WP4: Relation with Industry

Report

Third AIDA annual meeting

TU Wien 26th-28th March 2014

AIDA is co-funded by the European Commission within the Framework Programme 7 Capacities Specific Programme, Grant Agreement 262025

Agenda

- **AIME RPC-TGC Report**
- D4.1: Overall Industry Report
- D4.2: Follow-up structure for the project

AIME RPC-TGC Report

AIDA

Academia meets Industry:
Resistive-Plate Chambers and Thin-Gap Chambers
24-25 March 2014, Vienna University of Technology

ORGANIZING COMMITTEE:

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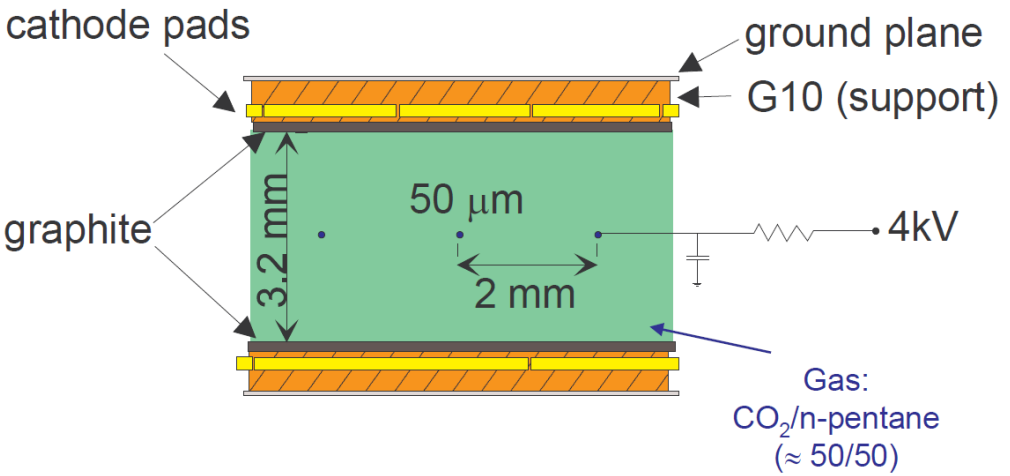
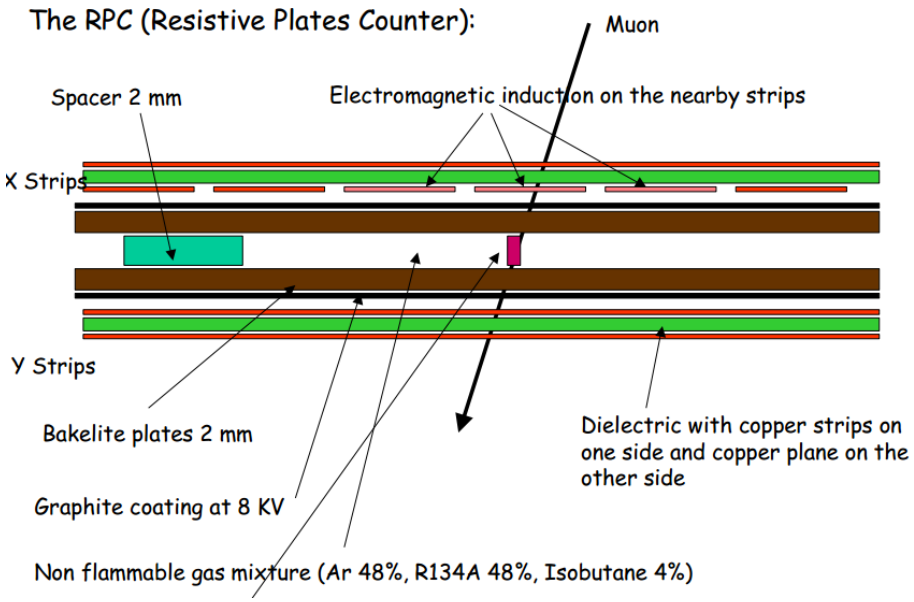
Rinaldo Santonico

HEPHY Institute of High Energy Physics · ÖAW Austrian Academy of Sciences · AIDA · CERN · HEPTech Leading HEP technologies for industry · Seventh Framework Programme

AIME RPC-TGC Summary

- Academic Needs
- Industry Capability
- Main Conclusions





From slides by:
Rinaldo Santonico, INFN Roma
Abdenour Lounis, LAL Orsay
George Mikenberg, Weizmann Inst

Needs

- Resistive electrodes
- Resistive graphite coating
- PCB for readout strips
- Gas
- High-precision mechanics & alignment
- Electronics

Resistive electrodes

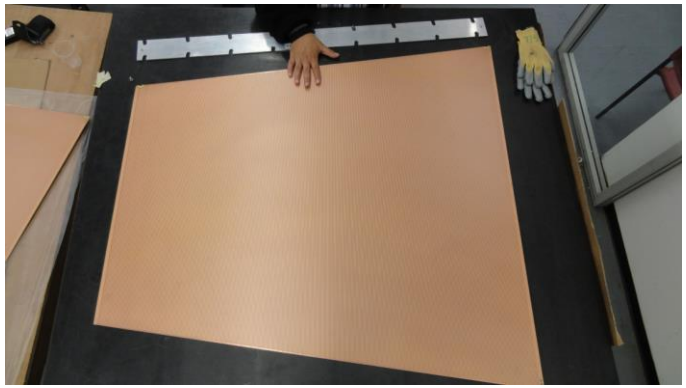
- Resistive bulk electrodes to limit the discharge energy
- Large area of quality materials of industrial standard
  - Resistivity around 10^{10} – 10^{12} Ohm.cm
  - Poor conductor, poor insulator → not available in electronics industry!
  - Efforts and time needed to adapt standard production to HEP specific needs
    - Phenolic high-pressure Laminates (PHPL) (→ Furniture industry)
    - Low-resistivity glass

