The European Spallation source

EFNUDAT, CERN 2010-09-02

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Mats Lindroos

Head of the ESS Accelerator Division

Accelerator Design @ ESS


The ESS Scandinavia site
Lund
The Öresund
Copenhagen Airport
Skåne
Malmö
The Öresund Bridge
Denmark
Copenhagen
Malmo

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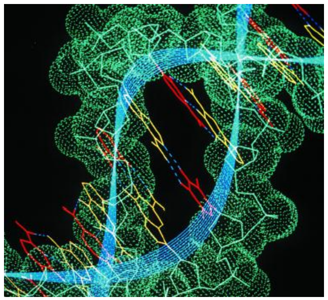
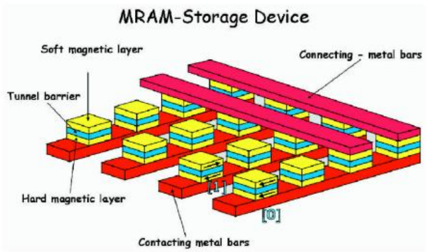
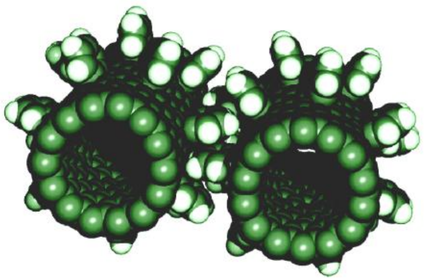
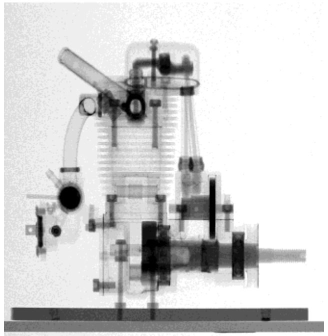
ESS – multi-science with neutrons

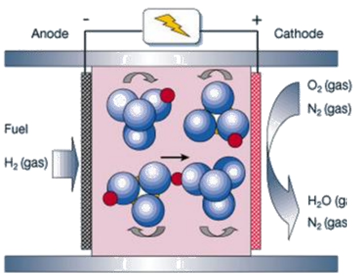
Materials science	Bio-technology	Nano science
Energy Technology	Hardware for IT	Engineering science











- Neutrons can provide unique and information on almost all materials.

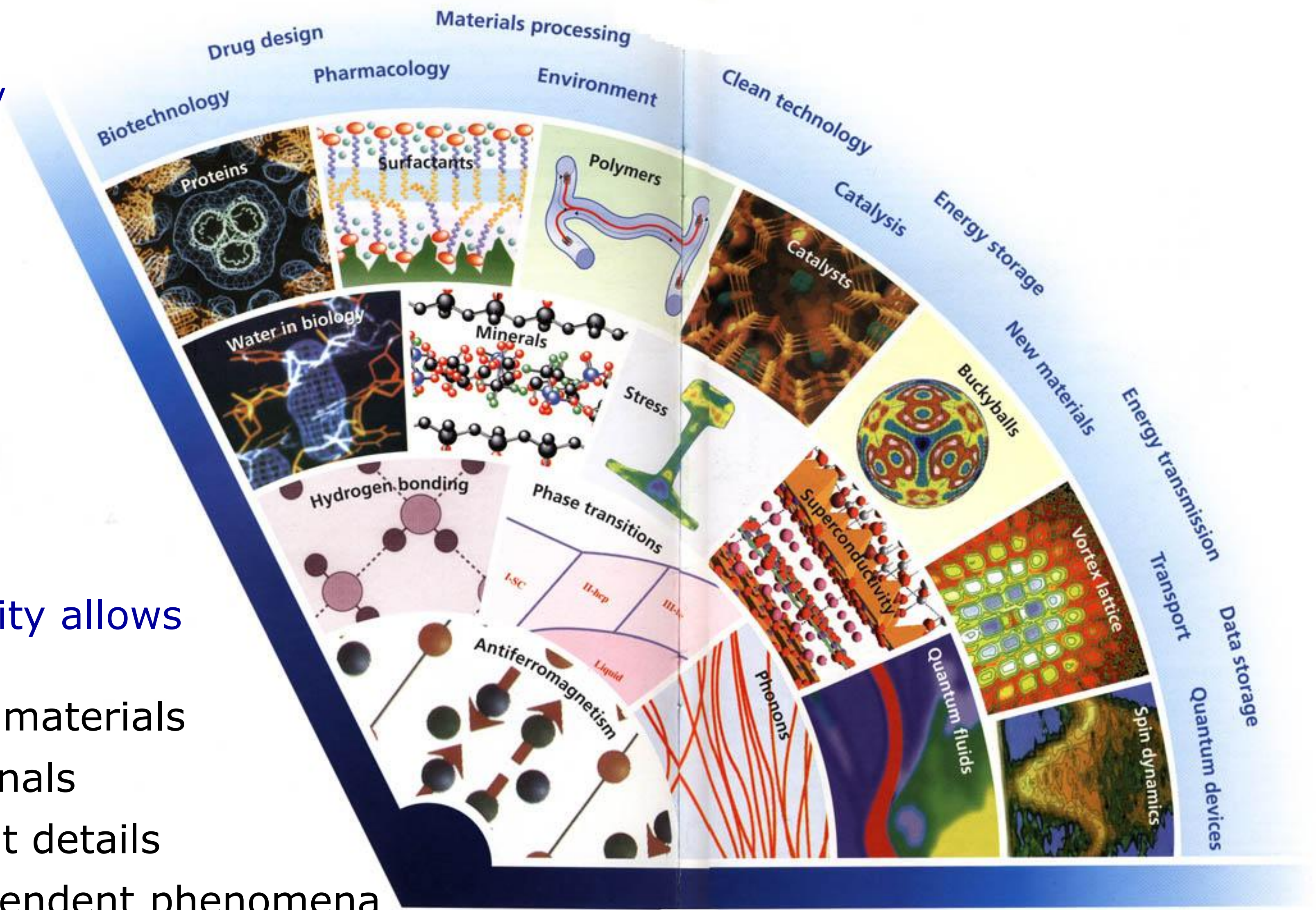
- Information on both structure and dynamics simulaneously. ”Where are the atoms and what are they doing?”

- 5000 users in Europe today
  Access based on peer review.

