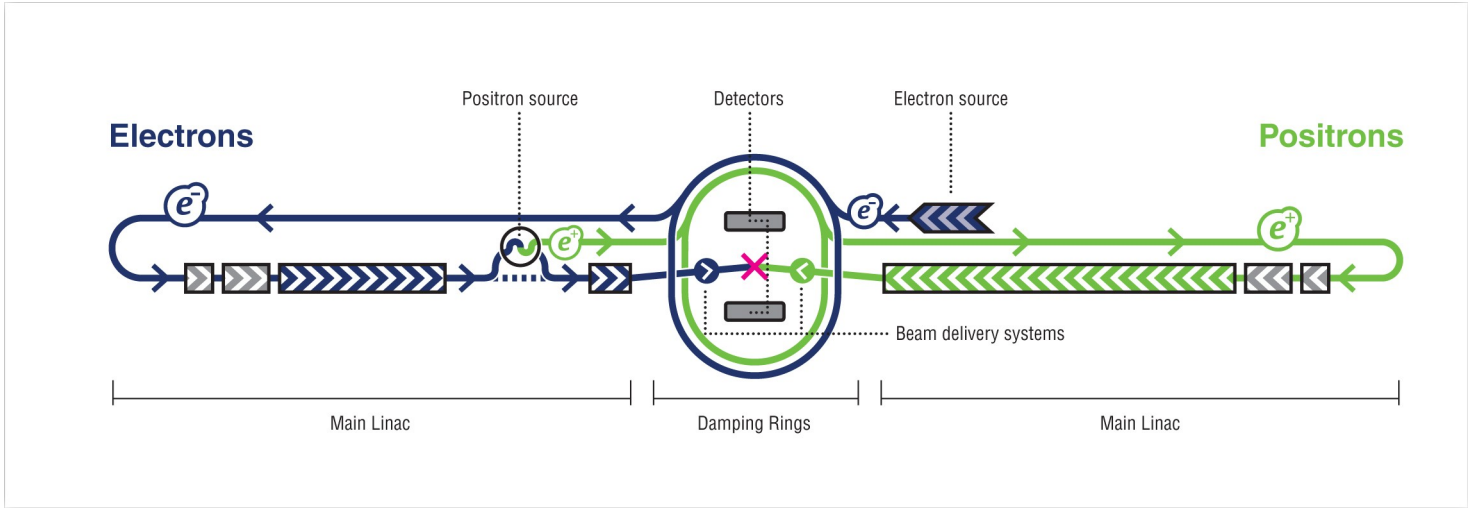
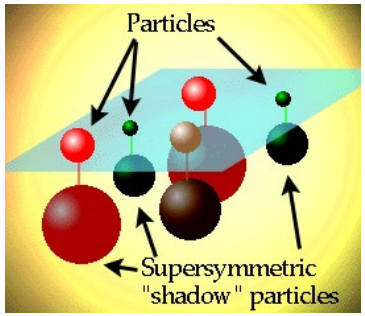
ILC
News from the future Linear Collider

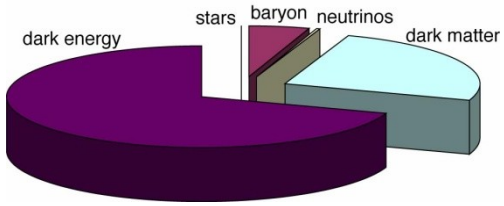


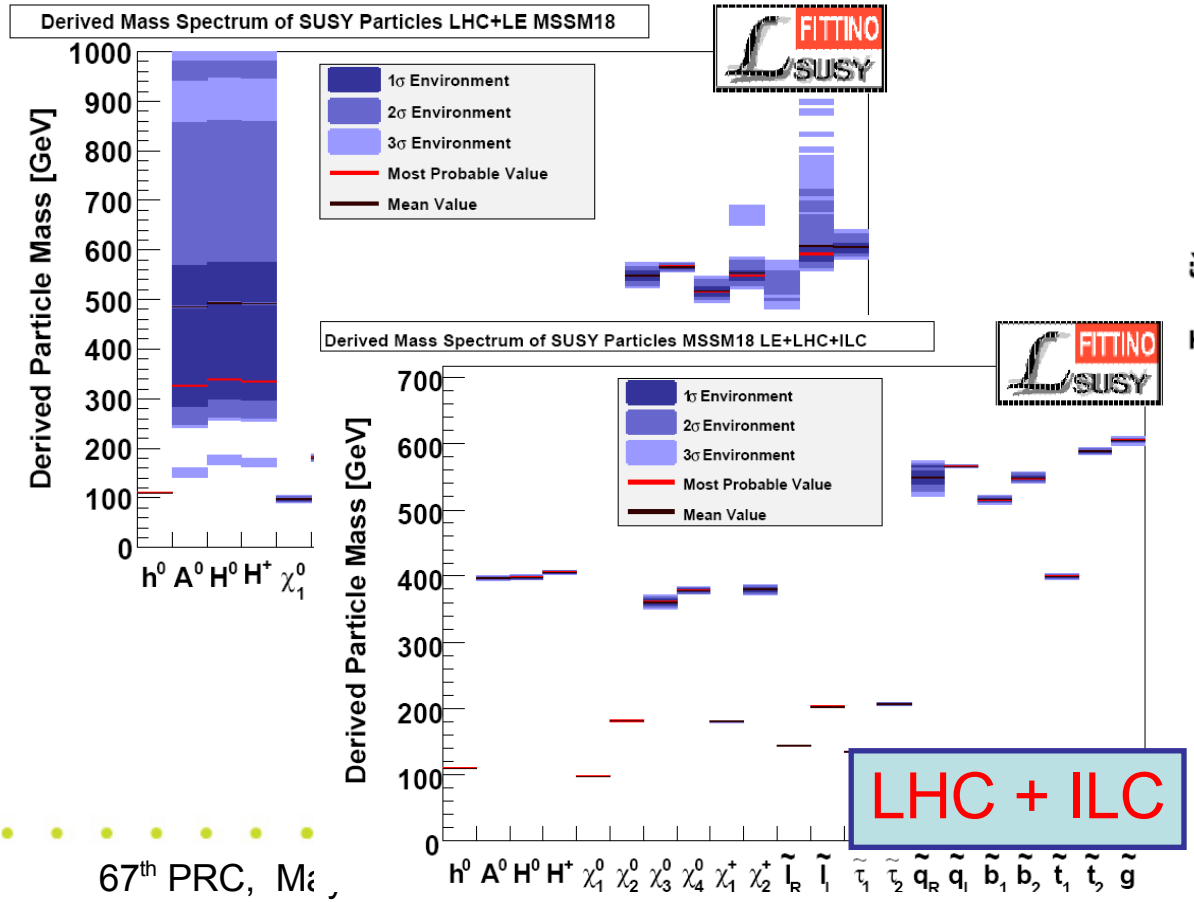
Jenny List
DESY

The future is a lepton collider

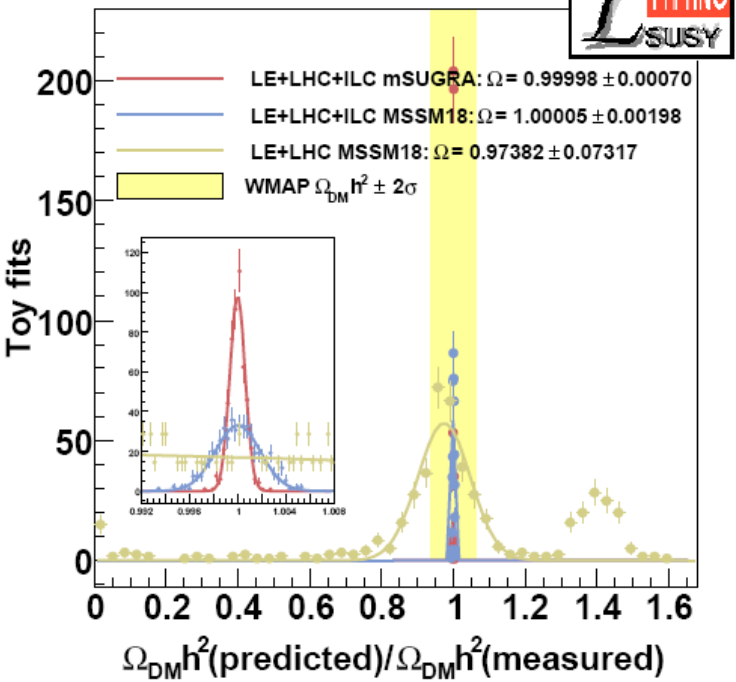


To complement the LHC discovery with high precision measurements the next step of HEP is to build an electron-positron collider
=> **ILC** is **the** ready-to-build technology!