→ Joint R&D efforts needed to obtain required resistivity

Collaborating Industry
PHPL (Riva Laminati, Italy)
Glass (NucTec, China)

PCB for readout strips

- Combining usual PCB printing methods with Computer Numerical Control (CNC) to
  - Achieve flatness over full dimension within 50µm
  - Edge removal
  - References for multi-layer alignment



→ Joint R&D efforts needed to obtain required alignment

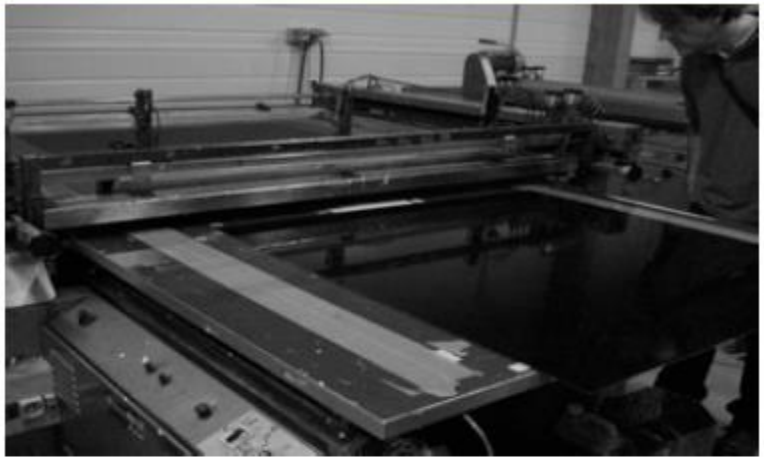
Collaborating Industry
Print Electronics (Israel)
MDT (Italy)

Resistive graphite coating

- Resistive coating to:
  - Distribute HV (RPCs and TGCs)
  - Reduce sparking risks for TGCs only
- Needs:
  - Achieve very uniform resistivity
  - Achieve high stability with time and current

→ Joint R&D efforts needed to obtain required stability using the colloidal graphite II method

Collaborating Industry
General Technical (IT)
NucTec (CN)



Silk-screen print method provides very good uniformity

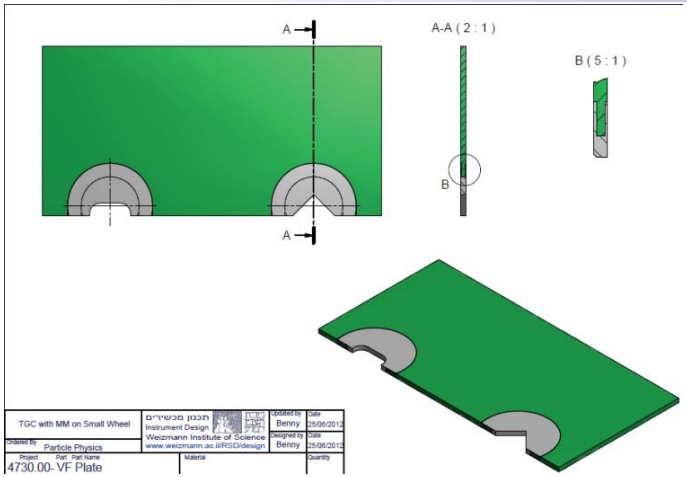
I. Laktineh/IN2P3

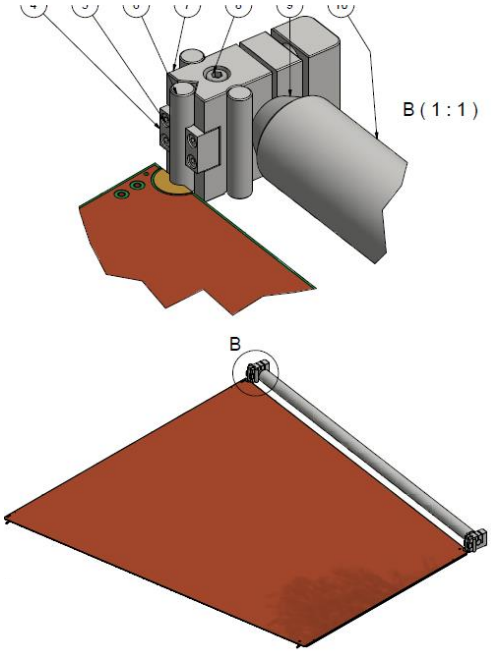
Gas

- A suitable RPC gas has good quenching properties
  - Good UV photon absorption
  - Somewhat electronegative
- Threat on $C_2H_2F_4$ due to its environmental impact
  - Global Warming Power: ~1500!
- Search for a replacement from refrigeration industry
  - $CH_2=CFCF_3$ (Tetrafluoropropene) with GWP=4
    - Industrial replacement of $C_2H_2F_4$
    - double Carbon bond → unprecedented for the RPC gas (TBE)

