the European Spallation Source
the next generation facility for materials research and life science

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acknowledgements: Mats Lindroos, Steve Peggs

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OECD RECOMMENDATION

"A High Power Spallation Source in each Global Region"

ESS SITE SELECTION PROCESS

ESS is a research infrastructure in ESFRI (European Science Forum for Research Infrastructures) roadmap

- *Three projects bidding for the site (Bilbao - Spain, Lund- Sweden and Debrecen - Hungary)*
- *Evaluation by ESFRI in 2008 by a Site Review Group*
- *Agreement on process to reach a site decision within the fringes of the European Competitiveness Council*
- *Core group for ESS formed (14 countries) and decision on site at a Ministerial meeting in Brussels (28 May)*
  - *Sweden proposed as ESS site with important contributions and supporting infrastructure in Spain*
- *Integration of ESS-B and ESS-S accelerator and target teams*
- *First ESS Steering Committee meeting in Copenhagen 22-23 October 2009*

ESS FIRST STEPS

- *ESS-S and ESS-B have become ESS which now has 12 future member states*
  - *Main site for facility in Lund in Sweden and complementary infrastructure in Bilbao in Spain*
- *First neutrons for 2019 with full design specifications in 2023*
  - *Ambitious goals requires ambitious planning*
- *Build on latest SC RF R&D*
  - *Requires high reliability and low losses*
- *Maximize synergies with other similar projects*
  - *Cost and time gains*
  - *Trained people are in short supply*
- *Very challenging task…*
  - *That is our job…*
  - *…and that is why we are here!*

