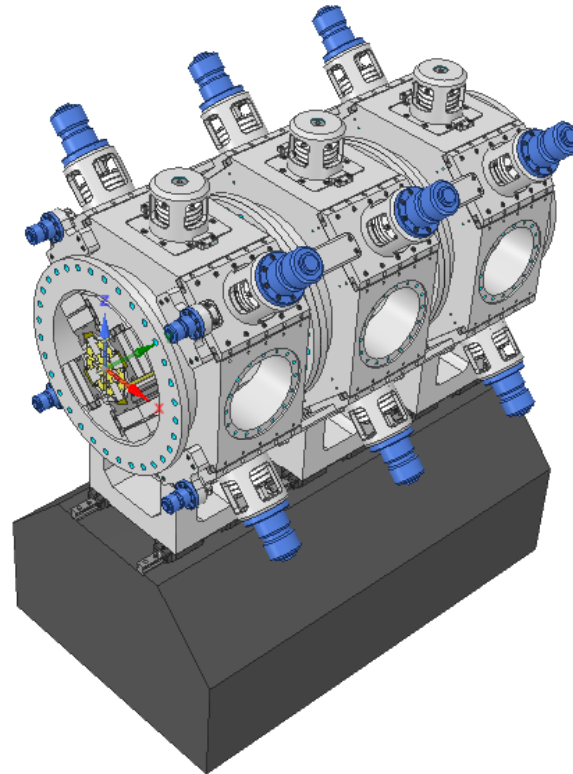




# Afterburner design estimates

Magnetic Error Study for The Compact Light Source Afterburner

Glasgow virtual meeting on 17<sup>th</sup> June 2020



Mirko Kokole, Kyma Tehnologija d.o.o.



## Afterburner parameters

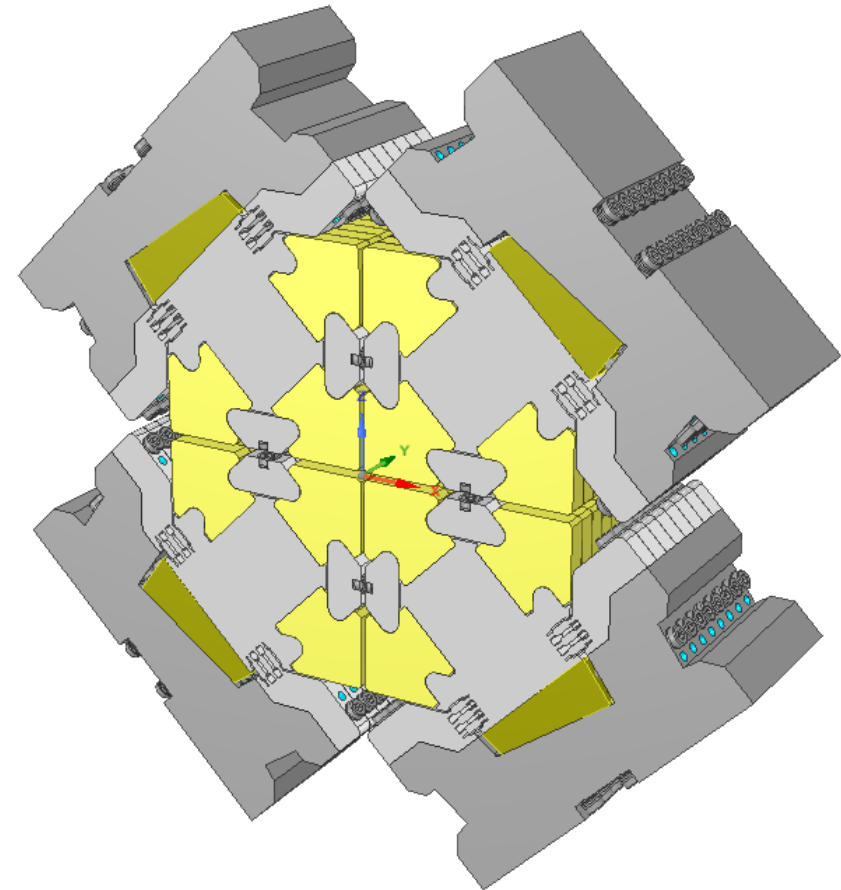
Parameter	Unit	Main radiator	Afterburner
Technology		SCU	IV-CPMU
Period length	mm	13	17
Minimum gap	mm	4	3
Undulator parameter $aw$		0.62 – 1.32	0.3 – 1.5
Maximum field on-axis	T	1.1	1.2
Segment length	m	1.8	1.8
Module length	m	2.3	2.0
Total length	m	37	6
Polarization		circular	variable

