Addendum No. 01

to the

Memorandum of Understanding
for Collaboration in the Construction of the
ATLAS Detector

Construction of the ATLAS Insertable B-Layer (IBL) Sub-Detector

Considering that:

The construction of the ATLAS Detector is governed by a Memorandum of Understanding, along with its Amendments and Addenda, setting out the responsibilities of the different participating Institutes and Funding Agencies for the construction of the ATLAS Detector [1] (Construction MoU).

Maintenance and Operation of the ATLAS Detector is governed by a Memorandum of Understanding for Maintenance and Operation (M&O MoU)[2].

In order to be able to take full advantage of planned luminosity improvements of the LHC, and as part of the LHC Consolidation Program (or so-called Phase 0), the Collaboration has proposed to add a fourth layer of detectors for the Pixel Sub-Detector (IBL).

On the basis of a Technical Design Report[3] submitted on September 15, 2011 and a detailed review of the scientific merits, the technological feasibility and estimates of the needed resources, the LHC Committee (LHCC) has recommended approval of the IBL Sub-Detector construction to the CERN Research Board.

Based on the recommendation by the LHCC, the Research Board recommended to the Director General of CERN to approve the IBL Sub-Detector construction project.

The Director General has accepted the Research Board recommendation and approved the IBL Sub-Detector construction.

It is agreed as follows

Article 1: Purpose

1.1 The purpose of this Addendum and its Annexes is to lay down the terms of participation of the contributing Institutes and Funding Agencies in the construction, installation and commissioning of the IBL Sub-Detector in conformity with the Construction MoU along with its amendments and addenda.

1.2 All the Annexes are an integral part of this Addendum.

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[1] Memorandum of Understanding for Collaboration in the Construction of the ATLAS Detector (RRB-D 98-44 rev.)

[2] Memorandum of Understanding for Maintenance and Operation of in the Construction of the ATLAS Detector (CERN-RRB-2002-035)

[3] IBL Technical Design Report (CERN-LHCC-2010-013)

Article 2: Parties

2.1 The Parties to this Addendum shall be all the Institutes that are contributing to the construction of the IBL Sub-Detector (severally the IBL Institutes, jointly the IBL Collaboration) and their Funding Agencies (the IBL Funding Agencies), and CERN as the Host Laboratory. The current list of IBL Institutes and Funding Agencies is given in Annex 3.

Article 3: Duration

3.1 This Addendum takes effect from the date of signature and shall remain valid until the ATLAS Management declares the end of the IBL Sub-Detector construction project.

3.2 Any IBL Institute may withdraw its support from the IBL Sub-Detector construction effort by giving not less than eighteen months notice in writing. In this event, reasonable compensation to the IBL Sub-Detector Upgrade project shall be negotiated through the ATLAS Management and endorsed by the RRB.

3.3 Any Institute that joins the IBL Collaboration after the start of the IBL construction project shall accept the agreements in force and shall be expected to make an appropriate contribution to the IBL Sub-Detector construction as shall be specified in a corresponding Addendum to this Addendum. This shall be negotiated by the ATLAS Management and endorsed by the RRB.

Article 4 : The IBL Sub-Detector Construction

4.1 The IBL Sub-Detector construction is defined in detail in the Technical Proposal submitted to the LHCC and in the Technical Design Report. The IBL Sub-Detector project consists of a number of sub-units as listed in Annex 1.

4.2 The management structure of the IBL Sub-Detector project is described in Annex 2, as well as persons currently holding management positions.

4.3 The technical participation of the IBL Institutes, grouped by Funding Agency, is set out in Annex 4.

4.4 The Collaboration decides for each IBL Sub-Detector cost item whether the cost is to be borne at the common expense of the Collaboration or not. The IBL Sub-Detector cost items are thereby divided into two categories:

4.4.1 Common Infrastructure Items, comprising those costs that the Collaboration has agreed to bear at its common expense;

4.4.2 Specific items that are the responsibility of IBL Sub-Detector IBL Institutes or groups of Institutes.

4.5 Annex 4 shows the value of the deliverables, by Funding Agency and Sub-Detector sub-units, to which the IBL Institutes and Funding Agencies are committed and for which they have foreseen the appropriate funding. The project payment profile over time is shown in Annex 5.

4.6 The schedule for the design, construction, installation and commissioning of the IBL Sub-Detector is given in Annex 6.

ANNEXES

Annex 1:	List of IBL Sub-Detector Sub-units (systems) and deliverables provided by participating institutes
Annex 2:	Organization and Management structure of the IBL Sub-Detector Collaboration and persons currently holding management positions
Annex 3:	List of Institutes, Funding Agencies and Representatives
Annex 4:	Value of deliverables, grouped by Funding Agency and sub-units (systems)
Annex 5:	Payment profile
Annex 6:	Construction Schedule

The European Organization for Nuclear Research (CERN)

and

....

declare that they agree on the Present Addendum to the Memorandum of Understanding for Collaboration in the Construction of the ATLAS Detector

Done in Geneva	Done in ....
....	....
for CERN	for ....
....	....
Sergio Bertolucci Director of Research and Scientific Computing	....
For participating institutes	....
	....
	....

IBL Project

Memorandum of Understanding

Annexes

Excel Spreadsheet:	IBL_v1.15_fill.v14.xlsx
Version	10
Date	15.03.2012

Annex 1

List of IBL Sub-units

	System	MoU Item	Description
1	Module	1	Sensor - prototype (including bumping to FE-I4), production, procurement & QC
		2	FE-I4 prototype (v1), production (v2), test
		3	Bump-bonding, thinning, bare module - prototype, production & QC
2	Stave	4	Local support (stave): CF structure, TM, pipe - prototype, production & QC
		5	Module assembly, stave loading, flex-hybrid, internal electrical services - design, production & QC
3	Off-detector	6	R/O chain: opto-board, opto-fiber, TX/RX, BOC, ROD, TDAQ (S-link, TIM, SBC, ROS, crate)
		7	Power chain: HV/LV PS, PP2 regulators, type2, 3 & 4 cables, interlock, DCS
4	Integration & Cooling plant	8	Integration in SR1 & System test
		9	Cooling plant & cooling services to PP1
5	Beam-pipe & Installation	10	Beampipe & mechancal interfaces (to staves, to type 1 services, IST)
		11	Installation in the pit: beampipe extraction, IBL+beampipe insertion, services installation
6	DBM	12	DBM - modules production & QC, support mechanics & services, IBL generic parts procurement

MoU Item **1** *Annex 1*

WBS Items: 1 ***Sensors: prototype & procurement***

Description: Sensor prototype:

Batches of final design FE-I4 sensors for technology qualification (3D, planar, diamonds). Dicing, processing for bump-bonding (UBM and bump deposition), flip chip. Produce 10% of IBL assemblies with planar and 3D sensor and 5% with diamonds. Irradiation to IBL requirements, laboratory and test beam measurements.

Sensor production:

Production of 6 batches of CiS n-in-n planar sensors, 3 batches of CNM and 3 batches of FBK double side 3D sensors. Electrical and mechanical qualification of the production.