FACILITY TECHNICAL OBJECTIVES

5 MW

Long pulse source

≤2 ms pulses

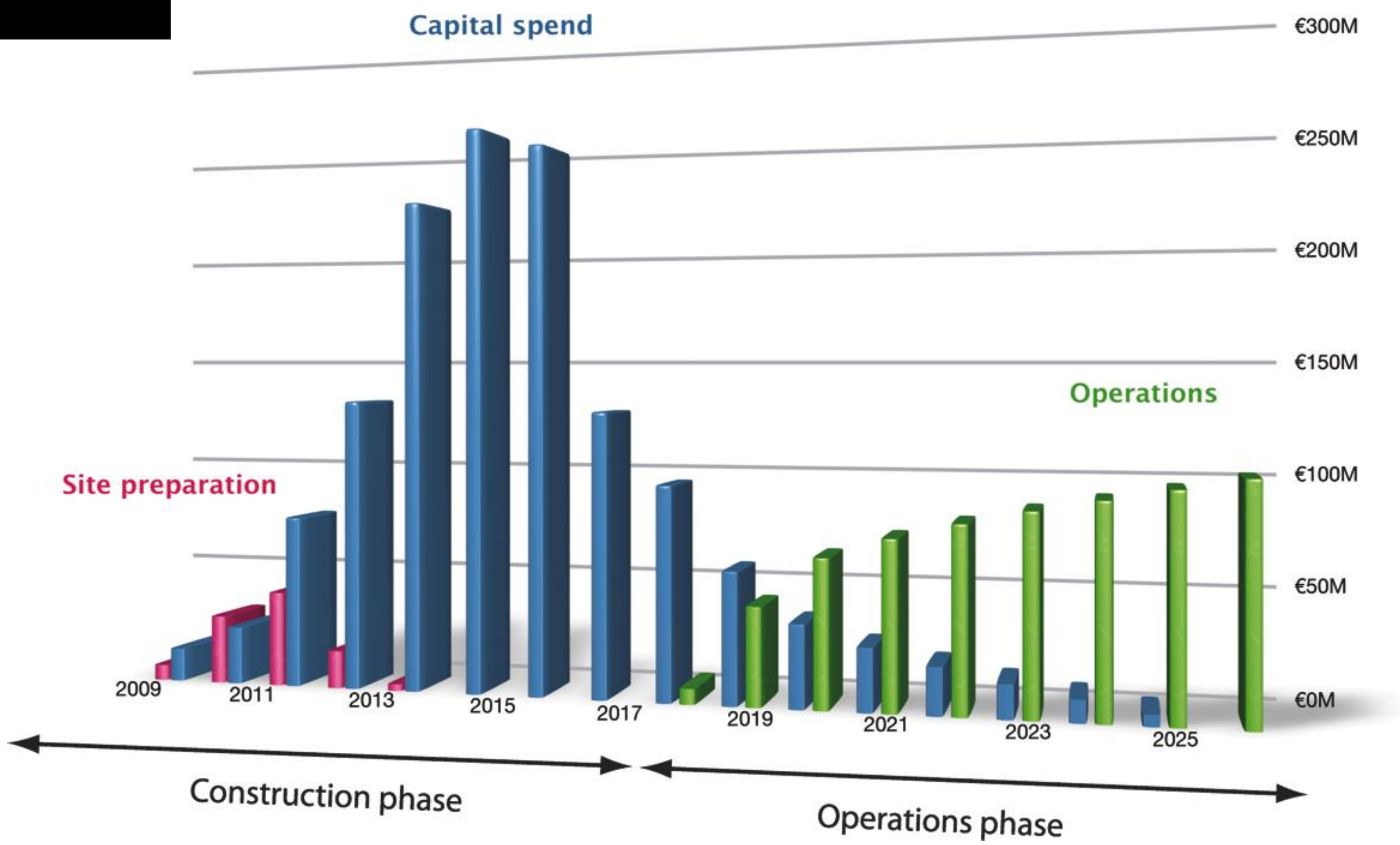
≤20 Hz

Protons (H+)

Low losses

High reliability >95%

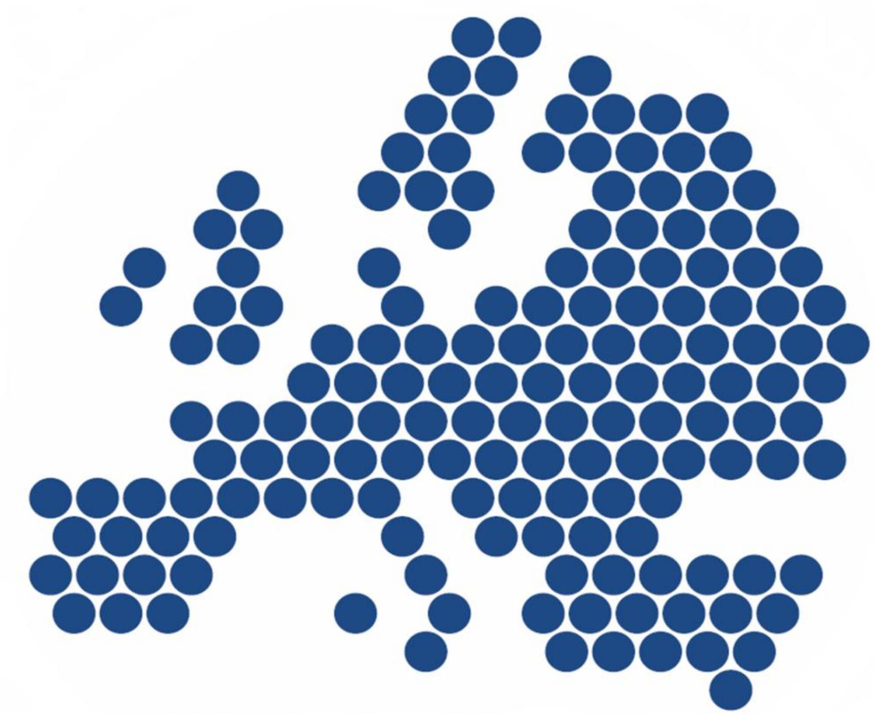
BUDGET



Facility investment: 1.377 M€$_{2008}$ with 22 instruments
+ 101 M€$_{2008}$ site specific cost
Operational cost: 89 M€$_{2008}$ per year
Decommissioning cost: 344 M€$_{2008}$

