



Elettra Sincrotrone Trieste

XVI INTERNATIONAL CONFERENCE
ON SCIENCE, ARTS AND CULTURE

INTERNATIONAL CONFERENCE ON SESAME
in Honour of Paolo Budinich

KYMA

XVI International Conference on Science, Arts and Culture
**INTERNATIONAL CONFERENCE ON
SESAME**
In honour of Paolo Budinich

KYMA



... riding the wave

Elettra Sincrotrone Trieste

Presentation of **Kyma** @ **Elettra**

Veli Lošinj, August 31st, 2016

Mauro Zambelli



Presentation of the company



A short history

A peculiar approach

- ◆ **Kyma Srl was established by Elettra Sincrotrone Trieste through an open European tender issued by the end of 2006**
- ◆ **The purpose was precisely to find potential suppliers/partners for realizing the undulators for the FERMI@Elettra project**
 - ◆ *Potential partners were required to set up a new company to that purpose, together with Elettra*
 - ◆ *Elettra had to hold 51% of the shares of the NewCo*
 - ◆ *The capital of the NewCo was fixed at 600,000 €*
 - ◆ *Industrial partners were requested to invest 294,000 € as initial capital*
 - ◆ ***Elettra had to contribute for 306,000 € transferring to the NewCo its know-how on undulators***

The company - Kyma Srl

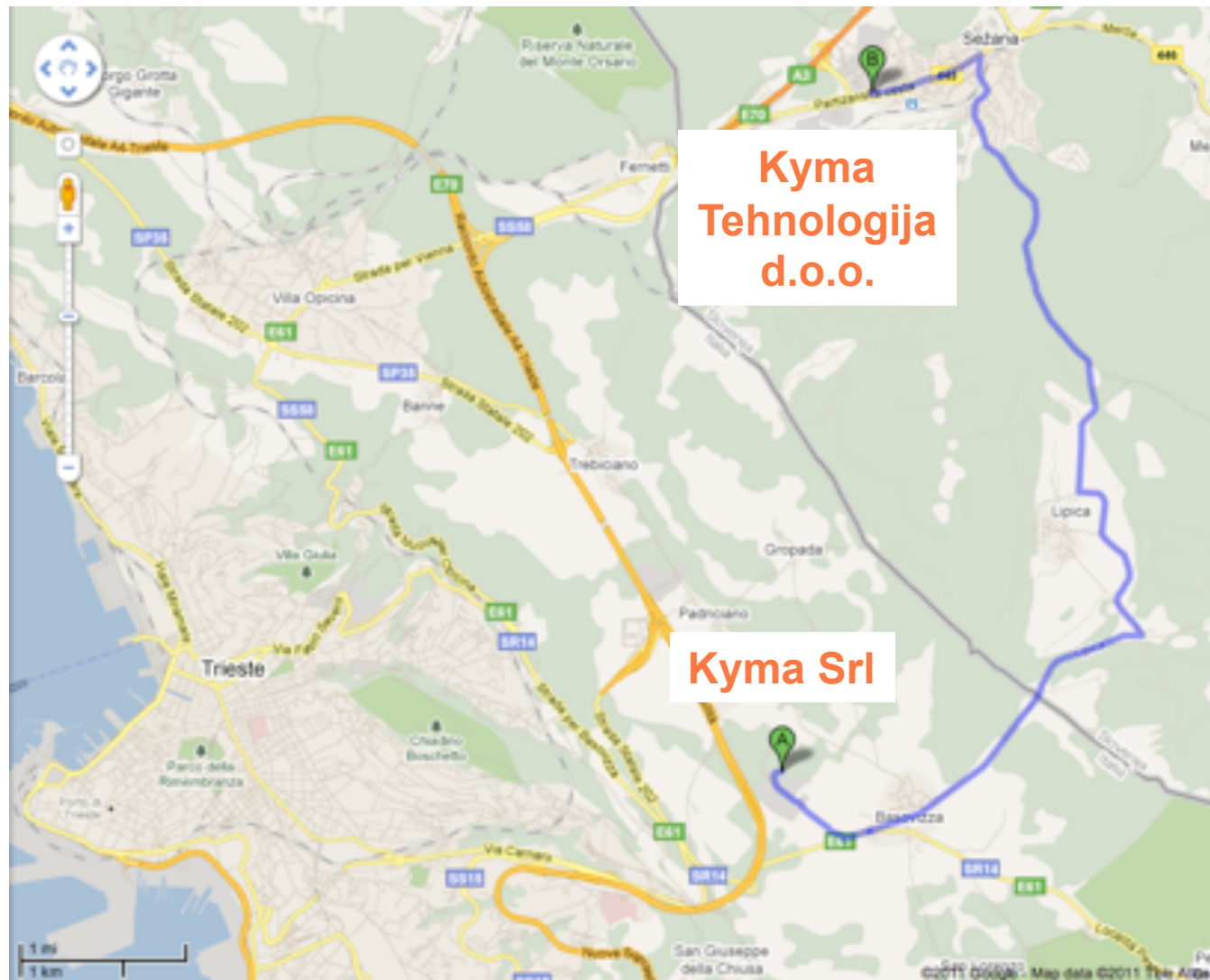
- ◆ **Kyma Srl was formally established on August 28th, 2007**
 - ◆ *Specific purpose was to realize the undulators for the FERMI@Elettra Project*
- ◆ **Contract for supply of undulators for FERMI@Elettra formally signed by end 2007**
- ◆ **Design of undulators started on January 2008**
- ◆ **Actual manufacturing began in October 2008**
- ◆ **All the 18 undulators (1 LHU, 2 LPU, 15 EPU) delivered by June 2011**
- ◆ **Realization of IDs for the “external” market started in 2010**

The company - Kyma Tehnologija d.o.o.

- ◆ **Refurbishment of Sežana lab started on January 2008**
 - ◆ *~ 120,000 € investment granted by Inkubator d.o.o.*
 - ◆ *~ 200,000 € investment managed by Kyma Srl*
- ◆ **Kyma Tehnologija d.o.o. was formally established on July 25th, 2008**
 - ◆ *100% shares owned by Kyma Srl*
- ◆ **Laboratory@Sežana inaugurated on August 28th, 2008**
 - ◆ *Fully operative since October 2008*
- ◆ **Laboratory@Euromisure (Pieve San Giacomo)**
 - ◆ *Fully operative since June 2008*



Kyma & Kyma Tehnologija locations





KyTe Lab inauguration



August 2008

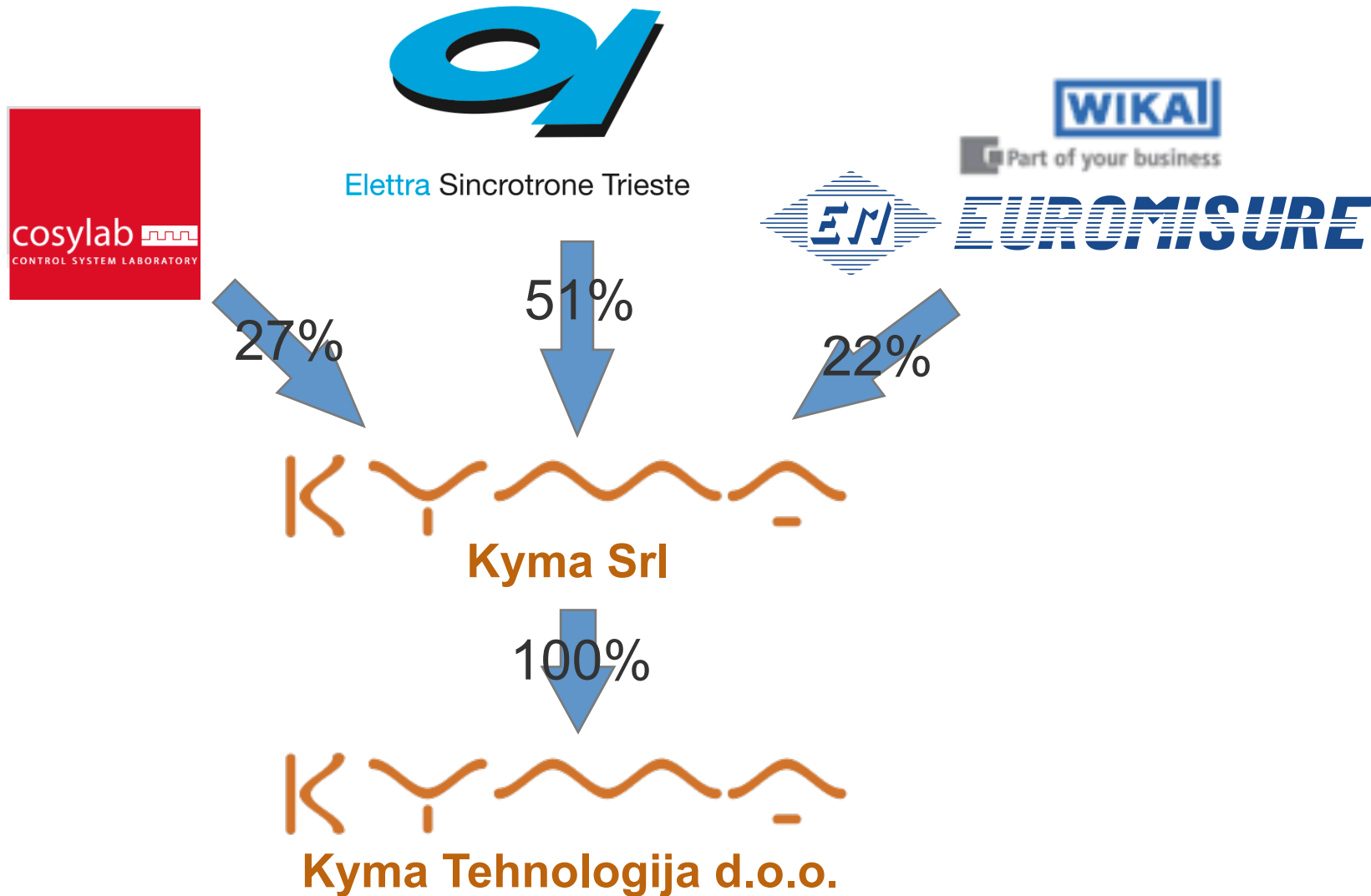


The Sežana Lab





The company and the Partners





Kyma as a virtual enterprise



A company made up by different legal entities, to develop a specific innovative business, under a unique central management and responsibility toward the Customer



