Spanish Network on Future Linear Accelerators

Granada, Mayo 16 2011

A. Ruiz (IFCA)

Outline

- ***Report of ALCPG11(Oregón, 19-23 March, 2011)***
  - ✓ ***Linear Collider status***
  - ✓ ***Future***
- ***Spanish Network (following talks)***
  - ✓ ***Activities and Projects (ILC, CLIC, Belle-II, SLHC…)***

AIDA Project→ Iván Vila
DEPFET for ILC → L. Andricek
Accelerator & detector activities in Spain → L.García-Tabarés, C. Lacasta, M.C.Fouz, S.Grinstein, A. Oyanguren, I. Vila, D.Esperante, G. Timón, J. Trenado, E. Vilella, M. Lozano, S. Hidalgo, M.C. Esteban
Physics phenomenology→ J.A. Aguilar-Saavedra, S. Heinemeyer, J.I.Illana, M.Vos
SiLC reorganization general discussion→All
LCWS11 (Granada, September 26-30)

New web page of the network: http://ilces.ific.uv.es

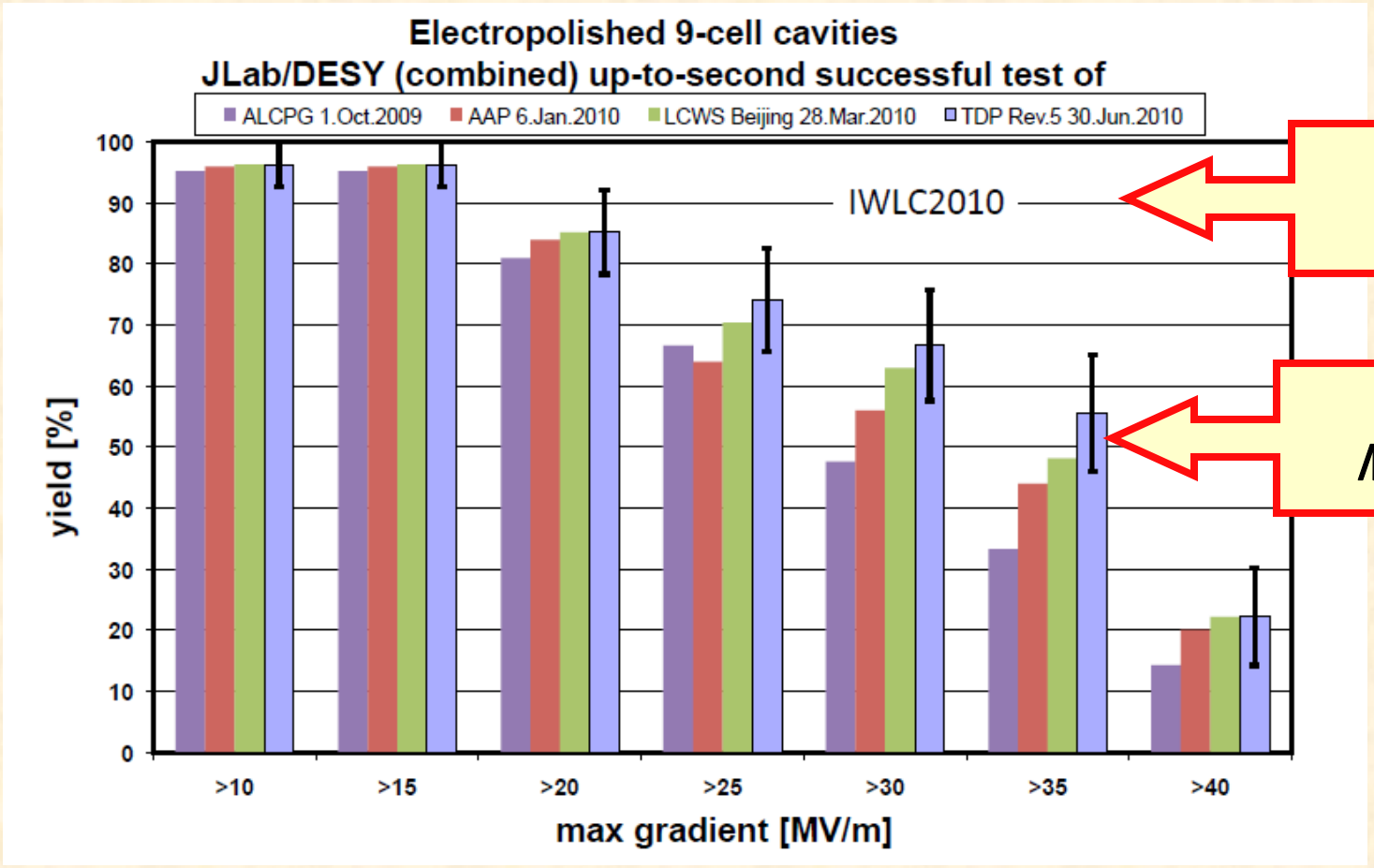
Global Plan for SRF R&D at ILC

Year	07	2008	2009	2010	2011	2012
Phase	TDP-1			TDP-2		
Cavity Gradient in v. test to reach 35 MV/m	→ Yield 50%			→ Yield 90%		
Cavity-string to reach 31.5 MV/m, with one-cryomodule		Global effort for string assembly and test (DESY, FNAL, INFN, KEK)				
System Test with beam acceleration		FLASH (DESY) , NML (FNAL) STF2 (KEK, test start in 2013)				
Preparation for Industrialization			Production Technology R&D			

Figure 1.2-1: A TESLA nine-cell 1.3 GHz superconducting niobium cavity.

- ~ 70 parts electron-beam welded at high vacuum
  - mostly stamped 3mm thick sheet metal
- pure niobium and niobium/titanium alloy
  - niobium cost similar to silver
- weight ~ 35 kg (less than 10% cryomodule mass)
- 6 flanges

