EUROPEAN
SPALLATION
SOURCE

European Spallation Source (ESS), a nova grande infraestrutura europea de investigación

D. Piso

Work Package Leader

www.europeanspallationsource.se

Xullo 16, 2014

Min mesmo....

EUROPEAN SPALLATION SOURCE

O Proxecto ESS

Un proxecto transformador

EUROPEAN SPALLATION SOURCE

- Max IV – unha infraestructura de investigación sueca en construcción, abre en 2015
- Science City – unha nova parte da cidade para recibir científicos

Hoxe:

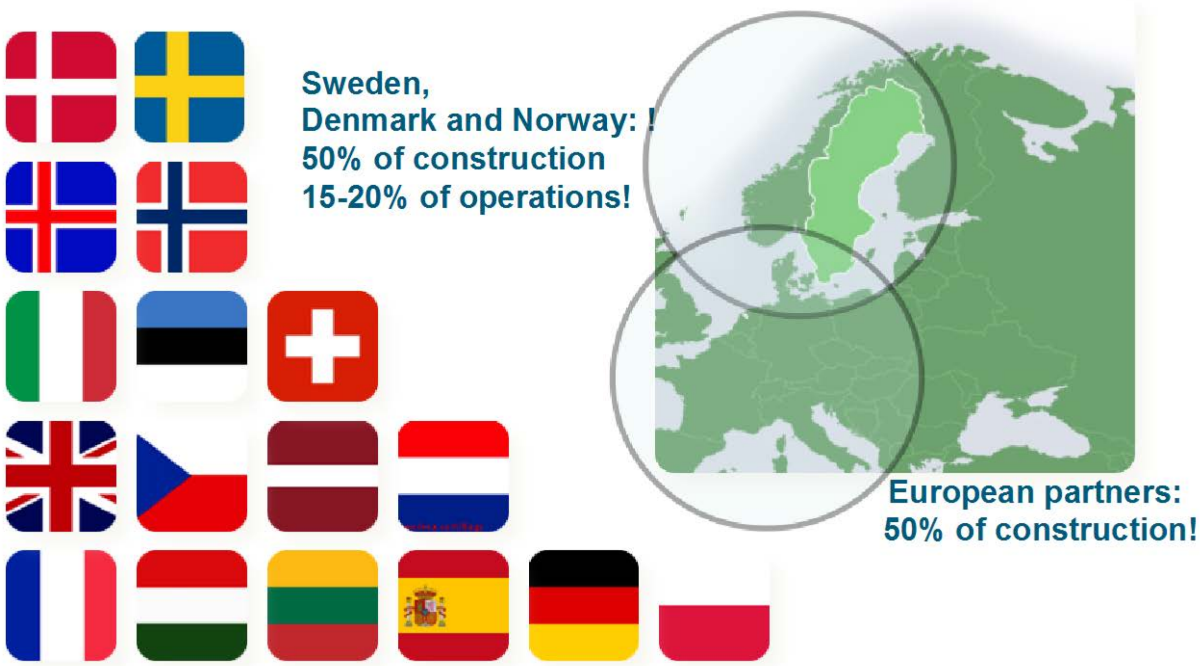
- 245 persoas
- 38 estados

2019:

- 400-500 persoas

Moito por facer

Un proxecto europeo



- Sweden 35%
- Denmark 12.5%
- Germany 11%
- United Kingdom 10%
- France 8%
- Italy 6%
- Spain 5%
- Switzerland 3.5%
- Norway 2.5%
- Poland 2%
- Hungary 1.5%
- Czech 0.3%
- Estonia 0.25%

En 2015, ERIC

A nosa misión

EUROPEAN SPALLATION SOURCE

PROJECT/FACILITY&

A partnership of 17 European nations committed to the goal of collectively building and operating the world's leading facility for research using neutrons by the second quarter of the 21st century.

SCIENCE&

The most powerful spallation source with the highest flux and realtime data acquisition

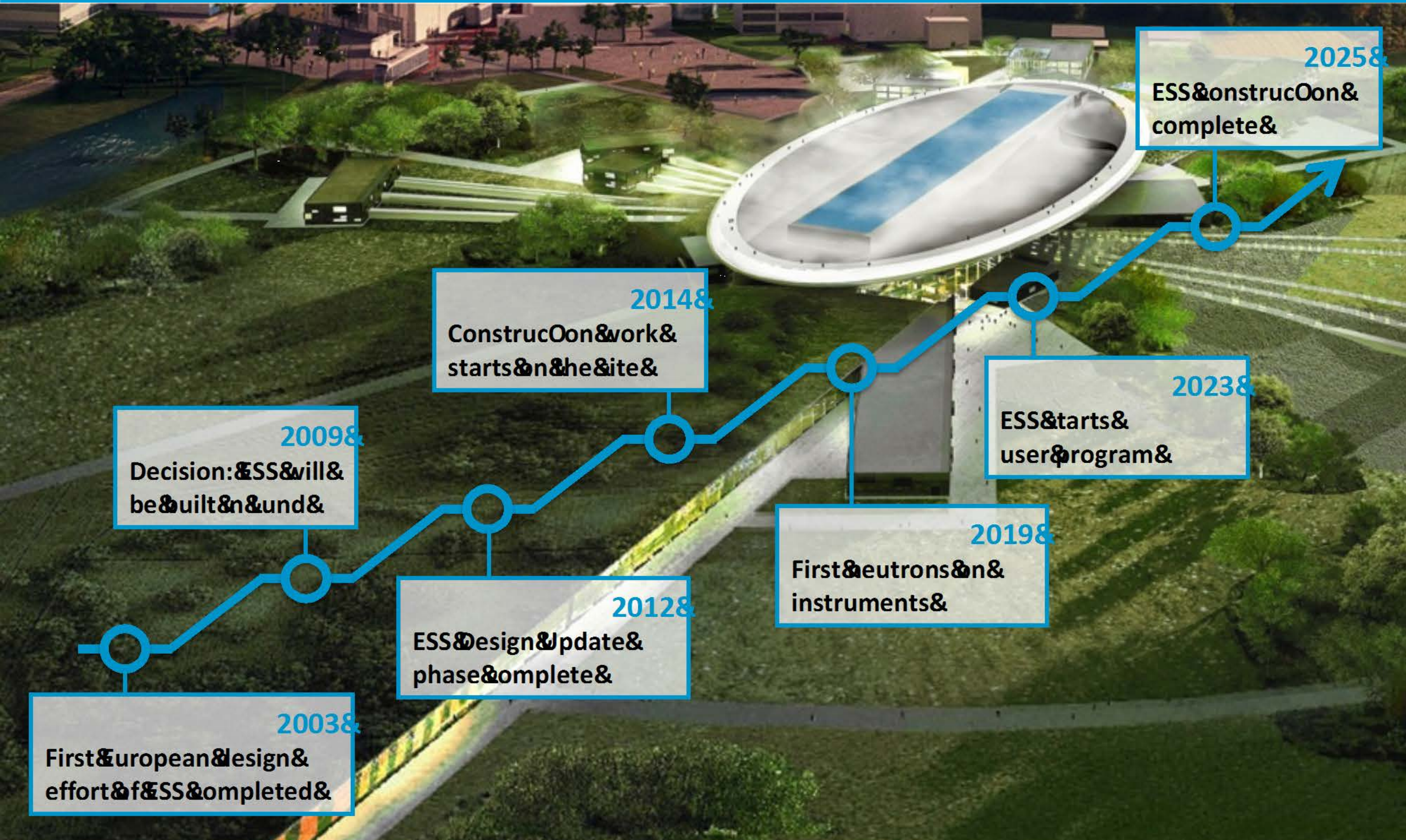
- Life science
- Soft condensed matter
- Chemistry of materials
- Energy research
- Magnetism and superconductivity
- Engineering materials and geosciences
- Archaeology and heritage conservation
- Fundamental and particle physics

SOCIETY&

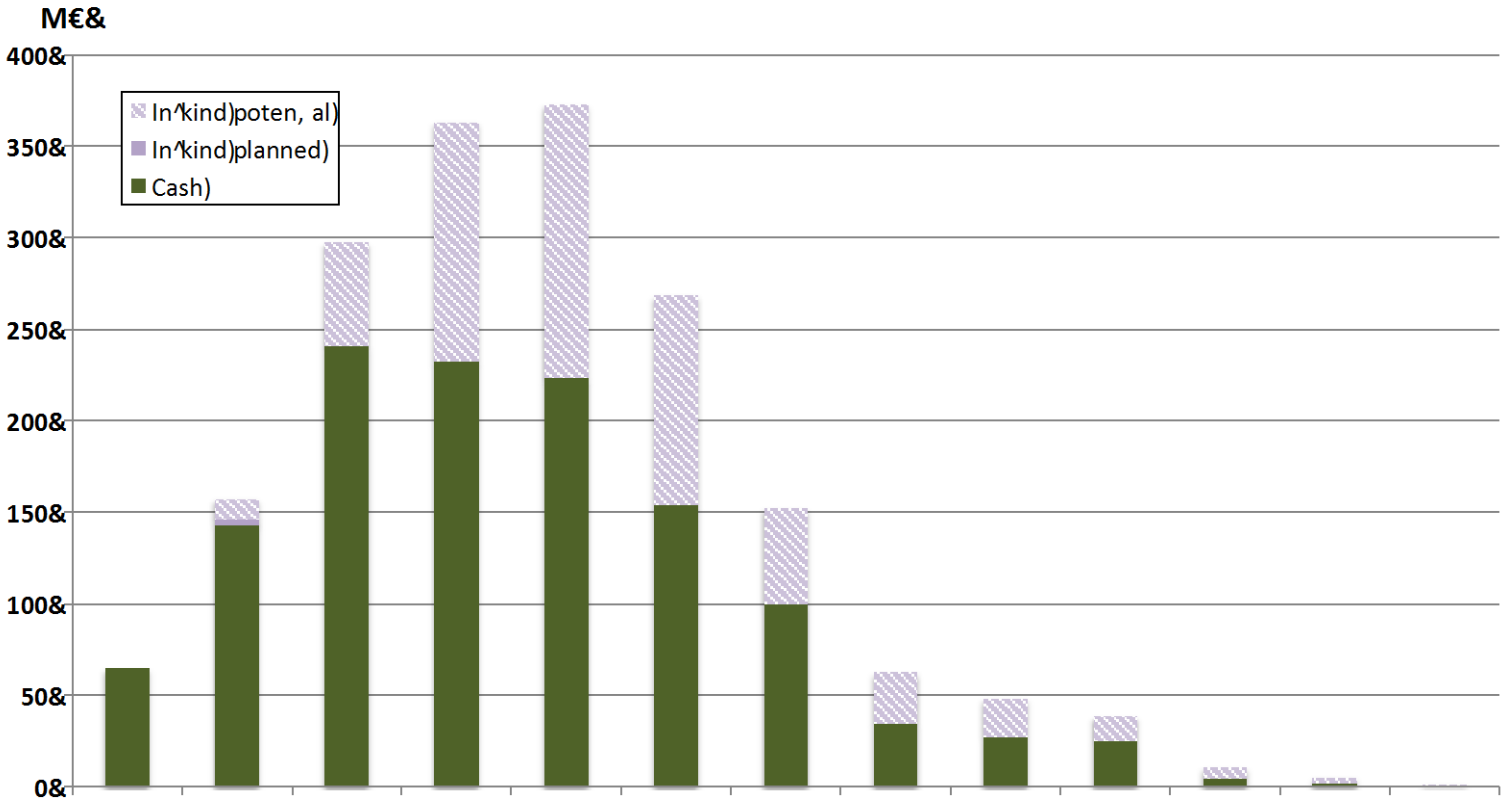
Research directly related to societal values
Opportunity to benefit from the innovation capacity of industry.
Driver for job creation

O camiño que hai que percorrer

EUROPEAN SPALLATION SOURCE



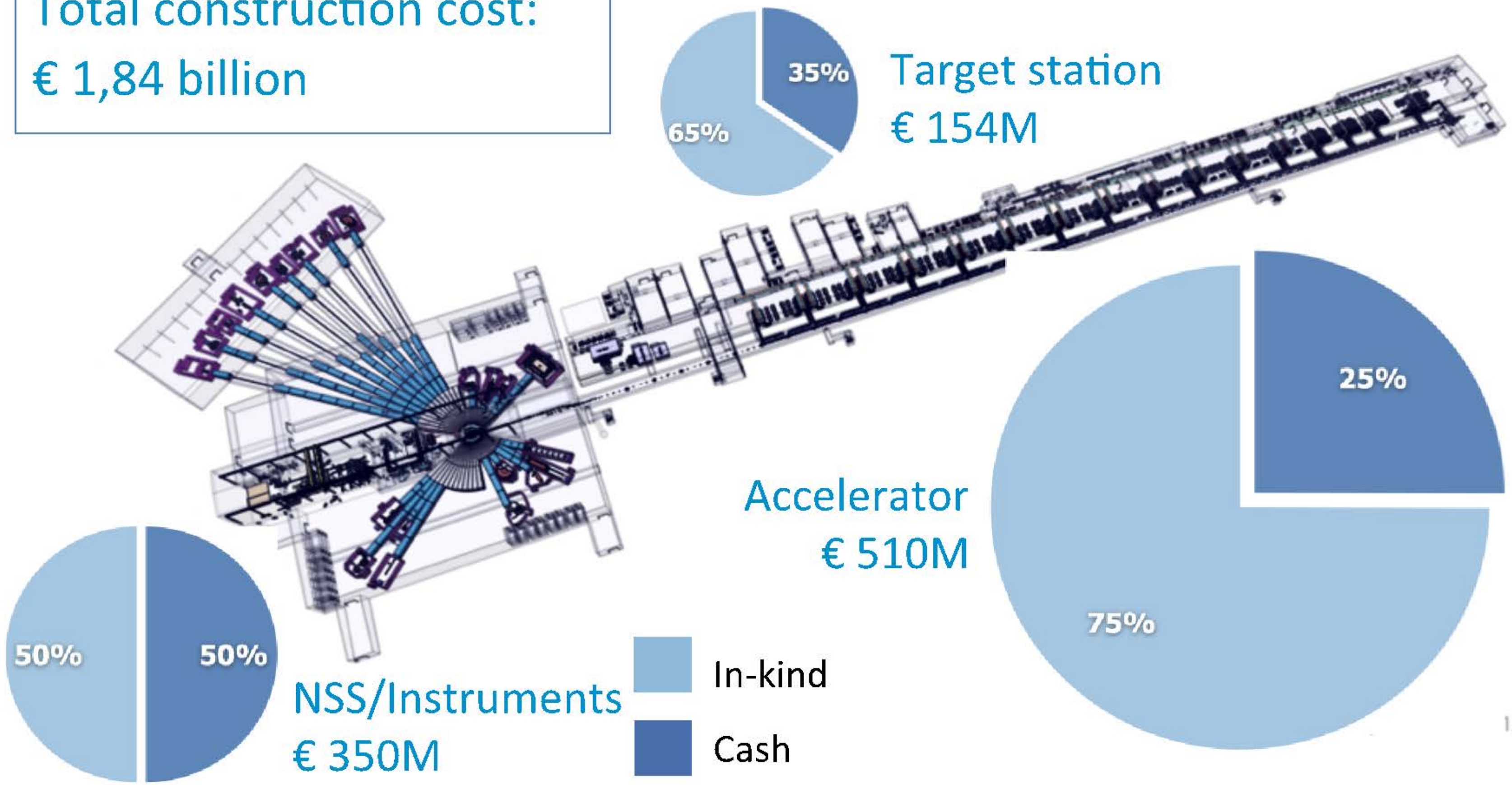
Cash vs. In-kind



	2013&	2014&	2015&	2016&	2017&	2018&	2019&	2020&	2021&	2022&	2023&	2024&	2025&	Sum (M€)
In-kind planned	0	4	0	0	0	0	0	0	0	0	0	0	0	4
In-kind potential	*0*	*11*	*57*	*131*	*150*	*115*	*53*	*28*	*21*	*14*	*6*	*3*	*1*	589
Cash	65	143	241	232	223	154	99	34	27	25	4	2	1	1 250
Total	**65**	**157**	**298**	**363**	**373**	**269**	**152**	**62**	**48**	**39**	**11**	**5**	**1**	**1 843**

Potencial In-kind

Total construction cost:
€ 1,84 billion



Presuposto construcción vs. operación

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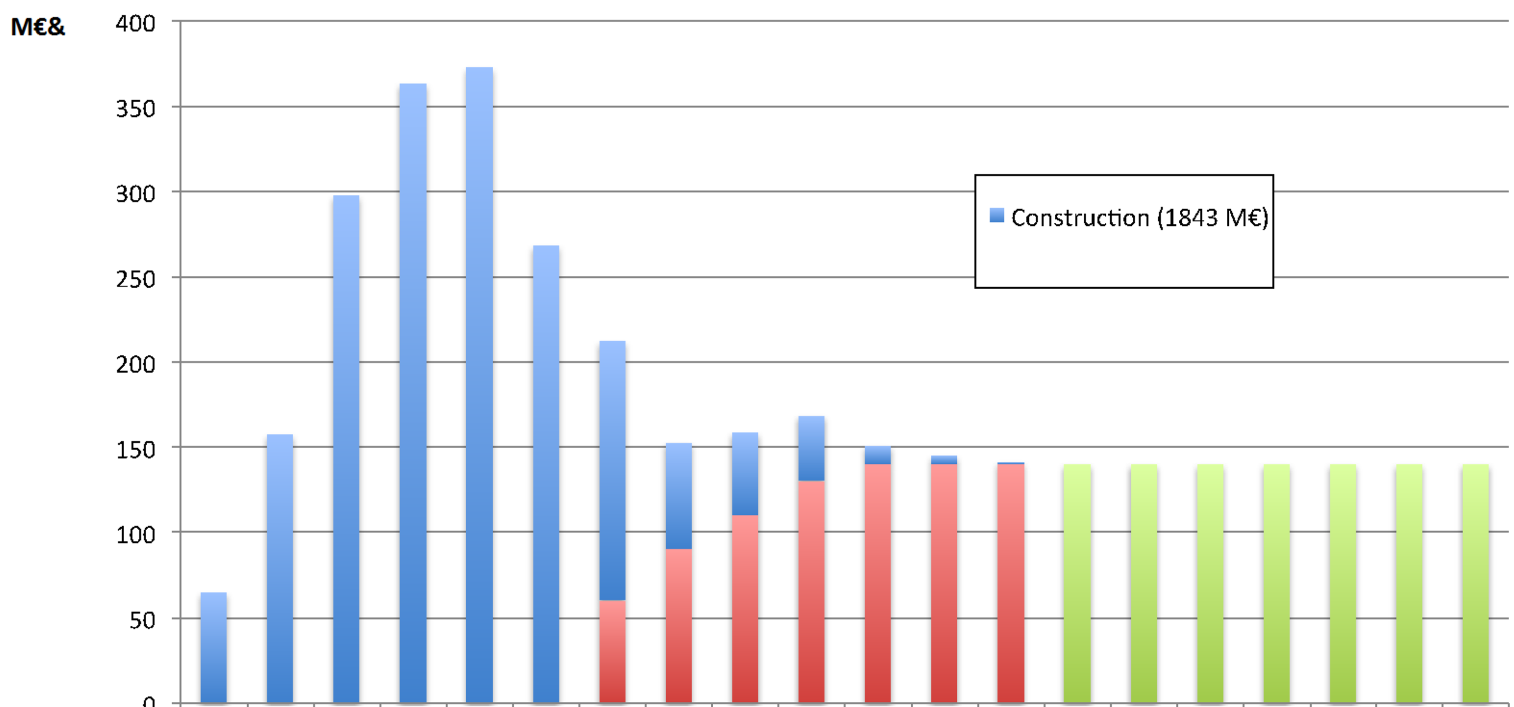
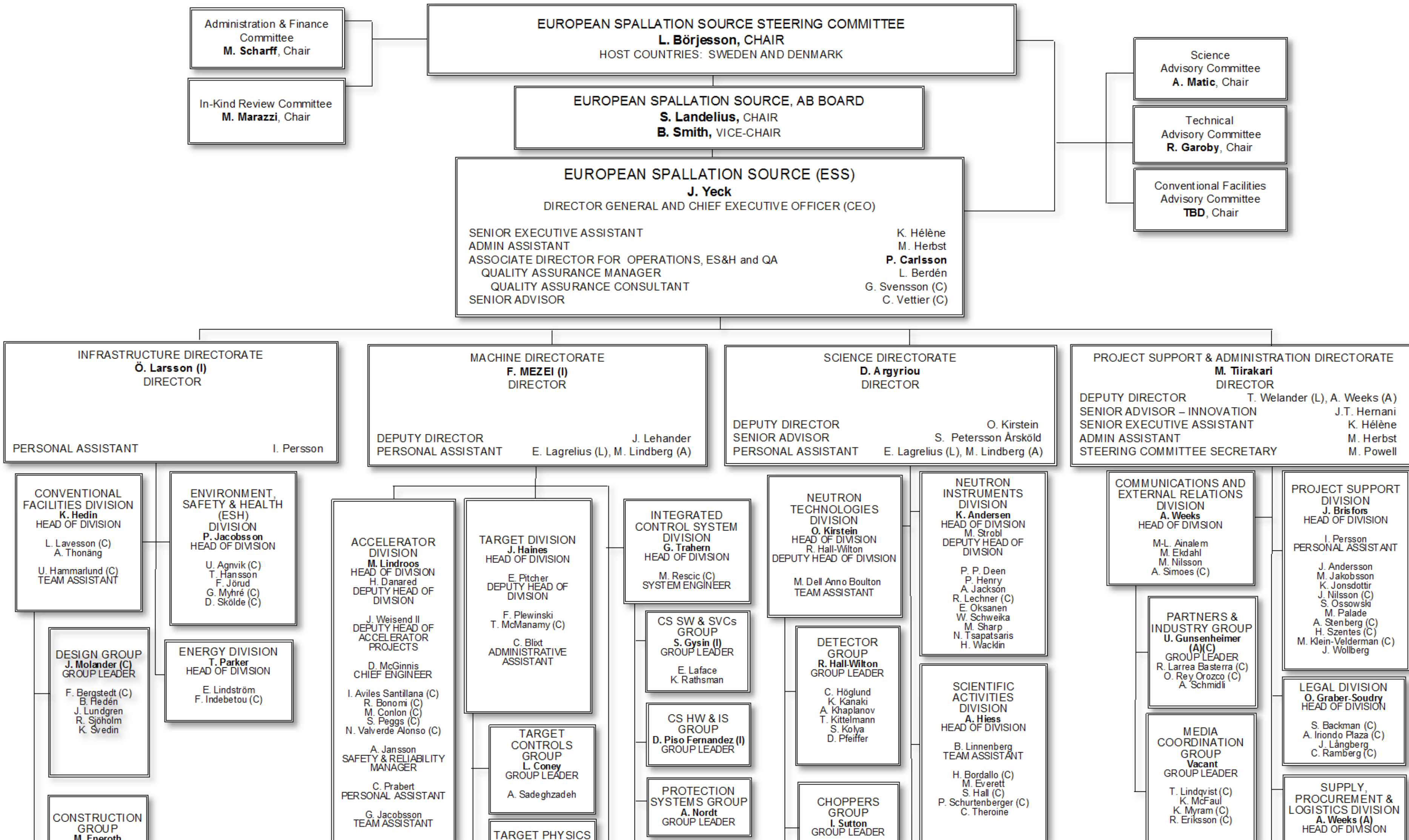


