La Red Española de Futuros Aceleradores

Madrid, 2-Diciembre 2009

A. Ruiz (IFCA)

Esquema de la Presentación

- ***Report of ALCPG09 (Albuquerque, Septiembre 2009)***
  - ✓ ***Situación del ILC***
  - ✓ ***Futuros pasos***
- ***Red española***
  - ✓ ***Actividades y progreso***
  - ✓ ***Proyectos europeos y nacionales***

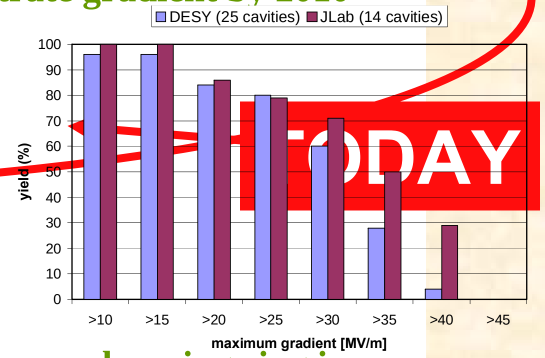
Acelerador

- **El AAP (Accelerator Advisory Panel) ha analizado el programa de SCRF, CFS (conventional facilities), electron-cloud R&D, instalaciones de test y dirección del proyecto**
- **La próxima revision de la AAP en Enero 2010, en Oxford, enfocada al nuevo "baseline"**
- **Resumen de las presentaciones del GDE en las siguientes transparencias**

Major R&D Goals for TDP 1

SCRF

- **High Gradient R&D - globally coordinated program to demonstrate gradient by 2010 with 50%yield**
- **Preview of new results from FLASH**



ATF-2 at KEK

- **Demonstrate Fast Kicker performance and Final Focus Design**

Electron Cloud Mitigation – (CesrTA)

- **Electron Cloud tests at Cornell to establish mitigation and verify one damping ring is sufficient.**

Accelerator Design and Integration (AD&I)

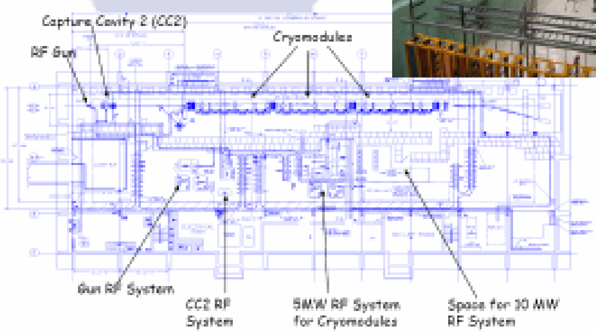
- **Studies of possible cost reduction designs and strategies for consideration in a re-baseline in 2010**

Global Plan for SCRF R&D

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 plug-compatible string** (DESY, FNAL, INFN, KEK)				
System Test with beam acceleration		**FLASH (DESY)**			**NML (FNAL)** **STF2 (KEK)**	
Preparation for Industrialization			**Mass Production Technology R&D**			

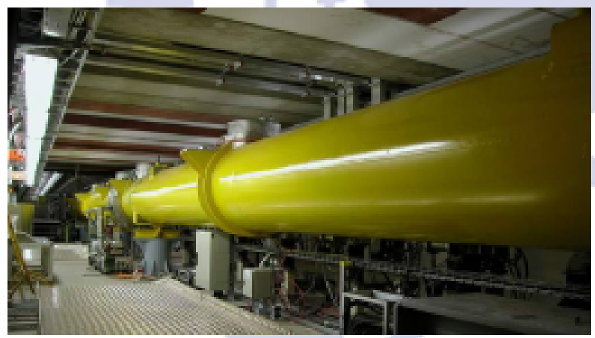
SRF Test Facilities

FNAL



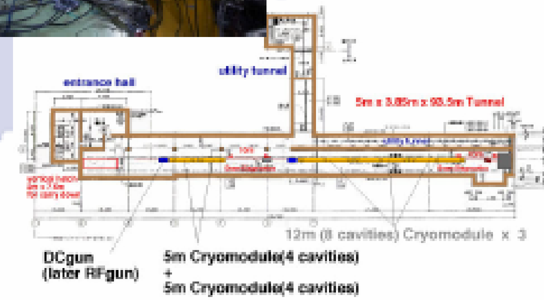
NML facility
Under construction
first beam 2010
ILC RF unit test

DESY



TTF/FLASH
~1 GeV
ILC-like beam
ILC RF unit
(* lower gradient)

KEK, Japan



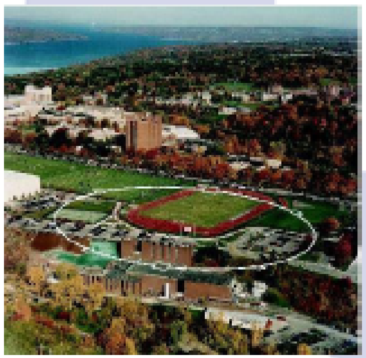
STF (phase I & II)
Under construction
first beam 2011
ILC RF unit test

