Survey Alignment Metrology

from Design to Commissioning…

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ESS Survey Alignment and Metrology

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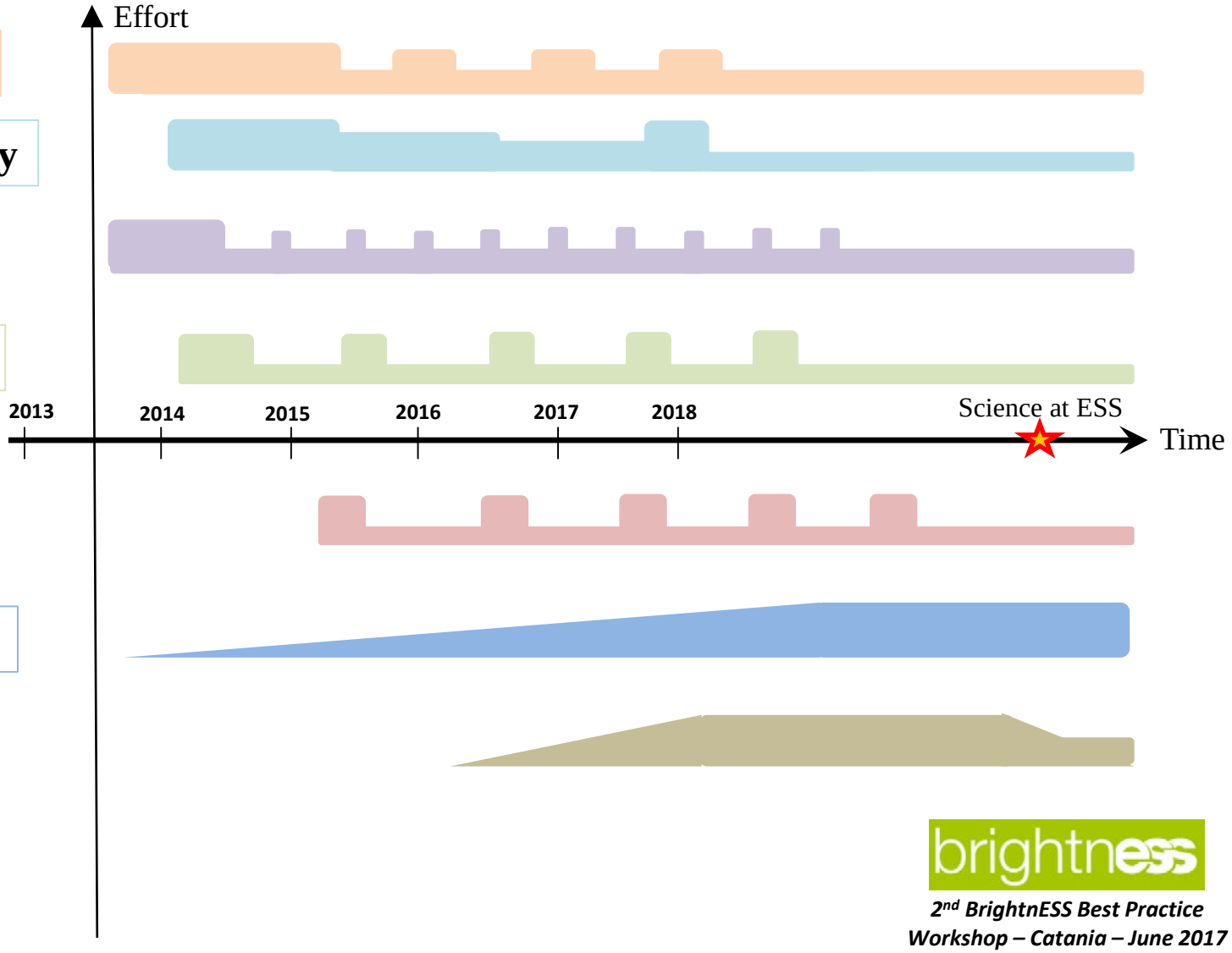
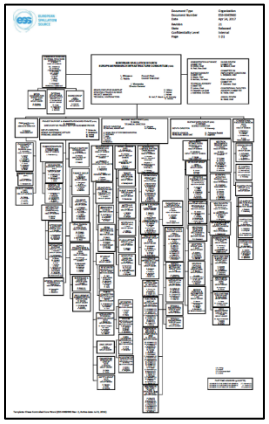
ESS Project – SAM Activities

