CERN

European Organization for Nuclear Research
Organisation Européenne pour la Recherche Nucléaire

Knowledge transfer and industry involvement

The impact of CERN on high tech industry developments
Focus: The construction of the LHC

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Content

1: Particle Physics characteristics and the LHC project

2: Economic utility resulting from CERN procurement contracts (CERN 1984 -14)

3: Technology transfer and technological learning through CERN's procurement

activities (LHC, CERN-2003-005)

4: TT: Lessons learned from the construction of a very large research apparatus (LHC)

5: Main impacts of Particle Physics on industry and society

6: Conclusions

1: Particle Physics context

PP characteristics

• PP research requires the construction of very complex and extremely large devices (one-off developments)

• PP is a highly collaborative open science environment requiring expertise in many technology domains requiring long-term and tight collaboration with high-tech Industry offering top quality education and training from apprentice to post-doctoral

• PP is extremely demanding in terms of equipment design, it generates novel technical approach which benefits many research disciplines and ultimately society

World standard institutions (centres of excellence) with high tech laboratories for:

• Accelerators

Accelerator elements, vacuum technologies, magnets, super-conductivity and cryogenics, mechanics & surface treatments

• Particle detectors Electronics

• Data and computer-intensive software

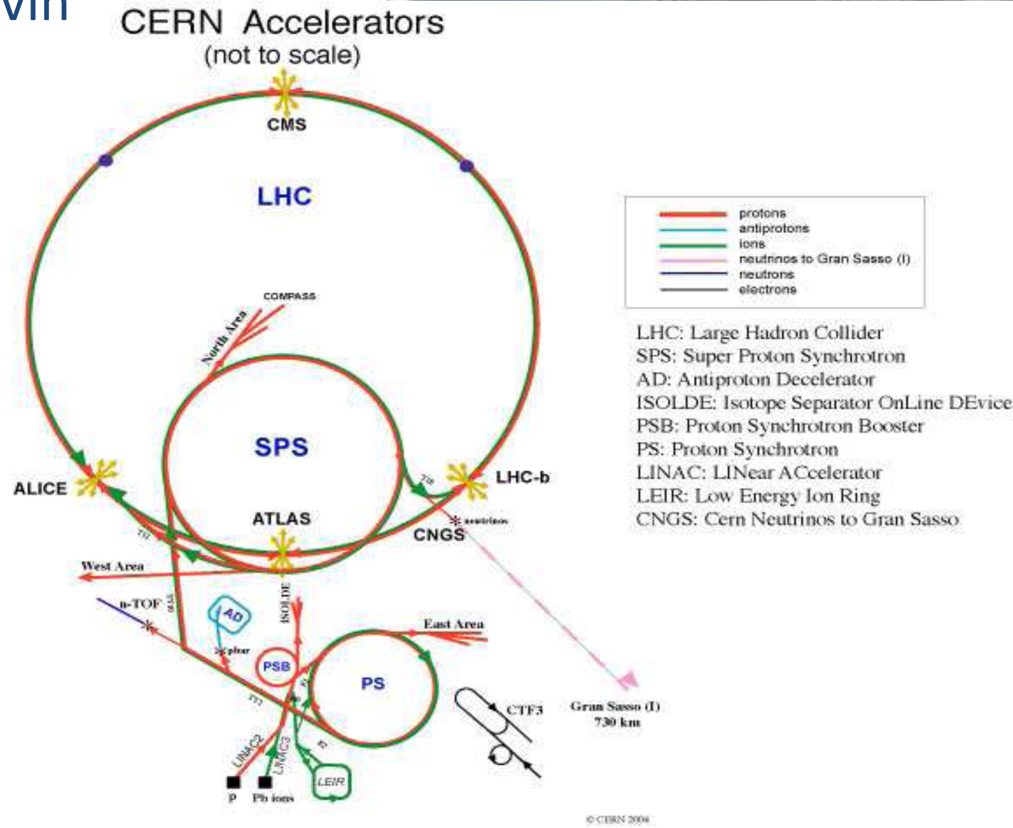
1: The Large Hadron Collider

Largest accelerator ever built

- 27 km ring of superconductive magnets
- Operation temperature: 1.8 Kelvin

Research machine

- New physics
- In operation since 2009



1: R&D context for Particle Physics and industry

Research: Open Science

Publication of discoveries & R&D results

Scientific recognition

Value in copyrights

- ***R&D to meet scientific programme objectives***

Long-term

Best possible solution within budgetary constrains

- ***R&D results: Technology***

IP rights to use internally

- ***Highly collaborative***

Memorandum of Understanding (MoU)

