CLIC09 Workshop Summary

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The workshop in numbers

~230	Participants
~21	Countries
>62	Institutes
20	Plenary talks
142	Parallel talks
10	(day-long) sessions
5	Working groups
5	Summaries of the working groups

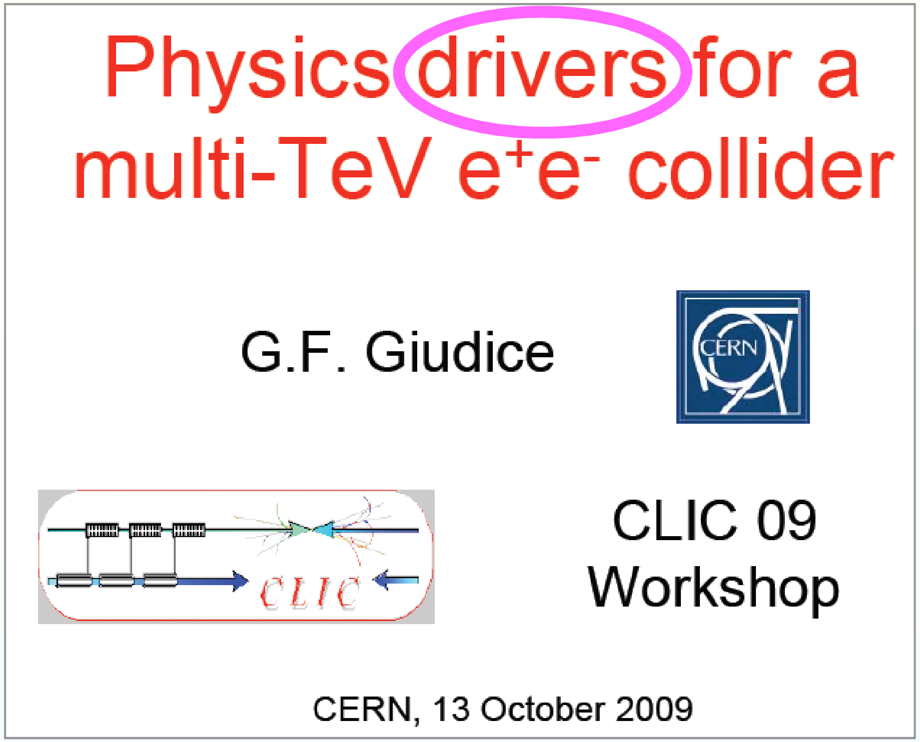
To cover all talks in 30 minutes

≡ >5 talks/minute!

Contents

- Physics motivation
- CLIC and ILC (& MC?)
- A year of progress
- Increasing understanding
- Two issues
- CDR & Future programme
- Summary

Physics Motivation



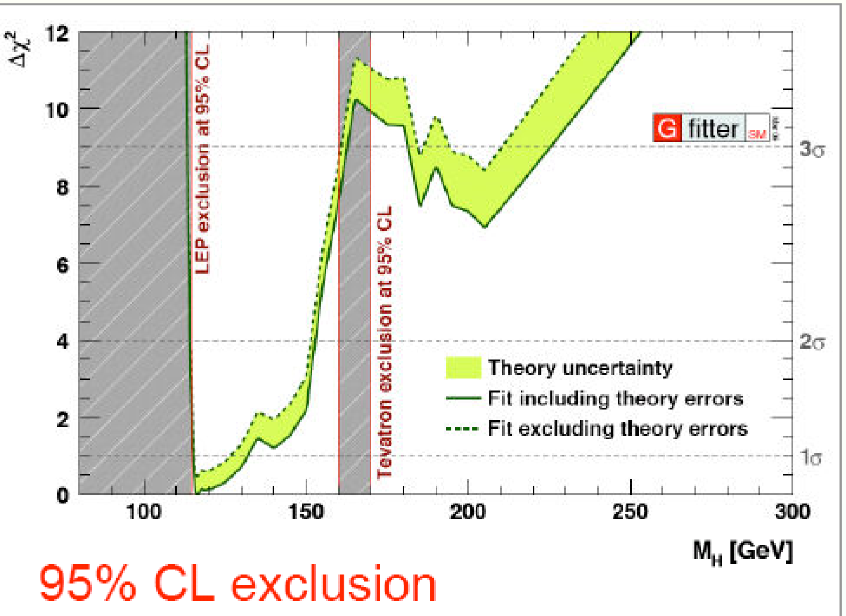
- **Gian Giudice**
  - **Higgs Physics**
  - **SUSY Higgs**
  - **SUSY**
  - **Dark Matter**

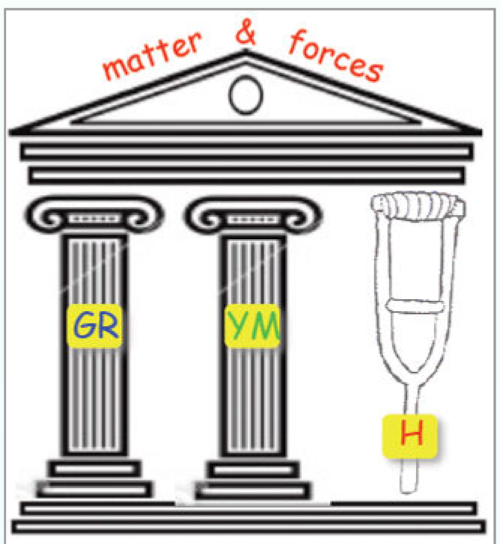
"Most likely, CLIC will give important additional information to the LHC results"

Gian Giudice

This is the minimal physics programme

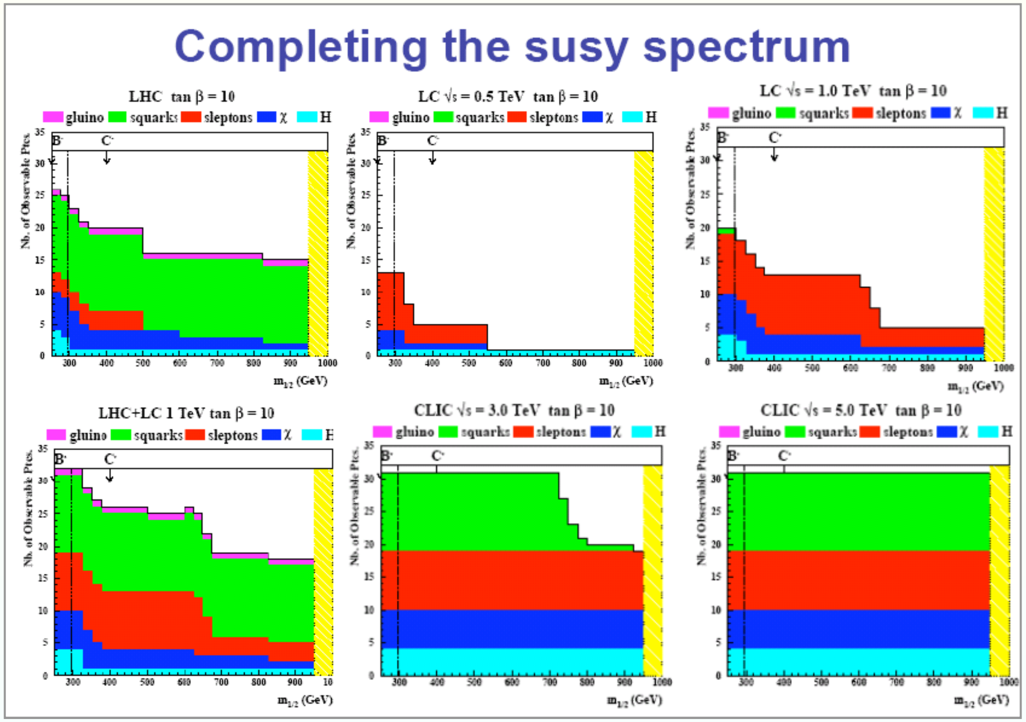
LHC Physics





- The LHC will soon
  - show the higgs landscape
    - single higgs or many higgs
      - but only "consistent with"
      - need to check <u>all</u> properties
        - » couplings
        - » spin-parity
  - reveal new symmetries
    - if any
      - if not ☹
    - if SUSY
      - is it simple?
      - or very complicated?
        - » if very complicated certainly need a LC

SUSY



- **Grand Unification?**
- **Dark matter**
- **…**

Gian's conclusions

Conclusions

- The LHC will determine the future of high-energy physics
- CLIC is one of the best options to complement and extend the LHC research programme
- Detailed investigation of the Higgs sector and discovery of new Higgs bosons
- Precise parameter determination (identification of the theory, tests of unification, reconstruction of DM density)
- Indirect probes up to 200-400 TeV

CLIC and ILC (& MC?)

