

Enhancing Thai-CERN Cooperation for Research, Engineering, Industry and Knowledge Transfer

Industry Procurement
Knowledge Transfer

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CMS Collaboration

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CERN Main Site (Meyrin)



European Organization for Nuclear Research

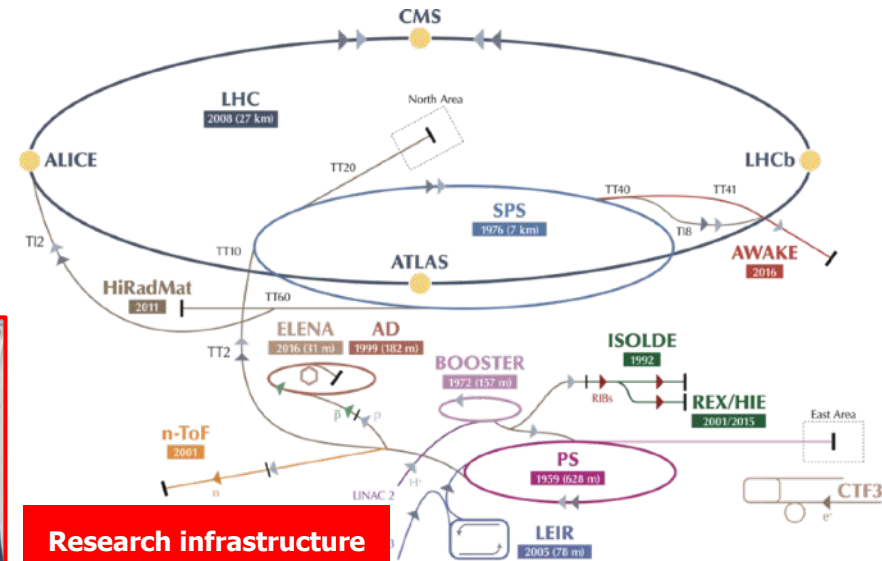
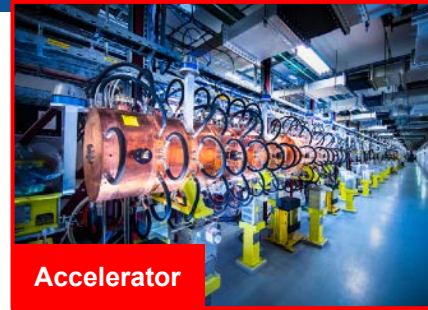
**View of the LHC machine, cavity RF. Tunnel.
LHC Point 4.**

European Organization for Nuclear Research (CERN)

Basic research in the field of experimental and theoretical particle physics, finding out what the Universe is made of and how it works.

CERN Missions

- **Research:** Seeking and finding answers to questions about the Universe
- **Technology:** Advancing the frontiers of technology
- **Education:** Training the scientists and engineers of tomorrow
- **Collaborating:** Bringing nations together through science



23 Member States

Austria – Belgium – Bulgaria – Czech Republic – Denmark – Finland – France – Germany
– Greece – Hungary – Israel – Italy – Netherlands – Norway – Poland – Portugal
– Romania – Serbia – Slovakia – Spain – Sweden – Switzerland – United Kingdom

3 Associate Member States in the pre-stage to Membership

Cyprus – Estonia – Slovenia

7 Associate Member States

Croatia – India – Latvia – Lithuania – Pakistan – Turkey – Ukraine

6 Observers

Japan – Russia – USA – European Union – JINR – UNESCO

More than 50 Cooperation Agreements with non-Member States and Territories

Albania – Algeria – Argentina – Armenia – Australia – Azerbaijan – Bangladesh – Belarus – Bolivia – Bosnia and Herzegovina –
Brazil – Canada – Chile – Colombia – Costa Rica – Ecuador – Egypt – Georgia – Iceland Iran – Jordan – Kazakhstan – Lebanon –
Malta – Mexico – Mongolia – Montenegro – Morocco – Nepal – New Zealand – North Macedonia – Palestine – Paraguay –
People's Republic of China – Peru – Philippines – Qatar – Republic of Korea – Saudi Arabia – Sri Lanka – South Africa –

– **Thailand** – Tunisia – United Arab Emirates – Vietnam



CERN founded in 1954 with
12 European Member States

CERN Annual Budget

(in MCHF, 2021 prices, rounded off to 0.1 MCHF until 2026, 1 MCHF thereafter)	Revised 2021 Budget	2022	2023	2024	2025	2026	Total 2021-2026	2027	2028	2029	2030	2031	Total 2021-2031
EXPENSES	1 349.2	1 395.0	1 347.6	1 322.4	1 246.6	1 185.3	7 846	1 127	1 102	1 115	1 103	1 077	13 371
Running of scientific programmes and support	1 064.4	1 054.0	1 017.6	1 004.2	974.0	975.4	6 089	992	1 035	1 049	1 037	1 010	11 212
Scientific programmes	508.0	486.7	474.5	471.2	492.2	488.8	2 921	478	515	514	515	536	5 479
<i>Accelerator programme</i>	307.5	290.5	294.6	293.1	316.5	308.3	1 810	291	311	311	312	333	3 370
<i>Experiments and research programme</i>	200.5	196.1	180.0	178.1	175.7	180.5	1 111	186	204	203	203	203	2 110
Infrastructure and services	556.4	567.3	543.0	533.0	481.8	486.6	3 168	515	520	534	521	474	5 733
<i>General infrastructure and services (incl. admin, external relations, safety)</i>	291.7	289.8	253.0	236.3	230.5	234.7	1 536	232	234	230	234	234	2 699
<i>Site facilities (incl. infrastructure consolidation, buildings and renovation)</i>	67.9	71.7	86.8	99.2	95.8	81.7	503	95	91	106	97	91	984
<i>Centralised expenses</i>	196.8	205.9	203.3	197.5	155.5	170.2	1 129	187	195	199	191	149	2 050
<i>Centralised personnel expenses</i>	38.4	39.7	39.0	37.8	37.4	38.3	231	38	38	38	38	38	422
<i>Internal taxation</i>	34.7	34.4	33.7	33.3	33.2	33.3	203	33	33	33	33	33	370
<i>Internal mobility, pers. paid special leave or paid from third-party accounts</i>	17.7	13.8	10.4	9.2	7.4	6.3	65	6	6	6	6	6	94
<i>Energy and water, insurance and postal charges, miscellaneous</i>	97.4	110.0	112.8	110.6	71.6	87.2	590	105	113	118	111	69	1 106
<i>Interest, bank and financial expenses, in-kind ¹</i>	8.6	8.0	7.3	6.6	5.9	5.1	41	4	4	3	3	2	58
Scientific projects	284.8	341.0	330.1	318.2	272.6	209.9	1 757	135	67	67	67	67	2 159
LHC upgrades	212.1	234.0	228.7	218.4	184.5	137.3	1 215	63	2	2	2	2	1 287
<i>LHC injectors upgrade (LIU)</i>	7.4						7						7
<i>HL-LHC upgrade</i>	162.9	159.7	156.6	150.5	131.7	98.0	860	38					897
<i>LHC detectors upgrades (Phase I) and consolidation</i>	7.9	3.8	2.0	2.0	1.0	2.2	19	2	2	2	2	2	30
<i>LHC detectors upgrades (Phase II) and R&D</i>	33.9	70.5	70.1	65.8	51.8	37.1	329	23					352
Future colliders studies	18.6	27.5	33.0	31.3	22.9	19.8	153	20	20	20	20	20	252
<i>Linear collider</i>	5.4	5.1	4.7	4.2	4.1		23						23
<i>Future Circular Collider</i>	11.7	20.2	26.3	25.1	16.8		100						100
<i>Muon colliders</i>	1.5	2.3	2.0	2.0	1.9		10						10
<i>High-energy frontier</i>						19.8	20	20	20	20	20	20	119
Accelerator technologies and R&D	26.8	35.5	31.5	28.6	31.3	28.2	182	27	26	25	25	25	311
R&D for future detectors	7.5	8.0	7.7	7.3	4.1	4.1	39	4	4	5	5	5	61
Scientific diversity projects	19.7	36.1	29.3	32.6	29.9	20.5	168	20	15	15	15	15	247
<i>Neutrino Platform</i>	8.8	23.0	17.1	20.0	18.4	9.0	96	9	4	4	4	4	119
<i>Physics Beyond Colliders</i>	2.3	4.2	3.7	3.5	3.3	3.3	20	3	3	3	3	3	36
<i>EU supported computing R&D, support to external facilities</i>	8.7	8.9	8.5	9.1	8.2	8.2	51	8	8	8	8	8	91
BALANCE													
Annual balance	50.3	-24.9	-19.5	7.1	59.8	106.1			160	181	171	182	206
Capital repayment allocated to the budget (FIPOI 1, 2 and 3, debt restructuring)	-1.1	-1.1	-1.1	-1.1	-1.1	-22.9			-45	-45	-45	-45	-1
Recapitalisation Pension Fund	-60.0	-60.0	-60.0	-60.0	-60.0	-60.0			-60	-60	-60	-60	-60
Annual balance allocated to budget deficit	-10.8	-86.0	-80.6	-54.0	-1.3	23.2			55	77	66	77	145
-Cumulative balance (at 31/12 of the year)²-	-260.9	-346.8	-427.4	-481.4	-482.6	-459.4		-404	-327	-261	-184	-39	

CERN's annual budget is 1300 MCHF (equivalent to a medium-sized European university)

¹ Including theoretical interest on the FIPOI loan (compensated by a corresponding heading in the revenues).

² The cumulative balance of -250.1 MCHF is the accumulated budget deficit at 31/12/2020 as stated in the Financial Statements for 2020 (CERN/FC/6494, page 17).

CERN Annual Budget

	Country	Currency	Net National Income at factor cost			Exchange rates			Net National Income at factor cost	2021 Theoretical Contribution	2021 Due Contribution
			in millions in national currency			national currencies in Swiss francs			in MCHF		
			2016	2017	2018	2016	2017	2018	Average 2016 to 2018	in %	in %
Member States	Austria	EUR	247 392	253 750	267 762	1.0902	1.1114	1.1547	286 957	2.20488%	2.20488%
	Belgium	EUR	311 731	324 200	330 818	1.0902	1.1114	1.1547	360 718	2.77163%	2.77163%
	Bulgaria	BGN	68 238	73 648	79 005	0.5574	0.5682	0.5904	42 177	0.32408%	0.32408%
	Czech Republic	CZK	2 982 304	3 194 051	3 437 920	0.0403	0.0422	0.0450	136 662	1.05006%	1.05006%
	Denmark	DKK	1 508 396	1 553 169	1 608 550	0.1464	0.1494	0.1549	234 037	1.79826%	1.79826%
	Finland	EUR	149 690	155 543	162 223	1.0902	1.1114	1.1547	174 460	1.34049%	1.34049%
	France	EUR	1 580 923	1 621 177	1 652 000	1.0902	1.1114	1.1547	1 610 944	13.91465%	13.91465%
	Germany	EUR	2 346 118	2 430 531	2 503 079	1.0902	1.1114	1.1547	2 716 430	20.87209%	20.87209%
	Greece	EUR	118 018	122 216	124 797	1.0902	1.1114	1.1547	136 199	1.04650%	1.04650%
	Hungary	HUF	23 223 830	24 693 025	27 078 769	0.0035	0.0036	0.0036	89 400	0.68692%	0.68692%
	Israel	ILS	886 899	927 479	981 353	0.2566	0.2736	0.2717	249 299	1.91552%	1.91552%
	Italy	EUR	1 186 507	1 219 942	1 248 290	1.0902	1.1114	1.1547	1 363 563	10.47729%	10.47729%
	Netherlands	EUR	506 217	545 645	573 188	1.0902	1.1114	1.1547	606 720	4.66182%	4.66182%
	Norway	NOK	2 350 279	2 500 454	2 700 105	0.1173	0.1191	0.1202	299 428	2.30070%	2.30070%
	Poland	PLN	1 328 890	1 415 265	1 495 190	0.2499	0.2611	0.2710	368 931	2.83474%	2.83474%
	Portugal	EUR	123 277	129 163	133 683	1.0902	1.1114	1.1547	144 103	1.10724%	1.10724%
	Romania	RON	549 052	617 573	685 939	0.2428	0.2433	0.2482	151 269	1.16230%	1.16230%
	Serbia	RSD	3 244 496	3 422 528	3 650 517	0.0089	0.0092	0.0096	31 908	0.24517%	0.24517%
	Slovakia	EUR	56 477	59 153	63 605	1.0902	1.1114	1.1547	66 919	0.51419%	0.51419%
	Spain	EUR	826 295	859 296	889 983	1.0902	1.1114	1.1547	961 165	7.38526%	7.38526%
Sweden	SEK	2 788 851	2 962 308	3 090 782	0.1152	0.1153	0.1126	337 053	2.58980%	2.58980%	
Switzerland	CHF	506 659	499 473	529 450	1.0000	1.0000	1.0000	511 861	3.93296%	3.93296%	
United Kingdom	GBP	1 420 345	1 496 028	1 539 642	1.3352	1.2683	1.3052	1 934 428	14.86347%	14.86347%	
Total Member States									13 014 853	100.0000%	100.0000%
Associate Member States in the pre-stage to Membership	Cyprus	EUR	13 543	14 426	15 224	1.0902	1.1114	1.1547	16 126	0.12390%	0.08487%
	Slovenia	EUR	25 670	28 120	30 281	1.0902	1.1114	1.1547	31 401	0.24127%	0.12064%
Total Associate Member States in the pre-stage to Membership									47 526	0.3652%	0.2055%
Associate Member States	Croatia	HRK	251 999	263 779	275 821	0.1447	0.1489	0.1557	39 563	0.30399%	0.03040%
	India	INR	110 240 707	123 061 826	136 915 674	0.0148	0.0147	0.0144	1 805 016	13.86911%	1.38691%
	Lithuania	EUR	27 919	30 588	33 247	1.0902	1.1114	1.1547	34 274	0.26335%	0.02634%
	Pakistan	PKR	20 864 717	22 979 911	24 933 113	0.0094	0.0095	0.0088	211 335	1.62382%	0.16238%
	Turkey	TRY	1 893 099	2 262 940	2 682 392	0.3257	0.2700	0.2077	595 546	4.57597%	0.45760%
	Ukraine	UAH	1 711 743	2 148 007	2 564 425	0.0385	0.0370	0.0359	79 178	0.60837%	0.06084%
Total Associate Member States									2 764 912	21.2448%	2.1245%

