Infrastructure session
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Introduction
Alain Blondel

Today's session is directed primarily to the issue of Infrastructures for the High Energy physics program.

This is perceived as a most important question in view of the upcoming upgrade of the European Strategy for Particle Physics by **C.E.R.N.**

Bruno Moor as representative of the Swiss Government reminded us that Switzerland, as a host state, has a great interest in the future of CERN, and the Swiss institute for Particle Physics (CHIPP, i.e. us) has an important role to play.

Before we enter this discussion it is fit to recall the large non accelerator infrastructure projects that have been discussed in this meeting

(I apologize for omissions or errors, I will be happy to be corrected)

Neutrinos (Pillar)

-- long baseline projects (funding ETH,UNI,
2010-? T2K and upgrade (hope significant results by 2025 on CPV and Mass hierarchy)
2026-? **DUNE and HyperK**
-- neutrinoless double beta decay
-- Searches for RH/sterile/HNL neutrinos and other Dark Sector candidates
-- NA62/64, **SHIP** (part of CERN proess)
-- Searches at B-factory, LHC, Z,H Factory **(part of high energy collider program)**
link between the pillars (colliders have contributed a lot to neutrino physics!)

Comments

DUNE and HyperK :

SERI(2015) has earmarked a sum of ~9 MCHF for the Long Baseline program at Fermilab

CHIPP "Given the physics potential of HyperK, the CHIPP considers that it is premature to close the possibility of contributing to HyperK at this moment.

CHIPP recommends (in 2016) to keep about 1/3 of the funds for the future discussion which should take place in two years".

Neutrino community to discuss among themselves

<u>Conditions to fullfill</u>

-- HyperK approved
-- strong interest by AB' successor (F. Sanchez)
-- discussion and support by the community

Possible CHIPP conclusions

- Recommendation to SERI for possible dedicated funding for the long baseline ν programme infrastructure:
  - Given the clear interest and commitment by the two CH groups, the CHIPP recommend the SERI to start discussing with the US to identify possible CH contribution to the infrastructure of LBNF/DUNE. This could even include toward the accelerator or beam line.
  - Such an initiative would call for an extra dedicated funding by SERI.
  - Given the physics potential of the project, the CHIPP considers that it is premature to close the possibility of contributing the the HyperK at this moment.
  - The CHIPP recommends that if the SERI were able to provide the dedicated funding, to keep about 1/3 of the funds for the future discussion which should take place in about two years. This would then still allow to make contribution to the infrastructure of the HyperK if there were strong push to join the project by the CH community and the project were approved by the Japanese government at that moment.

CHIPP board Oct. 2016

Approval Status:

-- T2K is running and progressing towards CPV observation.

-- T2K- NDupgrade is approved, under prototyping and funding requests, CERN participation.

-- DUNE is approved , construction started, large prototyping campain at CERN

-- part of funding secured, rest being seeked energetically (1.5-2 B$)

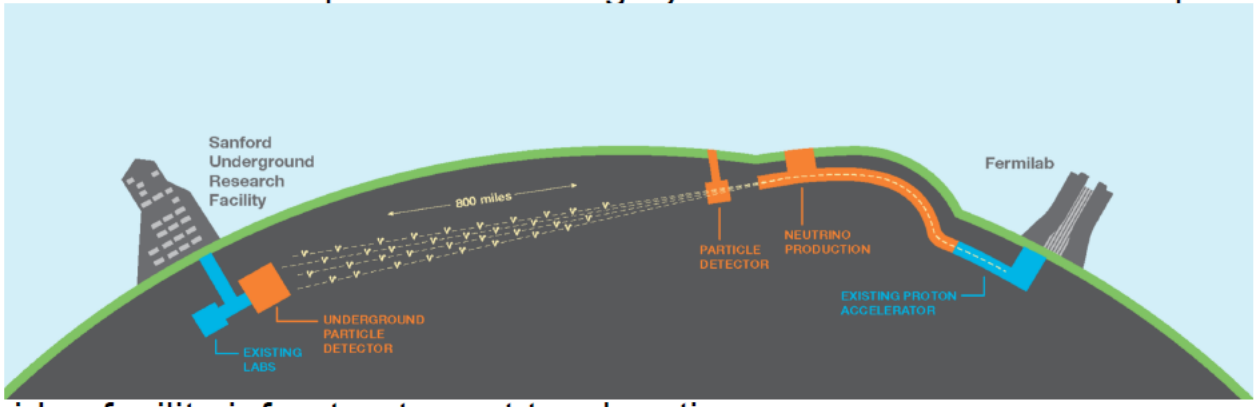
-- HyperK is proposed in priority to Japan Government for signature (but not signed yet)

proto legal entity at UNI Tokyo (0.5 B$ from Japan +20% foreign)

comment the two experiments are complementary: each benefits from the existence of the other some specificities (ex: HyperK for proton decay and astrophysical neutrinos)

