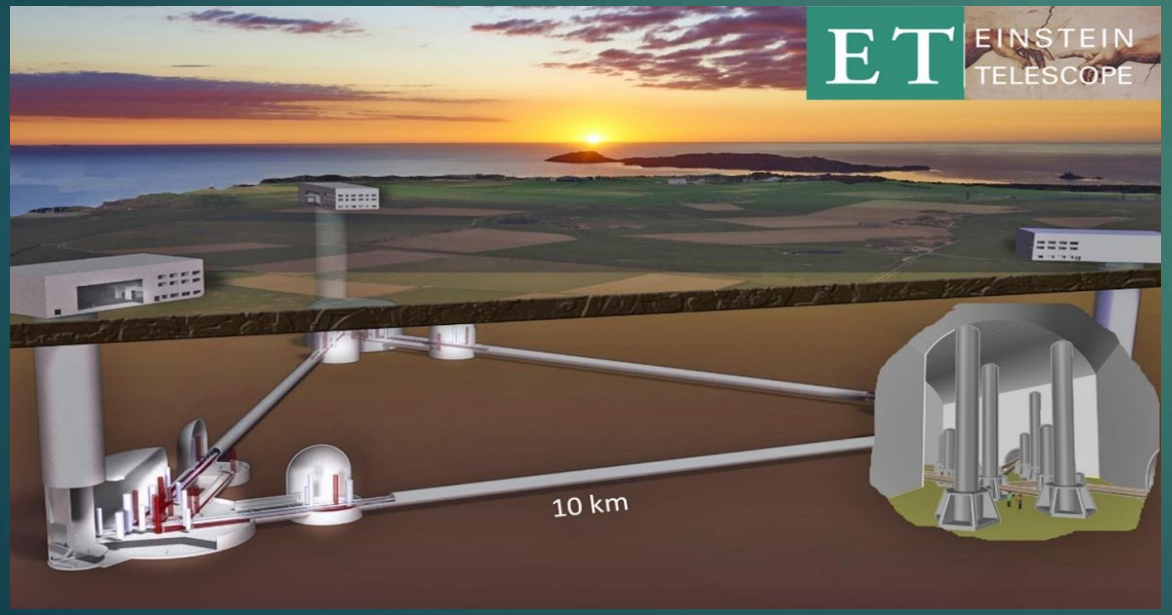
ET-PP Project WP 7 - Task 7.1
Promotion of innovative technologies

Institut de Física d'Altes Energies

Participants: IFAE, INFN, NIKHEF, UW

21/10/2022 Meeting



IFAE - TASK 7.1 LEADER

SPEAKER: I. ESPARBÉ

Innovation & Public Research

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*"In 2018, **more than 40% of the CERN budget** was returned to industry in its member-state countries through the **procurement of supplies** and services, generating corollary benefits such as **opening new markets."***

*"The utility ratio ((increased revenue + cost savings) /procurement value) related to the construction of the SPS accelerator at CERN was in the range of 3:1, meaning that **each franc that was spent by CERN in procurement generated 3 francs** worth of additional value to the suppliers."*

Main innovation channels

Universities & Research Institutes

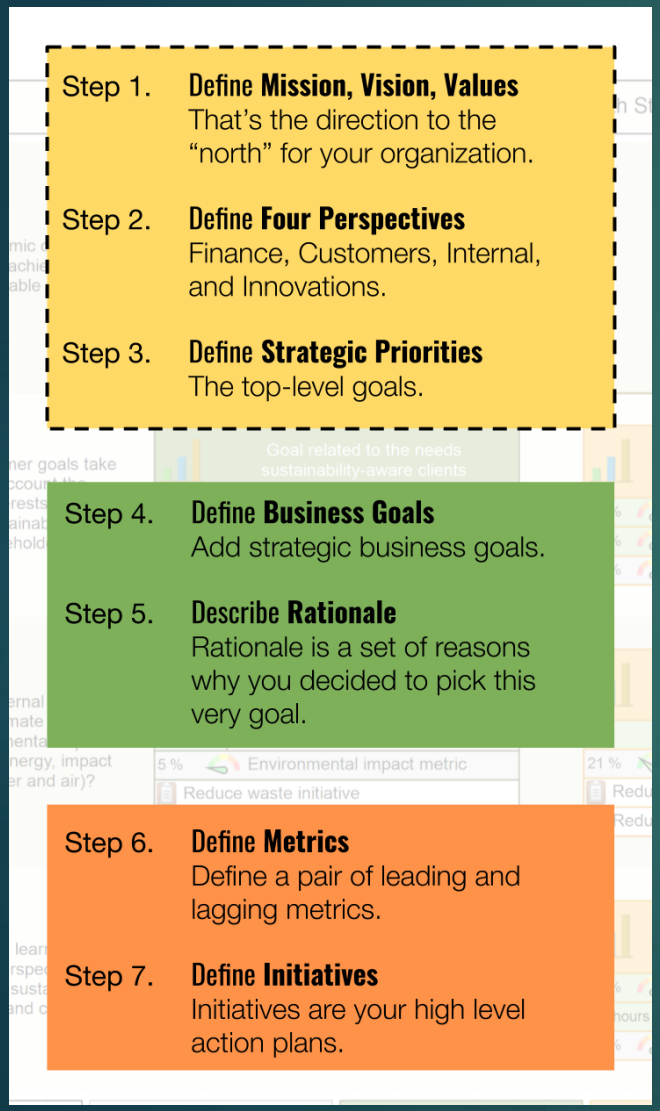
*Invention Disclosures (disruptive R&D results)
***Patents** (novelty, inventive step, industrial use)
*Know-how Licensing (tech transfer agreements)
***Creation of new firms** (highly qualified jobs)

Big Science Research Organizations (BSROs)

***Procurement** (relationship with suppliers)
***Collaborative Research** (public & private sectors)
***Intellectual Property**(strategy and policy)
*Spillovers (new developments & services)
***Entrepreneurship** (new ventures)

D. Scarrrà et al. The impact of technology transfer and knowledge spillover from Big Science: a literature review .Technovation 116 (2022) 102165.
Furthering America's Research Enterprise. Committee on Assessing the Value of Research in Advancing National Goals; Division of Behavioral and Social Sciences and Education; National Research Council; Celeste RF, Griswold A, Straf ML, editors. Washington (DC): National Academies Press (US); 2014 Oct 28.
Nelsen L. Ten Things Heads of Institutions Should Know about Setting up a Technology Transfer Office. Bangkok, Thailand: Concept Foundation; 2007

ET PP WP 7.1 Innovation Strategy



Mission: Promote and ensure Innovation Impact as a result of the ET project execution

Vision & Values: Maximize the social impact and returns for the science industry derived from the ET project

Perspectives: Procurement, IP generation, Collaborative R&D, Entrepreneurship

Top Level Goal: Innovation Plan design

Strategic Business Goals: Define Innovation promotion goals for each perspective conducting to a positive cost/benefit balance.

Rationale: Benchmark analysis of innovation outcomes from other BSROs (CERN, ESA, NASA, LIGO,etc) to define own ET project Business Goals.

Metrics: Definition of main innovation KPIs to monitor each perspective activity.

Initiatives: actions oriented to specific milestones (from month 3 to 12)

ET PP WP 7.1 Strategic Business Goals (SBG)

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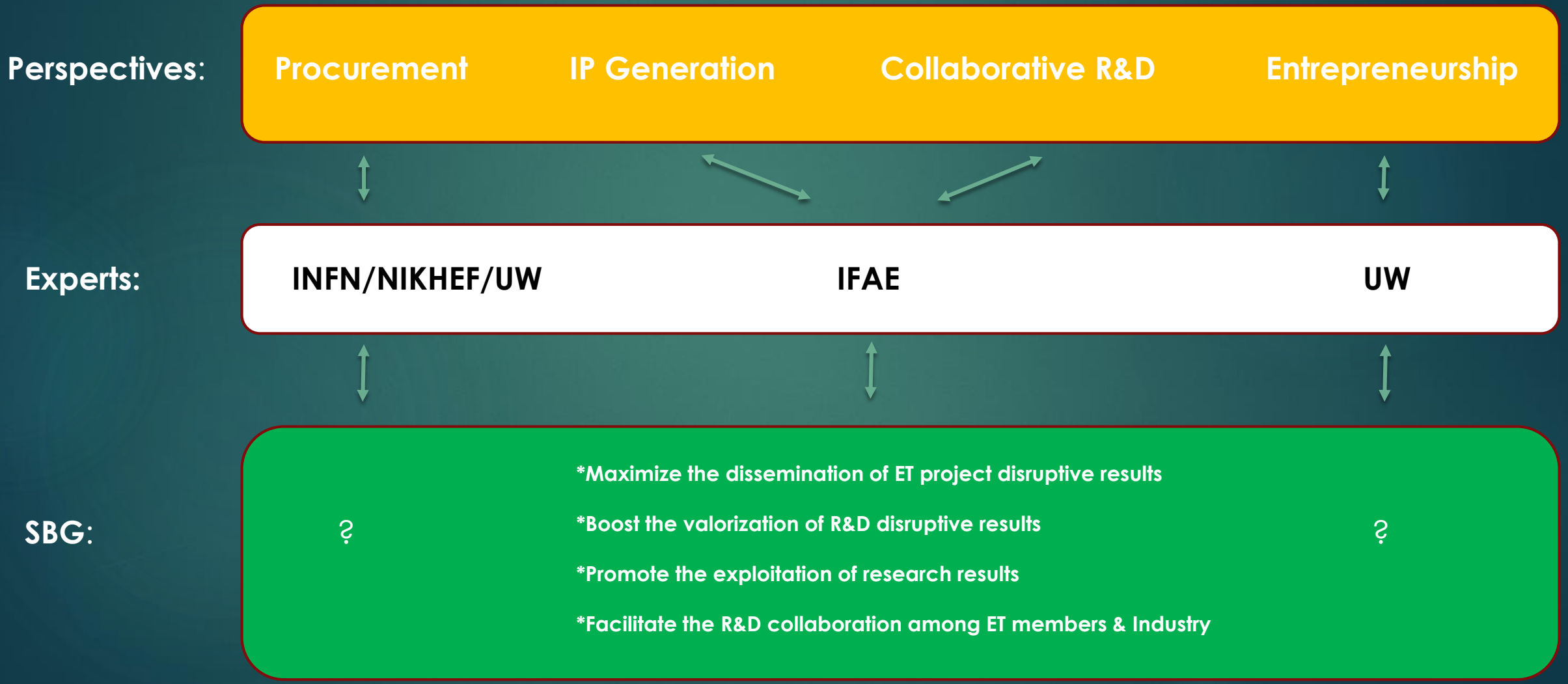