Other Test Facilities

ATF & ATF2 (KEK)
ultra-low emittance
Final Focus optics

KEK, Japan

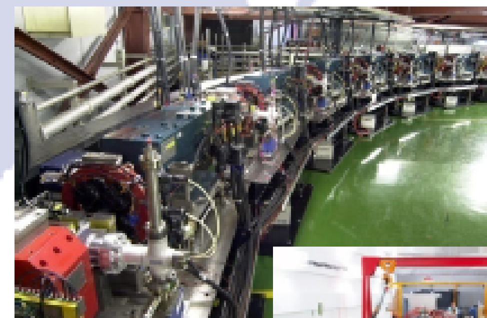
Cornell

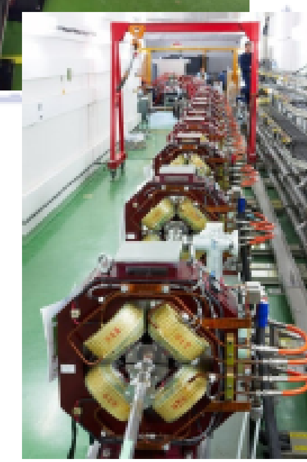


CesrTA (Cornell)
electron cloud
low emittance

INFN Frascati

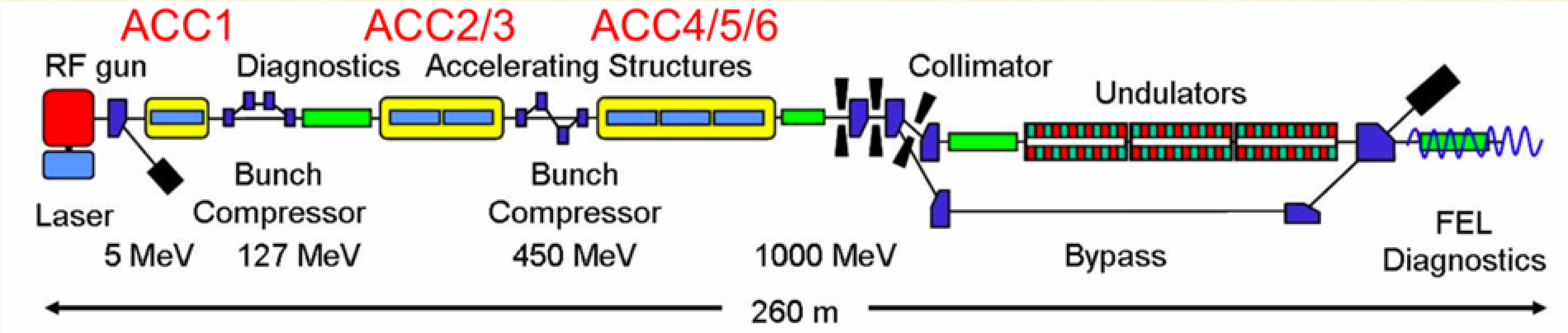
DAΦNE (INFN Frascati)
kicker development
electron cloud





TTF/FLASH 9mA Experiment

Full beam-loading long pulse operation → “S2”

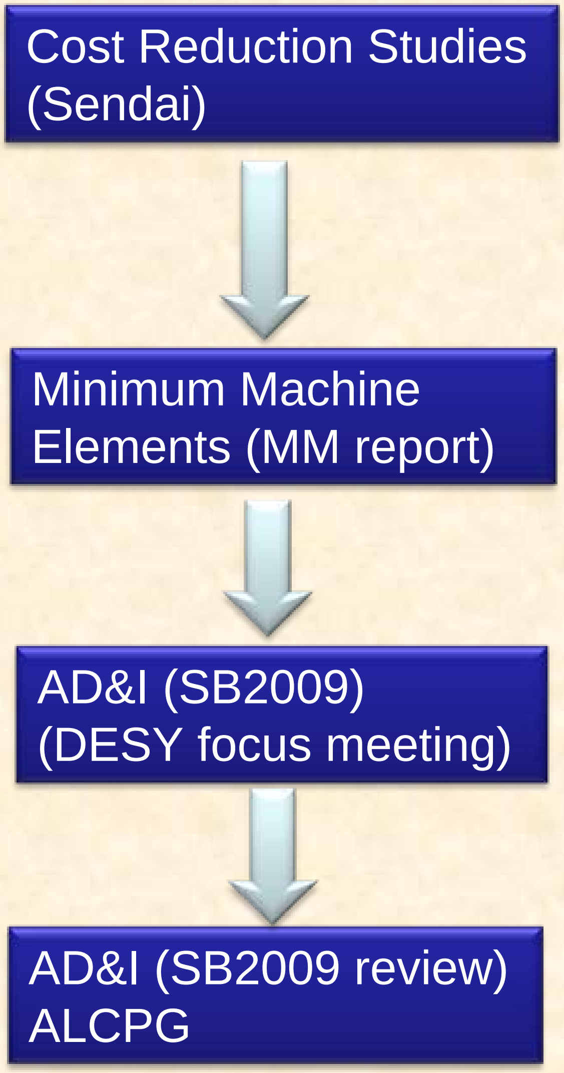


		XFEL	ILC	FLASH design	9mA studies
Bunch charge	nC	1	3.2	1	3
# bunches		3250	2625	7200*	2400
Pulse length	μs	650	970	800	800
Current	mA	5	9	9	9

- Stable 800 bunches, 3 nC at 1MHz (800 μs pulse) for over 15 hours (uninterrupted)
- Several hours ~1600 bunches, ~2.5 nC at 3MHz (530 μs pulse)
- >2200 bunches @ 3nC (3MHz) for short periods

AD&I, History (Review)

- DESY EC 01.2008
  - Cost reduction endorsed/encouraged as one of the themes of TDR Plan
- Sendai 03.2008
  - Cost reduction studies WG
- Dubna 06.2008
  - Review of Cost Reduction proposals (new ideas).
  - Single tunnel central theme
  - Consolidation of “Minimum Machine” elements.
- KEK EC 08.2008
  - EC endorses Minimum Machine elements
- PAC Paris 10.2008
  - MM elements reviewed.
  - Focus on ‘simplification’ not cost saving.
- LCWS Chicago 11.2008
  - Discussions on Minimum Machine (clarification)
- TILC09 Tsukuba 04.2009
  - AAP review, including ‘minimum machine’
  - Renamed as AD&I
- DESY AD&I 05.2009
  - Formation of AD&I group
  - PM’s proposal SB2009 Working Assumptions
  - Action items
- ALCPG ‘09 ALBU. 09.2009
  - See next slide



SB2009 Working Assumptions

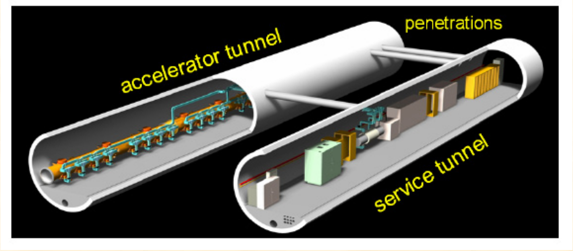
A Main Linac length consistent with an optimal choice of average accelerating gradient

RDR: 31.5 MV/m, to be re-evaluated

Single-tunnel solution for the Main Linacs and RTML, with two possible variants for the HLRF

Klystron cluster scheme

DRFS scheme



Undulator-based e+ source located at the end of the electron Main Linac (250 GeV)

Capture device: Quarter-wave transformer

Reduced parameter set (with respect to the RDR)

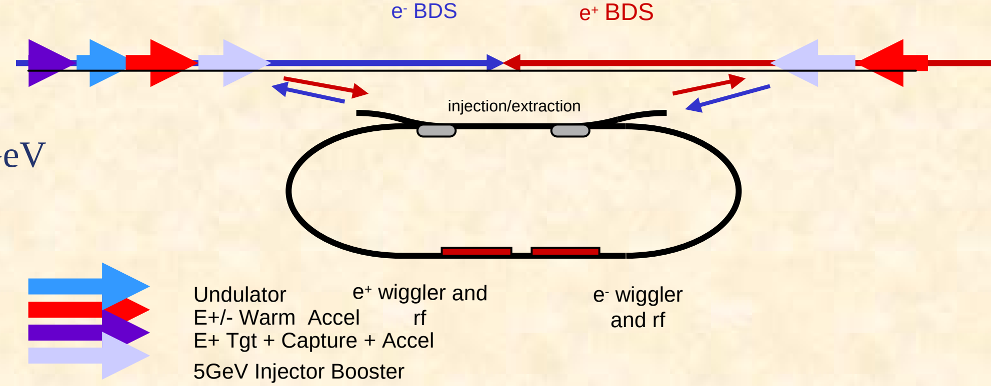
nb = 1312 (so-called "Low Power")

