Status Report on the Afterburner

T. Schmidt[1], M. Kokole[2], T. Milharcic[2] on behalft of WP5

[1]Paul Scherrer Institute
[2]Kyma

Summary Glasgow I: Afterburner (F. Nguyen)

Afterburner concept: (cryogenic) in-vac APPLE X

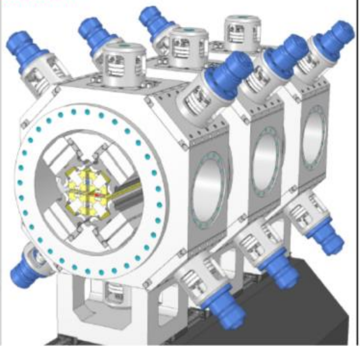
B_r = 1.37T @ RT, 1.7T @ 77K
round gap with 5mm diameter
period length 16 – 18 (19) mm

State of the art: 1 in-vac APPLE (BESSY II)
APPLE in FELs: FERMI and PSI (with 0.2mm wall thickness)

All new **compact** design concept:

- modular machined vacuum chamber on a girder
- no external support structure
- distributed drive unit at any link rod
- new hydraulic drives combine strength with sub-μm precision
- 8 magnets / period for higher K @ RT

compact would also mean cost effective:
dimensions comparable with scu FEL undulator
reduced infrastructure in cranes, floor preparation for air cushions



- Out of vacuum / in-vacuum
- Room temperature / cryo-cooled
- Individual magnets / magnet soldering
- Traditional mag. structure / magnetic compensation
- Traditional VC / segmented VC as support structure

Courtesy of T. Milharcic

Opt 1

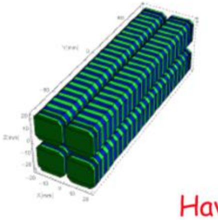
Opt 2

- Easier installation and alignment.
- Lighter structure, more compact solution.

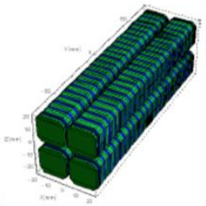
Courtesy of M. Kokole

- 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



Have to check against parameters hinted by Neil

Next steps: From T. Schmidt

define total length (number of modules) with 2m to 4(5)m length each
use of APPLE X transverse gradients could allow special operation modes

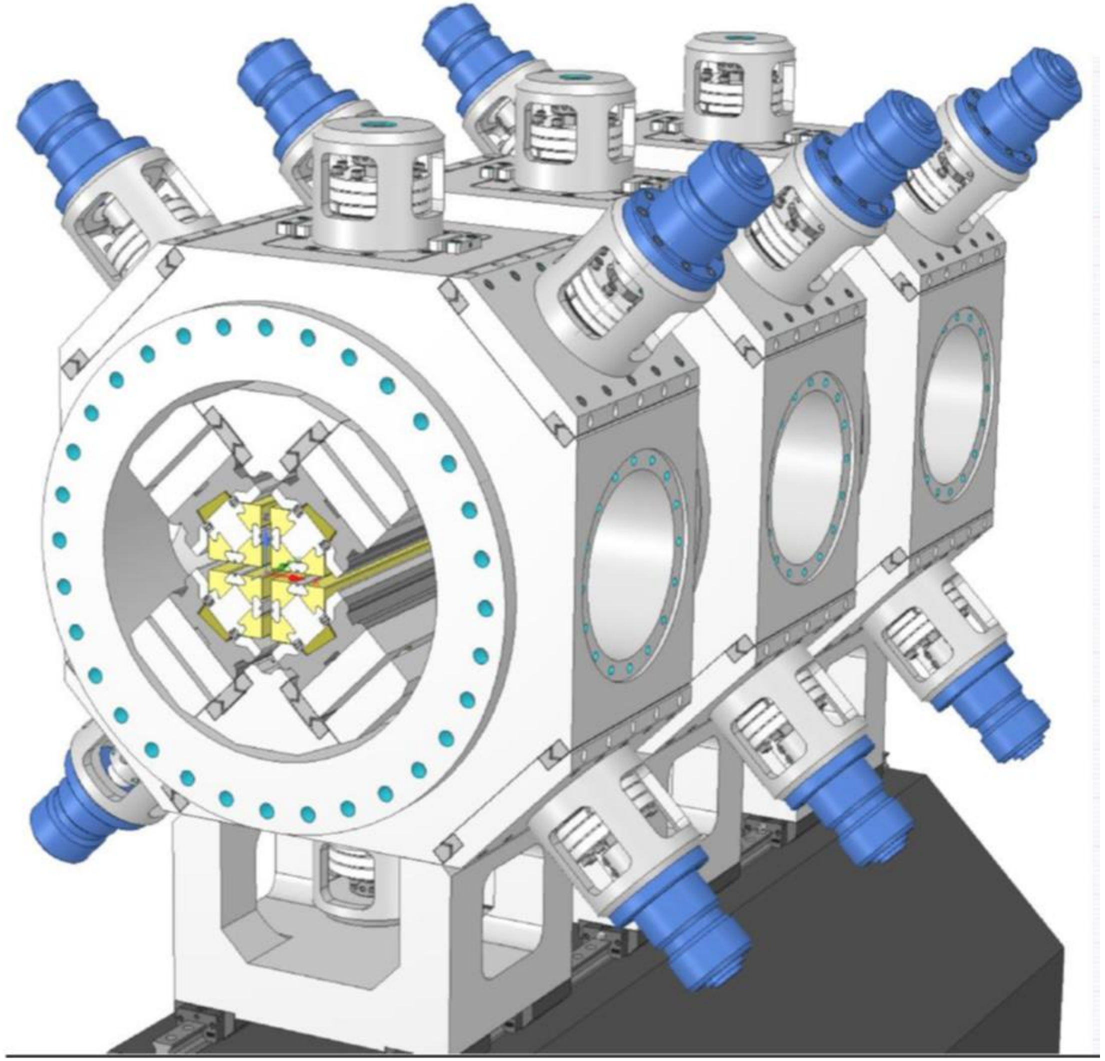
CDR -> TDR for risk analysis and better cost estimations