Total Cost:

WBS	kCHF	
1.2	210	Sensor prototype
1.3	542	Sensor production
	752	*Total* *(MoU item)*

Work Responsibility

Barcelona	Prototype: 3D, Planar; Production: contribution
Bonn	Prototype: 3D, Planar, Diamond; Production: contribution
CERN	Prototype: 3D, Planar, Diamond; Production: contribution
Dortmund (/MPI)	Prototype: Planar; production: wafer QC
KEK	Prototype: Planar; Production: contribution
Liverpool	Prototype: Planar; Production: contribution
Ljubljana	Prototype: Diamond
LPNHE/Orsay	Prototype: Planar; Production: contribution
Manchester/Glasgow	Prototype: 3D; Production: contribution; QC supervision (Manchester)
New Mexico	Prototype: 3D, Planar, Diamond; Production (silicon): contribution
Ohio SU	Prototype: Diamond
Oslo/Bergen	Prototype: 3D; Production: contribution
Prague AS	Prototype: Planar; Production: contribution
Santa Cruz	Prototype: Planar, (3D); Production: contribution
SLAC/Stony Brook	Prototype: 3D; Production: contribution
Toronto(/Carleton)	Prototype: Diamond
Udine(/Trento)	Prototype: 3D, Planar; Production: contribution

Cost Sharing:

	Prototype %	Production %	Total %
Barcelona (E)	12%	5%	7%
Bergen, Oslo (N)	12%	5%	7%
CERN	5%	10%	9%
Bonn, Dortmund (D)	8%	10%	9%
KEK (J)	-	5%	4%
LPNHE/Orsay (F)	6%	20%	16%
Ljubljana (SLO)	13%	-	4%
Glasgow/Manchester/Liverpool (UK)	12%	15%	14%
Ohio SU/Santa Cruz/New Mexico/SLAC/Stony Brook (US)	4%	10%	8%
Prague AS (CZ)	-	5%	4%
Toronto/Carleton (CD)	17%	-	5%
Udine (I)	12%	15%	14%
Unassigned	-	-	-
Total	100%	100%	100%

Note:

The purchase wafer quantities are enough to assemble 448 planar two-chip modules and 224 3D single-chip modules. Those numbers correspond to approximately 2 times the number of installed modules for either a 75%/25% or 100%/0% scenario of planar/3D surface coverage. Sensors yields are accounted for in this calculation.

MoU Item **2** *Annex 1*

WBS Items: 2.1 ***FE-I4 Design, Production and Wafer Testing***

Description: Design of the front-end chip FE-I4. Two engineering runs: FE-I4A (22 wafers) and FE-I4.v2 (28 wafers). Production (up to 2 additional batches x 24 wafers) of FE-I4B. Testing of one diced wafer with single chip card and USBPix hardware from each engineering and production batches. Radiation hard qualification. Wafer probing of engineering and production wafers. Provide USBpix single chip test setup. Wafer probing at commercial site.

Total Cost:

WBS	kCHF	
2.1.1	504	FE-I4A: engineering run and testing
2.7	42	FE-I4B: Hardware (USBPix) for single FE-I4 test (on wafer and on PCB)
2.1.2, 2.1.3	826	FE-I4B: engineering + production run and testing
	1 372	*Total* *(MoU item)*

Work Responsibility

Bonn — Deliver all relevant views, stand-alone verification and simulation, documentation of:

FE-I4A: PDR and DDC (pixel digital region & digital double column), EODCL (end of double column logic and also data formatter), DOB (Data Output Block including scan chain), CLKGEN (Clock Generator including PLL), IOB (I/O pad ring and LVDS), SLDO (Shunt-regulator Low Dropout).

Test setup for FE-I4 single chip / wafer level tests (USBPix). Digital test bench for whole chip functional simulation. Wafer probing & test board characterization (with USBPix).

FE-I4B: Update of their design blocks. Top level and block verification and simulation. ShuLDO simulations and measurements. Sharing of wafer probing with LBNL.Revision of single chip test board.

Geneva — Contribution to wafer probing at commercial facility.

Genova — Deliver all relevant views, stand-alone verification and simulation, documentation of:

FE-I4A: CMD (Command Decoder).

Bench testing of CMD block and scan chain test patterns. Test vectors for scan chain of CMD.

FE-I4B: Update of their design blocks. Contribution to wafer testing at commercial facility.

Göttingen — Deliver R/O software for the single chip test system (USBPix).

LBNL — Deliver all relevant views, stand-alone verification and simulation, documentation of:

FE-I4A: FEND (Analog front-end - single pixel) and DC (double column integration), DACS (for bias including stand alone shift register for configuration), DCDC (DC/DC converter), VREF (Voltage reference), EFUSE (E-Fuse memory block), GOPAMP (General purpose opAmp), PULSGEN (Charge injection pulse generator), MUX3to1 (for 4-chip module operation), AMUX (Analog MUX), CLKDIST (clock distribution block), ValueMUX (to combine 16 bit values from different blocks going to EOCHL), INMUX (digital test I/O block), conversion of CERN prompt radiation detector to DM stack and power-on reset generator, "glue logic".

Top level views and simulation, layout integration and verification, submission assembly. Wafer probing & test board characterization. Total dose radiation testing.

FE-I4B: Integration of regulator power scheme. Layout integration and verification; top level and block simulation; submission assembly. Total dose radiation testing. Wafer probing & test board characterization. Sharing of wafer probing with Bonn.

Marseille — Deliver all relevant views, stand-alone verification and simulation, documentation of:

FE-I4A: GADC (Generic ADC with input MUX) and ANAMUX (analog mux for input to GADC), TEMPSENS (Temperature sensor), CNFGMEM (SEU memory memory latches, as well as stand-alone triple redundant register cell), VcalTComp (temperature compensation for VCAL voltage), ANAMUX (standalone analog MUX and buffer for analog test outputs), COMP2 (low current comparator alternative), PixREG2 (SEU hard pixel register alternative).

Radiation hard and SEU qualification. Test of the PRD (Prompt Radiation Detector) in the high intensity beam.

FE-I4B: Delivery of new blocks not included in FE-I4A: ADC, tempsens, analog MUX. Verification. SEU testing.

Nikhef — Deliver all relevant views, stand-alone verification and simulation, documentation of:

FE-I4A: EOCHL (End-of-chip logic, includes R/O and error monitor), CREF (Current reference) Scan chain for EOCHL. Commercial wafer test for digital part

FE-I4B: Update of their design blocks. Mixed mode simulation. Test vectors for wafer testing at external facility.

Cost Sharing:

	FE-I4A	FE-I4B	Total
	%	%	%
Bonn, Göttingen (D-BMBF)	22%	22%	22%
Geneva (CH)	8%	14%	12%
Genova (I)	12%	12%	12%
LBNL (US)	22%	22%	22%
Marseille (F)	20%	15%	17%
Nikhef (NL)	16%	15%	15%
Unassigned	-	-	-
Total	100%	100%	100%

Note:

MoU Item 3 *Annex 1*

WBS Items: 3.1 ***Bump-bonding***

Description: Prototype

Development of bump-bonding for FE-I4. Dummy FE-I4/Sensor bump deposition and flip chip. Prototype FE-I4 thinning, bump-deposition, dicing (14 FE-I4A wafers, 2 FE-I4B wafers). Qualification of ≥2 vendors.

Production

FE-I4 wafer thinning, UBM & bump-deposition for FE-I4 (50 wafers) and Sensor (250 wafers) wafers, flip-chip (1300). Production QC.

Total Cost:

WBS	kCHF		
3.1.1	73	Prototypes and vendor qualification	
3.1.2	653	Bump-bonding production	
3.1	*726*	*Total*	*(MoU item)*

Work Responsibility

Barcelona	Prototype: dummy sensor, production procurement (part).
Bonn	AgSn vendor qualification, production procurement (part).
KEK	Production procurement (part).
CERN	Measurements on prototypes, production procurement (part).
Milano	Indium vendor qualification, production procurement (part).

Cost Sharing:

	Prototype %	Production %	Total %
Barcelona (E)	20%	10%	11%
Bonn (D-BMBF)	40%	50%	49%
CERN	-	20%	18%
KEK (J)	-	10%	9%
Milano (I)	40%	10%	13%
Unassigned	-	-	-
Total	100%	100%	100%

Note:

In the prototype phase the cost of FE-I4 wafer thinning and bump-deposition are in MoU item #3. The sensor wafer processing (UBM/bump-deposition) and flip chip is in MoU item #1.

