Comments
~~Conclusions~~ from CLIC
(IWLC 2010, Geneva)

Ken Peach

(JAI)

Contents

- The Collaboration
- Progress
- Present Status & Plans
  - Post-physical fire
  - Post-metaphorical fire [MTP]
- The Next Challenges

Disclaimer 1: These are *my* thoughts

Disclaimer 2: Apologies to those many whose excellent work is not cited – much better done in the other plenary and parallel sessions. I have selected just a few illustrations of where we are

Disclaimer 3: Detectors left to the next session (but a comment)

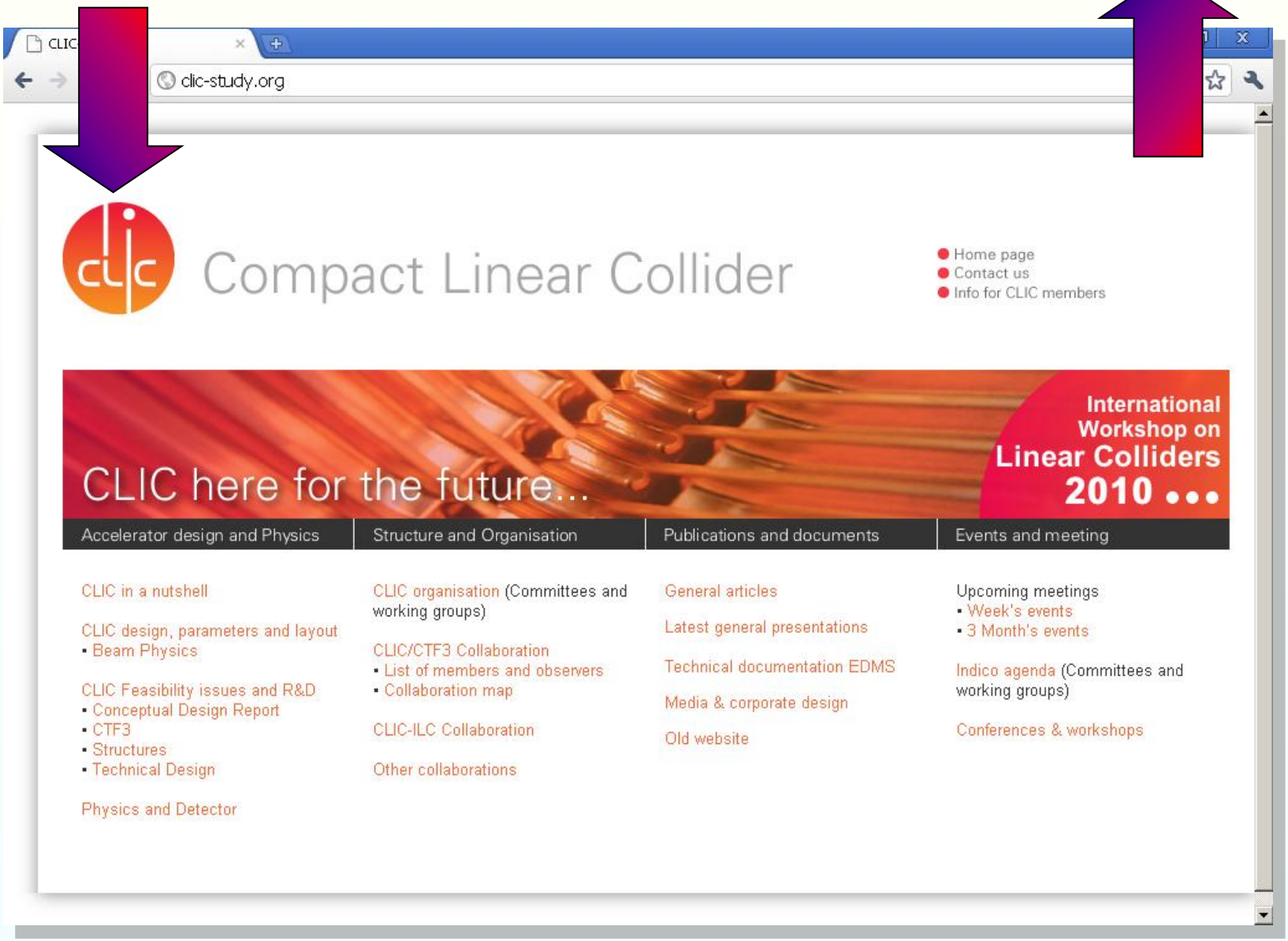
The Collaboration

The CLIC Collaboration

41 institutes, 21 countries & growing

ACAS (Australia)
Aarhus University (Denmark)
Ankara University (Turkey)
Argonne National Laboratory (USA)
Athens University (Greece)
BINP (Russia)
CERN
CIEMAT (Spain)
Cockcroft Institute (UK)
ETHZurich (Switzerland)
Gazi Universities (Turkey)
Fermilab
Helsinki Institute of Physics (Finland)
IAP (Russia)
IAP NASU (Ukraine)
IHEP (China)
INFN / LNF (Italy)
Instituto de Fisica Corpuscular (Spain)
IRFU / Saclay (France)
Jefferson Lab (USA)
John Adams Institute/Oxford (UK)
John Adams Institute/RHUL (UK)
JINR (Russia)
Karlsruhe University (Germany)
KEK (Japan)
LAL / Orsay (France)
LAPP / ESIA (France)
NIKHEF/Amsterdam (Netherland)
NCP (Pakistan)
North-West. Univ. Illinois (USA)
Patras University (Greece)
Polytech. University of Catalonia (Spain)
PSI (Switzerland)
RAL (UK)
RRCAT / Indore (India)
SLAC (USA)
Thrace University (Greece)
Tsinghua University (China)
University of Oslo (Norway)
Uppsala University (Sweden)
UCSC SCIPP (USA)

New CLIC website: http://clic-study.org/



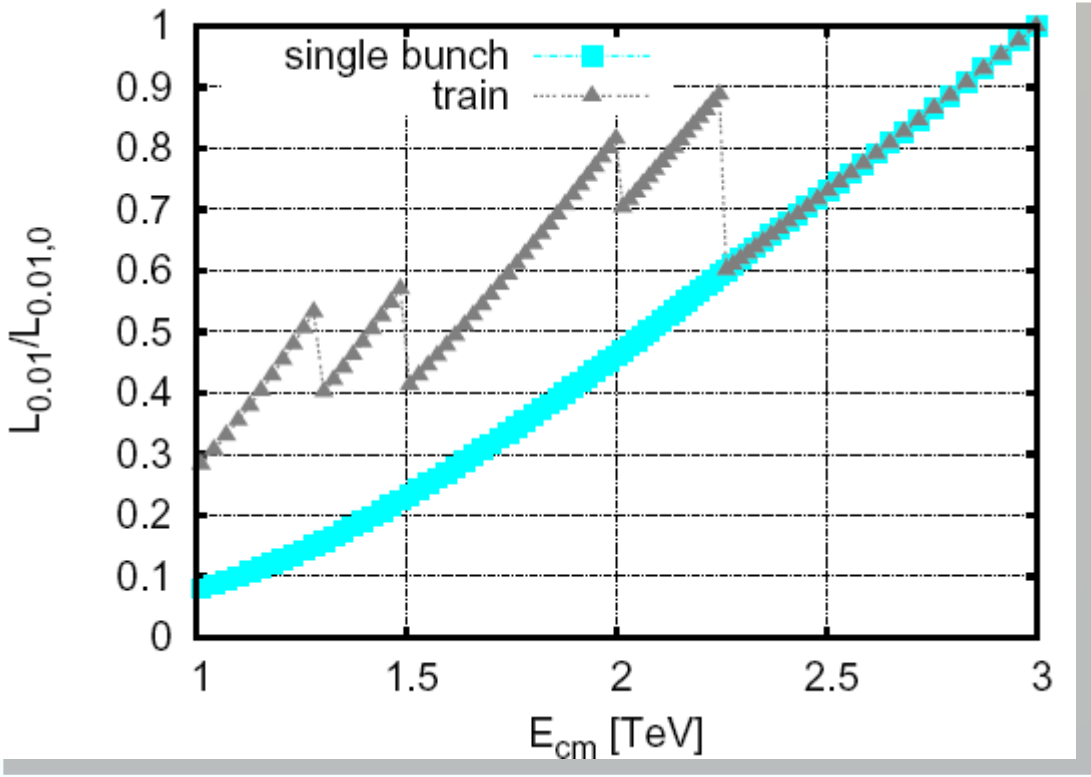
Progress

Progress-1: Energy scanning

- **The issue**
  - **Small (10%) scans can always be done**
    - **Tune magnets, detune RF**
  - **Optimise the machine for one energy**
    - **Running at much lower (or higher) energy**
      - **Compromised luminosity**
      - **Needs a machine reconfiguration**
      - **Cannot be done quickly (within a few hours)**
        - » **Can it be done at all?**

