Infrastructure for Detector development in Horizon 2o2o

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3rd Annual Meeting of AIDA
Vienna, March 27, 2014

Outline:

- EU Integrated infrastructure initiatives
- Expressions of Interest for AIDA-2
- Networking and Joint Research Activities
- Transnational Access, Communication & Impact, v's
  - Laurent's talk
- Follow-up
  - Silicon tracking and vertexing
  - Calorimetry
  - Gaseous detectors
  - Improvements of facilities
  - Microelectronics
  - DAQ
  - Software

Previous infrastructure initiatives

- FP6: EUDET: 2006-2010
  - Total budget 21M, EU contribution 7M
  - 31 partners + associates
  - detector development for a linear collider
  - pixel telescope, TPC magnet and field cage, calorimeter absorber and electronics, software, transnational access to test beams
- FP7: AIDA: 2011-2014
  - Total budget 26M, EU contribution 8M
  - 80+ institutes, 40 (direct) beneficiaries
  - detector development for LHC upgrades, ILC, CLIC, neutrino physics and Super-B
  - TA to test beam and irradiation facilities, DD4HEP, more telescopes, 3D integration, etc pp

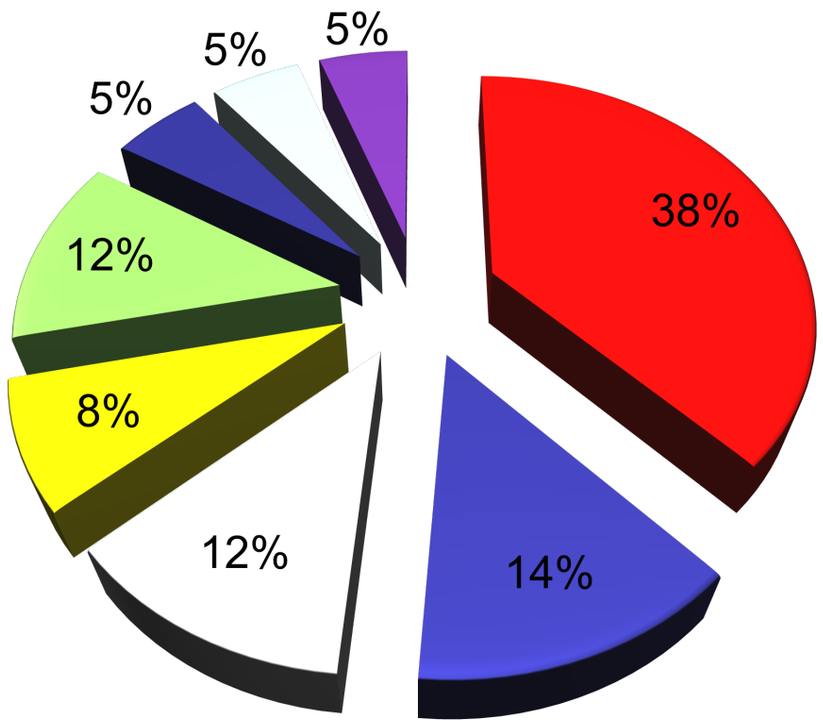
AIDA Advanced European Infrastructures for Detectors at Accelerators

Integrating activity

- Translating EU language - an IA should contain:
- Transnational access
  - support use of infrastructures
  - AIDA examples: test beams at DESY and CERN (mostly travel), irradiation facilities (shipment and fees)
  - Deliverables: usage reports
- Networking activities
  - between infrastructures, communities
  - AIDA examples: common software, interconnection technologies, relations with industries
  - Deliverables: tools, frameworks, investigations
- Joint research activities
  - improve the quality or quantity of research infrastructure
  - AIDA examples: test beam and irrad. facility upgrades, detector development infrastructure (creatively interpreted)
- Innovation
  - new

AIDA-2: Content

- End of 2013: call for "Expressions of Interest"
  - more than 50 EoIs received
  - more than 50 institutes
  - more than 50% LHC



- Solid state tracker, micro electronics, 3D
- Calorimeters
- gaseous detectors
- TransNational Access facilities
- Software
- Trigger/DAQ
- Infrastructure upgrade
- Others

Not weighted by
# of institutes, tasks
or budget request

summarised at Open Meeting
CERN, 17.2.2014
http://indico.cern.ch/event/289451/

General

- Very diverse interest
- In many cases the infrastructure character not visible, too generic R&D
- some are too national, or too much geared to one project
- some are simple AIDA continuation
- there are good examples, too
- ➜ Challenging to define coherent work packages

- Process has started, very early stage
- First reports from contacts, first feedback

