

# ESS – Status and Prospects

Ciprian Plostinar,  
on behalf of ESS Accelerator Collaboration

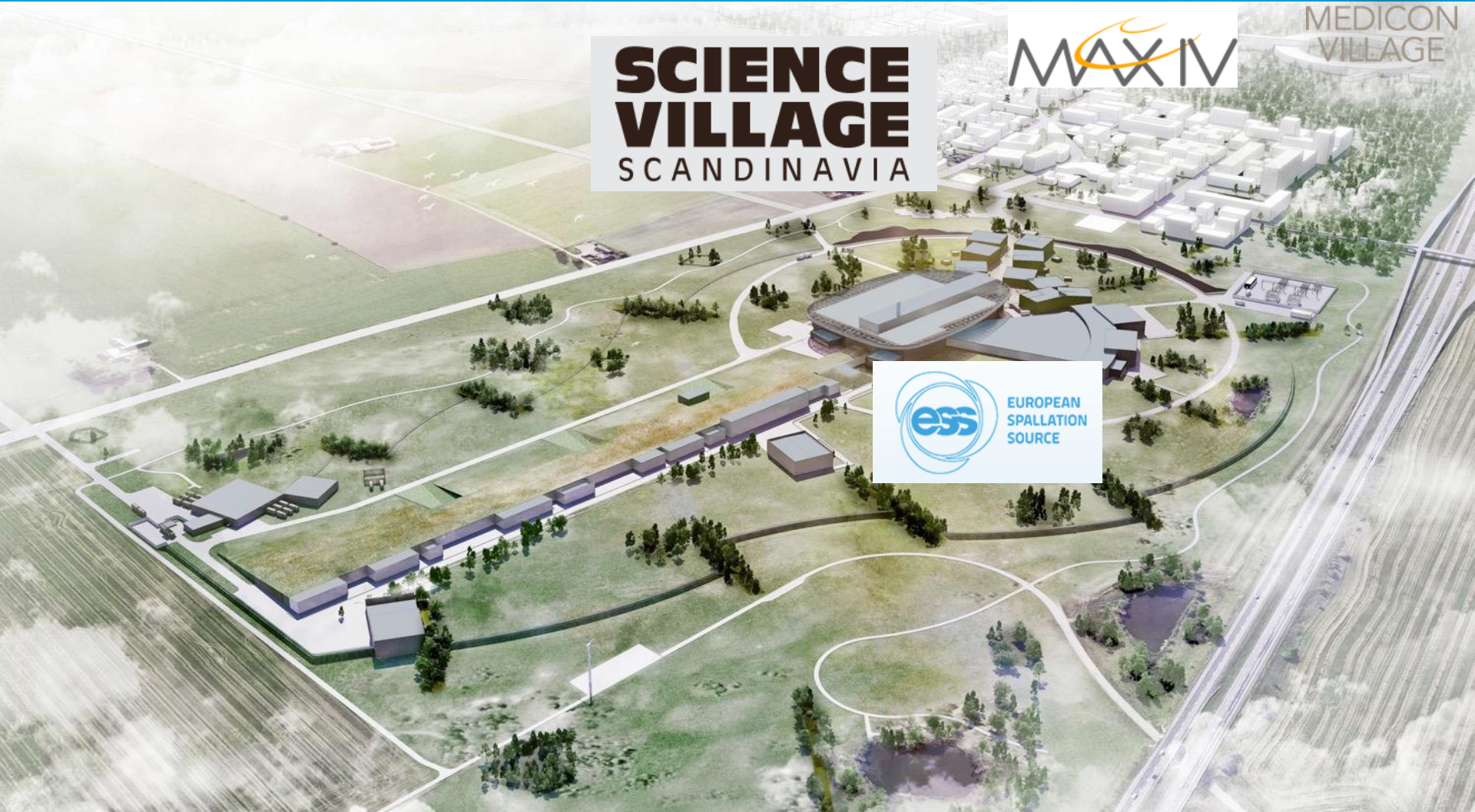
‘The Future and Next Generation Capabilities of Accelerator  
Driven Neutron and Muon Sources’ Workshop

RAL, 14 August 2018

[www.europeanspallationsource.se](http://www.europeanspallationsource.se)

- The ESS Project
- Recent Accelerator Highlights
- The New Baseline
- Some Lessons Learned (so far)

# A European Research Centre



**SCIENCE  
VILLAGE**  
SCANDINAVIA

MAX IV

MEDICON  
VILLAGE





# ESS Design

## High Power Linear Accelerator:

- Energy: 2 GeV
- Rep. Rate: 14 Hz
- Current: 62.5 mA

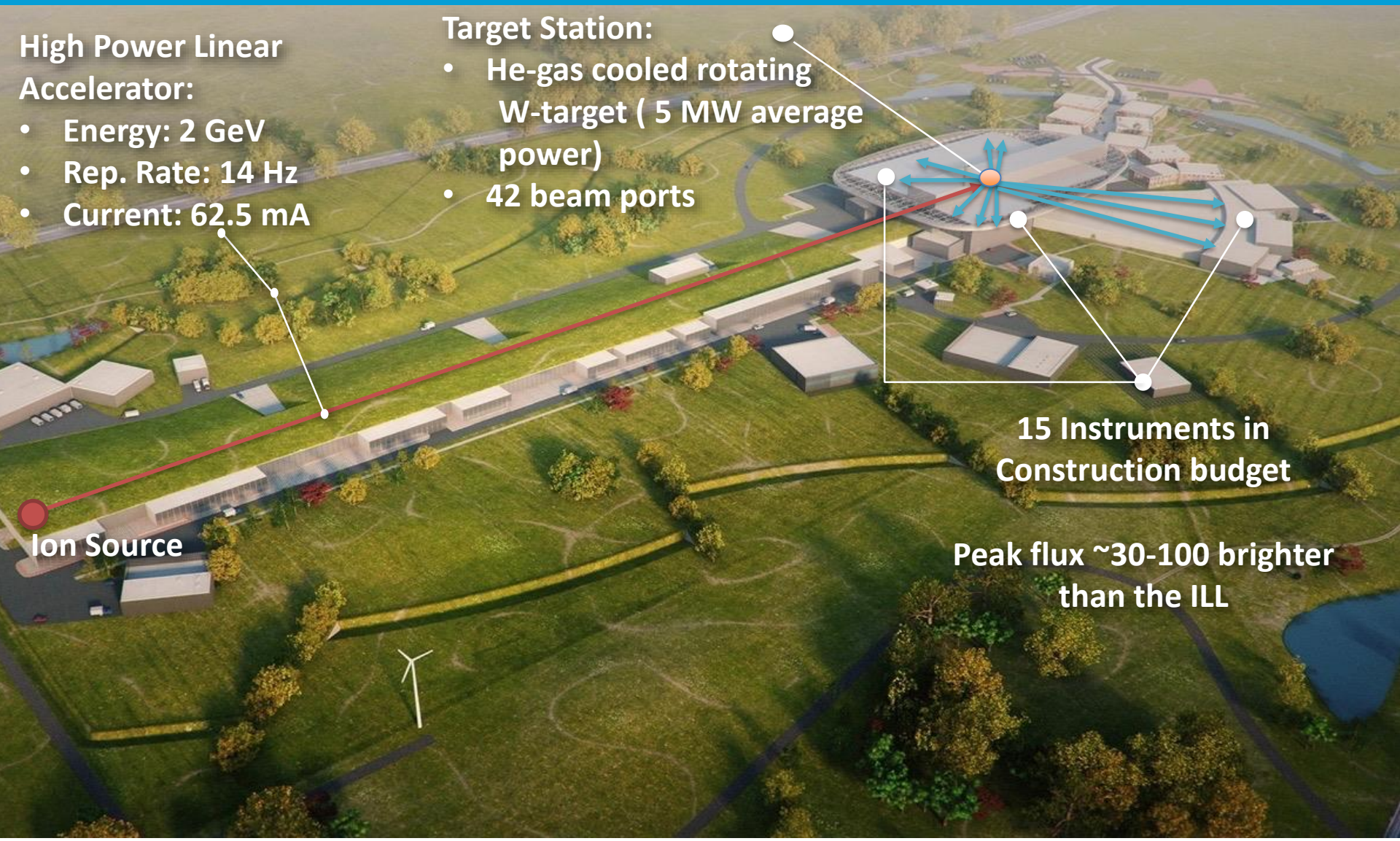
## Target Station:

- He-gas cooled rotating W-target ( 5 MW average power)
- 42 beam ports

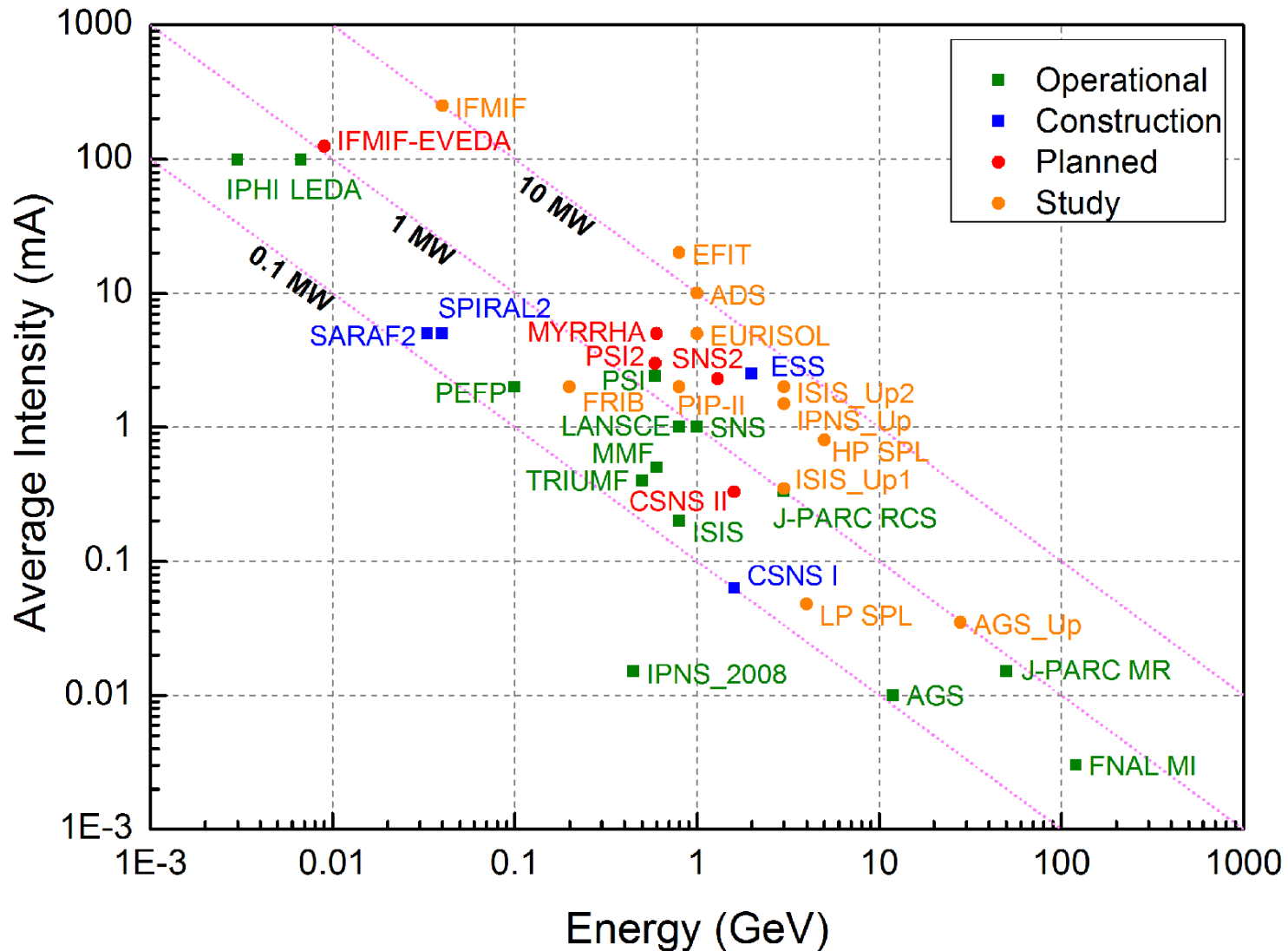
Ion Source

15 Instruments in Construction budget

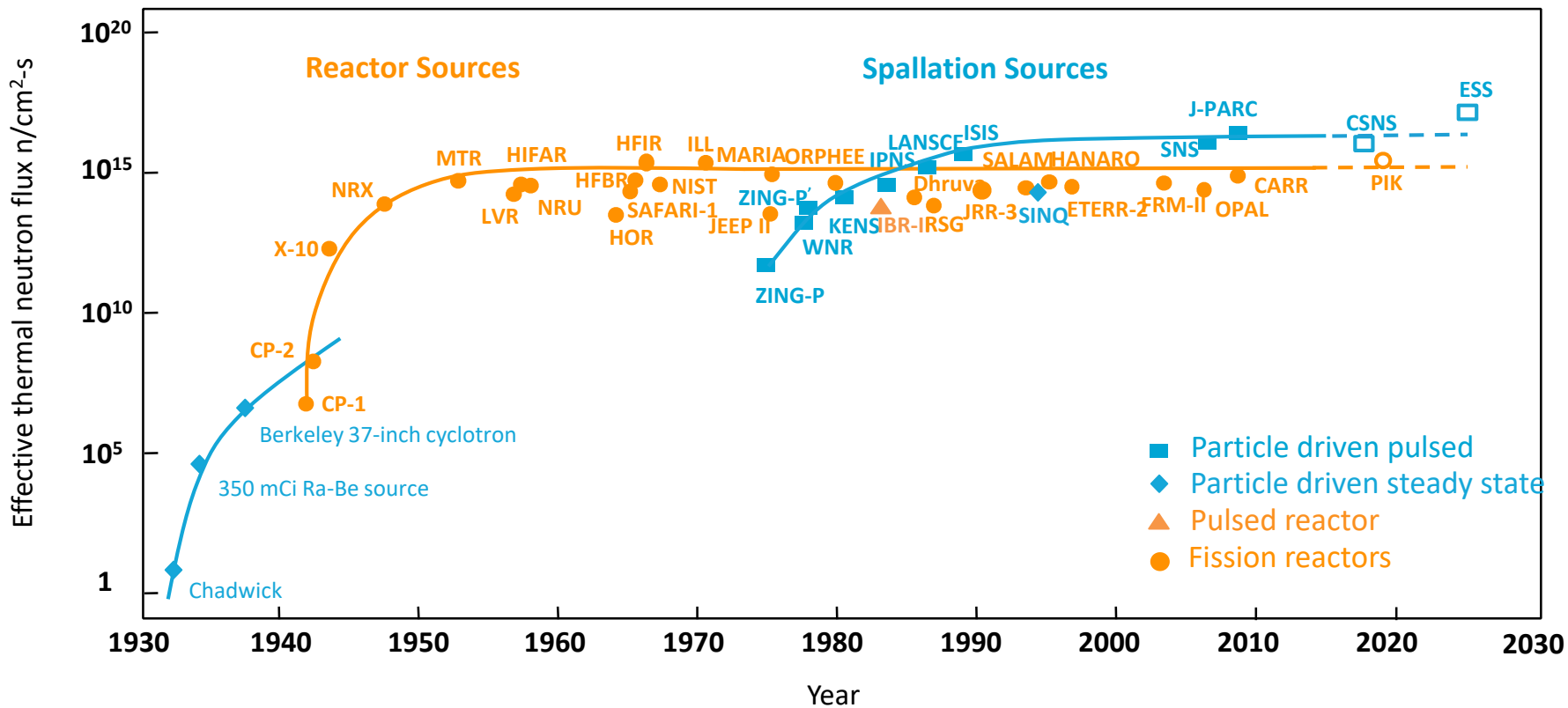
Peak flux ~30-100 brighter than the ILL



# High Power Machines










































































# Neutron Facilities











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

# Science Drivers for the Reference Instrument Suite

Large-Scale Structures	Multi-Purpose Imaging ODIN	    
	General-Purpose SANS SKADI	   
	Broadband SANS LOKI	 
	Surface Scattering	   
	Horizontal Reflectometer FREIA	  
	Vertical Reflectometer ESTIA	   
Diffraction	Thermal Powder Diffractometer HEIMDAL	   
	Bispectral Powder Diffractometer DREAM	   
	Monochromatic Powder Diffractometer	  
	Materials Science Diffractometer BEER	 
	Extreme Conditions Diffractometer	  
	Single-Crystal Magnetism Diffractometer MAGICS	 
	Macromolecular Diffractometer NMX	 

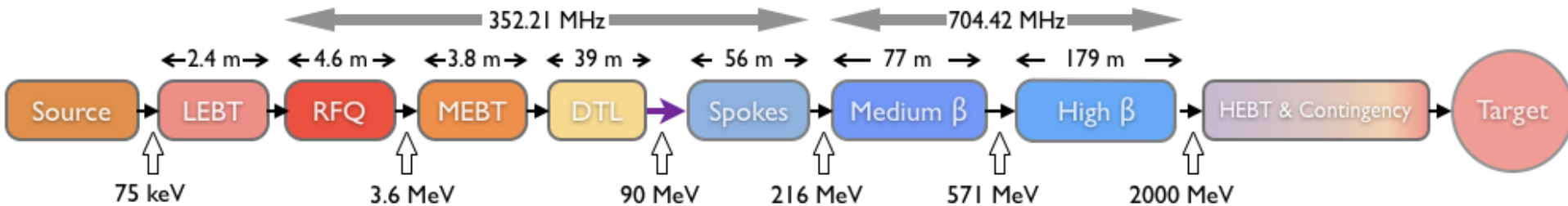
Spectroscopy	Cold Direct Geometry Spectrometer C-SPEC	  
	Wide Bandwidth Direct Geom. Spectrometer VOR	   
	Bispectral Direct Geometry Spectrometer TREX	  
	Cold Crystal-Analyser Spectrometer CAMEA	   
	Vibrational Spectrometer VESPA	  
	Backscattering Spectrometer MIRACLES	  
	High-Resolution Spin-Echo	   
	Wide-Angle Spin-Echo	   
	Fundamental & Particle Physics	