- Science with neutrons is limited by the intensity of today’s sources

Intensity opens new possibilities

Complexity/
Count-rate

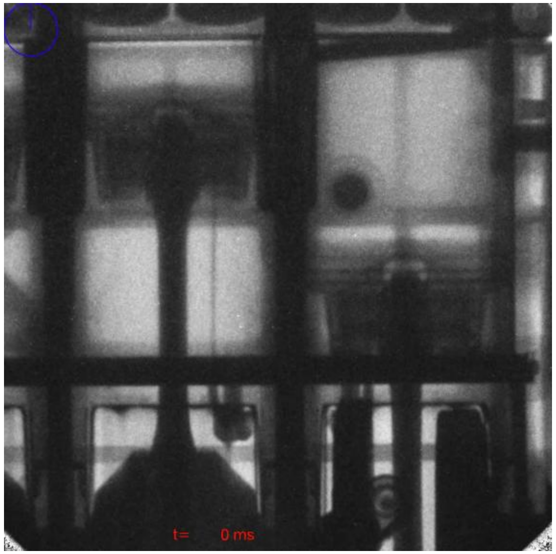


ESS intensity allows studies of

- complex materials
- weak signals
- important details
- time dependent phenomena

Details/Resolution

Tomography and "movies"



Dr. Burkhard SchillingerNeutronentomographie ANTARESForschungsreaktor FRM-II

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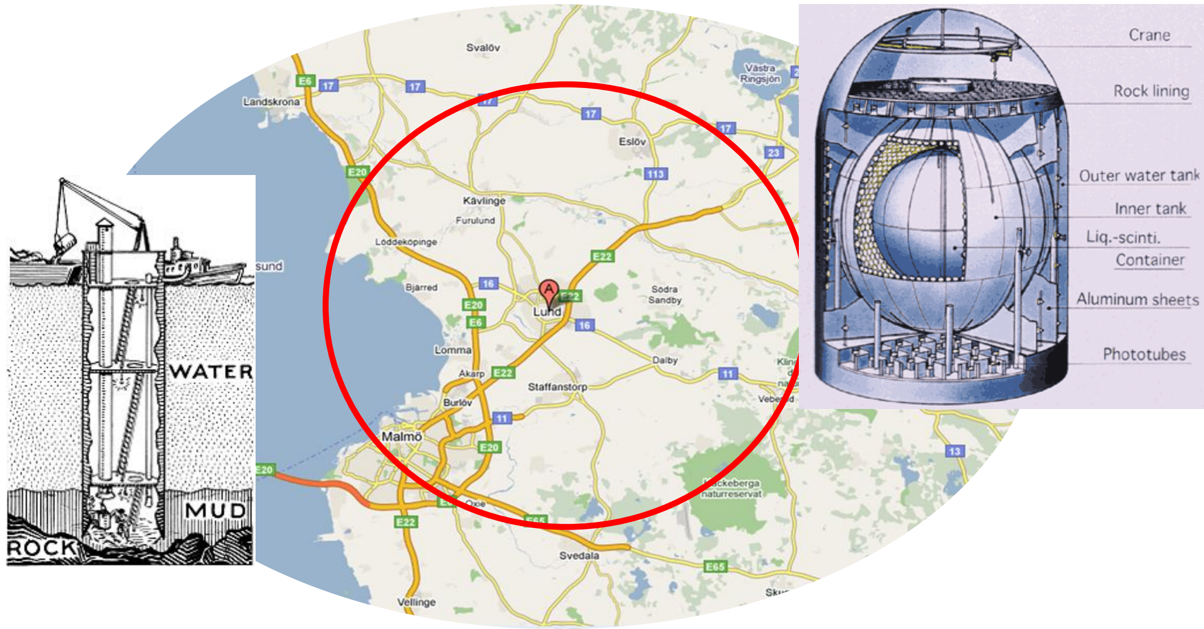
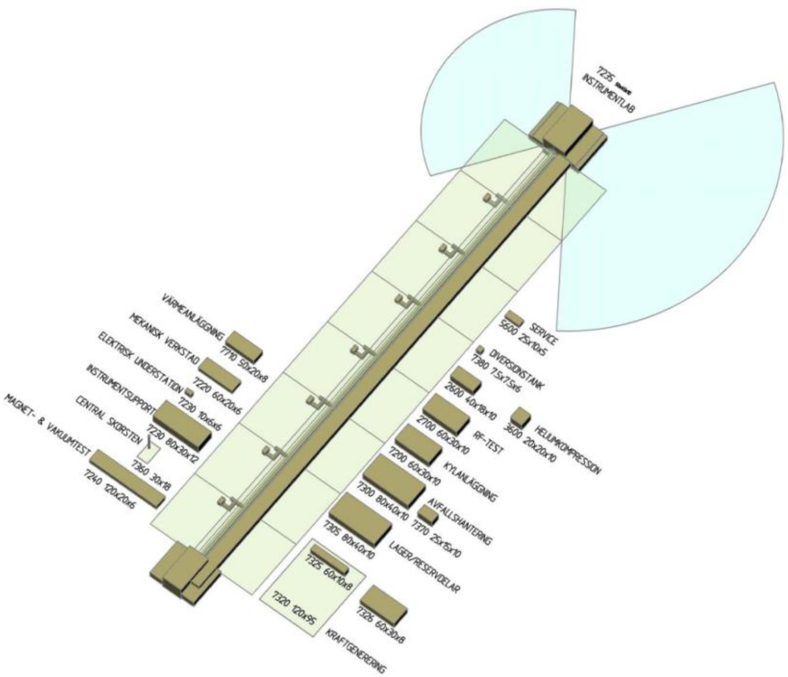
Fundamental physics at ESS

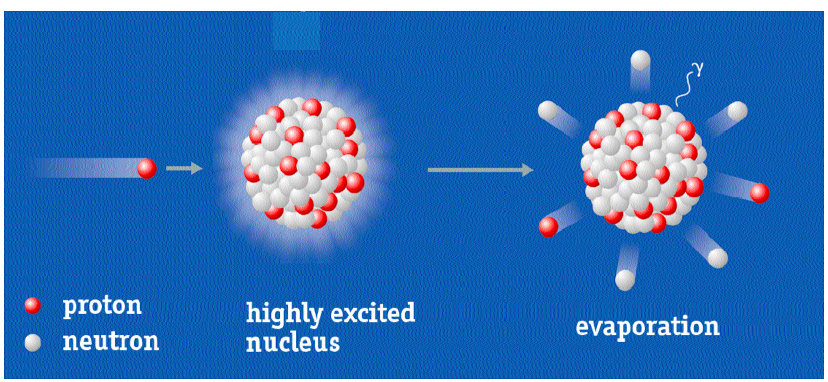


- Workshop held in Lund in December 2009 on possibilities for Neutron, Nuclear, Neutrino, Muon and medical physics at ESS
  - All presentation available at 3N2MP website: http://indico.hep.lu.se//conferenceDisplay.py?confId=896
- Follow up workshop in spring 2011 to produce Letter of Intents for ESS SAC

How does ESS work?