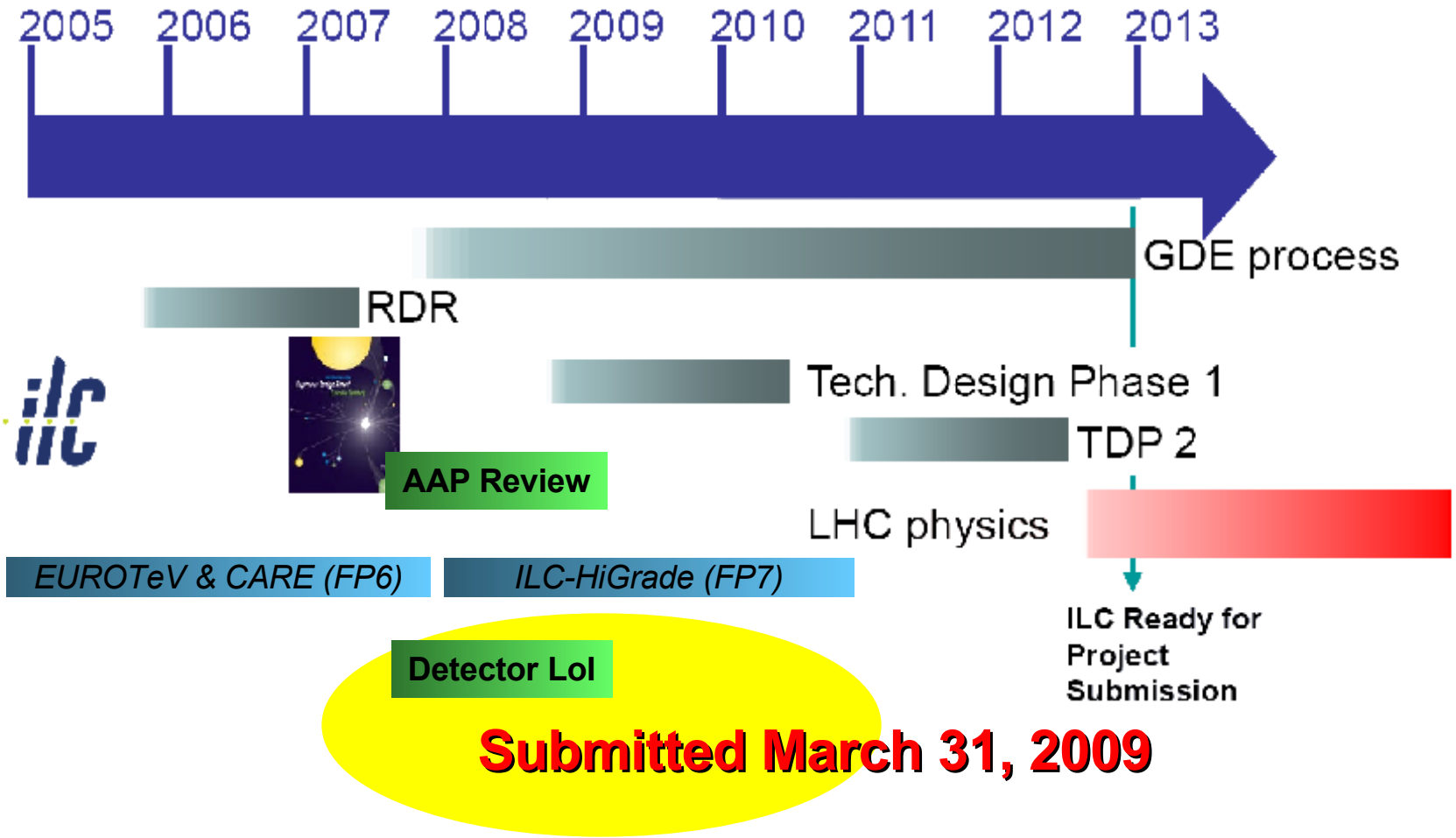
LHC + ILC



International advisory committees (US APP2010, CERN Council, ACFA, ECFA, ICFA) have repeatedly supported a future linear collider

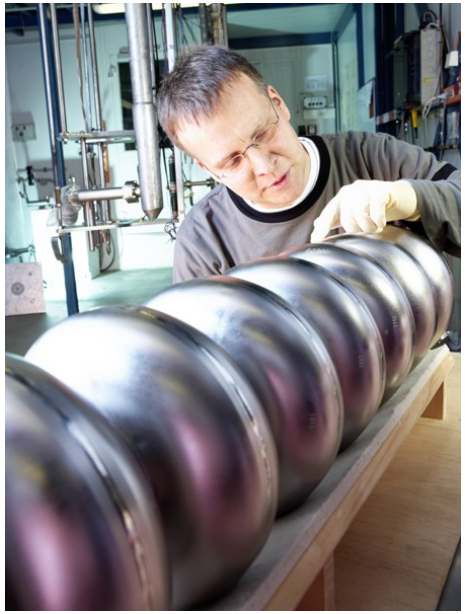
ILC Time Scales

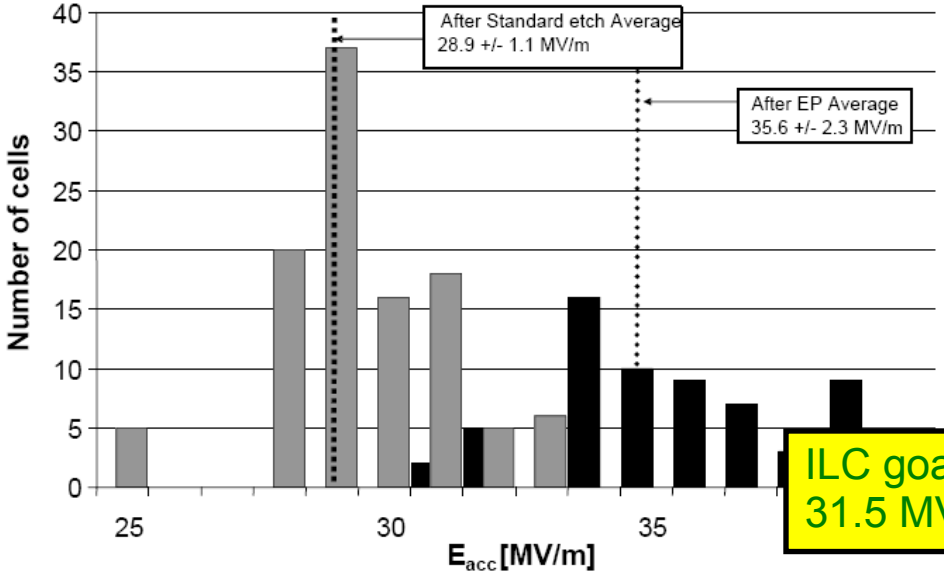
The International Linear Collider is the most mature project for a lepton collider



Superconducting RF

- 1990: 5 MV/m SCRF
- 2000: 25 MV/m achieved at TTF
- 2003: 35 MV/m achieved
- 2006: >35 MV/m achieved in single cells





ILC goal:
31.5 MV/m operational accelerator gradient

DESY develops the industrial procedure to produce high gradient SRF cavities with high efficiency