Courtesy of A. Hies

	life sciences		magnetism & superconductivity
	soft condensed matter		engineering & geo-sciences
	chemistry of materials		archeology & heritage conservation
	energy research		fundamental & particle physics



# The European Spallation Source



<b>Ion Species</b>	Protons	
<b>Output Energy</b>	2	GeV
<b>Frequency</b>	352.21/704.42	MHz
<b>Pulse Length</b>	2.86	Ms
<b>Peak Current</b>	62.5	mA
<b>Protons per Pulse</b>	$1.1 \times 10^{15}$	
<b>Repetition Rate</b>	14	Hz
<b>Duty Cycle</b>	4	%
<b>Average Beam Power</b>	5	MW
<b>Accelerating Structures</b>	RFQ, DTL, SC Spokes/Elliptical	
<b>Accelerator Length</b>	~365	m

	Length (m)	W <sub>in</sub> (MeV)	F (MHz)	$\beta$ Geometric	No. Sections	T (K)
LEBT	2.38	0.075	--	--	1	~300
RFQ	4.6	0.075	352.21	--	1	~300
MEBT	3.81	3.62	352.21	--	1	~300
DTL	38.9	3.62	352.21	--	5	~300
LEDP + Spoke	55.9	89.8	352.21	0.50 (Optimum)	13	~2
Medium Beta	76.7	216.3	704.42	0.67	9	~2
High Beta	178.9	571.5	704.42	0.86	21	~2
Contingency	119.3	2000	704.42	(0.86)	14	~300 / ~2

- Construction scope: 1.3 GeV with 11 powered High  $\beta$  cryomodules (44 x 1.5 MW klystrons)
- Nominal scope: 2 GeV with 10 more powered High  $\beta$  cryomodules (+40 x 1.5 MW klystrons)

# ESS Partners

Aarhus University

Atomki - Institute for Nuclear Research

Bergen University

CEA Saclay, Paris

Centre for Energy Research, Budapest

Centre for Nuclear Research, Poland, (NCBJ)

