FOLIS – New funding line for large research infrastructure

Swiss Institute of Particle Physics

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Present understanding of the world:

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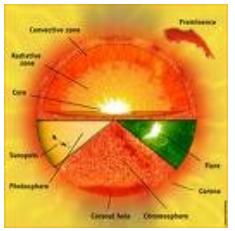
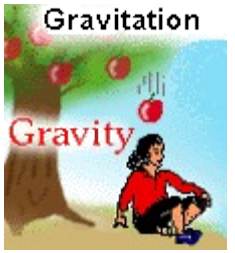
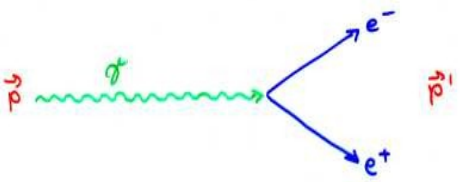
- "Everything" (the physical world) consists of quarks and leptons:
  - three generations of two types of quarks and leptons each = 12 fundamental particles

- Its dynamics is governed by four different kinds of interaction
  - strong interaction, weak interaction, electromagnetic interaction, gravitation





- There is also antimatter
  - for each particle there is an antiparticle
  - matter and antimatter is produced from radiation
    (from quantum fields of the interactions)
  - matter and antimatter obey – almost – the same laws



What we don't understand presently:

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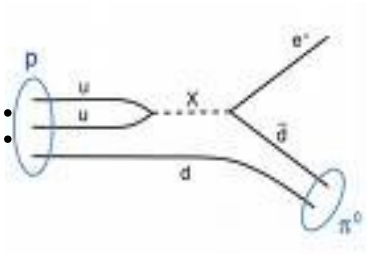
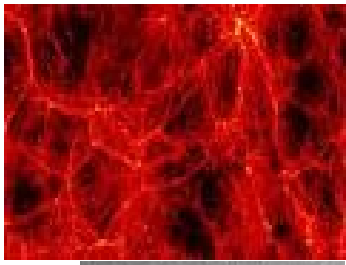
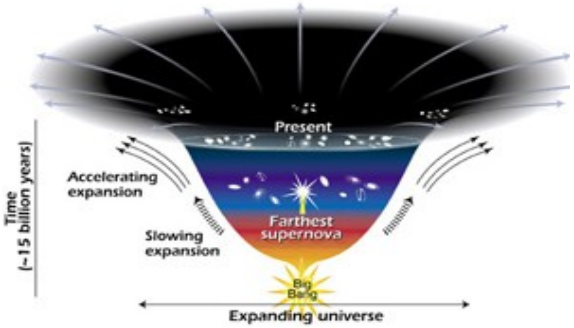
- Standard particle model (SM) is not fully understood:
  - The Higgs field is still missing.
  - Observed neutrino oscillations requires new theoretical mechanism.



- The four interactions tend to unify at very high energies:
  - Do they become identical? → If yes, proton should decay, very rarely

- Standard cosmology requires in addition to SM:
  - "dark matter", invisible, but interacts with gravitational forces: →
    Can not be made of ordinary quarks and leptons.





- accelerated expansion of the universe
  ← Need a new form of energy ("dark energy").

- all visible junk is made of normal matter, almost no antimatter
  Where is the asymmetry ("CP violation") coming from?
  Is there CP violation in the neutrino system, as observed in the quark system?

Future challenges in particle physics: Swiss involment (1)

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For solving the above mentioned questions, Swiss groups are involved in most fields:

- Higgs and any new type of interaction / particles / symmetry: → LHC@CERN

- Neutrino: measure oscillation products and mixing matrix
  oscillation experiments now: → OPERA, T2K
  oscillation in future: → accelerator based super beam / neutrino factory / GLACIER
  Neutrino mass and type: double beta decays; → EXO, GERDA (being prepared)

- Proton decay → GLACIER (future)

- Dark Matter
  - direct dark observation: → CDMS, XENON (give limits), new detector plans: DARWIN
  - indirect dark matter search: decay radiation: → CTA (design study ongoing)
  - interactions of dark matter particle with normal matter (Supersymmetry?): → LHC

- Dark energy / accelerated universe:
  - try to measure more precisely, no Swiss participation (yet?)