## Conceptual afterburner design

- IV-CPMU
- APPLE-X configuration
- PSI fish shaped magnets
- Magnetic force compensation

### Open questions for magnetic design

- Can thin fish shape (PSI type) magnets be made?
- Can we use 8 magnets per period instead of standard 4 magnets per period?
- Can we define magnetic specification for magnet blocks?

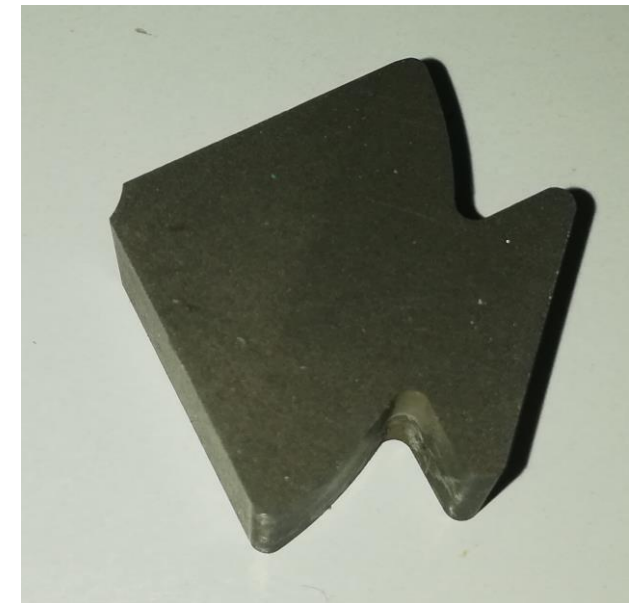


Conceptual magnetic array with force compensation magnets

## Magnet blocks manufacturing check

Production capabilities where checked with the magnet manufacturer

- Fish shaped (PSI type) magnets
  - CONFIRMED
- Very thin down to 1.3 mm magnets
  - CONFIRMED
- Two or more blocks assembly magnet
  - POSSIBLE
  - needs to be studied and tested.
- Small prototype production is necessary for final confirmation



KYMA sample PSI type magnet.

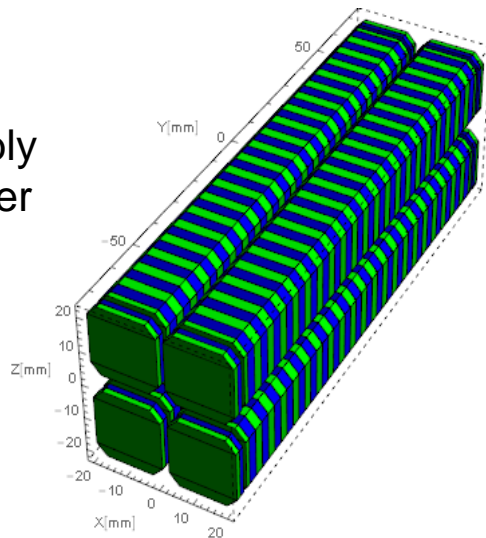
# Error study for specification of magnet blocks

