 100 Hz.

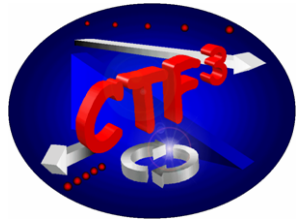
3. Vacuum equipment:

Vacuum pumping equipment, instrumentation and vacuum chambers have to be provided for Transfer Line TL2 and TL2', TBL and Califes: :

3.1. 60 ion pumps (60 l/s)
30 HV pump power supplies (compatible with CERN vacuum control system),
3.2. 10 vacuum gauges
3.3. 3 mobile turbo pumps
3.4. 20 shielded pumping ports according to existing drawings
3.5. 3 vacuum valves with RF shielding
3.6. 20 Bellows with RF shielding according to existing drawings

(Being ordered by CERN)

Open work packages for CTF3



4. Material for Test Beam Line (TBL)

4.1. 16 quadrupoles for TBL

4.2. 16 CLIC power extraction and transfer structures (PETS) modules. *A prototype is being built by Spain. The series production is still open*

4.3. 16 vacuum tanks for PETS structures. *A prototype is being built by Spain, the series is still open.*

4.4. 16 beam position monitors (BPM). *A prototype is being developed and built by Spain, the series is still open.*

4.5. 16 front end analogue electronics for the BPMs(4.4). *A prototype is being developed and built by Spain. The series is still open.*

4.6. 16 BPM digital electronics. *(Preferably use LAPP electronics)*

4.7. analogue front electronics for 12 GHz signal acquisition in TBL

4.8. digital read-out electronics for 12 GHz RF signals (see 4.7 above) *(CERN has started development)*

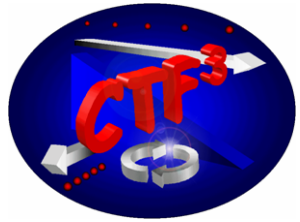
4.9. 32 power loads for 12 GHz RF and 16 directional couplers

5. Equipment for additional S-band RF power installation

Most of the component needed for a modulator has been provided by PSI. This could be used for an additional S-band power sources to power two additional RF accelerating structures in the CTF3 Drive Beal linac.

5.1 A 45 MW klystron is required

Open work packages for CTF3



6. Stand-alone X-band power source

For CLIC accelerating structure developments a stand-alone power source is required which allows to enhance the CLIC accelerating structure testing capacity considerably.

6.1. X-band klystron, peak power 50 MW, RF pulse length 1.5 ms.

6.2. Modulator for the klystron (6.1), 500 kV

7. 12 GHz RF components:

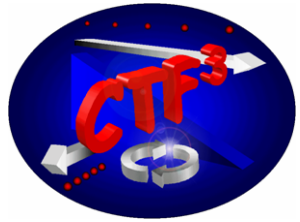
High-power X-band RF components including: flanges, bends, twists, directional couplers, hybrids, splitters, variable power dividers, windows, valves, loads etc. Some of these components will be adapted from SLAC and KEK designs and others will have to be designed from scratch. The components must be produced in quantities of approximately ten parts each for both the Two Beam Test Stand and

8. 12 GHz signal acquisition system

The 12 GHz RF pulses from both PETS and accelerating structures will need to be monitored by a fast acquisition system. The system will include: 12 GHz down-converter incorporating programmable attenuators, wideband IQ demodulators, data acquisition system sampling at 750MS/s. Around 50 channels will be required.

(CERN has started some of the work)

Open work packages for CTF3

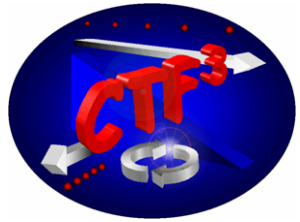


9. Prototype PETS structure manufacture:
These structures require 10 micron precision, fully three dimensional milling in relatively large, 1 m long, parts. We expect that two or three generations of PETS will required for the testing program.

10. Ultrasonic fatigue testing:
This work package consists in measuring the fatigue behaviour of bulk materials which can be applied for the construction of accelerating cavities for CLIC by ultrasonic excitation or similar methods. Testing should be extended to the nominal lifetime of the machine (1011 pulses) and should give a base for the estimate of the surface fatigue provoked by the RF pulses. The focus is at present on precipitation hardened copper alloys which have high electrical conductivity and mechanical strength. The influence of the various surface treatments which could improve fatigue resistance and be compatible with the requirements of RF application, high precision machining and in a second priority with bi-metal joining techniques should be investigated. Other potential candidates beyond such alloys, as composites or other materials, having similar and superior properties should be selected and evaluated.

11. CTF3 commissioning and operation support by experienced machine physicists

Conclusion



Commissioned up to including TL1

- Combiner Ring installed, being commissioned,
- TL2 in 2007/2008, all components covered
- CLEX : not all components covered by collaboration
- Stand alone x-band power source required

Already demonstrated:

- full Beam Loading operation of linac
- Phase coding of bunches
- Bunch Interleaving in Delay Loop

ADDENDUM
to

THE MEMORANDUM OF UNDERSTANDING
FOR A MULTI-LATERAL COLLABORATION

between

THE INSTITUTIONS AND FUNDING
AGENCIES OF THE CTF3 COLLABORATION

concerning

THE CONTRIBUTION OF THE JOHN ADAMS INSTITUTE AT ROYAL HOLLOWAY, UNIVERSITY OF LONDON

TO THE CTF3 COLLABORATION

June 2007

DRAFT v2

CONSIDERING:

The Memorandum of Understanding ("the MoU") defining the framework applicable to the construction of a 3rd generation Compact Linear Collider Test Facility (CTF3) and the performance of Experiments to demonstrate the feasibility of key issues of the CLIC scheme;

That Article 1.2 of the MoU envisages Addenda defining each contribution pledged to the CTF3 Collaboration,

THE JOHN ADAMS INSTITUTE AT ROYAL HOLLOWAY, UNIVERSITY OF LONDON (JAI@RHUL) REPRESENTED BY GRAHAME BLAIR, in its capacity as Member of the CTF3 Collaboration, **HEREWITH AGREES** to make the following contributions:

Already provided until/inclusive 30th April 2007

- Participation in CTF3 meetings and observer at the CTF3 Co-ordination Committee.
- Simulation studies, including the CLIC beam delivery system.
- Plans for collaboration in the EU-FP7 scheme.

The JAI@RHUL shall assume responsibility for the provision of the following contributions for the period 2007-2010 to CTF3:

- Collaboration in the area of radiative processes from electron beams such as transition, diffraction and synchrotron radiation consisting of a PhD student, 0.5 FTE of a post doc, fractional effort from Academic Staff at the John Adams Institute at RHUL, plus hardware contributions.
- Contributions to the design and proposal to the EU of an instrumentation test beam at the CTF3/CLEX facility.
- The total financial equivalent of these contributions will be approximately 640 kCHF.

This Addendum shall form an integral part of the MoU.

Done in Geneva on ……. 2007

For John Adams Institute at RHUL

Prof. Grahame Blair
Deputy Director of JAI

Dr. Hitesh Patel
Deputy Head (Research)