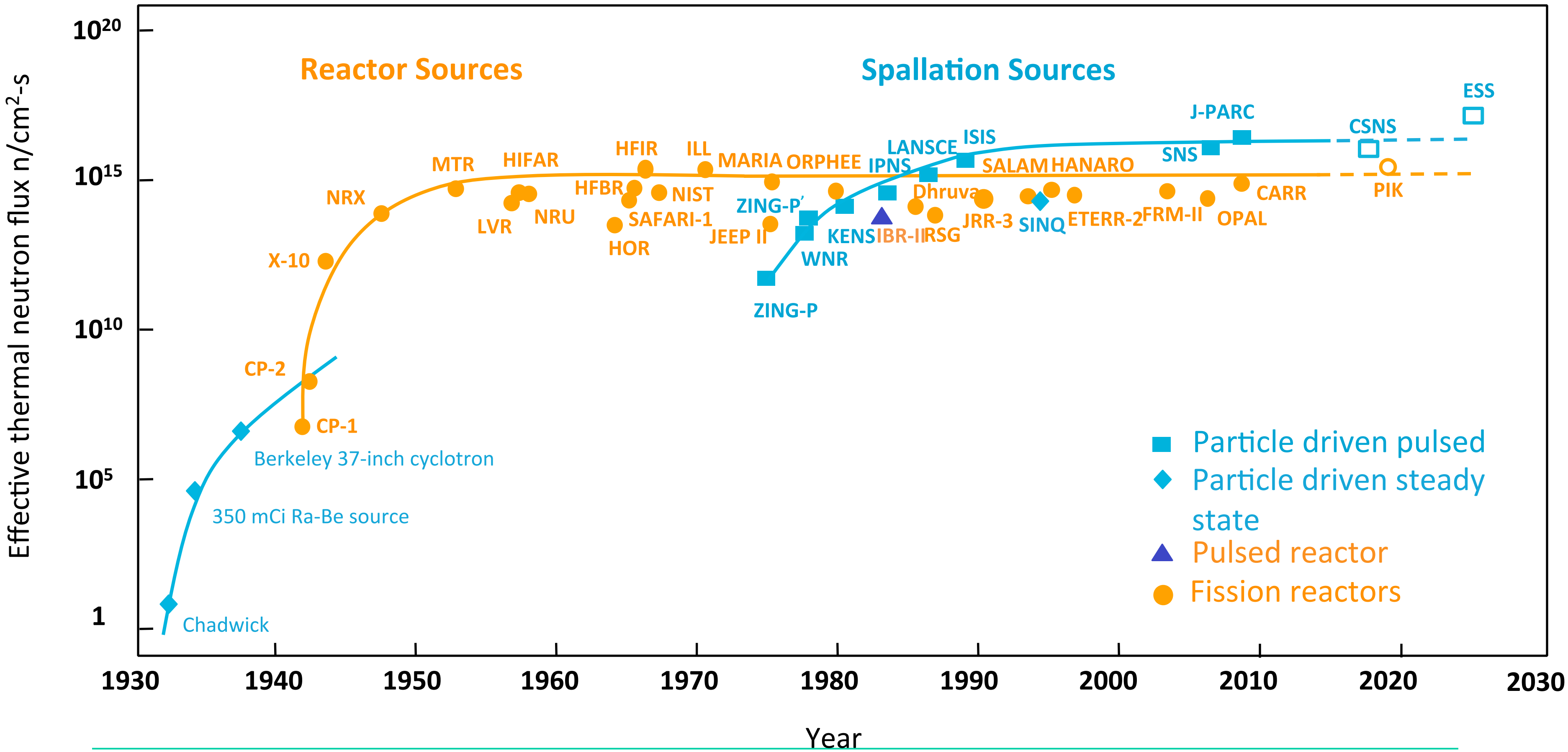
# *European Spallation Source: the INFN-LNS contribution*

*S. Gammino*

*Istituto Nazionale di Fisica Nucleare*
*Laboratori Nazionali del Sud, Catania*

# *European Spallation Source is….*

- ….The most powerful spallation source under construction with the highest flux and real-time data visualization.
- In particular, it includes the most powerful linac ever built.




(Updated from *Neutron Scattering*, K. Skold and D. L. Price, eds., Academic Press, 1986)

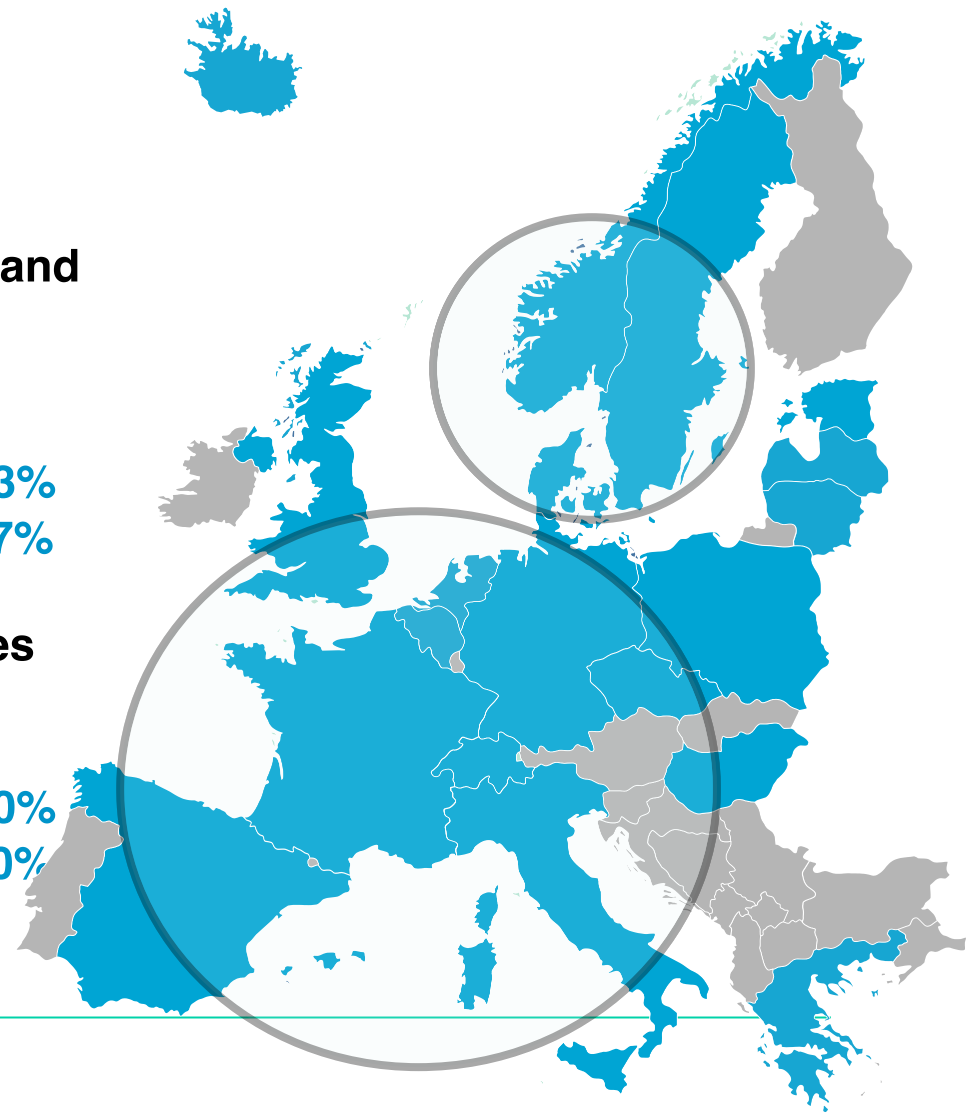
# *Financing includes cash and deliverables*

**Host Countries of Sweden and Denmark**

47,5% Construction
15% Operations
**In-kind Deliverables ~3%**
**Cash Investment ~97%**

**Non Host Member Countries**

52,5% Construction
85% Operations
**In-kind Deliverables ~ 70%**
**Cash Investment ~ 30%**

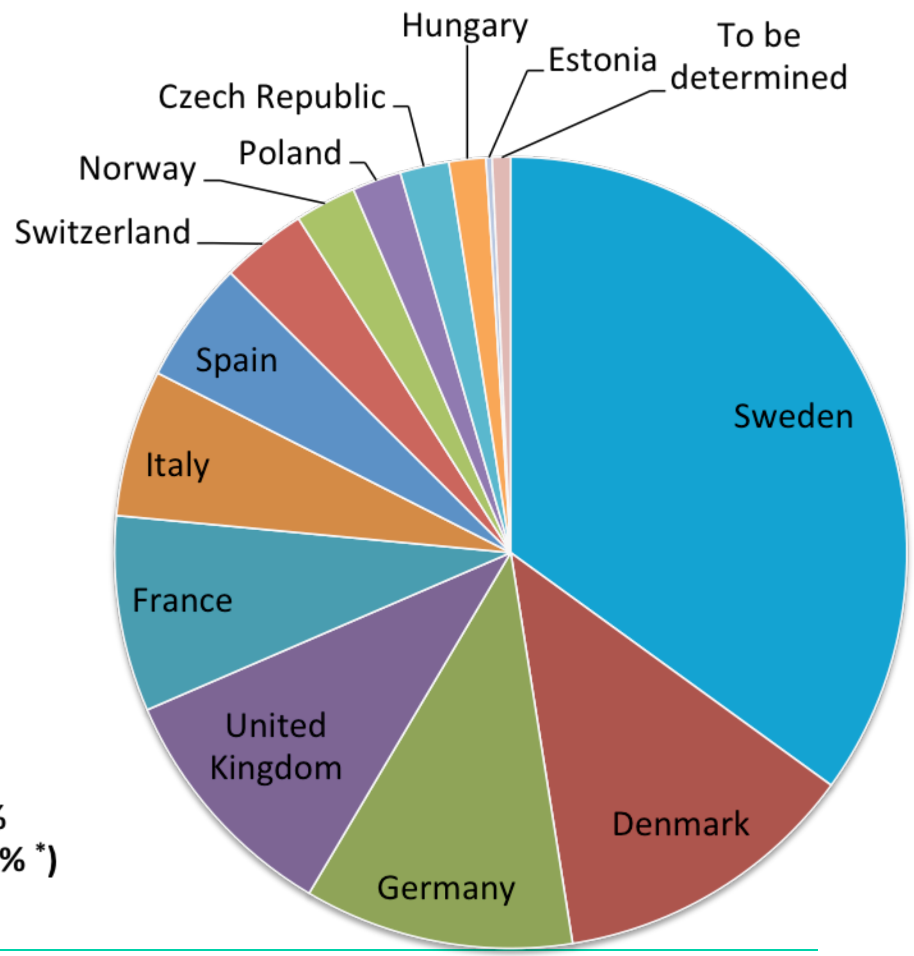


# *Construction investment*

| | |
|---|---|
| **Sweden** | **35.0 %** |
| **Denmark *** | **12.5 %** |
| **Germany *** | **11.0 %** |
| **United Kingdom** | **10.0 %** |
| **France** | **8.0 %** |
| **Italy** | **6.0 %** |
| **Spain *** | **5.0 %** |
| **Switzerland** | **3.5 %** |
| **Norway** | **2.5 %** |
| **Poland** | **2.0 %** |
| **Czech Republic** | **2.0 %** |
| **Hungary** | **1.5 %** |
| **Estonia** | **0.25 %** |
| **Total** | **99.25 %** |