Qualify the two vendors used by ATLAS Pixel - baseline AgSn - Technology backup Indium.

KEK develops bump-bonding R&D with Hamamatsu for sLHC (could become an option for IBL), participation to common procurement.
The "production cost sharing" covers 100% of the quote from the bump-bonder producer (IZM).

MoU Item **4** *Annex 1*

WBS Items: 4.1, 5.2, 9.1.1 ***Bare Stave & Cooling Pipe***

Description: Stave prototype with carbon foam. Pipe prototype in titanium (Ti) and carbon fiber (CF) (2, 3 & 4mm OD); pipe Ti/Ti welding/brazing; CF to Ti and Ti to Ti fittings; internal pipes from End-of-Stave (EoS) to PP1. Thermal management (TM) qualification with CO2 and C3F8; mockup for measuring thermal parameters from beam-pipe bakeout. Stave production and piping to PP1 (32 staves including spares). Tooling and glueing flex on stave. Production QC.

Total Cost:

WBS	kCHF	
4.1.1	242	Stave prototype (include Ti & CF pipes, Ti/Ti welding and fittings)
4.1.2	100	Stave production
5.2	95	Internal cooling pipes (PP0 to PP1) - Prot. (30kCH)+ prod. (65kCH)
9.1.1	30	Cooling design qualification (prototype)
	467	*Total* *(MoU item)*

Work Responsibility

Annecy	Design, production and QA/QC of Ti-to-Ti fittings; Ti/Inox-brazing. Electrical break at PP1; tooling PP0. Thermal cycling with CO2.
CERN	Thermo-mechanical prototype & QA. CO2 tests on stave. Procedure and glueing flex to stave.
LPNHE	Material budget, CAD design (software activity). Ruby fiducials, Ti screws/pins.
Marseille	Prototype: Ti-pipes, stave, TM qualification. Stave production & QC. Brazing of inlet/out pipes to stave pipe.
Milano	Prototype: CF pipe, CF-Ti joint, TM qualification, bakeout mockup, material irradiation. Stave production & QC. Tooling to glue flex on stave.
Nikhef	CO2 test on stave.
SLAC	Stave prototype thermal mechanical characterization with CO2 cooling test stand and stave design contributions such as the face-plate concept.
Wuppertal	Prototype: CF pipe & QA, stave. Stave production & QC.

Cost Sharing:

	Prototype %	Production %	Total %
Annecy, LPNHE, Marseille (F)	30%	30%	30%
CERN	10%	10%	10%
Milano (I)	30%	30%	30%
Wuppertal (D)	30%	30%	30%
Unassigned	-	-	-
Total	100%	100%	100%

Note:

MoU Item **5** *Annex 1*

WBS Items: 2.2, 3.2, 3.3, 4.2, 4.3, 5.1, 5.3 ***Module Assembly & Stave loading, Module to PP1 Connections***

Description: Module flex, assembled module (up to 224 with 3D sensors & 448 with planar sensors), module loading on stave, stave flex production and gluing on stave, intermediate flex, EoS PP0, internal services to PP1. Stave-0 prototype. Assembled module and loaded stave QC. Production spares.

Total Cost:

WBS	kCHF	
2.2	21	EoS card patch panel (PP0)
3.2	70	HDI (FE-I4 to EoS); replacement of Pixel module flex + type 0 cables
3.3	50	Assembled module production & QC/QA.
4.2	125	Loaded Stave
4.3	20	Stave-0
5.1	50	Internal cables (ex type 1)
5.3	100	PP1 (cables, cooling)
	436	*Total* *(MoU item)*

Work Responsibility

Bonn	"Flex module" production (50%) & QC; Al flex hybrid prototype.
CERN	Gluing flex to stave & QC; Loaded stave QC; stave-0.
Geneva / Bern	Jig & procedure for module loading on stave; loading modules on stave & QC; stave-0.
Genova	"Flex module" production (50%) & QC; module & stave flex hybrid design, procurement QA/QC.
Marseille	Tools and prototypes for module loading on stave and module reworking.
New Mexico	Qualification of flex hybrid with proton irradiation.
Oslo / Bergen	Contribution on flex hybrid; Intermediate flex, design, procurement & QC.
SLAC / Santa Cruz	Internal electrical services from EoS (PP0) to PP1; EoS (PP0 board) and PP1 (LV/HV & DT/CMD/CLK connectors) design and procurement; type 1 services QC.

Cost Sharing:

	Mod. Load		Total
	%		%
Bonn (D-BMBF)	6%		6%
CERN	4%		4%
Geneva (CH)	17%		17%
Genova (I)	22%		22%
Marseille (F)	10%		10%
Bergen, Oslo (N)	5%		5%
New Mexico, Santa Cruz, SLAC (US)	37%		37%
			-
Unassigned	-		-
Total	100%		100%

Note:

MoU Item 6 *Annex 1*

WBS Items: 2.3, 2.4, 2.5, 8.2, 8.4.1, 11.1 ***R/O Chain***

Description: Opto-boards (28 + spares) & opto-boxes (2) on ID end-plate, optoribbons (3x28 +spares) & optocables, RX/TX plugins (56/28 + spares), BOC/ROD (14 + spares), S-link source/destination and fibers (56 + spares), crates for ROD with backplanes, SBC, ROS, TIM. CTP/LTP from central ATLAS.

Total Cost:

WBS	kCHF	
2.3	129	Opto-board (VCSEL, PIN, opto-package), DORIC/VDC
2.4	236	BOC, TX/RX-plugin, S-link source card (LSC) + fiber
2.5	381	ROD
8.2	20	Opto-box on ID end-plate
8.4.1	72	Opto-fibers
	839	*Total Project part*
11.1	187	DAQ hardware (ROD crates/racks, TIM, ROS), S-link destination card (LDC)
	187	*Total M&O-A part*
	1 025	*Total MoU Item*

Work Responsibility [(4)]

Bern	Design, procurement [(3)] and test of RX-plugin.
Bologna	VME ROD design, production [(3)] (include calibration PCs), test. Contribution to BOC/ROD firmware & software.
DESY	Detector opto cables: fibers, ribbonization, termination - procurement [(3)] and QC.
Genova	ROD (TDAQ) & test. DAQ hardware procurement[(3)](in kind M&O-A): ROD crates, backplanes, SBCs, TIMs, ROSes, LDSs + fibers).
Göttingen	Contribution to BOC/ROD Software.
LBNL	Contribution to VME ROD design.
Ohio SU	Procurement [(3)] of PIN-diode and VCSELS with QC. Optopackage design, production [(3)] & QC. Optoboard design, production [(3)] and loading with opto-packages, DORIC and VDC. Optoboard test with Siegen. Contribution to opto-box design.
Oklahoma/ Oklah. SU	Opto-box design, production, QC.
Prague AS	Contribution to the BOC/ROD software.
Siegen	Optoboard test with Ohio SU.
SLAC/Stony Brook	Study ATCA option for the BOC/ROD [(2)]. Prototype with FE-I3 pixel modules.
Taiwan	TX-plugin procurement [(3)] ("commercial component" or same design as in the present Pixel detector).
Wuppertal/ Heidelberg	BOC (with s-link LSC [(1)]) design, production & test. Contribution to BOC/ROD firmware & software. TX-plugin commercial component design without BPM (central procurement) & QC.