CERN's annual budget is 1300 MCHF (equivalent to a medium-sized European university)

⇒ Use NNI to calculate percentage of contribution



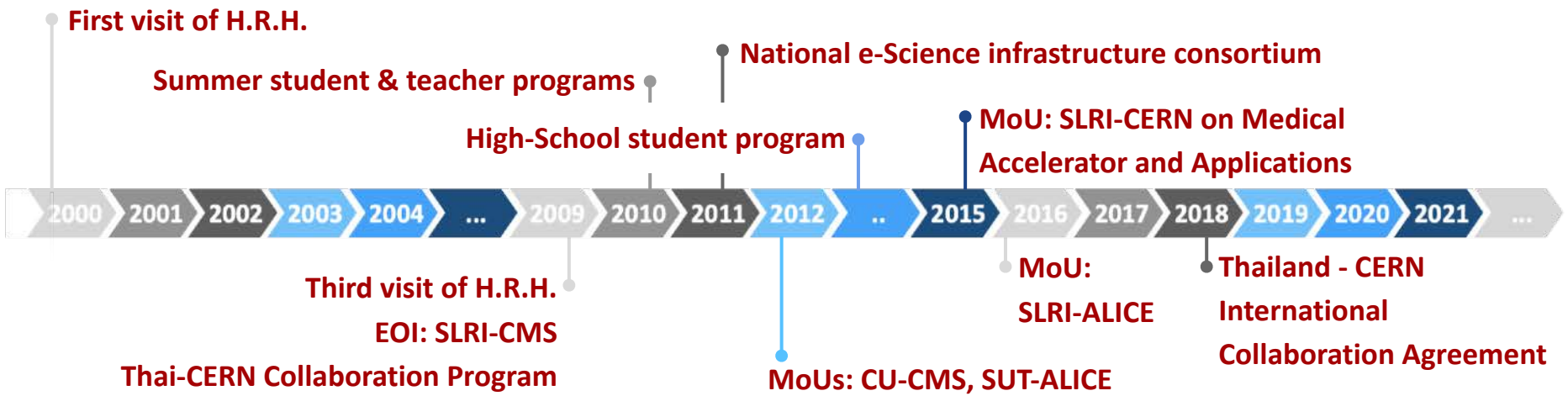
Thai-CERN program under H.R.H. Princess Maha Chakri Sirindhorn

**17 November 2015 - H.R.H. Princess Maha Chakri Sirindhorn visited CMS
Crystal factory at CERN.**



โครงการความร่วมมือ ไทย-เซิร์น

ในแนวพระราชดำริ สมเด็จพระกนิษฐาธิราชเจ้า กรมสมเด็จพระเทพรัตนราชสุดาฯ สยามบรมราชกุมารี
Thai - CERN Collaboration Program under the initiative of H.R.H Princess Maha Chakri Sirindhorn



Paving the Way for Collaborations between Thai-CERN

Physics

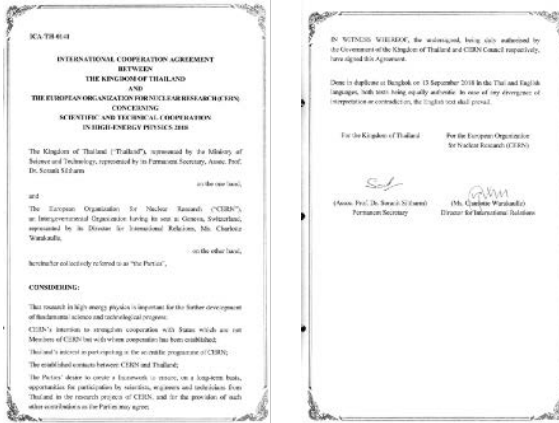
- ALICE
- CMS
- Participations in other (small) experiments?

Engineering & Infrastructure

- National eScience
- Software engineering
- Microelectronics
- Sensor and testing facility

Educations

- Summer high-school student
- Summer high-school teachers
- Summer students
- Local schools in High Energy Physics



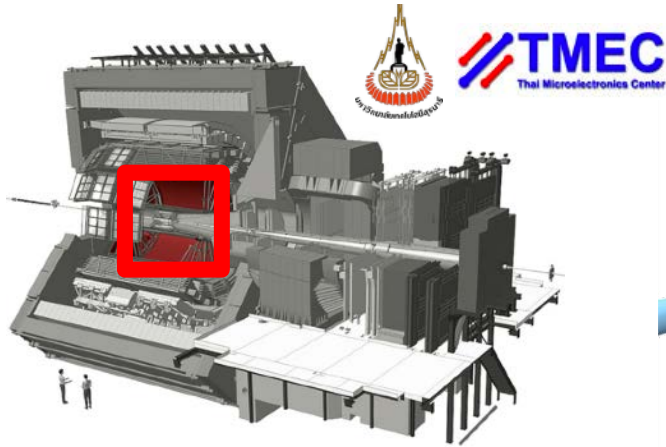
2018: Thailand-CERN International Collaboration Agreement

ARTICLE 3

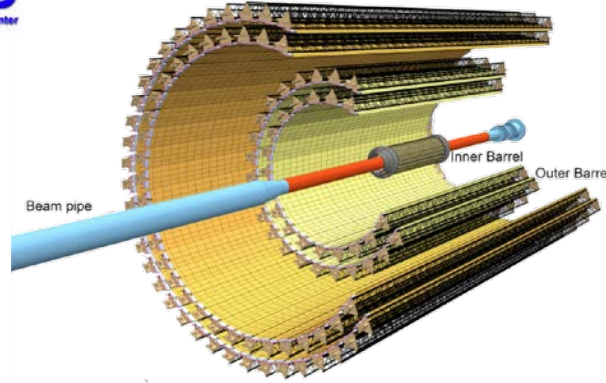
Forms of Cooperation

Subject to Article 5 hereunder, Thailand shall support such research projects of CERN for which scientific institutes and universities from Thailand have particular expertise, including in the field of experimental and theoretical physics, accelerator and detector engineering, and computing. The support may be in the form of human resources, know-how, equipment, materials, funds or any combination thereof.

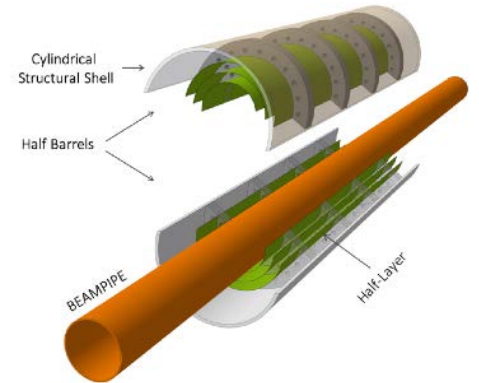
ALICE: A Large Ion Collider Experiment



ITS 2 (2021-2024)

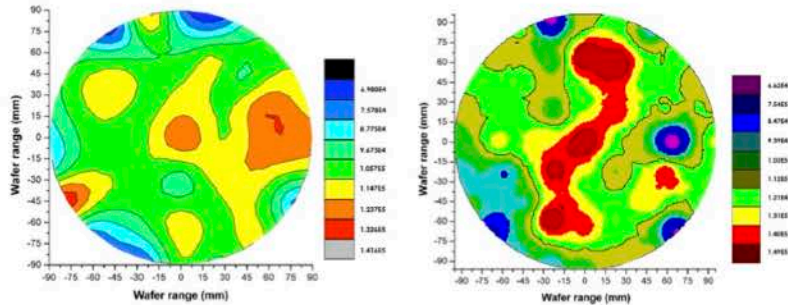


ITS 3 (2027-2030)

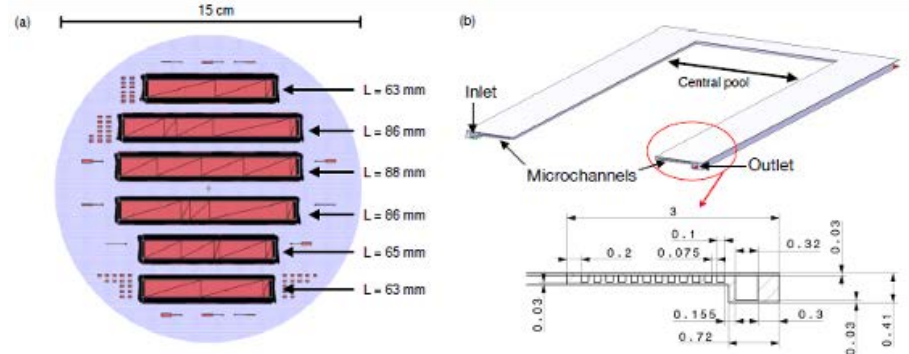


ITS 2 (2021-2024)

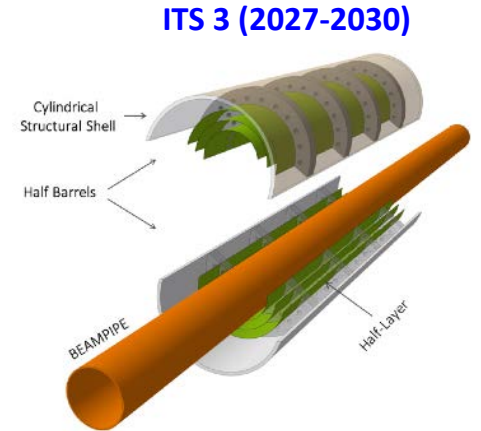
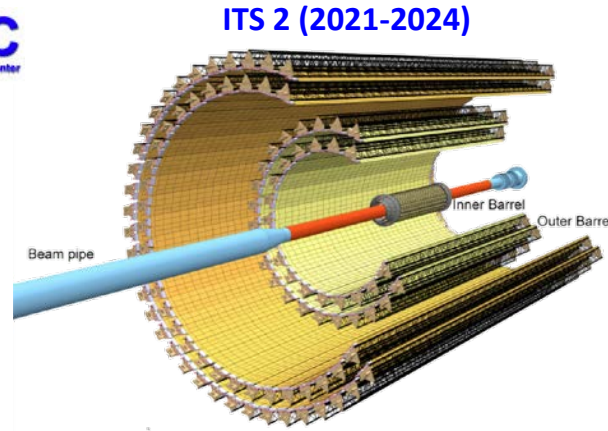
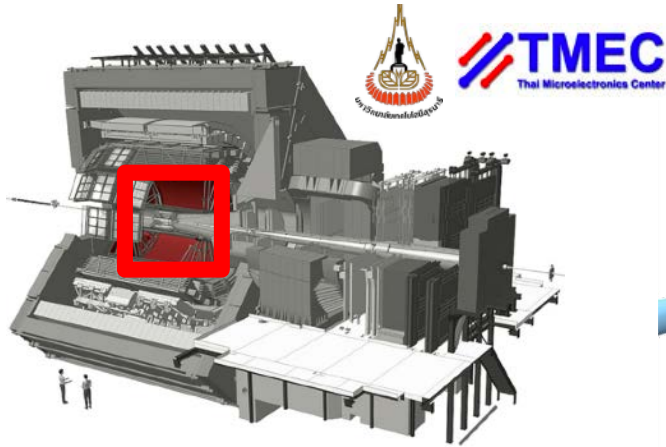
Resistivity Profile Study