- CP violation: → LHCb@LHC,
  → very longterm future neutrino beams

Future challenges in particle physics: Swiss involvment (2)

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- In most fields there is a significant Swiss intellectual contribution – good!
- There is a strong contribution to CERN projects - good!
- However: The new projects need big experiments, because these are very rare processes
  - → need large infrastructure
  - → need a lot of ressources, predictably distributed over many years, for construction and operation
  - → need for large international collaborations
  - → European and national roadmaps to plan the development

Future challenges in particle physics: Swiss involment (3)

CHIPP **roadmap 2004**:

- recommendation 5: on Neutrino Physics and the Near Future :
  ... (J-Parc neutrino programme).., that an active and visible contribution by Swiss groups should be investigated.

- recommendation 6: on particle physics at the interface with cosmology:
  ..., that a realistic strategy to participate meaningfully in future important fundamental experiments ... should be elaborated ...

CHIPP **situation as of 2009**:

- Neutrino:
  - strong cooperation of the 3 Swiss groups involved in J-PARC: T2K
  - concentrating on future projects, in accordance with international strategy

- Astroparticle physics:
  - strong cooperation of 4 institutes in one large project: CTA.
  - dark matter search strengthened by new professor in Zurich (leading scientist in the international context).

CHIPP prepares presently a document on "Implementation of Roadmap Strategy 2009"

How does it work with CERN? FORCE !

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FORCE:

- supports the construction and operation of the CERN infrastructures through scientific contributions of the Swiss research groups (SNF limits its support to research)

- founded in 1997
- spent 32 MCHF until 2007
- funding period 2008 – 2011: 14 + 5 MCHF

- It was only thanks to the FORCE instrument, that Swiss research groups could significanlty contribute to the construction and operation of the LHC experiments and other CERN based projects.

- It is essential for the continued Swiss engagement at CERN, that FORCE will continue also in the next funding period 2012-2016.

Funding needs for planned future participations: The CHIPP Tables

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The CHIPP Tables are

- yearly updated, since CHIPP roadmap 2004
- main source for "upper half": FORCE
- "lower half" not yet supported
- SNF does not want to support construction and operation of infrastructure

New funding instrument - FOLIS

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Idea: create a new funding line

- ***Fo****nds for the Swiss participation in the construction and operation of international* ***l****arge research facilities and* ***i****nfra****s****tructures*: **FOLIS**

- Structure, rules and size similar to FORCE
  - investments and operation costs only
    (no academic research positions)
  - only projects with established SNF grant in parallel
  - international projects with established collaborations only
  - ESFRI or other international roadmap

- available for the next funding period, 2012 - 2016.

Possible FOLIS projects: examples

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Project	CH institutes	Other countries	Roadmap	CH funding quota	Contribution items
CTA (gamma ray astrophysics)	UGE, UZH, EPFL, ETHZ	10	- ESFRI-Roadmap; - ASPERA priority	R&D: 10%; constr.: 5%	- data centre ISDC - camera electronics - mirror control mechatronics
DARWIN (dark matter)	UZH, ETHZ	7	- ASPERA priority;	20%	- project management - detector infrastructure - hybrid detectors - large area LEMs - low noise electronics
GERDA (double beta decay)	UZH	6	- ASPERA priority	5%	- calibration system - R&D and test facility for detectors
GLACIER (proton decay, neutrino astrophysics)	UZH, UBE, ETHZ	4	- ASPERA priority; - JAP Roadmap; - PL Roadmap; *(possibly in the next ESFRI Roadmap?)*	R&D: 50%; constr.: Ph 1: 33%; Ph 2: 10%	- LAr Time Projection Chamber technology (large cryo tanks, purification methods, readout methods and electronics, calibration methods) - readout electronics - calibration methods - collaboration management
PEBS (balloon)	EPFL, ETHZ	5		33%	- silicon PMT for fibre tracker - readout electronics - calorimeter - superconductive magnet

Possible FOLIS projects: comments

- These are examples only, based on a recent inquiry within the CHIPP community in order to illustrate the possible use of FOLIS
- The projects are broadly accepted by the community and motivated by by the physics interest of the Swiss research groups ("bottom up")
- There exists international networks for all projects
- The proposed Swiss contribution items seem to be compatible with the size and expertise of the research groups at the Swiss universities and ETHs.

