PAUL SCHERRER INSTITUT

Wir schaffen Wissen – heute für morgen

Paul Scherrer Institut

FEL‘15

SwissFEL Status Report

R. Ganter for the SwissFEL team

Outline

SwissFEL Layout & Time Plan

Status Building & Infrastructure

Status key Components

- RF Modules
- Undulators
- …

Summary

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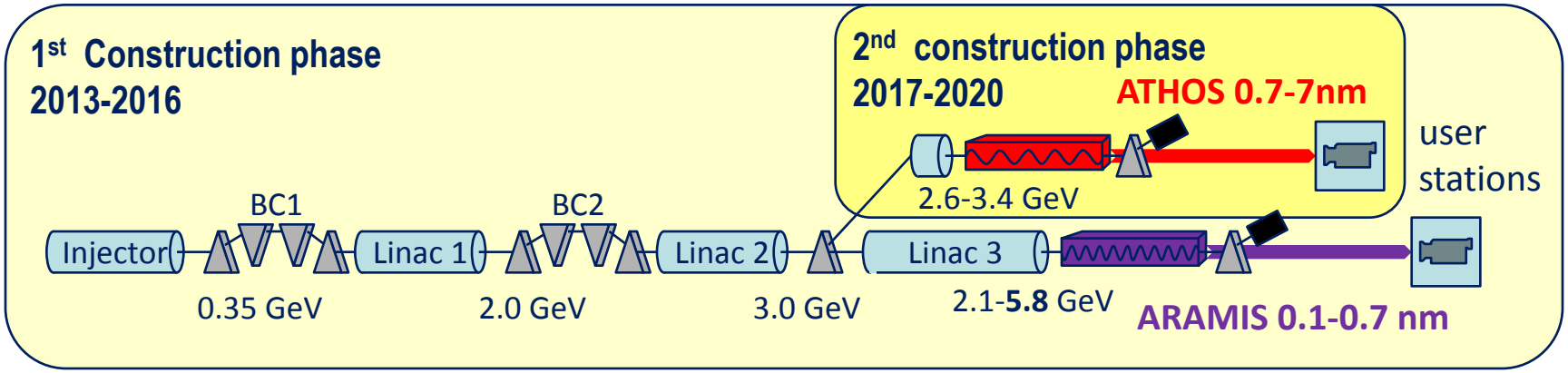
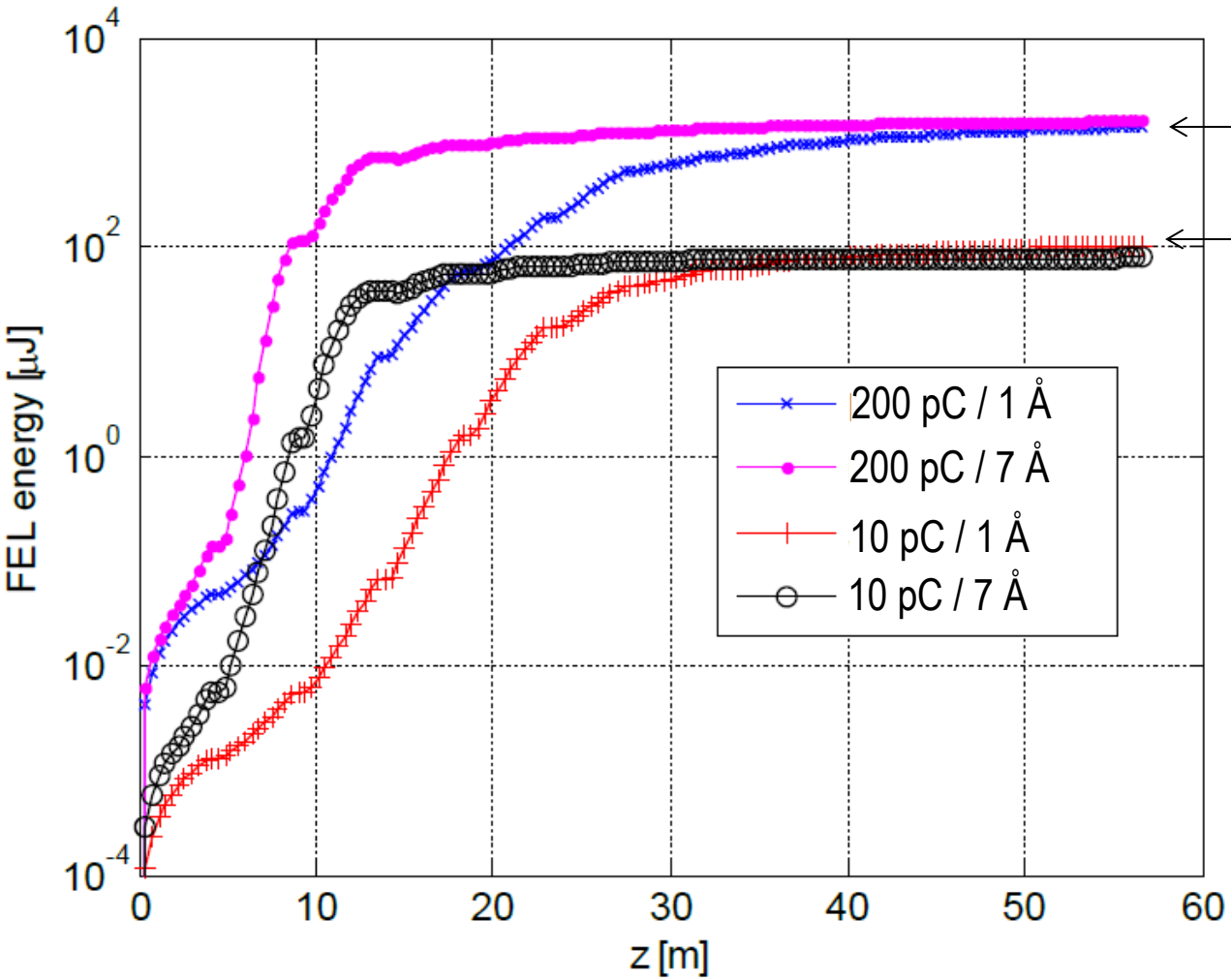
SwissFEL Layout



Main parameters

Pulse duration	1 fs - 20 fs
e^- Bunch charge	10-200 pC
Repetition rate	100 Hz

Aramis Hard X-Ray FEL line performances



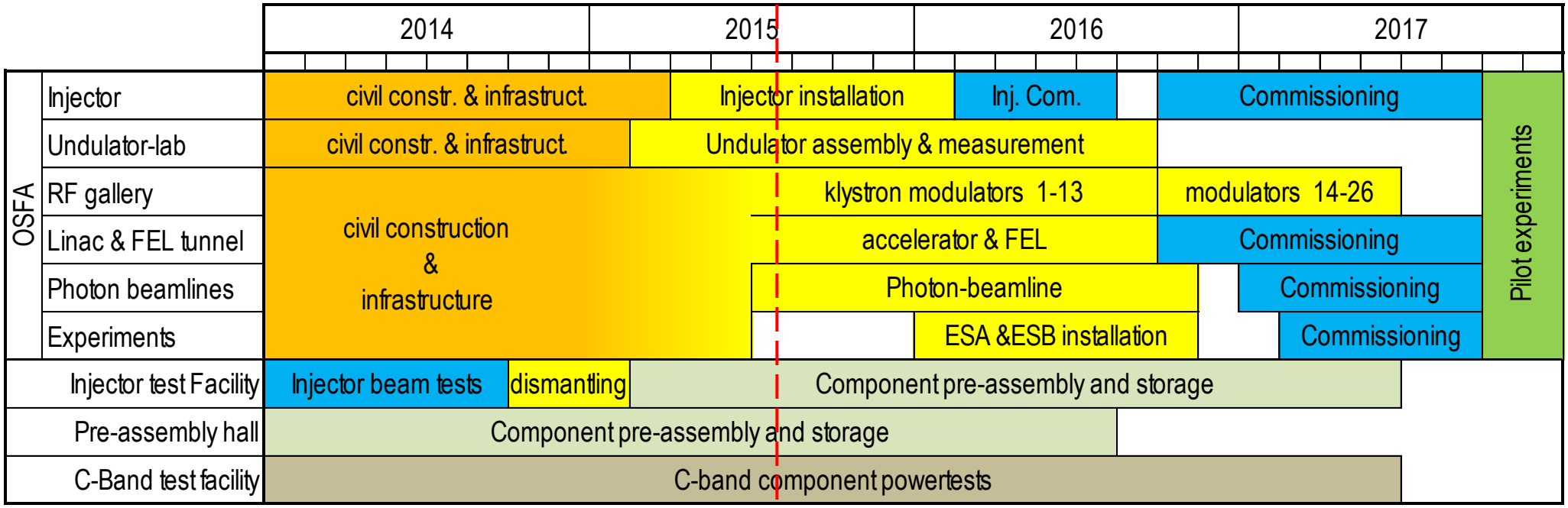
Long Pulses (200 pC): 1.4 mJ – 18 fs rms

Short Pulses (10 pC): 0.1 mJ – 1.5 fs rms

Best case assuming $\varepsilon_{n,slice}$= 0.2 µm
(see TUC03 this conference)

Genesis Simulations – Courtesy of S. Reiche / E. Prat

SwissFEL timeplan



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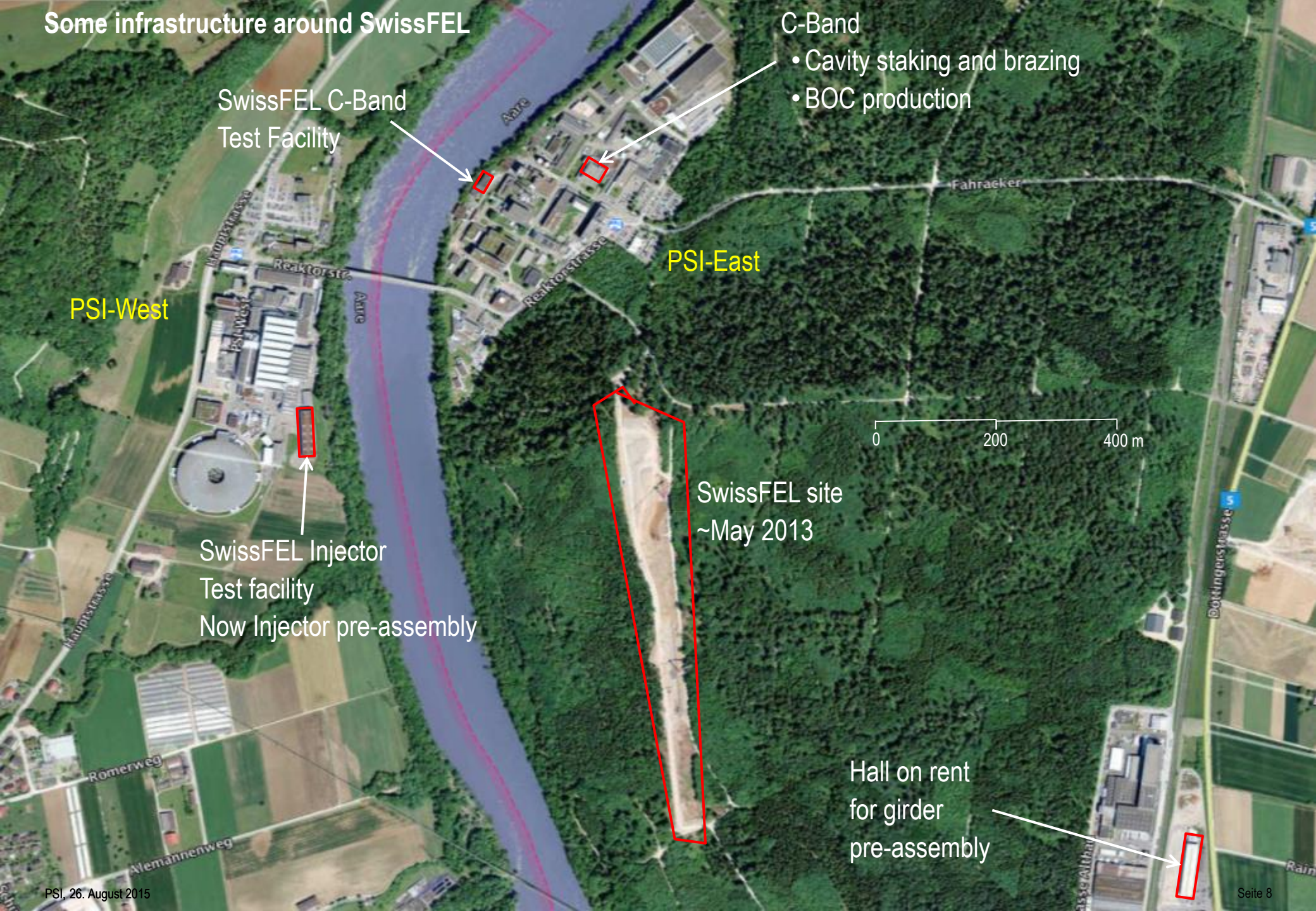
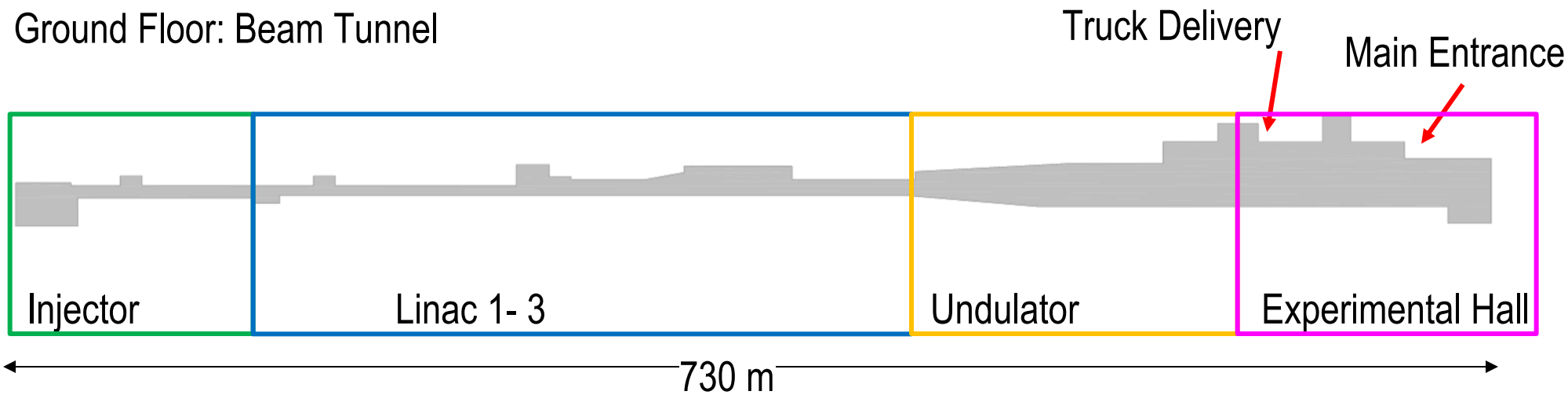
Some infrastructure around SwissFEL