ET PP WP 7.1 Innovation Rationale Inputs

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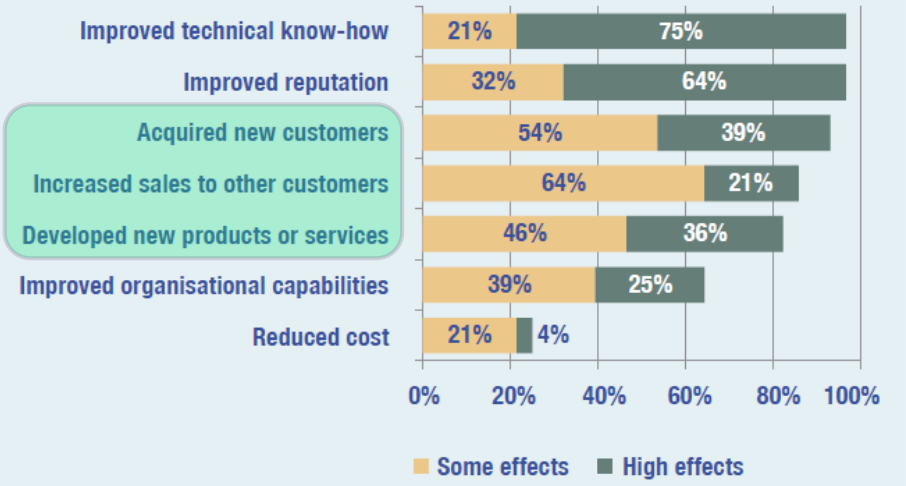
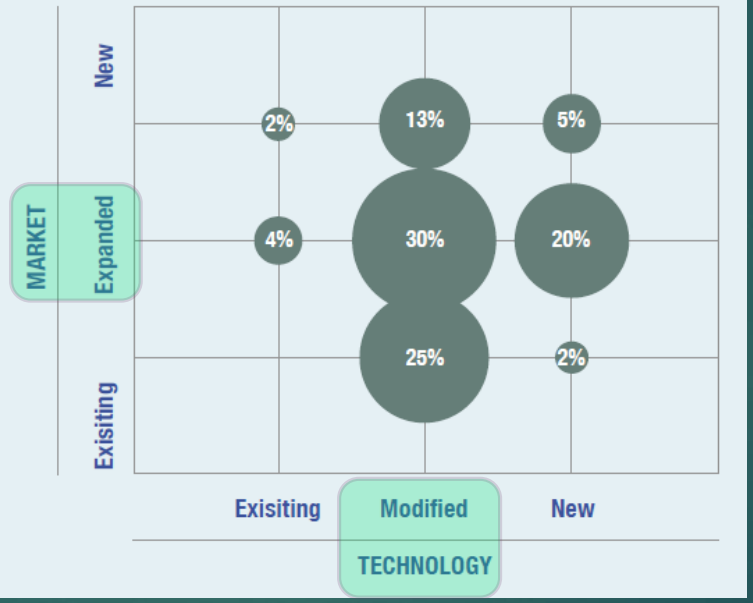
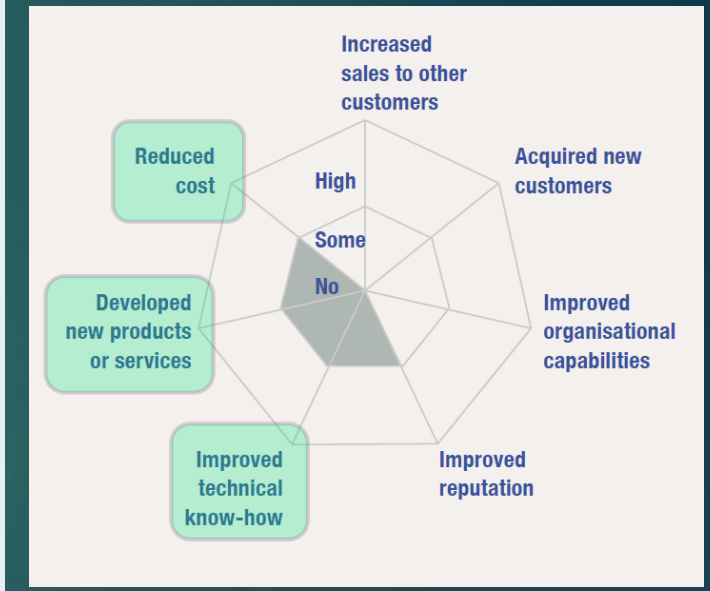
Procurement Perspective at CERN







Impact of CERN procurement actions on industry. CSIL – Centre for Industrial Studies. Milan, Italy, February 2019

ET PP WP 7.1 Innovation Rationale Inputs

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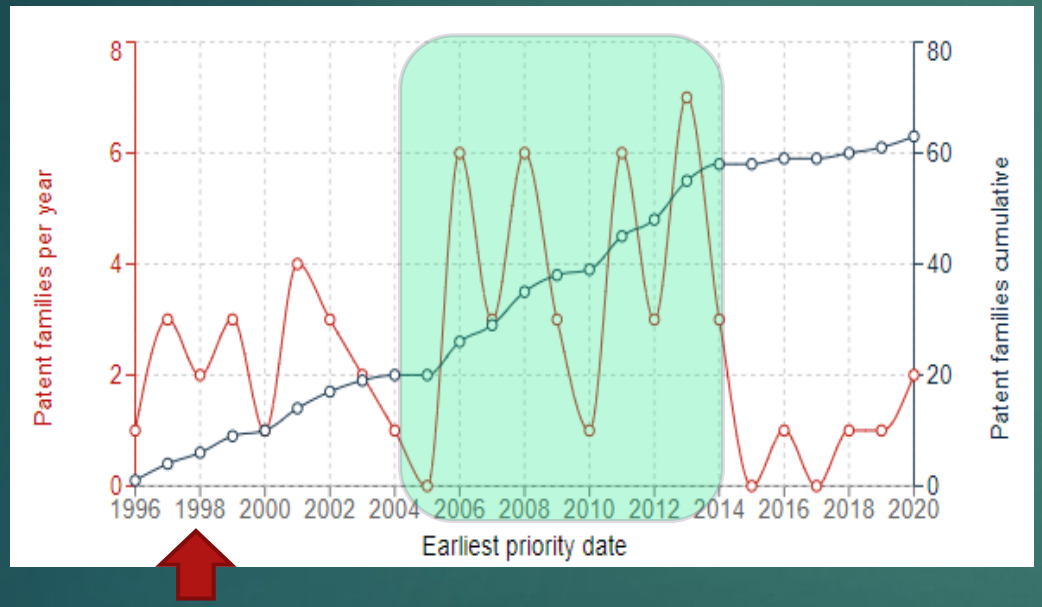
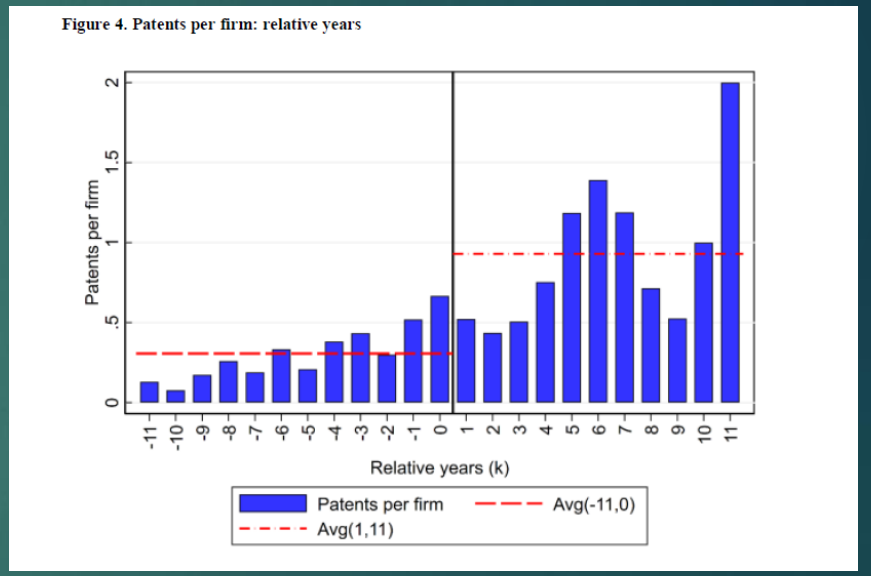
IP Generation Perspective at CERN

CERN's protected inventions timeline (Espacenet, EPO):



ATLAS, CMS and LHCb Projects approved

CERN's providers protected inventions before and after first tender contract signed:



CERN's public procurement **accelerates the private innovation by x3 factor** (from 0.3 patent app/year/firm to 0.9)

Technological Learning and Innovation Gestation Lags at the Frontier of Science: from CERN Procurement to Patents. Andrea Bastianina et al. 10 April 2019

