FP7 – DEVDET Proposal
EUVIF: the vertical integration facility

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RECFA Detector R&D Coordination Group

- A Detector R&D planning group for FP7 – set up by RECFA in Sep 2007
  - To coordinate the IA applications to maximise the chances for success, involving the European community as a whole.
  - Aim for a small number (one) good proposals allowing the European community to be correctly represented in them
  - Follow the example of ESGARD for accelerator R&D coordination

- The current composition of the group is:
  - Joachim Mnich, EUDET (Linear Collider Detectors)
  - Nigel Hessey and Jordan Nash, upgrade coordinators ATLAS, CMS
  - Lucie Linssen representing CERN
  - Rolf Heuer representing DESY
  - Alain Blondel representing neutrino detectors
  - Francesco Forti representing flavour factory detectors
  - One person from ESGARD (or/and frequent communication ESGARD)

- The group is lead by Norman McCubbin and Steinar Stapnes.

What are IAs (Infrastructure Activities)?

- Extract from the call:
  - … provide a wider and more efficient access to and use of, the existing research infrastructures…
  - Integrating Activities also aim to structure better and integrate, on a European scale, the way research infrastructures operate and to foster their joint development in terms of capacity and performance…

- Already used successfully in FP6
  - EUDET: ILC Detector R&D network
  - CARE: accelerator R&D

- **BUT:** Limited things you can actually do
  - Cannot do detector R&D proper, but infrastructure development
  - It should not be too much experiment specific

- Rigid structure
  - Need to include 3 different kinds of workpackages:
    - Networking – foster collaboration
    - Transnational access – allow access to facilities
    - Joint Research Activities – develop the facilities

DEVDET Proposal

Constitutes an Integrating Activity with three main objectives that are essential to European development of detectors for particle physics research at future accelerator facilities:

- creation and improvement of key infrastructures required for the development of detectors for future particle physics experiments
- provision of trans-national access for European researchers to access these research infrastructures,
- integrating the European detector development communities planning future physics experiments, and increasing the collaborative efforts and scientific exchange between them.

- 87 institutes from 21 different countries.
  - Bulgaria (2 institutes), Czech Republic (4 institutes), France (11 inst.) Germany (13 inst.), Greece (2 inst.), Israel (3 inst.), Italy (12 inst.), The Netherlands, (1 nat. lab.), Poland (4 inst.), Spain (6 inst.), Sweden (2 inst.) Switzerland (5 inst.)
  - **Request from EU: 11M€. Total budget: about 37.8M€**
  - **Duration: 4 years**

European Detector R&D

European priority projects (focus on detectors)	Timescales	Current Phase	Key R&D issues	DevDet Work Packages to address R&D needs
SLHC = Upgrade of LHC detectors for increased luminosity in 2016	Technical Design Reports (TDR) in 2011	Wide R&D focusing on key technology developments; irradiation and test beam measurements	Electronics, simulations/software, irradiation and test beam measurements	WP2, WP3, WP6, WP8, WP9, WP11
Linear Collider Detectors for next large international accelerator project	Letter of Intent 2009, then towards TDR	System studies in test beam, individual tests ongoing (EUDET)	Simulations/software, integration, system tests in beams	WP2, WP3, WP4, WP6, WP7, WP8, WP10, WP11
Neutrino Detector Studies for future Neutrino Facilities	Conceptual Design Report to be concluded in 2012	Design studies ongoing, test beam studies next step	Simulation/software, integration, test beam measurement at low energy	WP2, WP3, WP5, WP6, WP11
Flavour Physics Detectors at **SuperB** Factories	Conceptual Design Report in 2007, Technical Design Report next	Design studies, test beam measurements next step	Simulation/software, test beams with low energy and high intensity	WP2, WP3, WP6, WP8, WP11

EUVIF – European Vertical Integration Facility

- The next logical step for ILC: assess system aspects of the proposed detector concepts.
- The principle integrating factor in linear collider event reconstruction is the concept of “energy flow”: reconstructed objects from different detectors are combined into physics objects such as leptons, photons, or jets.