Possible FOLIS Projects (1): CTA

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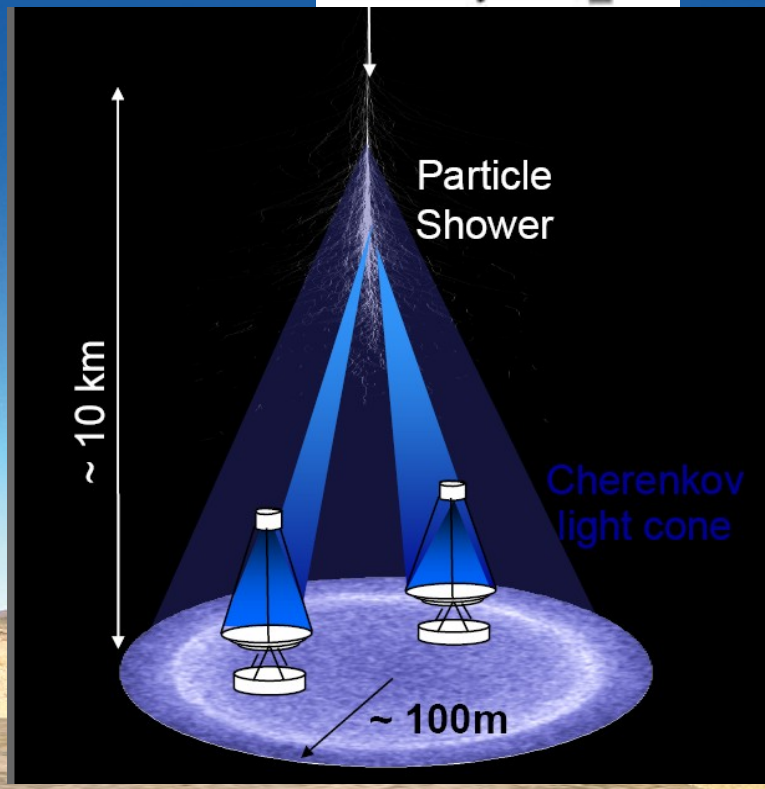
- Observe universe with very high energy photons

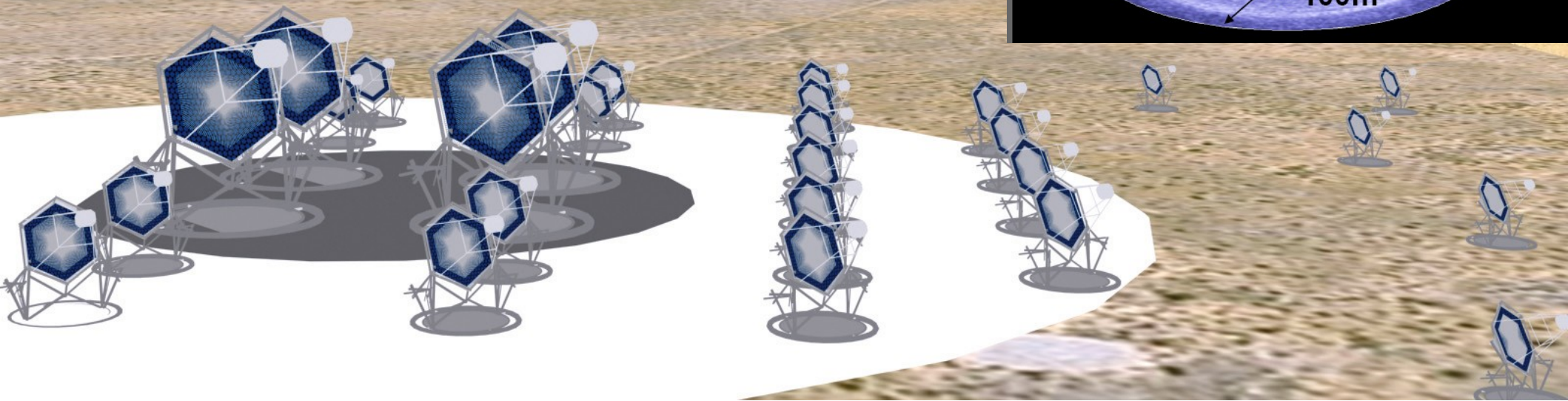
- How are cosmic ray particles accelerated?
- Can we find any signal from dark matter decays?
- Observe all kind of interesting objects in the universe

- International (mainly Europe) consortium of ~50 partners

- Design study and prototype telescope until 2011
  Swiss contributions: ISDC, camera, mirror control
  UniGE, UniZH, EPFL, ETHZ