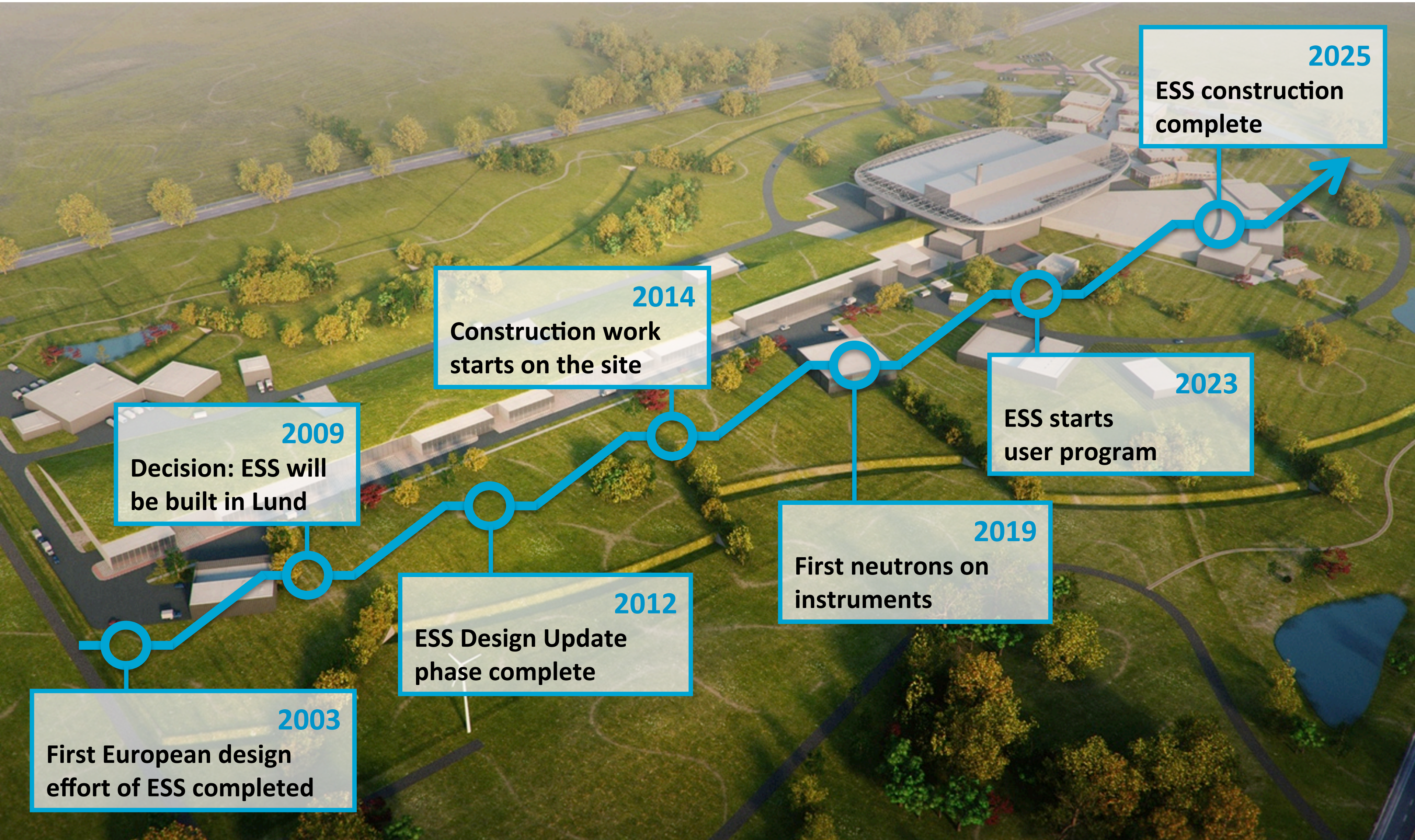
| | |
|---|---|
| **Iceland** | *tbd (0.25%)* |
| **Latvia** | *tbd (0.25%)* |
| **Lithuania** | *tbd (0.45%)* |
| **Netherlands** | *tbd (1.0%)* |
| **Belgium** | *tbd (2.0%)* |
| **Greece** | *tbd (1.0%)* |

➢ **0.75 %**
**(~4.95 % *)**




* Includes Pre-construction Costs

# Road to realizing the world's leading facility for research using neutrons



*Progress on civil construction*

http://europeanspallationsource.se/site-weekly-updates

# *Project execution strategy*

| Milestone | Date |
| --- | --- |
| Delivery TDR and Start Construction Phase | Jan 2013 |
| Start Site Preparations | Jun 2014 |
| Start First Installations for Accelerator On-site | Sep 2016 |
| First Beam on Target (570 MeV) | Dec 2019 |
| Machine installed for 2.0 GeV Performance | Dec 2022 |
| Construction Phase Instruments Complete | Dec 2025 |

- **5 MW accelerator capability**
- **Cost Book construction cost of 1,843 B€$_{2013}$**
- **Cost Book annual operations cost target of 140 M€$_{2013}$**
- **22 “public” instruments (16 included in the construction budget)**

- Comprehensive review of project baseline and execution plans
- Secure funding and resources and align schedules with the available resources

# Accelerator Project organization

| WP# | WP TITLE | WP LEADER | EXT. WP? | DEPUTY WP LEADERs FOR EXTERNAL WPs |
|---|---|---|---|---|
| WP01 | MANAGEMENT | J.G. WEISEND II | NO | |
| WP02 | ACCELERATOR PHYSICS | M. ESHRAQI | NO | |
| WP03 | NORMAL CONDUCTING FRONT END | S. GAMMINO | YES | W.WITTMER |
| WP04 | SPOKE CRYOMODULES | S. BOUSSON | YES | C. DARVE |
| WP05 | ELLIPTICAL CRYOMODULES | P. BOSLAND | YES | C. DARVE |
| WP06 | BEAM DELIVERY SYSTEMS | S. MØLLER | YES | P. LADD |
| WP07 | BEAM DIAGNOSTICS | A. JANSSON | NO | |
| WP08 | RF SYSTEMS | A. SUNESSON | MIX | A. SUNESSON |
| WP99 | ACCEL INFRASTRUCTURE & INSTALLATION | D. MCGINNIS | NO | |
| WP10 | TEST STANDS | W. HEES | MIX | W. HEES |
| WP11 | CRYOGENICS | P. ARNOLD | NO | |
| WP12 | VACUUM | P. LADD | NO | |
| WP13 | SAFETY | L. TCHELIDZE | NO | |
| WP14 | ACCELERATOR INTEGRATION | S. MOLLOY | NO | |
| WP15 | ELECTRICAL SUPPORT | F. JENSEN | NO | |
| WP16 | COOLING SUPPORT | A. LUNDMARK | NO | |
| WP17 | POWER CONVERTERS | C. MARTINS | NO | |

**Collaboration Board:**

1. ESS Technical Director
2. Project leader
3. Representatives of all contracted institutes (one elected as chair)

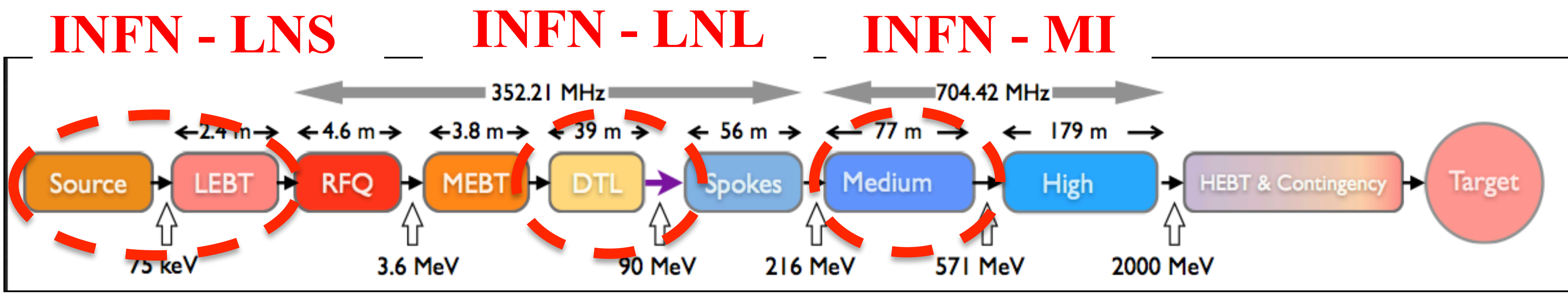
**Quarterly Technical Board:**

1. Weekly ESS management team
2. All WP leaders and deputies
3. Representatives of all contracted institutes if not already a WP leader

**Weekly ESS management team:**

1. Mats Lindroos, Project leader
2. John Weisend, Deputy project leader
3. David McGinnis, Chief engineer
4. Håkan Danared, In-kind manager
5. Lali Tchelidze, Safety including radiation safety
6. Anders Sunesson, RF systems
7. Luisella Lari, Head planner
8. Andreas Jansson, Beam instrumentation
9. Matthew Conlon, QA/QC

# *ESS Linac & INFN Contribution*




**INFN is in charge of the management of the WP3-Normal Conducting Linac**

1. **Ion Source & LEBT (INFN-Laboratori Nazionali del Sud, Italy)**
   **Including RFQ (CEA-IRFU, France) & MEBT (ESS Bilbao, Spain)**
2. **Drift Tube Linac (INFN-Laboratori Nazionali di Legnaro, Italy)**
3. **INFN-LASA-Milano (superconducting elliptical cavities for WP5)** construction of medium beta section **(strong industrial background for series construction)**
4. **Potential: LNL for ICS ; LNS, LNL and Milan for support to commissioning**

**1+2+3+management WP3 is agreed with ESS Accelerator Division, 4 under discussion**

## *The INFN background aimed for ESS*

- **The involvement of INFN** in the Accelerator Design Update **is a natural consequence of the R&D efforts done at INFN in the frame of the TRASCO-ADS research programme** (a study for a high power proton accelerator for the radioactive waste transmutation), along with **the daughter programmes NTA-HPPA at national level** and through different EU programmes aimed to the design of components for high power proton accelerators:
- studies done for the production **of intense beam of proton with small emittance** and high reliability/stability;
- the R&D for the following parts of the **low energy high power accelerator**;
- the development of **high performance superconducting cavities;**

# *Ion Source & LEBT*
# *Technical performances*

## Beam performances are specified by L3 requirements:

| Parameters | Value |
|---|---|
| Nominal proton peak current | 74 mA |
| Proton fraction | > 80 % |
| Stable operation current range | 60-74 mA |
| Current stability(over 50us period) | ± 2 % |
| Pulse to pulse variation | ± 3.5 % |
| Beam Energy | 75 keV (±0.01) |
| Distance between pulses | 1 Hz< f <14 Hz |
| Restart after vacuum break<br>Restart after cold start | <32 h<br><16 h |

| Parameters | Value |
|---|---|
| Beam current change<br>(2 mA step, ±1 mA res.) | 2-74 mA |
| Nominal pulse length | 2.86 ms |
| Pulse length range (±0.001 ms) | 0.005-2.88 ms |
| 99 % rms norm. emit. at RFQ input | < 2.25 pi.mm.mrad |
| Twiss parameter: α | α= 1.02 ±20% |
| Twiss parameter: β | β= 0.11 ±10% |
| Rise and fall time | <20 µs |
| Maximum LEBT pressure | 6e-5 mbar |

# *Ion source & LEBT: Selected technologies*

- The PS-ESS (Proton Source for ESS) is a MDIS (microwave discharge ion source) with improved features w.r.t. the previous ones (SILHI, TRIPS, VIS), either in terms of magnetic plasma generation and in terms of RF coupling to the plasma.
- The High voltage system and extractor ($\phi$=6,8,9 mm) are completely renewed, in order to cope with the request to minimize the emittance and to keep high the reliability.
- The six-blades iris is a new element designed to reduce the transmitted current and preserve the round shape of the beam.
- The chopper was optimized for a fast pulse transition and for reducing the heat issue at the end of the LEBT.
- Different "expedients" were taken into account for a space charge compensated transport of the beam.

