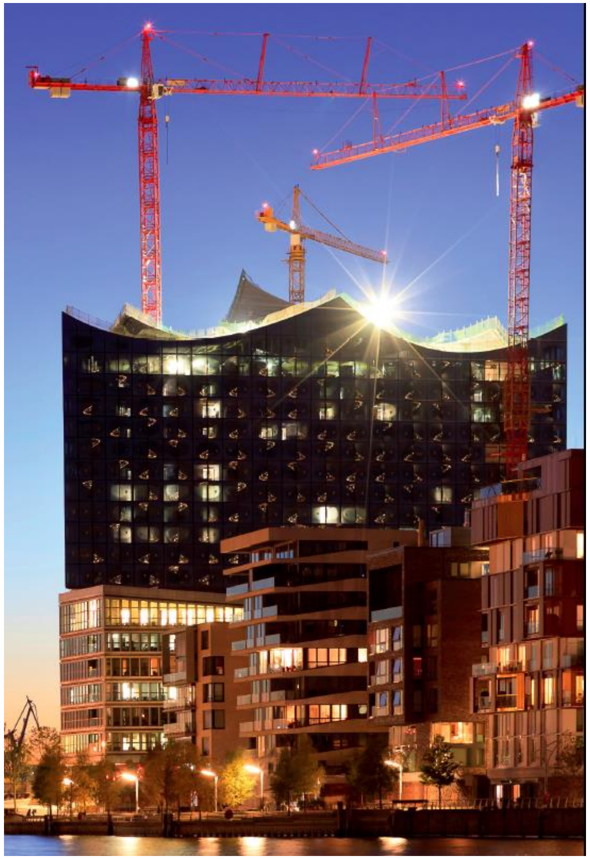
Technical Design Documentation.

How the TDD and EDMS support the ILC design process



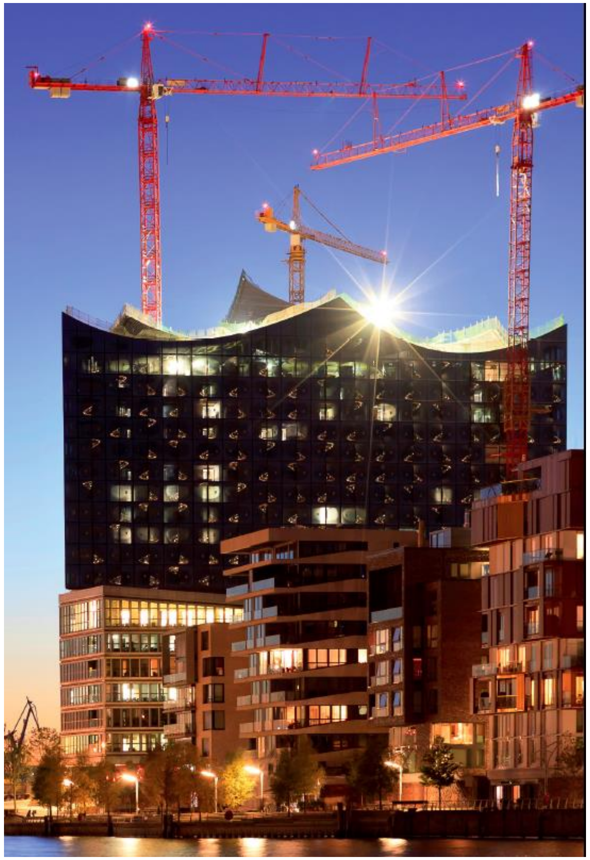
Benno List
DESY –IPP–

ECFA LC2013
European Linear Collider Workshop 2013
DESY, Hamburg
28.5.2013

HELMHOLTZ GEMEINSCHAFT

DESY

Introduction

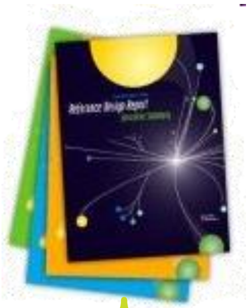


The Elbphilharmonie –
A project spinning out of control:
Completion date: 2010 -> 2015
Costs: 186M€ -> 789 M€

- ILC will be one of the biggest science projects ever
- Staying in time and budget will be an enormous challenge
- Engineering Data **Management** System / Product Lifecyle **Management** Systems are there to **support** the **Management** in their task

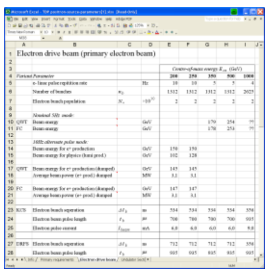
- We help you to manage information, for “knowledge is power”