- XFEL will order ~800 cavities specified at ~23.5 MV/m (28 MV/m expected)

Dedicated batch of 30 cavities available for high gradient studies

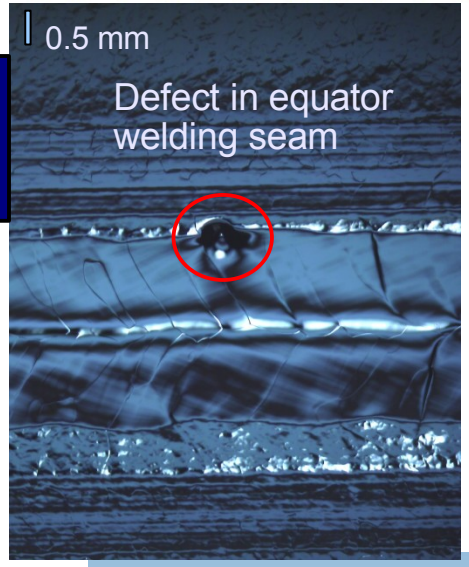
➔ ILC-HiGrade project

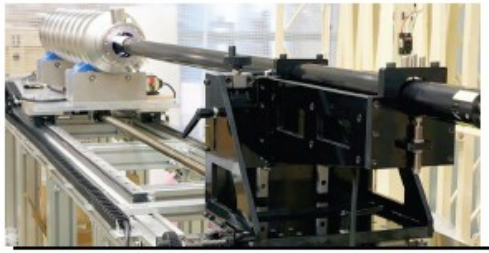
High Gradient Developments

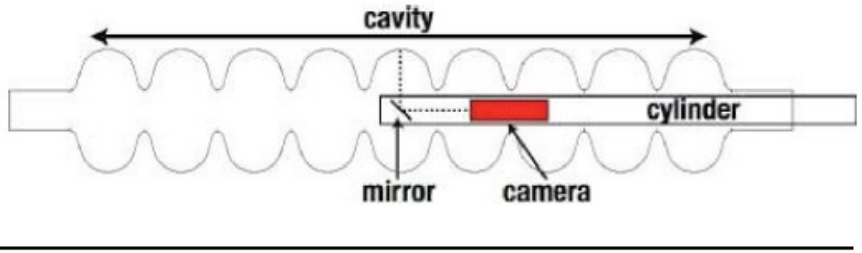
ILC focussed activities

Correlate surface defects with achieved gradient
Optical inspection of the inner surface of cavities
(DESY in coll. with KEK and Kyoto Uni.)

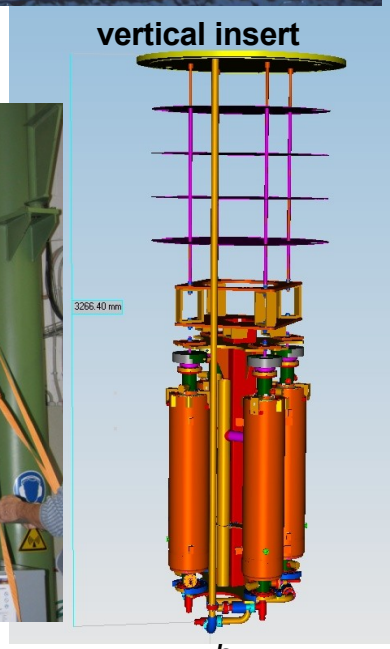
Defect identified to be correlated with quench!



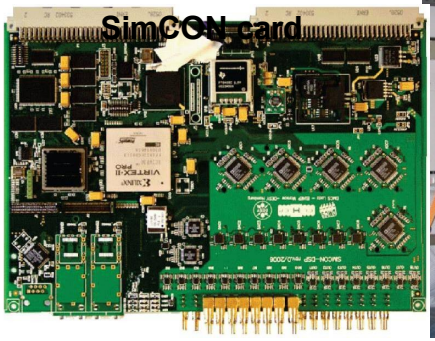


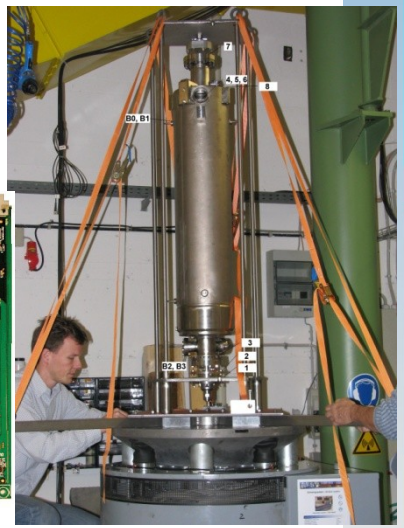


Vertical insert
- resonance determination
- shock test, transport study



Low level RF control
- automatic qualification of cavity
- resonances identification
- tuning





DESY & Uni Göttingen (Alliance project)