# *Ion Source & LEBT Interaction between ESS-Accelerator Division and NTA-Service@LNS*

- ISS (Ion Source Specialties)

Level 4 requirements describe the functions to create and maintain the plasma and extract a stable beam from it, with high reliability. This includes, among others, the high voltage platform and the protection cage, the RF power into the plasma (magnetron), the hydrogen gas flow, the magnetic confinement, the 400 V isolation transformer and the high voltage extraction power supply. ISS requirements map the WP 3 WU Ion Source deliverables and scope from INFN-Catania.

- In the LEBT, performances for chopper and its dump, magnets (solenoid with embedded steerers) and the iris (to modulate the current) are described by BMD (Beam Magnets and Deflectors) Level 4. Interfaces occur mainly with Beam Instrumentation (Diagnostic boxes: in between the solenoids and for commissioning) and with vacuum.
- ICS (controls) is interfaced to any device, MPS/PPS to selected ones.

# *Critical Design Review (Feb. 10th, 2015)*

The CDR was prepared since January, with the delivery of a detailed report to the Review Committee chaired by R. Ferdinand (GANIL).

A series of presentation with a long question time permitted to define strength and weakness for each part of the injector.

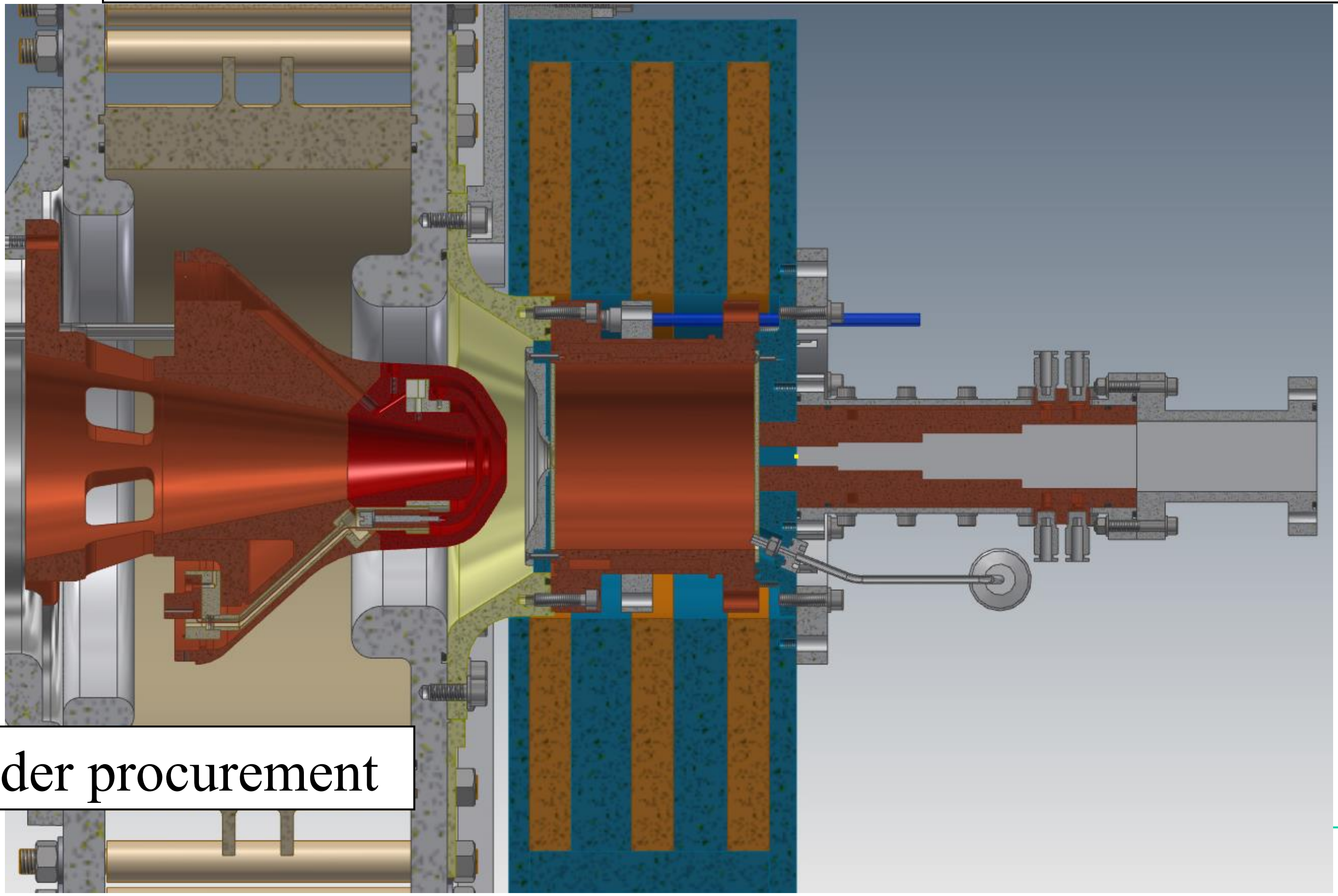
A positive evaluation was given to the design and the ongoing construction, with some recommandations, most of them about the integration.

A follow-up meeting occurred at INFN-LNS to answer to most of these recommandations.

An "Interface meeting" regarding the whole Normal Conducting Linac was held in Lund in April, 2015 and integration activities were extended to the other parts of the NCL

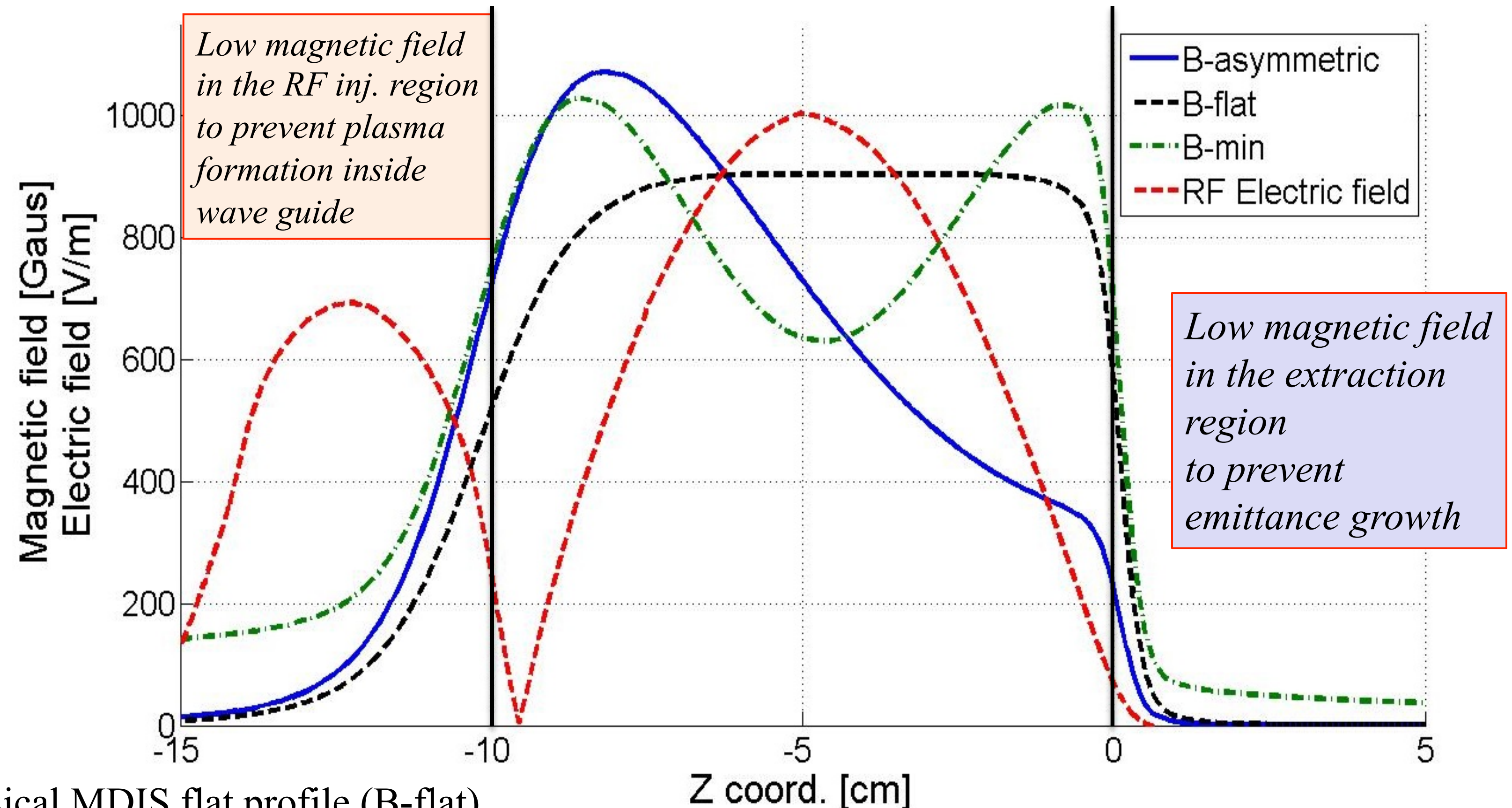
## *The Proton Source for ESS (PS-ESS)*

Flexible magnetic system + improved RF injection-Plasma coupling + increased reliability + easy assembly procedure