Collaborating Industry
Praxair notified community on the potential of $CH_2=CFCF_3$

Mechanics & Alignment





Brass inserts machined together with strips to ensure relative precision of 30µm within boards (3mx1.2m)

Collaborating Industry
Print Electronics (IL)
MDT Laminati (IT)

Electronics

- Very fast signal processing with low signal-to-noise ratio
  - FE electronics, gas mixture and HV strongly correlated
  - FE optimised for pulse signal

SiGe technology

Voltage supply	2–3 Volt
Sensitivity	2–6 mV/fC
Noise (independent from detector)	500 e^- RMS
Input impedance	50–200 Ohm
B.W.	30–100 MHz
Power consumption	2 mW/ch
Rise time $\delta(t)$ input	100–300 ps
Radiation hardness [4]	50 Mrad, 10^{15} n cm^{-2}

→new very promising Si-Ge family

- **Used for Microwave applications (>2GHz)**
- **To be operated ~100MHz with pulsed signals**

Collaborating Industry
Zener, IT
IHP, DE

Future Projects

HL-LHC offers large scale production of HEP detectors with unprecedented performance, suitable for industrial applications.
Important partnership with industry for

- R&D
- establishment of production protocols
- production, tests and quality control

HPL:	Puricelli, Riva
Gap :	General Tecnica
HV :	CPE
Cables:	Novacavi, ECS
Electronic:	Matrix
Power system:	CAEN

First commercial application

Muon GeoTomography is Now Commercial !

AAPS Advanced Applied Physics Solutions

ETPP Exploitation des Techniques de Pointe en Physique

Centre of Excellence for Commercialization and Research

Canada

Commercialization

CRM GEO TOMOGRAPHY TECHNOLOGIES

For-profit Canadian company
Based in Vancouver, BC
Employees in BC and Alberta

www.crmgtm.com

TRIUMF

UBC

With additional support from
Western Economic Diversification
Geological Survey of Canada,
Fermilab, NVI/Breakwater/Nyrstar

3D Mapping of Dense Ore Bodies in Mining Brownfield surveys

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Cosmic Ray Inspection and Passive Tomography (CRIPT): SNM Detection

Defence Research and Development Canada | Recherche et développement pour la défense Canada

A DRDC Muon based prototype imaging system intended to:

1. Inspect cargo for smuggled Special Nuclear Material (SNM).
2. Image spent nuclear fuel containers and nuclear waste.
3. Image nuclear reactor cores.

AAPS implemented in CRIPT the exact Geotomograpgy DAQ system

AAPS also provided the offline PC software that allowed reconstruction and visualization of the muon tracks

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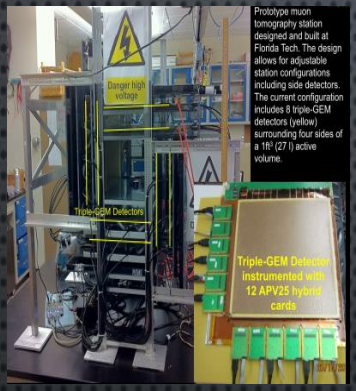
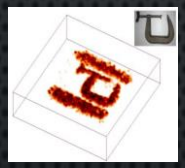
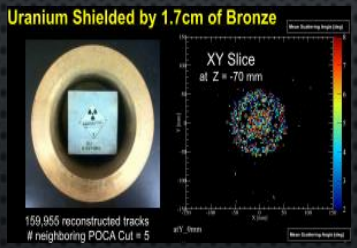
MUON TOMOGRAPHY – PRESENT STUDIES

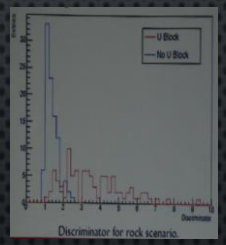
- From 2000, several muon imaging facilities had been setup all over the world based on different types of detectors, such as drift tube, drift chamber, GEM, RPC, scintillator and so on.

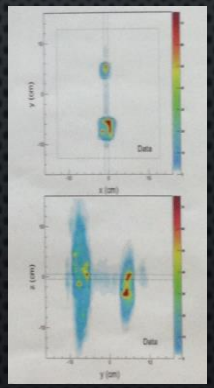
LANL FIT AECL BU GU TSINGHUA

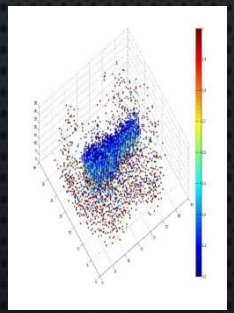


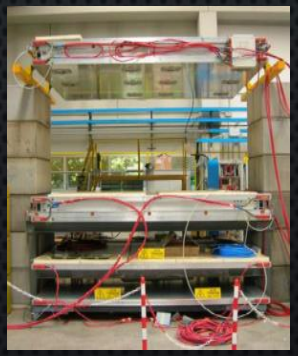












Gas Detectors: Academia vs. Industry

- Industrialisation process for gaseous detectors
  - Researchers look for industrial capability in other domains (gas, PCB, glass)
  - Tailor/improve production capability to meet detector needs
  - Convince industry to manufacture
- Future projects call for very large detector areas
  - Prospects for several applications of societal impact
  - Search for new partnership with industry on:
    - New materials
    - Gas gap size
    - Gas distribution in detector
    - Electrode thickness
  - Greater involvement of industry
    - Investments? Risk vs. Market
    - R&D Partnerships → complex: no industry for end product!
    - Promising applications

