

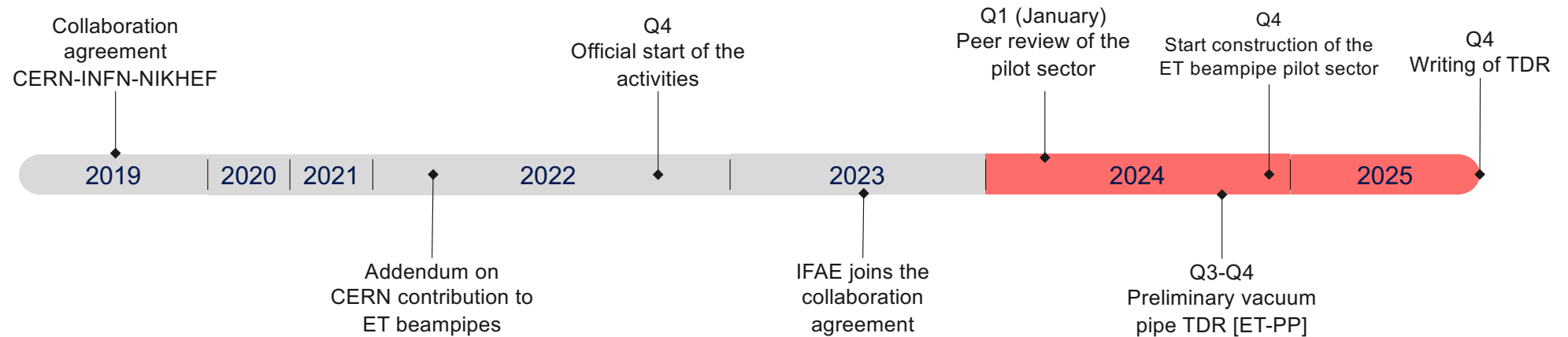


Progress on ET Pilot Sector and its future ET – CERN collaboration

Luigi SCIBILE on behalf of the ET-CERN Collaboration

XIV ET Symposium, Maastricht, 06-10 May 2024

CERN activities on ET beampipe vacuum



The main objectives are:

- **Coordinate the contributions** of all parties involved in the study of ET beampipes.
- Design, manufacture, assemble, and test a **pilot sector** of the selected ET beampipe vacuum systems.
- Preparing and writing the '**Technical Design Report**' for the vacuum systems of the ET's arms, including cost estimations.
- Contact and sharing of information with the **Cosmic Explorer community**.

Courtesy of Carlo Scarcia

ET pilot sector

The pilot sector aims to **test the design, fabrication, installation and commissioning** of the proposed **beampipes and support system**. It also aims to compare the feasibility of a selected number of technical choices.

Q1 2024 (January)

Project peer reviewed (international experts panel) with recommendations.

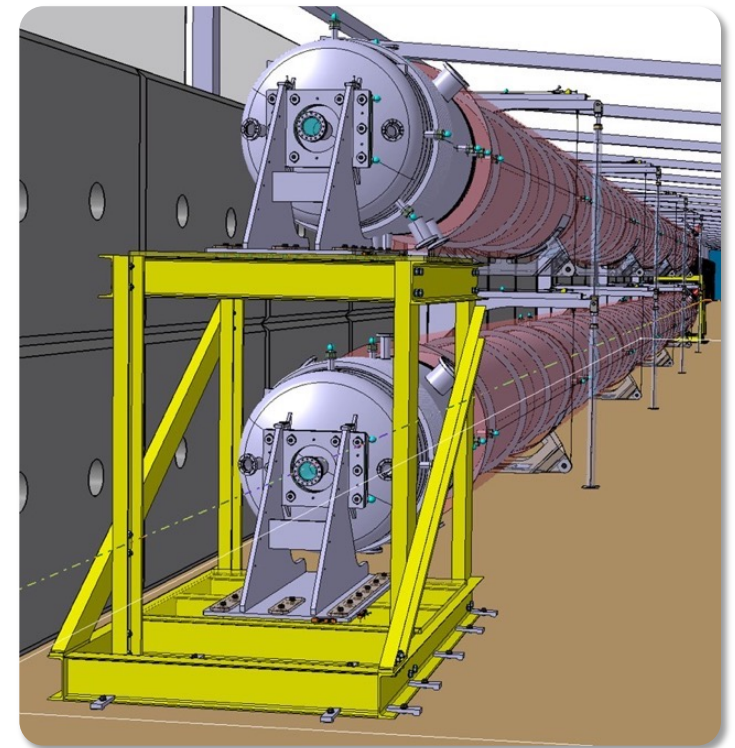
Q2-Q4 2024

Manufacturing and procurement of the ancillary components/equipment.

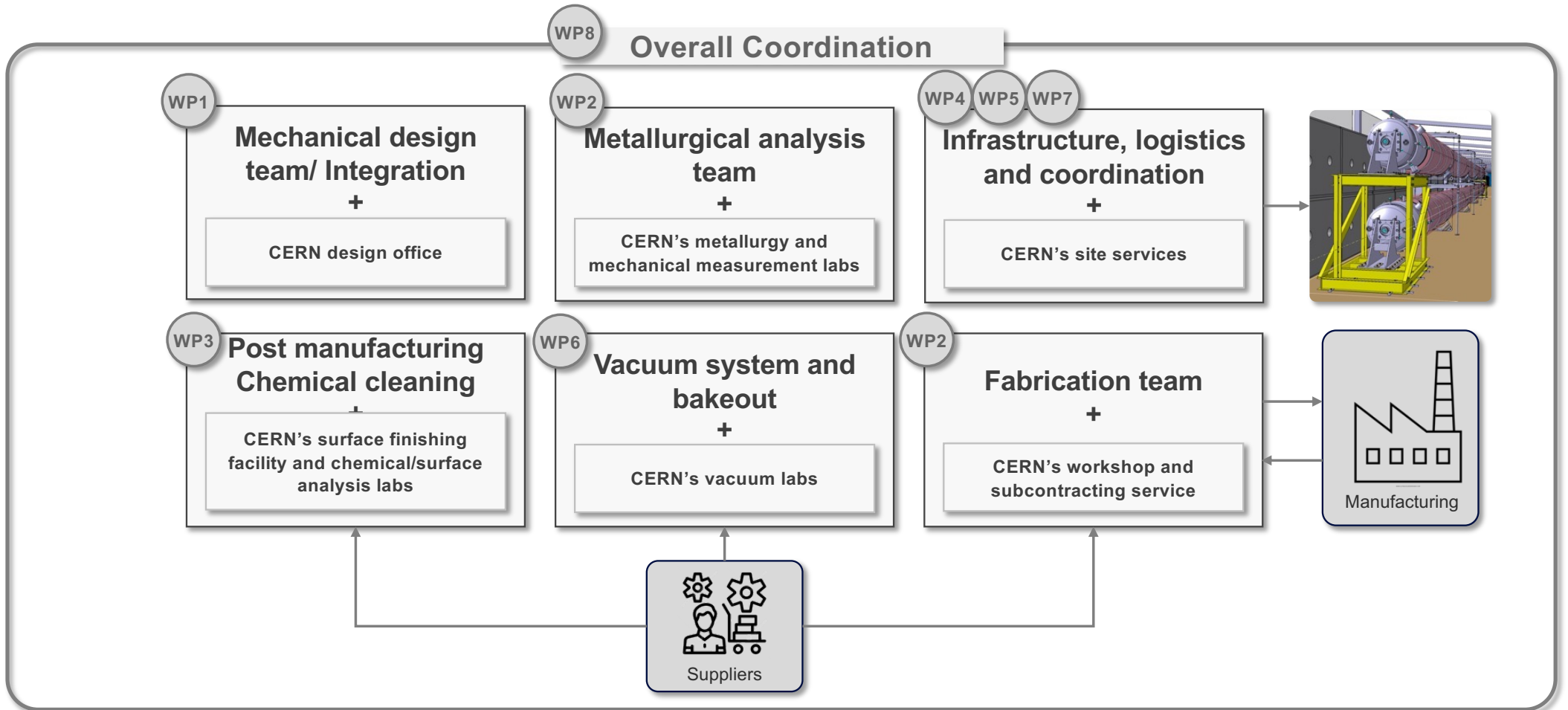
From Q4 2024/Q1 2025

Start of installation of a
AISI 441 VIRGO-like pipe \varnothing 1.08 m x 4 mm x 36 m