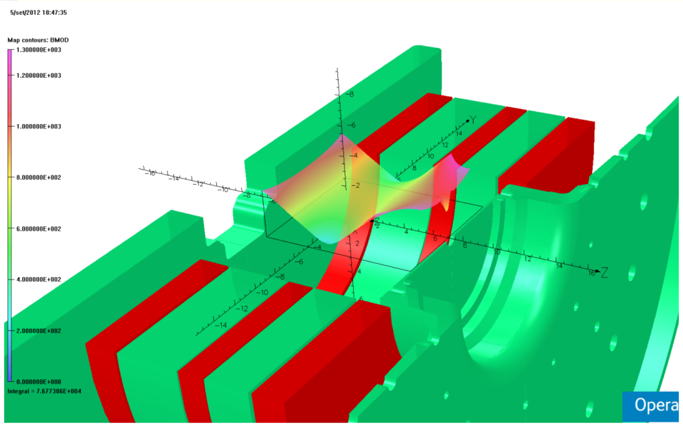
Under procurement

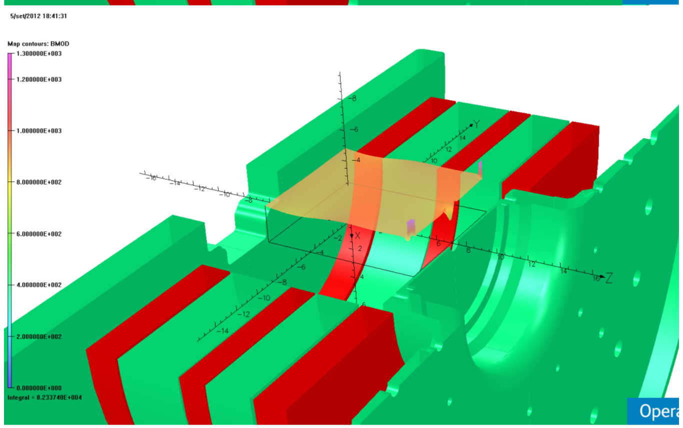
# *Flexible magnetic system (know-how available by NTA and CSN5 activities)*

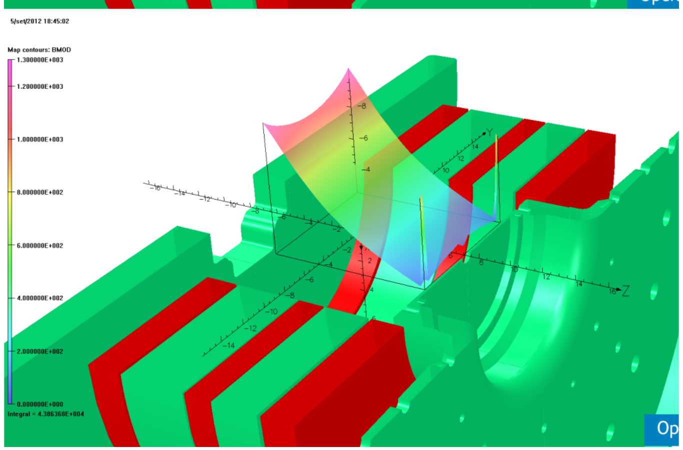


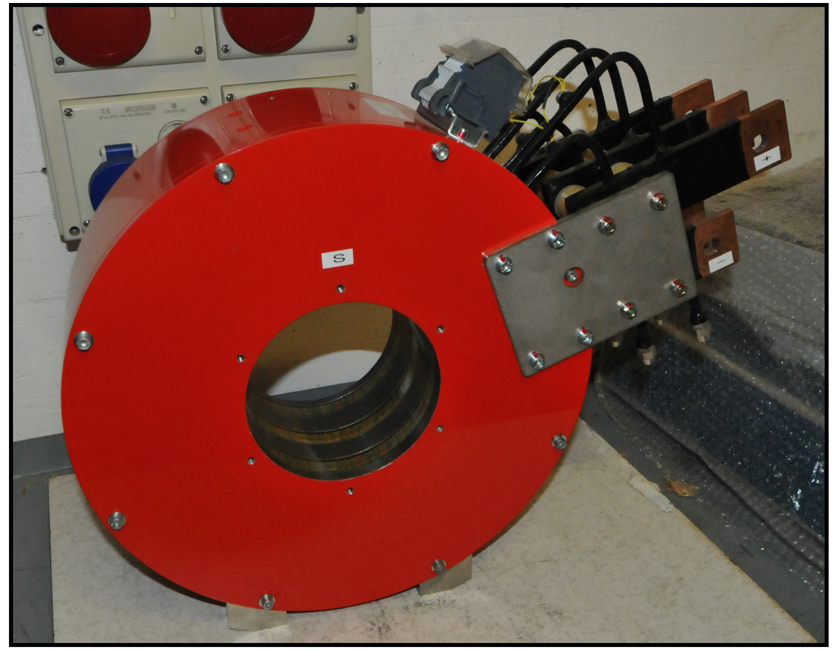

- ✓ <u>Classical</u> MDIS flat profile (B-flat)
- ✓ <u>Simple-mirror</u> (B-min) for the prolongation of $H_2^+$ molecule lifetime, thus increasing ionization efficiency and proton fraction
- ✓ <u>Magnetic beach</u> (B-asymmetric) making possible <u>Bernstein Waves</u> (BWs) formation through inner-plasma conversion of the input electromagnetic waves.