ET PP WP 7.1 Innovation Rationale Inputs

Collaborative R&D Perspective at CERN

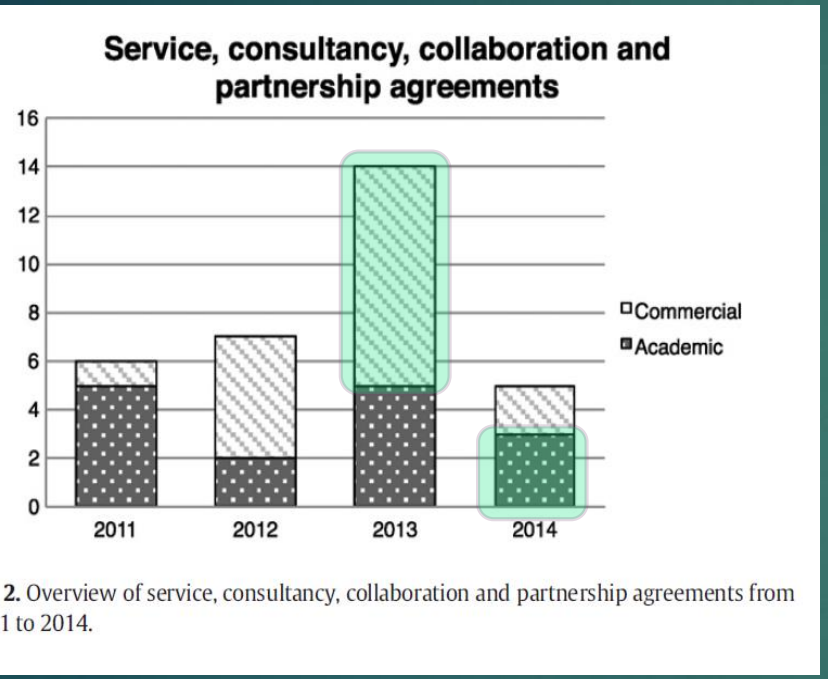


Fig. 2. Overview of service, consultancy, collaboration and partnership agreements from 2011 to 2014.

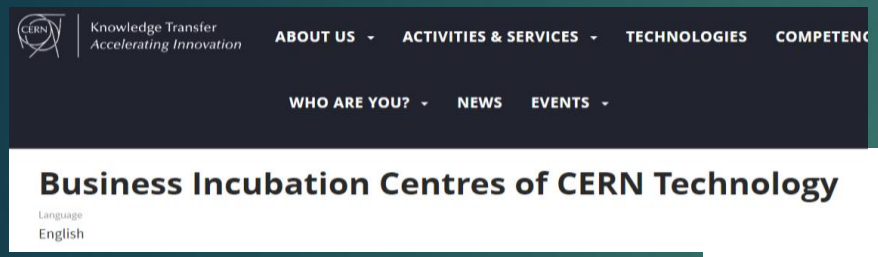
Table 1
Overview of the 17 companies active using the Open Hardware Repository to develop or produce hardware, software and drivers. Showing the country they are from, which areas and number of projects they are active in.

Company	Country	Hardware development	Hardware commercialisation	Firmware development (e.g. VHDL)	Software development	Projects
1	France	X	X	X	X	1
2	France			X		1
3	Germany		X	X	X	2
4	Italy				X	18
5	Poland	X	X	X	X	32
6	Slovenia	X		X	X	2
7	Spain	X	X	X	X	3
8	Spain				X	2
9	Spain			X	X	2
10	Spain	X	X	X	X	18
11	Spain				X	1
12	Sweden	X				1
13	Switzerland	X				1
14	Switzerland	X				2
15	The Netherlands	X	X		X	5
16	UK			X	X	1
17	USA		X			1

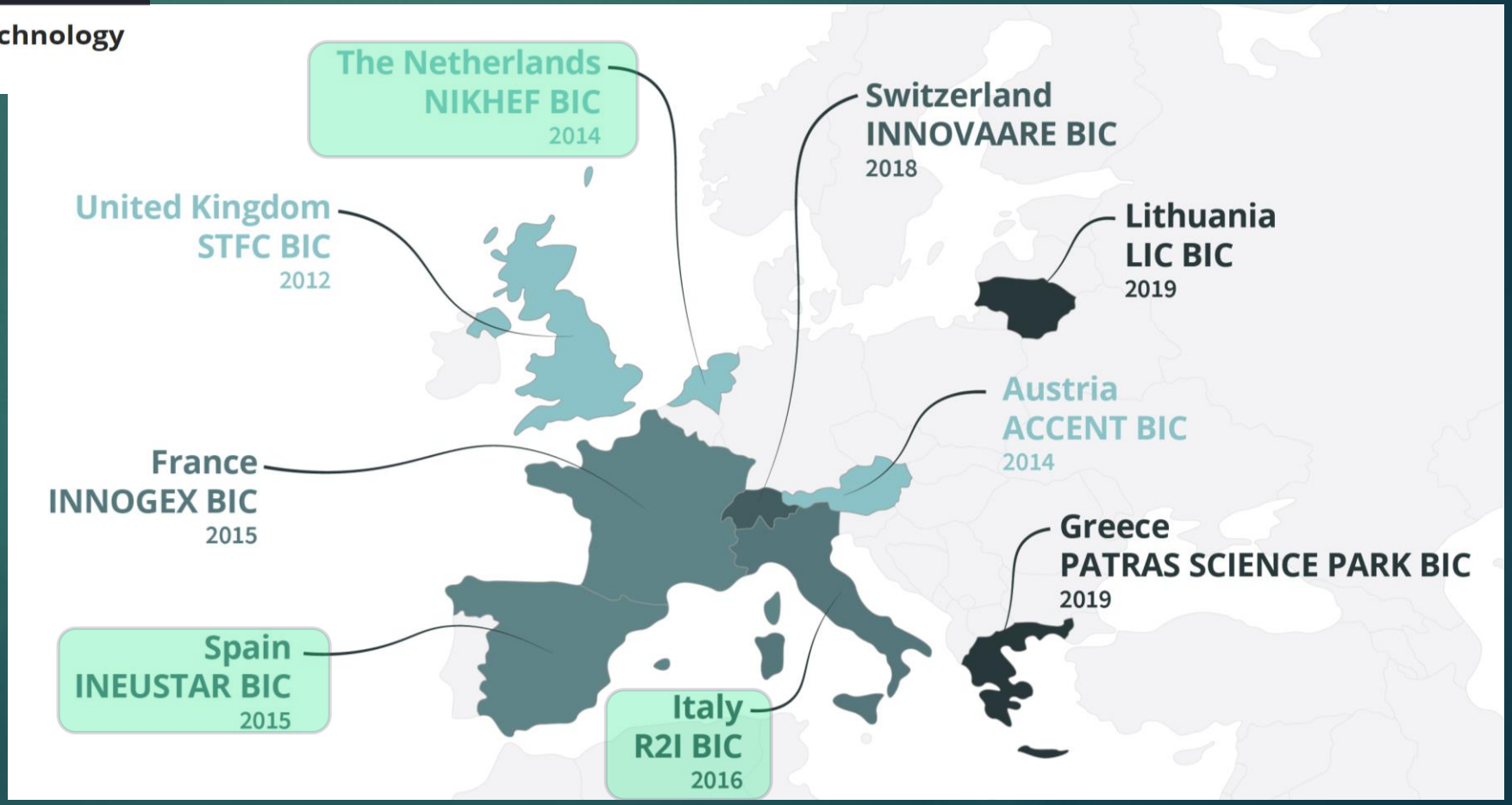
Anelli et al. Knowledge transfer at CERN. Technological Forecasting & Social Change 112 (2016) 113–120

ET PP WP 7.1 Innovation Rationale Inputs

Entrepreneurship Perspective at CERN



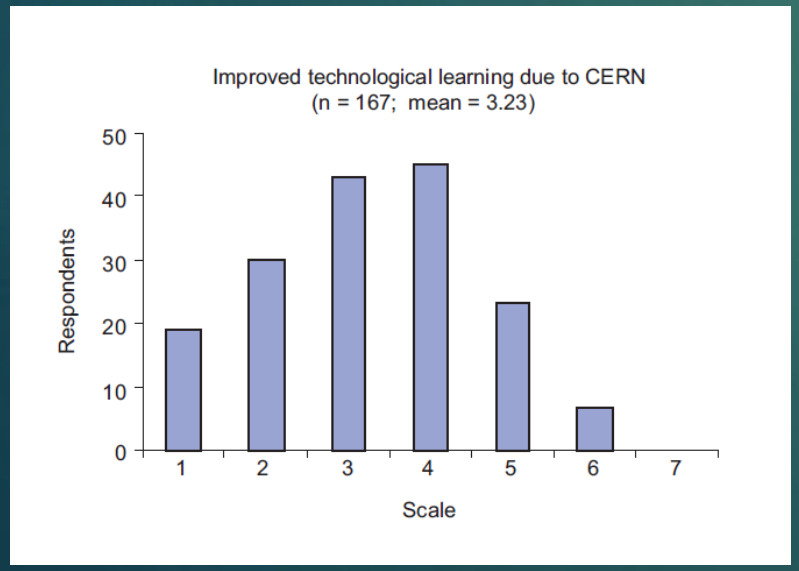
About 6 new firms created per year!