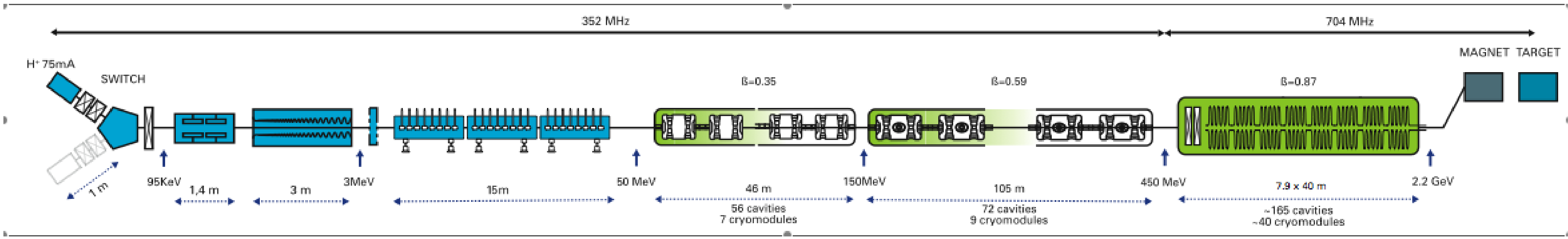
DESIGN UPDATE

ESS-Bilbao preparatory work



The ESS-B workshop held in Bilbao in March 2009 brought together more than ***160 experts*** *from across the world, leaders in the fields of* ***high power proton accelerators****,* ***beam dynamics and targets****, in a format and infrastructure that promoted open discussion, while maintaining the focus of documenting clear* ***recommendations*** *for* ***future collaborative R&D efforts****.*

ESS-Bilbao WORKSHOP CONCLUSSIONS



*In comparison to the originally proposed design (5 MW, 1 GeV, 150 mA, 16.7 Hz) the parameters have been modified in order to **simplify the linac design** and to **increase reliability**. In essence the current has been decreased and the final energy has been increased, keeping the footprint of the accelerator the same.*

- ✓ ***Increase in energy*** *– With increased energy the average pulse current can be reduced by the same factor.*
- ✓ ***Increase of the cavity gradient*** *– By decreasing the current to 75 mA, the gradient can be raised to 15 MV/m, keeping the coupler power constant at 1.2 MW.*
- ✓ ***Increase of beam energy*** *- the final energy was increased from 1 to 2.2 GeV.*
- ✓ ***Repetition rate*** *- The originally proposed repetition rate of 16.67 Hz has been increased to 20 Hz.*
- ✓ ***Pulse length*** *- The originally proposed pulse length of 2 ms has been reduced to 1.5 ms*

DESIGN UPDATE

ESS-Scandinavia preparatory work

Work with expert group (the ESSS linac reference group)

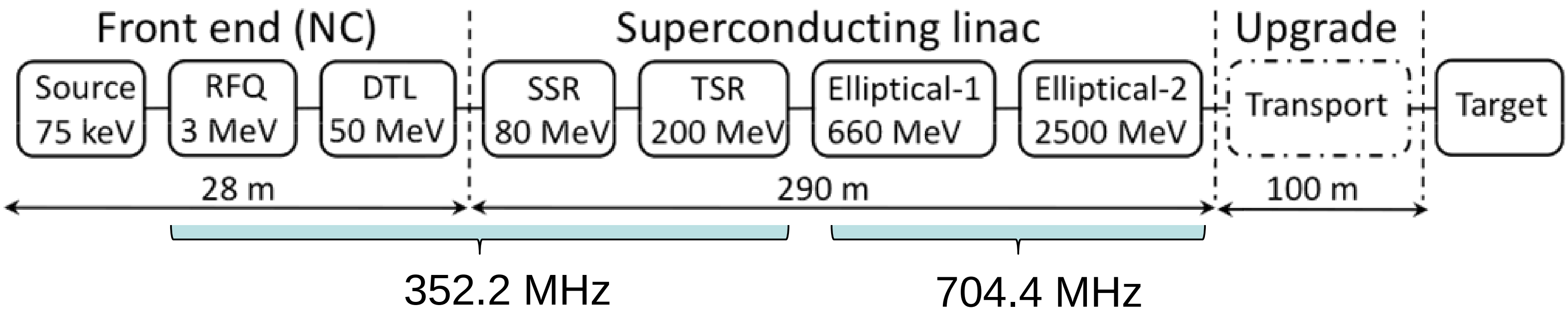


Table 1: Primary ESSS performance parameters in the long pulse conceptual design. There is no accumulator ring.