1. **Communication**
2. **Establish Strategy**
3. **Budget**
4. **Instrumentation**
5. **Staff**
6. **Construction site**
7. **SAM services**
8. **Conclusion**



Communication

- Internal ESS



Intense efforts from the beginning to be identified

Meetings
Seminars
Processes & Guidelines

+ CHESS + Confluence

SAM is well established across ESS.
Clear mandate and responsibilities.
Good example of centralization

- Our partners

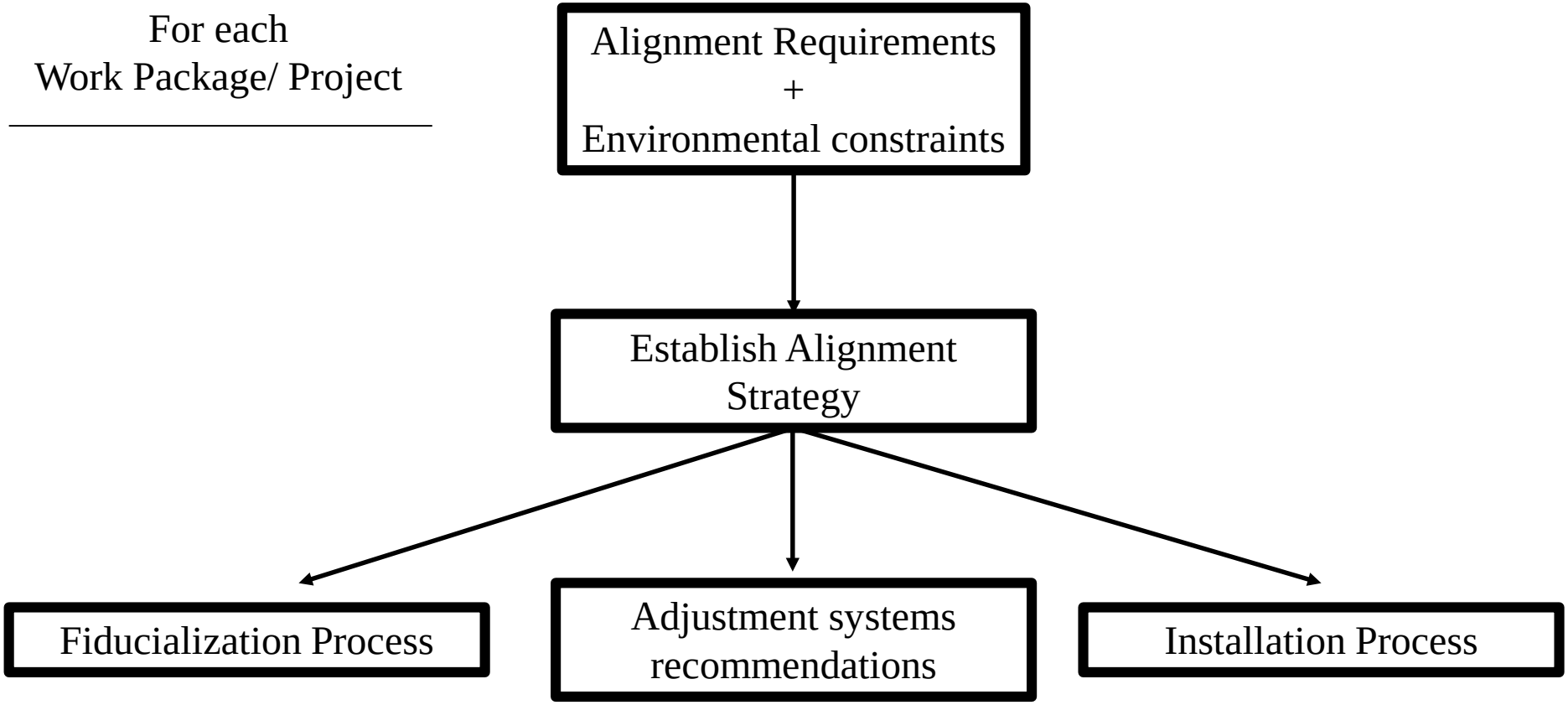
Meetings
Seminars
Skype
Visits
Reviews (TAC, PDR, CDR, IRR…)