- ***Unclear IP situation***

Joint ownership of R&D results

Complex dissemination

- ***Funding***

Public

Quality of research program

Industry:Open Innovation

Protection of innovations & know-how

Required to facilitate industrial dissemination

Value in IP rights (patents, etc.)

- ***R&D to increase market share***

Short-term

Best cost-effective solution

- ***R&D results: Products (prototypes)***

IP rights to manufacture

- ***Highly competive***

Licence and/or partnership agreement

- ***Clear IP situation***

Clear ownership of R&D results

Dissemination based on manufacturing

- ***Financing***

Private with public support (EU,

2: Economic benefit to High Tech industry involved in CERN’s procurement contracts in relation to their sales

Interviews of 160 European firms (out of the 519 firms providing high tech equipment to CERN) which supplied estimates of their:

- Increased turnover on sales
- Cost savings on production and procedures

due to CERN’s procurement contracts, in view of estimating the economic impact of Scientific equipment necessary for carrying out the research and supplied by industry:

- Included: New products, quality improvements, productivity increases arising from procurements contracts
- Excluded: Direct impact on the economy of CERN’s material and personnel budget (multiplier effect)

Quantitative results

- Every **€1 paid to industrial firms generates €3 of additional business.**
- 75% of the increased sales were to sectors outside particle physics, such as: solar energy, the electrical industry, railways, computers and telecommunications

3: TT & Technological learning through procurement activities

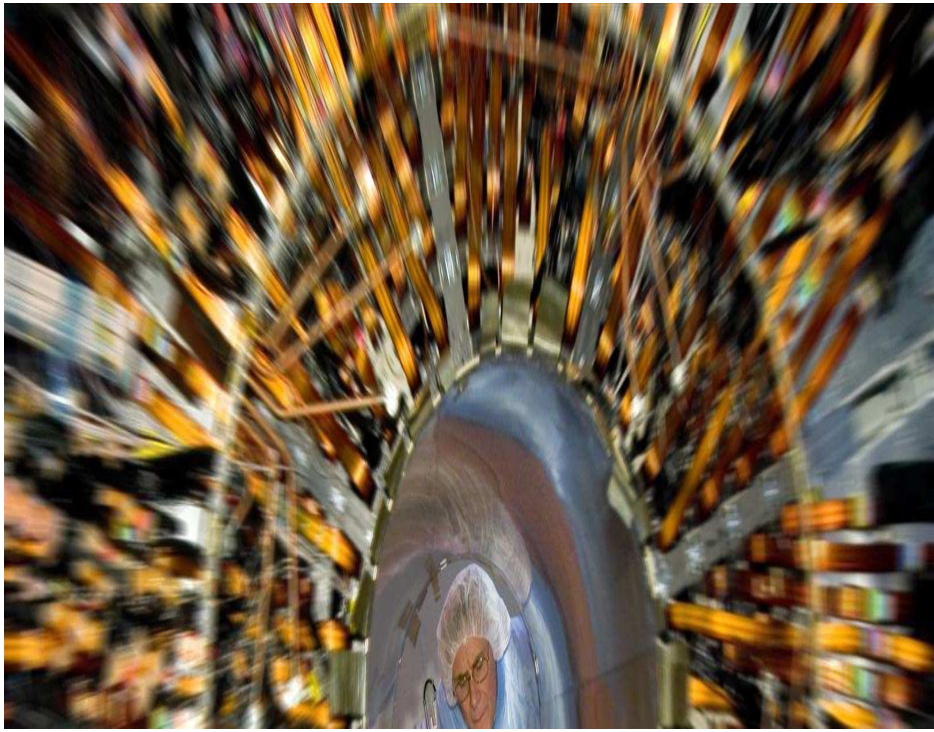
- *38% developed new products as a direct result of the supplier project*
- *13% started new R&D teams because of the CERN project*
- *14% started a new business unit*
- *17% opened a new market*
- *42% increased their international exposure*
- *44% indicated technological learning*
- *36% indicated market learning*

The benefits assessed by the present study suggest that, for this subpopulation of companies participating in highly demanding development and cutting-edge technological projects, conventional procurements and stringent requirements are not the most appropriate modes of interaction when one wishes to foster learning and innovation in the long term.