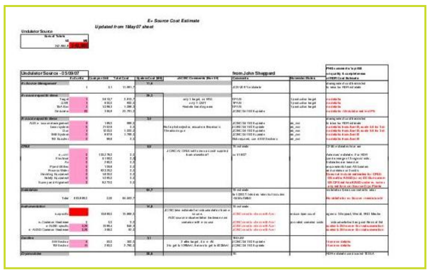
TDD, TDR and ILC-EDMS

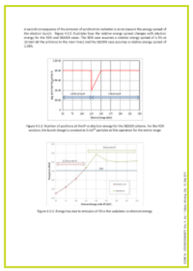


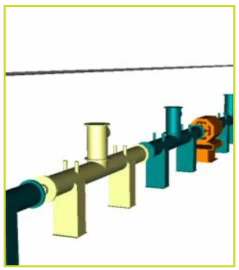
Technical Design Report (TDR) <u>summarizes</u> TDD for publication

Technical Design Documentation (TDD) captures entire design efforts, results & rationale



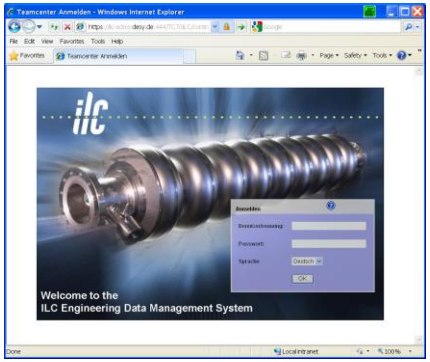






…

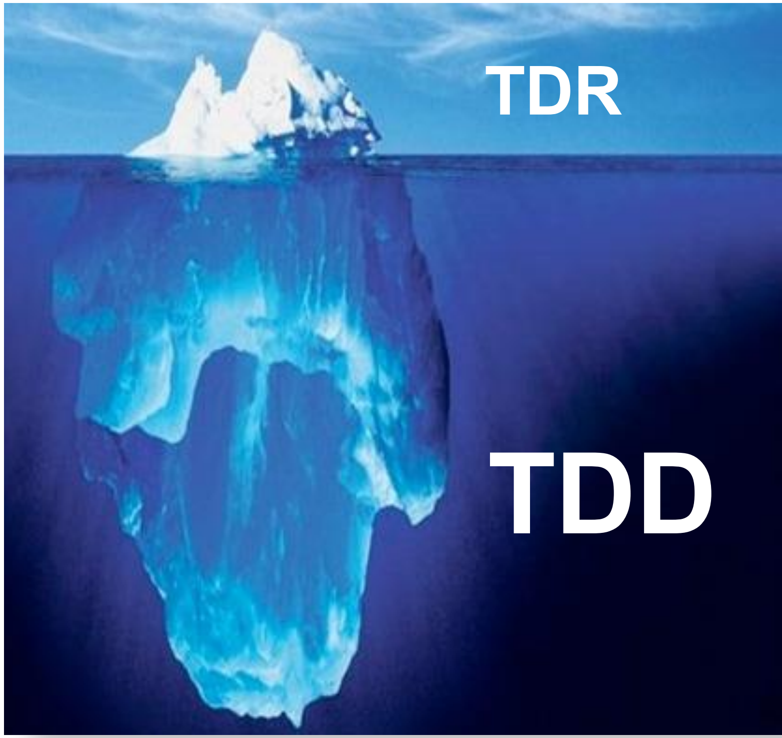
Parameters | Specifications | Cost Estimation | Calculations | CAD Models | Design Summary



ILC-EDMS <u>organizes</u> the Technical Design Documentation, providing **structure**, **traceability**, **version & configuration mgt.**, and **change control**

The Technical Design Documentation

- **Technical Design Documentation** provides the basis for all that is written up in the **Technical Design Report**
- Support the Design while it is being done, not as an afterthought:
  - Provide the single point of information
  - Provide up-to-date, authoritative data
  - Support processes:
    Reviews, Approvals, Change Requests
- We want to complete the TDD, and **continue** it



Some Statistics

- Statistics:
  - about 170 documents and CAD-models connected to WBS in EDMS
  - + >100 confidential cost documents
  - + ~100 CFS documents
  - + many, many more
  - Altogether > 1500 ILC documents in EDMS!
- Documents organized according to a WBS
- TDD web site (hosted by Fermilab) for easier access

ILC Technical Design Documentation

Reference Material | from EDMS

from EDMS

ILC TDP(163) *Last updated on: 2013-05-26*

Technical design and cost estimation of the the International Linear Collider (ILC)

SB2009 Proposal Document

This report documents the proposal from the ILC Project Management Design Team for major changes to the published RDR baseline, as a result of the effort in accordance with the GDE R&D Plan . It represents the culmination of approximately one-year of study and includes new results from the on-going risk-mitigating R&D, as well as a critical review of the existing
Reference Design. *2009-12-17*

D*900425

Parameters for the Linear Collider - Update November 20, 2006

This document, prepared by the Parameters Subcommittee of the International Linear Collider Steering Committee, provides a set of parameters for the future Linear Collider and the corresponding values needed to achieve the anticipated physics program. *2011-10-25*