Cost Sharing:

	R/O chain		Total
	M&O-A(*)	Project	%
Bern (CH)	-	6%	5%
Bologna, Genova (I)	100%	45%	55%
DESY	-	9%	7%
Heidelberg, Göttingen, Siegen, Wuppertal (D-BMBF)	-	19%	16%
Ohio SU,Oklahoma,Oklahoma SU,LBNL,SLAC,Stony Brook (US)	-	16%	13%
Taiwan	-	5%	4%
Unassigned	-	-	-
Total	100%	100%	100%

Note:

(*) Expression of interest to M&O-A in kind contributions. The recognized values of M&O-A items are firm and fixed.

DAQ hardware (for a total & fixed value of 187 kCHF) proposed as in kind contribution from INFN.

(1) LSC is integrated on BOC main board and not a plugin. S-link cost for FTK R/O is on FTK project.

(2) Selected IBL ROD design is VME. ATCA version is studied for HL-LHC

(3) Production/procurement quantities include spares, system test, set-ups in contributing labs (for non off shelf parts).

(4) Commissioning of the R/O chain is with the Institutes sharing the Work Responsibilities.

MoU Item **7** *Annex 1*

WBS Items: 2.6, 8.3, 8.4.2, 8.4.3 8.4.4, 11.3, 11.4 ***LV / HV Power Supply Chain & DCS***

Description: PP2 regulators (LV: 28 + spares, opto: 4 + spares) with crates, backplanes and controllers (4). Cables for power and DCS from PP1 to PP2 and from PP2 to USA15 (type 2, 3 & 4). LV-PP4. LV and HV power supplies. DCS: BBIM, BBM, PP1 Box (Laser + DDS), BOX-I-Box, BOC Monitor.

Total Cost:

WBS	kCHF	
2.6	36	PP2 power regulation (active elements).
8.3	30	PP2 boxes (crates/patch panels).
11.3	106	DCS hardware (monitoring, control and interlock), LV-PP4.
	172	*Total Project part*
8.4.2-4	166	Type 2, 3 & 4 cables.
11.4	167	LV & HV power supplies.
	333	*Total M&O-A part*
	505	*Total MoU Item*

Work Responsibility [1]

Barcelona	Contribution to the design of the LV power chain with Milano. Type 2 cables specification and test. Radiation test (cable & PP2 components). Commissioning of LV power chain with Milano.
DESY	Commissioning of HV chain.
Genova	Type 3 HV cables specification and test. HV PS procurement and test (cost on M&O-A).
Grenoble	Type3-LV and Type3/4-DCS cables specification and test.
Iowa	LV-PP4 (crates, inter-board, opto-isolator boards, ELMB) design, production test. Contribution in testing DCS cards with Wuppertal.
Milano	PP2: regulator card + box + controller; design, production & test. LV-PS procurement (in-kind contribution to M&O-A). LV chain commissioning with Barcelona.
Wuppertal	DCS hardware: BBIM, Logic Unit, IDB, BOB, OH-Ibox, PIM (Pixel Interlock Matrix), PP1 Box (Laser + DSS), BOC-I-Box, SCOL, BBM, BOC Mon, PP2 aux PS (Wiener), CAN aux PS, PCs and Kvaser CAN interface cards, PP3. Commissioning of DCS.
ATLAS TC	Procurement of cables with connectors, based on Barcelona/Genova/Grenoble specifications.

Cost Sharing:

	Power chain		Total
	M&O-A [*]	Project	%
Barcelona (E)	-	-	-
DESY (D-DESY)	-	-	-
Genova, Milano (I)	50%	38%	46%
Grenoble (F)	-	-	-
Iowa (US)	-	19%	6%
Wuppertal (D-BMBF)	-	43%	15%
M&O-A	50%	-	33%
Unassigned	-	-	-
Total	100%	100%	100%

Note:

[*] Expression of interest to M&O-A in kind contributions. The recognized values of M&O-A items are firm and fixed.

LV and HV power supplies (for a total & fixed value of 167 kCHF) proposed as in kind contribution from INFN.

[1] Commissioning of the power chain is with the Institutes sharing the Work Responsibilities.

MoU Item **8** *Annex 1*

WBS Items: 7, 11.6 ***Integration in SR1 & System Test***

Description: Stave Mounting Tool (SMT), IBL Multipurpose Container (MPC). Procedure to integrate stave and type1 services on beam-pipe. Test of IBL with cooling and R/O in SR1. Integration Mock-up. System Test in SR1.

Total Cost:

WBS	kCHF	
7.1, 7.3	75	Tooling for integration of staves & type1 services on beam-pipe
7.2	122	SMT: loading of staves on global supports
7.4	25	Transport and testing tool - IBL enclosure for cold test
7.5	70	Services to PP1 installation and portable cooling system in SR1
7.6, 11.6	200	System Test (ST) and Integration Mock-up in SR1
	492	*Total* *(MoU item)*

Work Responsibility

Bern, CERN, Geneva	Surface Integration work, IBL surface and system tests before installation. Infrastructure for integration and qualification of IBL staves and complete IBL. Construction and operation of a high performance thermo-mechanical facility at the SR1 building. Construction of an active integration and qualification mock-up of IBL prototype. System test infrastructure. Major responsibility in tooling (SMT, MPC).
Oklahoma, Prague AS Stony Brook	Integration work in SR1.
SLAC, Santa Cruz	Integration of internal services.
Barcelona, Bonn Göttingen, Iowa, Oslo Prague AS, SLAC Wuppertal	Contribution to System Test.

Cost Sharing:

	Integration %	ST / Mock-up %	Total %
CERN	50%	50%	50%
Bern, Geneva (CH)	50%	50%	50%
			-
			-
			-
			-
			-
			-
Unassigned	-	-	-
Total	100%	100%	100%

Note:

Bern, CERN and Geneva are the main contributors to this package with shared responsibilities.

Several Institutes interested in work contribution to integration and system test in SR1 and Installation in the pit.

MoU Item **9** *Annex 1*

WBS Items: 8.5, 9.1.2, 9.2, 9.3, 9.4, 9.5 ***Cooling plant & services***

Description: Cooling plant, cooling distribution, cooling pipes, manifolds/heaters, nitrogen pipes.

Total Cost:

WBS	kCHF		
8.5	130	Cooling pipes and manifolds	
9.1.2	220	Cooling plant	
9.2	50	Cooling services (distribution system)	
9.3	20	Nitrogen flow	
9.4-5	41	Plant installation and fluids	
	461	*Total*	*(M&O-A)*

Work Responsibility

ATLAS TC	Steering of the design and prototyping of the CO_2 cooling plant. Procurement and installation of cooling distribution, cooling pipes, manifolds/heaters, nitrogen pipes and the necessary liquids. Cooling plant controls development and commissioning.
Nikhef	Construct the vessel of the cooling plant according to the ATLAS technical specification; commissioning and functional tests before delivery to CERN for installation in the ATLAS cavern. Participation in the design phase.

Cost Sharing:

	Cooling		Total
	M&O-A(*)		%
Nikhef (NL)	48%		48%
M&O-A	52%		52%
			-
			-
			-
			-
			-
Total	100%	-	100%

Note:

(*) Expression of interest to M&O-A in kind contributions. The recognized values of M&O-A items are firm and fixed.

Construction of the cooling plant (for a total & fixed value of 220 kCHF) proposed as in kind contribution from Nikhef

MoU Item **10** *Annex 1*

WBS Items: 6.1, 6.2, 6.3 ***Beam-pipe & Interfaces***

Description: Beam-pipe extraction & IBL insertion: tooling & test on mock-up. New beam-pipe design & procurement. Global support for beam-pipe & IBL: IBL Support Tube (IST) with supports for staves and internal services, volume enclosure, support and alignment for beam-pipe.