- Point of contact clearly identified
  SAM Strategy communicated

Discussions : design, fiducialization, adjustment systems, assembly , installation

Alignment Strategy

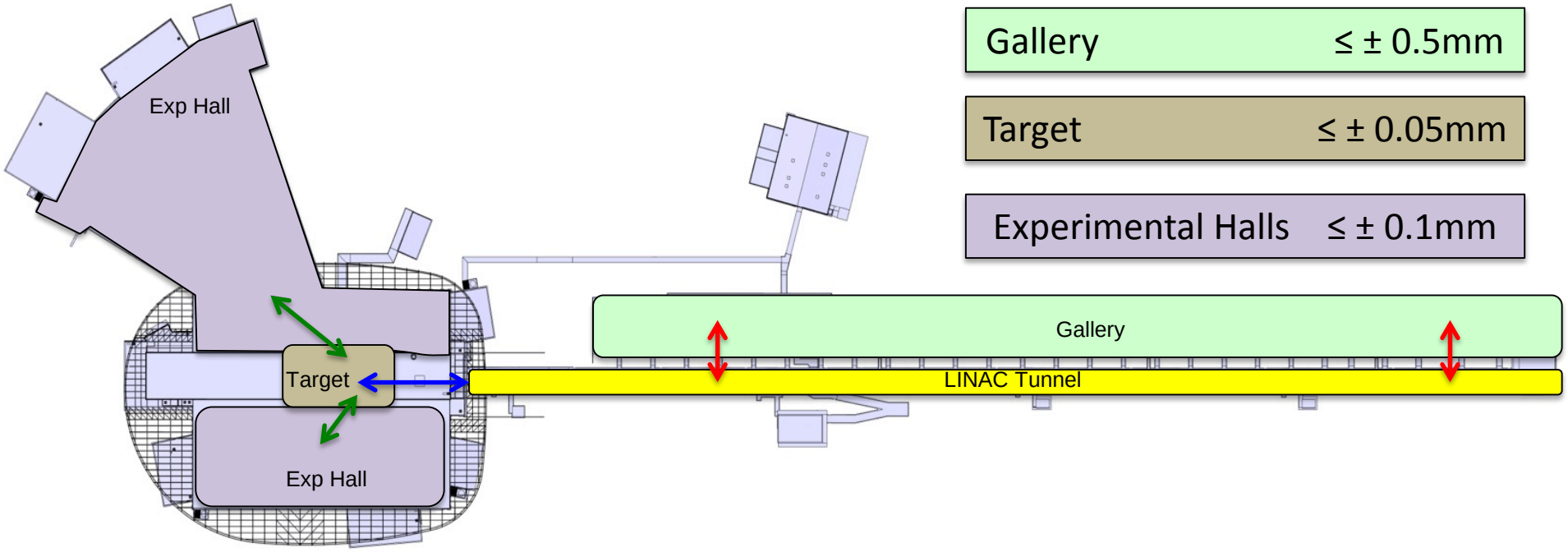
For each
Work Package/ Project



Alignment Strategy

Internal Alignment budget:

LINAC Tunnel	≤ ± 0.1mm
Gallery	≤ ± 0.5mm
Target	≤ ± 0.05mm
Experimental Halls	≤ ± 0.1mm



Relative Alignment budget:

LINAC Tunnel ≤ ± 1mm Gallery

LINAC Tunnel ≤ ± 1mm Target

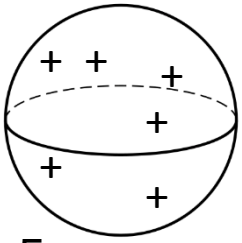
Target ≤ ± 1mm Experimental Halls

Alignment Strategy

3d free stationing technique with least squares adjustment calculus

Dense 3D network of reference points + Laser Tracker Total Station Digital Level + Adjustment Software

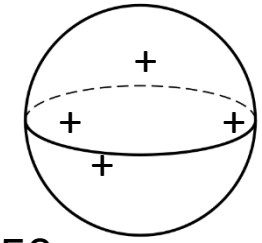
Inside



R=5m

6 points

Outside



R=50m

4 points

Describe **machine geometry** and **CAD models** in Cartesian system including **geodetics aspects!!!**