D*948205

Straw-man TeV parameter set for 2011 studies

Short report on two possible parameter sets for the TeV upgrade, based on 5% and 10% beamstrahlung respectively, and an estimated AC power limit of 300 MW. *2011-12-23*

D*965015

IP RMS energy spread summary

Summrises the contributions to the IP energy spread for all parameter sets, including the TeV upgrade. *2012-04-13*

D*972475

CFS Tunnel Drawing Set for KILC12

This drawing set includes the Overall Machine Layout, Beam "Arrow Diagram" and detailed tunnel drawings of the entire machine layout at larger scale. Status: Apr 23, 2012 (KILC12) *2012-04-21*

D*898245

ILC Machine Parameter Tables

Machine parameters for the ILC TDR Baseline. Includes parameters for Ecm=100,250,350,500GeV as well as parameter set for the 1TeV upgrade. *2013-03-10*

D*925325

Accelerator Systems(77)

Design, technical description and R&D program for demonstrating feasibility & performance of accelerator sub-systems

Recommendations for ILC Configuration Satisfying Timing Constraints

Report by a special group commissioned by EC to address the timing constraint specifications at ILC in early 2006. *2011-10-24*

D*829945

Electron Source(5)

Positron Source(16)

Reverse Engineering the TDR

- The TDD should provide the foundation for the presentation in the TDR
- In some areas, TDR text & tables provide more information than the TDD
  -> aim: solidify TDD, reconcile what is written in TDR with info in TDD
- Already now, this amounts to reverse engineering in some cases
  -> gets harder every day!
- We will try to contact the AS and TAG leaders and ask for more information (guideline: all numbers in TDR tables should be reflected in the TDD)

- The goal: TDD should form a consistent & complete documentation of the design, as basis for the design in the **Engineering Phase**
- Use this as an opportunity to check numbers again

Random Example: Modulator Specs

Table 3.15
Parameter specifications for the klystron modulators of the main linacs of ILC.

Parameter	Unit	Specification
Output voltage	kV	120
Output current	A	140
Pulse width	ms	1.65
Pulse repetition frequency	Hz	5 (10)
Max. average power	kW	139
Output pulse flat-top	%	± 0.5
Pulse-to-pulse voltage fluctuation	%	± 0.5
Energy deposited into klystron during a gun spark	J	< 20

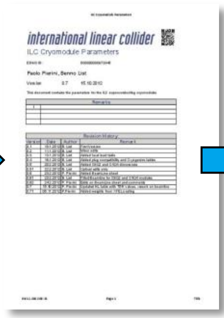
- Average power: 139 kW
- OK for Main Linac running with 5Hz @ full gradient, or 10Hz@reduced gradient
- Insufficient for running with10Hz@full gradient
  -> staged 250GeV machine, Bunch Compressor?
- We need parameter tables that link component specs to top-level parameters

Tracing Changes
Example: Cavity slot length

- Scenario: Cavity slot length is changed to accommodate a different tuner (e.g. DESY-Saclay tuner used at XFEL)
- Trace changes through (existing) documentation
  -> keep an integrated, consistent design