INPUT		**Nominal**	**Upgrade**
Average beam power	[MW]	5.0	7.5
Macro-pulse length	[ms]	2.0	2.0
Pulse repetition rate	[Hz]	20	20
Proton kinetic energy	[GeV]	2.5	2.5
Peak coupler power	[MW]	1.0	1.0
Beam loss rate	[W/m]	< 1.0	< 1.0
OUTPUT			
Duty factor		0.04	0.04
Ave. pulse current	[mA]	50	75
Ion source current	[mA]	60	90
Total linac length	[m]	418	418

DESIGN UPDATE: SOME ISSUES

Question for future users and ESS technical teams:

- *How long is the ideal "long pulse" and what is the ideal repetition rate?*
- *Can the neutron pulse be shaped in a more useful shape for physics through shaping of the proton pulse?*
- *Can we confirm that the neutron intensity at the instruments is constant per MW up to a certain energy? (< 3 GeV)*
- *What flexibility can be left in the design for future upgrades without compromising construction time, schedule and budget?*
- *Using the best SCRF technology, what is the optimum design of the linac with given objectives?*

COLABORATION MODEL FOR LINAC DESIGN

Work Packages (work areas)

1. *Management Coordination*

2. *Beam Physics*

3. *Infrastructure Services*

4. *SCRF Spoke cavities*

5. *SCRF Elliptical cavities*

6. *Front End and NC linac*

7. *Beam transport, NC magnets and Power Supplies*

8. *RF Systems*

ESS- BILBAO
WHERE ARE WE HEADING TO?

Spain and Sweden have signed an agreement that formalises a ***joint candidature*** *between both countries for the development of ESS*

The agreement establishes the bases for a unique project, with ***two centres****: the main centre in Lund and another in Bilbao, which shall contain an important complementary infrastructure of the main one.*

ESS- Bilbao previous organization is now nucleating ***a stable R&D centre*** *focusing on the production and use of light-ion beams for research purposes as well as* ***a remote experimental and educational centre*** *for materials science research.*