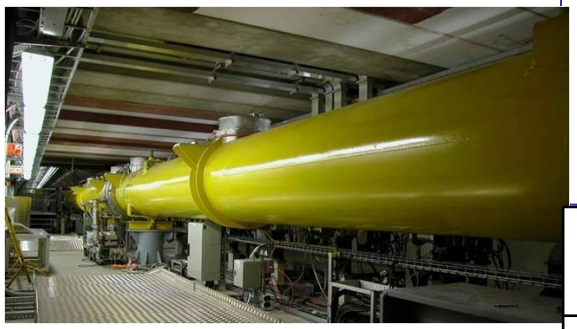
➔ Fast feedback on RF quality

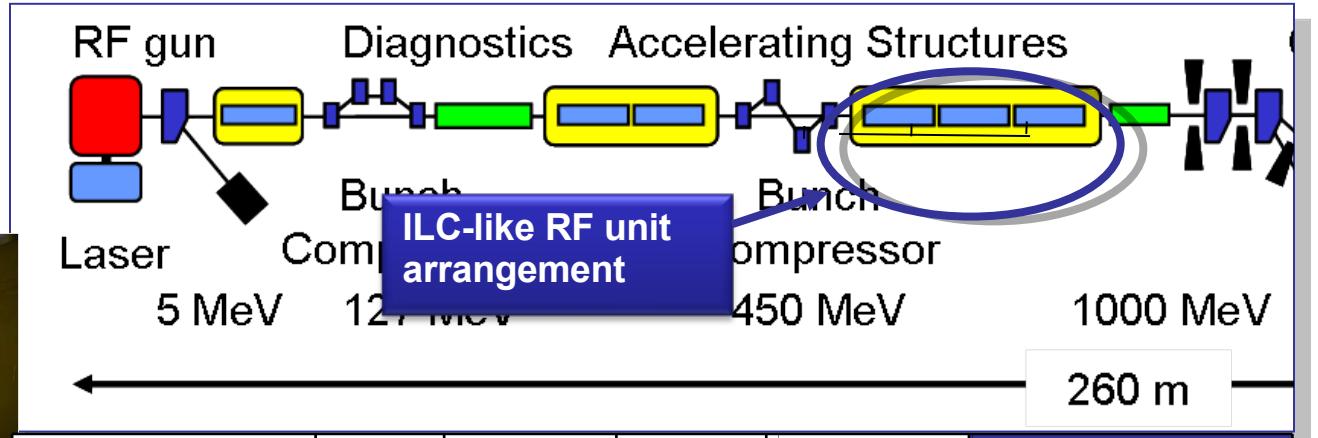
A strong synergy between accelerators

Operation of TTF/ FLASH with ILC-like beam parameters: 9mA experiment

➔ Unique opportunity at DESY because of TTF/ FLASH

... the only facility to test cavity strings until 2012





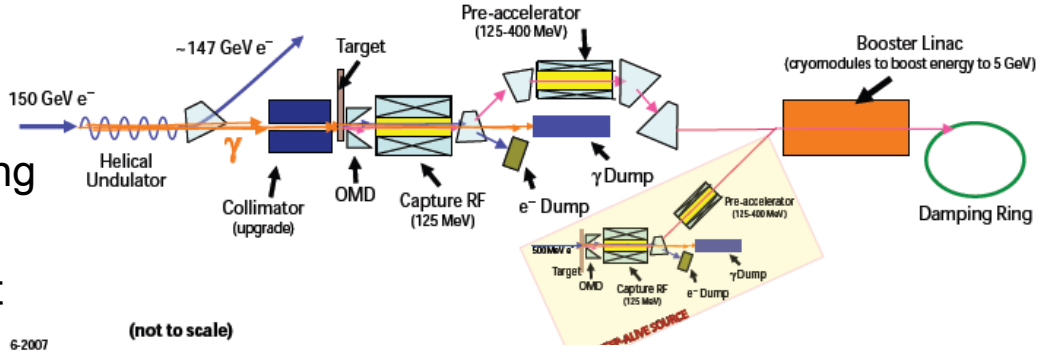
		XFEL X-Ray Free-Electron Laser	ILC	FLASH Free-Electron Laser in Hamburg	FLASH experiment
Bunch charge	**nC**	**1**	**3.2**	**1**	**3**
# bunches		**3250***	**2625**	**7200***	**2400**
Pulse length	**μs**	**650**	**970**	**800**	**800**
Current	**mA**	**5**	**9**	**9**	**9**

Growing International Collaboration (ILC-driven)

SLAC, FNAL, KEK, SACLAY, ANL,DESY…

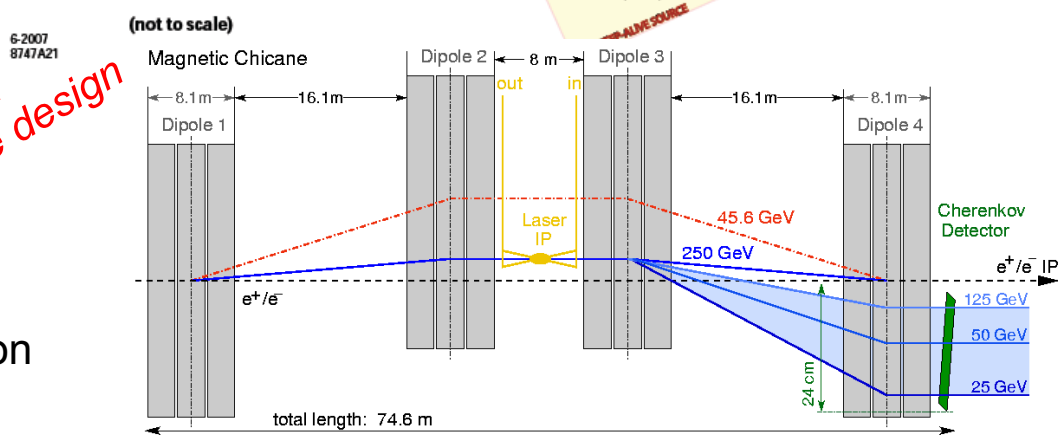
Beam Instrumentation

- Positron source development
  - baseline design: helical undulator
  - technological optimization / prototyping in collaboration with UK institutes
  - generation / measurement / transport of polarized positron



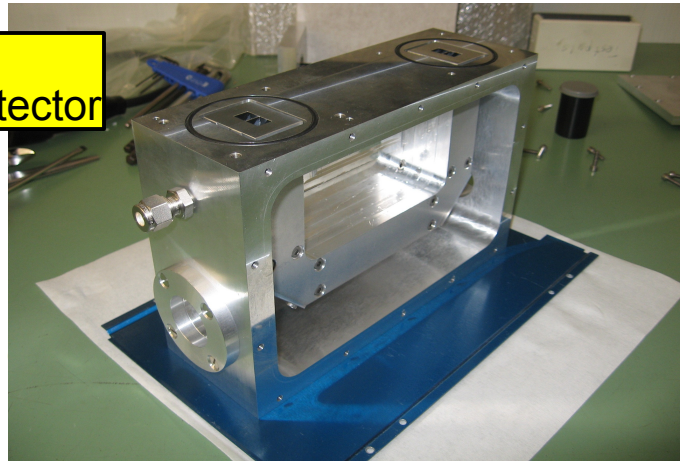
- Polarimetry
  - at low and high energy
  - R&D at DESY: Cherenkov Detectors & Chicane Design
  - Recently: baseline changed in reaction to studies done at DESY

impact on machine design



- Beam dynamics
  - main linac dynamics
  - beam delivery and machine detector interface
  - spin transport

Prototype of polarimeter detector



ILC physics demands precision detectors

Precision Physics/ New Physics

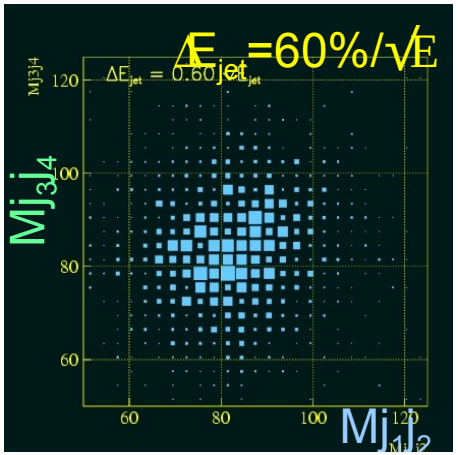
- rare processes/limited statistics
- many final states involving heavy bosons (Z,W,H):

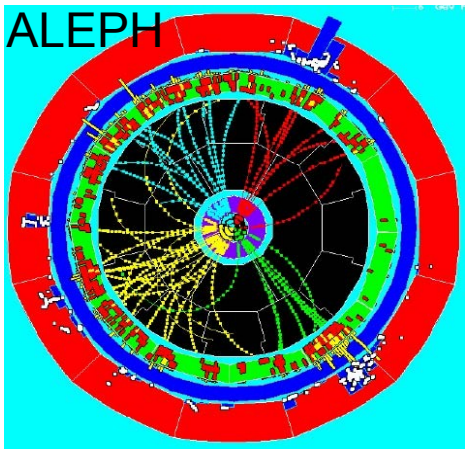
$e^+e^- \rightarrow WW\,w$, $e^+e^- \rightarrow ZZ\,w$

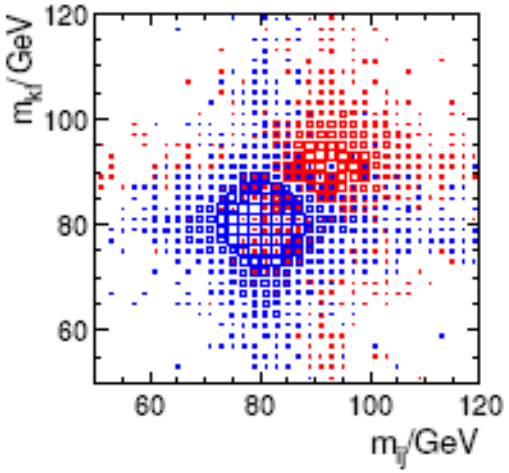
- hadronic decay of W and Z
  - branching ratio ~70%
  - result in two hadronic jets

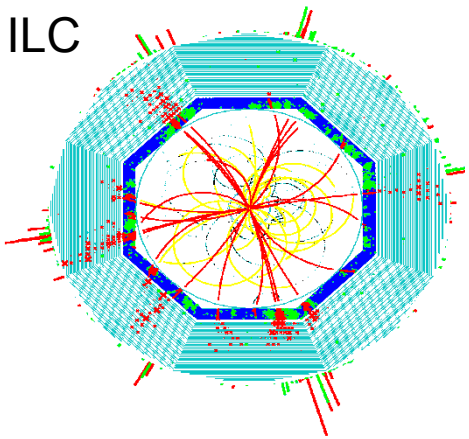
requires excellent jet energy resolution

➔ Concept: Particle Flow
Validate by testbeams and full simulations!