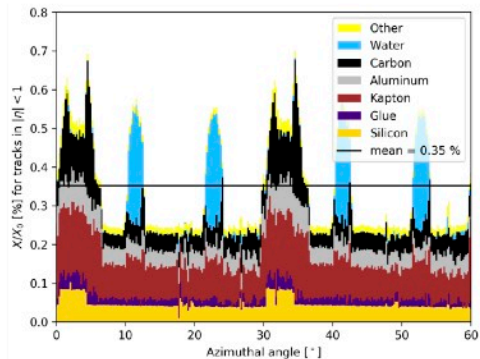
Silicon Microchannel cooling design and fabrication



ALICE: A Large Ion Collider Experiment



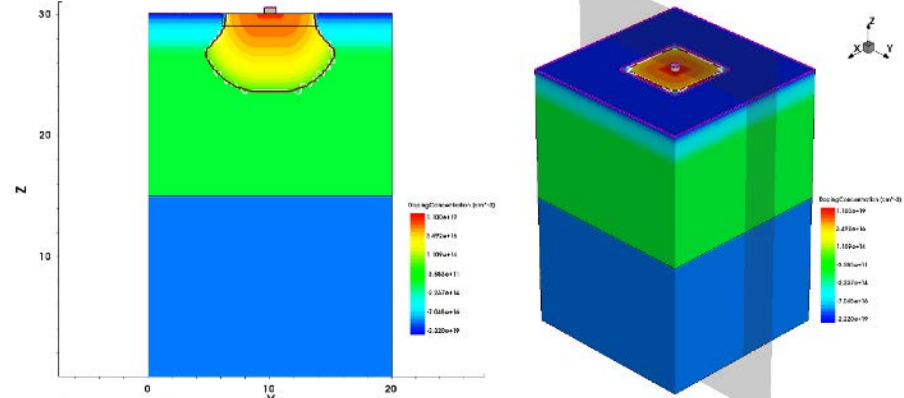
ITS 3 (2027-2030)



Motivation

- Get closer to the interaction point
- Reduce material, as Si makes only 1/7th of total material. Irregularities due to support/cooling

Design and study the structure of CMOS-like sensor for pixel detector

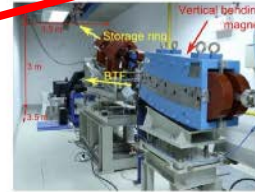
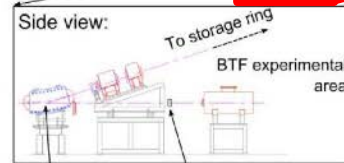
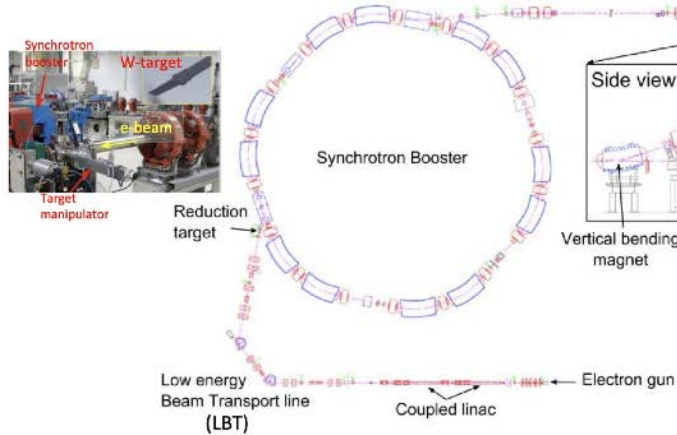


ALICE: A Large Ion Collider Experiment



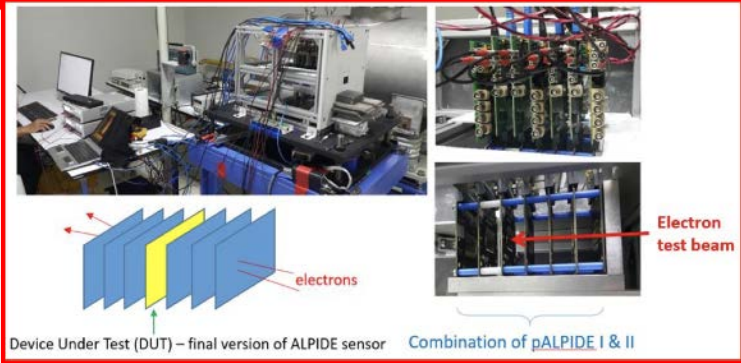
- Beam-test is a part of the lifecycle of any detector we build.
- Provide electron test beam with energy between 40 MeV - 1.2 GeV
- Benefit to testing and calibration of high-energy instrumentations and detector

SPS Injector



3 x 3.5 m² available area, reserved for Faraday cup

Particle	electron
Energy	1 / 1.2 GeV
Energy spread	0.05% at 1 GeV
Pulse duration	8.5 ns

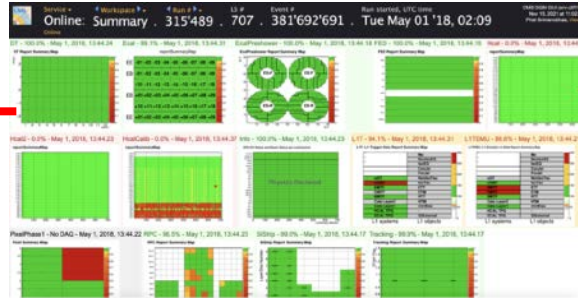


World-wide professional beam test facilities

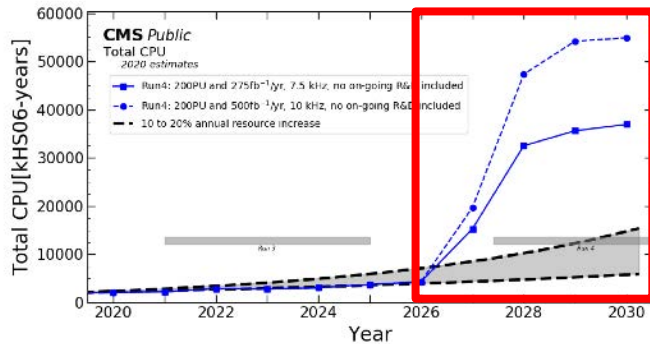
- Hadron: FNAL (US) and CERN (EU)
- Electron: SLAC (US), DESY (Germany)
- Photon: ELPH (Japan)



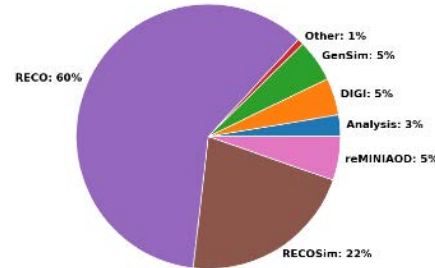
- Focus on computer engineering, increasing person-power.
 - Improving Data Quality Monitoring: Handling more than 300,000 histograms every day



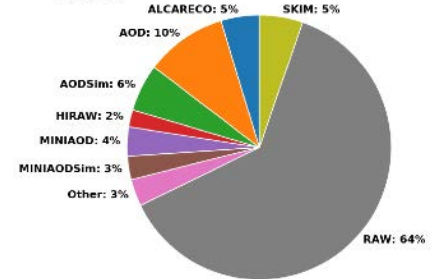
- Improving Software performance, focusing on LHC Run-4, Run-5

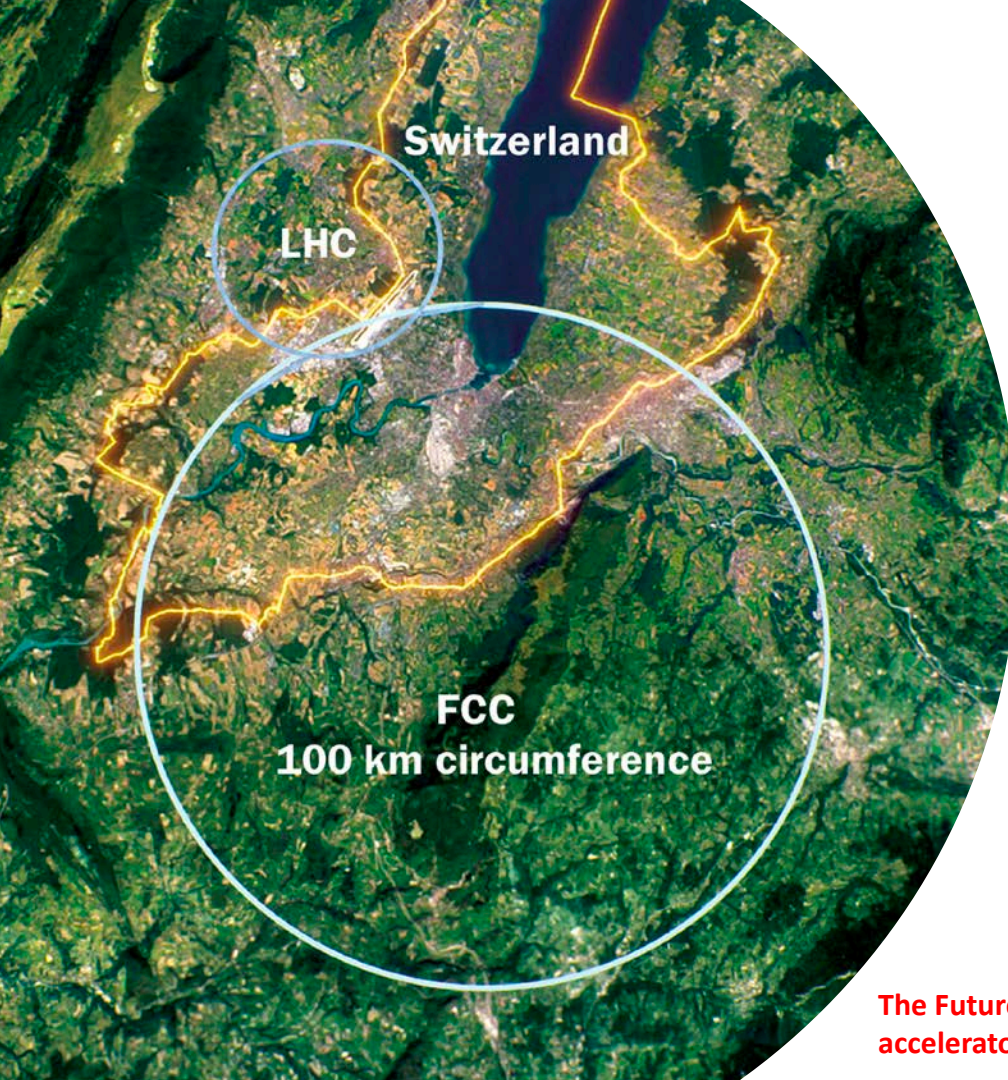


CMS Public Total CPU HL-LHC fractions
2020 estimates



CMS Public Total Tape usage HL-LHC fractions
2020 estimates

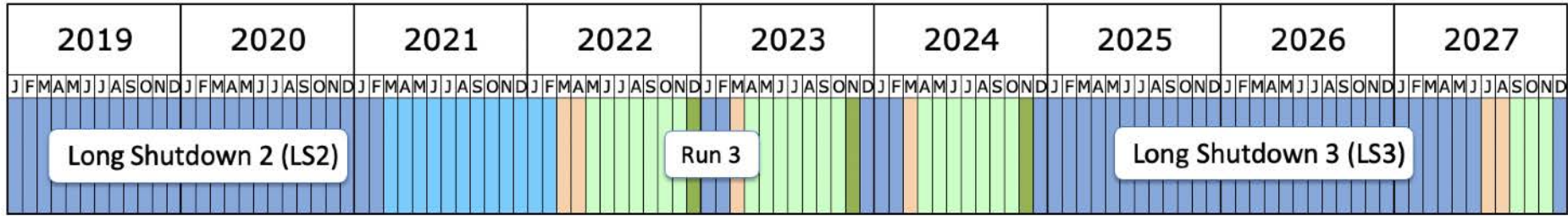




CERN Future Project

The Future Circular Collider (FCC) is a proposed post-LHC particle accelerator with an energy significantly above the LHC.

CERN Future Project



- Shutdown/Technical stop
- Protons physics
- Ions
- Commissioning with beam
- Hardware commissioning/magnet training

And what beyond?