Proposal structure, contacts

- Management
  - coordinating institute: CERN (tbc)
- Transnational access
  - test beam at CERN and DESY
    - Wilkens, Stanitzki
  - irradiation facilities
    - Mikuz, Moll
  - more?
- Networking activities
  - Innovation and dissemination
    - Anelli, Szeberenyi
  - Software
    - Gaede, Prokorski
  - Microelectronics, interconnection
    - de La Taille, Re
- NA or JRA
  - DAQ
    - Cussans, Wing
  - Silicon vetrex and tracking
    - Bergauer, Dannheim, Lacasta, Macchiolo
- JRA
  - Gaseous detectors
    - dalla Torre, Laktineh
  - Calorimeters
    - Poeschl, Simon
  - Cryogenic detectors
    - Autiero
  - Improvements of Facilities
    - Coordination team

Workpackages

- Vertical
  - Silicon tracking and vertexing
  - Calorimetry
  - Gaseous detectors

- Improvements of facilities

- Horizontal
  - Microelectronics
  - DAQ
  - Software

Silicon: tracking and vertexing

- The largest community
- The biggest challenge for the LHC upgrade

- Four contacts charged to define structure
- First meeting took place last Friday, > 45 participants
  - Communities represented: LHC, ILC, CLIC, Belle
- Proposal:

① Networking Activity: Capacitively coupled HV/HR CMOS Pixel Sensors

② Networking Activity or Joint Research Activity: Light Support Structures and μ-channel cooling for Silicon Sensors

③ Networking Activity: Network of European Companies for HEP Si Sensor Production

Silicon 1: CMOS sensors

AIDA-2 Reorganization of activities on CMOS sensors

HV/ HR CMOS Sensors – Networking activities

3+14+38+ 44+37-a	CMOS sensors for colliders experiments	LHC+ILC+CLIC	CPPM, Bonn, CERN, Geneva, Heidelberg, Oxford, RAL, Sheffield, Glasgow, Liverpool
2+46+58	Hybridization of CMOS pixel devices	LHC+ILC+CLIC	IFAE, INFN Genua, Bonn, Trento, Santander, Liverpool, CERN

- Need to build larger consortia of beneficiaries, for example in this case the UK participants (comment also valid for all the other activities)

Silicon 1: CMOS sensors

AIDA-2 HV/HR CMOS sensors networking activities

Possible NA tasks:

- CMOS Technologies Evaluation
  - Coordination of MPW submissions → establish HEP as a possible market for the CMOS vendors
- Common TCAD simulation tools and set of libraries for HV/HR CMOS sensor design
- Coordination of the technological developments for hybridization: wafer to wafer (8") bonding options, R&D on dielectric layers for the capacitive coupling of the CMOS active sensors
- Establish an inter-experiment HR/HV CMOS sensor collaboration

- Fits well a NA

Silicon 2: Mechanics and cooling

AIDA-2

Reorganization of activities on support structures and μ-cooling

5-a	Integrated micro-cooling for pixel detectors	LHC	CERN
6	Development of cooling systems for silicon detectors for High Energy Physics based on micro-channels	LHC	IN2P3(LPNHE,LAL), MPP, DESY, FBK, PD,GOE
15+16+36 +37-b	Integrated support structures and novel cooling concepts for position sensitive silicon detectors	LHC+ILC +CLIC	Bristol, CERN, CNM, DESY, Santander, IFIC, MPI, Liverpool, Oxford, IPHC, NIKHEF
59	3D printed low mass mechanical support for future detector systems	LHC+ILC	Manchester

- Should avoid single institute tasks

Silicon 2: Mechanics and cooling

AIDA-2 Support structures and μ-cooling tasks

Possible NA or JRA tasks:

- Set-up of testing facilities for vibration and cooling studies → deliverable suited for a JRA organization
- Development of μ-channel cooling in Silicon and Kapton, including interconnects:
  - Minimal mass fluidic connectors and interconnectors in silicon and kapton
  - Integrated micro pressure sensors (for 2-phase flow control)
- Finite element simulation and prototyping of ultra-light support structures + 3D printing
- Advance thermo-fluidic modelling