FEM analysis of mode dependent deformations
gap measurement with distributed drive system
interface to electron beam, foils or slotted pipe
flexible taper
integration of cooling incl. shielding
integrated measurement system

Synergies:
modular compact design as option for SLS 2.0 upgrade
cryogenic APPLE also topic in LEAPS

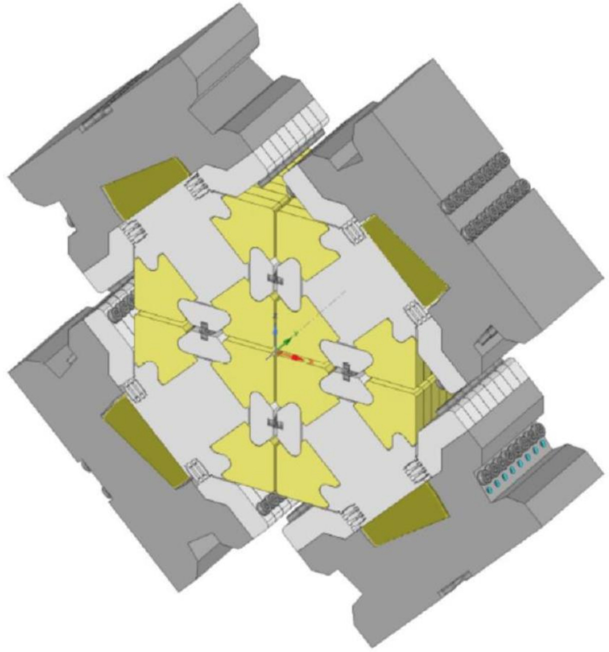
Both room temperature and cryogenic structures will be written in the XLS CDR