- Established how to form these particle-flow objects, mechanical integration, data acquisition.
- This requires the definition of interfaces and their implementation.

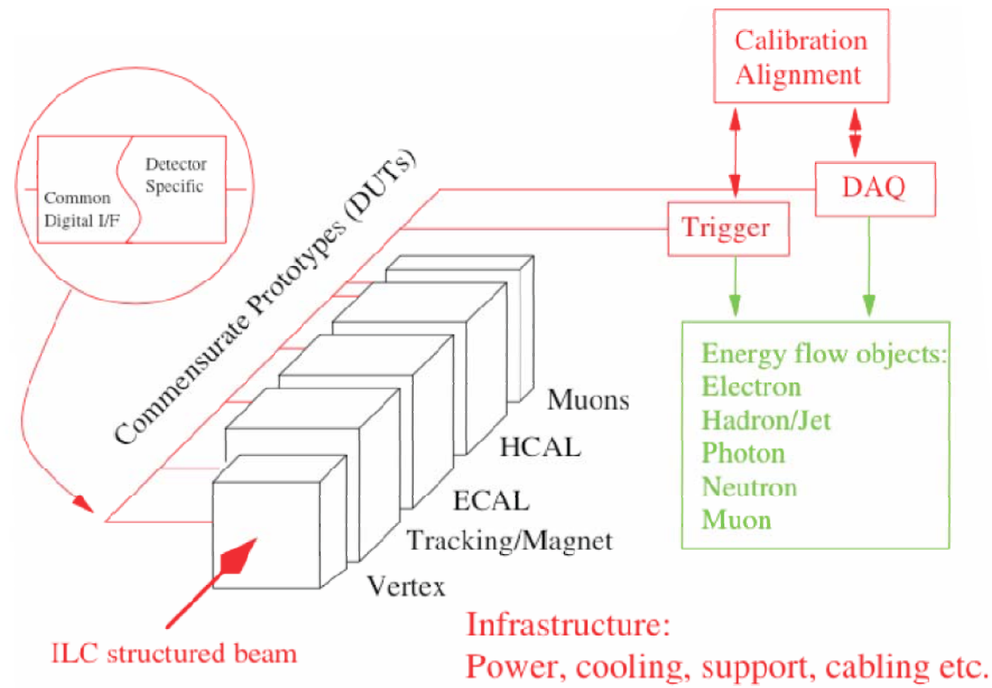
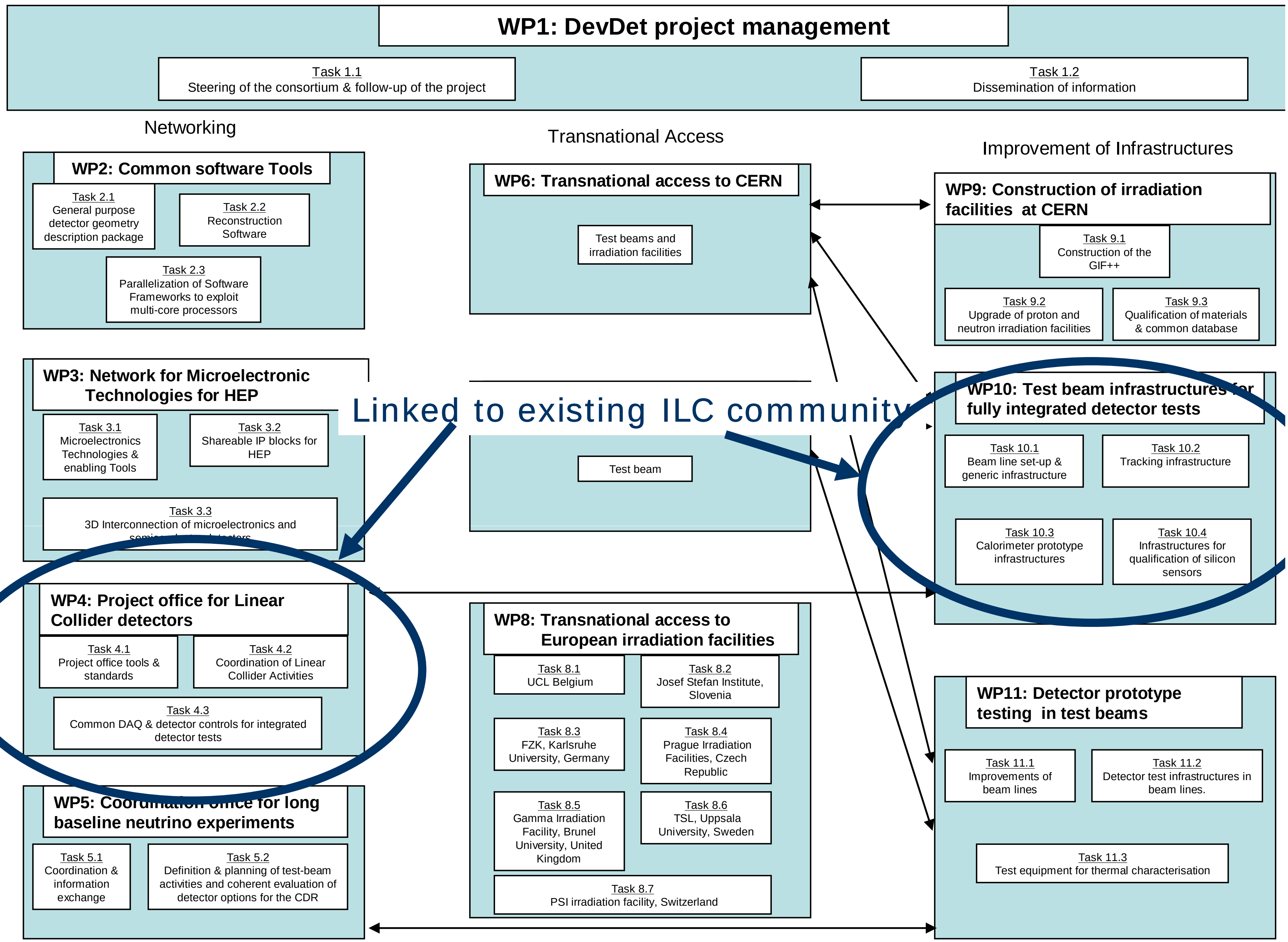