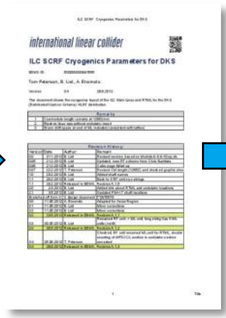
Cavity Parameters D*0973245

Cavity Design



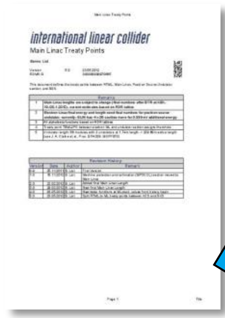
Cryomodule Parameters D*0973345

Cryomodule Design

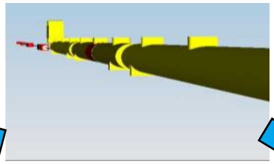


Cryogenics Parameters D*0991555

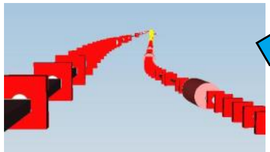
Cryogenics Design



Main Linac Treaty Points D*0970685



Main Linac Lattice D*0977355



RTML Lattice D*0977625

Tunnel Design D*0898245

CFS electrical, mechanical, Costs, Schedules,

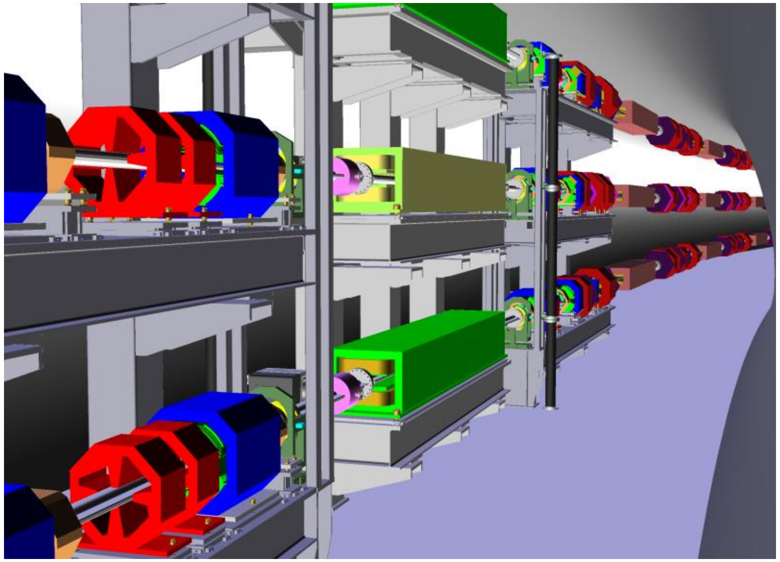
DESY

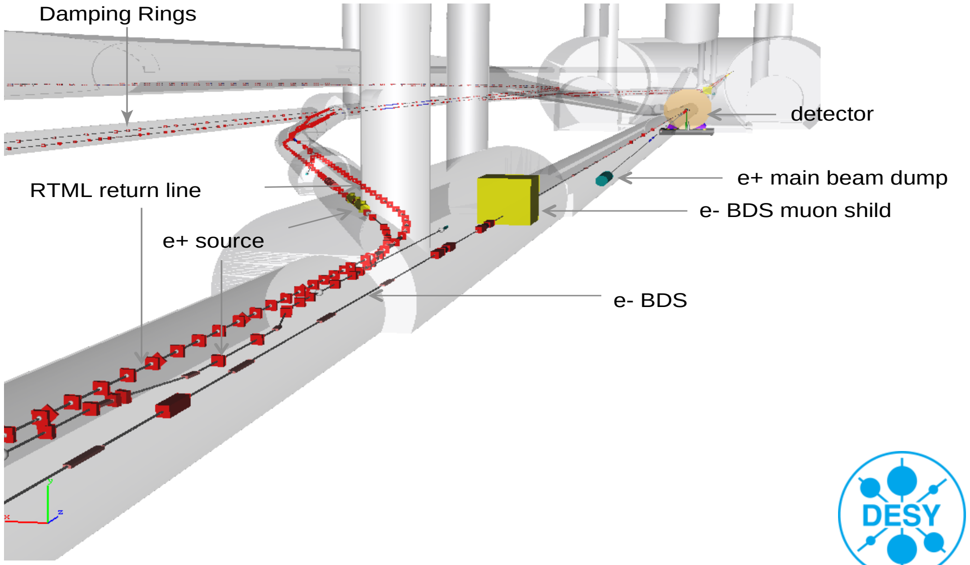
Into the Future: Change Control

- Maintaining the design consistent and up-to-date requires **Change Control**
- First step: define a process
  - Which changes need to be addressed formally? (Change management guidelines)
  - How are changes requested? (Template for written document)
  - Who decides? (TB)
  - Who coordinates the implementation?
- EDMS provides support support such processes:
  - Track a change request through its lifecycle
  - Link affected documents to the change request

Design Integration

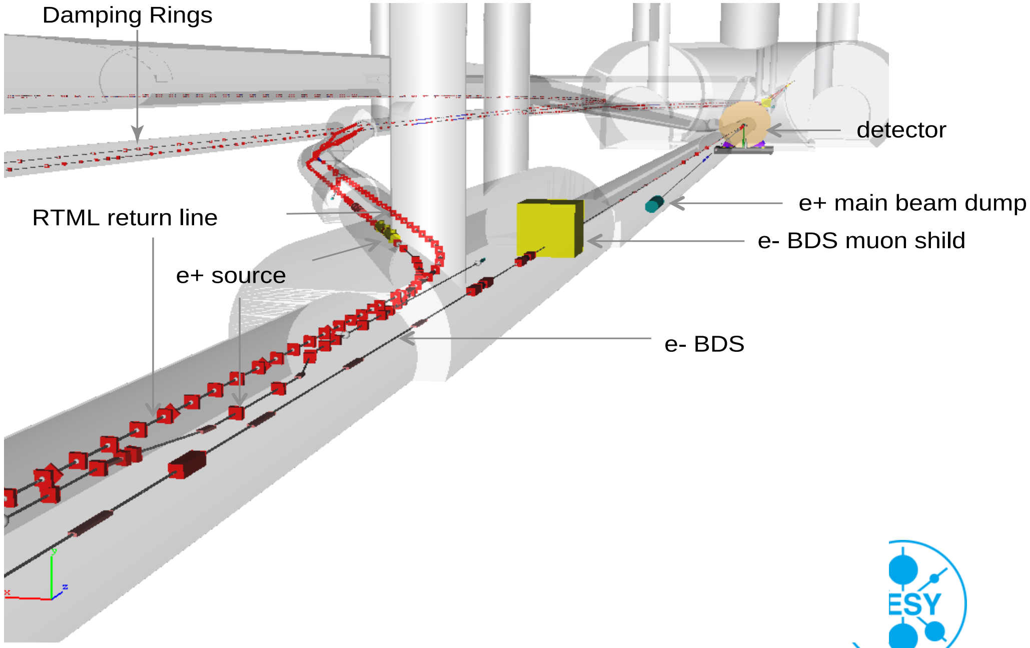
- For TDR: Achieved an integrated design:
  - Horizontally: Lattices from all accelerator systems fit together
  - Vertically: Tunnels fit to lattice, lattice fits to component dimensions
- An important step forward, as noted in internal cost review
- Goal: Keep the design integrated (consistent) in the next project phase -> form an **integration group (office)** to keep the integration up-to-date
- A global project can be integrated from anywhere in the world