- Fits well a JRA

Silicon 3: Hybrids and large areas

AIDA-2 Hybrid Pixel sensors and Large area foundries

17	Industrialization of the production of large-area silicon tracking detectors	Bergauer	HEPHY, KIT, Freiburg, Liverpool	Large area commercial foundries
18	Standardization of common test structures to qualify HEP SI-detectors	Bergauer	HEPHY, KIT, Freiburg, Liverpool	
7+8	Development of a beam monitor based on Ultra Fast Silicon detector	Cartiglia	INFN (Turin, Trento), Lubljana, CNM, Freiburg, HEPHY	Hybrid pixels with MEMS technologies
42	Infrastructure for the development of 3D sensors and Pixel modules suitable for HL-LHC upgrade of ATLAS and CMS	Darbo	INFN, IFAE	
54	3D silicon detectors	Da Via	Manchester, Oxford, Trento	
4	Development of pixel modules with reduced inactive edges	Macchiolo	MPP, IN2P3(LAL,LPNHE)	
n.a.	Silicon detector technology common access plus design framework	Lozano	D+T Microelectronica, A.I.E. and/or CNM	

- Rather heterogenous

Silicon 3: Hybrids and large areas

AIDA-2 Hybrid Pixel sensors and Large area foundries

Reorganization of the EoIs in a single NA:

- Network of European Companies for HEP Si Sensor Production

Suggested tasks:

candidate for industrial impact?

- Establish European suppliers for large area production of silicon sensors (strips and pixels) , possibly in cooperation with groups interested in the development of Si/W calorimeters
- Promote actions to build a pool of European companies able to produce pixel sensors with MEMS technologies (3D, thin planar with active edges, LGAD) for the inner layers of tracking systems at HL-LHC and CLIC
  - Development of common technologies
  - Common R&D and procurement of thinned substrates
- Promote common sensor wafer submissions across experiments
- Open access design and simulation tools

Silicon: Observations

- Communities represented: LHC, ILC, CLIC, Belle
- Final composition of WP should somehow reflect European strategy

- Institutes which appear in several WP should define where their main impact as beneficiary is, and where they are associates

- Tasks in WP 3 not so well connected
  - but want to avoid too small WP
  - consider link large area task with calorimetry or impact

Calorimetry submissions

- Updated list

Title	Insitutes
High Granularity Calorimeter SI-Cal at LHC	CERN, imperial college + US
Creation of instrumental facilities for novel high time resolution ionizing radiation detecting techniques	CERN, Minsk, Vilnius, Moscow
Quality assurance for highly granular scintillator based calorimeter components	DESY, Heidelberg, Mainz, Wuppertal,
Read-out for highly granular scintillator based calorimeters	DESY, Heidelberg, Mainz, MPI
New materials for calorimeters and fluence monitoring for high fluence environment	CERN,Vilnius, Belarus state university
Infrastructure development towards innovative calorimetry for future colliders	INFN (Milano), ETH, CERN
Ultra-granular Si W ECAL for ILD *(10 subprojects!!!)*	IN2P3
FCAL: development of highlycompact and precise luminimeters *(3 subprojects*)	DESY, CERN, IFJPAN, TAU
SDHCAL prototyping study for ILD	IN2P3, CIEMAT
Infrastructure upgrade for Calorimetry	Prague +
Optimization, calibration, monitoring, slow control and data base for large systems with SiPM readout	Bergen, Prague +

Calorimetry WP

- Broader community than in AIDA
- Submissions from
  - ECAL for LHC and LC
  - HCAL for LC
  - FCAL for LC
  - Generic studies with optical read-out
- Post-dead line submissions

- First meeting took place
- Will be a JRA

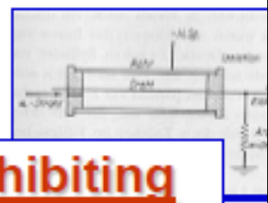
- Will privilege infrastructure oriented projects
- Build multi-national tasks
- Balance of CMS-related activities should reflect their priorities

Gaseous detectors

- First meeting took place
- ~ 20 participants

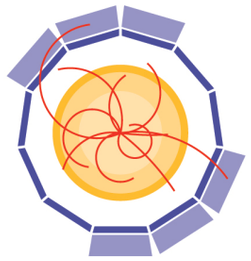
AIDA

PROPOSAL



PRELIMINARY

- **A single NA including the major consolidated InfraStructures (IS) exhibiting complementary features → budget mainly for manpower & travelling**
- **IS (directly financed)**
  - CERN
    - MPGD common lab & test BEAM, SRS (read-out system) support and maintenance, support to gas-detector simulation (progress and maintenance)
  - INFN cluster
    - Bari - dedicated electronics, GEM & RPC lab
    - Frascati & Torvergata – GEM lab, material lab, RPC lab
    - Trieste – THGEM & photon detection lab
  - SACLAY
    - MICROMEGAS lab: design, fabrication, assembly, characterisation
  - Lyon
    - High rate, fine time precision RPC (electronics, low R materials), realization and test
  - Desy
    - TPC development IF (1 T magnet, movable stage, power, cooling, slow controls,…)
- **Other groups active in the gas detector field (indirect support)**
  - Identify synergies with the ISs
  - Agree with IS groups about commont activity and get from their resources support (mainly travelling) to make concrete use of the ISs