Building Layout

1st Floor: Infrastructure gallery

Ground Floor: Beam Tunnel

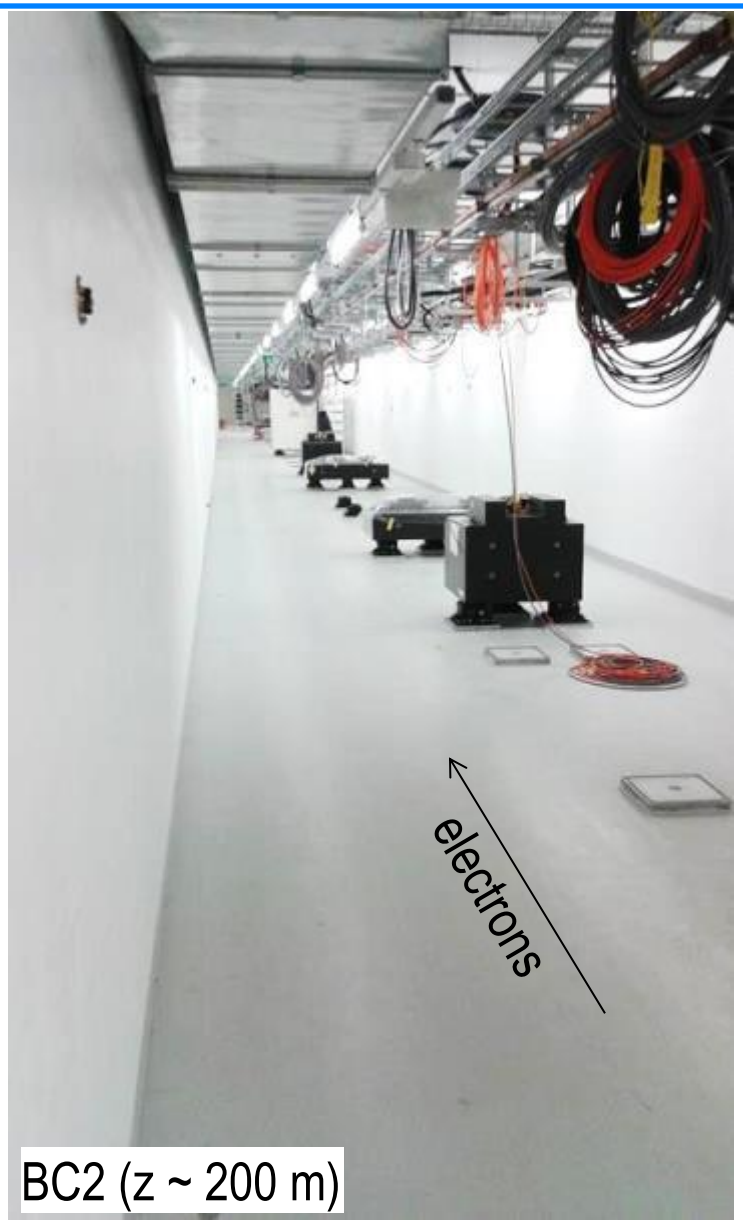


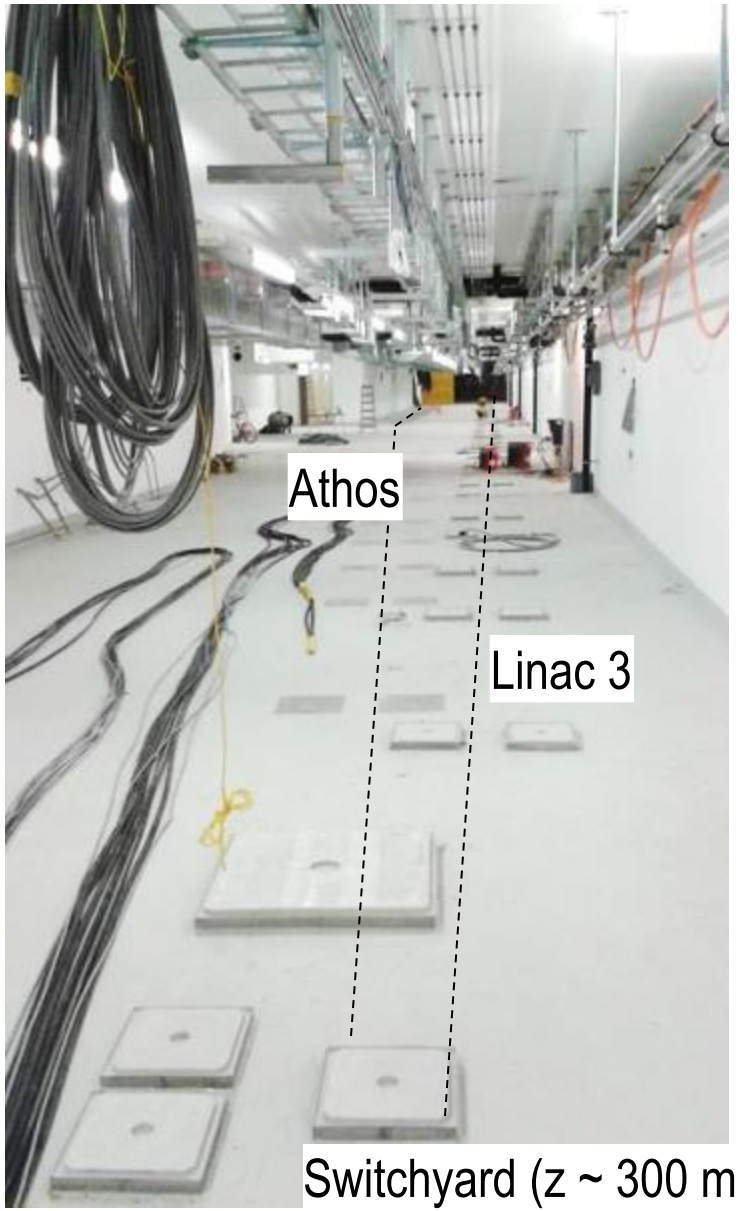
SwissFEL Tunnel

Electron Gun (z ~ 0 m)

Tunnel: BC1 (z ~ 60 m)

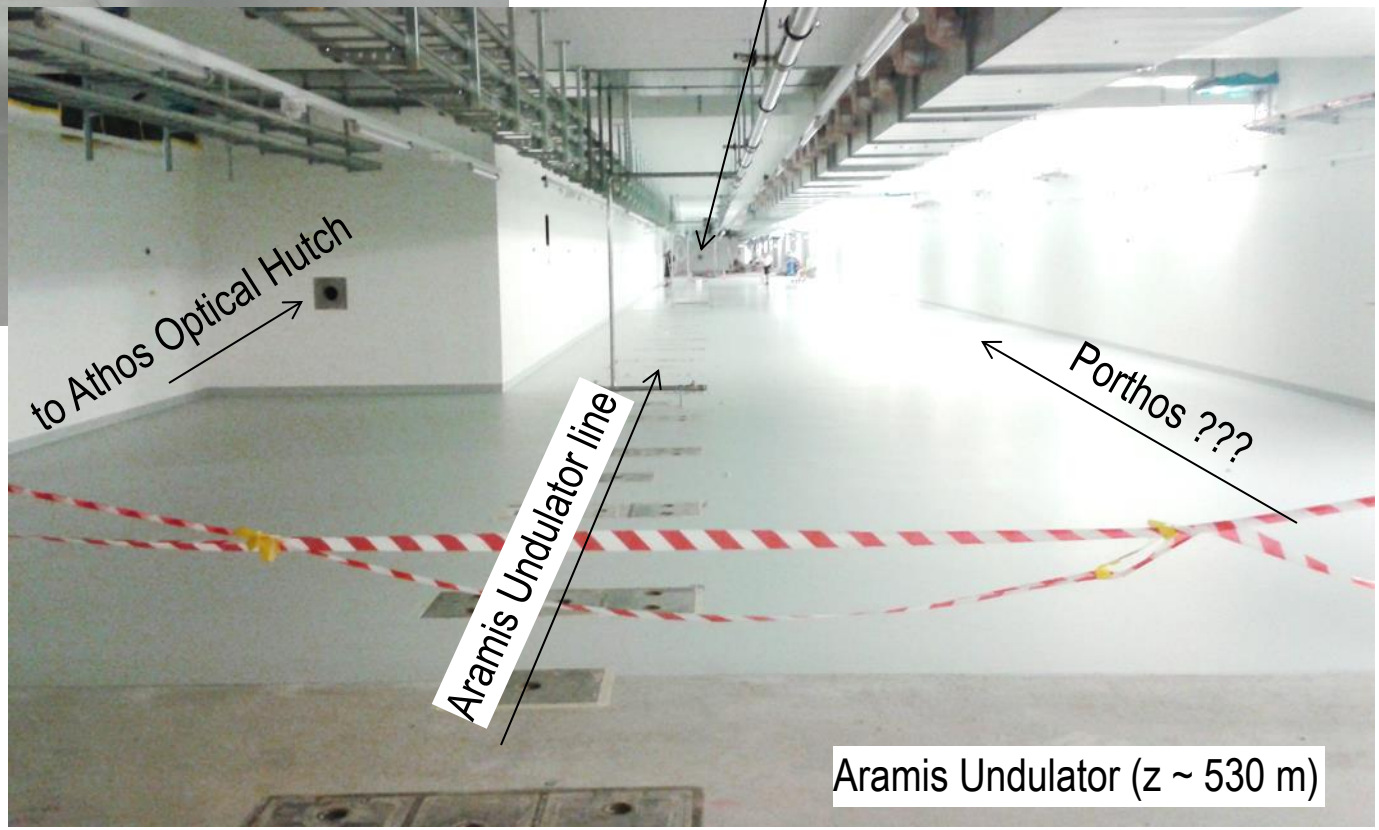
SwissFEL Tunnel





Undulator Hall

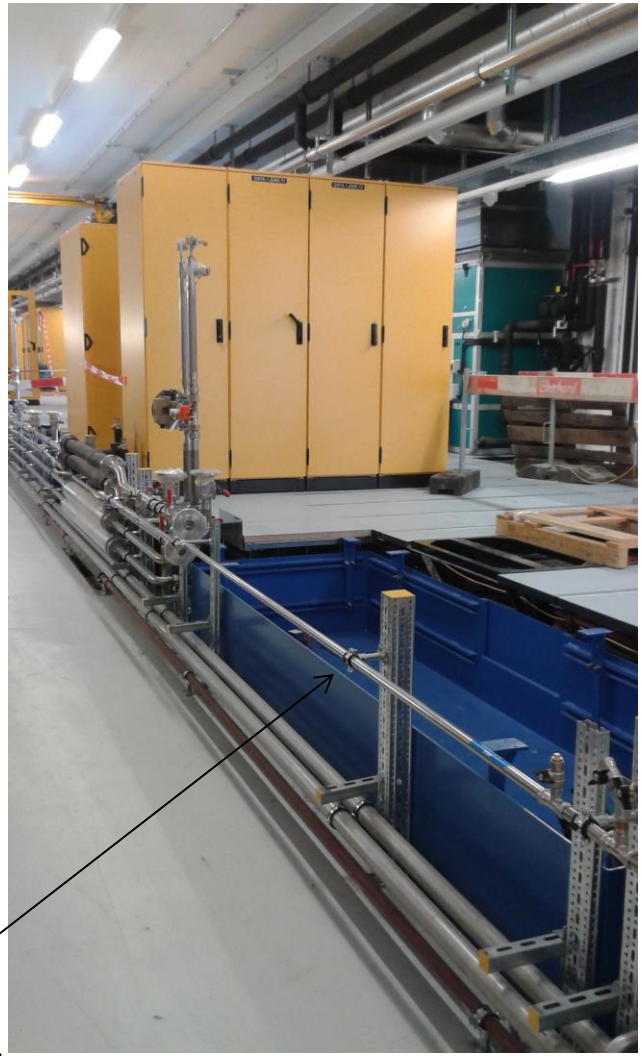
Athos Undulator / Linac 3 (z ~ 460 m)