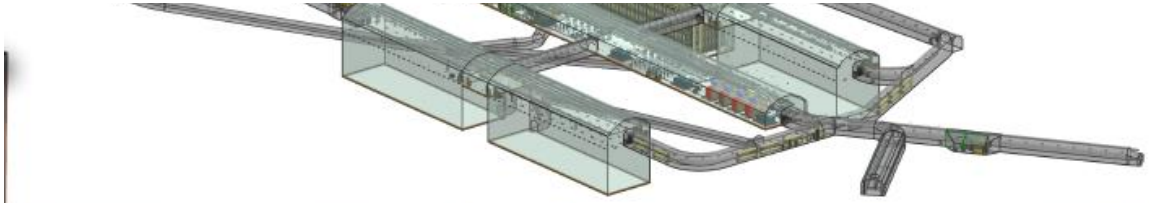
Long Baseline Neutrino Facility - LBNF

LBNF-DUNE (Deep Underground Neutrino Experiment) is one of the Research Infrastructures identified for potential funding by SERI in the 2015 Roadmap.



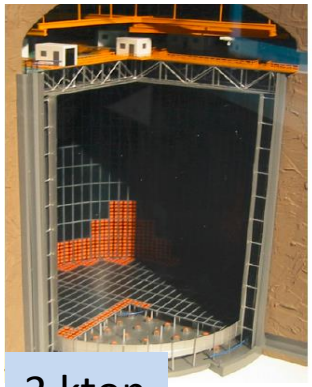
LBNF Provides facility infrastructure at two locations:

Near site: Fermilab, Batavia, IL – facilities to create neutrino beam
Far site: Sanford Underground Research Facility, Lead, SD – facilities to support



summer 2017:
DUNE construction started!

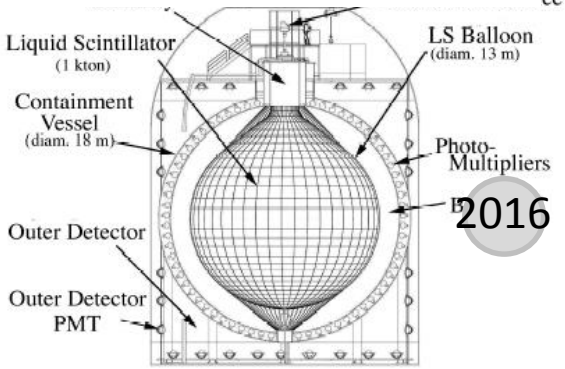
KamiokaNDE (1983-1996)
SN and solar neutrinos