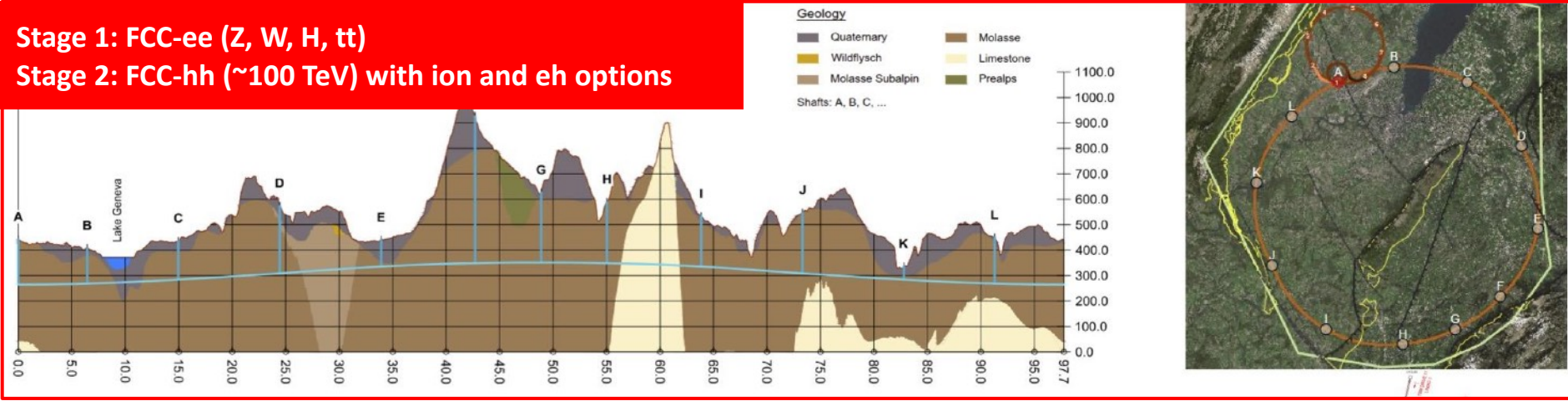
Last updated: June 2021



Engineering: Future Circular Collider - Global Opportunity

Stage 1: FCC-ee (Z, W, H, tt)

Stage 2: FCC-hh (~100 TeV) with ion and eh options



FCC Engagement Meetings

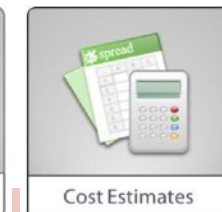
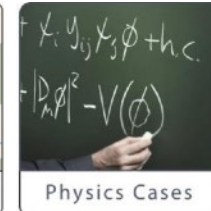
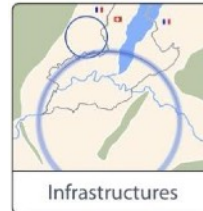
For Non Member State

- Physicists & Engineers from University, Research institute
- Funding agencies
- Gov representations



September 2021

- 14 Sep [FCC Pakistan Engagement Meeting](#)
- 03 Sep [FCC Republic of Korea Engagement Meeting](#)





Status of Global FCC Collaboration

increasing international collaboration
as a prerequisite for success



FCC feasibility study 2021 - 2025

- Financial feasibility
- Technical and administrative feasibility of tunnel: no show-stopper for 100 km tunnel
- Technologies of machine and experiments: magnets; minimized environmental impact; energy efficiency & recovery
- Gathering scientific, political, societal and other support

Chances for Thai Physicists, Engineers, Geologists.

Paving the Way for Collaborations between Thai-CERN

Physics

- ALICE
- CMS
- Participations in other (small) experiments?

Engineering & Infrastructure

- National eScience
- Software engineering
- Microelectronics
- Sensor and testing facility
- Next: High-Luminosity LHC
- Next: Future Circular Collider

Educations

- Summer high-school student
- Summer high-school teachers
- Summer students
- Local schools in High Energy Physics

Applications

- Medical
- Agriculture
- Thai frontier researches
 - Space
 - Quantum

Industries

- CERN Procurement
 - Civil Engineering
 - Electrical Engineering
 - Mechanical Engineering
 - Electronics & RF
 - Information Technology
 - .. etc





Business Opportunities at CERN

**In the search for a more reliable and economical solution,
CERN has procured a machine to manufacture surgical masks.**

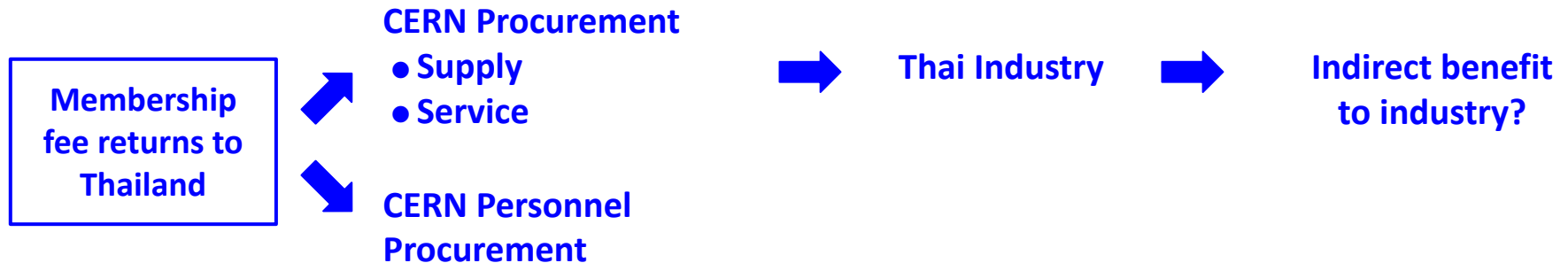
Annual Financial Contributions from Associate Members

“Associate Members pay an annual financial contribution of at least 10% of their “theoretical” full Membership contribution, calculated based on economic performance indicators (Net National Income - NNI). Thailand’s contribution as an Associate Member State would thus be at the level of about 2.6 million Swiss Francs per year.



Estimated at 2019 (used 2015-2017 NNI at factor cost)
In 2021, estimation at 2.9 MCHF/year (~106 MTHB/year)

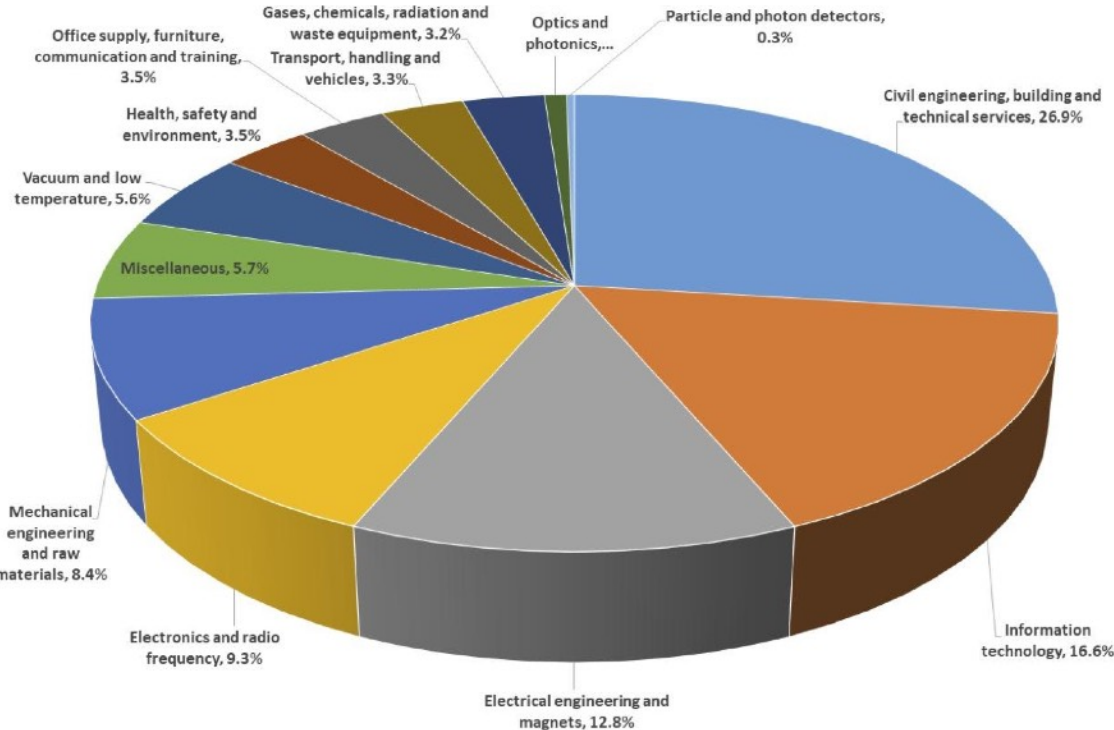
The combined direct return to the country in terms of supply and/or service contracts and personnel recruitment cannot exceed the annual amount of the AMS contribution.”



Associate Members: Comparisons

Country	Population (2020)	GDP (2020) in MUSD	NNI at factor cost (Avg 2017-2019) in MCHF	Contribution as AMS (MCHF)	
Cyprus	1,207,359	23,804	17,225 [CERN]	1.02	EXAMPLE
Estonia	1,326,535	31,030	20,114 [CERN]	1.30	
Slovenia	2,078,938	52,880	34,174 [CERN]	1.48	EXAMPLE
Croatia	4,105,267	55,967	41,345 [CERN]	1.00	
Latvia	1,886,198	33,505	No information. Latvia joins as AMS on Aug 2, 2021.		
Lithuania	2,722,289	55,887	37,479 [CERN]	1.00	EXAMPLE
Turkey	84,339,067	720,101	570,959 [CERN]	4.94	EXAMPLE
Ukraine	43,733,762	155,582	93,771 [CERN]	1.00	
India	1,380,004,385	2,622,984	1,937,730 [CERN]	16.76	
Pakistan	220,892,340	263,687	212,209 [CERN]	1.84	EXAMPLE
Thailand	69,799,978	501,795	363,555 [NESDC, not at factor cost]	2.90 (Estimated by CERN)	

Supplies (235MCHF spent in 2020 – CERN budget only)



Well Balanced	Poorly Balanced	Very Poorly Balanced
Austria	Belgium	Estonia*
Bulgaria	Croatia*	India*
Czech Republic	Cyprus*	Israel
France	Denmark	Latvia*
Hungary	Finland	Norway
Italy	Germany	United Kingdom
Netherlands	Greece	
Romania	Lithuania*	
Slovak Republic	Pakistan*	
Switzerland	Poland	
	Portugal	
	Serbia	
	Slovenia*	
	Spain	
	Sweden	
	Turkey*	
	Ukraine*	

Return coefficient = ratio between that Member State's percentage share of the value of all Supply contracts and that Member State's percentage contribution to the CERN Budget over the same period

>1

<0.4

CERN buys everything that is needed to run the organization and its accelerators!

<https://found-java-ext.cern.ch/java-ext/found/CFTSearch.do>



What do we buy:

- Information Technology
- Computing systems
- Servers
- Software
- Network equipment
- Personal computer equipment

Information Technology

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What do we buy?

- Civil engineering:
- Construction
- Renovation of buildings
- Metallic structures
- Earthworks
- Roads
- Cooling and heating

Civil Engineering

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What do we buy?

- Electrical engineering and magnets
- Transformers
- Switchboards and switchgears
- Cables
- Automation
- Power supplies

Electrical Engineering

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What do we buy?

- Mechanical engineering and raw materials:
- Machining
- Sheet metal work and arc welding
- Special fabrication techniques
- Raw materials, finished products

Mechanical Engineering

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What do we buy?

- Electronics and radiofrequency:
- Electronic components (active, passive)
- PCBs and assembled boards
- LV and HV power supplies
- Radiofrequency plants
- Amplifiers

Electronics & RF

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
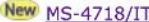

What do we buy?

- As well as:
- Cryogenic and vacuum equipment
- Optics and photonics
- Particle and photon detectors
- Health and safety equipment
- Transport and handling

and more ...