# *The PS-ESS magnetic system*



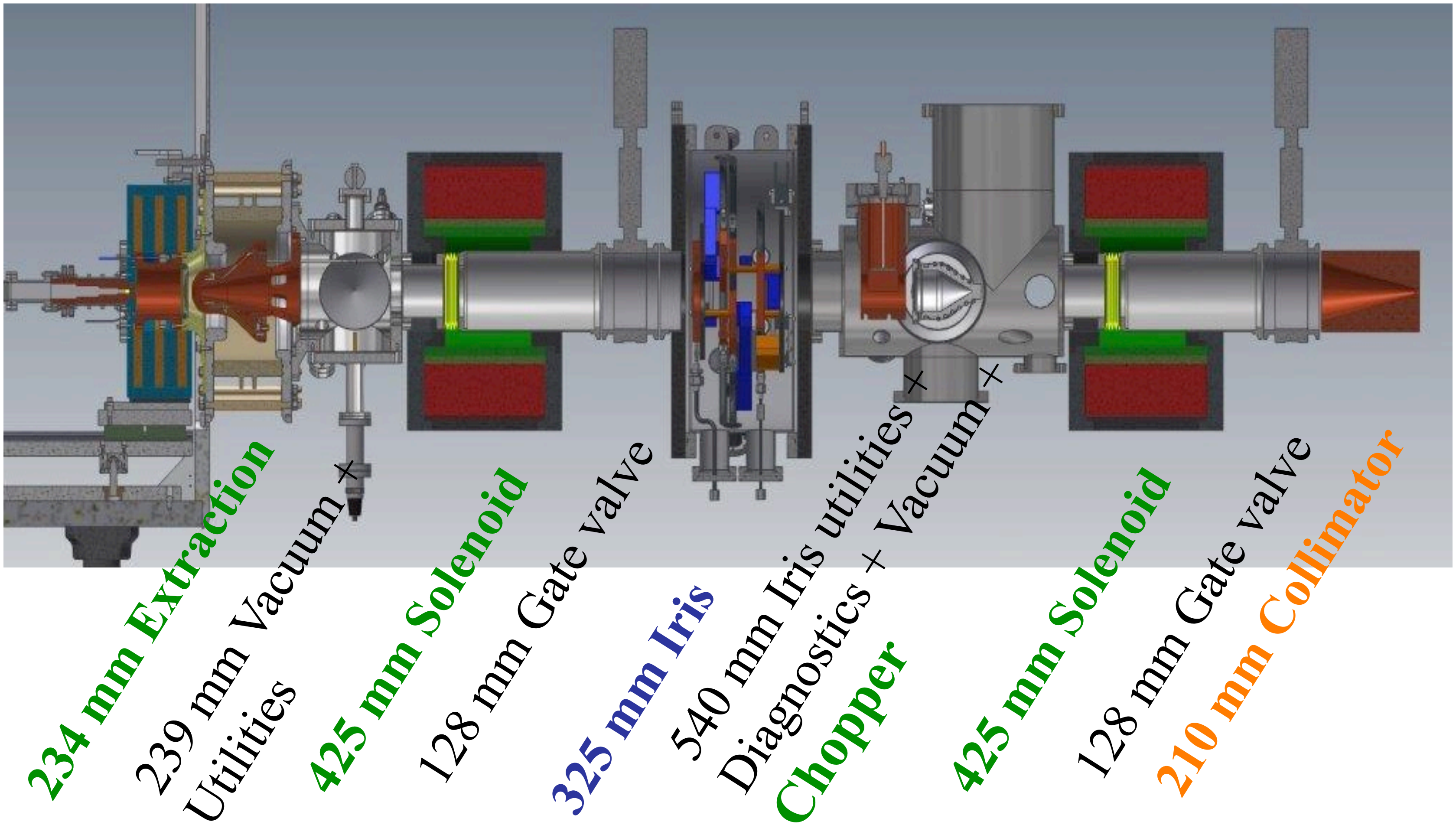





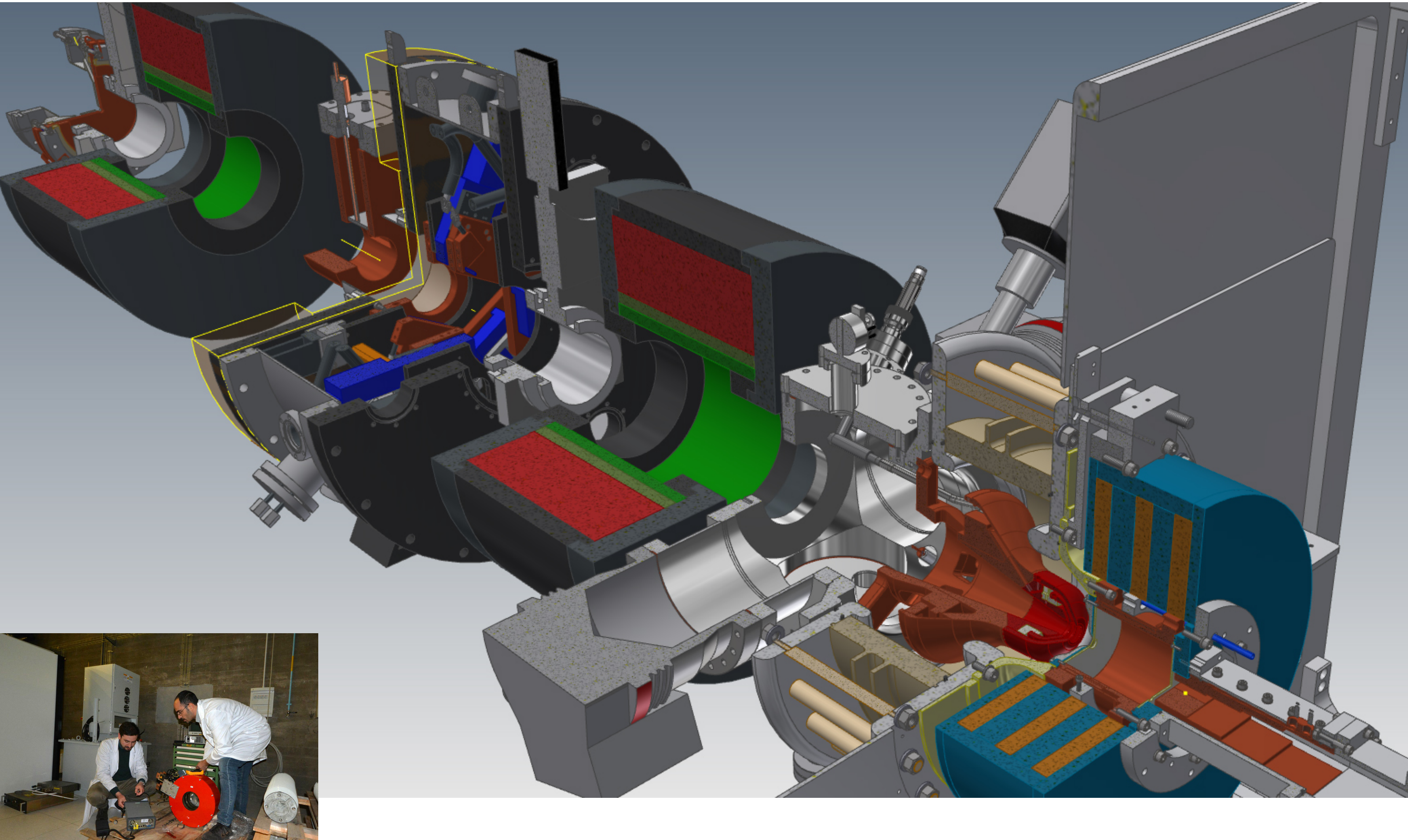

- Magnetic system **Ready for installation**

## *LEBT Layout*

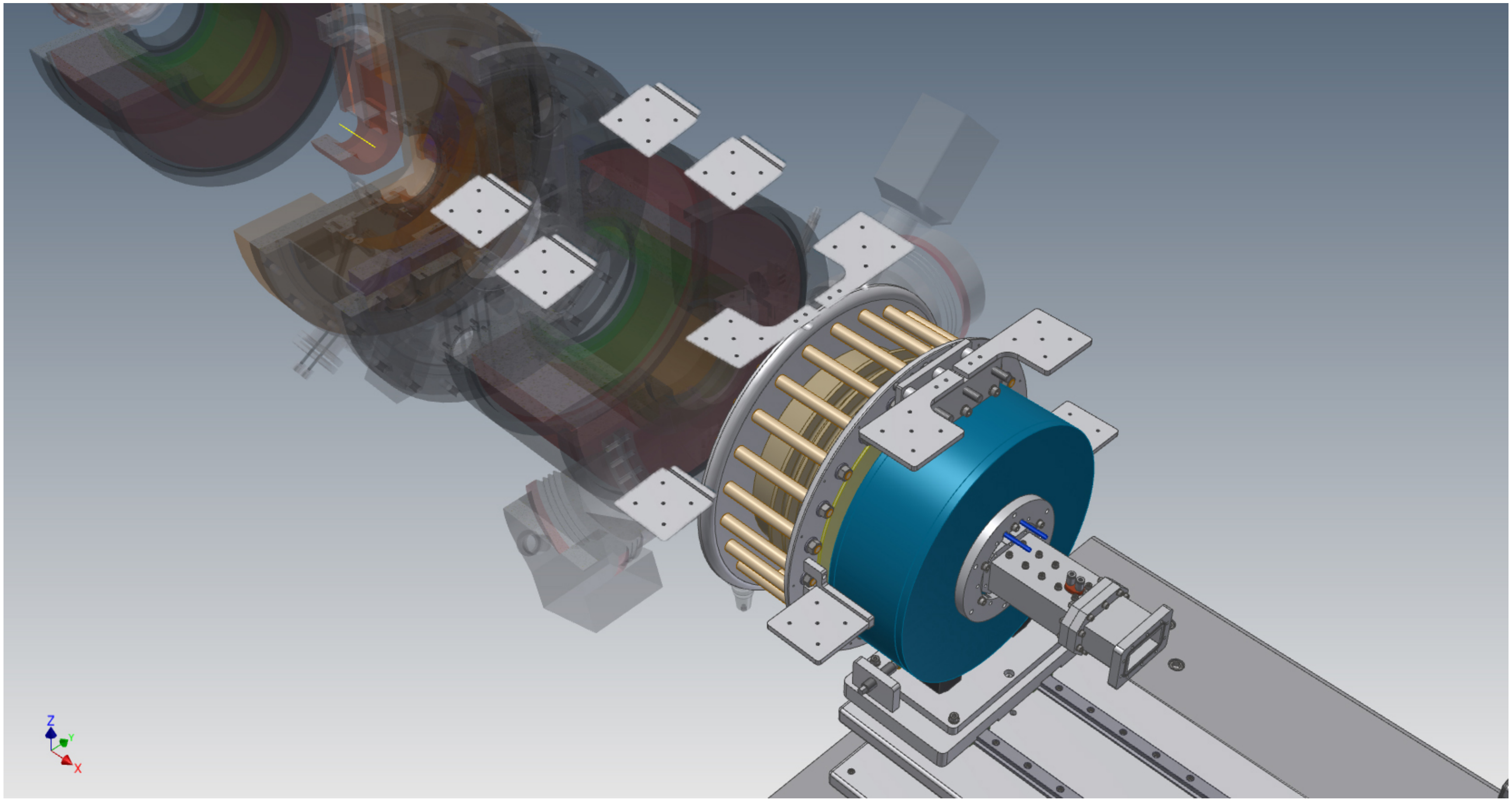
2654 mm from plasma electrode to LEBT collimator