3 kton

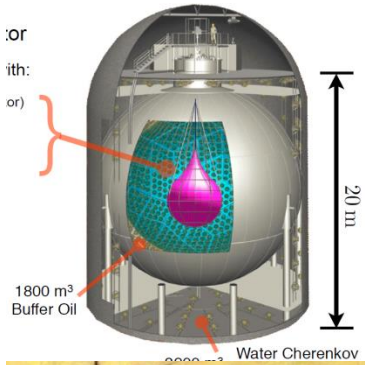
2002

KAMLAND (1998-2006)
reactor neutrinos, Δm^2_{12}



2016

KAMLAND-Zen (2013— 0νββ

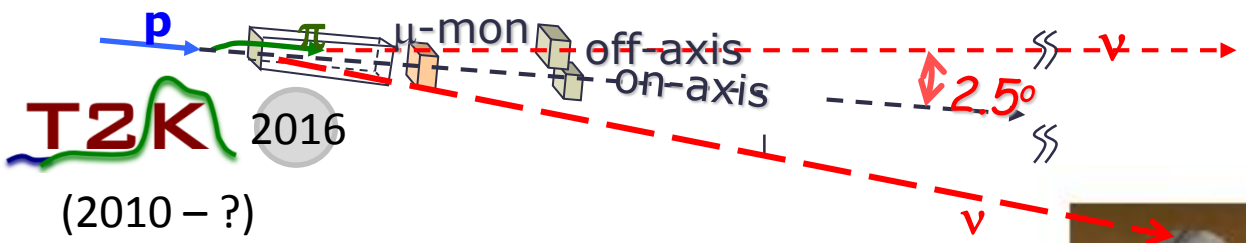


50 kton

SuperKamiokande (1996–
+ Gadolinium (2019 -

2015

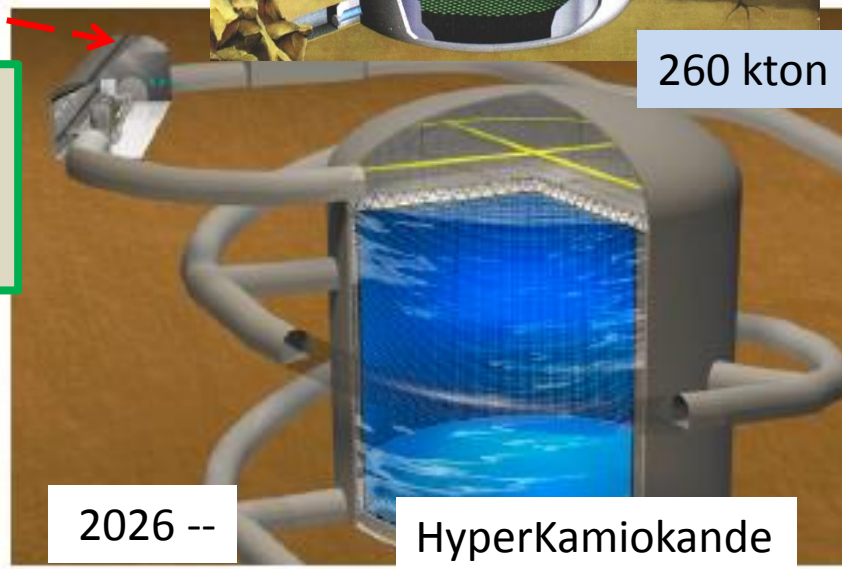
2016



T2K 2016

(2010 – ?)

260 kton



2026 --

HyperKamiokande

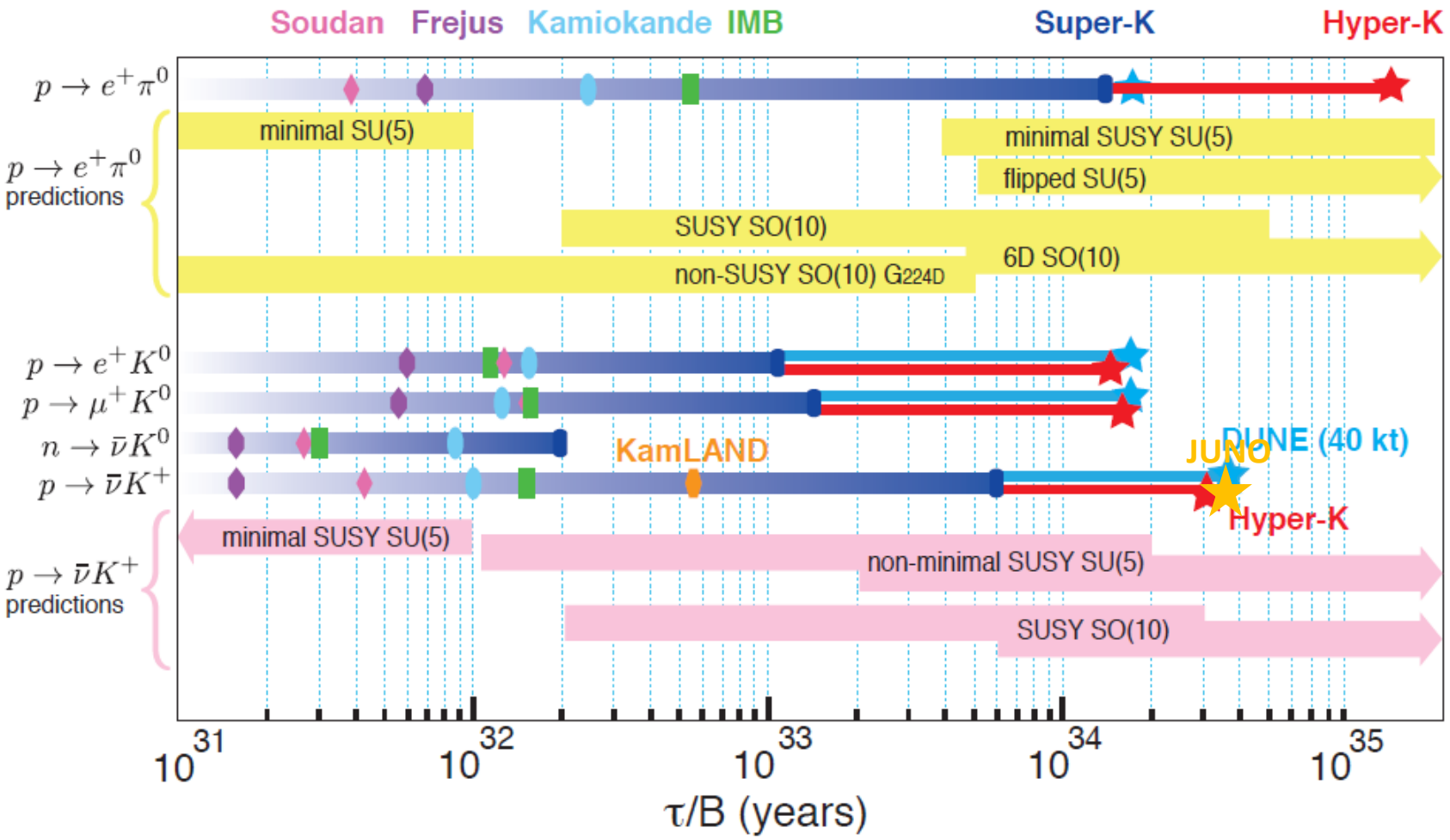
The Japan Neutrino program

A powerful example of INFRASTRUCTURE **SYNERGIES**
+ 2 nobel prizes and 3 Breakthrough prizes!