CNR, Rome

CNRS Orsay, Paris

Cockcroft Institute, Daresbury

Elettra – Sincrotrone Trieste

ESS Bilbao

Forschungszentrum Jülich

Helmholtz-Zentrum Geesthacht

Huddersfield University

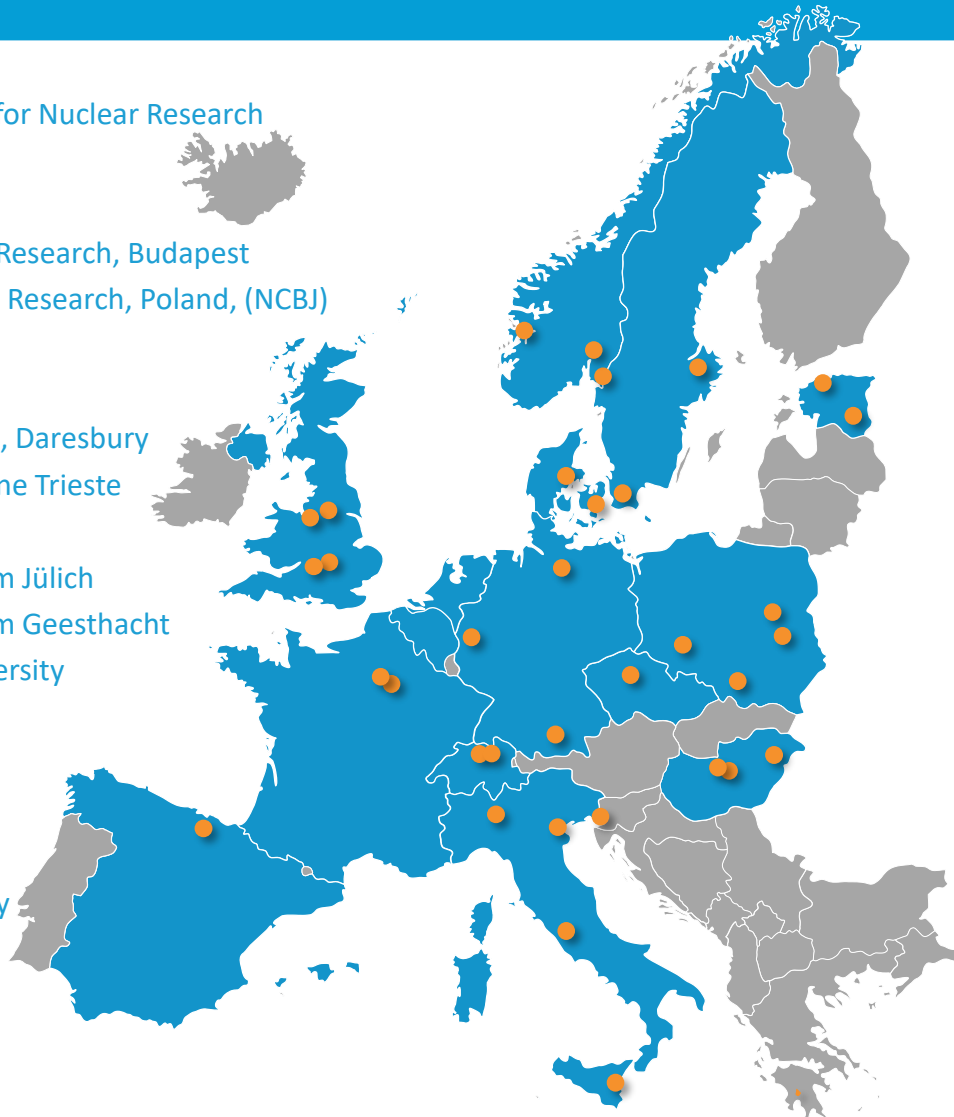
IFJ PAN, Krakow

INFN, Catania

INFN, Legnaro

INFN, Milan

Institute for Energy  
Research (IFE)



ISIS - Rutherford-Appleton Laboratory, Oxford

Laboratoire Léon Brillouin (LLB)

Lund University

Nuclear Physics Institute of the ASCR

Oslo University

Paul Scherrer Institute (PSI)

Polish Electronic Group (PEG)

Roskilde University

Tallinn Technical University

Technical University of Denmark (DTU)

Technical University Munich (TUM)

Science and Technology Facilities Council

University of Copenhagen (KU)

University of Tartu

Uppsala University

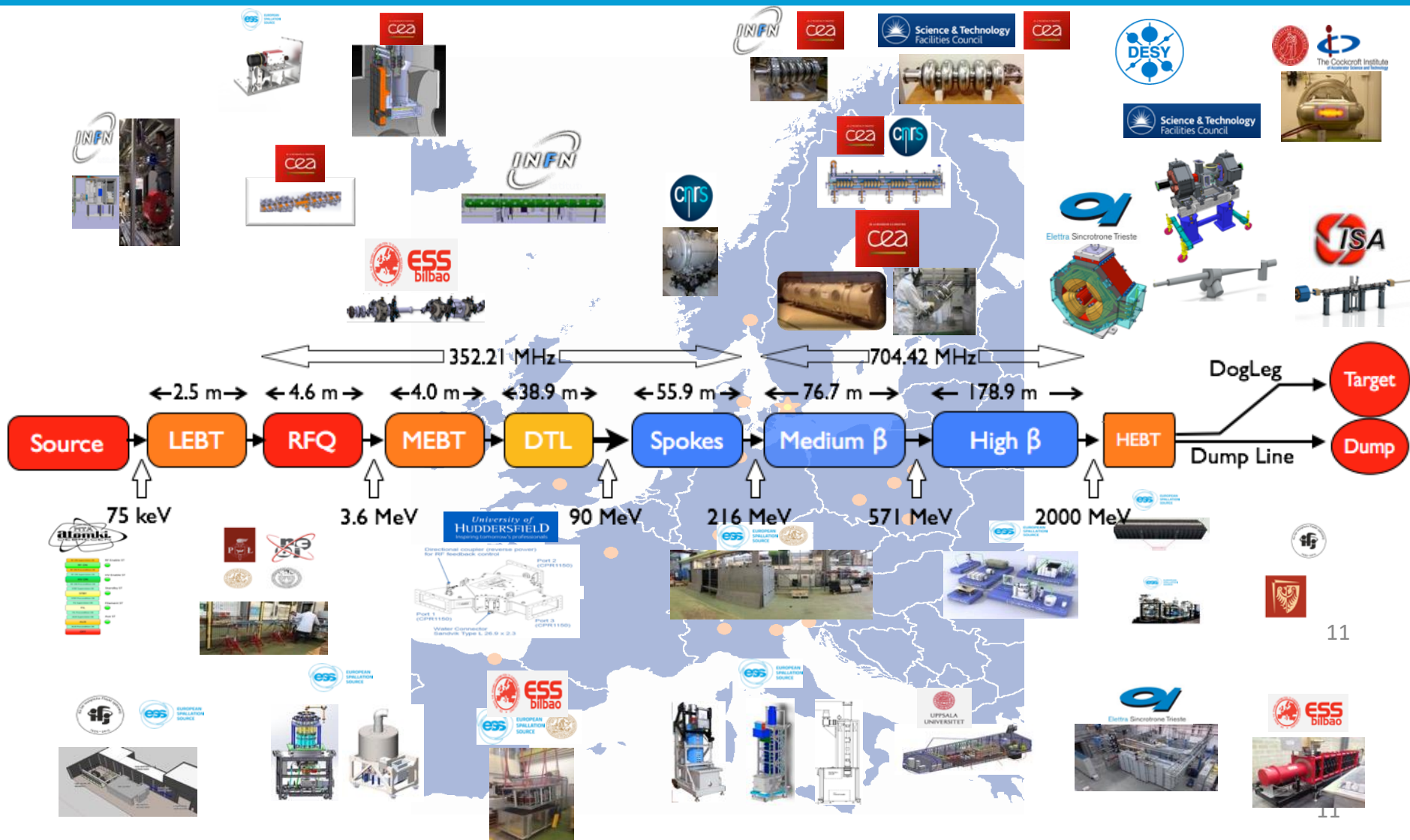
Wigner Research Centre for Physics

Wroclaw University of Technology

Warsaw University of Technology

Zurich University of Applied Sciences (ZHAW)

# Accelerator Collaboration





# Recent Highlights: Ion Source and LEBT (INFN Catania)



- Ion Source and LEBT delivered and installed – In-Kind Delivery from INFN Catania.
- Commissioning will soon begin.
- First major accelerator milestone.
- [#IonSourceAdventure](#)