Approx. 3.2 km circumference damping rings at 5 GeV

6 mm bunch length

Single-stage bunch compressor

compression factor of 20



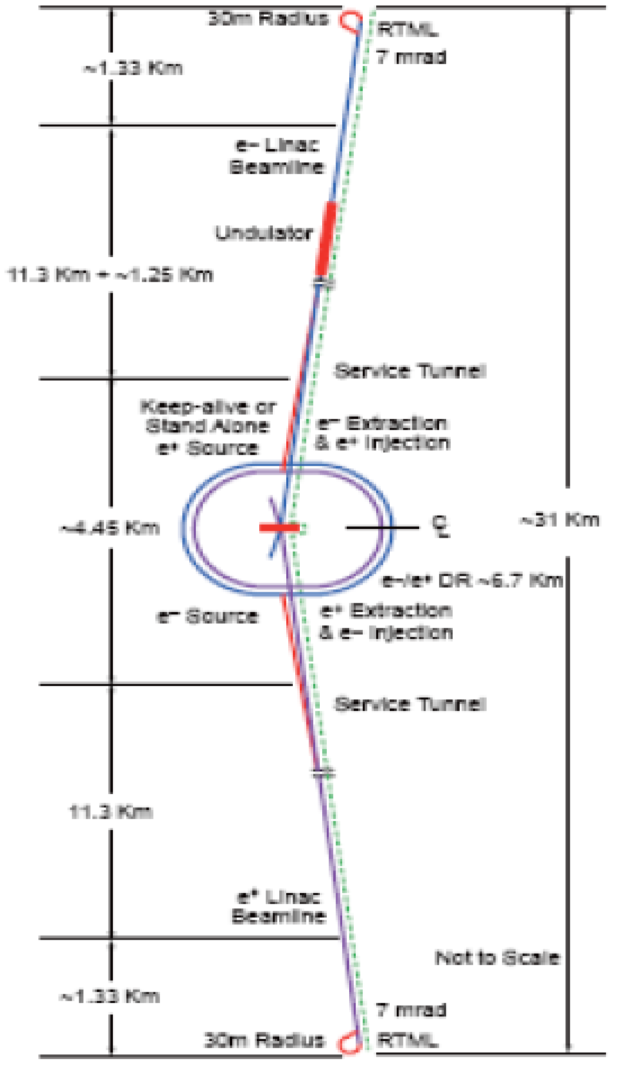
Integration of the e+ and e- sources into a common "central region beam tunnel", together with the BDS.

SB2009 Parameters (WA)

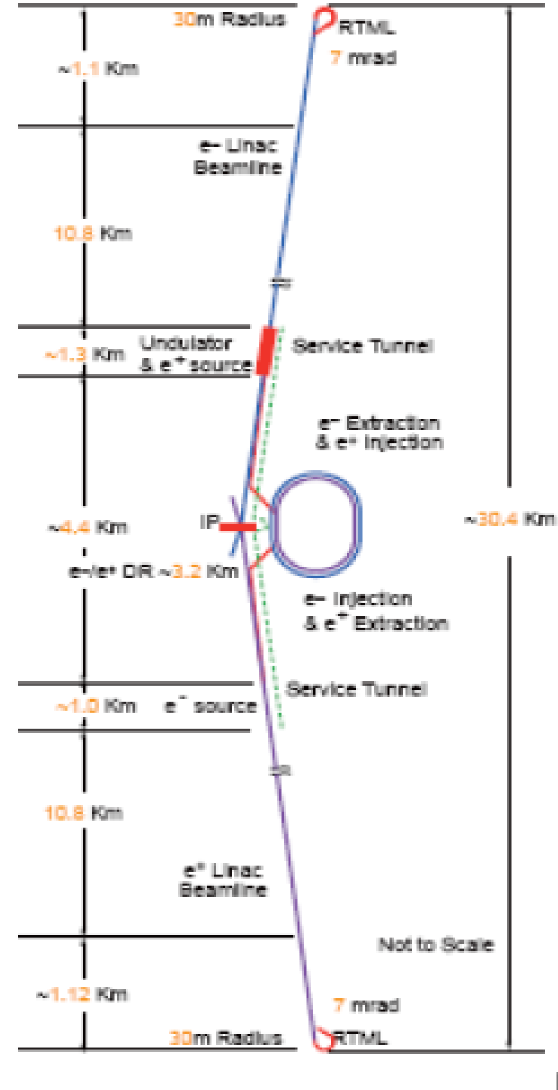
		RDR	SB2009	
Beam and RF Parameters				
No. of bunches		2625	1312	
Bunch spacing	ns	370	740	
beam current	mA	9.0	4.5	
Avg. beam power (250 GeV)	MW	10.8	5.4	
Accelerating gradient	MV/m	31.5	31.5	
P_{fwd} / cavity (matched)	kW	294	147	
Q_{ext} (matched)		3×10^{6}	6×10^{6}	
t_{fill}	ms	0.62	1.13	
RF pulse length	ms	1.6	2.0	
RF to beam efficiency	%	61	44	
IP Parameters				
Norm. horizontal emittance	mm.mr	10	10	
Norm. vertical emittance	mm.mr	0.040	0.035	
bunch length	mm	0.3	0.3	
horizontal b*	mm	20	11	
horizontal beam size	nm	640	470	
			no trav. focus	with trav. focus
vertical β*	mm	0.40	0.48	0.2
vertical beam size	nm	5.7	5.8	3.8
D_y		19	25	21
dE_{BS}/E	%	2	4	3.6
Avg. P_{BS}	kW	260	200	194
Luminosity	$cm^{-2}s^{-1}$	2×10^{34}	1.5×10^{34}	2×10^{34}