Progress-1: Energy scanning-2

- **Compensate partially for loss of (useful) luminosity from *decreasing* the RF gradient by *increasing* the pulse length**

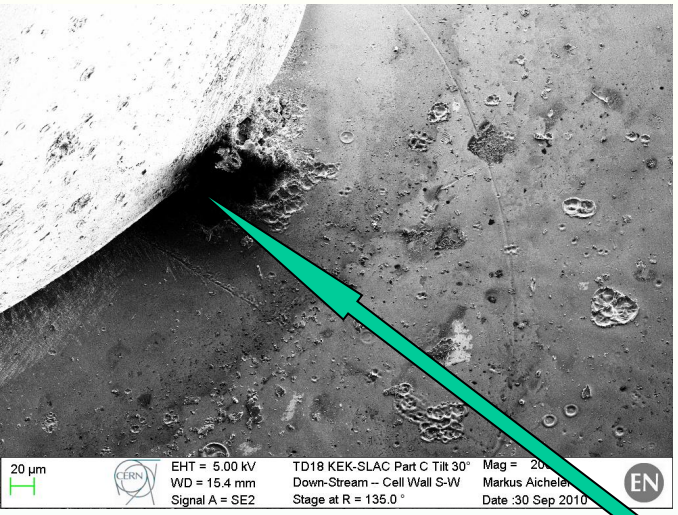


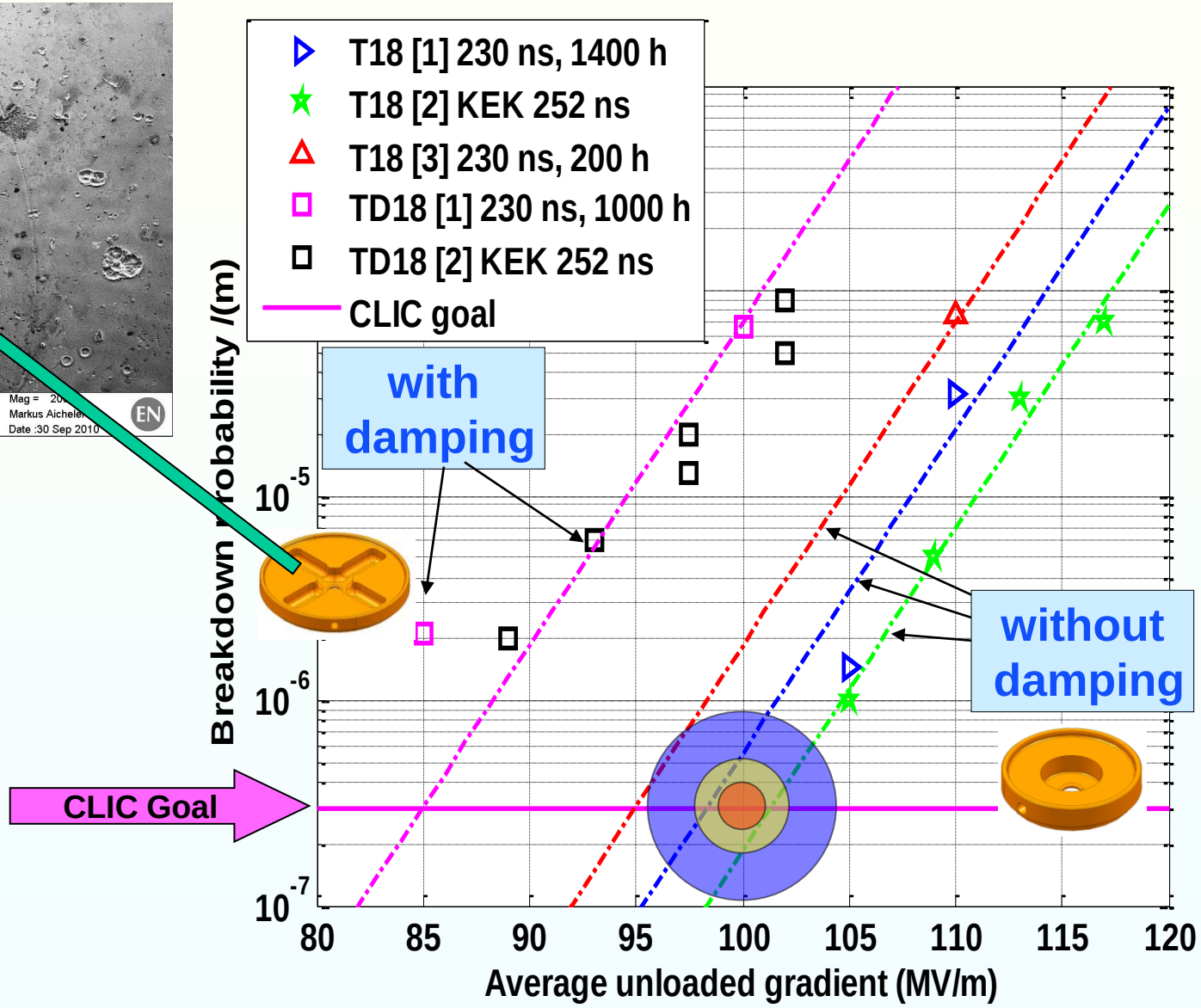
E/E_0	n_b	$n_{\mathcal{L}}$	$Q_p/Q_{p,0}$
1.0	312	1.0	1.0
0.75	472	1.5	1.12
0.667	552	1.77	1.18
0.5	792	2.54	1.27
0.375	1112	3.56	1.34
(0.333)	(1272)	(4.08)	(1.36)