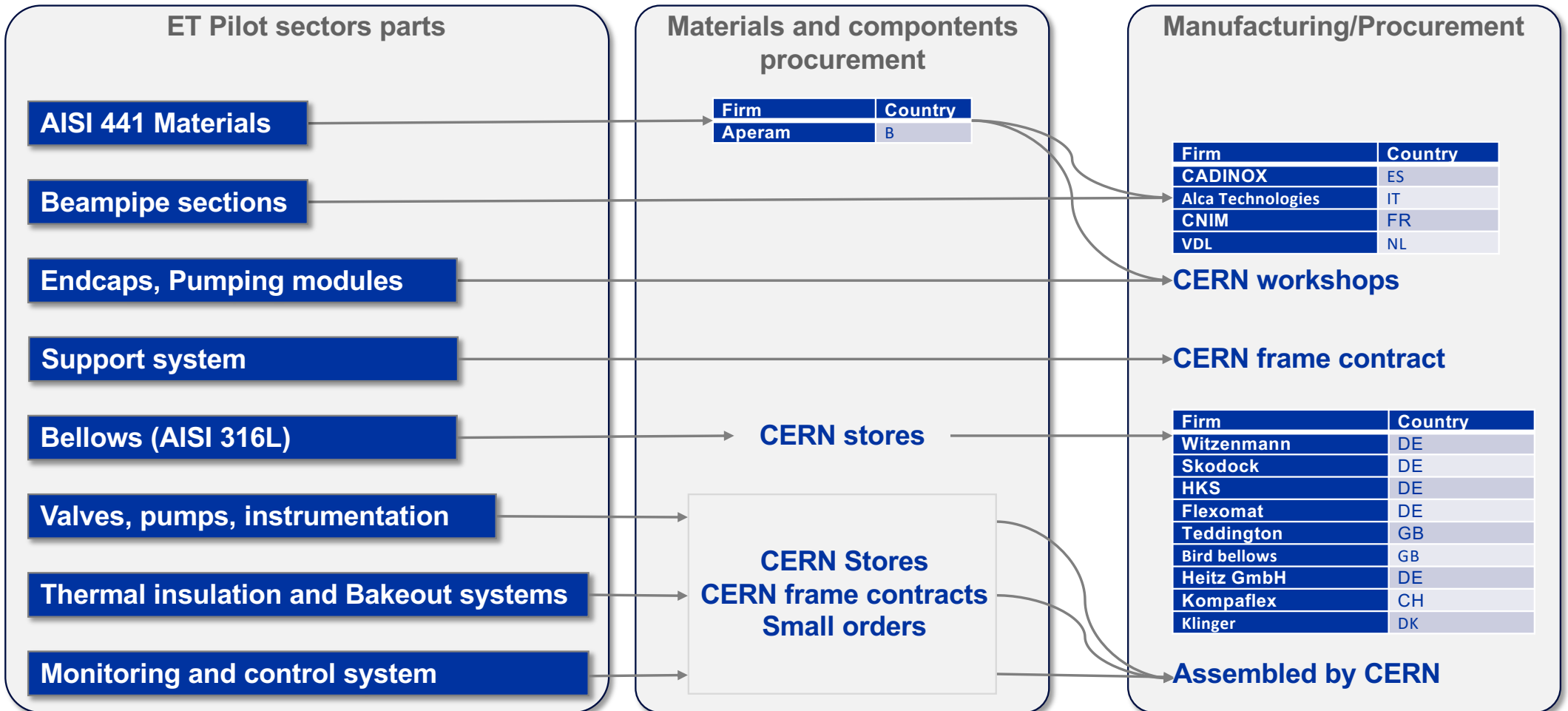
Courtesy of Carlo Scarcia



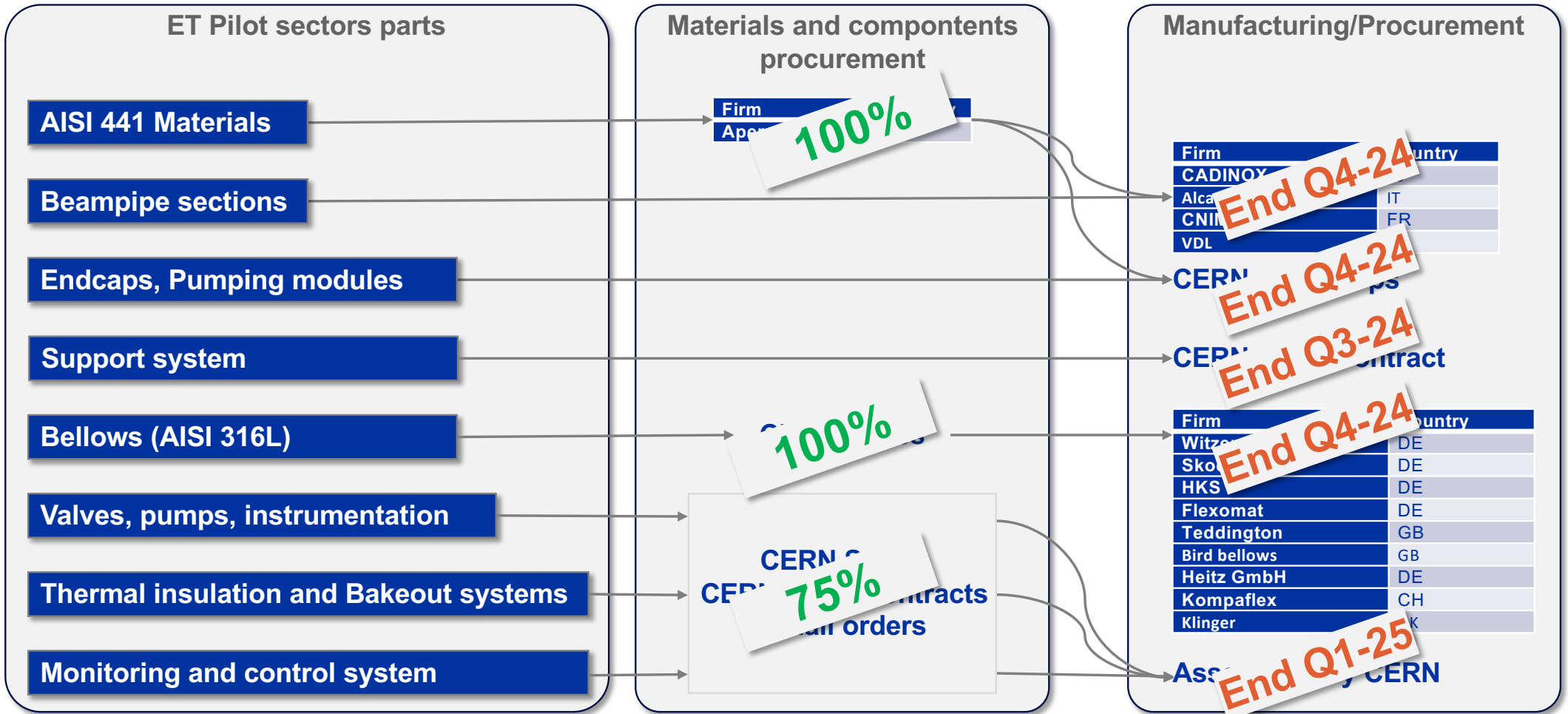
ET Pilot sector - Organisation



ET pilot sector – Procurement and manufacturing



ET pilot sector – Procurement and manufacturing



ET pilot sector – Procurement and manufacturing

ET Pilot sectors parts

AISI 441 Materials

Beampipe sections

Endcaps, Pumping modules

Support system

Bellows (AISI 316L)

Valves, pumps, instrumentation

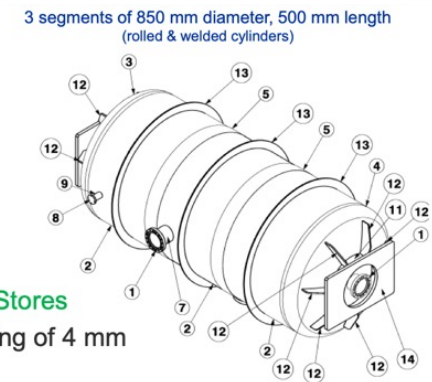
Thermal insulation and Bakeout systems

Monitoring and control system

Mock-up Ø850 mm

Manufacturing progress

- Fabrication expected to be completed **mid-July**
- **Base material (4 mm thickness) received at CERN**
- **2x End Cups successfully manufactured**
- **Sleeves material (2 mm thickness) received at CERN**
- **Stiffeners material (304L square bars) available in CERN Stores**
- Welding developments **on-going** → Plasma and TIG welding of 4 mm