Floris Berthoud | flberthou@CERN

CERN Procurement and Chances for Thai Industries: Examples

22-10-2021	Supply	 MS-4725/SCE	Framework Market Survey concerning the Supply of renovation or construction works of tertiary buildings on the Swiss or French parts of CERN's sites. (01020101)
20-10-2021	Supply	 MS-4723/SCE	Supply of a new chilled water production system for building 40 on the Swiss part of CERN's Meyrin site. (01030300)
20-10-2021	Supply	 MS-4718/IT	CERN intends to place a contract for the supply of audiovisual equipment and installation services, for a period of three years (04040200 , 04040200 , 04040300 , 04040300 , 04040400 , 04040400 , 04040600 , 04040600 , 04040700 , 04040700 , 08010502 , 08010502)
14-10-2021	Supply	 MS-4720/SCE	Supply of desktops, laptops and monitors. (04010500 , 04010700 , 04020100)
16-09-2021	Supply	MS-4716/EN	Supply of an instrumented indentation hardness standalone machine operating at room temperature. (05900300)

07-09-2021	Supply	MS-4714/SCE	Framework Market Survey for the performance of consultancy and works supervision services for the construction and renovation of tertiary buildings on the Swiss or French part of the CERN site. (01900200 , 01900300)
06-09-2021	Supply	MS-4715/IR	Supply, installation and commissioning of audiovisual equipment, lights and technical and interpretation rooms for the Science Gateway auditorium. (04040100 , 04040600 , 04040700 , 04040900 , 08010502 , 12010600)
23-08-2021	Supply	MS-4713/TE/HL/LHC	Supply of 11.5 km of REBCO high temperature superconducting (HTS) tape for CERN's HL-LHC Project. (02250502)
11-08-2021	Supply	MS-4703/TE/HL/LHC	Tin-silver electroplating of 1000 km of Nb-Ti superconducting wire supplied by CERN for the corrector magnets for the High Luminosity LHC upgrade. (05040410)
22-07-2021	Supply	MS-4700/PF	Supply of document management and workflow systems for the CERN Pension Fund. (04050700)

CERN Procurement and Chances for Thai Industries: Examples

15-07-2021	Supply	MS-4711/IR	Supply, installation and commissioning of an LED wall for CERN Studio. (13040100 , 02029000 , 04040700 , 08010504)
08-07-2021	Supply	MS-4710/IT	Provision of mobile services and associated infrastructure. (04110200)
08-07-2021	Supply	MS-4709/ATS	Supply of one ion source turn-key bench for production of Helium and Proton beams. (03060100 , 02050200 , 02250300 , 05900100 , 06010202 , 06010700 , 06010800 , 09040200)
01-07-2021	Supply	MS-4704/EN	Supply and refurbishment of personnel lifts up to 3 ton capacity. (11060100)
29-06-2021	Supply	MS-4708/SY	Supply of six HV generators, with voltage multiplier stack (02100600)

28-06-2021	Supply	MS-4707/EN	Supply of medium voltage primary distribution switchgear. (02020200 , 02020200)
17-06-2021	Supply	MS-4702/EN	Supply of electrical power conversion systems including engineering, manufacturing and testing. (02030400)
16-06-2021	Supply	MS-4643/EN	Supply, installation and testing of flexible water-cooled copper cables of various sections and lengths. (02050500)
15-06-2021	Supply	MS-4701/BE	Supply of Low Voltage Electrical Distribution Switchboards (<=630A) (02020600 , 02800100 , 02900100)
14-06-2021	Supply	MS-4666/EN/HL/LHC	Supply and installation of eight mobile doors to be fitted with shielding in the HL underground caverns of the LHC accelerator (01020416)

Empirical studies (by the analysis of financial data from 1995 to 2008 from 365 CERN suppliers for the LHC) show that after working with CERN on high-tech contracts, CERN suppliers outperform their peers by:

- Investing more in R&D and filing more patents
- Higher productivity, revenue and profitability

Doing business with CERN: the facts

supplier survey (669 suppliers in 33 countries, 2017):



Examples: Lithuania (Personnel + Procurement)



Lithuania (Apr 2021, [Industry](#); [Procurement status](#)) 1 MCHF/year (~0.08% of total CERN budget)

Companies Registered:

2018: 7
2019: 23
2020: 53

Companies doing business:

2018: 7
2019: 14
2020: 15

Companies from:

- Lasers, Optics sector
- Mechanical & Materials Engineering
- Printing

Lasers, optics, optomechanics

Mechanical & Materials engineering

[kCHF]

Year	Personnel [A]	Procurement [B]	Total [C]=[A]+[B]	Contribution [D]	Remaining [D]-[C]
2018	171	61	232	1 000	768
2019	540	120	660	1 000	340
2020	772	409	1 181	1 000	- 181
2021*	997	64	1 061	1 000	- 61

The CERN Accelerator School

CAS
CERN Accelerator School

The art of printing / **KOPA**

CAS blue reports:
Vacuum, Beam Instrumentation, Numerical Methods, Wakefield Acceleration

Examples: Lithuania (Business Incubation Center)



Business Incubation Center

Lithuanian BIC of CERN Technologies: Second call, 2021

- Mar 29 – May 1: Phase I, call for applications.
- June - July: Pitch to Selection Committee, winners.

OUTREACH: LT BIC webinar. 2021 April 22, with:

Giovanni Anelli, Head of CERN's Knowledge Transfer Group;
Ash Ravikumar, Business Development Officer at CERN's Knowledge Transfer Group;
Laima Kaušpadienė, Director of SSMTP;
Paulius Nezabitauskas, Director of KMTP;
Adomas Jelinskas, Project Coordinator at LT BIC.



LITHUANIAN
INNOVATION
CENTRE



MINISTRY OF
THE ECONOMY
AND INNOVATION



SUNRISE VALLEY
SCIENCE AND TECHNOLOGY PARK

<http://www.cern.lt/en/incubator>



LITHUANIAN
INNOVATION
CENTRE

26 April 2021

9

The Business incubation center, **Lithuanian BIC** of CERN Technologies, aims to assist start-ups, small and medium enterprises (SMEs) to implement innovative technologies and expertise developed at CERN into disruptive products or services

Winner of 2020 BIC [\[Link\]](#)

LT BIC Startups 2020



Olfaction digitization



LT BIC Startups 2020

Paulai
TECH



AR-based STEM EdTech App



LT BIC Startups 2020

CYBER^{POD}



3D electronic printing





Pakistan (May 2021, [Industry](#); [Procurement status](#)) 1.9 MCHF/year (0.16% of total CERN budget)

PROCUREMENT STATUS (2015-2020)

- Pakistan Industry/R&D institutes low response for Market surveys/tenders sent by CERN due to technological gaps.
- Services contracts not possible due to EU labor laws and local presence of firms.
- Most of the Industrial Return are based on collaboration agreements includes manpower and equipment.

SUGGESTIONS/PROBLEMS:

- CERN may consider/ amend rules for the eligibility of firms for participating in CERN **services** contracts for associate members.
- The price is high for the tenders due to import of special material/ components from International market and than again exporting to CERN.
- Time constraints.

Will we expect the same situation of Thailand?

Outcomes and Benefits

Expertise in

- Normal Conducting Magnets Manufacturing
- Superconducting Magnet and Equipment Assembly.
- Experienced Manpower in Different Areas of Normal and Superconducting Magnets

Seem to focus on magnet technology

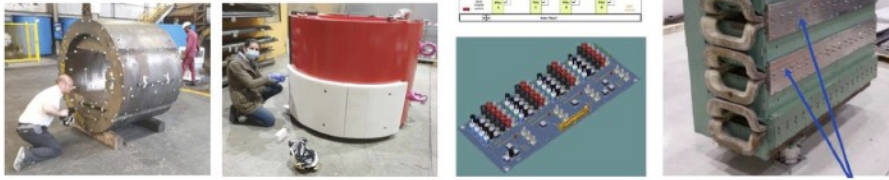
Expenditures (Pakistan, kCHF)

Year	Remaining	Procurement**	Personnel
2016	968	328	54
2017	746	278	454
2018	482	169	851
2019	-457	476	1 645
2020	412	214	1 254
2021*	1 212	79	608



Supplies to CERN

- Supply of 62 units (2 Pre-series & 60 series production) Support Plates for Energy upgrade of the PS Booster, from 1.4 GeV to 2.0 GeV, within the LIU project, LS2.
- Semi-automated tester to test power supplies (TE-EPC) feeding electronic equipment.
- 02 No. JTT Plug (11 tonn Each) for ATLAS Experiment

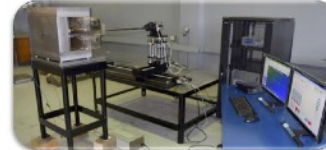


Supplies to CERN

Infrastructure in Pakistan

Normal Conducting Magnet Production Facilities Developed in Pakistan

- Tooling and Lamination Stacking
- Lamination Curing
- Yoke Assembly
- Magnet Assembly
- Coil Winding
- Vacuum Impregnation
- Magnet Testing
- Magnet Measurement



Beam Line Expertise Gained

- Experienced Manpower
- Fabrication of Beam line Equipment
- Small and Large Magnet Assembly
- Cabling and electrical infrastructure installation
- Magnet Testing and Measurement





Technical Services at CERN

Pakistan Serving in Different Departments at CERN (2015-2020)

- No. of Addendums/agreements Signed: 20
- Total Engineers and Technicians: 127
- 15 Engineers, 112 Technicians
- Technology Department: SCD, MNC, LMF, CMI
- Engineering Department: CV, EL, BE, MME
- Experiments: ALICE, ATLAS, CMS

Diodes Insulation and Superconducting Magnets Consolidation (DISMAC)

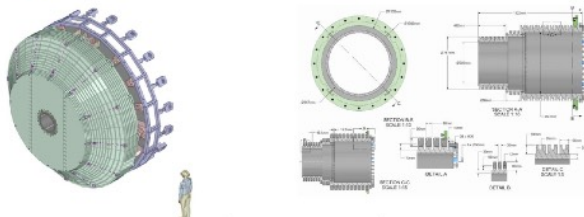
- 3 Engineers and 8 Technicians worked on consolidation of diodes of LHC Superconducting magnets
- Cutting and welding of interconnections (CWIC) for installation of insulating half moon splices
- Installation/Consolidation of insulating half moon splices.
- Participation in the Quality assurance activities
- 01 Engineer Selected for Technical Auditor for the Project



Services to CERN

CMS CE-H Hadronic Structure Design

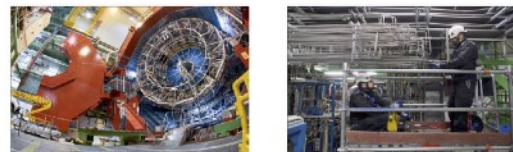
- 01 Engineer Working for CMS CE-H Assembly Design
- Structure Weight: 500 tonn Approx.



Design Carried out by PAEC Expert (M. Zahir Shah) under supervision of Stefano Moccia.

Consolidation of ALICE Cabling Infrastructure

- Group of 1 Engineer and 4 Technicians
- Removal of old cables and detectors
- Installation of new copper and optical fiber cables
- Installation of new chilled water tubing





Turkish Atomic Energy Authority represents Turkey in CERN:

- Supreme Council for Science and Technology,
- Turkish Atomic Energy Authority,
- Scientific and Technological Research Council of Turkey,
- Turkish Academy of Sciences,
- Universities,
- Turkish President's Office of Budget and Strategy

Industrial Return Ratios	
Supplies	Industrial Services
VIII = (VI/IV) / III	IX = (VII/V) / III
CHF	CHF
.22 (0.9)	0 (0.4)
.23 (0.9)	0 (0.4)
.87 (1)	0 (0.4)
1.04 (1)	0 (0.4)

VI = supplies by Turkey

IV = total supplies

III = contributions by Turkey

Goals



Our main goals related to Associate Membership of Turkey;

- to increase the number of qualified researchers working in the field of high energy physics,
- to have laboratories, equipment and facilities capable of contributing to research conducted in CERN,
- to increase the return rate of country contribution by providing participation of Turkish industrialists to the CERN tenders,
- to increase the number of Turkish citizens employed at CERN.