RADIA model including errors for Br and magnetization angles

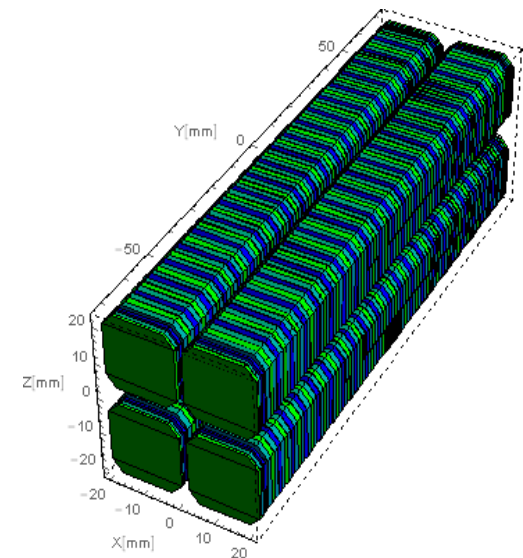
Two models

- (1) Standard EPU with 4 magnets per period
- (2) EPU with 8 magnets per period
- Flat and Normal distribution of errors for Br and magnetization angles
- 500 random assemblies are calculated.

Standard EPU  
magnetic assembly  
with 4 magnets  
per period



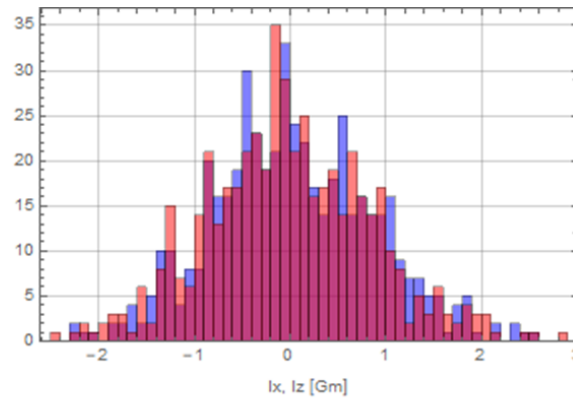
Proposed EPU  
with 8 magnets  
per period



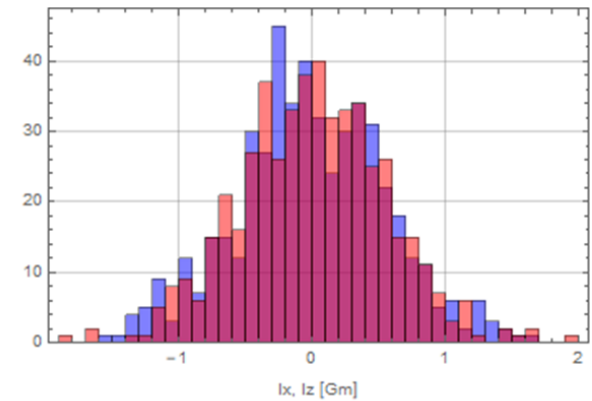


# Field integrals – Flat distribution

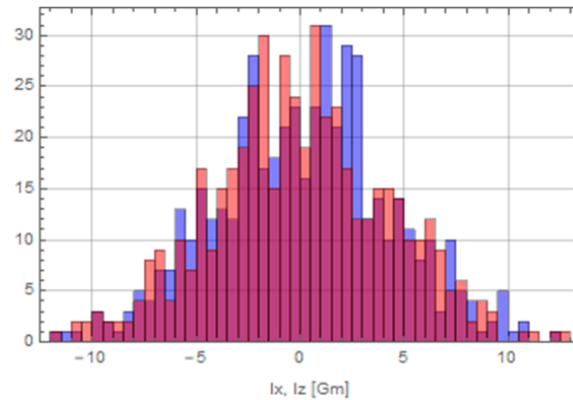
Standard EPU  
Angle errors = +/- 1°  
500 random assemblies



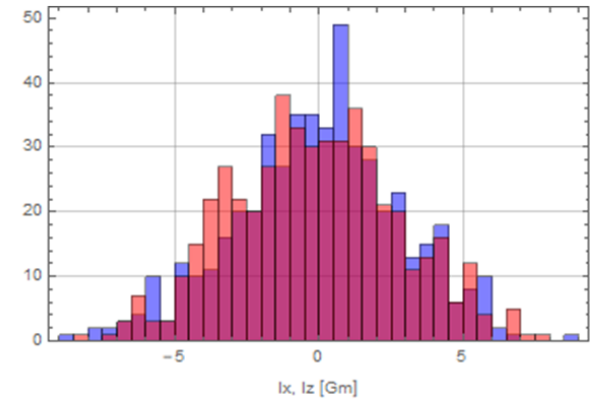
8 mag. per period  
EPU  
Angle errors = +/- 1°  
500 random assemblies