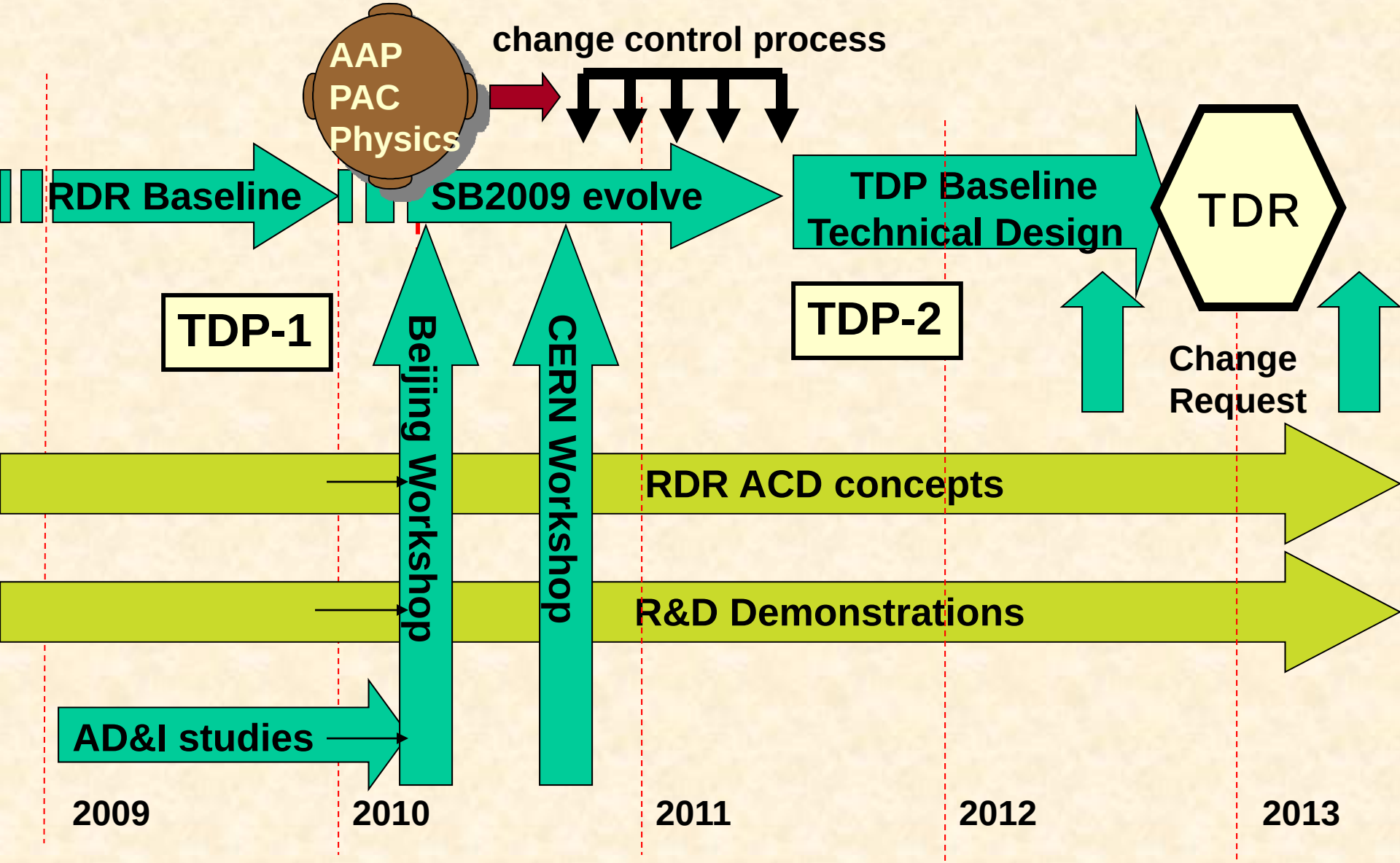
Cavity Gradient Milestone Achieved



TDR Goal

2010 Milestone

Technical Design Phase and Beyond



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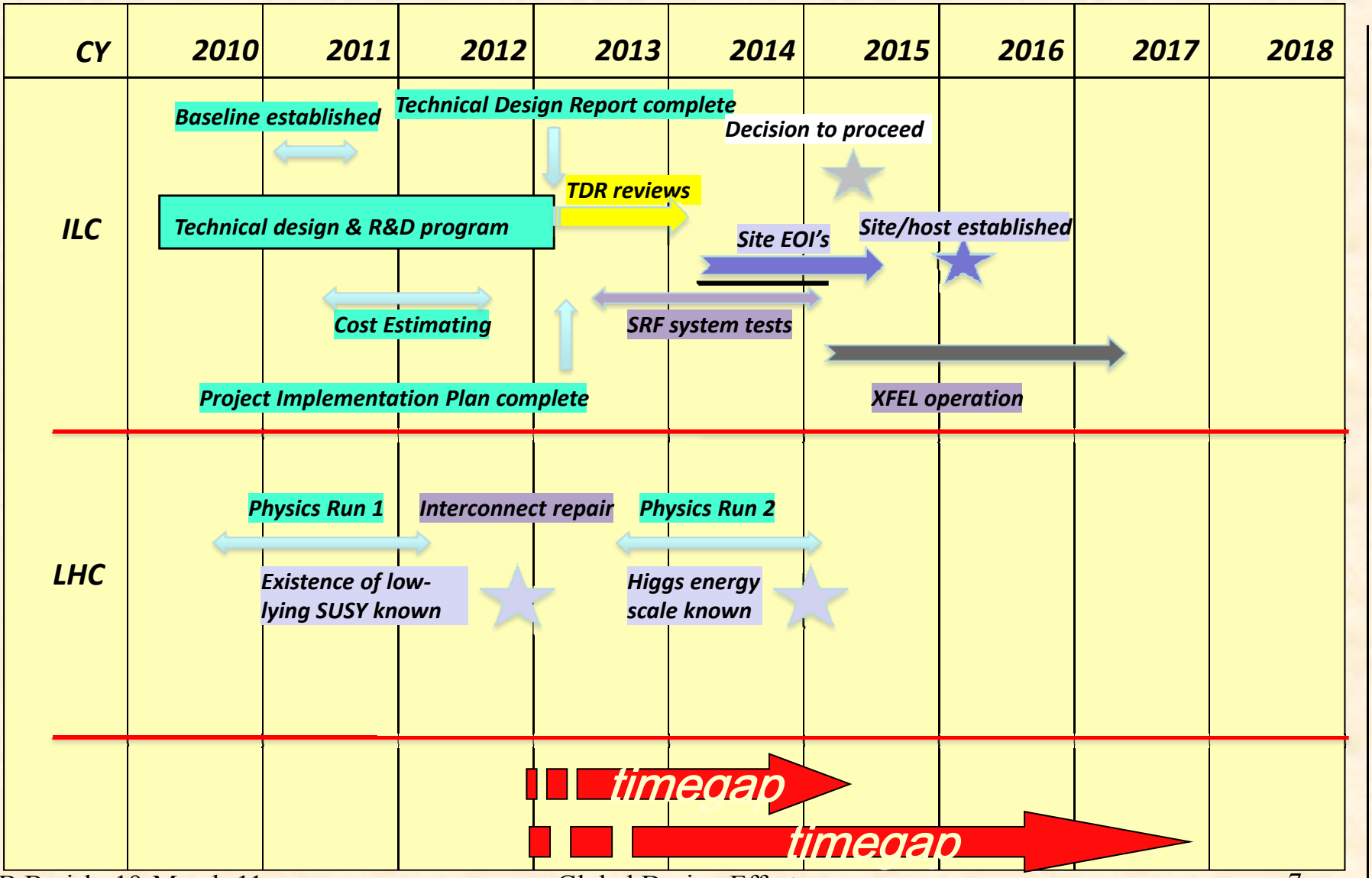
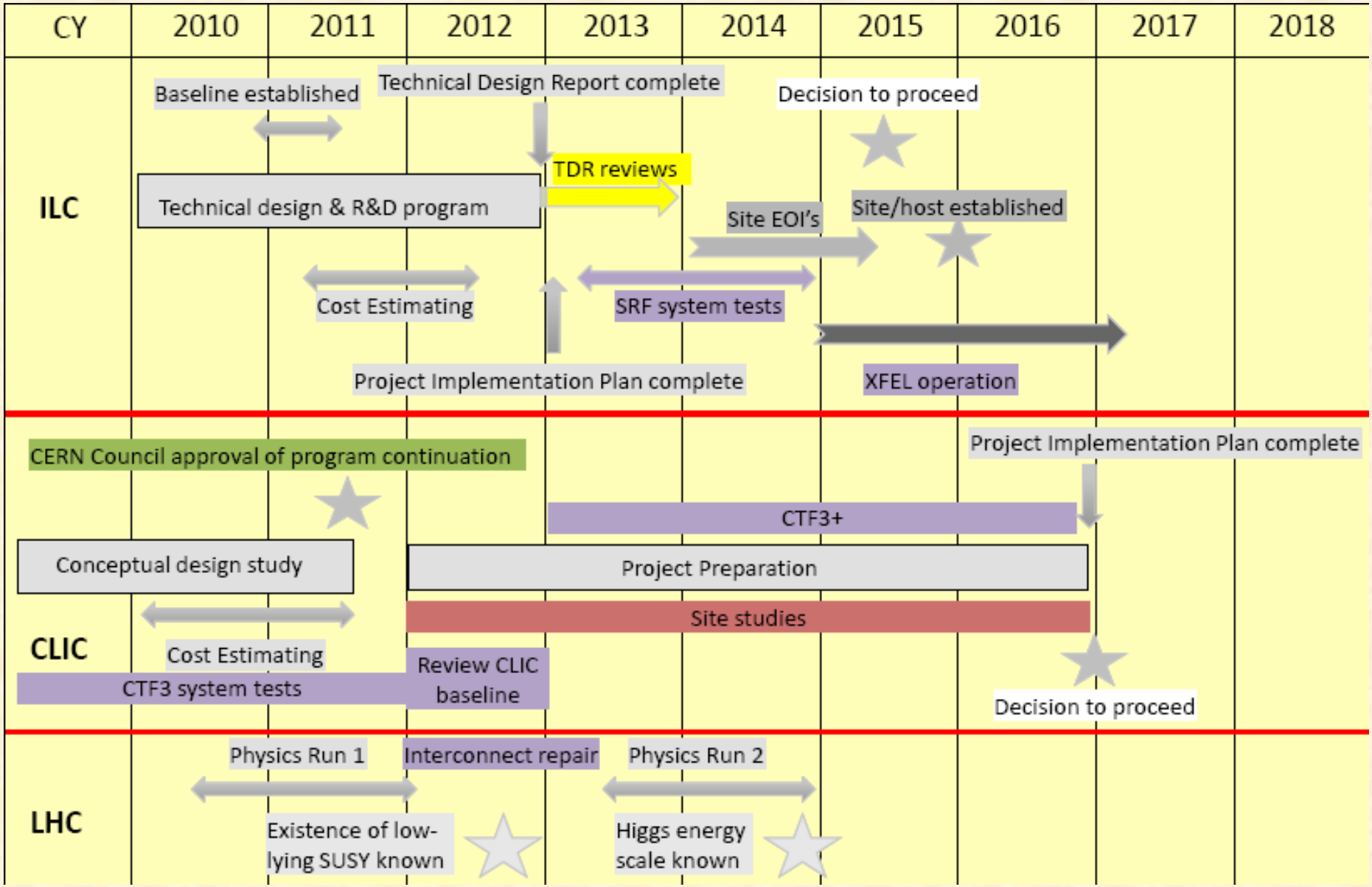
ILC possible timeline





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Design Challenges

Physics

- **Unambiguous identification of multi-jet decays of Z's, W's, top, H's, χ's,**

  $$ZHH$$

- **Higgs recoil mass and Susy decay endpoint measurements**

  $$ZH \to \ell^+\ell^- X$$

- **Full flavor identification and quark charge determination for heavy quarks**

  $$ZH, H \to c\bar{c}, b\bar{b}, \ldots$$

- **Full hermiticity to identify and measure missing energy and eliminate SM backgrounds to SUSY**

  $\tilde{\mu}$ decay

- **The unexpected**

Detector

- **Demands unprecedented jet energy resolution**

  $$\sigma_{E_{jet}} / E_{jet} = 3\%$$

- **Pushes tracker momentum resolution**

  $$\sigma(1/p_T) = 5 \times 10^{-5}\ (GeV^{-1})$$

- **Demands superb impact parameter resolution**

  $$\sigma_{r\phi} \approx \sigma_{rz} \approx 5 \oplus 10/(p \sin^{3/2}\vartheta)$$

- **Instrumented forward region**

  $$\Omega = 4\pi$$

- **Smarts**

Towards DBD

Simulation baseline: To react to new benchmark scenarios at 1 TeV
Will be used for mass simulation and reconstruction