Courtesy of M. Dakshinamurthy and A. T. Pérez

ET pilot sector – Procurement and manufacturing

ET Pilot sectors parts

AISI 441 Materials

Beampipe sections

Endcaps, Pumping modules

Support system

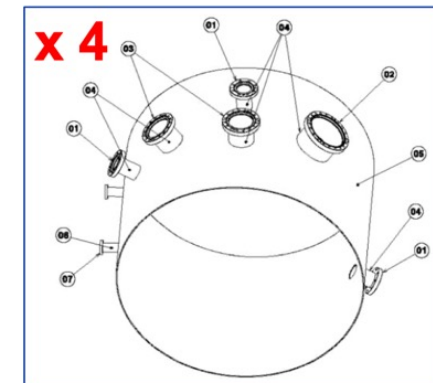
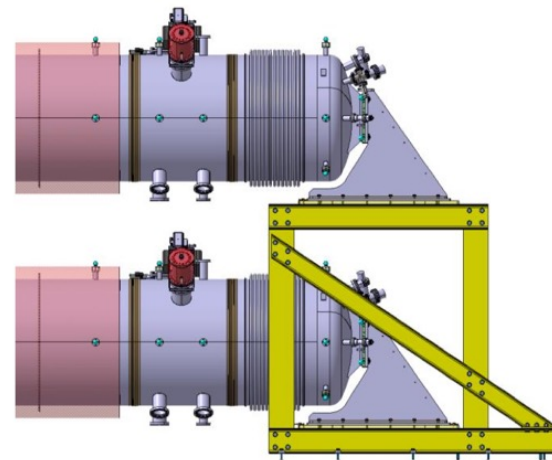
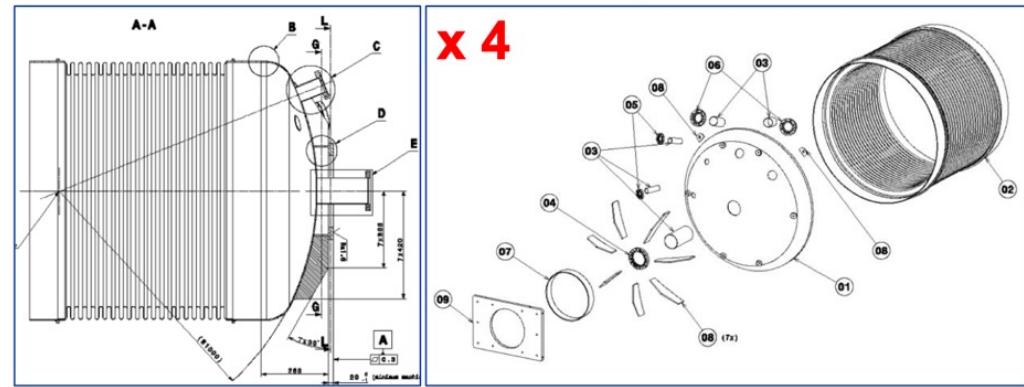
Bellows (AISI 316L)

Valves, pumps, instrumentation

Thermal insulation and Bakeout systems

Monitoring and control system

End-Cap module



Instrumentation module

Courtesy of G. Favre

ET pilot sector – Procurement and manufacturing

ET Pilot sectors parts

AISI 441 Materials

Beampipe sections

Endcaps, Pumping modules

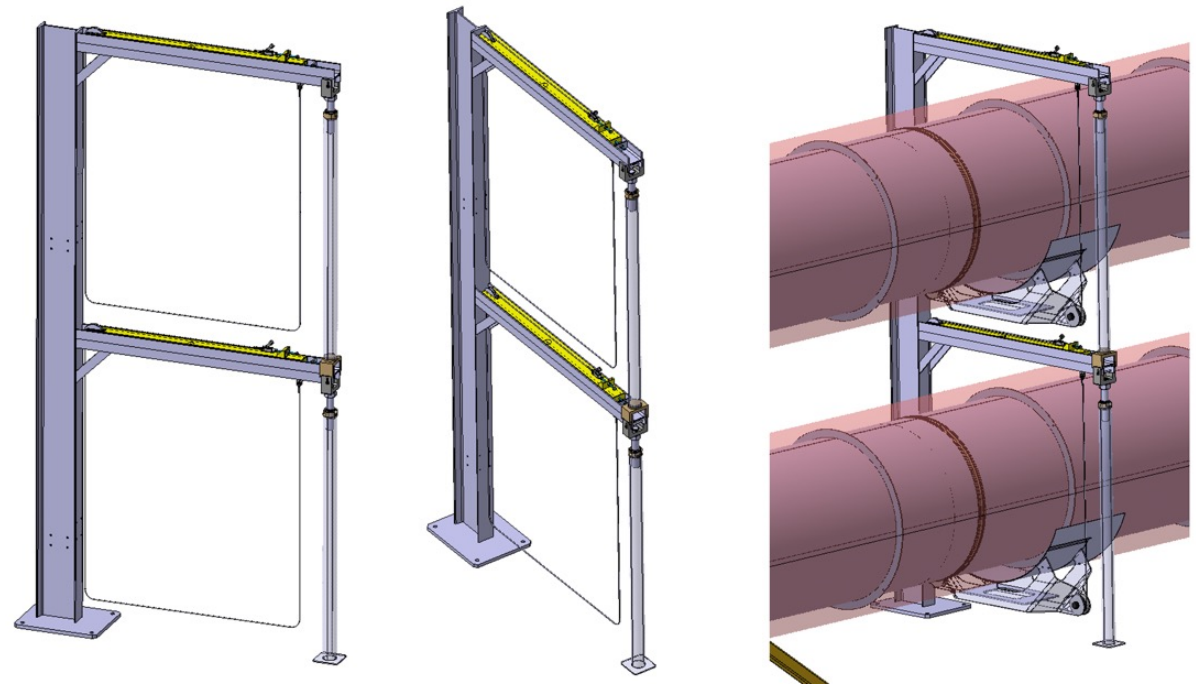
Support system

Bellows (AISI 316L)

Valves, pumps, instrumentation

Thermal insulation and Bakeout systems

Monitoring and control system



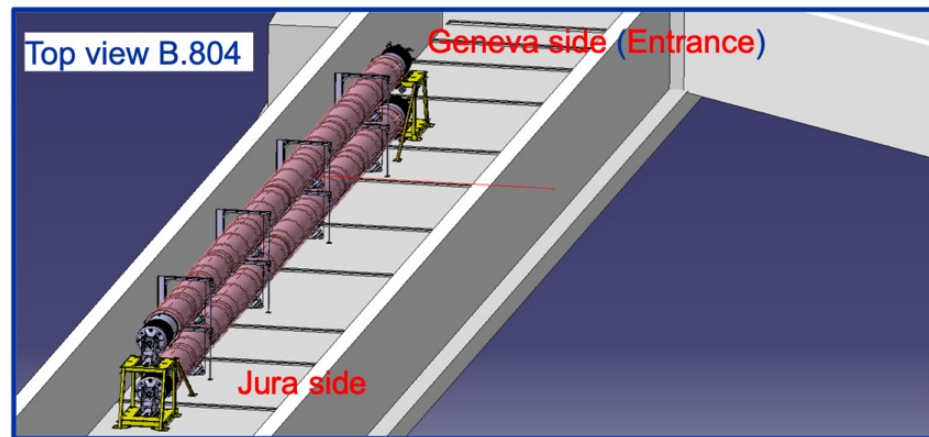
Courtesy of C. Garion, L. Gentini

ET pilot sector – Logistics

Place of Installation

Courtesy of J. Hansen

- Building B973 old base line
- New base line is TT4 (B804)