Standard EPU  
Angle errors = +/- 5°  
500 random assemblies



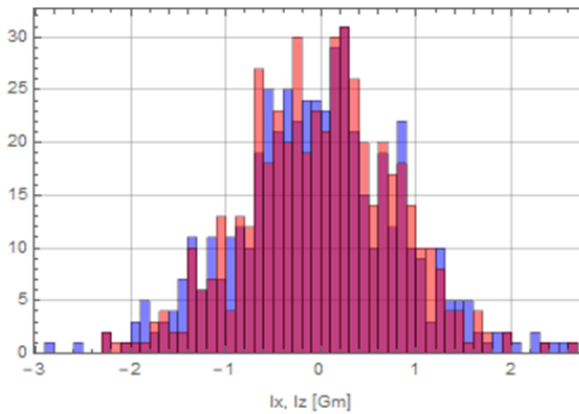
8 mag. per period  
EPU  
Angle errors = +/- 5°  
500 random assemblies



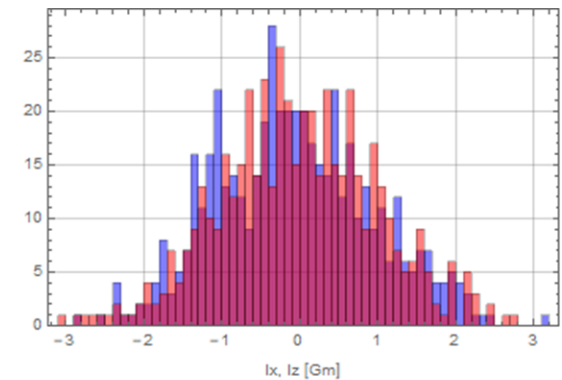


# Field integrals – Normal distribution

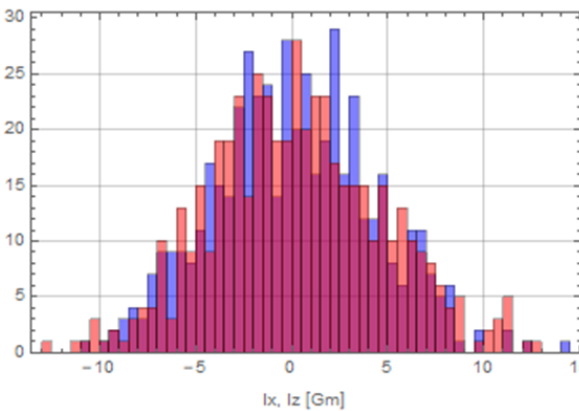
Standard EPU  
Angle errors =  $\pm 1^\circ$   
500 random assemblies



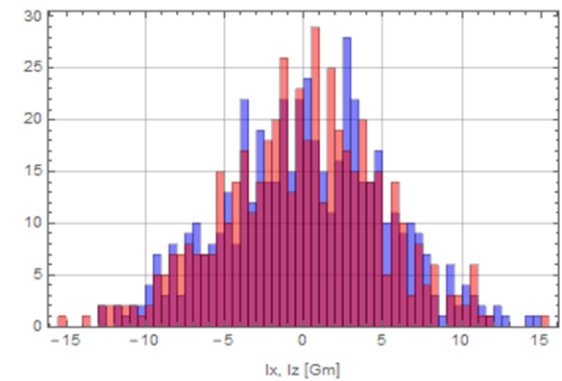
8 mag. per period  
EPU  
Angle errors =  $\pm 1^\circ$   
500 random assemblies