- Whatever the discoveries at the LHC
  - We will need a future lepton collider
    - even more true if the LHC discovers little
      - but difficult to "sell" politically
- We do not yet know
  - the energy/luminosity required
  - the detector performance required
- We *do* know that we would like
  - the fastest track to the next machine
    - given budget and technical constraints
      - this is for operation >2020.

CLIC and ILC (& MC?) - 2

- ***When*** **we know the LHC results**
  - **we can discuss the next machine**
    - **it needs to be able to do the job**
      - **as soon as possible**
- **Until then**
  - **we must prepare alternatives**
- **and when we *know***
  - **be prepared to make decisions**
    - **about what we actually want to build**
- **In the meantime**
  - **work together on common issues**

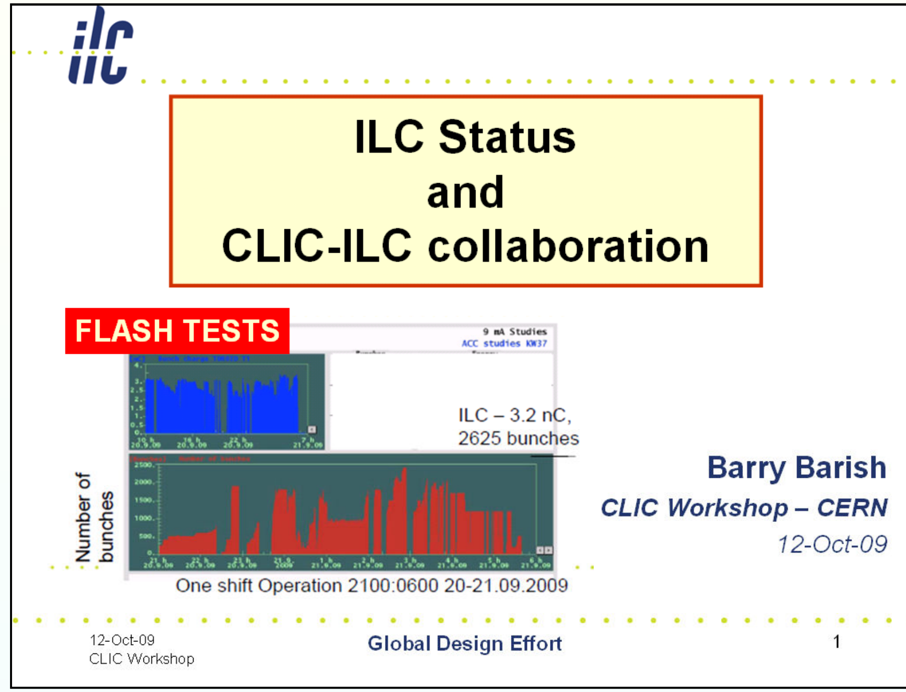
CLIC / ILC Joint Working Group on General Issues

- ILCSC has approved formation of a CLIC/ILC General Issues working group by the two parties with the following mandate:
  - Promoting the Linear Collider
  - Identifying synergies to enable the design concepts of ILC and CLIC to be prepared efficiently
  - Discussing detailed plans for the ILC and CLIC efforts, in order to identify common issues regarding siting, technical issues and project planning.
  - Discussing issues that will be part of each project implementation plan
  - Identifying points of comparison between the two approaches .
- The conclusions of the working group will be reported to the ILCSC and CLIC Collaboration Board with a goal to producing a joint document.

Barish

Interconnections

- **JPD to ILC Workshop**
- **BB to CLIC workshop**



CLIC-ILC Collaboration meeting #2

Friday 12 June 2009
from 08:15 to 16:00
Europe/Zurich
at CERN (354-1-001)
chaired by: *Jean-Pierre Delahaye (CERN)*, *Barry Barish (CalTech)*

CLIC Parameters

Center-of-mass energy	CLIC 500 GeV		CLIC 3 TeV	
Beam parameters	Relaxed	Nominal	Relaxed	Nominal
Accelerating structure	502		G	
Total (Peak 1%) luminosity	$8.8(5.8)\cdot10^{33}$	$2.3(1.4)\cdot10^{34}$	$7.3(3.5)\cdot10^{33}$	$5.9(2.0)\cdot10^{34}$
Repetition rate (Hz)	50			
Loaded accel. gradient MV/m	80		100	
Main linac RF frequency GHz	12			
Bunch charge 10^9	6.8		3.72	
Bunch separation (ns)	0.5			
Beam pulse duration (ns)	177		156	
Beam power/beam MWatts	4.9		14	
Hor./vert. norm. emitt ($10^{-6}/10^{-9}$)	7.5/40	4.8/25	7.5/40	0.66/20
Hor/Vert FF focusing (mm)	4/0.4	4 / 0.1	4/0.4	4 / 0.1
Hor./vert. IP beam size (nm)	248 / 5.7	202 / 2.3	101/3.3	40 / 1
Hadronic events/crossing at IP	0.07	0.19	0.28	2.7
Coherent pairs at IP	10	100	2.5 10^7	3.8 10^8
BDS length (km)	1.87		2.75	
Total site length km	13.0		48.3	
Wall plug to beam transfert eff	7.5%		6.8%	
Total power consumption MW	129.4		415	