- An ion source creates positive hydrogen ions (protons).
- Pulses of protons are accelerated into a target with neutron rich atoms.
- In the target neutrons are liberated by a a spallation reaction.
- The neutrons are then guided to instruments where they are used for materials studies.



Spallation: A nuclear process in which a high energy proton excites a neutron rich nucleus which decays sending out neutrons (and other particles).

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Preconstruction phase

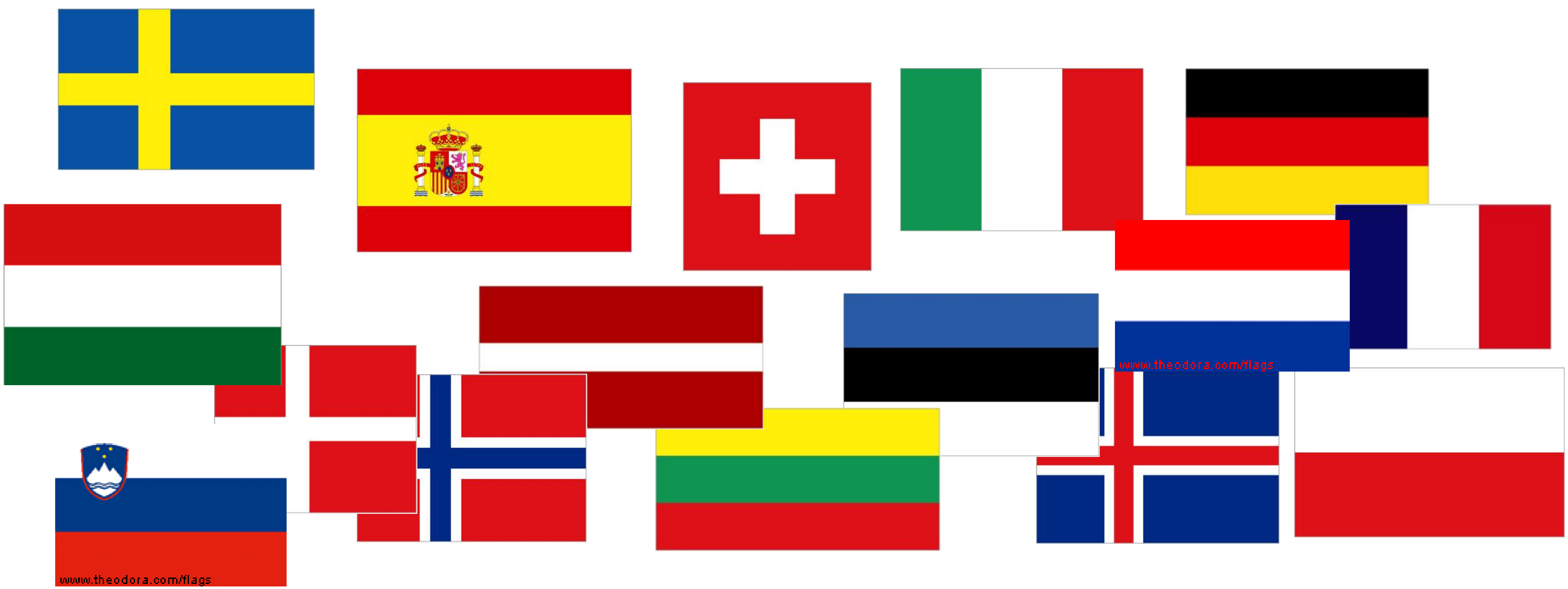
1^{st} ESS Steering Committee: 22^{nd} & 23^{rd} October 2009 Copenhagen

Strong support from 13 countries to:

- to engage in the ESS Design Update
- to prepare organisation aimed for construction

5^{th} ESS Steering committee: 7^{th} & 8^{th} October 2010 in Stockholm

- ESS AB fully operational, 16 member states and planning for Design Update project in full progress!