Standard EPU  
Angle errors =  $\pm 5^\circ$   
500 random assemblies



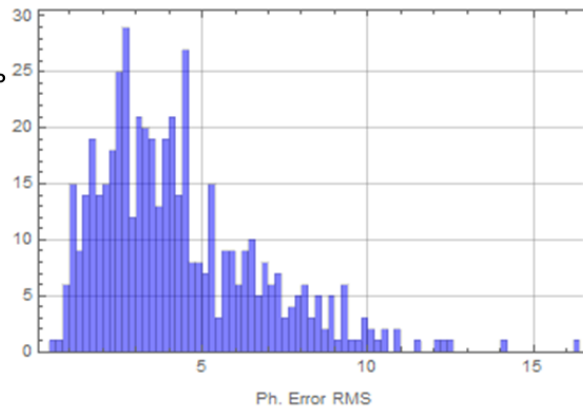
8 mag. per period  
EPU  
Angle errors =  $\pm 5^\circ$   
500 random assemblies



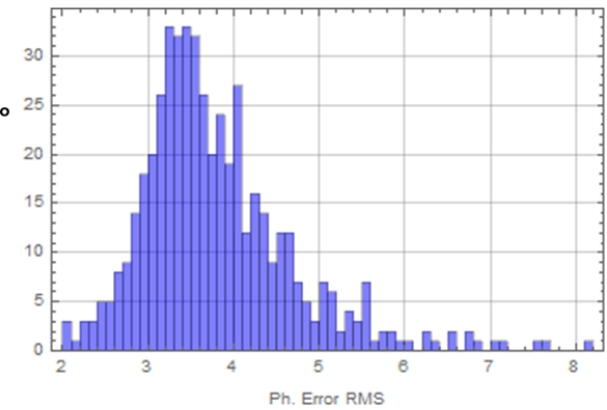


# RMS Phase Error – Flat distribution

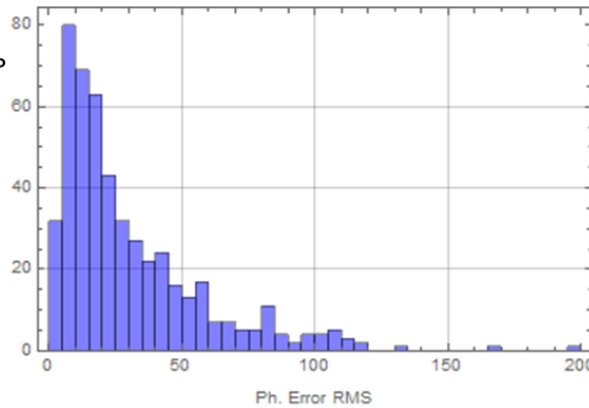
Standard EPU  
Angle errors = +/- 1°  
500 random assemblies  
10 periods model



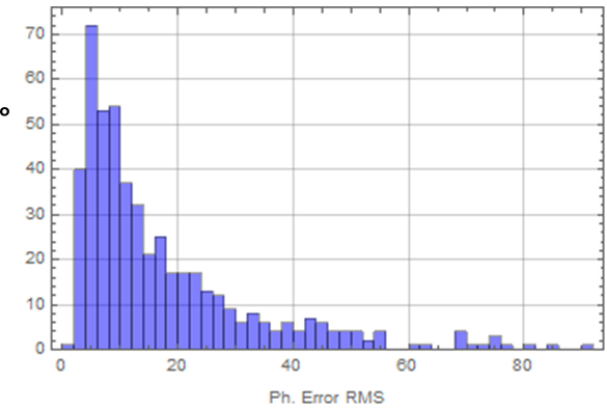
8 mag. per period  
EPU  
Angle errors = +/- 1°  
500 random assemblies  
10 periods model



Standard EPU  
Angle errors = +/- 5°  
500 random assemblies  
10 periods model



8 mag. per period  
EPU  
Angle errors = +/- 5°  
500 random assemblies  
10 periods model