E maximum centre-of-mass energy for operation mode

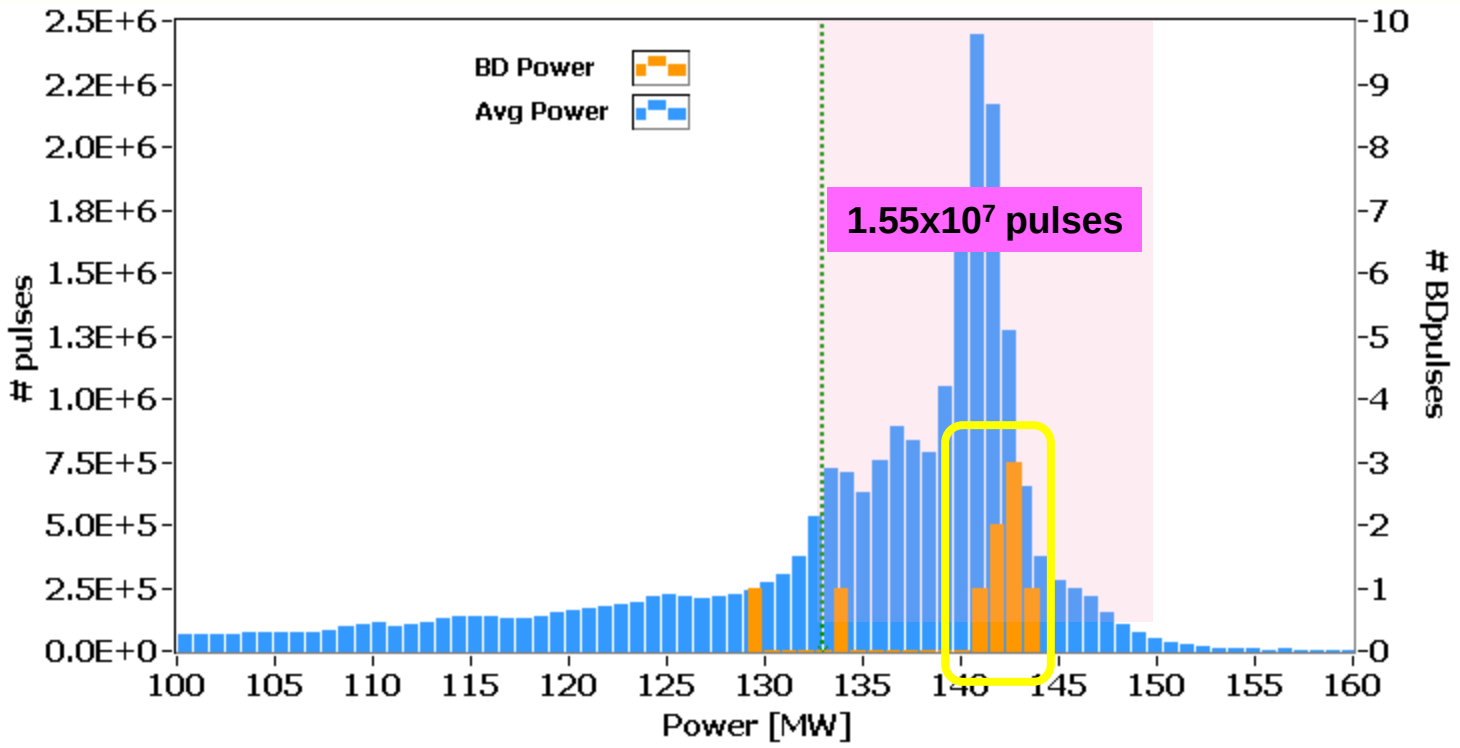
Progress-2: Accelerating Structures

Delahaye
Wuensch





Progress-2: PETS

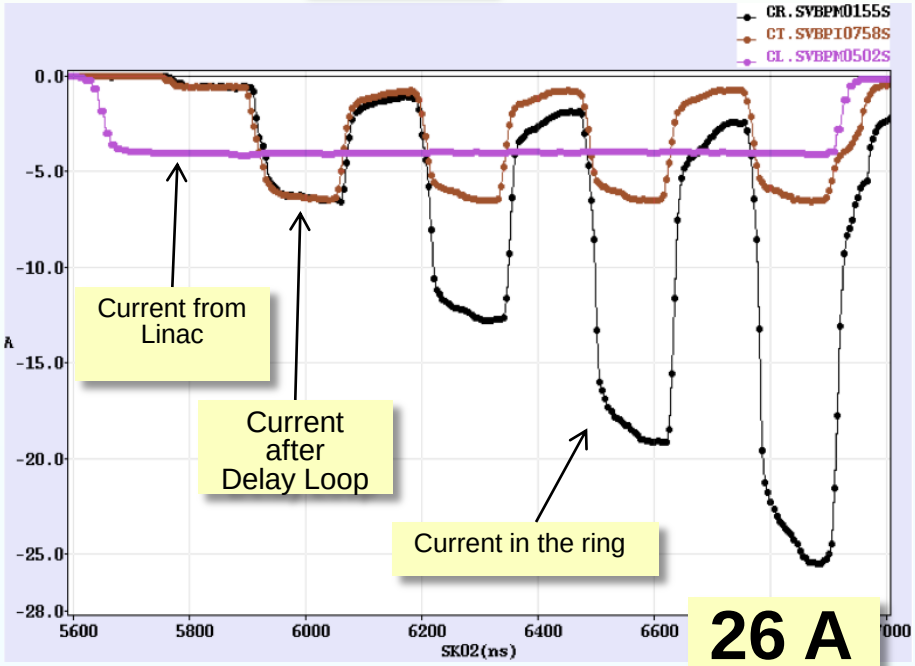


- **8 PETS breakdown events in 1.55 10^7 pulses (125 hours)**
  - **Breakdown rate 5.3 10^{-7}/pulse [CLIC Goal <2 10^{-7}/pulse]**
    - **(excluding the 8 in the cluster – 1.3 10^{-7}/pulse)**
  - **last 80 hours no breakdowns were registered**
    - **BDR <1.2x10^{-7}/pulse**

CTF3

- **4 x combination**
  - **Lower current ←→ Missing klystron**
  - **But back in operation – continue work**

2009



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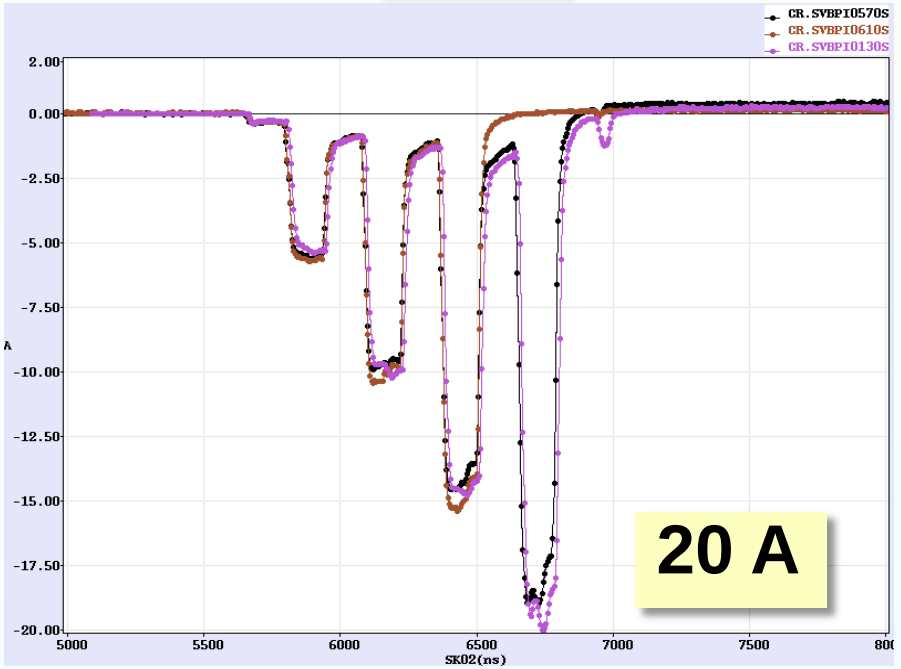
2010



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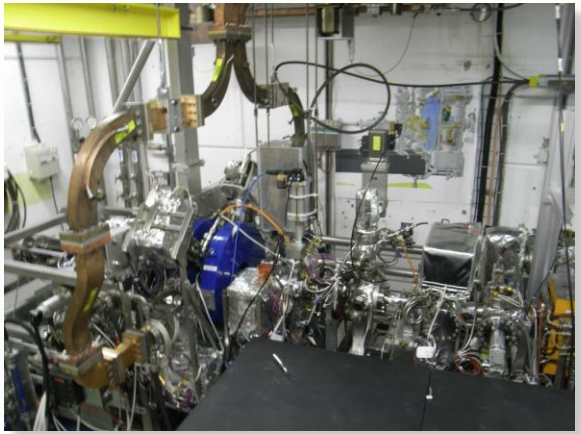
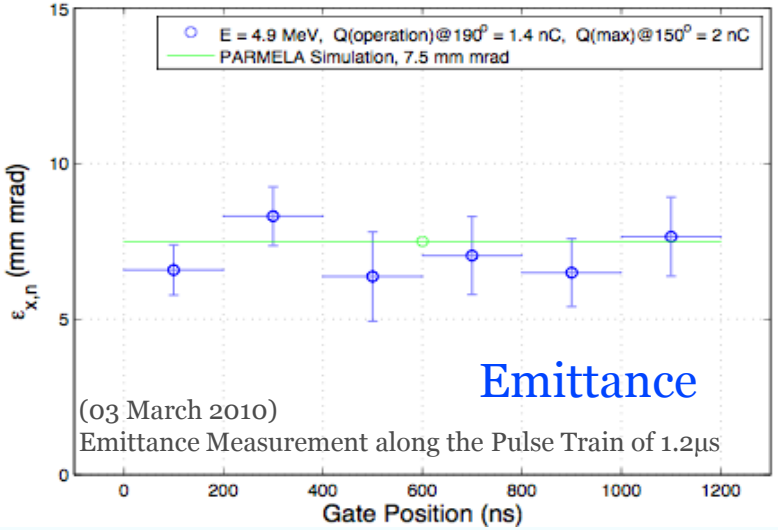
PHIN

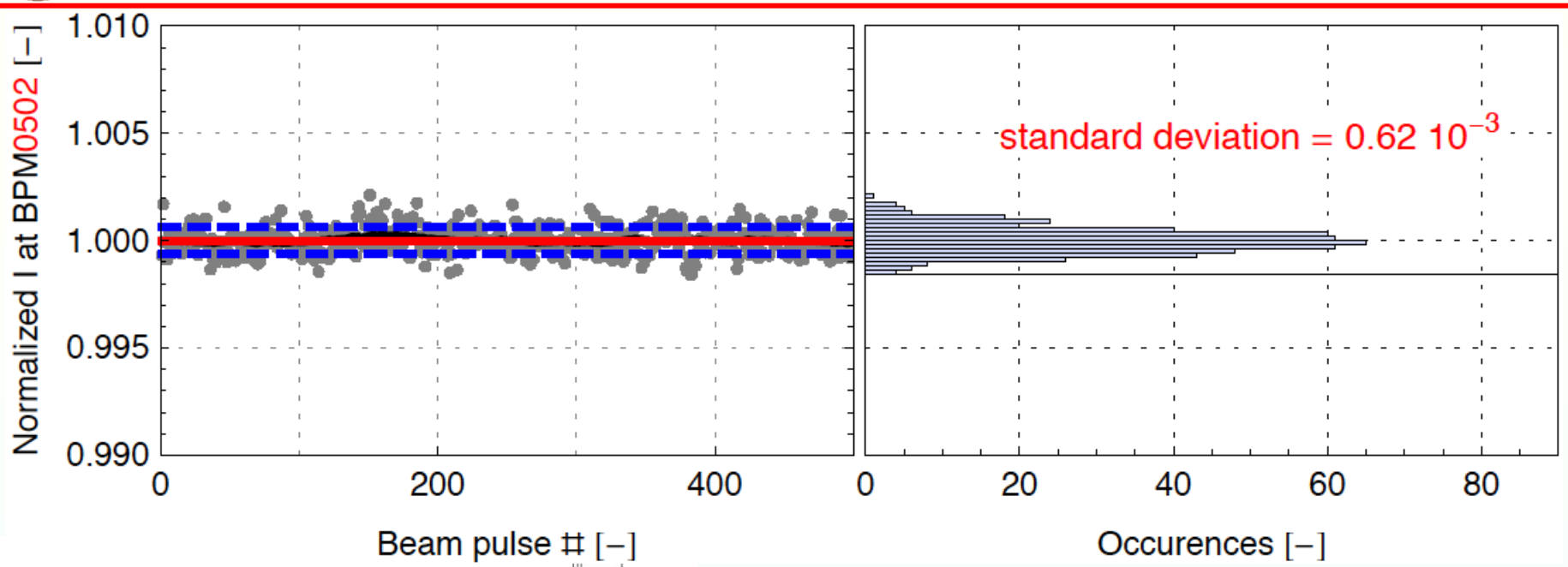
- specifications successfully demonstrated during the June run
- measurements along pulse train