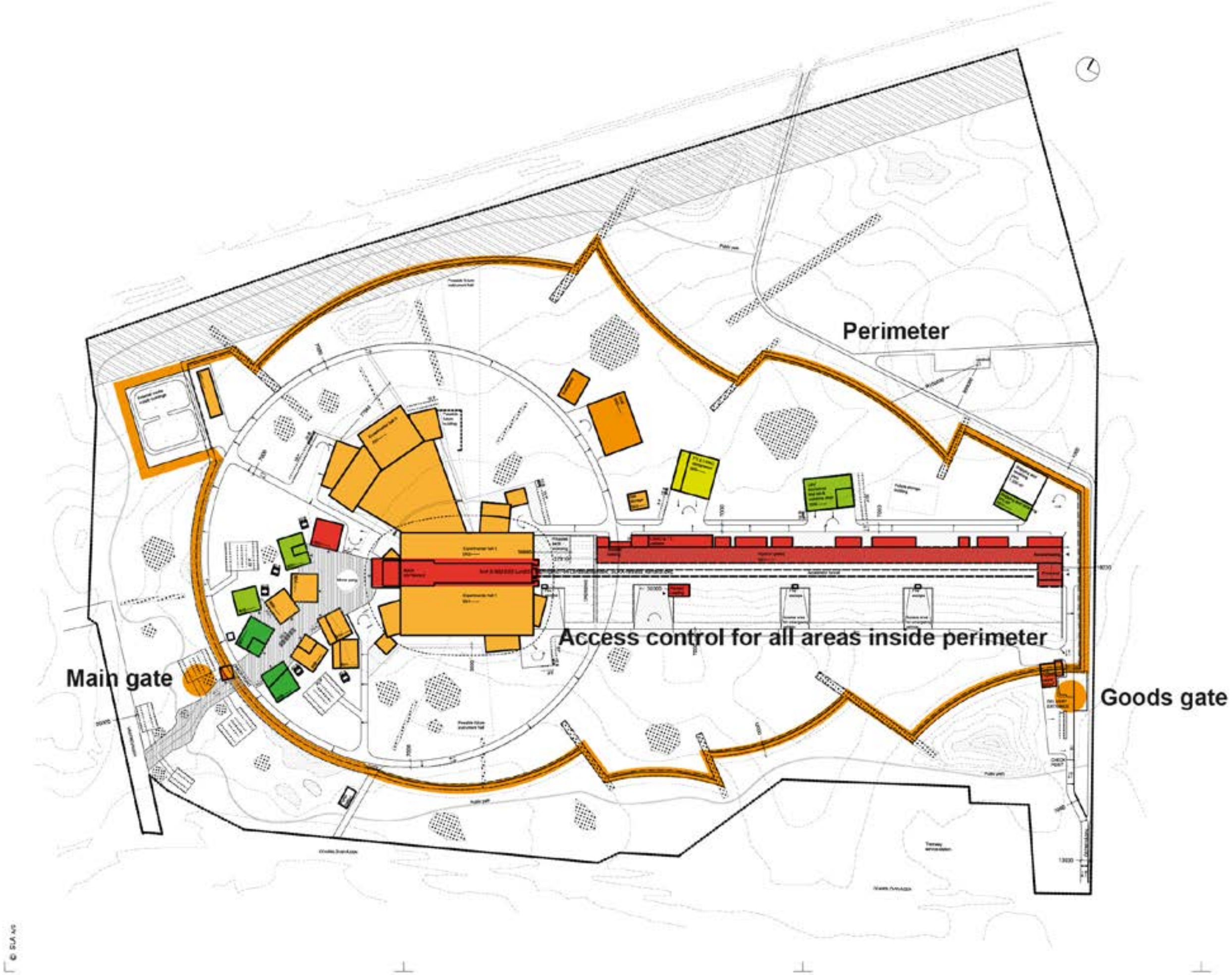
	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	...	...	2064	2065
Construction (1843 M€)	65	157	298	363	373	269	152	62	48	39	11	5	1							
Initial Operations + ramp-up							60	90	110	130	140	140	140							
Steady State Operations														140	140	140	140	140	140	140

A nosa organización

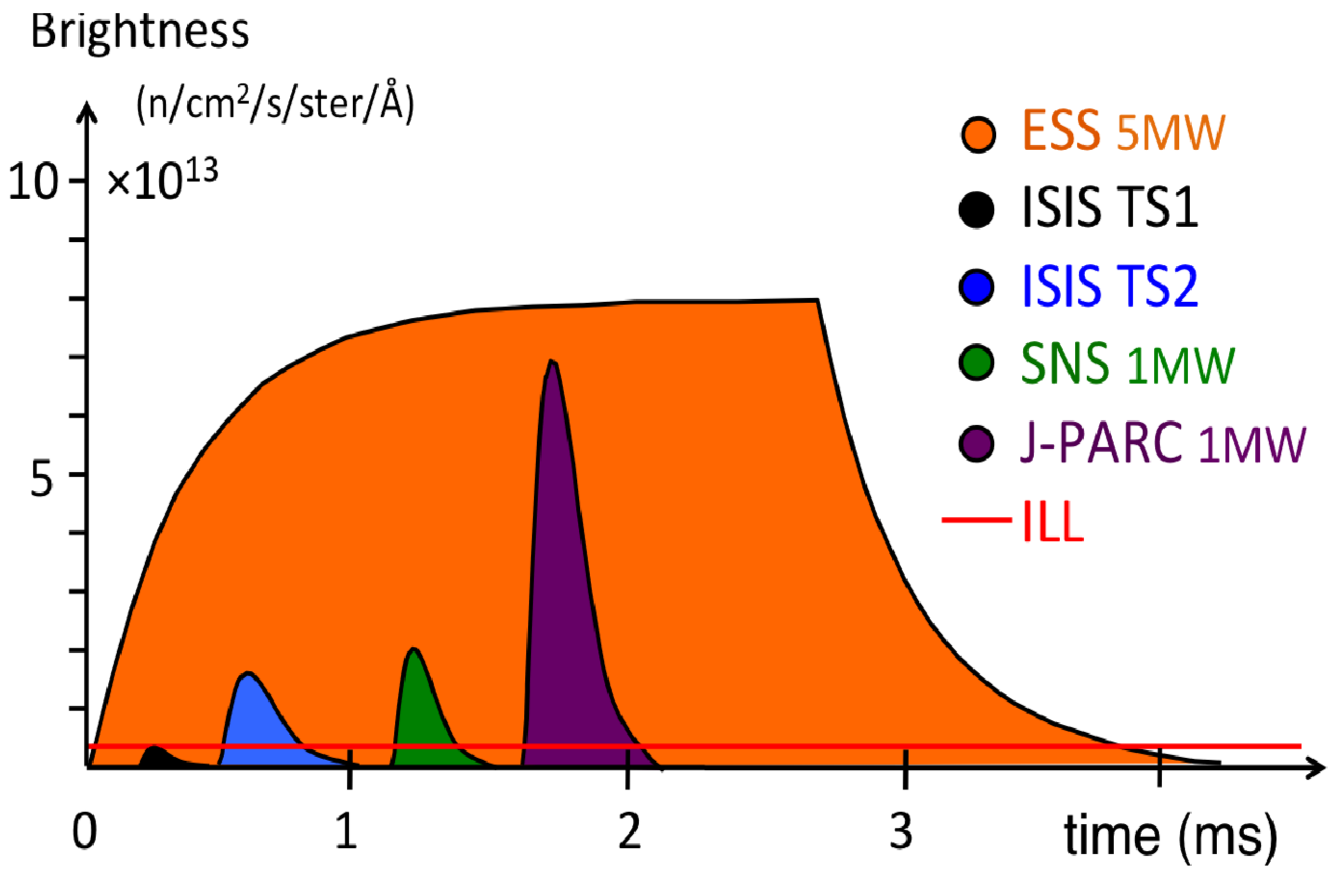
EUROPEAN SPALLATION SOURCE



A instalacion

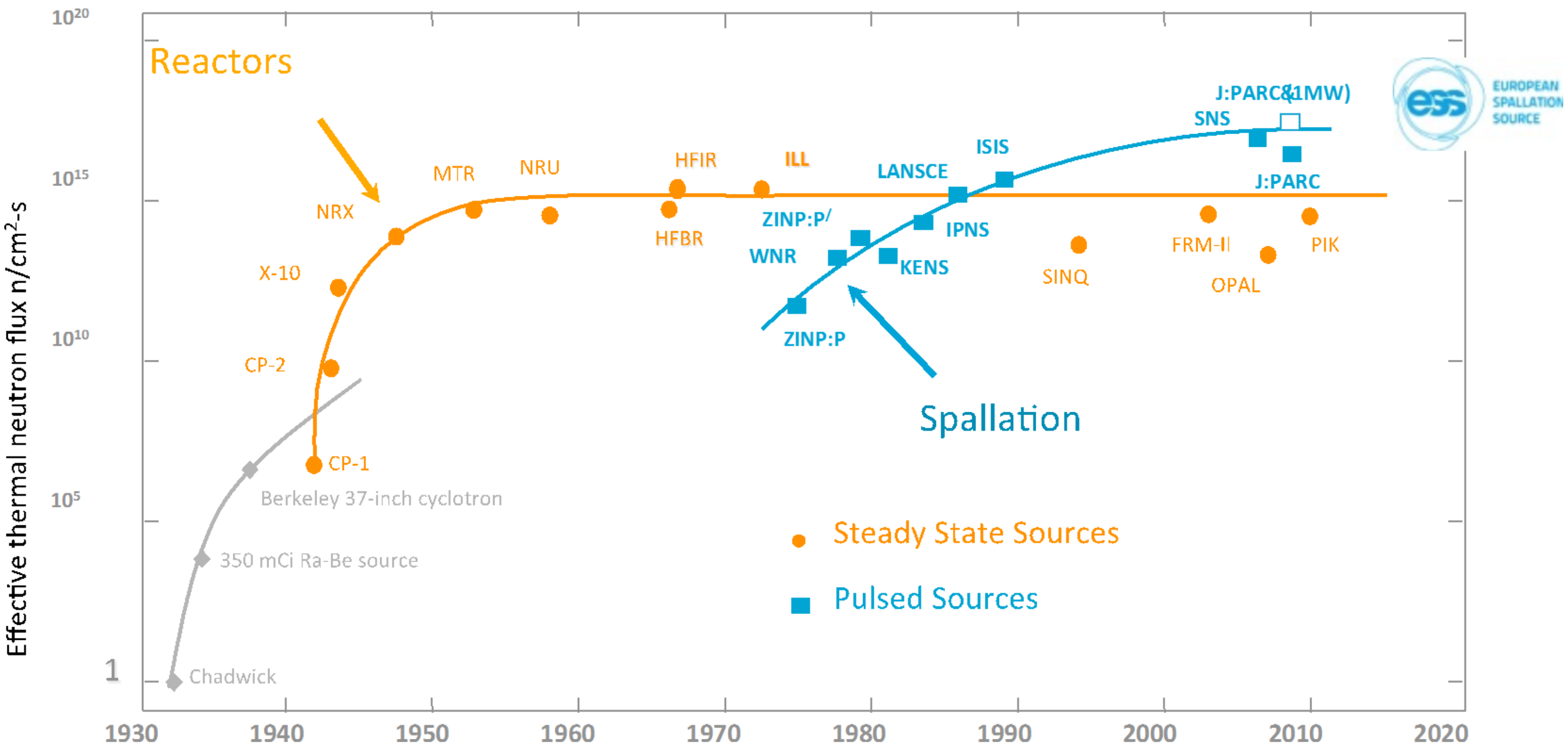


Unha fonte de neutróns de pulso largo

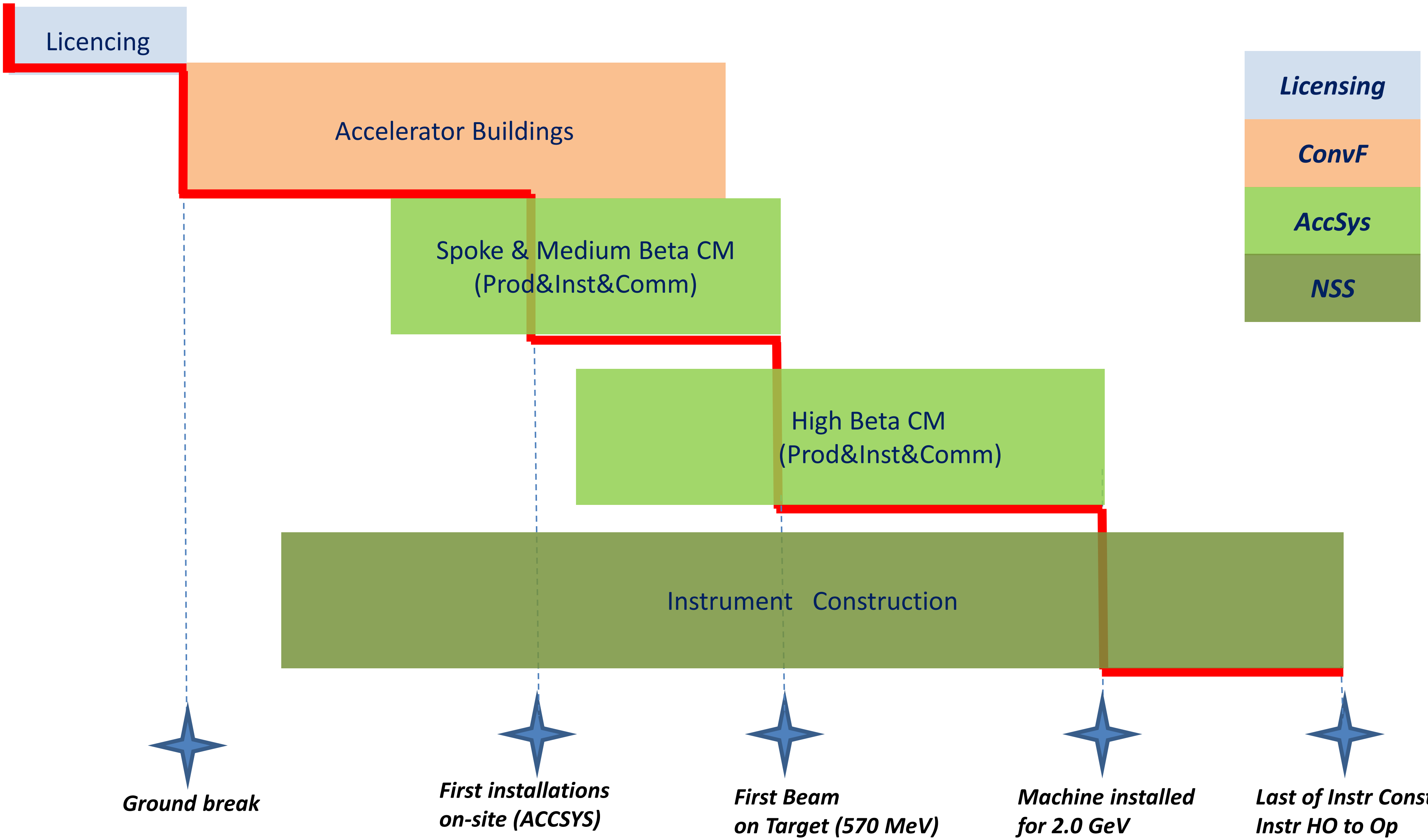


O ‘neutron gap’

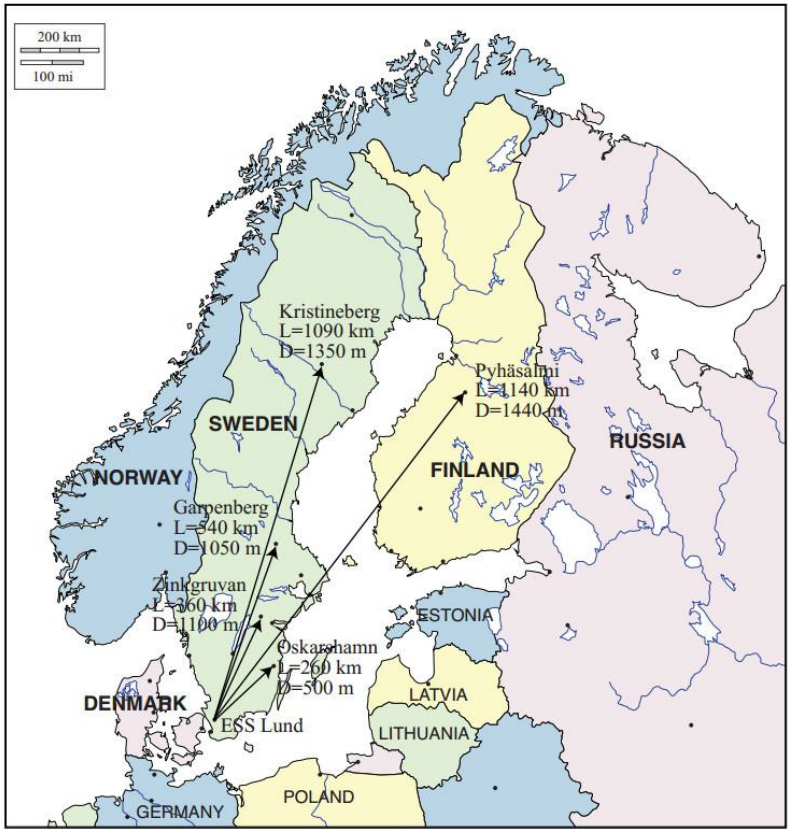
ESS será a fonte de neutróns mais potente e varias veces mais brillate que as existentes



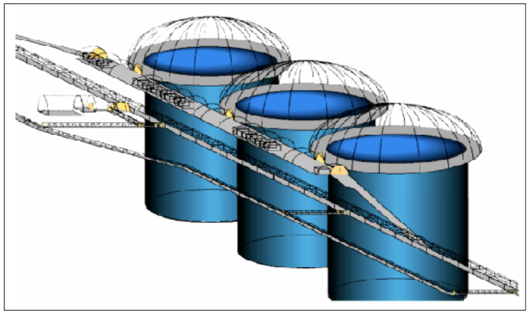
Vía Crítica do proxecto



Mais ca neutróns: neutrinos tamen!