Total Cost:

WBS	kCHF		
6.3	420	IST, interfaces to support staves & services	
	420	*Total*	*(Project part)*
6.1	180	Beam-pipe extraction/IBL insertion. Tooling, test on mock-up, ALARA	
6.2	1 390	New beam-pipe with insulators and heaters	
	1 570	*Total*	*(M&O-A part)*
	1 990	*Total*	*(MoU Item)*

Work Responsibility

ATLAS TC	Coordination of the CAD integration. Contribution to global supports design. Design, prototype and fabrication of VI beam-pipe support system. Design and fabrication of beam-pipe support outside IBL. Procurement of the Be beam-pipe with instrumentation.
Brandeis	Development and fabrication of the Long Guiding Tube (LGT), an active tool to compensate bow of the beam pipe during its extraction and the bow of the IST during its insertion.
Geneva	Design and fabrication of the installation mock-up in bld.180. Visual inspection with endoscope of the extraction/insertion process. Dummy beam pipe design and procurement. Contribution to prototype IST fabrication.
Genova	Z-stopper and sliding pads production and qualification.
Grenoble LPSC	Engineering of the extraction/insertion table (tooling for beam-pipe extraction/IBL insertion).
LBNL	Wire tension system and IST support system design.
LPNHE Paris	Design and follow up of an IBL mock-up (dummy beam pipe, services, support rings, dummy staves) to practice IBL insertion. Design and fabrication of the support rings for staves, services and beam-pipe.
Orsay LAL	Design, fabrication and installation of the sealing ring closing IBL volume and the interface supporting the IST at the level of the Pixel end plate. Those design shall integrate the grounding connection. Design, prototype and production of IBL/ID end-plate sealing.
Seattle Washington	Design, prototype and fabrication of the Inner Support Tube (IST). Including the shielding and grounding connection.

Cost Sharing:	Beam-pipe & Global supports		Total
	M&O-A (*)	Project	%
Geneva (CH)		71%	15%
LPNHE Paris, Orsay LAL (F)		10%	2%
Brandeis, Seattle Washington (US)		19%	4%
Grenoble LPSC	1%		1%
ATLAS TC	99%		78%
Unassigned	-	-	-
Total	100%	100%	100%

Note:

(*) Expression of interest to M&O-A in kind contributions. The recognized values of M&O-A items are firm and fixed.

Installation tools (for a total & fixed amount value of 20 kCHF) proposed as in kind contribution from IN2P3.

MoU Item **11** *Annex 1*

WBS Items: 8.1.1, 10 ***Installation***

Description: Extraction of the present beam-pipe, installation of the external services & test, installation of the IBL package, connection to the services at PP1/PP2 and testing

Total Cost:

WBS	kCHF	
10.1	370	Radiation work and limitation (safety & IMB)
10.2	500	Extraction of the Beam Pipe (Present)
10.3	435	Installation of the b-layer "Package"
10.4	130	Services Installation from PP1 to PP2, counting room.
8.1.1, 10.5	80	Services Routing, Connection & Testing
	1 515	*Total* *(M&O-A)*

Work Responsibility

ATLAS TC — Operation planning, supervision and execution.

Cost Sharing:

	Cooling M&O-A		Total %
M&O-A	100%		100%
			-
			-
			-
			-
			-
			-
			-
			-
Total	100%	-	100%

Note:

MoU Item **12** *Annex 1*

WBS Items: 13 ***Diamond Beam Monitor***

Description: Diamond Beam Monitor detector assembly and test, R/O, PS, services and mechanics.

Total Cost:

WBS	kCHF		
2, 8, 11	*150*	*Total*	*(IBL Common)* [(1)]
13.1	115	Sensor	
13.3	35	Mechanics	
13.4	10	Flex	
13.5	26	Integration	
	186	*Total*	*(DBM Production)*
Total	*336*	*Total*	*(Total)* [(3)]

Work Responsibility

Bonn	*Lead role:*	Module assembly and testing
	Responsibility	Test-beam
	Participation:	DAQ, off-line
CERN	*Lead role:*	Services and integration
	Responsibility	Module testing, DAQ
	Participation:	Sensor procurement and testing, test-beam, offline
Göttingen	*Lead role:*	Test-beam
	Responsibility	Module testing, DAQ
	Participation:	Module assembly, offline
Ljubljana	*Lead role:*	DAQ
	Responsibility:	
	Participation:	Module testing, services and integration, test-beam
New Mexico	*Lead role:*	
	Responsibility	Module irradiation and testing, services
	Participation:	
Ohio SU	*Lead role:*	Sensor procurement and testing
	Responsibility	Module assembly
	Participation:	Module testing, mechanical support, test-beam
Toronto	*Lead role:*	Mechanical support, offline
	Responsibility	Module testing, test-beam
	Participation:	

Cost Sharing:	IBL Common[(1)]	DBM Prototype[(2)]	DBM Production	Total[(3)]
	%	%		%
Bonn/Gottingen (D-BMBF)	30%		28%	29%
CERN		10%	21%	12%
Ljubljana (SLO)	20%	30%	16%	18%
New Mexico, Ohio SU (US)	30%	30%	16%	22%
Toronto (CND)	20%	30%	19%	19%
				-
				-
Unassigned				-
Total	100%	100%	100%	100%

Note:

(1) Estimate, 50 % contingency added until cost finalized, needs negotiation with IBL institutes supplying deliverables.

(2) For information only. The actual work package is in Annex A1.1 - WBS 1.2: sensor prototypes developed for IBL sensor qualification.

(3) Total of "IBL Common" and "DBM Production".

IBL Common Parts (customized for DBM)

Item	Lead Institute in DBM	Lead Institute in IBL
FE-I4	Bonn	Bonn, CPPM, Genova, Geneva, Nikhef
DCS	Gottingen	Wuppertal
HV-PS - Crate	Gottingen	Genova
HV-PS - Modules	Gottingen	Milano
HV-PP4	Gottingen	DESY
LV-PS	Gottingen	Milano
LV-PP4	Gottingen	Iowa
PP2: boards+controller+crate	CERN, Gottingen	Milano
ROD	Ljubljana	Bologna
BOC+S-link	Ljubljana	Wuppertal/Heidelberg
TX plugin	OSU	Taiwan
RX plugin	OSU	Bern (Ohio)
ROD-Crate+BP+SBC	Ljubljana	Bologna/Genova
LTP	Ljubljana	Genova
S-link RX+ROS	Ljubljana	Genova
Opto-board/box	OSU	nSQP, Ohio
Type 0 services	N/A	Genova
Type I services	CERN, Toronto	SLAC
Type 2 services	New Mexico	Barcelona, LAPP
LV, DCS cables	New Mexico	Grenoble
HV cables	New Mexico	Genova
Fiber optics	New Mexico	DESY

Memorandum of Understanding (MoU)

Annex 2

Description of the IBL Organization

The IBL [1] Organization operates under the control and guidance of ATLAS Collaboration Management Structure as is defined in the Annex.5 of the ATLAS Construction MoU [2]. The IBL Management Structure organization chart is shown in Fig.1. The IBL Management Board (IBL MB) takes decisions on technical execution matters and makes recommendations to the Institute Board on major technical choices and on matters of sharing resources and responsibilities. The Institute Board (IB), which is an extension of the Pixel IB, takes decisions on major technical choices and on sharing of resources and responsibilities.

The IBL Project Leader (PL) is directly and ultimately responsible to the ATLAS Collaboration, for ensuring that the design and construction of the IBL is carried out on schedule, within the cost ceiling, and in a way that guarantees the required performance and reliability, within the framework of the ATLAS resource planning.