Paolo Chiggiato, Luigi Scibile and Jan Hansen | ET pilot sector

4/25/2024

3



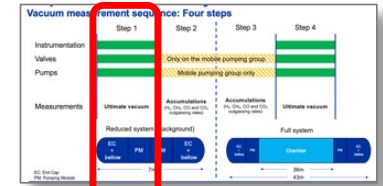
ET EINSTEIN
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XIV ET Symposium,
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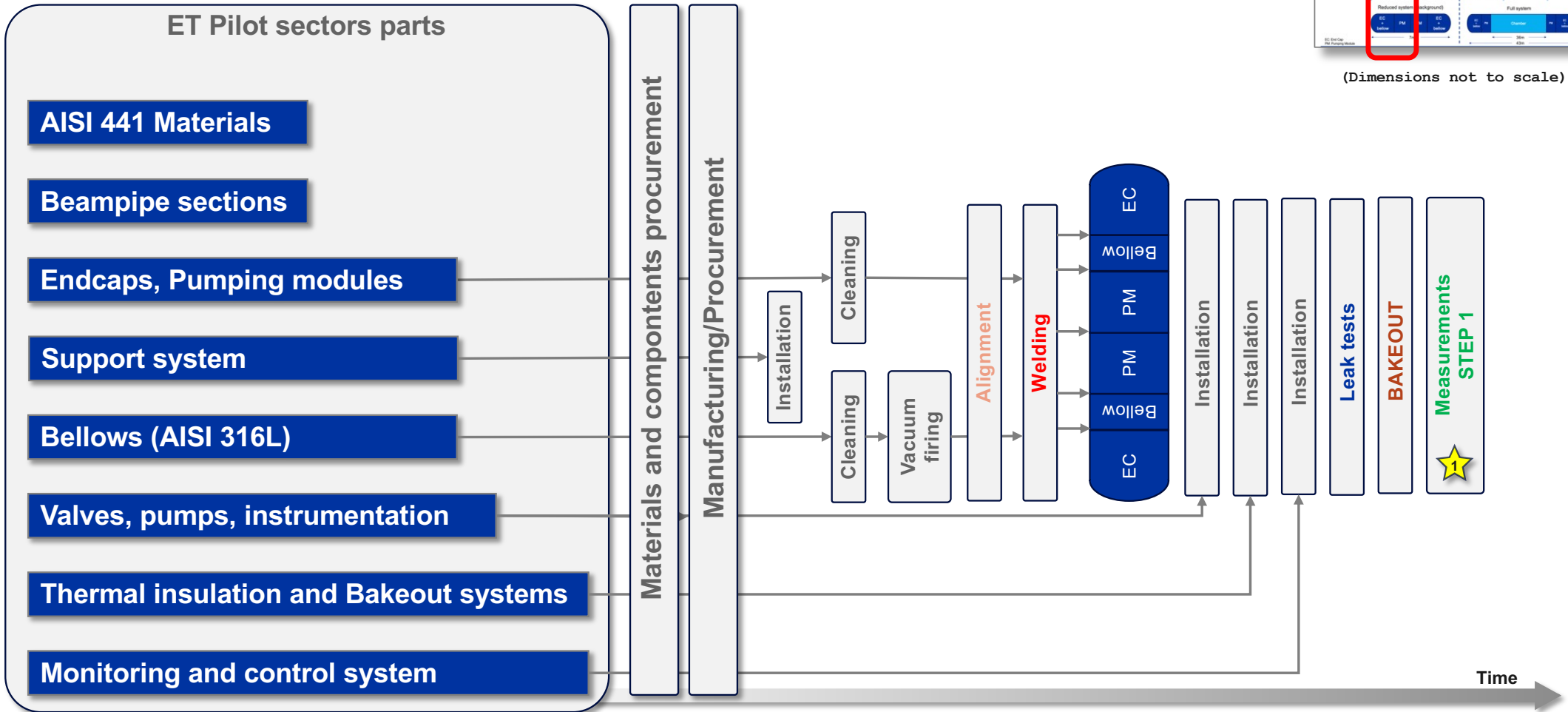
Luigi SCIBILE for the ET-CERN collaboration

ET-TDS: ET-0176A-24
CERN EDMS: 3087459

ET pilot sector – Logistics for step 1



(Dimensions not to scale)



ET pilot sector – Logistics for STEP 2

ET Pilot sectors parts

AISI 441 Materials

Beampipe sections

Endcaps, Pumping modules

Support system

Bellows (AISI 316L)

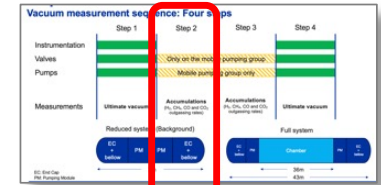
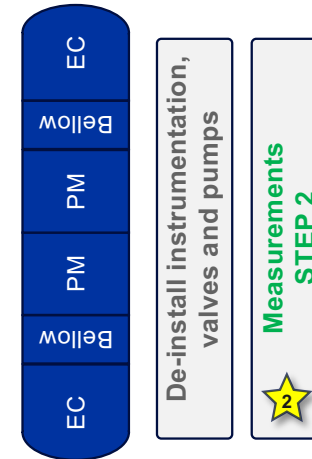
Valves, pumps, instrumentation

Thermal insulation and Bakeout systems

Monitoring and control system

Materials and components procurement

Manufacturing/Procurement



(Dimensions not to scale)

ET pilot sector – Logistics for STEP 3/4

ET Pilot sectors parts

AISI 441 Materials

Beampipe sections

Endcaps, Pumping modules

Support system

Bellows (AISI 316L)

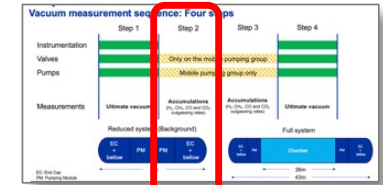
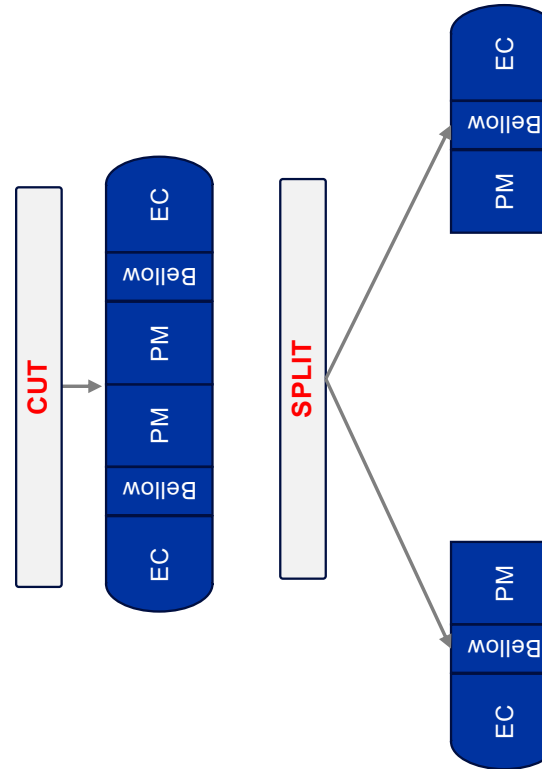
Valves, pumps, instrumentation