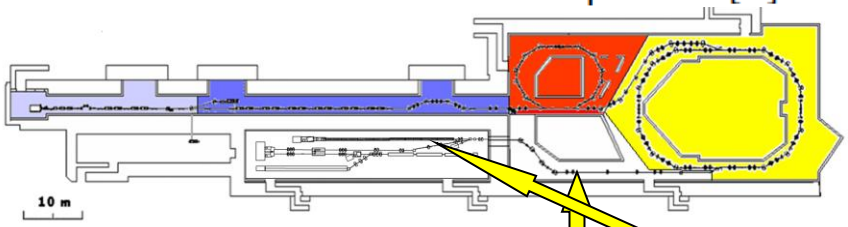


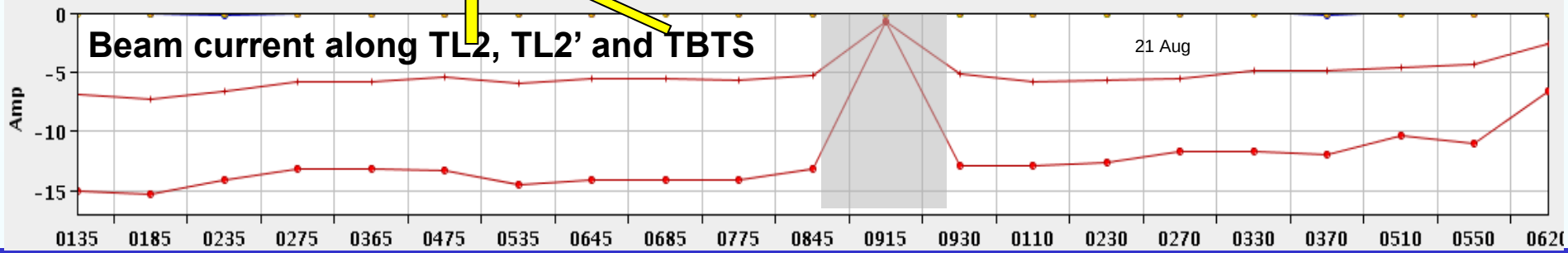


Parameter	Specification	Achieved	
Charge per Bunch (nC)	2.33	4.4	✓
Charge per Train (nC)	4446	>4446	✓
Train Length (ns)	1273	1300	✓
Current (A)	3.5	~3.4	✓
Normalized Emittance (mm mrad)	<25	14	✓
Energy Spread (%)	<1	0.7	✓
Energy (MeV)	5.5	5.5	✓
UV Laser Pulse Energy (nJ)	370	400	✓
Charge Stability (%)	<0.25 rms	1-2	✗
Cathode	Cs_2Te	Cs_2Te	✓
Quantum Efficiency (%)	3	18 (peak)	✓
RF Gradient (MV/m)	85	85	✓
RF Frequency (GHz)	2.99855	2.99855	✓
Micropulse Repetition Rate (GHz)	1.5	1.5	✓
Macropulse Repetition Rate (Hz)	1-5	1-5	✓

Beam Stability

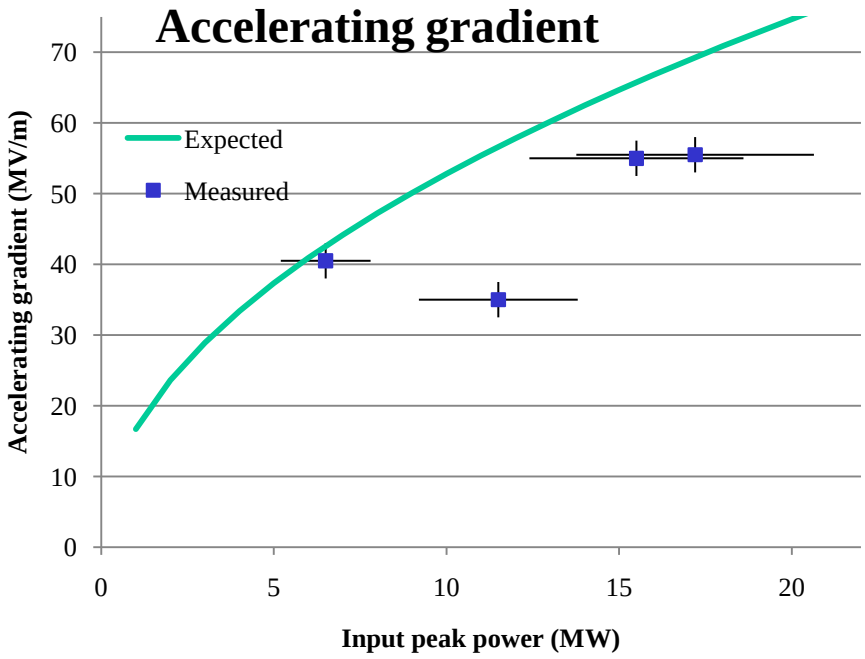


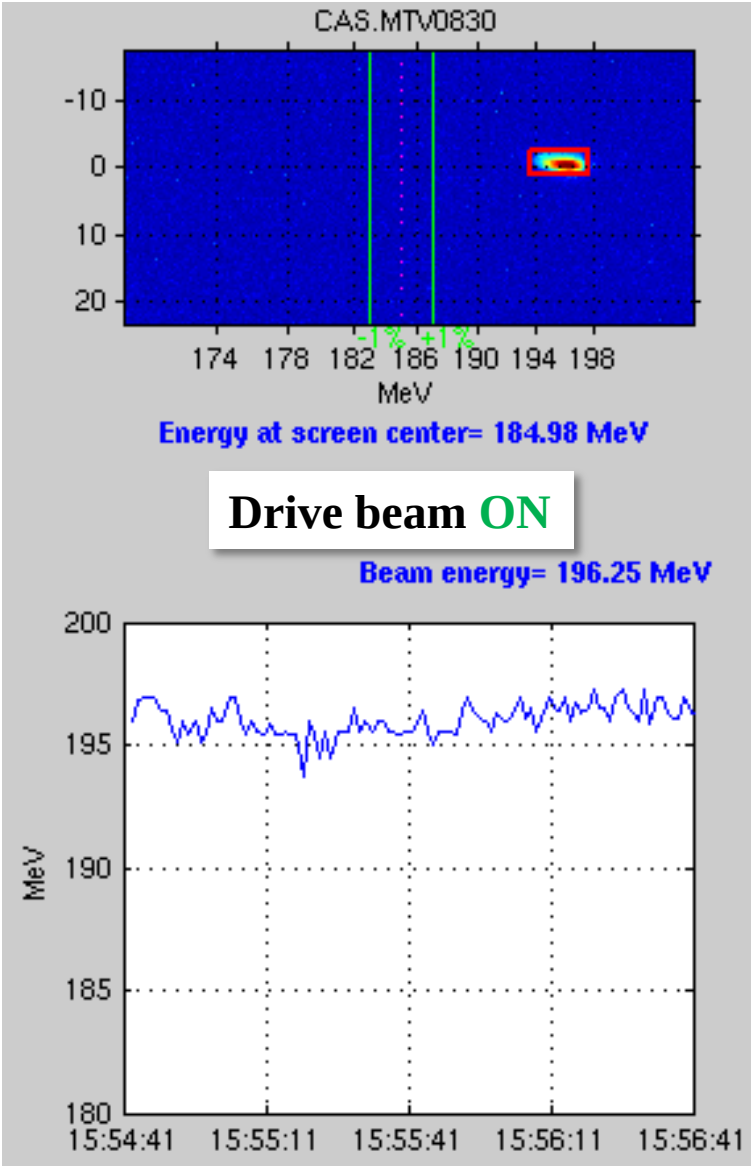




Two-beam acceleration in CTF3

- maximum probe beam acceleration of 11 MeV measured
- => **gradient ~55 MV/m**
- RF calibrations to be verified