Scenarios: $e^+e^- \to \nu\bar{\nu}h^0$

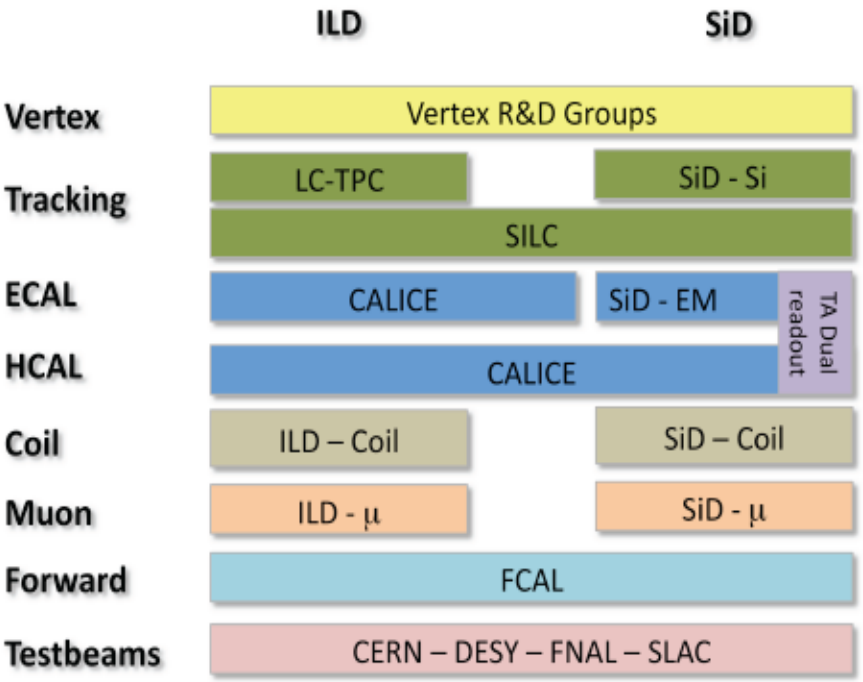
$e^+e^- \to W^+W^-$

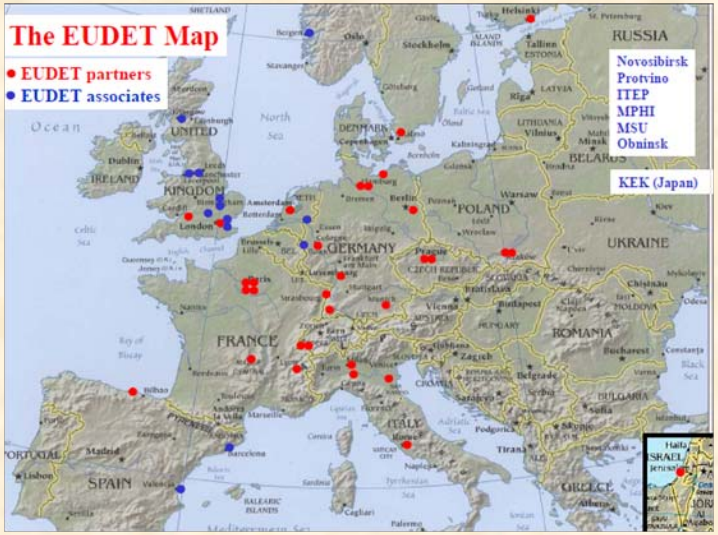
$e^+e^- \to t\bar{t}h^0$

Technology baseline: Propose sub-detector technologies options which (in principle could) be used for detector construction
Rely on input from R&D collaborations
No technology decision in DBD
Alternative technologies will be considered, too
Detailed simulation of physics processes?

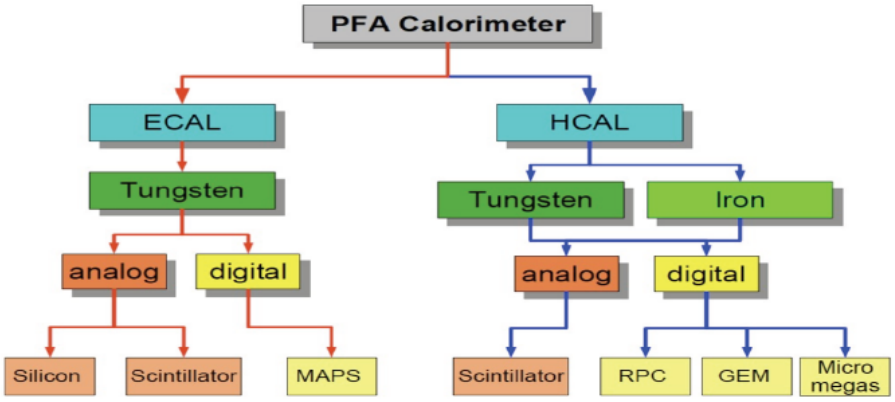
Timeline: Next iteration at ILD group meeting at KEK
Baseline by LCWS 2011 @ Granada