Thermal insulation and Bakeout systems

Monitoring and control system

Materials and components procurement

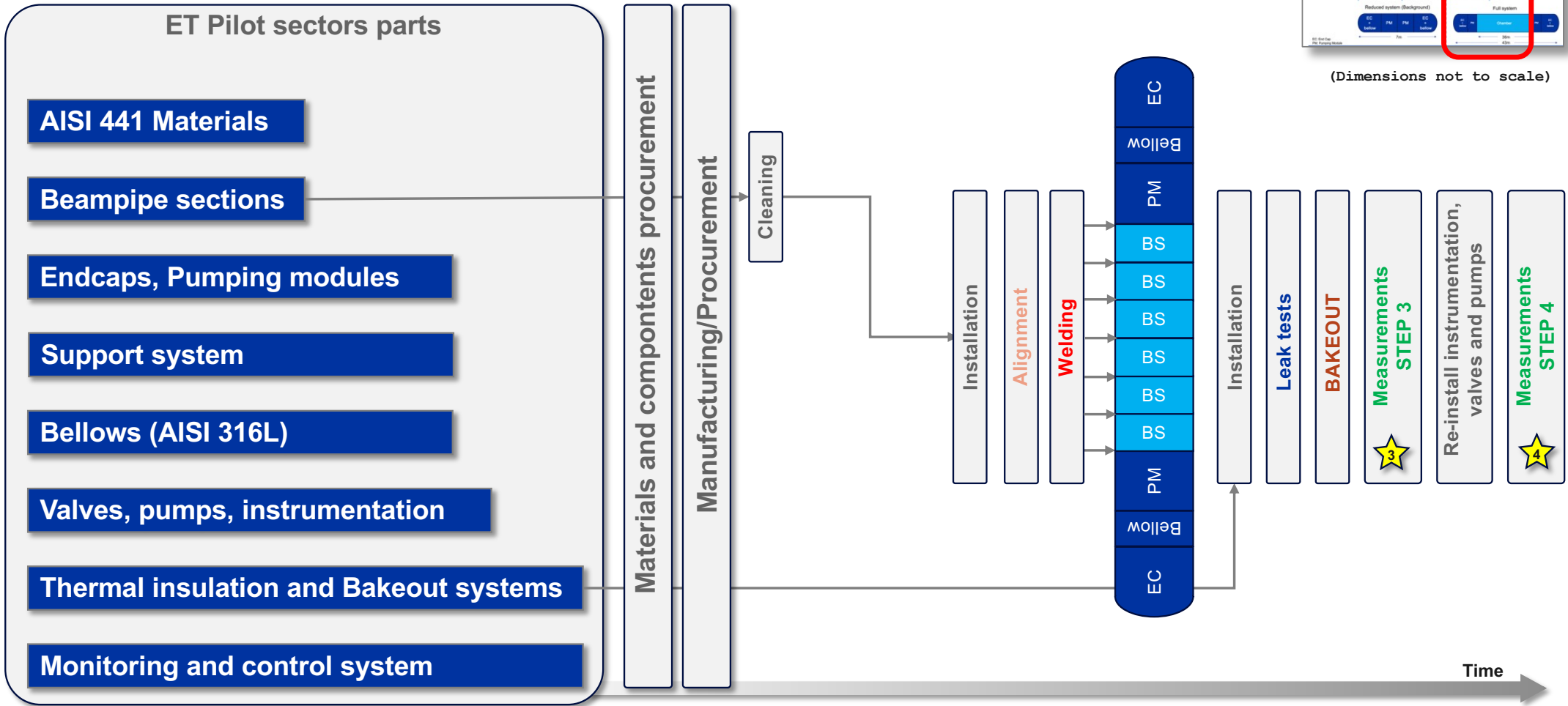
Manufacturing/Procurement



(Dimensions not to scale)