Delahaye

10 CLIC Feasibility Issues

Delahaye

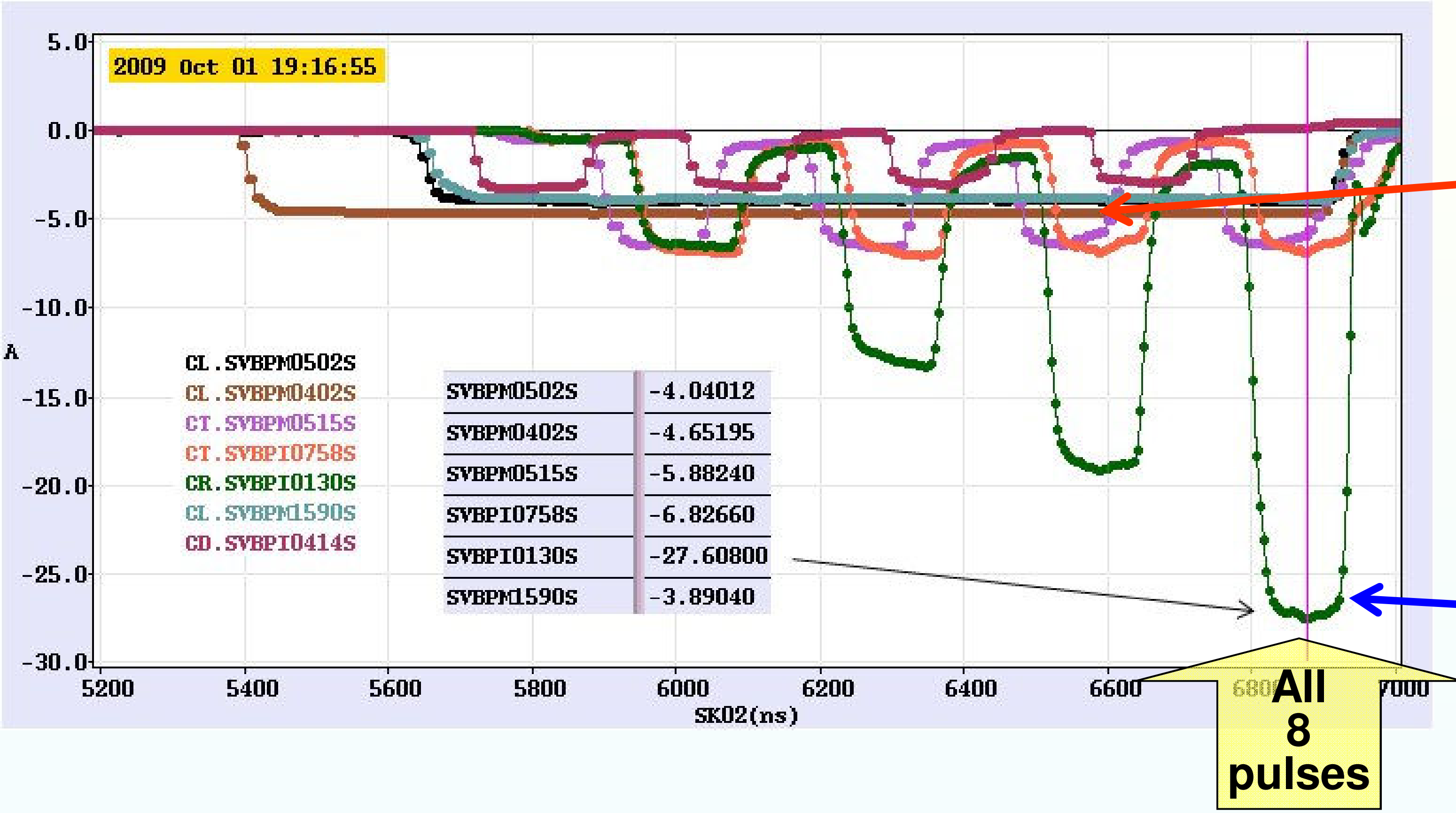
- **Two Beam Acceleration:**
  - Drive beam generation
  - Beam Driven RF power generation
  - Two Beam Module
- **RF Structures:**
  - Accelerating Structures (CAS)
  - Power Production Structures (PETS)
- **Ultra low beam emittance and beam sizes**
  - Emittance preservation during generation, acceleration and focusing
  - Alignment and stabilisation
- **Detector**
  - Adaptation to short interval between bunches
  - Adaptation to large background at high beam collision energy
- **Operation and Machine Protection System (MPS)**

A year of progress

- **Physics and Detectors**
  - Marco Battaglia & Hitoshi Yamamoto
- **Injectors and Damping Rings**
  - Alessandra Variola, Jim Clarke, Louis Rinolfi, Susanna Guiducci, Mark Palmer & Yannis Papaphilippou
- **Beam Physics/Low emittance transport**
  - Caterina Biscari, Kiyoshi Kubo, Bernard Jeanneret, Deepa Angal-Kalinin, Rogelio Tomas, Andrei Seryi, Roberto Corsini & Toshiyuki Okugi
- **RF structures and sources**
  - Walter Wuensch & Chris Adolphsen
- **Technical Systems**
  - Grahame Blair & Hermann Schmickler

Combiner Ring Performance

Tecker

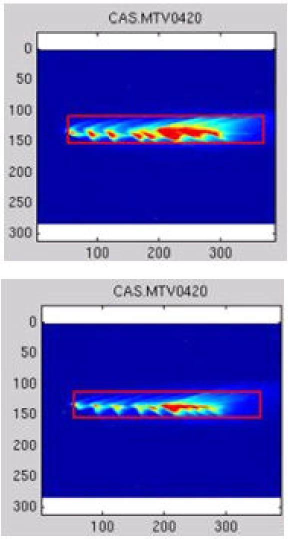


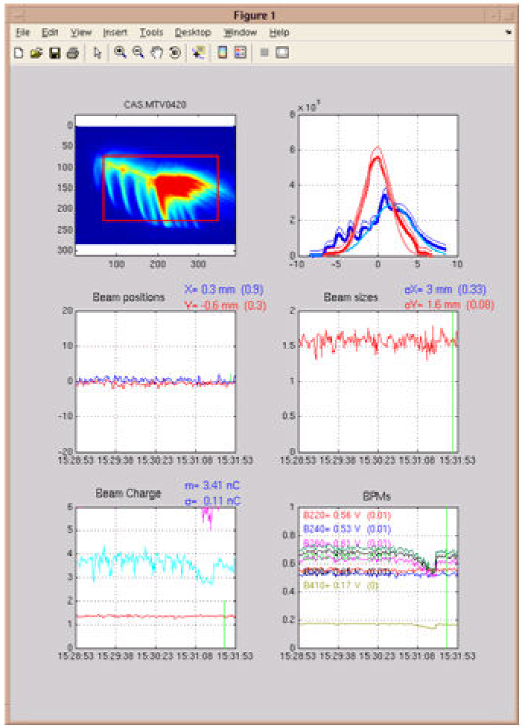
Extracts from an Email from Gunter and Roberto, 5/10 @ 9:25

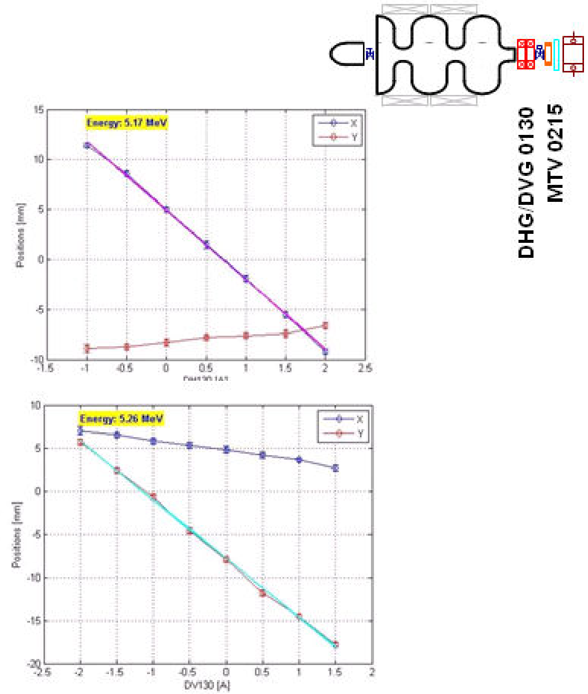
beam re-combination of a factor 2 in the Delay Loop four 140 ns pulses of about 6.5 A beam current.
in the Combiner Ring an additional factor four, yielding a 140 ns pulse with a peak current of about 27 A.
This is the first experimental demonstration of the nominal 2 x 4 re-combination scheme of CTF3**,**
and represents another important milestone towards the CLIC feasibility demonstration.