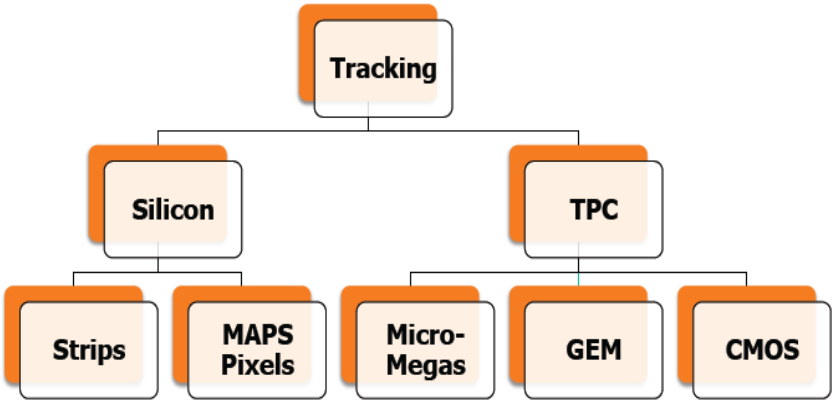
Detectors



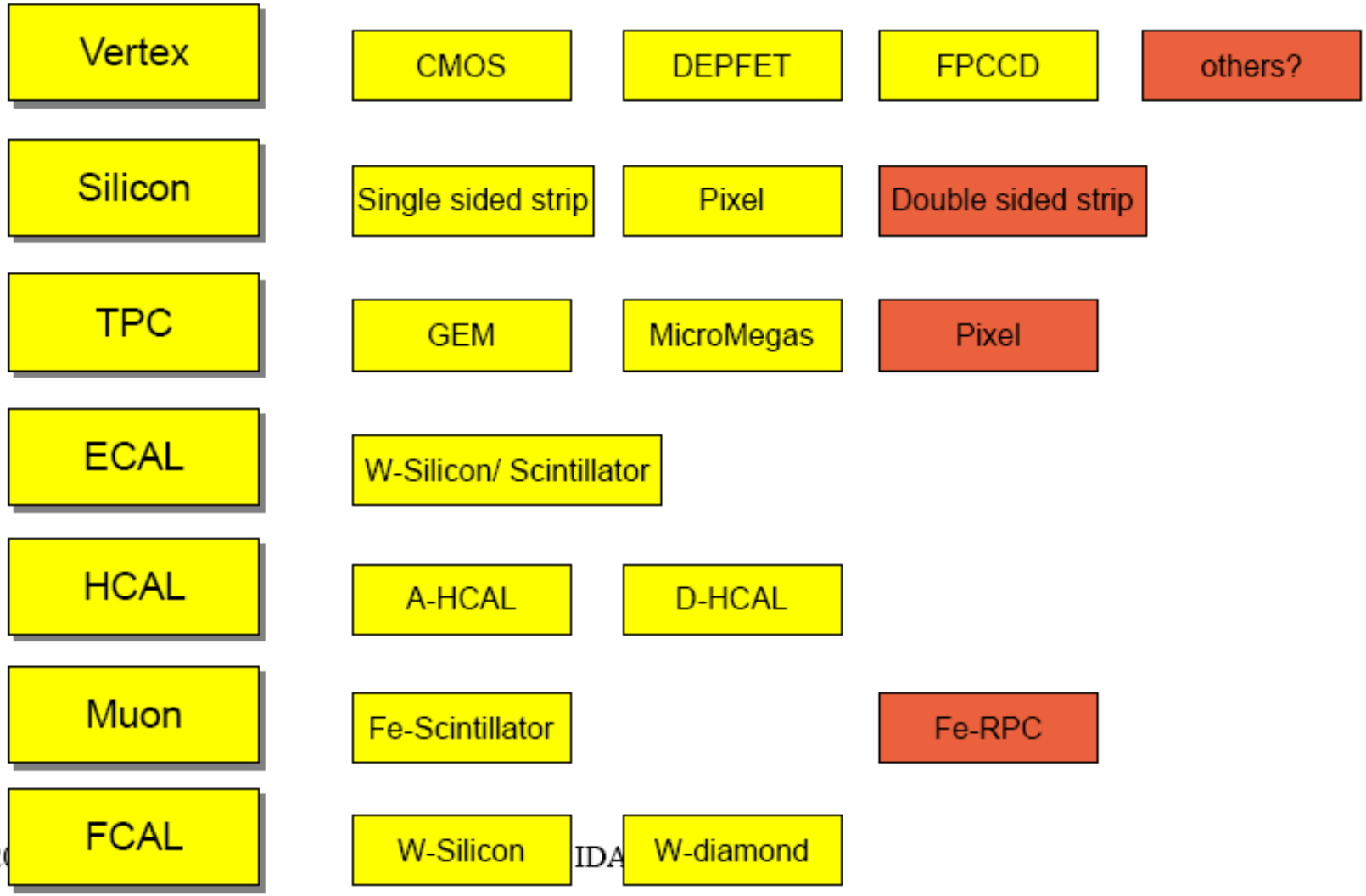


Big advances through collaborative projects
As e.g. EUDET → AIDA, …





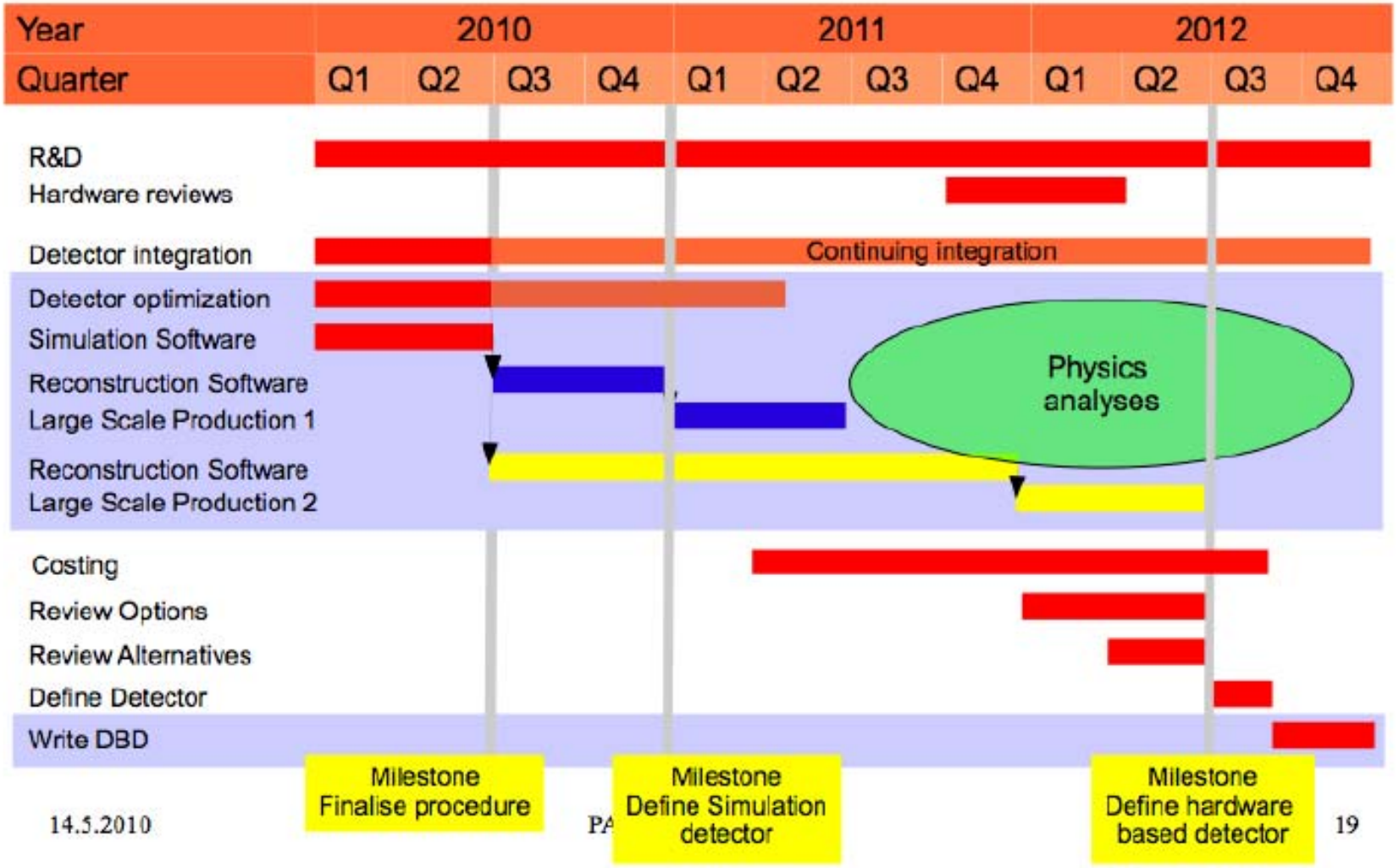
ILD: baseline detector
The anticipated picture



Plans subdetectors

Vertex	Full scale ladder prototype (mechanics) including cooling concept, several chip technologies (FPCCD, DEPFET, MAPS)	PLUME project
Silicon	Single sided Silicon sensor tested edgeless sensors tested Readout chip prototyped	SiLC
TPC	GEM, muMegas readout tested with multi-module in LP, pixel readout demonstrated under realistic conditions Model for advanced end plate demonstrated	LCTPC
ECAL	Extensive test beam data, demonstrate system integration, second generation prototype	CALICE
AHCAL	Extensive test beam results, second generation readout designed and tested, second generation prototype demonstrated	CALICE
DHCAL	Extensive test beam results, feasibility established, readout concept established, second generation prototype demonstrated	CALICE
Muon	Extensive Simulation and optimization, Scintillator readout with SiPM established and prototyped, mechanical design established	
FCAL	Sensor tests and readout chain done, system established	FCAL

Main Milestones



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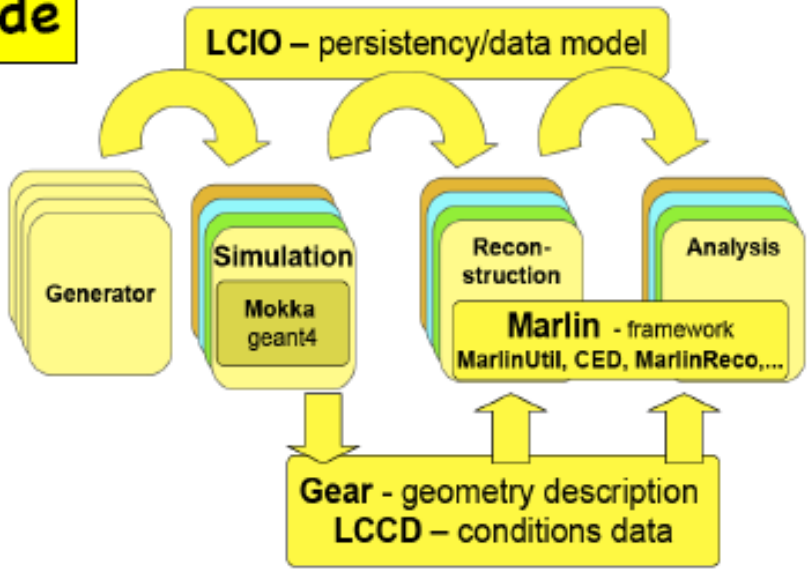
ILD Core Software Tools

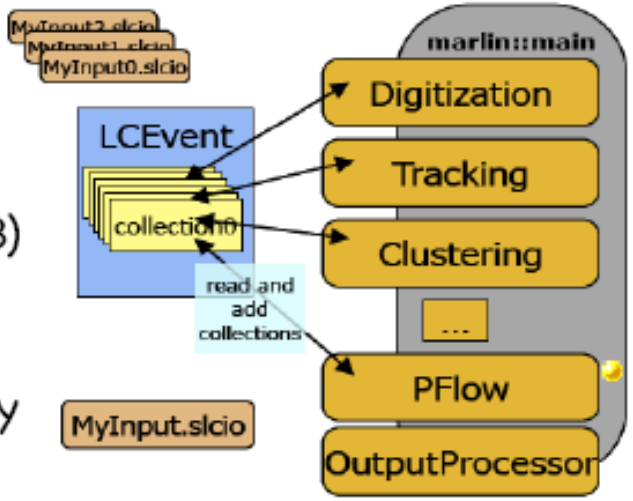
http://ilcsoft.desy.de

- **Mokka** (LLR)
  - geant4 simulation application
- **LCIO** (DESY/SLAC)
  - international standard for persistency format / event data model
- **Marlin**
  - core application framework for reconstruction & data analysis
- **GEAR** geometry package f. reconstruction
- **LCCD**
  - conditions
  - data toolkit (DB)
- **CED**
  - 3d event display



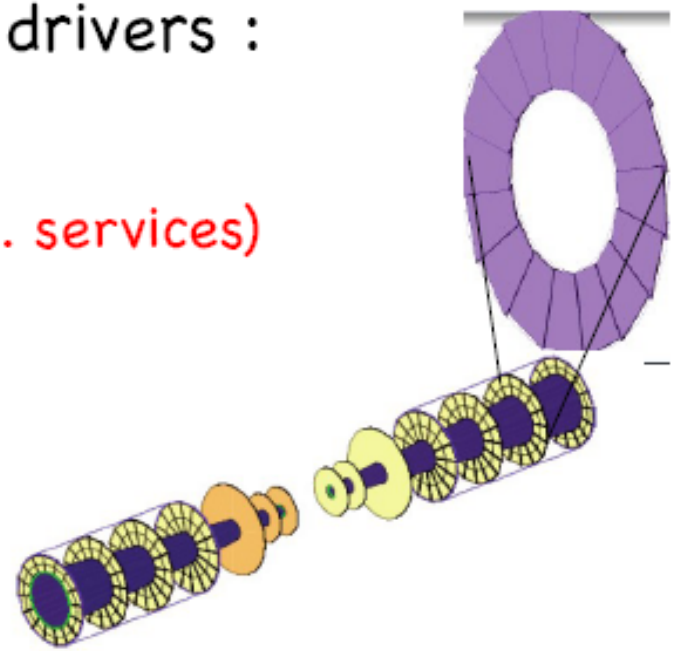
- complete framework used in Monte Carlo & 'real experiments':
  - **ILD detector concept** studies
  - **Calice** calo testbeam
  - **LC-TPC** testbeam
  - EUDET - **Pixel Telescope**

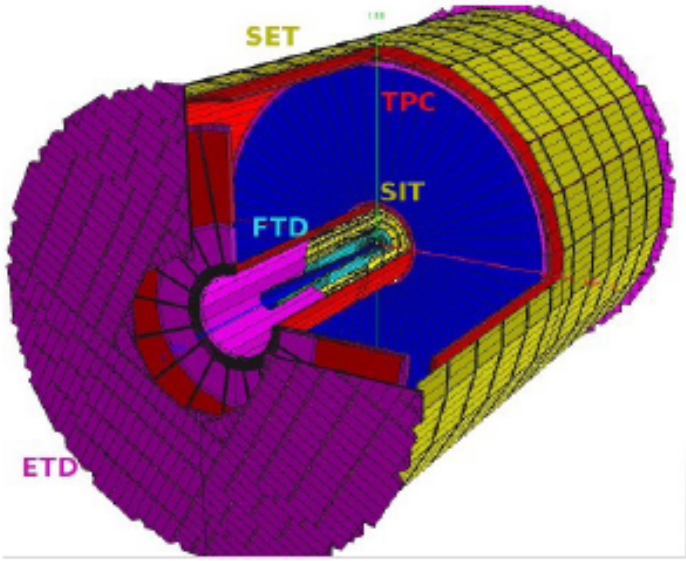
synergies between testbeam and global detector optimization



new Mokka release - ILD_01_pre01

- major rewrite of some sub detector drivers :
  - SIT, SET, ETD - FTD - Muon
  - increased level of detail and realism (incl. services)
- TPC
  - added endcap services (cooling)
- new ECal driver:
  - mixing of Scintillator and Si layers
- improved aHcal driver:
  - included electronics & services
- overall services for TPC, Ecal, Hcal

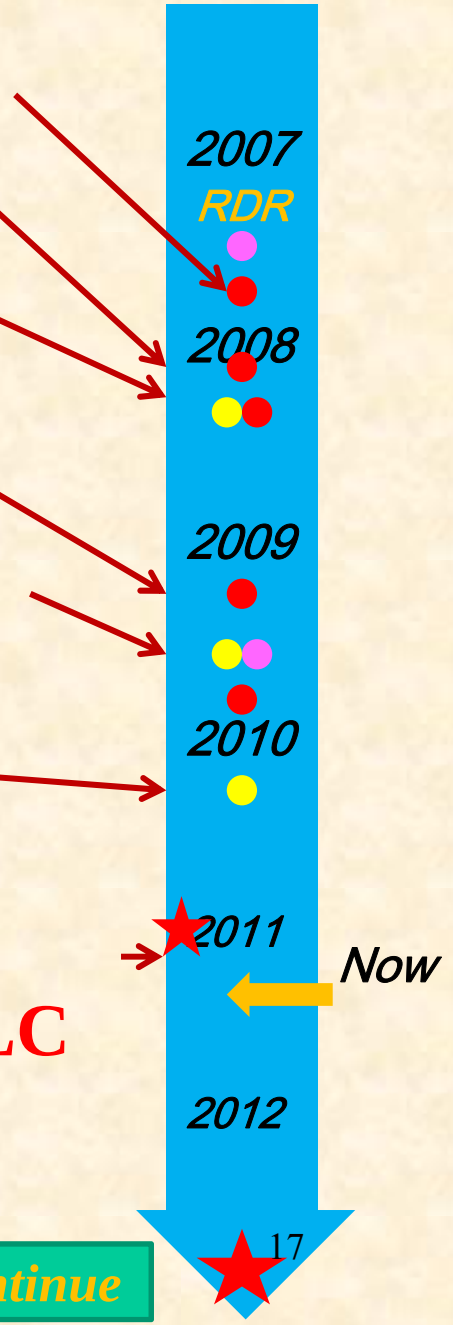




work of many people:
A.Charpy, J.Duarte, A.Saveliev, G.Musat,
A.Lucaci, P.Mora de Freitas,....