Alignment Strategy

750m

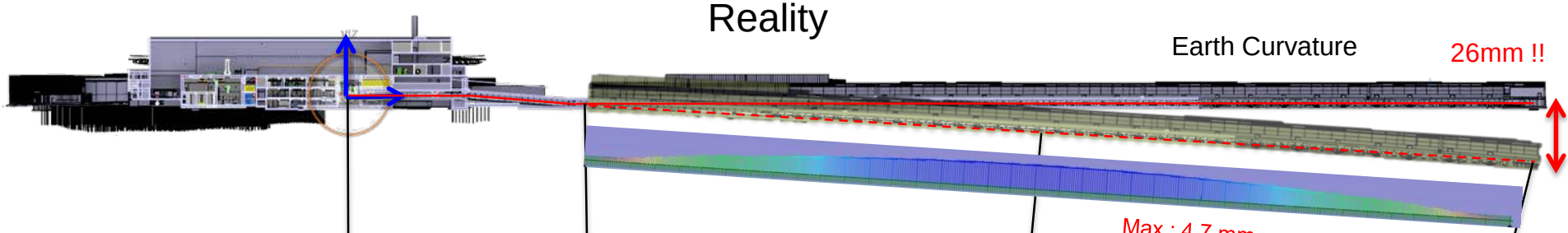
CAD Model

Perfect Cartesian Space

Reality

Earth Curvature

26mm !!

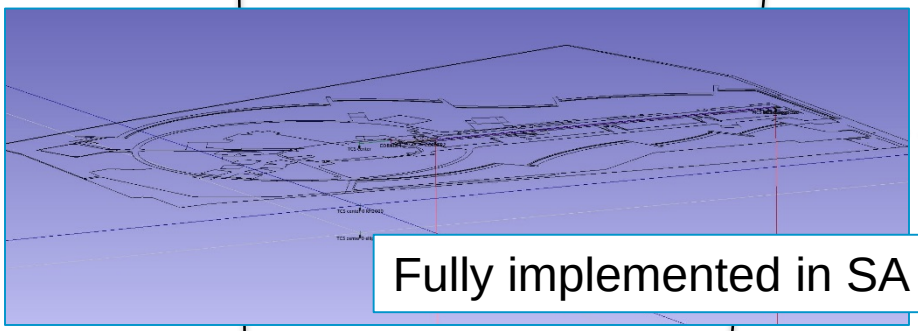


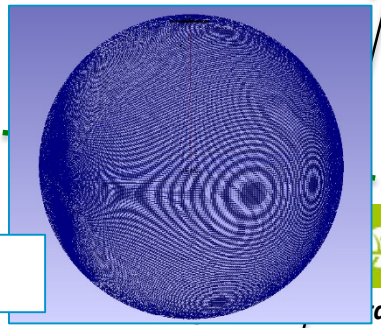
Max : 4.7 mm
Less than Construction Tolerance of the Tunnel floor : Good !!