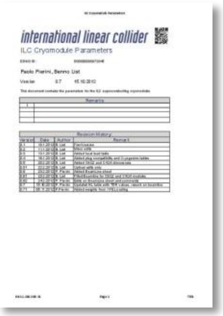
Example: Transfer Tunnel Branch-off

- Design integration: during Central Region BTR, DESY, Oct. 2011
- Issues discussed and solved:
  - Beamlines have to avoid muon stop (magnetized iron)
  - Space for spin rotators in straight transfer tunnel section
  - Branch-off angle: odd multiple of 7.93˚ (for spin rotation): 5x7.9 -> 3x7.9
  - Commissioning dump locations
  - Accessibility issues, transfer tunnel cross section
- Additional issues:
  - Positron source needed
    new chicane for sufficient R56
  - Chicane amplitude limited
    to avoid BDS
- Process profited from
  - Structured process (treaty point
    and waypoint documents)
  - Fast 3D visualisation

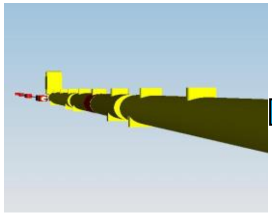


“Vertical,” Lattice-Centric Design Integration

- Use Lattice as central design element
- Lattice has to reflect component dimensions
  -> example: cryomodule slot length governs Main Linac lattice
- Lattice generates requirements for components (magnets!)
- Lattice dictates tunnel design
- Tunnel design optimization (cross section, access/egress, space for survey/installation/transport) needs to be reflected in lattice