Key R&D – CF&S & Rebaselining

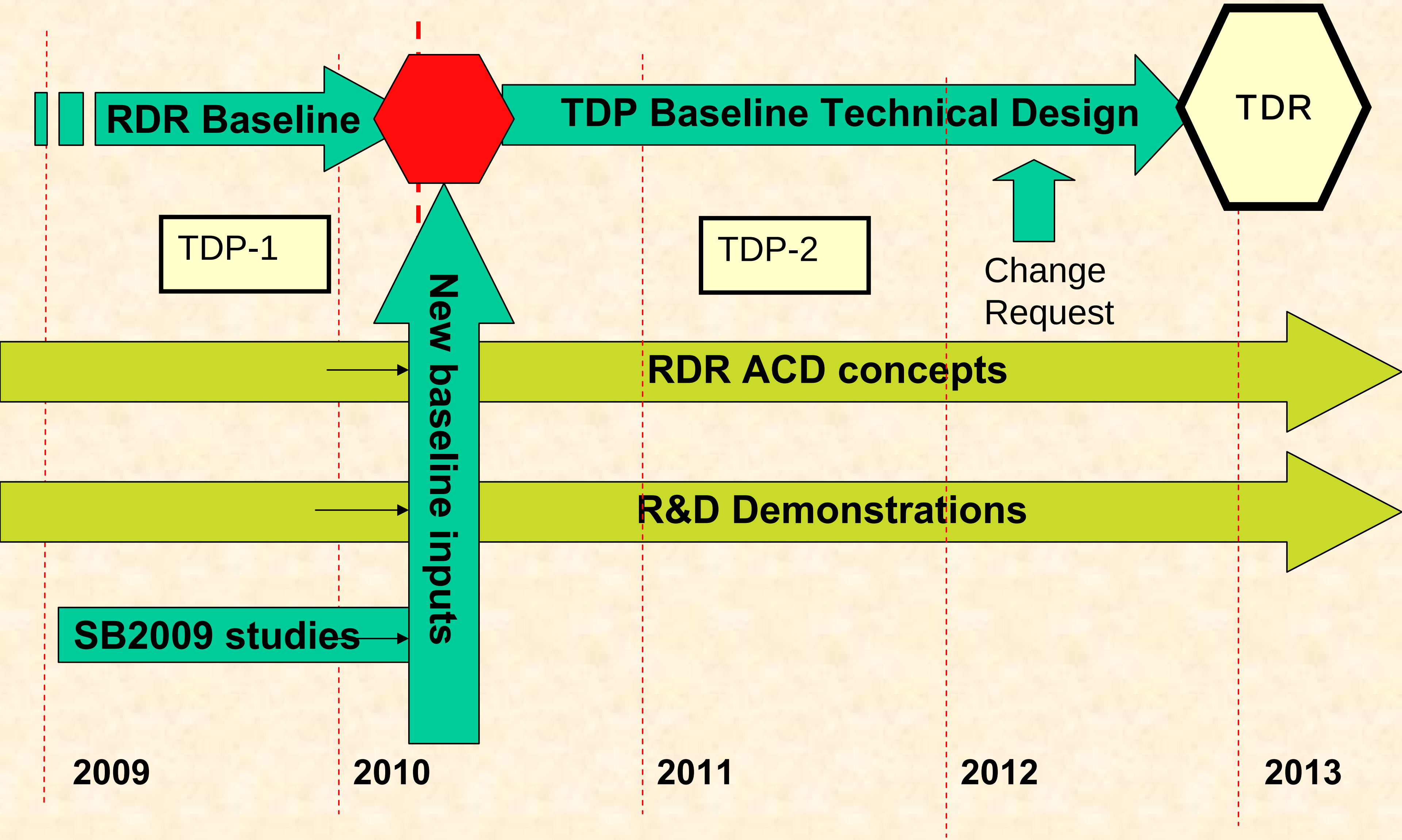
- RDR layout (not to scale)



- SB2009 layout (not to scale)



Technical Design Phase and Beyond



Governance Timescales

1) **Albuquerque Sep 29 – Oct 3 – tentative conclusion on funding model – fractions per partner, size of common fund etc.**

2) **EC face-to-face ~ Jan. Oxford – conclusion on funding models, preliminary conclusion on governance model options**

3) **Beijing March/April 2010? – conclusion on governance model options**

4) **Write preliminary governance report and iterate May – June 2010**

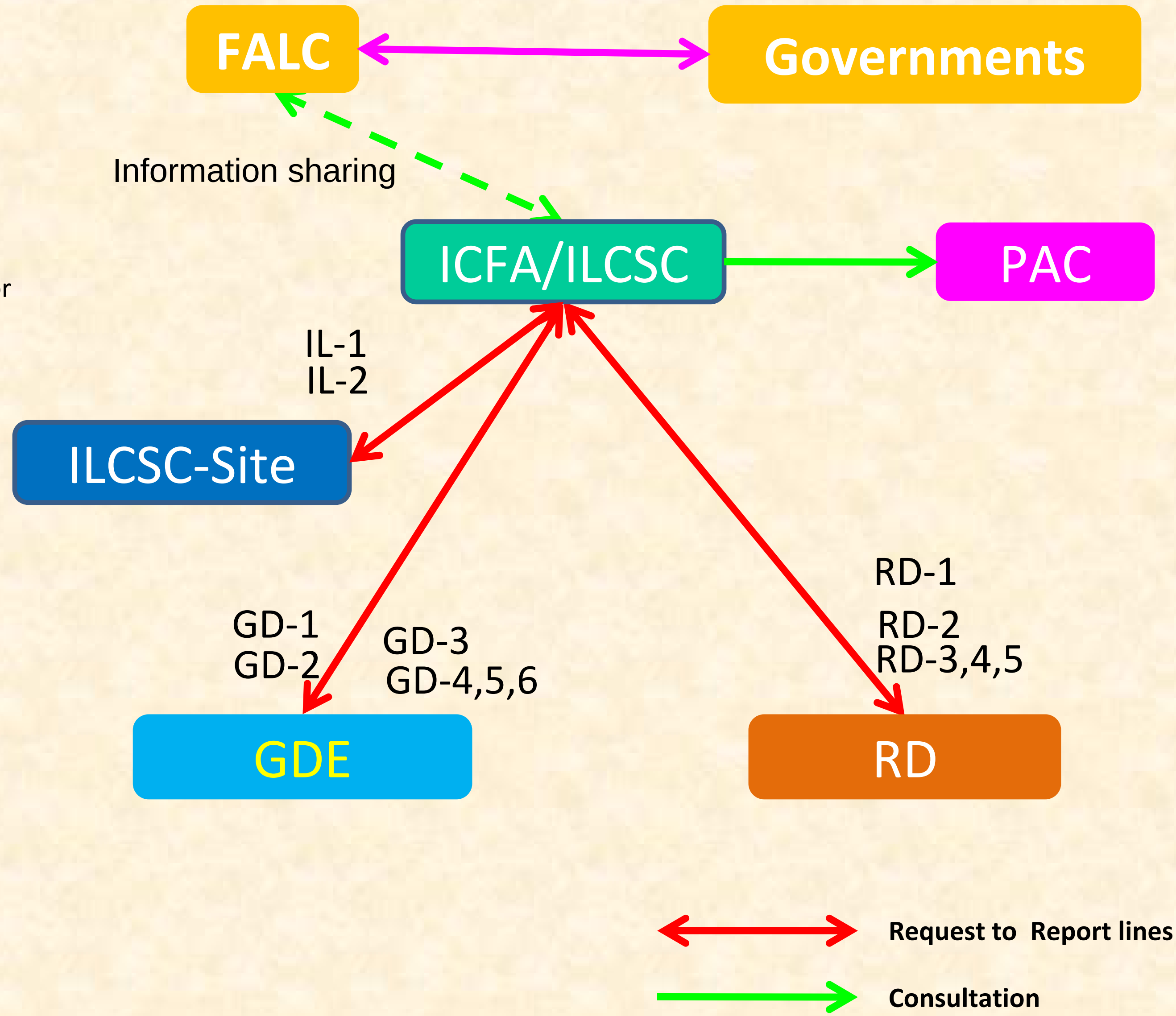
5) **Present to and hope to get agreement from ICFA, ILCSC, PAC & FALC – June-July 2010?**

6) **Present at Paris ICHEP July 2010 – N.B. this is not a final report and no funding authority/government will be expected to sign off on it. Comments/criticisms etc however would be *very* welcome.**

B Foster
FALC & ILCSC

Proposed Organization

Work-Packaging and Job Sharing



IL-1 Top-level management structure (government – research)

IL-2: Siting process (required and/or desirable processes)

GD-1: Sharing models from Technical View points

GD-2: Management models from Technical View points Acc.