# Recent Highlights: Ion Source and LEBT



# Recent Highlights: Accelerator Cryoplant



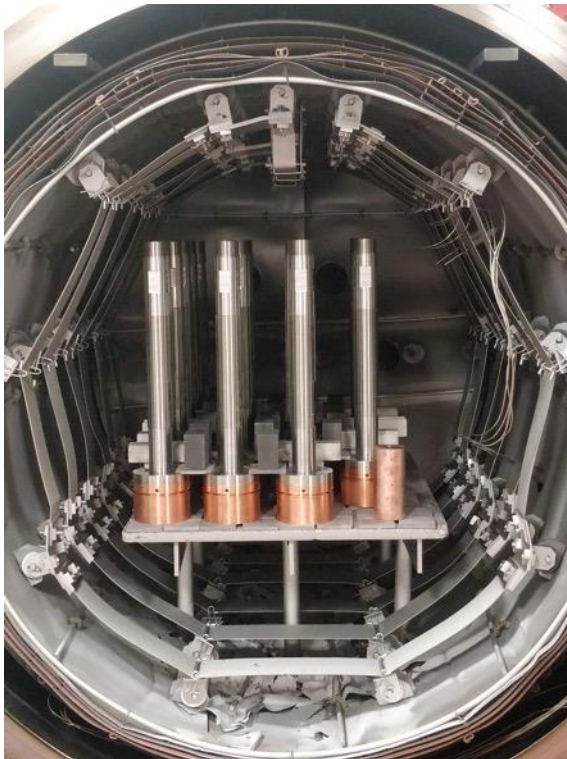
# Recent Highlights: Accelerator Cryoplant



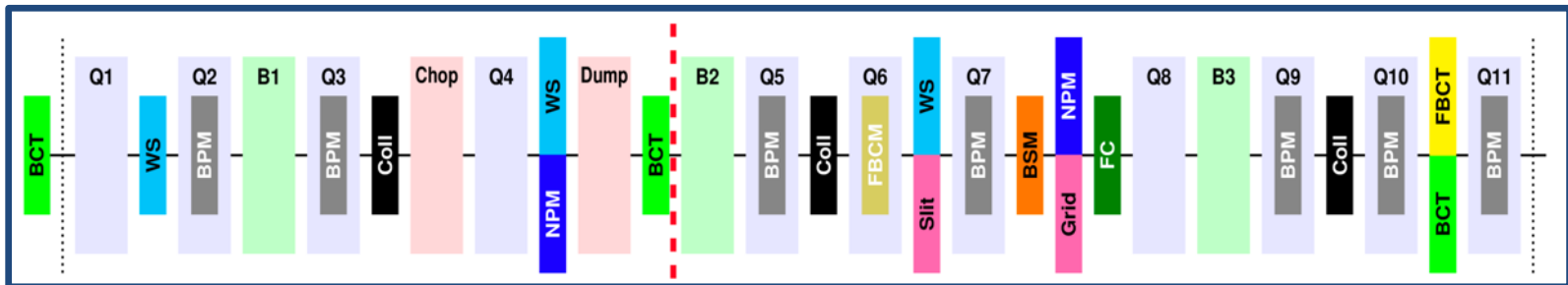


# Recent highlights – RFQ (CEA)

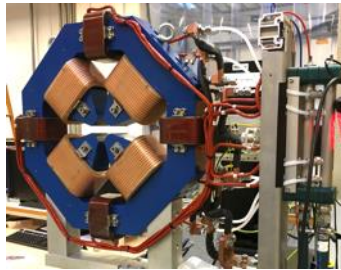
- Manufacturing underway
- Current estimated delivery is end of 2018
- Cooling skid delivered and installed



# Recent highlights – MEBT (ESS Bilbao)



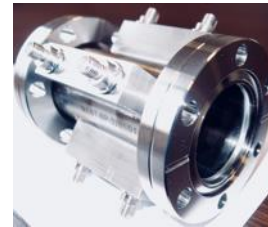
DIAGNOSTIC  
VESSELS



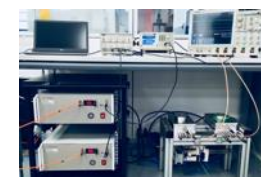
QUADRUPOLES



BUNCHERS &  
RF COUPLER



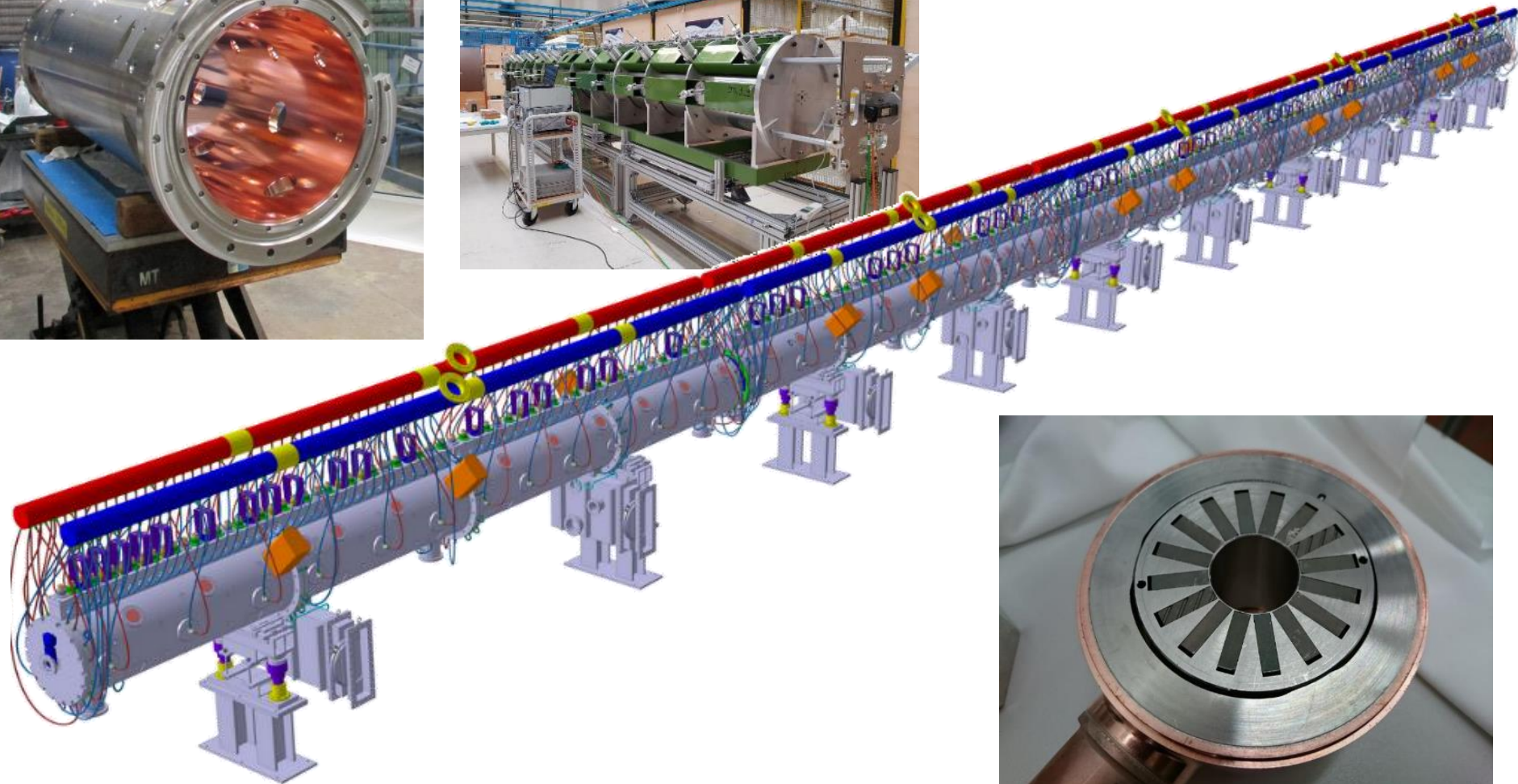
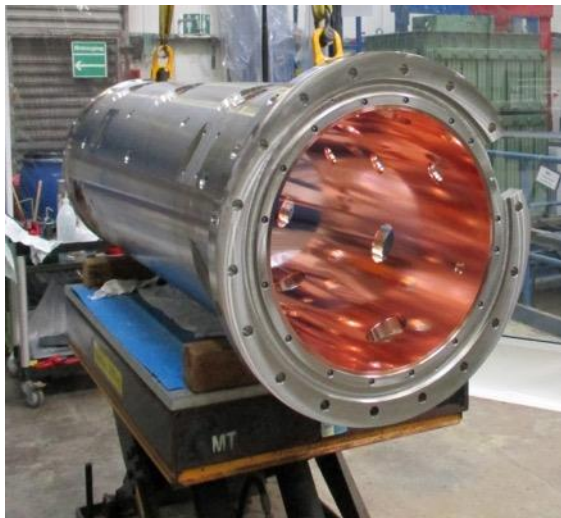
ProtonBeam  
Instrumentation