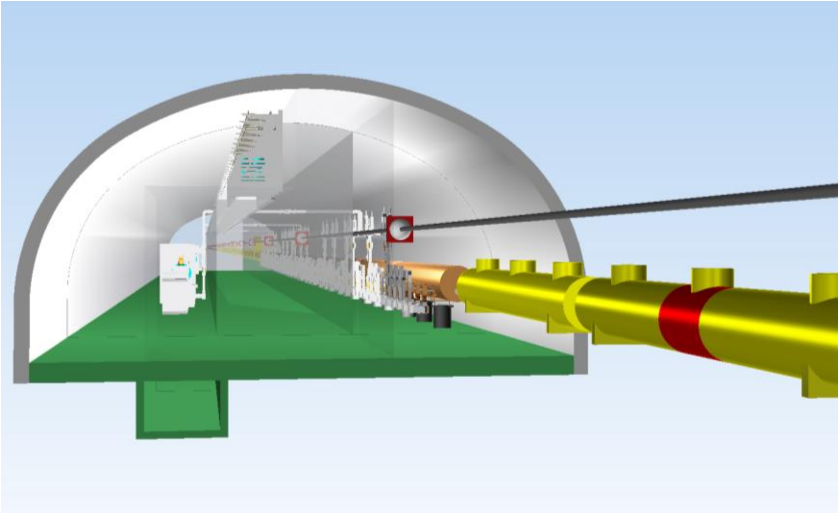


Cryomodule
Parameters
D*0973345



Main Linac
Lattice
D*0977355

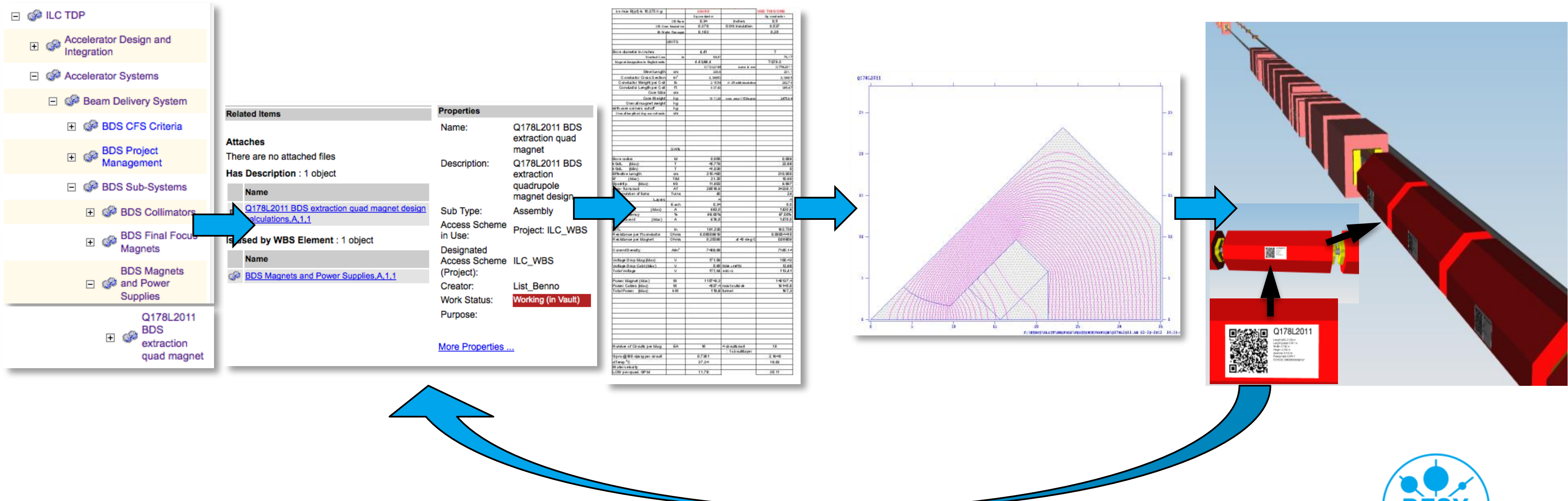
Tunnel
Design
D*0898245



DESY

Component Properties / Specifications

- Many component specifications follow from lattice (magnet strengths!)
- Work going on to arrive quickly at a first guess for magnet dimensions, based on design calculations
- -> More realistic component dimensions available in lattice visualisation models, for better planning of tunnel infrastructure



Learning from other Projects: EDMS @ XFEL

- EDMS supports **review processes**, e.g. production readiness reviews, of components and beamline sections
- EDMS supports **tendering processes** with industry, esp. for civil engineering
- EDMS supports detailed design coordination for civil engineering

- In all these cases, EDMS functionality (e.g. reviews, signing for approval) is used to arrive at and document binding decisions.

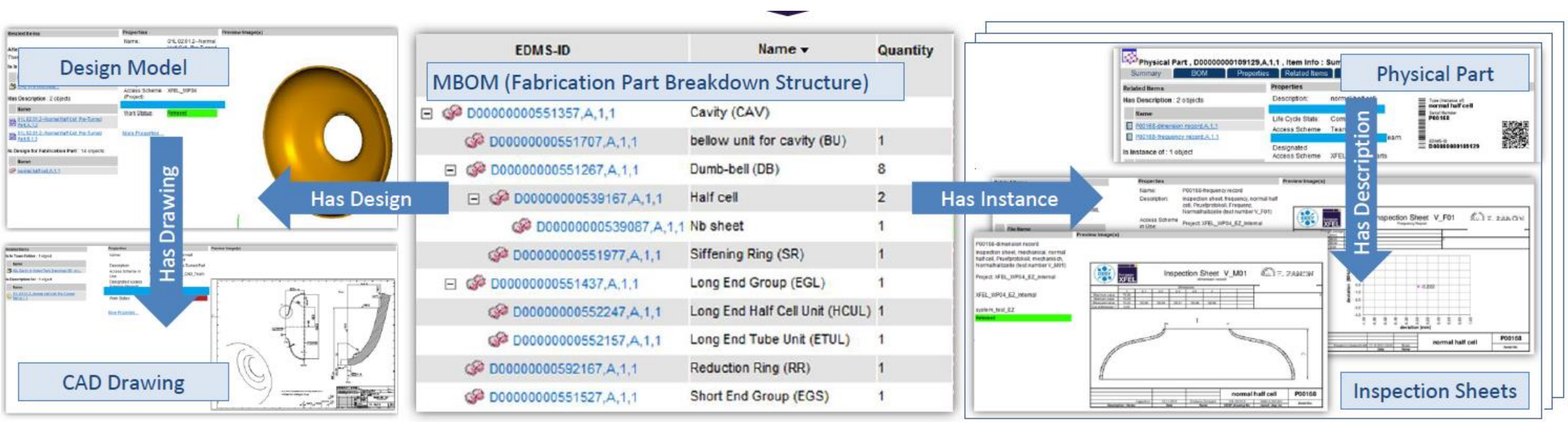


Parts Tracking for XFEL

- Pressure Vessel Code: demands detailed, persistent, tamper-proof documentation of all production steps of pressure bearing parts.
- Example: Cavities
  - XFEL uses 800 TESLA-style cavities, with 9 cells / 18 half cells each
  - ~20000 niobium sheets are produced, scanned, tested, formed to half cells
  - All the fabrication steps, test results, certificates have to be documented
  - Done by automatic upload tools, together with industry
- Benefits:
  - Less manual intervention, less human error
  - Real-time update of production data means:
    real-time information on production progress! -> Supply chain control (dashboard)
  - Facilitates real-time quality control checks (impurities, gradients, etc)
  - Early-warning information available: Do we have the niobium sheets for the cavities that are due for cryomodule installation in 6 months?