CALIFES progress

Energy and energy spread





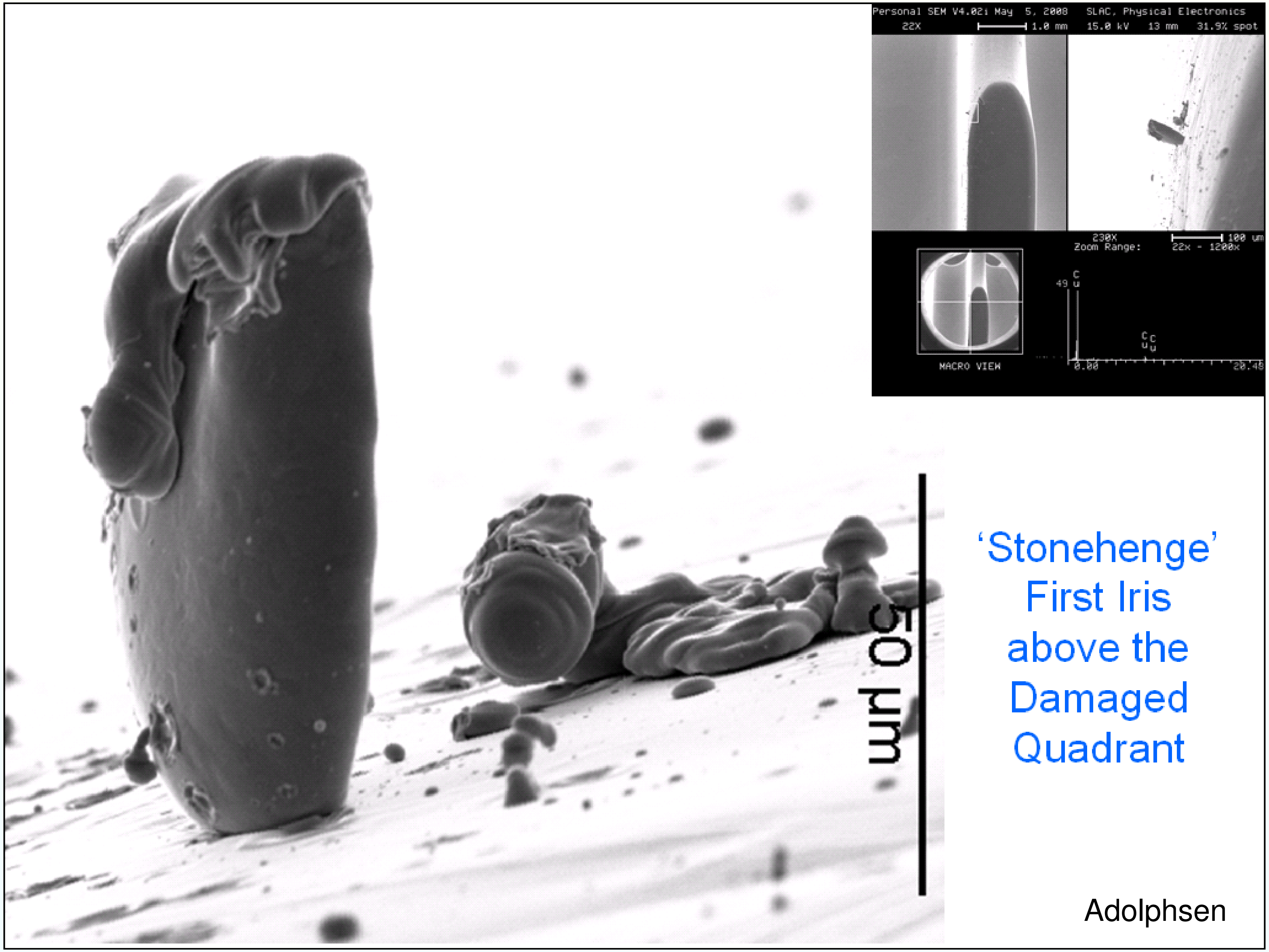


- Max. energy reached 143 MeV at the end of the line.
- Pulse to pulse energy drift (beam loading or amplitude/phase shift during pulse train

- At gun output, using corrector DV/DH 130 : about 5.2 MeV.
- Hor. and Vert. coupling due to gun solenoids fringe field