Time line of the LOI process

- Oct. 2007: **Call for LOIs was made by ILCSC**
- Jan. 2008: Detector management was formed
- Mar.2008: IDAG formed, 3 LOI groups known
- Mar.2009: 3 LOIs submitted
- **Summer 09: IDAG recommendation for validation and ILCSC's approval**
- Oct 2009: Work plan of the validated groups
- Mar:2009: IDAG began monitoring the progress
- **End 2010: Interim report(still being prepared)**
- **End 2012: Detailed Baseline Design Report and updated physics case for ILC**



How to continue

Interim Report

- **We are now editting an interim report which can be published in a very similar form as the GDE's report.**
- **It is a good time to make such a report, passing the middle point till DBD completion.**

- **Readers:**
  - **ILCSC**: to report the status of the detector activity
  - **Colleague physicists and funding agencies**
  - **Ourselves: to review where we are in each activity**

Detector groups

The groups are in the middle of detector R&D, design work and preparation for simulation in view of the 9 items to be considered.

E.g.

- R&D for critical components to demonstrate feasibility,
- Define baseline design including realistic support structure, holes, I/O cables, etc.
- Settle Push-Pull scheme
- Study new benchmarks
- Improved cost estimation

PHYSICS, new Comon Task Group

Next role of the physics CTG:

The group will further play a major role to make **the physics chapter of the DBD**, which is common to the both detectors, by sharing efforts with the detector groups.

(Michael Peskin volunteered to coordinate the writing of the chapter during the PEB meeting in Geneva.)

The physics chapter includes update of ILC physics case from the physics volume of RDR, *taking into account of the studies for LOI and the new information from LHC.*

The group organized a team of subject conveners, inviting more members, and preparation works will start in earnest this Summer. **It will be a center of focus at the Granada LC meeting in September.** The current plan can be found at:

http://www.slac.stanford/edu/~mpeskin/PhysicsChapter.html

People who are interested to contribute, please contact Michael Peskin or an appropriate subject convener.

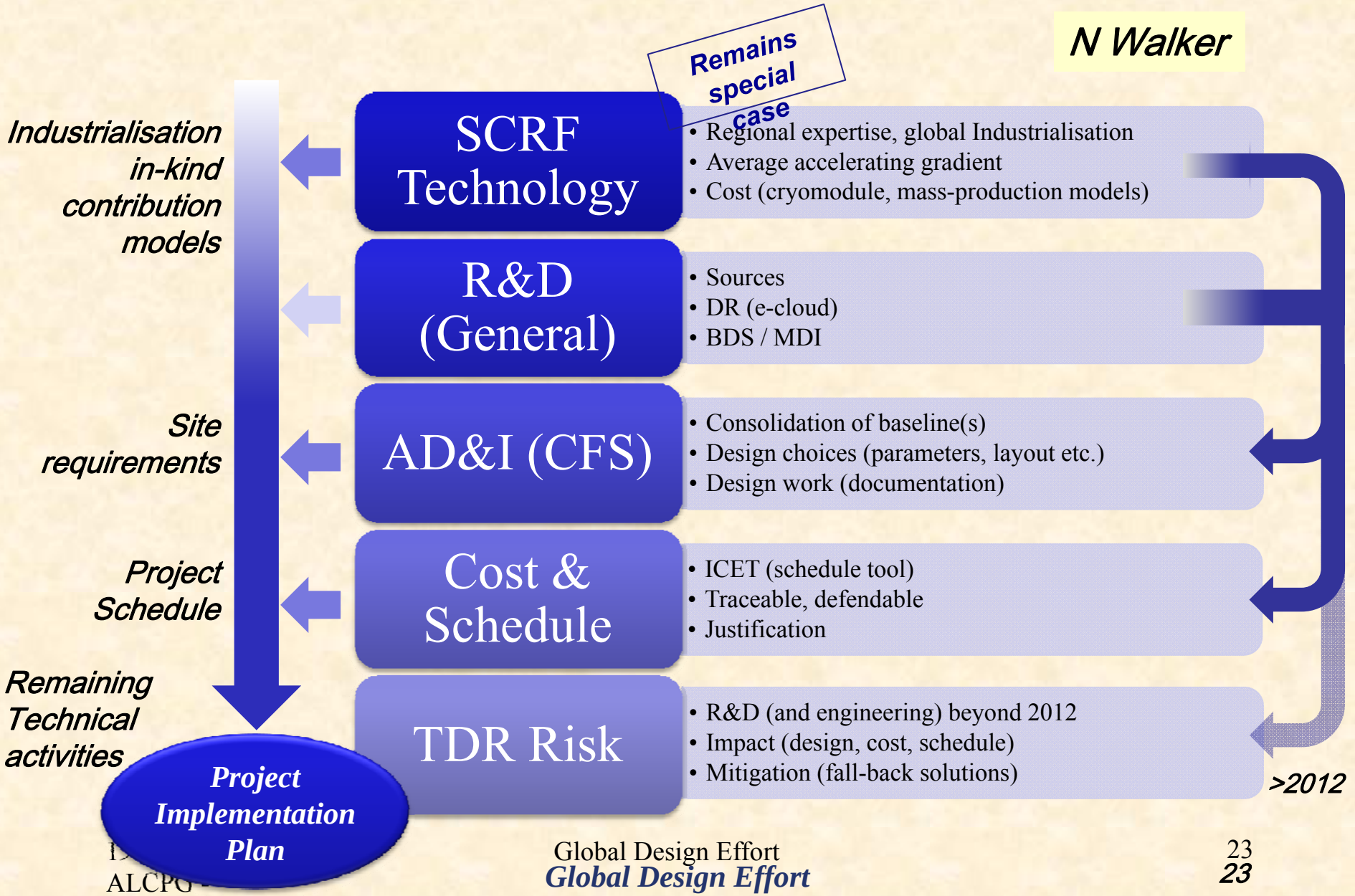
Plan for Post 2012 (continued)

- ***It is crucial that the detector community, or the user community of ILC, remain actively participating in the discussions,***
  to continue R&D/physics studies after 2012,
  to reduce the difficulties which we have now
  and to prepare for the project realization.

- **ILCSC discussed about the possibility of international consortium as the intermediate scheme after 2012. This will be studied in each region by relevant ILCSC members by the next meeting in Mumbai.**
- **Consideration for the scheme in detail will be made after that.**