FAST CHOPPER<sup>®</sup>



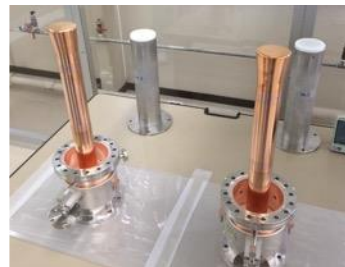
# Recent highlights – DTL (INFN Legnaro)



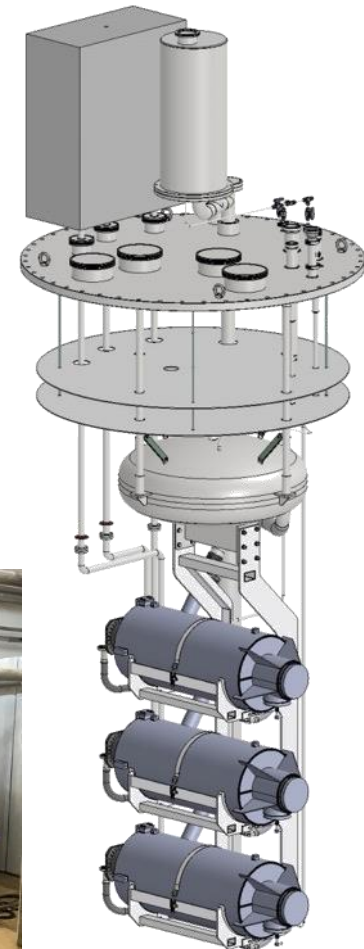
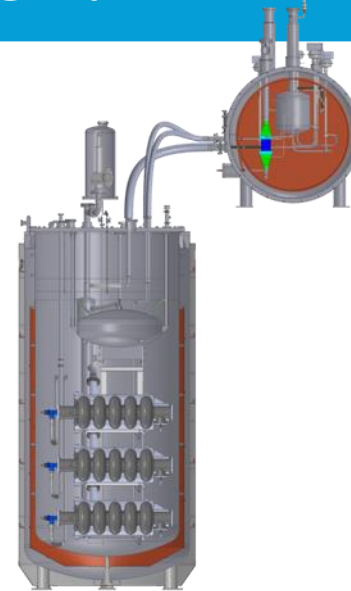
# Recent Highlights: Spokes (CNRS – IPNO)



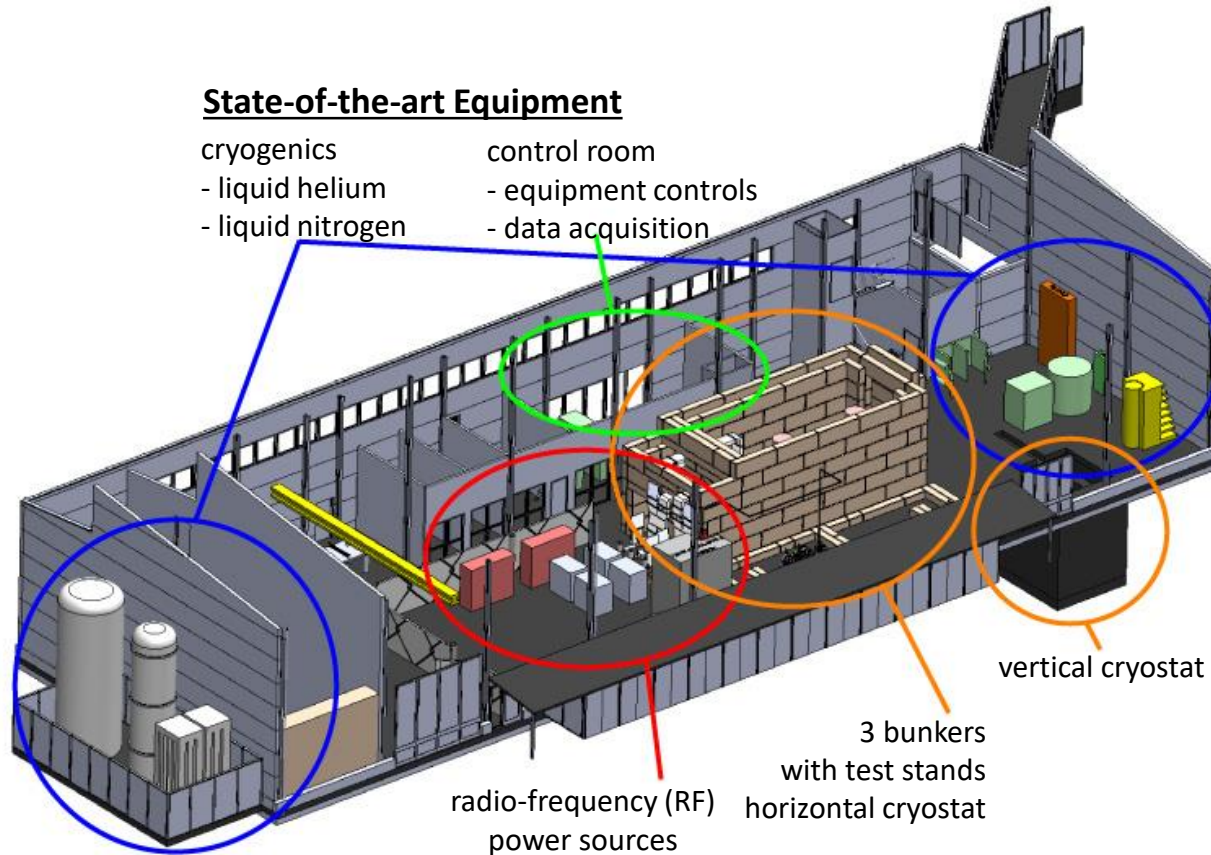
# Recent Highlights – MB Prototype Cryomodule (CEA)