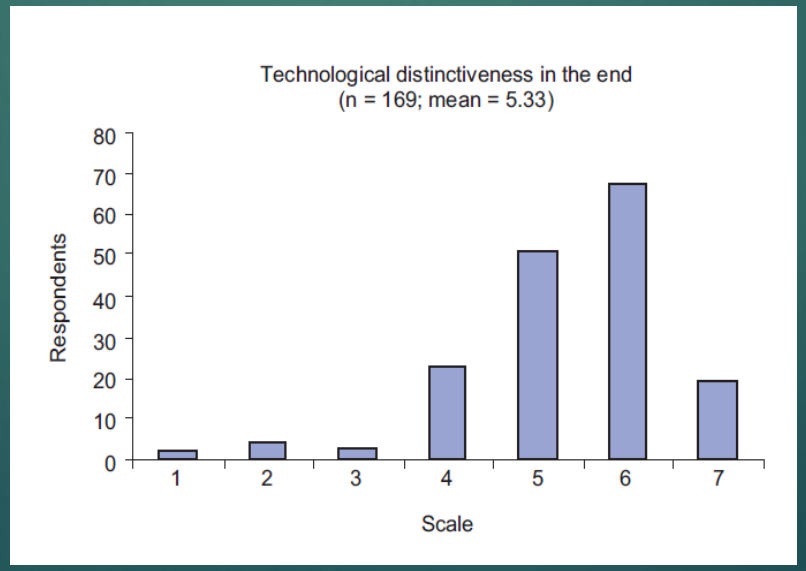


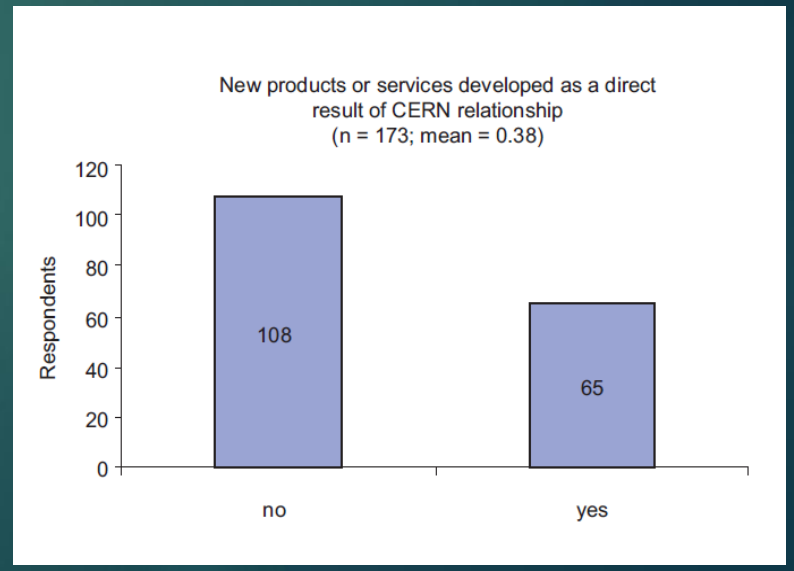
ET PP WP 7.1 Innovation Metrics

Procurement KPIs at CERN

Statement	N	Mean[a]	Median[b]	Scale
'The CERN project helped us improve our R&D processes'	131	4.01	4	1 = Do not agree 7 = Agree fully
'The CERN project helped us strengthen our marketing capability'	170	3.39	4	1 = Do not agree 7 = Agree fully
'The CERN project helped us strengthen our project management capability'	169	3.67	4	1 = Do not agree 7 = Agree fully
General capability improvement due to CERN project (alpha 0.82)	173	3.83	4	1 = Do not agree 7 = Agree fully







Erkko Autio et al. Technology transfer and technological learning through CERN's procurement Activity Book · January 2003

ET PP WP 7.1 Innovation Metrics

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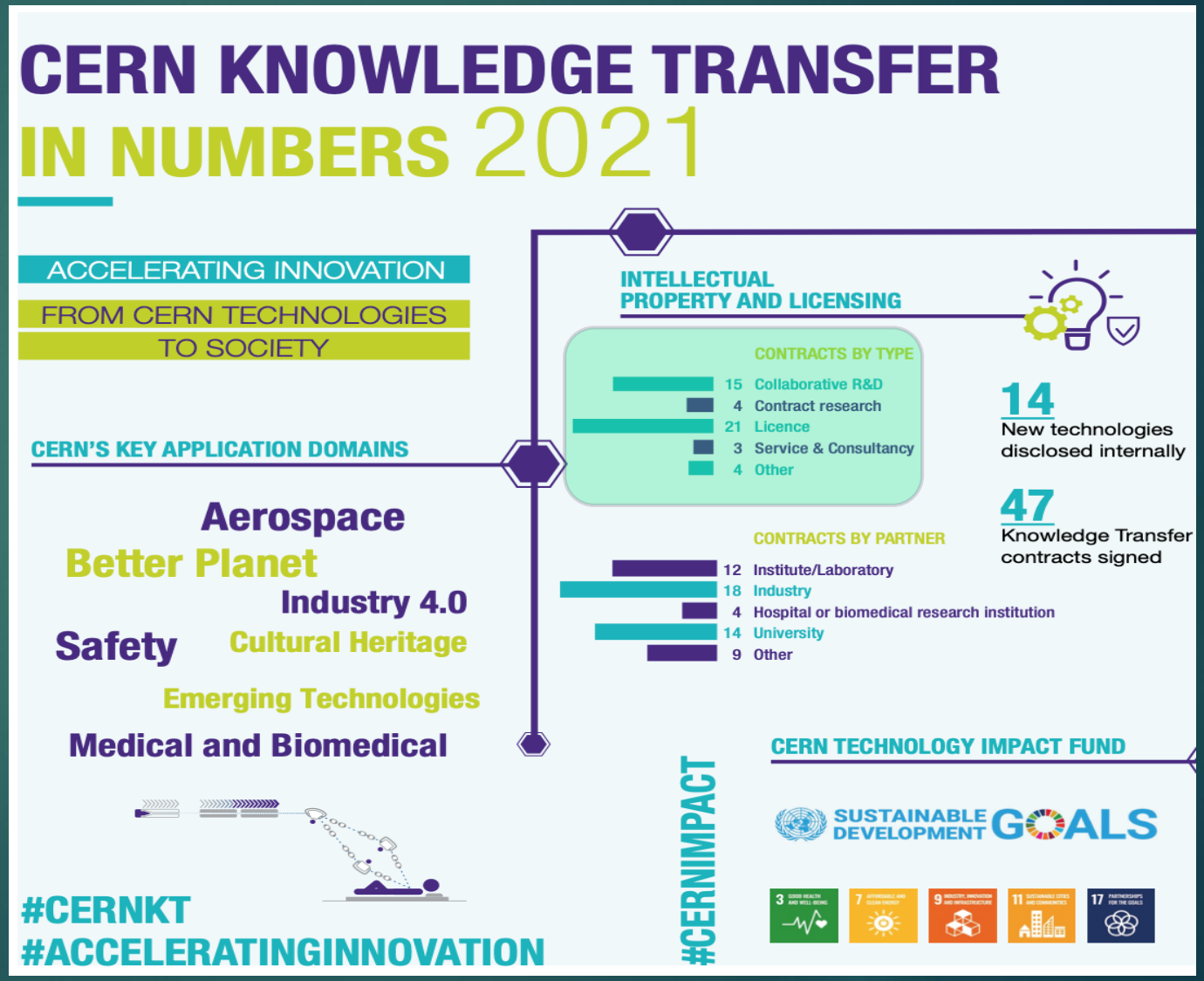
Collaborative Research KPIs at CERN



ET PP WP 7.1 Innovation Metrics

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CERN vs LIGO IP Generation & Entrepreneurship KPIs

	CERN (CMS + ATLAS)			LIGO		
	Absolute data	Annuity (year)	Annuity (year) /funding (€)	Absolute data	Annuity (year)	Annuity (year) /funding (€)
Innovation production period (years)	26			30		
Project Cost(M€)	20750	798		2000	67	
Providers patenting after project procurement contracts	100	3.8	4.8E-03	20	0.67	1.0E-02
Disclosures of Invention	1096	42.2	5.3E-02	19	0.63	9.5E-03
Patented inventions owned by the legal entity representing the collaboration	63	2.4	3.0E-03			
Patented inventions owned by the member entities of the collaboration				13	0.43	6.5E-03
Ratio of Provider Patent applications after project tender/before project tender	3.1			1.9		
Patent license agreements	182	7.0	8.8E-03	4	0.13	2.0E-03
Spin-off's derived from the project	163.8	6.3	7.9E-03	1	0.03	5.0E-04
Contract/collaborative research contracts	111	4.3	5.3E-03	4	0.13	2.0E-03

An innovation strategy impacts on the innovation outputs (time & funding normalized)with **differences of about 1 order of magnitude depending on the strategy model implemented**

Data sources:

Knowledge transfer at CERN. Vetle Nilsen, Giovanni Anelli. European Organization for Nuclear Research, CH-1211 Geneva 23, Switzerland. Technological Forecasting & Social Change 112 (2016) 113–120

LIGO Caltech website

(https://www.ligo.caltech.edu/page/technology-transfer-case-studies)

ET PP WP 7.1 Innovation Milestones & Deliverable

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Internal milestone 1 (M3) - Organizational aspects driving the development and the implementation of a strategy of technology innovation promotion. Processes and mechanisms for identifying results with innovation potential.