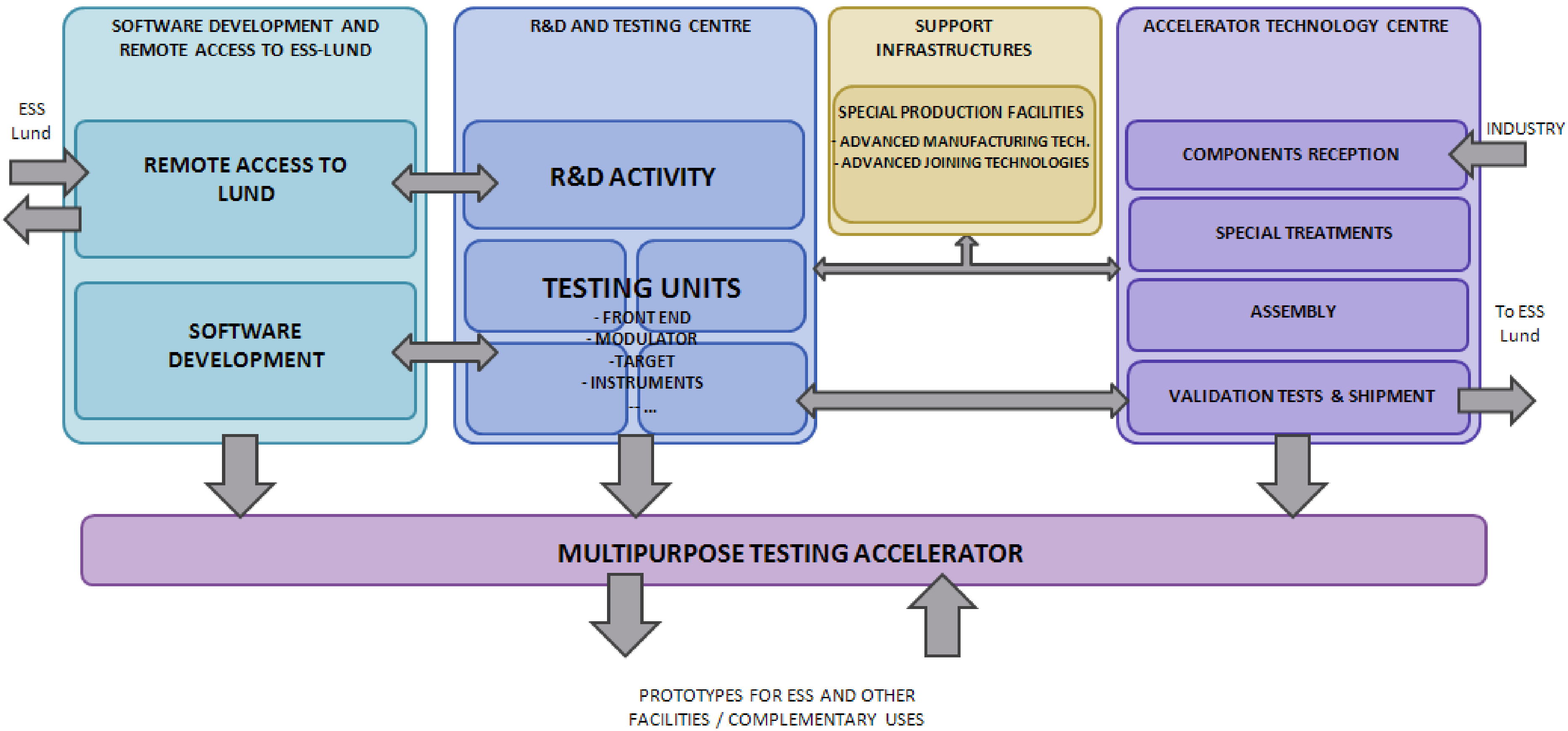
We view such a development as a cornerstone for our significant participation within several ongoing projects (ESS, IFMIF, FAIR…),

The development of the Bilbao Centre represents a ***significant investment of 180 M€*** *by the Spanish government and Basque Government starting in 2009.*

ESS- BILBAO
STRATEGIC OBJETIVES

1. ***Technology*** *development*
   - ✓ *R&D, prototyping and testing of technologies related to the construction and operation of research infrastrutures*
2. *Knowledge transfer to* ***industry***
   - ✓ *Validation infrastructure for accelerators components*
3. ***Science*** *performance improvement*
   - ✓ *Remote access for experimentation*
   - ✓ *Dissemination and outreach activities*

ESS- BILBAO
FACILITY DEFINITION



ESS- BILBAO
TECHNICAL OBJECTIVES

- ***Phase 1**: Build a proton injector following the performance expected for ESS, also able to run beams of deuterons with moderate current (5 mA or so)*

- ***Phase 2**: Build and commision accelerating structures (RFQ+ DTL or SC cavs) able to reach 40- 50 MeV for protons. Extract a proton beam for materials/ radiation biology applIcations.*

- ***Phase 3**: Set up a test bench for SRF structures (cavities + cryomodules) able to carry out tests of SRF cavities with beam. Provide acceleration up to 150 MeV / 200 MeV (H^+) and extract a beam for applications purposes.*

ESS- BILBAO
ONGOING PROJECTS

ECRIS - *at present under design. Expect to start next January, extracting a H^- beam from an ISIS-like Penning source*

LEBT - *Two solenoid structure. Design based upon that developed within the MICINN-ISIS collab. Capability to chop the beam to reduce the rise time.*