Geoid : Sphere of radius: Rm + N

H :Geoid height

Ellipsoid = Sphere of mean radius :Rm



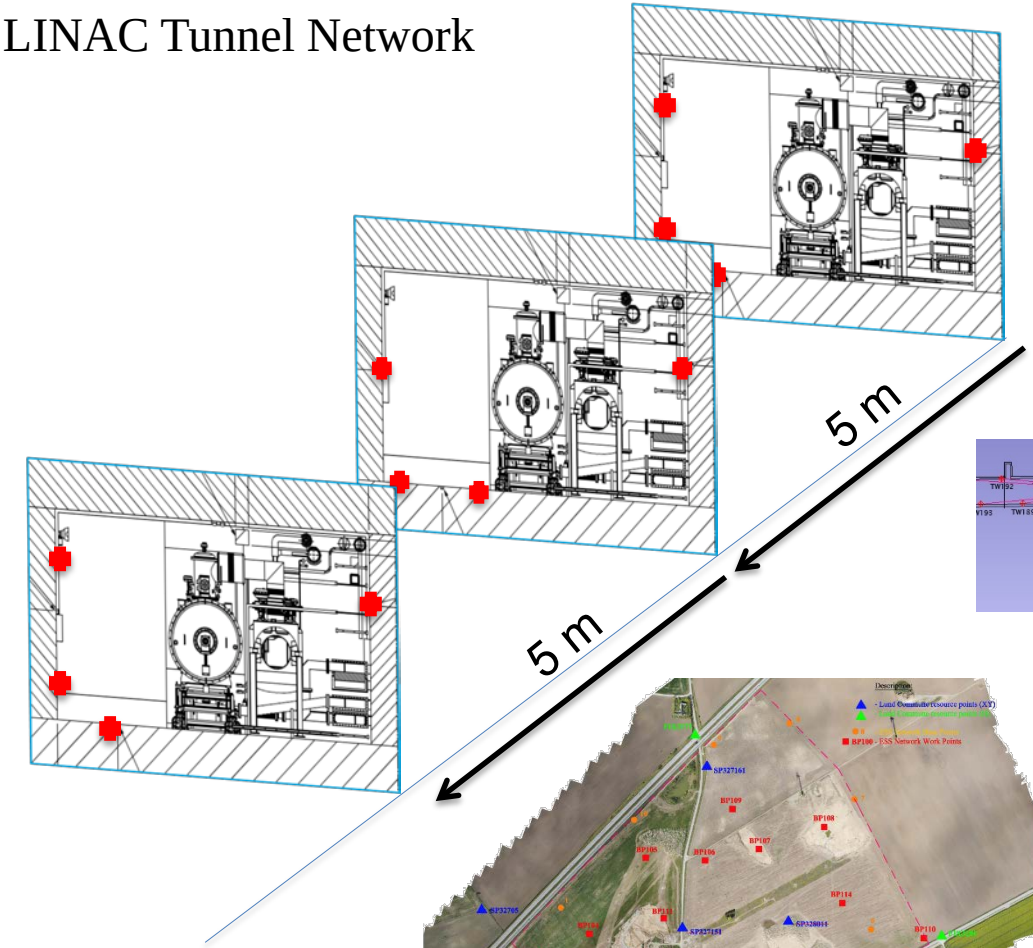


Fully implemented in SA

Earth Center

Alignment Strategy

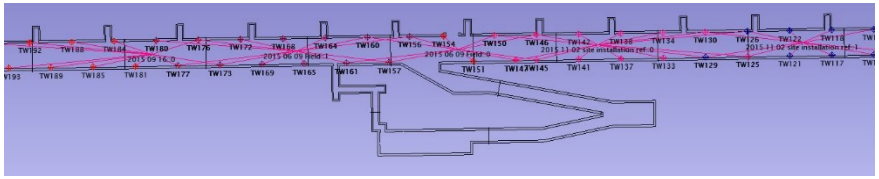
LINAC Tunnel Network

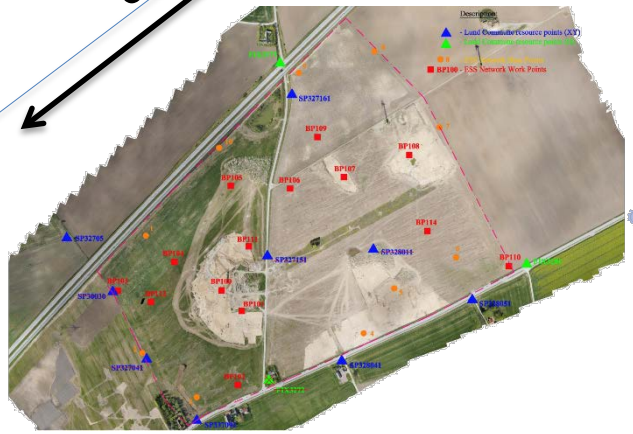


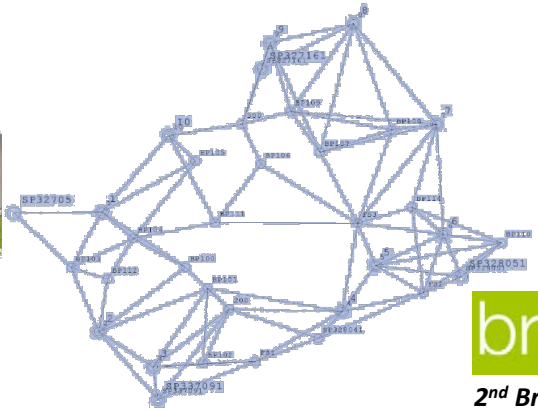
Two reference networks connected:

- outside Geodetic Pillar Network (mm accuracy)
Measurements: GPS, Total Stations, Digital Levels.