Internal milestone 2 (M4) - SWOT analysis of innovation promotion best practices and experiences in similar Big Science projects. Cost / benefit ratio

Milestone 7.1 (M8) - Analysis of Promotion Strategies. Goals, KPIs and Actions for promoting innovative technologies during the ET project

Internal milestone 3 (M10) – Actions to be carried out by ETO in C&O phase to promote innovation

Deliverable 7.1 (M11) – Innovation Plan for ET project

ET PP WP 7.1 Internal milestone 1.1 (M3)

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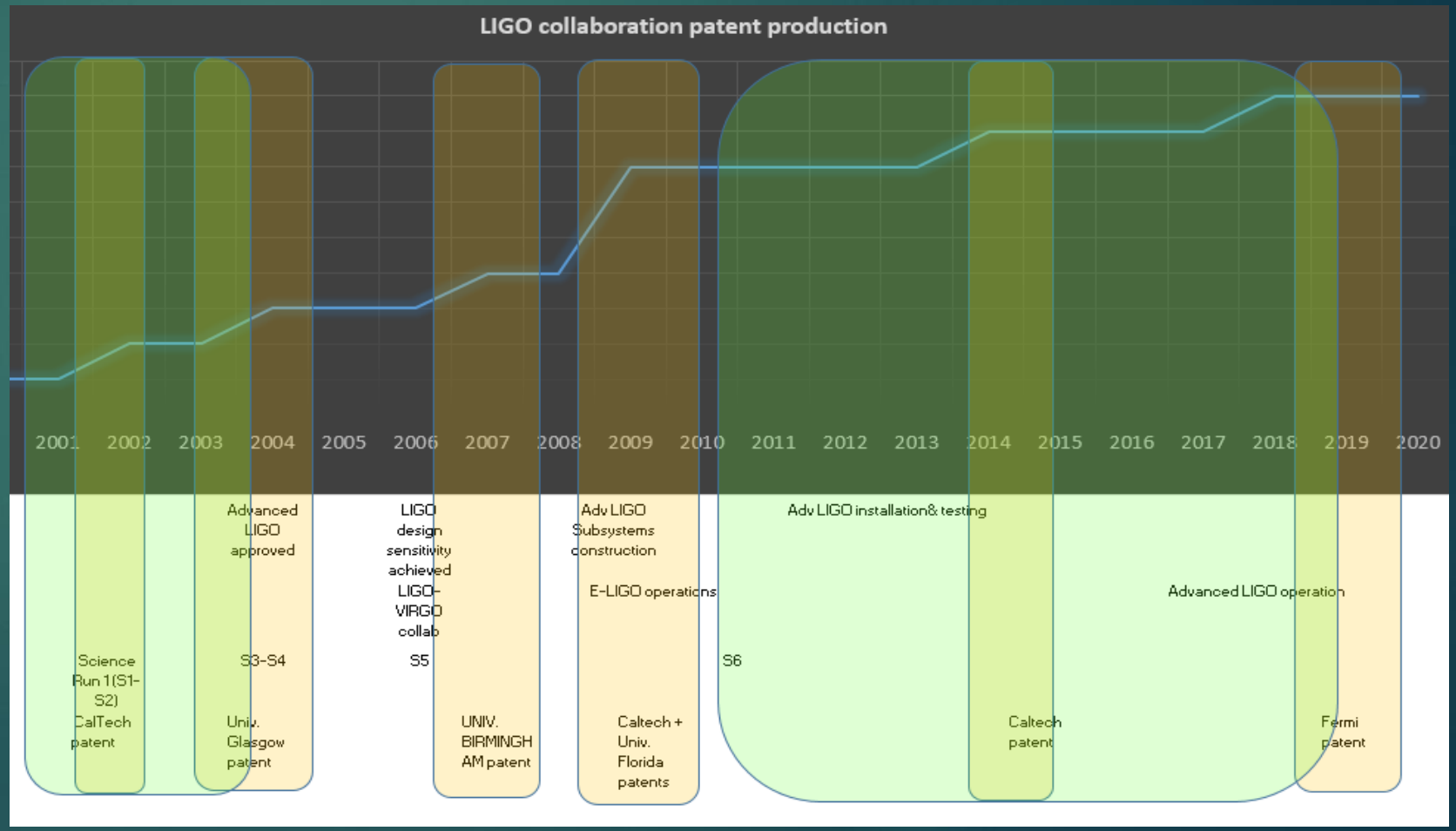
Organizational aspects driving the development and the implementation of a strategy of technology innovation promotion

1) Strategy development (slides above)

2) Strategy Implementation

Timeline for the IPR generation perspective

(different for other perspectives!)



ET PP WP 7.1 Internal milestone 1.1 (M3)

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Organizational aspects driving the development and the implementation of a strategy of technology innovation promotion

3) Allocation of resources

IPR data bases access, professional legal advise and technical profile HHRR team to interact with research leaders, companies and investors.

4) Innovation model definition

	LIGO	CERN
Project Budget	2 B$	**20 B€**
KTT Team	National KTT Units	**Project KTT Office**
IPR Ownership	Project members	**Project Organization** & Project members
Innovation channels	Licensing/Partnerships with vendors/ Creation of new ventures/Research applications	Licensing/Collaboration with Industry & **Consulting**/ Spin-offs /**Human Capital/ EU Projects/ Open Software & Hardware**.

ET PP WP 7.1 Internal milestone 1.2 (M3)

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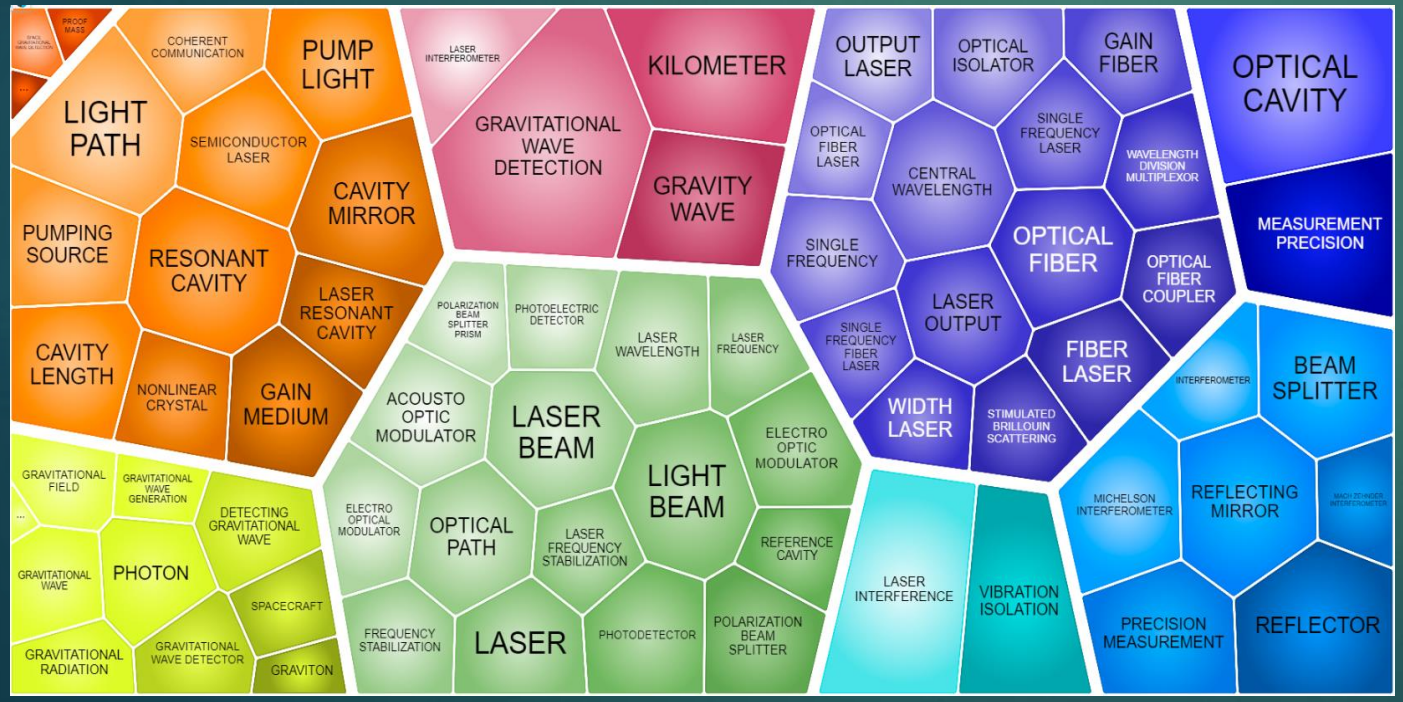
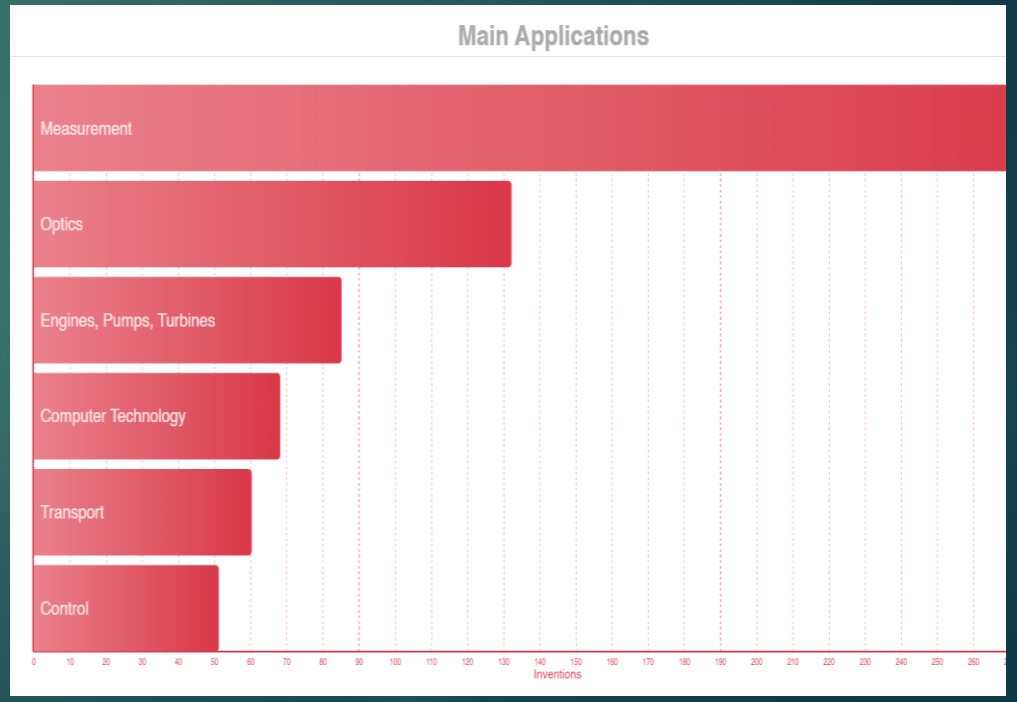
Processes and mechanisms for identifying project results from ET members having innovation potential.

Patent data science provides key innovation information.