Kyma in a nutshell

Kyma is the only industrial company worldwide whose unique business is the realization of Insertion Devices for Light Sources

- ◆ **Full specialization**
 - ◆ *All personnel fully specialized and dedicated to the single topic of ID design and realization*
 - ◆ *Integration of top level scientific and industrial competences*
- ◆ **Scientific backup**
 - ◆ *25 years of experience in IDs design and operation*
 - ◆ *Capability to design and simulate any insertion device structure*
- ◆ **“Vertical” business**
 - ◆ *In-house design, manufacturing, assembling and characterization of any part and component of Insertion Devices*
 - ◆ *Supply of any ID-related product and service*

Kyma in a nutshell

***Kyma is a true INDUSTRIAL company,
but with the knowledge available on IDs
at major SCIENTIFIC Institutions***

- ◆ **Fully open cooperation with the Customers**
 - ◆ *Preparation of specifications for tendering*
 - ◆ *Co-design of mechanical and magnetic structures, control system*
 - ◆ *Common R&D projects*
- ◆ **Sharing of all information relevant to the project**
- ◆ **Presence of Customer's representatives at Kyma's premises at any time during the project**
- ◆ **Training on design, characterization, operation of IDs**
- ◆ **Support for installation and commissioning**
- ◆ **Supply of any ID-related product and service**



◆ A full range of IDs

◆ *Pure Permanent Magnet IDs*

- ◆ LPU, LHU, Apple-II, Apple-III, Delta, Compact

◆ *Elliptically Polarizing Undulators (world record!)*

◆ *Hybrid Undulators and Wigglers*

◆ *In-vacuum Undulators and Wigglers*

◆ *Superconducting Undulators and Wigglers*

◆ Additional products

◆ *Mechanical support structures*

◆ *Top quality permanent magnet blocks*

◆ *Benches for magnet measurements*

◆ Services

◆ *Design studies and consultancy*

◆ *Design and simulation of magnetic structures*

◆ *Design of mechanical structures and components*

◆ *Magnetic measurements and characterization*

◆ *Refurbishment of obsolete IDs*

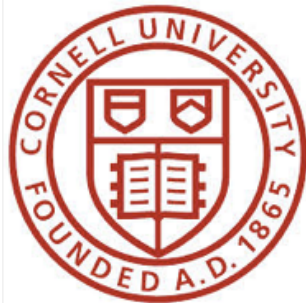
**Much more
and much less
than just IDs**



A worldwide network of cooperation on IDs



Elettra Sincrotrone Trieste



Looking for more Partnerships ...



Presentation of the company



Projects & Products **A success story**



FERMI@Elettra - Undulator zoo

Function		Type	Lenght	Period
Laser heater		LPU	540	40.0
FEL I	Modulator	LPU	3220	100.0
	Radiator	6 x EPU	2415	55.0
FEL 2 1 st stage	Modulator	LPU	3220	100.0
	Radiator	2 x EPU	2415	55.0
FEL 2 2 nd stage	Modulator	EPU	2415	55.0
	Radiator	6 x EPU	2400	34.4



Kyma ID summary table

ID type	Short name	# of units	Status
Laser Heater Undulators	LHU	1	Operation
		1	Commissioning
Linearly Polarizing Undulators	LPU	9	Operation
Elliptically Polarizing Undulator – Apple-II	EPU	24	Operation
		1	Commissioning
		3	Realization
Short-Period Linearly Polarizing Undulator	SP-LPU	1	Operation
In-Vacuum Undulator (@ BASC)	IVU	1	Operation
Hybrid Wiggler	HW	1	Operation
Permanent Magnet Phase Shifters (30 @ Kyma / 30 @ BASC)	PMPS	60	Delivered
Variable-Phase Compact Undulators	CCU	2	Operation
		2	Realization

46 IDs
and 60 Phase Shifters
In 8 years!



ID projects (1/6)

- ◆ **Elettra - Sincrotrone Trieste, Italy**
 - ◆ *Two Linearly Polarizing Undulators (2.5 m)*
 - ◆ Elettra storage ring - SuperESCA beamline
- ◆ **Canadian Light Source, Saskatoon**
 - ◆ *Hybrid Wiggler (1.68 m)*
 - ◆ *In-vacuum undulator (2.0 m)*
 - ◆ BioXAS beamline
- ◆ **Raja Ramanna Centre for Advanced Technology, Indore, India**
 - ◆ *Linearly Polarized Undulator (2.5 m)*
 - ◆ IR FEL



ID projects (2/6)

- ◆ **ENEA, Frascati, Italy**
 - ◆ *Short-period “exotic” Undulator (~ 1.0 m)*
 - ◆ SPARC FEL
- ◆ **Pohang Accelerator Laboratory, Pohang**
 - ◆ *2 x Elliptically Polarized Undulators*
 - ◆ PLS-II – 2A Magnetic Spectroscopy beamline
 - ◆ PLS-II – 10 A Nanoscopy beamline
- ◆ **University of Aarhus, ISA, Denmark**
 - ◆ *Linearly Polarized Undulator (2.5 m)*
 - ◆ ASTRID-2 Storage Ring
- ◆ **Uppsala University, Sweden**
 - ◆ *Laser Heater Undulator (1.0 m)*
 - ◆ European XFEL, Hamburg



ID projects (3/6)

- ◆ **Brookhaven National Laboratory, Upton, N.Y.**
 - ◆ ***Two Elliptically Polarized Undulators (2.5 m)***
 - ◆ NSLS-II storage ring (8 axes – anti-parallel operation)
- ◆ **European XFEL, Hamburg, Germany**
 - ◆ ***30 + 30 (Kyma & Bruker ASC)***
Permanent Magnet Phase Shifters (PMPS)
 - ◆ EXFEL
- ◆ **Pohang Accelerator Laboratory, Pohang**
 - ◆ ***Elliptically Polarizing Undulator (3.2 m)***
 - ◆ PLS-II – 6A MPI beamline
- ◆ **Huazhong University of Science and Technology
Wuhan, Hubei province, China**
 - ◆ ***Linearly Polarized Undulator (1.0 m)***
 - ◆ TeraHertz FEL



ID projects (4/6)

- ◆ **Raja Ramanna Centre for Advanced Technology, Indore, India**
 - ◆ ***Two Linearly Polarizing Undulators (2.5 m)***
 - ◆ AMOS and ARPES beamlines @ INDUS-2
- ◆ **Pohang Accelerator Laboratory, Pohang**
 - ◆ ***Elliptically Polarizing Undulator (3.6 m)***
 - ◆ PLS-II – 4A1 ARPES beamline
- ◆ **Cornell University, Ithaca, N.Y.**
 - ◆ ***Two Compact Linearly Polarizing Undulator (1.5 m)***
 - ◆ CHESS Storage Ring
- ◆ **Jagellonian University, Krakow**
 - ◆ ***One Elliptically Polarizing Undulator (2.2 m)***
 - ◆ SOLARIS Storage Ring, ARPES beamline



ID projects (5/6)

- ◆ **Raja Ramanna Centre for Advanced Technology, Indore, India**
 - ◆ ***One Elliptically Polarizing Undulators (2.5 m)***
 - ◆ INDUS-2 Storage Ring
- ◆ **Cornell University, Ithaca, N.Y.**
 - ◆ ***Two Compact Linearly Polarizing Undulator (1.5 m)***
 - ◆ CHESS Storage Ring
- ◆ **Brookhaven National Laboratory, Upton, N.Y.**
 - ◆ ***One Elliptically Polarized Undulators (1.6 m)***
 - ◆ NSLS-II storage ring
- ◆ **Elettra – Sincrotrone Trieste S.C.p.A.**
 - ◆ ***One Elliptically Polarized Undulator (2.5 m)***
 - ◆ FERMI FEL-2 Free Electron Laser



ID projects (6/6)

- ◆ **Brookhaven National Laboratory, Upton, N.Y.**
 - ◆ *Two Elliptically Polarized Undulators (2.5 m)*
 - ◆ ESM & SIX beamlines @ NSLS-II storage ring



ID mechanical carriages

- ◆ **European Synchrotron Radiation Facility (ESRF), Grenoble, France**
 - ◆ *Mechanical support structure for one Apple-II Elliptically Polarizing Undulator (2.5 m)*



ID-related products – Measurement benches

- ◆ **Brookhaven National Laboratory, Upton, N.Y.**
 - ◆ *One Helmholtz Coil Bench for magnet blocks characterization*
- ◆ **Hitachi Metals / Neomax, Osaka, Japan**
 - ◆ *One Helmholtz Coil Bench for magnet blocks characterization*



ID-related products – Permanent magnet blocks

- ◆ **Elettra - Sincrotrone Trieste, Italy**
 - ◆ *Permanent magnet blocks for one short-period Linearly Polarizing Undulator (LPU) prototype*
- ◆ **European Synchrotron Radiation Facility (ESRF), Grenoble, France**
 - ◆ *Permanent magnet blocks for one Apple-II (EPU) and two planar (LPU) undulators*
- ◆ **European Synchrotron Radiation Facility (ESRF), Grenoble, France**
 - ◆ *Permanent magnet blocks for one short wiggler*
- ◆ **Brookhaven National Laboratory, Upton, N.Y.**
 - ◆ *Permanent magnet blocks for one Apple-II (EPU) prototype*