RFQ - *Structure composed by three resonantly-coupled cavities operating at 352.2 MHz, able to bunch and accelerate a beam up to 5 MeV with transmission better than 90% and emittances better than de 0.2" mm.mr (norm. rms) en transverso y 0.2" grad MeV (rms) long. Reference designs (for the time being) LEDA, Linac4 and ISIS-FETS. A first prototype of a LLRF module built within our premises will be ready in 2 months.*

MEBT · *Composed by a set of focusing quads plus re-bunching cavities and diagnostics equipment. Detailed design will depend upon operational results after chopping experiments with the LEBT chopper.*

Beam Dump - *A prototype able to stop a 5 MeV /2 MW beam already under construction. Planning to develo something sturdier.*

ESS- BILBAO
ONGOING PROJECTS

Development of Distributed Control and Remote Handling Systems - *Already started to implement Networked Control Systems (NCS), based upon the EPICS standard.*

Beam Dynamics - *Results from multiparticle (tracewin & track) simulations already available.*

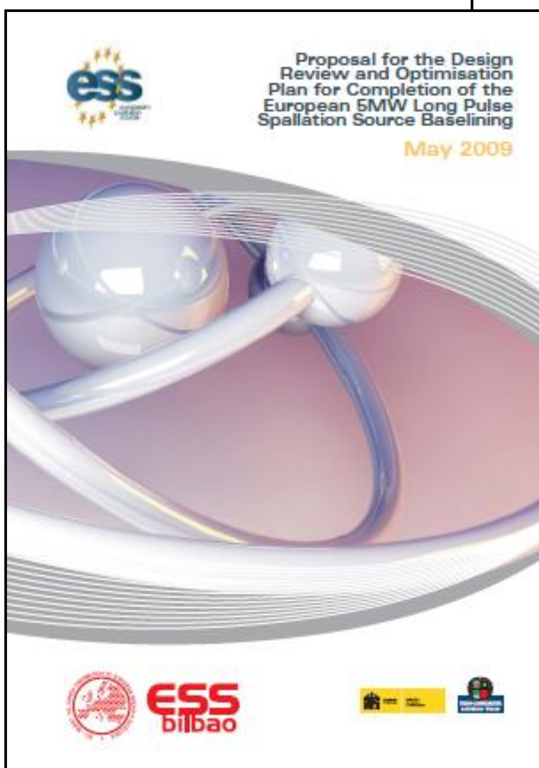
Power Klystron *- Negotiations to develop a 1.3 MW pulsed klystron (352.2 MHz). A high power HVCM already beind under development in collab. with SNS.*

Low b Spoke Cavities *- A EM design already available. Activities to test them on cold models already ongoing. Nb prototypes to be built within an agreement with ACS- France.*

Target *– Rotating target design studies in collaboration with SNS. First prototype to be built and tested during 2010*

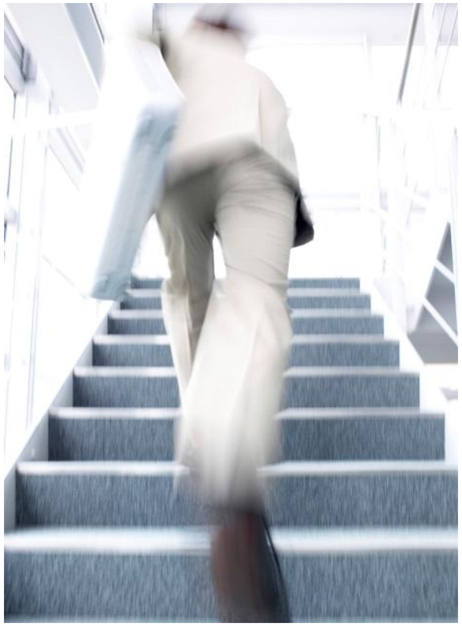
PREPARATORY WORK FOR THE DESIGN UPDATE

Workshop Conclussions Report



Proposal for ESS Baselining and Redesign

NEXT STEPS



- ✓ Definition of detailed objectives
- ✓ Facility definition
- ✓ Facility construction plan
- ✓ Legal aspects and organisational definition
- ✓ Team building
- ✓ Budget plan definition