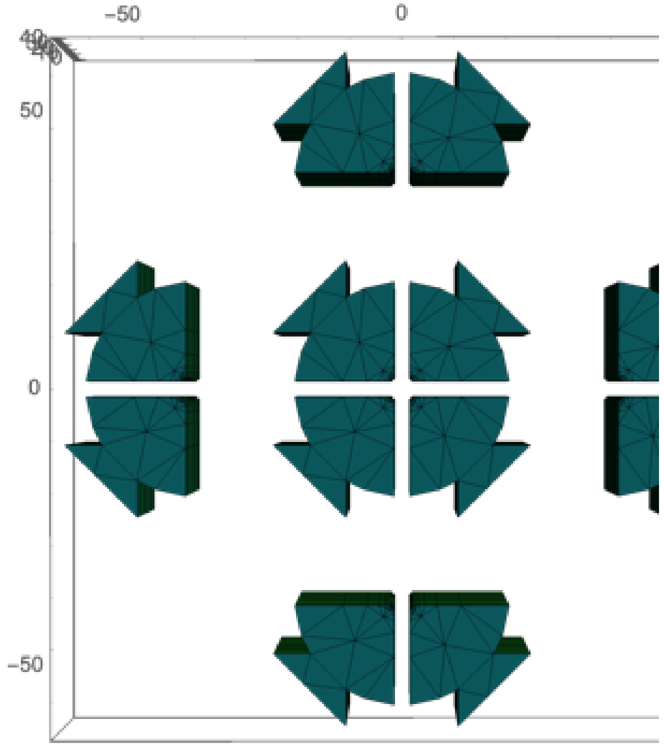
Status Glasgow I

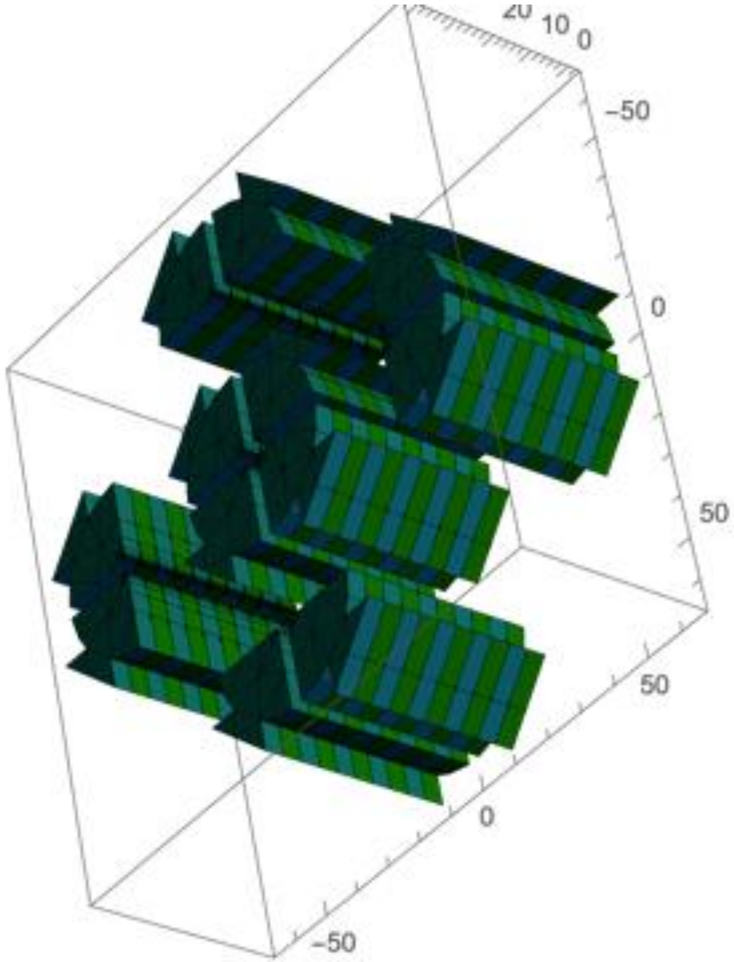


Funded by the
European Union

Magnetic force compensation







change in force compensating magnet geometry

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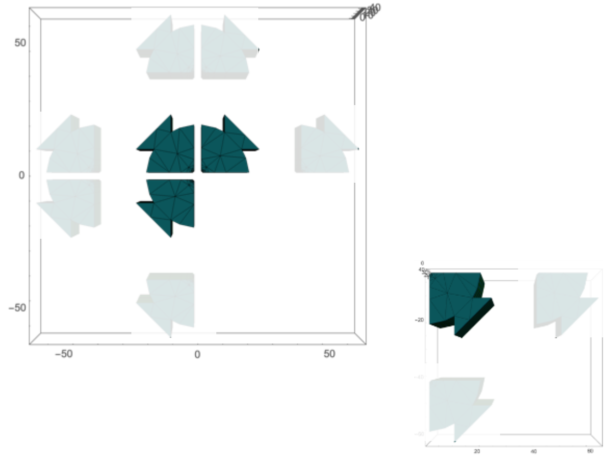
Forces on single rows