- H+ e H-
- 14 Hz a 20 Hz
- Anel the compresión (1.5us)
- 5MV a 10 MW
- Target
- 13MW de potencia RF
- Redeseño das cavidades

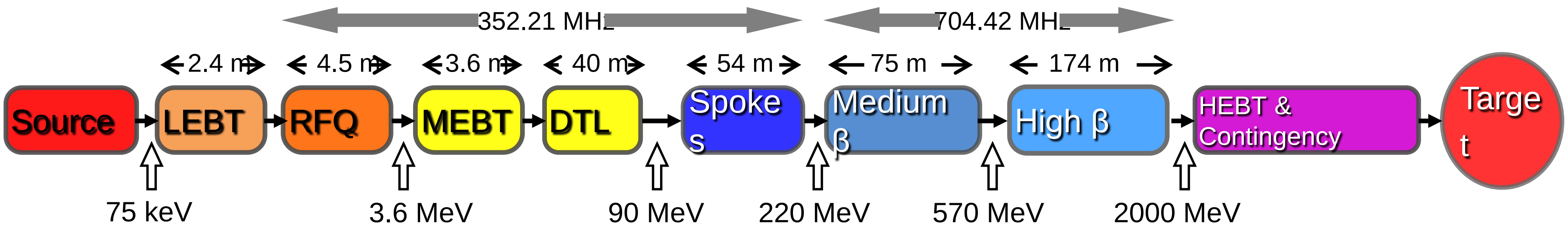


[Measuring CP violation with an ESS neutrino beam](), Tord Ekelof (Uppsala University). Neutrino Town Meeting at CERN

Figure 2. The MEMPHYS water Cherenkov detector of a total fiducial mass 440 kton consisting of three cylindrical modules of 65 m high and 65 m diameter and with 3x81000 12" photomultipliers mounted on the walls, providing 30% geometrical coverage.

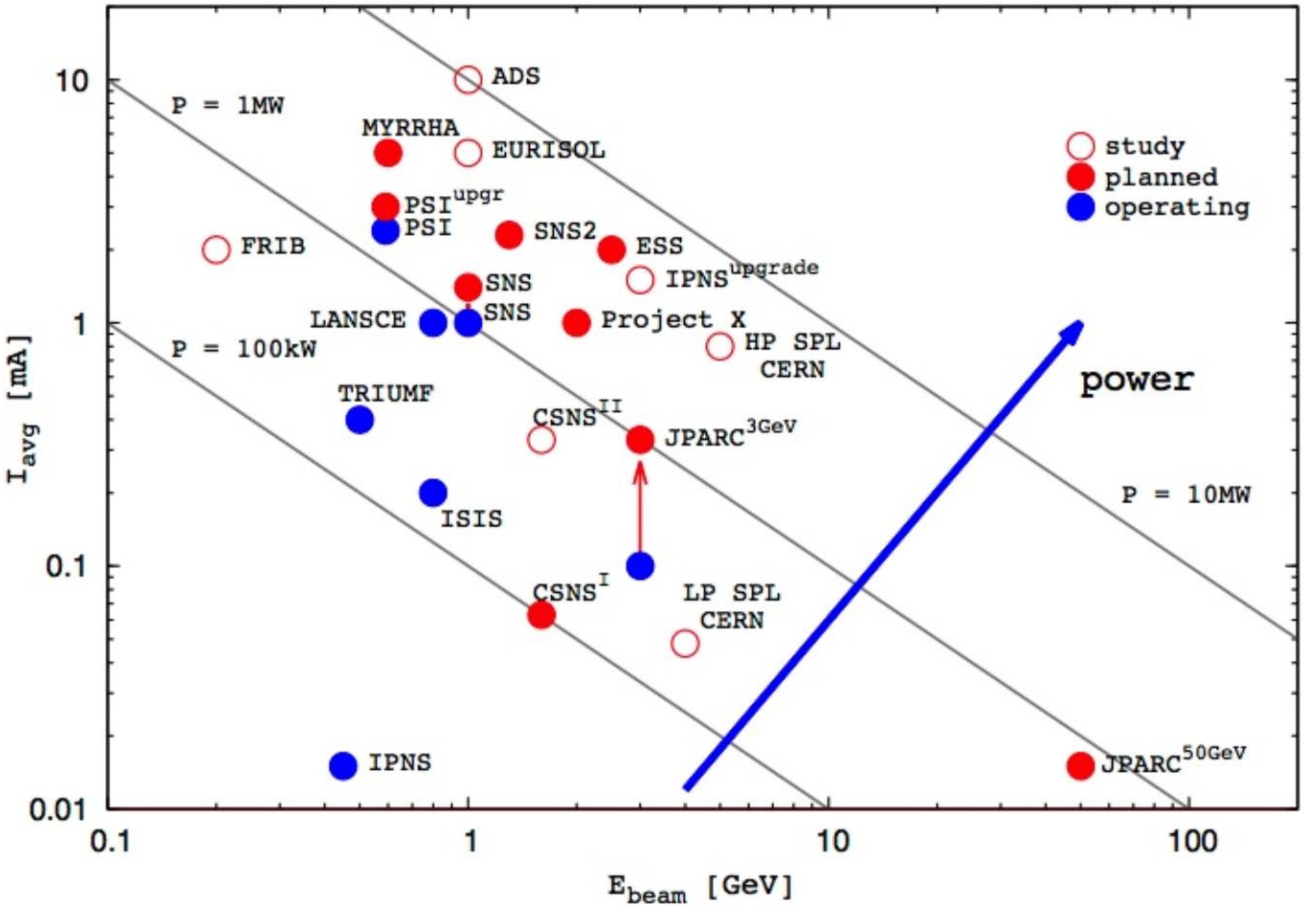
O Linac

O acelerador

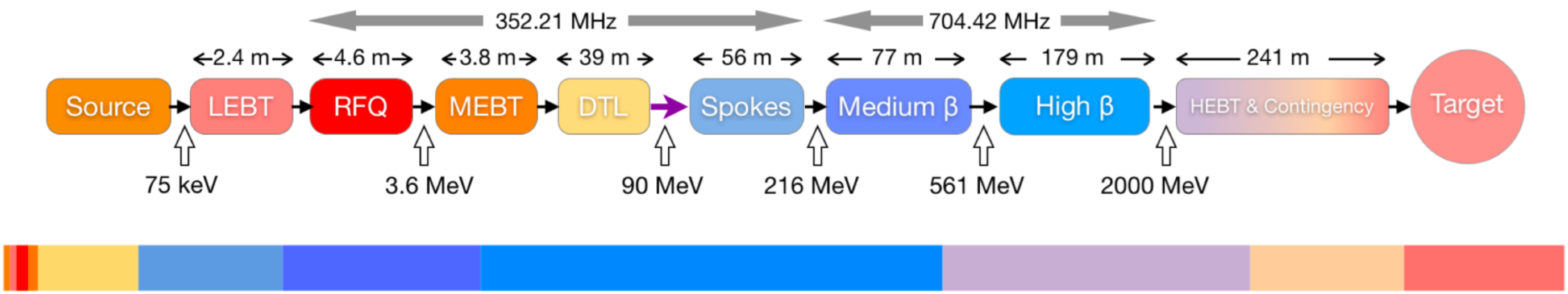


	Energy (MeV)	No. of Modules	No. of Cavities	βg	Temp (K)	Cryo Length (m)
Source	0.075	1	0	–	~300	–
LEBT	0.075	–	0	–	~300	–
RFQ	3.6	1	1	–	~300	–
MEBT	3.6	–	3	–	~300	–
DTL	90	5	5	–	~300	–
Spoke	220	13	2× 13	0.5 β_{opt}	~2	4.14
Medium β	570	9	4× 9	0.67	~2	8.28
High β	2000	21	4× 21	0.86	~2	8.28
HEBT	2000	–	0	–	~300	–

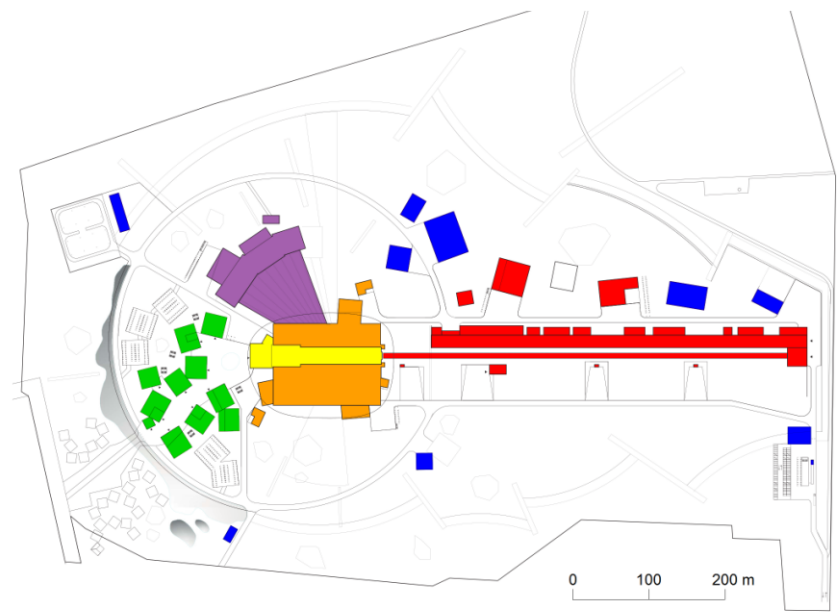
5MW de potencia



Algúns parámetros



Particle species	p
Energy	2.0 GeV
Current	62.5 mA
Average power	5 MW
Peak power	125 MW
Pulse length	2.86 ms
Rep rate	14 Hz
Max cavity surface field	45 MV/m
Operating time	5200 h/year
Reliability (all facility)	95%



A parte non conductora do acelerador

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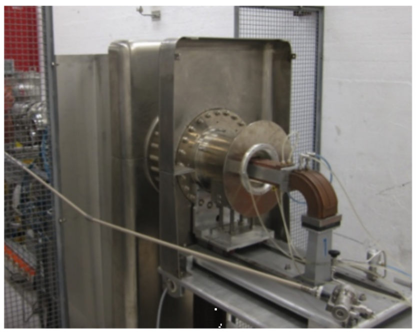
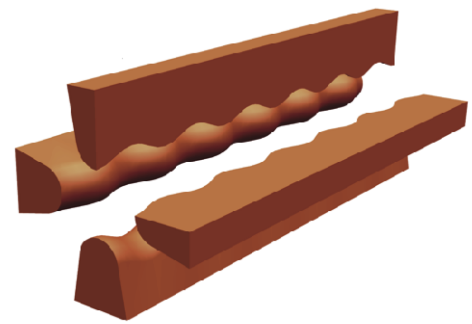
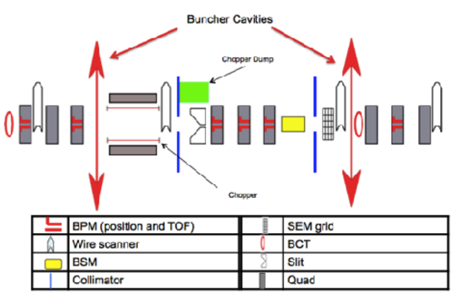


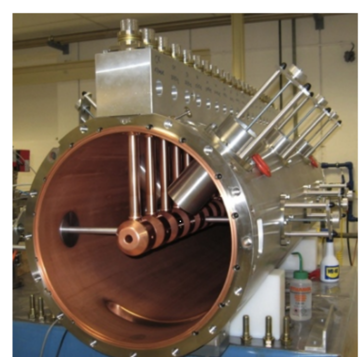
Prototype proton source operational, and under further development, in Catania. Output energy 75 keV.



Design exists for ESS RFQ similar to 5 m long IPHI RFQ at Saclay. Energy 75 keV->3.6 MeV.



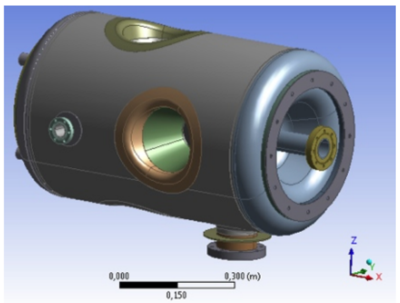
Design work at ESS Bilbao for MEBT with instrumentation, chopping and collimation.



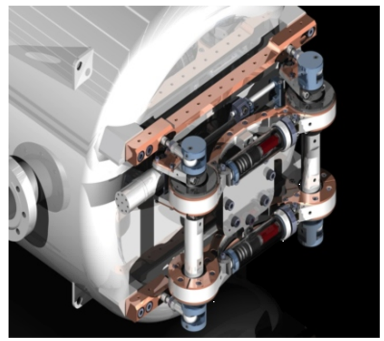
DTL design work at ESS and in Legnaro, 3.6 ->90 MeV.

Picture from CERN Linac4 DTL.

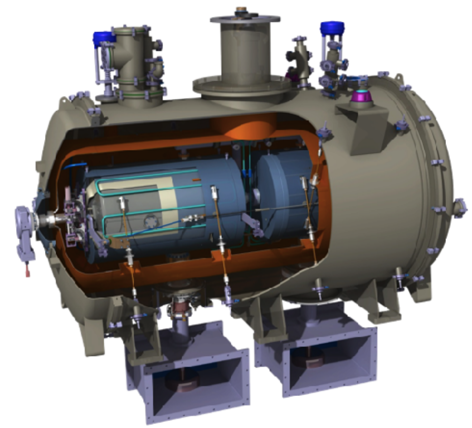
Spokes



Superconducting double-spoke accelerating cavity, for particles with beta = 0.5, energy 90->216 MeV.



Cold tuner, to mechanically fine-tune the 352 MHz resonance frequency.



Cryomodule, holding two cavities at 2 K with superfluid helium. Length 2.9 m, diameter 1.3 m.

Power coupler, the antenna feeding up to 300 kW RF power to the cavities.

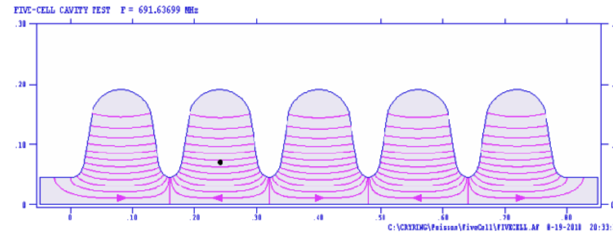
Single-spoke prototype for EURISOL

Cavity design done at IPN, Orsay. Prototype cavities are being manufactured.

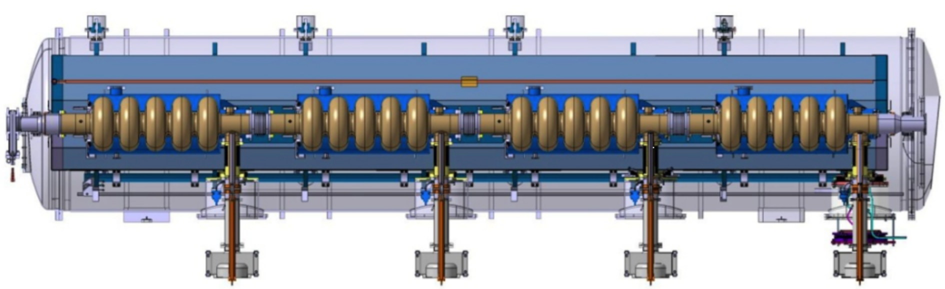
Cryomodule design highly advanced but not fully complete.

Cavidades elílpticas

Two families of superconducting elliptical cavities, for beta = 0.67, energy 216->561 MeV and beta = 0.86, energy 561->2000 MeV. First high-beta protoype shown.



Electrical field lines in ESS-like 5-cell cavity, 704 MHz, with cross section constructed from ellipses and straight lines.

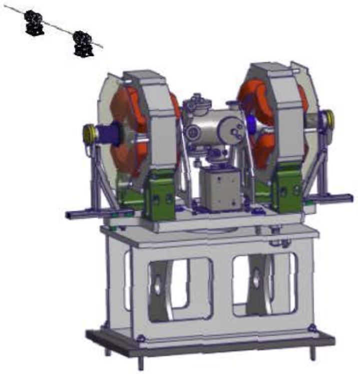


ESS elliptical cryomodule (not final) with 4 5-cell cavities and 4 power couplers for up to 1.1 MW peak RF power.

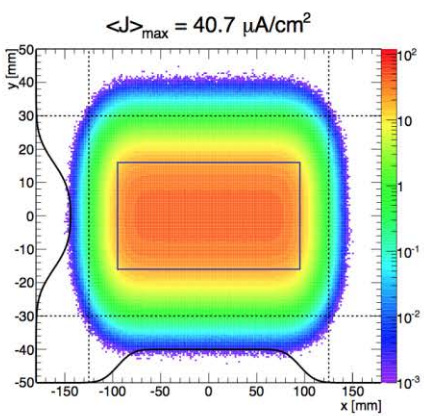
First cavity prototype delivered to Saclay, Cryomodule design well advanced at Orsay and Saclay.

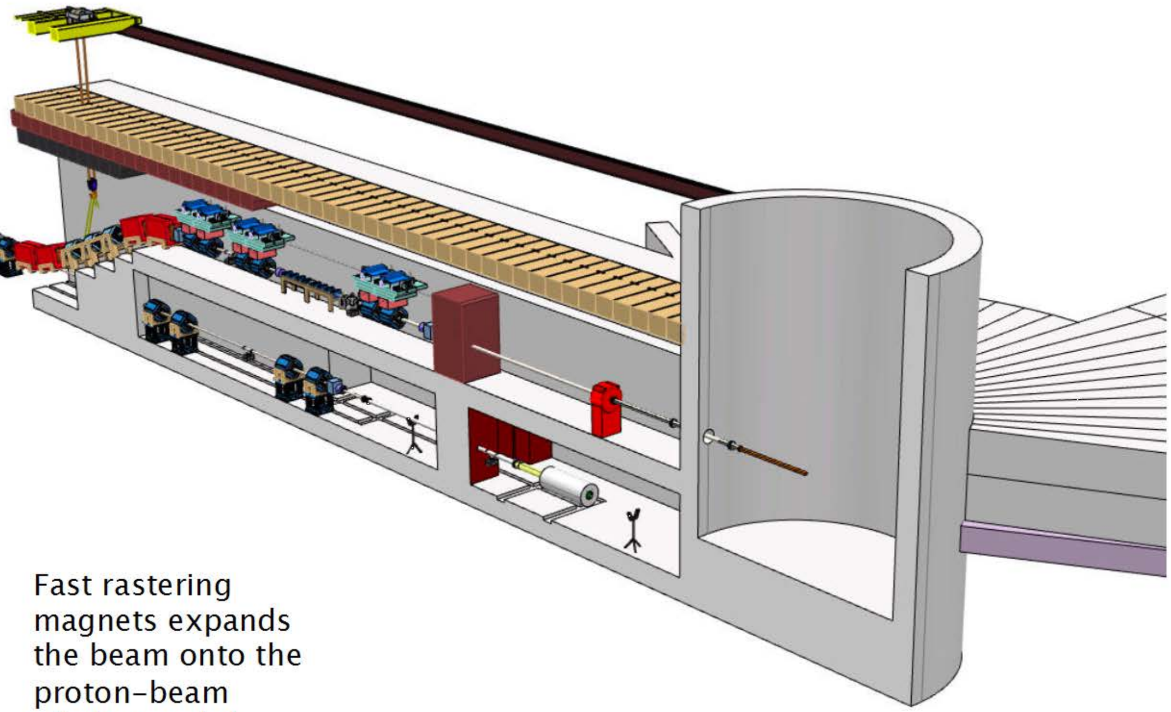
Elliptical Cavities Cryomodule Technology Demonstrator, ECCTD, to be ready 2015.

HEBT



Quadrupole doublet for linac and HEBT





Fast rastering magnets expands the beam onto the proton-beam window and the 250 mm × 60 mm beam entrance window on the target wheel

The HEBT design is a contribution from ISA, Århus.