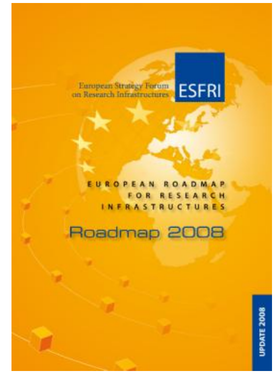


Time lines

first design

2002-2003

ESFRI Report
2003



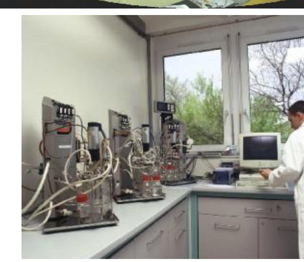
site
decision
2009

ESS Pre-construction phase 2010-2012

ESS Construction phase 2013-2018

Completion phase 2018-2025

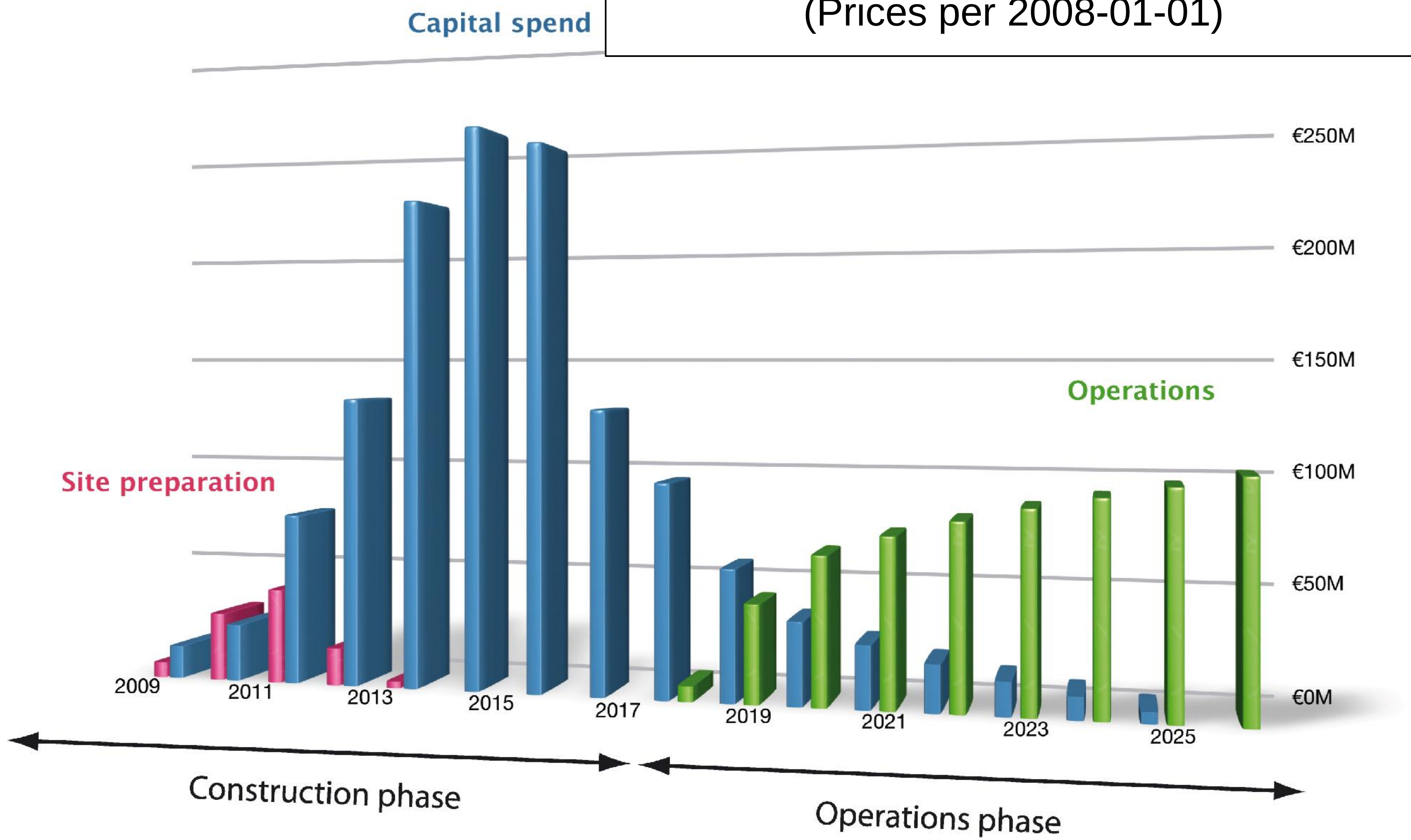
Operations phase 2026-2066



Decommissioning phase !!! 2067-2071

ESS cost estimates

Investment: 1478 M€ / ~10y
Operations: 89 M€ / y
Decomm. : 346 M€
(Prices per 2008-01-01)



What can you get for 1.5B€ today ?

You could buy four A380 airbuses...

or, 28% of the Fehmarn Bridge

or, you could pay the bonuses of US bankers for...

24 days

The Sustainable Research Centre

Responsible – Recyclable – Renewable

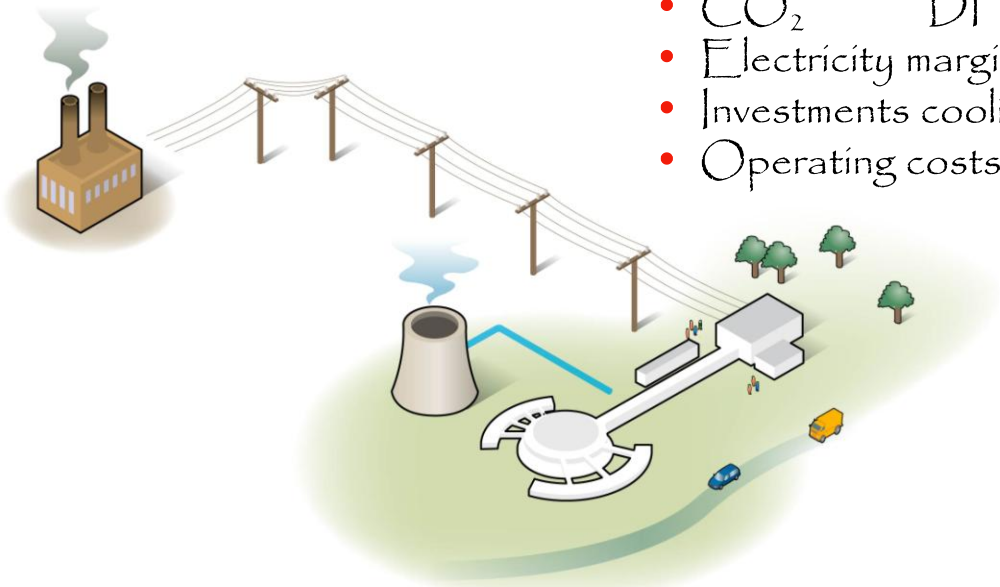
↓

To be carbon dioxide neutral over the lifetime of the facility, including transportation to and from the site.

ESS Energy solution: The Conventional solution – Buy it in

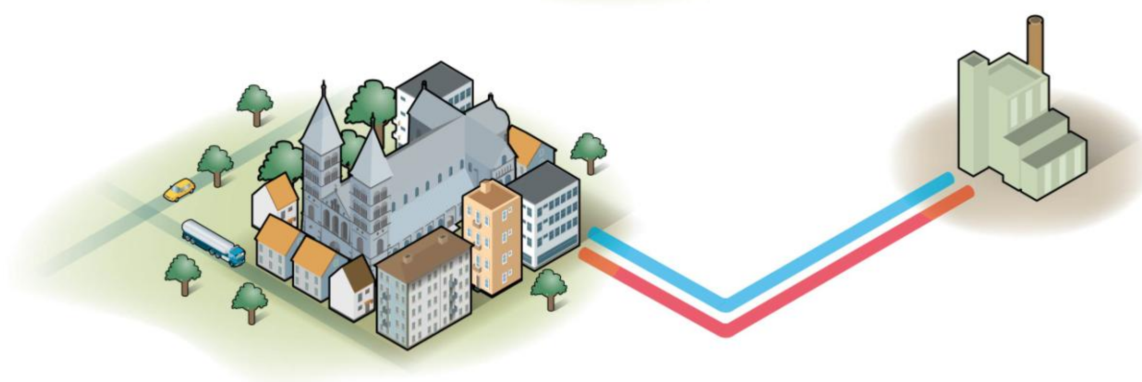
Annual Operations

- Energy use: 300 GWh
- CO_2 ESS: 150,000 tonnes
- CO_2 DH Lund: 15,000 tonnes
- Electricity margin production Nordic coal/gas
- Investments cooling tower 1.5 M€
- Operating costs cooling system: 0.6 M€