CLIC Feasibility status

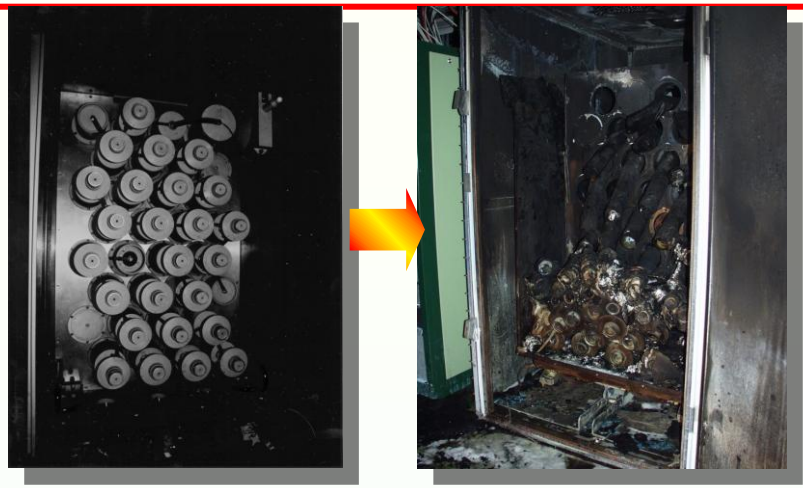
System	Item	Feasibility Issue	Unit	Nominal	Achieved	How	Feasibility
Two Beam Acceleration	Drive beam generation	Fully loaded accel effic	%	97	95	CTF3	✓
		Freq&Current multipl	-	2*3*4	2*4	CTF3	✓
		12 GHz beam current	A	4.5*24=100	3.5*8=28	CTF3	✓
		12 GHz pulse length	nsec	240	240	CTF3	✓
		Intensity stability	1.E-03	0.75	0.6	CTF3	✓
		Drive beam linac RF phase stability	Deg (1GHZ)	0.05	0.035	CTF3, XFEL	✓
	Beam Driven RF power generation	PETS RF Power	MW	130	130	TBTS/SLAC	✓
		PETS Pulse length	ns	170	>170	TBTS/SLAC	✓
		PETS Breakdown rate	/m	< 1·10-7	>1.2 10-6	TBTS/SLAC	✓
		PETS ON/OFF	-	@ 50Hz	-	CTF3/TBTS	2011
		Drive beam to RF efficiency	%	90%	-	CTF3/TBL	2010-11
		RF pulse shape control	%	< 0.1%	-	CTF3/TBTS	
	Accelerating Structures (CAS)	Structure Acc field	MV/m	100	100	CTF3 Test Stand, SLAC, KEK	✓
		Structure Flat Top Pulse length	ns	170	170		✓
		Structure Breakdown rate	/m MV/m.ns	< 3·10-7	5·10-5(D)		2010-11
		Rf to beam transfer efficiency	%	27	15		2010-11
	Two Beam Acceleration	Power producton and probe beam acceleration in Two beam module	MV/m - ns	100 - 170	55 - 170	TBTS	2011-12
		Drive to main beam timing stability	psec	0.05	-	CTF3	2012
		Main to main beam timing stability	psec	0.07	-	CTF3	2012
Ultra low beam emittance & sizes	Ultra low Emittances	Emitttance generation H/V	nm	500/5	3000/12	ATF, NSLS/SLS + simulation	✓
		Emittance preservation: Blow-up	nm	160/15	160/15		2010-12
	Alignment	Main Linac components	microns	15	10 (princ.)	Alignement & Mod.Test Bench	2010
		Final-Doublet	microns	2 to 8			2010
	Vertical stabilisation	Quad Main Linac	nm>1 Hz	1.5	0.13 (principle)	Stabilisation Test Bench	2010-12
		Final Doublet (assuming feedbacks)	nm>4 Hz	0.2			

- **ILWC: experimental results and plans scrutinized**
  - **compared with parameter specifications for feasibility demonstration.**

Present Status & Plans

"Circumstances Beyond Our Control"

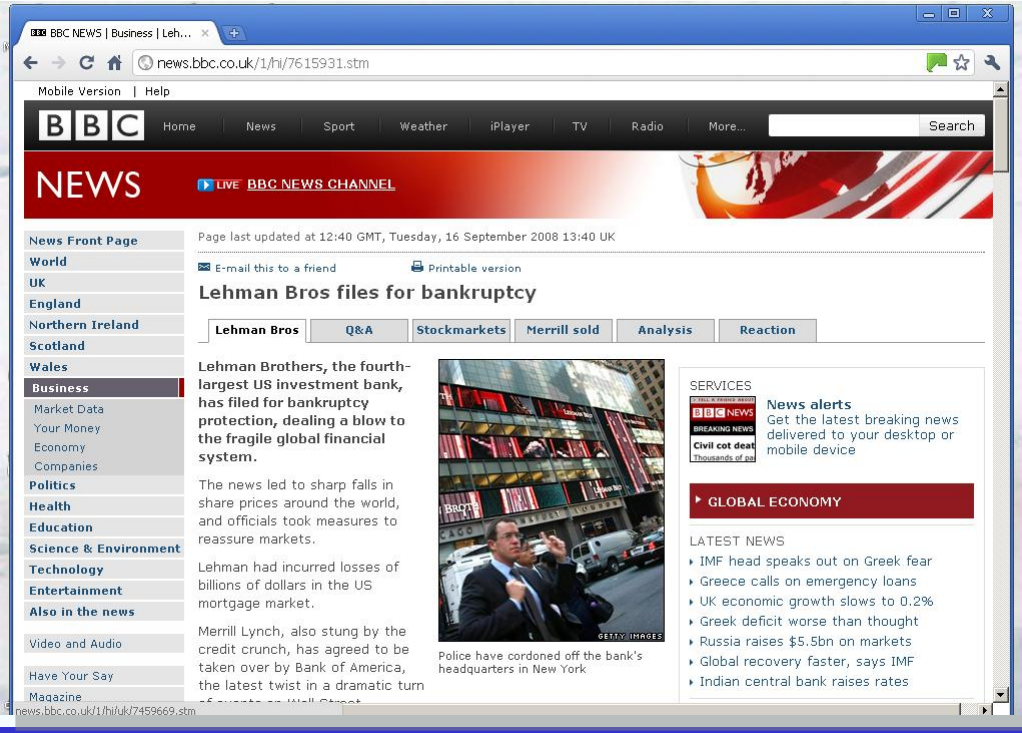
- **The fire (March 4th)**



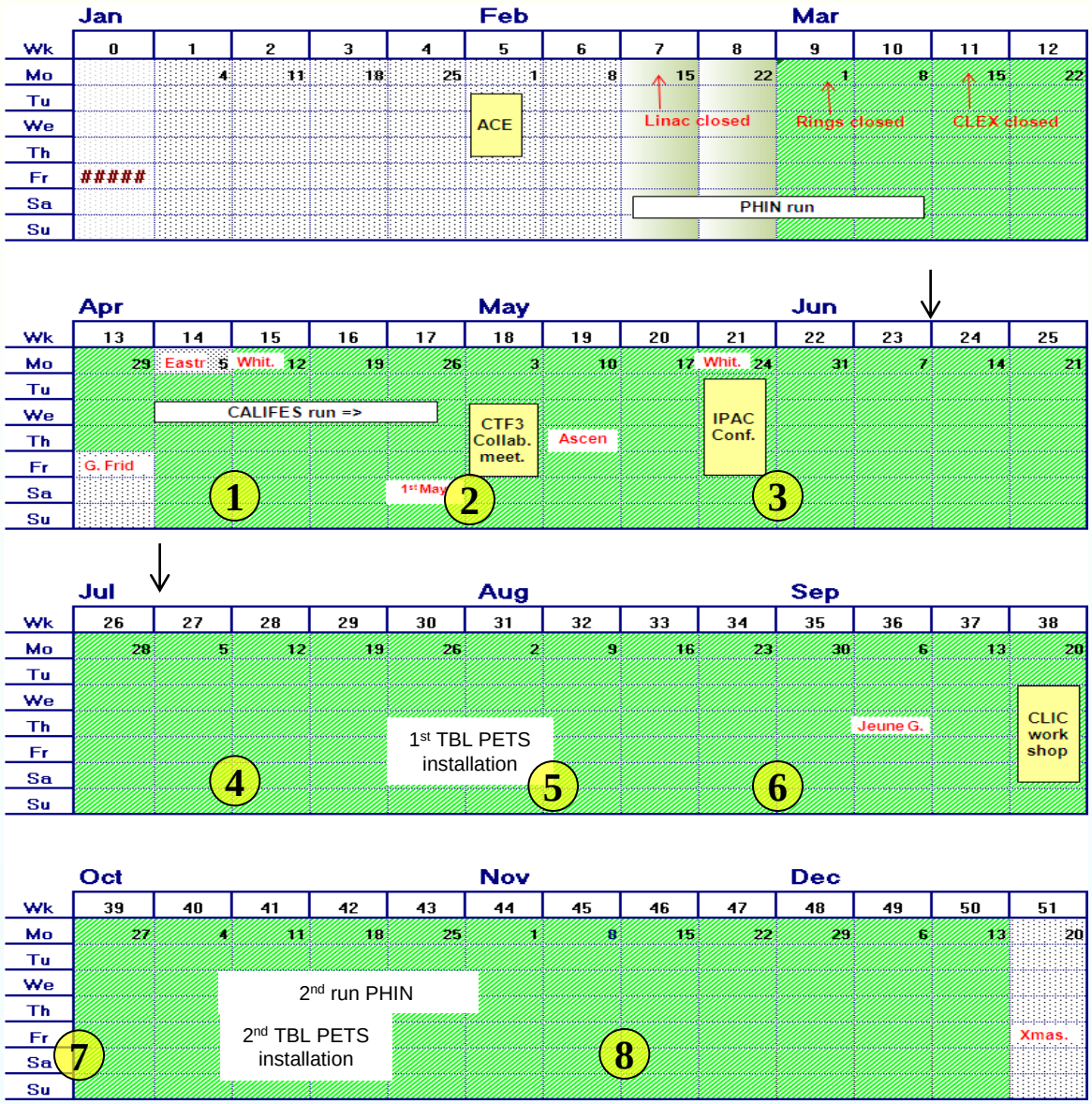
- **The "Lehman" effect**
  - **Reduced CERN budget 2011-2015**