Gaseous detectors: feed-back

- Should concentrate on one major place for given technology
  - GEM, Micromegas, RPC
  - clarify usage scheme
- Organise tasks by technology

- Also a networking activity should define clear goals, deliverables

- TPC / DESY related activity is rather a JRA
  - moved to facility improvements

Facility upgrades: CERN

EUDET telescope was very successful, 5 built by DESY, sixth in the making:

- ***EUDET***, the original one, commuting between DESY and CERN SPS
  NB. after a number of upgrades, ***EUDET*** has become the ***AIDA telescope***
- ANEMONE, copy for Bonn, used there.
- ACONITE, copy for ATLAS used at CERN-SPS, DESY, going to SLAC.
- DATURA, copy for DESY, at the TB21 area.
- CALADIUM, copy for Carlton, used at FNAL.
- DRYOPTERIS, copy being prepared for DESY.

- All using AIDA projects:
  - EUDAQ common DAQ software
  - TLU trigger units
  - EUTelescope analysis software
  - Different sensors being prepared Mimosa, Timepix, FE-i4.
- Propose one more pixel telescope for permanent installation at CERN PS

Costs ~ 75kEuro, +12kEuro for DCS.

Improvements of facilities: DESY

- Telescope Improvements
  - AIDA TLU enhancements and improvements
  - FE-I4 based trigger planes to provide additional trigger capabilities like precise time-stamping or region of interest triggers
  - 80 k€
- Slow control data logger and software
  - requested by many users
  - 40k hardware + 120k manpower
- External reference silicon tracker for the PCMAG
  - Extremely thin and compact
  - Provides precise hits inside the PCMAG
  - 50 k€ hardware plus 130 k€ effort and some travel
- High field magnet test stand
  - Doesn't fit into the test beam package, as magnet is not located in the Beam area
  - Has a big iron yoke, so of limited usefulness in the beam
  - Should become a separate facility

Improvements of facilities: Frascati

- 4 proposals:
  - Shielding: partially cover area with concrete
    - overcome intensity limitations, crucial for, e.g, neutron production
  - Collimation: add two collimators (vacuum)
    - reduce divergence for tracking studies
  - **Photon tagging**: open yoke magnet and electron detector
    - overcome complexity and resolution limitations of present system

priority

  - New beam line: pulsed magnet and focussing
    - enhance capacity
- Usage in HEP community was questioned
  - interest declared by LHCb and CMS
  - to be further substantiated

Facility upgrades: status of discussion

- DESY: generally positive feedback, budget frame still to be decided
- CERN: matching funds and support to be discussed
- Frascati: usage case to substantiated
- Irradiation: meeting and proposal in 2 weeks

Micro-electronics

- Changed focus with respect to AIDA:

Goal : provide innovative readout chips for the detectors in the other WP

Task 1 : 65 nm for tracker (lead CERN)
Fine pitch, low power, advanced digital processing

Task will offer 1 or 2 runs in 65 nm, where design know-how and common circuit blocks can be shared in different chips in a collaborative way by the community of IC designers.

Task 2 : SiGe 180 nm for calorimeters and gaseous detectors (lead IN2P3)
Highly integrated charge and time measurement

1 our 2 runs in common

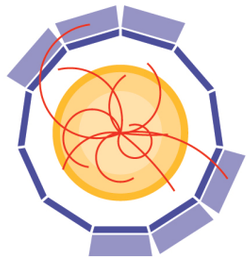
Task 3 : interconnections between different technologies (lead INFN)
20 µm TSVs for pixels, TSV post-processing of tasks 1&2, chip to wafer bonding

Share interconnection process

Micro-electronics: remarks

- The runs are open for participants, we however have to find a way to limit the number of fuzzy designs.

- In the preparation stage of the AIDA-2 proposal, we will ask the community to submit projects.
- Projects will be admitted to this WP on the basis of the needs of the community) and of their financial contribution.
  - E.g, a project may pay its fraction of the costs for a 65 nm prototype run, and ask for support for TSV processing in the wafers.



Testbeam DAQ framework

- Driven by LC community
  - need a framework which LHC upgrades have, and LC projects don’t
  - still benefits for LHC projects expected (e.g. in hardware)

- Applications (could become deliverables)
  - FCAL precision alignment validation with pixel telescope
  - TPC momentum resolution with Si reference tracker
  - ECAL or HCAL non-uniformities with Si tracker
  - ECAL HCAL inter-calibration and combined performance

- Some general goals formulated
- Deliverables need to be defined
  - together with detector groups; discussions started

DAQ

Scientific / technical programme

•Ease integration, through common interfaces, of any given sub-detector into test-beam set-up.