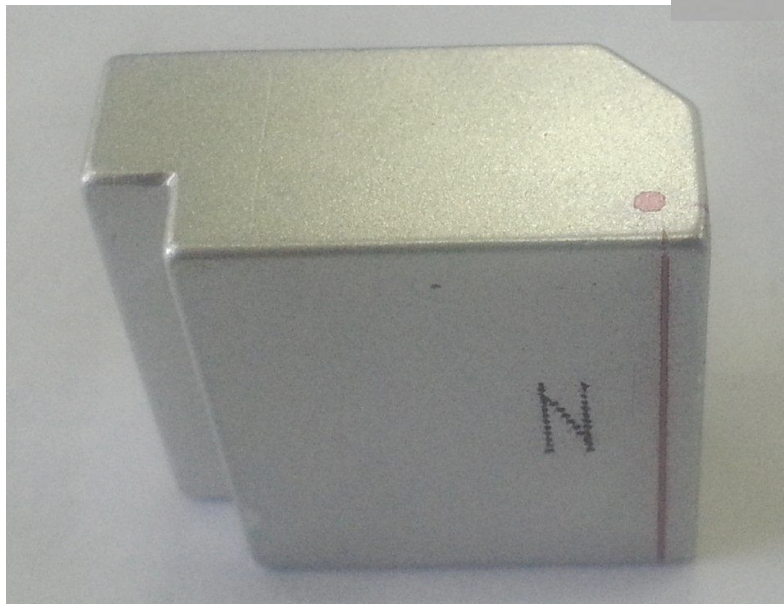


ID-related services – Magnet characterization

- ◆ **MAX-IV @ MAX-Lab, Lund**
 - ◆ *Characterization and sequencing of the permanent magnet set for one Elliptically Polarizing Undulator*
- ◆ **Canadian Light Source, Saskatoon**
 - ◆ *Characterization and sequencing of the permanent magnet set for one Elliptically Polarizing Undulator*
- ◆ **MAX-IV @ MAX-Lab, Lund**
 - ◆ *Characterization and sequencing of the permanent magnet set for one Elliptically Polarizing Undulator*