Technical gallery

Rack gallery above injector

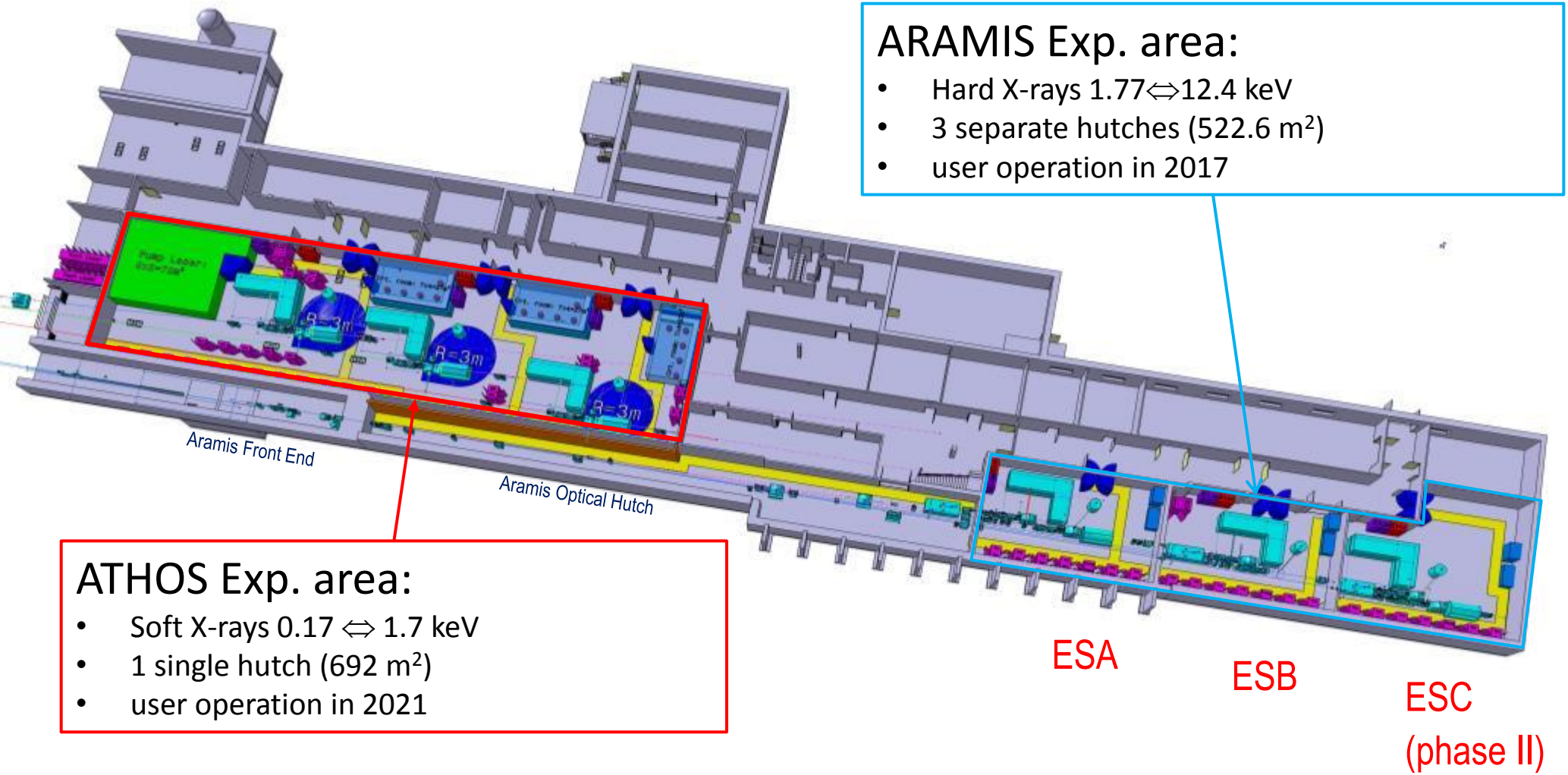
Future location of S band Modulators



Future location of a C band Modulator

Rack gallery above Linac 1

Overview Experimental Area



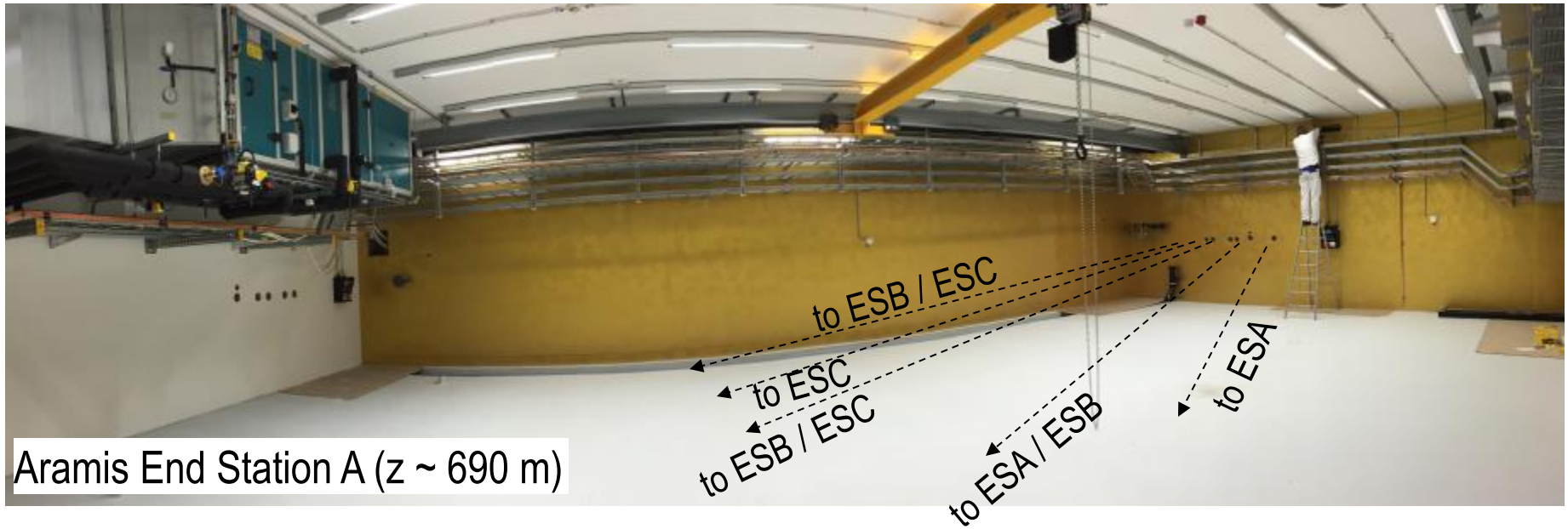
ARAMIS Exp. area:

- Hard X-rays 1.77⇔12.4 keV
- 3 separate hutches (522.6 m^2)
- user operation in 2017

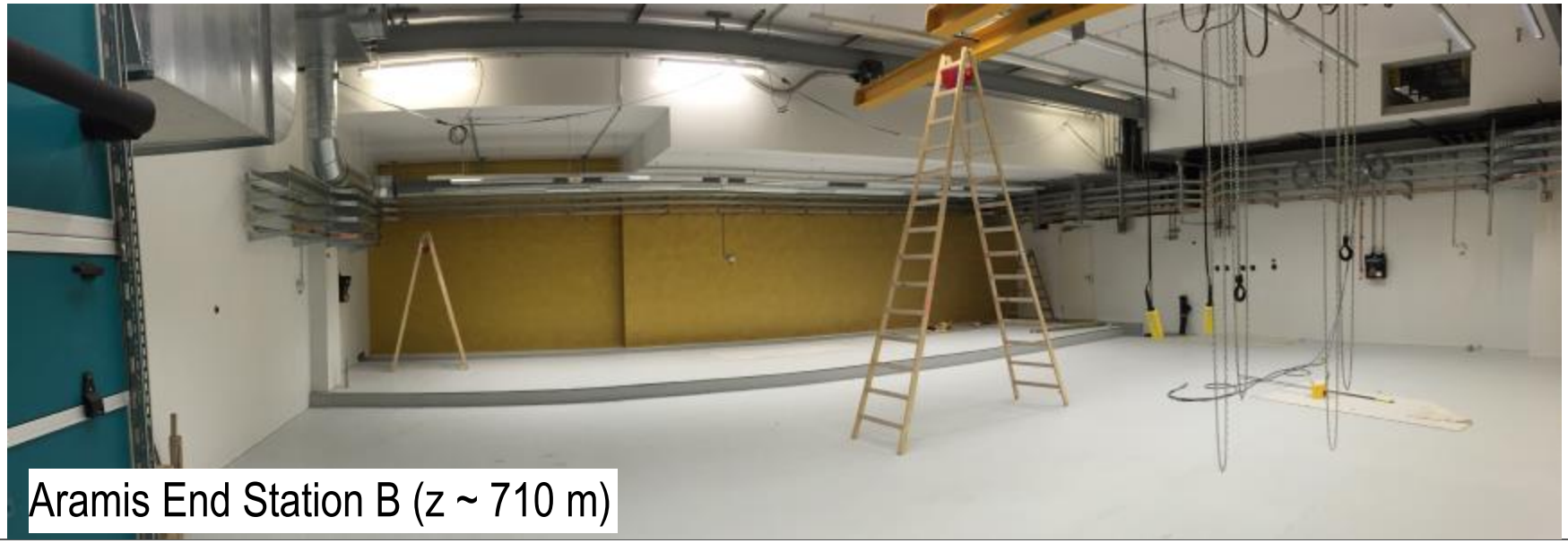
ATHOS Exp. area:

- Soft X-rays 0.17 ⇔ 1.7 keV
- 1 single hutch (692 m^2)
- user operation in 2021

SwissFEL End Stations A & B



Aramis End Station A (z ~ 690 m)



Aramis End Station B (z ~ 710 m)

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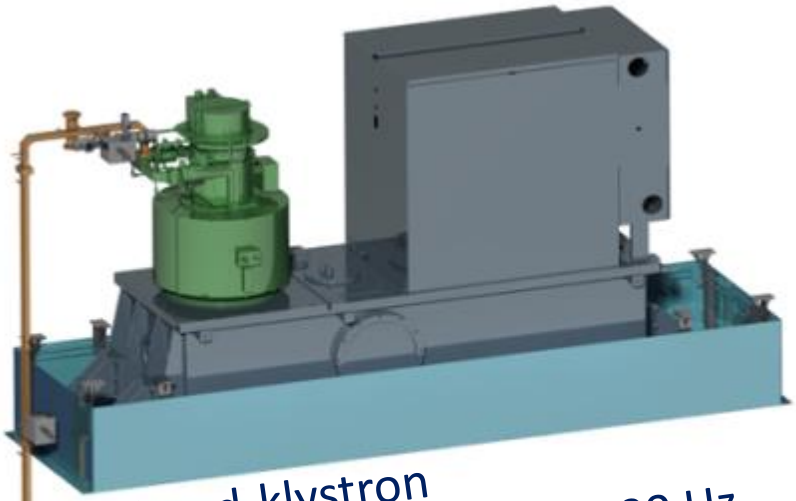
SwissFEL main Linac module

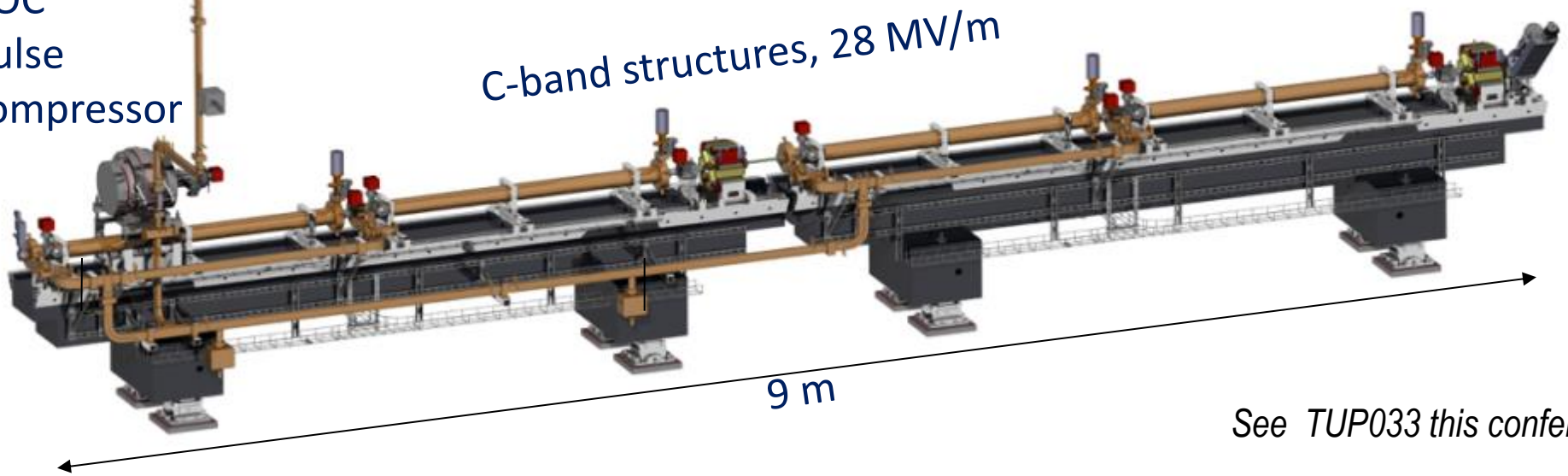


C-band-klystron
5.7 GHz, 50 MW, 3 µs, 100 Hz

Energy Gain:	220 MeV / module
Number of modules:	26

BOC
pulse
compressor

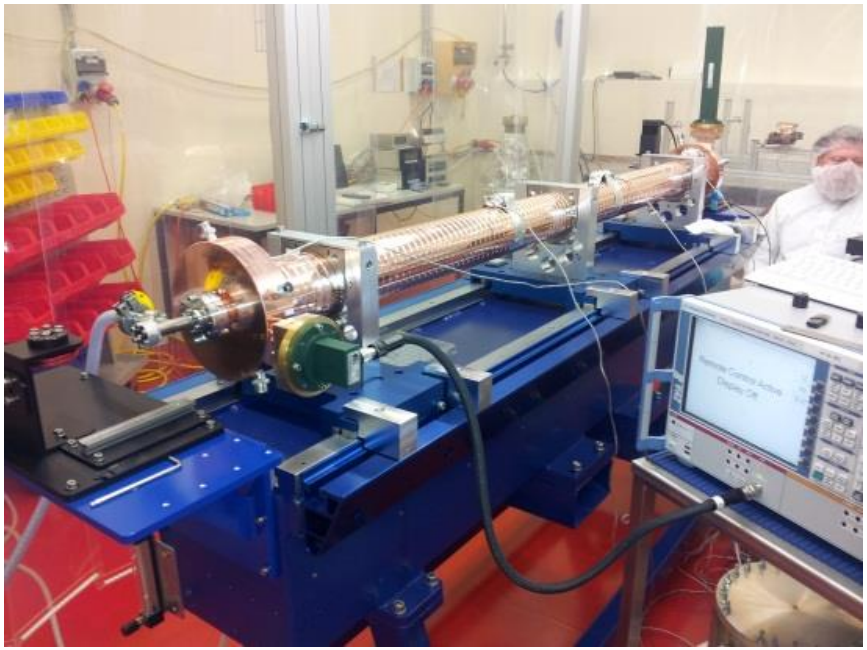
C-band structures, 28 MV/m



9 m

See TUP033 this conference

C Band Structures production



C Band structures brazed and measured at PSI

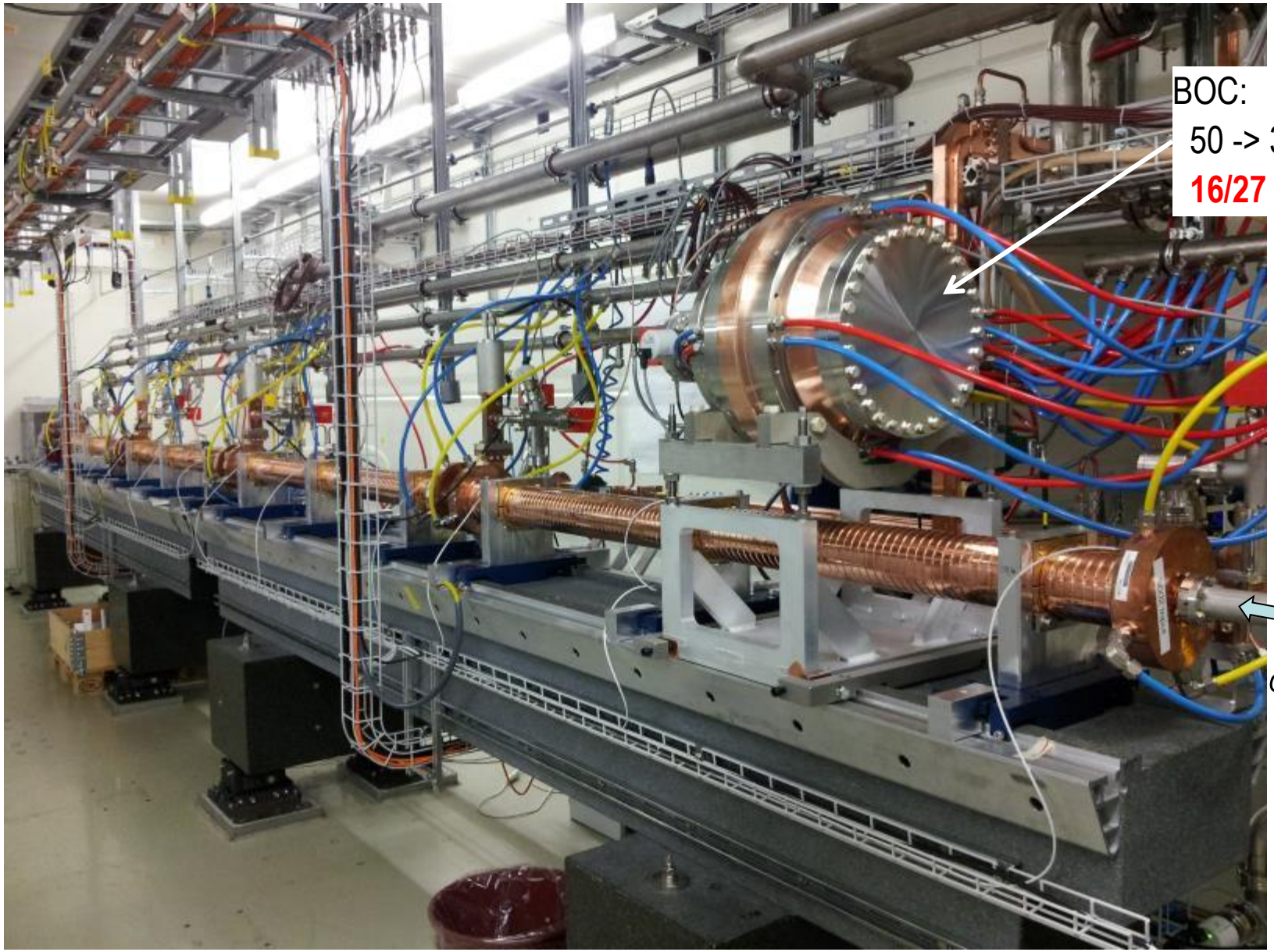
- **46 / 104** structures are ready
- **1 to 2 units / week**