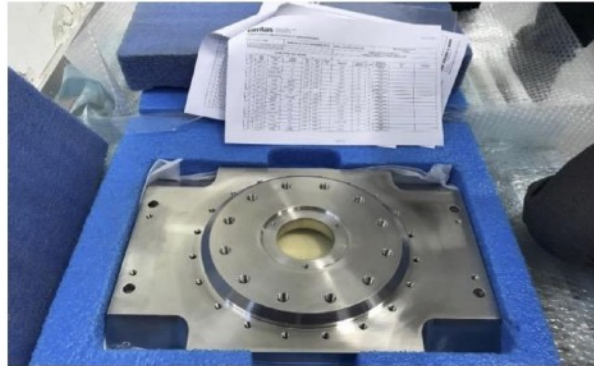


END CAPS FOR SPS COAX LINE



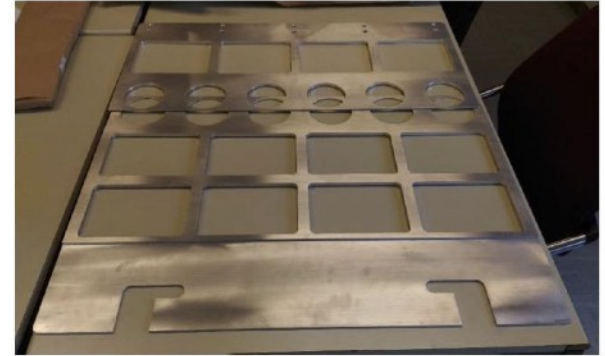
SPS COAX LINE

COLD MASS SUPPORT



MQXFB MAGNET: TOOLING

PSB FINEMET



FINEMET COOLING DISK PSB

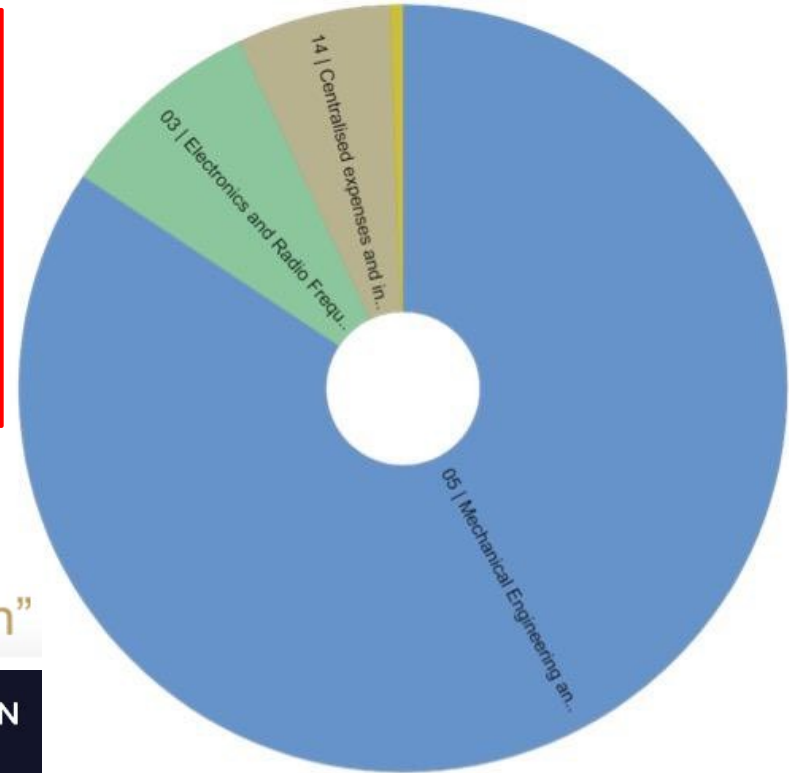


Slovenia (May 2021, [Procurement status](#)) 1.4 MCHF/year (0.12% of total CERN budget)

Pre-stage to Membership

Expenditures (Slovenia, kCHF)			
Year	Remaining	Procurement**	Personnel
2017	438	10	52
2018	826	90	84
2019	753	122	125
2020	697	187	181
2021*	1 179	96	135

*Provisional figure
 **Including supplies, services, utilities and small orders



Zustel as a major supplier of Slovenia





Cyprus (June 2021, [CERN Program](#); [Procurement status](#)) 1 MCHF/year (0.08% of total CERN budget)

Pre-stage to Membership

Expenditures (Cyprus, kCHF)

Year	Remaining	Procurement**	Personnel
2016	520	–	230
2017	583	17	401
2018	124	39	837
2019	8	92	900
2020	165	200	636
2021*	563	–	437



HOME ABOUT US ENGINEERING SERVICES PRODUCTS CONTACT



1 supplier in Cyprus in mechanical / electrical engineering and materials.



Problems and Solutions

Problems

1. Lack of critical mass of researchers in most fields
2. Insufficient PhD fellowships
3. Moderate infrastructure—lack of hardware & machine shops
4. Difficulties to activate industry and high-tech companies
5. Need clearly expressed research strategy
6. Need more support for young researchers
7. Brain drain
8. Lack of venture capital organizations
9. Need more flexibility and less paperwork

Proposed Solutions → Quite URGENT to do

1. Create strategic axis in RIF for funding CERN programs
2. Introduce PhD fellowships at sufficient level (universities, RIF programs, IKYK, other Organizations)
3. Attract engineers, physicists, material and computer scientists to formulate critical mass in CERN projects
4. Provide incentives to industry and SMEs to participate in CERN tenders and support researchers
5. Reduce unnecessary paperwork

Perspectives for the Future (2021-)

(1.) Upgrade of CMS for the HL-LHC phase

> **High Granularity Calorimeter upgrade:** PENDING
 Develop stations for testing readout electronics & power supplies
 Work on flexible electronics, Integrated circuits, rad hard materials

Trigger upgrade:
 Work on Level 1 trigger algorithms and simulation RUNNING

> **Data testing:**
 Stations for remote monitoring of data quality UNDER DEVELOPMENT

(2.) LHC phenomenology and CMS Analysis

> **Searches for Dark Matter and additional Higgs bosons**
 Expand on running experimental projects UNDER DEVELOPMENT

(3.) Education Program

> **Virtual visits at CERN**
 Development of Distance Learning programme PENDING

> **Host CERN Schools, Conferences and Workshops**
 Accelerator School, Analysis Workshops PENDING

> **IPPOG (signature pending ~1000 euro/year)**
 Masterclass program for high-school students RUNNING

Perspectives for the Future (2021-)

(4.) Medical Physics Collaboration with CERN

> **HERMES Network (Greece, Cyprus, CERN):**
 Universities, medical centers, companies, fellowships DEVELOPED

> **Development of better detectors:**
 Crystals, SiPMs and detectors with better resolution NEW PHASE

> **Cyclotron Center for Radiopharmaceuticals & diagnosis:**
 Promotion of Business Plan, PET scanning DEVELOPED
 Implementation of construction, funding PENDING

> **Cyclotron Center for Proton Therapy**
 Hadron therapy, radiation oncology, FLASH therapy UNDER DEVELOPMENT
 Implementation of construction, funding PENDING

> **KT Forum at CERN on Medical Applications** RUNNING

> **Collaboration with Bank of Cyprus Oncology Center** RUNNING

> **(5.) Collaboration on Data Science**
 Develop program on AI & Deep Learning: UNDER DEVELOPMENT



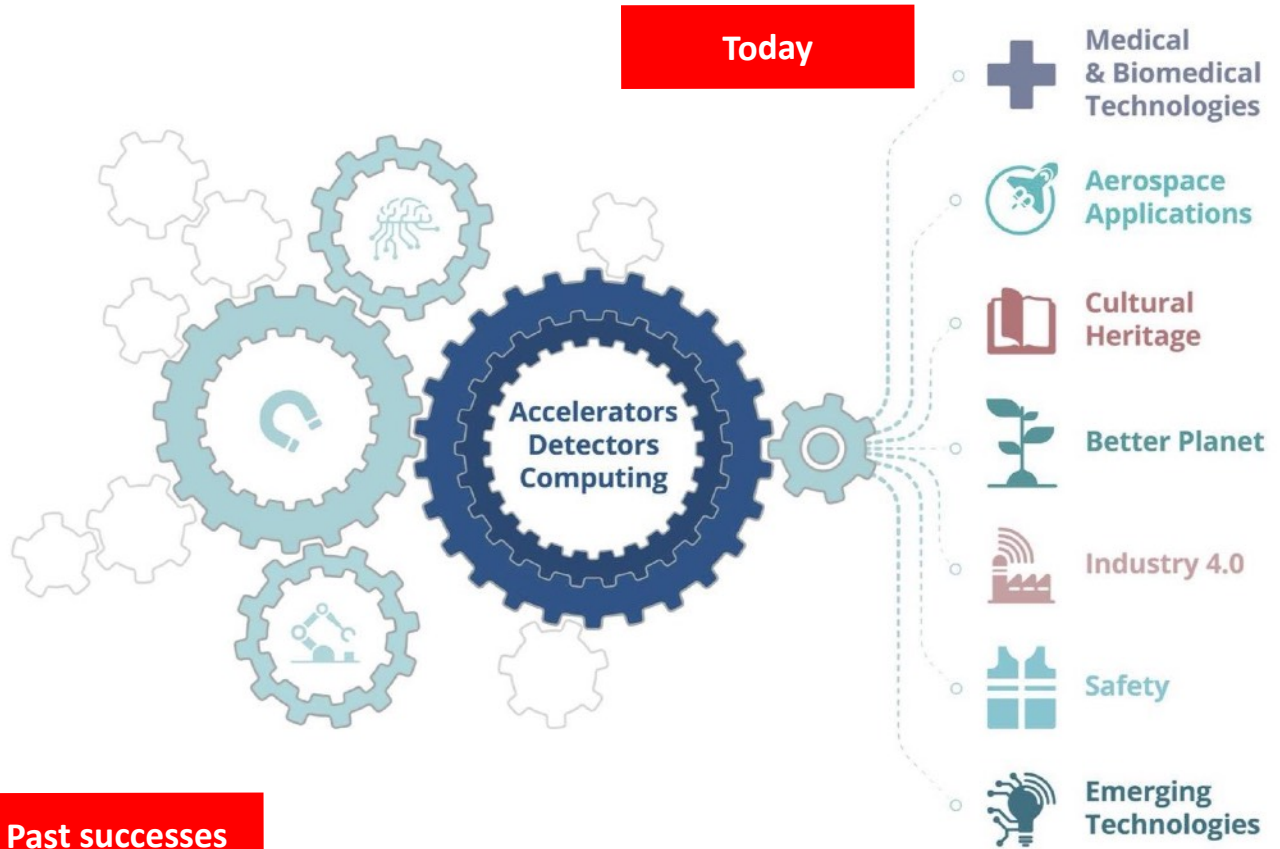
CERN Knowledge Transfer

CERN's Timepix particle detectors, developed by the Medipix2 Collaboration, help unravel the secret of a long-lost painting by the great Renaissance master, Raphael

CERN Knowledge Transfer: Chances for Thai inventors & Tech Startup

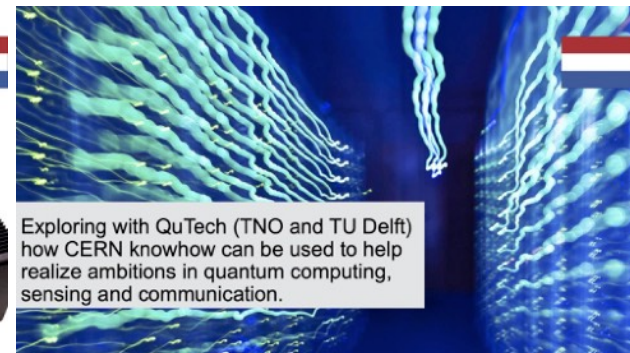
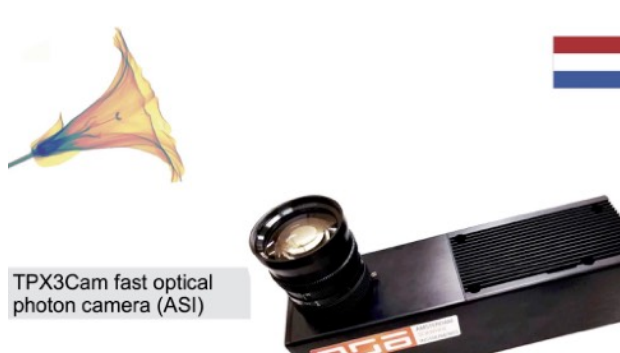
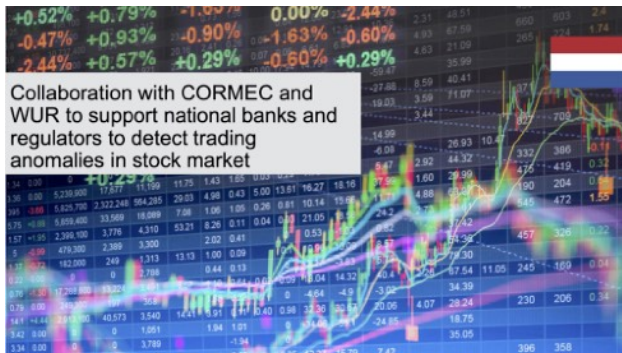
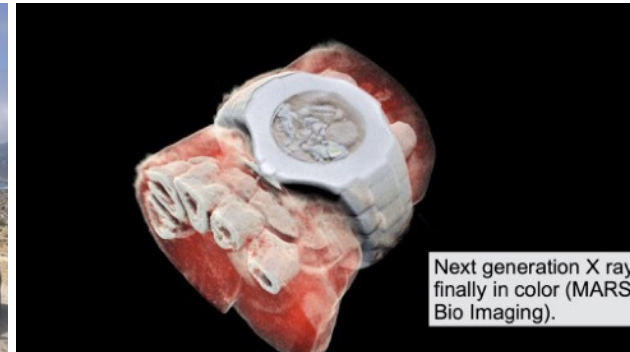
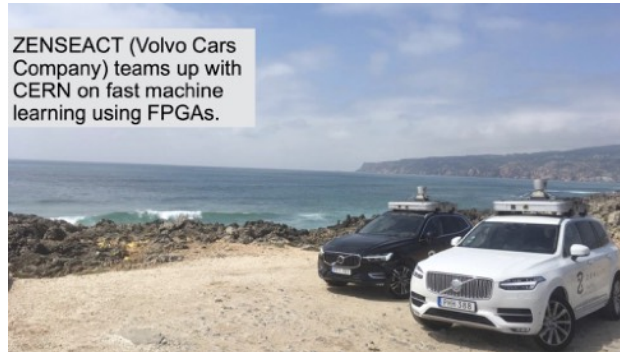