- internal reference network (0.1 mm accuracy)
Measurements: Laser Trackers , Total Stations, Digital Levels

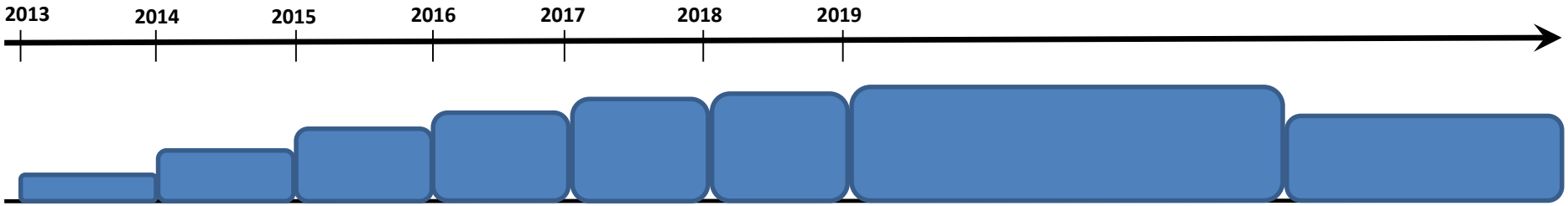






Budget

Construction Budget	Initial Operation Budget	Steady State



Difficult exercise:

- **Construction budget defined very early**
- **Make sure you cover all requirements**
- **Anticipate and Plan all major procurements**
- **Do not forget running cost for licenses, maintenance programs and calibration!!!!**

- **Reserve for some unexpected expenses !!!**

OR → **Change Request to Control Change Board**

Instrumentation

How do we get the instrumentation needed using public procurement rules ?

Know the market

Tendering Process

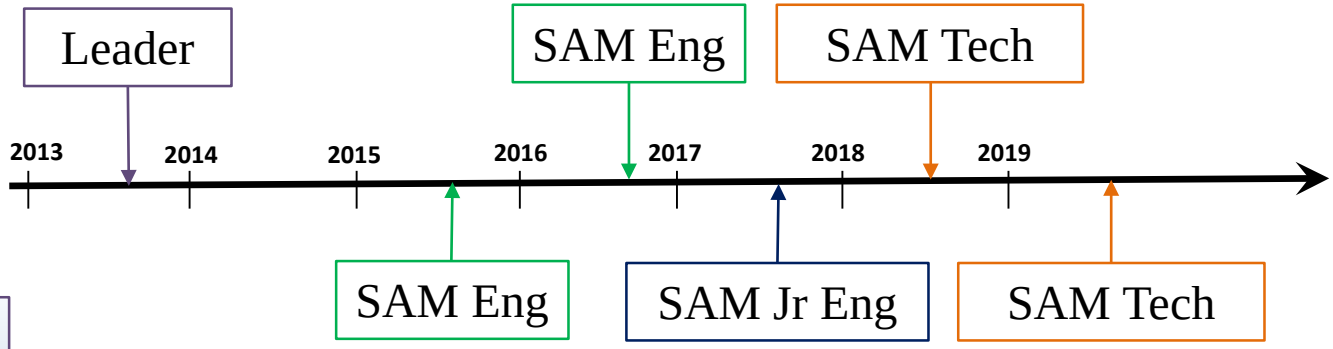
- **Close relation with all local providers**
- **Understand technical capabilities of the instrument (datasheet + experience)**
- **Analyze differences between providers**

- **Write accordingly <u>Technical Specs</u> and <u>Evaluation Criteria</u>**
- **Wide enough not to exclude !!**
- **Precise enough to select !!**

<u>Include in tender</u>: - maintenance program
- calibration

Staff

Recruitment



Profile

- Experience
- Motivation
- Engagement
- Long term

- Very challenging
- Be attractive
- Advertise among particle accelerators surveying community
- Take a lot of time

Very lucky up to now !!