- Large international R&D effort to prove Particle Flow
- DESY detector R&D program covers the key issues relevant to Particle Flow

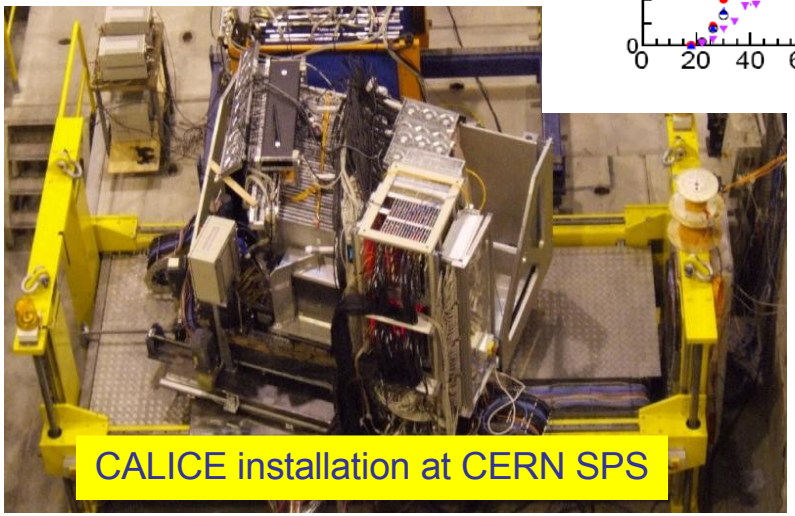
Calorimetry: Testbeam Results

CALICE collaboration:

Testbeam at CERN and FNAL with 3 highly granular calorimeter prototypes

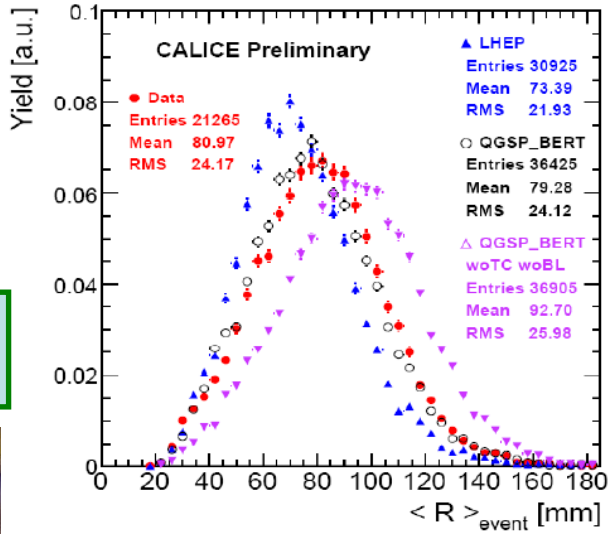
➔ proof of principle of Particle Flow!

~30TByte data collected (>300 M events)

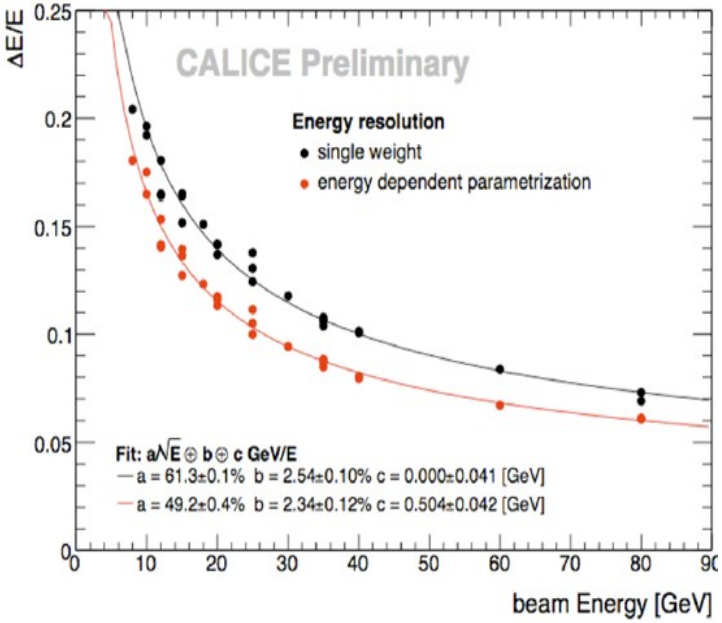


CALICE installation at CERN SPS

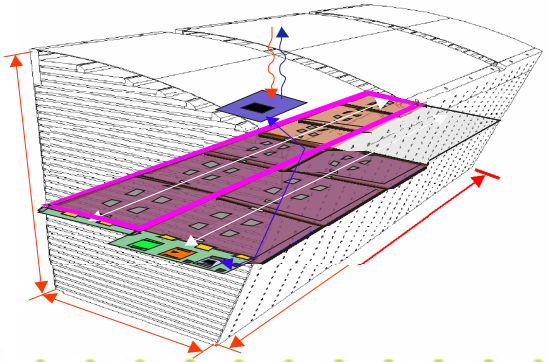
Transverse shower shape: QGSP_BERT with correct neutron treatment (timing, Birks law) works very well



Energy resolution w/o Pflow: 49%/√E with very simple energy weighting -> very good calo by itself



Next generation HCAL prototype (EUDET):
-solve technical issues
-mechanics
-integrated electronics
-scalable to ILD



Tracking & Vertexing R&D

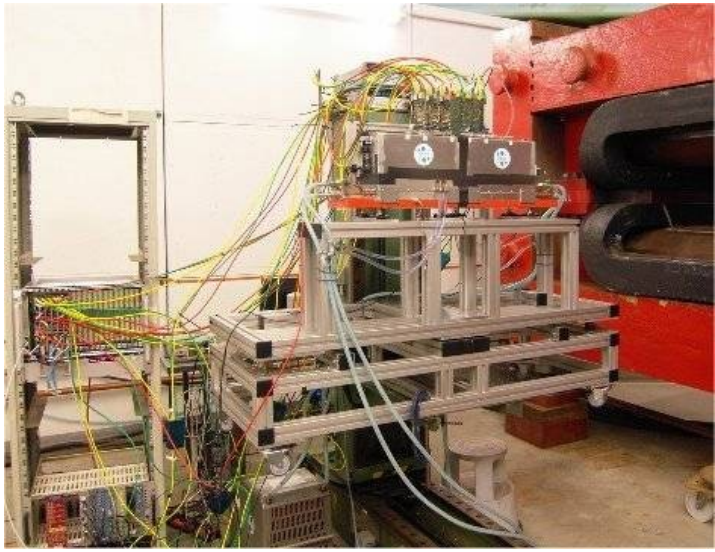
A large Time Projection Chamber prototype:

international effort:
LC-TPC, EUDET, Alliance, KEK, CERN

Particle Flow requires an excellent tracking detector
DESY goal:

- demonstrate the feasibility of a Micro-Pattern Gaseous Detector TPC
- offer an infrastructure to do extensive tests of different gas amplification systems

Initial installation and operation in DESY test beam



Test beam telescope for silicon vertex detector tests:

DESY supports the world wide effort to compare different technologies for a silicon vertex detector

➔ support central services needed to operate the detector

- power and cooling schemes
- test beam telescope with high precision and readout speed (EUDET project)