C band Components available via Advanced Accelerator Technologies AG

- **High power results for first structure:**
  - → conditioned to 54 MV / m
  - → At nominal 28MV/m, break-down rate negligible

Courtesy of R. Zennaro

Assembly of First Linac Module for in the RF test stand building



RF Modulators

2 prototypes at PSI : 50 MW / 3µs RF, 370kV / 344A

Spring 2015: < 20 ppm voltage stability pulse to pulse @ 100 Hz

AMPEGON

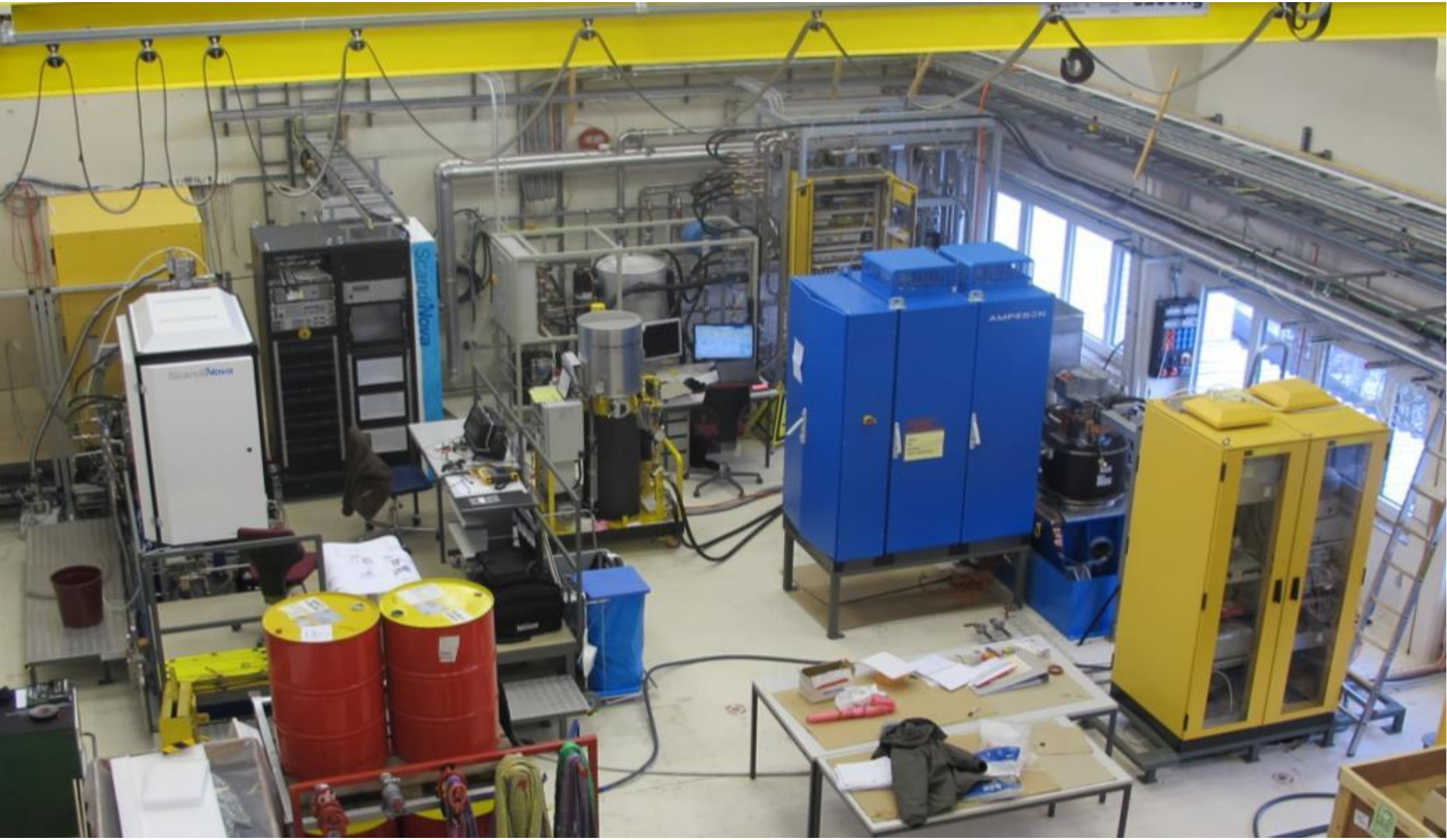
Type-µ modulator prot. for PSI C-band

ScandiNova

K2-3 proto. for PSI C-band

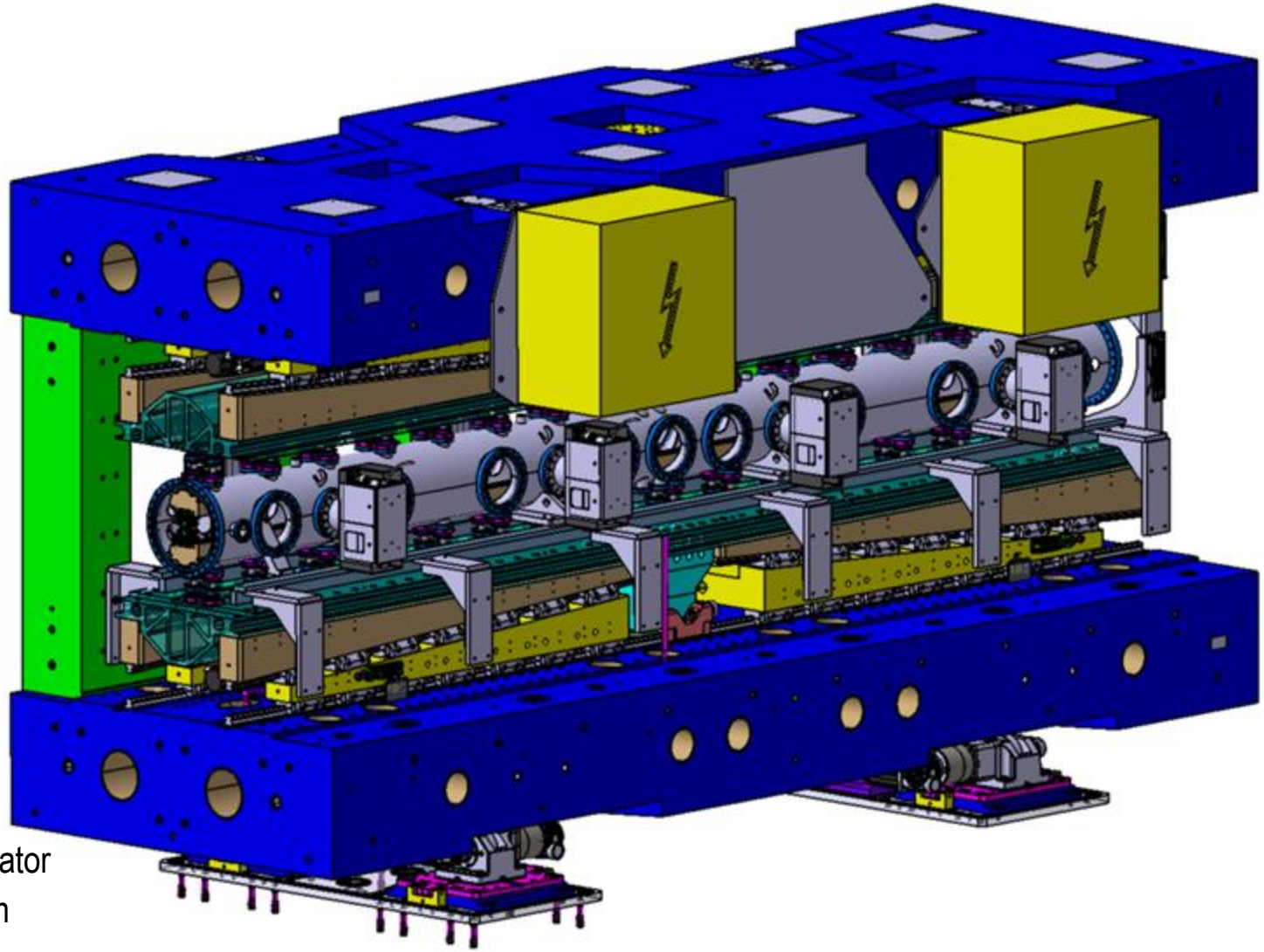
- Order: summer 2015 for 26 units
- Delivery rate: 2 modulators/month
- Goal: 13 modulators operating end of September 2016 (Linac 1 & 2 => 3 GeV)
  26 modulators in spring 2017

Both Modulators at PSI's C-Band Test Area



Undulator sub-components delivery

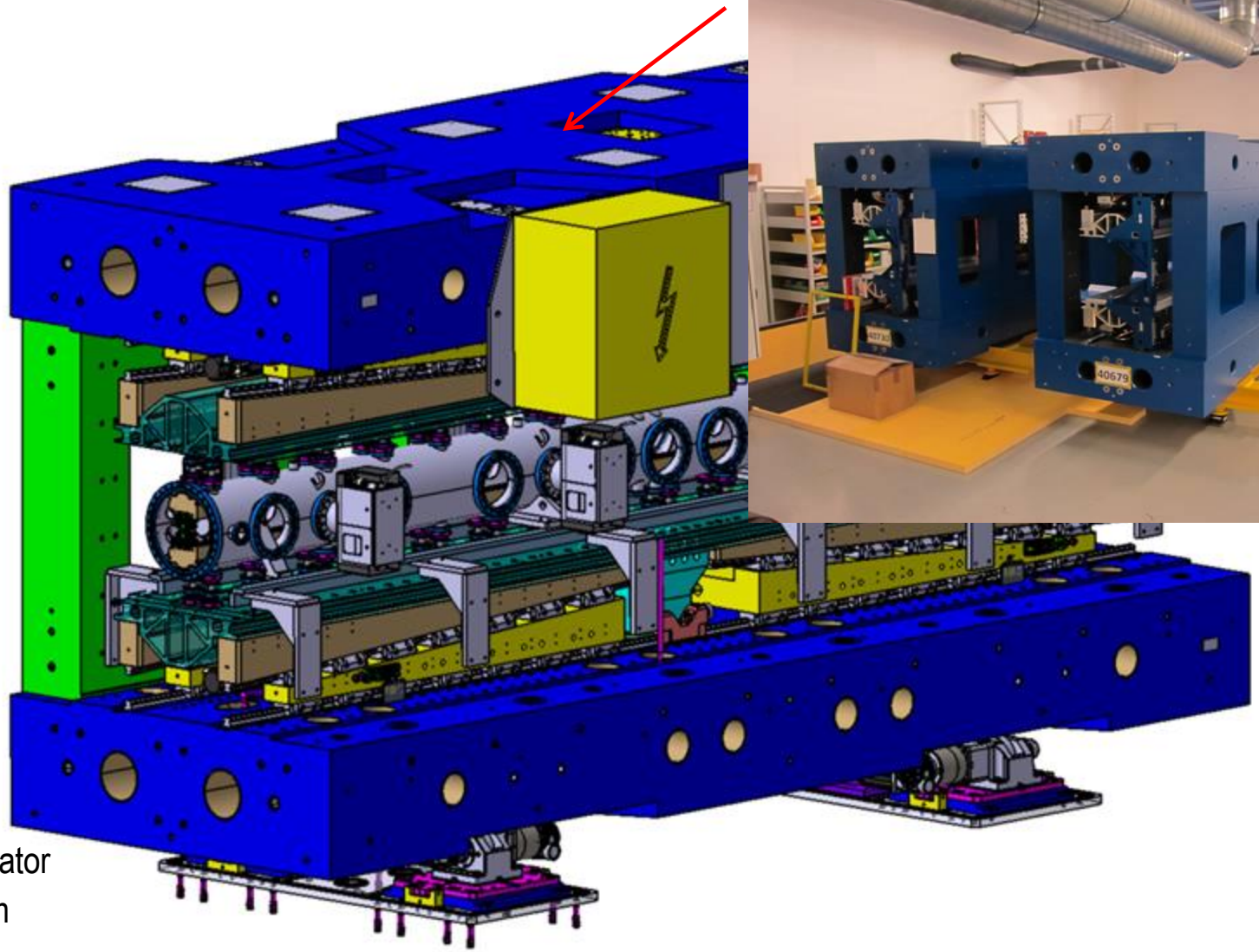
Undulator frames : 9/13 ready



In Vacuum Undulator
Hybrid, λ_u=15 mm
K ~ 0.9 -1.8

Undulator sub-components delivery

Undulator frames : 9/13 ready



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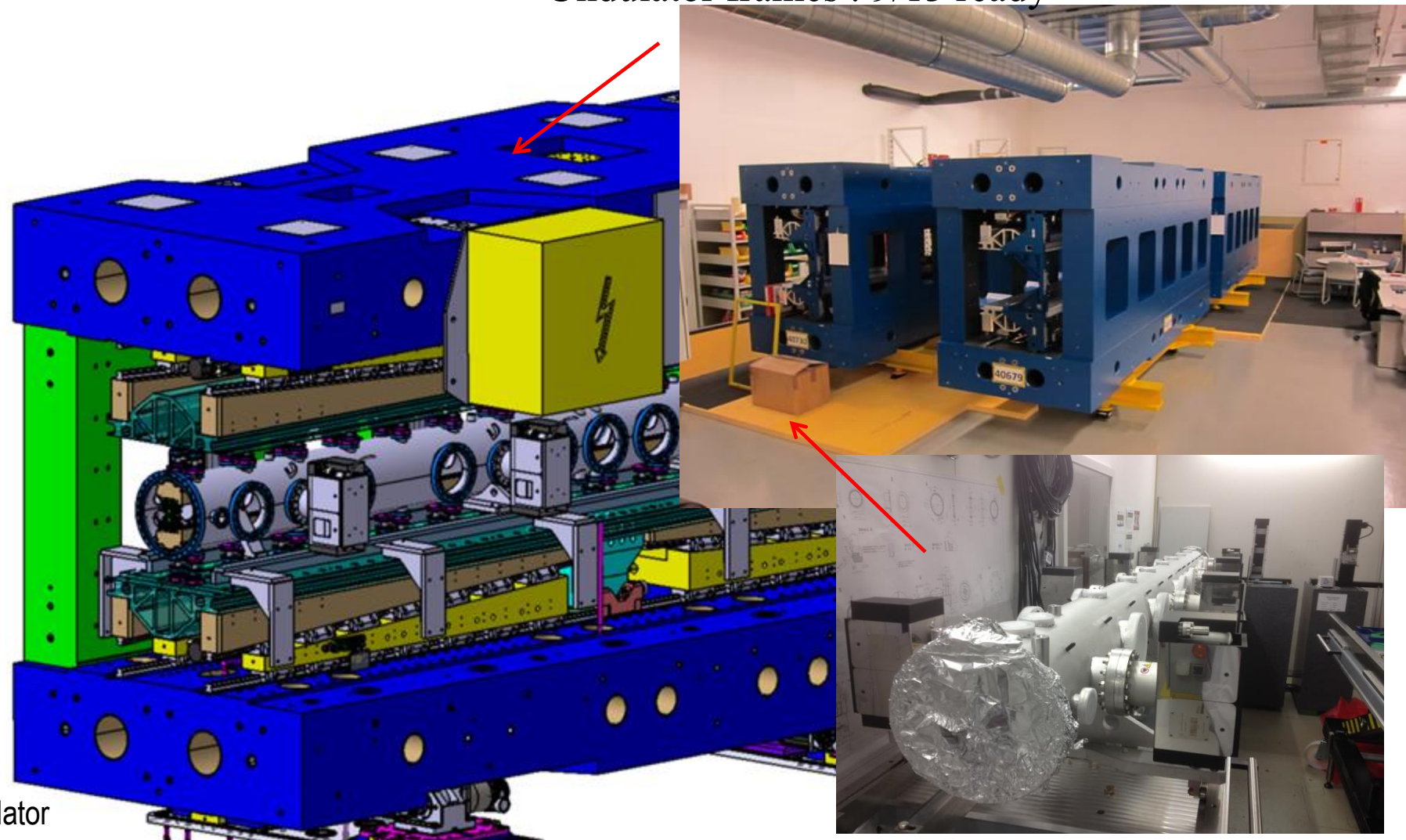