The IBL Technical Coordinator (TC) oversees and assesses the feasibility of the technical aspects. He or she assists the Project Leader (PL) in the technical decisions by preparing and keeping updated the schedule, organizing the technical reviews, assigning the technical manpower.

Participation to the IBL construction can be from the existing Institutions, which are in the Pixel collaboration, or from new Institutions, which join directly the project. Participation is also possible through the Upgrade Project Office (UPO).

IBL PL and TC have to report to the Institute Board, at the ATLAS Weeks, to the Upgrade Project Office, Upgrade Steering Group and Pixel and Inner Detector meetings.

The IBL Project Leader (IBL PL) is elected in accordance to the ATLAS rules [3] and is in charge for two years, with the possibility to be renewed by 2/3rd majority. The Institutes signing the IBL MoU, which are the ones bringing the resources to the project, vote for the selection of the PL. It is up to the IB, in consultation with the PL, to decide whether to continue to have a Technical Coordinator (IBL TC), and if so, on the selection process.

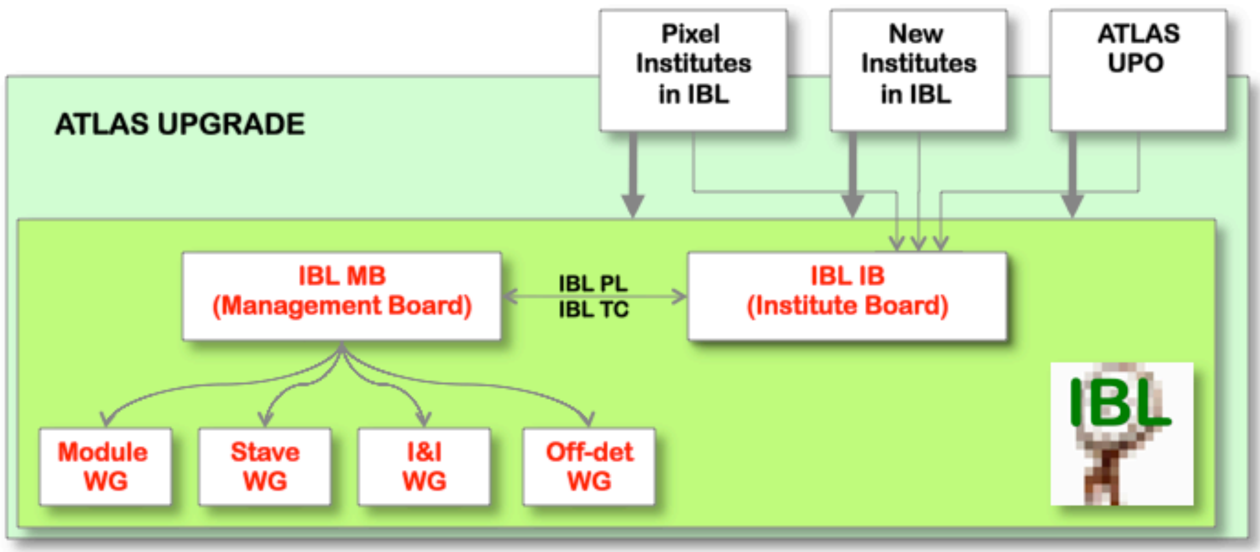


Figure 1: IBL Organization Chart.

Management Board

The IBL Management Board (MB) controls the execution of the project. The IBL MB meets every two weeks in phone meetings chaired by the IBL PL and TC. Meetings have closed participation to MB members and speakers could be invited to report on specific issues on request of the IBL MB. The IBL MB uses indico and SharePoint to distribute material for discussion. Minutes circulated to the IBL collaboration and Issue Tracking is the way the MB works.

The management board members are appointed by the IBL PL in consultation with the IBL TC and endorsed by the IB.

Working Groups

The construction activities of the whole IBL project are divided into four working groups. Each working group has two coordinators. Sharing of responsibilities between the two coordinators in each working group is defined on the basis of a mandate document.

The four groups are:

– *Module WG (Coordinators: M. Garcia Sciveres and F. Hügging)*

Activities: Sensor design, prototyping, production and quality control.

Design of the front-end chip (FE-I4), prototyping, procurement and quality control.

Bump-bonding, thinning, bare module production and quality control.

– *Stave WG (Coordinators: O. Rohne and E. Vigeolas)*

Activities: Local support (stave) including cooling pipe design, procurement and quality control.

Cooling and stave thermal management design.

Flex Hybrid and internal service design, procurement and quality control.

Stave loading with module and electrical, thermal and mechanical quality control.

– *Integration & Installation WG (Coordinators: F. Cadoux and R. Vuillermet)*

Activities: Design and procurement of global support for beam-pipe, staves and services.

Procurement of new beam-pipe.

Integration of the staves with beam-pipe and services in SR1 and QC with cooling system and electronics.

Design and installation of cooling plant and cooling services.

Extraction of beam-pipe.

Installation of IBL package with beam-pipe.

Installation of services (type2, 3 and 4 cables, cooling and gas piping).

ALARA compliance.

– *Off-detector WG (Coordinators: T. Flick and S. Débieux)*

Activities: Design and procurement of the R/O chain, including ROD/BOC and opto-links

Design and procurement of the power chain, including LV and HV power supplies and PP2 regulators.

Design and procurement of DCS and interlock system.

Design of procurement of cables and opto-fibers.

System test.

The Working Group coordinators steer the activities they are concerned with in periodic meetings that are largely in the form of a phone conference.

Diamond Beam Monitor - DBM

The Diamond Beam Monitor (DBM) is a technological spin-off of the IBL module qualification program and offers the possibility for ATLAS to measure luminosity with high precision on a bunch-by-bunch basis. The DBM is a sub-project of the IBL project and is an IBL deliverable. Its construction activities are followed in the IBL project through the IBL management in close collaboration with DBM experts. Installation of the DBM in the present Pixel detector volume is planned and prepared in the framework of the nSQP project. One representative of the DBM is member of the IBL Management Board to oversee sub-project dependent activities and report on its status.