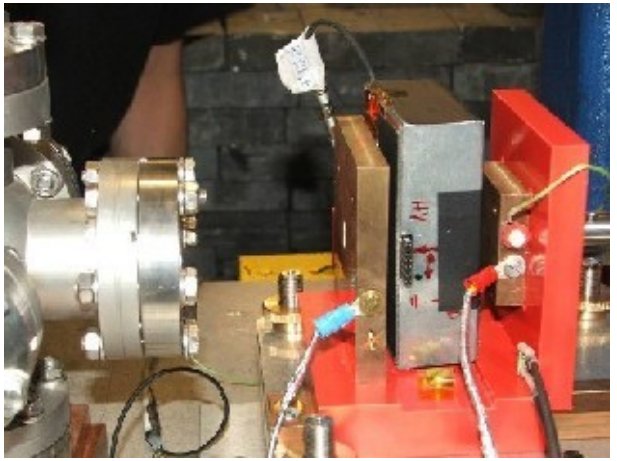
Forward Calorimetry

Collaboration
High precision design

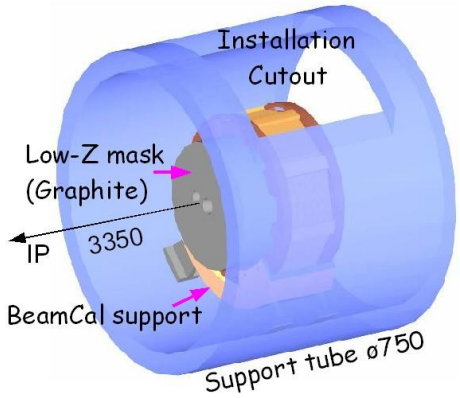
Belorussia, France, Germany, Israel, Japan, Poland, Romania, Russia, Serbia, Switzerland, UK, USA

functions: - precise and fast measurement of the luminosity
- electron veto down to lowest polar angles

challenges: - radiation hard sensors
- fast readout



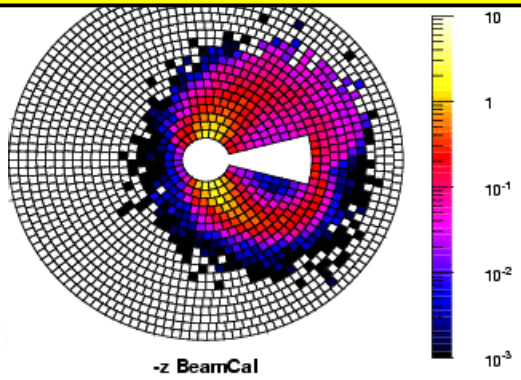
http://www-zeuthen.desy.de/ILC/fcal/



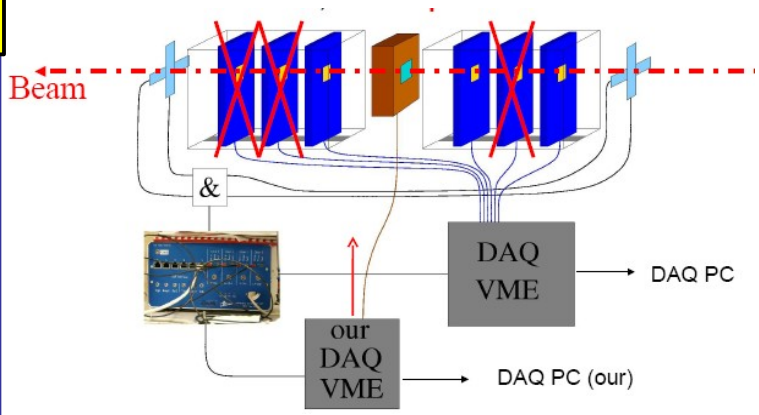
setup for sensor irradiation tests ➔ in an high intensity electron beam

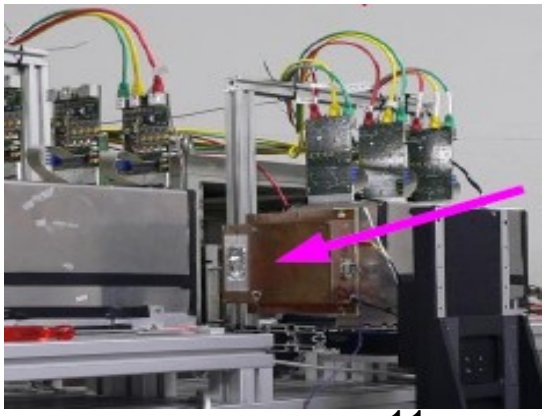
integration of BeamCal into the ILD detector

Beam background simulation



Testbeam equipment for diamond sensor performance studies using the EUDET telescope





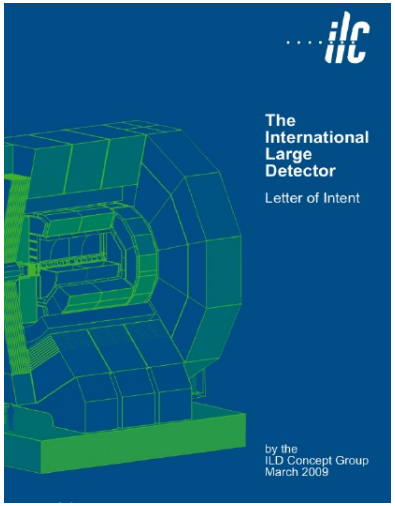
Letters of Intent & IDAG

Early 2008, ILCSC called for Letters of Intent for detectors

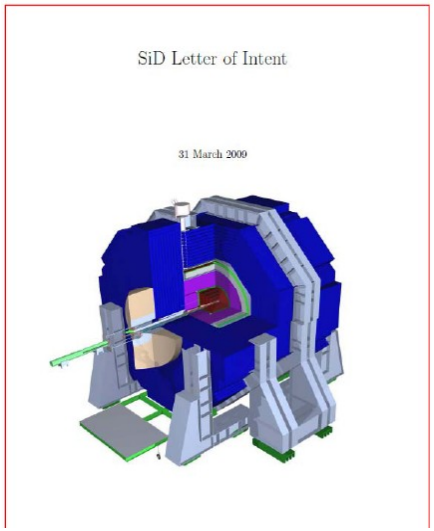
Deadline was March 31 2009

3 LoIs submitted:

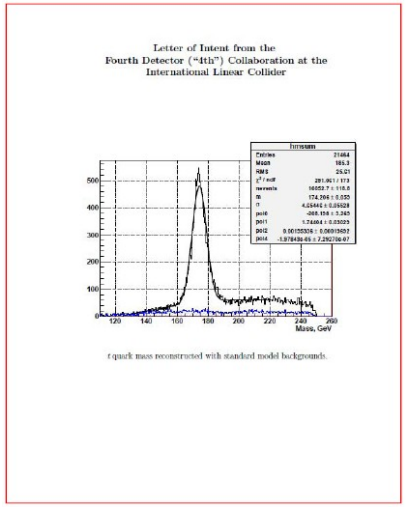
ILD



SiD



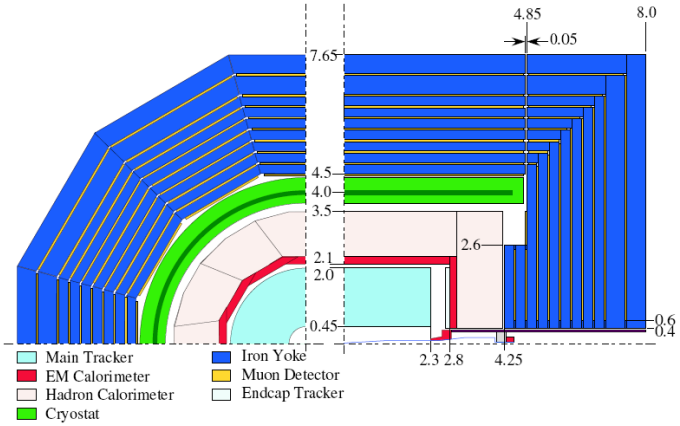
4th



Will be reviewed by **I**nternational **D**etector **A**dvisory **G**roup
(16 members from theory, experiment, accelerator communities)

Validation by IDAG = "green light" to write a Technical Design Report ~2012
in time for the ILC Project Proposal at the end of Technical Design Phase 2

Detector Concept: GLD + LDC = ILD



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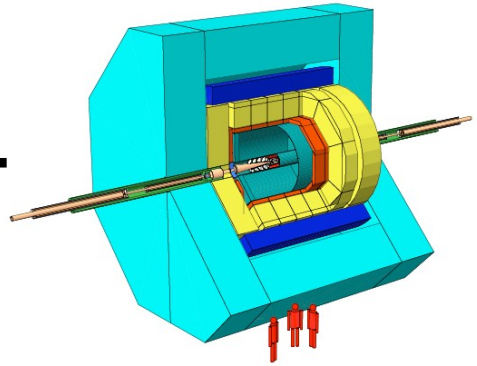