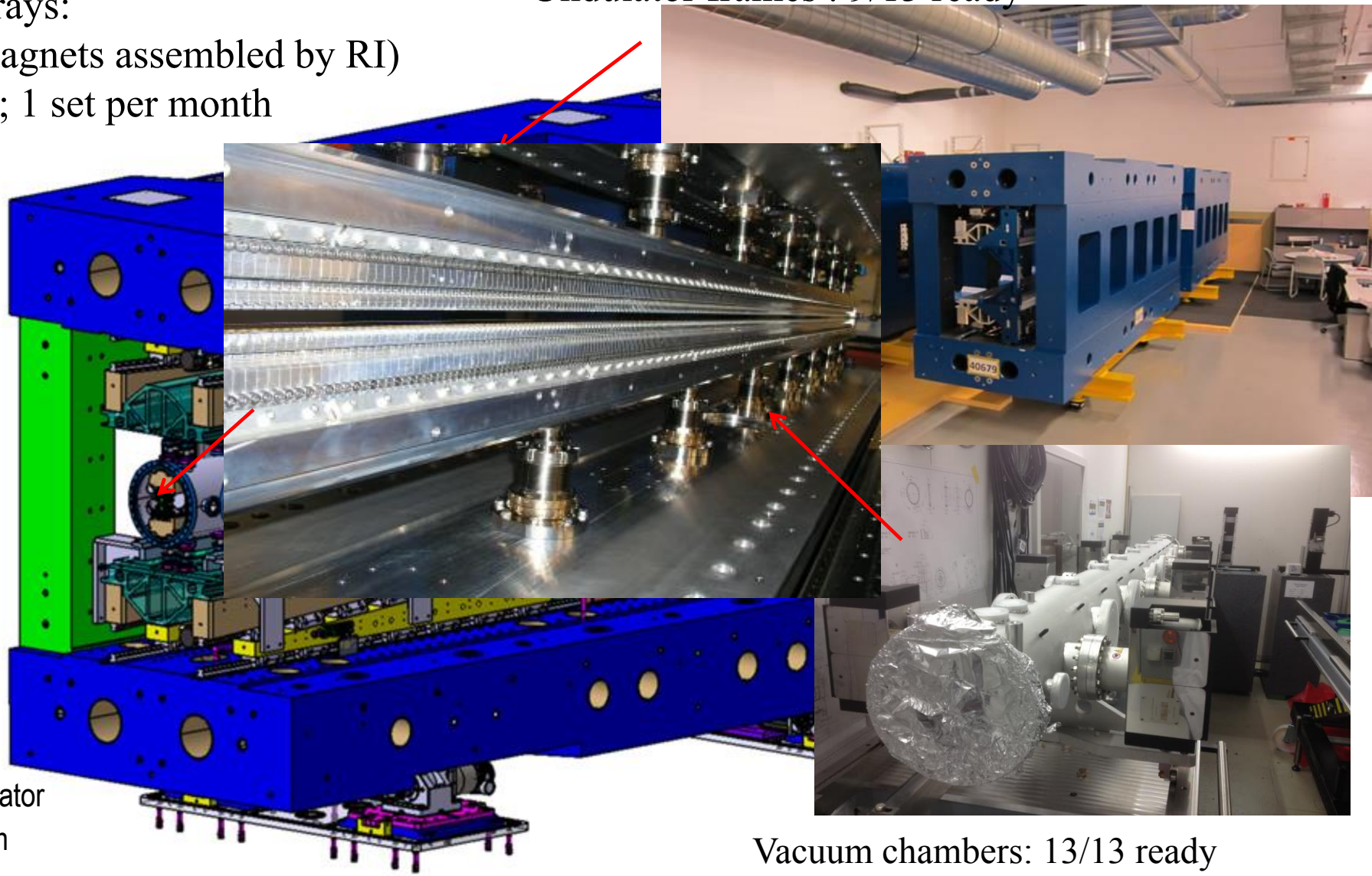
Vacuum chambers: 13/13 ready

In Vacuum Undulator
Hybrid, λ_u=15 mm
K ~ 0.9 -1.8

Undulator sub-components delivery

Magnet arrays:
(Hitachi magnets assembled by RI)
4/13 ready; 1 set per month

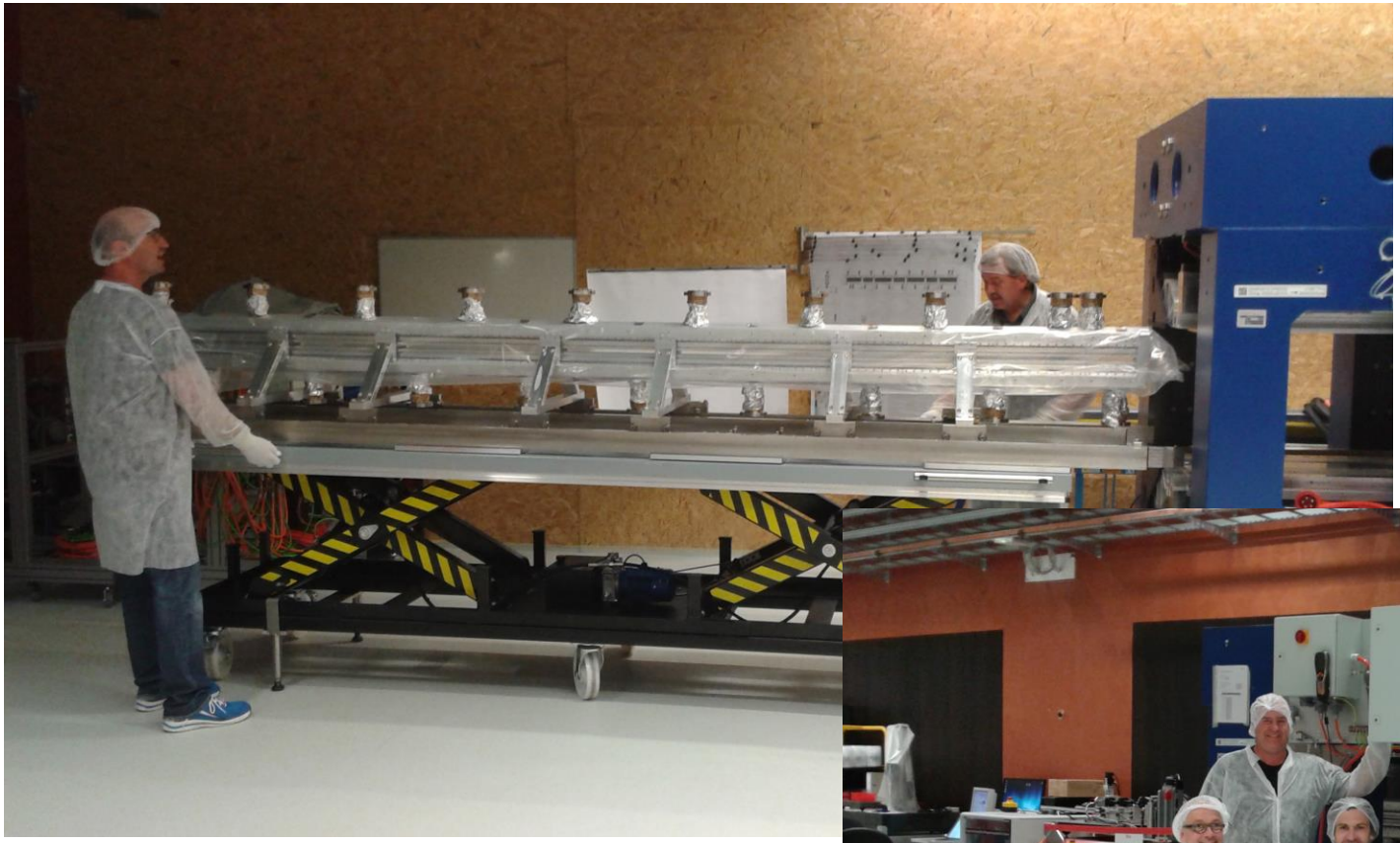
Undulator frames : 9/13 ready



In Vacuum Undulator
Hybrid, λ_u=15 mm
K ~ 0.9 -1.8

Vacuum chambers: 13/13 ready

U15 Assembly and Optimization Status

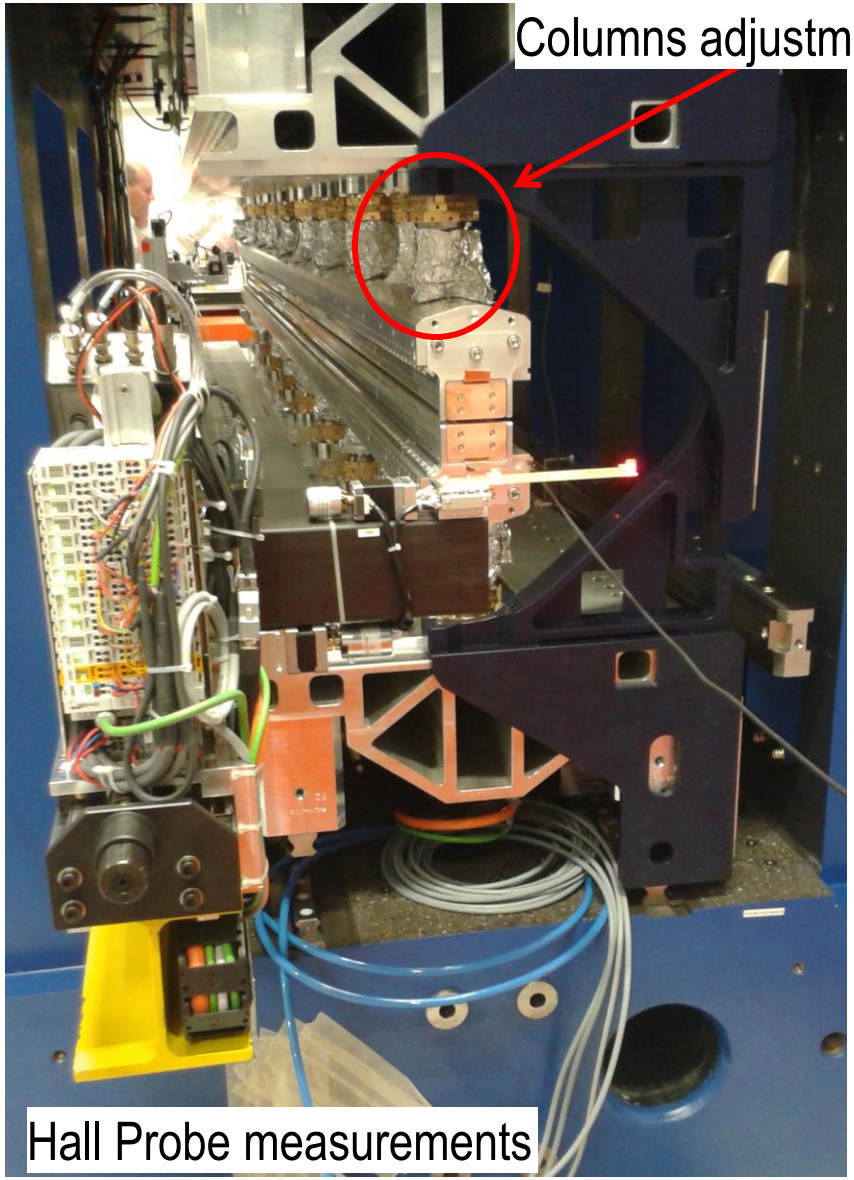