    (Lehman: 16/9/08

    CERN impact 16/6/10)



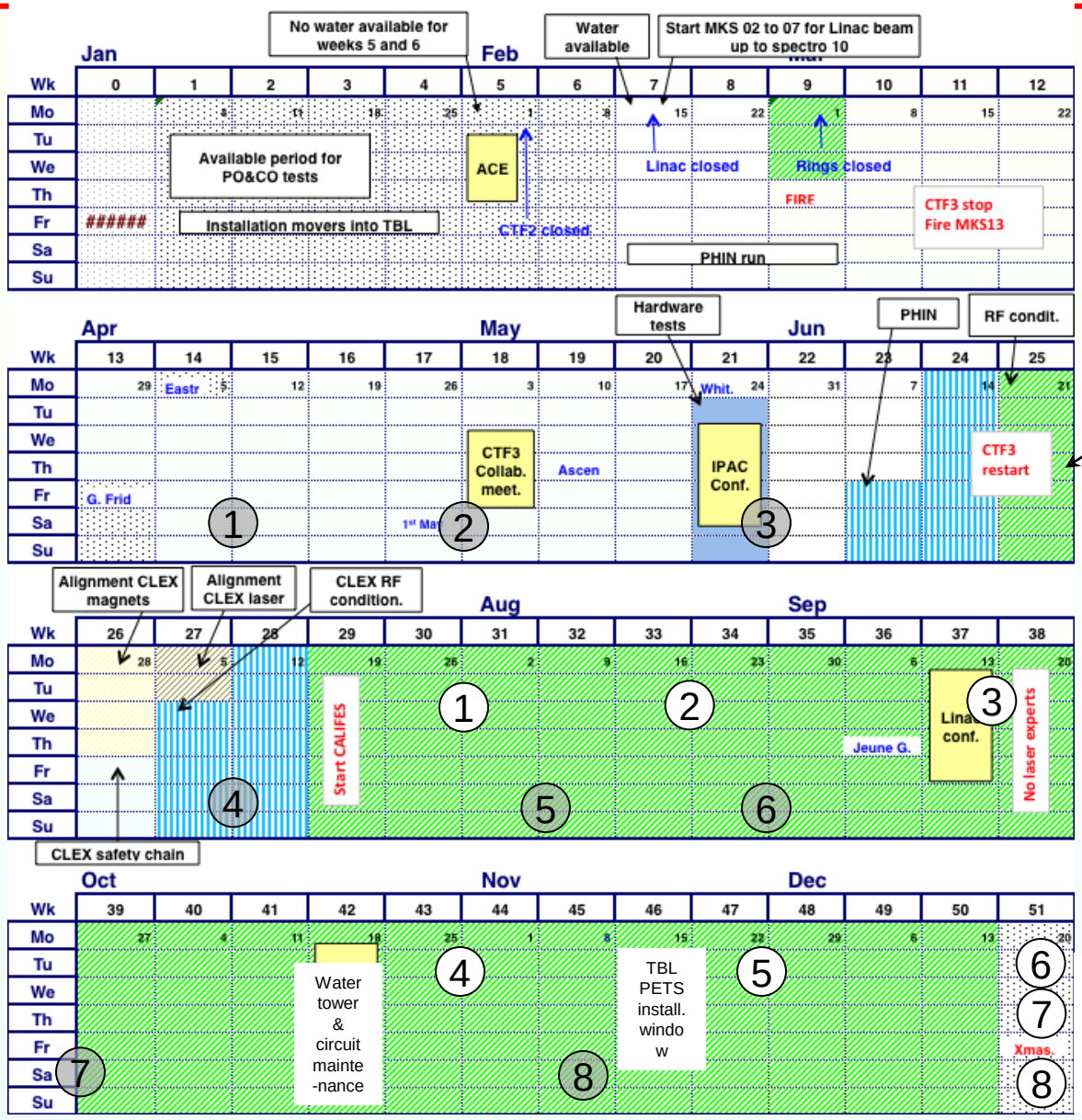
Schedule (February 2010)



1. Optics improvements (DL dispersion)
   Full transport to CLEX
   Bunch length control (first tests)
   TBTS initial PETS tests
   CALIFES setup
   new setup when MKS13 available
2. PETS conditioned to nominal power/pulse length
3. Accelerating structure conditioned to nominal power/pulse length
   Two-Beam test power & energy gain, 100MV/m
4. TBL studies
   PETS breakdown rate measurements?
5. Measurement of breakdown kicks
   Beam Loading compensation experiment
6. Measurement of effect of beam loading on breakdown rate
7. Test of new PETS on-off scheme
8. TBL studies 30% deceleration ?

- Stability studies & improvements
- PETS no recirculation
- Phase stability
- Operation at 5 Hz (or more)
- Control of beam losses
- Coherent Diffraction Radiation …

Schedule (updated)



1. Optics improvements (DL dispersion)
   Full transport to CLEX
   Bunch length control (first tests)
   TBTS initial PETS tests
   CALIFES setup
   ~~new setup when MKS13 available?~~
2. PETS conditioned to nominal power/pulse length
   TBL PETS tests
3. Accelerating structure conditioned to nominal power/pulse length — Two-Beam test power & energy gain, 100MV/m

Beam

4. TBL studies (limited) — PETS breakdown rate measurements???
5. Measurement of breakdown kicks — Beam Loading compensation experiment
6. Measurement of effect of beam loading on breakdown rate
7. Test of new PETS on-off scheme
8. TBL studies 30% deceleration ?

2nd TBL PETS installation

6 weeks PHIN phase-coding Laser preparation

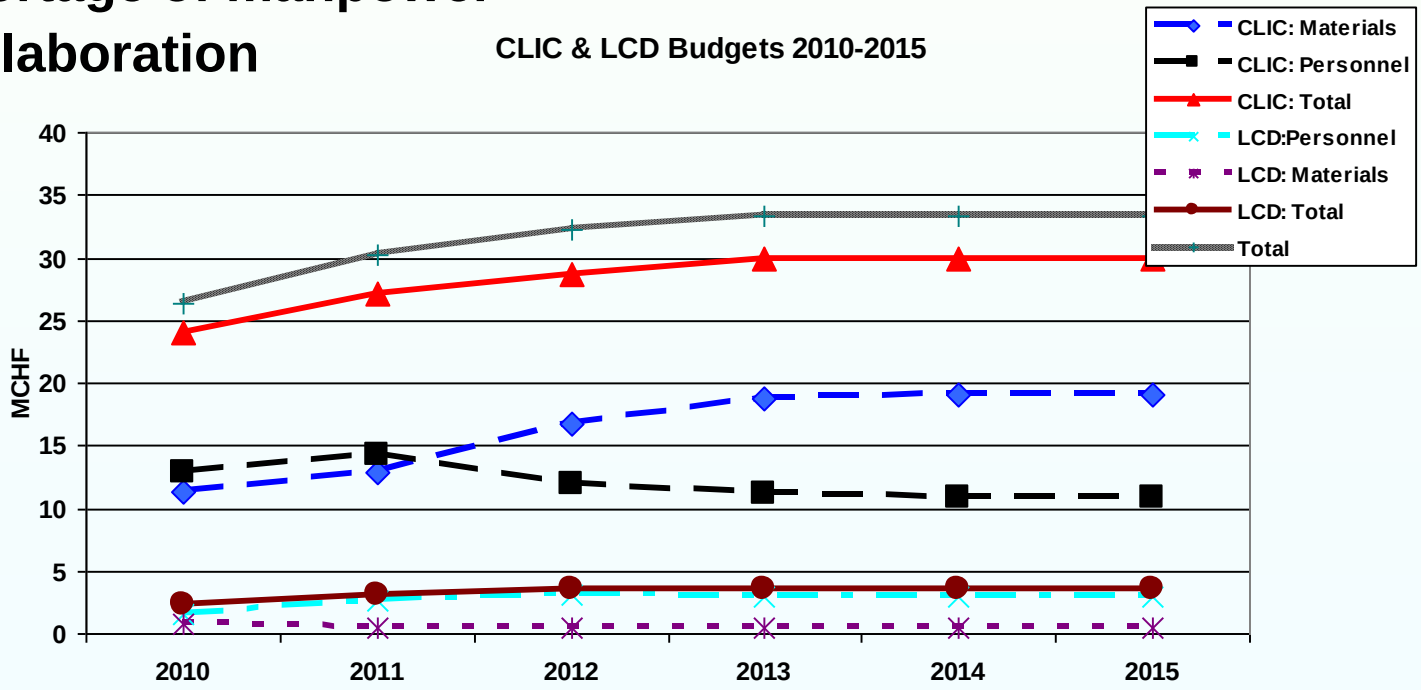
- Stability studies & improvements
- PETS no recirculation
- Phase stability
- Operation at 5 Hz (or more)
- Control of beam losses
- Coherent Diffraction Radiation …