Diagram of DevDet work packages



EUVIF – European Vertical Integration Facility

WP4: Project office for Linear Collider detectors

- Task 4.1: Project office tools & standards
- Task 4.2: Coordination of Linear Collider Activities
- Task 4.3: Common DAQ & detector controls for integrated detector tests

WP10: Test beam infrastructures for fully integrated detector tests

- Task 10.1: Beam line set-up & generic infrastructure
- Task 10.2: Tracking infrastructure
- Task 10.3: Calorimeter prototype infrastructures
- Task 10.4: Infrastructures for qualification of silicon sensors

- Combination of WP4 and WP10

WP4: Project Office for Linear Collider detectors

Networking Infrastructure

- manage and operate the infrastructure built up through WP10
- develop and make available more generally tools for the management of distributed detector development projects

- Task 1: Project Office Tools
  - Documentation of information and standardisation of tool, interfaces etc.
- Task 2: Coordination of Linear Collider Activities
  - Coordination of the Vertical Integration Facility EUVIF
  - Application of project office tools to the CLIC forward region integration
- Task 3: Common DAQ and detector controls for integrated detector tests
  - common DAQ, event building facility, detector control and monitoring, interface to the common DAQ etc.

WP10: TB infrast. for fully integrated detector tests

Joint Research Activity

- Task 1: Beam line set-up and generic infrastructure
- Task 2: Tracking infrastructure
  - 2.1: Vertex detector infrastructure
  - 2.2: Intermediate tracker infrastructure
  - 2.3: Improvement of infrastructure for gaseous tracking detectors
- Task 3: Calorimeter prototype infrastructures
  - 3.1: Infrastructure for electromagnetic calorimeters
  - 3.2: Infrastructure for hadron calorimeters
  - 3.3: Infrastructure for forward calorimetry
- Task 4: Infrastructures for qualification of silicon sensors