XFEL: Tracking of Cavity Half Cells

- EDMS stores
  - design data (CAD model, drawing),
  - fabrication documentation (MBOM, specs, test procedures)
  - Fabrication data (certificates, test protocols)
- Automatic upload of data keeps database up-to-date
- Allows Inventory Documentation / Supply Chain Monitoring



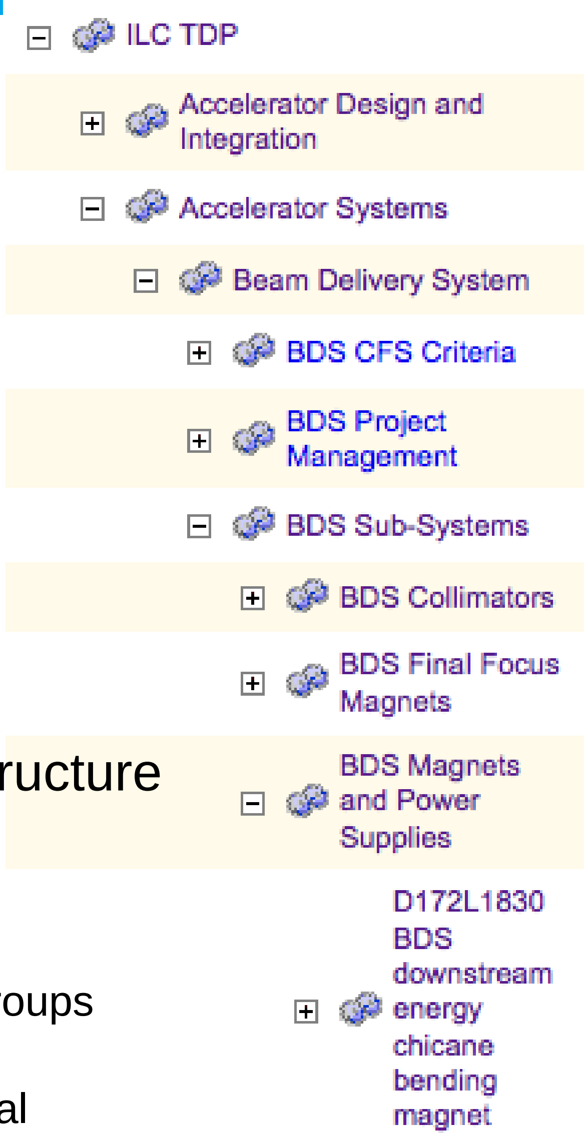
Design Documentation specifies the part's properties and behavior.

Fabrication Planning defines the production process & its intermediate parts, i.e. "how to" build a cavity.

Inventory Documentation catalogs all physical parts which have been produces and tracks their individual history.

Plans: Reconciling Document & Cost Structure (WBS)

- Work Breakdown Structure is a central tool in modern project management for
  - Scope management: What does the project entail? What is in, what is out?
  - Cost management
  - Project scheduling
  - Progress monitoring (reporting, cost control / Earnend Value Management)
- We currently use WBS's for
  - Structuring of the documentation
  - Structuring of costs
- The Goal: unify the cost and the documentation structure
- Benefits:
  - Better tracking of cost impact of design changes
  - Better correspondence between cost items and people / groups working on them
  - Better correspondence between cost estimate and technical documentation



Next Steps: Consolidation / Expansion of the WBS

- Consolidate: Define what the WBS elements entail (WBS dictionary)
- Expand: Identify the deliverables and work needed to complete the project (1-2 levels down from accelerator systems / technical areas)
- Keep flexible to adjust to project structure as it emerges

Benefits:

- Solid foundation for costing and scheduling
- Foundation for risk analysis -> risk management: identify and react to
  - Threats, e.g. by dedicated R&D or early prototyping
  - Opportunities, e.g. larger gradient (-> provide enough RF to utilize that)

Next Steps: Interface Documentation

- Advice given during the Cost Review:
  Interface documents are important -> experience from ITER
- Interface documents delineate the boundaries between work packages
- Examples (contrived):
  - Interface CFS – Cryogenics: CFS provides tunnels, caverns, foundations for cryo plants, electricity of given voltage and power, cooling water, air, cable trays, supports for pipes, venting system; Cryogenics takes care of cryo plants, pipes, isolation, …
  - Interface Cryogenics – Cryomodules: …
  - Interface Cryogenics – Installation: Cryogenics (group) delivers components for cryo plants, piping, installation material to staging area; Installation (group) transports material into tunnel, installs piping, …; Cryo group assembles cryo plants, performs leak tests, provides cryogenic fluids, commissions plants, …
- Interface documents help to make sure that nothing (not too much) falls “between the cracks”; defines exactly up to which point a work package is responsible; may trigger adjustments of work packages
- **Interface documents** must accompany the **scope documents** for the elements of the WBS hierarchy