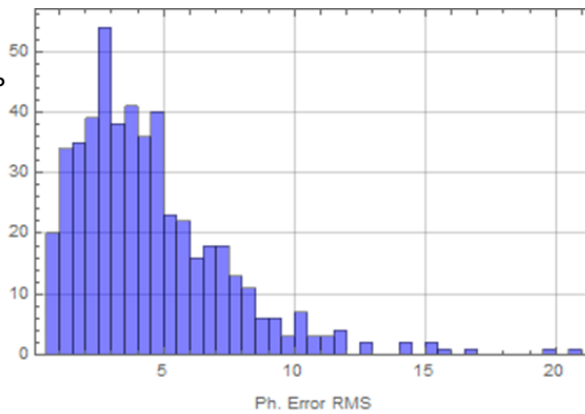




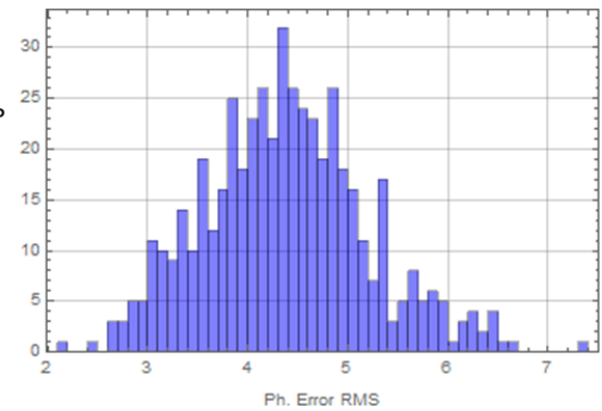


# RMS Phase Error – Normal distribution

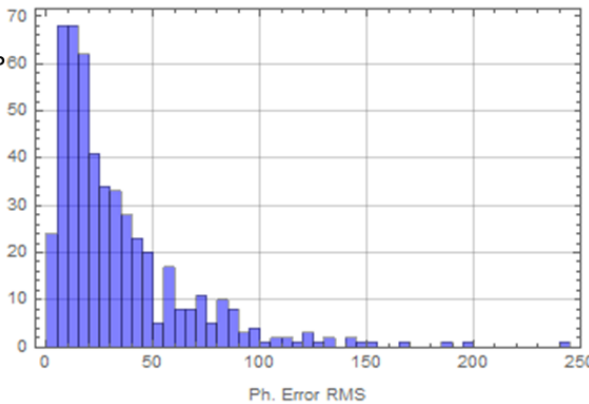
Standard EPU  
Angle errors =  $\pm 1^\circ$   
500 random assemblies  
10 periods model



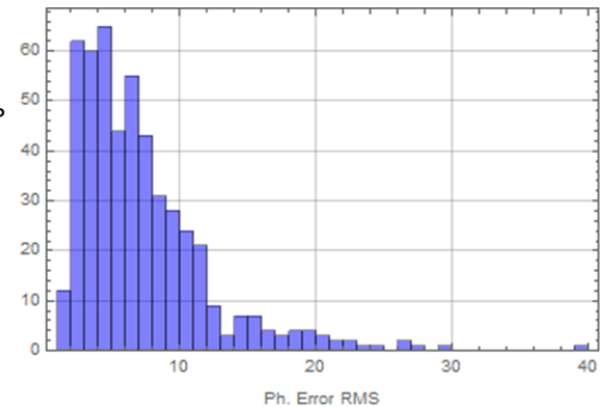
8 mag. per period  
EPU  
Angle errors =  $\pm 1^\circ$   
500 random assemblies  
10 periods model



Standard EPU  
Angle errors =  $\pm 5^\circ$   
500 random assemblies  
10 periods model



8 mag. per period  
EPU  
Angle errors =  $\pm 5^\circ$   
500 random assemblies  
10 periods model





# Conclusions

Manufacturing of small thin magnets is feasible

A small prototype is necessary

- Check production of magnets
- Check mechanical layout
- Check measurement and shimming capabilities