Some measures to facilitate true R&D partnership with industrial partners are required

4: TT activities during the LHC construction

Lessons learned from the construction of a very large research apparatus (LHC)



4: CERN technology portfolio

During the period of analysis, 163 TT cases have been recorded:

• More than **90% are related to the LHC programme**

Technology/expertise originating from the LHC programme

– Ex: Mechanics: Diaphragm system used for the assembly of the LHC dipoles Developments carried out to support the LHC programme

– Ex: IT: Electronic Document Management System (EDMS) used for the handling of the LHC and experiments construction data

• Cases almost evenly distributed across technology domains

Accelerators

Detectors

Electronics

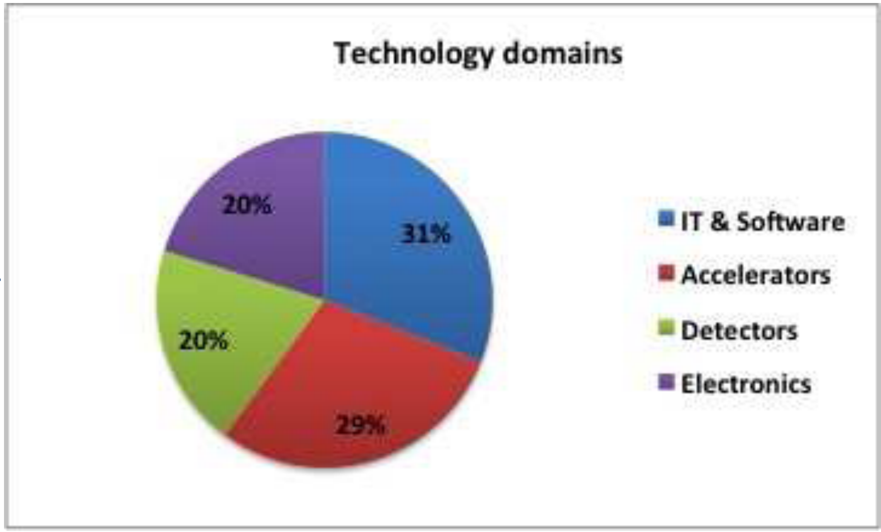
IT & software

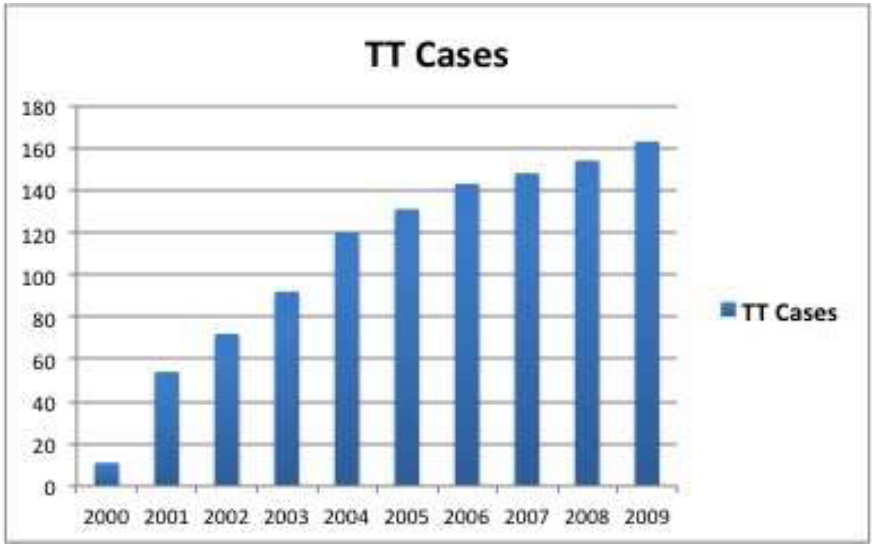
• Average exploitation level of the technology portfolio: **50%**