Interface Documents, cont'd

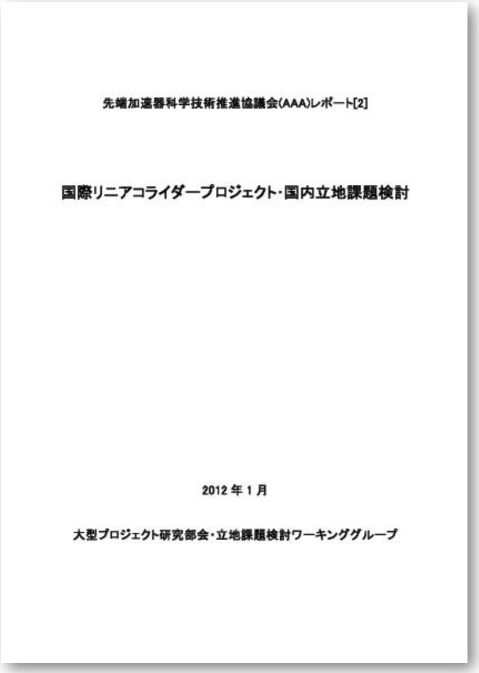
- Benefits:
  - Improves the understanding and definition of the scope of the project
  - Improves the accuracy of the cost estimate
- Interface Documents between "Accelerator" (everything covered by the GDE / TDR) and the "Rest":
  - Detectors
  - Laboratory (electricity, HVAC, offices, computing, workshops, …)
  - Site (roads, housing, electricity, water, infrastructure [shopping, schools, hospital])
- -> likely to lead to re-arrangement of costs
- This involves high-level, political decisions (what is paid by whom, what is counted into project costs) -> goes beyond the scope of this discussion

Supporting Multiple Languages

- EDMS can store documents in original language (German, Japanese) and translated versions; metadata in Japanese is possible
- User interface is available in German and English

Properties

ILC Document Type:	Report
Name:	ILC Project Study Report on Issues to Construct ILC in Japan (Original)
Description:	Japanese title: "国際リニアコライダープロジェクト·国内立地課題検討", filename: 国内立地課題検討.pdf
Access Scheme in Use:	Team: ILC_CFS_Team
Designated Access Scheme (Project):	ILC_CFS



先端加速器科学技術推進協議会(AAA)レポート[2]

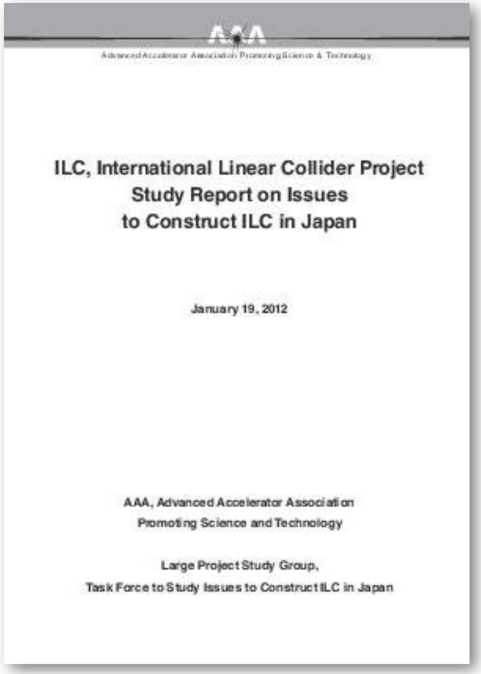
国際リニアコライダープロジェクト·国内立地課題検討

2012 年 1 月

大型プロジェクト研究部会·立地課題検討ワーキンググループ

D*1011835

Has Translation



Advanced Accelerator Association Promoting Science & Technology

ILC, International Linear Collider Project
Study Report on Issues
to Construct ILC in Japan

January 19, 2012

AAA, Advanced Accelerator Association
Promoting Science and Technology

Large Project Study Group,
Task Force to Study Issues to Construct ILC in Japan

D*1011805

From Technical Design to Engineering and Production

- TDD draws together existing design information
- TDD/EDMS supports processes to update the design in a controlled manner (change control):
  - Analysis of dependencies / consequences
    (What consequences does a design change have? What else needs updating?)
  - Involvement of stakeholders through notifications / reviews
  - Approval or rejection processes
- EDMS can (be extended to) support further activities
  - Cost estimation (incl. Earned Value Management)
  - Scheduling
  - Risk Analysis

Plans and Interests at DESY

- **Support for ILC EDMS will continue!**
- Consolidation of existing design documentation has high priority
- This includes support for uploading and cross-linking the final cost estimation documents
- Work on design integration will continue

Medium / Longer Term Interests:

- Continue our support for the project into the Engineering Phase
- Develop / provide supporting tools (integration, documentation, cost estimation / control) and services for the TB / Project Management

Send us you wishlist!

Acknowledgements

It has been a pleasure, and a privilege, to work for you!