- Construction from 2012





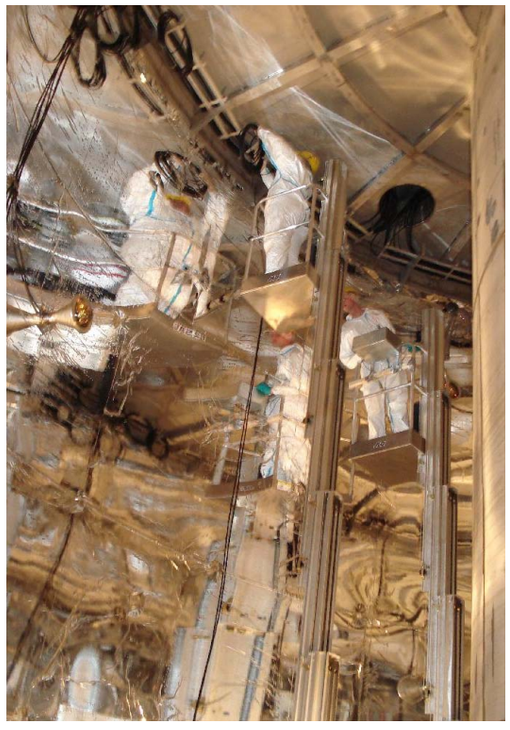
GERDA (GERmanium Detector Array)

- **Physics goal: detect the neutrinoless double beta decay in enriched ^{76}Ge detectors** operated in liquid argon, with a sensitivity to the effective Majorana neutrino mass of:
- **Phase I (30 kg yr) m_{ee} < 0.27 eV ; Phase II (150 kg yr) m_{ee} < 0.11 eV; Phase III (1 ton yr) m_{ee} < 0.01 eV**

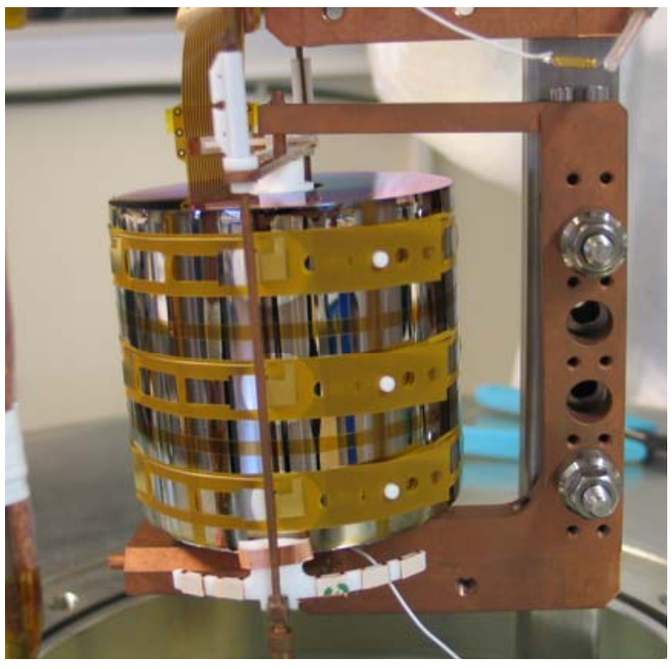
- **Status:** under construction at LNGS; **Phase I detector commissioning planned for fall 2009**
- **Participants:** 11 institutions from 6 countries; in CH: University of Zurich (group of L. Baudis)
- **CH responsibilities:** calibration system + R&D and test facility for Phase II/III detectors

LAr cryostat
(March 2008)

Water tank
(July 2008)



PMT mounting
(May 2009)



Phase II prototype
(segmented HPGe detector)