Nobel

Breakthrough

search for proton decay



NB JUNO starts in 2021

Neutrino–less double beta decay

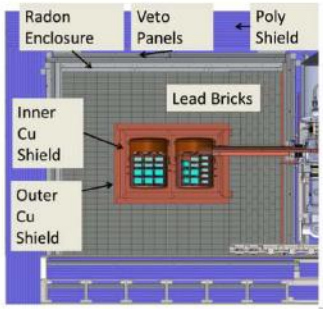
➔ tests the existence of a Majorana mass term in the neutrino mass generation

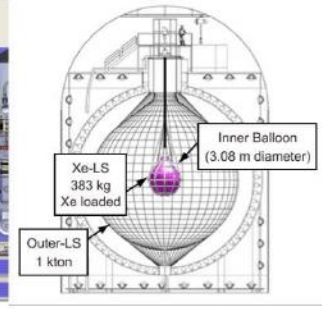
$0\nu\beta\beta$ landscape

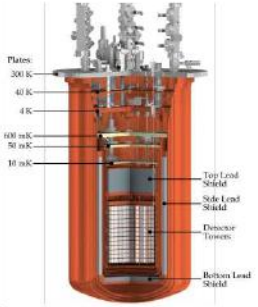
Majorana and CUORE published in **Phys. Rev. Lett. 120, 132503 (2018)**, too, EXO-200 in 072701 of the same volume.

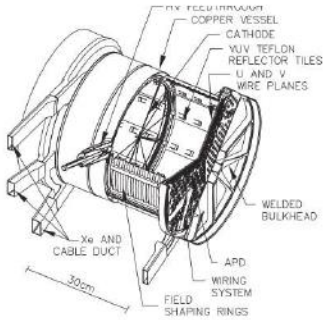
UZH contributions

Experiment	Isotope	M (kg)	Sensitivity (10^{25} yr)	Limit (10^{25} yr)
GERDA	^{76}Ge	31	5.8	8.0
Majorana	^{76}Ge	26	2.1	1.9
KamLAND-Zen	^{136}Xe	343	5.6	10.7
EXO	^{136}Xe	161	1.9	1.1
CUORE	^{130}Te	206	0.7	1.5





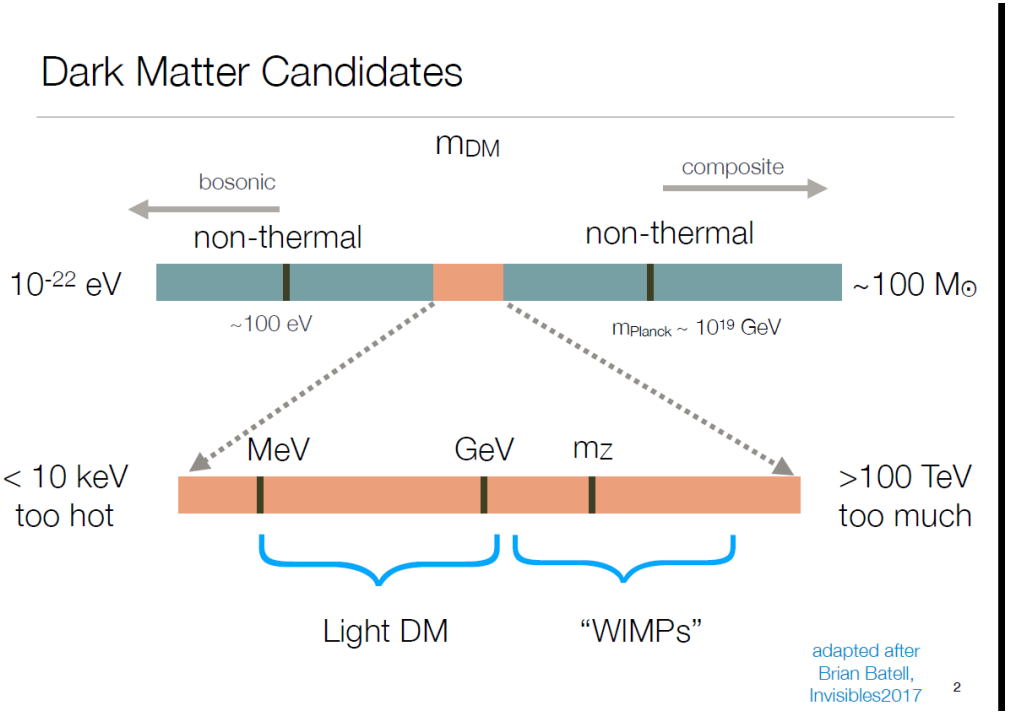




- Calibration system
- Low neutron emission ^{228}*Th* calibration sources
- WLS foil for the LAr veto
- BEGe detectors