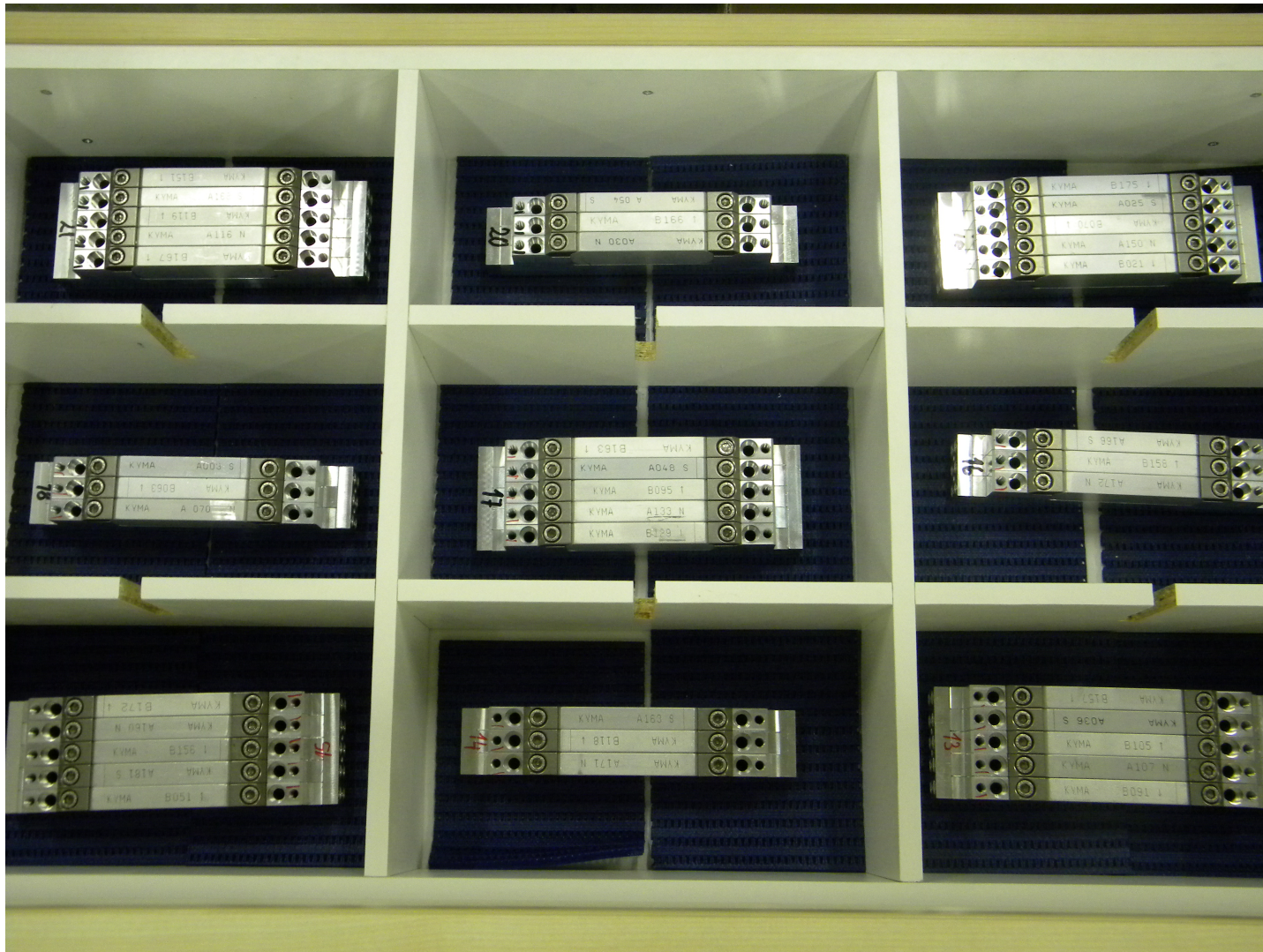


KYMA Permanent Magnet Blocks





Magnet modules for LPU@ASTRID-2





LHU - Laser Heater Undulator



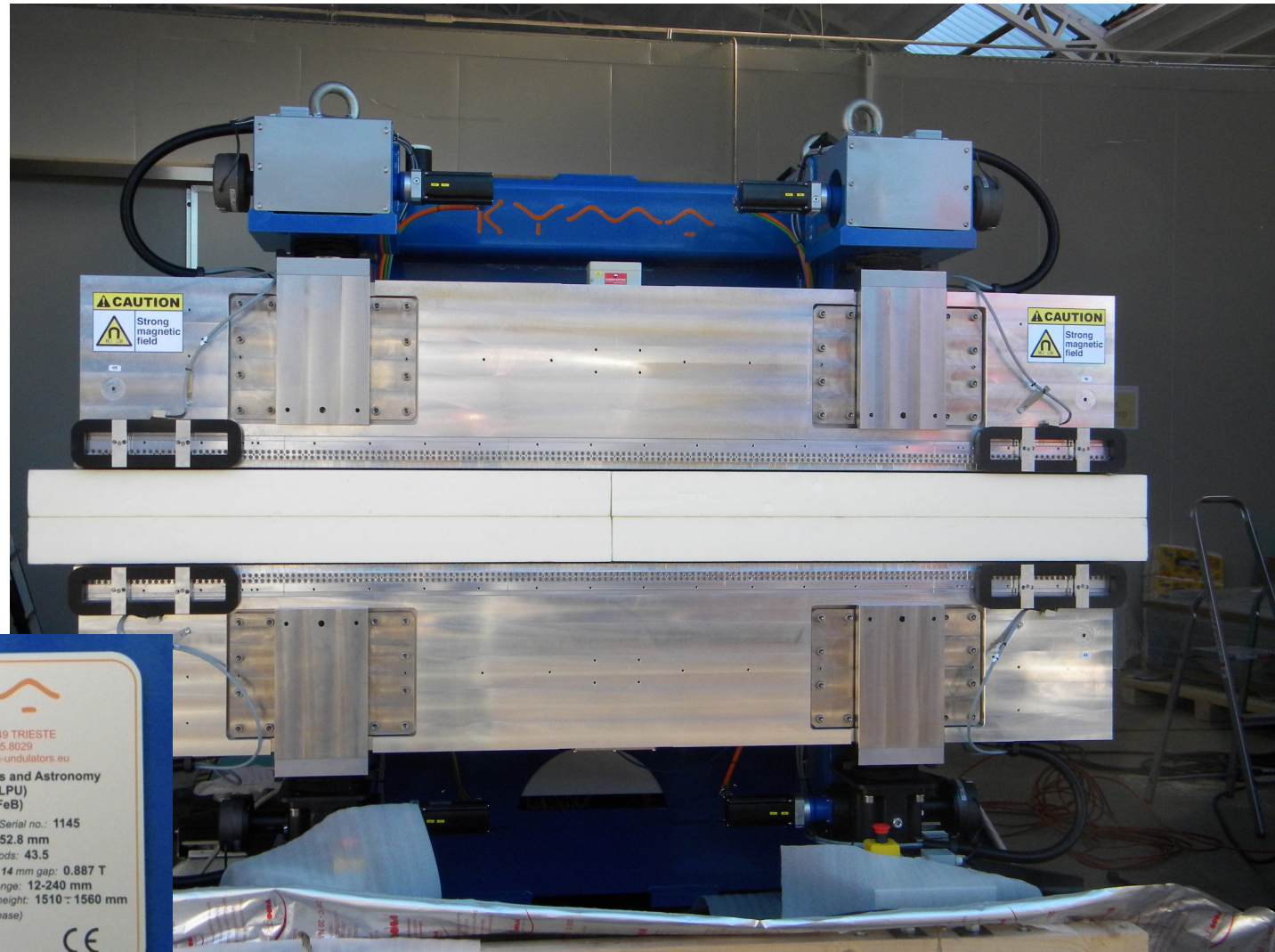


EPU@FEL1 - Radiators





LPU @ ASTRID-2 – Århus University




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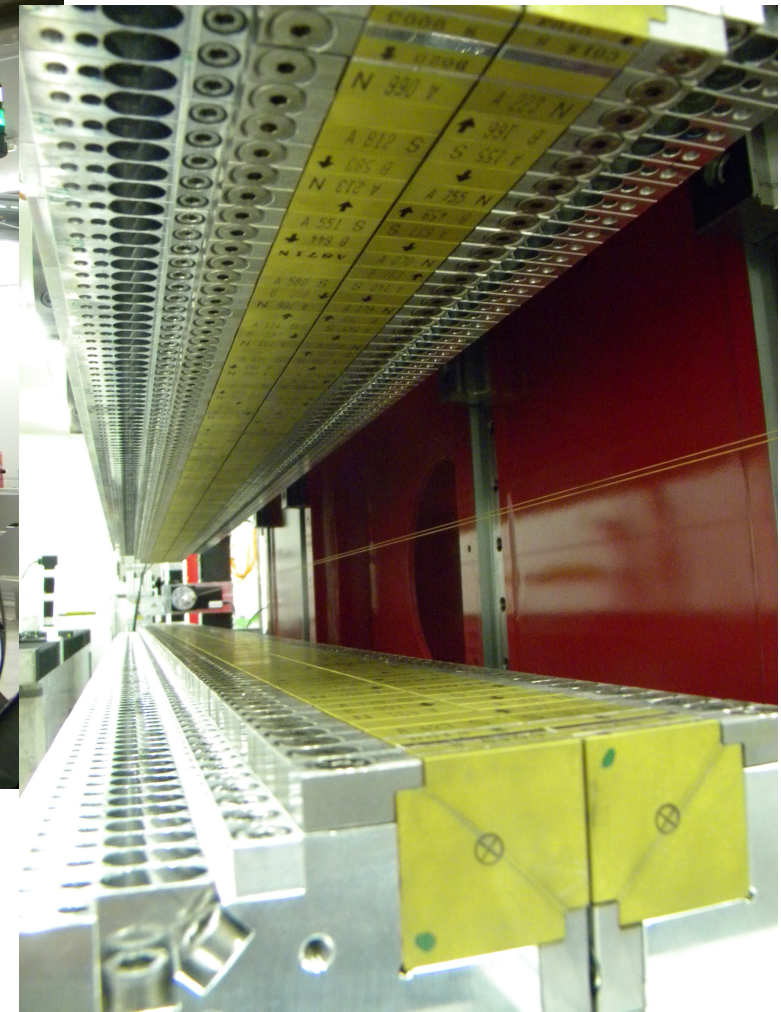
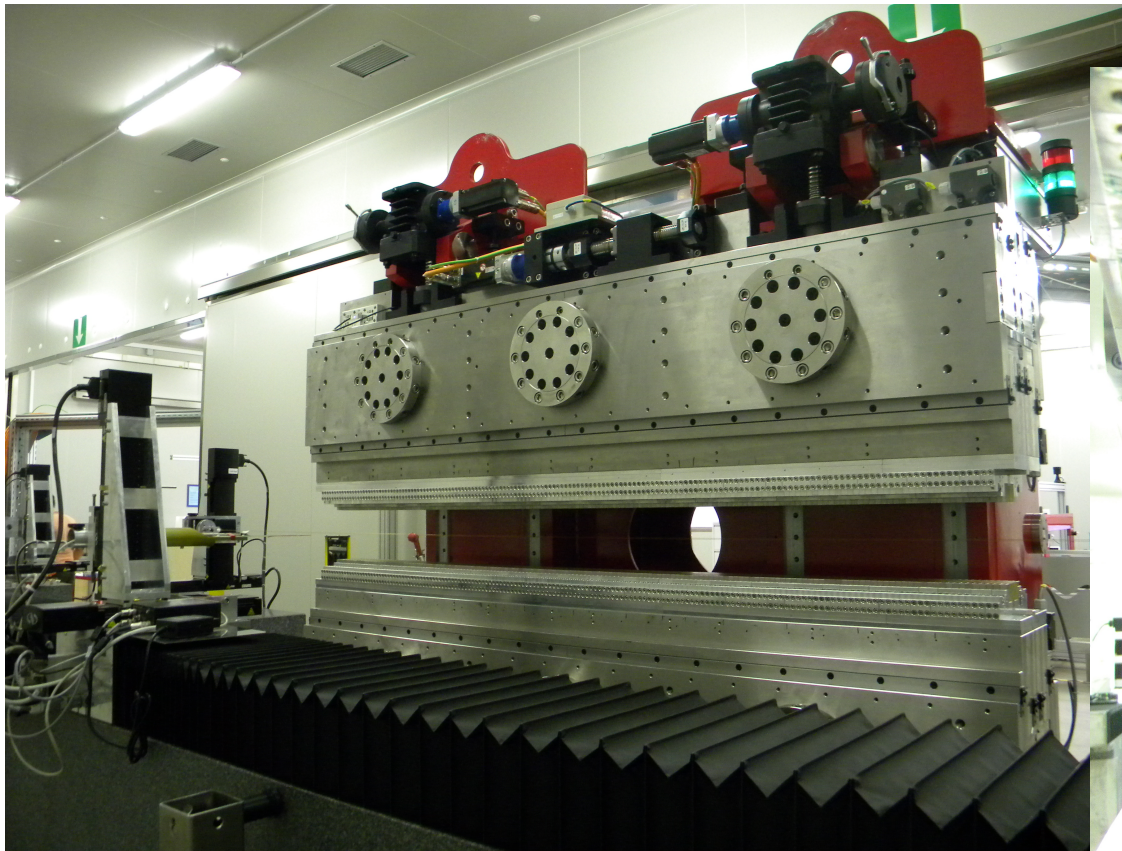
Customer: Aarhus University – Dept. of Physics and Astronomy
Insertion Device: Linearly Polarizing Undulator (LPU)
Magnetic structure: Pure Permanent Magnet (NdFeB)

ID nickname: LPU@ASTRID2	Kyma project / Serial no.: 1145
Year of delivery: 2012 (Dec.)	Period length: 52.8 mm
Dim.: 2357x1355x2550 mm ³	Number of periods: 43.5
Weight: ~ 4250 kg	Peak B field at 14 mm gap: 0.887 T
Control: delta tau BRIK CONTR.	Gap working range: 12-240 mm
Supply: 220-230 / 380-400 V _{ac} , 47-63 Hz, 10 A	Magnetic axis height: 1510 - 1560 mm (from the feet base)

 MADE IN EU 

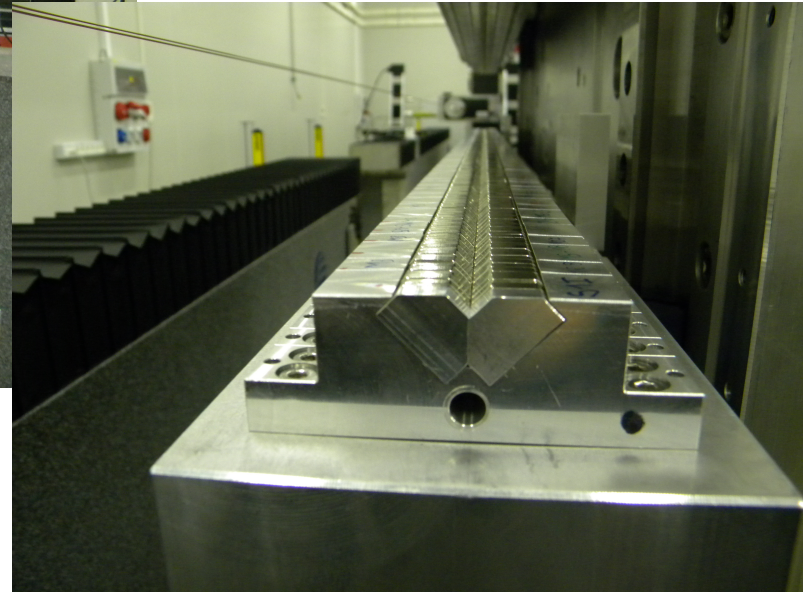
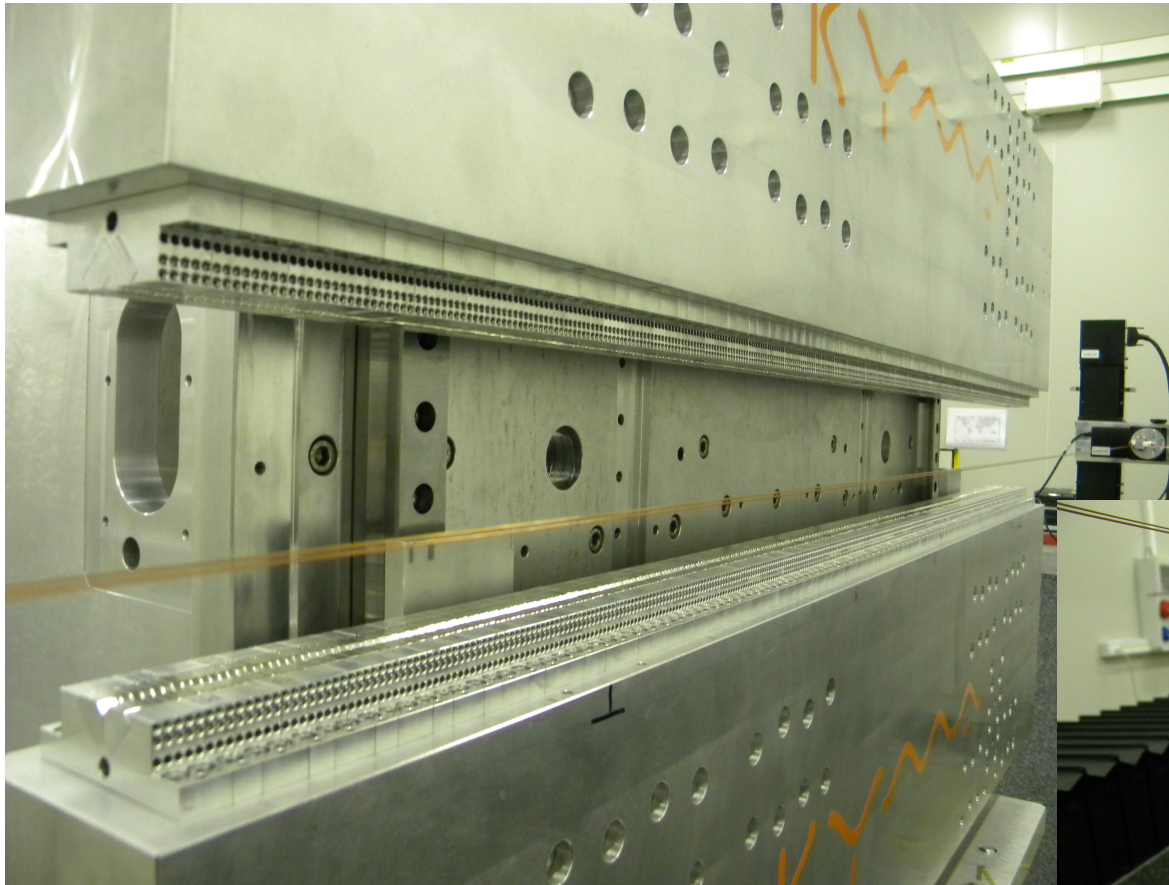


EPU's @ NSLS-II – Brookhaven National Lab.