Compact

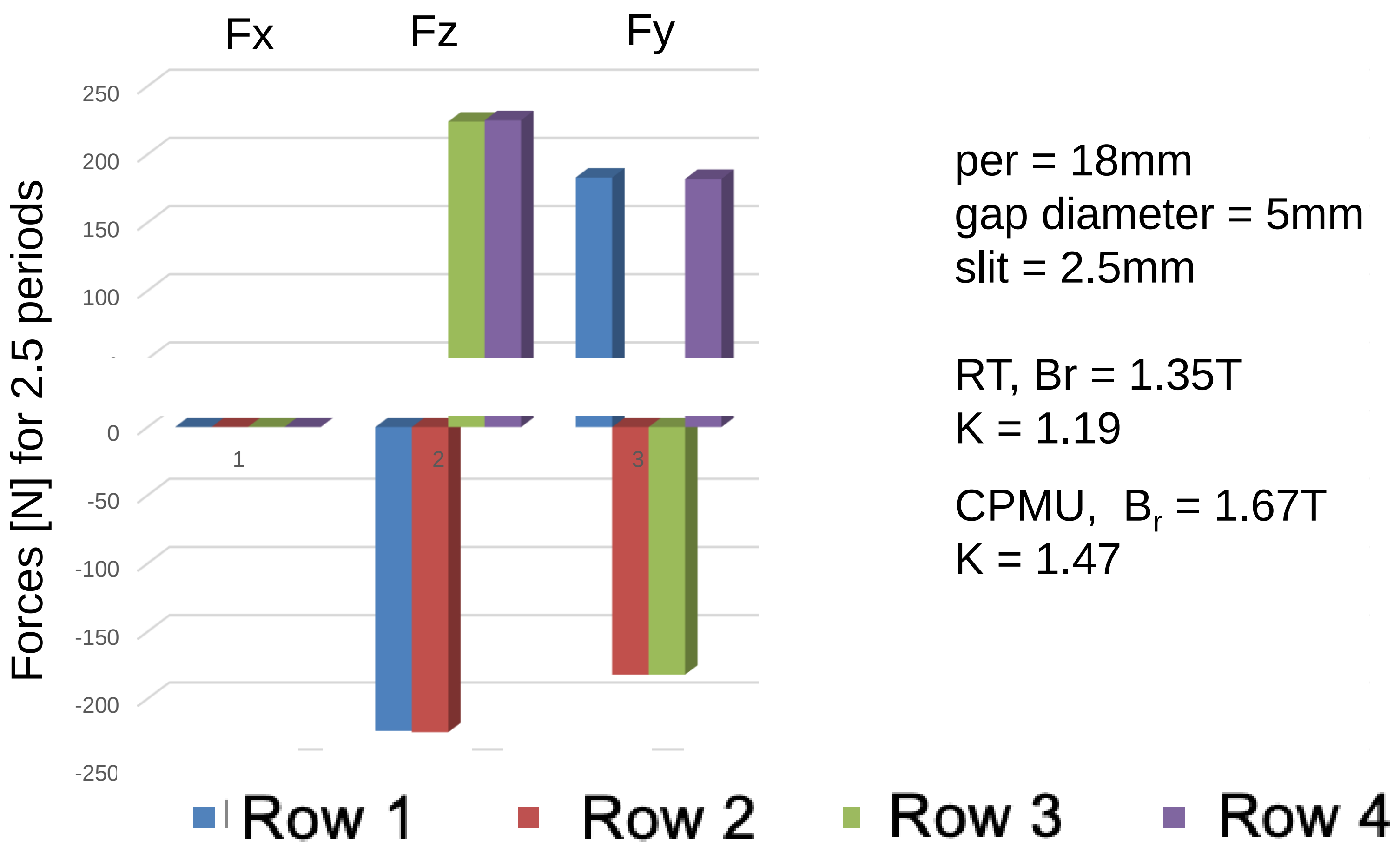
Mode: LH



Forces (2.5 periods)

RT:
274 N -> 6082 N/m

CPMU:
416 N -> 9235 N/m

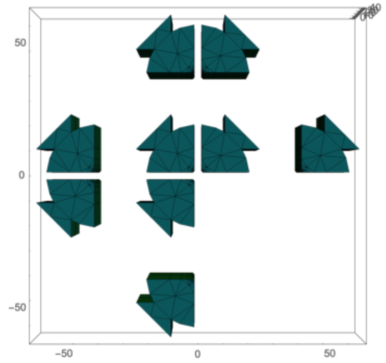


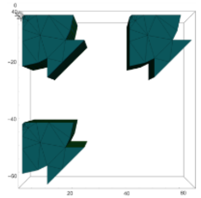
per = 18mm
gap diameter = 5mm
slit = 2.5mm