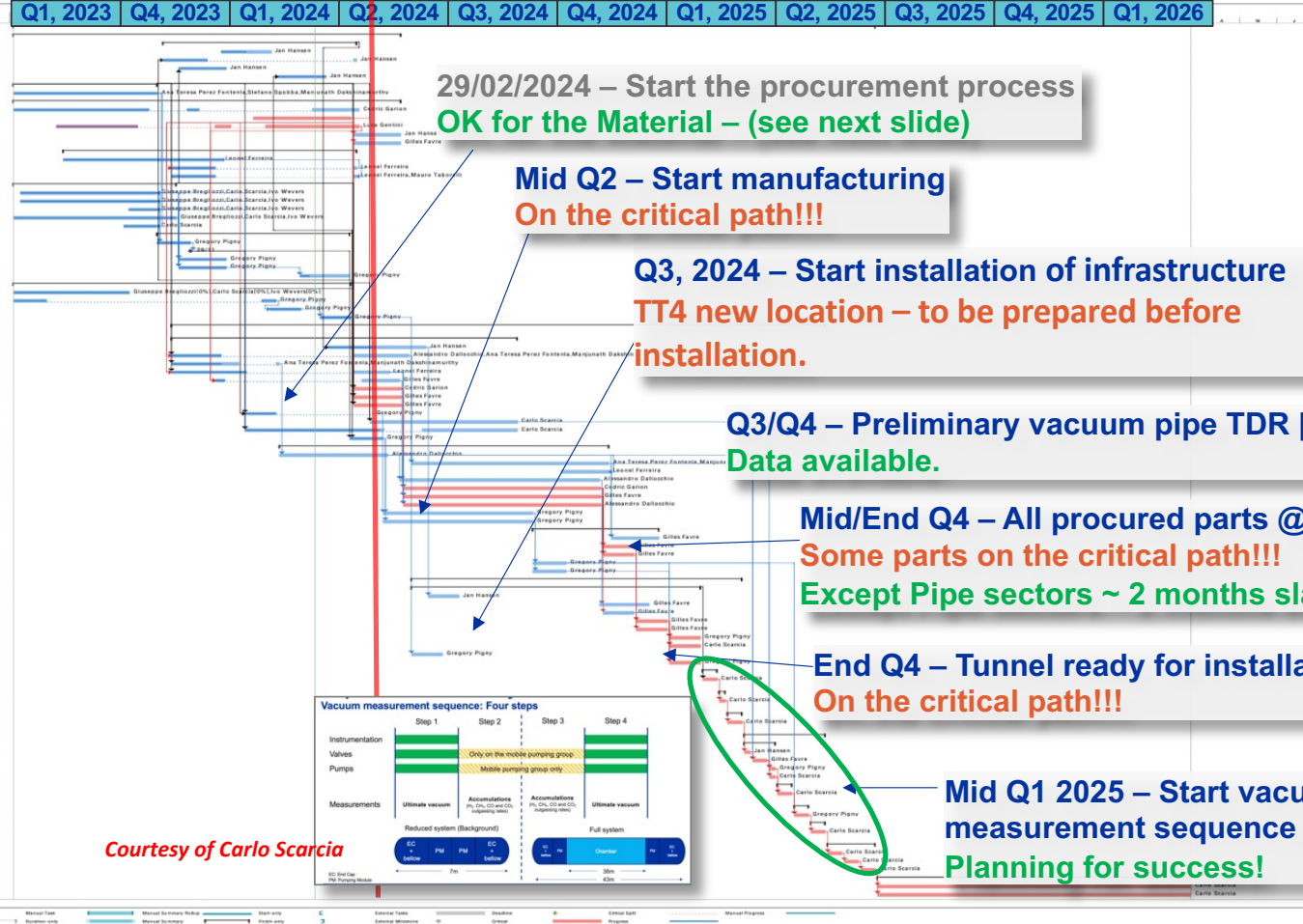
Time

ET pilot sector – Logistics for STEP 3&4



ET pilot sector – Main milestones

ID	Task Name	Duration	Start	Finish	%	Professionals	Resource Name
1	Build pipe Arm Vacuum Prototype Sector	138 days	Tue 04/07/23	Fri 23/06/24	100%	79%	Luigi Scibile, Paolo
2	Design prototype sector	234 days	Tue 04/07/23	Fri 24/06/24	79%		Carlo Scarcia
3	Design of prototype sector infrastructure	113 days	Tue 07/12/23	Wed 17/06/24	100%		
4	Design of pipe thermally controlled volume	30 days	Tue 26/12/23	Mon 05/07/24	50%		Jan Hansen
5	Design of electrical distribution	30 days	Tue 07/12/23	Wed 17/06/24	100%	33	Jan Hansen
6	Design of compound of distribution	30 days	Mon 05/12/23	Fri 23/07/24	100%	30	Jan Hansen
7	Design of IT network	30 days	Mon 12/07/24	Mon 26/07/24	100%	26	Jan Hansen
8	Material selection	87 days	Tue 04/07/23	Wed 03/12/23	100%		Ana Teresa Pereira
9	Material selection	200 days	Tue 04/07/23	Fri 24/06/24	100%		
10	Design of pipe arm vessels	120 days	Tue 04/07/23	Fri 15/04/24	75%		Carlo Scarcia
11	Design of pipe arm support and alignment	135 days	Mon 05/06/23	Fri 15/04/24	42%		Luca Garcia
12	Design of pipe arm support system	30 days	Mon 12/06/23	Fri 15/04/24	0%	12	Jan Hansen
13	Design of pipe arm assembly tools	30 days	Mon 12/06/23	Fri 15/04/24	0%	12	Gilles Faure
14	Design of the heating procedure	177 days	Tue 04/07/23	Wed 17/06/24	100%		
15	Market search of potential solutions	30 days	Mon 12/06/23	Mon 26/12/23	100%	100%	Leonel Ferreira
16	Definition of cleaning method	30 days	Tue 14/12/23	Wed 17/06/24	100%	13	Leonel Ferreira
17	Design of clearance measurement	30 days	Tue 14/12/23	Wed 17/06/24	100%	100%	Leonel Ferreira, Mauro Tassinari
18	Design of pipe vacuum system	90 days	Mon 05/07/23	Fri 13/12/23	100%		Giuseppe Brigante
19	Design of rough pumping	80 days	Mon 05/07/23	Wed 03/12/23	100%	100%	Giuseppe Brigante, Carlo Scarcia, Joe Wevers
20	Design of intermediate pumping	80 days	Mon 05/07/23	Wed 03/12/23	100%	100%	Giuseppe Brigante, Carlo Scarcia, Joe Wevers
21	Design of high pumping at RT	180 days	Mon 05/07/23	Wed 03/12/23	100%	100%	Giuseppe Brigante, Carlo Scarcia, Joe Wevers
22	Design of the measurement procedure	90 days	Tue 04/07/23	Fri 13/12/23	100%		Giuseppe Brigante, Carlo Scarcia, Joe Wevers
23	Design instrumentation	138 days	Tue 04/07/23	Mon 03/12/23	100%	100%	Carlo Scarcia
24	Design and programming of monitoring and control	138 days	Tue 04/07/23	Thu 19/04/24	78%		
25	Design monitoring and control instrumentation	20 days	Thu 03/12/23	Wed 03/12/23	100%	100%	Gregory Pigny
26	Install pipe - CERN vacuum system / monitoring & control	0 days	Wed 03/12/23	Wed 03/12/23	100%	27	Gregory Pigny
27	Signal and power cable test	30 days	Fri 12/07/23	Mon 21/03/24	100%	21,23,24,24	Gregory Pigny
28	Install PLC, SCADA and DB	30 days	Mon 05/12/23	Fri 23/07/24	100%	21,23,24,24	Gregory Pigny
29	IT programming PLC, SCADA and DB	30 days	Fri 12/07/23	Thu 19/04/24	100%	30	Gregory Pigny
30	Design of thermal insulation	80 days	Tue 04/07/23	Mon 05/07/23	100%		Giuseppe Brigante
31	Design of thermal insulation	80 days	Tue 04/07/23	Mon 05/07/23	100%		Giuseppe Brigante
32	Design of return busbar conductor	30 days	Mon 05/06/24	Fri 15/04/24	100%	34	Gregory Pigny
33	Design of return busbar conductor	30 days	Mon 05/06/24	Mon 05/06/24	100%	34	Gregory Pigny
34	Procurement, manufacturing, assembling and installation of prototype sector	368 days	Tue 14/12/23	Fri 18/06/26	14%		Jan Hansen
35	Procurement components of prototype sector	200 days	Tue 14/12/23	Fri 18/06/26	42%		Jan Hansen
36	Procurement of prototype sector infrastructure	60 days	Mon 05/06/24	Mon 5/6			Jan Hansen
37	Procurement of pipe arm pipe sections	60 days	Tue 14/12/23	Fri 13/06/24	48%	8,13	Alexandro Dalboschi
38	Procurement of pipe arm conductor	60 days	Tue 14/12/23	Mon 18/06/24	71%	8	Ana Teresa Pereira, Fernando Marquetti
39	Procurement of heating service equipment	67.5 days	Tue 14/12/23	Wed 13/06/24	67%	8,13	Leonel Ferreira
40	Procurement of pipe arm support and alignment	30 days	Mon 12/06/23	Mon 12/06/23	100%	13,13	Carlo Scarcia
41	Procurement of bellows	30 days	Mon 12/06/24	Fri 24/06/24	0%	8,13,13	Carlo Scarcia
42	Procurement of pipe arm vessels	30 days	Mon 12/06/24	Fri 24/06/24	0%	8,13,13	Gilles Faure
43	Procurement of bellows	30 days	Mon 12/06/24	Fri 24/06/24	0%	8,13,13	Gilles Faure
44	Procurement of pipe arm support and alignment	30 days	Mon 12/06/24	Mon 12/06/24	100%	8,13,13	Gregory Pigny
45	Procurement of insulation material	30 days	Mon 05/06/24	Fri 18/06/24	0%	8,13,13	Carlo Scarcia
46	Procurement of pipe vacuum system	140 days	Fri 13/06/24	Fri 30/06/24	57%	21,23,23,28	Carlo Scarcia
47	Procurement of pipe monitoring and control	138 days	Fri 13/06/24	Mon 03/12/24	100%	26,28	Gregory Pigny
48	Manufacturing components of prototype sector	138 days	Tue 14/12/23	Fri 13/12/24	0%		
49	Manufacturing of pipe arm	60 days	Tue 14/12/23	Mon 18/06/24	0%	41	Alexandro Dalboschi
50	Manufacturing of pipe arm components	120 days	Mon 05/06/24	Fri 13/12/24	0%	40,13	Ana Teresa Pereira, Fernando Marquetti
51	Manufacture pipe arm support and alignment	120 days	Fri 14/06/24	Thu 07/12/24	0%	43,13	Alexandro Dalboschi
52	Manufacture and vacuum firing of bellows	120 days	Mon 05/06/24	Fri 13/12/24	0%	3,4,13,13,13	Leonel Ferreira
53	Manufacturing of pumping modules	120 days	Mon 05/06/24	Thu 07/12/24	0%	45,47,48,44,52	Carlo Scarcia
54	Manufacturing of envelope modules	120 days	Mon 05/06/24	Thu 07/12/24	0%	45,47,48,44,52	Alexandro Dalboschi
55	Manufacturing of pipe bellows system	120 days	Fri 13/06/24	Thu 14/06/24	0%	41,13	Gregory Pigny
56	Manufacturing of pipe bellows system	120 days	Fri 13/06/24	Thu 14/06/24	0%	50	Gregory Pigny
57	Assembling components of prototype sector	70 days	Fri 13/06/24	Thu 27/06/24	0%		
58	Assembling of pipe arm	30 days	Mon 18/12/24	Fri 27/06/24	0%	53,53,53	Gilles Faure
59	Assembling of pumping modules	20 days	Mon 12/12/24	Fri 06/06/24	0%	51,56,56	Gilles Faure
60	Assembling of envelope modules	20 days	Fri 13/06/24	Fri 06/06/24	0%	51,56,56	Gilles Faure
61	Assembling of pipe bellows system	20 days	Fri 13/06/24	Fri 06/06/24	0%	58	Gregory Pigny
62	Assembling of pipe monitoring and control	20 days	Fri 13/06/24	Thu 19/06/24	0%	60	Gregory Pigny
63	Installation and testing for background measurement	200 days	Mon 05/06/24	Fri 18/06/26	0%		
64	Installation of prototype sector infrastructure	30 days	Mon 12/06/24	Fri 13/06/24	0%	38	Jan Hansen
65	Installation of pipe arm support and alignment	30 days	Fri 06/12/24	Thu 13/12/24	0%	54	Gilles Faure
66	Installation of bellows	20 days	Mon 12/12/24	Thu 06/06/24	0%	54	Gilles Faure
67	Installation and welding of envelope modules	20 days	Mon 05/12/24	Fri 06/06/24	0%	4,6,6	Gilles Faure
68	Installation and welding of piping modules	20 days	Mon 05/12/24	Fri 06/06/24	0%	4,6,6	Gilles Faure
69	Installation and welding of envelope modules	20 days	Mon 05/12/24	Fri 06/06/24	0%	4,6,6	Gilles Faure
70	Installation of pipe vacuum system	20 days	Mon 05/06/24	Fri 06/06/24	0%	73,65,73,71	Gregory Pigny
71	Preparation of pipe monitoring and control	20 days	Mon 05/06/24	Fri 06/06/24	0%	73,73,71	Carlo Scarcia
72	Installation of pipe monitoring and control	20 days	Mon 05/06/24	Fri 06/06/24	0%	73,73,71	Gregory Pigny
73	Testing background measurement 1	10 days	Mon 05/06/24	Fri 14/06/24	0%	66,73,73,71	Gregory Pigny
74	Background measurement 1: all instrumentation installed, all valves in place	10 days	Mon 05/06/24	Fri 14/06/24	0%	66,73,73,71	Carlo Scarcia
75	Installation for background measurement 2	5 days	Mon 12/06/24	Fri 23/06/24	0%	69	Carlo Scarcia
76	Checked all instrumentation, pumps and valves removed, sector TMAP group	5 days	Mon 12/06/24	Fri 23/06/24	0%	70	Carlo Scarcia
77	Testing background measurement 2	10 days	Mon 19/06/24	Fri 29/06/24	0%	81	Carlo Scarcia
78	Background measurement 2: all instrumentation, pumps and valves removed, except TMAP group	10 days	Mon 19/06/24	Fri 29/06/24	0%	81	Carlo Scarcia
79	Installation and testing for beamsize measurement	30 days	Mon 05/06/24	Fri 18/06/26	0%		
80	Installation for beamsize measurement 1	10 days	Mon 05/06/24	Fri 06/06/24	0%		
81	Cut between the two pumping modules	5 days	Mon 05/06/24	Fri 14/06/24	0%	83	Jan Hansen
82	Installation and welding of pipe sections	10 days	Mon 12/06/24	Fri 20/06/24	0%	85,53,53	Carlo Scarcia
83	Installation of pipe vacuum system	5 days	Mon 12/06/24	Fri 06/06/24	0%	85,87	Gregory Pigny
84	Installation of pipe monitoring and control	5 days	Mon 12/06/24	Fri 06/06/24	0%	87,48	Carlo Scarcia
85	Testing beamsize measurement 1	10 days	Mon 07/06/24	Fri 14/06/24	0%	88,88	Carlo Scarcia
86	Background measurement 1: all instrumentation, pumps and valves in place	10 days	Mon 07/06/24	Fri 14/06/24	0%	88,88	Carlo Scarcia
87	Installation for background measurement 2	10 days	Mon 12/06/24	Fri 20/06/24	0%		
88	Installation of all instrumentation, pumps and valves	10 days	Mon 12/06/24	Fri 20/06/24	0%	63,91	Gregory Pigny
89	Testing background measurement 2	10 days	Mon 05/06/24	Fri 14/06/24	0%	63,91	Carlo Scarcia
90	Background measurement 2: all instrumentation, pumps and valves in place	10 days	Mon 05/06/24	Fri 14/06/24	0%	63,91	Carlo Scarcia
91	Testing and commissioning of prototype sector	30 days	Mon 05/06/24	Fri 27/06/24	0%		Carlo Scarcia
92	Leak testing	10 days	Mon 05/06/24	Fri 14/06/24	0%		Carlo Scarcia
93	Safety tests	10 days	Mon 05/06/24	Fri 14/06/24	0%	97	Carlo Scarcia
94	Test background procedures	10 days	Mon 05/06/24	Fri 14/06/24	0%	97	Carlo Scarcia
95	Operate Pilot sector	100 days	Mon 05/06/24	Fri 18/06/26	0%		Paolo Chigotto
96	Operate Pilot sector	100 days	Mon 05/06/24	Fri 18/06/26	0%		Paolo Chigotto
97	Wrap up results of testing campaign	100 days	Mon 05/06/24	Fri 20/06/26	0%		Carlo Scarcia