GD-3: Siting from Technical View points

GD-4,5,6: Construction process technical

RD-1: Management models from Technical View points Det./Exp.

RD-2: Siting issues from living environment (desirable features)

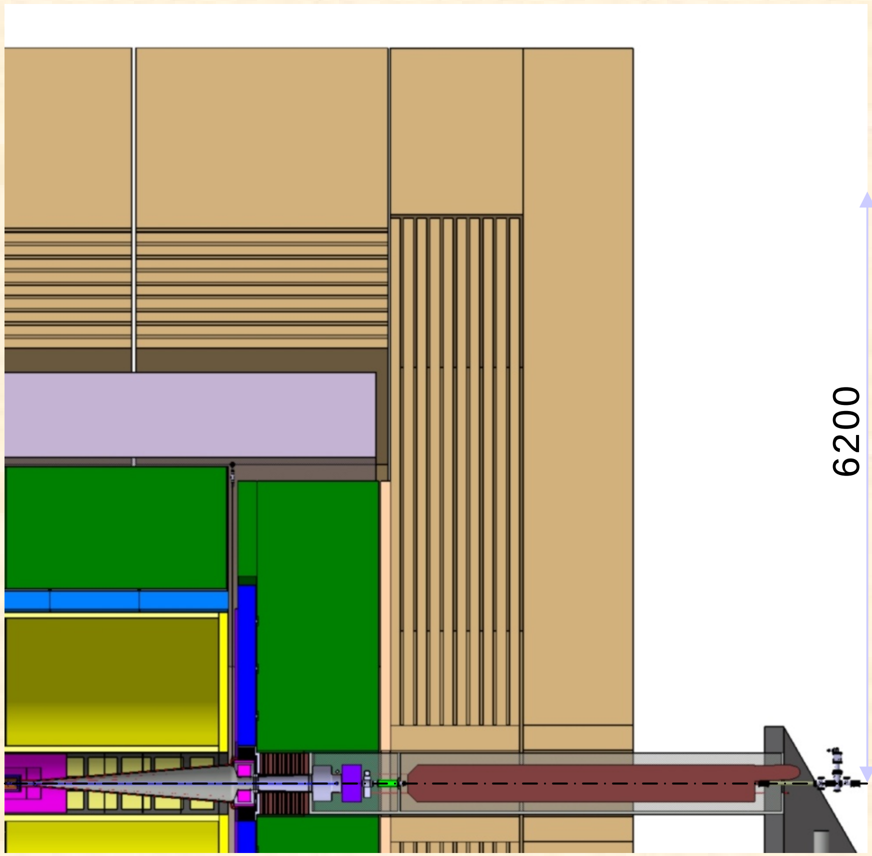
Detectores

- **Resumen de las presentaciones del ALCPG en las siguientes transparencias.**

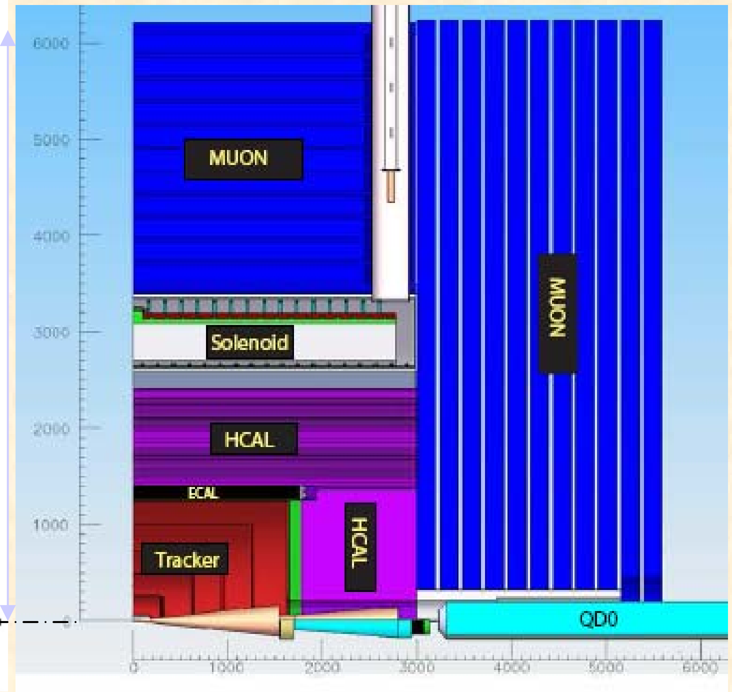
The 3 concepts: choices and numbers

	ILD	SiD	Fourth
Vertex	Si pixels	Si pixels	same as SiD
Tracker	TPC + Si strips layers	Si strips 5 double layers	Small-cell He drift chamber (clusters)
Forward	Si strips disks	Si strips disks	not specified
EM calo	W+Si pix.(scint.strips) 23 X_0 0.25 cm^2	W +Si pix. 26 X_0 0.13 cm^2	BGO +? 25 X_0 4(1) cm^2
Had calo	Fe+scint. tiles (gas) 5.5 λ 9 cm^2	Fe+RPC pads 4.8 λ 1 cm^2	Cu+quartz/scint. fibers 7.3 λ 19 cm^2
Magnet	3.5 T 3.35 m	5 T 2.6 m	3.5 T 3 m (inner)
Flux return	Fe 7 m	Fe 6 m	Air 1.5T outer sol.
Muon	RPC (scint.strips)	RPC (scint.strips)	Al drift tubes

7755



6200



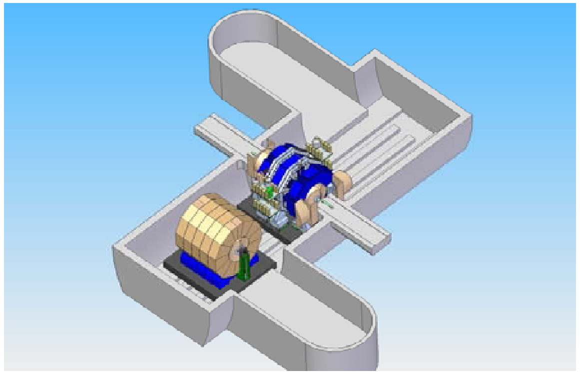
6620

5500

ILD

SiD

Push pull



- Importance of push-pull aspects
- (also for CLIC) which will be studied in detail by ILD & SiD
- Why 2 detectors ?
- Scientific arguments (competition, independence, confidence on results)
- Complementarity with contrasting technologies (OK if data can be combined)
- Risk mitigation: allows for high performance detectors with reasonable risks (e.g. failure with a large SC Coil)
- ‘Sociological’: a worldwide project needs to accommodate a diversity of cultural approaches
- …