RT, Br = 1.35T
K = 1.19

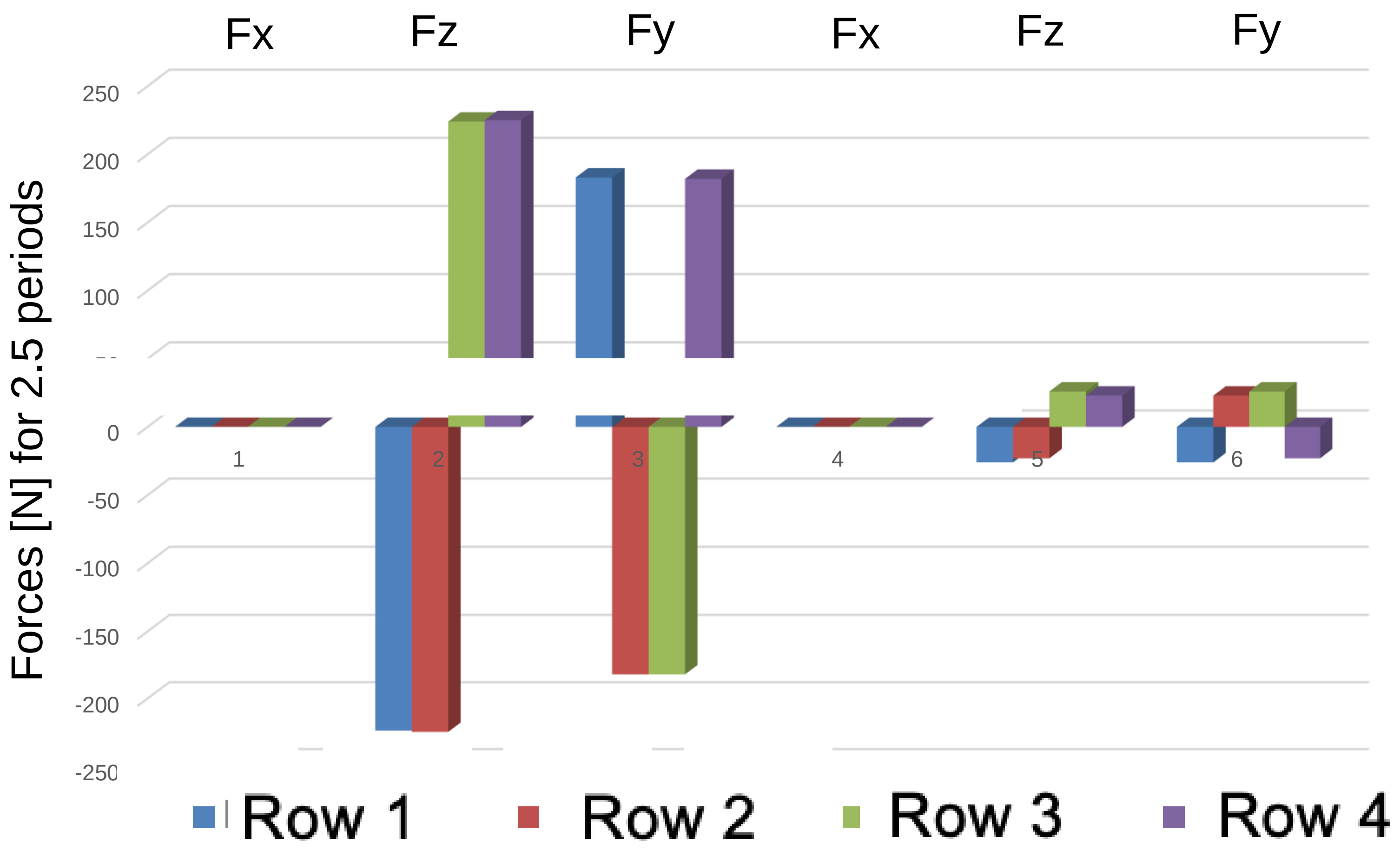
CPMU, B_r = 1.67T
K = 1.47

Forces on single rows





Mode: LH



Forces (2.5 periods)