Funding through SNF

Dark Matter Searches



Switzerland groups mainly on WIMPS, both at colliders and in low noise experiments

Xenon, ArDM

The ArDM project at LSC

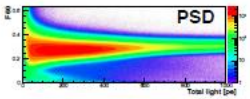
ETH Eidgenössische Technische Hochschule Zürich Swiss Federal Institute of Technology Zurich

LSC Laboratorio Subterráneo de Canfranc

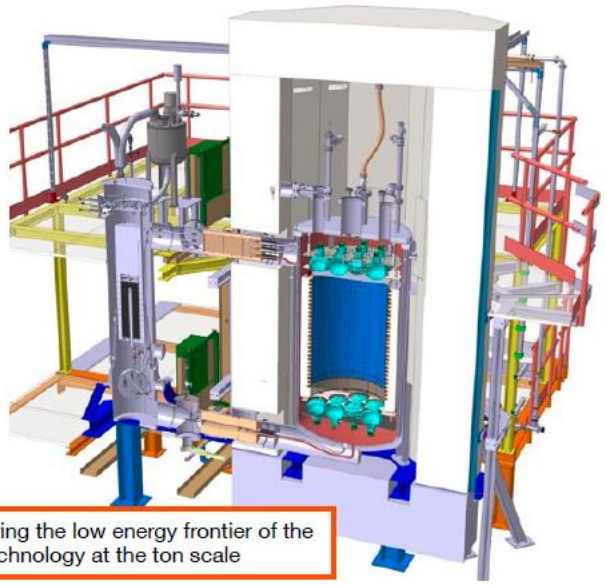
Installed at LSC, Spain

First operation of a dual phase tonne-scale LAr DM TPC

- Experiment characterised from Run I data
  - Low background goal confirmed
  - ER BG validation -> NR BG extrapolated
  - PSD verified



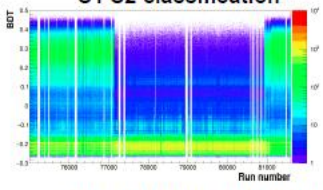
- Run II in dual phase operation started recently



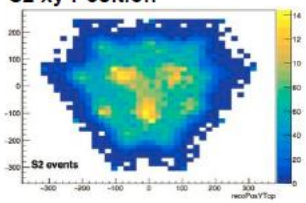
Exploring the low energy frontier of the LAr technology at the ton scale

- First preliminary results from dual phase operation

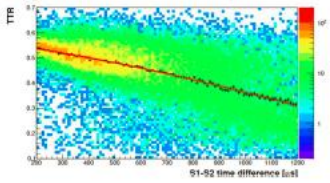
S1 S2 classification



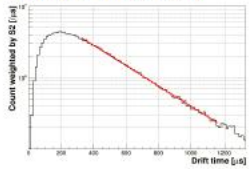
S2 xy Position



z position reconstruction



Purity assessment

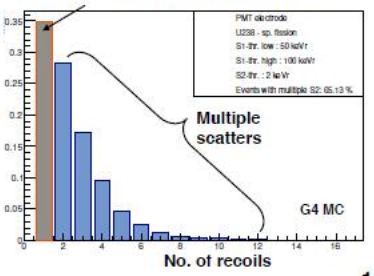


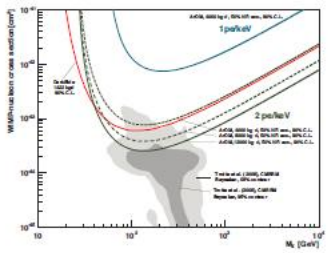
- Next Goal:

  Neutron IA and verification of sensitivity

11

Single scatter neutrons (indistinguishable BG)

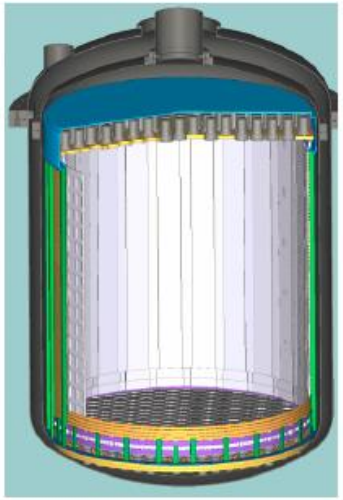
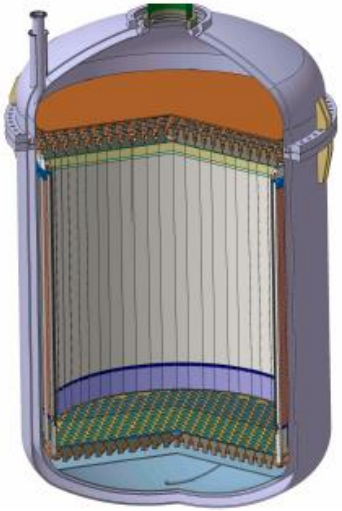




1 neutron SS event per ~20d expected

The XENON and DARWIN Programme

Universität Zürich[UZH]

XENON10	XENON100	XENON1T	XENONnT	DARWIN
				
2005-2007	2008-2016	2012-2018	2019-2023	2020+
15 kg	161 kg	3200 kg	8000 kg	50 tonnes
~10^{-43} cm^2	~10^{-45} cm^2	~10^{-47} cm^2	~10^{-48} cm^2	~10^{-49} cm^2

DARWIN is listed in SERI 2015 and in the APPEC road map.