Physics performances

- assessed through the chosen benchmark processes
- SM background generation common to all concepts (SLAC)
- beamstrahlung-induced background included
- full simulation and reconstruction
- Higgs mass determination in ($Z \rightarrow l^+l^-$) H :
  36-50 (59-97) MeV for $\mu\mu$ (ee) (all)
- Higgs BR $H \rightarrow$c cbar : precision ~10% (ILD, SiD)
- precision EW measurements with ee$\rightarrow\tau\tau$: σ, A_{FB}, P_τ (ILD, SiD)
- t tbar production : t mass to 30-60 MeV, b-tagging (ILD, SiD)
- gaugino pair production: separate W and Z (jet energy resolution) best with dual read-out calorimetry (Fourth), still acceptable for particle flow (ILD, SiD)
- PF still works at 1 TeV (ILD)
- exercice very useful: proposed concepts able to exploit ILC potential; reveals ability to carry out complex analyses with realistic simulation
- analyses still in flux: several unexplained differences

Reference reactions

Reaction	Detector parameter tested	Measurements
$e^+e^- \to Z(\to l^+l^-)H$ $m_H = 120$ GeV, $\sqrt{s} = 250$ GeV	p resolution material distribution γ recovery	m_H σ
$e^+e^- \to ZH(H \to c\bar{c}, Z \to \nu\bar{\nu})$ $m_H = 120$ GeV, $\sqrt{s} = 250$ GeV	heavy flavor tagging secondary vertex reconstruction particle id.	$BR(H \to c\bar{c})$
$e^+e^- \to ZH(H \to c\bar{c}, Z \to q\bar{q})$ $m_H = 120$ GeV, $\sqrt{s} = 250$ GeV	same as for $e^+e^- \to ZH(H \to c\bar{c}, Z \to \nu\bar{\nu})$ confusion resolution capability	$BR(H \to c\bar{c})$
$e^+e^- \to Z \to \tau^+\tau^-$ $\sqrt{s} = 500$ GeV	τ reconstruction particle flow π^0 reconstruction tracking of close tracks	σ A_{FB} τ polarization
$e^+e^- \to t\bar{t}(t \to bqq')$ $m_t = 175$ GeV, $\sqrt{s} = 500$ GeV	multi jets particle flow b tagging lepton tagging tracking	σ A_{FB} m_t
$e^+e^- \to \chi^+\chi^-/\chi_2^0\chi_2^0$ $\sqrt{s} = 500$ GeV	particle flow WW, ZZ separation multi jets	σ masses

M. Peskin:

If the LHC discovers that electroweak symmetry breaking results from a new spectroscopy such as supersymmetry,

the ILC is needed to determine the model unambiguously by measuring the masses, couplings and spins of new particles.

If the LHC discovers that electroweak symmetry breaking results from strong interactions in the Higgs sector,

the ILC is needed to measure these strong interactions through W and top processes.

If the LHC discovers a minimal Higgs boson and nothing else,

the ILC is needed to check precisely that this particle indeed generates all masses of quarks, leptons, and gauge bosons.

M. Peskin

We recommend that the following processes be studied in the LOI frameworks in preparation for a possible LHC discovery in 2010:

$$
\begin{aligned}
&500 \text{ GeV} : \\
&\quad e^+e^- \rightarrow b\bar{b}, c\bar{c} \qquad \sigma, A_{FB} \text{ for each } P_e \\
&\quad e^+e^- \rightarrow t\bar{t} \qquad \sigma, A_{FB} \text{ for each } P_e \\
&\quad e^+e^- \rightarrow \chi^+\chi^-, \chi^0\chi^0, \ \chi \rightarrow \nu, \ell + \text{stable } L \\
&1 \text{ TeV} : \\
&\quad e^+e^- \rightarrow \nu\bar{\nu}h^0, \ h \rightarrow b\bar{b} \quad m_h = 200 \text{ GeV} \\
&\quad e^+e^- \rightarrow t\bar{t}h^0, \ h^0 \rightarrow WW, ZZ \quad m_h = 200 \text{ GeV}
\end{aligned}
$$

IDAG Recommendations

a. **The ILD and SiD concepts are validated and should be considered for the next phase of detailed baseline studies together with GDE. They constitute a solid basis for the two-detector push-pull concept with a large amount of complementarity in their design and expected performances. Tracking options are very different, and even if their baseline choices for calorimetry are similar, their implementation and exploitation will ensure robustness in the ILC physics results. They should both demonstrate a feasible solution at the end of the TDR phase of the accelerator.**

b. **The Fourth concept is not validated. However R&D on dual readout calorimetry should be supported in view of its potential for higher energy colliders.**

Full IDAG report available in ILC Documents, link to be activated soon in Physics and Detectors area

The Landscape: Lepton Colliders

- At least three possible options for a Lepton Collider have been discussed:
  - ILC superconducting linear collider
  - CLIC or a variation of it based on warm technology
  - Muon Collider

- All are aiming to provide documentation on the 2012 timescale or earlier

- These three options are serious proposals and we cannot dismiss them

- However, only the ILC is "shovel ready" (already today).

  If the LHC says 'go!' – even if that signal comes as late as 2015 – the ILC is the only viable option!