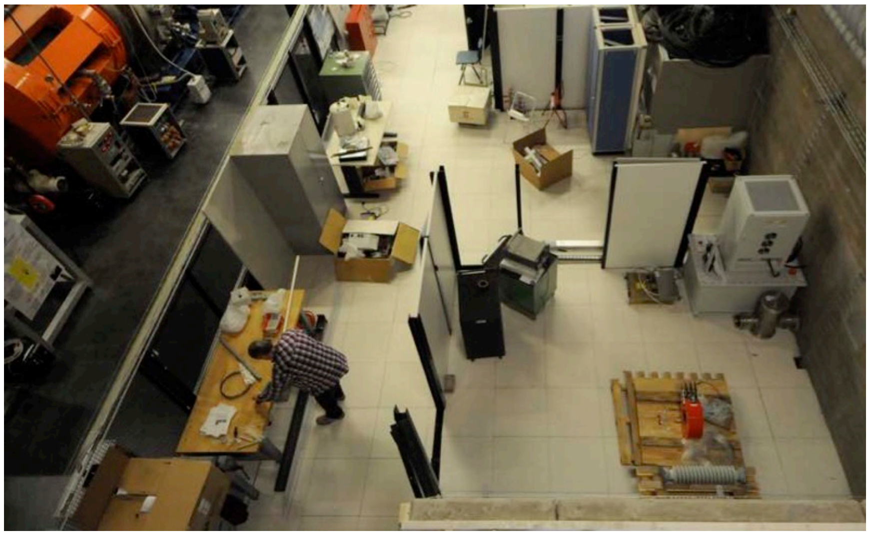
# *Ion source & LEBT*

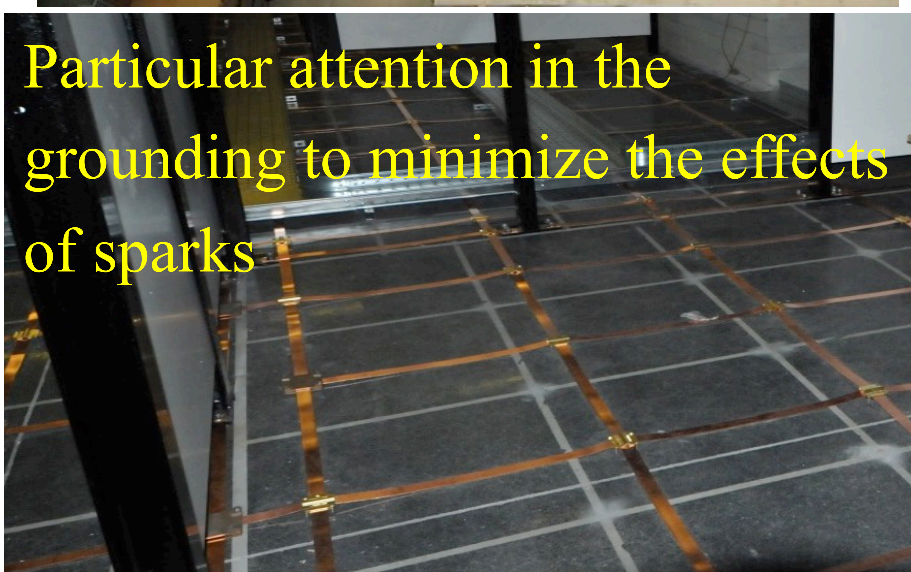


# *Alignment strategy in progress*

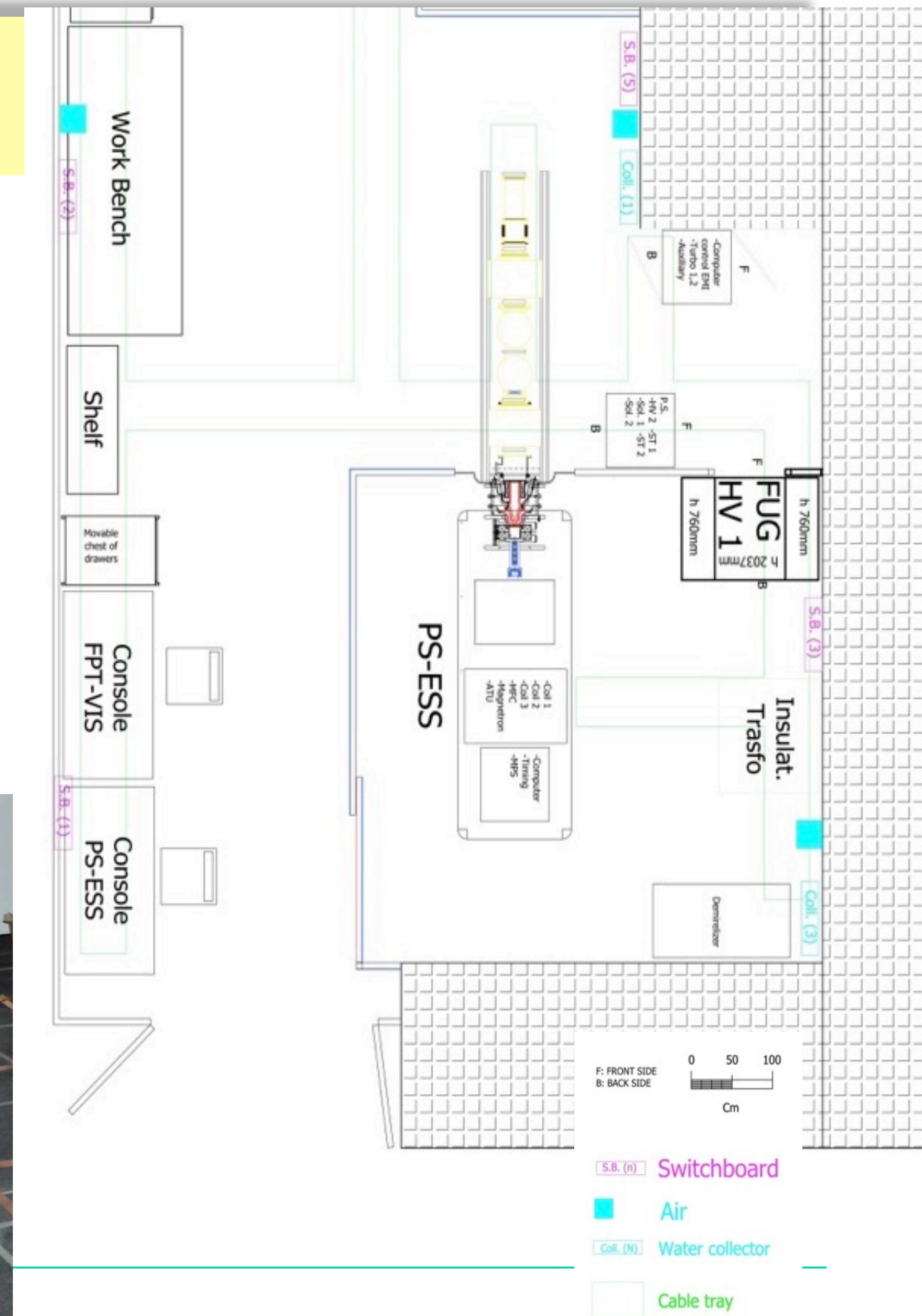


# *ESS test area at LNS*





Particular attention in the grounding to minimize the effects of sparks



## *Status and open items*

**Sites**

| | |
|---|---|
| • LNS site | Complete except for interlocks |
| • ESS-Lund site | in progress, interaction supported by Lead Engineer (@ESS Accelerator Division) |

**Proton source (PS-ESS) and accelerator column**

| | |
|---|---|
| • HV platform | To be ordered, short delivery time |
| • Power supplies (High current, High voltage) | Delivered |
| • Microwaves equipment | Ordered |
| • Magnetic system | Delivered |
| • Plasma chamber | Ordered |
| • Mechanical integration and LEBT | Defined, actions ongoing |
| • Extraction system | Ordered |

**Interfaces**

| | |
|---|---|
| • MPS | actions ongoing |
| • Control interface | definition in progress |

# *Status and open items*

**Low Energy Beam Transport line (LEBT)**

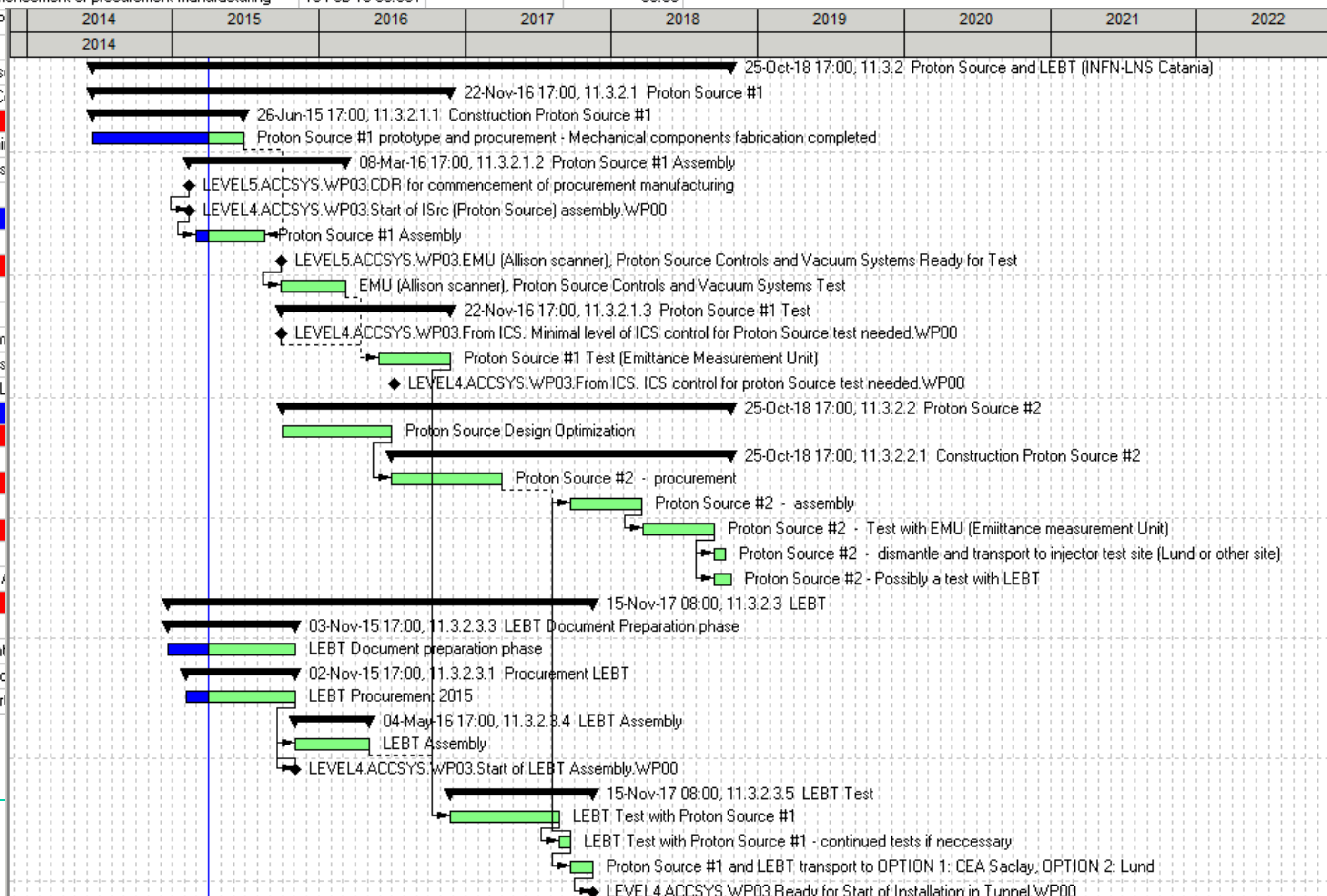
| | |
|---|---|
| • Solenoids & Steerers | Procurement in progress, not critical because of short delivery time (3 months from now) |
| • Chopper mechanics | Revised after tests in 2014, material partially available, order of remaining parts in process |
| • LEBT collimator | Delivery time not critical |
| • Diagnostics box | definition with Beam Diagnostics WP done, delivery time compatible with schedule |
| • Mechanical integration | Work in progress |
| • IRIS | Motors ordered, mechanics to be ordered, short delivery time |

# *ISLEBT within WP03 Schedule*

| | |
|---|---|
| Feb. 10th, 2015 | **Successful CDR** |
| March to Sept., 2015 | **Procurement (second phase)** |
| Sept. 30th, 2015 | **PS#1 assembly completed** |
| Oct. to March 8, 2016 | **Tests of source and ancillaries** |
| Jun to Nov, 2016 | **Full tests with diagnostics and controls** |
| May to Nov, 2015 | **LEBT Procurement** |
| Nov, 2016 to Aug,17 | **Full tests with LEBT** |
| Nov. 1st, 2017 | **First source ready for installation** |
| July, 16 to Mar,17 | **Procurement PS#2** |
| Sept, 17 to Mar, 18 | **Assembly PS#2** |
| Mar to Sept, 2018 | **Tests with diagnostics and controls PS#2** |
| Nov, 2018 | **Delivery** |

# *Ion source & LEBT: Schedule*

| Activity ID | Activity Name | Start | Finish | Budgeted Total Cost |
|---|---|---|---|---|
| 11.3.2 | Proton Source and LEBT (INFN-LNS Catania) | 16-Jun-14 08:00 A | 25-Oct-18 17:00 | €3,722,662.00 |
| 11.3.2.1 | Proton Source #1 | 16-Jun-14 08:00 A | 22-Nov-16 17:00 | €390,662.00 |
| 11.3.2.1.1 | Construction Proton Source #1 | 16-Jun-14 08:00 A | 26-Jun-15 17:00 | €134,462.00 |
| A26030 | Proton Source #1 prototype and procurement - Mechanical components fabrication c | 16-Jun-14 08:00 A | 26-Jun-15 17:00 | €134,462.00 |
| 11.3.2.1.2 | Proton Source #1 Assembly | 10-Feb-15 08:00 A | 08-Mar-16 17:00 | €105,000.00 |
| A2014418( | LEVEL5.ACCSYS.WP03.CDR for commencement of procurement manufacturing | 10-Feb-15 08:00 A | | €0.00 |
| A2014419( | LEVEL4.ACCSYS.WP03.Start of ISrc (P | | | |
| A34090 | Proton Source #1 Assembly | | | |
| A51570 | LEVEL5.ACCSYS.WP03.EMU (Allison s | | | |
| A145590 | EMU (Allison scanner), Proton Source C | | | |
| 11.3.2.1.3 | Proton Source #1 Test | | | |
| A52260 | LEVEL4.ACCSYS.WP03.From ICS. Minii | | | |
| A34100 | Proton Source #1 Test (Emittance Meas | | | |
| A52250 | LEVEL4.ACCSYS.WP03.From ICS. ICS | | | |
| 11.3.2.2 | Proton Source #2 | | | |
| A34110 | Proton Source Design Optimization | | | |
| 11.3.2.2.1 | Construction Proton Source #2 | | | |
| A18730 | Proton Source #2 - procurement | | | |
| A18750 | Proton Source #2 - assembly | | | |
| A18760 | Proton Source #2 - Test with EMU (Em | | | |
| A22460 | Proton Source #2 - dismantle and trans | | | |
| A51310 | Proton Source #2 - Possibly a test with L | | | |
| 11.3.2.3 | LEBT | | | |
| 11.3.2.3.3 | LEBT Document Preparation phase | | | |
| A34140 | LEBT Document preparation phase | | | |
| 11.3.2.3.1 | Procurement LEBT | | | |
| A34150 | LEBT Procurement 2015 | | | |
| 11.3.2.3.4 | LEBT Assembly | | | |
| A34160 | LEBT Assembly | | | |
| A2014420( | LEVEL4.ACCSYS.WP03.Start of LEBT A | | | |
| 11.3.2.3.5 | LEBT Test | | | |
| A22450 | LEBT Test with Proton Source #1 | | | |
| A48740 | LEBT Test with Proton Source #1 - cont | | | |
| A22060 | Proton Source #1 and LEBT transport tc | | | |
| A2014426( | LEVEL4.ACCSYS.WP03.Ready for Star | | | |