Task 1: Beam line set-up and generic infrastructure

- EUVIF will be located at CERN SPS, one dedicated beam line would be set up for this
- Supply beam line with adequate magnets necessary for the vertical infrastructure:
  - Dipole magnet for the tracking infrastructure and dipole magnet for calorimeter infrastructure
- Equip beam line area with gas supplies, electrical and network cables

Task 2: Tracking infrastructure

- 2.1: Vertex detector infrastructure
  - Building a global mechanical infrastructure to host multi-layer modules for vertex detectors in different technologies
  - Developing the data acquisition system including hardware from EUDET to suit the new infrastructure
  - Producing a target system to create jet-like structures
  - Integrating the EUDET telescope upstream of the target

Task 2: Tracking infrastructure

- Task 2.2: Intermediate tracker infrastructure
  - Evaluating lightweight support structures for both module carrier and overall support structure
  - Developing prototype silicon modules with minimized material consumption
  - Developing an overall support structure for modules/ladders arranged in layers
  - Improving the existing EUDET readout chip and developing a front-end hybrid prototype suitable for testing silicon sensors with conventional (wire-bonding) or novel (bump-bonding) connection techniques
  - Integration of the front-end electronics developed in EUDET into the central DAQ system (see WP4)

- Tasks 2.3: Improvement of infrastructure for gaseous tracking detectors
  - Providing the EUDET TPC infrastructures for combined tests of the particle flow concept
  - Develop and provide readout software
  - Integration into DAQ and slow-control system

Task 3: Calorimeter prototype infrastructures

- Tasks 3.1: Infrastructure for electromagnetic calorimeters
  - Develop facility for mechanical and system integration
  - Develop facility for optimization and test of silicon readout sensors
  - Develop facility for the test and characterization of readout systems
- Tasks 3.2: Infrastructure for hadron calorimeters
  - Develop facility for mechanical and system integration
  - Develop facility for the optimization of SiPM micro-structures and on-wafer sensor tests
  - Develop facility for the characterization of packaged sensors and integrated scintillator systems
  - Develop facility for the test and characterization of readout and calibration systems
- Tasks 3.3: Infrastructure for forward calorimetry
  - Design and prototyping of a flexible tungsten absorber structure for beam tests including a laser position monitoring
  - Development of a prototype of a multi-channel readout system including fully instrumented sensor planes, FE ASICS and high throughput transmission lines to link the FE electronics to the common DAQ

Description of Work I (Vertex)

Global Mechanical Structure

- Mechanical structure outside of the acceptance to mount devices of different sensor technologies.
- Common mechanical interface needs to be defined.

Data Acquisition (Hardware and Software)

- focus on data throughput and multi-event data storage and maximum event rate,
- Could be handled by a dedicated board evolving from the EUDET telescope DAQ board.
- Care needs to be taken incorporating a central clock and time-stamp system (based on the proposed CALICE "Clock and Control for test-beam")
- Hardware based on the trigger logic unit (TLU) developed within EUDET. Also the necessary software will evolve from existing EUDET data acquisition software.

Description of Work II (Vertex)

Analysis Software

- reconstruction and analysis of data from the high resolution, low material vertex slice will be developed evolving from the EUTelescope
- functionality for calibration, alignment and offline data reduction as well as for pattern recognition and determination of the resolution

Target

- Jet-like particle showers will be produced from high energy particles hitting a target.
- will be constructed of a number of thin plates in which the impinging particles showers.
- Simulations will help to define the optimal geometry and material.
- Actuators enable the target to move in and out of the beam.

EUDET Telescope

- by then existing final telescope will be positioned upstream of the target to provide precise information on incoming beam particles

Description of Work III (Vertex)

Reference System

- based on existing pixel sensor to allow the development of the fully integrated facility at an early stage of the project
- The reference module will rely on the Mimosa22+ sensor,
- For each layer a light weight mechanical structure will be designed. An effort will be made to limit the material to optimise the single point resolution.
- The pixel sensors and the data acquisition board will be interconnected by a light ultra-thin flexible cable. This cable design will be based on existing experience within the consortium

Some Comments

- Proposal was submitted February 29th to the EC - 137 pages
- Outcome to be expected for this summer. Start of DEVDET January 1st 2009, EUVIF January 1st 2010 (no overlap with EUDET allowed)
- 11MEUR sounds a lot, but distributed on 87 institutes incl. 3263 person months gives very small amounts for each group
  - E.g each institute participating in the vertex infrastructure of EUVIF ->0.25FTE per year
- Did it anyway:
  - Within EUDET collaboration building effect was very positive
  - Want to continue this way!
- Will keep European ILC community alive with this support and commitment!