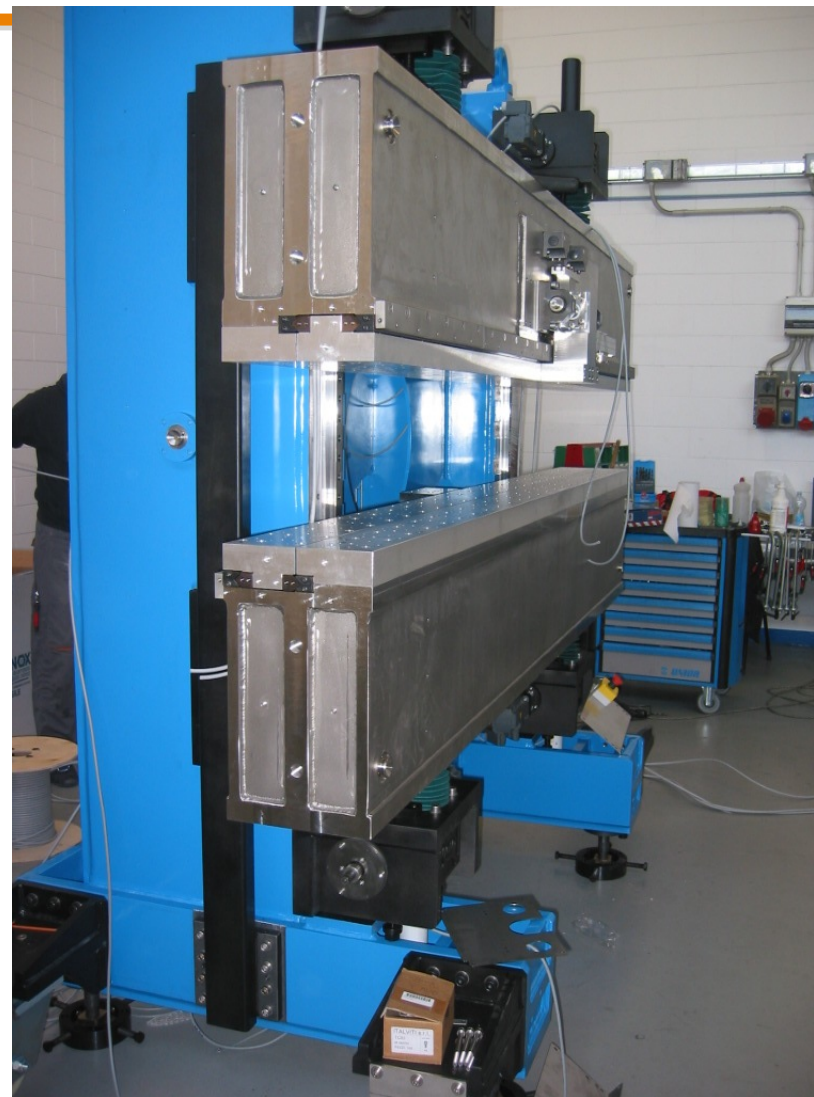


SP-LPU @ SPARC – ENEA Research Centre



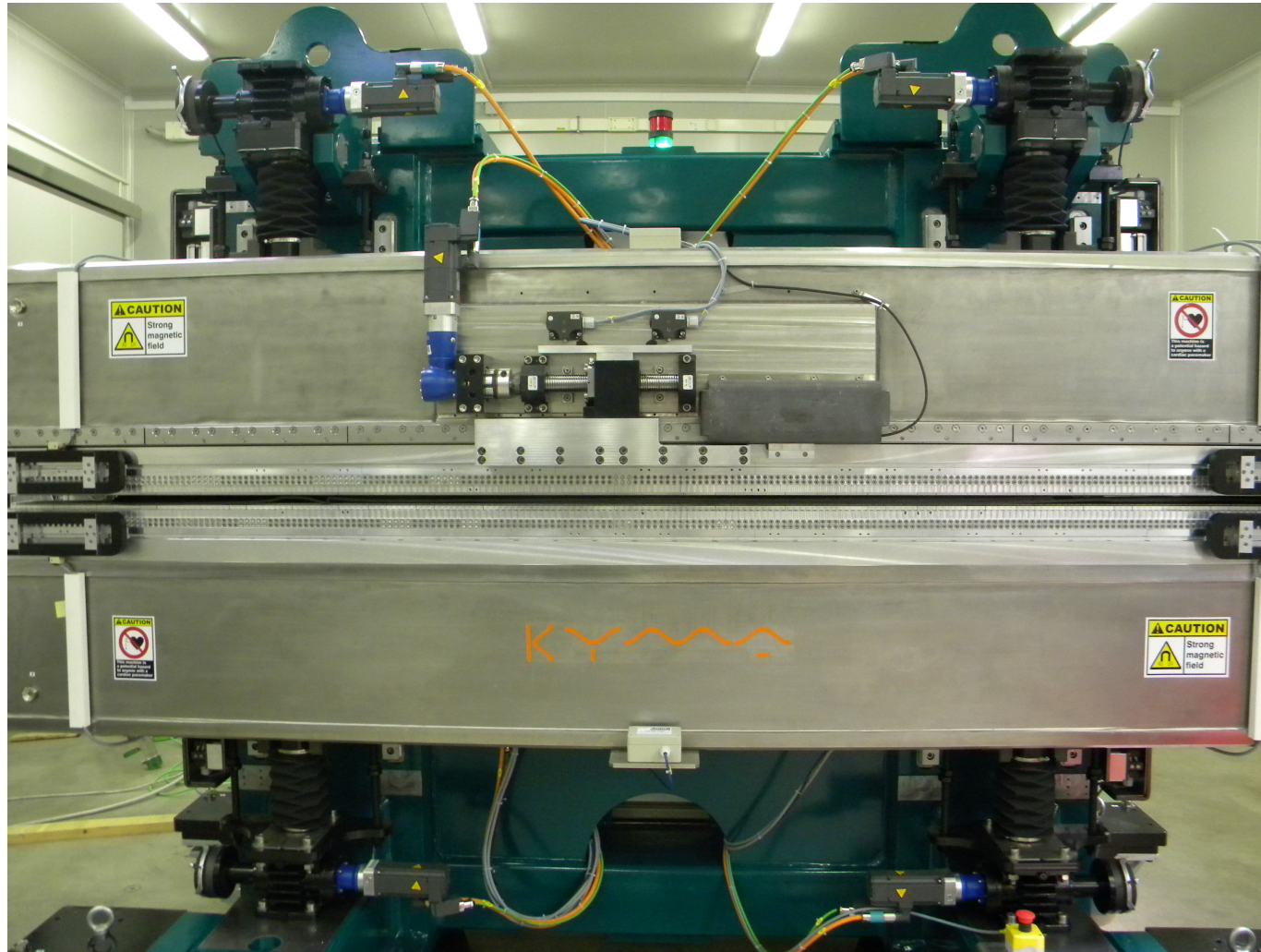


EPUb#PLS2 – Pohang Accelerator Lab.



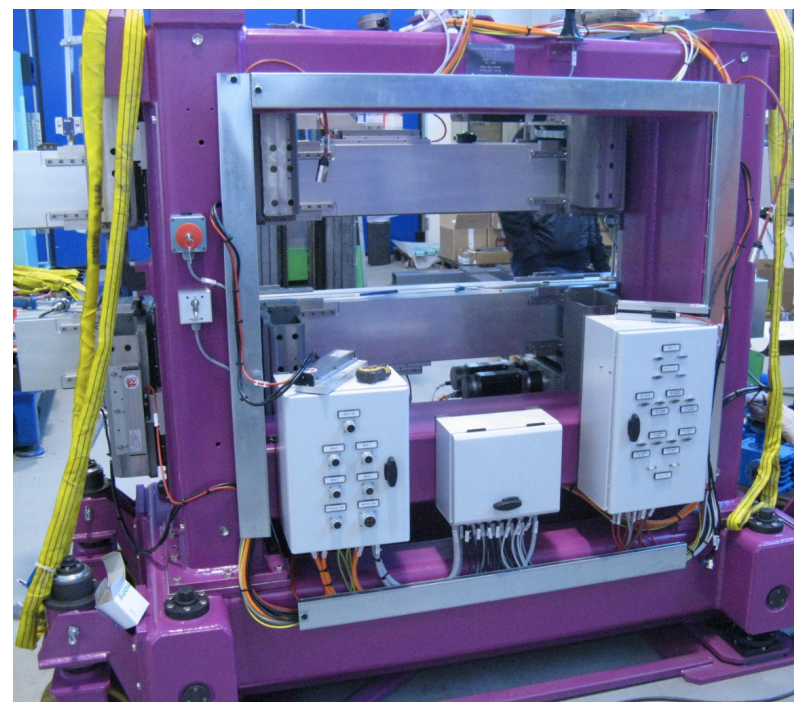
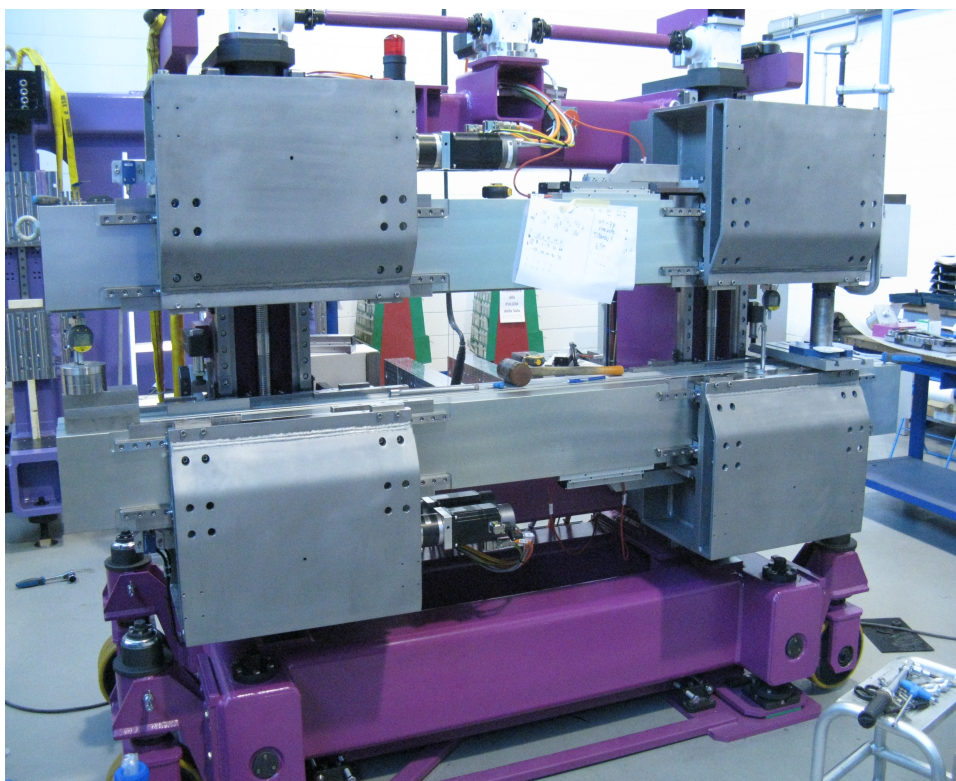


EPU_MPI @ PLS-II - Pohang Accelerator Lab.