RT:
274 N -> 6082 N/m
34 N -> 755 N/m

CPMU:
416 N -> 9235 N/m
52 n -> 1147 N/M

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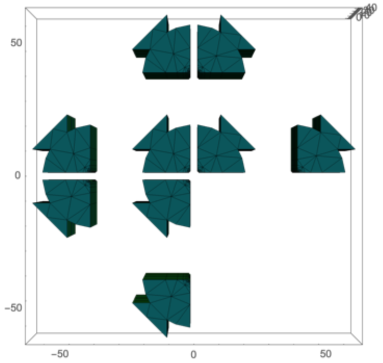
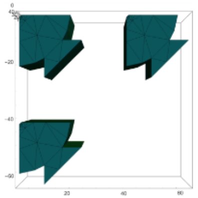
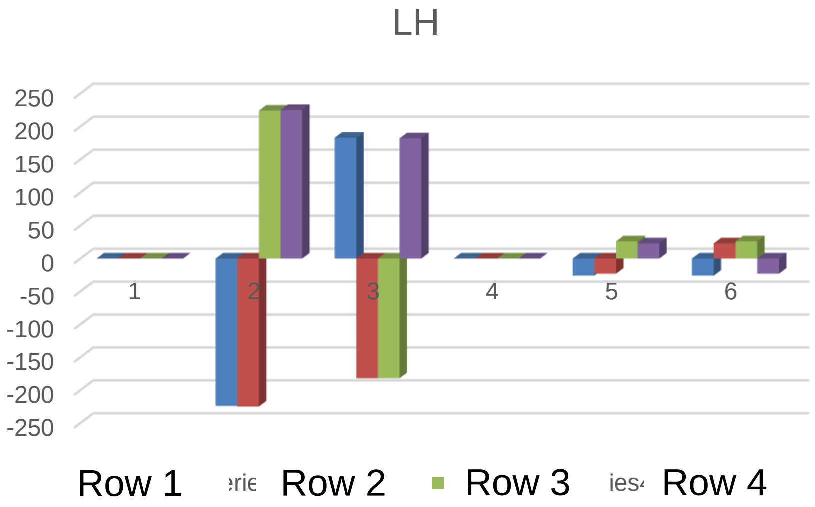
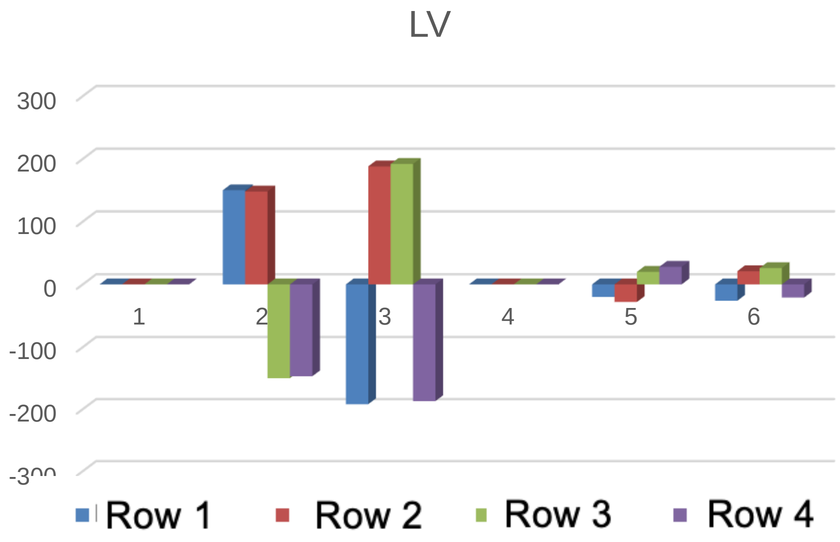
Forces on single row