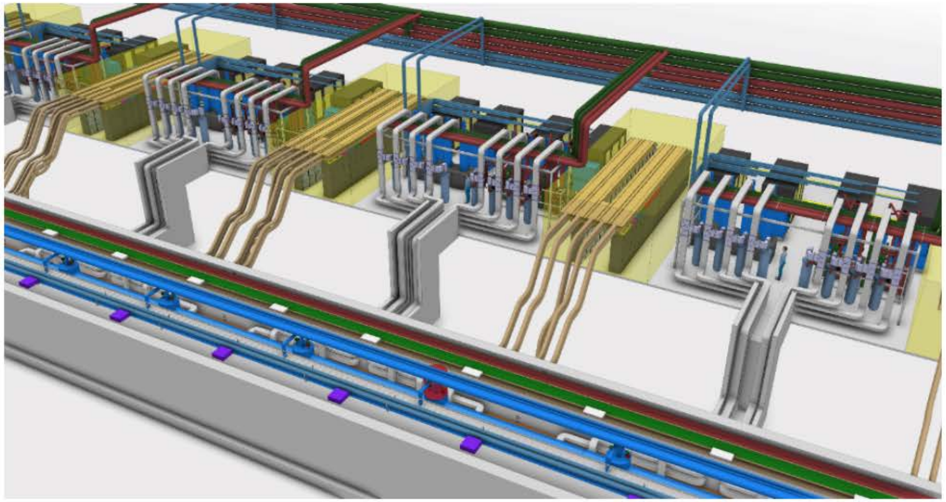
RF

SNS klystron gallery

Main features:

- One RF power source (klystron, IOT, ...) per resonator
- Two klystrons per modulator for ellipticals
- Pulsed-cathode klystrons for RFQ, DTL
- Gridded tubes (tetrodes or IOTs) for spokes
- Klystrons for medium-beta ellipticals, and as backup for high-beta
- Developments with industry for high-power IOTs

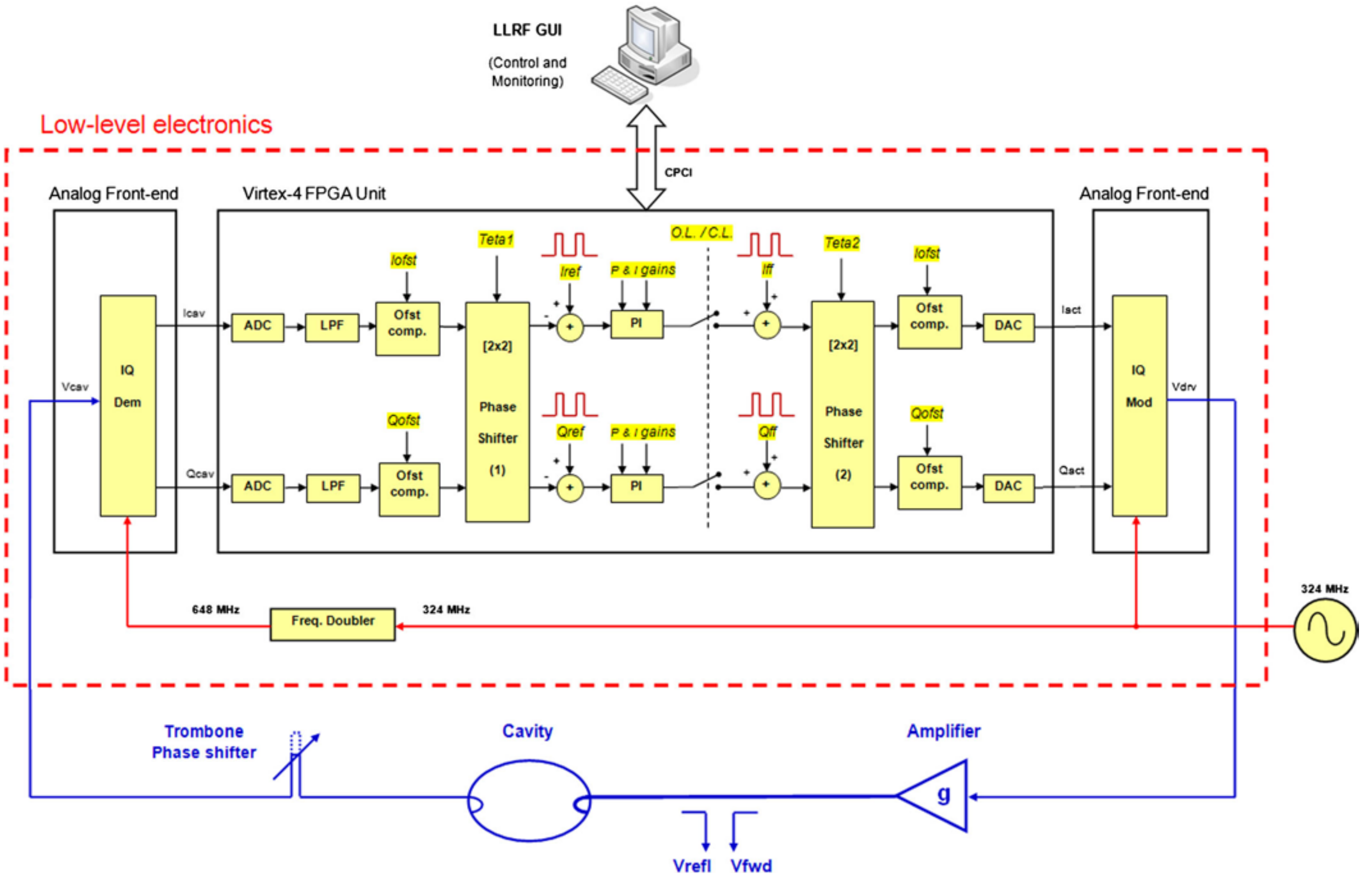
	Frequency (MHz)	No. of couplers	Max power (kW)
RFQ	352.21	1	900
DTL	352.21	5	2150
Spokes	352.21	26	350
Medium betas	704.42	32	900
High betas	704.42	88	1100



Layout of ESS linac tunnel and klystron gallery

Low Level RF

- **Control Low Level RF**(LLRF) le o campo en cada cavidade a través dunha sonda, controla este campo no dominio dixital usando lazos ‘feedback’ e ‘feedforward’ xenerando unha sinal de entrada para o amplificador de RF. O obxectivo e manter a cavidade cun campo de amplitude e fase con marxes de erro menores que 0.5% e 0.5 graos respectivamente. O valor nominal do campo é único para cada cavidade.



Crioxenia

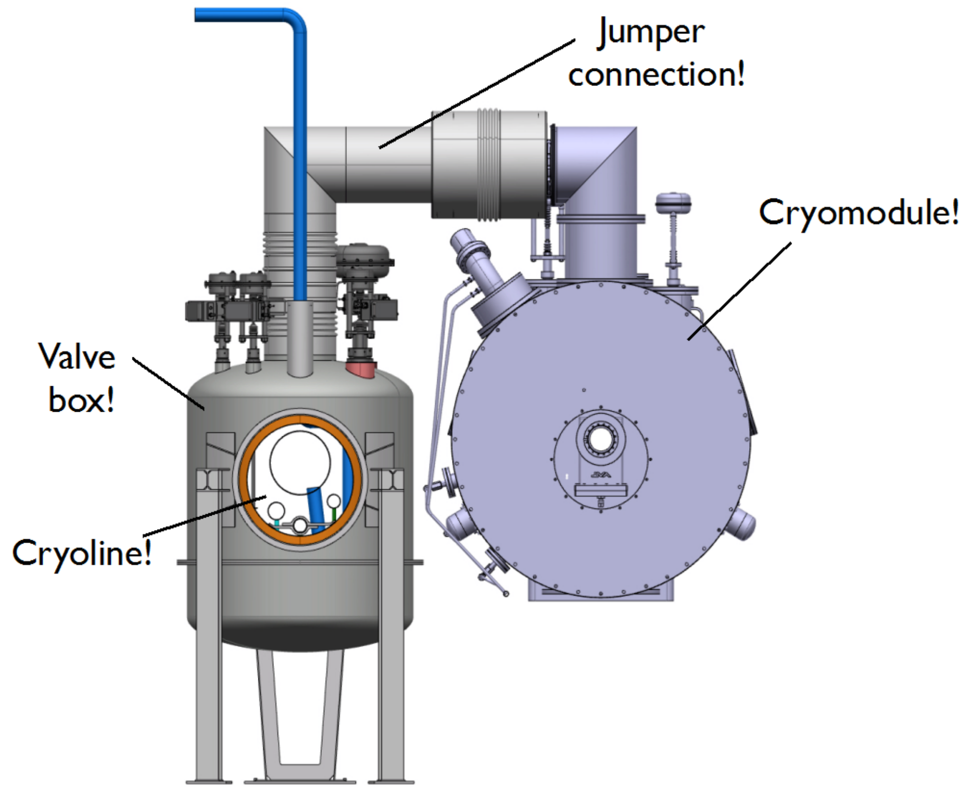
Three cryogenic plants

- Accelerator: 3.1 kW @ 2K, 12.8 kW @40 – 50 K plus 8 g/s helium liquefaction
- Target: ~ 20 kW @ 16K
- Test & Instruments ~ 250 W@ 4.5 K and 200 W @ 40K

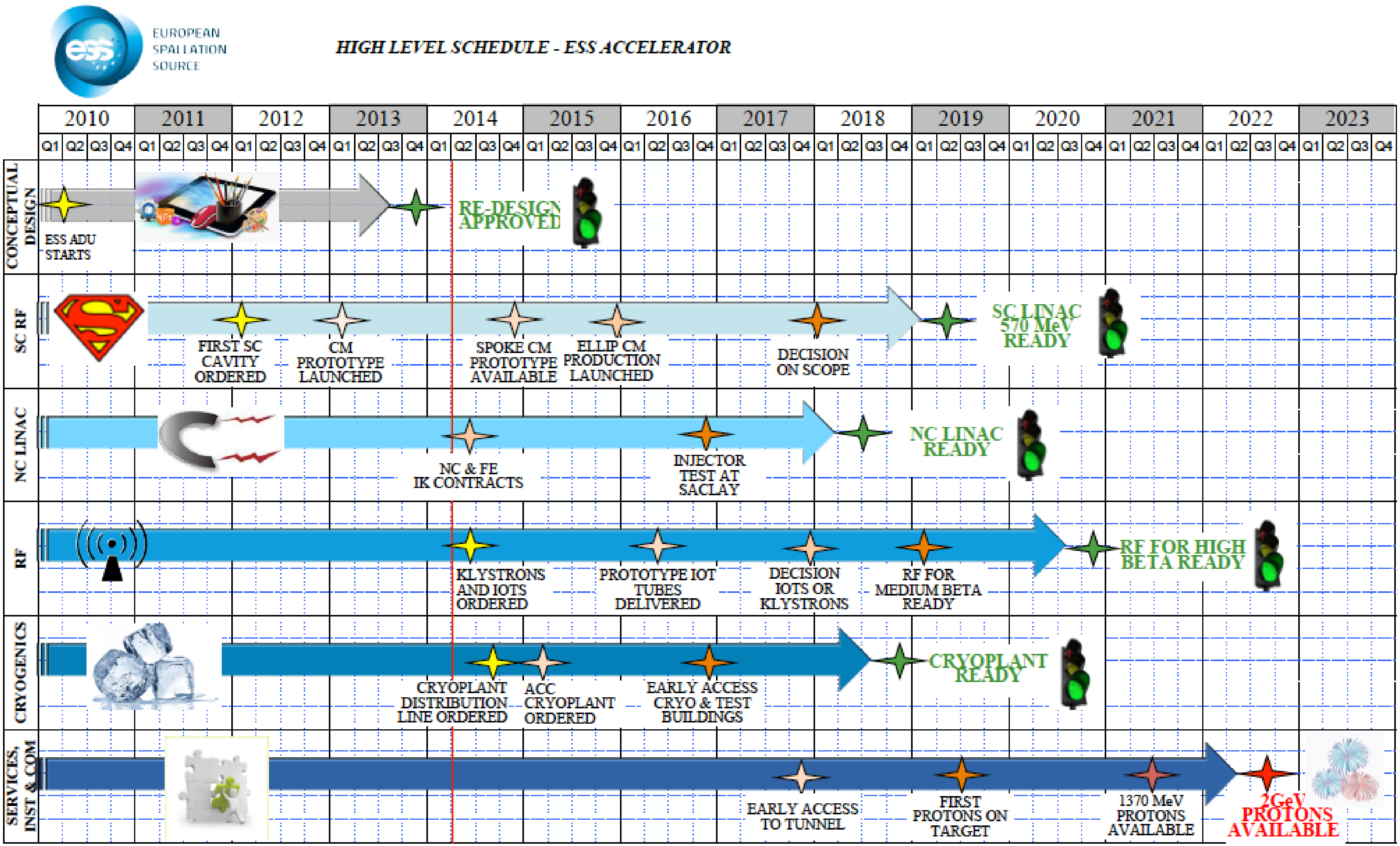
Distribution system

- Permits independent cool down & warm up of cryomodules, likely IKC

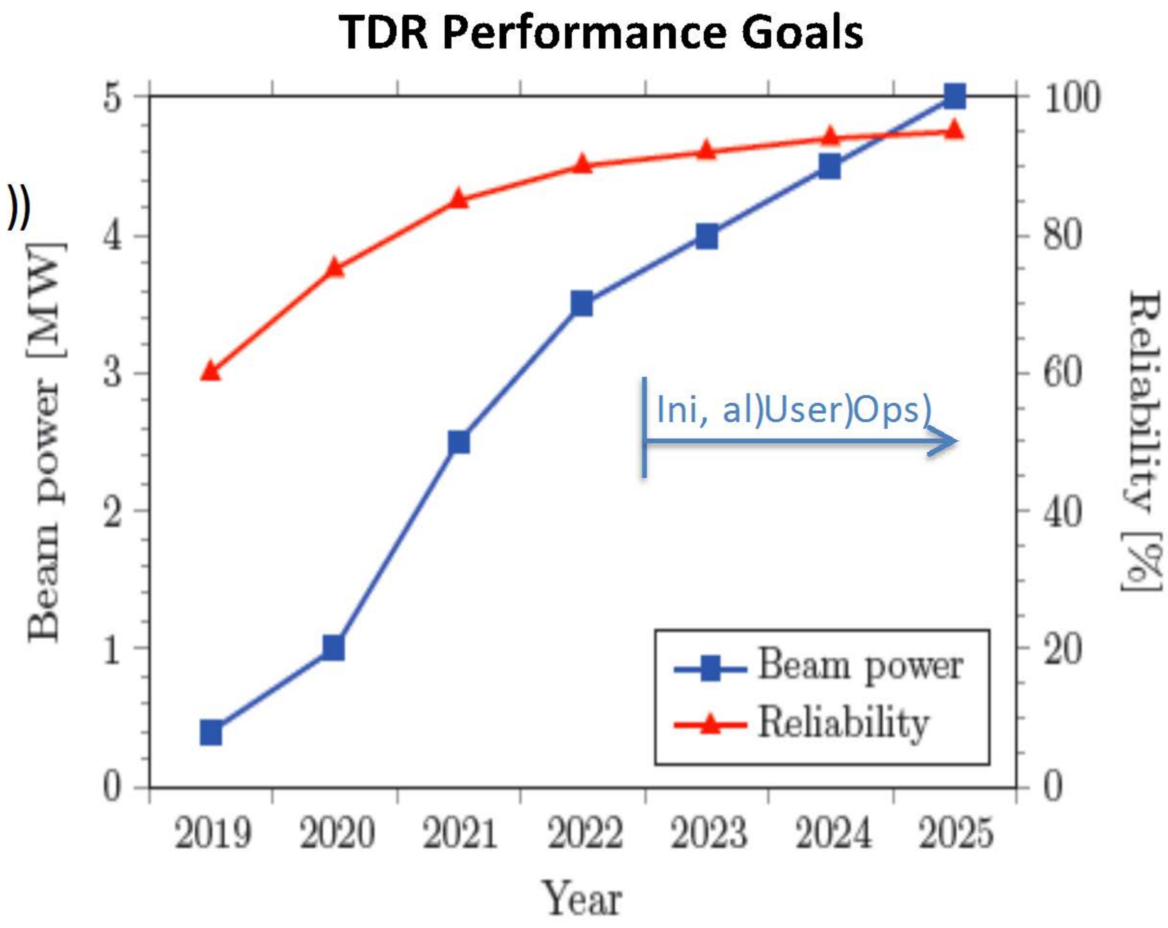
Cryoplant orders to be placed in 2015 with operations starting in 2017 – 2018



Un plan de moi alto nivel

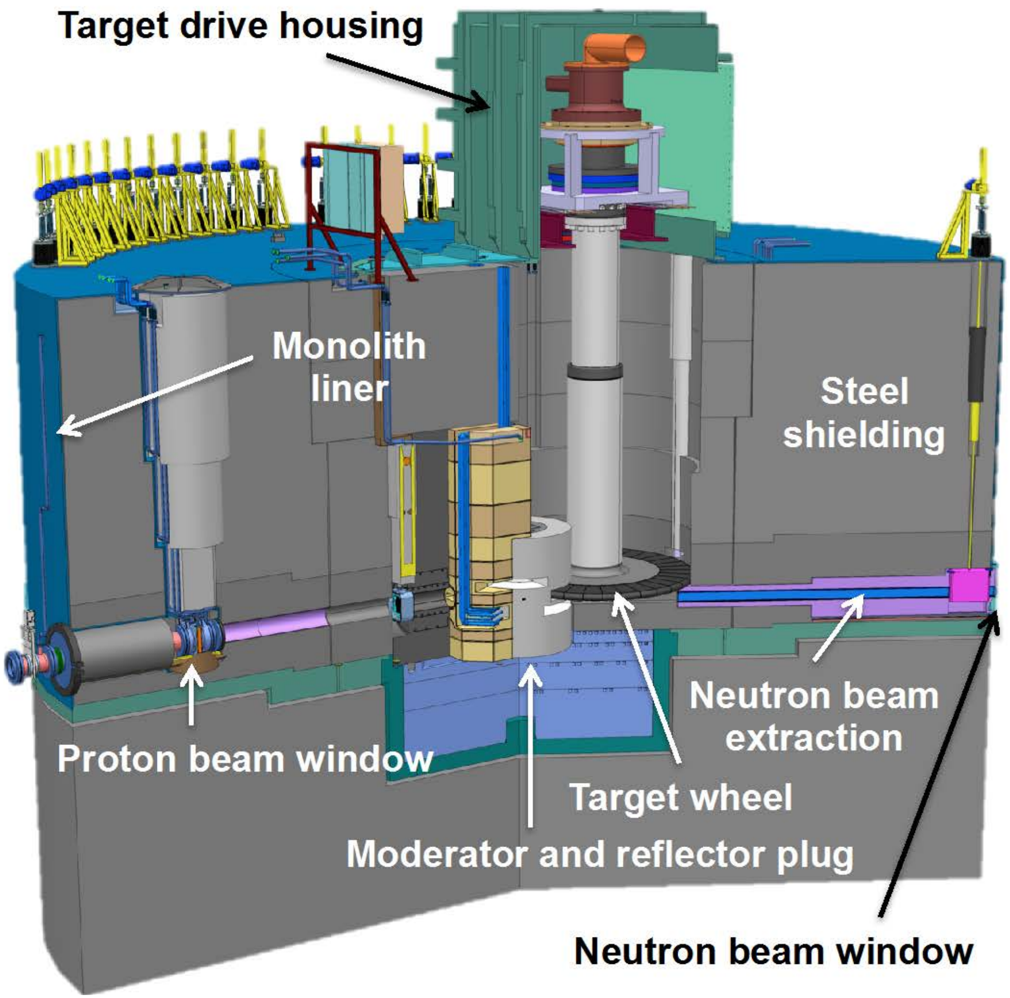


Cara a fase estacionaria



O blanco

O blanco



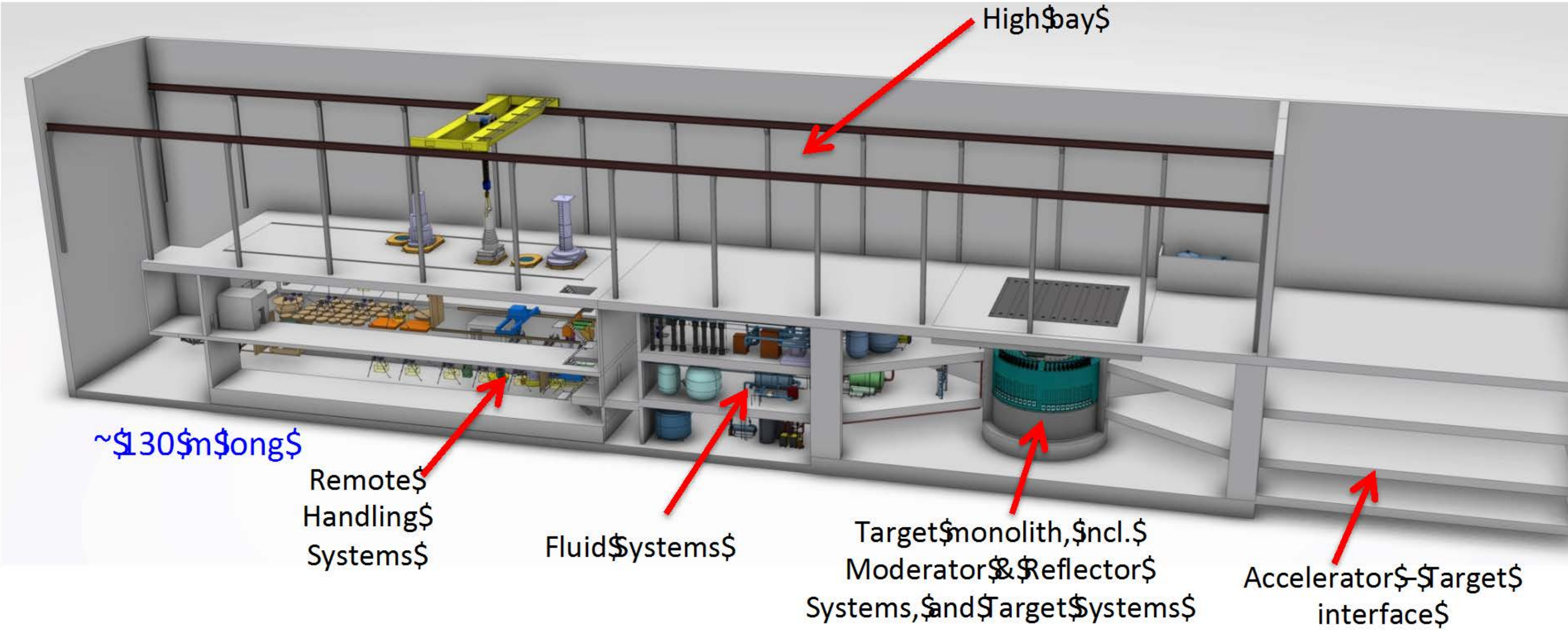
Requirements:

- Convert protons to neutrons
  - Peak brightness (E < 10 meV) at 5 MW: 2×10^{14} n/cm^2/s/sr (30 x ILL)
- Heat removal - 5 MW proton beam
- Confinement and shielding

Unique features:

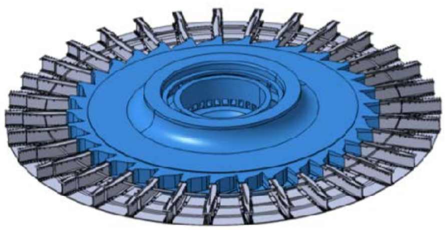
- Rotating target
- He-cooled W target

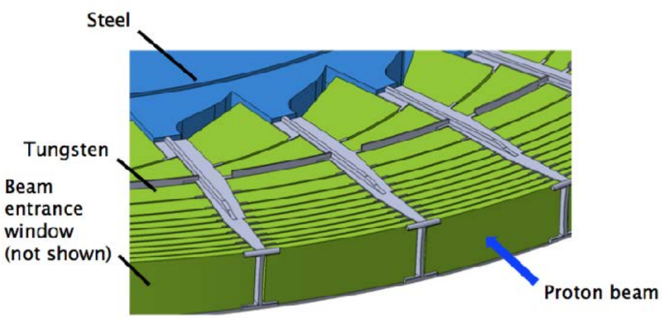
O blanco…e dous



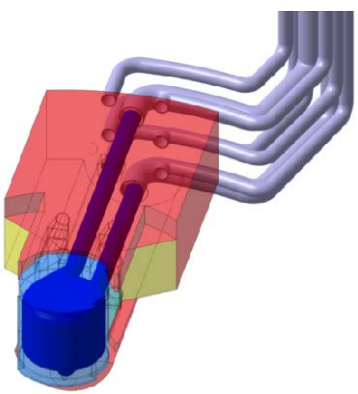
- Hot$cells$plus$casks$and$tooling$to$transport$components$ from$monolith$to$cells$$
- Safety$credited$controlstoprotect$public$and$ environment$from$radioac*ve$hazard$

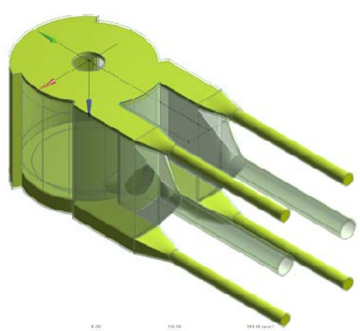
O blanco…algúns detalles mais





- 33 sectores de tungsteno
- 2.5 m de diametro
- Eixo > 5m
- Helio para enfriamento
  - 3 atmósferas
  - Entrada (20 C)/Saida (220C)
- 25.5 r.p.m.
- 5 anos de vida (@5MW)

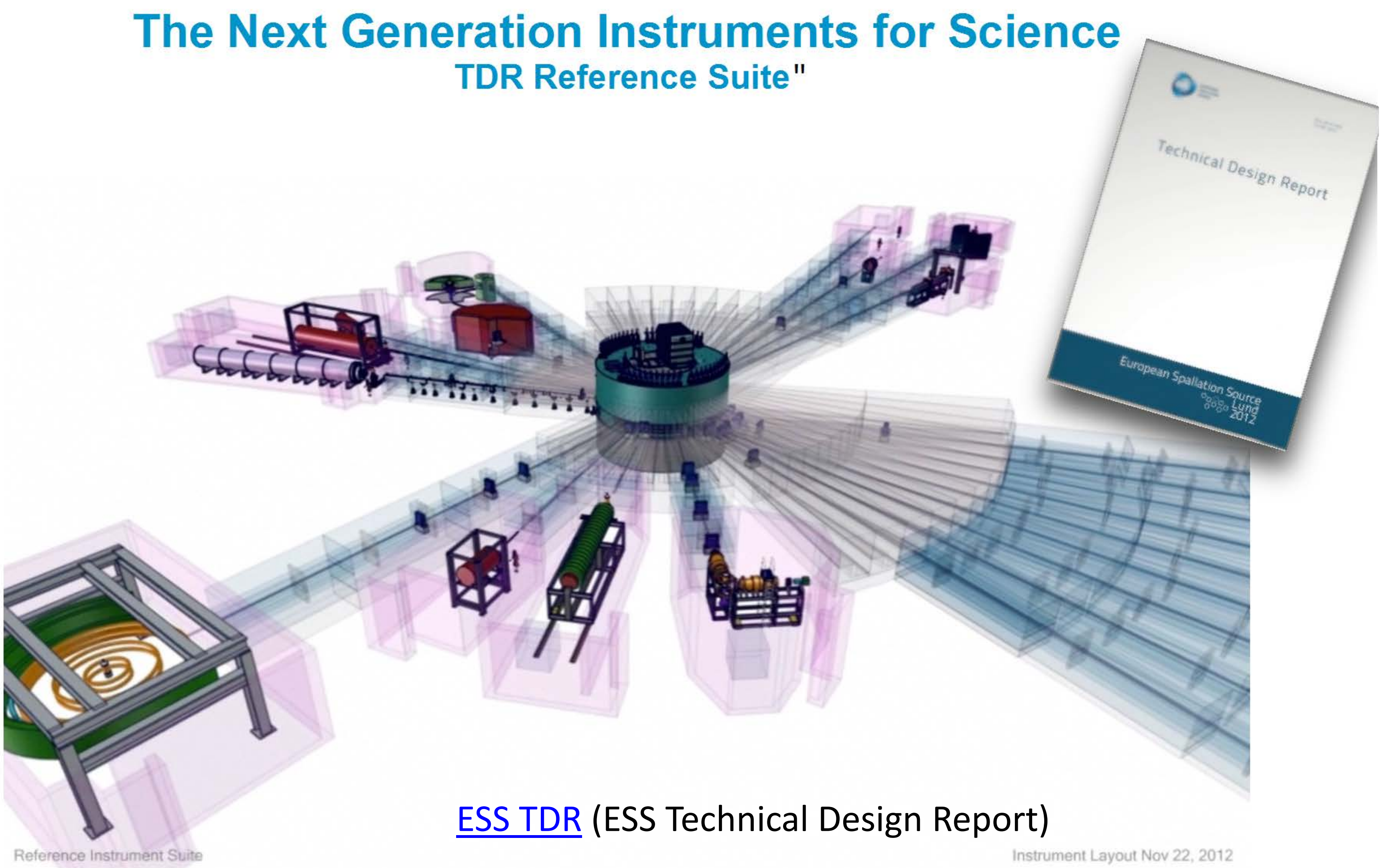




- Moderadores fríos (hidróxeno supercrítico a 20K, 1.5MPa, 1 ano de vida)
- Moderadores termais (auga, 1 ano de vida).

Os intrumentos

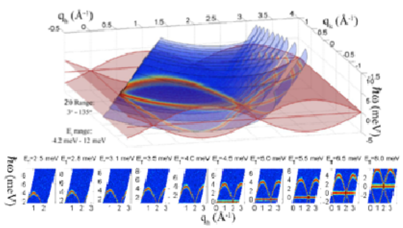
Moitos instrumentos….22!



ESS TDR (ESS Technical Design Report)

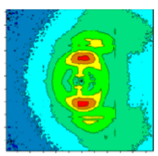
Instrumentos propostos

Spectroscopy"



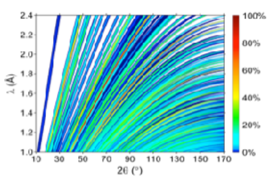
Instrument	Description
VOR	Wide Bandwidth Spectrometer
T-REX	Bi-Spectral Spectrometer
ESS-CCS	Cold Chopper Spectrometer
Tempus Fugit	Time-Focusing Spectrometer
CAMEA	Indirect Geometry Spectrometer
ESS-NSE	Spin Echo Spectrometer

SANS"



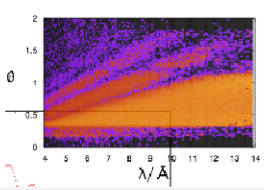
Instrument	Description
SKADI	High Intensity SANS
Compact-SANS	SANS Biology & Materials Science

Diffraction"



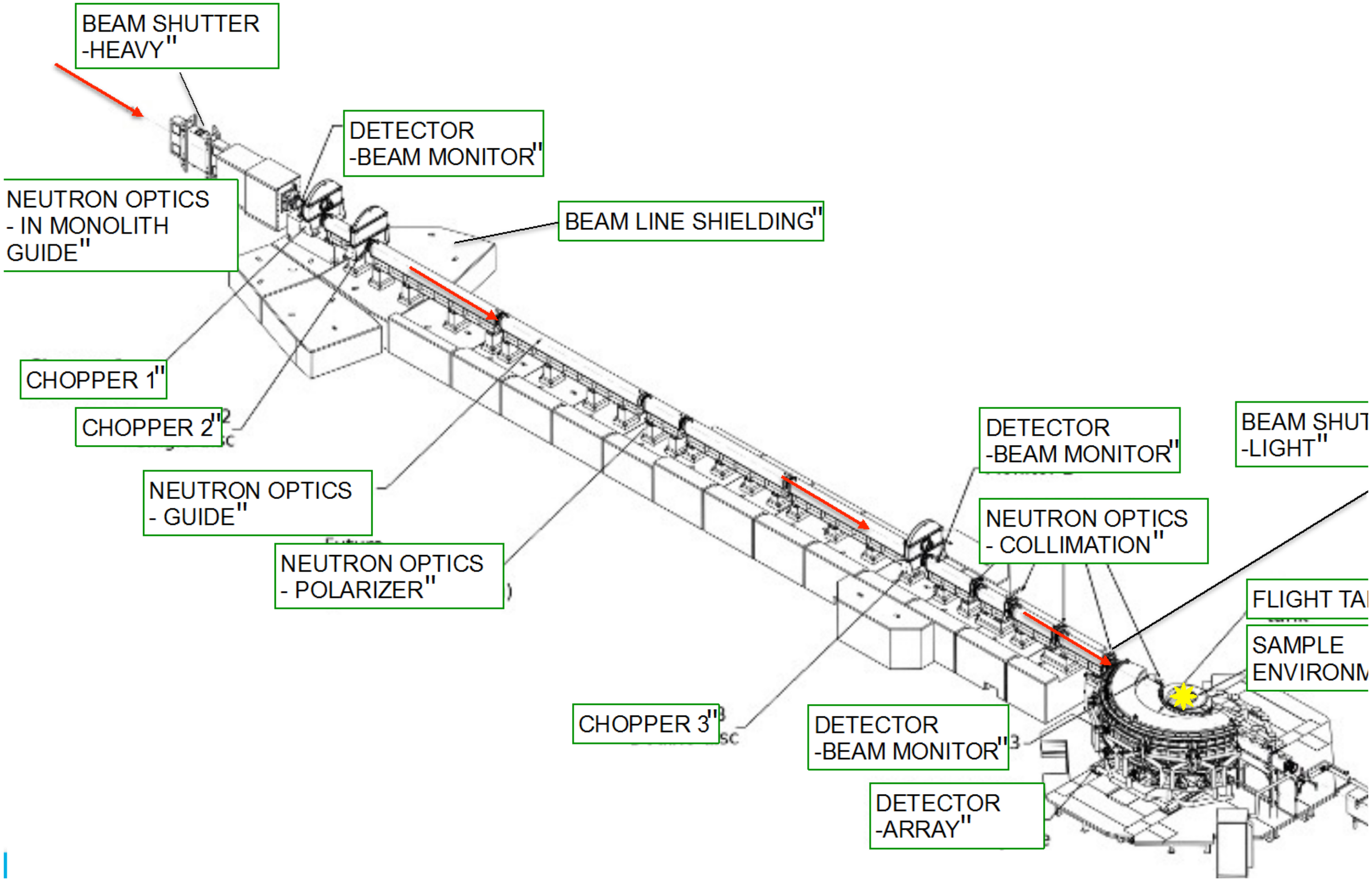
Instrument	Description
BEER	Engineering Diffractometer
MODI	Monochromatic Diffractometer
HEIMDAL	Thermal Powder Diffractometer
POWHOW	Bi-Spectral Powder Diffractometer

Reflectometry"



Instrument	Description
FREIA	Reflectometer for liquid interfaces
THOR	Horizontal Reflectometer
ESS-PAREF	Polarised Reflectometer

Qué pinta ten un instrumento?



E finalmente…o proxecto de control!!

Requerimentos de alto nivel

- O noso cometido en ESS:
  - Proporcionar un entorno de control e monitorización para o **acelerador**, **blanco**, **instrumentos** e a **infraestructura técnica.**
  - Servicio de Timing para **xenerar eventos**, **sincronización** de dispositivos e '**time stamping'** (ata nanosegundos).
  - Servicios e aplicacións para **'commissioning'** e **operacións**.
  - **Controladores** e **Integración** para os diferentes subsistemas**.**
  - **Sistemas de protección** para a máquina e **sistemas de seguridade** para as persoas.
  - Sala de control
- Importante!!
  - Alta fiabilidade e dispoñibilidade (**>95%**)!

A nosa organización

Garry Trahern
Head of Division

Deputy Head of Division (vacant)
Timo Korhonen – Chief Engineer
Miha Reščič – Deputy Project Manager, Lead Systems Engineer
Thilo Friedrich – Systems & Standardization Engineer, PhD
Iñigo Alonso - Intern

Solveig Aas – Team Assistant (50%)

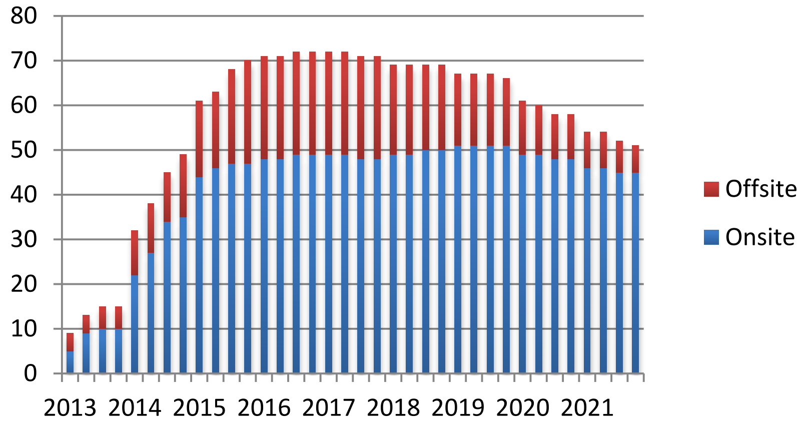
SOFTWARE AND SERVICES
- Suzanne Gysin – GL
- Leandro Fernandez
- Richard Fearn
- Ricardo Fernandes
- Emanuele Laface
- Karin Rathsman
- Jaka Bobnar (C)
- Jakob Battellino (C)
- Miha Vitorovič (C)
- Jure Krašna (C)
- Marko Kolar (C)
- Miroslav Pavleski (C)

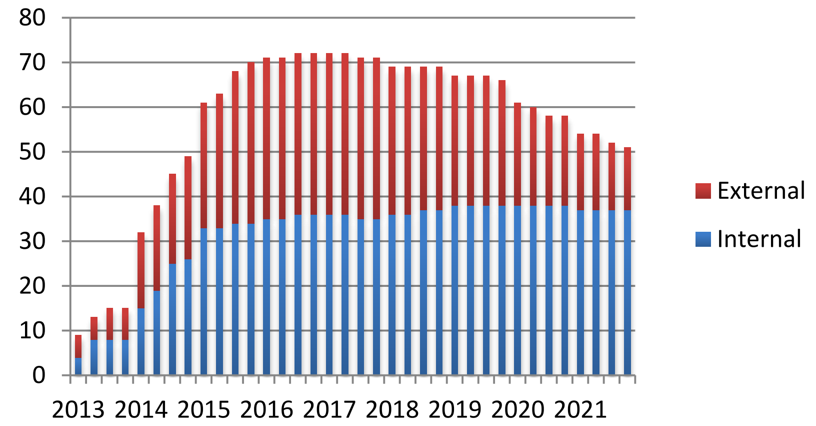
HARDWARE AND INTEGRATION
- Daniel Piso Fernandez
- Lead Integrator, Accelerator (vacant)
- Lead Integrator, Target (vacant)
- Klemen Strniša (C)
- Urša Rojec (C)
- Niklas Claesson (C)
- Alexander Söderqvist (C)
- Žiga Kroflič (C)
- Rok Štefanič (C)
- Gregor Cijan (C)

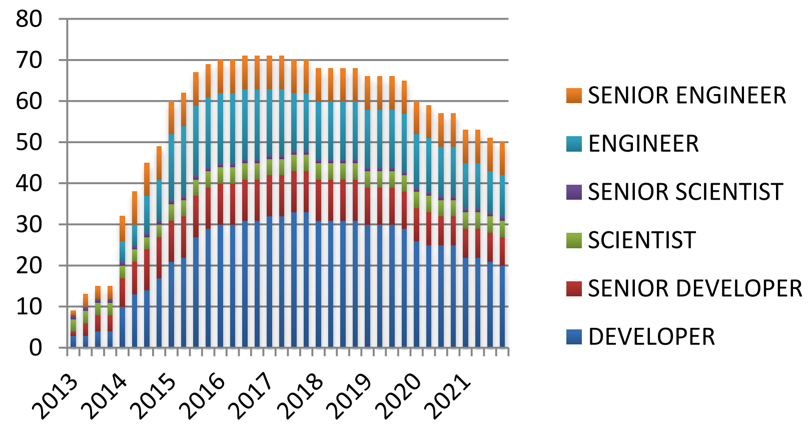
PROTECTION SYSTEMS
- Annika Nordt – GL
- MPS PLC Expert
- MPS FPGA Expert
- PSS WU Leader
- Paul Wright (C)

INFRASTRUCTURE
- Technology Architect (vacant)

Cantos somos e cantos seremos….