Past successes



CERN Knowledge Transfer: Chances for Thai inventors & Tech Startup

Examples of today team-up



CERN Knowledge Transfer: Matching with Thai (frontier) researches

CERN aerospace-related competences & expertise

- Radiation monitoring and dosimetry
- Radiation-hardened components
- Radiation-tolerant systems
- Superconducting and cryogenics
- Thermal management, advanced materials and processes
- Big data handling and analysis tools
- Irradiation and cryogenic testing facilities

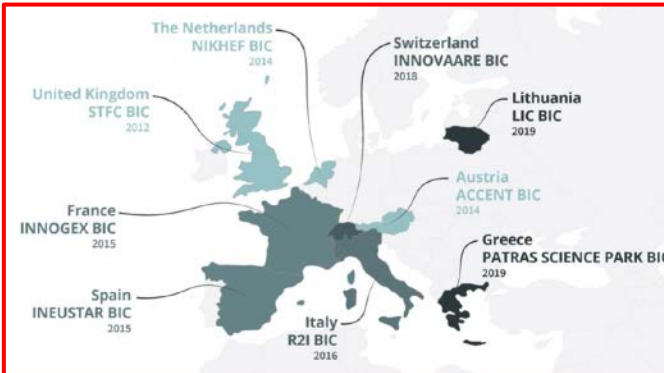
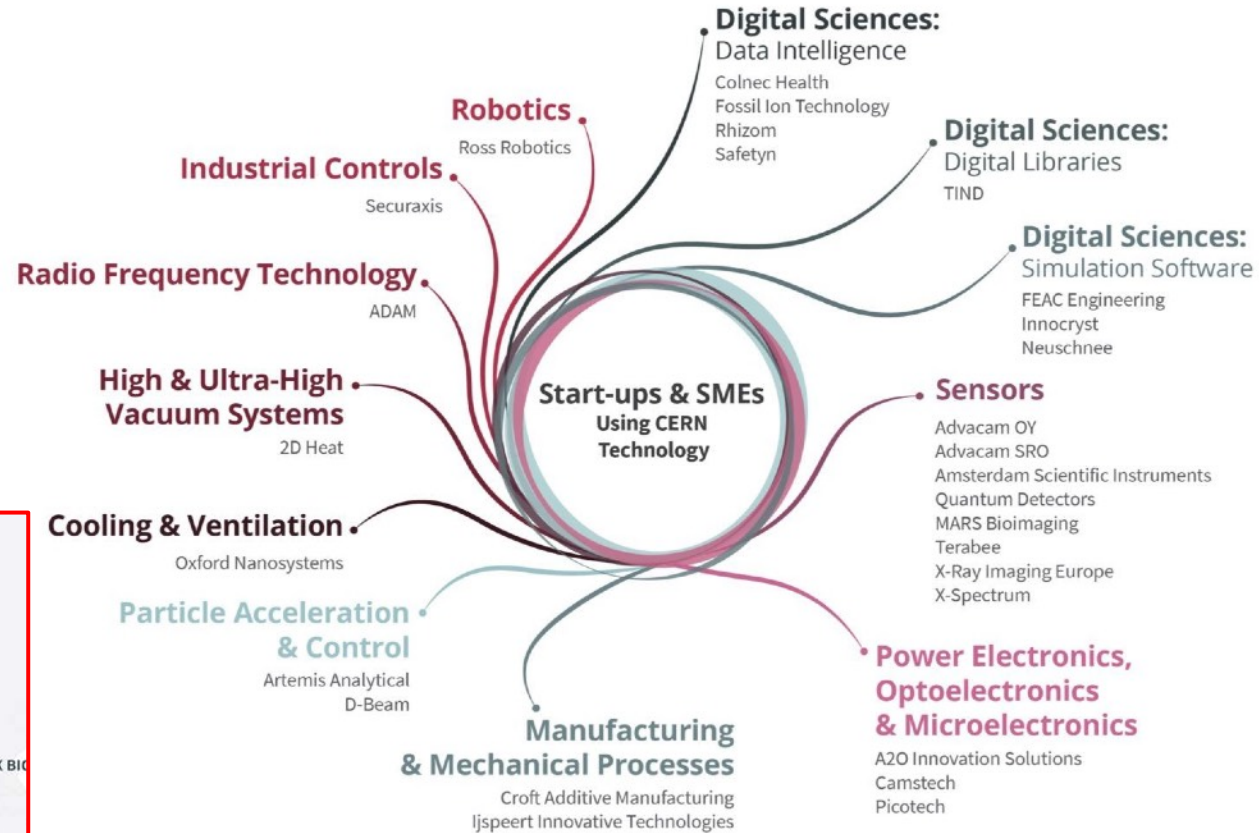
Medical & Biomedical

- Radiation and hadron therapy
- Radioisotopes
- Imaging
- Dosimetry
- Simulation and computing



Quantum@CERN for Thai research program

- quantum computing and algorithms
- quantum theory and simulation
- quantum sensing, metrology and materials
- quantum communication and networks



Summary

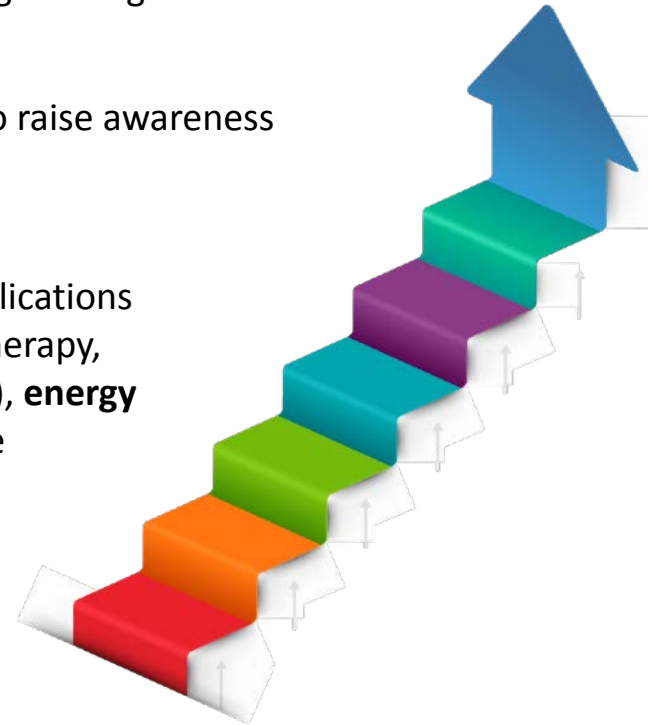
12 years with Thai-CERN programs (22 years after the first visit of H.R.H.), Thai has a great chance to participate in a global effort of scientific research and to increase our person-power in Science and Technology. ***It is a time to look forward to the next step.*** In this talk, we focus on Thai industry and engineering.

Industrial Procurement

CERN assists Associate Member in organising industrial events in the AMS to raise awareness of CERN within industry, and explore potential avenues of collaboration.

Knowledge and Technology Transfer

CERN endeavours to maximise this knowledge transfer to MS and AMS. Applications relevant, for example, to the fields of **medicine** (accelerator-based cancer therapy, imaging, etc.), **information technology** (data science, cloud computing, etc.), **energy and the environment** are excellent candidates for the transfer of knowledge and technology between CERN and an AMS. CERN also supports entrepreneurship and start-up activities focused on CERN technologies in the MS and AMS.



Industrial Procurement

- If interest, organizing events between CERN and Thai industry
- Match Thai product catalog, and CERN shopping list
- Any supports from Thai-CERN program to industries?
- If we see potential, we need to discuss on how to move

Knowledge and Technology Transfer

- Question to answer: Can CERN technology help us?
 - Frontier: Space
 - Frontier: Quantum
 - Medical
 - ... Startup or SMEs
- How to kick start?
 - Workshop with CERN KTs and what CERN has in hand



HOMEWORK

References

1. Thailand-CERN-Associate Membership [[Link](#)]
2. Rights and benefits related to CERN associate membership general [[Link](#)]
3. Geographical Enlargement of CERN [[Link](#)]
4. CERN: Bridging the gap between science and business [[Link](#)]
5. Doing Business with CERN [[Link](#)]
6. Following the positive report of the CERN expert group, the CERN Council votes on the opening of accession negotiations with Latvia [[Link](#)]
7. รายงานความก้าวหน้าของ Associate members ในด้านต่าง ๆ (ฟิลิกส์ อุตสาหกรรม บริษัททางด้านเทคโนโลยีที่ได้ประโยชน์จาก เซิร์น) [[Link](#)]
8. Engagement to FCC [Link: [Indico](#)] [Link to slides: [Link](#), [Link](#), [Link](#)]
9. CERN Quantum Technology Initiative [Link: [Web](#); [Roadmap](#)]

Backup

1. Participation in CERN's Experimental Particle Physics Programme

- CERN providing assistance to set up laboratory and workshop infrastructure in the AMS that could subsequently provide a contribution to the LHC experiments through the design, R&D, construction and testing of new particle detectors in the AMS for the LHC experiment upgrades. **This model can also be considered for any other aspect of CERN's particle physics programme of interest to the AMS.**

1. Participation in CERN's Accelerator Projects

- Contribution of an AMS to the high-luminosity upgrade of the LHC (HL-LHC), as well as to a future Higgs factory and a 100 km energy-frontier Future Circular Collider (FCC).

1. Attendance at the Council and its Committees

- Help to shape the international scientific agenda at the highest level.

1. Industrial Procurement

- Usually, at an early stage of Associate Membership CERN proposes and assists in organising industrial events in the AMS to raise awareness of CERN within industry, and explore potential avenues of collaboration.
- For non-European industries, working with CERN can be a means of gaining a strong foothold in the European marketplace – often through shared contracts.



เราได้รับผลประโยชน์นี้อยู่แล้ว



ผลประโยชน์ใหม่ที่จะได้รับ



เราได้รับผลประโยชน์นี้อยู่แล้ว
แต่เราจะได้ผลประโยชน์มากขึ้น

5. Knowledge and Technology Transfer

- CERN endeavours to maximise this knowledge transfer to MS and AMS. Applications relevant, for example, to the fields of **medicine** (accelerator-based cancer therapy, imaging, etc.), **information technology** (data science, cloud computing, etc.), **energy** and the **environment** are excellent candidates for the transfer of knowledge and technology between CERN and an AMS. CERN also supports entrepreneurship and start-up activities focused on CERN technologies in the MS and AMS.

5. Capacity-building through training and temporary employment

- Staff positions (fixed term, usually five years)
- One- to three-year studentships
- Two- or three-years contracts for entry-level professionals
- Summer students 



เราได้รับผลประโยชน์นี้อยู่แล้ว



ผลประโยชน์ใหม่ที่จะได้รับ



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5. CERN Schools of Excellence

- Advanced schools in high-energy physics, accelerator science and high-performance computing

5. High School Teacher Programmes

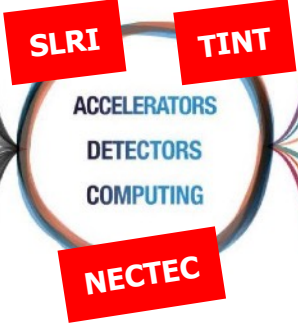
Financial contribution of an AMS will return to the AMS in the form of direct benefits, covering scientific, technical and administrative aspects.

การถ่ายทอดเทคโนโลยีจากเซิร์น

เอกสาร [4]

- Cryogenics
- Cooling & Ventilation
- High & Ultra High Vacuums
- Magnets
- Superconductivity
- Metrology
- Manufacturing & Mechanical Processes
- Particle Tracking & Radiation Monitoring
- Electronics
- Microelectronics
- ICT
- Industrial Controls & Simulations
- Materials
- Beam Component & Systems
- Radio Frequency Technology
- Radiation Protection
- Testing Facilities

Quantum ?



โรงเรียนแพทย์

Direct connection with CERN activities

Science education

- MEDICAL & BIOMEDICAL TECHNOLOGIES
- AEROSPACE APPLICATIONS
- SAFETY
- ENVIRONMENT
- INDUSTRY 4.0
- EMERGING TECHNOLOGIES



NARIT Thai Space Consortium

Boosting EEC industry



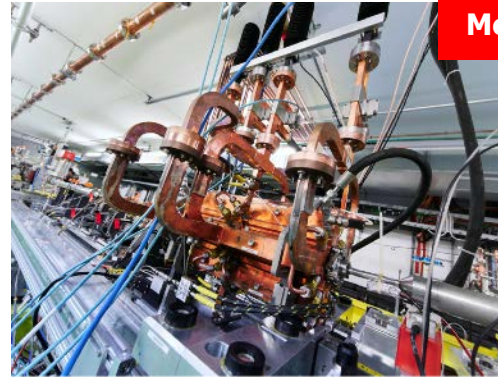
NSTDA - BIOTEC

And somethings fit to Thai needs, e.g.