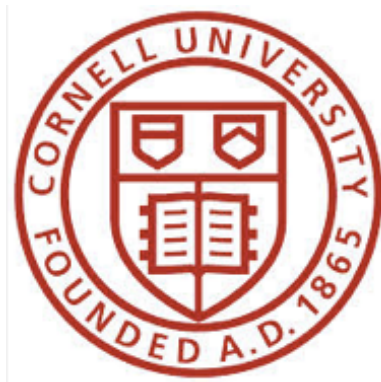


Mechanical carriage for one EPU @ ESRF





The license agreement with



CORNELL UNIVERSITY

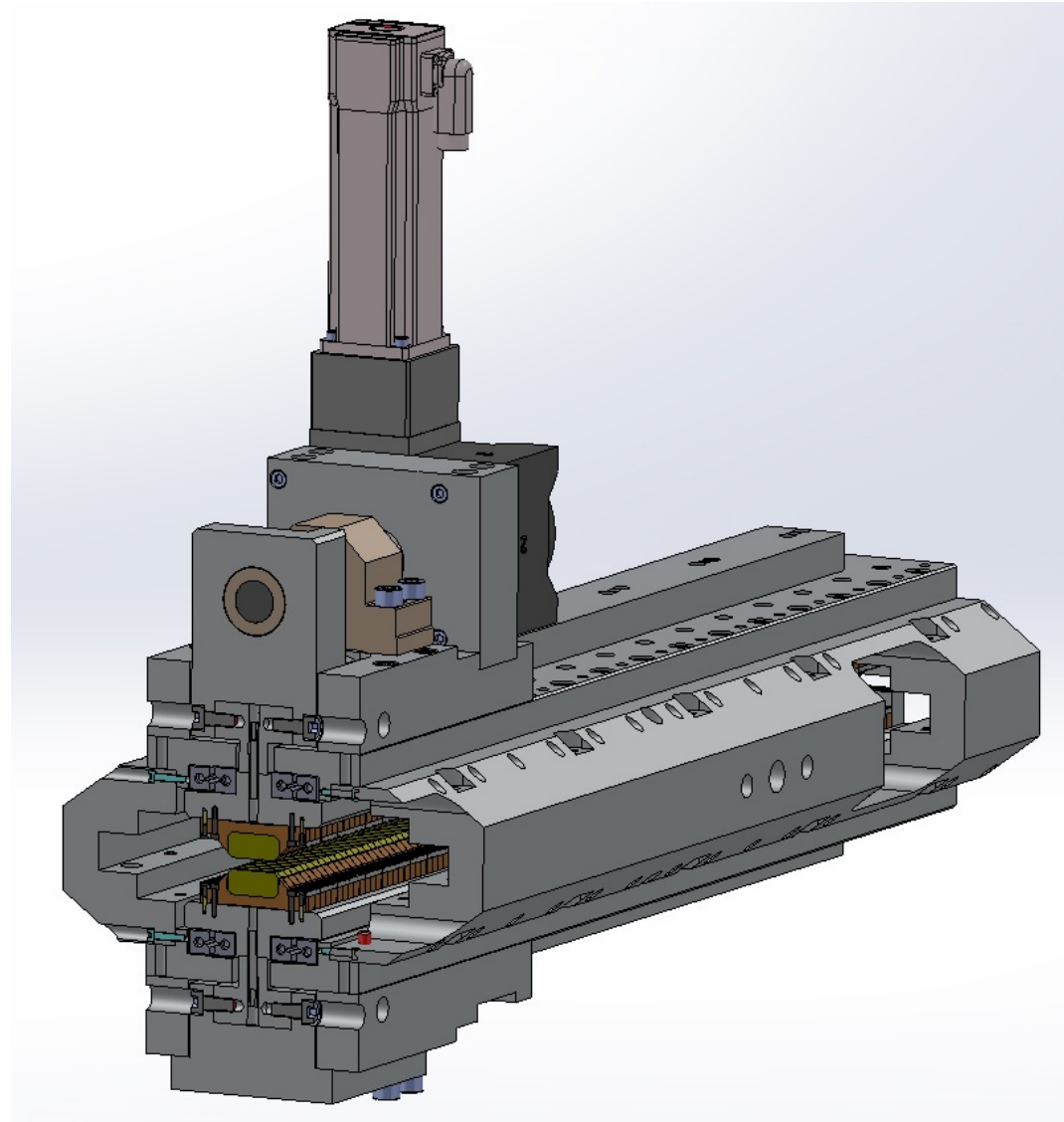
Committed to develop
new generations of IDs

The partnership with Cornell University

- ◆ **Kyma and Cornell University are cooperating under an exclusive license agreement for the design, realization and commercialization of undulators based on new realization concepts**
- ◆ **Low-cost, High-performance Compact Undulators**
 - ◆ *2011 -> Cornell to search for industrial partners*
 - ◆ *2012 -> Kyma identified as leading company for IDs*
 - ◆ *2013 -> Order placed to Kyma for two compact linearly polarizing undulators (CCU)*
 - ◆ *2013 -> Co-design of CCU completed*
 - ◆ *2014 -> Realization and commissioning of two CCUs*
 - ◆ *2015 -> Signature of formal license agreement*
 - ◆ *2015 -> Realization of two more CCUs*