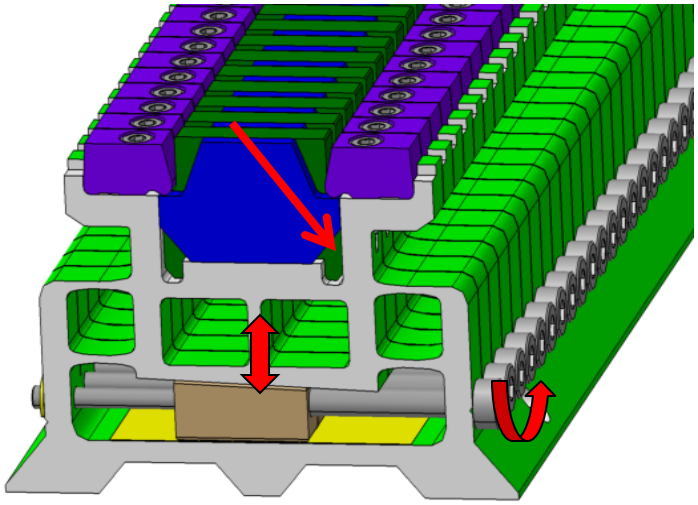
Magnet arrays inserted in the frame

Goal: 1 Undulator completed / month

U15 on his Measuring / Shimming bench

Undulator shimming procedure

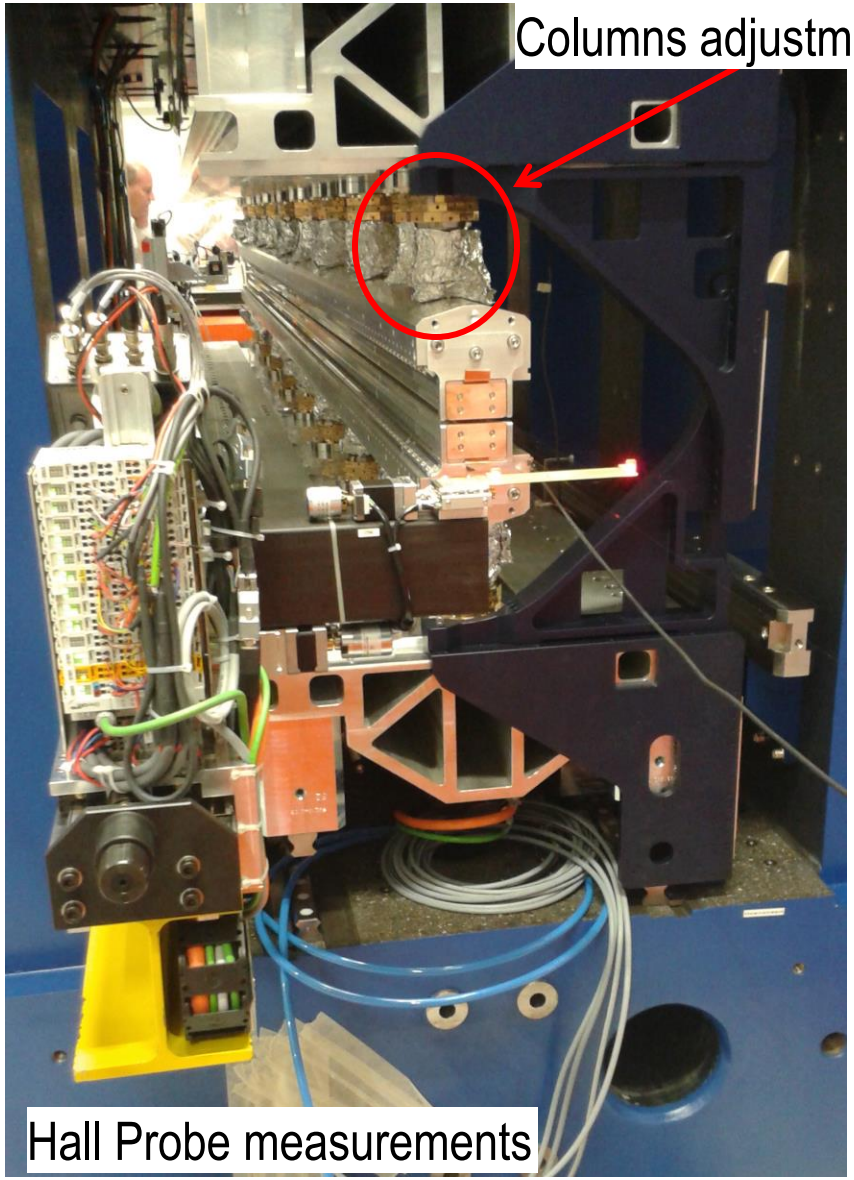




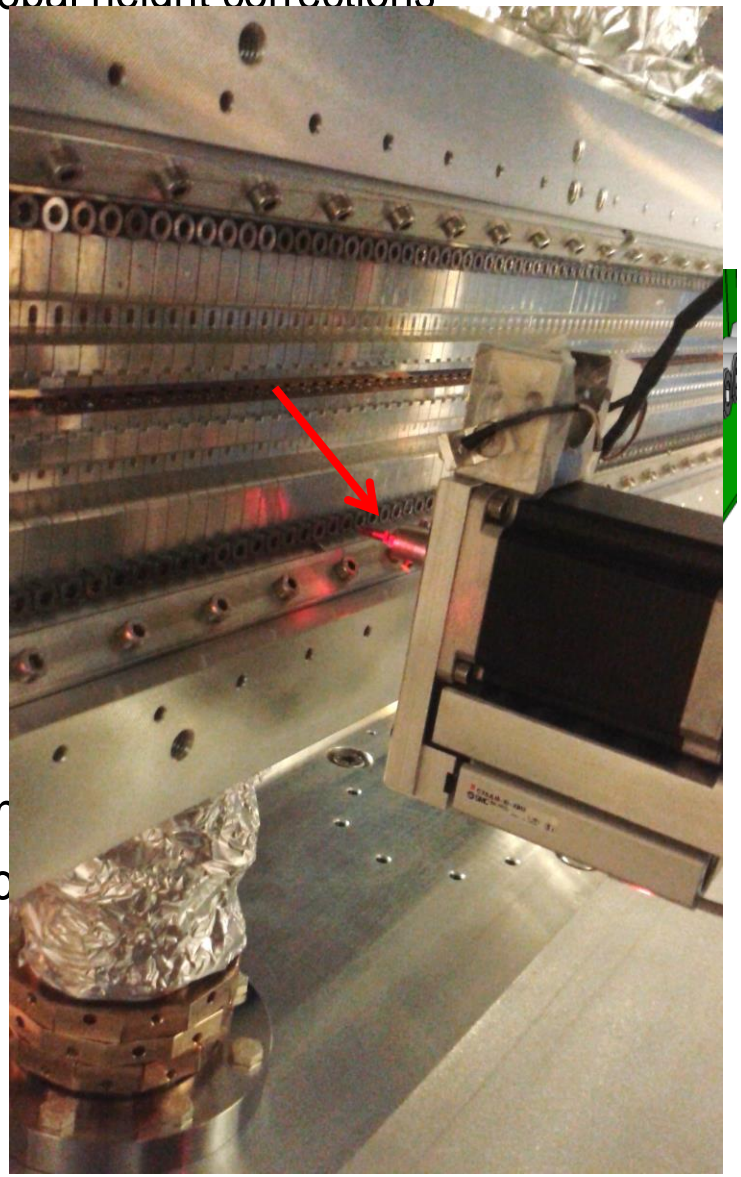
Individual Pole Height adjustment for local height corrections

Undulator shimming procedure

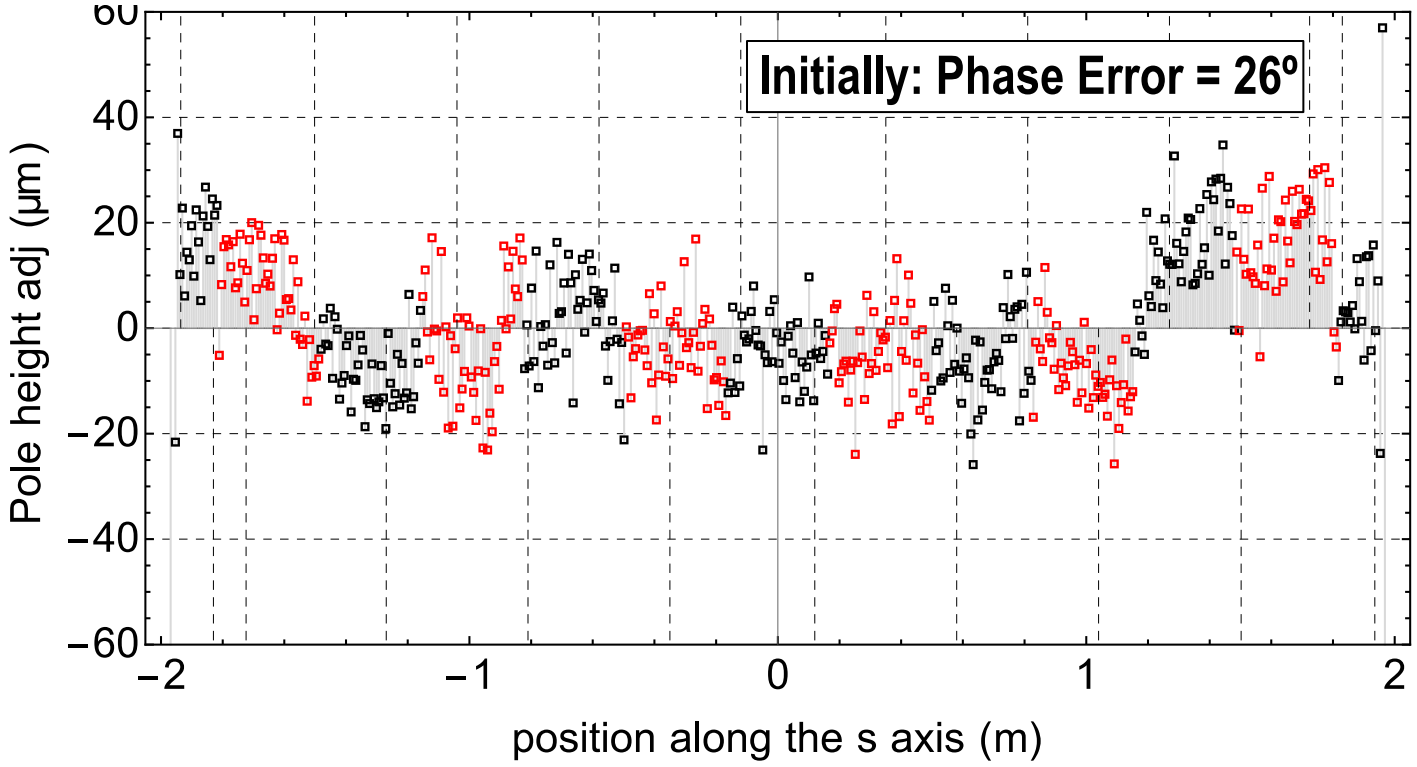
Columns adjustment for global height corrections