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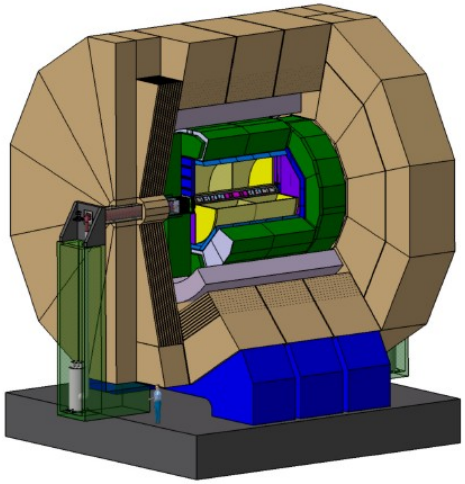


2008: two concepts based on TPC & Particle Flow merged into ILD

=> reoptimise overall detector dimensions:

R, B, aspect ratio, cell sizes, calorimeter layers, ...

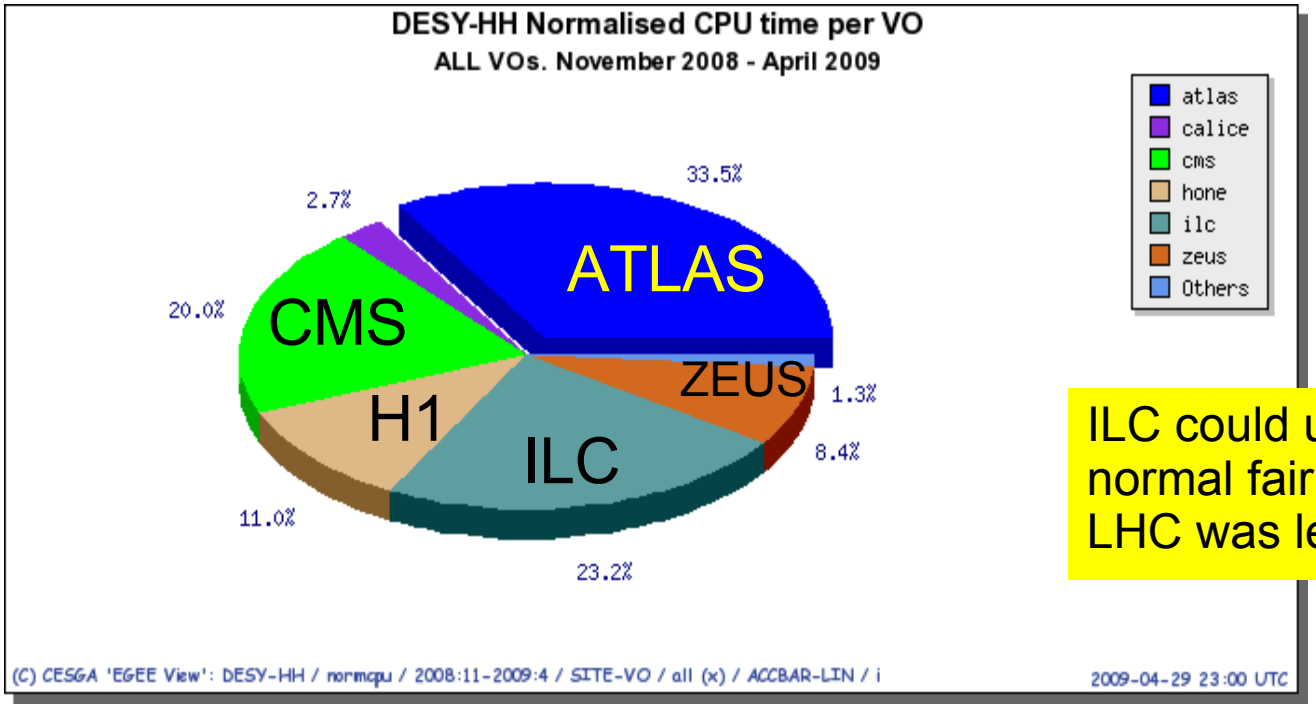
=> ILD defined in September 2008

merging coordinated by *joint steering board* with members from LDC and GLD and from all three regions

for practical reasons:

agreed to use LDC software (core supported by DESY) for LoI

Behind the scenes: MC production

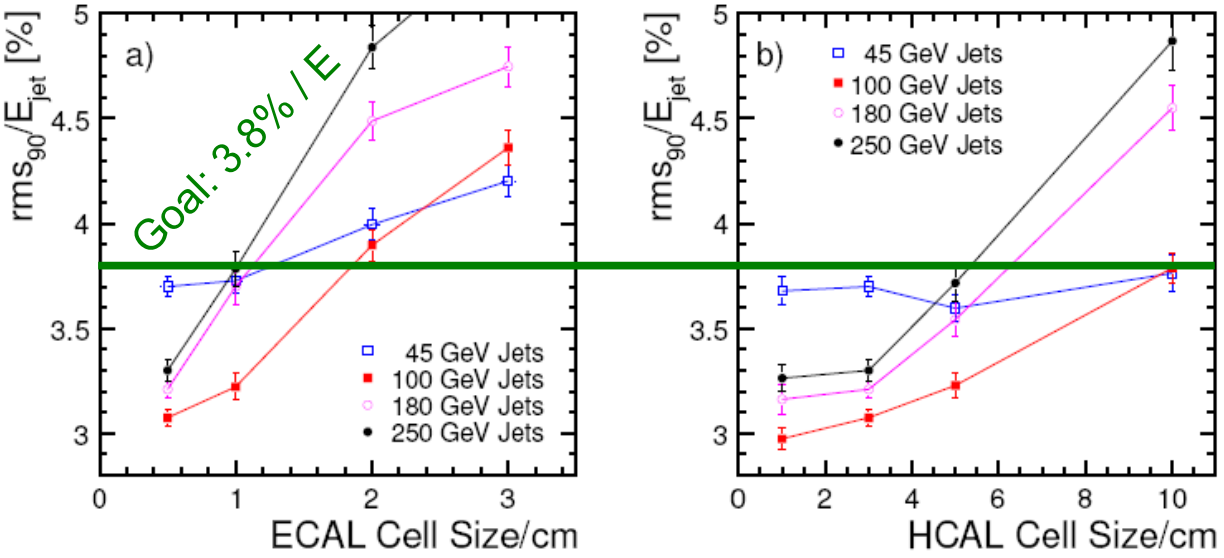


ILC could use more than normal fair share since LHC was less active

MC Samples for LoI:

- **Common generator files for all concepts -> separate simulations**
- **ILD:**
  - In total 44 Mio events simulated and reconstructed
  - Production managed by DESY – IT / FLC
  - nearly all sim / rec jobs run at DESY Tier 2 + small fraction at Lyon

ILD optimisation & detector performance

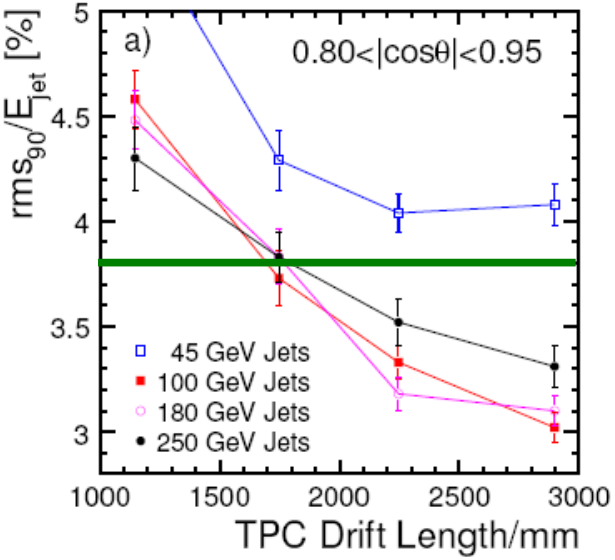


Jet energies ≥ 100 GeV require high granularity:

ECAL: 0.5 cm x 0.5 cm

HCAL: 3 cm x 3cm

(no significant gain by going below that!)