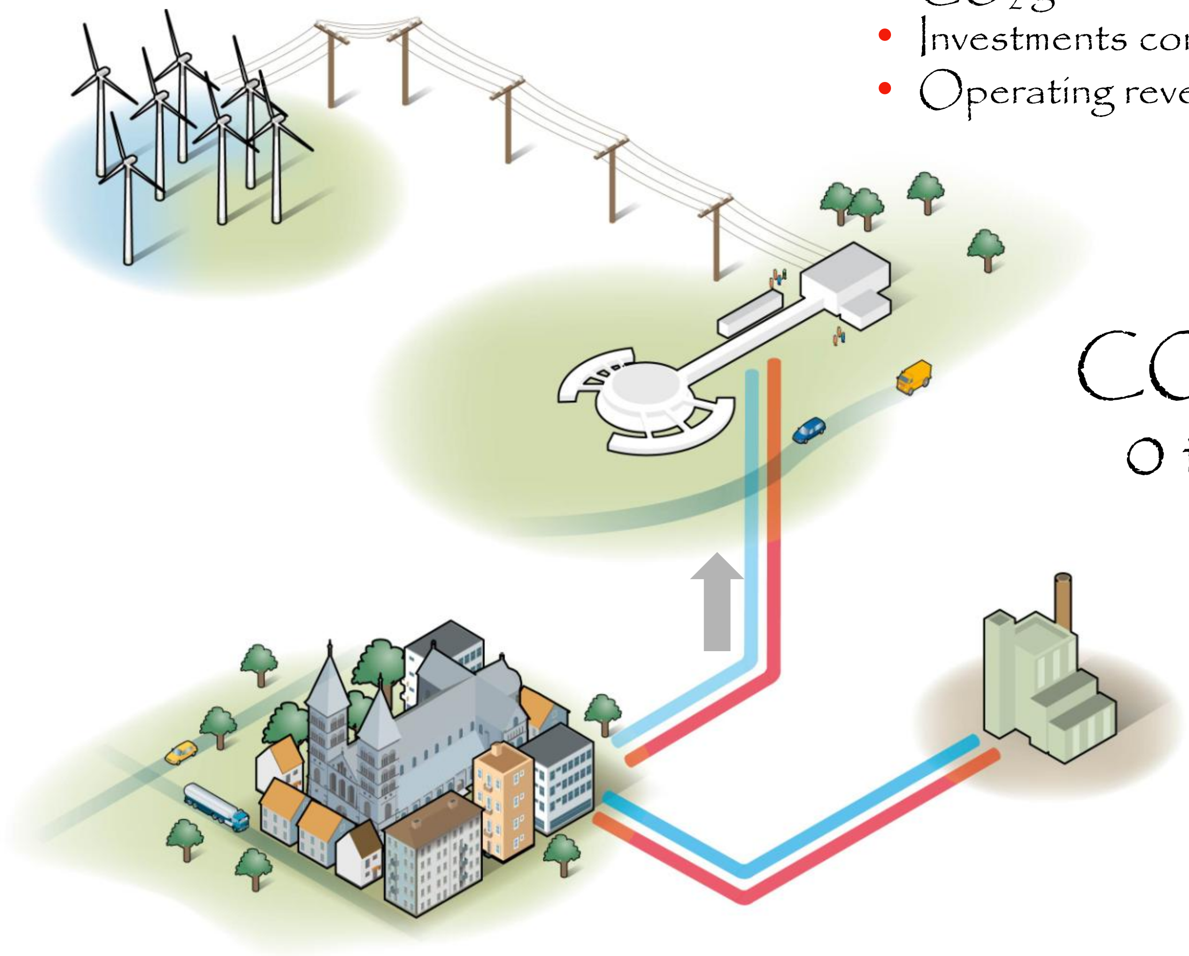
District heating & cooling

CO_2 production
15,000 tonnes/year



ESS Energy Solution - Economy and Sustainablility Advantage

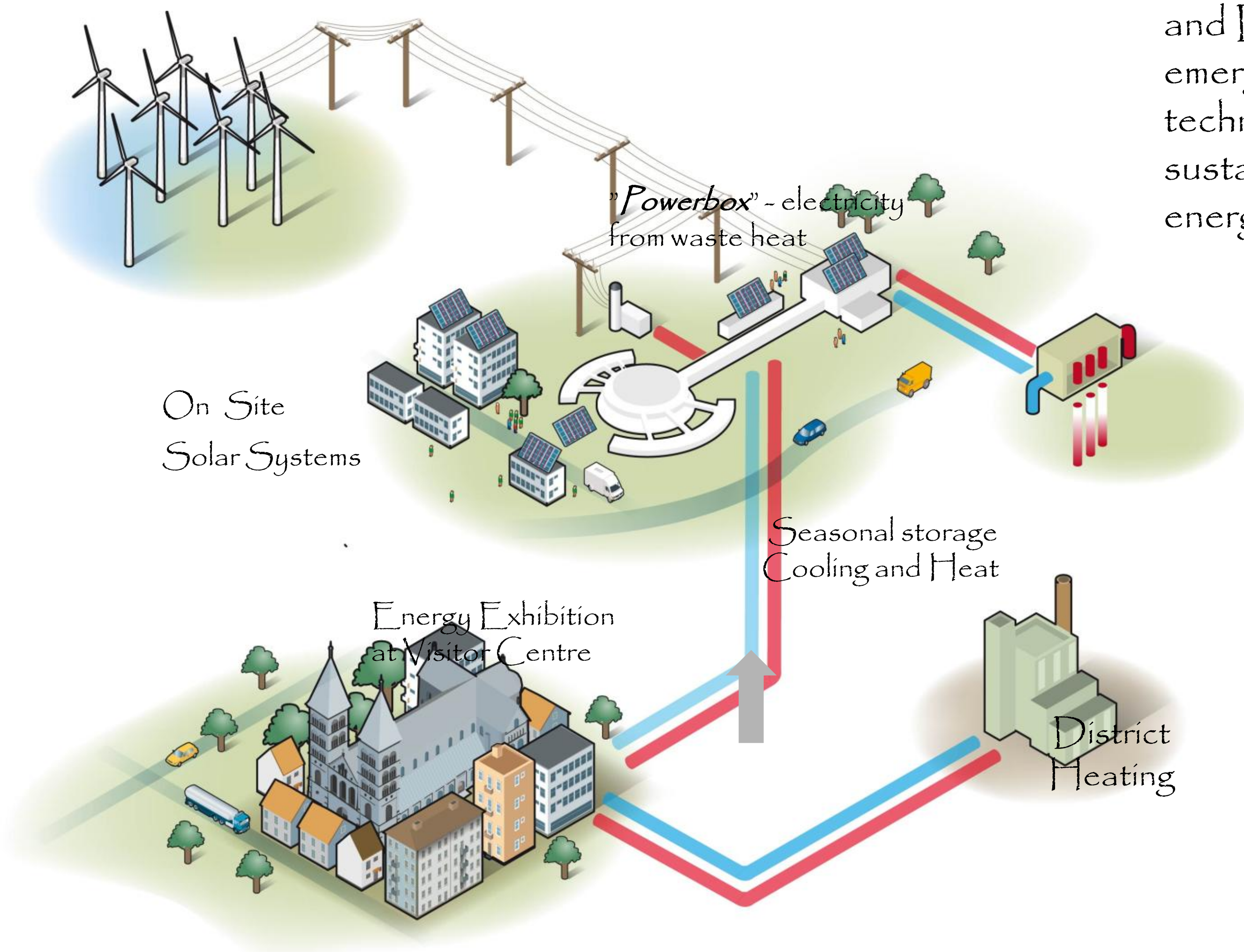
- Energy savings in improved efficiency equipment: 20 %
- CO_2 global impact: 0 ton/year
- Investments connection DH: 1 M€
- Operating revenue : - 1,5 M€



