AIDA – WP 12

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Task 12.1. Coordination and Communication

See introductory section on page 29.

Task 12.2. Turnkey Software

WP12

- Integrated Turnkey Software Stack, for physics and performance studies
- Simplified data model toolkit for modern hardware platforms
- Digitisation extensions for geometry toolkit
- R&D study on frameworks to manage heterogeneous resources

Task 12.3. Simulation

- Fast simulation techniques integrated into Geant4
- Machine learning based calorimeter simulation toolkit for training and inference

Task 12.4. Track Reconstruction

- Develop complete track reconstruction chain with Acts composable algorithms
- Implement a portable version of Acts algorithms, for heterogeneous computing
- Machine learning reconstruction algorithm for MPGD detectors

Task 12.5. Particle Flow Reconstruction

- Advanced PFA algorithms for DUNE detectors using new readout technologies
- PFA algorithm with particle ID for dual-readout calorimeters
- Optimised APRIL PFA algorithm for hadronic jets

12.2 TURNKEY SOFTWARE

Sedi INFN coinvolte: Bari, Bologna, Padova, Pisa

Responsabile Task: Tommaso Boccali (Pisa)

TURNKEY SW STACK FOR DETECTOR STUDIES

Name of the legal entity	Type (university, institute, laboratory, company)	Country
CERN	Laboratory	Switzerland
DESY	Laboratory	Germany
IHEP	Laboratory	China
INFN	Institute	Italy

Sforzi “vicini” / “connessi”:

- CERN EP R&D fellows
- CMS Patatrack
- CERN (ATLAS + LHCb) Gaudi
- ILC / CLIC sw
- FCC sw
- CEPC sw (whatever exists…)

Deliverables (max. 3): list the expected deliverable(s) of the proposed activities

- Requirements and design document. It should include:
  - input from the collider communities
  - adoption of software best practices
  - development of project templates
  - testing and evaluation of alternative solutions
  - planning for the components to be incorporated into the turnkey stack
- First version of the turnkey stack. It should include at least:
  - Definition and adoption of the common event data model (EDM4HEP)
  - Adaptation of geometry package (DD4HEP)
  - Selection of the data processing framework with upgraded set of features
  - Packaging, building, deploying, CI system
  - Complete documentation with description of all included components and examples in various domains
- Production-ready version of turnkey system
  - Compete the integration of all the components identified in first deliverable
  - Automation of the procedures to ease maintenance and the evolution of the software stack.

~~Pisa~~ INFN will contribute to the generalisation of the framework to heterogeneous resources.
Task Leader: DESY; partner: INFN; unfunded partner: IHEP

FINANZIAMENTO DA TABELLA

Beneficiary	2.1
CERN	34.2
DESY	57
LAL	
Manchester	
INFN-Pisa	20
INFN-Ferrara	
INFN-Roma Tre	
Cambridge	
Warwick	
IP2I Lyon	
Total	111

G.Stewart (EP/SFT)

F.Gaede (ILC)

\+ China

\+ IN2P3

Interessi italiani (funded e non … vedere prossima slide)

- **Pisa**: evaluation of Framework Components, comparison with other existing frameworks
- **Bari**: heterogeneous framework extensions (via/from patatrack)
- **Padova**: tests of the framework on Mu collider

PERSONALE

- Rendicontante su Pisa:
  - Tommaso Boccali (4 PM) - 10%
  - Giuseppe Bagliesi (4 PM) - 10%
  - 1 AR (20kE) da bandire ASAP … ricerca persona in corso

- Inserito a 0 mesi (attivo ma non rendicontante):
  - Lucia Silvestris (BA) - 5% = 2 PM
  - Lorenzo Sestini (PD) - 10% = 4 PM
  - PD: Lucchesi + 1-2 tecnologi interessati (stanno valutando per eventuale richiesta AR)
  - Queste sedi avrebbero ovviamente interesse a AR
    - Mi pare di capire che la possibilita' di chiedere a CSN1 sia svanita
- Sinergia per rendicontazione RD_FCC – dal punto di vista progettuale anche RD_MUCOL

12.4 TRACK RECONSTRUCTION

Sedi INFN coinvolte: Bologna, Ferrara, LNF, Torino

Responsabile Task: Gianluigi Cibinetto (Ferrara)

DEVELOPMENT OF MACHINE LEARNING ALGORITHMS FOR MICRO PATTERN GASEOUS DETECTORS

Task timeline and deliverables

- **Timeline and task: 4 years**
  - First year: uRWELL simulation → cluster reconstruction GEM and uRWELL.
  - Second year: development of track finding
  - Third year: track cleaning and refinement
  - Fourth year: application to IDEA detector pre-shower and muon → optimization

- **Deliverables**
  1. A scientific paper describing the performed activity and the results.
  2. An open-source software suite for training and testing ML algorithms with MPGD data and simulations.