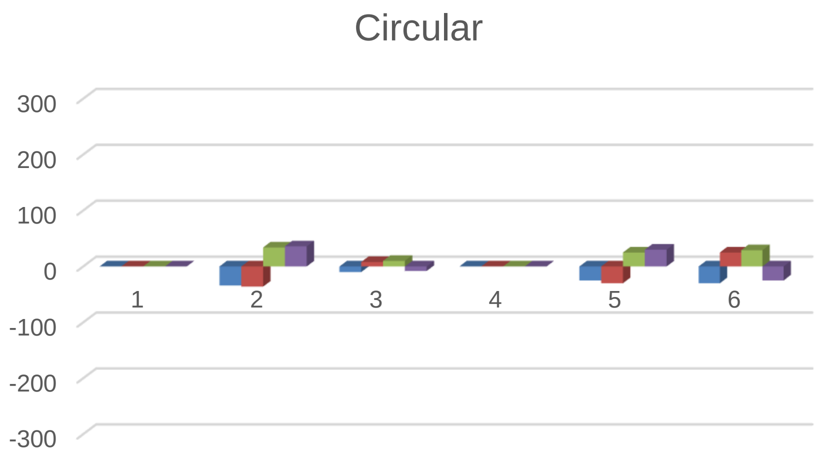


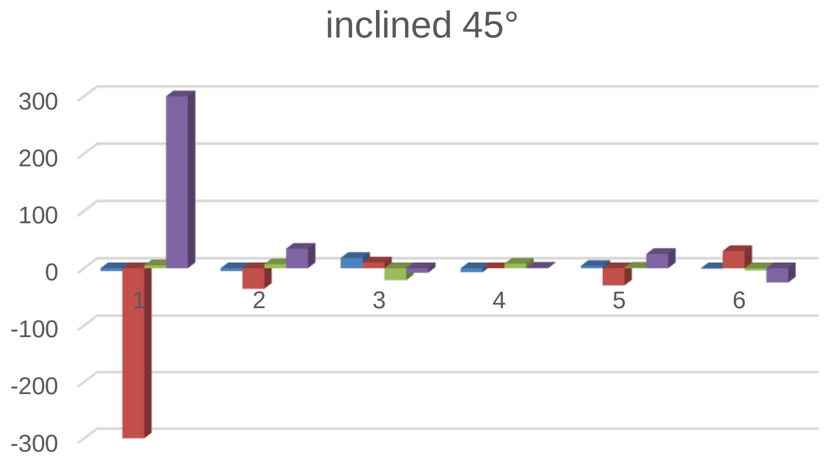




Force compenstion

- works in all modes
- does not change in major operation modes
- is the key to compact design





Flexible taper

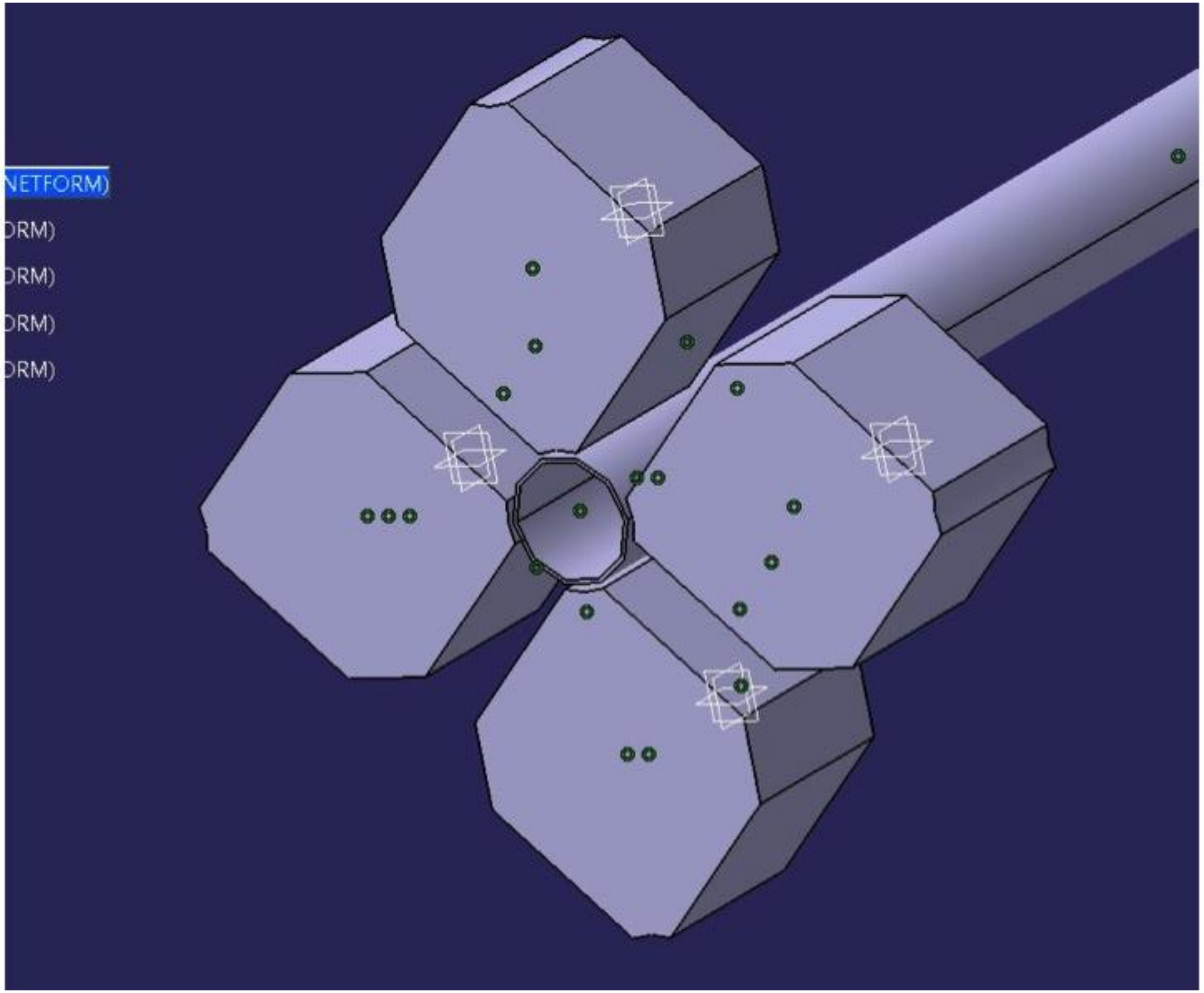
in storage rings all in-vacuum undulators (planar + BESSY II) have flexible taper