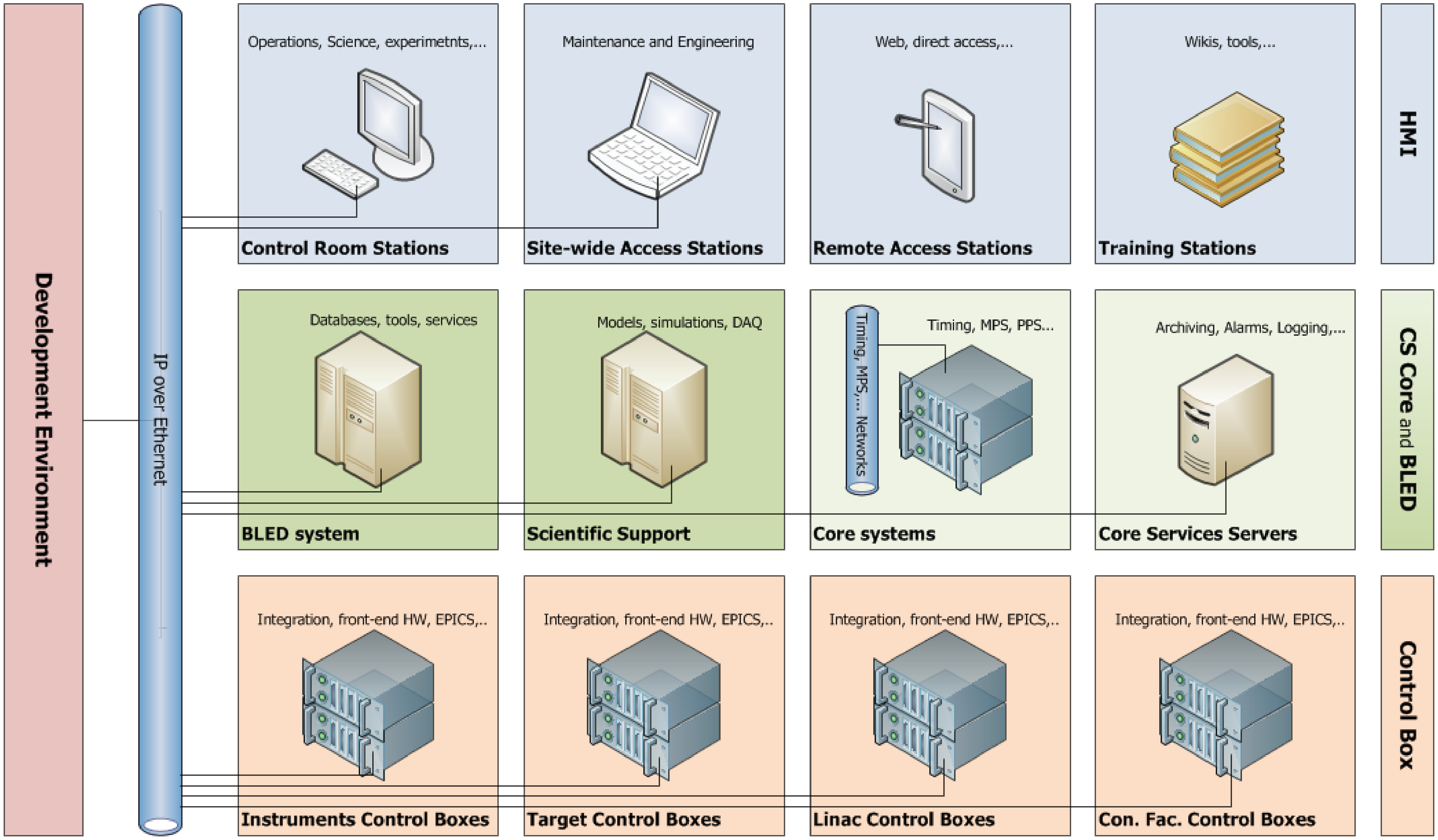




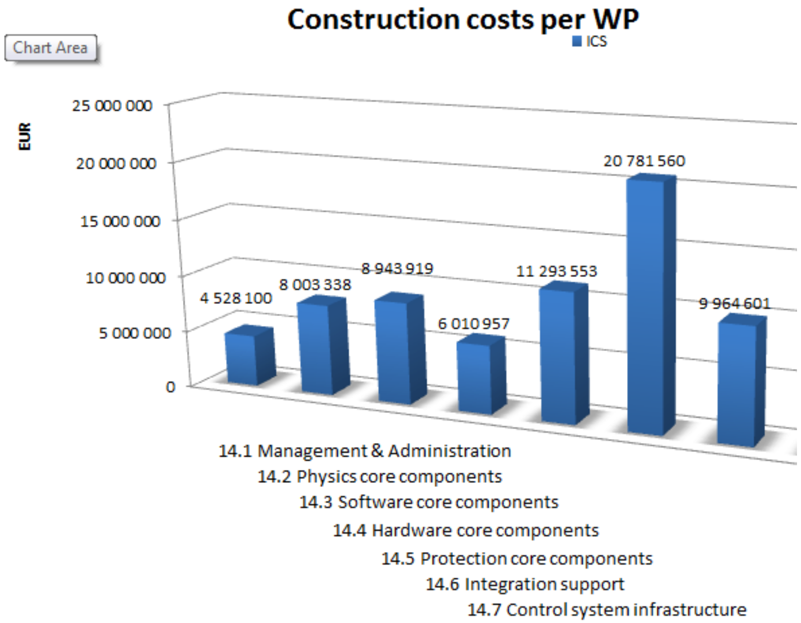
Project Structure

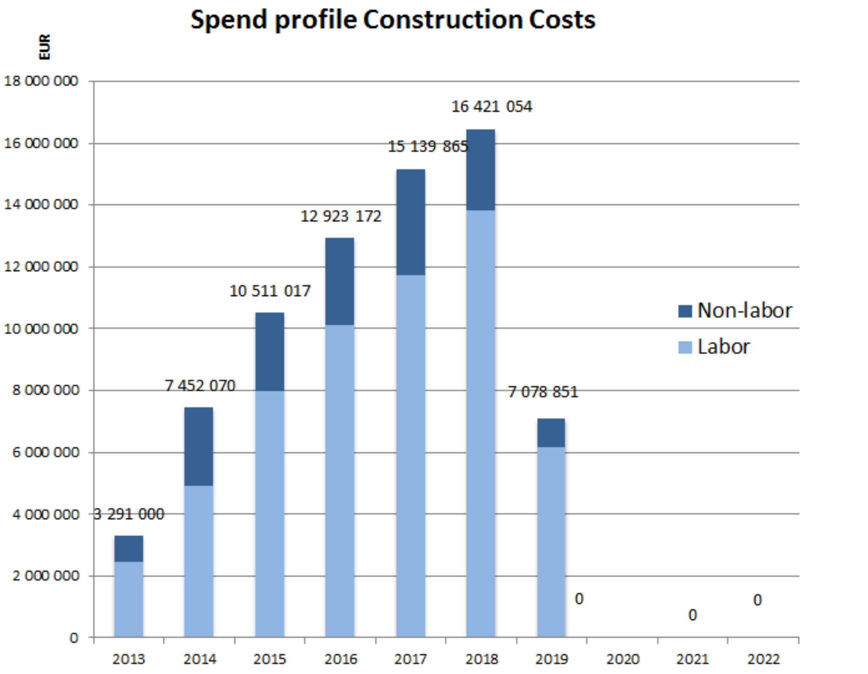
- **Core components**
  - WP.2 Applications
  - WP.3 Software core
  - WP.4 Hardware core
  - WP.5 Protection core
  - WP.7 CS Infrastructure
  - WP.8 Physics
- **Integration support**
  - WP.10 Accelerator
  - WP.11 Target
  - WP.12 Instruments
  - WP.13 Conventional Facilities
  - WP.14 Test Stands

Architecture



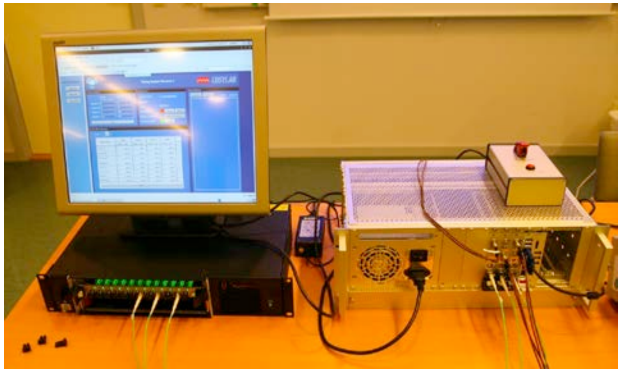
Canto costa?

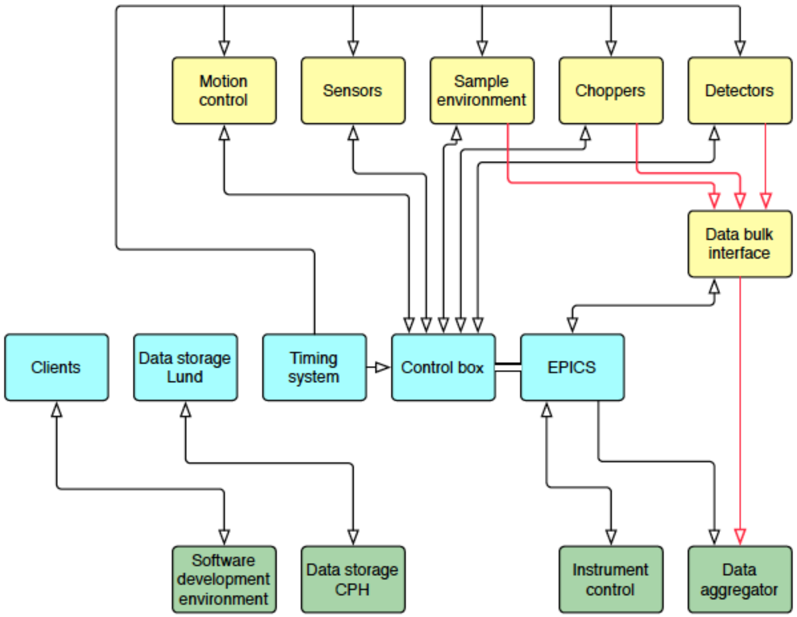

Construction costs per WP
ICS
Chart Area
EUR
25 000 000
20 000 000
15 000 000
10 000 000
5 000 000
0
4 528 100
8 003 338
8 943 919
6 010 957
11 293 553
20 781 560
9 964 601
14.1 Management & Administration
14.2 Physics core components
14.3 Software core components
14.4 Hardware core components
14.5 Protection core components
14.6 Integration support
14.7 Control system infrastructure


Spend profile Construction Costs
EUR
18 000 000
16 000 000
14 000 000
12 000 000
10 000 000
8 000 000
6 000 000
4 000 000
2 000 000
0
3 291 000
7 452 070
10 511 017
12 923 172
15 139 865
16 421 054
7 078 851
0
0
0
Non-labor
Labor
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022

Retos

- Tecnoloxías & Interfaces





Control baseado en EPICS

- EPICS e unha abreviatura de: **E**xperimental **P**hysics and **I**ndustrial **C**ontrol **S**ystem

- EPICS é:
  - unha colaboración
  - un conxunto de ferramentas
  - unha arquitectura de control

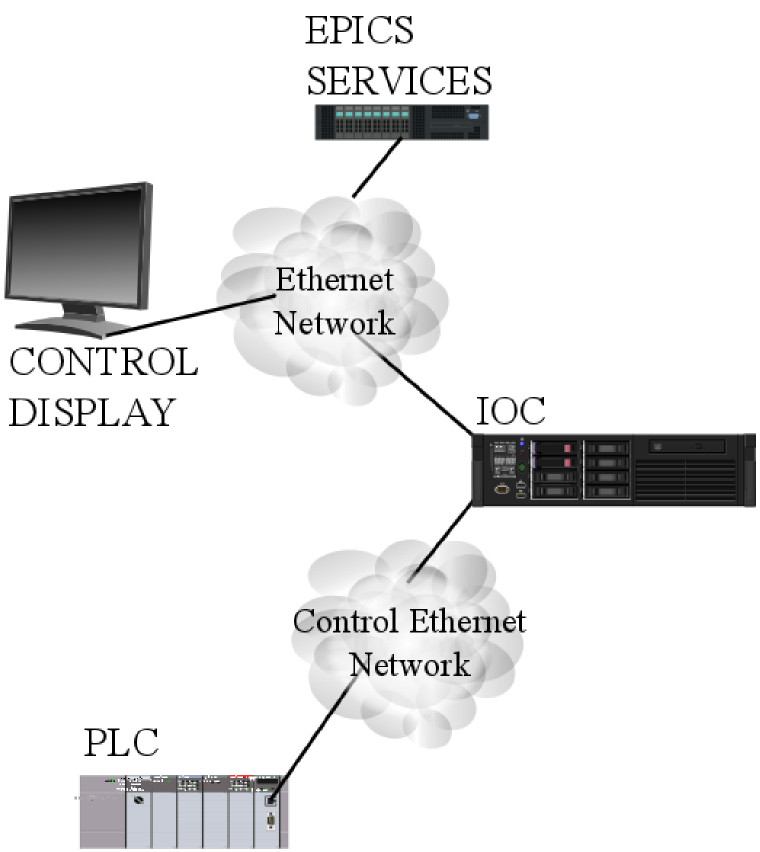
– En 1989, comezou coma unha colaboración enter o Laboratorio Nacional de Los Alamos e o Nacional Argonne (USA) (Jeff Hill, Bob Dalesio & Marty Kraimer)

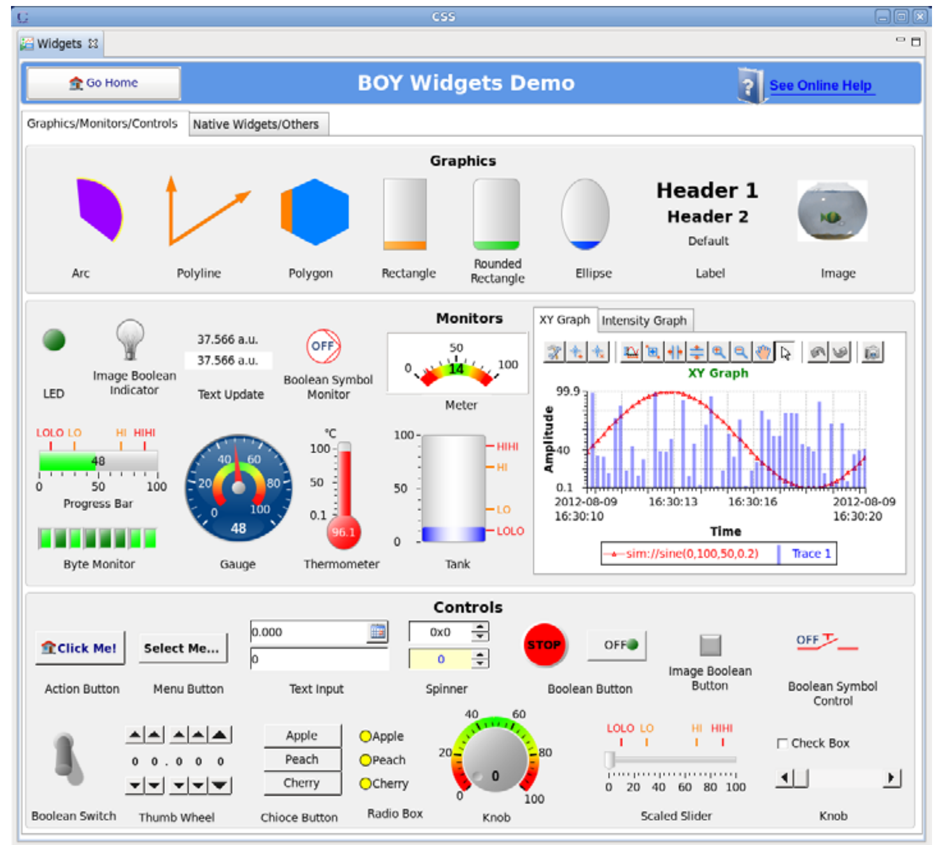
– Firmáronse 150 licenzas antes de que EPICS fose liberado coma Open Source

– Desenvolmento colaborativo, como exemplo "Tech Talk" mailing list

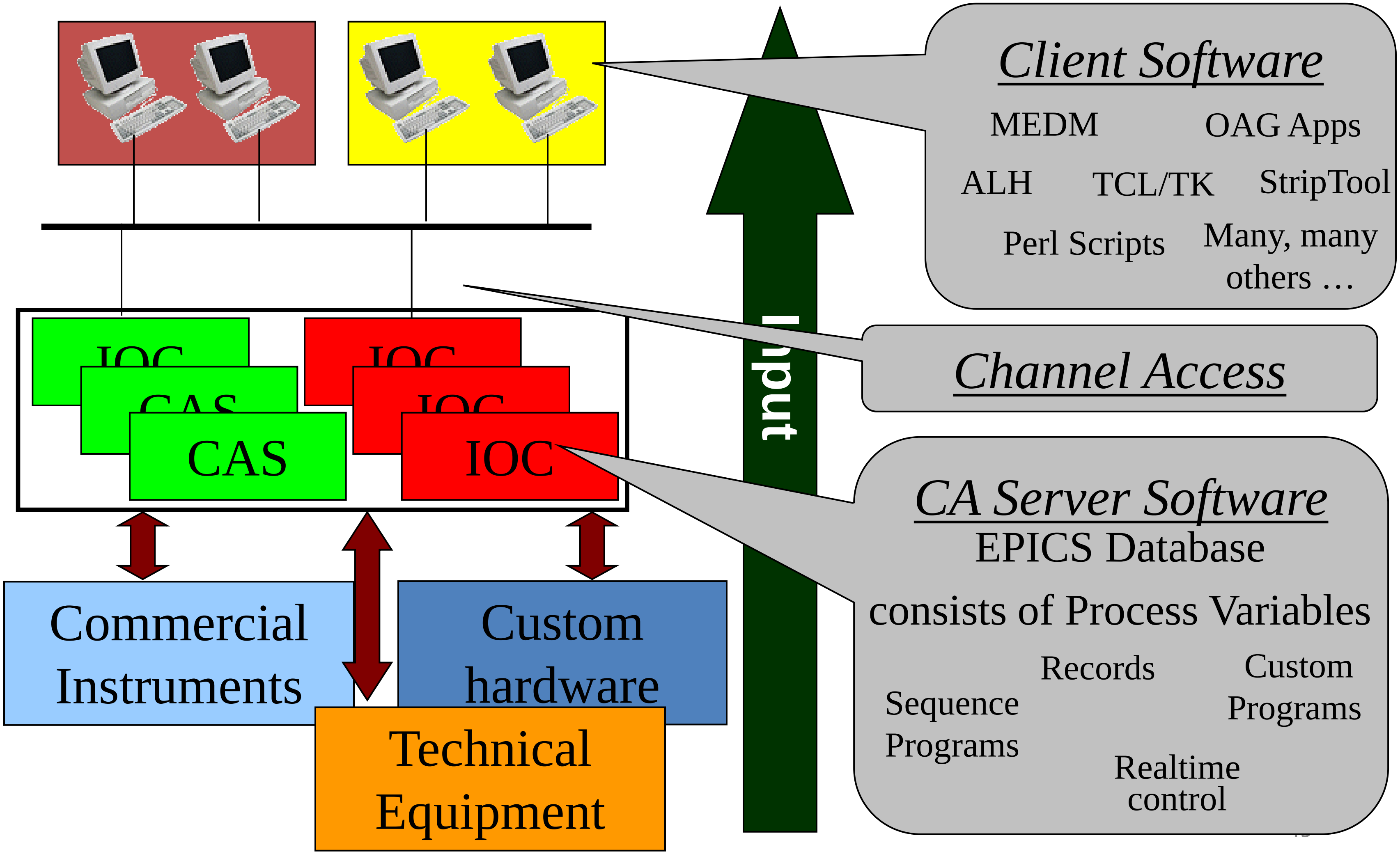
– Esforzos colaborativos de distinta natureza
  - Assistencia na deteccion de fallos
  - Ferramentas compartidas, axuda