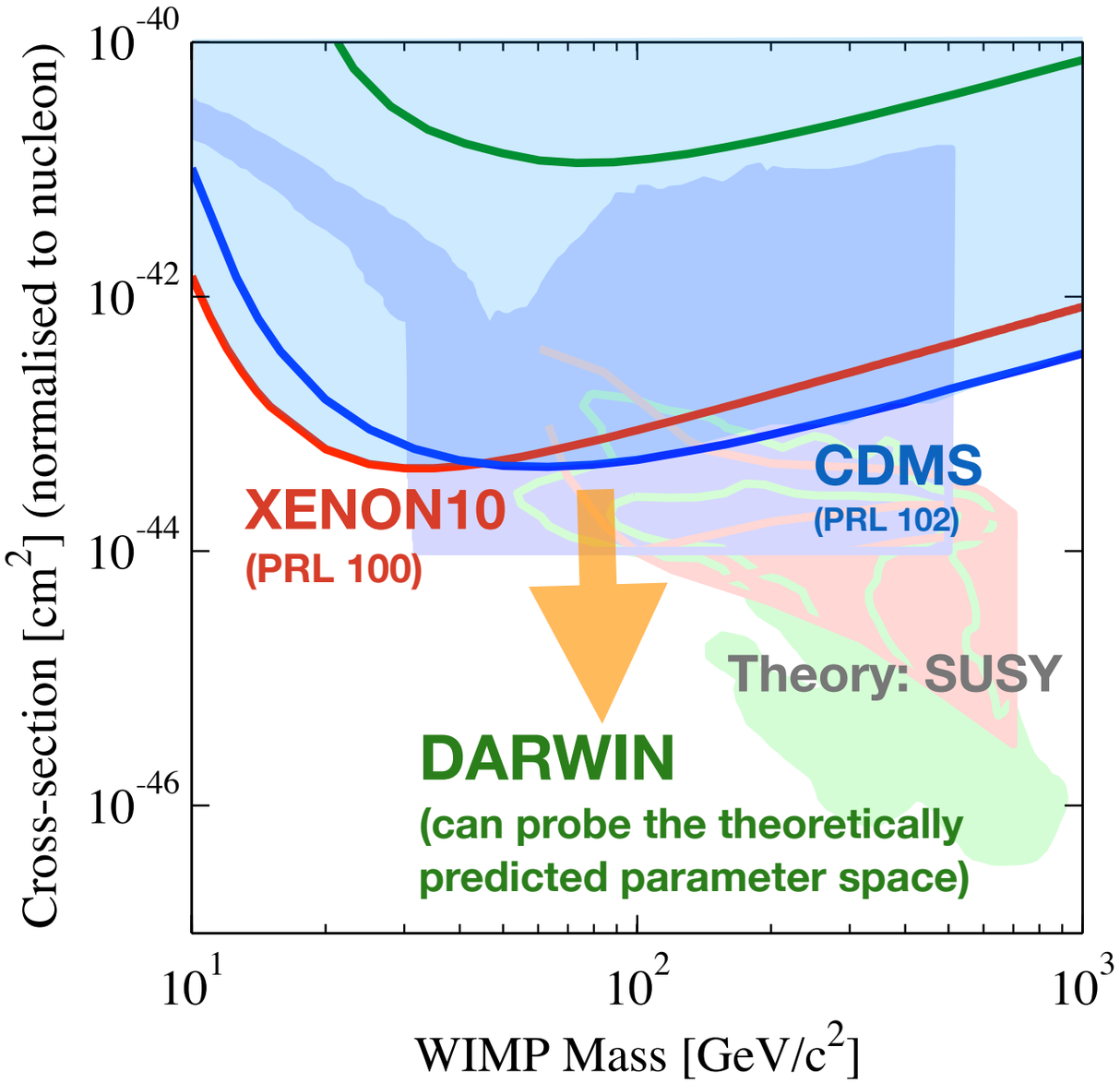
DARWIN (DARk matter WImp search with Noble liquids)

- **Physics goal: detect galactic dark matter in the form of WIMPs,** via their interactions with Xe/Ar nuclei in a large Xe/Ar-TPC, with a sensitivity of
- **10^{-47} cm^2 for the elastic scattering WIMP-nucleon cross section (best current limits at ~ 4 x 10^{-44} cm^2)**

- **Status: proposal for a design study submitted in response to the first ASPERA common call, for a next-generation noble liquid dark matter detector**

- **Participants:** 21 institutions from 7 countries; in CH: University of Zurich (group of L. Baudis, PC and group of C. Amsler), ETHZ (group of A. Rubbia) for a total of about 25 CH persons

- **CH responsibilities:** project management, detector infrastructure, hybrid light detectors, large area LEMs, low-noise electronics, underground site investigations, background studies, scientific impact