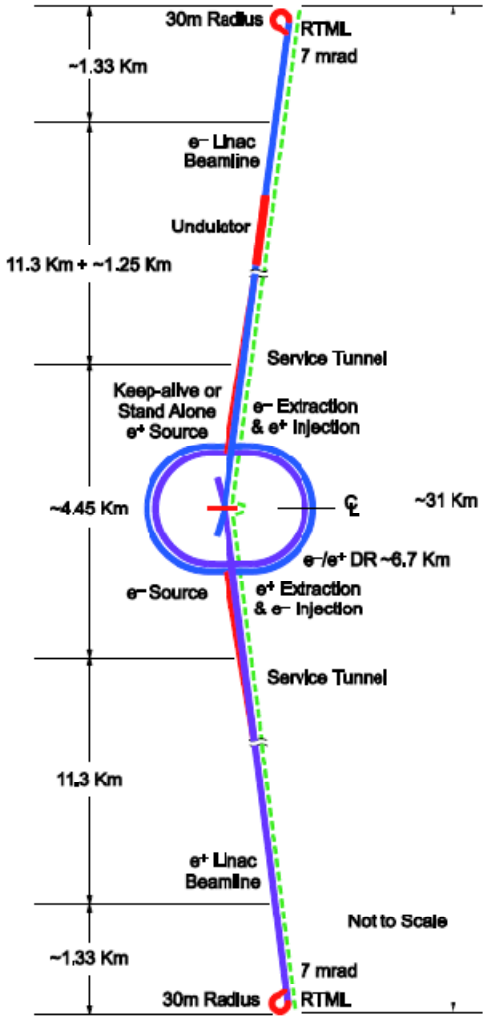
BACKUP

Five Themes to Develop

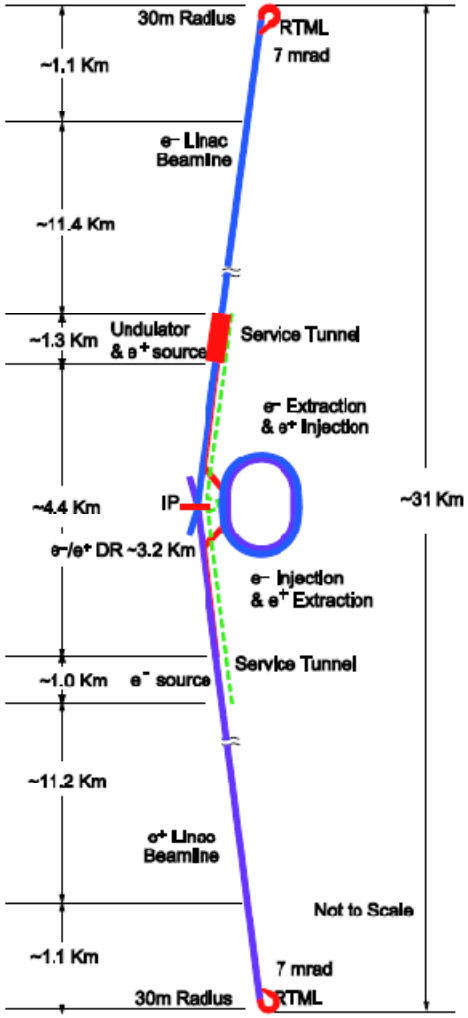


Proposed Design changes for

RDR

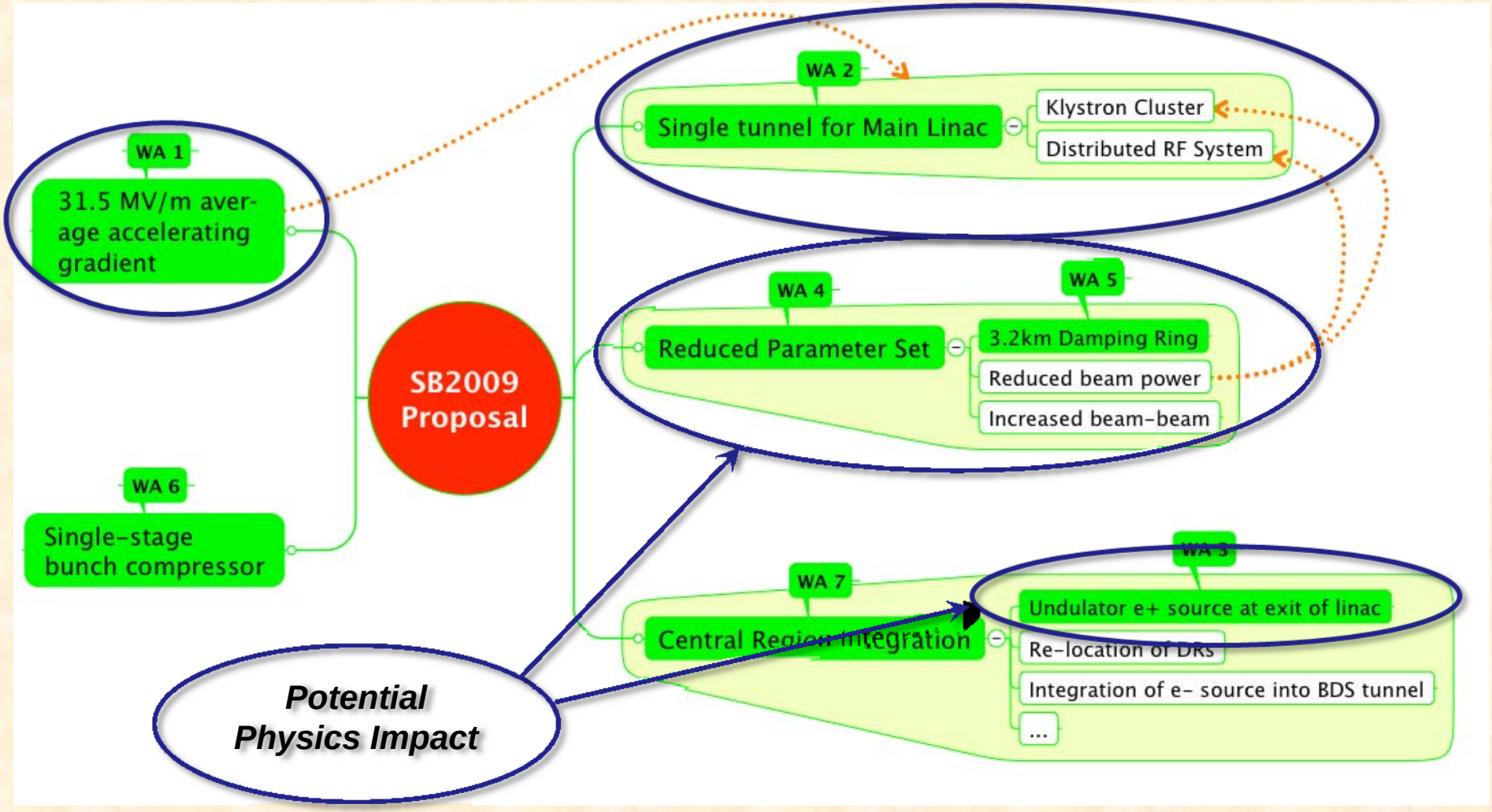


SB2009



- *Single Tunnel for main linac*
- *Move positron source to end of linac ****
- *Reduce number of bunches factor of two (lower power) ***
- *Reduce size of damping rings (3.2km)*
- *Integrate central region*
- *Single stage bunch compressor ????*

Top Level Change Control Process Themes

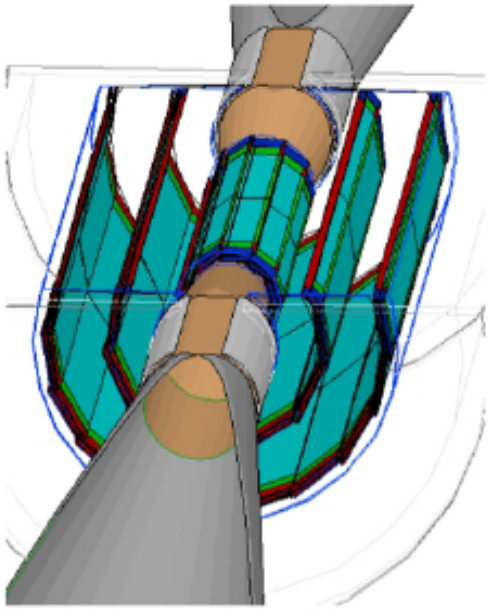


For LCWS11 – Granada

- 26-30 September 2011
- Joint CLIC / GDE Workshop
  - Prepare for European Strategy for PP mid 2012
  - CLIC will indicate by Spring 2012 the CLIC cost in an energy band including 500 GeV up to an energy (1 to 2 TeV?)
  - ***Strong overlap with GDE (500 GeV to 1 TeV)***
- Workshop to be planned 'jointly'
- From GDE:
  - Goals and agenda to help prepare for ESPP

Subdetector components I – Vertex detectors

Aim to equip three doubled sided layers

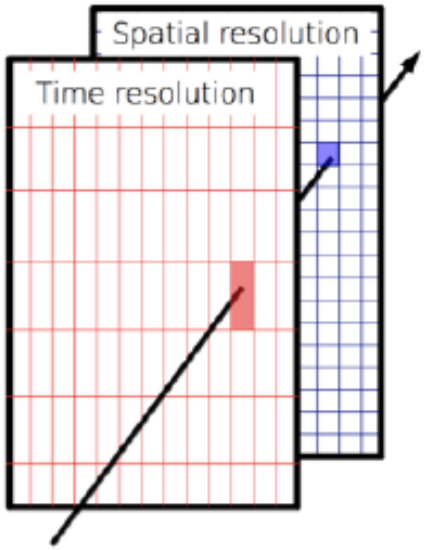


Sensor development

Inner double layer inner radius
- binary charge encoding
- 16x16 μm^2 pitch => < 3µm resol.
- r/o time 40-50 µs

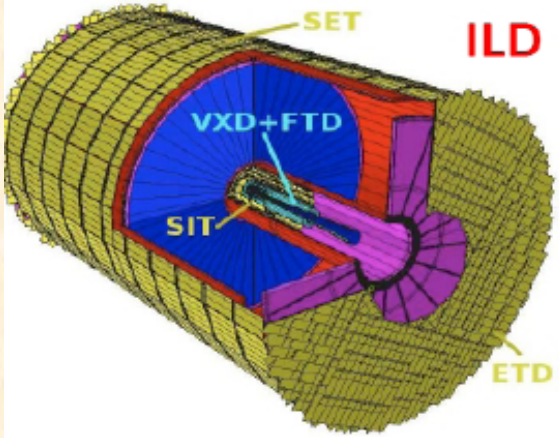
Inner double layer outer radius
- binary charge encoding
- 16x64 μm^2 pitch => 5µm resol.
- r/o time 10-12 µs

Outer layers
- 35x35 μm^2 pitch
- charge encoding with 4 bit ADC
  => expected resolution 3-4 µm
- r/o time < 100 µs



Design of prototypes meeting these specs ongoing
Fabrication in danger due to short funding

Subdetector components II – Silicon Inner Tracking



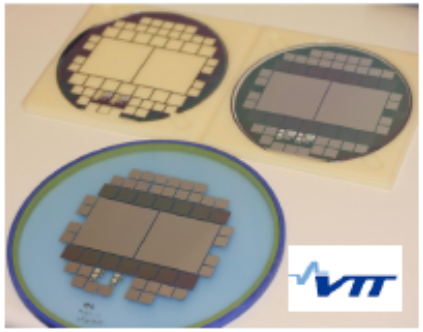
- Developed within SiLC R&D collaboration framework
- Based on 4 Silicon components surrounding the TPC:
  SIT, SET, FTD, ETD
- **Main objectives: high performances & low % X0 =>**
- Main R&D streams: sensors, FE readout, interconnection
- *Baseline sensor technology: Single sided strips for all but 3 FTD disks nearest to Vertex detector (pixels)*
- For DBD:

New planar single sided strips technology, large sensors (6'') edgeless and high transmittance (IR laser alignment) options

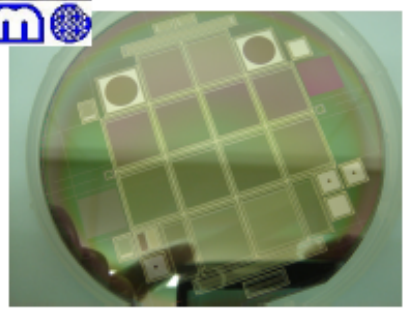
- **SiLC strategy on sensors R&D**:

✓ *Close collab with expert Silicon Labs: CNM-IMB, IRST, VTT, ETRI and with industrial firms: HPK, Micron etc.*

✓ *Performances validated on test beams prototypes*



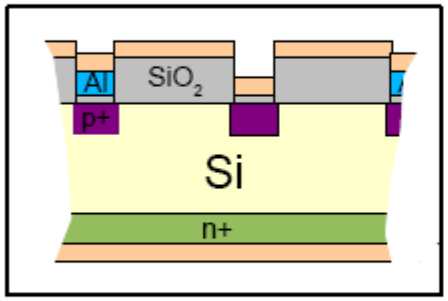
New edgeless sensors



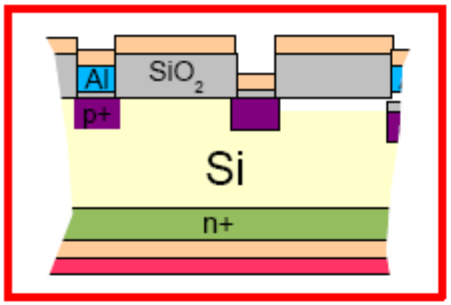
High transmittance sensors
Goal: T~70%; Already now: 50%

From general point of view:
High benefit from involvement in shorter term experiments for keeping/developing expertise & for funding and from synergy with (s)LHC.