• Common software and common firmware.

  ○ EUDAQ (pixel telescope system) has been successful at providing a common framework, but not easily scalable; learn from and use its strengths. Consider other software.

  ○ Detectors should have common systems available: run control, ease of configuration changes, event display, data logging, etc.

  ○ Slow control such as environmental conditions needs monitoring and integrating.

  ○ Data format and handling.

• Some central hardware.

  ○ E.g. timing and control units.

  ○ But not large-scale hardware systems which is being developed by detector groups and not realisable here.

  ○ Can specify standards and come up with hardware designs, with technical reports as deliverables.

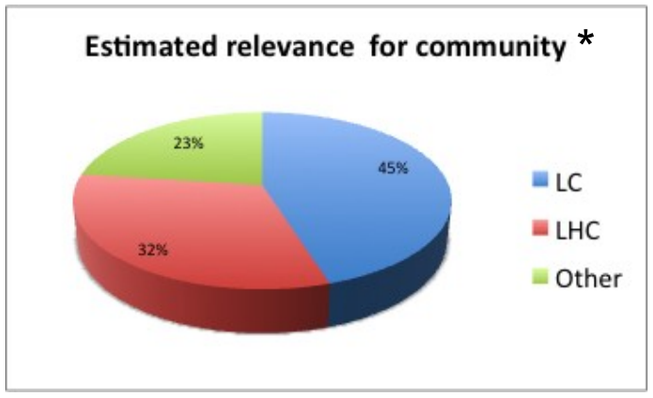
Focus is common software and firmware with some common hardware. To make beam-tests run smoother, be more successful, and understand the physics and technical details better.

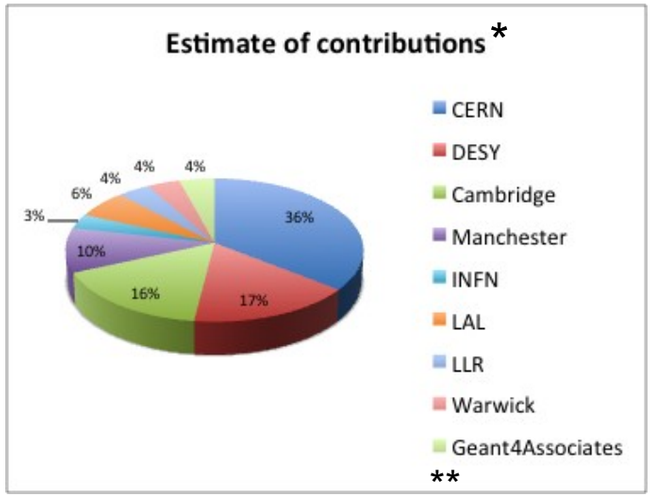
Interest from Mainz, DESY, Prague (HCAL); LAL, LLR (ECAL); Lyon (DHCAL); DESY, Lund (TPC); Bristol, UCL, UK groups (DAQ), + …

Advanced software

Summary of EOIs

- very strong interest in AIDA-2 software activities
  - need some adjustments to overall budget scope
- reasonably good balance of possible partners across Europe
- many proposals with several collaborators
- good mix of AIDA continuation and new innovative activities
- many activities that are relevant for larger communities and future projects or even all of HEP
- started to put together a coherent software work package





* very rough estimate based on current EOIs → subject to change during proposal phase

** additional. interest from Brunel

Advanced software

AIDA Software work package

- proposed software work package based on current EOIs:
- Advanced simulation and reconstruction for HEP
  - Core software
    - DD4hep and USolids extensions
    - alignment and conditions data (test beam)
    - tools for profiling
  - Simulation
    - DD4hep and Geant4 based simulation toolkit
  - Reconstruction
    - advanced tracking tools
    - advanced particle flow algorithms
  - address high performance computing in all tasks: parallelization, vectorization → added value
  - details to be defined in the coming weeks and at AIDA annual meeting

Next steps

- Contact persons will (further) define work package structure
  - define (select) tasks
  - roles of partners in tasks
  - commitments of partners (manpower and funds)
  - proposed use of EU funds
- 2 months process
- Intermediate meeting end of April
  - coordination team plus contact persons
  - CERN, 28.4., 11-17 (face-2-face and remote)
- Write proposal before summer break
  - first draft proposal mid May (scientific part)
- Submit in September
- …

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Back-up