Possible FOLIS Projects (4): GLACIER

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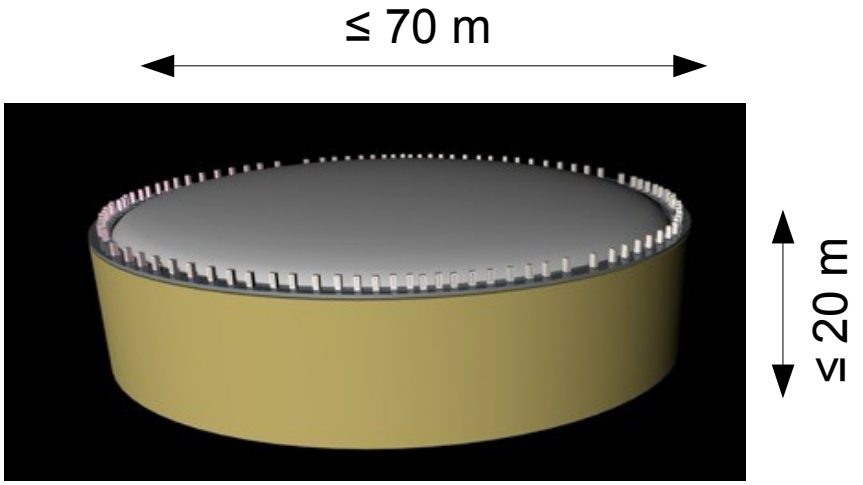
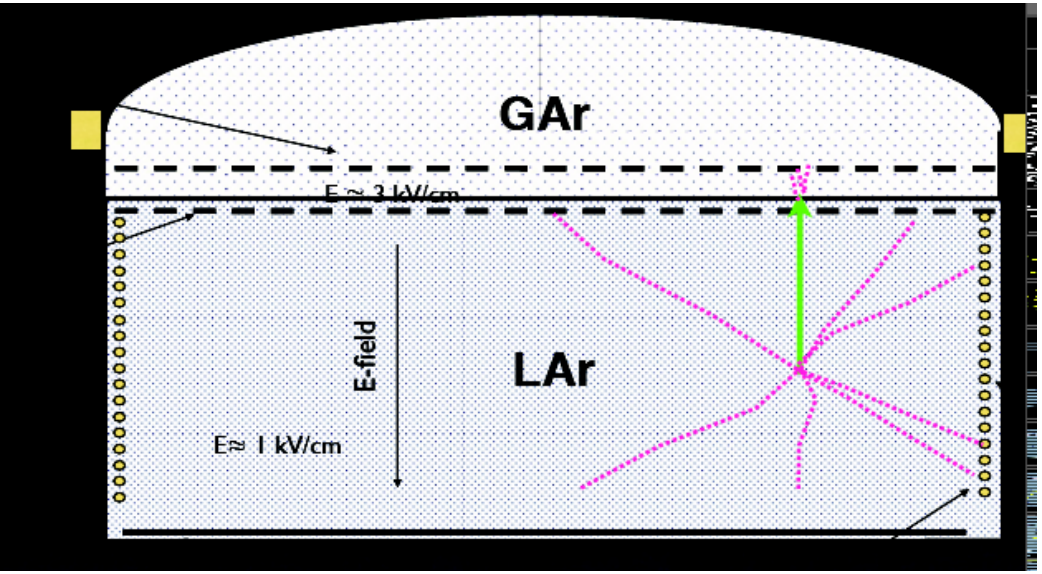
New project for an European large underground observatory:

- Look for proton decay
- Observation of astrophysical neutrinos
- Future long baseline neutrino oscillation experiments (e.g. beam from CERN)





LAGUNA FP7 design study addresses feasibility of site and detector technology (9 countries, 21 parties, coordinated by ETHZ)

Swiss interest in LAr option:

- Liquird Argon dual phase time projection chamber with LEM readout.
- Swiss R&D active in CERN, UniBE, ETHZ
- Collaboration with KEK (Japan)

Possible FOLIS Projects: Assessment of Swiss quotas

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- Total sum of 48 MCHF in 2012-2016 corresponds to the quotas according to the ideas of the groups involved. Probably unrealistic!

  This quotas for Swiss contributions have not yet been discussed in the community.

- Other observations on quotas:
  - In the draft SER roadmap a typical number of 3.5% is mentioned. Is this reasonable?
  - Should it depend on number and size of other countries involved?
  - Should it depend on the size of the Swiss community in this project?

- My personal assessment, based on the number, expertise and size of Swiss groups involved:

  FOLIS should be of same order of magnitude than FORCE.

Summary

- Science first: fascinating new international projects
  - large research infrastructures in particle physics
  - to understand what the world is made of.

- Swiss community is well coordinated and
  plans its contributions according to their CHIPP roadmap.

- But we are not competitive without funding for
  construction and operation of infrastructure.
  There is no infrastructure funding from SNF, and
  only small contributions by Universities and ETHs

- We propose FOLIS as a new funding instrument in addition to FORCE,
  to allow the Swiss research groups to participate in a competitive
  way in international research activities outside of CERN.

This is very important to keep the excellent level of basic research in CH.