EPICS

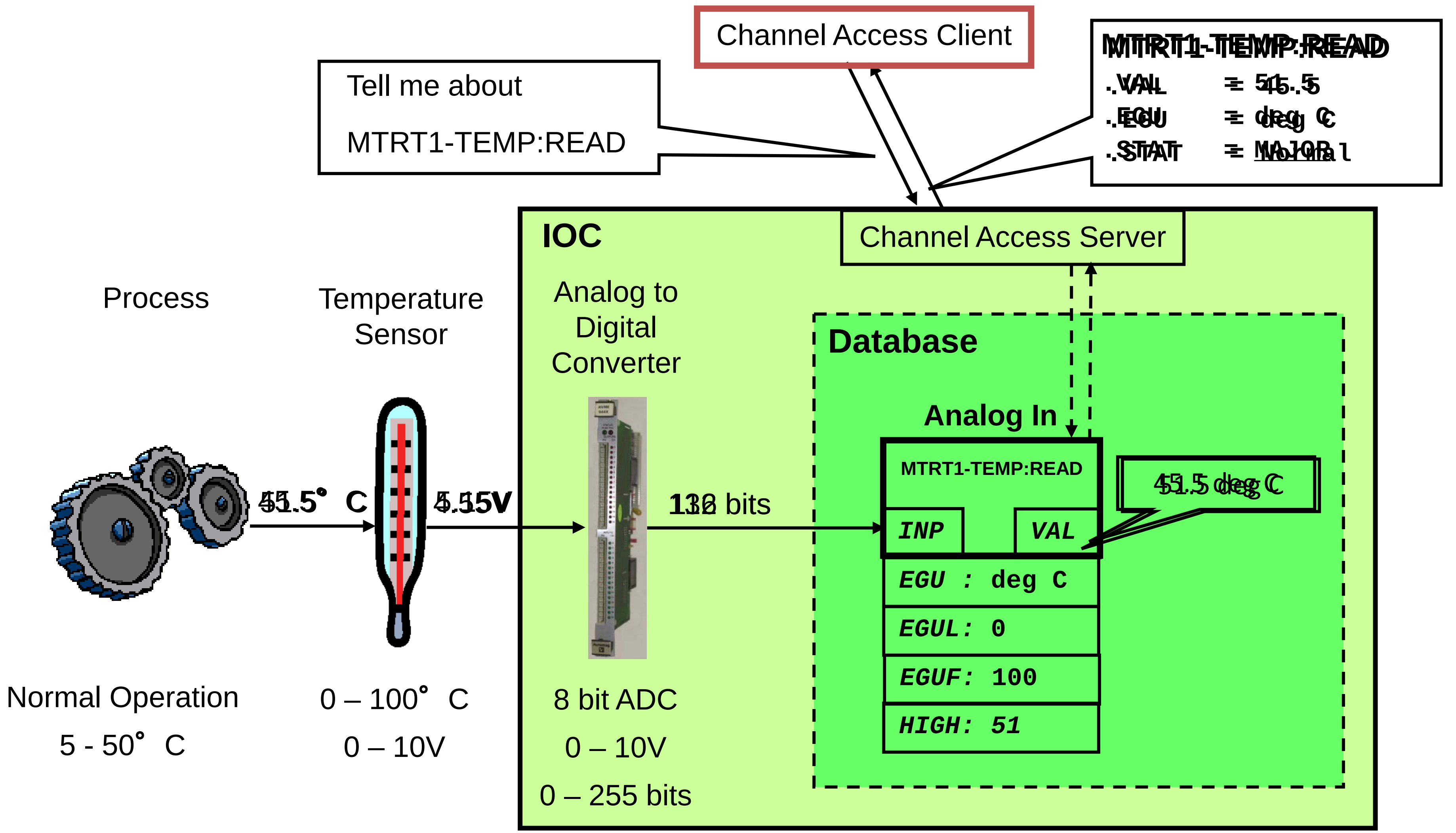

EPICS
SERVICES
Ethernet
Network
CONTROL
DISPLAY
IOC
Control Ethernet
Network
PLC


CSS
Widgets
Go Home
BOY Widgets Demo
See Online Help
Graphics/Monitors/Controls
Native Widgets/Others
Graphics
Header 1
Header 2
Default
Arc
Polyline
Polygon
Rectangle
Rounded Rectangle
Ellipse
Label
Image
Monitors
LED
Image Boolean Indicator
37.566 a.u.
37.566 a.u.
Text Update
Boolean Symbol Monitor
Meter
Progress Bar
Byte Monitor
Gauge
Thermometer
Tank
XY Graph
Intensity Graph
Amplitude
Time
sim://sine(0,100,50,0.2)
Trace 1
Controls
Click Me!
Select Me...
Action Button
Menu Button
Text Input
Spinner
STOP
Boolean Button
Image Boolean Button
Boolean Symbol Control
Boolean Switch
Thumb Wheel
Apple
Peach
Cherry
Chioce Button
Radio Box
Knob
Scaled Slider
Check Box
Knob

EPICS …e dous


IOC
CAS
CAS
IOC
IOC
IOC
Input
Client Software
MEDM
OAG Apps
ALH
TCL/TK
StripTool
Perl Scripts
Many, many others …
Channel Access
CA Server Software
EPICS Database
consists of Process Variables
Records
Custom Programs
Sequence Programs
Realtime control
Commercial Instruments
Custom hardware
Technical Equipment

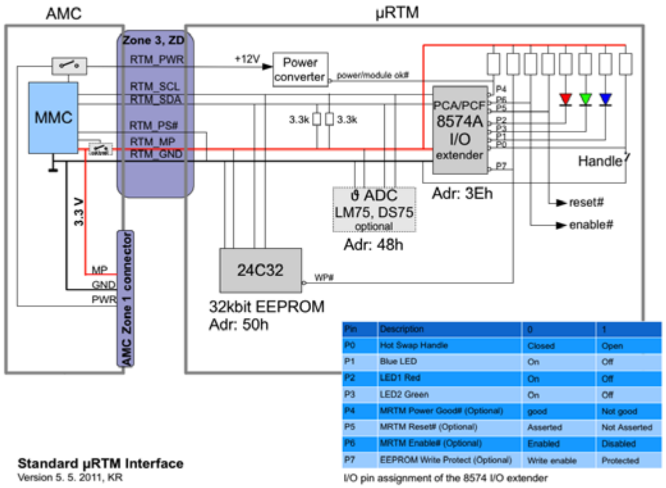
Como funciona EPICS?



Compoñentes hardware (Controladores, PLCs, Servidores)

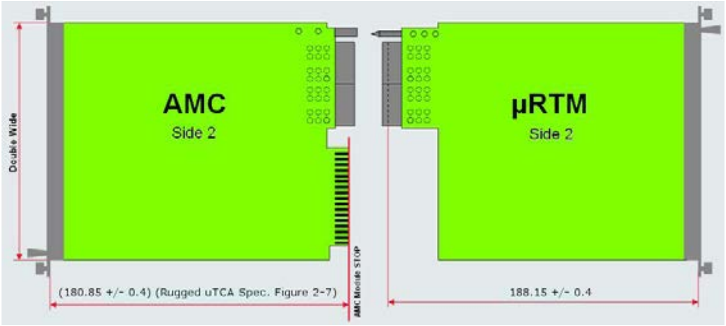
EUROPEAN SPALLATION SOURCE

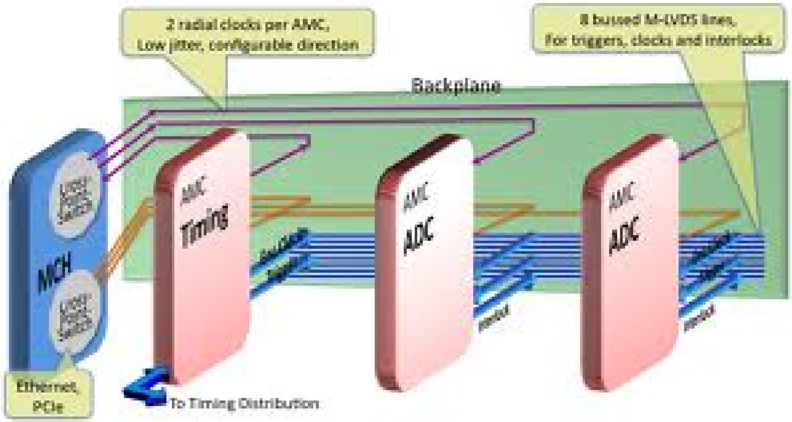
µTCA



Pin	Description	0	1
P0	Hot Swap Handle	Closed	Open
P1	Blue LED	On	Off
P2	LED1 Red	On	Off
P3	LED2 Green	On	Off
P4	MRTM Power Good# (Optional)	good	Not good
P5	MRTM Reset# (Optional)	Asserted	Not Asserted
P6	MRTM Enable# (Optional)	Enabled	Disabled
P7	EEPROM Write Protect (Optional)	Write enable	Protected

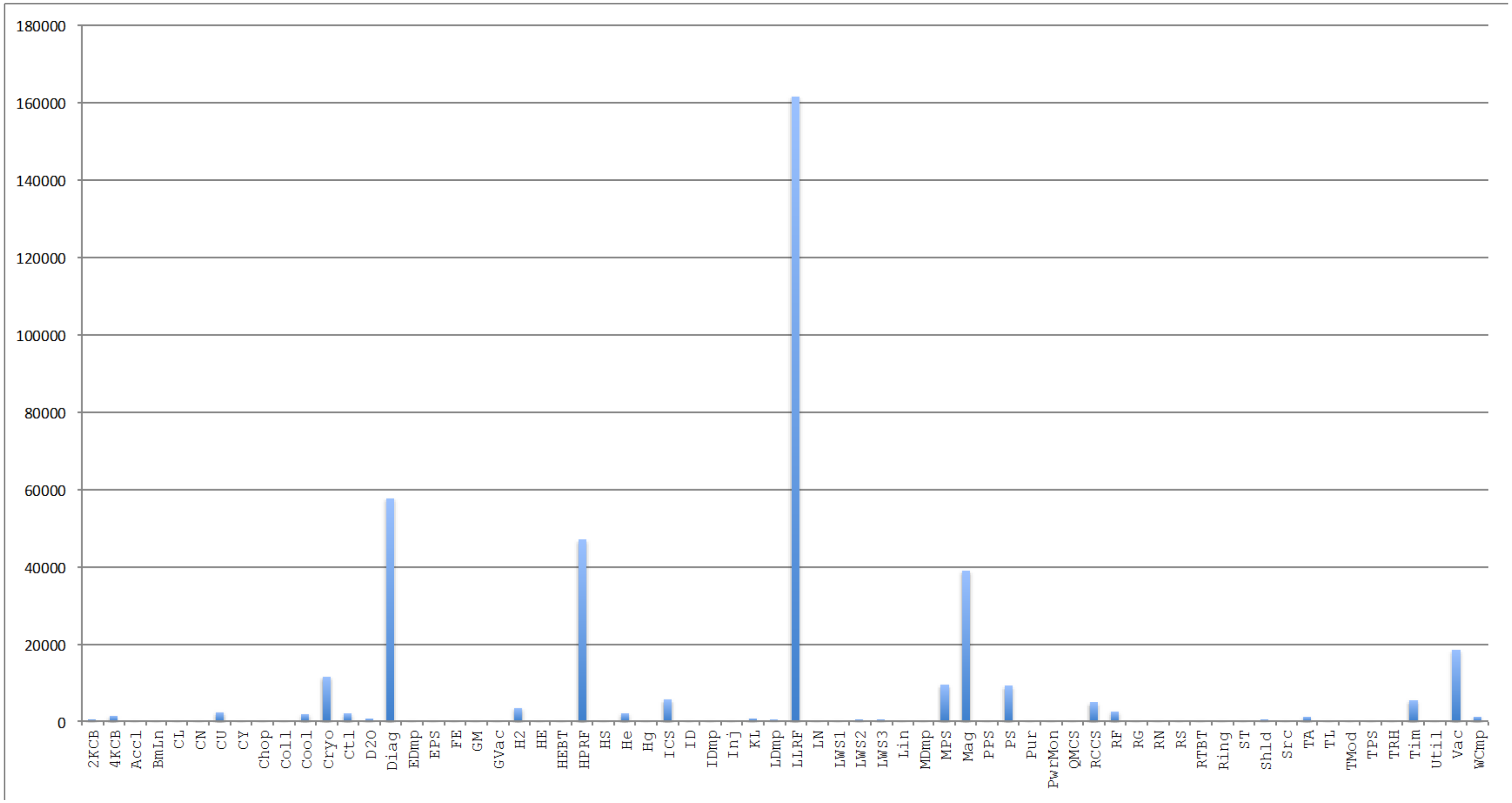
I/O pin assignment of the 8574 I/O extender





Compoñentes software

SNS ten arredor de 405K sinais, 160K so para LLRF.
ESS (estimación): 1M sinais



Cortesia de Karin Rathsman

Compoñentes software: Configuration Management

Configuration Management aborda a recollida, almacenamento e distribución de datos estáticos que se necesitan antes de acender a máquina. Poden ser:

1. Repositorios de datos (RDBs ou outros)
2. Ferramentas Software

- Diseño de datos
    - Diagramas ER
- Ferramentas de administración (MySQL admin app)
    - Browsing GUI
    - Views
    - Performance monitors
- Ferramentas básicas de usuario
    - APIs para aplicacións
        - One example is OpenXAL
        - JDBC/ODBC
        - Other xml
    - Tradución RDB -obxectos(Hibernate?)
    - Browsing GUI

Controls Configuration Database (CCDB):

Static, physical attributes of the devices in the scope of the ICS

Cable Database:

Static information relevant to cables and connections

Lattice Database (BLED):

This is an import of the simulation using Tracewin and additional elements from Beam Diagnostics.

Device Configuration Database (DCDB):

The configurations files for the EPICS IOC's, PLC integration.

Unit Conversion Database:

Standard unit conversion algorithms

Compoñentes software: Servicios

Application
Archiver
Save and Restore
Alarms
Logger
EPICS Gateway
Post Mortem
Logbook
Access Control
Video
Data feed forward
On demand data acquisition
Traveler

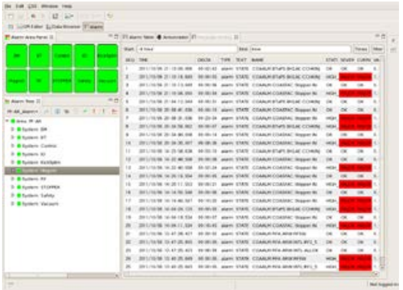
Productos para cada aplicación (dunha forma iterativa):

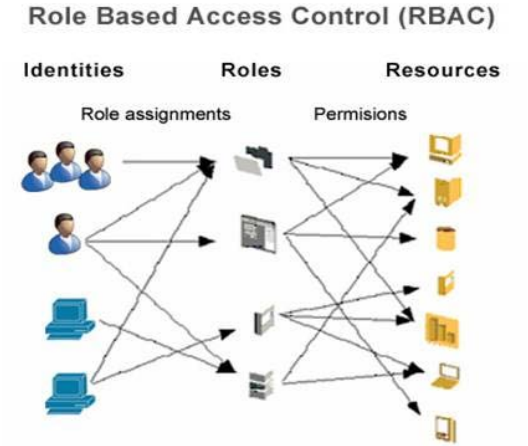
- Requerimentos
- Selección de candidatos/ferramentas
- Deseño/prototipo
- Progamación
- Probas unitarias
- Integración
- Probas de sistema
- Desplegamento

Algúns detalles sobre servicios

Short Term Archiving

Alarms





Long Term Archiving

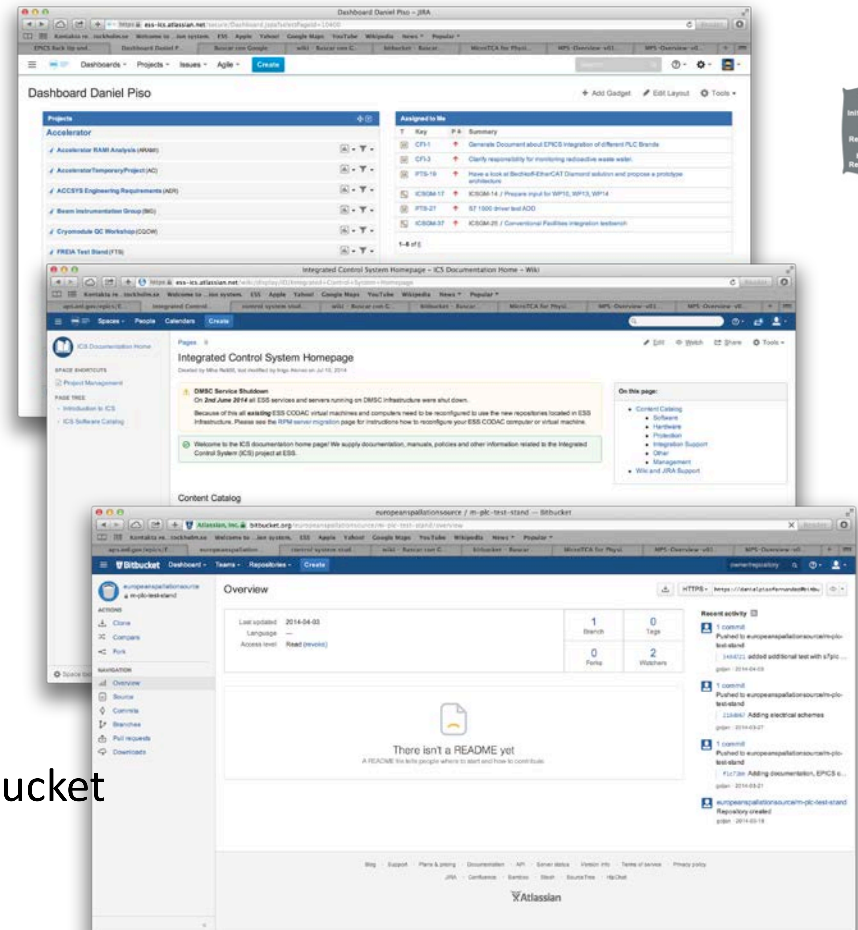
Compoñentes software: Entorno de desenvolvemento e aplicacións de alto nivel

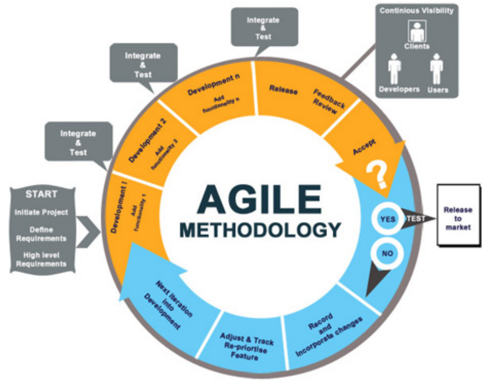
Ferramentas de Atlassian

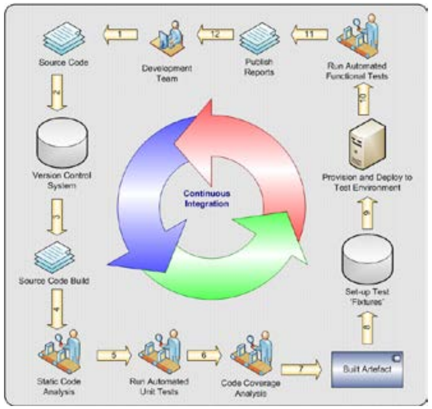
Jira

Wiki

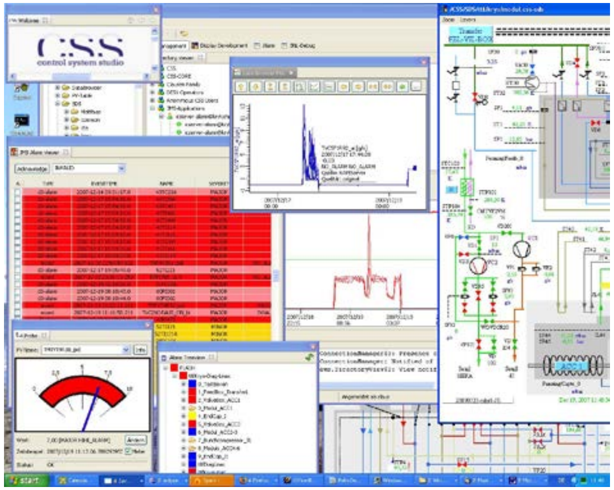
Bit-Bucket





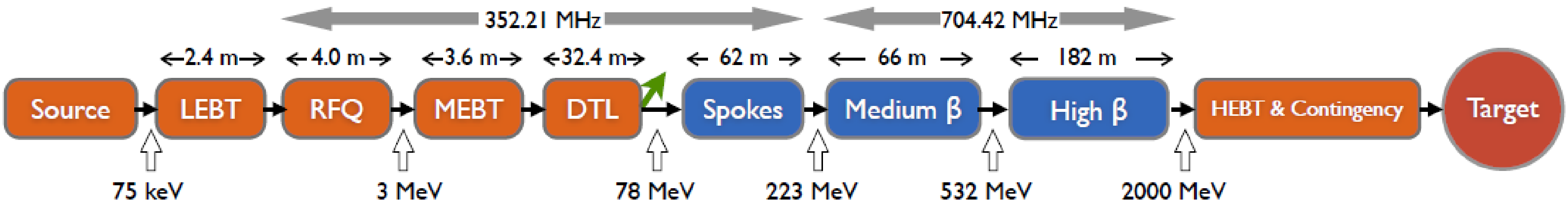


Aplicacións de alto nivel



Requerimentos do Sistema de Timing

- Parámetros do acelerador para o Sistema de Timing
  - Frecuencia Front-end é 352 MHz (CERN Standard)
  - A frecuencia da sección de alta enerxía é704 MHz
  - Oscilador Maestro a 88 MHz
    - (Tamén podería ser dividido de 352 MHz)
  - Repetición 14 Hz
    - Dictatado polos ‘neutron choppers’
    - Non se necesita sincronización coa AC (ou iso nos dín…)
  - A Repetición debe de ser programable
    - Non hat pulsado de RF cando non hai feixe (consumo de potencia)
    - Algúns dispositivos necesitan ‘triggers’ a 14 Hz

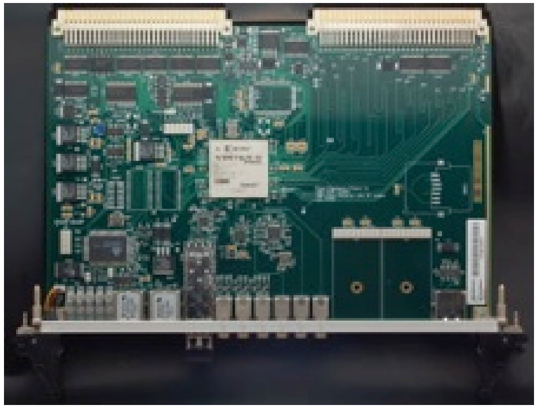


Requerimentos do Sistema de Timing

- Requerimentos típicos para un acelerador pulsado
  - 'Triggering' de dispositivos
  - Adquisición e manexo de datos síncrona
    - Pulsos largos significa moitos datos por pulso!
  - Distribución de parámetros do feixe
    - Modo da máquina: a dónde vai o feixe (blanco, carga de tunning)
    - Modo do feixe: intensidade do pulso, lonxitude
  - Control da Repetición
    - Pulsos aillados– se é posible
  - Marcado de tempo dos datos
  - Hai outros requerimentos de alto nivel que aínda están discutíndose.
- Os grandes retos:
  - Interfaz co sistema de protección de máquina (MPS).
  - Asegurar que os modos da máquina e do feixe son propagados a tódolos receptores.