CO_2 production
0 tonnes/year

Income 1.5 M€

ESS Energy Solution - Development and Demonstration



- Research, Development and Demonstration of emerging energy technologies strengthen sustainability message and energy culture

ESS accelerator high-level technical objectives:

- 5 MW long pulse source
  - ≤2 ms pulses
  - ≤20 Hz
  - Protons (H+)
  - Low losses
  - High reliability, >95%

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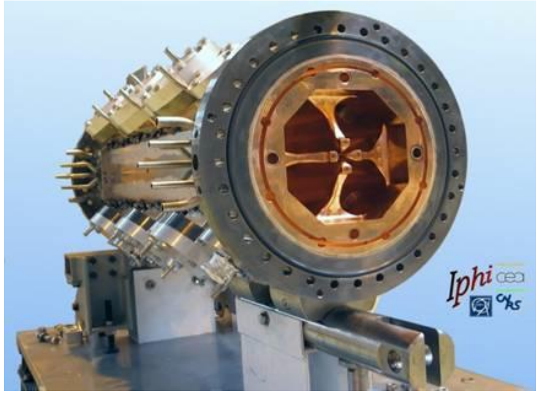
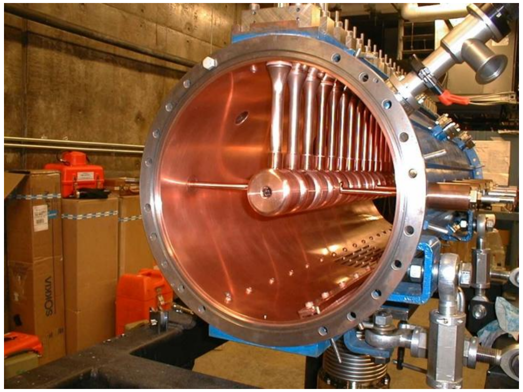
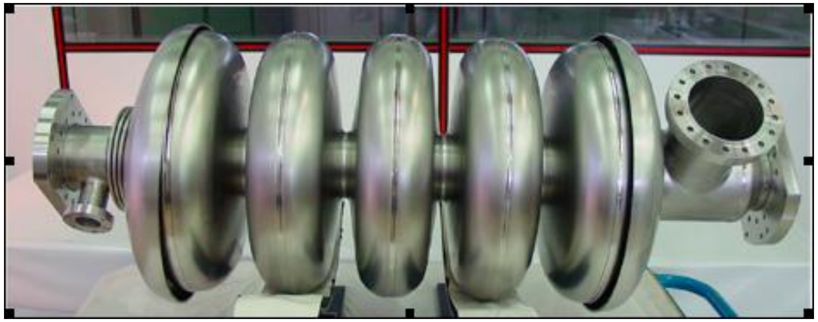
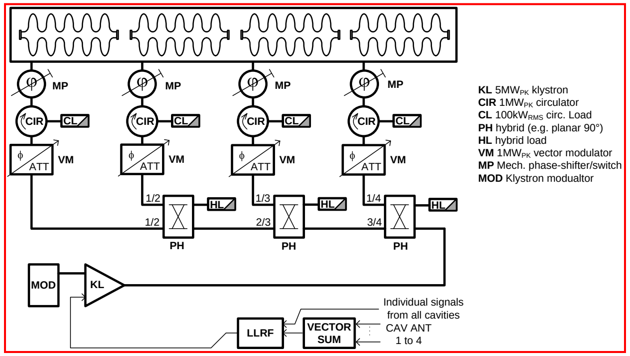
Linac R&D in progress