Hall Probe measurements

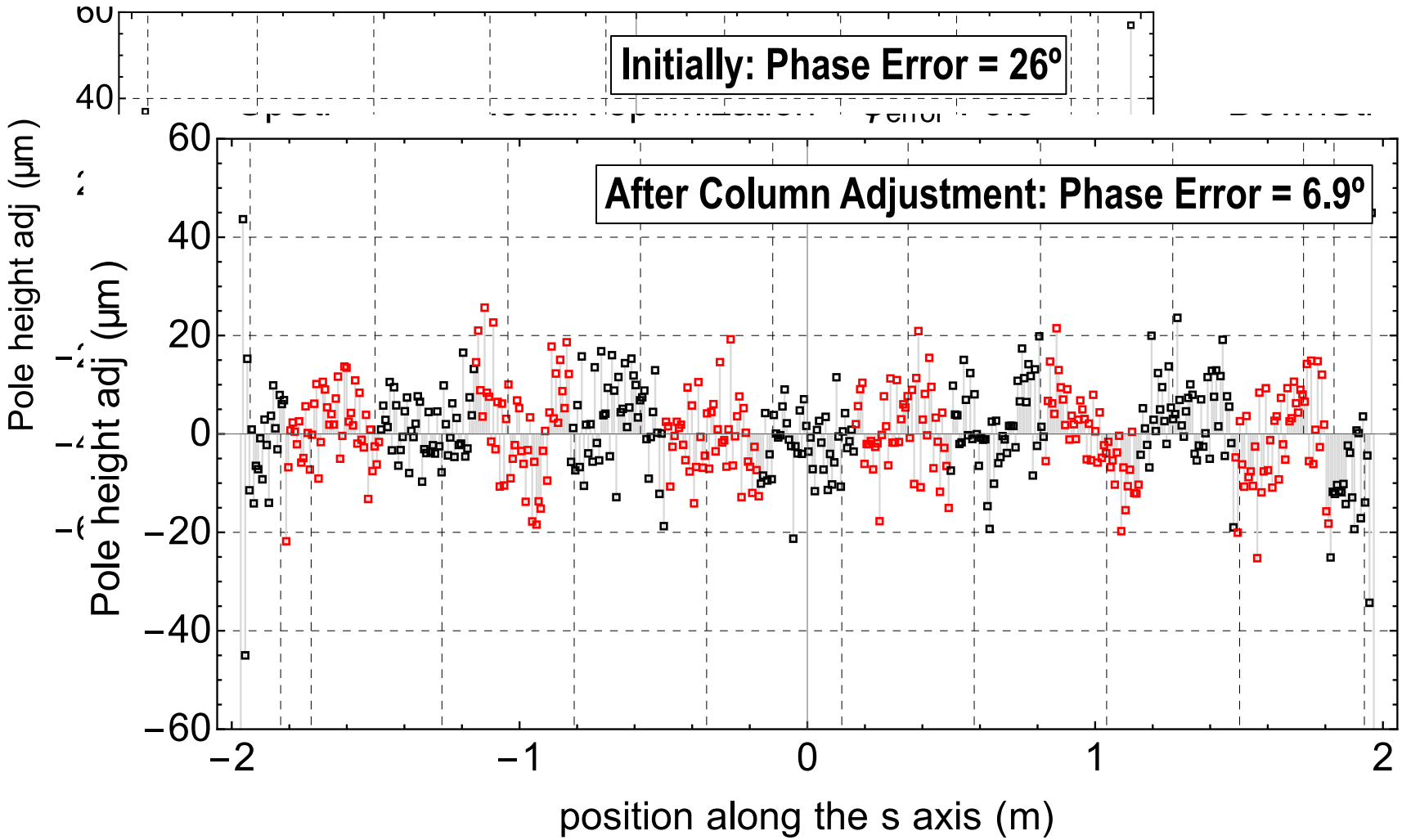


Undulator shimming



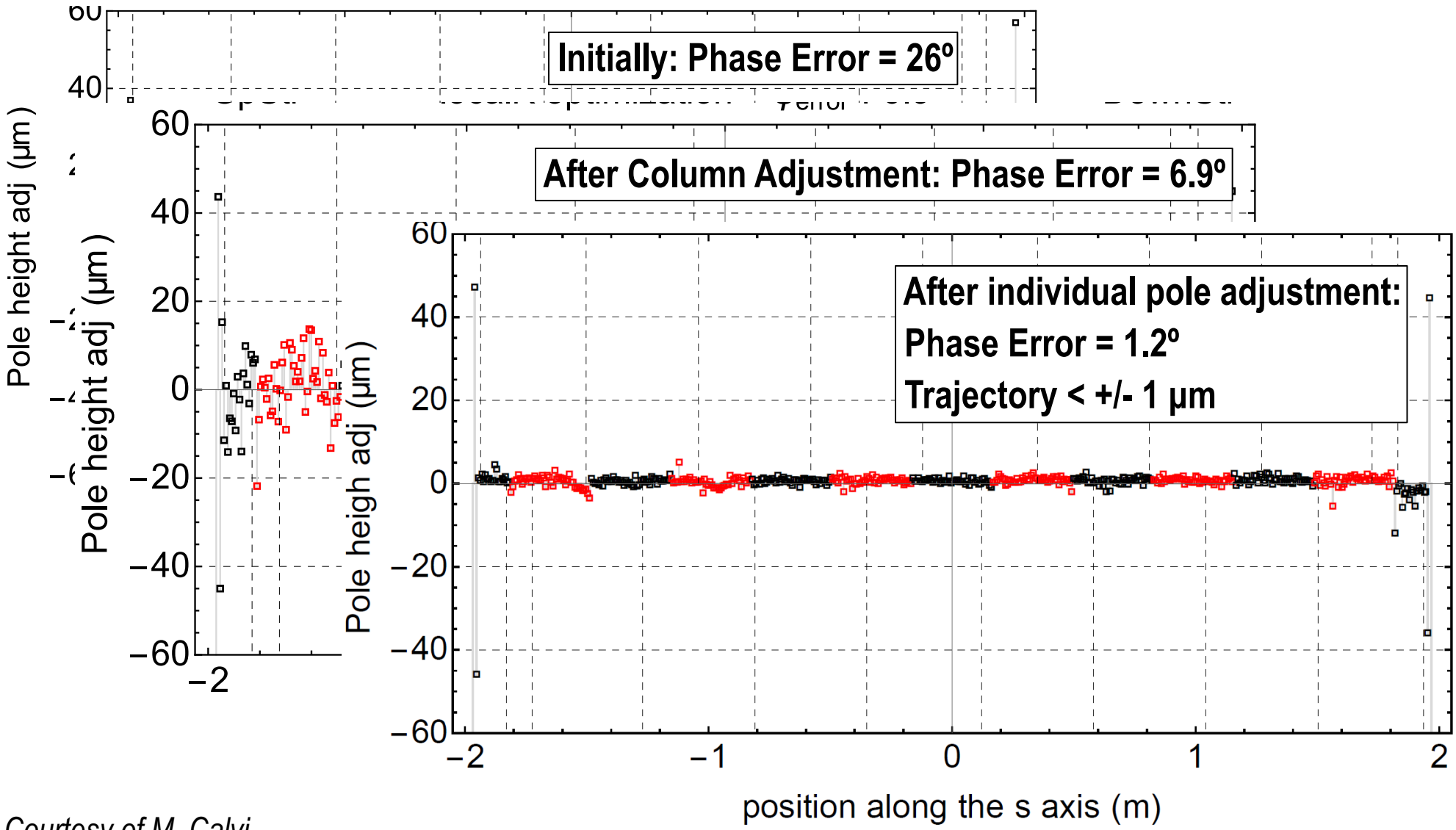
Courtesy of M. Calvi

Undulator shimming



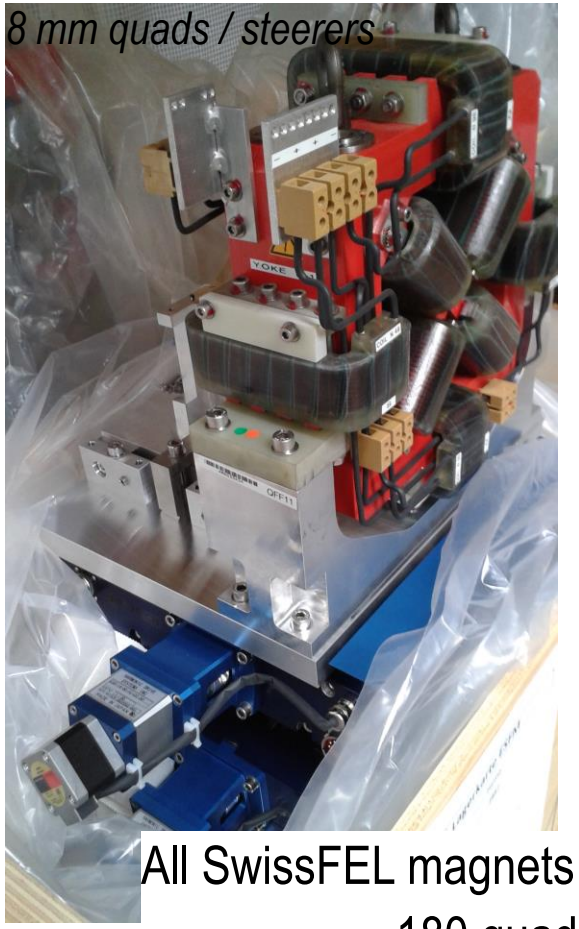
Courtesy of M. Calvi

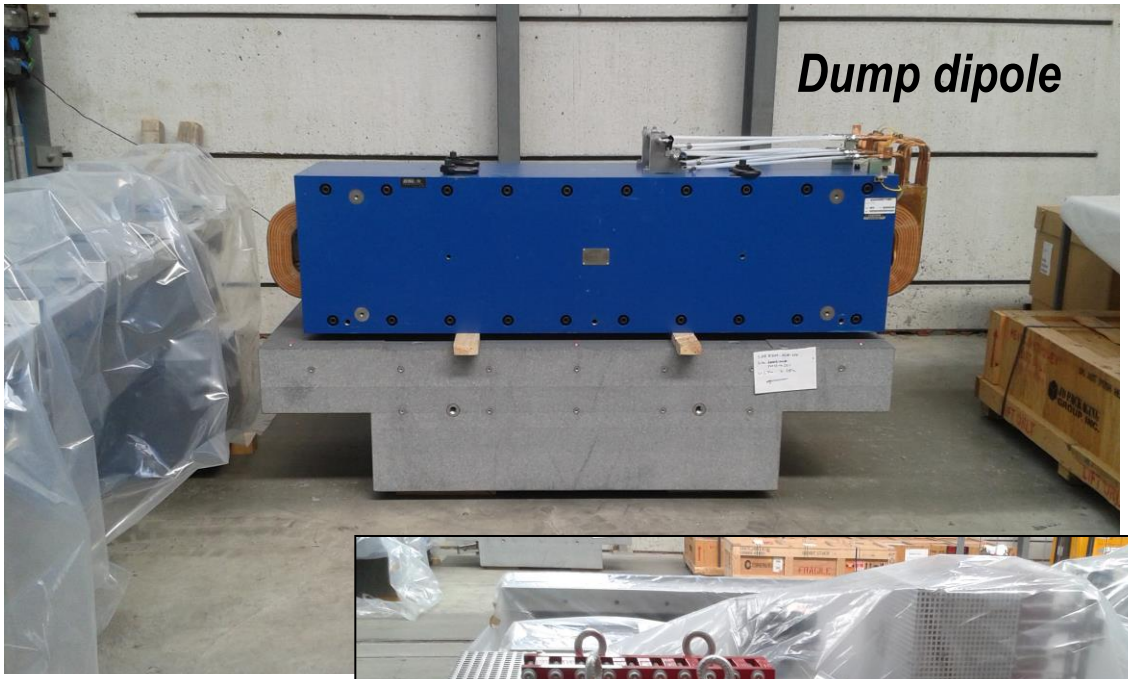
Undulator shimming

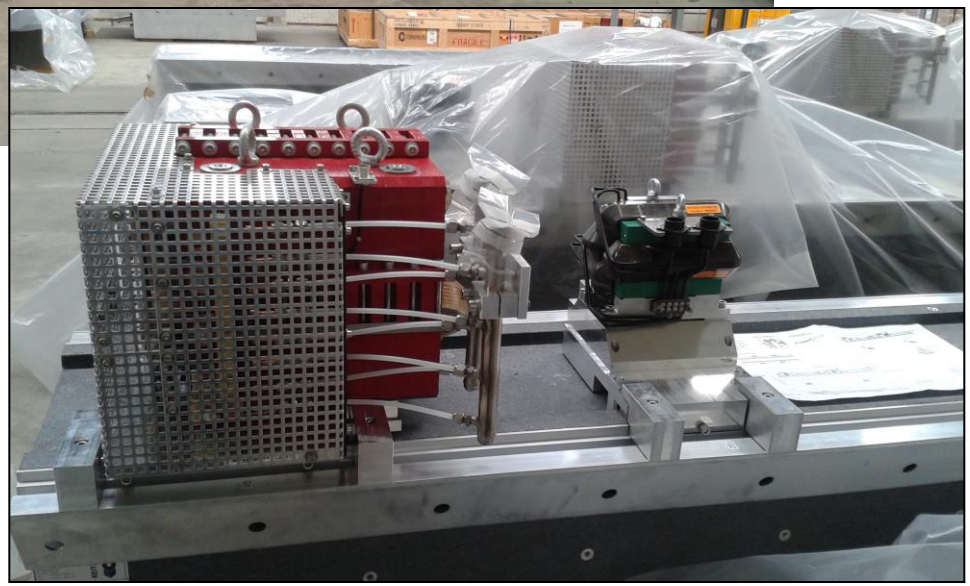


Courtesy of M. Calvi

Many other components tested …





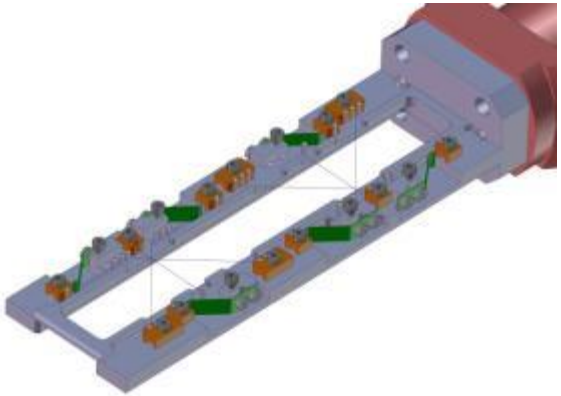


Magnets:

All SwissFEL magnets measured and ready:

- 180 quads of various types
- 35 dipoles
- 210 steerers pairs (X-Y)
- Sextupoles, …

Many other components tested …



Electron Beam Diagnostic

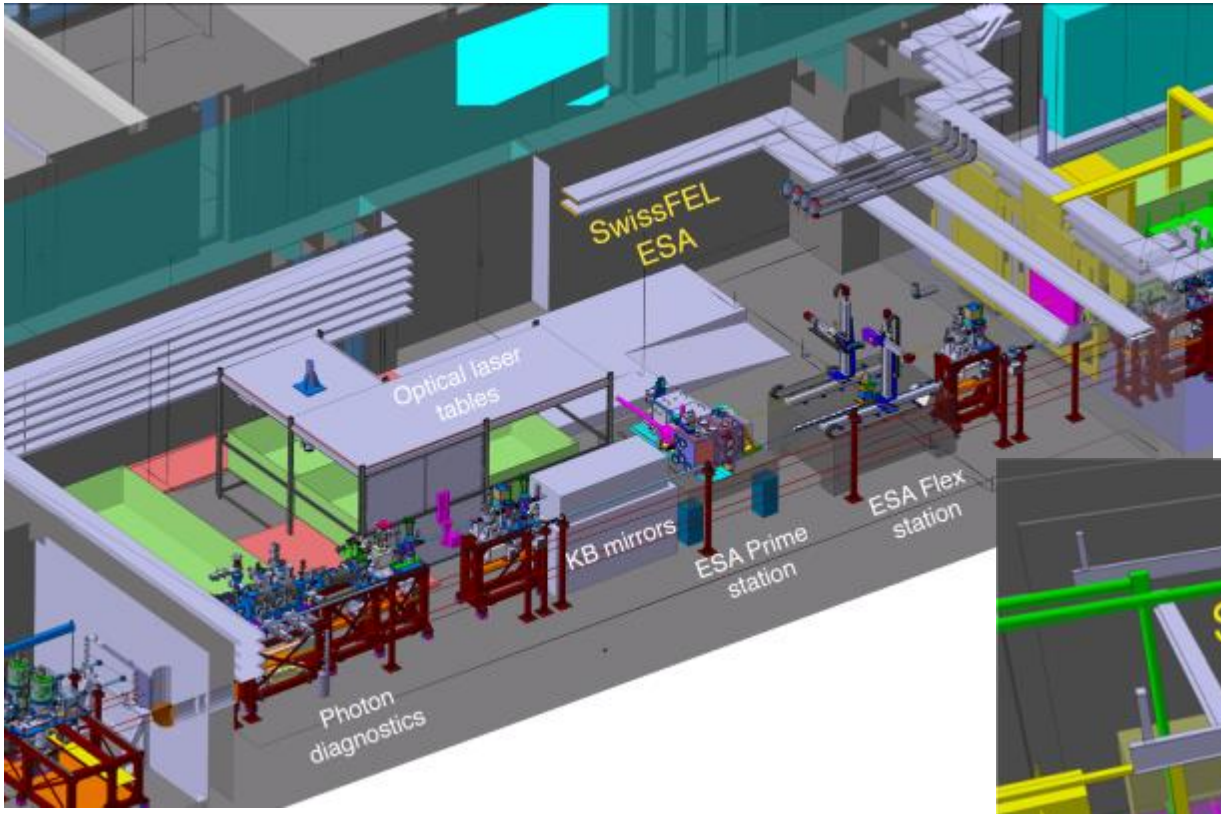
Wire Scanner tested at FERMI - Trieste

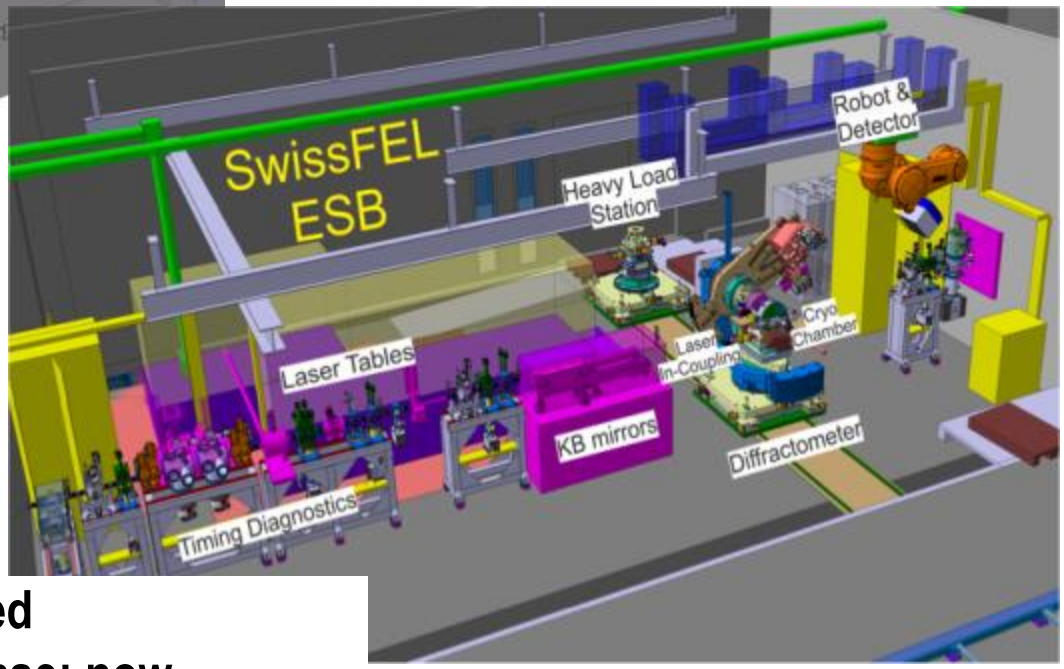
Beam size < 50 µm, 1.5 GeV, 5 µm tungsten wire;

See MOP034 this conference

Courtesy of G. Orlandi

ESA & ESB: Experimental stations





- **End Stations A & B:** **Design Completed**
  Procurement phase: now
  Assembly: Summer 2016

Courtesy of Gerhard Ingold and Chris Milne

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Assembly of accelerator components has started…

- Vacuum, Magnets, Mechanical Supports components already available
- Diagnostics, Undulators, RF structures, Photonics components under production
- Controls, High Level Applications on design

Next Milestone: Start of Injector commissioning in March 2016

Main risks for SwissFEL schedule …

Building infrastructure delays (interface PSI / civil engineering)