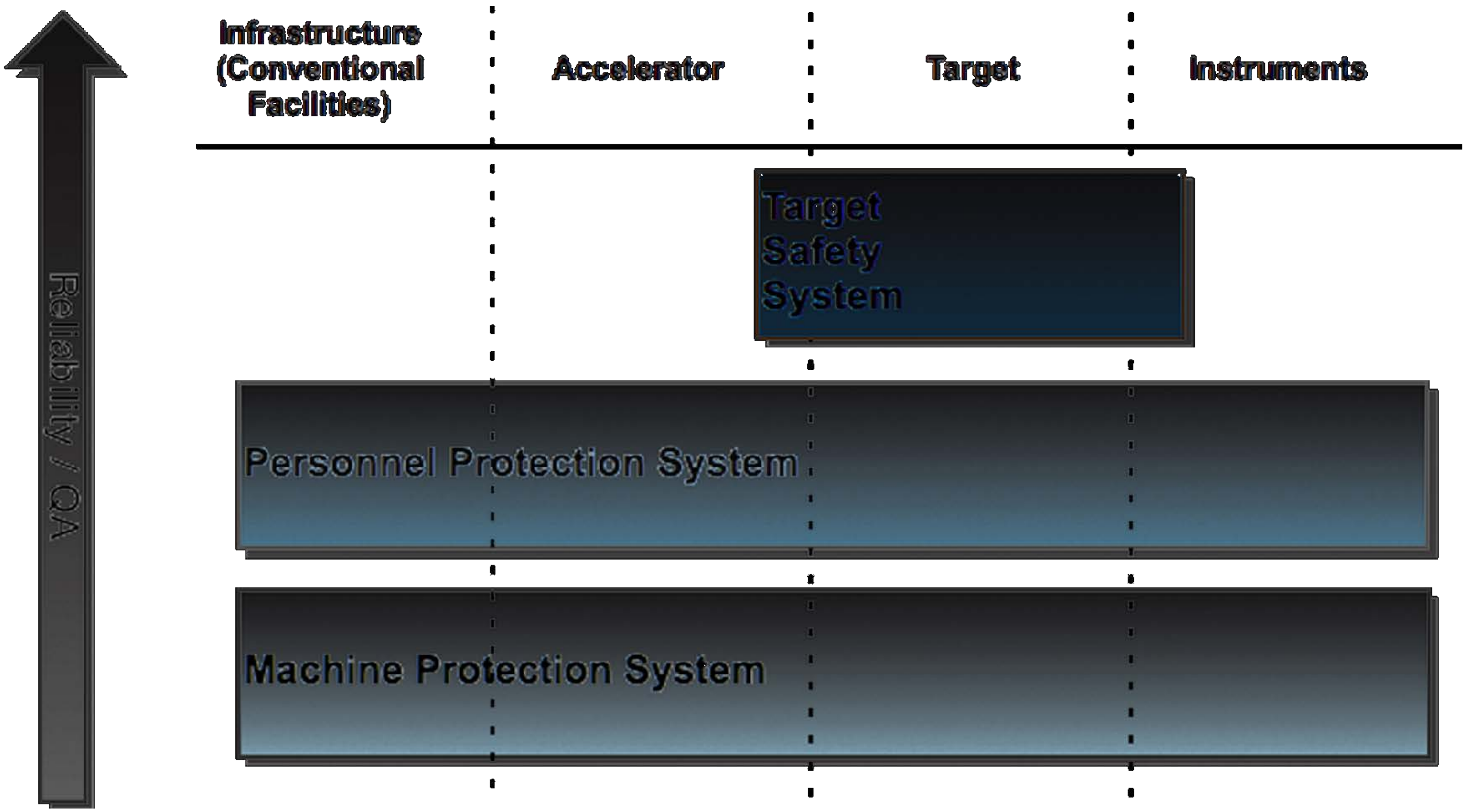
Exemplos hardware para o Timing System

- front panel RF input and programmable divider /1, /2, /3, ..., /12, /14, ..., /20
- bit rate 1.0 Gbps to 2.5 Gbps, event clock rate 50 MHz to 125 MHz
- front panel mains synchronization TTL input (ACIN)
- two front panel TTL inputs
- six front panel TTL outputs
- two universal I/O slots
- rear I/O

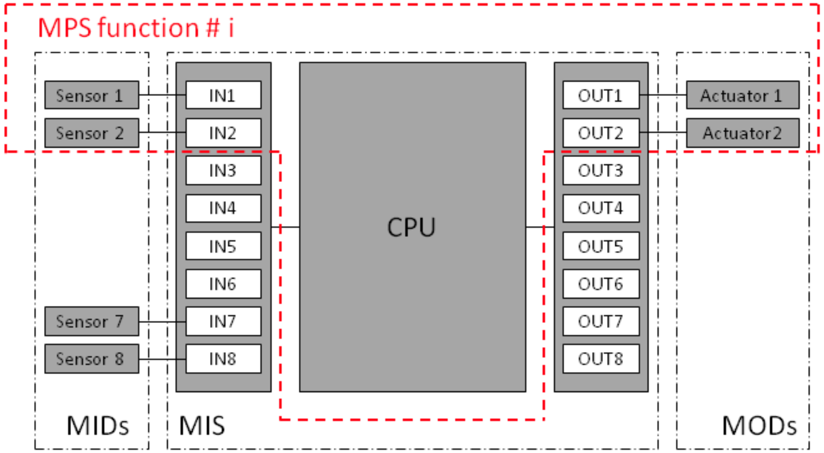


- bit rate 1.0 to 2.5 Gbps, event clock rate 50 MHz to 125 MHz
- four programmable front panel TTL outputs
- two front panel TTL inputs
- three differential CML pattern outputs capable of RF recovery
- two universal I/O slots
- rear I/O
- jitter typically < 15 ps rms for TTL outputs, < 5 ps rms for CML outputs

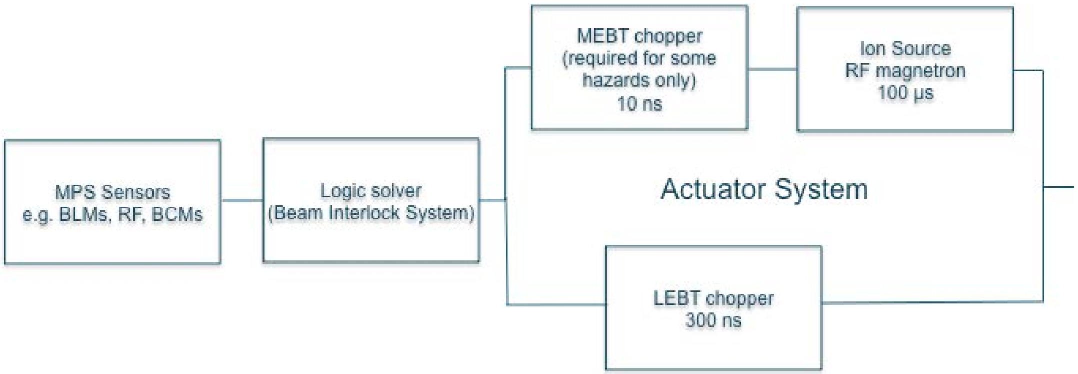
Compoñentes de protección e seguridad



Sistema de protección de máquina



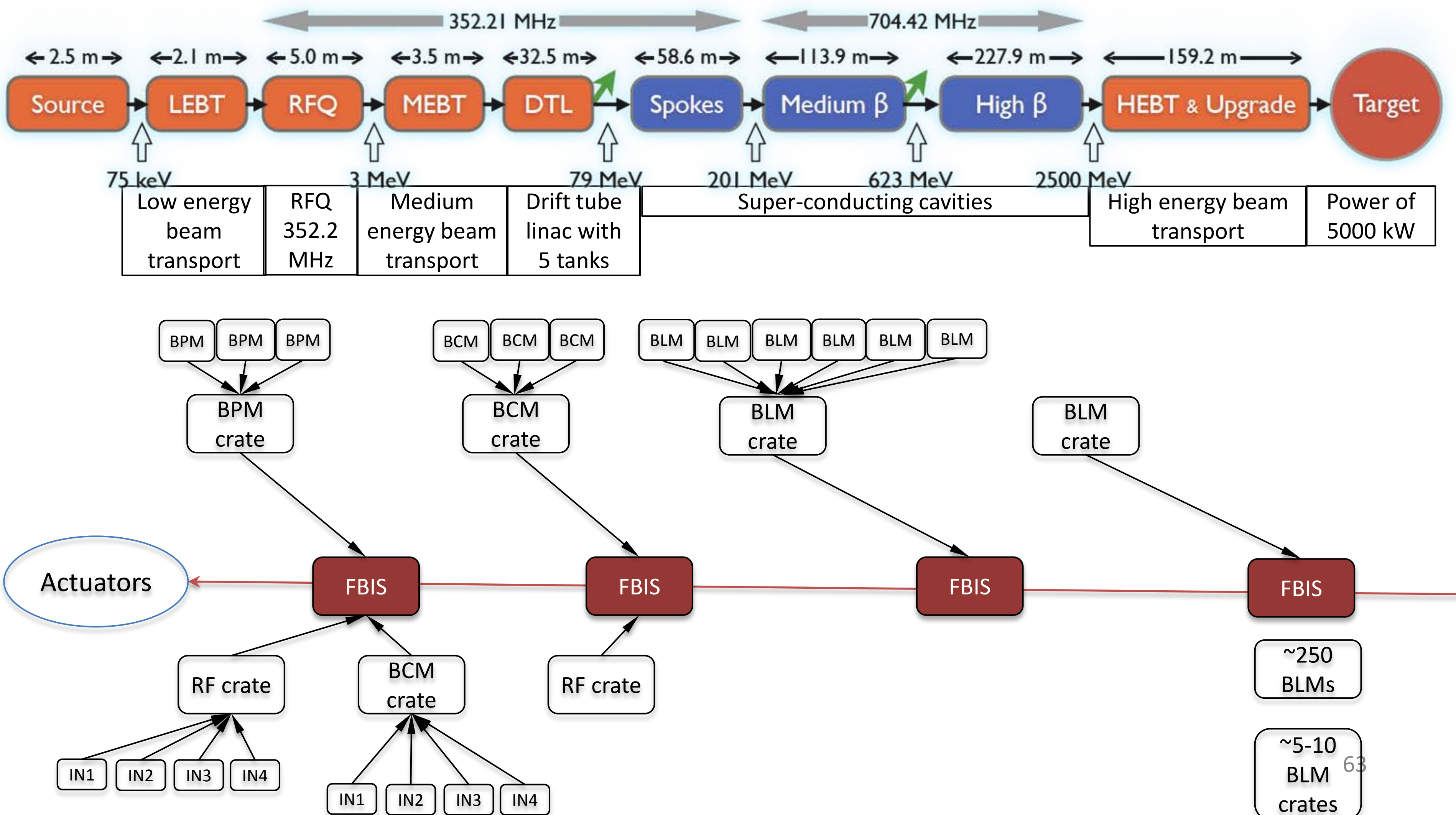
O tempo de resposta mais rápido requerido a MPS é de **10 µsecs.** (sensor+ BIS+ actuador para cada función MPS)



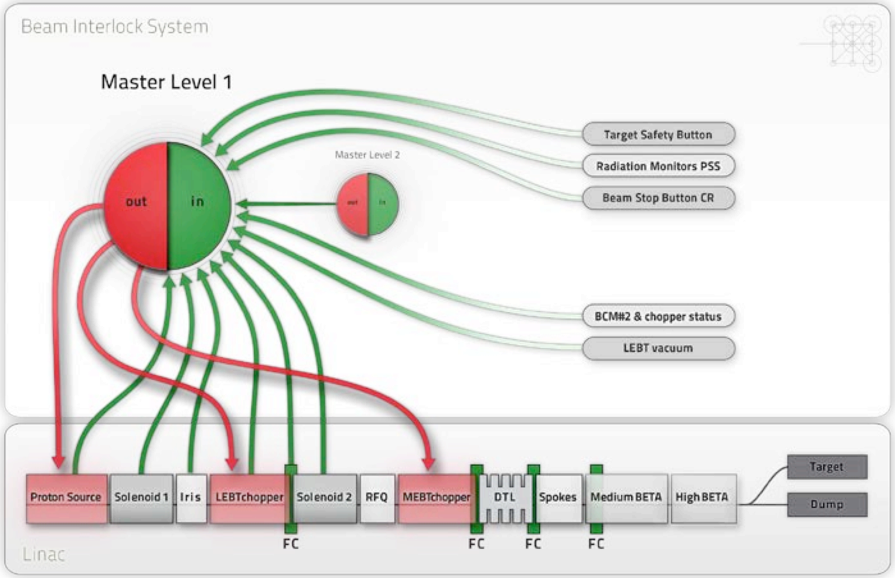
Duas mitigacións differentes:

- **Intra-pulse** (dentro dun pulso):interrupción rápida do feixe
- **Inter-pulse** (entre pulsos):permite o pulso actual pero inhibe os n seguintes pulsos

Fast Beam Interlock System (FBIS)

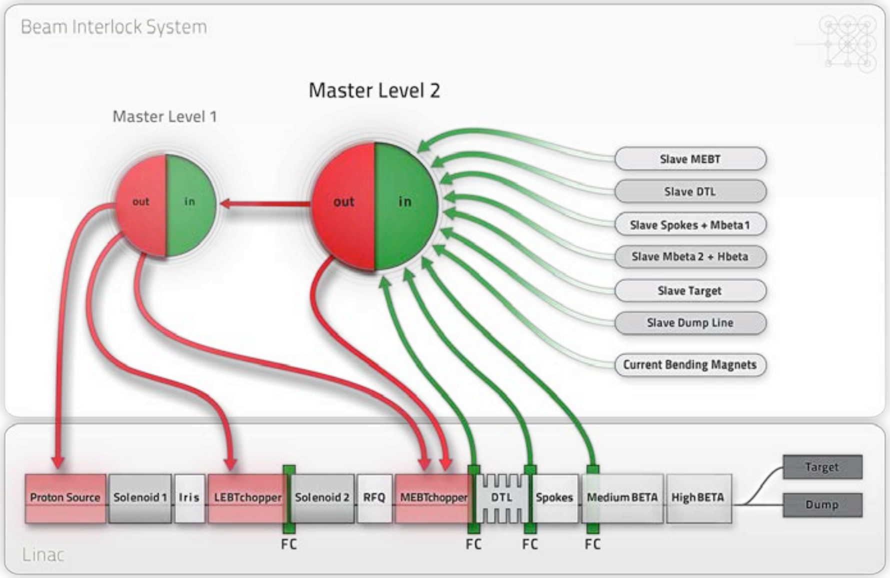


Fast Beam Interlock System (FBIS)….e dous



- **MPS** ten que protexer a maquina
- **MPS** ten que protexer o feixe
- **MPS** ten que proporcionar informacion en caso de situación de emerxencia

- Automatización de procesos para alcanzar alta fiabilidade/dispoñibilidade:
  - Carga de modos de operación
  - Self-testing da funcionalidade
  - Chequeo da conectividade con sensores/actuadores

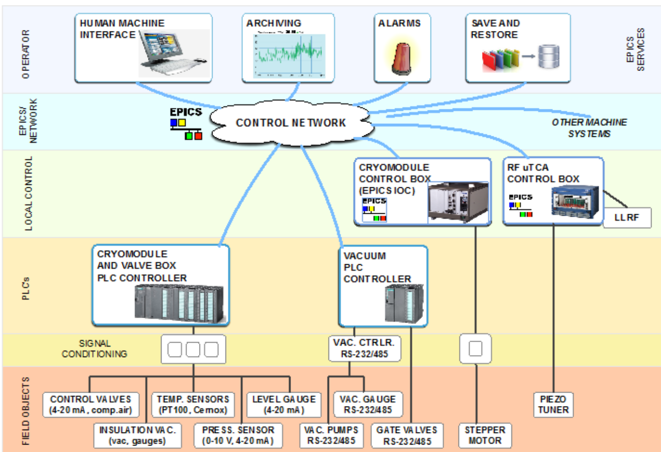


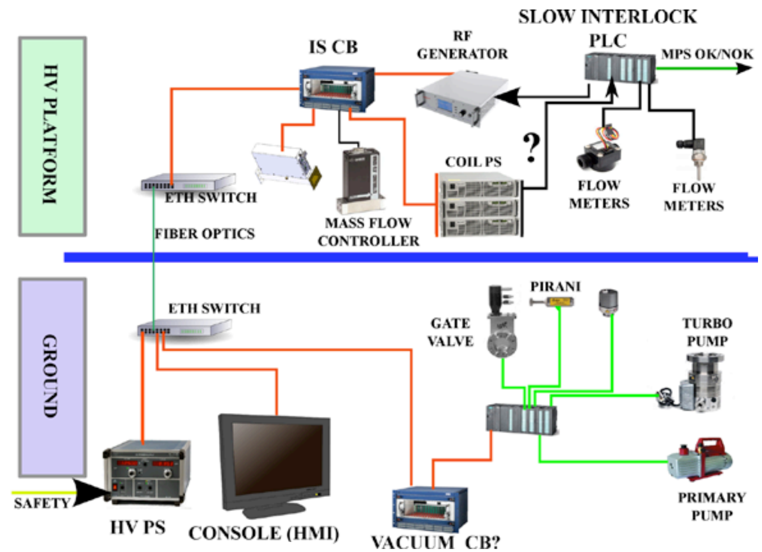
E por último....Integracion!

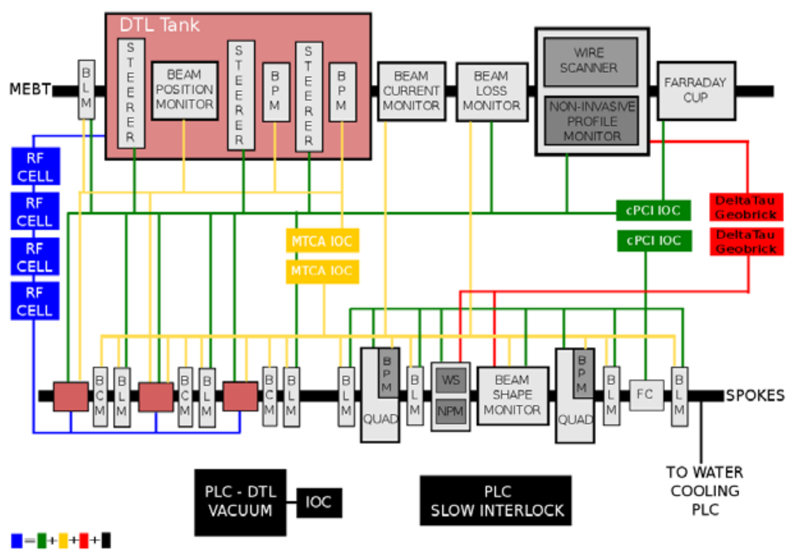
- Producto final
  - Control local para subsistemas
  - Soporte hw/sw para subsistemas
  - HMIs de enxeñaría e expertas
  - Integración co sistema de Timing
- Garantías
  - Os subsistemas e dispositivos deben de ser capaces de operar ailladamente
  - Pero, deben contribuir a unha funcionalidade global (operación da máquina)

- Obxectivo/Vision
  - Acadar unha abstracción dos subsistemas como una colección de variables EPICS que permita operación e monitorización.
  - Acceso remoto a tódolos parámetros locais e tódolos datos relevates para operación e mantenemento da máquina.
  - Os datos almacenados deben permitir correlación de eventos ó longo da máquina
- Estratexia
  - A máquina é xigante- deseño para uniformidae
  - Interfaces a sistemas locales iguais ten que ser igual
    - DAQ , fontes de potencia, control de movemento, imaxes, ...
  - Proporcionar datos de subsistemas/e dispositivos sempre da mesma maneira
  - Manter ó mínimo o numero de compoñentes HW
  - Manter ó mínimo o nùmero de compoñente SW
  - Concentración en documentación e soporte a desenvolvedores e integradores

Integración....e último







Graciñas!!,

Preguntas?