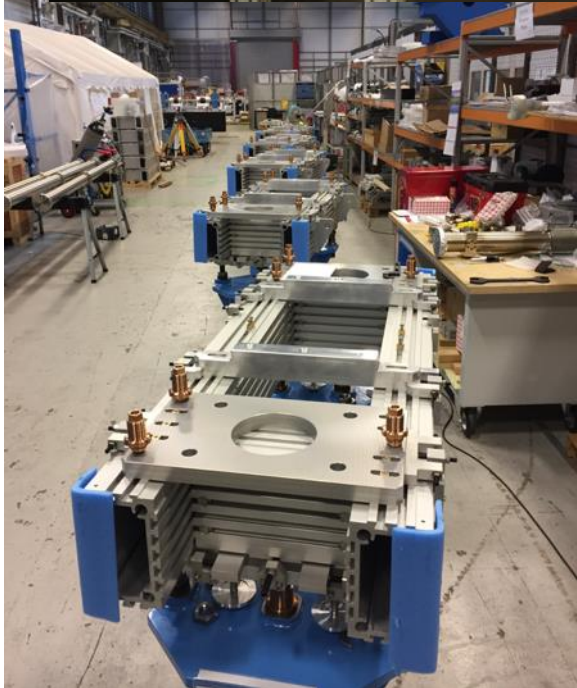
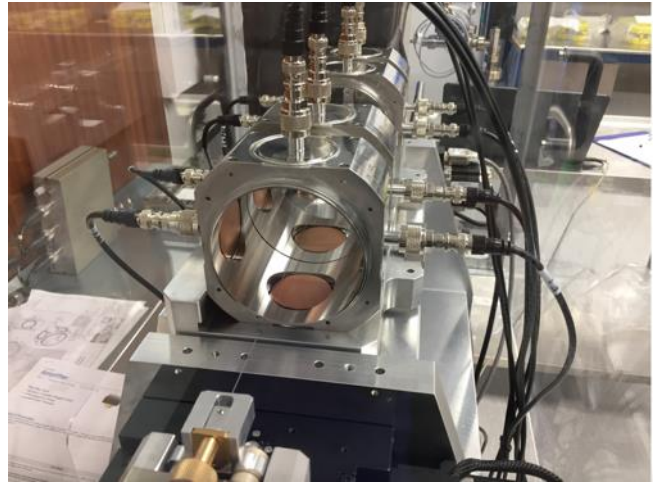
# Recent Highlights: Elliptical HB cavities: DL Vertical Test-Stand is becoming operational.



# Recent Highlights: FREIA at Upsala University Infrastructure for Spoke CM Testing is Operational



# Recent Highlights – Linac Warm Units (LWUs)





## Europa construye el acelerador de partículas más potente del mundo para viajar al interior de la materia

La fuente de neutrones de Suecia servirá para desarrollar fármacos más efectivos y nuevos materiales



NUÑO DOMÍNGUEZ 

Lund (Suecia) - 5 JUL 2018 - 20:18 CEST



NEWSLETTERS

Apúntate a nuestras newsletters

### TE PUEDE INTERESAR

Científicos del CERN insisten en que el Bosón de Higgs "hay que vivirlo" porque es una cosa "muy nuestra"



El mayor acelerador de partículas se actualiza para quintuplicar las colisiones



# 2018 Re-Baselining

- Significant delays experienced since 2013
  - Both at ESS and IK Partners (cash-flow issues, VAT issues, procurement issues, technical issues, etc.)
- We now have a much better understanding of the manufacturing and installation complexity.
- Installation sequences have been optimised.
- Many contracts have been signed and tenders launched.
- A new plan was therefore developed to reflect these changes
  - Risks for delays still exist.

# Key Assumptions

## Installation

- **In-Kind Model**
- **Ready for Installation Dates (RFI):**
  - Some contractual
  - Others “best estimate”
- **Optimised Sequence:**
  - Logic
  - Safety
  - Flexibility
- **Parallel Installation and Commissioning:**
  - Shielding Wall
  - Demanding Schedule
- **Coordinated Installation of Utilities/Services**
- **No Internal Float**

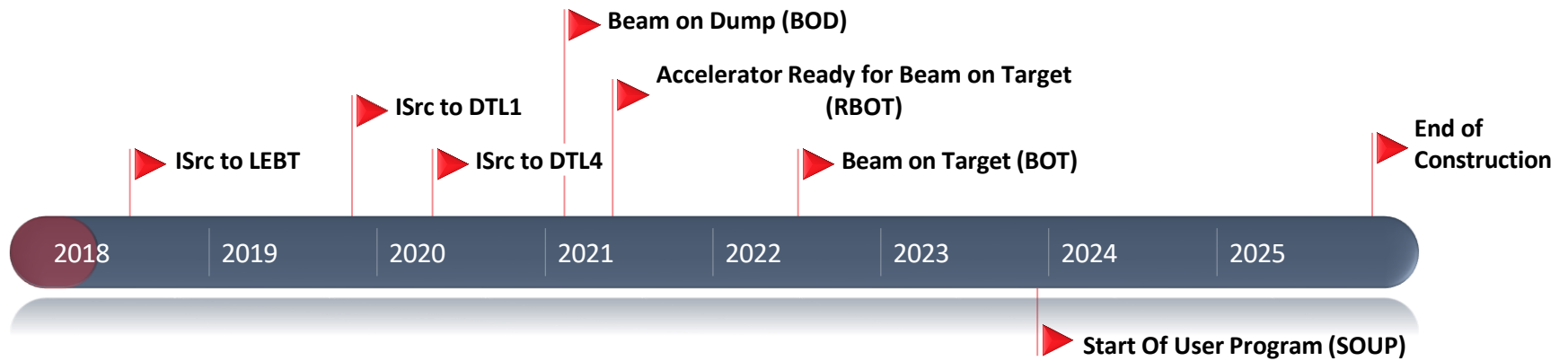
## Testing

- **Realistic time allocation**
- **Relevant Permits**
  - SSM
- **Safety Measures**
- **Correct Gateways**
  - Suitable Reviews

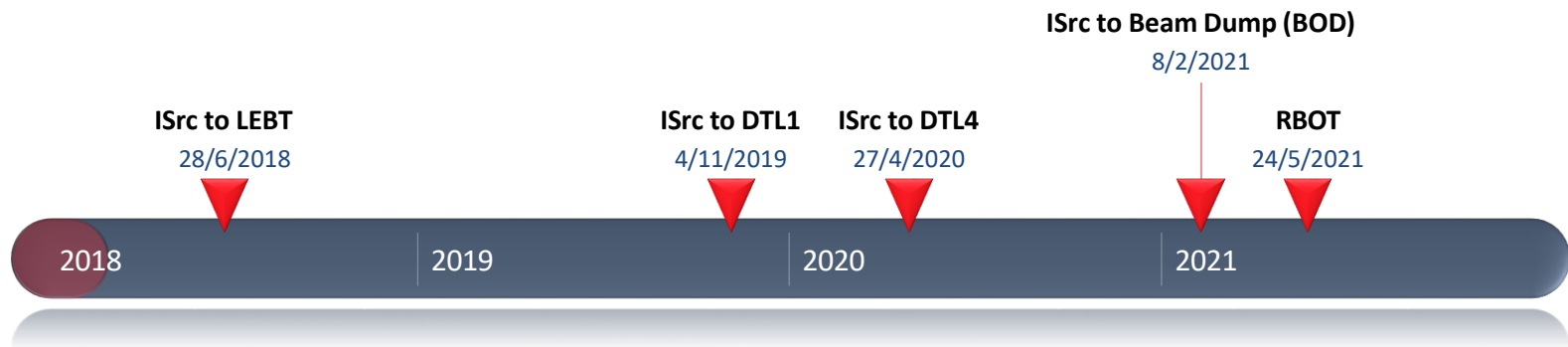
## Commissioning

- **Hardware**
- **Beam**
- **Key Dependencies**
  - Other Divisions
- **Critical Parameters**