GWs concept clusters extracted from GW patents show the most relevant **Innovation Topics** and correlations among different technologies:



Measurement and Optics are the most popular technology domains patented:



ET PP WP 7.1 Internal milestone 1.2 (M3)

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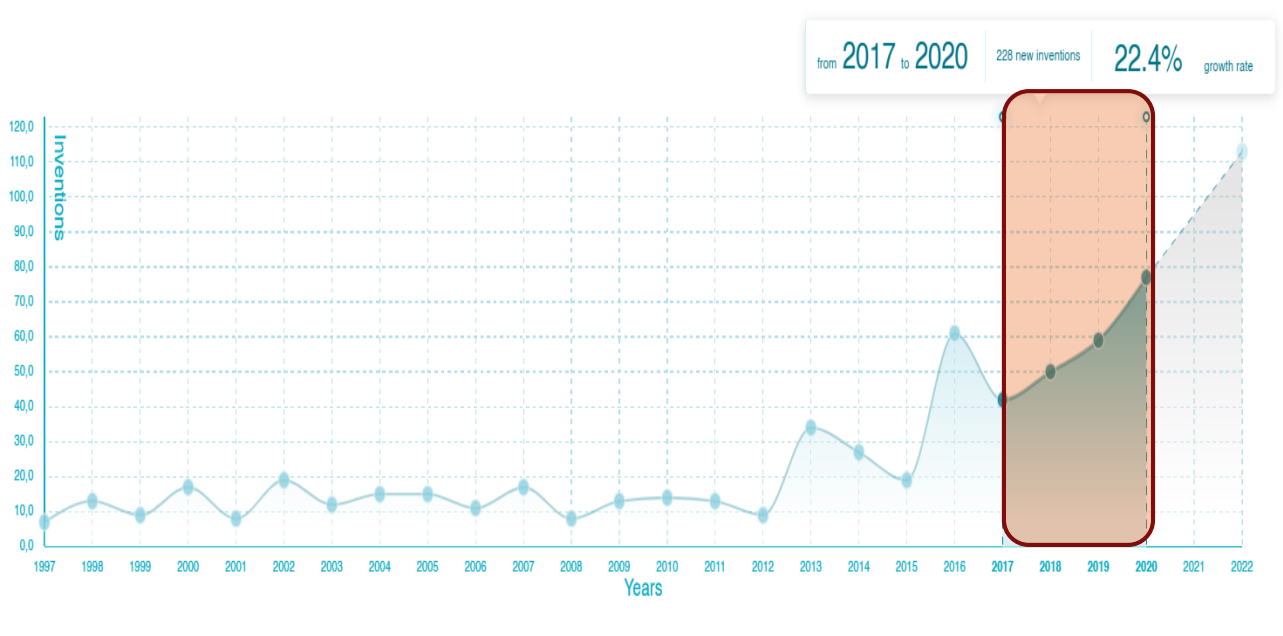
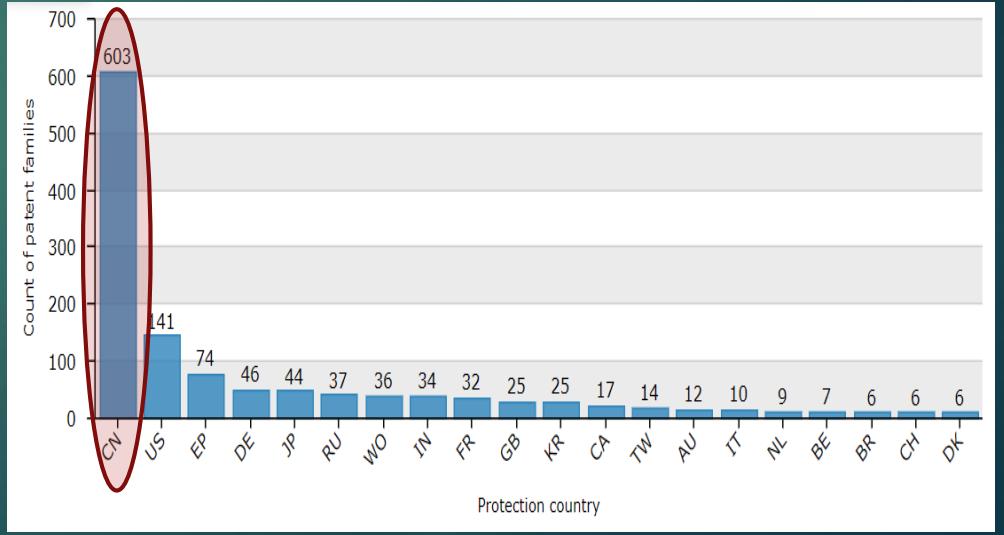
Processes and mechanisms for identifying project results from ET members having innovation potential.

About **1k patents filed** worldwide since 1997 related to gravitational waves.

22% increase of gravitational wave related patent applications from 2017 to 2020.



China is leading the protection of GW inventions followed by US, EU and JP:



ET PP WP 7.1 Internal milestone 1.2 (M3)

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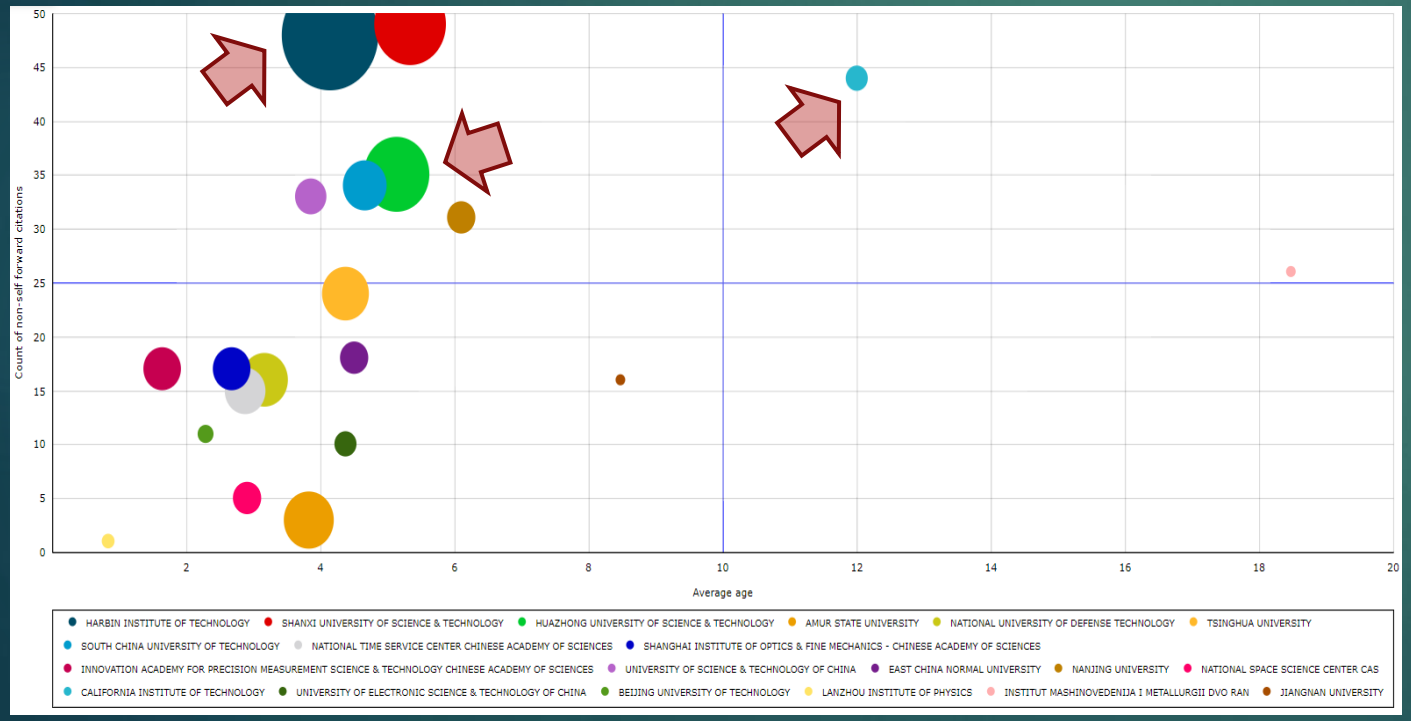
Processes and mechanisms for identifying project results from ET members having innovation potential.

Chinese public institutions are the most cited patent assignees (also CalTech in the US):



The LIGO Scientifc Collaboration **industrial partners** were about 50/50 US and EU companies (also from AU), almost all managing **own IP portfolios**:

Companies mentioned by LSC groups.

Company		Activity	Patents
Stanford Photo-Thermal Solutions (SPTS)	US	Interferometry instrumentation	18
Lightwave Electronics Corp[a] (LWE)	US	Laser technology, LIGO laser	58
New Focus Inc[b]	US	Tunable laser; modulators	88
Toptica Photonics	DE	High precision laser photonics	37
Sacher Lasertechnik GmbH	DE	Scientific lasers, diode lasers	–
Advanced Thin Films	US	Optical components and assemblies	–
Vescent Photonics	US	Electro-optical modules, lasers	8
NP Photonics Inc	US	Fibre lasers, laser locks	32
Poseidon Scientific Instruments Pty Ltd[c]	AU	Sapphire cavity resonators	17
Spanoptic Ltd[d]	UK	Optical components	–
Gooch and Housego	UK	Crystal and precision optics	34
HighYag Lasertechnlogie GmbH	DE	Laser processing heads	32
Calyxo GmbH	DE	Thin-film solar modules	18
Healey Engineering Pty Ltd	AU	Solar & renewable energy systems	–
Gravitec	AU	Gravity & magnetic gradiometers	11
Fugro Co	UK	Geotechnical surveys	126
WMC Resources Ltd[e]	AU	Mining, metal and petroleum	52
Lazer Zentrum Hannover eV (LZH)	DE	Lasers, advanced LIGO laser	30
Freescale Semiconductors Inc[f]	US	Semiconductor manufacture	+
Analog Devices Inc & Global	US	Integrated circuits	+

+ Freescale and Analog Devices patent documentation numerous.
[a] acquired by JDS Uniphase which split into Viavi Solutions and Lumentum Holdings Inc. in 2015.
[b] acquired by Newport Corporation.
[c] acquired by Raytheon Australia.
[d] acquired by Gooch and Housego.
[e] acquired by BHP Billiton Ltd.