29/02/2024 – Start the procurement process
OK for the Material – (see next slide)

Mid Q2 – Start manufacturing
On the critical path!!!

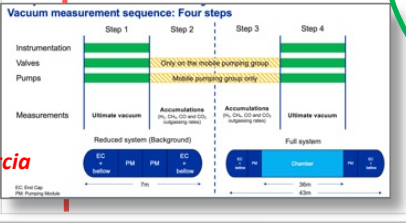
Q3, 2024 – Start installation of infrastructure
TT4 new location – to be prepared before
installation.

Q3/Q4 – Preliminary vacuum pipe TDR [ET-PP]
Data available.

Mid/End Q4 – All procured parts @ CERN
Some parts on the critical path!!!
Except Pipe sectors ~ 2 months slac.

End Q4 – Tunnel ready for installation
On the critical path!!!

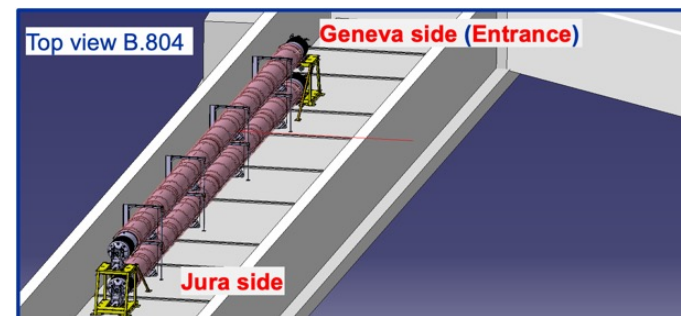
Mid Q1 2025 – Start vacuum
measurement sequence
Planning for success!



Courtesy of Carlo Scarcia

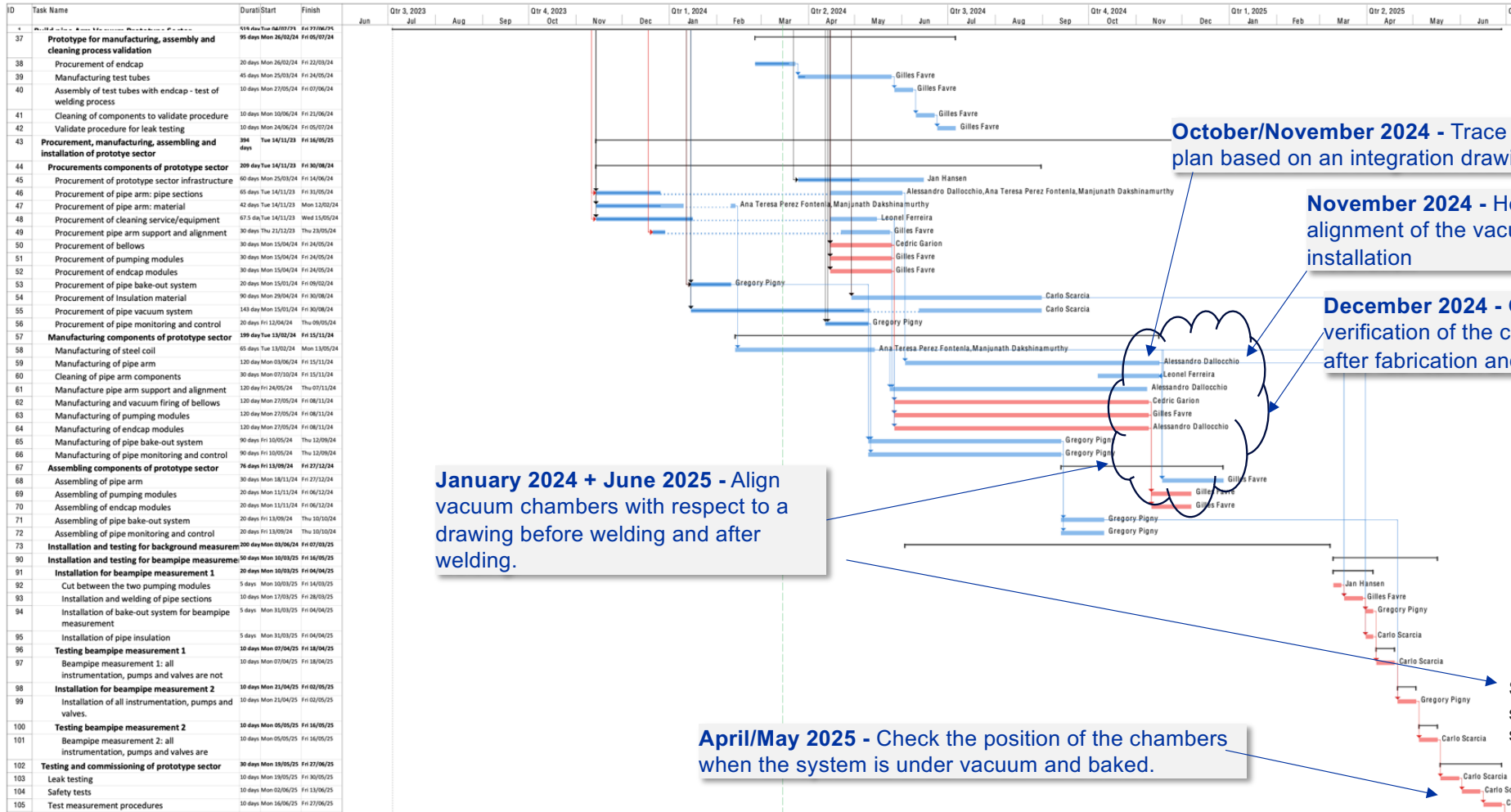
ET pilot sector – Alignment

- Contact established with **CERN alignment and survey services**.
- Request for support during the installation sequence in TT4 (see also next slide):
 - Trace the floor plan before installation of the supports
 - Help with the alignment of the vacuum supports during installation
 - Help with the alignment of vacuum chambers with respect to the end supports before welding.
 - Check the position of the chambers when the system is under vacuum.



- Started discussions for the **alignment techniques for the 10km installation**.