# *Manpower and Synergies with other Ion Sources activities*

- Full time : 3 Junior Scientist + 1 CTER (all with temporary contract)
- Part time: 2 Senior Scientist (30 and 50%)+ 2 Junior Eng. (30%) + 6 CTER (10 to 30%) + 1 CTER (50%)

**Synergies and common developments**

- AISHA (L. Celona) and IRPT
- Ion sources for the Supercond.Cycl. and Tandem
- R&D activities of 5$^{th}$ National Committee (RDH and VESPRI experiments)
- R&D for the ISODAR experiment

**Budget (not including manpower) for two sources, ancillaries, LEBT, support to assembly in Lund (support to commissioning in Lund to be agreed)**

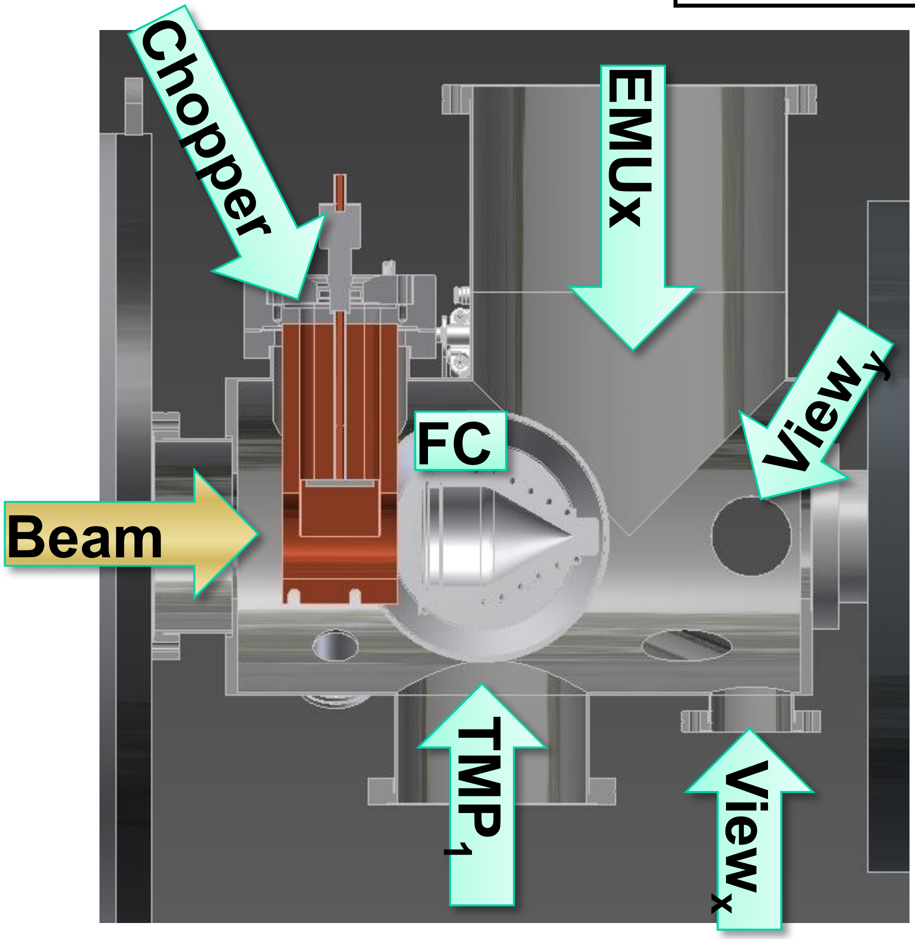
| | |
|---|---|
| 2014 | 827 |
| 2015 | 495 |
| 2016 | about 600 (expected) |

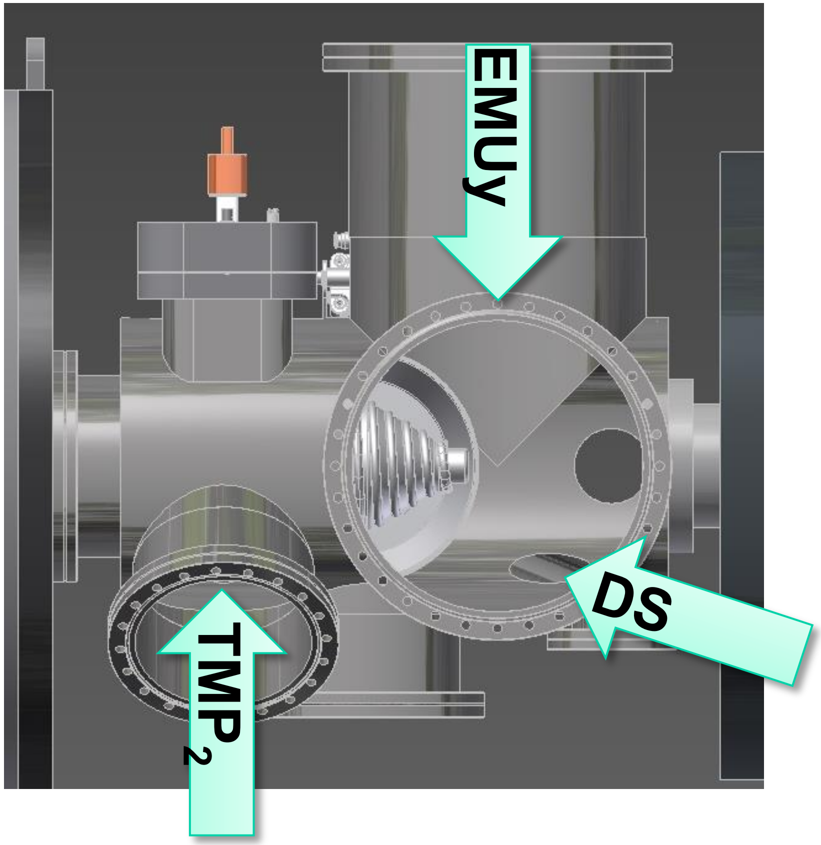
## *Strength and weakness*

- **Strength**: R&D partially developed for other experiments, no major changes to the INFN-LNS activities
- **Strength**: ESS participation improved the ability of NTA service to operate in success-oriented initiatives involving different Laboratories
- **Strength**: the additional manpower (though temporary) has increased the critical mass, permitting further upgrade (right chance, at the best moment)
- **Weakness**: the contemporary construction of AISHA, which involves some people interested to ESS-ISLEBT, has moved some dates forward (not critical for WP3 path, L.Lari and R. Garoby)
- **Weakness**: the preparation of an area adapted to the requirements has been a real burden for the LNS
- **Weakness**: the complex organization chart of ESS Acc.Div. has been evolving in these years, with some effects on the work of INFN-LNS personnel (some works have been repeated or delayed)

# *e.g. Diagnostic box with chopper*

Length 540 mm

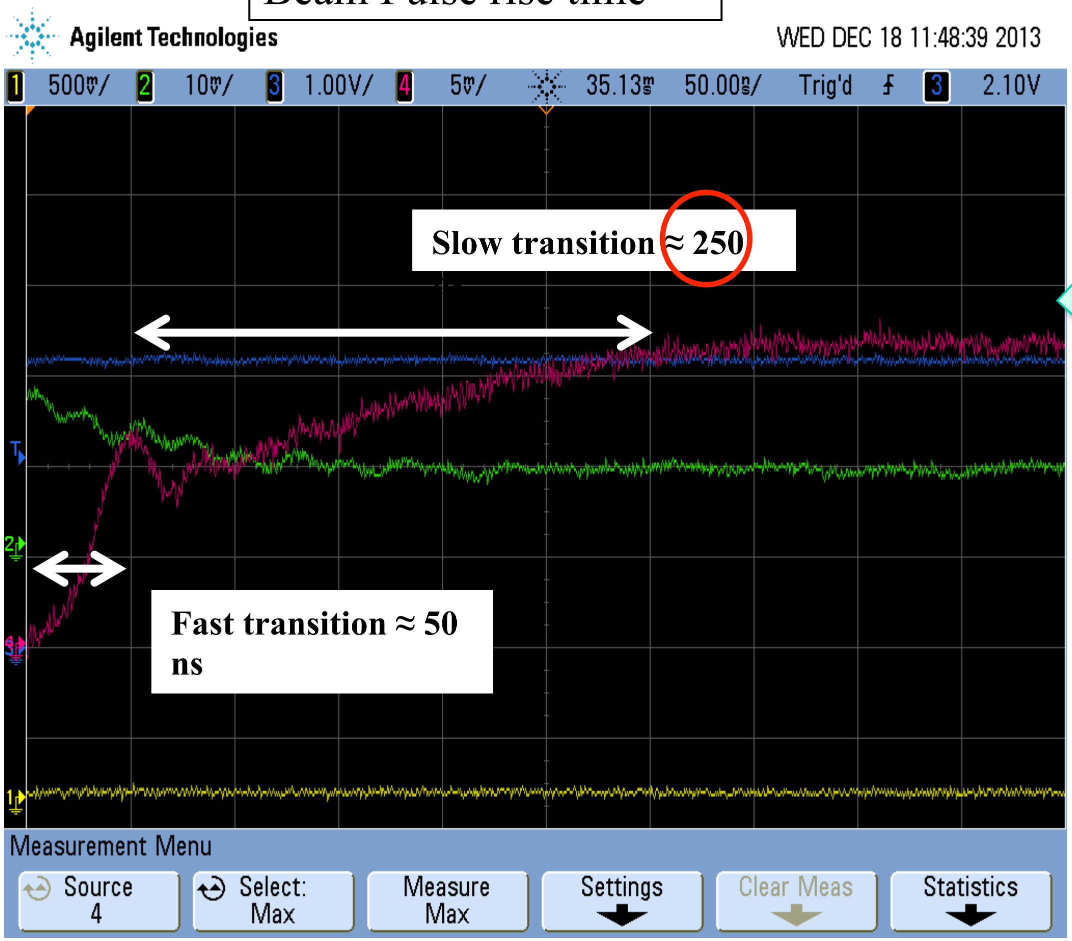


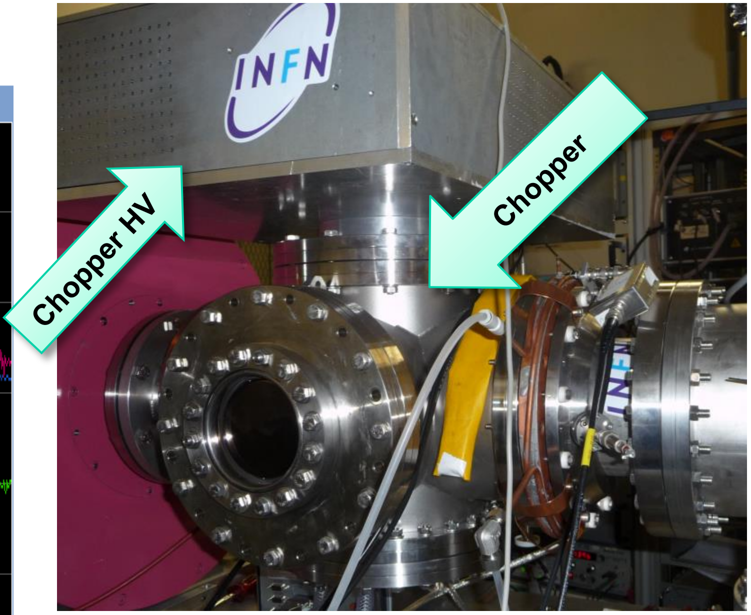




Note: 1) Close collaboration with ESS diagnostic group; 2) Two diagnostic boxes will be used for the commissioning