Work Package List with Finances

Work package No	Work package title	Type of activity	Lead participant No	Lead participant short name	Person-months	Start month	End month	Indicative Total costs (MEuro)	Indicative requested EC contribution
1	DevDet project management	MGT	1	CERN	108	1	48	1.56	0.80
2	Common software tools	COORD	11	DESY	385	1	48	3.61	1.20
3	Network for Microelectronic Technologies for High Energy Physics	COORD	1	CERN	437	1	48	5.63	1.20
4	Project office for Linear Collider detectors	COORD	38	UNIGE	338	1	48	3.42	0.52
5	Coordination office for long baseline neutrino experiments	COORD	34	CSIC	68	1	48	0.74	0.25
6	Transnational access to CERN test beams and irradiation facilities	SUPP	1	CERN	2	1	48	0.23	0.15
7	Transnational access to DESY test beam	SUPP	11	DESY	0	13	48	0.15	0.10
8	Transnational access to European irradiation facilities	SUPP	3	UCL	10	1	48	0.86	0.75
9	Construction of irradiation facilities at CERN	RTD	1	CERN	176	1	48	3.00	1.00
10	Test beam infrastructures for fully integrated detector tests	RTD	11	DESY	1198	13	48	12.95	3.14
11	Detector prototype testing in test beams	RTD	1	CERN	539	1	48	5.65	1.89
	TOTAL				3261			37.80	11.00

Transnational Access

Participant number	Organisation short name	Short name of infrastructure	Installation n	Installation Short name	Operator country code	Unit of access	Unit cost (€)	Min. quant. of access to be prov.	Estimated number of users	Esti. number of proj.
1	CERN	CERN testbeams and irrad.facilities	6	CERN-Test-Beams, CERN-Irrad-East-Hall, CERN-Irrad-GIF	CH	8 hours	4840	1200	480	48
11	DESY	DESY testbeam	7	DESY testbeam	DE	Week	16392	30	100	25
3	UCL	CRC	8.1	UCL	BE	Hour	292	350	30	15
33	JSI	JSI	8.2	JSI Triga Reactor	SL	Hour	218	450	46	23
13	UNIKARL	UNIKARL	8.3	Compact cyclotron	DE	Hour	450	120	30	15
6	IPASCR	IPASCR	8.4	NPL; U120M; Microtron	CZ	Hour	184; 308; 100	300	115	23
41	UBRUN	UBRUN	8.5	High-rate Gamma Facility, Low-rate Gamma Facility	UK	Hour	20,5	2000	30	15
37	SWEDET	UUpps	8.6	TSL	SE	Hour	577	150	24	12
38	UNIGE	PSI	8.7	PIF, EH facilities	CH	Hour	246	250	15	10

Proposal strategy

1. Common detector R&D facilities needed 2009-2012 (as identified by representatives of the coordination group)
   - Testbeams, Irradiation facilities, Electronics development tools, Software tools - focus on items/projects which adapt them to next detector R&D stage
2. SLHC detector R&D facilities
   - Adaptation of the facilities/tools for SLHC detector R&D
3. Linear Collider Detector R&D facilities
   - Focus on facilities that allow follow up of EUDET (combined set up and testing of detectors), plus related electronics, software and detector integration tools
4. Neutrino detector Detector R&D facilities
   - Study of detector elements in testbeams, electronics and software development, detector integration tools
5. SuperB
   - Testbeam measurements, irradiations, detectors and software

Many of these facilities/common tools are linked to equipment and projects taking place in the CERN beams but several are also distributed (for example irradiation facilities, electronics, software, etc)