Multi messengers astroparticle physics

neutrinos

ICECUBE High energy sources (also atmo neutrino)

Gamma Rays

Magic (pioneer in Switzerland)

CTA the large Swiss common project from CHIPP

-- creation of a new laboratory as European organization

Gravitational Waves

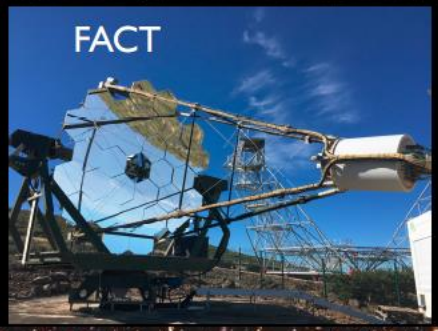
no experimental program within CHIPP

but of course great interest in neutrino+gamma ray+ GW correlations!

Multi-Messenger Astrophysics

Teresa Montaruli
University of Geneva

ICECUBE



Two new «labs»!

A new laboratory, for now largely administration and legal processes.

Present Government: CTAO gGmbH

Council of 14 shareholders from 11 countries

Employees:

- Director
- Project Manager
- Lead System Engineer
- Legal advisor+HR, administration and outreach (8)
- Infrastructure (3.5)
- Science and Engineering (4, plus 6 secondments)

Need much more engineering people

Advisory committees to council:

- Administrative and Finance committee (AFC)
- Scientific and technical advisory committee (STAC)
- In kind contribution review committee (IKRC)

cherenkov telescope array

CTA project phases and resources

comments to the table in the next slide:

(1) Future years correspond to my personal estimation, there is no official time schedule yet.

(2) Core costs: These numbers are defined by the council, based on costs estimates of the PO

(3) Transitional measures by SBFI: As CTAO is a research infrastructure like Cern, ESS or ESO, construction and operation fraction of CH is financed directly through the SBFI. Due to several reasons the start of the construction was delayed, therefore SBFI provided additional means to bridge the gap between the end of the FLARE funding and the start of the official construction.

(4) Operation cost fraction for each member country will be defined in the ERIC regulations.

(5) Scientific exploitation: Both the participation in the Key Science Projects (KSP) and the individual observation proposals need to be financed (mainly salaries). This has not been discussed yet, but I would assume, that a natural financial source would be regular SNF requests and local University grants.

CTA project phases and CH resources

Phase	*Organisation*	*Years (1)*	*Activities*	*CORE costs (2)*	*Swiss contr. to CORE [source]*	*Local Swiss activities [Source]*
pre-con-struc-tion	Project Office DoI / FP7	before 2014	R&D	Run project office	25 k€ operation cost [FLARE]	R&D and Prototypes of SST-1M, software, AMC, FlashCam [regular SNF, FLARE, SINERGIA, local University grants]
	GmbH	2014 - 2017	R&D, prototyping	Operate GmbH, 2.5 M€ / y	2% (Minimum), 50k€ / y [FLARE]	
now →	GmbH / ERIC	2018 - 2020	Complete System design, CDR, Start infrastructure construction, create ERIC	2.7 .. 5 M€ / y	2% (Minimum), 53k .. 100k€ / y [SBFI transitional measures (3)]	Prototype evaluation, documentation, reviews. [SBFI transitional measures]
Con-struc-tion	ERIC	2021 - 2025	Telescope construction and installation Early science	250 / 400 M€ total construction costs	7.3 M€ of which 25% cash: MoU. [SBFI:parliament decision 2016]	Construction guided by CTA project management.
Opera-tion	ERIC	2026 - 2056	Observatory operation	>= 20 M€ / y (full project is assumed)	Fraction to be determined, [SBFI (4)]	Scientific exploitation through KSP and individual obs. programs. [tbd (5)]