# e.g. Chopping strategy

Beam Pulse rise time



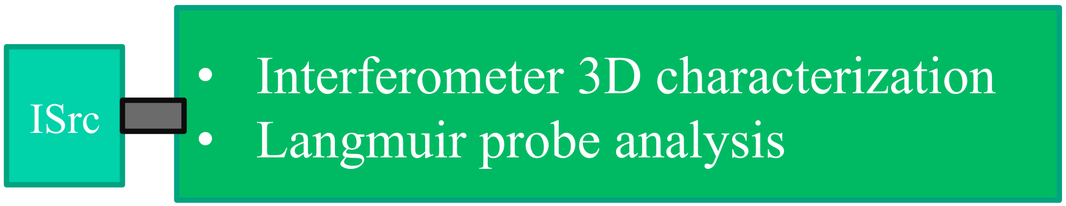

Ch4: Beam Stop (Rτ = 5,5 ohm; C = 183 pf ; Rτ * C = 1 ns)
Ch2: Collimatore (Rτ = 5,5 ohm; C = 534 pf ; Rτ * C = 2,9 ns)

Chopping strategy tested in 2014

Criticalities have been solved, integration recently done

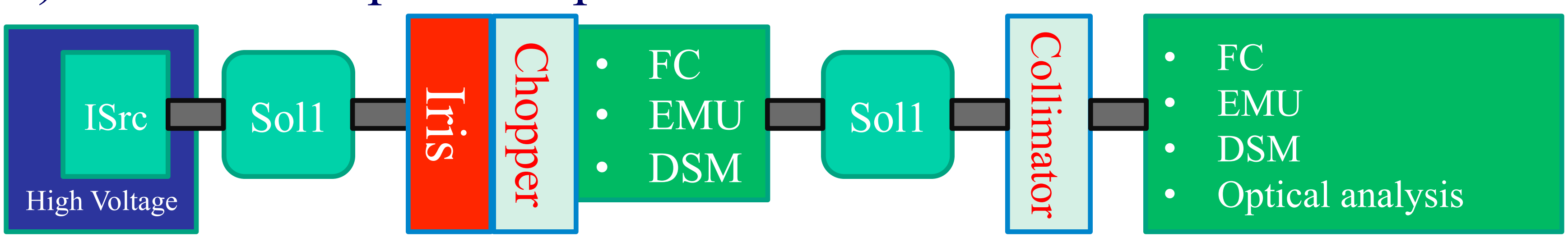
## *Ion source & LEBT: Commissioning at Catania*

1) Plasma Studies




2) Extracted Beam


3) Beam transport and pulse formation



# *Ion source & LEBT: Test series*

a. **Plasma characterization**
b. **High voltage tests**
c. **Beam extraction**
d. Nominal beam optimization
e. Production and transport of 10-20-...-90-100% of nominal current
f. Tests of beam diagnostics
g. **Emittance measurements 10 to 100%**
h. Emittance minimization
i. **Study of different magnetic field profiles/RF inputs to minimize the emittance further and maximize the current**
j. Assembly of full LEBT and verification of above results
k. ICS tests and unmanned operations
l. **Long run tests (1 month full current, 1 week 20%, 50%, 80%)**

# *Ion source & LEBT: Top risks*

- The ion source & LEBT are based on proven technologies developed on already working devices. Therefore, we do not expect major changes in the described layout, but during the commissioning at INFN-LNS minor improvements of some parts are compatible with the schedule.
  - Extraction system optimization
  - Microwave injection and magnetic field optimization
  - Beam transport optimization
- The time needed to properly solve the above mentioned problems may extend after the "minimum" commissioning time at INFN-LNS. This extra-time was partially considered in the schedule and Roland Garoby noticed that immediately (experience!) stating that "delivery of the first source could be anticipated if no troubles occur"
- I agree "if no troubles occur and CF/interfaces are ready"

# *Ion source & LEBT: To be addressed*

**A number of themes are still undefined or not satisfactory or not mature:**

- Technical spaces availability for maintenance (for all WUs of WP)
- Storage area, labs, workshop (no clean room requested but dusty construction areas are not acceptable for Ion Source installation)
- Transportation (proposal from INFN-LNS and comments/changes from ESS)
- Installation phase at ESS-Lund for Isrc#1 and LEBT: procedures, HR requested to INFN, responsibilities of INFN personnel and ESS interfacing engineers
- Procedures for installation (24/24h, weekends? Presence of ESS staff necessary at any time?)
- Training of ESS staff: when and how? Prescriptions in the In-kind contract ?
- Transfer of people from INFN-LNS: if required, it should be known by INFN before end 2015

# *Ion source & LEBT: Summary*

The design phase of the injector for ESS is on track.

Few of the most important parts are ready for the installation and the delivery of the remaining part is expected in the next months.

The site preparation is completed.

Integration activities are ongoing: the control system is under realization at CEA-Irfu, the integration with the diagnostic elements is close to the final solution as well as with the ESS vacuum standards.

The mechanical interface with the next part of the accelerator is under definition.

No major delays are expected, but the different integration activities on the source will require adequate interactions with all the stakeholders to avoid sequence of minor delays in the schedule.

# *Management of WP3*
# *Normal Conducting Linac*

The construction of Ion Source & LEBT and the integration within the final site is the major part of the responsibility of INFN-LNS in the ESS Linac construction.

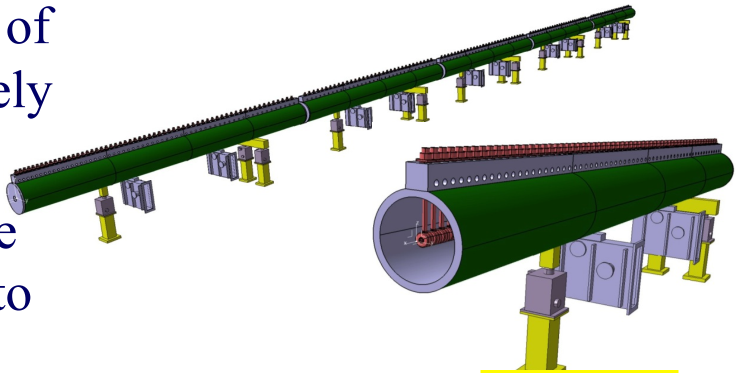
a. Supervision of RFQ construction and integration (CEA-IRFU, Saclay)
b. Supervision of MEBT construction and integration (ESS-Bilbao)
c. Supervision of DTL construction and integration (INFN-LNL)
d. Interaction with Lead Engineers of ESS Acc.Div.
e. Participation to Technical Board, documentation, etc
f. Interaction with Planning managers

(S. Gammino + 1 junior scientist)

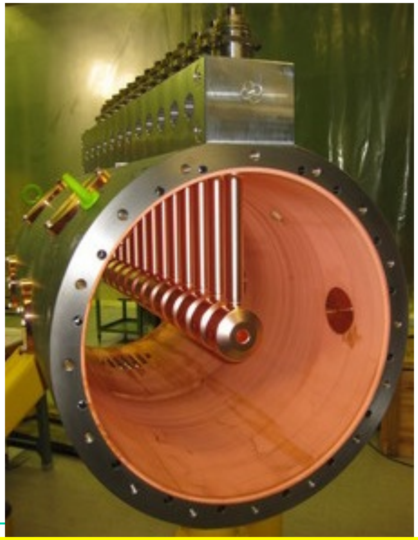
# Drift Tube Linac

- The DTL (Drift Tube Linac) cavity is constituted of 20 modules, assembled in 5 tanks, composed of 4modules each, for a total length of approximately 40 m.
- This profile describes the life cycle phases of the DTL regardless of the responsibilities assigned to contributors of this Scope of Works.

1. *DTL design*
2. *Manufacturing of test of components*
3. *Assembly, low power test and tuning of each tank.*
4. *Transport and Installation in the ESS tunnel in Lund*
5. *Check out and RF conditioning to full power*
6. *Beam commissioning in two steps, beam dump after tank 1 and tank 5*
7. *Operation with the other Accelerator components (and neutron production target).*



First tank



CERN-INFN prototype

# *Drift Tube Linac*

INPUT CONSTRAINTS

- ✧ Input Energy equal to **3.62** MeV.
- ✧ Final energy > 88 MeV in 5 tanks
- ✧ Tank length < 8 m
- ✧ Current = **62.5** mA.
- ✧ Power 2.2 MW per tank, including margin=1.25 on MDTfish computation.

INTERFACES COMPLEXITY

- ❖ Inter-tank connections
- ❖ Interfaces between the RF system and the electromagnetic resonator
- ❖ Water-cooling skid, manifold and interfaces
- ❖ Requirements for reception, assembly and test space in Lund

# *Medium β-cavities contribution to ESS*

TECHNICAL PERFOMANCE

| **Requirements** | **Medium beta** |
|---|---|
| Frequency (MHz) | 704.42 |
| Geometric beta | 0.67 |
| Nominal Accelerating Gradient (MV/m) | 16.7 |
| Epk (MV/m) | $< 50$ |
| Cell coupling k(%) | $\geq 1.5$ |
| RF peak power (kW) | 1100 |
| Q ext | $7.5\ 10^5$ |
| Q0 at nominal gradient | $> 5\ 10^9$ |

# *Medium β-cavities contribution to ESS*

| Deliverable no. | Deliverable |
|---|---|
| 1 | Medium beta pre-series cavity, vertically tested at LASA |
| 2 | High beta pre-series cavity, vertically tested at LASA |
| From 3 To 38 (# 36) | Superconducting RF cavity for the **medium beta section** of the linac, equipped of **all the necessary ancillaries** (helium tank, flanges, vacuum valve, frame, RF antenna and pickup), **tested vertically** and delivered at the cryomodule assembling facility. |

Two **spare cavities** could be foreseen during the series production (**constituting Deliverable nos. 39-40**).

RI and EZ keep average production rate of **4 cav/week**
End of XFEL cavities production **September 2015**
**First 4 series cavities delivered by end 2017**

# *Summarizing*

- The IK contribution related to Isrc & LEBT, DTL and WP3 management is well defined
- The IK contribution related to medium beta superc. cavities has been recently agreed and the details of integration in cryomodules are to be defined soon.
- The amount of INFN contributions should account to about **33 M€**
- "Heads of Agreement" have been signed recently by INFN President.
- IK contract preparation is under way.