CFT3: post-fire status

- **Many feasibility issues addressed**
  - **e.g. RF phase stability**
- **6 months delay in the final 3 goals**
  - **Measurement of effect of beam loading on breakdown rate**
  - **Test of new PETS on-off scheme**
  - **TBL studies 30% deceleration**
    - **Serious but not catastrophic**
    - **Delay on CDR less**
      - **but delay in presentation to SPC**
- **On track to complete CDR next year**

"Lehman" impact

- **Increase in resources for CLIC**
  - **Materials 11.9→19.0MCHF**
  - **Personnel 12.8→10.9MCHF**
    - **Overall increase ~60%**
  - **but**
    - **Shortage of manpower**
    - **Collaboration**



CLIC Tentative Schedule

Final CLIC CDR and proposal next phase @ CERN Council

European Strategy for Particle Physics @ CERN Council

	2010	2011	2012	2013	2014	2015	2016	2017	2018
Feasibility issues (Accelerator&Detector)									
Conceptual design & preliminary cost estimation									
Engineering, industrialisation & cost optimisation									?
Project Preparation									
Project Implementation									?

Draft Conceptual Design Report (CDR)

Project Implementation Plan (PIP) and proposal for next phase

A new project plan is being developed

IWLC 2010

Work Plan for the next years:

Before 2011

CDR (2011), CLIC feasibility established

2011-2016 – Project Preparation phase

This is the current focus for planning in the collaboration, with main activities covering:
- review of the CLIC baseline design, taking into account CDR results and including:
  - cost & power consumption optimization
  - energy staging
  - technical risks and performance risks
- technical developments and test of critical component prototypes, using several facilities across the collaboration
- exploitation and upgrade of CTF3 to CTF3+, construction and commissioning of CLIC drive beam injector
- detector and physics studies
- site studies
- preparation of a Project Implementation Plan (PIP) for CLIC

This phase will culminate with a document, or several, covering the points above, with a detailed plan for the next phase

After 2016 – Project Implementation phase, including an initial period to lay the grounds for full approval

Considering the preparation steps foreseen and the resources situation it is clear that several key tasks will need further effort before the project can move into construction:
- finalization of the CLIC technical 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
- possible construction of CLIC Zero as first CLIC phase
- industrialization and pre-series production of large series components with validation facilities
- further detector and physics studies, with increased emphasis on technical coordination issues and integration
- revision of the Project Implementation Plan (PIP) of CLIC, following the energy staging strategy and detailed resource discussion with all partners – providing the basis for a staged or full approval, and subsequent construction start up

During this initial period we will need to produce the necessary documents to support a proposal for CLIC construction start-up

- We need the help of present – and new – collaborators, in order to:
  - Revise, improve and better refine the technical plan
  - Provide additional resources

~50 FTE

~60 MCHF

Please send your expressions of interest to us at clic-tdr-contributions@cern.ch

Detectors

CLIC CDR Volume 3: Physics & Detectors

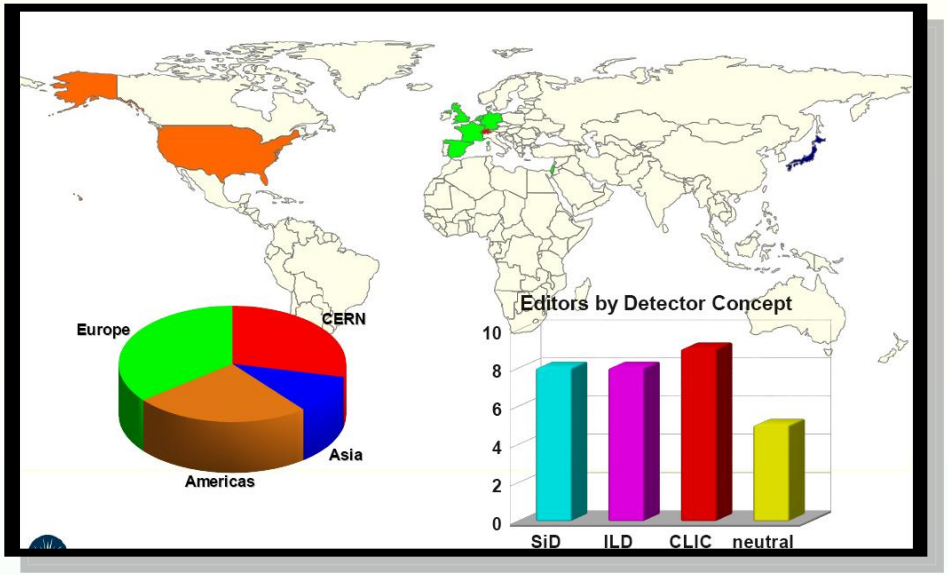
- It will be carried by the entire Linear Collider Community, the Editors represent all regions
- Input from ILC detector concepts, R&D collaborations, theorists
- CDR to focus on 3 TeV case

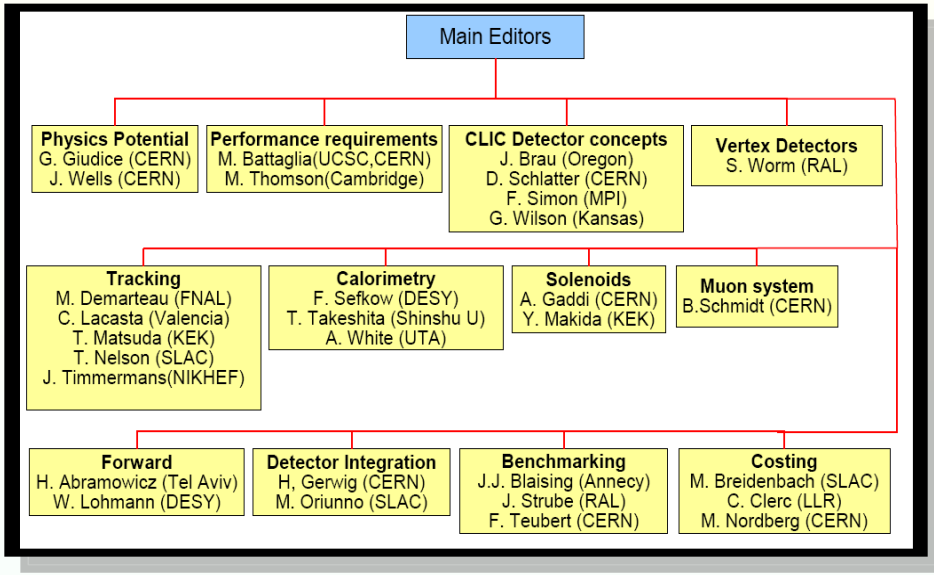
Goals of Vol. 3

- Describe the CLIC physics potential
- Show that CLIC physics can be measured with adequate precision

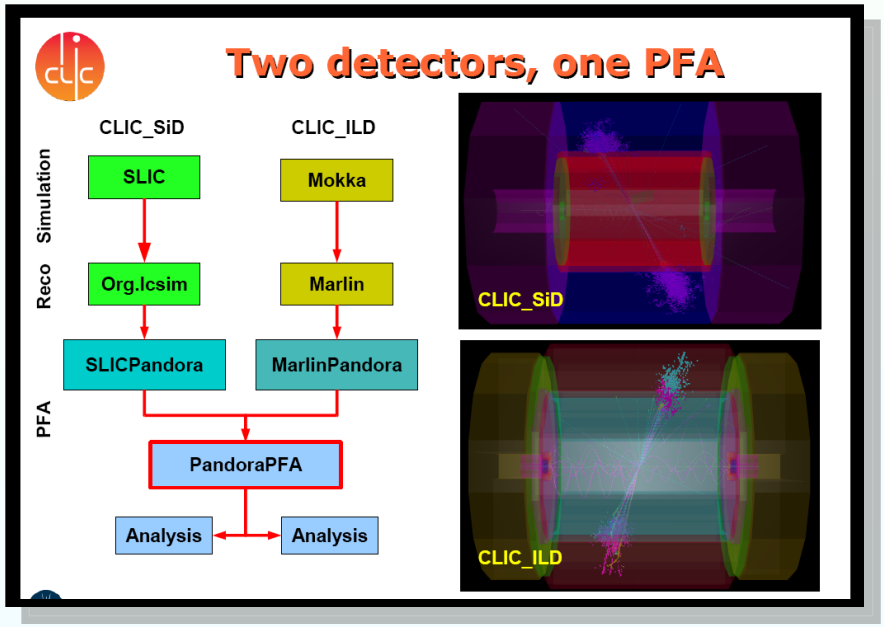
- Four Main Editors
  - Lucie Linssen (CERN)
  - Akiya Miyamoto (KEK, Asia)
  - Marcel Stanitzki (RAL, Europe)
  - Harry Weerts (ANL, Americas)