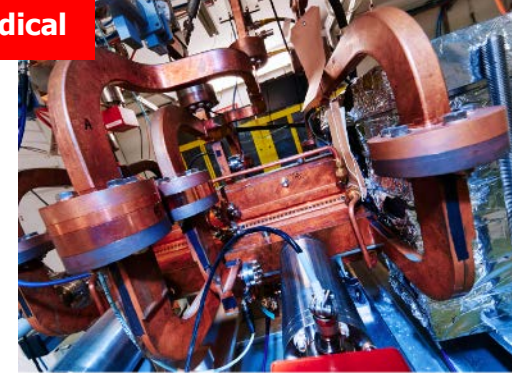
ตัวอย่างการถ่ายทอดเทคโนโลยีจากเซิร์น

Paving ways for electron-based cancer therapy; fruits from CLIC

- Very high-energy electron beams to focus on a small, dense spot [[Link](#)]
- FLASH therapy [[Link](#)] [[Link](#)]



Medical



Space



Sparking breakthroughs in radiation protection for spacecraft, aviation and accelerators [[Link](#)]

- to carry out a thorough review and characterisation of the particle beams used to qualify commercially available electronic components,
- to develop guidelines for radiation testing and verification of radiation-tolerant space equipment and small satellites based on commercial electronics.
⇒ a basis for a new European radiation testing standard

ความพยายามในการขยายการใช้เทคโนโลยีของเซิร์นกับงานด้านอื่น ๆ

In 2020, the CERN Knowledge Transfer group began exploring possible knowledge-transfer opportunities with companies and institutes within the European quantum community.

[\[Link\]](#)

To look for potential collaborative R&D projects to develop new quantum solutions.

Quantum

CERN key competences:

- Measurement & control of quantum-scale systems
- Picosecond Synchronisation
- FPGAs for quantum simulators
- Digital Low-Level Radio Frequency (LLRF) control systems
- Cryogenic system design, measurement & control
- Vacuum system design & control (HV, UHV, XHV)
- Thin film coatings for high-performance applications
- Laser devices

Education: STEM



How to use the detector technology for secondary education [\[Link\]](#)

The range of experiments can be done including the analysis of background radiation, the identification of specific particles, the study of cosmic rays or the demonstration of the attenuation of particles passing through different materials.

กองทุนเพื่อการส่งเสริมการนำเทคโนโลยีไปใช้ประโยชน์



CERN launches Technology Impact Fund to address global challenges [[LINK](#), March 2021]

To bridge the gap between the technology developed for research at CERN and its potential applications to address societal challenges. The Fund was launched with support from CERN's Knowledge Transfer group and the CERN & Society Foundation.

Financial support provided via the CERN Technology Impact Fund will enable CERN technologies to be adapted for use in wider society, with a particular focus on potential contributions to the UN 17 SDGs.

First selected technology: Compact Precision Laser Inclinometer used to measure the ground movements around CERN's ATLAS detector ⇒ lower-cost and more precise alternative to existing earthquake detection devices.

International Cooperation Agreement (ICA)



Associate Member States



1. ศึกษาความเป็นไปได้ และผลประโยชน์ที่ประเทศไทยจะได้รับจากการขยายความร่วมมือระหว่างไทยกับเซิร์น

1. นำความขึ้นกราบบังคมทูลสมเด็จพระกนิษฐาธิราชเจ้า กรมสมเด็จพระเทพรัตนราชสุดาฯ สยามบรมราชกุมารี

1. นำเสนอผลการศึกษาต่อ รมต.อว. และคณะรัฐมนตรีเพื่อพิจารณา

1. รัฐบาลส่งเอกสารแสดงความสนใจต่อการเข้าร่วมเป็น Associate member states ถึง CERN Council

a. the status and organization of research and particle physics in the State concerned, including the current level of expenditure in research; ✓

b. the current level of expenditure in research and the anticipated impact of CERN Membership or Associate Membership, as the case may be, on domestic particle physics research; ✓

c. a projection of the evolution of the economy & the research funding over a 5-year timescale;

d. official data on the State's economic situation and forecasts;

1. CERN Council แต่งตั้ง CERN Task Force เพื่อประเมินประเทศไทย

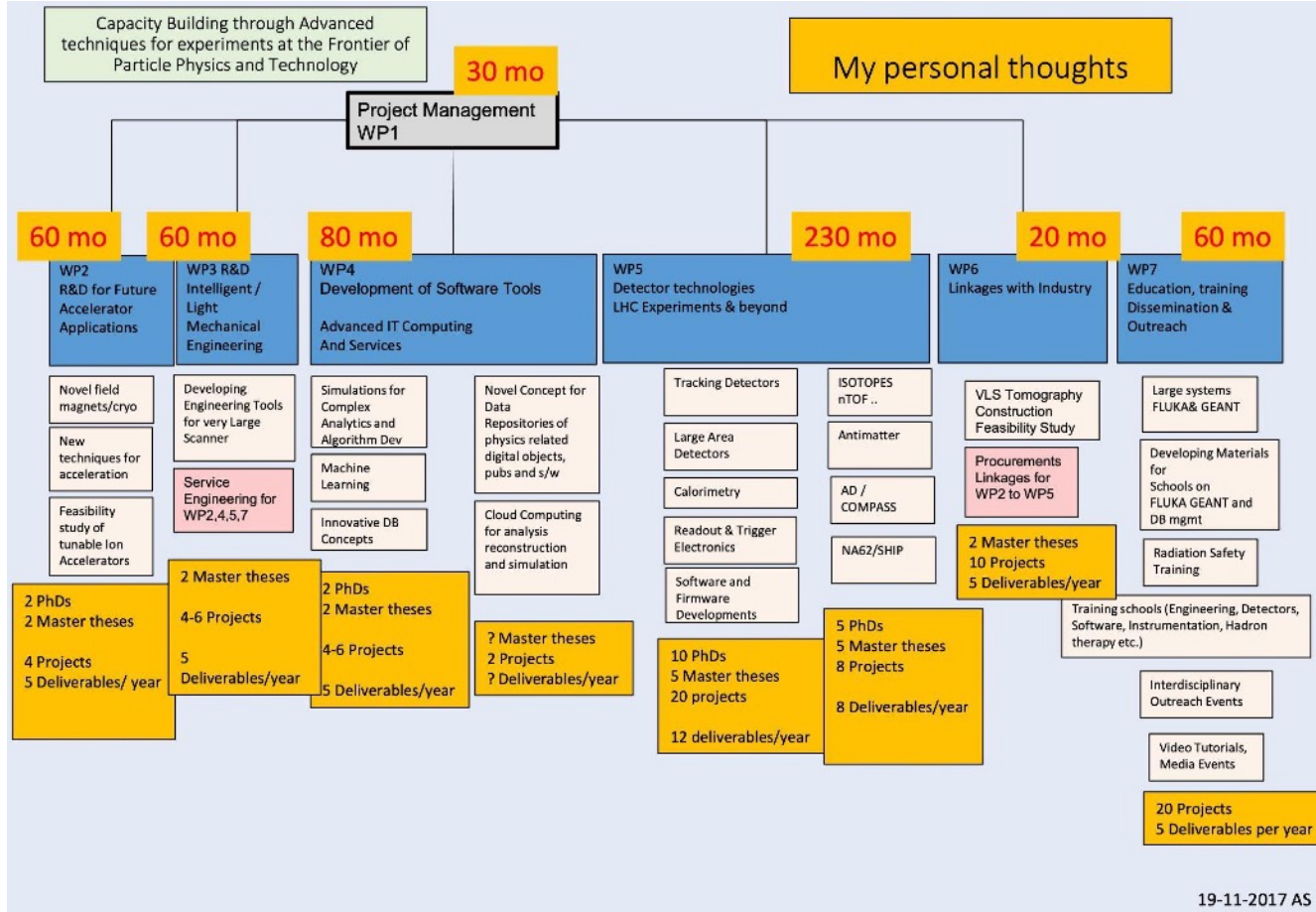
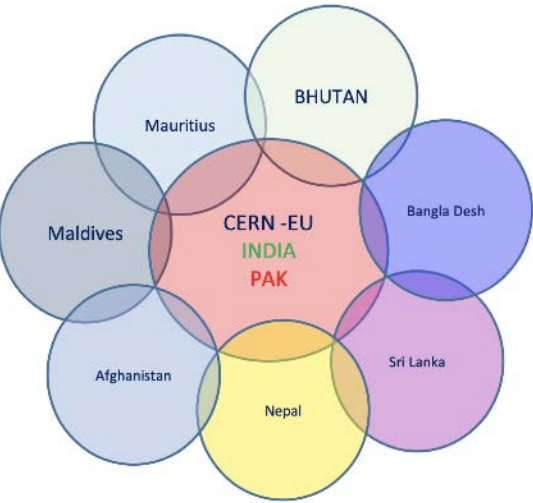
a. whether Thailand has the political will and appropriate financial instruments to ensure meaningful participation in CERN's scientific programs in the long term;

b. how strong the country is in the high-energy physics community, whether it is sufficiently funded to participate fully in CERN science projects;

c. whether Thai industry has the sufficient capacity to successfully participate in CERN procurement processes.

1. Task Force นำเสนอผลการประเมินประเทศไทยแก่ CERN Council

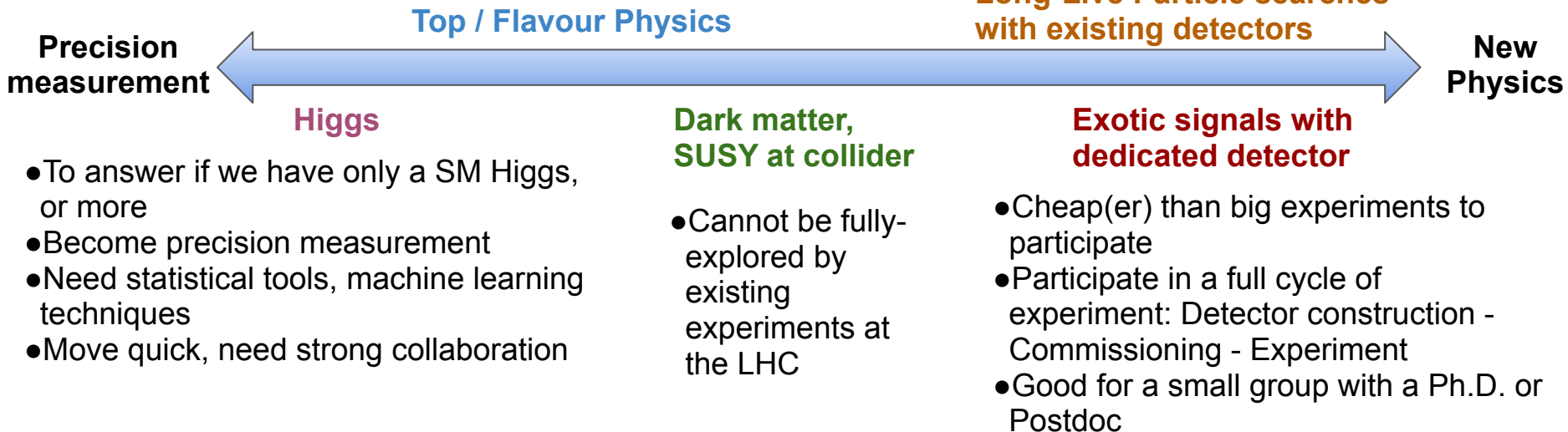
ด.ย.ความร่วมมือในเอเชียใต้ ⇒ หนทางของ Southeast Asia ในการร่วมพัฒนากับเซิร์น



Participations in other (small) experiments: for the next 10 years

- LHC is the only machine to produce top, until the new FCC-hh comes (2050++, after FCC-ee)
- High-luminosity LHC may reveal unexpected results, lead to BSM
- Need precision measurement to test SM predictions

- Use infrastructures of big experiments
- Study exotic signals with dedicated trigger, reconstruction
- Uncovered models to try





14 OCTOBER, 2021 [[Link](#)]

CERN Quantum Technology Initiative unveils its strategic roadmap shaping CERN's role in the next quantum revolution. The roadmap builds on high-quality research projects already ongoing at CERN, with top-level collaborations, to advance a vision and concrete steps to explore the potential of quantum information science and technologies for high-energy physics.

4 main quantum research areas including:

- quantum computing and algorithms,
- quantum theory and simulation,
- quantum sensing, metrology and materials,
- quantum communication and networks

Benefits to Thai Quantum?