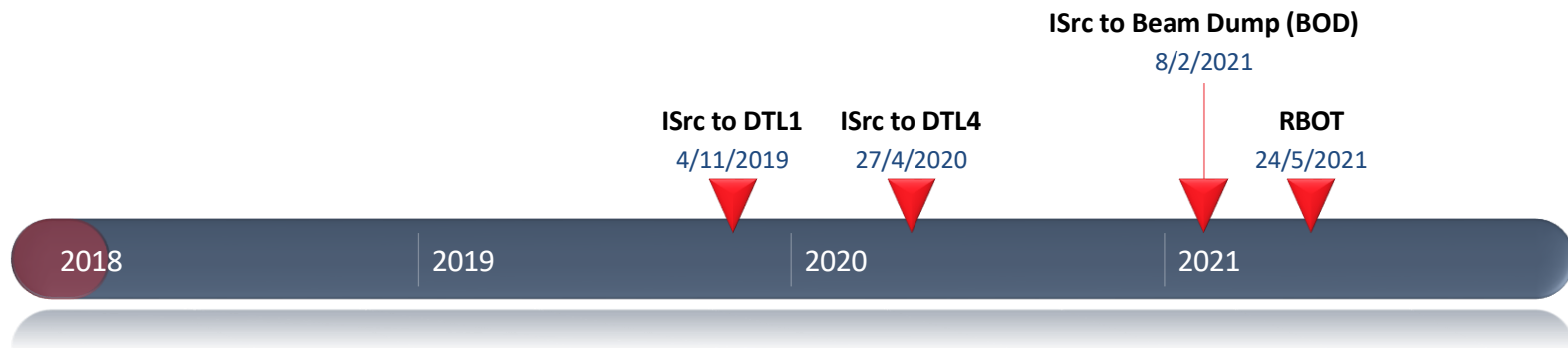
# The Big Picture – The ESS Timeline



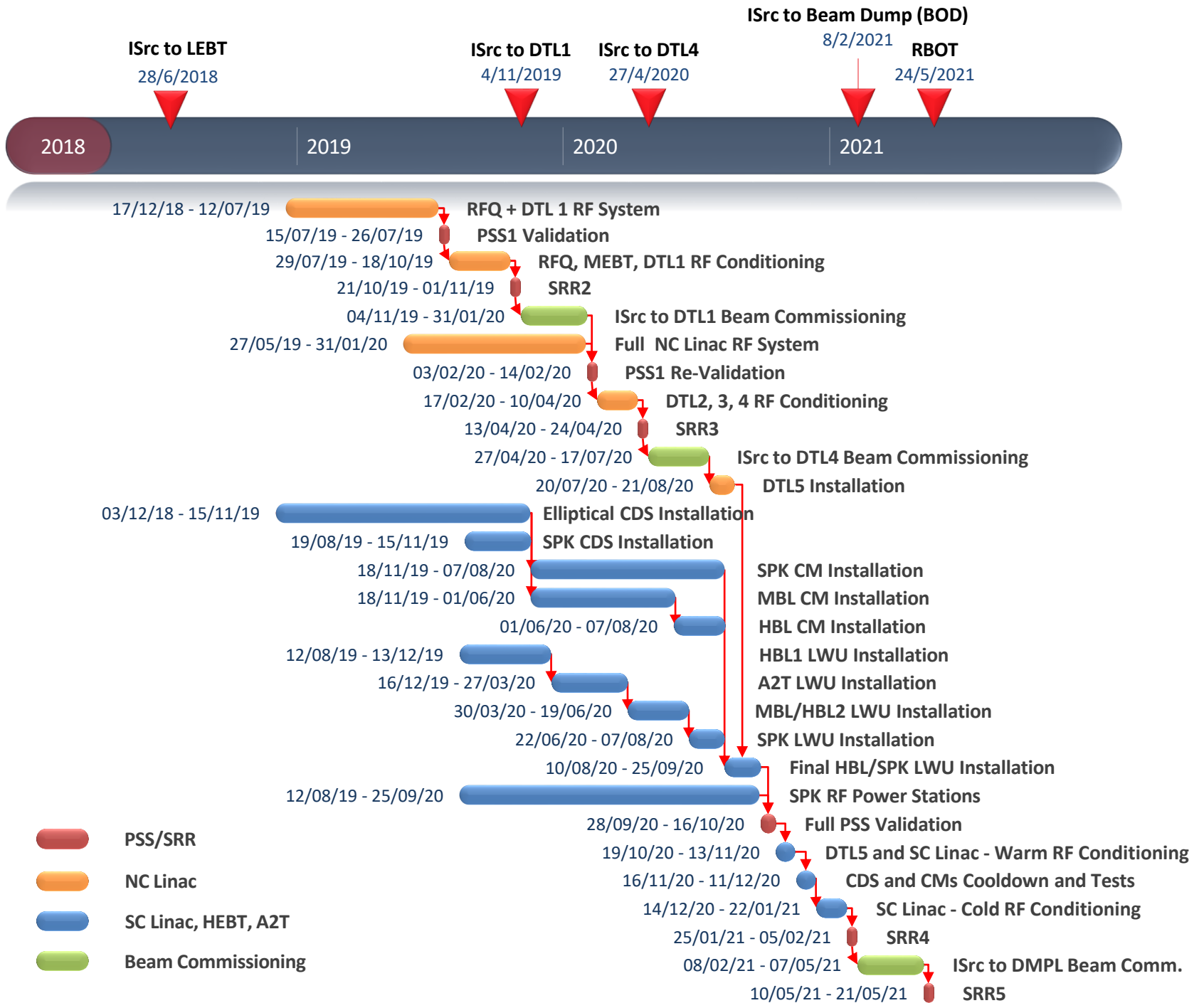
# Accelerator Milestones



# Critical Path for Accelerator



- The ACCSYS Critical Path to RBOT goes through four intermediate milestones.
- The Ion Source to LEBT beam commissioning (Summer 2018) is not on the critical path, but an important transition to initial operations milestone.



# (Some) Lessons Learned

- A greenfield project has significant advantages, but also challenges
  - Building a facility while setting up a new laboratory is not easy.
- IK Model is a powerful concept, but it has its challenges.
- The design, procurement and installation time needed for infrastructure and utilities should not be underestimated.
- Anticipate the need for various permits well in advance.
- Develop the right installation organisation.
- Be adaptable.
- Etc. (a lot more to come)



# Thank you!

