Construction Site

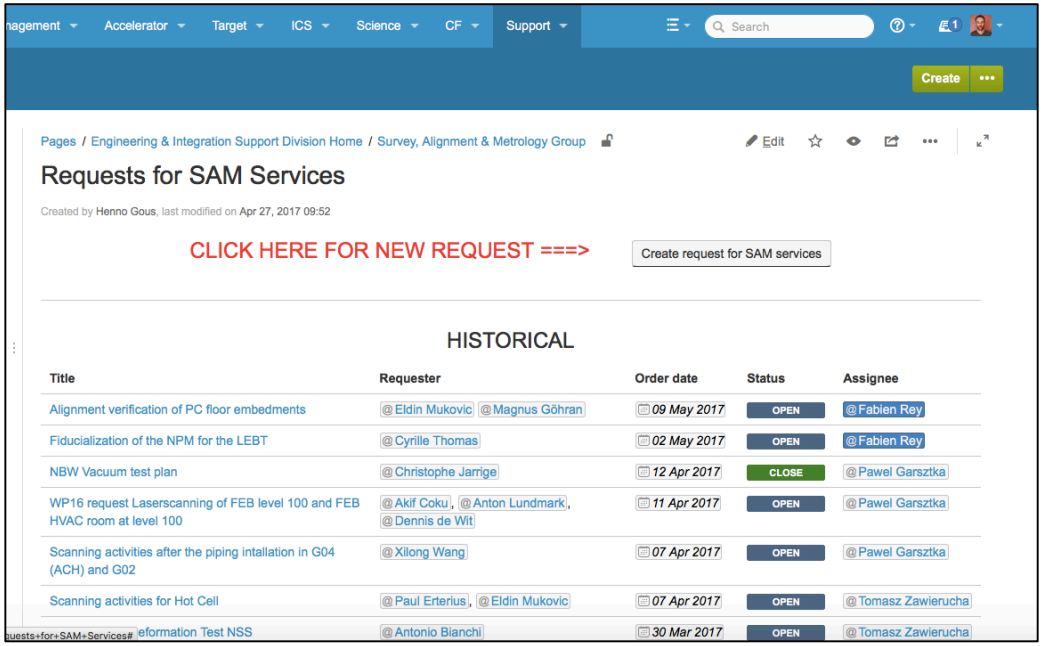
Active on site since 2014

- Establish relation with Skanska Surveying Team
- Logistic / Storage
- Transportation
- Safety
- Get used to the changing environment

- Follow construction activities
- Network Installation/Measurement
- Installation
- Scanning : 3d Point clouds

SAM Services

Services based on Requests:



- Marking
- Survey
- Alignment
- Fiducialization
- Calibration
- 3D Scanning

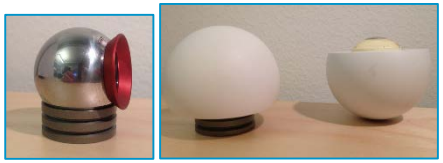
- Excellent communication channel
- Discussion forum for all stakeholders
- Following progress