ET pilot sector – Alignment planning



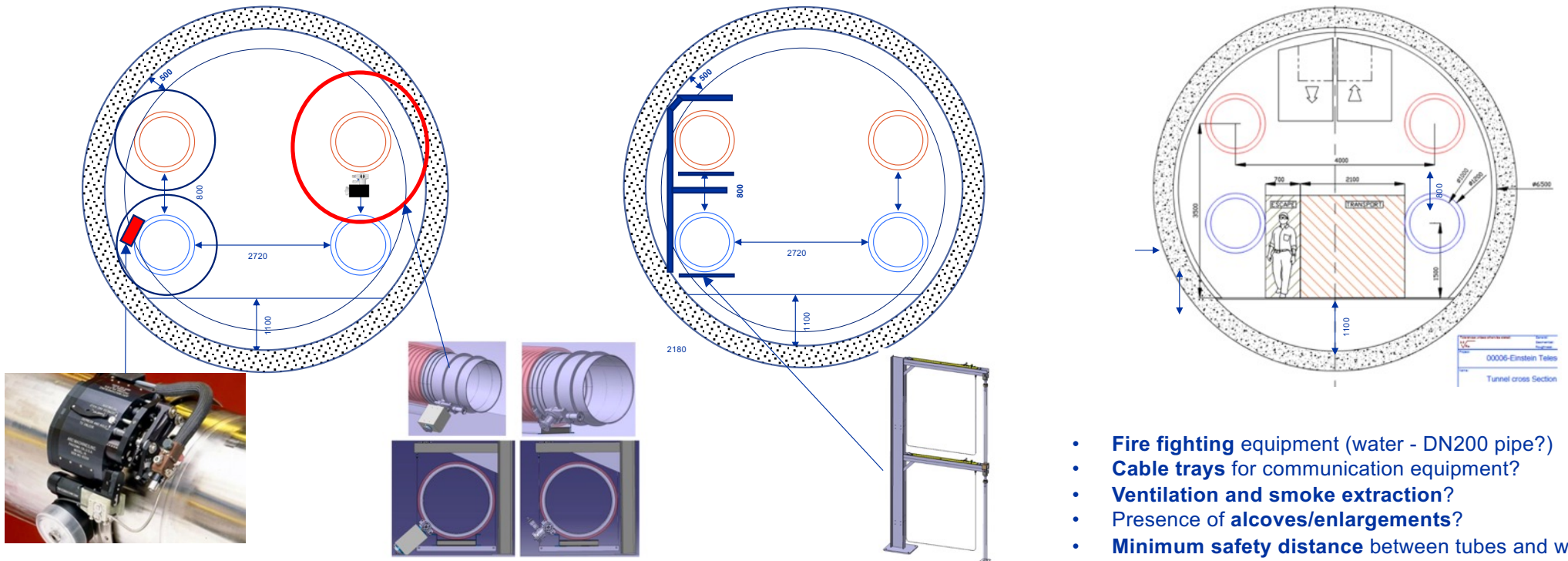
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Interfaces/Interferences between the beampipe and the tunnel: cross section

- Space required for the supporting structure, for welding and future inspections (min 500mm), for gate valves, for pumping modules and related control units (depending on design installation).

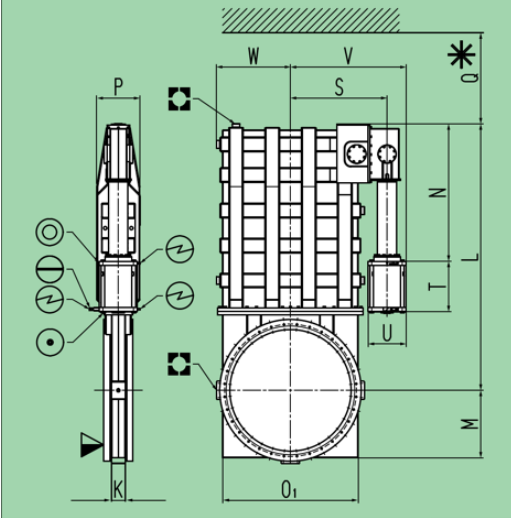


- **Fire fighting** equipment (water - DN200 pipe?)
- **Cable trays** for communication equipment?
- **Ventilation and smoke extraction?**
- Presence of **alcoves/enlargements?**
- **Minimum safety distance** between tubes and wall?

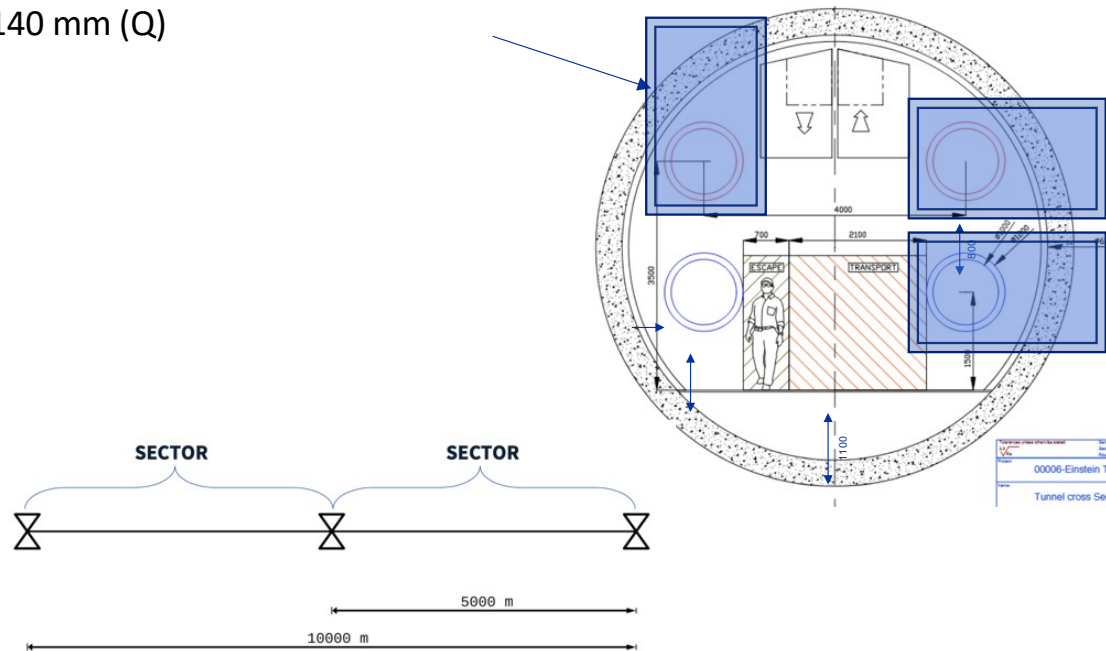
Interfaces/Interferences between the beampipe and the tunnel: cross section

Space required for sectional gate valves (DN1000)

Series 19.1, 19.2 (with bellows):
HV/UHV valve with pneumatic actuator: double acting
DN 900–2000 (36"–78")



1565 (W+V) x 2751 (L +M) x 356 (P) mm
+ 140 mm (Q)



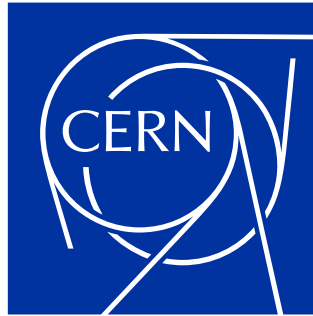
ET – CERN to be proposed future scope extension

- Test of beampipe other than AISI 441 4mm VIRGO-like.
- Prepare the framework for other beampipe solutions to be tested in the same environment.
- Purchase a gate valve and carry out the mechanical integration studies, the UHV characterization including the conditioning and outgassing rate measurements.
- Workout the detailed integration with the civil engineering.
- Study alignment techniques for the 10km assembly and installation and eventual optimisations of the support system.
- Design of leak detection systems for the manufacturing, installation and final system.
- Design the detailed procedures for the installation and commissioning in the final ET tunnel design.
- Study for the control of dust during all assembly and installation processes.
- Carry out the baffle material outgassing studies and its integration and alignment in the ET final tubes.
- Open to discuss, via ETO, the possibility to carry out other type of tests.
- Update the TDR and costing in line with general ET timeline.

ET pilot sector: peer review recommendations

Recommendation	Action
Investigation on corrosion resistance of ferritic stainless steels (tunnel environmental conditions)	Contract with UGhent to be launched for comparative corrosion studies
Use pilot sector as testbed for extrapolation of ET leak detection	Methodologies and testing under investigation
ET pilot sector to be used to test different insulation materials and solutions (installation, removal)	Contact with companies started
Implementation of large gate valves (DN1000+) to test thermal cycling, stroke cycling, treatments etc.	Planned in the extension of ET-CERN scope
Implementation of temperature control systems in selected building	ET pilot sector moved to TT4 tunnel – stable temperature.
Consider launching a parallel test on a corrugated chamber (perhaps through external contribution)	Planned in the extension of ET-CERN scope

See Carlo's Presentation



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