CHIPP in the sky

- **3 missions successfully launched so far**
- **AMS-02 (UNIGE, ETHZ): launched in May 2011, in operation, until at least 2024**
  - Significant contributions to the silicon tracker construction
  - Data analyses ongoing: Si flux, Be isotopes, high Z charge correction, …
- **DAMPE (UNIGE): launched in Dec. 2015, in operation, until at least 2023**
  - Proposer and leading institute for the Silicon-Tungsten Tracker (STK)
  - Lead contributor to the electron flux measurement published in Nature
  - Data analyses ongoing: p and He flux, ML for electron ID, photon analyses, …
- **POLAR (UNIGE (DPNC+ASTRO), PSI): launched in Sept. 2016, operated for 6 months**
  - Proposer and leading institutes of the payload (Gamma-ray Burst Polarimeter onboard the Tiangong-2 spacelab)
  - 52 Gamma-ray Bursts observed, significant first results on the brightest ones to be published soon
  - Data analyses ongoing: detailed GRB polarization and light curve analysis, pulsar studies

(possible) Future projects in next 10-15 years

- **HERD: next generation HE cosmic ray detector, acceptance 10x DAMPE, 30xAMS**
  - Expected approval in 2018, launch ~2025 to the Chinese Space Station (2022)
  - CHIPP: develop a fiber tracker using LHCb technology
- **eASTROGAM: MeV-GeV gamma-ray observatory (both Compton and Pair modes)**
  - ESA M5 proposal, first down selection May 2018, launch ~2030
  - CHIPP: co-lead the development of the double-sided strip silicon tracker
- **eXTP: Chinese "flagship" x-ray astronomy satellite, with large Europe participation**
  - Approved in China for phase A, final approval within 1 year, launch ~2025
  - CHIPP: assembly of Silicon Drift Detector modules, heritage of LOFT (ESA M3)
- **POLAR 2: improved and larger (~2x) version of POLAR**
  - Proposal in preparation for the Chinese Space Station, launch ~2025
  - CHIPP: lead an EU consortium to build the payload (scintillator + SiPM)
- **PAN/miniPAN: GeV magnetic spectrometer for deep space and planetary missions**
  - Multi-disciplinary (Cosmic ray, solar physics, space weather, dosimetry, …)
  - CHIPP: original proposer. Idea presented to ESA and NASA for the Deep Space Gateway. Also submitted an H2020 proposal (decision August 2018).

High energy, low energy and polarization frontiers!

Funding for Space projects (Xin Wu)

The Swiss funding of current projects:
AMS: SNSF
DAMPE: CAS (Chinese Academy of Sciences) and SNSF
POLAR: SSO (Swiss Space Office) and SNSF

SNSF typically covers R&D and data analysis through project funding.
SSO and CAS covered the payload construction:
3.7 M Frs for POLAR (SSO) and 5.1 M Frs for DAMPE (CAS).
The M&O fee for AMS is 18k Frs per year, which I plan to apply to FLARE.
DAMPE has no M&O fee for the moment.

The SNSF project funding is not sufficient for R&D and pre-production of larger space astroparticle project like HERD. So we need some support for HERD through "infrastructure" (FLARE) funding,
before we get payload construction funding from SSO.

High Energy Research Infrastructure

We are very lucky in Europe to have an Organization for Nuclear Research (C.E.R.N.)
«Conseil Européen pour la recherche Nucléaire»
which has one (and only one) Laboratory called 'CERN'.

The governing body is the C.E.R.N. council, the decisions andplans proposed by the director general must be endorsed by Council.

CERN has enjoyed remarkably stable funding, thanks to its successful program, the great service it provides to users, and the broad basis of member states.
Also it has had a steady policy to invest at regular intervals in large infrastructures and using them to the best. *→

The «strategy process» was decided by R. Aymar (then DG, previously ITER director) to formalize the committment of Council to a 5 years plan, and stabilizes further the resources (and the lab orientations).