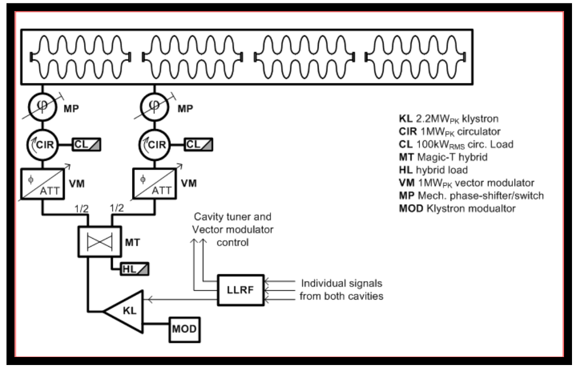


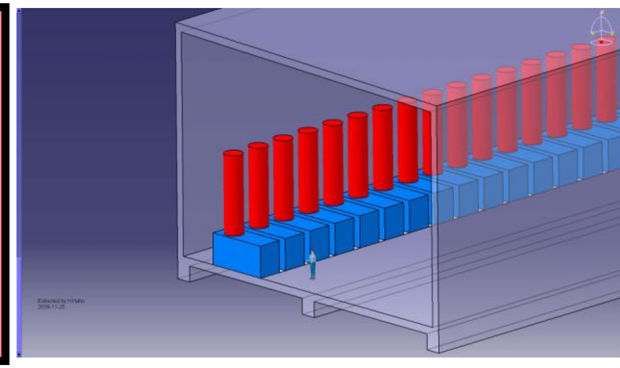




RF distribution

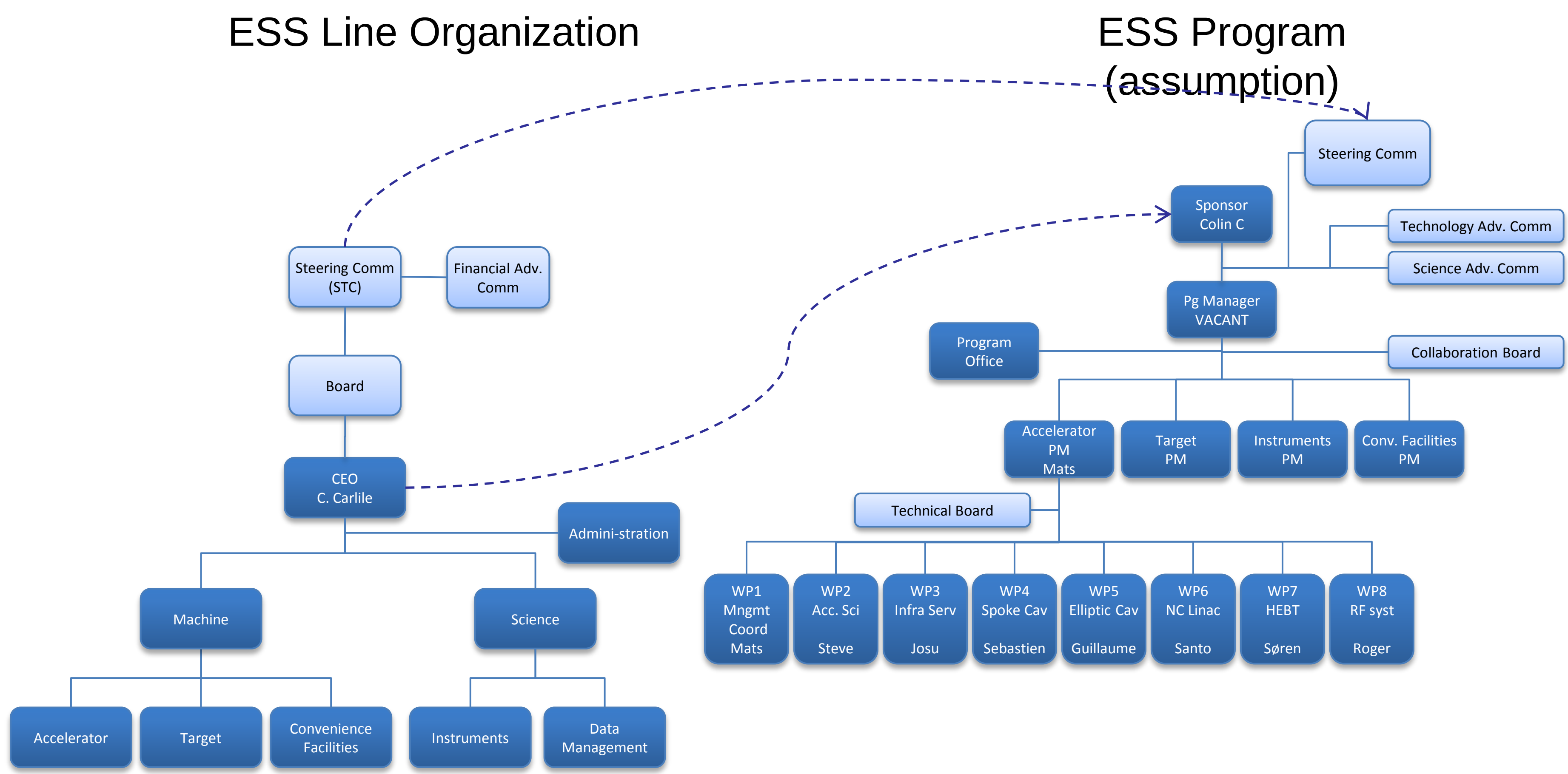






Option	Configuration	Cost of 4 cavity (K-Euro)	For	Against
1	Four cavities per Klystron	2420	Fewest power sources	Complexity, bulk, power overhead, fault tolerence
2	One Cavity per Klystron	2880	Reduced hardware inventory, minimum R&D, fully independent control, minimum RF power overhead, best fault tolerance, easy upgrade to HPSPL	Number of power sources
2a	One cavity per IOT	2520	As above, perhaps cheaper & more compact	HPSPL would need doubling of IOTs, or larger rating IOTs
3	Two cavities per Klystron	2520	Half the number of klystrons	Need full hardware set, associated R&D, Power overhead, Reduced flexibility wrt option 2
3-VM	Two cavities per Klystron Without VMs	2370	Half the number of klystrons, more economical than Option 3	Risk for higher intensity?

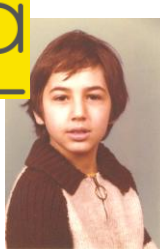
ESS organization



Writing Group for linac project plan

- Project plan for the linac design update and prototyping
  - Design Report for the end of 2012, 20% precision in costing
  - Readiness to construct by the end of 2012 -- the design will be a safe baseline design with technical choices made for which the writing of specifications, detailed drawings and completion of late prototypes could be launched without any further delay after 2012
  - Energy budget and sustainability should be taken into account in each work package
- Responsibilities within WG
  - S.Peggs – Accelerar Physics and configuration control
  - R. Duperrier – System engineering
  - C.Oyon – Project planning
  - M. Lindroos – Coordination and planning
- WG schedule and milestones
  - Project specification for ESS STC in October
  - Start date 1 January 2011

Extended writing group



Romuald Duperrier
(30 years ago)

Steve Peggs

Cristina Oyon

Josu Eguia

Work Package (work areas)

1. Management Coordination – ESS (Mats Lindroos)
2. Accelerator Science – ESS (Steve Peggs)
3. Infrastructure Services – Tekniker, Bilbao (Josu Eguia)
4. SCRF Spoke cavities – IPN, Orsay (Sebastien Bousson)
5. SCRF Elliptical cavities – CEA, Saclay (Guillaume Devanz)
6. Front End and NC linac – INFN, Catania (Santo Gammino)
7. Beam transport, NC magnets and Power Supplies – Århus University (Søren Pape-Møller)
8. RF Systems – Uppsala university (Roger Ruber)

Guillaume Devanz

Mats Lindroos

Roger Ruber

UPPSALA UNIVERSITET

Søren Pape Møller

Santo Gammino

Sebastien Bousson

Status of the DU planning

- Excellent feedback from the first TAC for the architecture.
- A plan B was suggested in case the spoke initiative fails.
- The DU project plan is presently refined and the planning is being consolidated. PBS is complete.
- The present architecture is already the result of a functional analysis from the long pulse need. This analysis phase is continuing.
- First subsystem specifications will follow. Several will be established after a convergence on interfaces (target, ...).
- First risk analysis for the DU will be conducted before 2011.
- Negotiations between ESS and external contributors have started.
- Documentation and communication plan is being set-up.