Agenda

- AIME RPC-TGC Report
- **D4.1: Overall Industry Report**
- D4.2: Follow-up structure for the project

WP4 objectives

- Objectives
  - Primary (funded)
    - To establish a complete overview of the needs, specifications and trends within the key detector technology fields constituting the main detectors needed for HEP projects, with a 5-10 years perspective.
  - Secondary (not funded by AIDA)
    - To explore modes for interactions with industry in the development phase and during (large scale) construction, where different criteria apply, moving from rapid turn-around to reliable mass-production of components for large systems.
    - To identify examples of transfer to industry, industry-related spin-offs, and collaboration and co-development with other fields where relevant, in particular related to future detector developments

Milestones/Deliverables

- Next deliverable: D4.1 Overall industry relation report
  - Due: M37 (February 2014)
  - http://aida.web.cern.ch/aida/results/deliverables/
- Deadline for D4.1 moved to M42
  - To include AIME event on TPC & TGC (Vienna)

D4.1 Report: Content

- Strategy
  - Foster collaborations between Academia & Industry
- Methodology
  - AIME
    - Topical Events
    - Needs of communities (HEP and others)
    - Capability of Industry
    - Two half-day events with booths, posters, long coffee breaks
    - Networking dinner
- Statistics

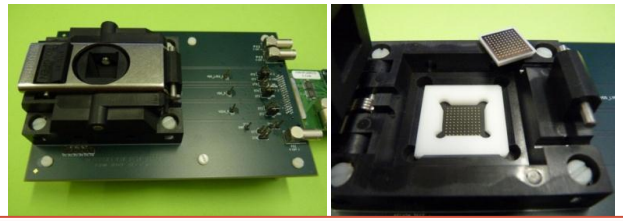
AIME's scope

- **Enhance industry involvement in R&D for curiosity driven research**
- Foster collaborations between academia and industry
- Promote the use of research results in other research disciplines and industrial applications

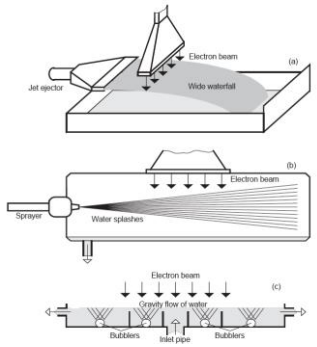
Pre-commercial procurement

Application oriented

3D-IC



3D Interconnection event (Frascati)



Industrial Applications Accelerators

Events for Industry Report

11 events organised by the time of 3rd AIDA plenary

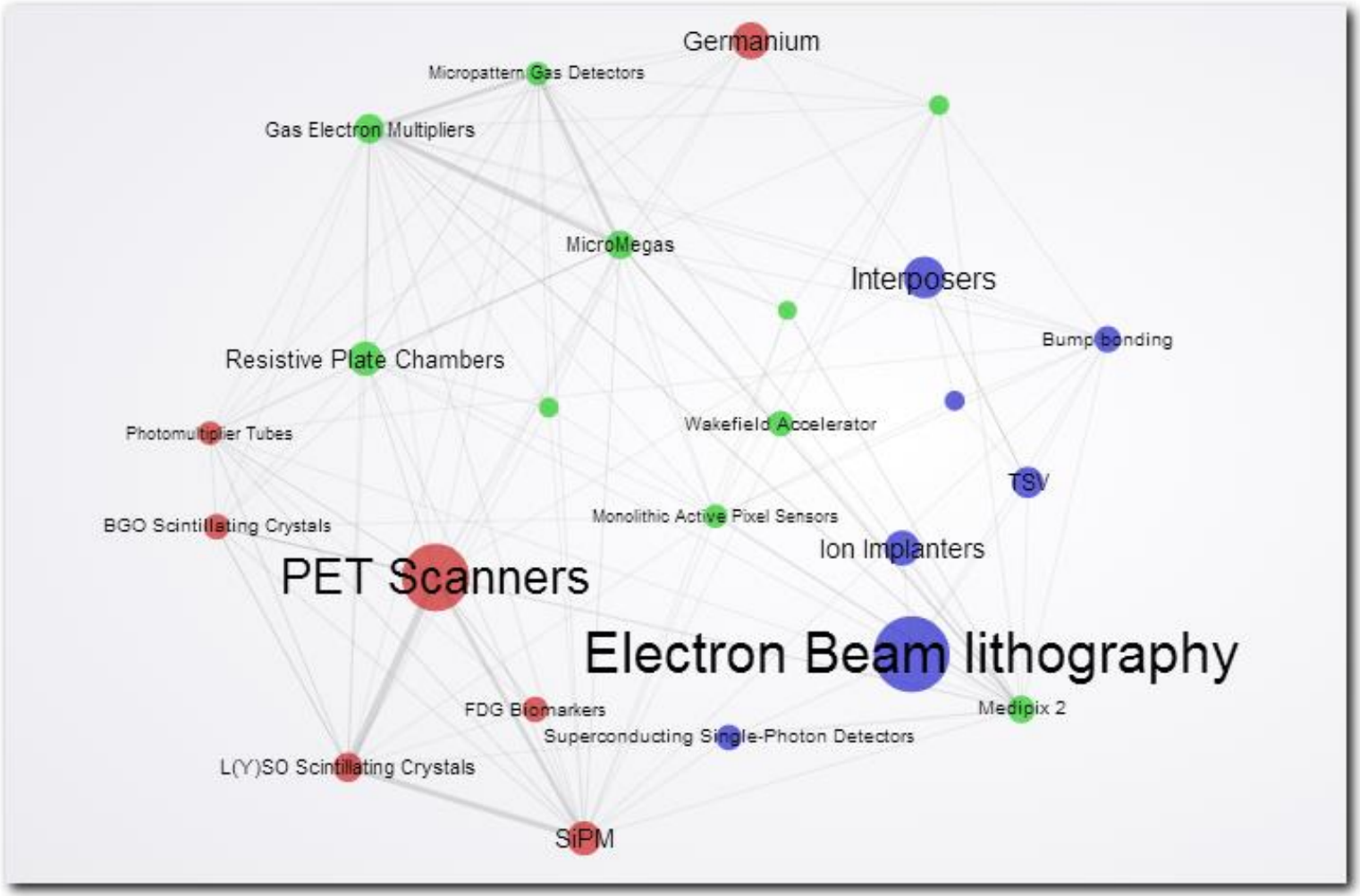
- Si-Photomultipliers (CERN, Geneva, 2011)
- Vacuum & Cryogenics (GSI, Darmstadt, 2011) (Jointly organised with ASPERA)
- **Position Sensitive Solid State Detectors (DESY, Hamburg, 2012)** (Jointly organised with AIDA)
- Beam monitoring (GSI, Darmstadt, 2012)
- Micro Pattern Gaseous Detectors (IN2P3/LAPP, Annecy, 2012)
- **3D-IC (INFN, Frascati, 2013)** (Jointly organised with AIDA)
- Super conductivity (CIEMAT, Madrid, 2013)
- *Industrial applications of accelerators (STFC, Daresbury, 2013)*
- Neutron detection with MPGDs (CERN, Geneva, 2013) (Jointly organised with RD-51)
- Control Systems (Demokritos, Athens, 2013)
- **RPC and TGC event jointly organised with AIDA** (Vienna, 2014)

- National Events
  - AIME-like event at Thessaloniki, 4-5/4/2011
    - Implementation of informatics to the HEP research
    - NTUA, NRSC “Demokritos”, SEPVE
  - AIME-like event at Alexandroupolis, 26-27/11/2011
    - Implementation of Advanced Electronics and Precise Mechanical Components to the HEP research
    - NTUA, NRSC “Demokritos”
  - Event organized by Ivan Vila in Seville, 24-25/6/2013
    - CPAN Workshop on technology transfer at CNA

D4.1 Report: Content

- Analysis
  - Technical
    - Using the manufacturing readiness of the technology
    - Using the information on the various industry landscapes
      - Different industry for different technology
  - Impact
    - Using questionnaires
    - Using Collaboration Spotting
      - Find organisations active in event technology topic
      - follow-up: track event
        - » publications
        - » patents, with delay
    - Place AIDA's AIMEs in perspective with HEPTech's

Collaboration Spotting



Tracing things

- In principle, collaboration Spotting can trace the evolution of the publication and patent landscape:
  - For any individual organisation or technology (built-in)
  - To show the impact of:
    - Any organisation participating in an event
    - Any organisation participating in a project or scientific collaboration
  - To position project members
  - To show the impact of a project on a specific technology

Example: Project follow-up

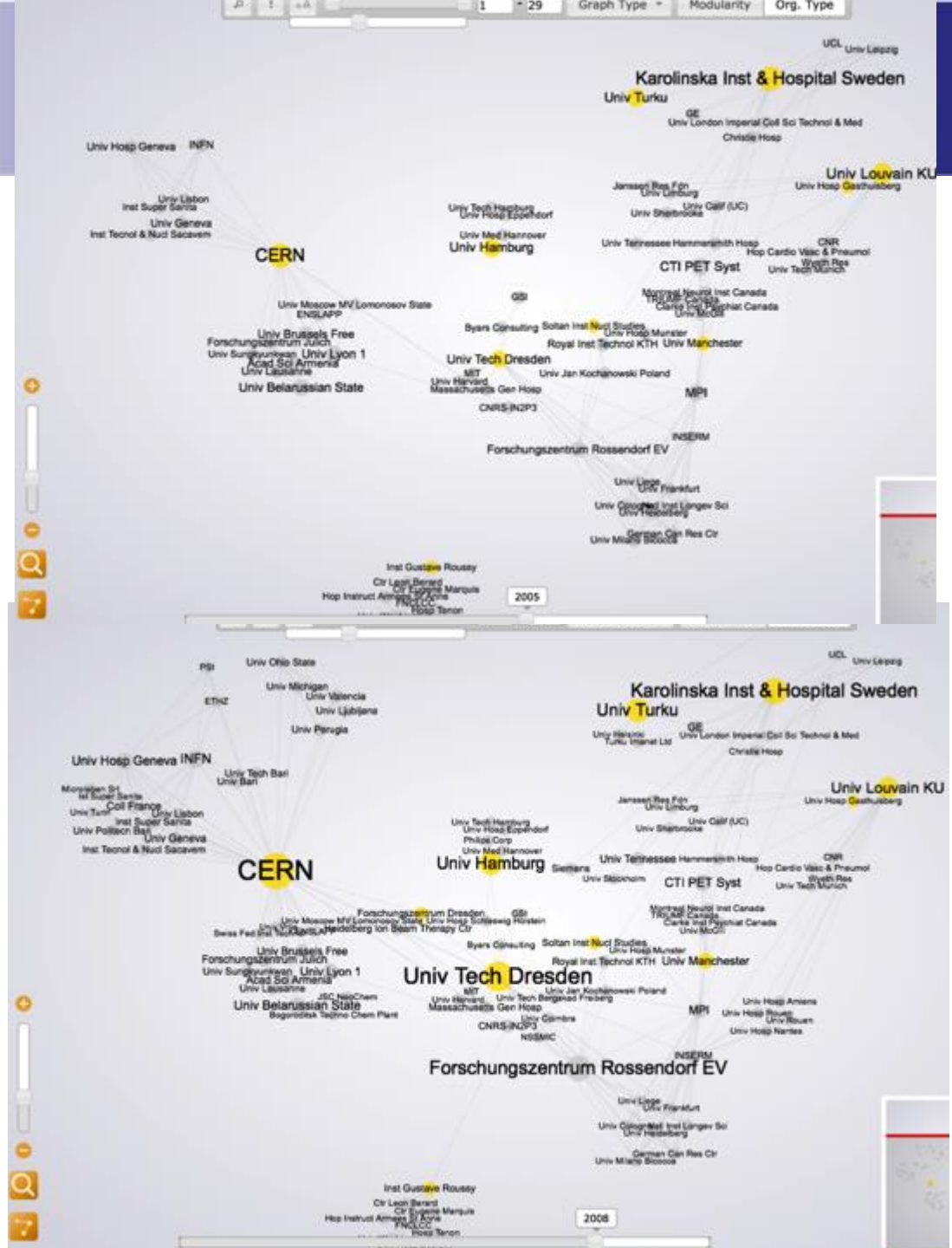
- We can use Collaboration Spotting to trace the impact over time of projects, collaborations, topical events (i.e.: Academia-industry matching events)
  - Ex: FP6 Project:
    - Biocare → Focus: PET scanners and Radiotracers
- Collaboration Spotting offers the possibility to trace the evolution of the landscape on individual technologies
  - Ex: PET scanners

Results: PET landscape

- Searches on PET with the Web of Knowledge
- Biocare: (21 Partners in consortium agreement)
- → Technology development and usage all included

Numbers	Context
2005: 425 Organisations→581 papers 43 Organisations→ 90 patents 2013: 918 Organisations→1437 papers 159 Organisations→ 623 patents	Involved worldwide in PET activities and having published
2005 (Biocare) 71 Organisations→41 papers 8 Organisations→52 patents	Where linked with the Biocare consortium members at the time of kick-off (2005) →**~17%** of the active community for **7.0%** of the papers →**~18%** of the active community for **56.5%** of the patent filings →**Pertinent choice of consortium members**
2013 (Biocare) 141 Organisations→113 papers 36 Organisations→414 patents	Where linked with the Biocare consortium members in 2013 →**15.3%** of the organisations for **7.9%** of the papers →**22.6%** of the active community for **66.4%** of the patent filings → **Retained activity level in a growing community**

AIDA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Karolinska Inst & Hospital Sweden
Univ Turku
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CERN
Univ Hamburg
CTI PET Syst
Univ Tech Dresden
Univ Belarussian State
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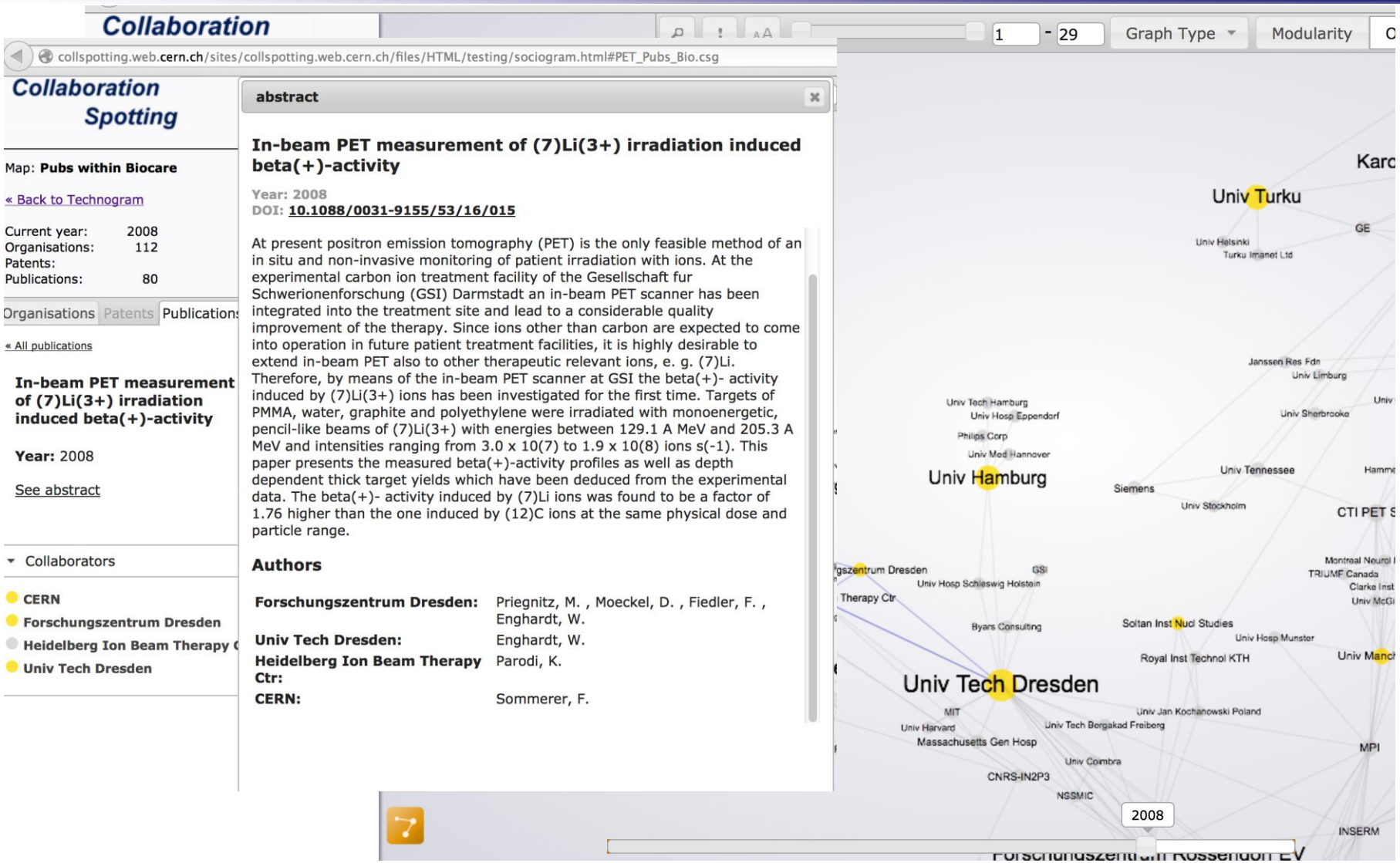
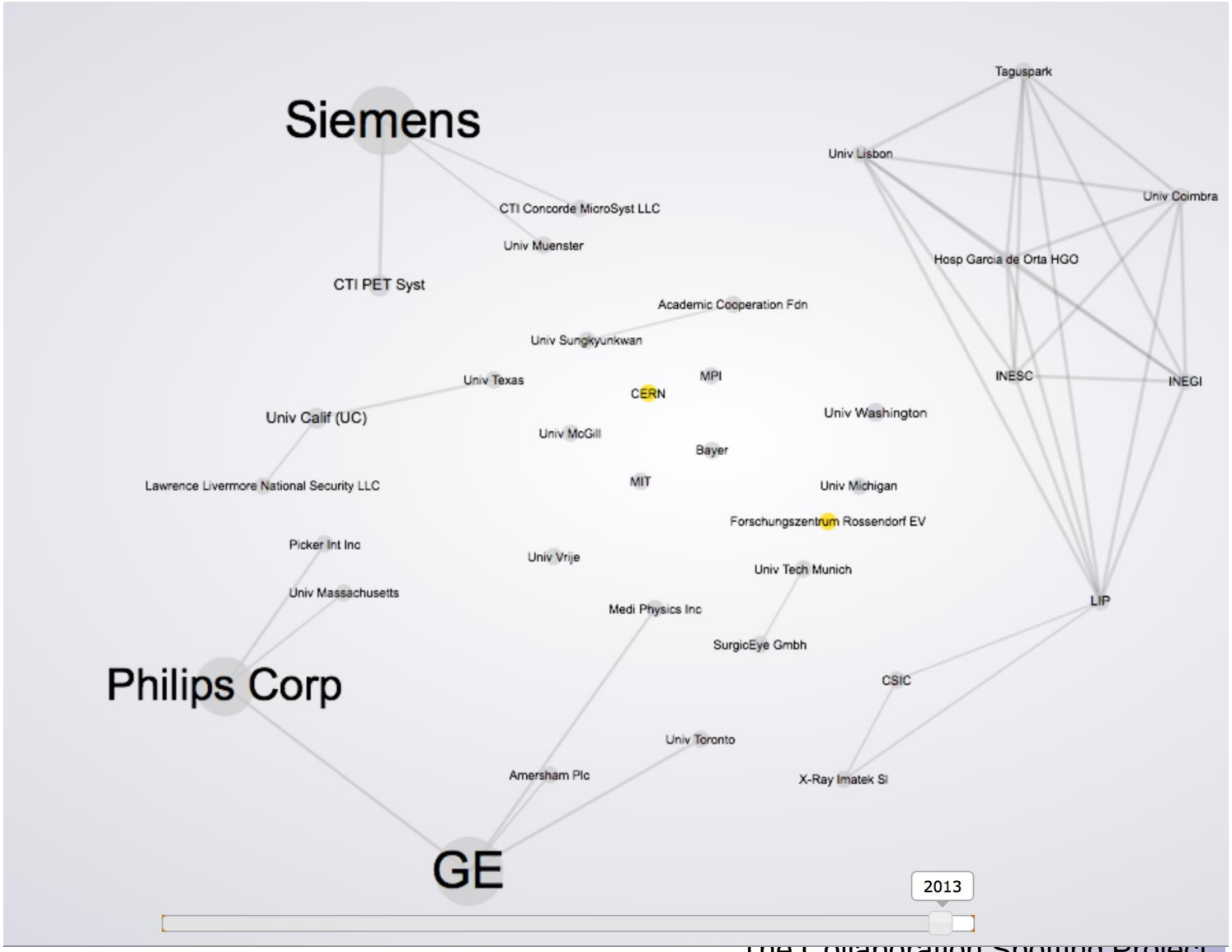
2008

Trace results (2)



The Collaboration Spotting Project

Biocare partners patent landscape



AIDA

Spotting

Map: **PET Scanners**

« Back to Technogram

Current year:	2013
Organisations:	36
Patents:	414
Publications:	113

Organisations | Patents | Publications

« All patents

Tomography by emission of positrons (PET) system

Year: 2011

See claims

Collaborators

- **Hosp Garcia de Orta HGO**
- **INEGI**
- **INESC**
- **LIP**
- **Taguspark**
- **Univ Coimbra**
- **Univ Lisbon**

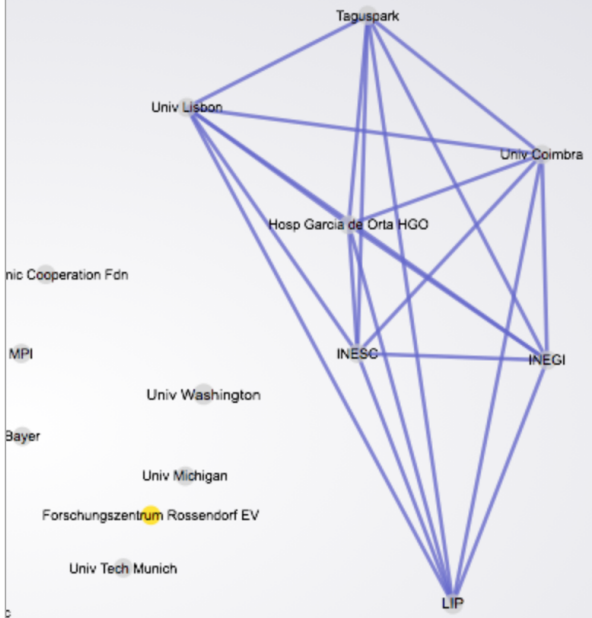
claims

Tomography by emission of positrons (PET) system

Year: 2011
Patent number: US7917192B2

Claims

1. A Positron Emission Tomography (PET) system dedicated to close examination, at a few millimeters from the skin, of human body parts including the breast, axilla, head, neck, liver, heart, lungs, prostate region and other body extremities or, to the detection and follow-up of different types of cancers in of the human body, that integrates in two movable, light-weight and compact PET detector heads the large number of individual detection channels, more than 12000 channels, based on LYSO (Cerium Doped Lutetium Yttrium Orthosilicate) crystals and avalanche photo-diodes (APD) arrays, with a small number of interconnections to a trigger and data acquisition system, necessary to allow high-sensitivity and image resolution of 1 mm in the full field-of-view comprised between two detection plates of LYSO crystals, and that is characterized by: a. two detector heads housing more than 6000 LYSO crystals each with dimensions of the order of 2×2×20 mm3, two avalanche photodiodes per crystal pixel, electronic front-end readout system for each APD detection channel, and ancillary systems, the detector heads having a density larger than 0.5 detection channels per cm3;b. means for measuring of the coordinates of the photon interaction point in the detector with a precision of the order of 1 mm in the three space directions, by using fine-grained crystal granularity and a means for measuring a depth of interaction based on the sharing of scintillating light at the two ends of the crystal pixels;c. a means for detecting and measuring individual hits of Compton events in the detector and in consequence to use in image reconstruction the events where at least one of the two PET photons has Compton diffusion in the detector, without significant degradation of the image resolution;d. motorized mechanical means to allow the movement of the detector heads under manual or computer control, including the rotation around two independent axis and the translation along three perpendicular axis, plus the relative positioning of the two detector heads, making it possible to place the



The Collaboration Spotting Project

Agenda

- AIME RPC-TGC Report
- D4.1: Overall Industry Report
- **D4.2: Follow-up structure for the project**

D4.2: Follow-up structure for the project

- Moving from R&D to pre-construction
- Distinguish between
  - HEP-driven developments (Ex: Gaseous detectors)
  - Industry-driven developments (Ex: Silicon detectors)
- AIMEs are very useful
- Follow-up
  - Technical:
    - HEP community to propose topics requiring further AIMEs
    - Adjust topics according to detector development needs
    - Suggest continuing AIMEs in collaboration with RD-51, HEPTech, etc. to reach the HEP community beyond AIDA
    - For HEP-driven developments, include success stories to widen the market prospects for industry
  - Impact-assessment: Collaboration Spotting

Thank you for your attention