PERSONALE

- The group
  - INFN Bologna: main sub-task → porting and integration with IDEA general framework
  - INFN Ferrara/Torino: MPGD parametric simulation, uTPC development and ML algorithms
  - INFN Frascati Laboratory: responsible for uRWELL technology and test beam data
  - INFN Ferrara/Torino and IHEP (Beijing): tracking and ML development

- Personale rendicontabile (INFN Ferrara)
  - Gianluigi Cibinetto 0.1 FTE
  - Roberto Malaguti 0.1 FTE
  - Michele Melchiorri 0.2 FTE

BUDGET E STATO DEL PROGETTO

- Assegnati 30 kE (sinergia con altri task uRWELL, 7.3.2 e 11.3)
  - 10 kE dal Task 11.3
  - Ricerca di 10 kE per arrivare a 2 AdR + richiesta di raddoppio in sezione

- Primo AdR in partenza a novembre

- L'attività del primo anno (i.e. simulazione parametrica di una uRWELL) è già avviata in sinergia con il progetto Cremlinplus. Il framework è ereditato dal lavoro fatto per il rivelatore a GEM di BESIII. La parametrizzazione del resistivo è in corso.
- Sinergia RD_FCC, BESIII, Cremlinplus

12.5 PARTICLE FLOW RECONSTRUCTION

Sedi INFN coinvolte: Padova, Pavia, Roma1, Roma3

Responsabile Task: Biagio Di Micco (Roma 3)

TASK DESCRIPTION

Task 12.5. Particle Flow Reconstruction *(*UWAR, CERN, INFN-RM3, CNRS-LLR, CNRS-IP2I, UOS)

Particle flow algorithms (PFA) are the state-of-the-art reconstruction for HEP calorimeters and neutrino detectors. The task will further develop and tune these algorithms for the next generation of large LAr detectors for neutrino experiments, with a variety of readout technologies (dual-phase, 3DST, optical 3D). Machine learning approaches will also be developed. An alternative algorithm, APRIL.PFA, particularly for hadronic jets, and PFA for a new generation of dual-readout calorimeters will be tackled, too. All of these developments will be incorporated into the generic Pandora framework so they can be used and compared to other approaches.

D12.4 PFA Reconstruction Algorithms *Improved and documented particle flow algorithms, including machine learning based algorithms, available in the PandoraPFA toolkit, suitable for detectors using new readout technology*	**deliverable**

PERSONALE

- INFN (Roma1, Roma 3, Padova, Pavia), Sussex, CERN

- Sussex: Calorimeter simulation at GEANT level
- CERN: NN algorithm development in imaging calorimeter (mainly providing know how)
- INFN:
  - Roma 1: Machine learning competence for particle ID;
  - Roma 3, Padova: expertise in machine learning and simulation of physics processes for HE colliders (general framework and NN training studies)
  - Pavia: Expertise in dual-readout calorimeter construction and layout

FINANZIAMENTO E STATO DEL PROGETTO

Sinergia con RD_FCC

Budget: 20k-euro assigned to Roma Tre

Cofund of the project: 2 units from Roma Tre (Ada Farilla, Michela Biglietti) 4 years x 0.1 each, 1 unit from Padova (Patriza Azzi) 0.1x3 years, for a total of 13.2 months in 4 years (9 required)

Budget utilisation: “Assegno di ricerca” for 2 years, second year founded by Roma Tre director (informal availability already checked), we need 5 k-euro more to get the first year.

Project status: collaboration already started with Sussex providing raw hit with photon simulation and Warwick inside the WP12 for the implementation of the algorithm in the Pandora Toolkit (development software for PF algorithms used as baseline for WP 12.5)