ET PP WP 7.1 Internal milestone 1.2 (M3)

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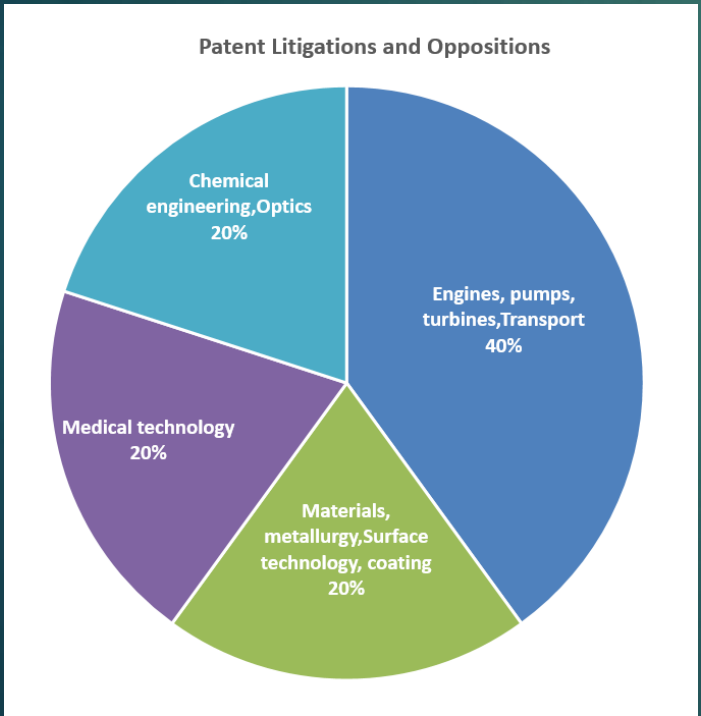
Processes and mechanisms for identifying project results from ET members having innovation potential.

Teradiode company invented and protected in 2011 the highest impact GW Technology (laser pump beam)

Engines and pumps are mostly present in the market as new products or services



Laser, ultrasound and AI tecnologies have the greatest impact (patent forward citations corrected to account for patent age and technical domains)

Title	Family Normalized Assignee name (value)	Publication number	1st app. date	Impact	Patent strength	All fwd cit.	Geographic cov.	Generality
Scalable wavelength beam combining system and method	TERADIODE	US8824049	2011-03-04	8.18	6.14	122	4	0.83
Feedback in medical ultrasound imaging for high intensity focused ultrasound	SIEMENS MEDICAL SOLUTIONS	US8992426	2009-05-04	7.56	5.82	96	2	0.82
Wavelength beam combining based laser pumps	TERADIODE	US20110305256	2011-03-04	7.5	3.26	90	0	0.89
System and processor implemented method for improved image quality and generating an image of a target illuminated by quantum particles	US ARMY	US9727959	2013-11-21	7.49	4.49	92	1	0.92
Algorithm for wireless, motion and position-sensing, integrating radiation sensor for occupational and environmental dosimetry	LANDAUER	EP3004932	2013-05-31	7.48	5.47	97	4	0.96
Pulse wave examination apparatus	SEIKO EPSON	EP1477112	1998-11-20	7.44	5.96	152	0	0.79
Rnai inhibition of influenza virus replication	GEORGE MASON INTELLECTUAL PROPERTI PRINCETON UNIVERSITY	EP2202239	2006-11-01	7.33	4.52	123	2	0.93
Fine wind field simulation method based on spatial correlation and monitoring data	HARBIN INSTITUTE OF TECHNOLOGY	CN113627096	2021-07-14	7.29	4.07	2	1	0

ET PP WP 7.1 Internal milestone 1.2 (M3)

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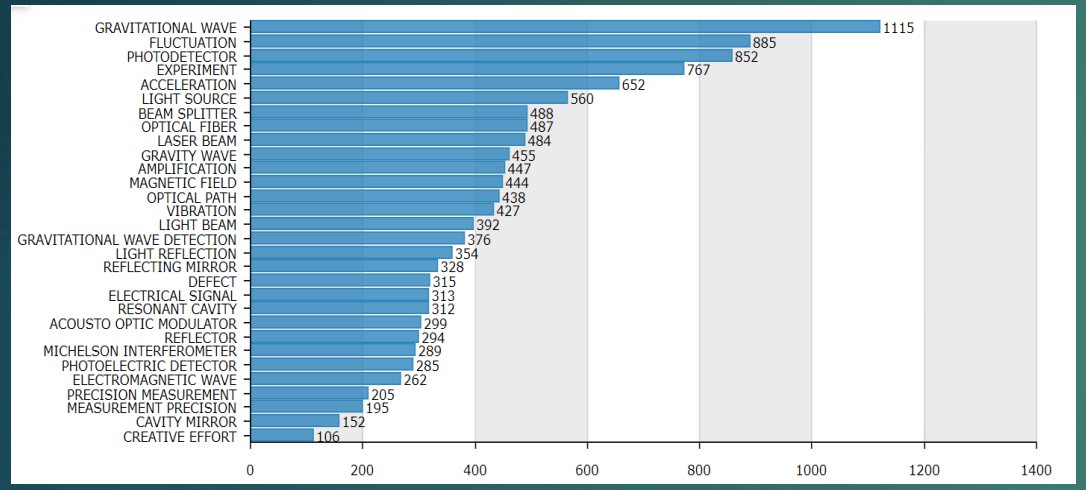
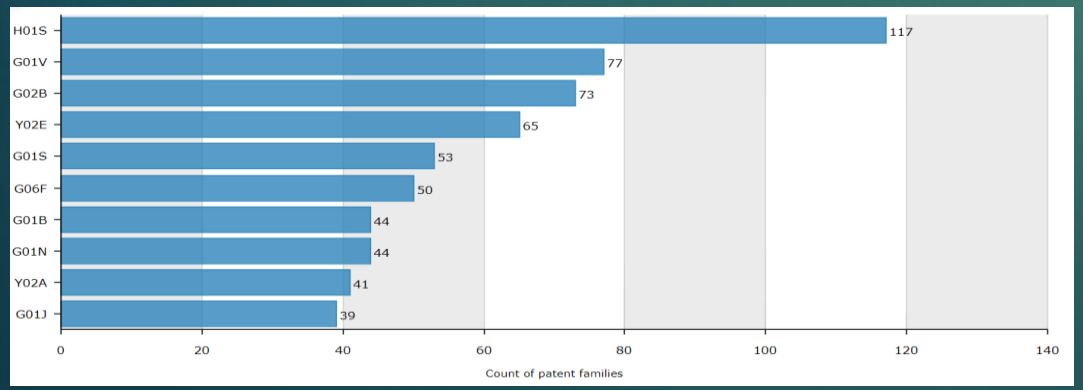
Processes and mechanisms for identifying project results from ET members having innovation potential.

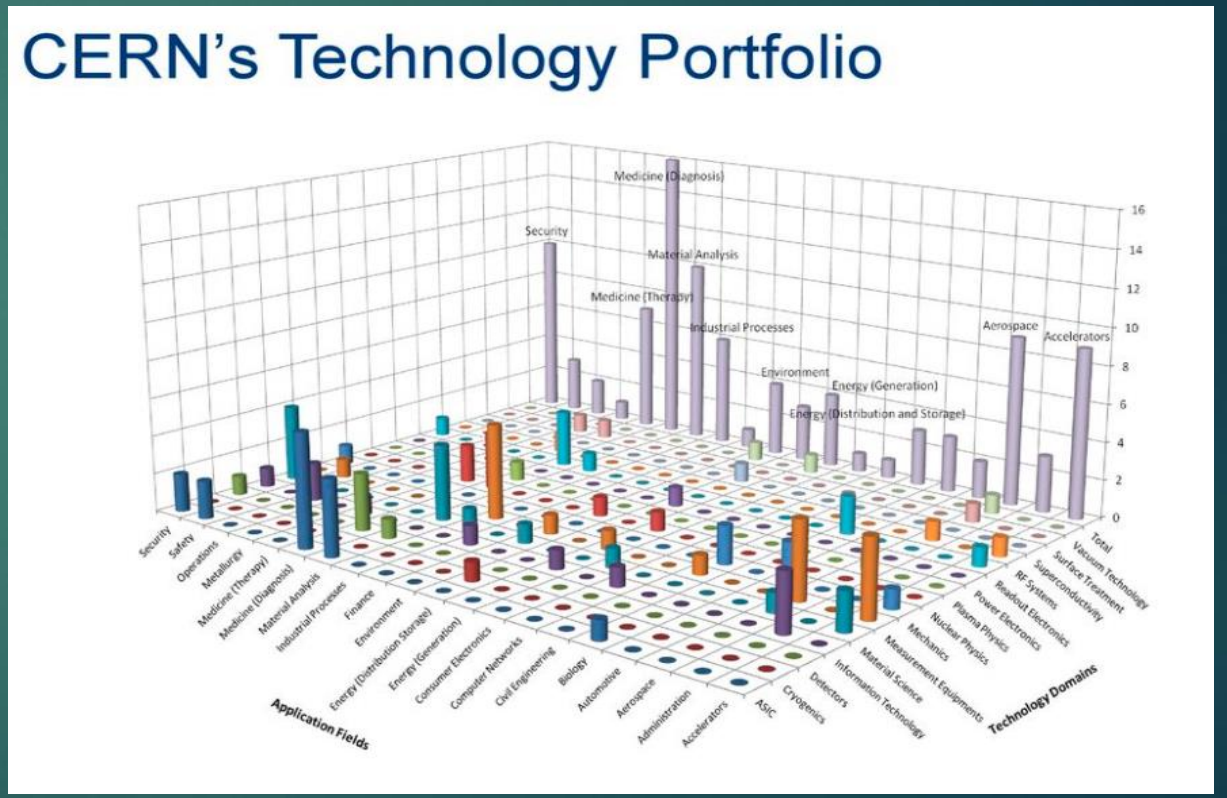
Photodetectors, Optical fibres and Laser Beams among the most cited concepts in GW patents:



Most common GWs **Cooperative Patent Classification (CPC) codes:**



Patent concepts are correlated with specific technology fields of application. Powerful tool for identifying **innovation potential of research results**



(H01S): DEVICES USING THE PROCESS OF LIGHT AMPLIFICATION BY STIMULATED EMISSION OF RADIATION **(LASER)** TO AMPLIFY OR GENERATE LIGHT; DEVICES USING STIMULATED EMISSION OF ELECTROMAGNETIC RADIATION IN WAVE RANGES OTHER THAN OPTICAL

(G01V): GEOPHYSICS; GRAVITATIONAL MEASUREMENTS; DETECTING MASSES OR OBJECTS; TAGS

(G02B): OPTICAL ELEMENTS, SYSTEMS OR APPARATUS

ET PP WP 7.1 Internal milestone 1.2 (M3)

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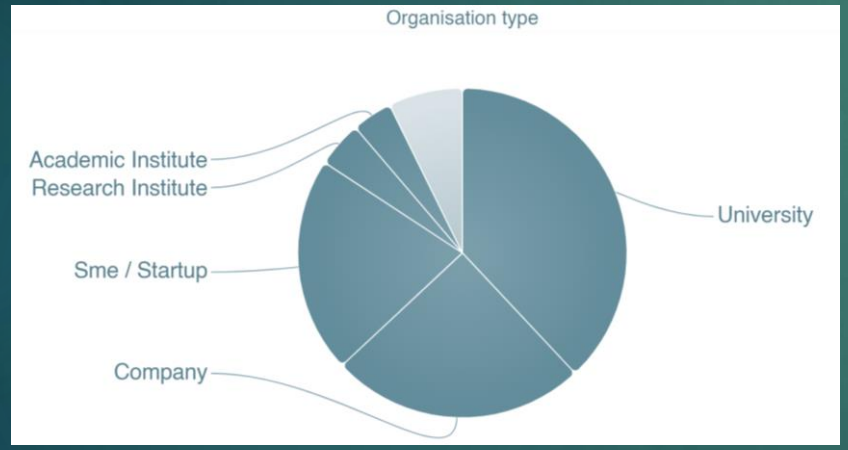
Processes and mechanisms for identifying project results from ET members having innovation potential.

Main companies and Academia performing R&D activity in the GW field (not only patent production)



Thales Group	Cerner Corporation	Siemens	e2v Technologies	Toptica Photonics
Paris France	Kansas City United States	Munich Germany	Chelmsford United Kingdom	Graefelfing Germany

Harbin Institute of Technology	Université Paris Diderot	Huazhong University of Science and	Sapienza University of Rome
Harbin China	Paris France	Wuhan China	Roma Italy

ET PP WP 7.1 Internal milestone 2 (M4)

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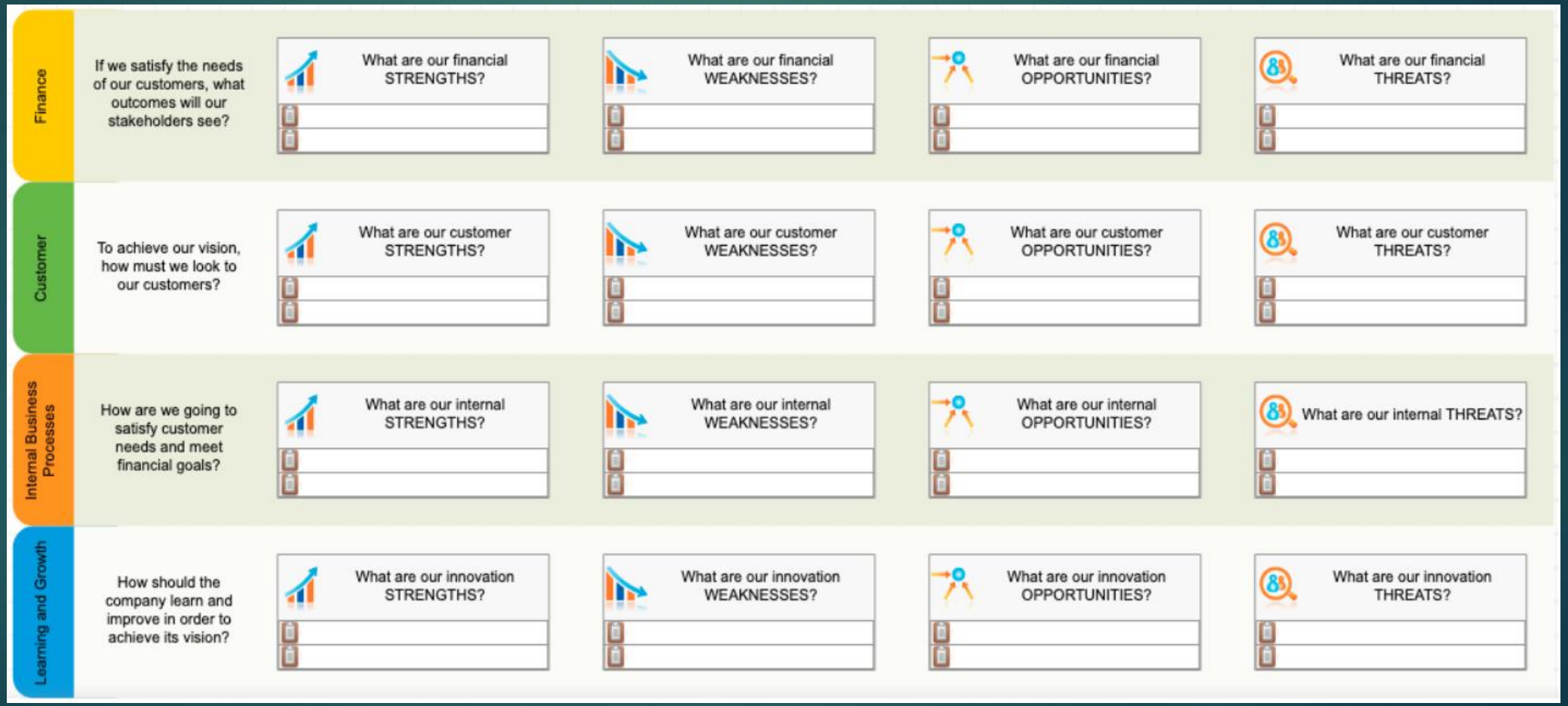
SWOT analysis of innovation promotion best practices and experiences in similar Big Science projects. Cost / benefit ratio

4 Perspectives SWOT map example



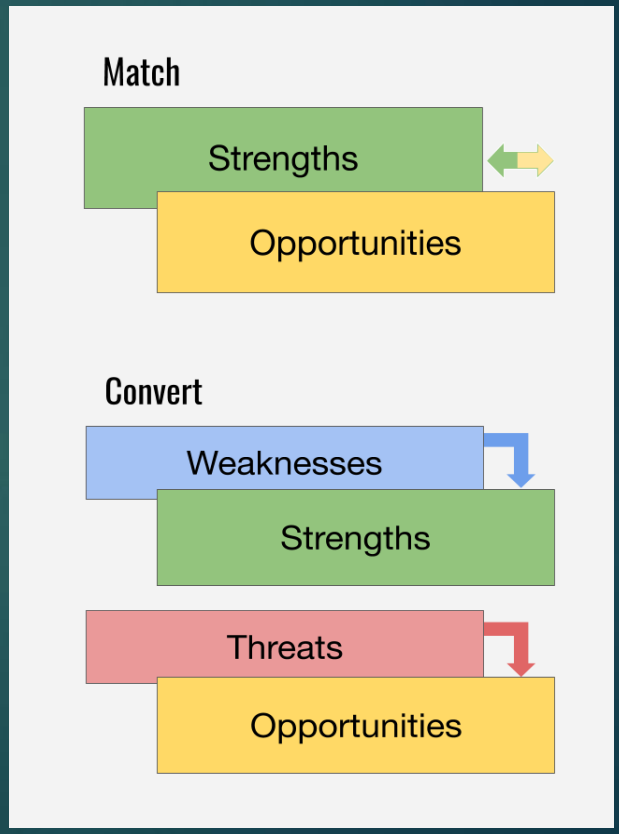
ET PP WP 7.1 Internal milestone 2 (M4)

Institut de Física d'Altes Energies

SWOT analysis of innovation promotion best practices and experiences in similar Big Science projects. Cost / benefit ratio

Strengths	**Weaknesses**
What do you do well? What unique resources can you draw on? What do others see as your strengths?	What could you improve? Where do you have fewer resources than others? What are others likely to see as weaknesses?

Opportunities	**Threats**
What opportunities are open to you? What trends could you take advantage of? How can you turn your strengths into opportunities?	What threats could harm you? What is your competition doing? What threats do your weaknesses expose to you?



ET PP WP 7.1 Internal milestone 2 (M4)

Institut de Física d'Altes Energies

Next steps for all 7.1 Task participants

1) Identify relevant **innovation bibliographic references** (done by IFAE, documents sharing pending)

2) Identify the **innovation key Goals, KPIs and actions** set by other BSROs for each innovation perspective (partially done by IFAE)

3) Compare the **ET project nature, internal organization and objectives** with other BSROs (CERN, LIGO,..) for each innovation perspective in a SWOT format (pending)

4) Define **own KPIs** per each innovation perspective (partially done by IFAE)

5) Define **Strategyc Business Goals** for each innovation perspective (partially done by IFAE)