Magnetic error analysis

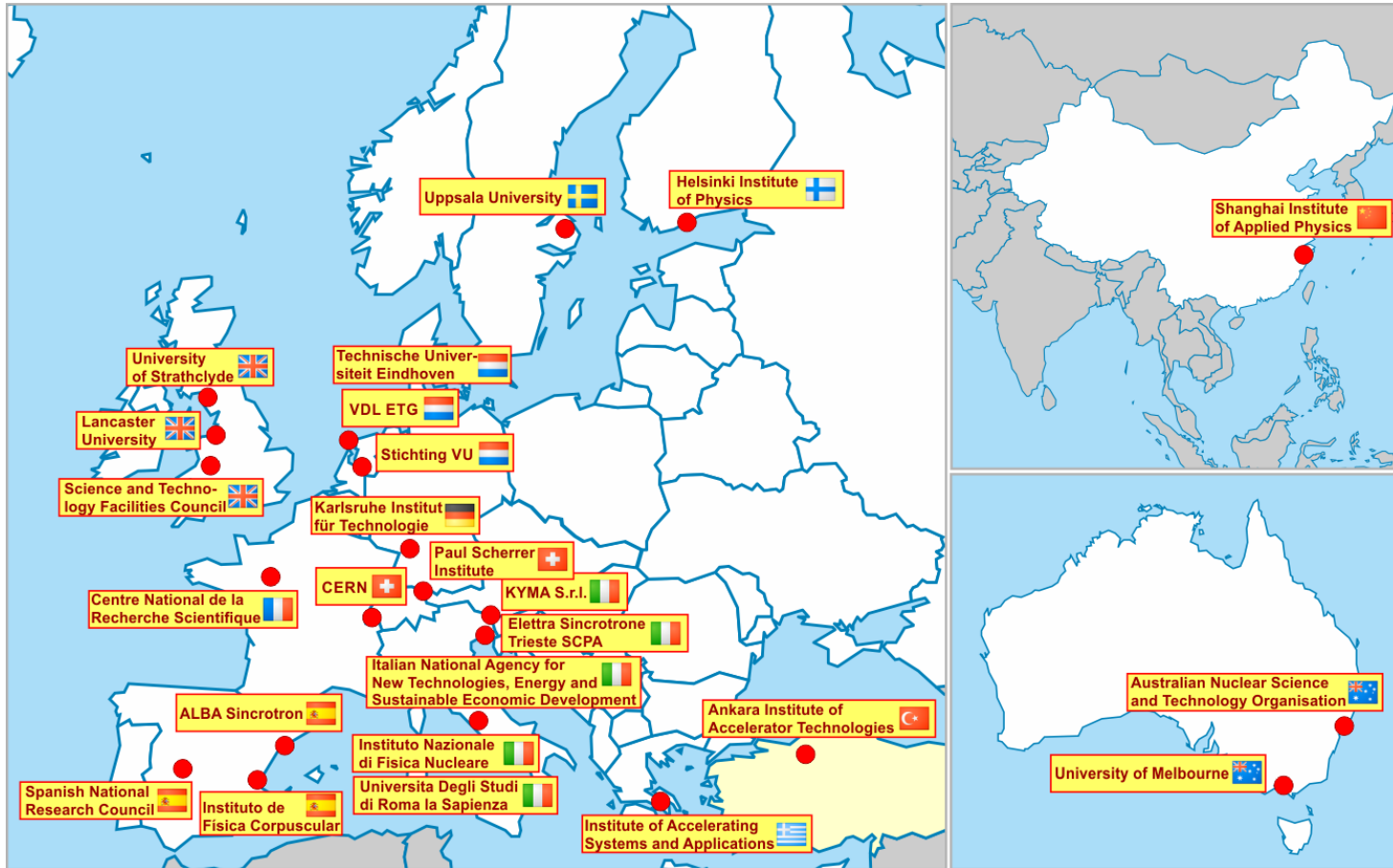
- Both 4 and 8 magnet per period EPUs behave similarly
- 8 magnet EPU better than 4 magnet EPU
- Same magnetic tolerances as for standard EPU are suggested
- Further studies are necessary



# Thank you!

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