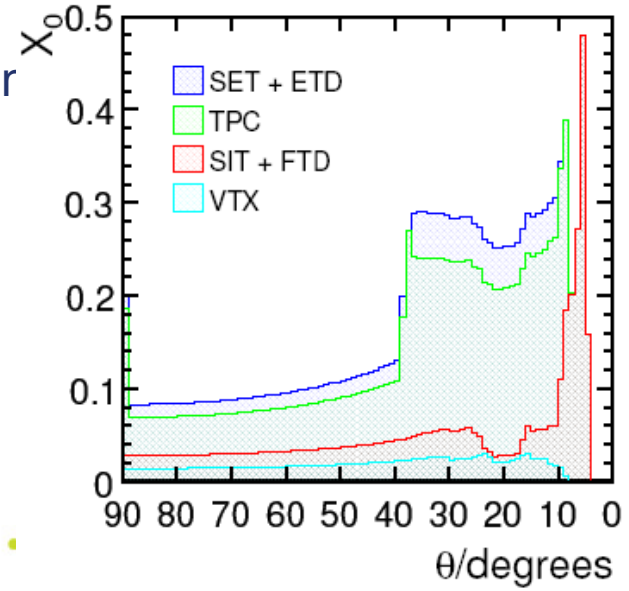
TPC length: jet energy resolution in forward regior requires L > 2m

(no significant gain beyond that!)

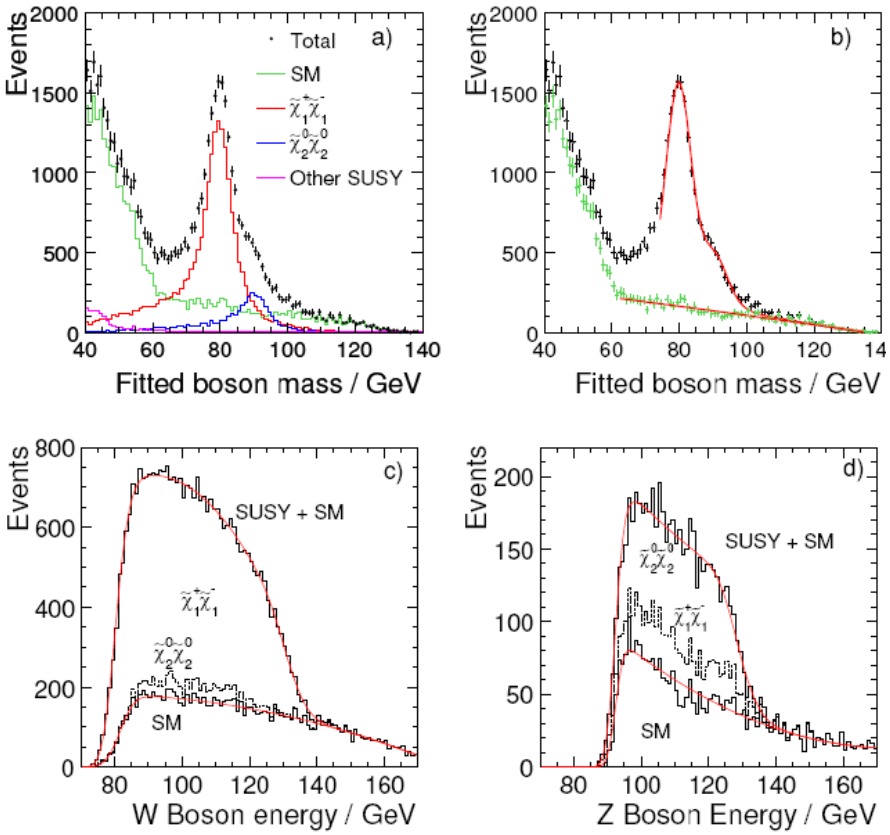
Material budget in front of ECAL :

≤ 0.1 X_0 center

≤ 0.3 X_0 endcaps



ILD physics performance



Common physics benchmarks:

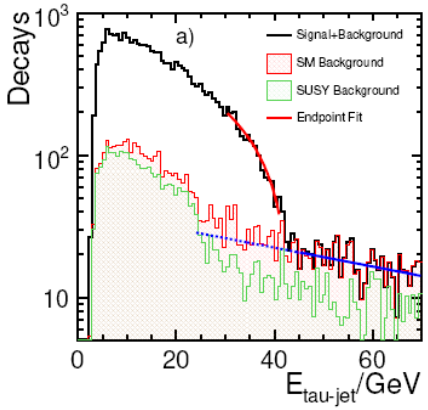
- SM Higgs: recoil mass, BR(H->bb/cc/gg)
- SM tau-pairs: AFB, tau polarisation
- SM top-pairs: mass, AFB
- SUSY: separating

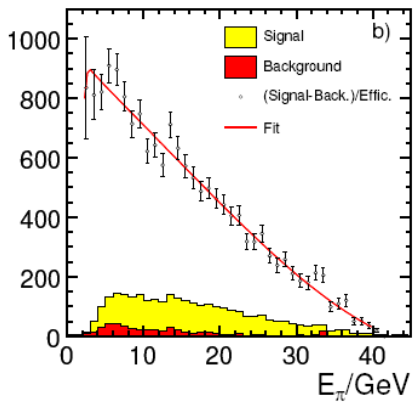
$$\tilde{\chi}_1^+\tilde{\chi}_1^- \rightarrow qq\tilde{\chi}_1^0 qq\tilde{\chi}_1^0$$
$$\tilde{\chi}_2^0\tilde{\chi}_2^0 \rightarrow qq\tilde{\chi}_1^0 qq\tilde{\chi}_1^0$$

=> excellent jet energy resolution crucial!

SPS1a' stau mass and polarisation:

- low Δm SUSY: test forward tagging!
- Analysis includes full *beam background* (nominal parameters)





After Validation: Goals for 2012

Machine schedule:

Technical Design Phase II ends in 2012 with a Project Proposal

Detector Concepts? - be ready for this as well!

- ***Prepare* technology choices: TPC read-out, Vertex detector options ECAL SiW / Sci-Strips, HCAL gas / scint. , fwd Calorimeters, ...**
  ILD approach: hardware developments should stay within R&D collaborations at least until ILC is a funded project!
- ***Conceptual* engineering: make sure there are no show-stoppers** (no resources for full engineering)
- **More detailed beam background studies**
- **Evaluate effects of different beam parameter sets** (lowP...)
- **Prove triggerless read-out scheme:** simulate a full bunch-train of machine background, e^+e^-, $e^+\gamma$, γe^-, $\gamma\gamma$ interactions taking into account the different subdetectors read-out integration times
  => and "sort it out"
- **Update physics case in view of LHC results**
  including results from R&D collaborations, background studies, full-simulation detector performance,...

Conclusions

- ILC is the proven technology for an e^+e^- Collider
  - **Quest for high gradients shows significant progress**
- DESY's assets in SCRF:
  - **FLASH is a unique test facility – many ILC parameters reached**
  - **XFEL entails industrialisation and mass production of cavities**
- Detectors: many interesting results from large scale testbeams
- Most recent event: submission of Letter of Intents (ILD, SiD, 4th)
- DESY: substantial contributions to ILD concept
  - **Computing: MC mass production**
  - **Machine Detector Interface: Push-Pull scheme, magnetic field...**
  - **Reconstruction: tracking, background studies**
  - **Physics analyses: benchmark processes and more**
- Towards 2012: ILC Project Proposal to funding agencies
  - **ILD: no technology choices planned before ILC is a funded project**
  - **BUT: be ready to make decisions fast once ILC is funded!**