CLIC CDR: P&D Editorial Team





	CLIC_SiD	CLIC_ILD
Vertex detector	inner radius 2.7 cm 5 single barrel layers 6 single layer forward disks	inner radius 3.1 cm 3 double layers 3 double layer pixel forward disks
Tracker	Si, unchanged	TPC, unchanged
ECAL	unchanged	unchanged
HCAL Barrel	W+Scintillator, 3x3 cm tiles 7.5 Λ_I 1 cm plates W+RPC, 1x1 cm tiles 7.5 Λ_I 1 cm plates	W+Scintillator, 3x3 cm tiles 7.5 Λ_I 1 cm plates
HCAL Endcap	Fe+Scintillator, 3x3 cm tiles 7.5 Λ_I 2 cm plates Fe+RPC, 1x1 cm tiles, 7.5 Λ_I 2 cm plates	Fe+Scintillator, 3x3 cm 7.5 Λ_I 2 cm plates
Coil	5T, Radius=2.68 m	4T, Radius=3.35 m



The Next Challenges

From Rolf on Monday …

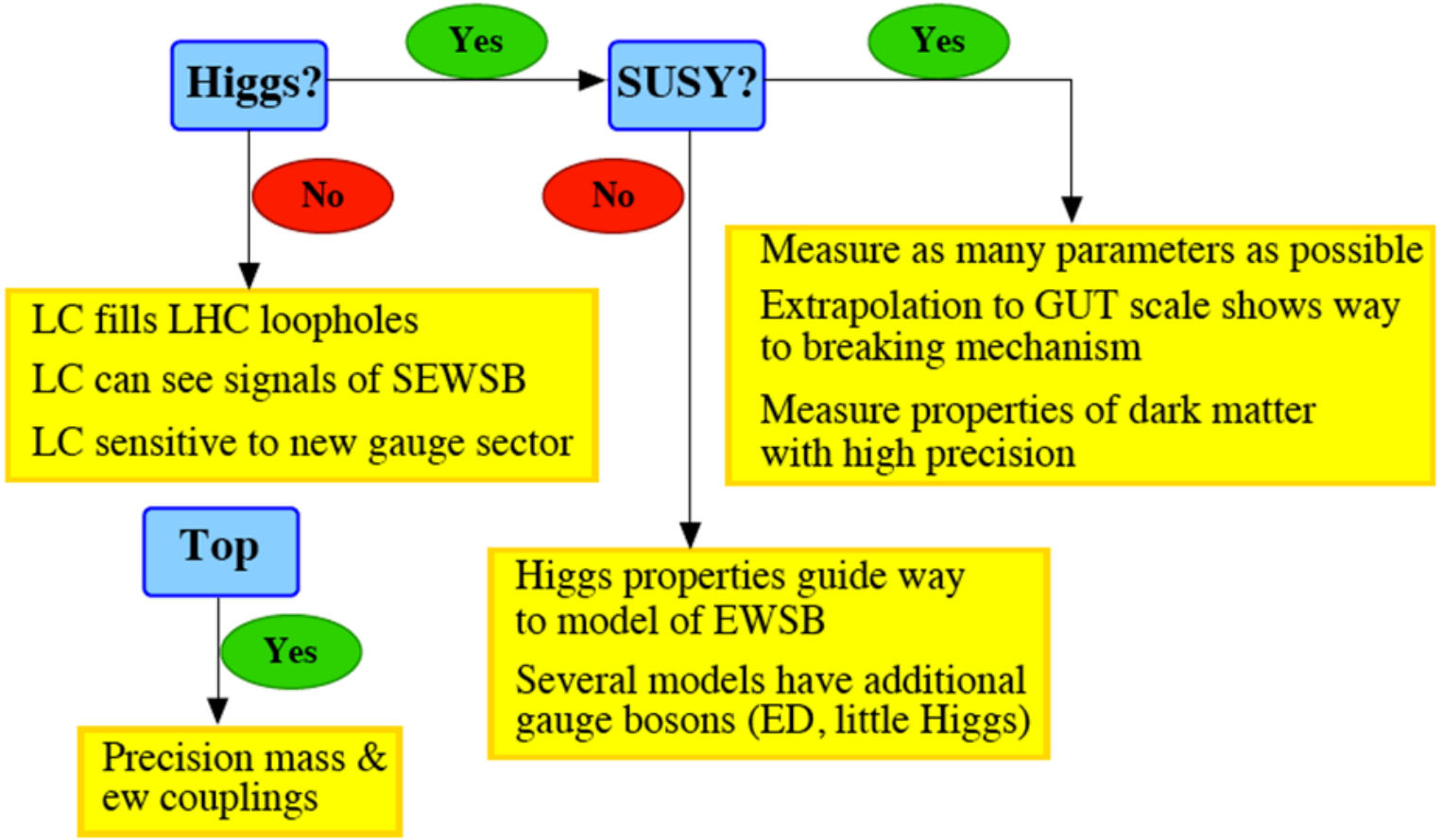
What can we expect from LHC and Tevatron

- LHC will have results on masses of SUSY particles (squarks, gluinos) up to/beyond around 800 GeV by end of 2011
- LHC and Tevatron together will have results on Higgs mass exclusion or even possible allowed mass range up to around 500 GeV by end 2011

→ 2012 could be a decisive year concerning LC (in time with update of European strategy)

… and from Steinar

Physics – very short



Physics potential of a linear e+e- collider (Klaus Moenig):
http://indico.cern.ch/materialDisplay.py?contribId=0&materialId=slides&confId=69540

We need to be ready to assess the implications

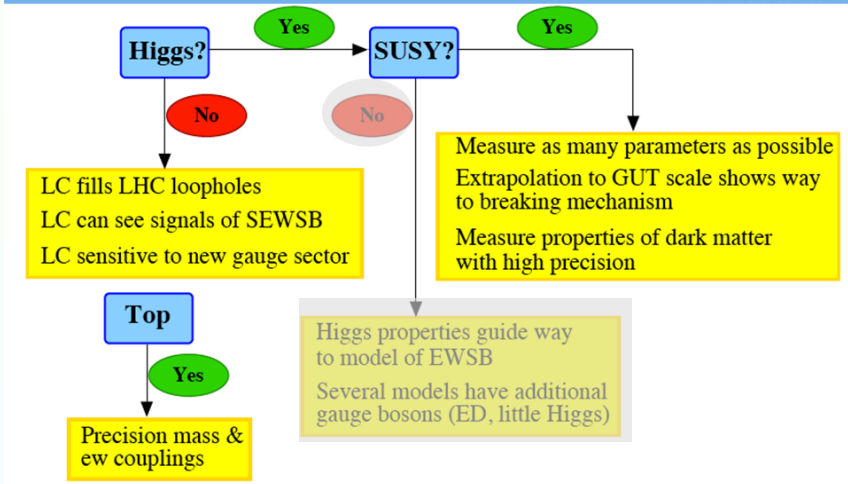
What can we expect from LHC and Tevatron

- LHC will have results on masses of SUSY particles (squarks, gluinos) up to/beyond around 800 GeV by end of 2011
- LHC and Tevatron together will have results on Higgs mass exclusion or even possible allowed mass range up to around 500 GeV by end 2011

2012 could be a decisive year concerning LC (in time with update of European strategy)

10

Physics – very short



Physics potential of a linear e+e- collider (Klaus Moenig):
http://indico.cern.ch/materialDisplay.py?contribId=0&materialId=slides&confId=69540

Summary – a mixed year

- **Excellent technical progress to the CDR**
  - **Delayed ~6 months by the fire**
  - **Address remaining feasibility issues**
  - **On track for CDR by end 2011**
- **Plans developed for the post-CDR phase**
  - **Disrupted by the financial crisis**
    - **But a revised plan emerging**
- **Opportunities for greater collaboration**
  - **Prepare for the post 2012 landscape**
    - **New connections ILC←→CLIC?**
    - **New organisational structures?**
- **Wait for "good news" from the LHC**

Thank you

CLIC – Zero (Project after 2016?)