• TT cases distribution

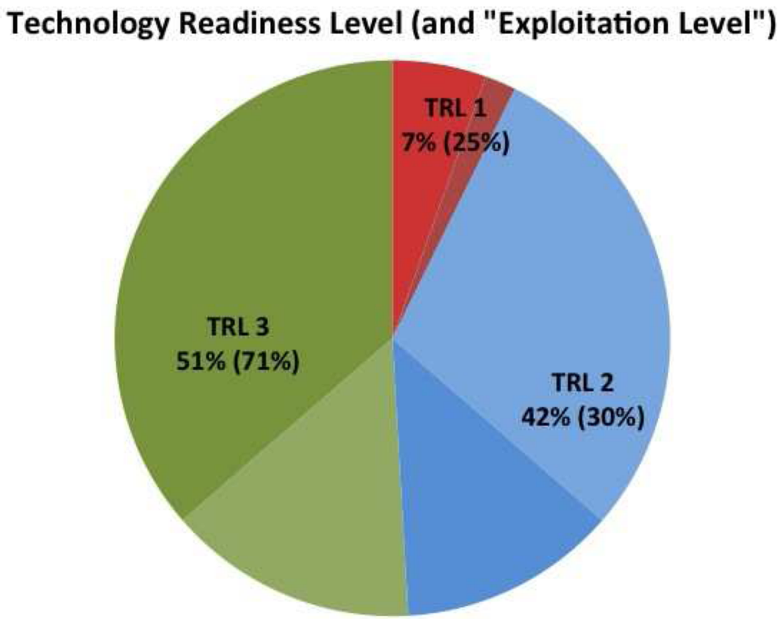
00-04: On average 22 new TT cases/year on

05-09: Decreasing to 9/year -> end of LHC construction





Technology readiness and exploitation level



TRL Simplified Definition

1 Technology application formulated and basic concept demonstrated

2 Functional validation in laboratory environment

3 Representative prototype fully qualified

51% of the CERN technologies are ready to transfer

The exploitation level decreases with the Technology Readiness Level

- 71% of the technologies with TRL 3 are exploited
- 30% of the technologies with TRL 2 are exploited
- 25% of the technologies with TRL 1 are exploited

CERN Patent portfolio

37 patents in the CERN portfolio at the end of 2009

- An average of 3.7 new patents per year
- **51% of the patents are related to the LHC programme**
- **22% are in co-ownership (academia, industry: filed as a result of partnerships)**
- **40% of the portfolio is currently licenced**
- Starting 2007: Stricter criteria on the commercial potential of the portfolio have been applied

Contractual arrangements

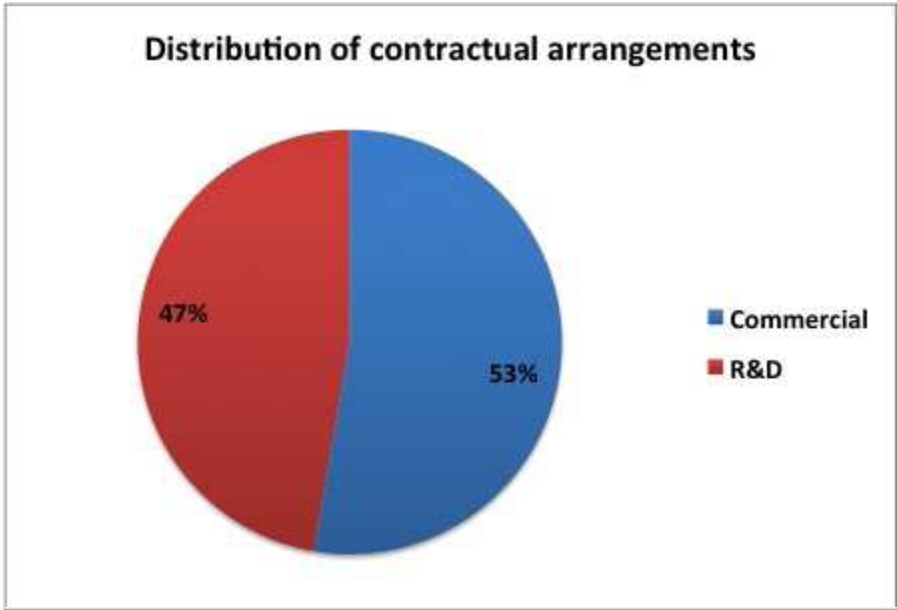
239 contractual arrangements during the period of analysis