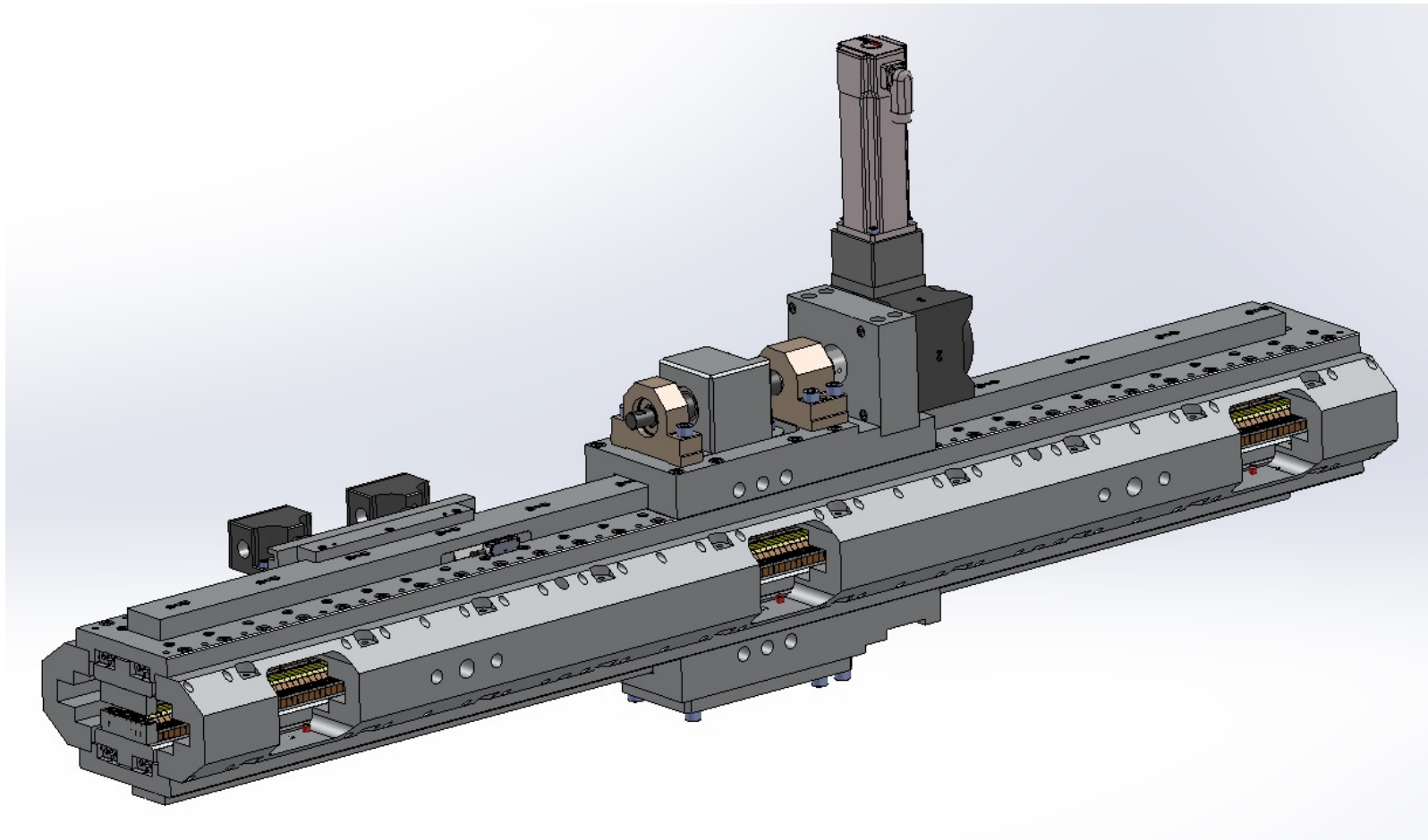


Fixed-gap, variable-phase, CCU



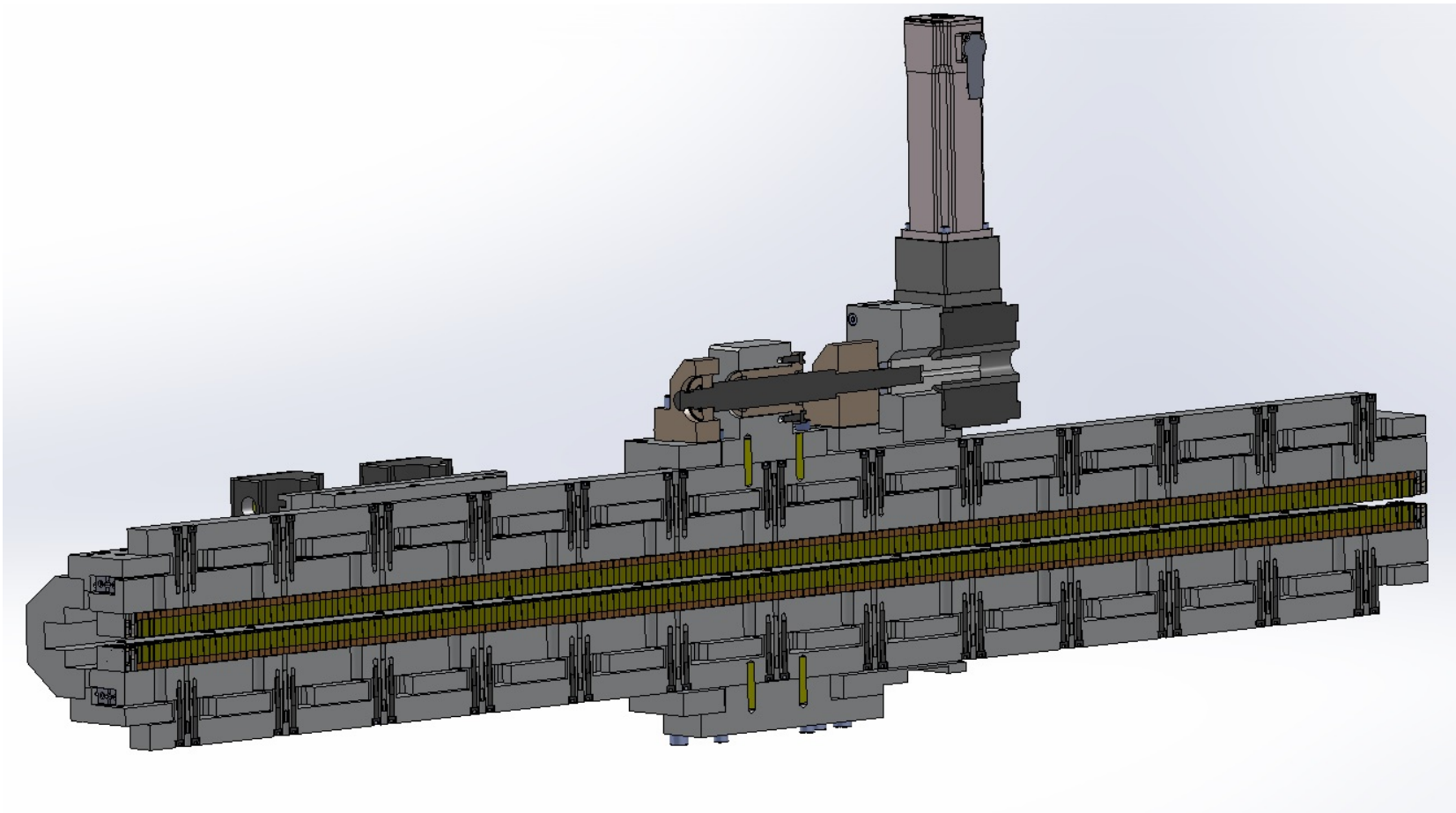


Fixed-gap, variable-phase, CCU





Fixed-gap, variable-phase, CCU





CCUs in operation @ CHESS



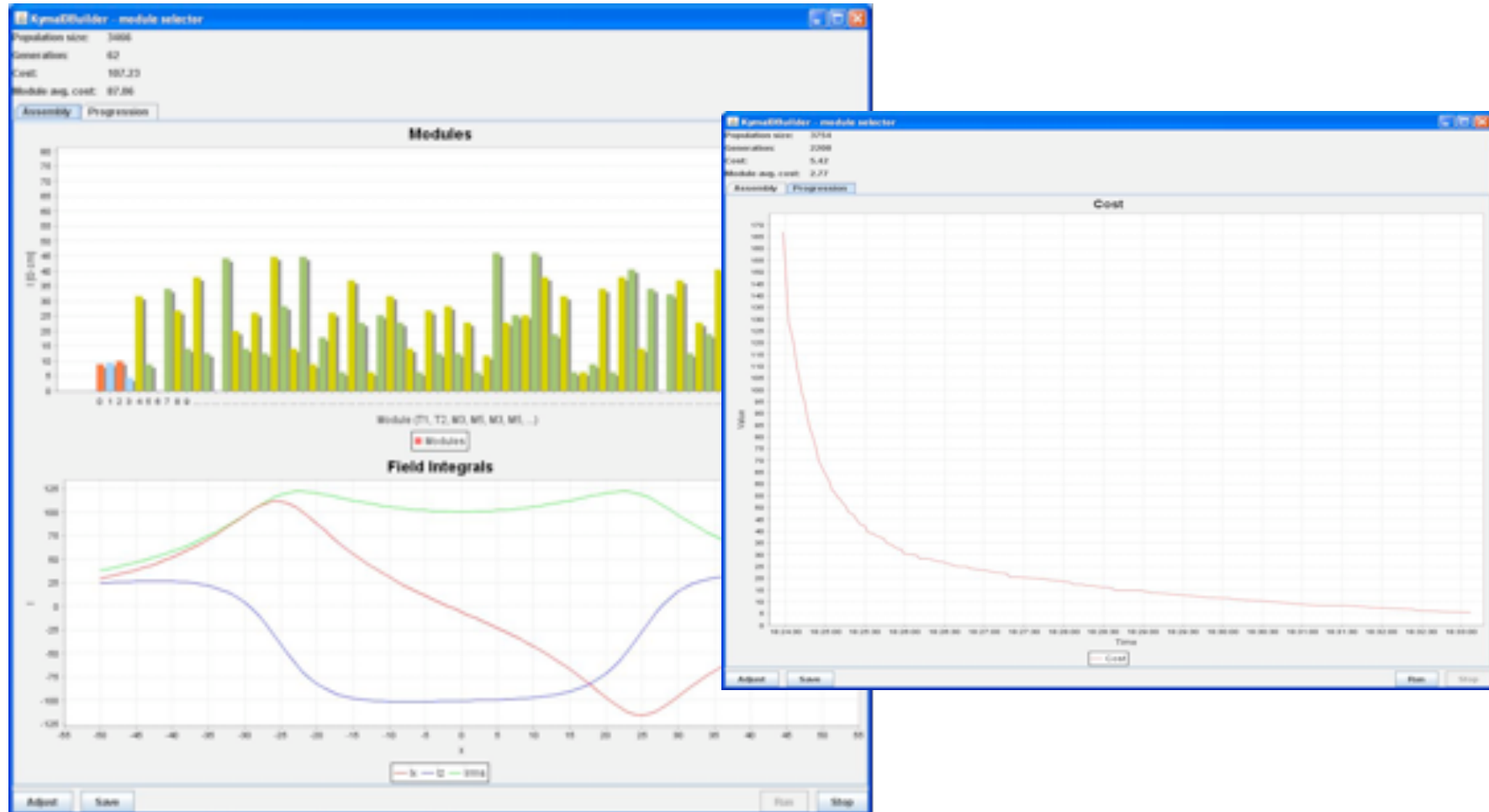


Kyma approach to magnetic optimization and assembling

@ Kyma Tehnologija d.o.o.
Sežana

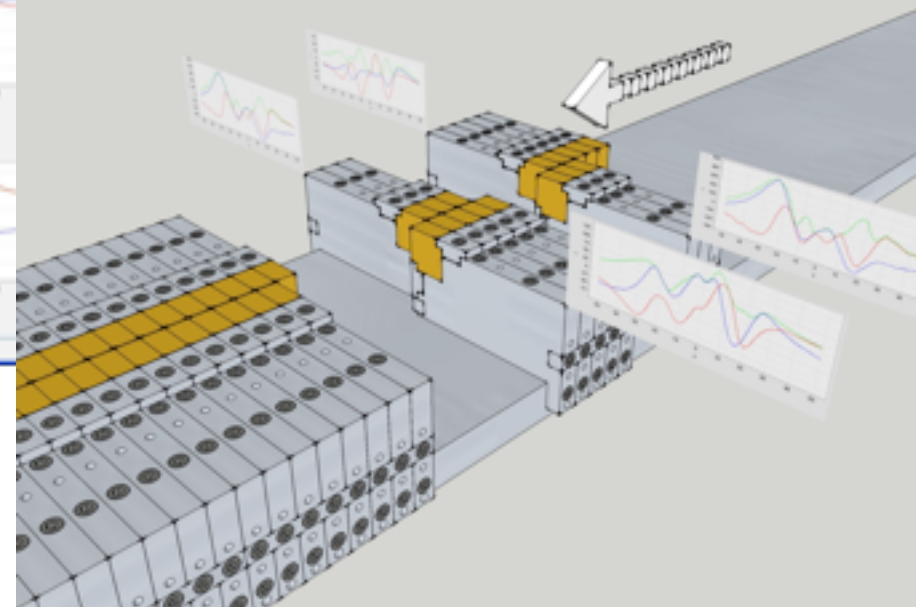
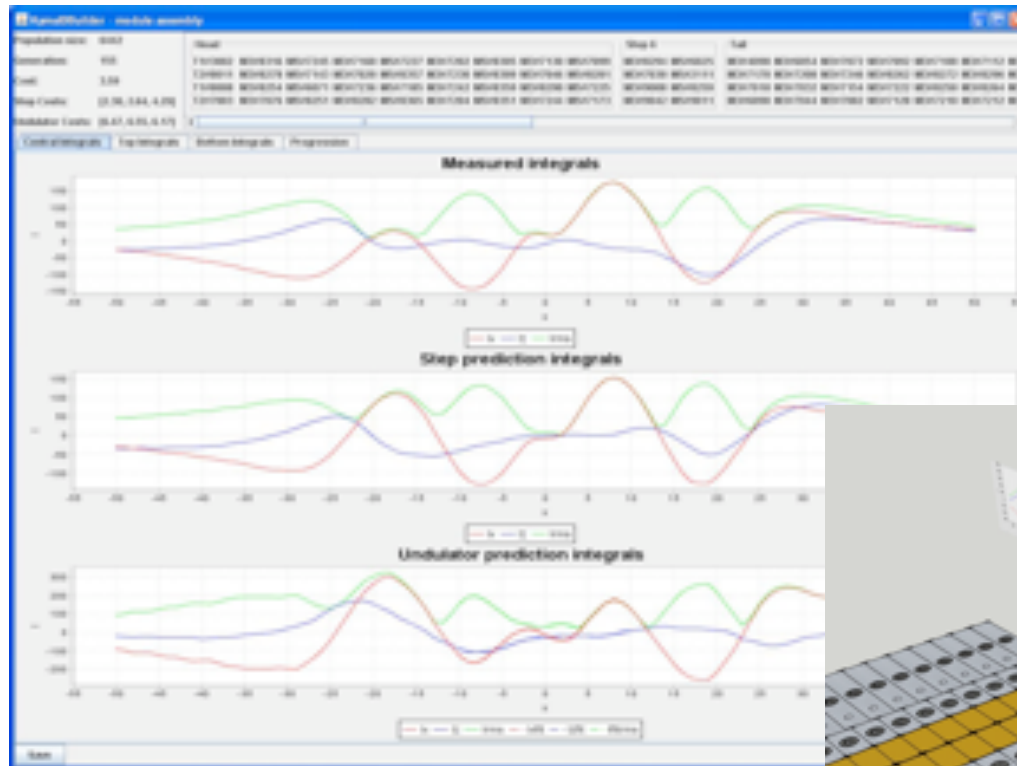