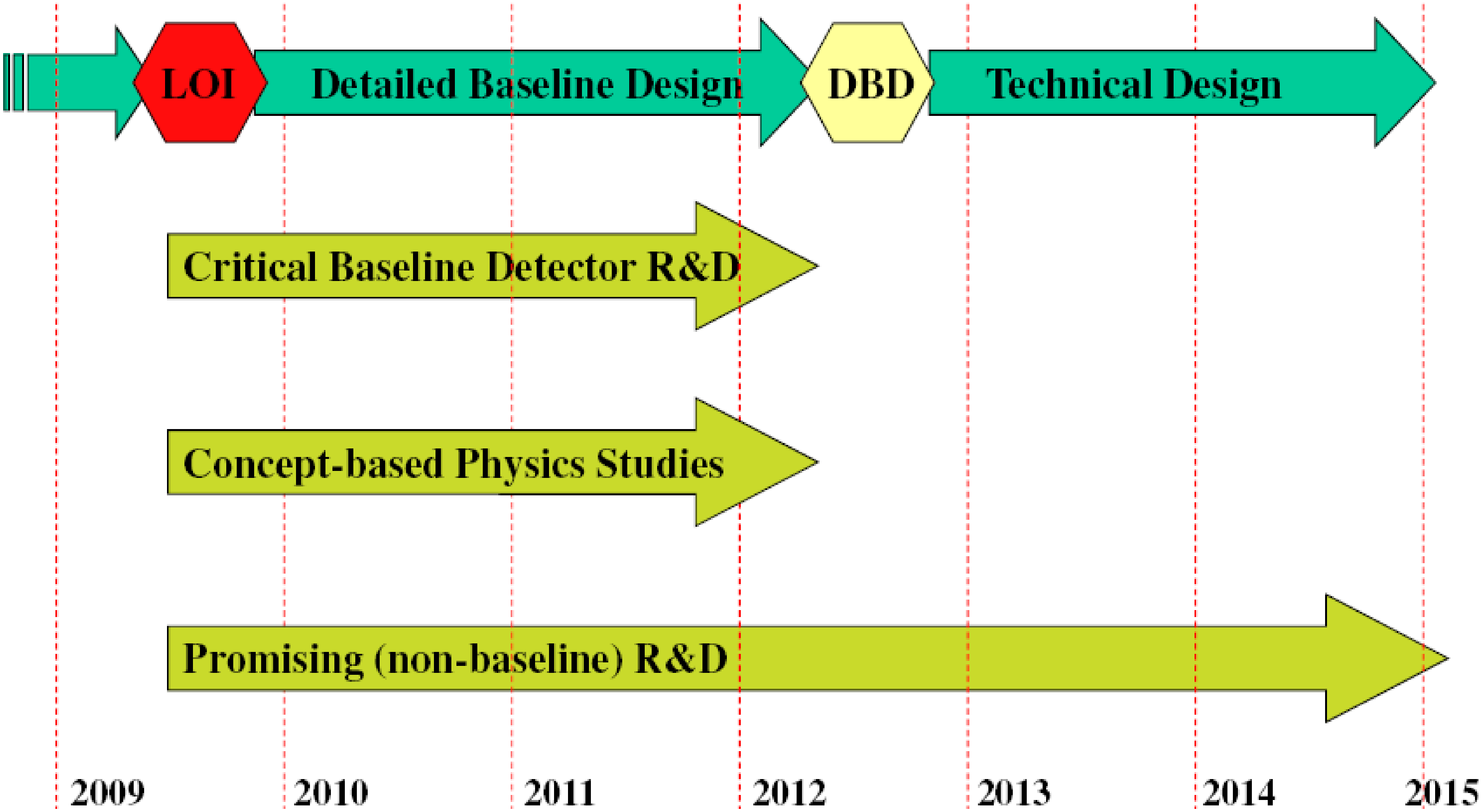
R&D Collaborations

- CALICE Collaboration
- FCAL Collaboration
- LC-TPC Collaboration
- SILC Collaboration
- VERTEX Detector R&D groups
- SiD Tracking
- SiD ECal
- Dual Readout Studies
- EUDET
- ...

- Dedicated teams, good R&D programs, good and steady progress, some within collaborations that do not hold authority or resources. Real tribute to their commitment!

- The work presented in the parallel sessions speaks for itself

A Three-Fold Path



- Three paths listed in decreasing priority

Cooperation

- Baseline / Reference choices for the validated detector concepts

Detector	ILD	SiD
Premise	PFA + TPC	PFA + Si Trkr
Vertex Detector	5/6-layer silicon pixel	5-layer silicon pixel
Tracking	MPGD-TPC + Si	Silicon strips
EM calorimeter	Silicon-Tungsten	Silicon-Tungsten
Hadron Calorimeter	Analog- scintillator	Digital Steel - RPC
Solenoid	3.5 Tesla	5 Tesla
Muon	Instrumented flux return	Instrumented flux return RPC
Forward Cal	Si-W	Si-W

CLIC and ILC

E_{JET}	$\sigma_E/E = \alpha/\sqrt{E_{jj}}$ $\lvert\cos\theta\rvert<0.7$	σ_E/E_j
45 GeV	25.2 %	3.7 %
100 GeV	28.7 %	2.9 %
180 GeV	37.5 %	2.8 %
250 GeV	44.7 %	2.8 %
375 GeV	71.7 %	3.2 %
500 GeV	78.0 %	3.5 %

- CLIC aims at a CDR in 2010 after establishing a proof of principle by CTF3 and at a TDR ~2016 for a 3 TeV project with a 500 GeV 1st step
- ILC has provided help and tools to develop a CLIC detector concept
- ILD and SiD (with increased size) are viable at 3 TeV with thicker calorimeters (8 Λ_I)
- Two issues however: time structure and increased background at higher energies
- At 3 TeV γγ interactions deposit ~25 GeV every 0.5 ns with impact on jet reconstruction

CLIC and ILC

- Key aspects: time stamping in µvertex (Si3D) and forward calorimetry
- For instance ILD assumes 25 µs (~30 bunches) time integration at µvertex while CLIC should aim at ~10 ns
- Note also that the excellent collaboration with CLIC extends to MDI+Engineering with the help of CERN experts (LHC detectors, with very active participation from CMS engineers)
- While the spontaneous collaborative approach seems to work very well, some overview is needed and a ILC-CLIC working group is being organized in agreement with the RD and ILSSC

Coordinated FLC detector- effort in Spain

Silicon for Large Colliders

IFIC, IFCA (since 2005), UB, CNM, USC
IFCA→EUDET member, several associates
New EU project: AIDA

Strong Spanish participation in DEPFET
IFIC (since 2005)
USC, UB, URL, CNM (since 2008)
IFCA soon