RF Solid State Modulators development & procurement: critical path of project

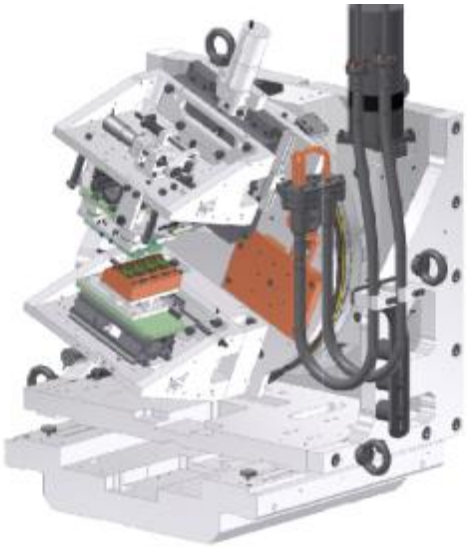
Side rooms

Gun Laser Room

Undulator Assembly Room

Photonic Components

X ray FEL Pulse Energy and Position Monitor at PSI
(procured by DESY)



Double Crystal Monochromator:
Delivery Oct. 2015

Offset Mirrors : Mid 2016

Optical surface: 630 x 30 mm^2

Roughness < 0.2 nm

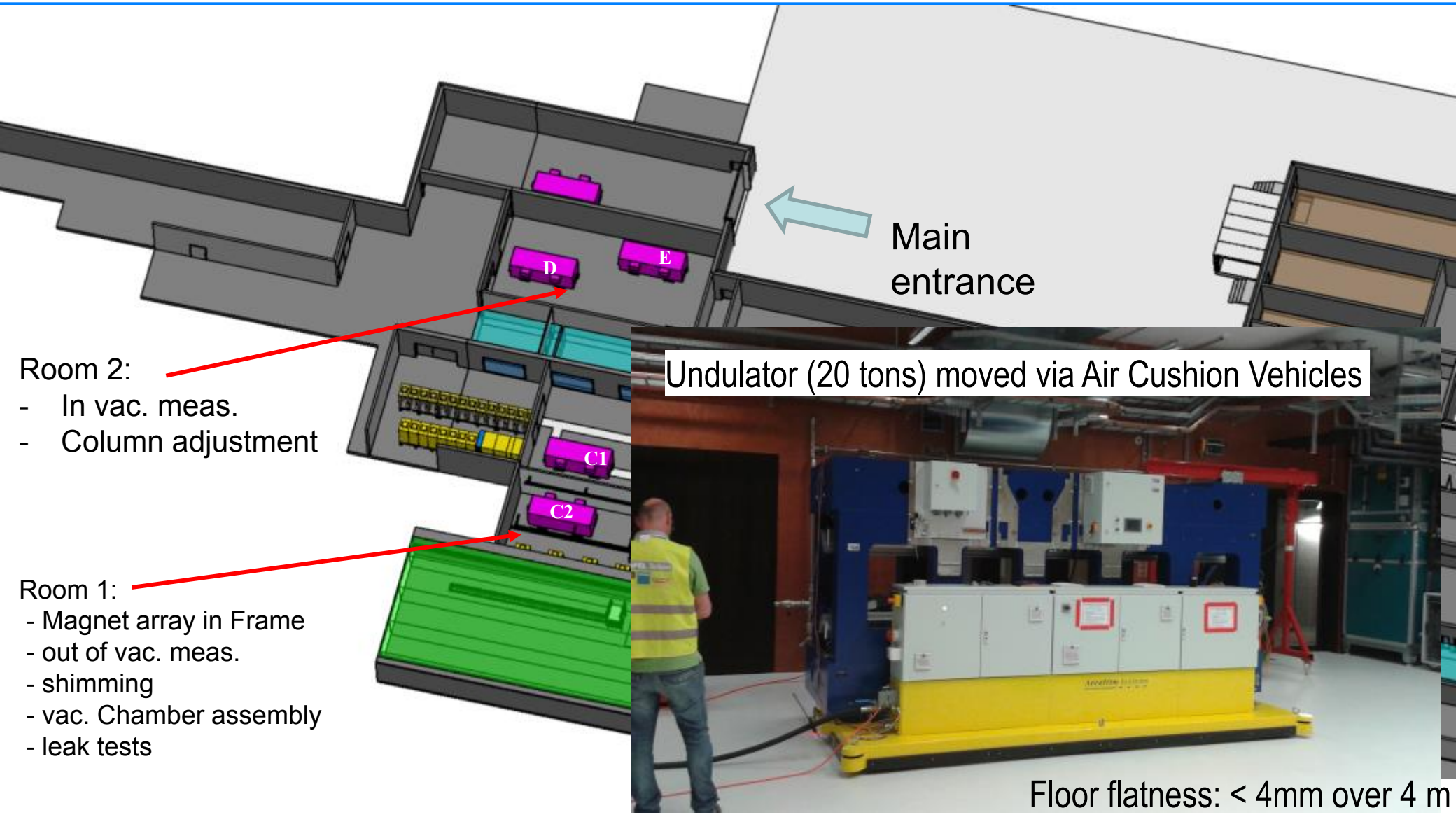
Courtesy of L. Patthey

Undulator U15 assembly

Room 2:
- In vac. meas.
- Column adjustment

Room 1:
- Magnet array in Frame
- out of vac. meas.
- shimming
- vac. Chamber assembly
- leak tests

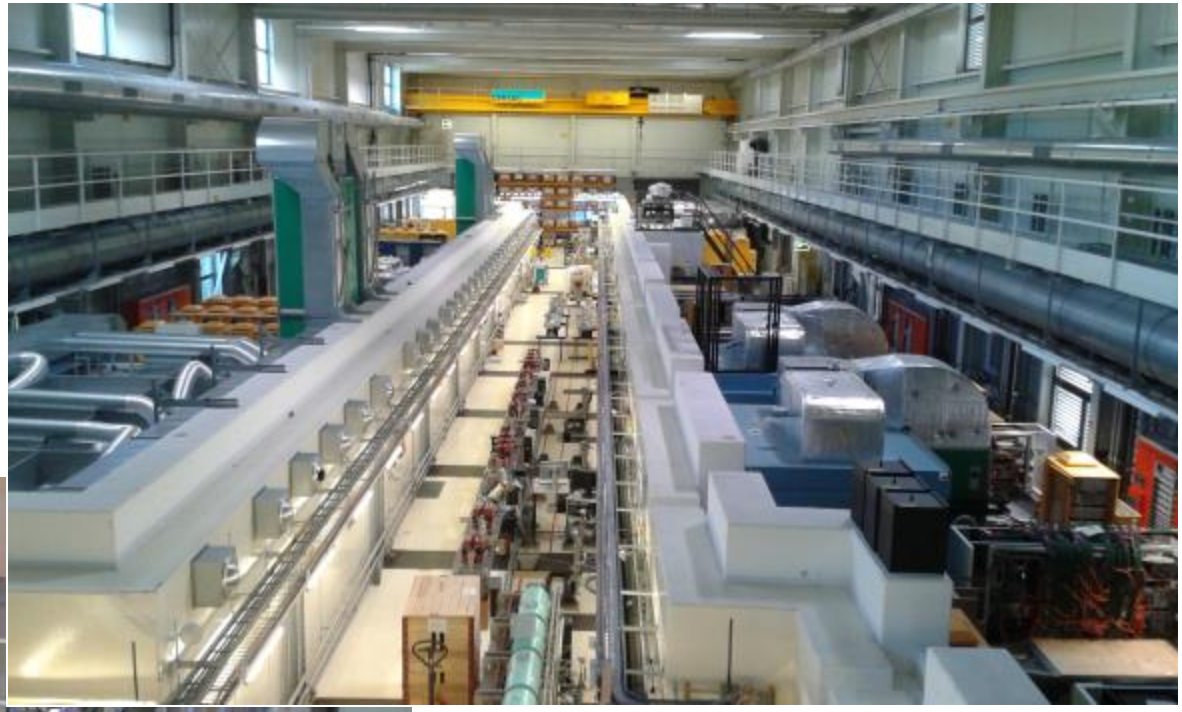
Undulator U15 assembly

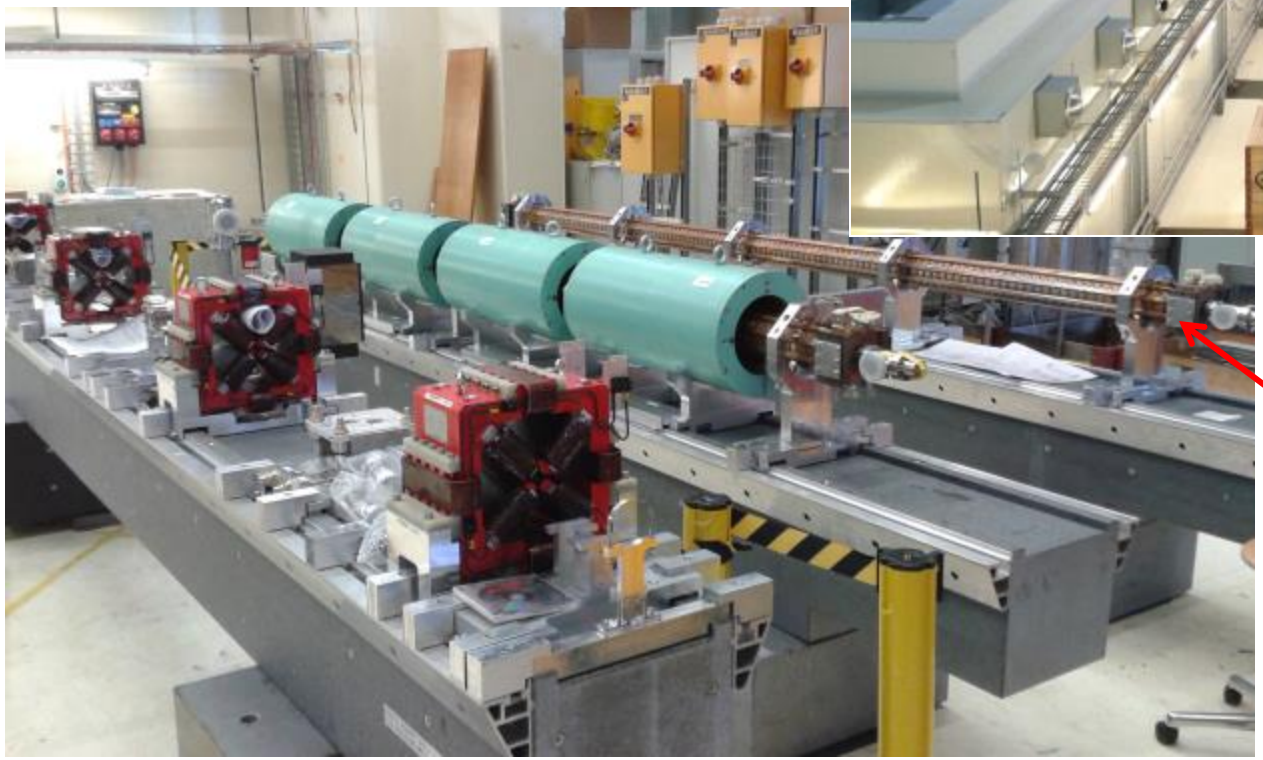


SwissFEL Injector Test Facility (SITF)

SwissFEL Injector Test Facility: 2010 - 2014

⇨ Now a pre-assembly Hall !





Injector S – Band structures

SwissFEL Building progress

Building key figures

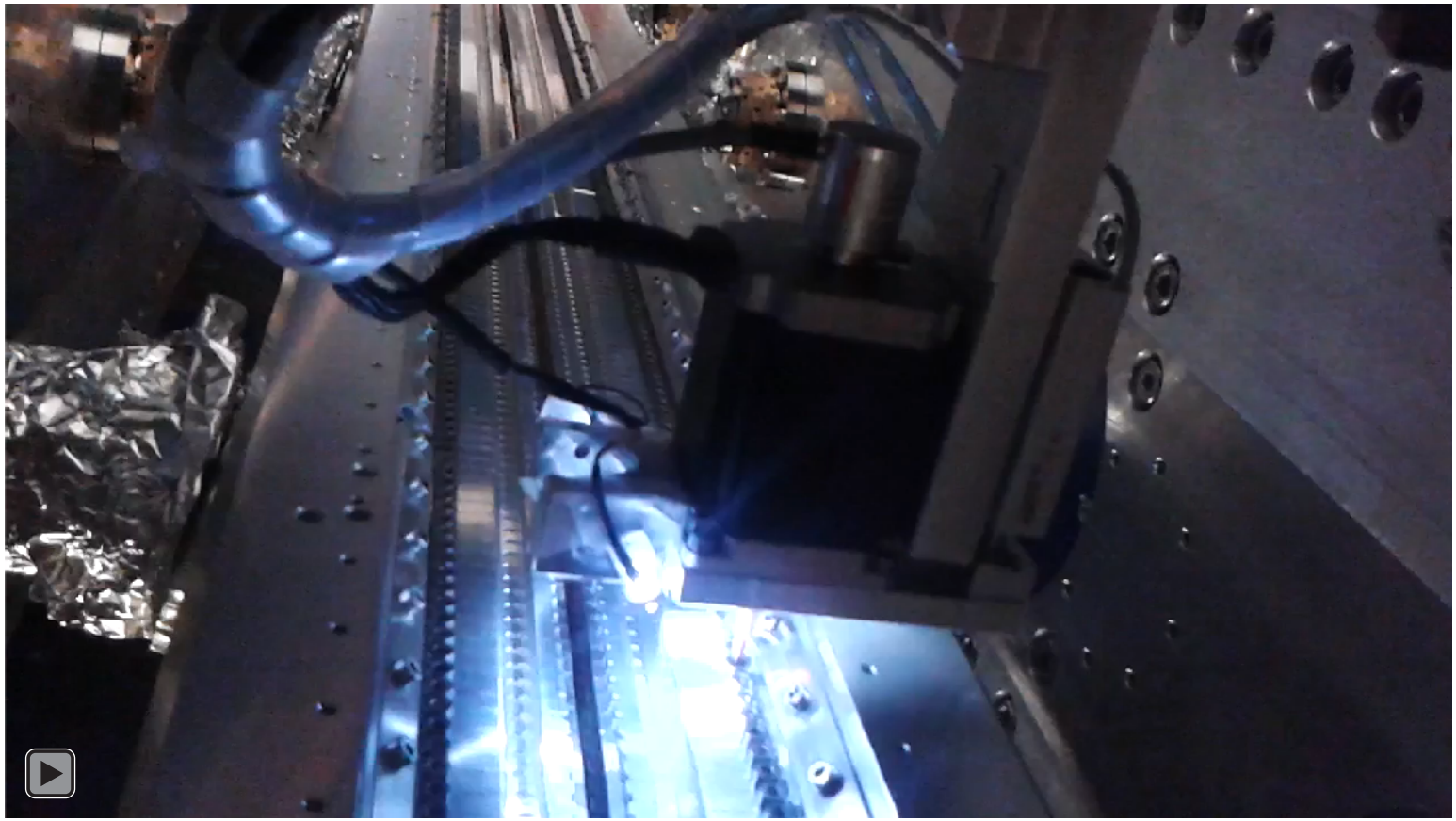
overall length: 740 m

soil movements: 95’000 m3

casted concrete: 21’000 m3 or 50’000 t

Courtesy of I. Widmer

Automatic shimming



Robot screw driver for local K value correction