SAM Services

Focus on 3D Scans

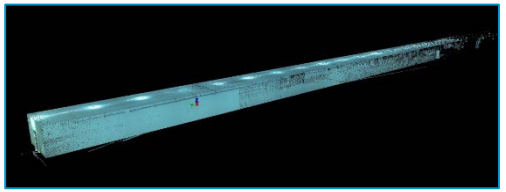
Raw data Acquisition

P30

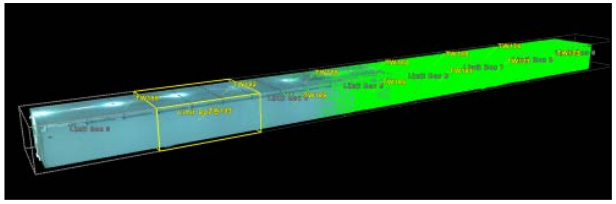


Concentric Spheres

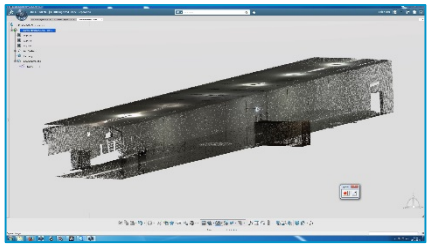
Analysis in Cyclone

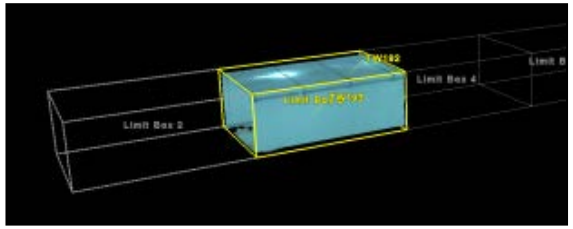


Data Cleaning
Orientation of Scans (registration)
Geometries created on demand

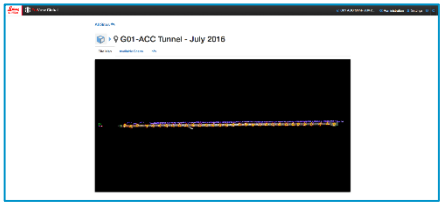


CATIA V6
For Reverse Engineering and Integration





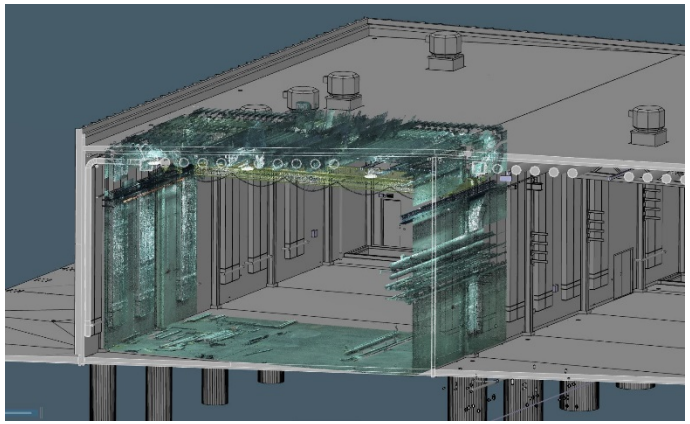
TruView Global

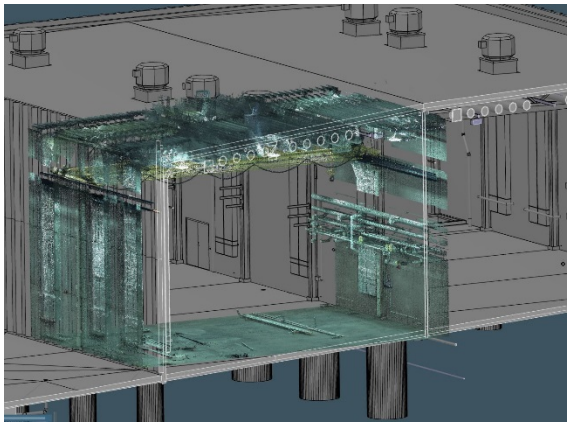


Non CAD users
Visualization/Simple measurments

SAM Services

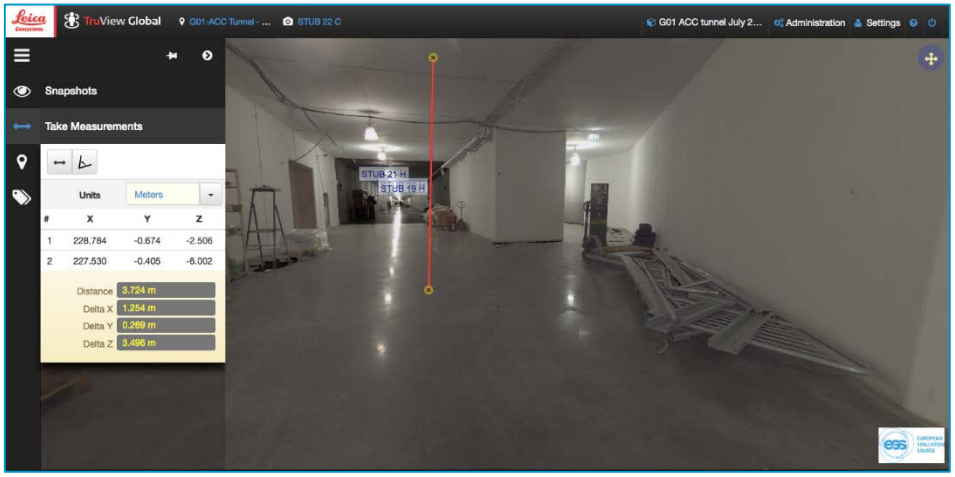
Reverse Engineering





G04- 3D model vs SCANS

Publication in Truview



Conclusion

- Very hard work during last 4 years
- SAM is providing full services
- Ready for coming challenges

Thanks for your attention !!

Usefull Links:

- Confluence SAM page
- Request for SAM services
- Instructions for Point Cloud Viewer
- Truview service