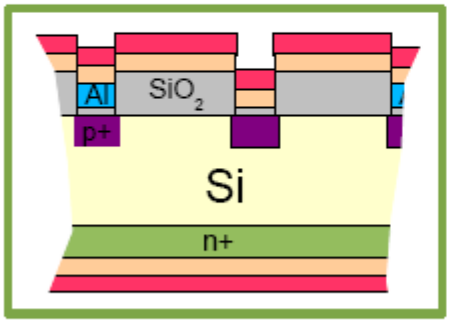
LEGEND



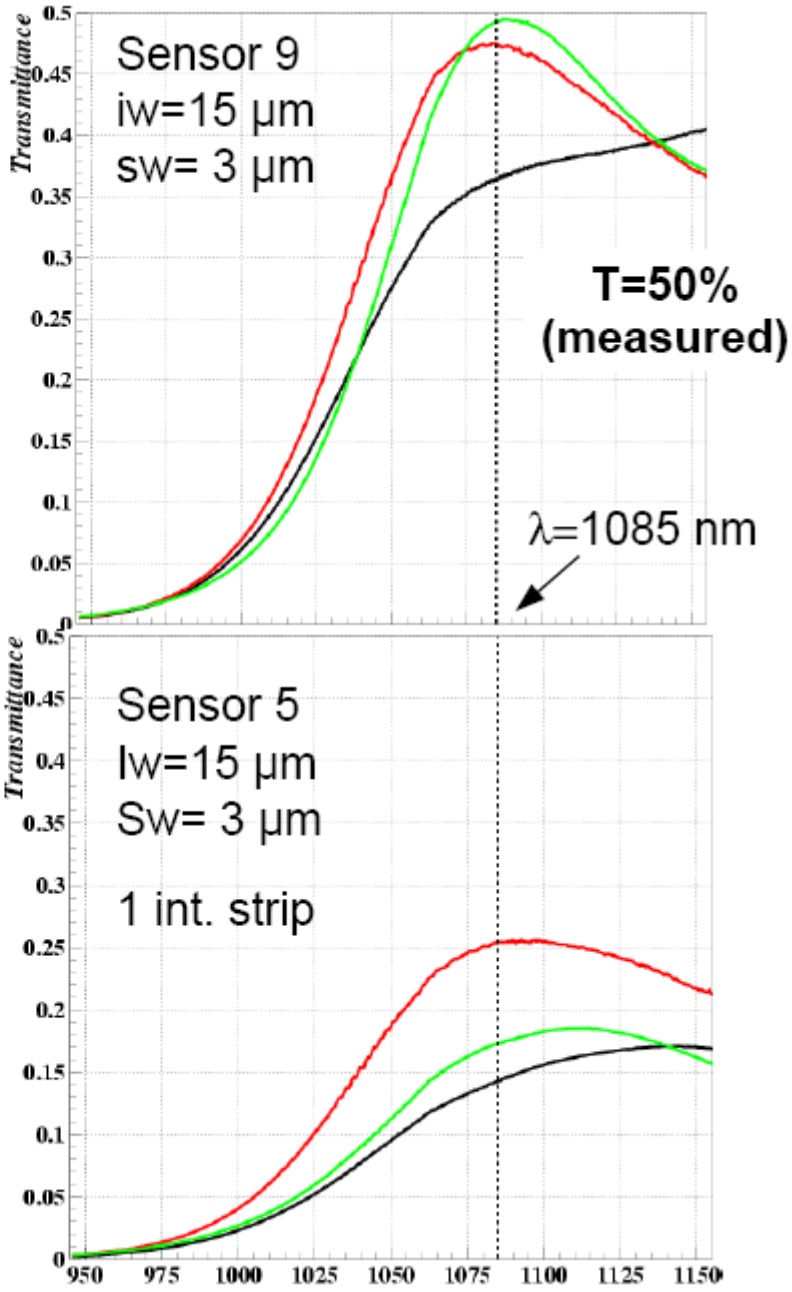
Step 1
SiO2 on top and below. (No nitride)



Step 2
Nitride below



Step 3
Nitride on top and below

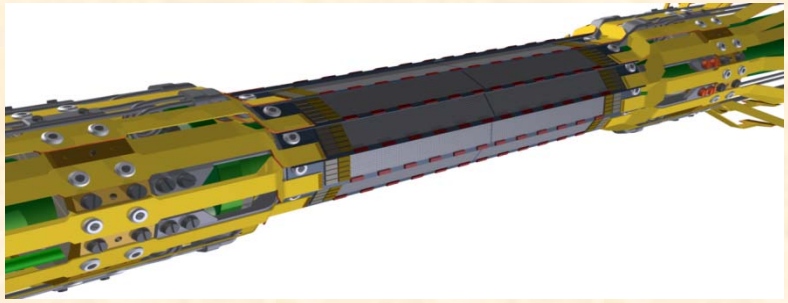


$$\sigma_{r\phi} \approx \sigma_{rz} \approx a \oplus b/(p\sin^{3/2}\vartheta)$$

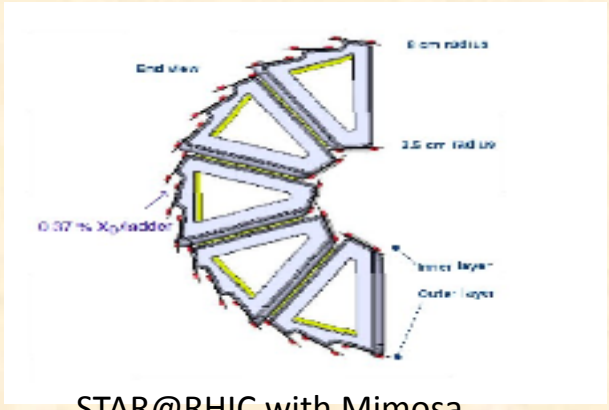
Accelerator	a (μm)	b (μm)
LEP	25	70
SLD	8	33
LHC	12	70
CLIC	**<5**	**<15**
ILC	**<5**	**<10**

Vertex*: *low material, high granularity, good single point resolution, low power consumption, time resolution

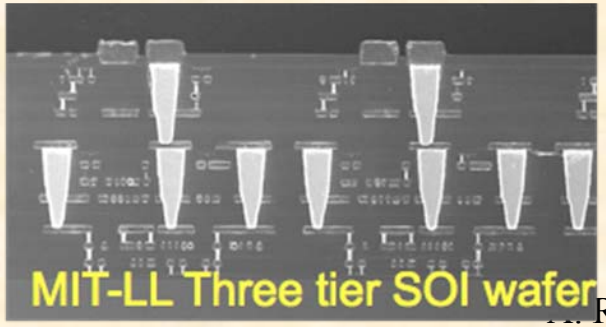
Some almost mature technologies



Belle II VXD with DEPFET (2014)



STAR@RHIC with Mimosa (2012)



Others in well advanced R&D status

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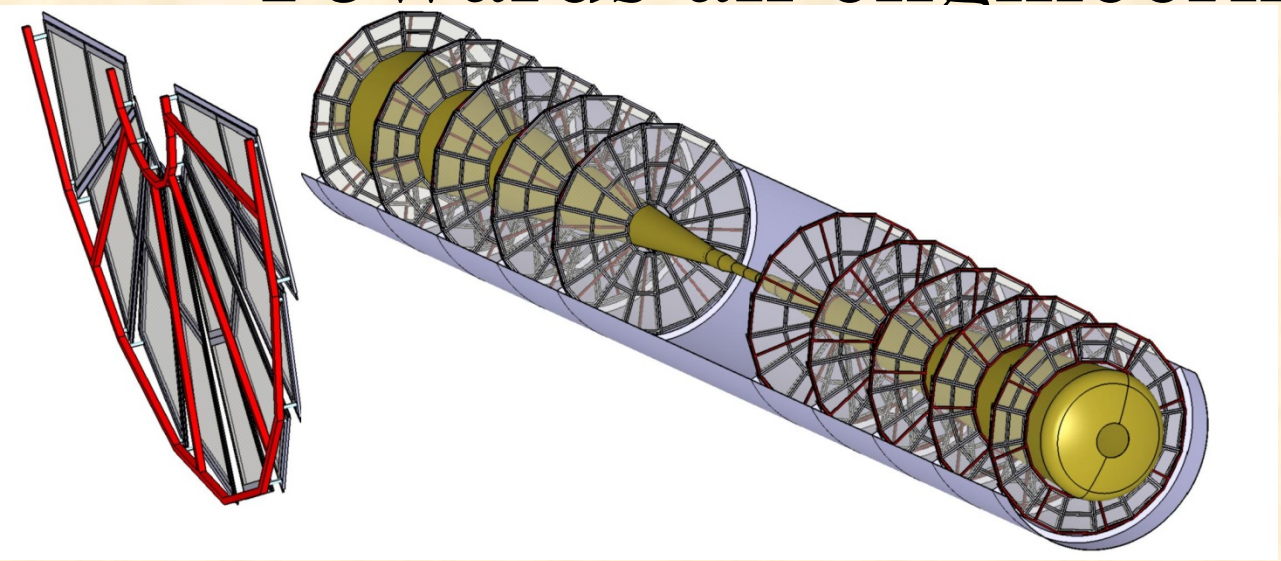
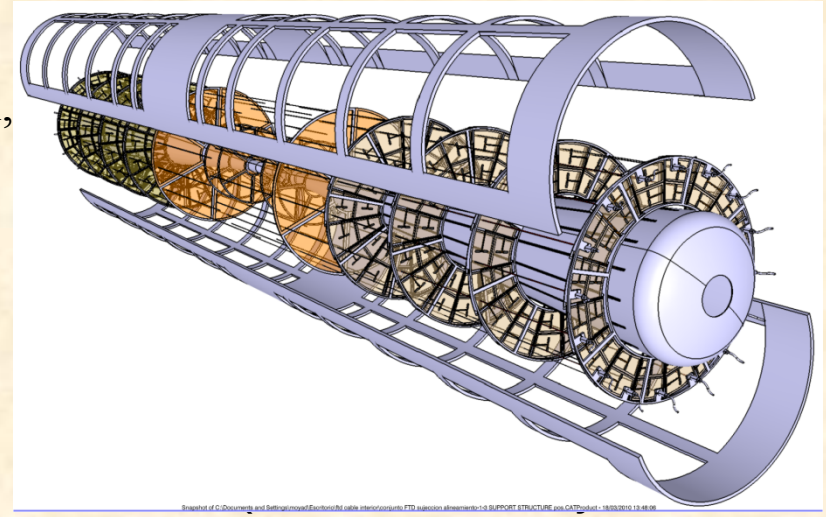
Towards an engineering design