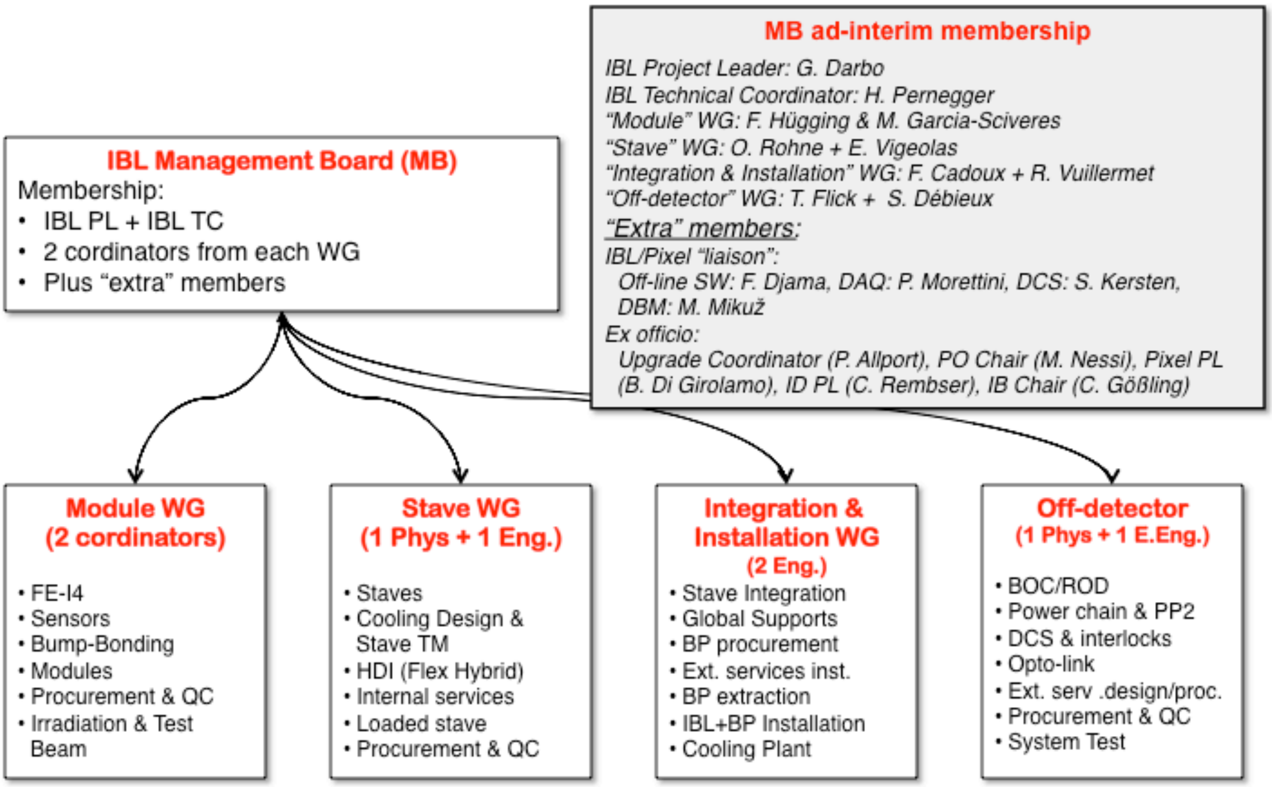


Figure 2: IBL Management Board and its membership as at 1st October 2011.

Institute Board

The Institutions taking part in the project, in a direct way (as opposed through the UPO), with money and manpower, are part of the Institute Board (IB). The IB is an extension of the Pixel IB and usually meets after the normal Pixel IB with the additional Institutions members in the IBL.

The Institute Board takes decisions on major technical choices and on sharing of resources and responsibilities. Major technology choices affecting the overall performance of ATLAS have to be brought forward to the collaboration as a whole for decision in the Collaboration Board. The institutions are the source of money and manpower, and therefore all major questions involving sharing of responsibilities and contribution of resources have to be agreed upon by the Institute Board.

Composition of the IB is one member for each institute, as listed in the Annex 3, plus Pixel, IBL and ATLAS management.

IBL General Meetings

These meetings are held three or four times a year and constitutes the forum where discussions on any aspect of the Pixel project should take place. The results of the working groups should periodically be presented at the general meetings. The session are organised by the IBL PL and TC with the help of the working group coordinators.

Collaborative Tool and EDMS depository

To transmit the information in the IBL project a "Share Point" [4] Collaborative Workspace is created where material relative to the project is uploaded and maintained under the responsibilities of the working group coordinators and of the IBL PL and TC. This depository is used during the phase of preparation of the documents in their final form. The approved documents are referenced and posted in the EDMS structure [5].

Workgroup meetings and IBL General Meeting are on indico [6].

To transmit the information, a few open-subscription (to ATLAS members) mailing lists {7} have been created: a general mailing list and one for each working group. The software simulation activities have a dedicated mailing list too. Additional mailing lists can be created on discretion of working group coordinators or project leader and technical coordinator.

References.

[1] ATLAS Collaboration, Insertable B-layer Technical Design Report, CERN- LHCC-2010-013. ATLAS-TDR-019, CERN, Geneva, Sep 2010.

[2] ATLAS Collaboration, Memorandum of Understanding for Collaboration in the Construction of the ATLAS Detector, CERN-RRB-98-44 rev.

[3] ATLAS CB, ATLAS System Organization, ATLAS GEN-No-015 29/11/96, rev 2.1 Nov 2006.

[4] IBL Collaborative Workspace: https://espace.cern.ch/atlas-ibl/default.aspx

[5] IBL EDMS root node: https://edms.cern.ch/nav/ATLAS/ATU-0000000042

[6] Indico IBL category: http://indico.cern.ch/categoryDisplay.py?categId=2337

[7] IBL mailing lists:

a. IBL General: atlas-ibl-gen@cern.ch
b. IBL Working Group 1 (Module): atlas-ibl-wg1@cern.ch
c. IBL Working Group 2 (Stave): atlas-ibl-wg2@cern.ch
d. IBL Working Group 3 (Integration & Installation): atlas-ibl-wg3@cern.ch
e. IBL Working Group 4 (Off-detector): atlas-ibl-wg4@cern.ch
f. IBL Software Simulation: atlas-ibl-software@cern.ch