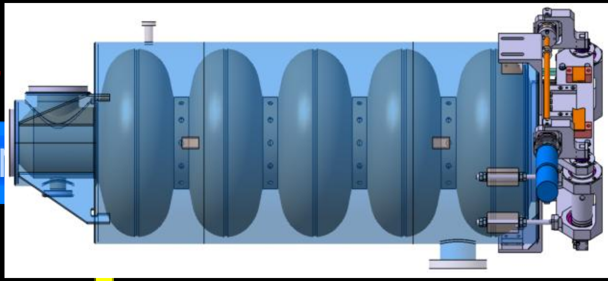
Synergies with High Power SPL study at CERN

LP-SPL (4 GeV)

3 MeV 50 MeV 102 MeV

H$^-$ source — RFQ — chopper — DTL — CCDTL — PI

352.2 MHz



704.4 MHz

Development going on for SPL Eucard at CEA-Saclay (beta=1)

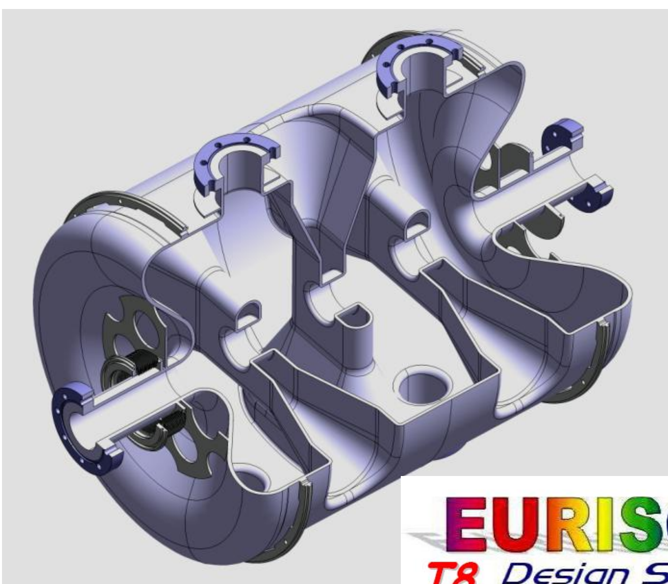
- construction of Low-Power SPL together with PS2,
- main users: PS2 (LHC), ISOLDE upgrade, EURISOL-0 (?),
- operation in 2020

kinetic energy	[illegible]
beam power (@	[illegible]
repetition rate	[illegible]
pulse length	[illegible]
average pulse current	20 mA
protons p. pulse	1.1 10^{14}
length (SC linac)	427 m

Spoke cavities

- Most of the spoke cavity tests were performed in vertical cryostat. Only a few were done in an accelerator-like configuration.
- Tests with beam have never been performed !

BUT expected (and partially experimentally proven) performances are worth it !

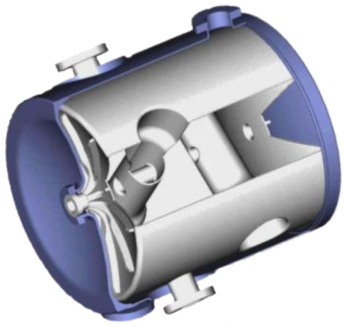


EURISOL
T8 Design Study

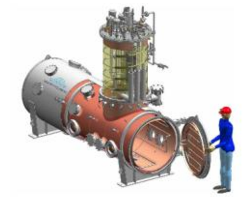
Prototype strategy

- Planned and proposed prototypes in DU phase (before 2013):
  - SC Cavities (All elliptical and spoke types) at CEA and IPNO
  - Half length cryomodule for 4 elliptical, with CERN
  - Existing ion source and RFQ in Catania and at CEA
  - Control system HW unit with SW interface (“Control box”)

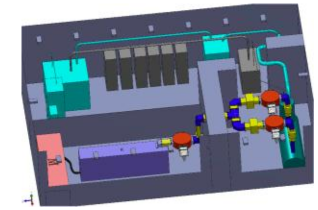
- Planned and proposed prototypes in (pre-)construction phase based on preparatory work in DU phase (2013++)
  - RF source, control and distribution system in Uppsala
  - Full length cryomodules for all SC cavity types
  - Beam instrumentation
  - Final version of Ion source in Catania
  - DTL



Test stand strategy



- 704 MHz test stand for SC elliptical cavities and a cr e
  - Possible sites CERN, CEA, Uppsala and DESY (after XFEL)
  - Study and costing in progress for CERN, CEA and Uppsala
  - Focus in Uppsala on RF source, control and distribution
- 352 MHz test stand for SC spoke cavities and cryomodules
  - One test stand at CEA
  - One test stand under construction at IPNO in Paris
- 352 MHz test stand for NC structures
- Test area for Ion Source development in Catania



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Important issues

- Configuration management:
  - Requires 6 months lead time and central repository for baseline parameters
- Reliability and upgrade strategy - Mandate from STC is a 5 MW accelerator
  - Physicist can always use more intensity…
  - “Shorter pulses (>0.8 ms) can’t hurt and it will do a lot of good for some instruments”, F.Mezei
  - Important to be study upgrade scenarios now with proper costing including the additional cost already at construction

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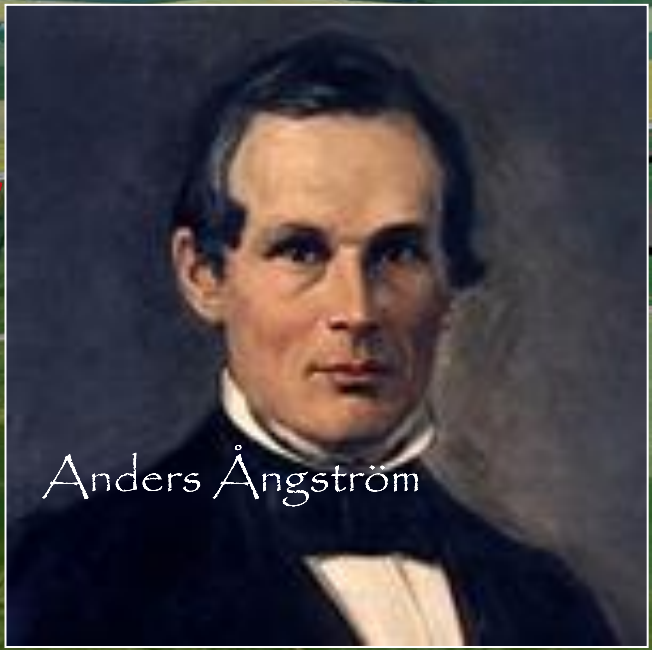
Blue skies research on a truly a green field site

http://ess-scandinavia.eu/jobs



The Ångström Bohr Centre