Magnet blocks sequence optimization



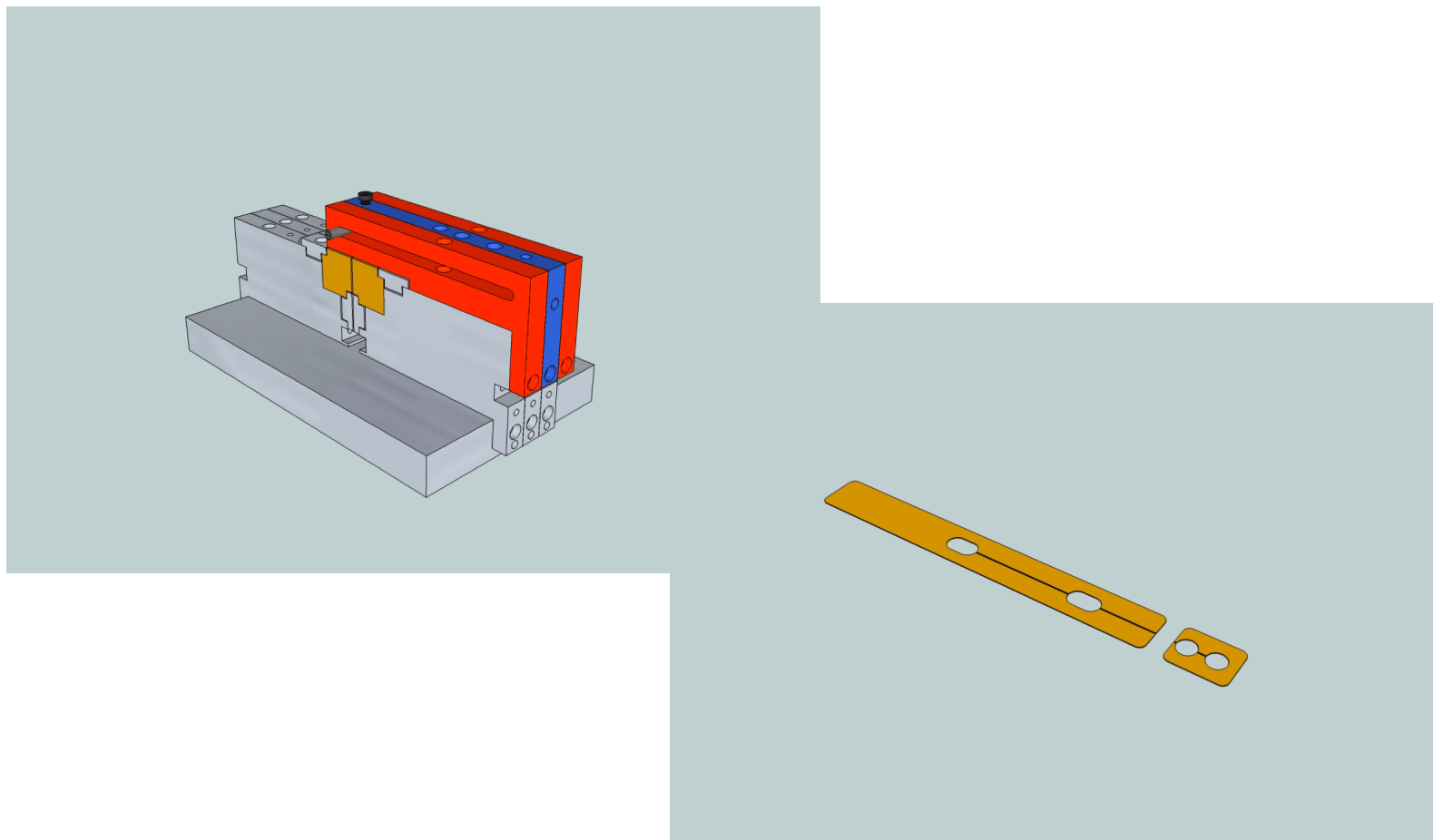


Step-wise assembling



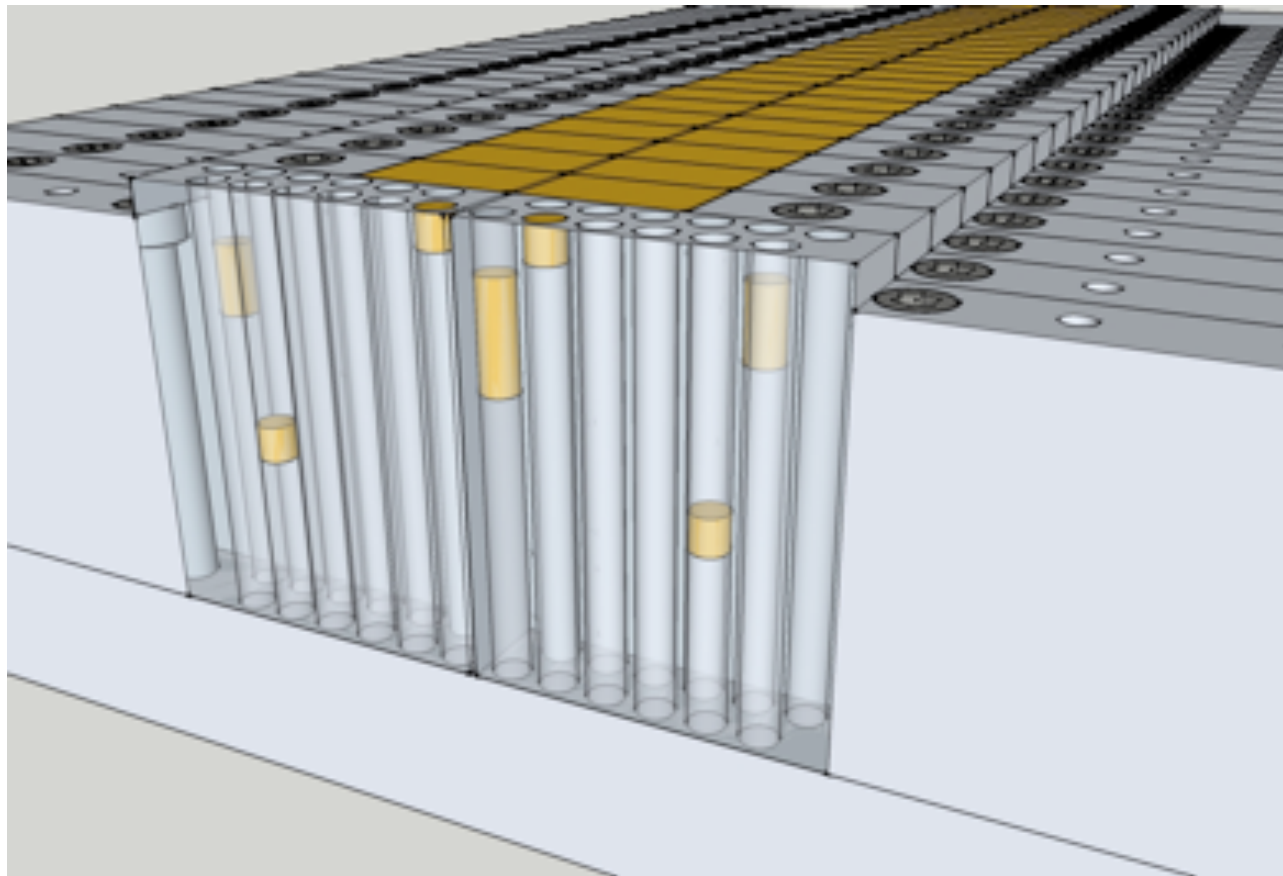


Magnetic tuning (virtual shimming)





Magnetic tuning (magic fingers)





Conclusions



Achievements in a nutshell

- ◆ Kyma Srl established in August 2007
- ◆ Kyma Tehnologija d.o.o. established in July 2008
- ◆ Operations started by end 2008
- ◆ All undulators for the FERMI@Elettra project delivered on spec, on time, on budget
- ◆ Supply of insertion devices to the light source market started in 2010
- ◆ Kyma to serve and cooperate with major scientific institutions worldwide



Kyma unique competitive advantage

*The only industrial
company worldwide
that is fully and uniquely
focused on the
realization of
Insertion Devices*



Elettra Sincrotrone Trieste

**Thank you
for your kind attention !**

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