FTD

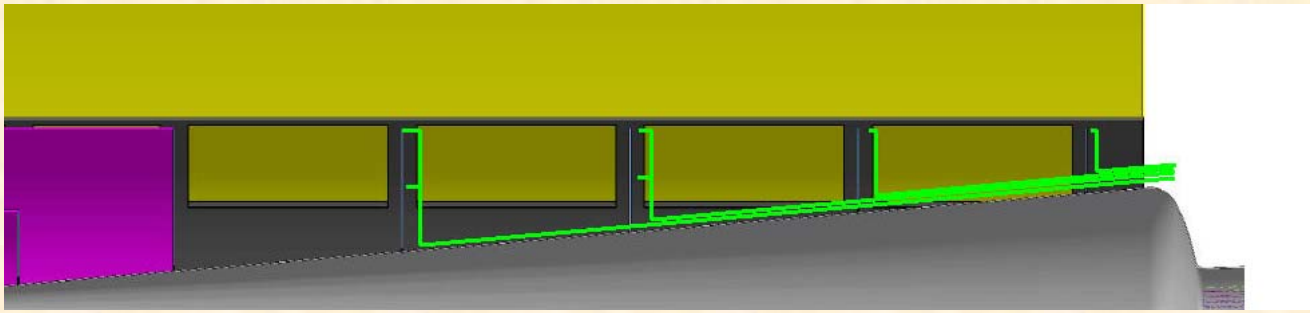
- Preliminary design
  - Must be enhanced
    - June Workshop held in Paris (Vertex, MDI,FTD)
    - Cabling / Services
    - Realistic Module design
    - Support Structure
      - Beam Pipe / Vertex / FTD as a part (IMP)
      - IMP with TPC



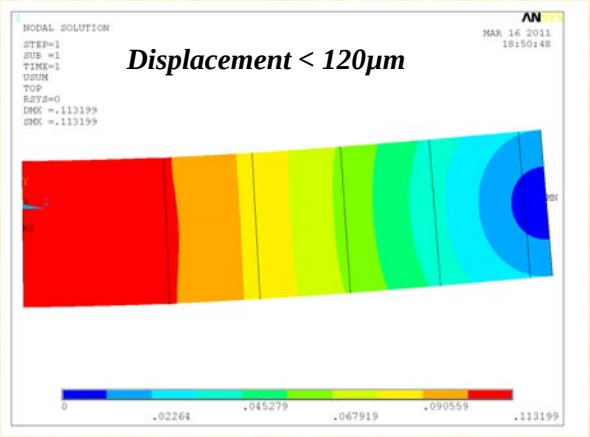
(IFCA))

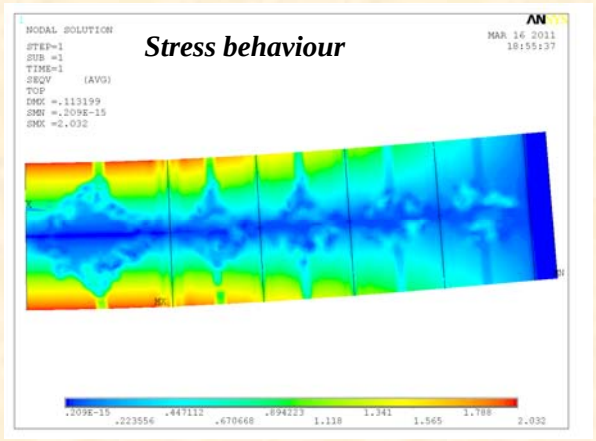
(4) FTD 3-7

- Cables/electronics :
  - Will be estimated and integrated in a near future
  - Cables will run along the beam pipe



- Calculations ongoing to design the inner support tube (D. Moya)

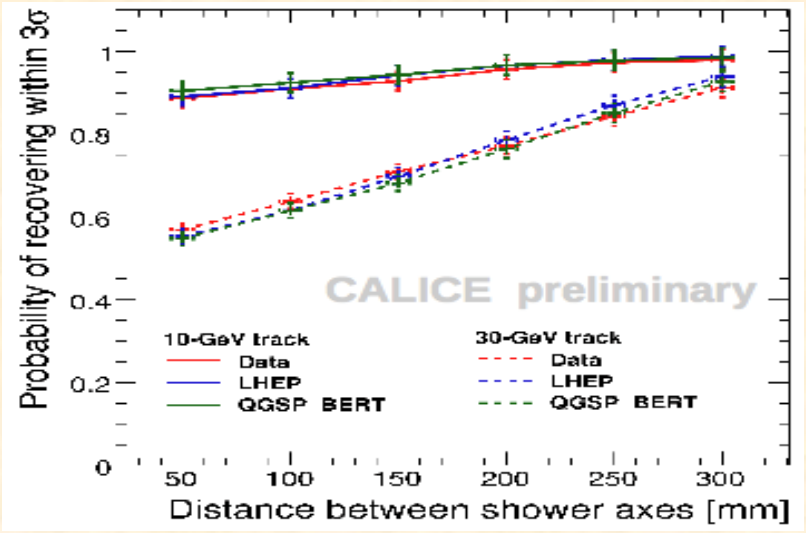




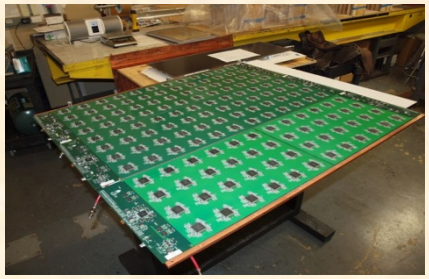
Tube of 1mm thick , composite material + + additional rings at FTD positions

Calorimetry:

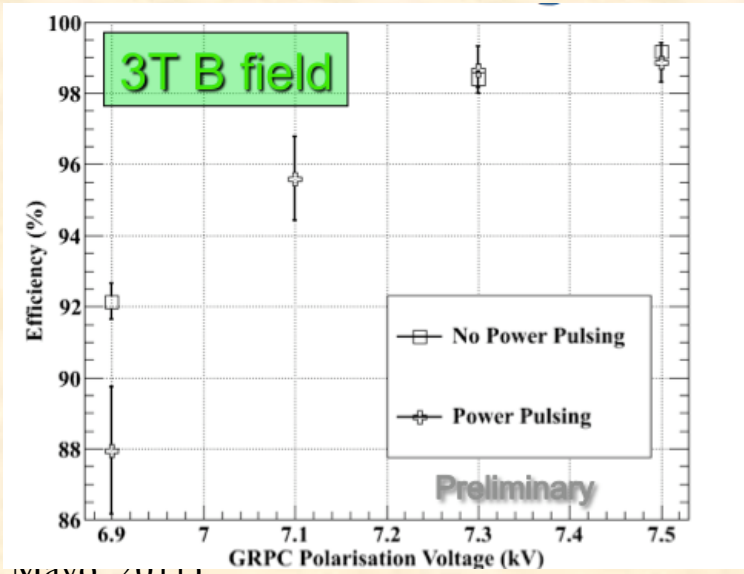
Particle Flow concept, double-track resolution **with test-beam data**



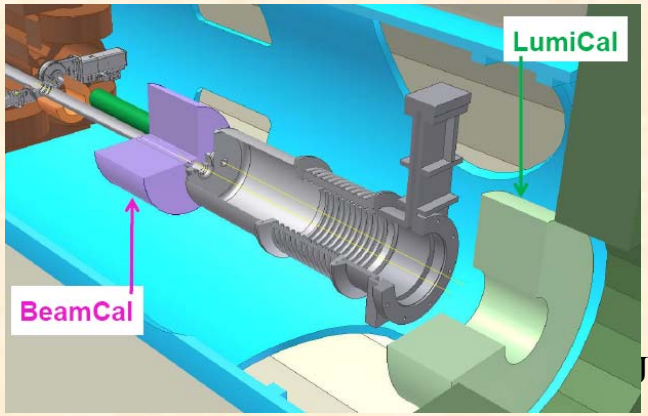
DHCAL test beam at FNAL: cubic metre steel instrumented with RPCs



sDHCAL, Power Pulsing test beam, with magnetic field , 3Tesla. Technological prototype with integrated electronics and ASICs



LumiCal, BeamCal testing, good preliminary results



Driver costs

The price is completely dominated by few items. The idea is to focus on the main cost drivers without forgetting that the sum of the smaller contributions may be huge: