



CERN

European Organization for Nuclear Research

Organisation Européenne pour la Recherche Nucléaire

## Highlights on HEP Tech activities

# HEP Tech, a key driver for moving PP science results to society

*Friday, May 17<sup>th</sup>*

CEA-IRFU, Saclay



*Jean-Marie Le Goff, PhD, DPhil*  
*Senior physicist*  
*HEP Tech chairman*  
*CERN*

# Content

**1: Academia-Industry matching events**

**2: Fostering collaborations**

**Ultra-compact SC cyclotron**

**Scalable Readout System**

**MPGD →Stephan Aune**

**3: Collaboration Spotting: A tool to identify and track key technology players**

**4: Pre-commercial procurement workshop**



*The complex and sophisticated tools of particle physics are rich sources of new concepts, innovation and groundbreaking technologies, which benefit various applied research disciplines and eventually find their way into many applications that have a significant impact on the knowledge economy and society.*

# 1: Academia-Industry Matching Events

# The concept

*Organise topical events on technologies of prime importance to the HEP community an/or having important transfer potential.*

- Local organising committee composed of
  - HEPTech members
  - Experts in the technology

*Identify key technologies and assess their Technology Readiness Level (TRL)*

*Identify key academic and industry players*

*Foster academic-industry collaborations*

**Process:**

**Technology selection**  
→HEPTech's Nodes input

**Review of the situation in academia & industry worldwide**

**Event**  
→Focus on European organisations

**Follow-up**  
→Technology  
→Impact

# AIME's topics

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## *Achieved events*

- SiPM
- Vacuum & Cryogenics
- Beam monitoring
- MPGD
- PSSSD
- 3D-IC

## *Planned (2013)*

- Super conductivity
- Industrial applications of accelerators
- Controls

# AIME's scope

*Enhance industry involvement in R&D for curiosity driven research*

*Promote the use of research results in other research disciplines and industrial applications*

*Foster collaborations between academia and industry*

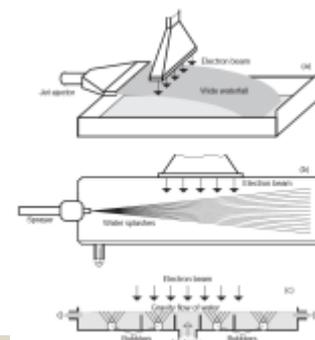
Pre-commercial procurement

Application oriented

3D-IC



CERN CEA/LETI



Industrial Applications Accelerators

# Examples of Technology Readiness Levels

## *SiPM*

- Very technology-specific → SiPM
- High Technology Readiness Level (TRL)

## *Position Sensitive Solid State Detectors*

- Wider focus → Medipix, Pilatus, Bumpbonding, etc.
- High TRL

## *3D Interconnections*

- Very technology-specific
  - TSV
  - SLID
  - Interposers
- Low TRL

# Format: SiPM academia-industry matching event

## • Programme

### ▫ Day 1

- SiPM: State of the art
- Overview of Si-PM's ASIC
- Calorimetry (Part I & II)
- SiPM in medical imaging (Part I & II)
- Issues in bio-applications
- Medical applications: an industry perspective
- Exemplary illustrations of applications from R&D projects

### ▫ Day 2

- Company presentations
- One-to-one meetings

### ▫ Side features

- 9 live demos from research teams
- 10 company booths
- 14 technology offerings
- 6 CV's posted by post-doc and researchers
- 4 job offers

## • Outcome

- Two persons who published their CVs got job offers
- One company developed a business-to-business link with two other companies in view of offering complementary technologies
- One collaboration including a company attending the event had their first meeting to apply for a common FP project
- Three research teams asked for consultancy on the use of SiPM on new applications



## ▫ Adoption of the academia-industry matching event concept, format and agenda by:

- ASPERA: The network of government agencies responsible for coordinating and funding national efforts in astro-particle physics

# SiPM Participation

## *101 attendees from 40 institutions*

- Austrian Acad Sci
- CERN
- CIEMAT
- CNRS-IN2P3
- CPAN
- CSIC
- DESY
- EPFL
- ETHZ
- FBK
- FNAL
- Forschungszentrum Julich GmbH
- GSI
- IFAE
- INAF
- INFN
- Kernfys Versneller Inst
- MPI
- PSI
- Rhein Westfal TH Aachen
- UERJ
- Univ AGH Sci & Technol
- Univ Bari
- Univ Gent
- Univ Glasgow
- Univ Heidelberg
- Univ Insubria
- Univ Leicester
- Univ Louvain KU
- Univ Michigan
- Univ Napoli Federico 2
- Univ Oxford
- Univ Pisa
- Univ Politech Bari
- Univ Roma 1
- Univ Siena
- Univ Surrey
- Univ Tech Delft
- NTUA
- Univ Udine

## *29 attendees from 23 companies*

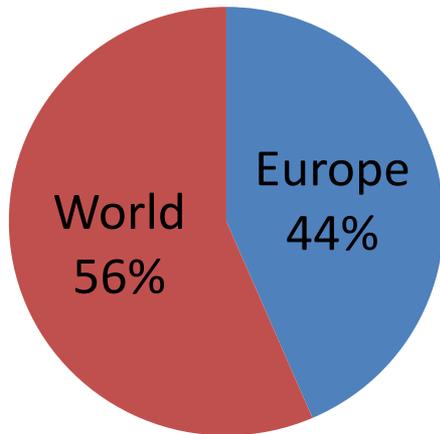
- AdvanSiD
- Atostek\_Ltd
- AXINT
- Bruker\_AXS
- CAEN\_SpA
- CPTA\_Moscow
- CSEM
- djh consult
- e2v\_technol
- Excelitas\_Tech\_Inc
- Gamma\_Medica\_Ideas\_Inc
- Hamamatsu\_Photonics
- ID\_Quantique\_SA
- INOV\_INESC\_Inovacao
- KETEK\_GmbH
- kromek?
- Philips\_Corp
- Photek\_Ltd
- Pulsar\_Enterprise
- Raytest
- SensL
- STMicroelectronics
- Zecotek\_Photonics\_Inc

**130 participants**

# Distribution of participants to the event (SiPM)

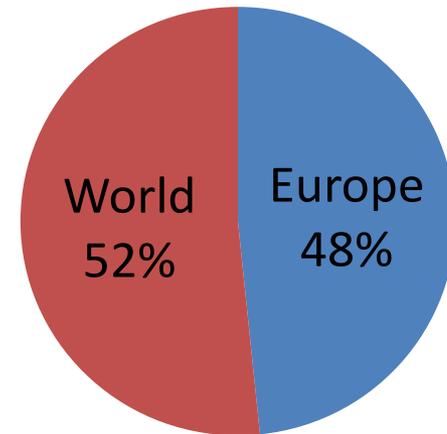
## Companies

(Total: 108)



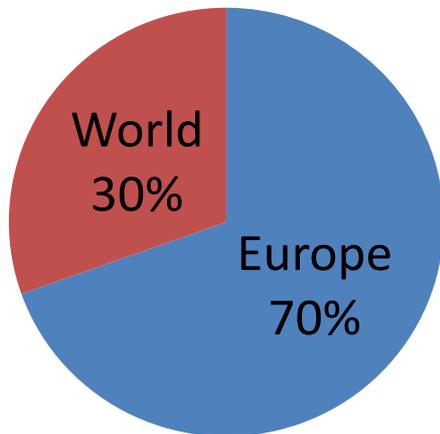
## Institutions

(Total: 339)



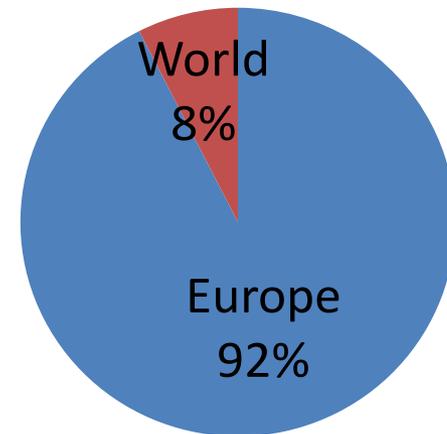
## Attending companies

(Total: 23)



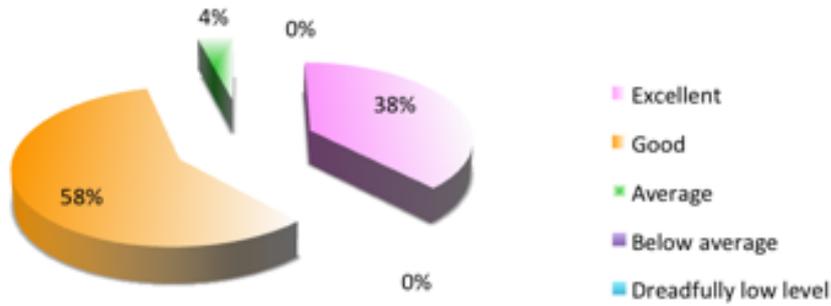
## Attending institutions

(Total: 40)

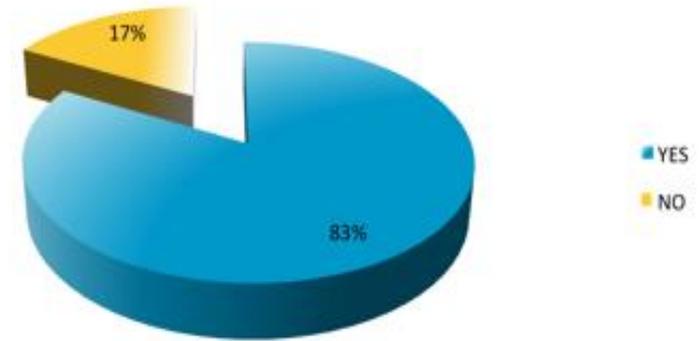


# Feedback from the participants: Survey results

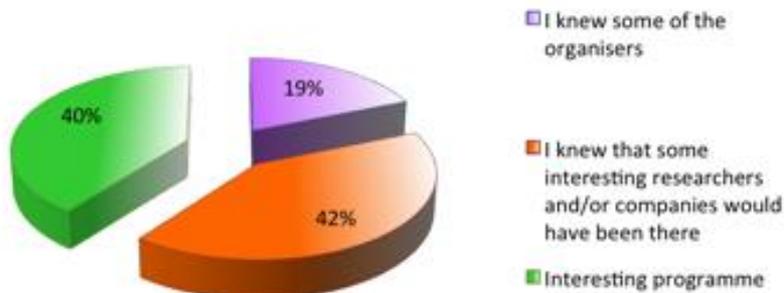
## Rating of the event



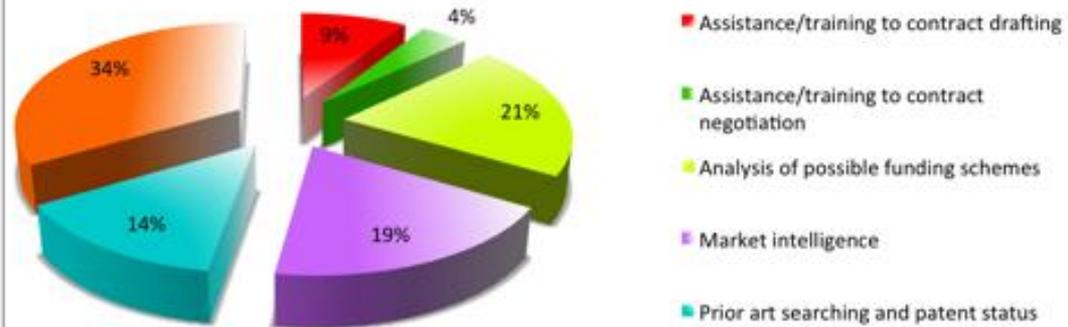
## Would you appreciate a follow-up phase of the event?



## Main reason for participating to the event



## Topics of interest for the follow-up and in future events





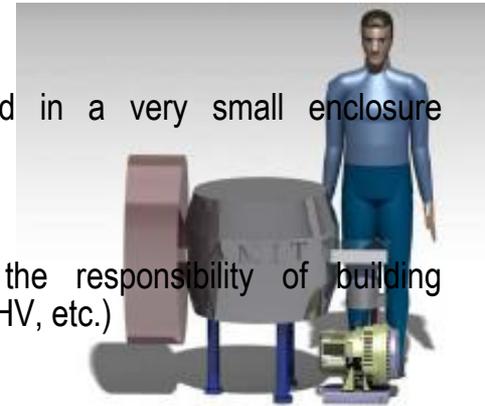
*Basic and applied sciences go hand in hand, relying on and challenging one another. Public support is instrumental to fostering this delicate alchemy. Europe's future prosperity depends on it.*

## 2: Fostering collaborations

# Collaboration: Compact cyclotron for producing medical isotopes

***R&D collaboration with CIEMAT/SPAIN representing a consortium (AMIT) of 9 companies and 14 research laboratories in Spain for the design and construction of a demonstrator of the smallest possible accelerator for producing medical isotopes***

- Analysis of the situation regarding the production of medical isotopes (2008):
  - Size and costs of cyclotrons for producing isotopes are strong limiting factors for the use of PET devices for drug discovery.
  - Isotopes are limited in practice to  $^{18}\text{F}$ , due to the short half-life of other positron emitters such as  $^{11}\text{C}$  (preferred isotope)
- Solution:
  - Build a very small cyclotron capable of producing  $^{18}\text{F}$  and  $^{11}\text{C}$  that could be installed in a very small enclosure within a clinical facility combined with microfluidic techniques for synthesising drug markers in situ
- Scheme elaborated by HEPTech:
  - Foster 'cash-less' R&D collaborations with national PP laboratories that would take the responsibility of building demonstrators with industrial partners using LHC technologies (superconductivity, super fluidic, UHV, etc.)
- Benefits of this scheme:
  - Use of accelerator technologies from the PP community in industrial applications
  - Opportunity for national PP labs to acquire cutting edge technologies and expertise while taking a leading role in applied projects
  - Possibility for CERN to license and/or establish R&D collaborations to transfer results to other applications
- Results:
  - Two Nodes of the HEPTech (CERN and CPAN via CIEMAT) have implemented the scheme, sought industrial partners and funding
  - R&D collaboration contract signed (Sept 7<sup>th</sup>; Project has just started)



# HEPTech: From an idea to a collaboration on a demonstrator

## *Analysis of the situation*

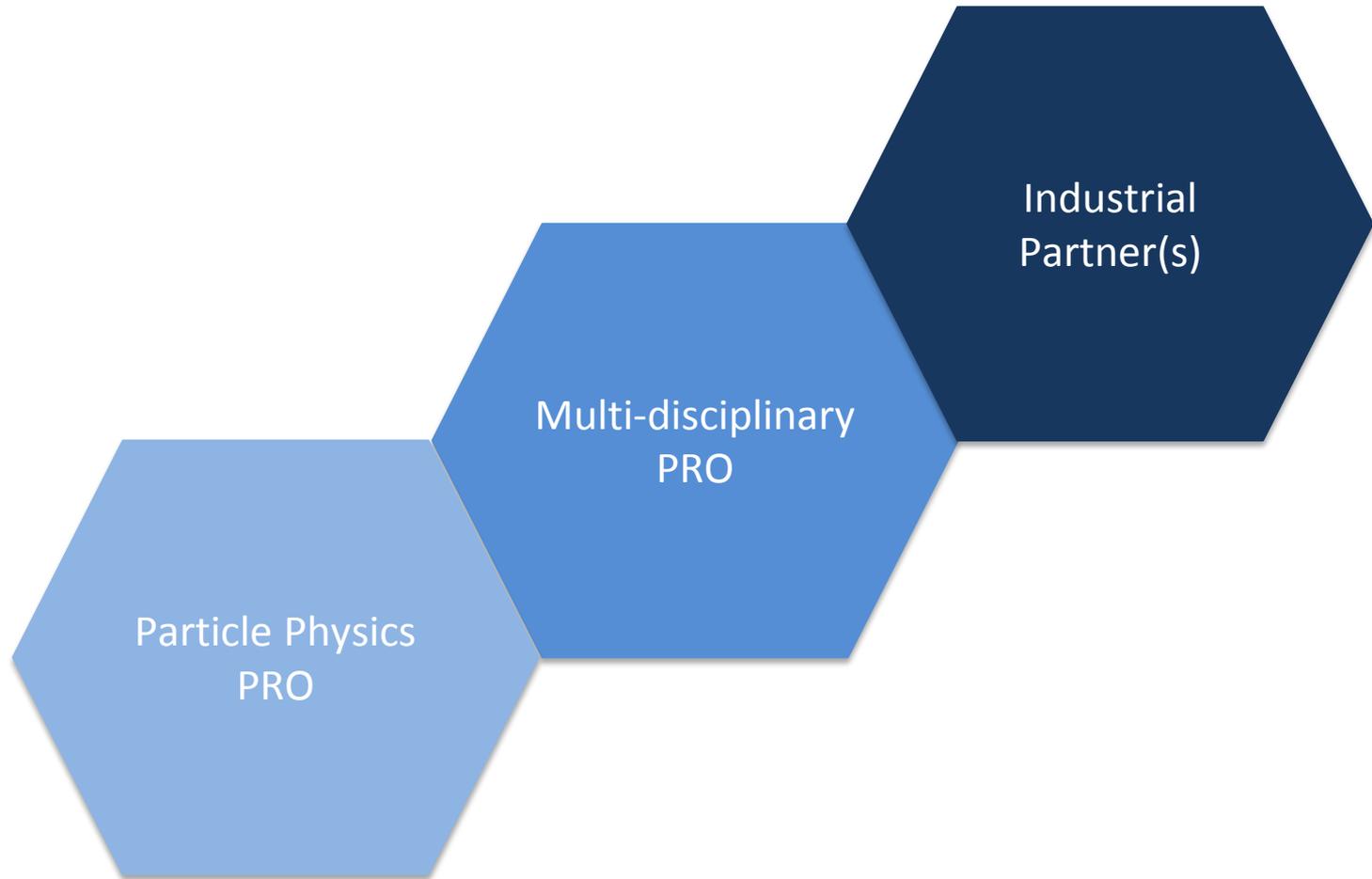
- PP laboratories with important experimental facilities
  - Have expertise and technology that can significantly benefit a large variety of applications
  - Lack resources (Human and Financial) and time to take care of the construction of the pre-industrial demonstrator
    - Same experts to work on too many projects
    - Compensations
- Multi disciplinary Institutions
  - Active in applied R&D
    - Have expertise on aspects that are complementary to PP
    - Have pertinent industrial contacts
    - Have access to dedicated national funds to support the construction of pre-industrial demonstrators
  - Interest in developing in-house expertise on PP high-tech matters
    - To position itself better with respect to the PP Community
  - Interested in enhancing their visibility
    - At the national level
    - With the PP community
- HEPTech is a pool of expertise and contacts that acts as a facilitator and catalyst

# HEPTech: From an idea to a collaboration on a demonstrator

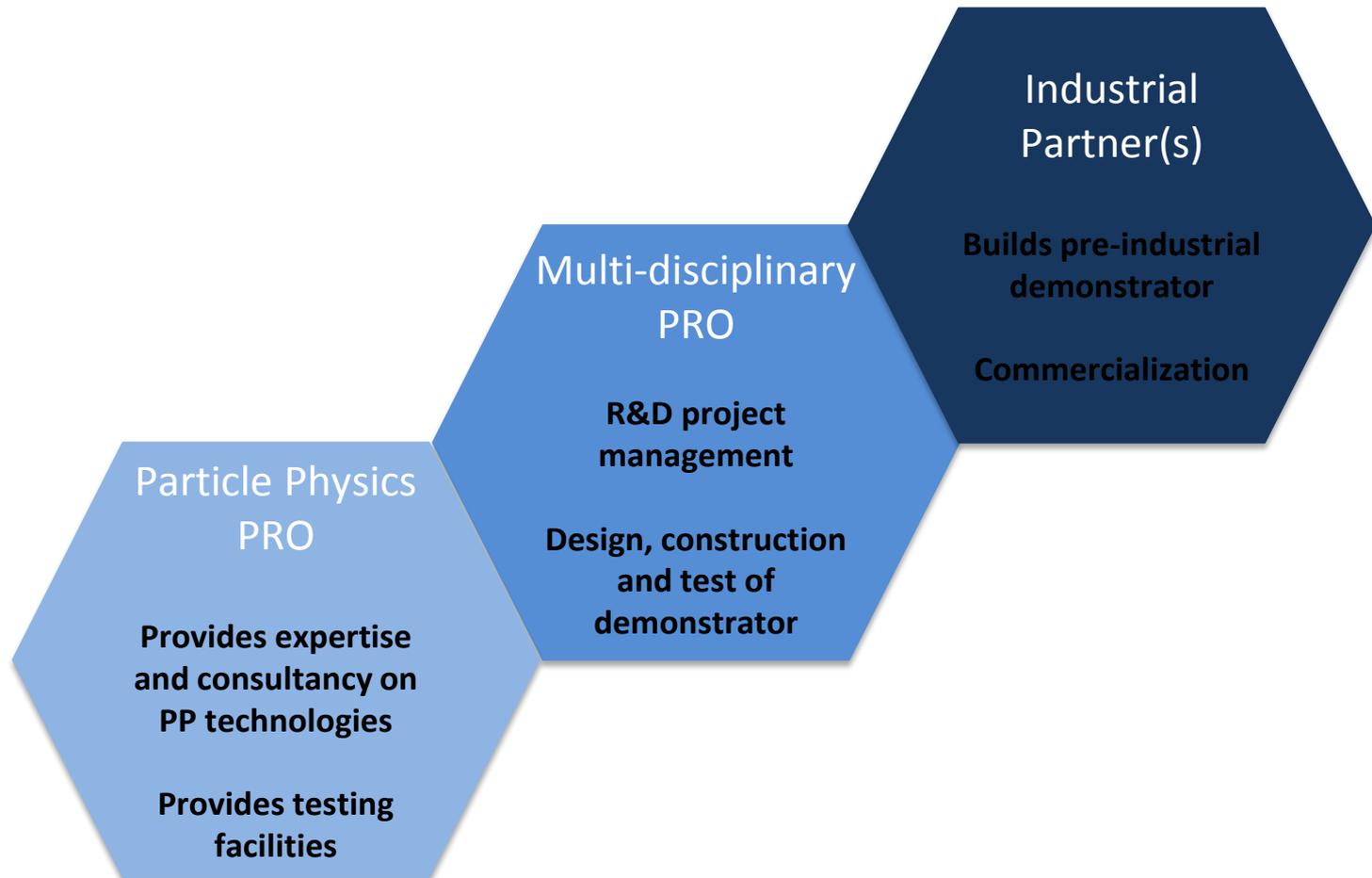
## Steps:

- Idea from CERN → KT Group launched a case study
- Case study → Important market potential
  - 1: Small animal (C-11 does not require FDA's approval)
- Funds from industry needed
- HEPTech
  - Look for institutions willing to take the lead and submit a proposal to funding agencies
- CPAN/CIEMAT (Madrid) agreed to take the lead
  - Consortium lead by a Large industrial partner (Sedecal)
  - CIEMAT responsible for the construction of the first compact cyclotron prototype
  - Collaboration agreement between CIEMAT and CERN for cryogenics

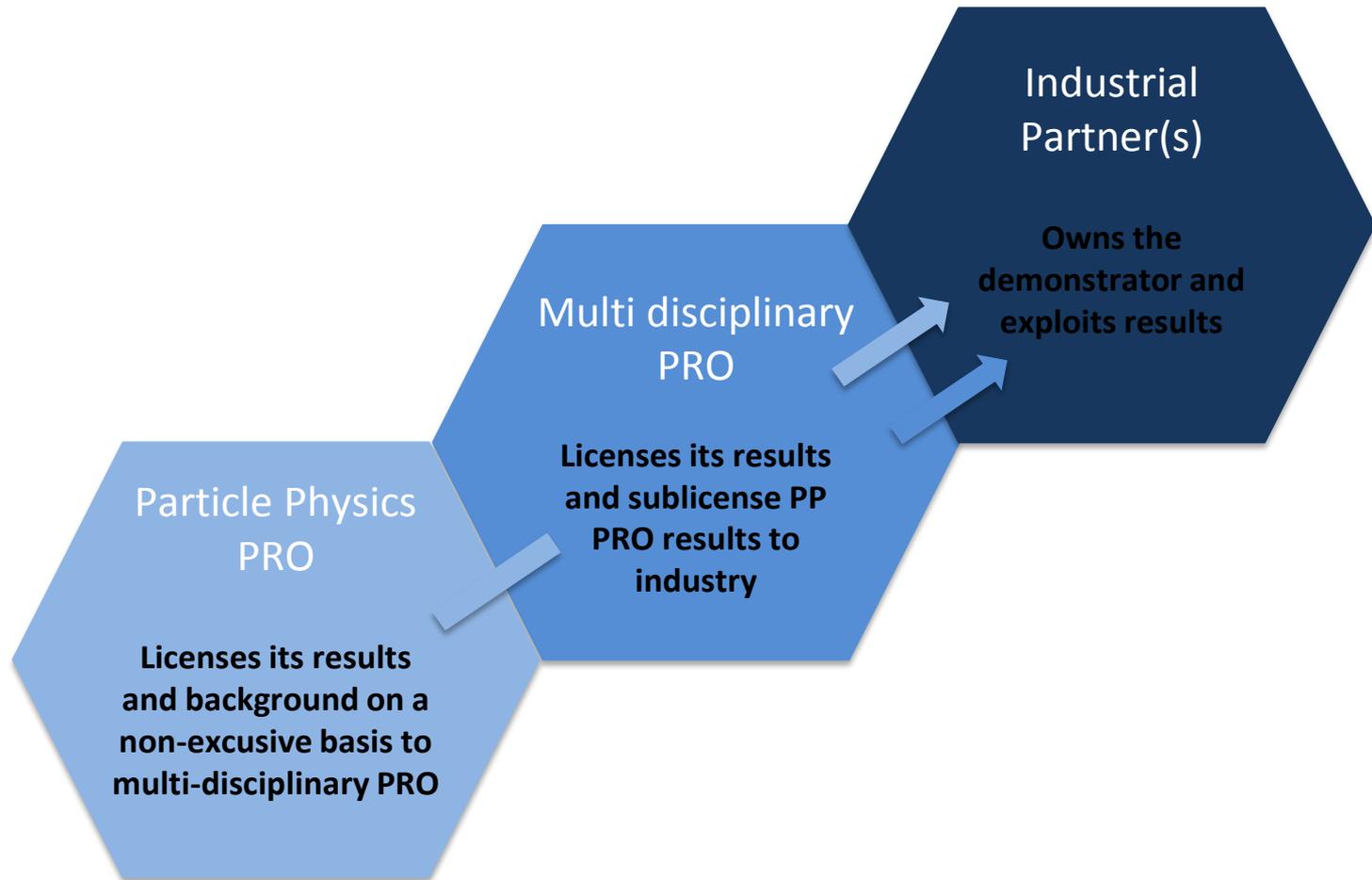
# The model



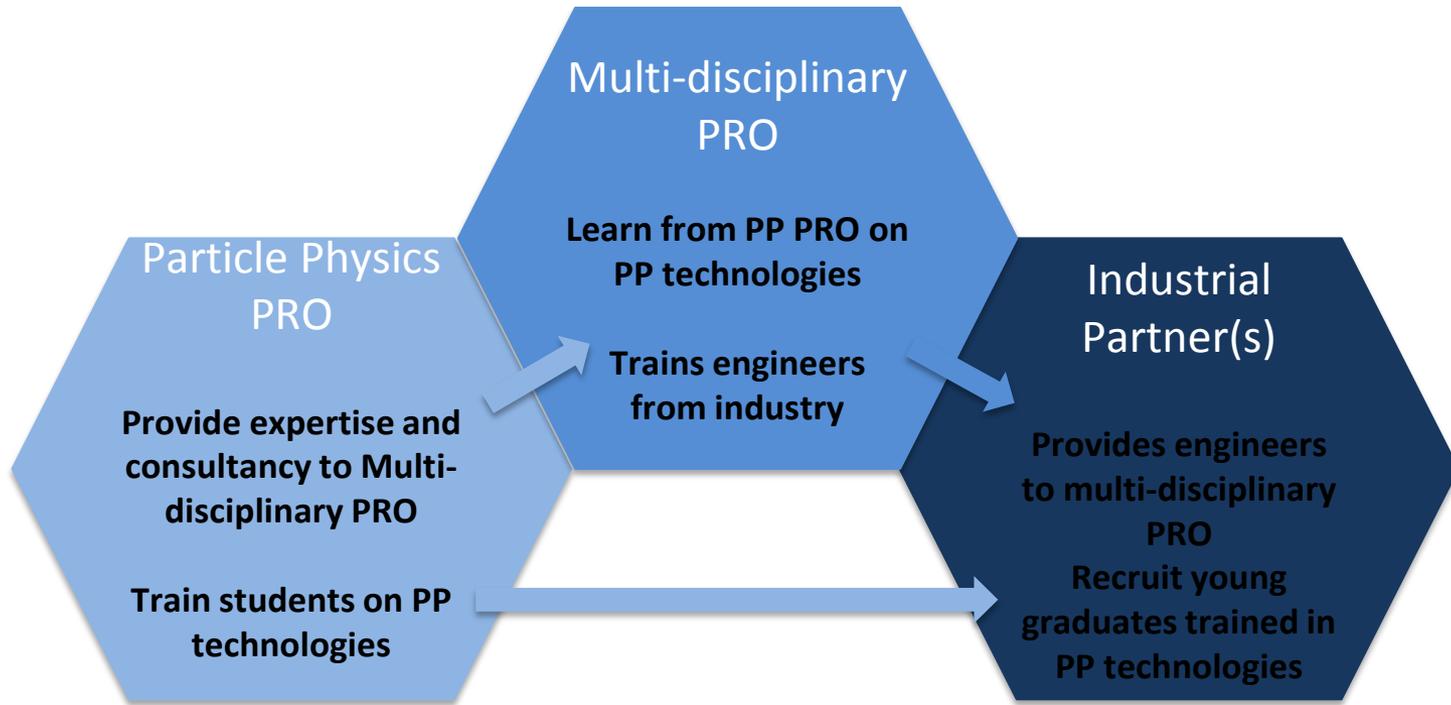
# Role and resources



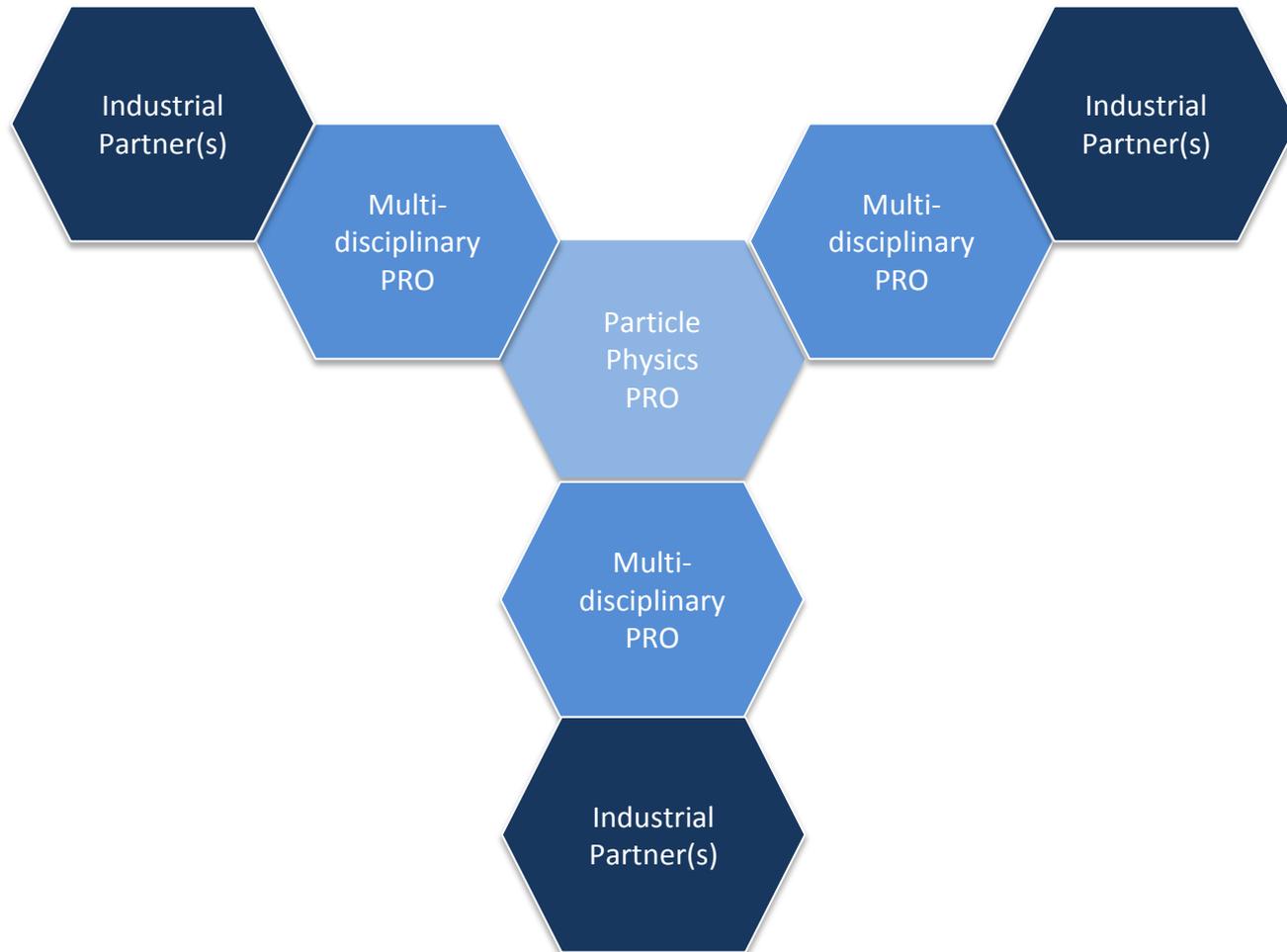
# Technology transfer: formal Intellectual Property



# Technology transfer: expertise and know-how



# Minimize dedicated resources and maximize impact



# Scalable Readout System (SRS)

*Product of the RD51 Collaboration for the Development of Micro-Pattern Gas Detectors Technologies*

*General purpose multi-channel readout solution for a wide range of detector types, detector complexities, and different experimental environments.*

## **Scalable - size**

- Only point-to-point links. No busses
- Star topology

## **Scalable - application**

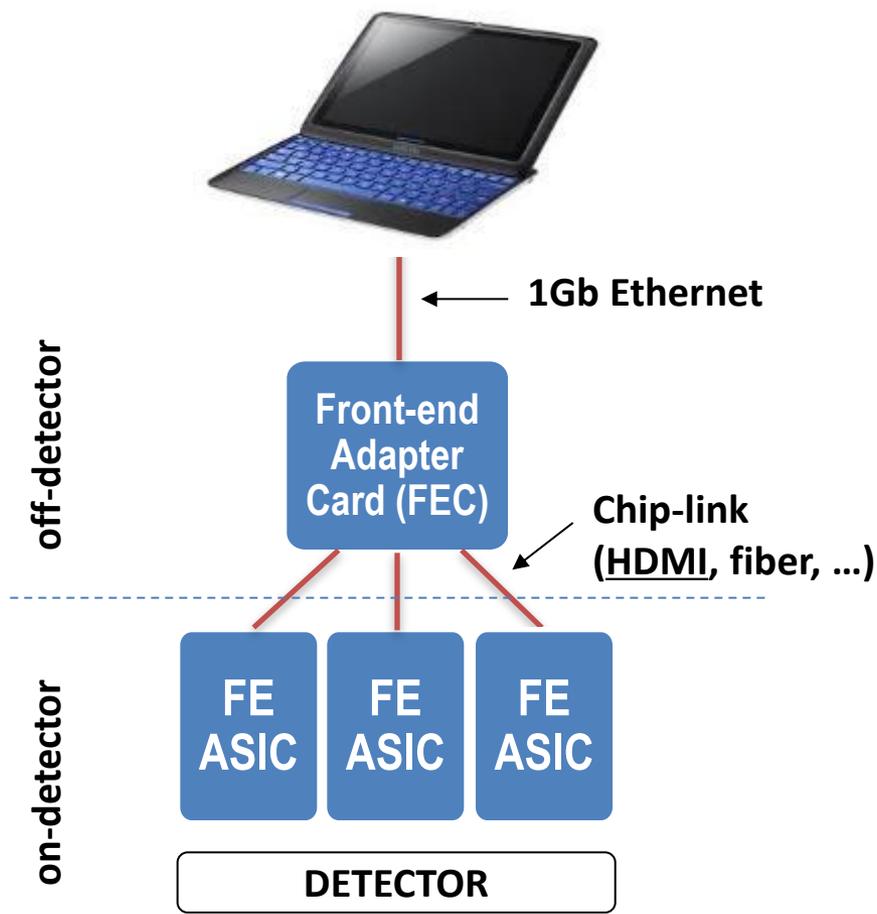
- Allows the use of different front-ends
- Can integrate different sub-detectors DAQ in the same system

## **Cost effective**

- Use of cost effective components from high-volume markets (eg. HDMI cables, PCIe connectors, Cat5/6 UTP cables, ...)

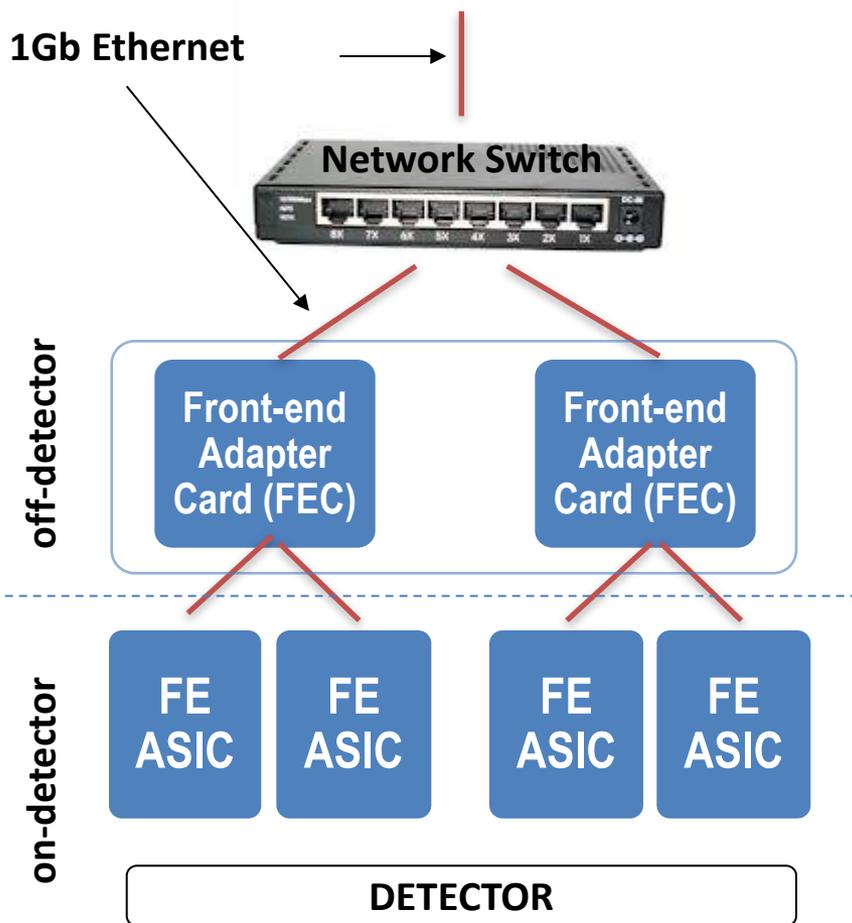
# Scalability Concept

## System Size (small)



# Scalability Concept

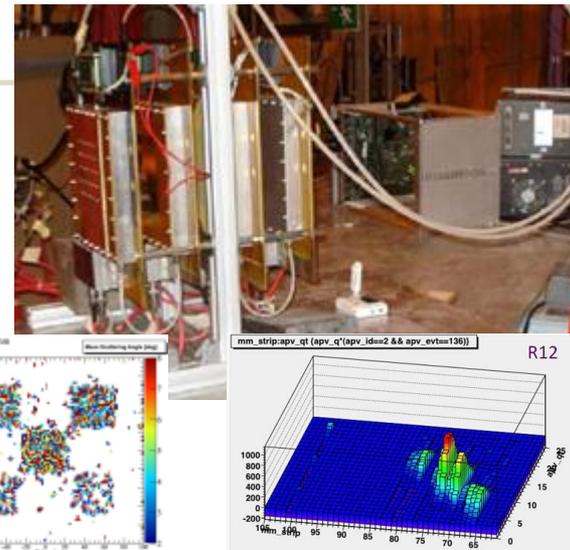
## System Size (medium)



Muon Tomography (Florida)



MAMMA Beamtest (CERN)



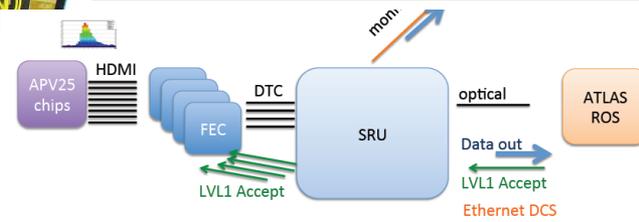
# Scalability Concept

## System Size (large)

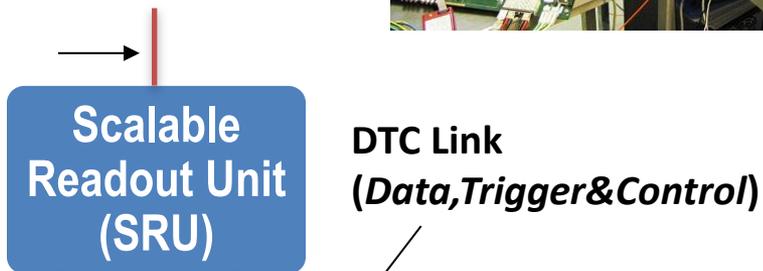
ALICE EMCal Upgrade (SRU)



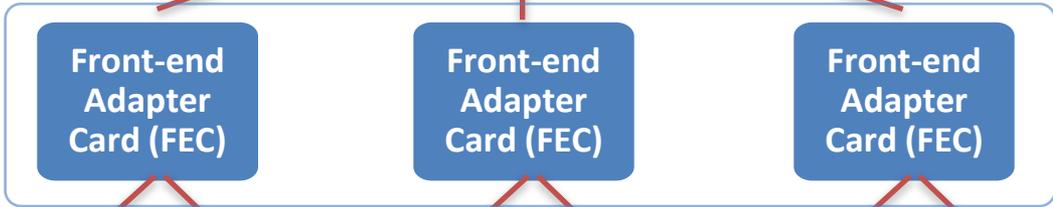
MAMMA test installation in ATLAS



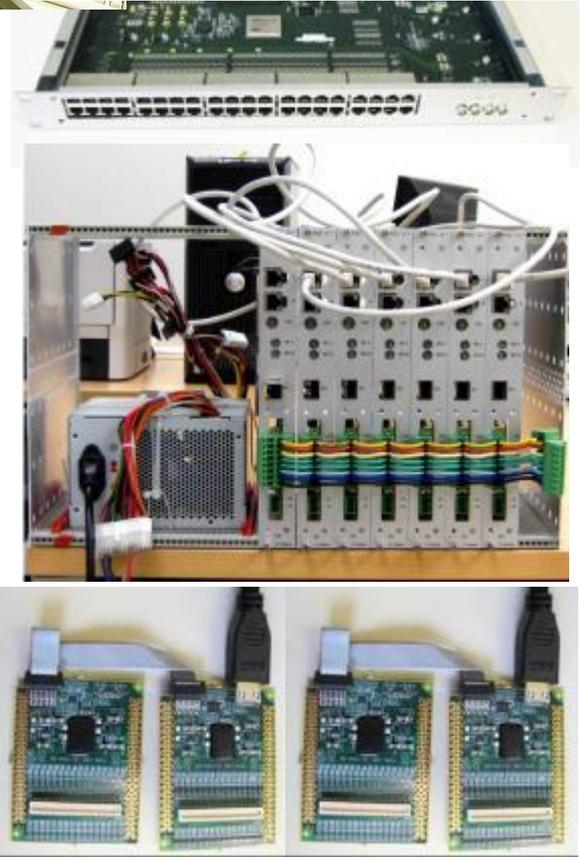
1/10/40.. Gb Ethernet  
(opt. DDL/S-Link/...)



off-detector



on-detector



# SRS Front-End Overview

## Front-End Hybrids (on-detector)

- APV25
- VFAT
- BEETLE
- ...

## Chip-links

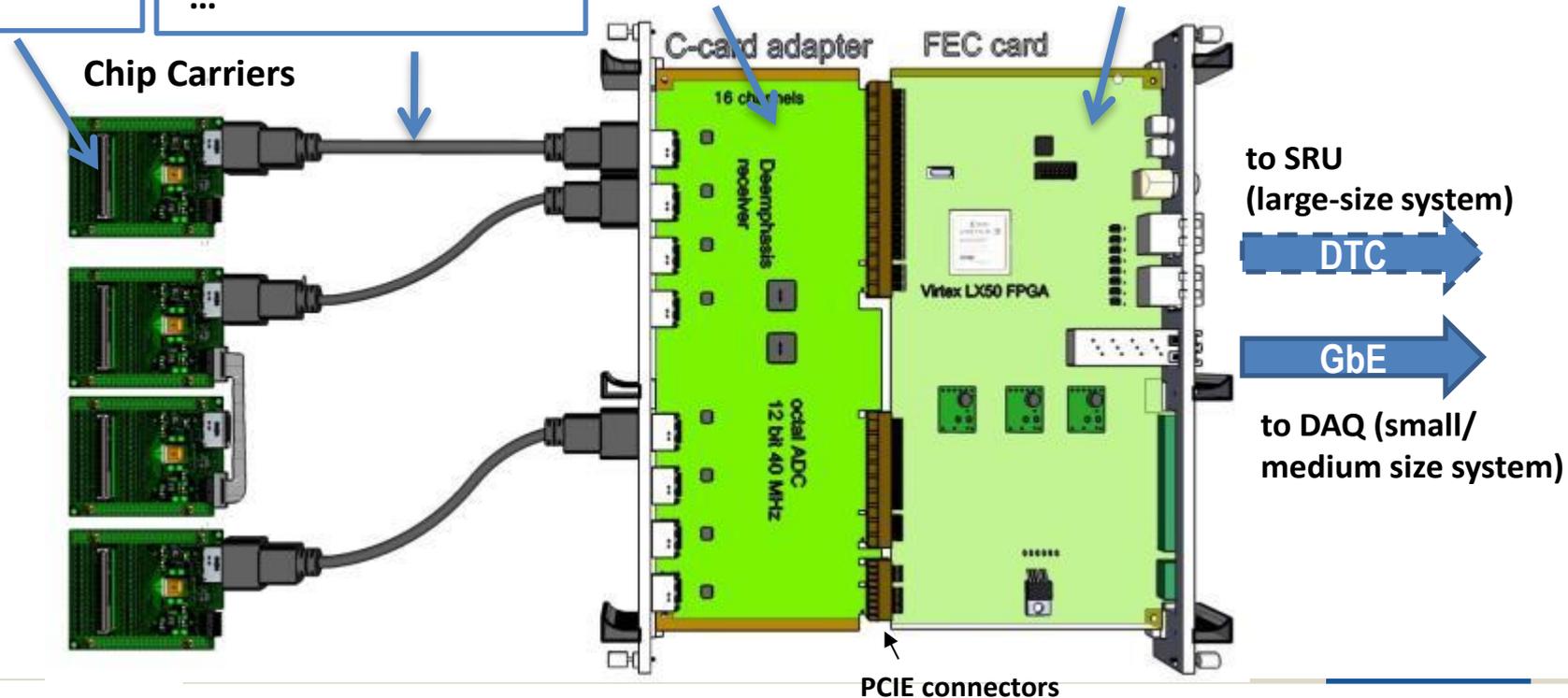
- HDMI
  - analog (APV/Beetle)
  - digital (VFAT/Beetle)
- optical (GBT, ...)
- ...

## Front-end adapter

- ADC card
- digital FE card (VFAT)
- GBT receiver
- ...

## Front-end FPGA card (SRS standard)

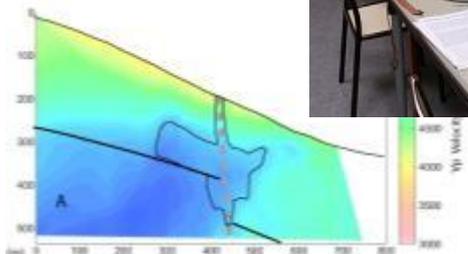
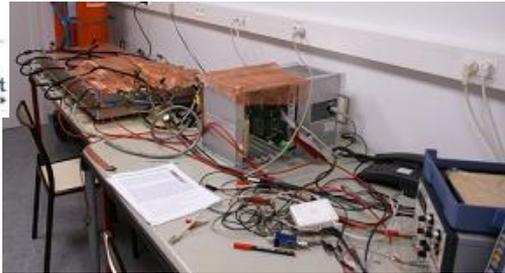
- modular firmware:
- SRS DAQ & control
  - application specific FW



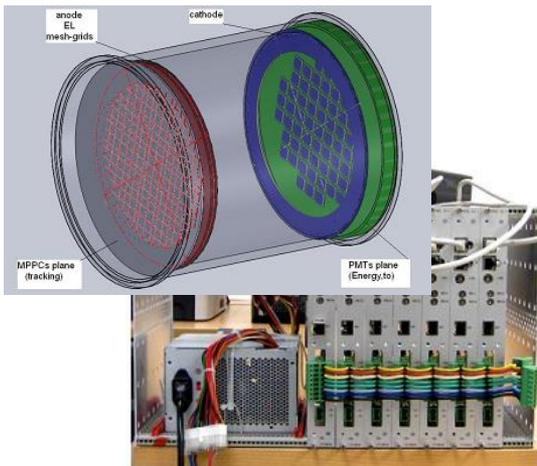
# Applications

## Laboratory

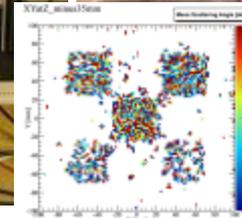
### Geophysical Muon Tomography (France)



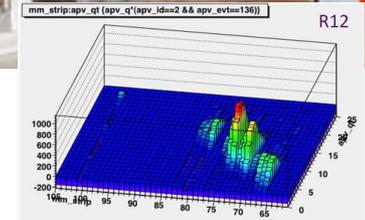
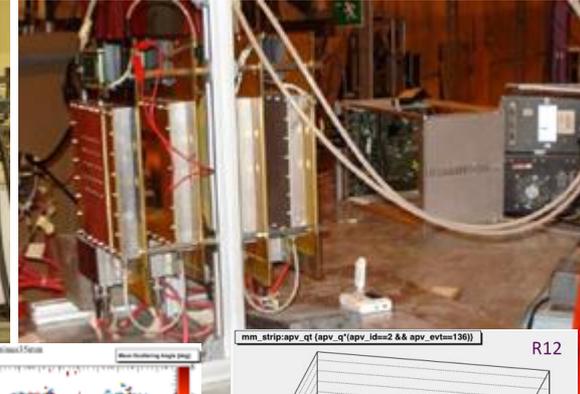
### NEXT double-beta decay prototype (Spain)



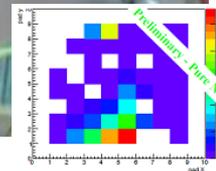
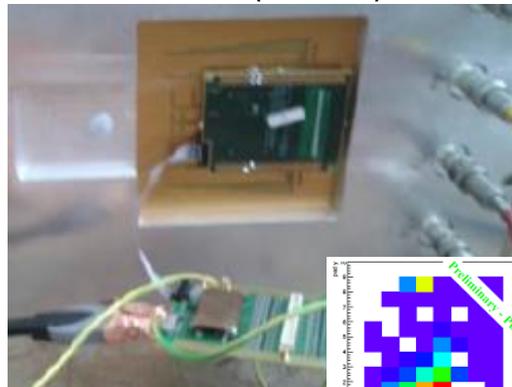
### Muon Tomography (Florida)



### Micromega R&D (MAMMA-CERN)

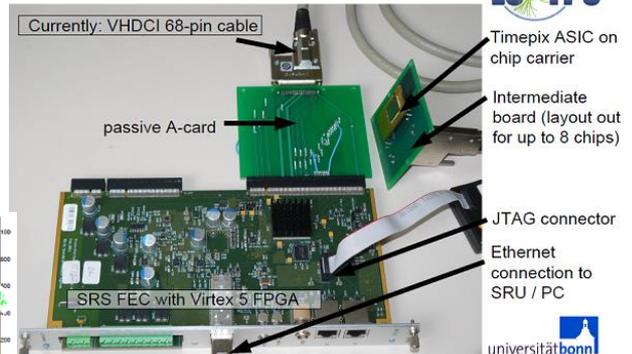


### ThGEM R&D (Rehovot)



### TIMEPIX TPC R&D (Bonn)

#### SRS with Timepix readout

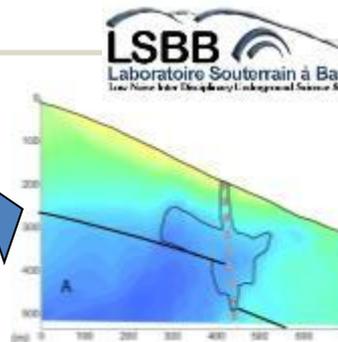
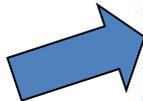
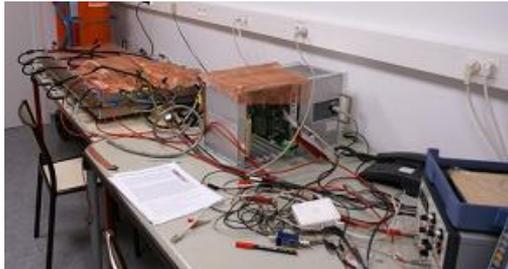


  
 Timepix ASIC on chip carrier  
 Intermediate board (layout out for up to 8 chips)  
 JTAG connector  
 Ethernet connection to SRU / PC  

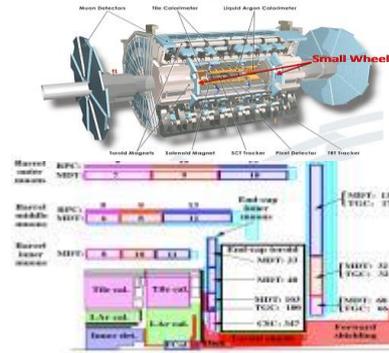
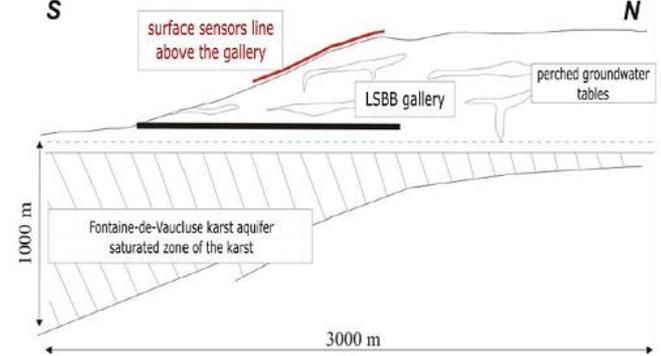

20.09.2012

# Applications

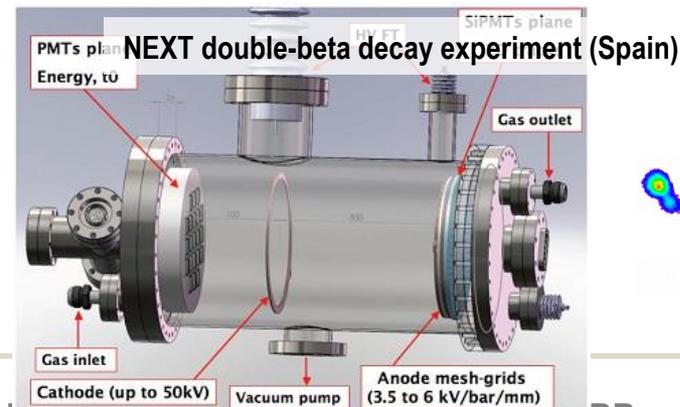
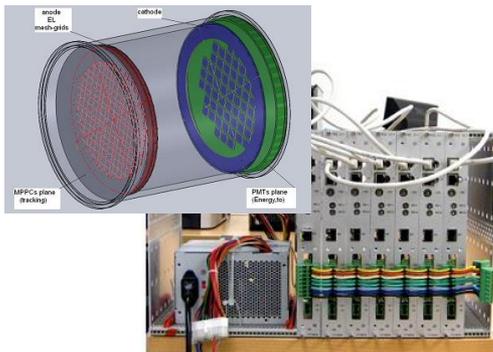
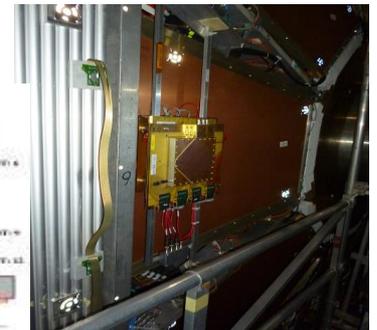
## Experiments



## Geophysical Muon Tomography (France)



## MAMMA ATLAS Small Wheel Upgrade

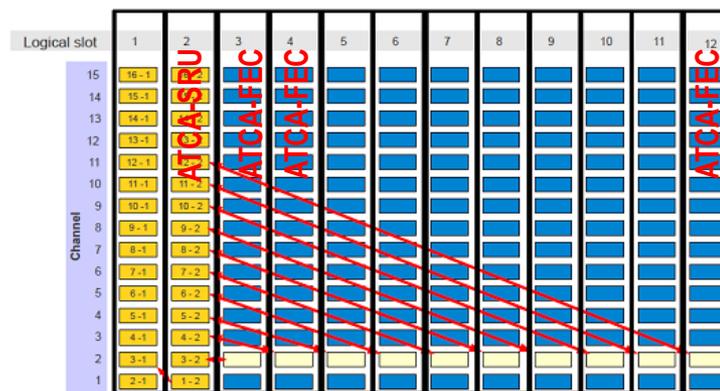
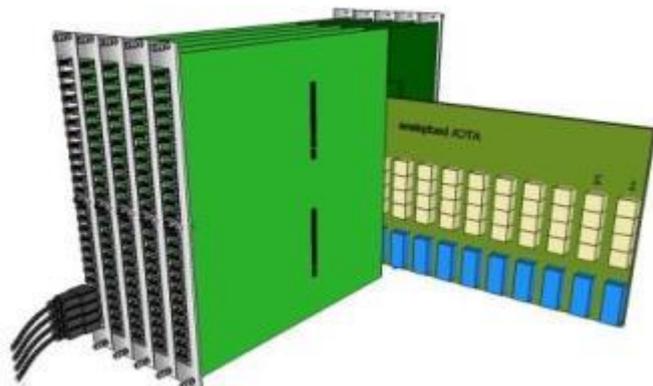


HEP Tech, a key driver for bringing PP science to society

sorin.martoiu@cern.ch

# Industry solution → ATCA-SRS

- ❑ 1 SRU Board per the shelf
- ❑ Connection over standard backplane
- ❑ → point-to-point (multi-) gigabit link between FEC and SRU boards (DTCC - *Data, Trigger, Clock and Control*)
- ❑ → no external cables (maintenance, assembly)
- ❑ Scalable (1-board or many shelves)
- ❑ Optical and/or Ethernet between shelves
- ❑ In-built remote management and diagnostic (IPMC)



# HEPTech and RD-51 (MPGD collaboration with 70 members)

## Steps

- A company approached RD-51 via CERN for the commercialisation of SRS
- CERN inventor contacted HEPTech for advise
- HEPTech contacted CERN, IFIN-HH and Valencia Tech Uni TTOs
  - Inform on the case
  - Liaise with their scientists
  - Validate the approach elaborated by HEPTech and RD-51
- To do next:
  - CERN-KT: to draft the exploitation agreement
  - CERN-KT to negotiate with Company

## Exploitation agreement

- Shared ownership
  - 80% CERN, 10% IFIN-HH, 10% Valencia Tech University
  - CERN KT
    - Responsible for exploitation agreement
    - Grant licenses
    - Distribute revenues

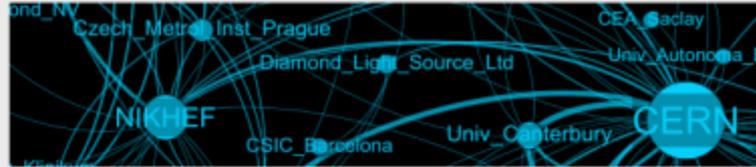
## Licence

- Manufacturing SRS for RD-51 needs
- Commercialise SRS
  - Medical imaging
  - Other scientific domains

# 3: Collaboration Spotting

<http://collspotting.web.cern.ch>

CERN Accelerating science



## Collaboration Spotting

Spotting Collaborations in Particle Physics

[About us](#) [Home](#) [Our Approach](#) [Samples](#)

Authentication

[CERN SSO Login](#)

## Samples

### Micropattern Gaseous Detectors

Technologies

Publications

Patents

Publications + Patents



Micropattern Gaseous Detectors General (MPGDs)

# Positioning CEA: MPGD (Publications)

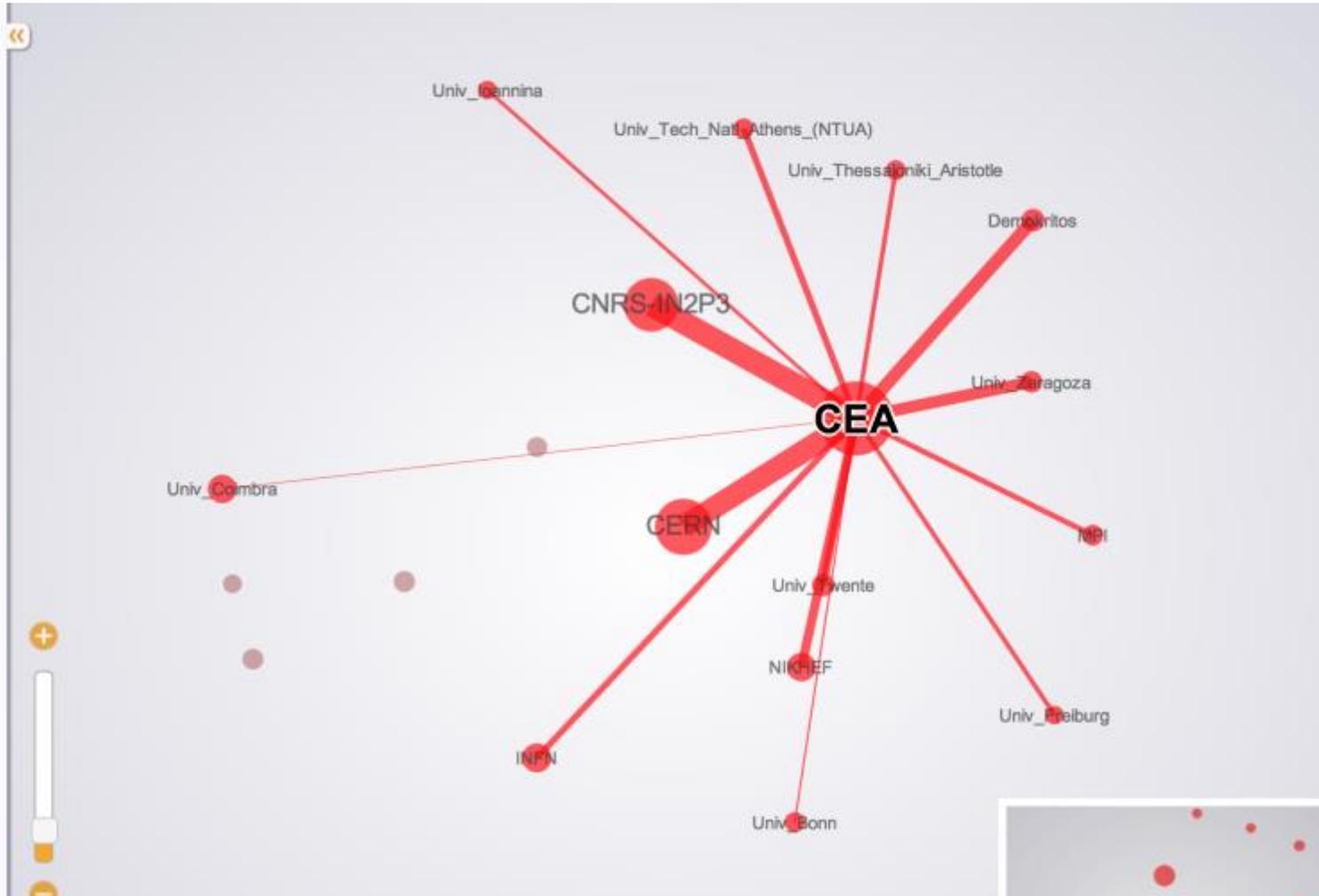
Organizations: 19  
Publications: unknown

● CEA

Organization Type : Institution  
Publications : 116  
modularity class : 10

Collaborations (14)

- CERN [24.0]
- CNRS-IN2P3 [25.0]
- Demokritos [14.0]
- INFN [7.0]
- MPI [6.0]
- NIKHEF [10.0]
- Univ\_Coimbra
- Univ\_Ioannina [4.0]
- Univ\_Tech\_Natl\_Athens\_(NTUA) [7.0]
- Univ\_Thessaloniki\_Aristotle [5.0]
- Univ\_Twente [8.0]
- Univ\_Zaragoza [13.0]
- Univ\_Bonn [2.0]
- Univ\_Freiburg [5.0]



# Positioning CEA: MPGD (Patents)

Organizations: 73  
Publications: unknown

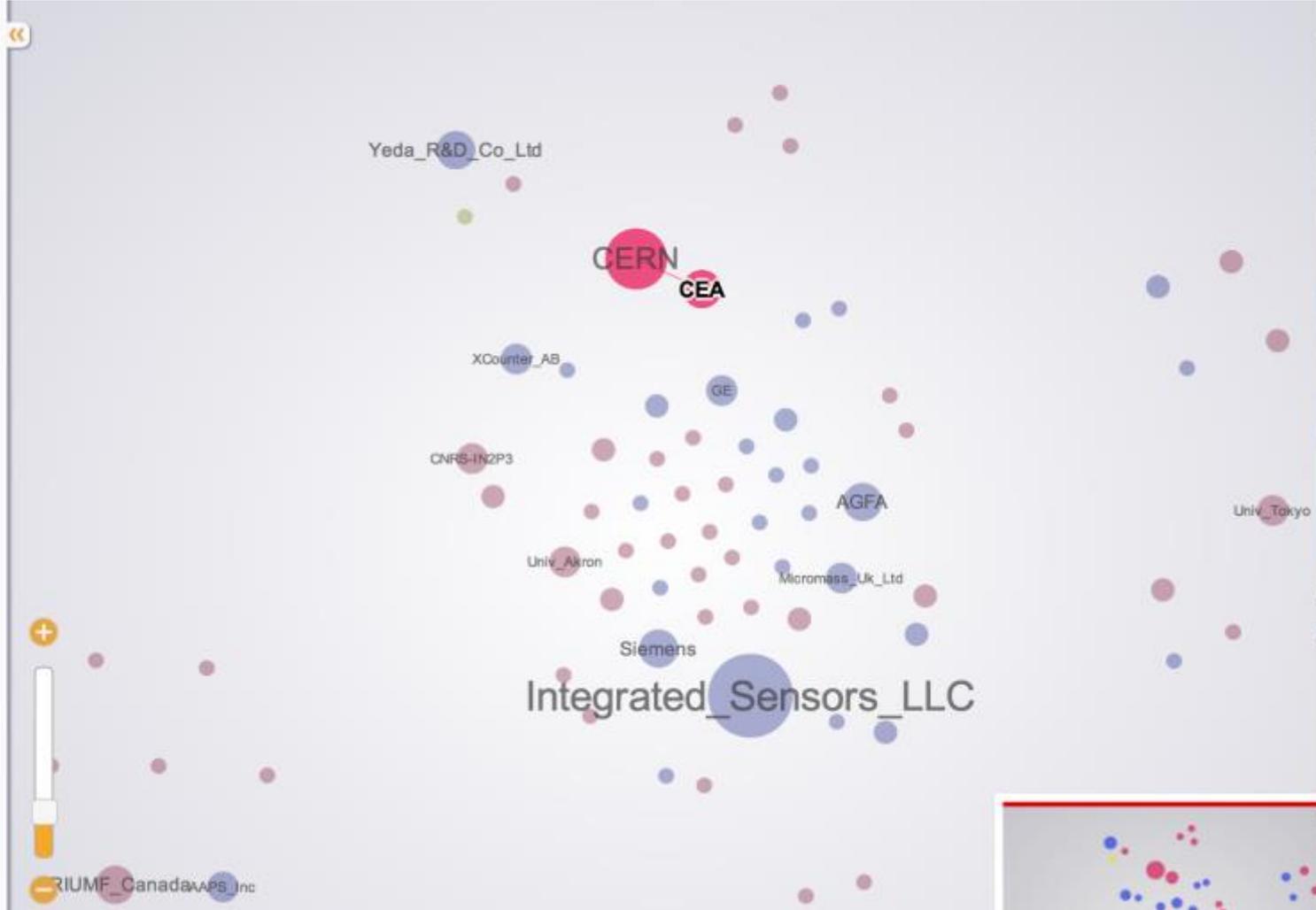
● CEA

Organization Type : Institution

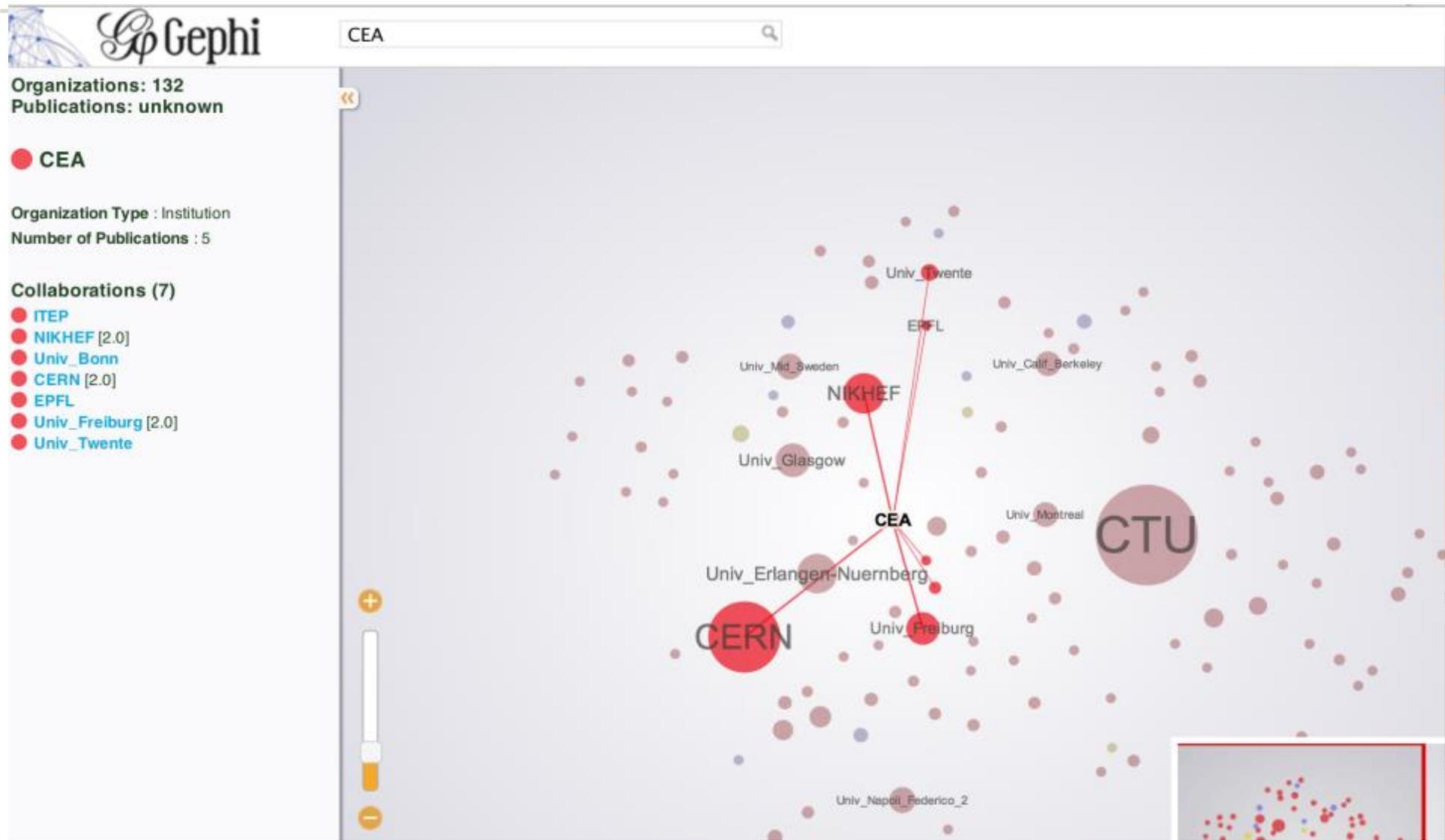
Patents : 4

Collaborations (1)

● CERN



# Positioning CEA: Medipix (Publications)



# Identified organisations for the 3D-IC matching event

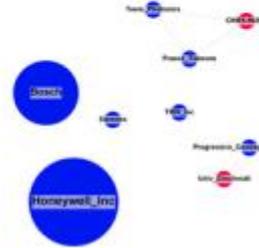
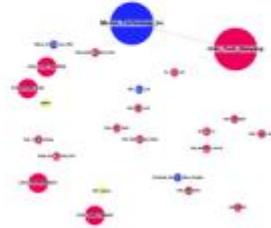
Technologies

Publications

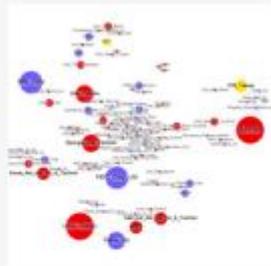
Patents

Publications + Patents

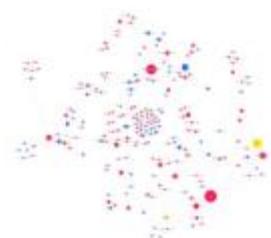
Solid-liquid interdiffusion (SLID)



Interposers  
Organizations information



Through-Si Vias (TSV)  
Organizations information



# Collaboration follow-up

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## *Impact of Academia-Industry matching events in terms of collaborations*

### ***Case: SiPM Event (February 2011)***

- First Data Set (pubs): before the event
- Second Data Set (pubs): two years after the event

### ***Tracing:***

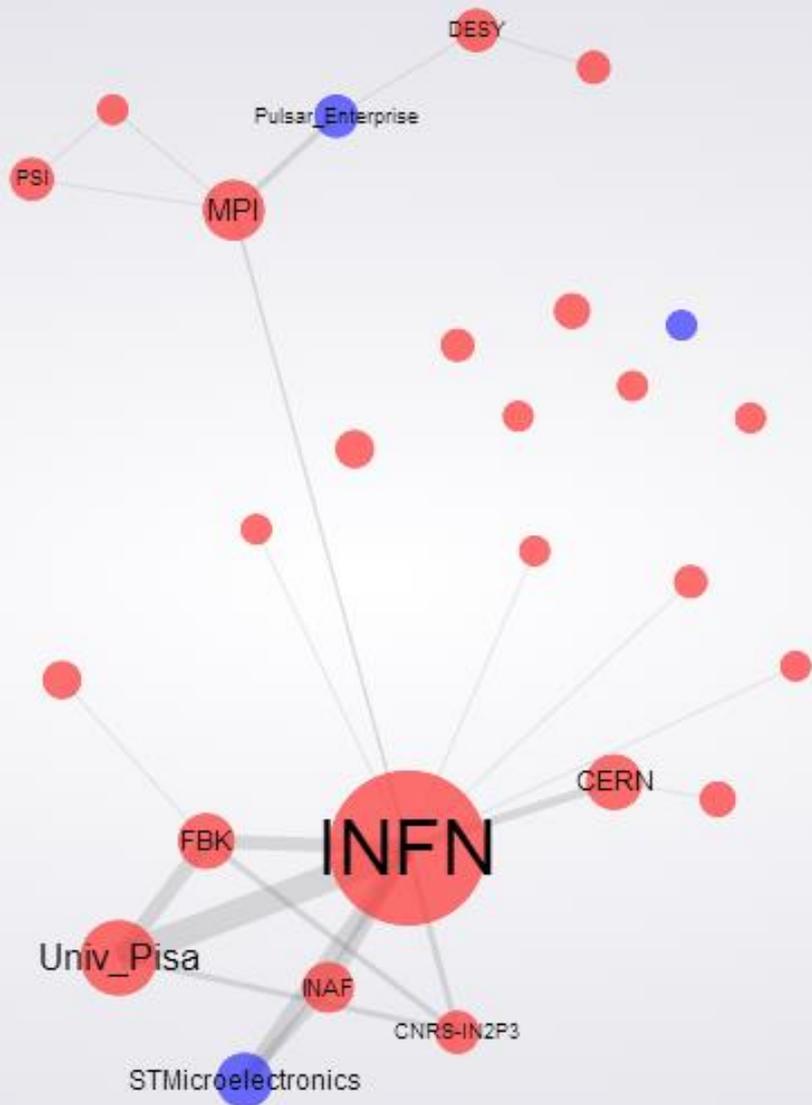
- All organisations attending the event

### ***Results:***

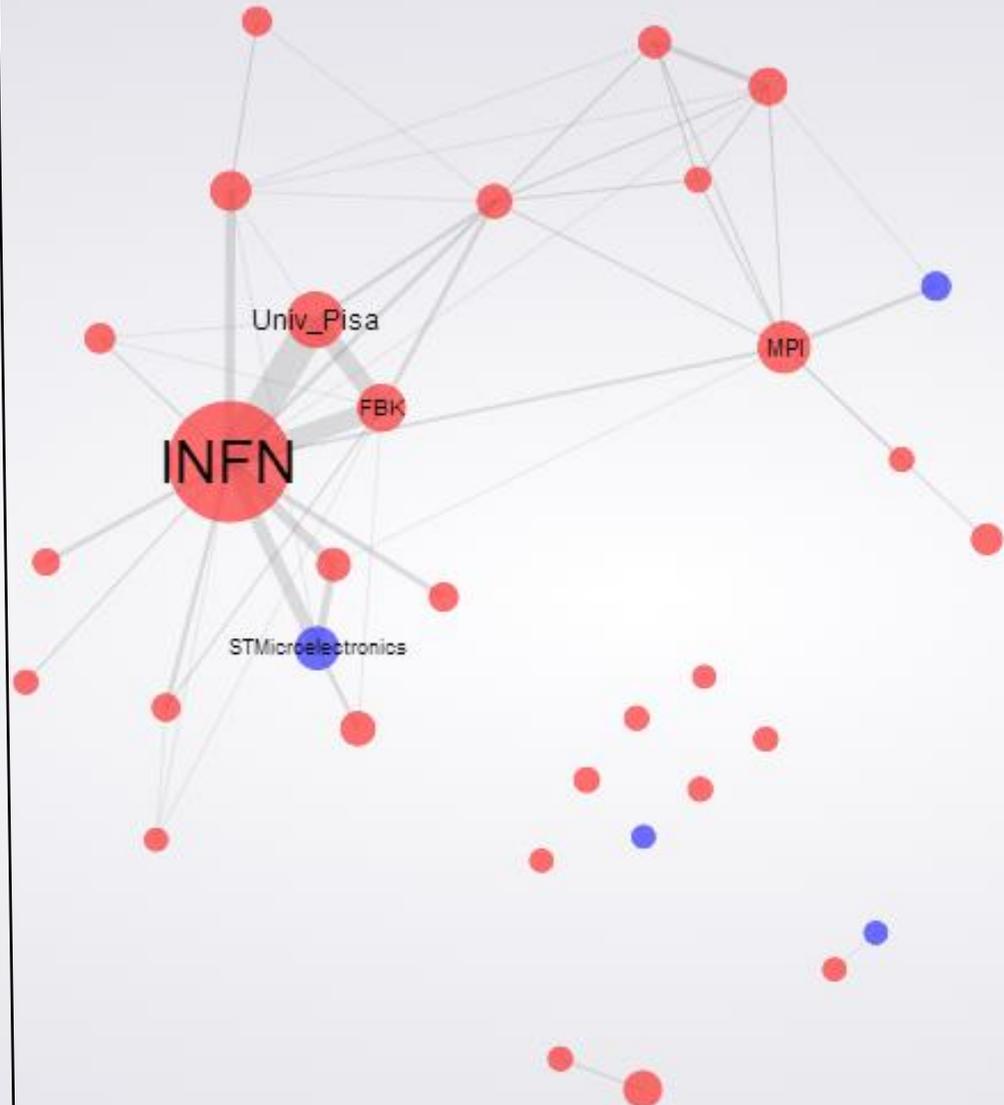
- Increase in publications
- Collaboration development

# Attendees (before-after the event)

graph from timeline – 2010



graph from timeline – 2013



# Increase in publications

Organisation name	Pubs 2010	Pubs 2013	$\Delta P$
CERN	11	16	5
CIEMAT	0	3	3
CNRS-IN2P3	6	11	5
CPTA_Moscow	2	2	0
CSIC	3	7	4
DESY	6	14	8
EPFL	3	6	3
ETHZ	1	2	1
FBK	11	23	12
FNAL	4	11	7
GSI	0	3	3
INAF	9	10	1
INFN	51	91	40
KETEK_GmbH	1	1	0
Kernfys_Versneller_Inst	0	2	2

Organisation name	Pubs 2010	Pubs 2013	$\Delta P$
MPI	13	27	14
PSI	6	8	2
Photek_Ltd	0	1	1
Pulsar_Enterprise	6	6	0
STMicroelectronics	11	19	8
Univ_AGH_Sci_&_Technol	1	1	0
Univ_Glasgow	0	1	1
Univ_Heidelberg	2	9	7
Univ_Insubria	1	5	4
Univ_Leicester	0	1	1
Univ_Napoli_Federico_2	1	4	3
Univ_Oxford	1	2	1
Univ_Pisa	19	31	12
Univ_Roma_1	2	6	4
Univ_Siena	1	2	1
Univ_Surrey	1	2	1
Univ_Tech_Delft	4	14	10
Univ_Udine	0	1	1

No increase

Increase

# Collaboration development

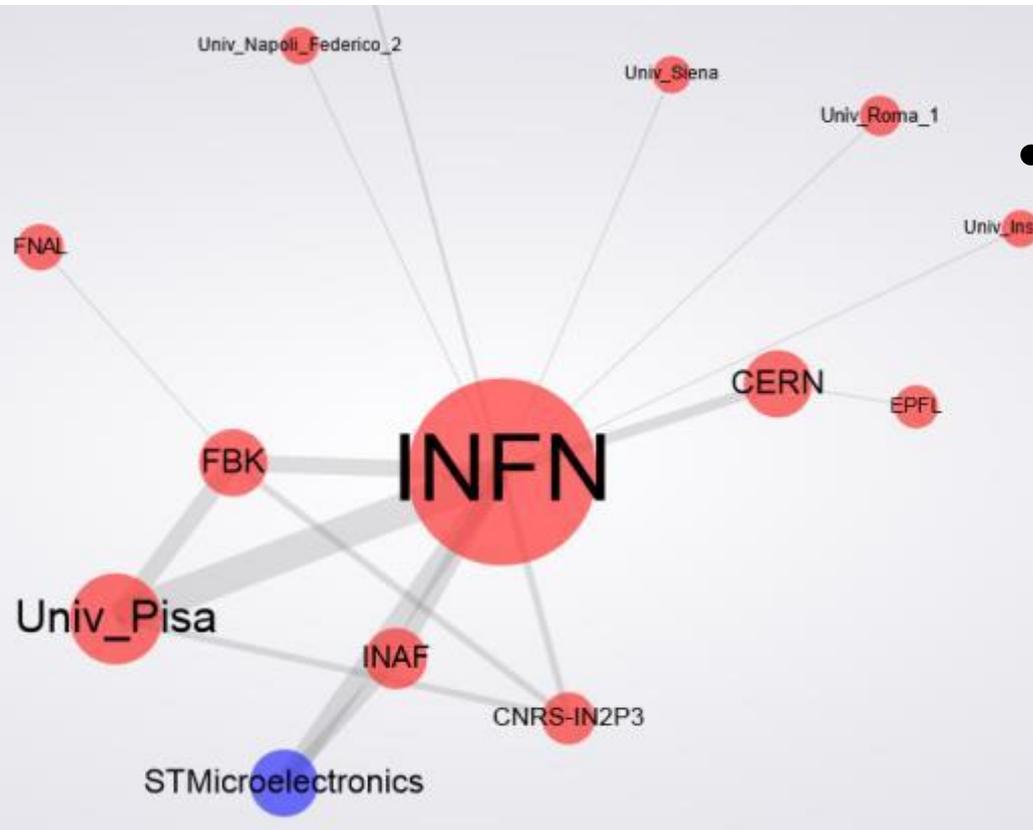
## *Existing collaborations*

- INFN
- CNRS-IN2P3
- MPI

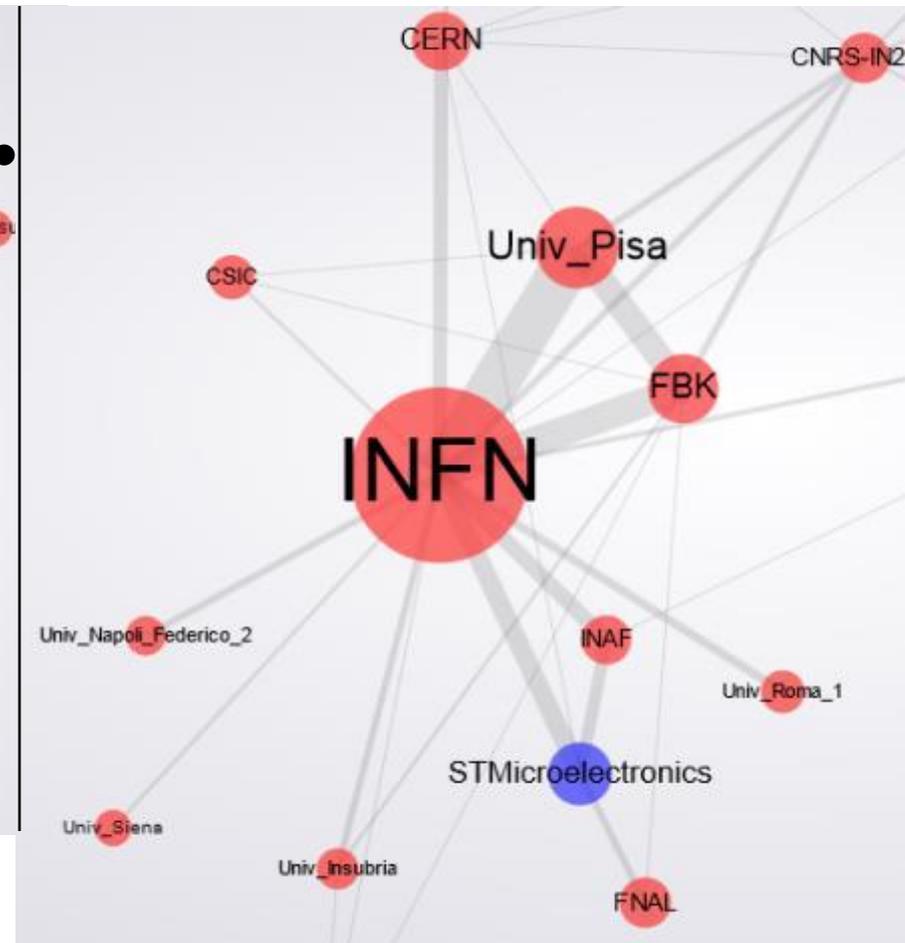
## *New collaborations*

- Photek Ltd – Uni Leicester
- Tech Uni Delft – Kern Versneller Institute

# Collaboration development (INFN)

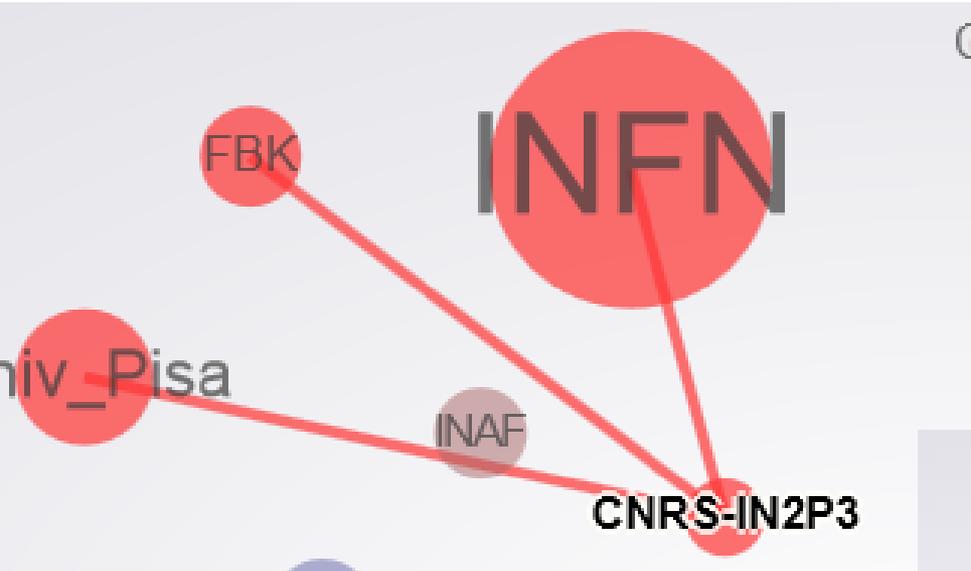


2010

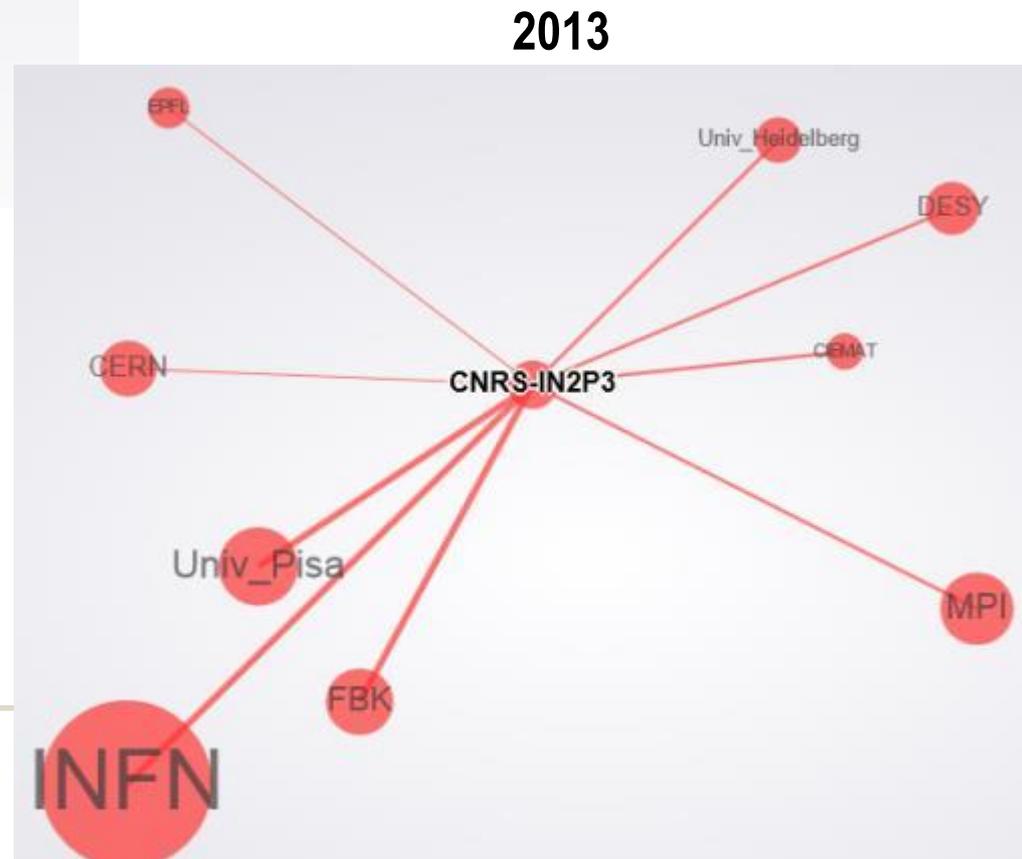


2013

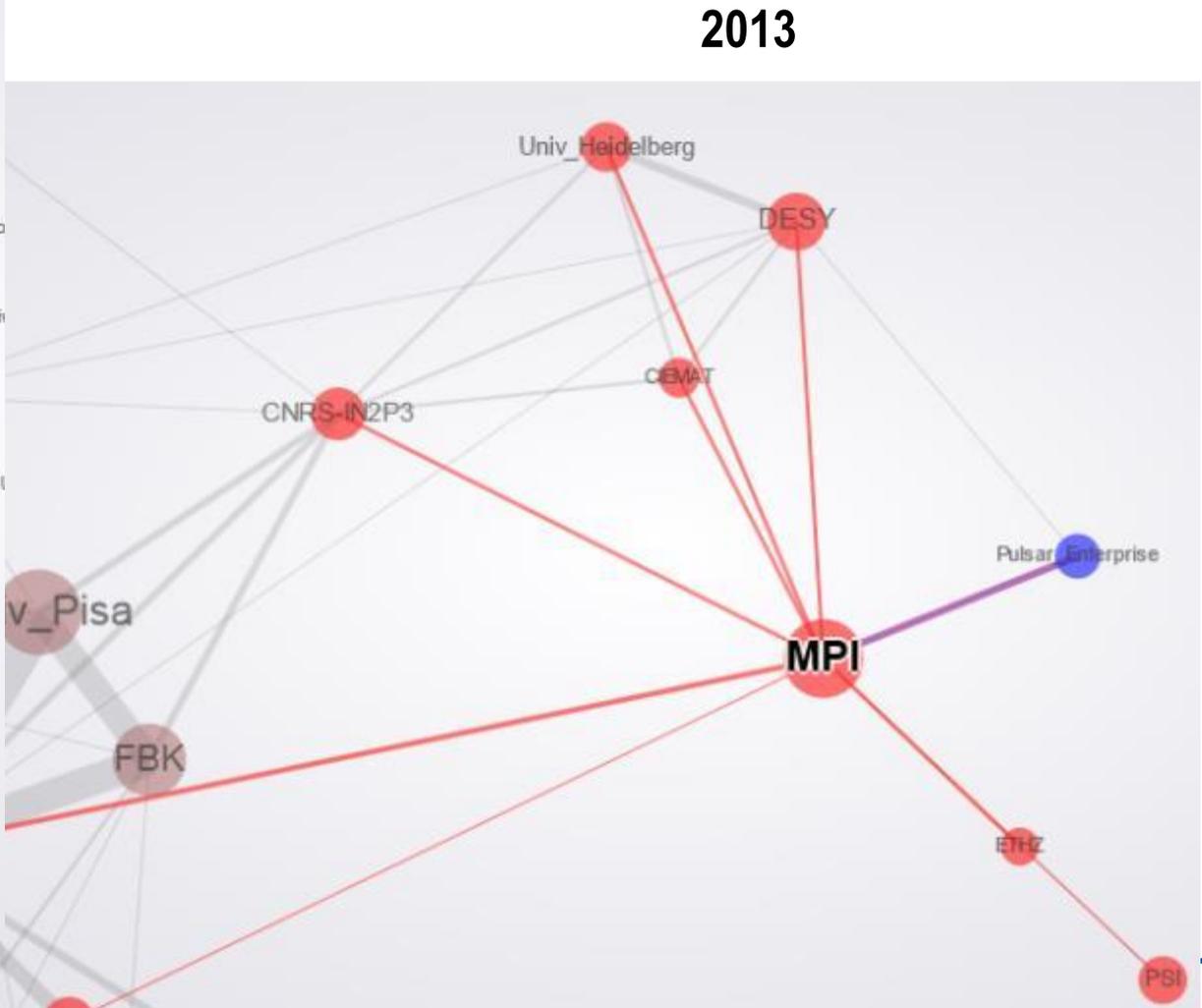
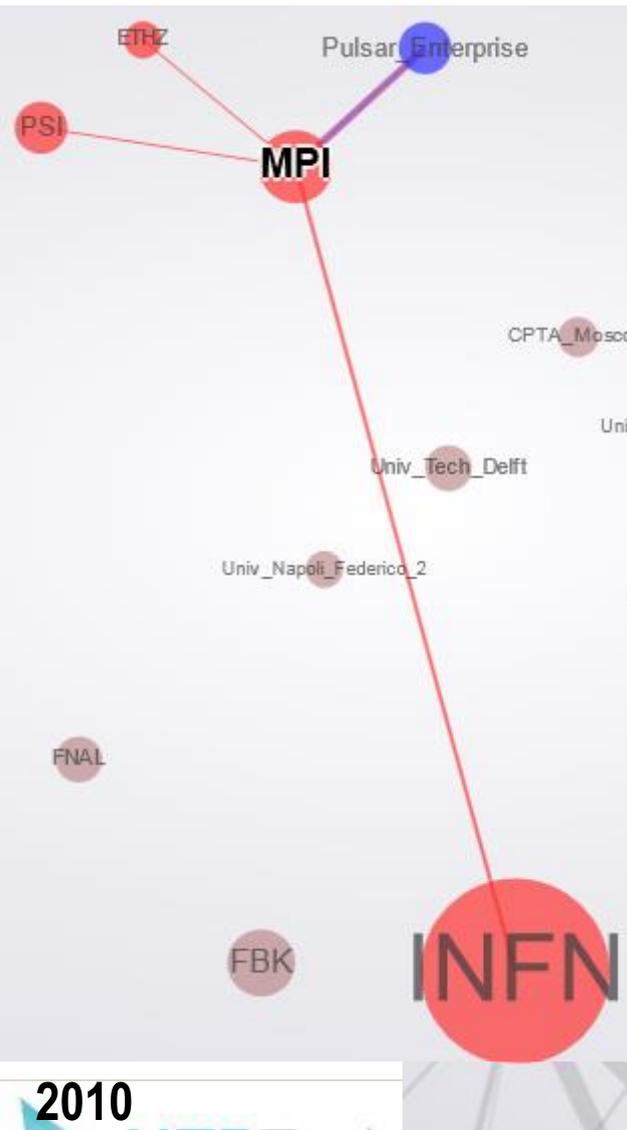
# Collaboration development (CNRS-IN2P3)



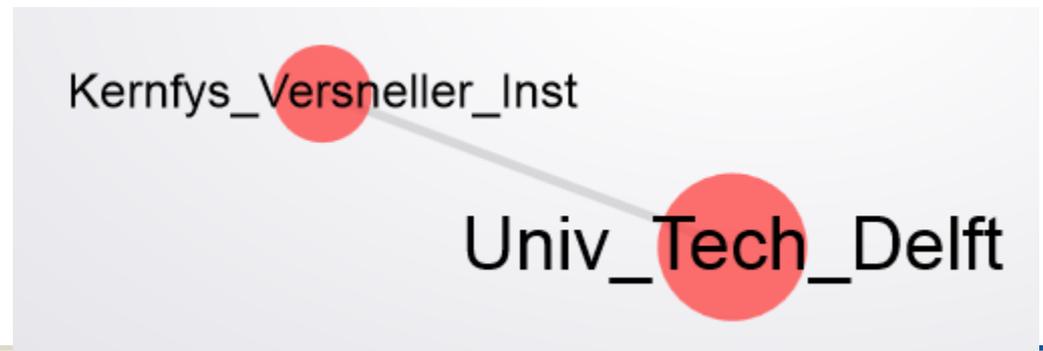
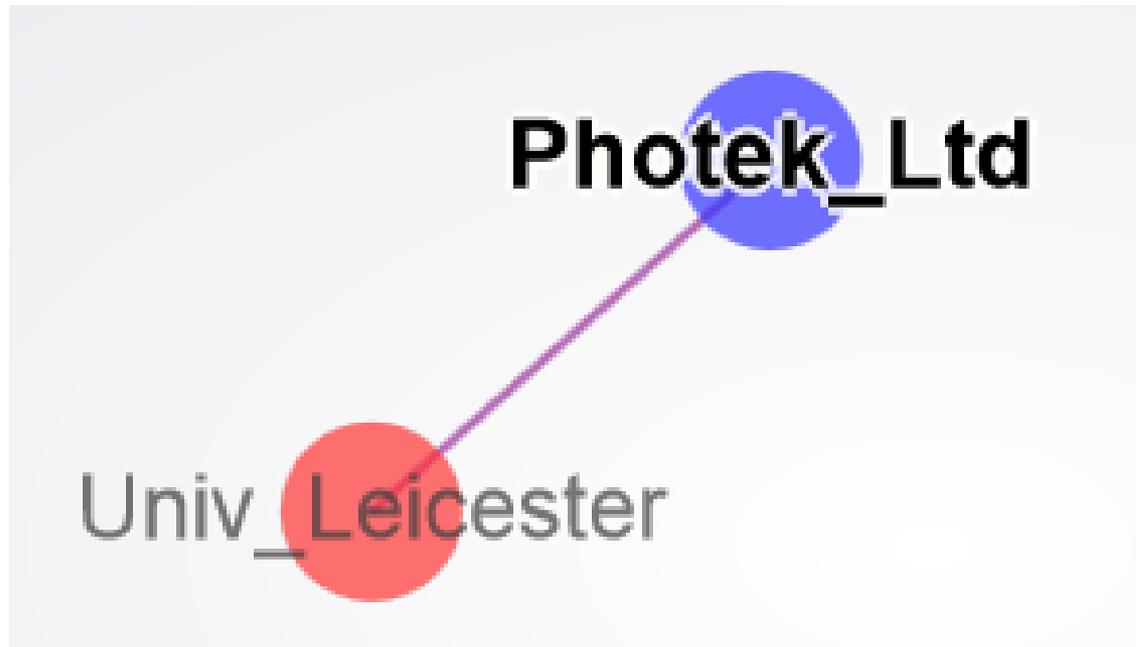
2010



# Collaboration development (MPI)



# New collaborations



# Pre-commercial procurement workshop

*By acting as technologically demanding first buyers, public procurers can drive innovation from the demand side. In December 2007, the European Commission adopted a Communication to promote the use and address the underlying barriers of pre-commercial procurement in Europe. Pre-commercial procurement is an approach where public procurers involve industry at an earlier stage in R&D projects and share the risks and benefits of designing, prototyping and testing new products. This approach is now becoming the focus of attention, in particular in relation with standard procurement. It is also a very pertinent topic for Research Infrastructures.*



**Venue:** European Spallation Source - Tunavägen 24, Lund

**Organizing Committee:**

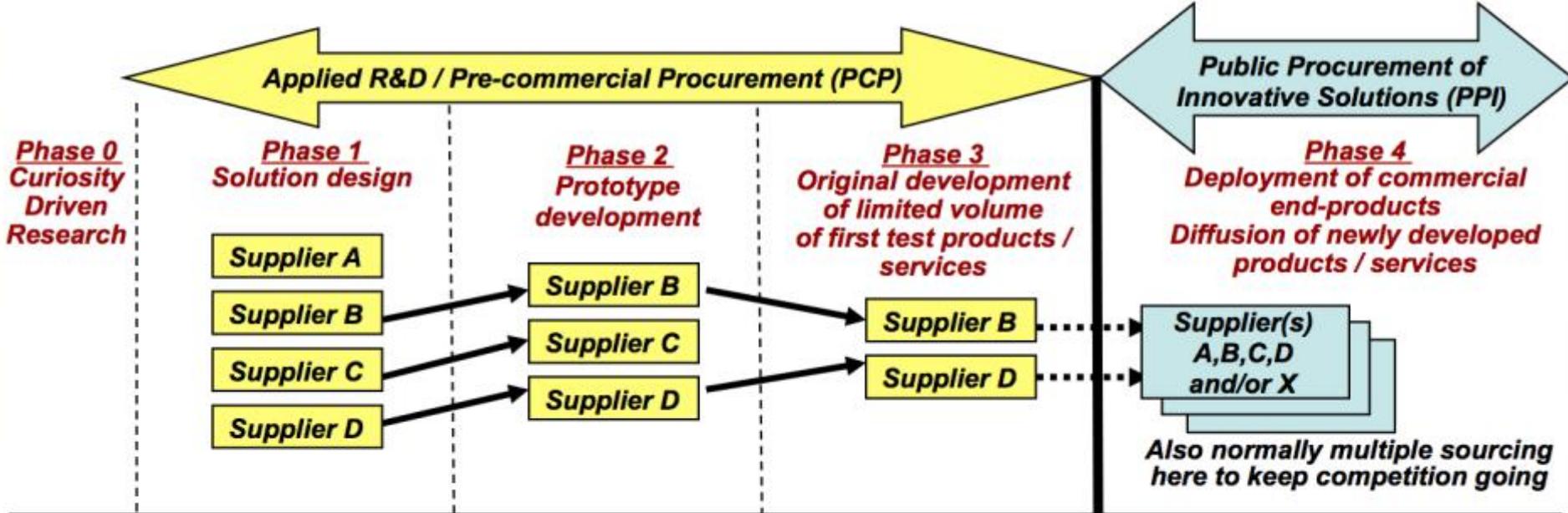
Juan Tomas Hernani	ESS
Jean-Marie Le Goff	CERN
Antonio de Valladares Pacheco	CERN
Ute Gunsenheimer	ESS
Ian Tracey	STFC
Bernard Denis	CERN/JRC

# Why? To create growth and jobs 'in Europe'

## How? PCP-PPI combo



- **PCP** to steer the development of solutions towards concrete public sector needs, whilst comparing/validating alternative solution approaches from various vendors
- **PPI** to act as launching customer / early adopter / first buyer of innovative commercial end-solutions newly arriving on the market



Because of split between PCP and PPI:

- PCP falls outside WTO rules & proc directives (can encourage job creation 'in Europe'),
- PPI for buying ltd PCP test series also exempted from WTO (neg. proc. wo publication)
- PPI for large volumes / quantity production (check for type of product category/buyer whether exempted or not from WTO and public procurement directives)

# Workshop conclusions

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## *Observations*

- PCP & PPI will be an integral part of H2020
- The Commission did not consider RIs' characteristics when setting up this new programme
- There are risks for RIs of not being eligible

## *Actions*

- ESS has agreed to a follow-up HEPTech event to bring these concerns to the Commission

# Conclusions

*Research in curiosity-driven science is a key driver for technological innovation and economic success*

*HEPTech aims to get the best of scientists and TTOs of organisations active in particle, astro-particle and nuclear physics with a view to bringing more science to society*

*Fostering synergies between academia and industry in R&D for future PP projects is instrumental to sustainable knowledge transfer.*

- → This is one of HEPTech's primary role
- → One of the main source of transfer in the future

**Thank you for your attention**