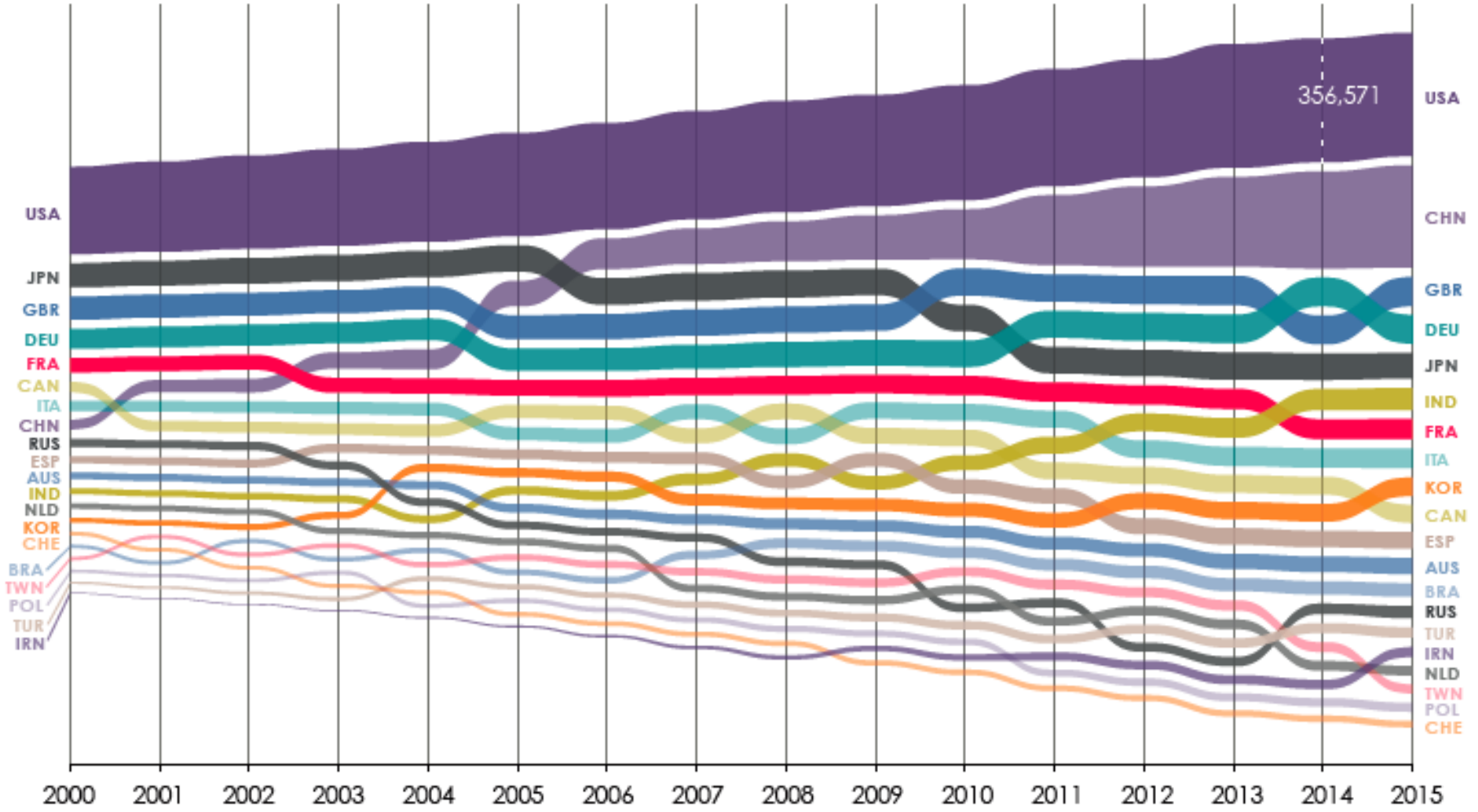
Switzerland as a host state (with France) plays a special role.
It has also a huge return for the presence of CERN on its territory

The 2013 strategy recommended the HL-LHC and that CERN comes back with an

"ambitious post-LHC accelerator project"

what will that be?

Graphique 3. Nombre de publications des 20 premiers pays, 2000-15



www.hceres.fr/Rapport-PSF-Graphique-3

Source : Base OST-WoS, calculs OST

Where the LHC comes from:

PHYSICS WITH VERY HIGH ENERGY
e^+e^- COLLIDING BEAMS

CERN 76-18
8 November 1976

L. Camilleri, D. Cundy, P. Darriulat, J. Ellis, J. Field,
H. Fischer, E. Gabathuler, M.K. Gaillard, H. Hoffmann,
K. Johnsen, E. Keil, F. Palmonari, G. Preparata, B. Richter,
C. Rubbia, J. Steinberger, B. Wiik, W. Willis and K. Winter

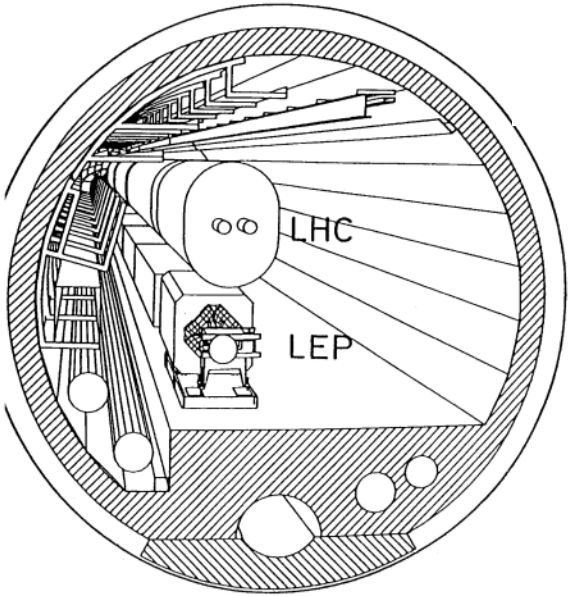
ABSTRACT

This report consists of a collection of documents produced by a Study Group on Large Electron-Positron Storage Rings (LEP). The reactions of

Did these people know that we would be running HL-LHC in that tunnel >**60 years later?**

ECFA 84/85
CERN 84-10
5 September 1984

e+e- 1989-2000



LARGE HADRON COLLIDER
IN THE LEP TUNNEL

Vol. I

p p 2009-2038