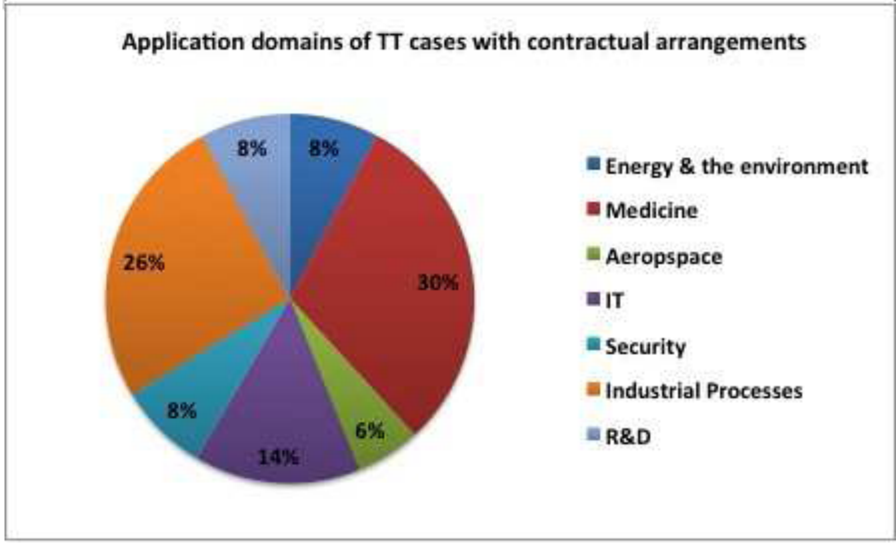
- 82% are still active today

Distribution in two categories

- Commercial **(53%)**
  Licences
  Services & consultancy
  Exploitation of results from R&D projects
- R&D for academia and/or industry **(47%)**
  Collaborations (academia)
  R&D Partnerships (industry)
  R&D Licences

Medicine, industrial processes and IT are the main application domains of CERN technologies (70% of all arrangements)





Revenues from TT activities

Revenues generated to finance applied R&D activities and from commercial activities are equivalent
On average CERN receives:

• About 940 kCHF/year from industry to finance the development of pre-industrial prototypes in which CERN technologies play a key role

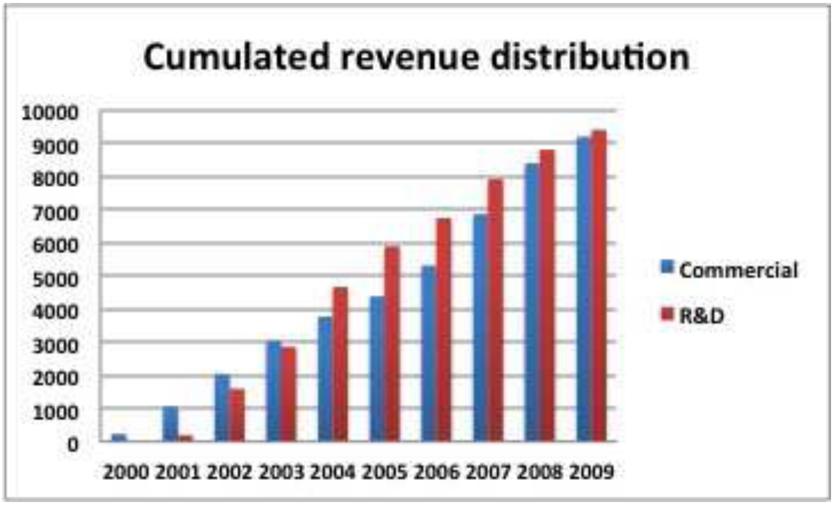
This funding covers:

– Material costs
– Access to CERN services
– Personnel devoted to the project

• About 920kCHF/year from commercial activities

This revenue is from:

– Commercial licences
– Services and consultancy
– Commercial exploitation of the results of R&D activities



This revenue is used to cover:

– Departments and Groups costs (experts and material)
– KTT costs (administration, patents)

After cost deduction, the net revenue is redistributed to:

– The Departments and Groups involved in the TT activities
– The KTT fund for promoting new activities

4: TT lessons learned from the construction of the LHC

A large scale physics research programme boosts innovation

• 90% of the technology disclosures to the KTT group during the period of analysis corresponded to technologies & know-how related to the LHC programme

The LHC programme has fostered a rich variety of technologies and know-how

• Showing effective transfer 50% of the technology portfolio is exploited

• The maturity of the technologies increases the chances of transfer 71% of the technologies with high readiness level are exploited

A large fraction of the CERN know-how and technologies is not patentable

• Patents are not the most suited protection for know-how and electronics

• Complex joint-ownership of developments reduces chances of filing patents

• Results of R&D partnerships with industry are an additional source of patents (co-ownership)

Pooling PP technologies can enhance dissemination prospects

• Various institutions are working on the same technology topic

• Pooling results can make the PP offer more attractive to industry

4: TT Lessons learned (2)

CERN technologies can be used in various domains but a large fraction lacks readiness

- Only 51% of the technologies are at the highest technology readiness level for transfer
- Promoting technologies and know-how is often insufficient to attract industrial interests
- Difficulty to identify pertinent applications where:

The technology should be adapted to the needs of industry

The use of the technology will definitely give industry a competitive advantage

No alternative technology is easily accessible to industry

- Lack of dedicated funds to finance early demonstrators aiming to attract industrial interests

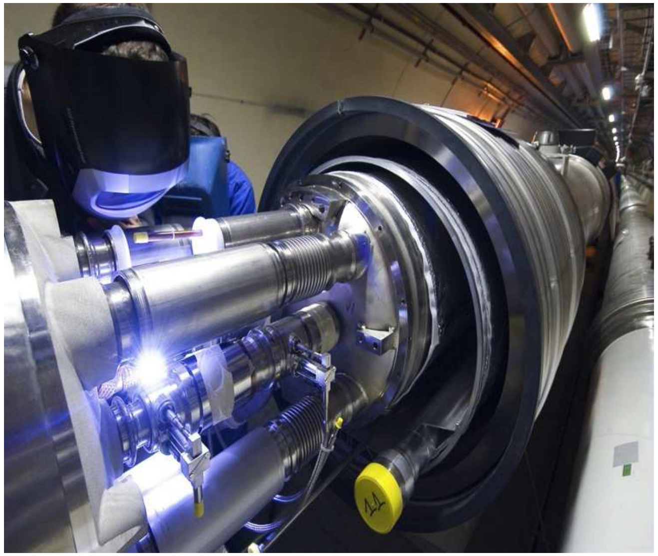
CERN technologies require further applied R&D to increase their market readiness

- About half of the contractual arrangements addresses R&D matters
- About 50% of the annual revenue is for financing R&D activities aiming to get closer to the market

Typical time to market for PP technologies ranges between 10 to 20 years

- Typical R&D project duration ranges between 3 to 5 years
- Commercialisation of products occurs typically 8 to 10 years after patent filing

5: Main impacts of PP on industry and society



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.

Economic benefits

More than 30,000 accelerators are active worldwide; Less than 200 are for research purposes.

The impact of the world economy is much larger than just the sales of these accelerators;

Products and processes produced have a monetary value that is 100-1000 times larger than the initial capital cost.

All the final products that are processed, treated or inspected by the particle beams of industrial accelerators worldwide, have a collective annual value of more than €500 billion.

HEPTech: A model for setting up R&D collaborations with industry?

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 building 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

• **The HEPTech offers a pool of expertise and contacts and acts as a facilitator and catalyst**

Conclusions

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

Technology transfer activities related to PP do not properly reflect the impact of the discipline on society

Procurement, publications, networking events and researchers mobility are key drivers for Knowledge transfer

Fostering synergies between academia and industry in R&D for future PP projects is instrumental to sustainable KT

There is a clear need to join forces at the PP research community level and across other research disciplines

- Joint TT actions are essential to bridge the funding and time gaps between research and industry