Institutes / Institutions Participating in the IBL Construction

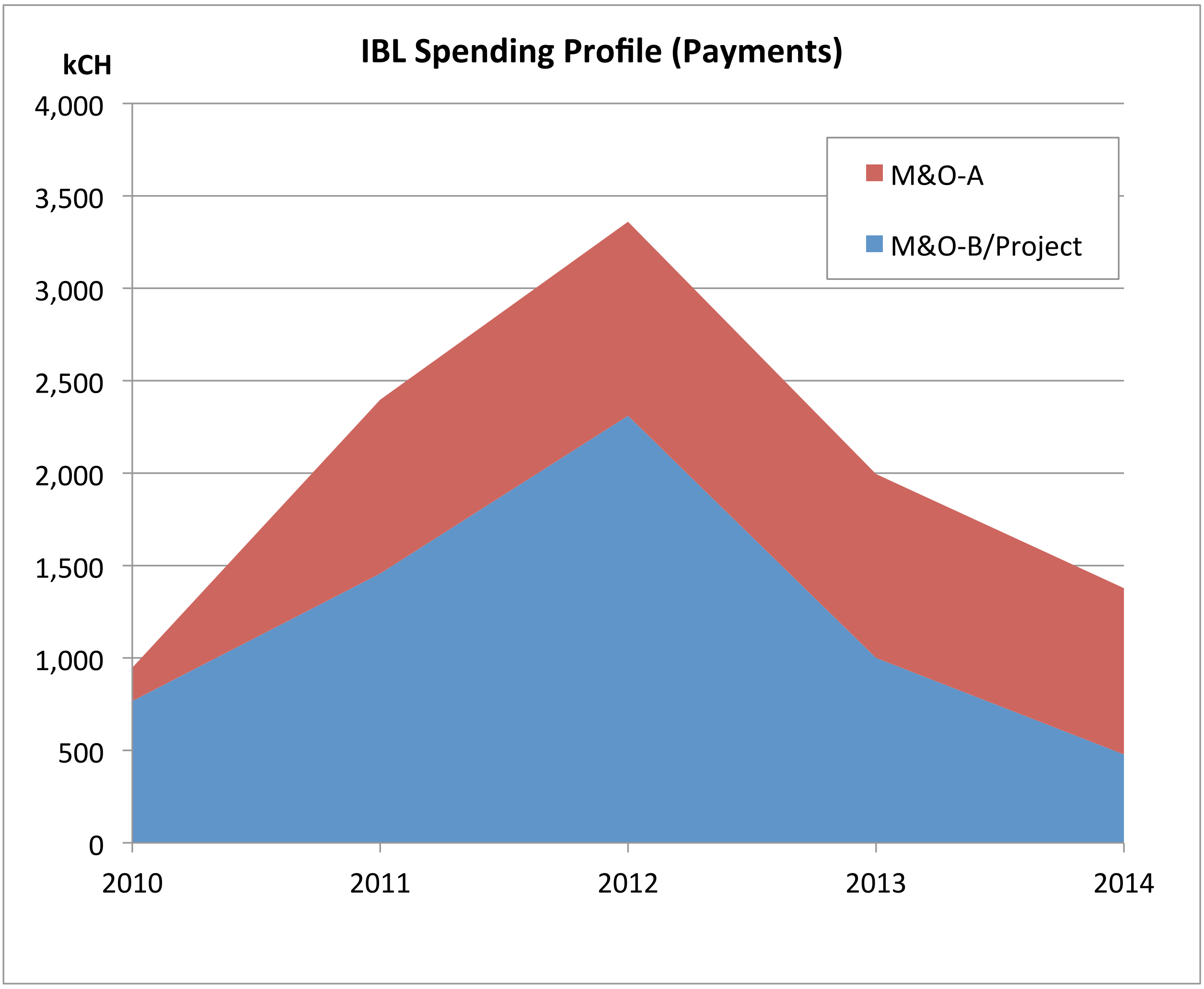
Institution	Country	Funding Agency	Institute Representative	National Contact Physicist
Toronto	Canada	Canada	Trischuk, William	McPherson, Robert
CERN	Switzerland	CERN	Dittus, Fido	Mornacchi, Giuseppe
Prague AS	Czech Republic	Czech Republic	Sicho, Petr	Vrba, Vaclav
Annecy LAPP			Di Ciaccio, Lucia	Fournier, Daniel
Grenoble LPSC			Malek, Fairouz	Fournier, Daniel
LPNHE Paris			Schwemling, Philippe	Fournier, Daniel
Marseille CPPM			Talby, Mossadek	Fournier, Daniel
Orsay LAL	France	France - IN2P3	Schaffer, Arthur	Fournier, Daniel
Berlin HU			Lacker, Heiko	Mättig, Peter
Bonn			Wermes, Norbert	Mättig, Peter
Dortmund			Gößling, Claus	Mättig, Peter
Göttingen			Quadt, Arnulf	Mättig, Peter
Heidelberg ZITI			Kugel, Andreas	Mättig, Peter
Siegen			Buchholz, Peter	Mättig, Peter
Wuppertal		Germany - BMBF	Mättig, Peter	Mättig, Peter
DESY		Germany - DESY	Mönig, Klaus	Mönig, Klaus
Munich MPI	Germany	Germany - MPI	von der Schmitt, Hans; Bethke, Siegfried	Bethke, Siegfried
Bologna			Zoccoli, Antonio; Bruni, Graziano	Rossi, Leonardo
Genova			Morettini, Paolo	Rossi, Leonardo
Milano			Meroni, Chiara; Troncon, Clara	Rossi, Leonardo
Udine	Italy	Italy	Cobal, Marina	Rossi, Leonardo
KEK	Japan	Japan	Unno, Yoshinobu	Tokushuku, Katsuo; Kobayashi, Tomio
Nikhef	Netherlands	Netherlands	Bentvelsen, Stan	Bentvelsen, Stan
Bergen			Sandaker, Heidi	Ould-Saada, Farid
Oslo	Norway	Norway	Ould-Saada, Farid	Ould-Saada, Farid
Ljubljana	Slovenia	Slovenia	Mikuz, Marko	Mikuz, Marko
Barcelona	Spain	Spain	Grinstein, Sebastian; Padilla, Cristobal	Higon-Rodriguez, Emilio
Bern			Ereditato, Antonio	Clark, Allan
Geneva	Switzerland	Switzerland	Iacobucci, Giuseppe	Clark, Allan
Taipei AS	Taiwan	Taiwan	Lee, Shih-Chang	Lee, Shih-Chang
Glasgow			Buttar, Craig	Tovey, Daniel
Liverpool			Allport, Phillip	Tovey, Daniel
Manchester	United Kingdom	United Kingdom	Loebinger, Fred	Tovey, Daniel
Berkeley LBNL			Hinchliffe, Ian	Gordon, Howard; Tuts, Michael
Brandeis			Bensinger, James R.	Gordon, Howard; Tuts, Michael
Iowa			Mallik, Usha	Gordon, Howard; Tuts, Michael
New Mexico			Seidel, Sally	Gordon, Howard; Tuts, Michael
Ohio State University			Gan, KK; Kagan, Harris	Gordon, Howard; Tuts, Michael
Oklahoma			Skubic, Patrick	Gordon, Howard; Tuts, Michael
Oklahoma SU			Rizatdinova, Flera	Gordon, Howard; Tuts, Michael
Santa Cruz UC			Seiden, Abraham	Gordon, Howard; Tuts, Michael
Seattle Washington			Lubatti, Henry	Gordon, Howard; Tuts, Michael
SLAC			Dong, Su	Gordon, Howard; Tuts, Michael
Stony Brook	United States of America	United States of America	Tsybychev, Dmitri	Gordon, Howard; Tuts, Michael

Annex 4 **MoU System Items**

	Funding Agency	1 Module	2 Stave	3 Off-detector Electronics	4 Integration & Cooling Plant	5 Beam-Pipe, Interfaces & Installation	6 DBM	Total Include DBM	 Exclude DBM
Project	Canada	35	-	-	-	-	65	100	35
	Czech Republic	27	-	-	-	-	-	27	27
	France IN2P3	353	183	-	-	40	-	576	576
	Germany BMBF	-	-	-	-	-	-	-	-
	Germany DESY	-	-	72	-	-	-	72	72
	Germany MPI	-	-	-	-	-	-	-	-
	Italy	365	235	447	-	-	-	1 047	1 047
	Japan	92	-	-	-	-	-	92	92
	Netherlands	211	-	-	-	-	-	211	211
	Norway	52	21	-	-	-	-	73	73
	Slovenia	28	-	-	-	-	60	88	28
	Spain	132	-	-	-	-	-	132	132
	Switzerland	159	75	50	246	300	-	830	830
	United Kingdom	106	-	-	-	-	-	106	106
	US DOE & NSF	-	-	-	-	-	-	-	-
	CERN	196	65	-	246	-	39	546	507
	Total	**1 758**	**577**	**569**	**492**	**340**	**164**	**3 900**	**3 736**
M&O-B	Czech Republic	-	-	-	-	-	-	-	-
	France IN2P3	-	-	-	-	-	-	-	-
	Germany BMBF	728	165	235	-	-	97	1 225	1 128
	Italy	-	-	-	-	-	-	-	-
	Taipei	-	-	41	-	-	-	41	41
	US DOE & NSF	364	161	167	-	80	75	846	771
	Total	***1 092***	***326***	***442***	***-***	***80***	***172***	***2 111***	***1 939***
M&O-A	**Total**							**4 065**	**4 065**
Total		**2 850**	**903**	**1 011**	**492**	**420**	**336**	**10 077**	**9 741**

Annex 5 **IBL Payment Profile**

	2010	2011	2012	2013	2014	Total
M&O-A	180	940	1 050	995	900	4 065
M&O-B/Project	767	1 457	2 310	1 000	478	6 012
Total including DBM	947	2 397	3 360	1 995	1 378	10 077



Annex 6

Component	Start	Finish
TDR approved by ATLAS	-	Sep 2010
Stave 0: loading FE-I4A modules on stave	Apr 2012	Jul 2012
FE-I4B: submission to end of probing	Sep 2011	Apr 2012
Sensor: production and QC	Feb 2011	Mar 2012
Bump bonding process: UBM, bump deposition and flip-chip	Nov 2011	Oct 2012
Module assembly with flex and QC	Apr 2012	Jan 2013
Module loading on stave and QC	Jul 2012	Mar 2013
Beam-pipe: procurement	May 2011	Dec 2012
Stave integration with beam-pipe and internal services	Mar 2013	Jun 2013
Whole IBL test and commissioning	Jul 2013	Sep 2013

Production schedule for main IBL components