CALICE

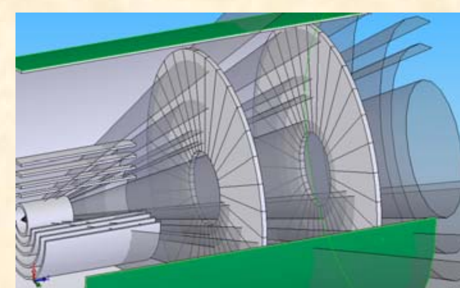
CIEMAT Madrid

and activities in accelerators R&D

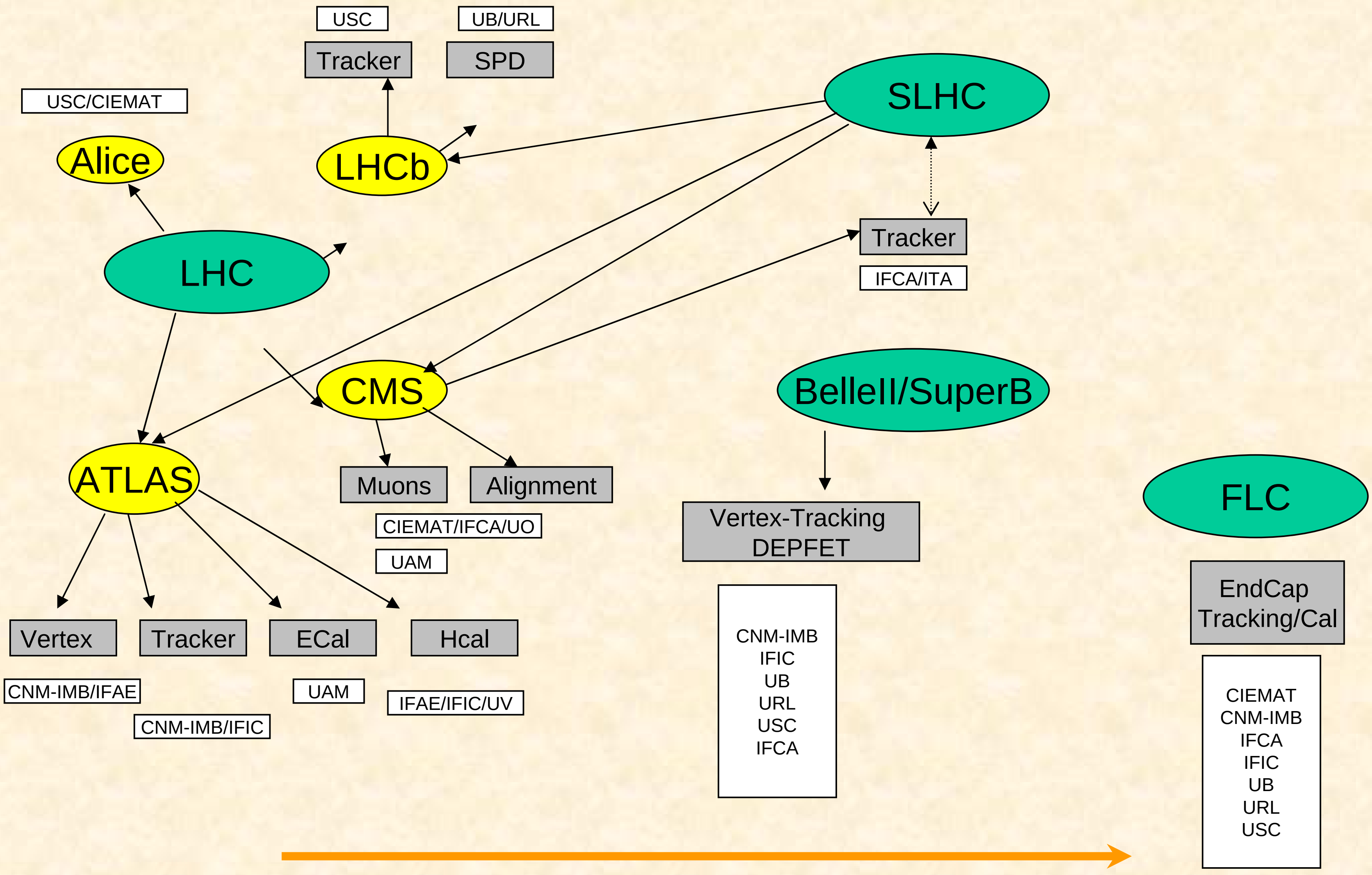
Coordinated effort :

- **regular meetings**
- **funding/projects**
- **R&D interests**
- **the forward tracker…**

Forward Tracker



Spanish interest and evolution



CMS Upgrade: Outer Silicon Tracker

- Since 2009 part of two official R& D projects for the upgraded CMS Tracker.
- R&D Targets:
  - Sensors
    - Thin sensor, Short strips, embeded Optical Fiber S (OFS), INTEGRATED PITCH ADAPTORS
  - Module engineering
    - Integration of structural and environmental monitor based on OFS in CFC
    - Laser-based alignment
    - Powering, EM safe module design.

LARGE OVERLAP WITH FP7 AIDA R&D

Infrastructure, for whom?

AIDA must be supported by,
and the proposal must cater to,
the whole detector R&D community

(s)LHC →

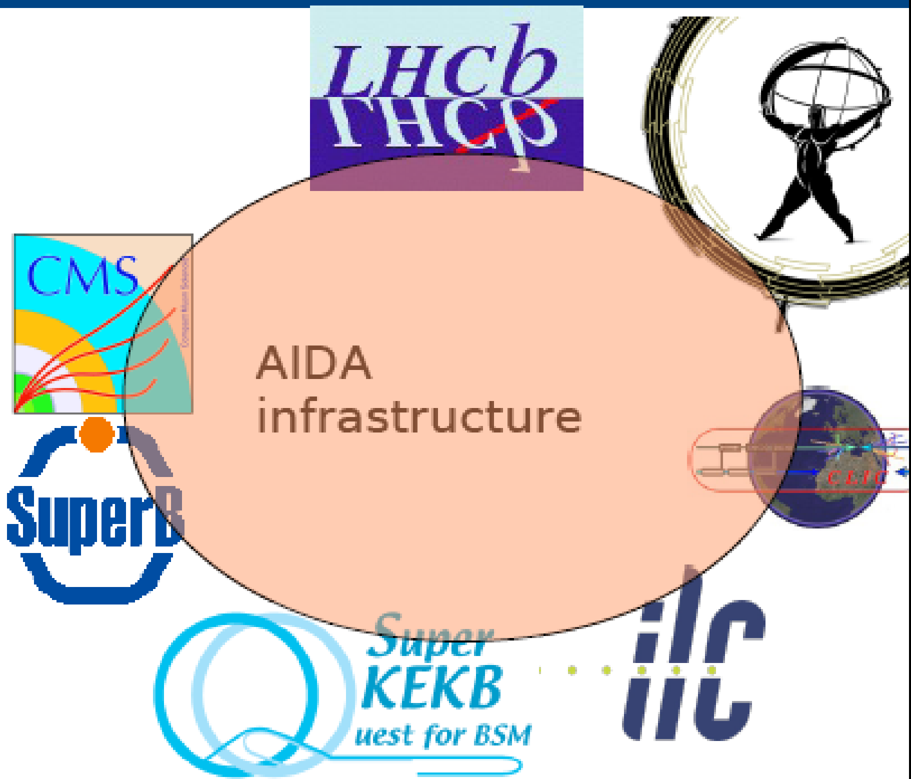
- ✔ *ALICE (sALICE?)*
- ✔ *ATLAS (WP9)*
- ✔ *CMS (WP2)*
- ✔ *LHCb (WP9)*

Future e+e- machines →

- ✔ *ILC (WP9)*
- ✔ *CLIC (strong overlap with ILC)*

Super B-factories →

- ✔ *Belle-II (WP9)*
- ✔ *SuperB (WP8)*
- ✔ *Accelerator-based neutrino experiments (WP8)*



Caters to communities developing detectors that are to be installed within the AIDA life-time (ATLAS IBL, LHCb VELO upgrade, Belle-II PXD) and to others pursueing exciting new concepts that may yield the detector technology of the next (or next-to-next) generation of experiments)

Spanish participation

WP3.2 3D interconnections

CNM
UB

WP9.3 Precise Pixel Detectors

USC
IFAE
IFIC
IFCA

WP9.4 Silicon Tracking

CNM
IFIC
IFCA
UB

WP9.5 Granular Calorimetry

CIEMAT

EC will evaluate the validity of CPAN as a JRU in the negotiation phase

- ✔ if AIDA is funded
- ✔ in ~4 months