13th october 2009 Califes CTF3 probe beam - Wilfrid Farabolini 13

Surface damage

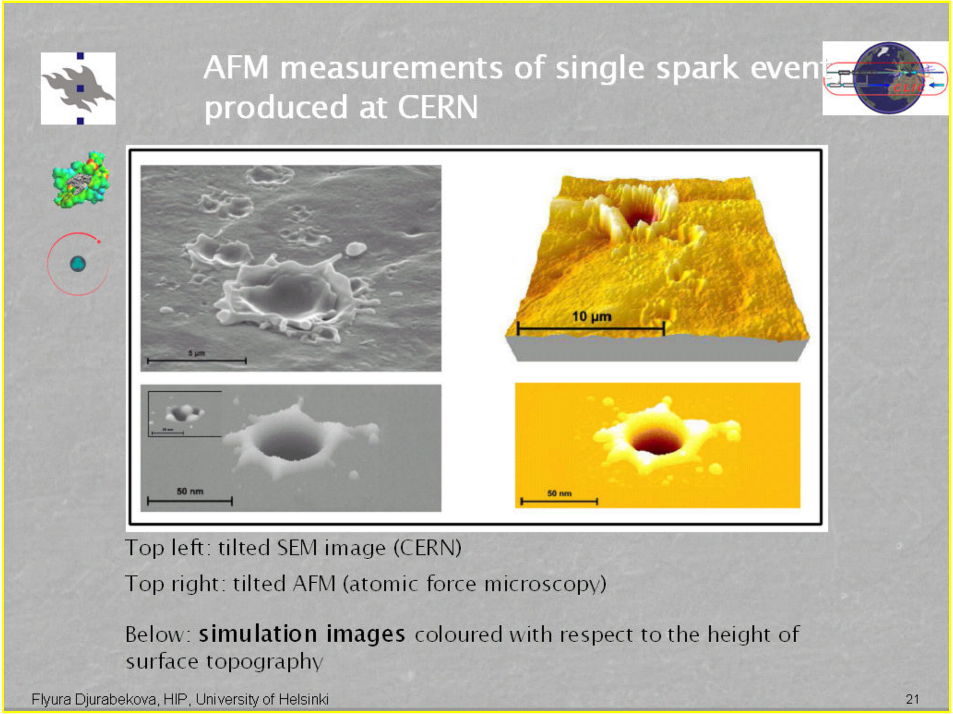


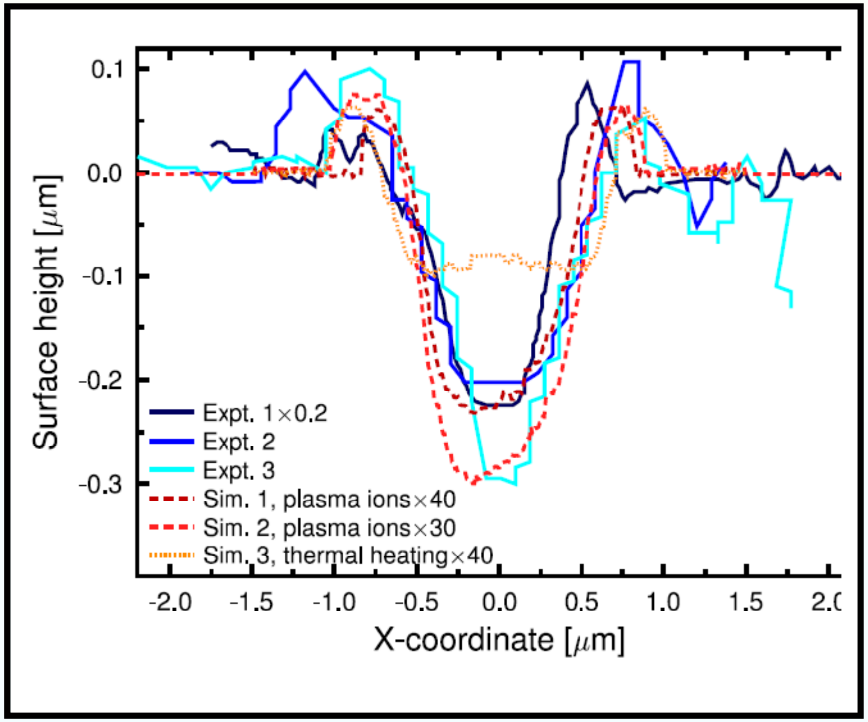
Increasing understanding

- **In solving technical problems**

  …it is important to ***understand*** the solution

  …which means ***understanding*** the problem





Djurabekova

… and from the other side …

CERN

Understanding breakdown

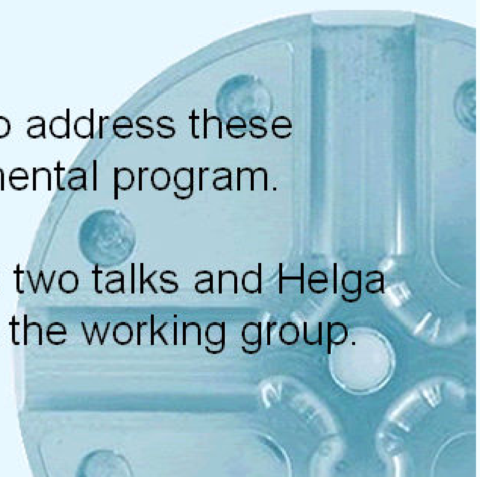
Specifically we would like to understand how the performance depends on geometry and material - gradient for the accelerating structure and power for the PETS and the rf system.

Example: Small structure apertures are good for gradient but bad for beam dynamics. Finding optimum requires knowing scaling of gradient.

We know that there are different regimes where performance can be limited by electric field, real power flow, complex power flow, pulsed surface heating and dark current capture.

A number of simulation studies have been launched to address these questions along with a supporting specialized experimental program.

Flyura Djurabekova will present breakdown physics in two talks and Helga Timko, Jan Kovermann and Jim Norem will present in the working group.



12 October 2009 W. Wuensch

Wuensch

Issue 1: One or two detectors?

- **Assumption**
  - 2 detectors, 1 beam delivery system
    - Push-pull with fast changeover

- **I believe that this is correct**

  but

- **we need the correct arguments**

  and to follow the consequences

One or two detectors?

- **I can think of 5 good arguments**
  - **for 2 detectors**

1. **Sociological argument**
   - **Too many physicists for 1 detector**
2. **Moral argument**
   - **Two detectors keep us honest**
3. **Risk argument**
   - **If one breaks, we have another**

May not work politically

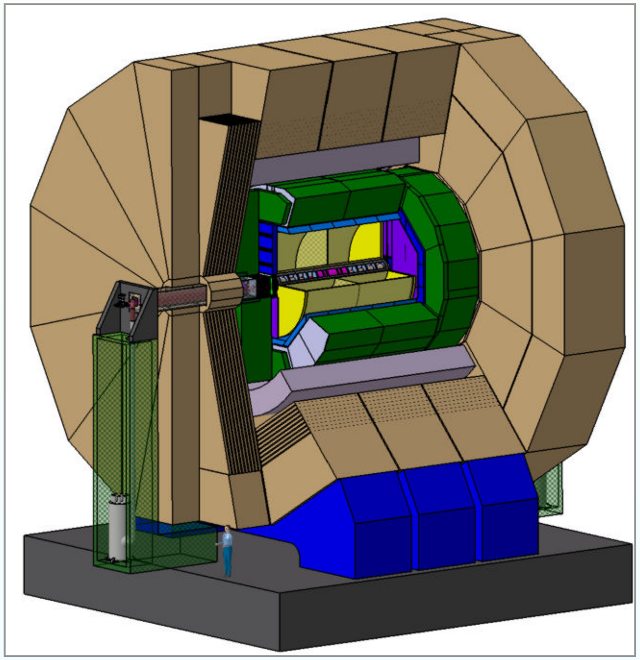
4. **Systematic error argument**
   - **2 detectors with different systematic errors** **when combined give much reduced systematic error**
5. **Statistics argument**
   - **Low statistics regions of phase space** **need 2 detectors to separate signal from noise**

OK with identical detectors

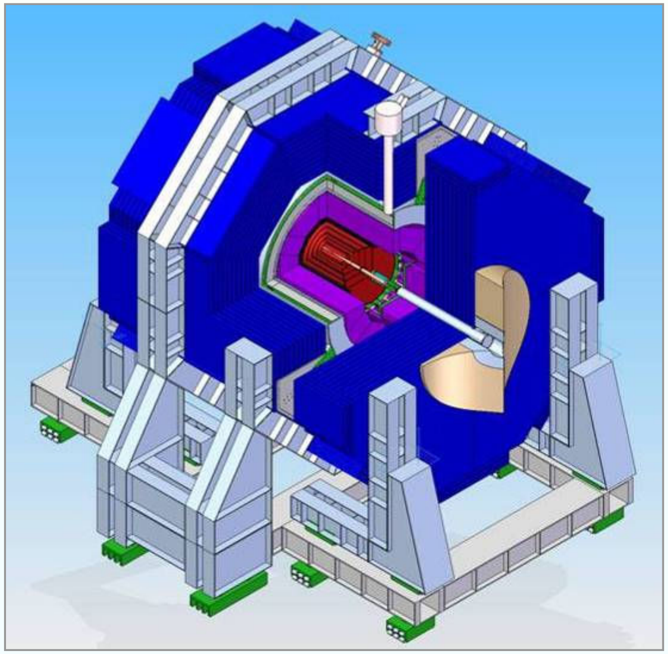
One or two detectors?

4. **Systematic error argument**
   – **2 detectors with different systematic errors**
   when combined give much reduced systematic error

- **Needs 2 (very) different detectors!**



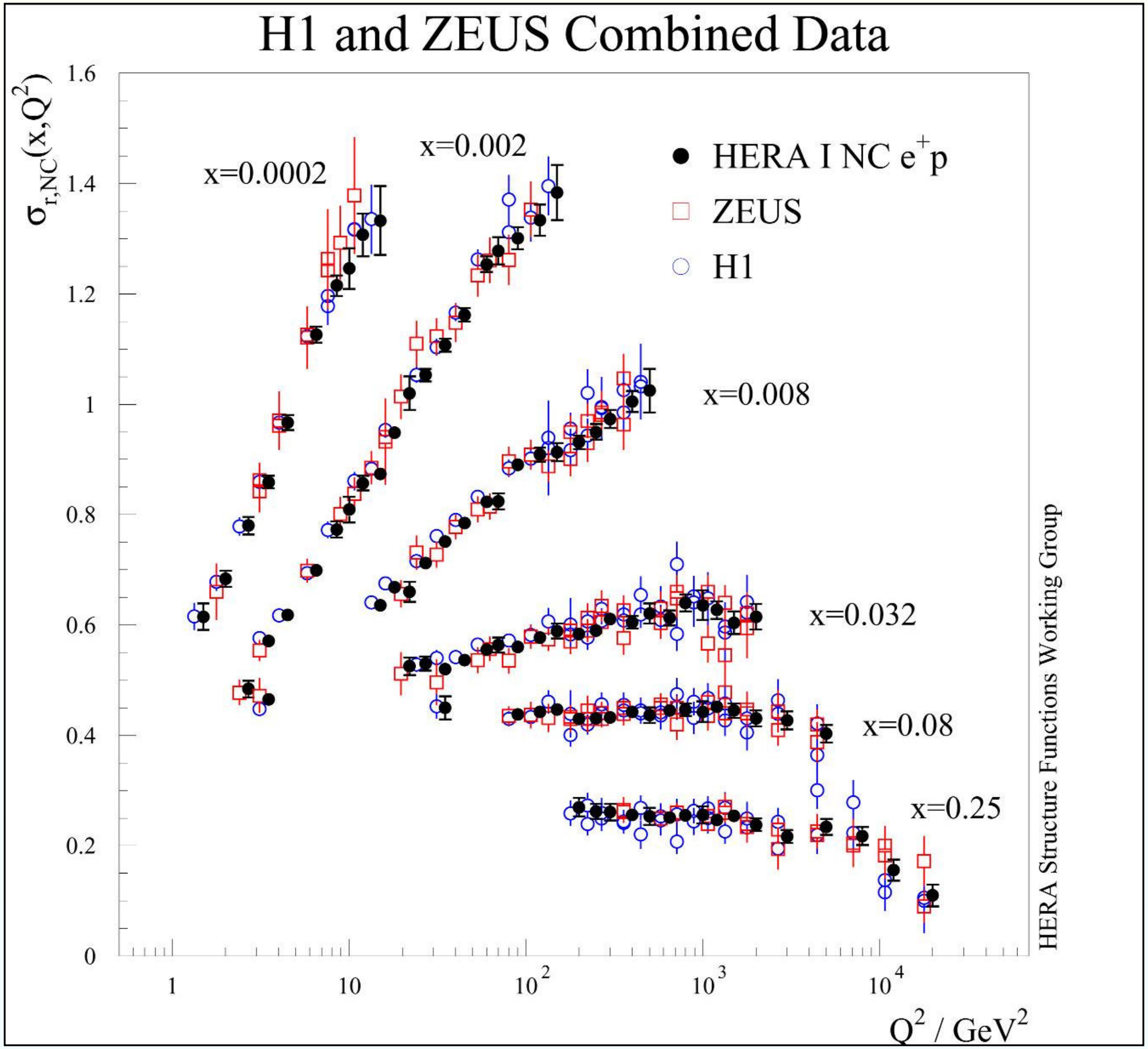
Vertex
Tracker
ECAL
HCAL
Muons



ILD **SiD**

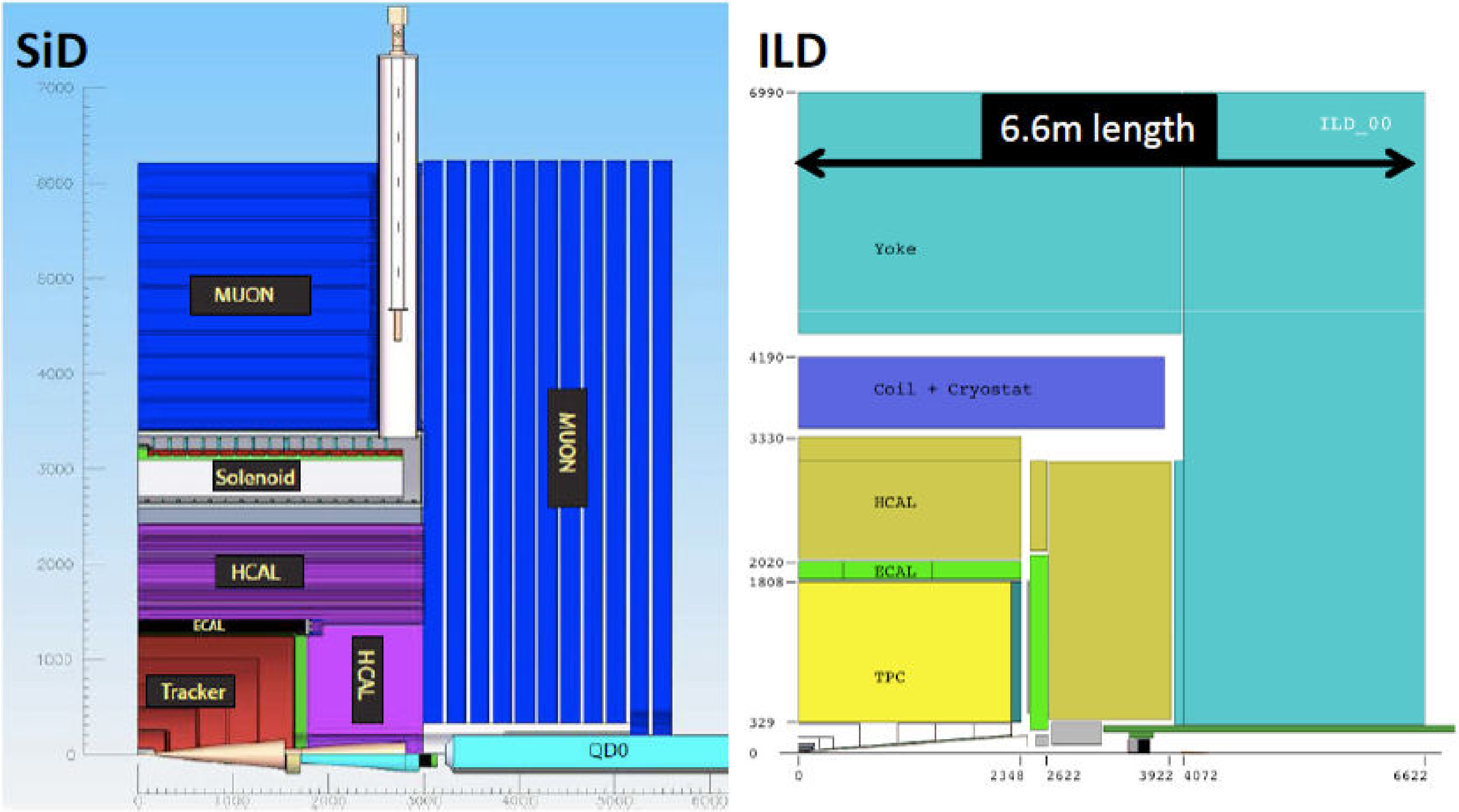
Thomson

In practice



Foster

Transverse quadrants to same scale

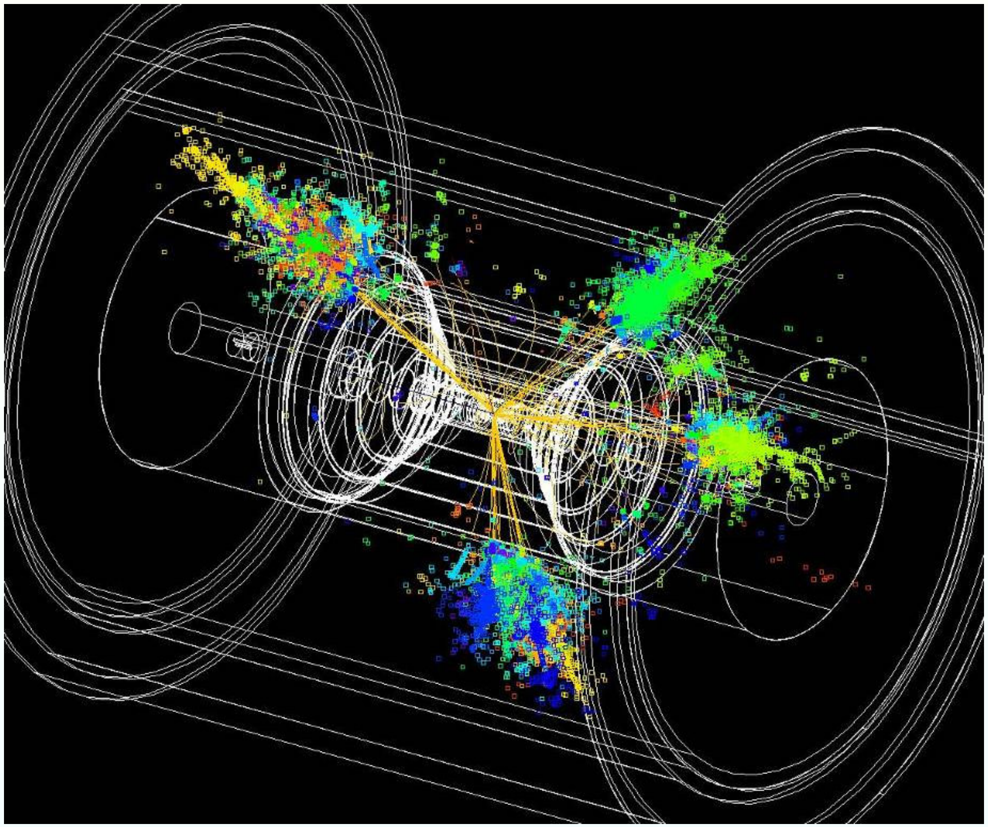


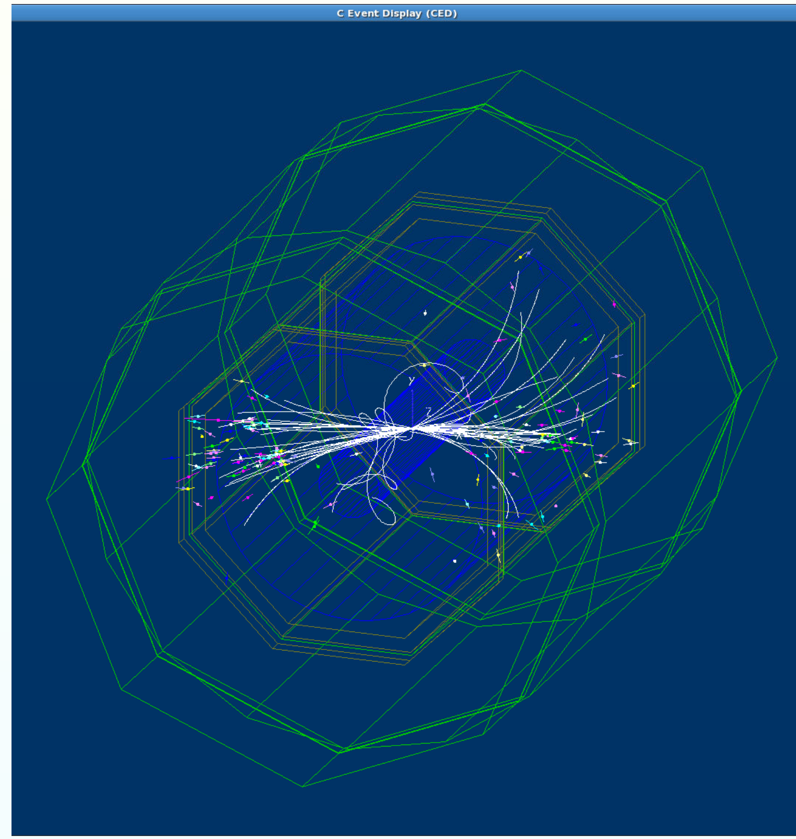
Linssen (Sailer, Gatignon)

SiD & ILC scaled to CLIC

CLIC_SiD detector

CLIC_ILD detector

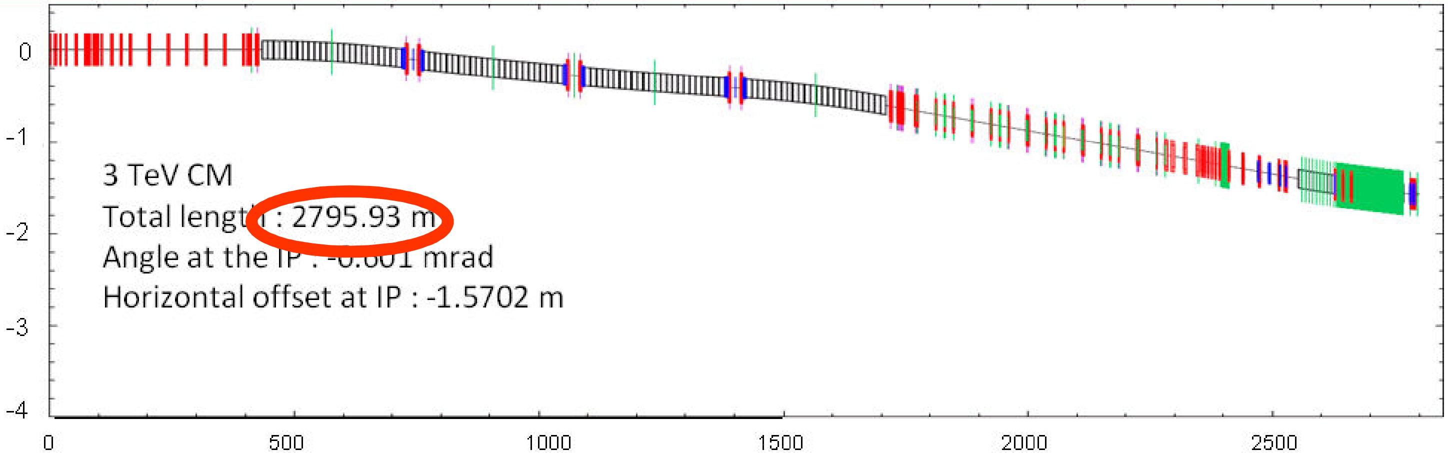




Linssen

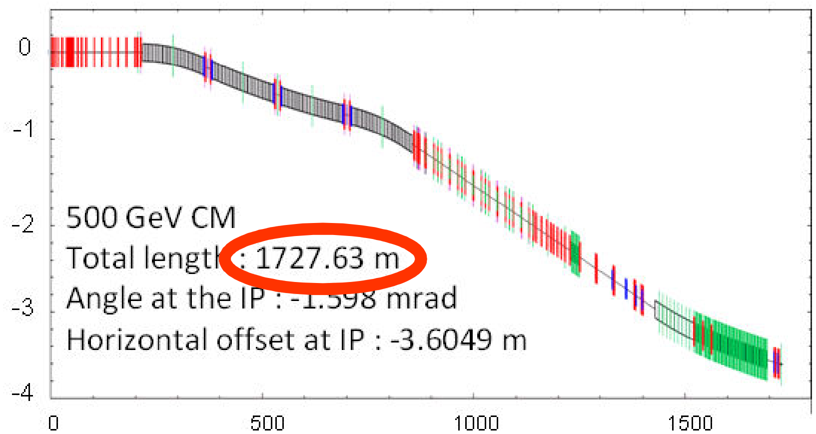
Issue 2: Optimised for what energy?

Layout for 500 GeV and 3 TeV CM designs



- Keep the locations of IP, post collision lines and main beam dumps the same.
- Need to optimise the design considering the upgrade scenario.

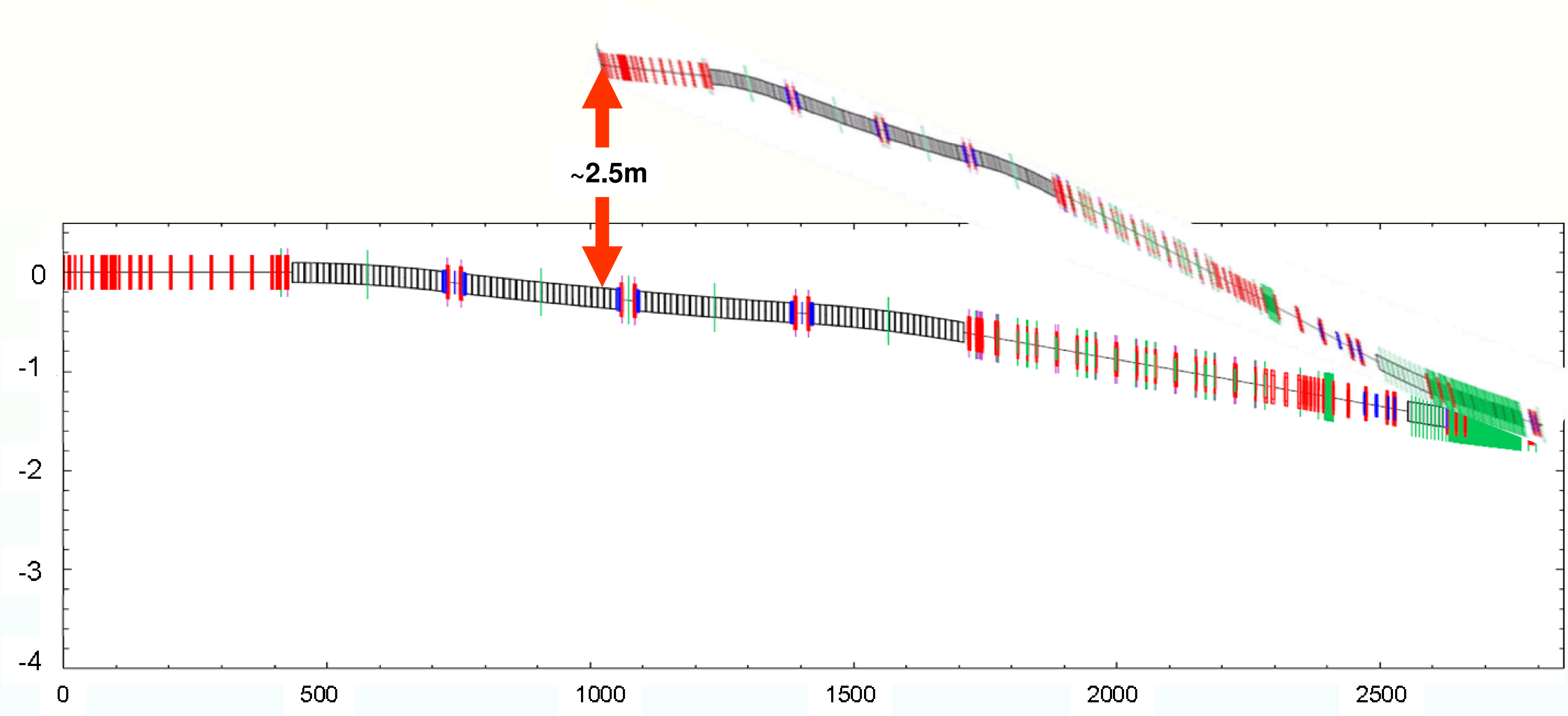
'From 500 GeV to 3 TeV', D. Angal-Kalinin, WG3, Wednesday



CLIC09, 12th-16th October09, CERN 7

Angal-Kalinin

0.5 TeV & 3 TeV



- **Switching from 0.5-1 TeV to 2-3 TeV**

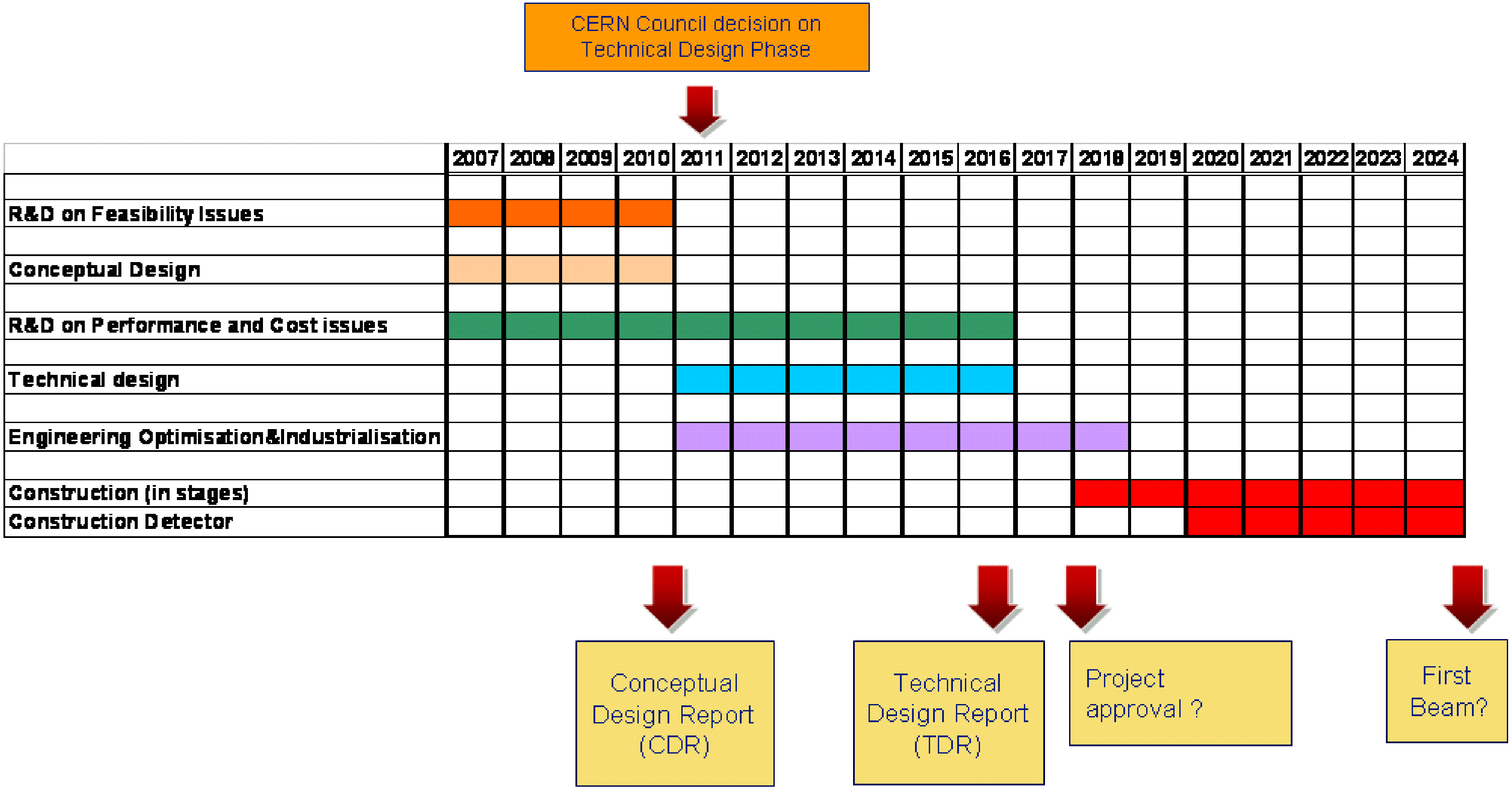
  ? 1 year ?

After Angal-Kalinin

CDR & Future programme

Tentative long-term CLIC scenario

Shortest, Success Oriented, Technically Limited Schedule



Delahaye, Corsini

Next year?

Linear Collider Workshop

CERN

September 20-24 2010

I
CLIC
C

Summary of a Summary

1. An excellent workshop
2. Good technical progress
3. Clear short and medium term goals

but

- need the LHC to show the way
  - Energy range!!!

and we need

the technology to meet the challenge

We were born to succeed,
not to fail

Henry Thoreau (1817-1862)

We will either find a way,
or make one

Hannibal (248-183 BC)

inveniemus viam aut faciemus

Backup slides

Final Remarks

- The central frontier of particle physics is and will continue to be the energy frontier!
- The LHC will open a new era at that frontier and its discoveries will motivate the next machine --- a lepton collider.
- That machine could be the ILC or CLIC (or maybe a muon collider). Science must dictate the choice of machines, informed by the realities of technical performance, readiness, risk and cost for each option
- It is our jobs (ILC and CLIC design teams) to make sure our R&D and design work will enable the best informed decision for our field.

12-Oct-09
CLIC Workshop

Global Design Effort

33

Barish