SwissFEL hard x-ray undulator line U15 has hard steps with small gap in entire undulator line (13 modules a 4m)

works without problems ☺

avoiding flexible taper especially in APPLE X
and even more in Cryogenic APPLE X is a serious simplification.

Simplified magnet geometry



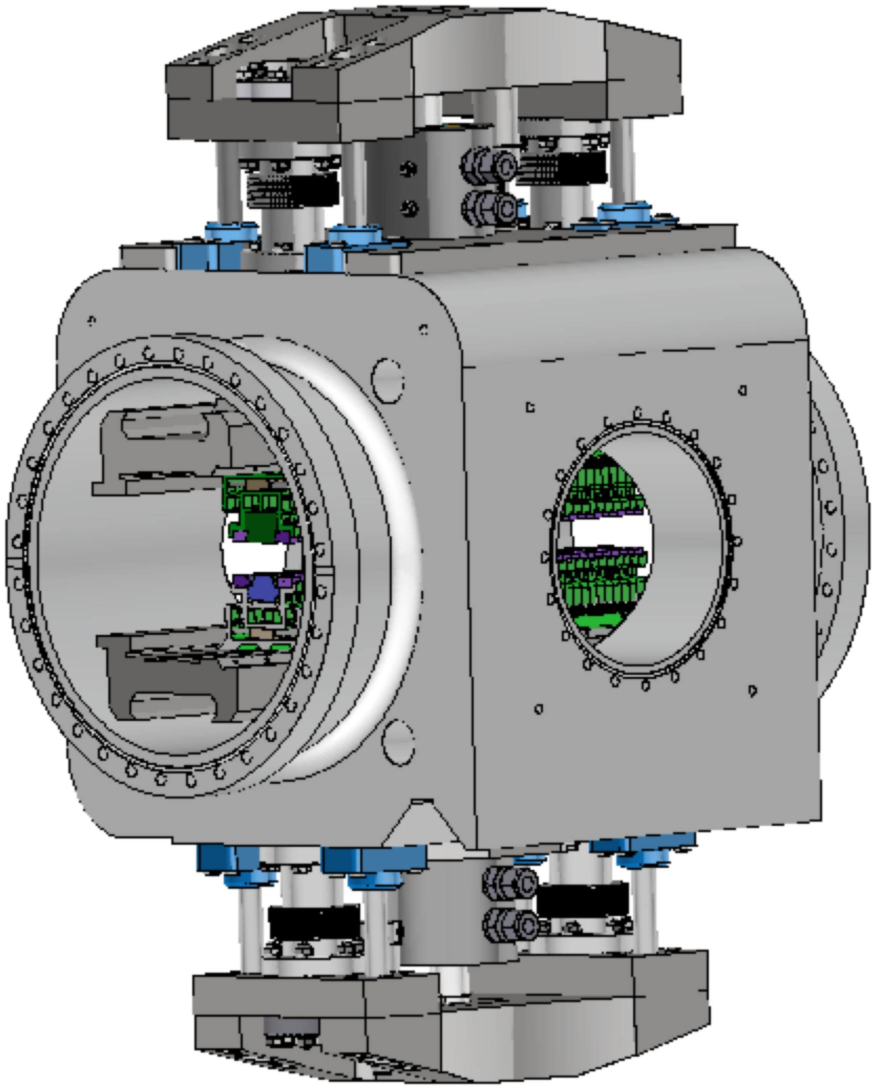
pro:

- increased sorting freedom due to symmetry
- simplified machining, reduced costs

con:

- this model may too simple cause of missing form closure

Simplified magnet geometry



Prototype under construction
for compact planar in-vacuum (CPMU)
undulator for SLS2.0 @ PSI

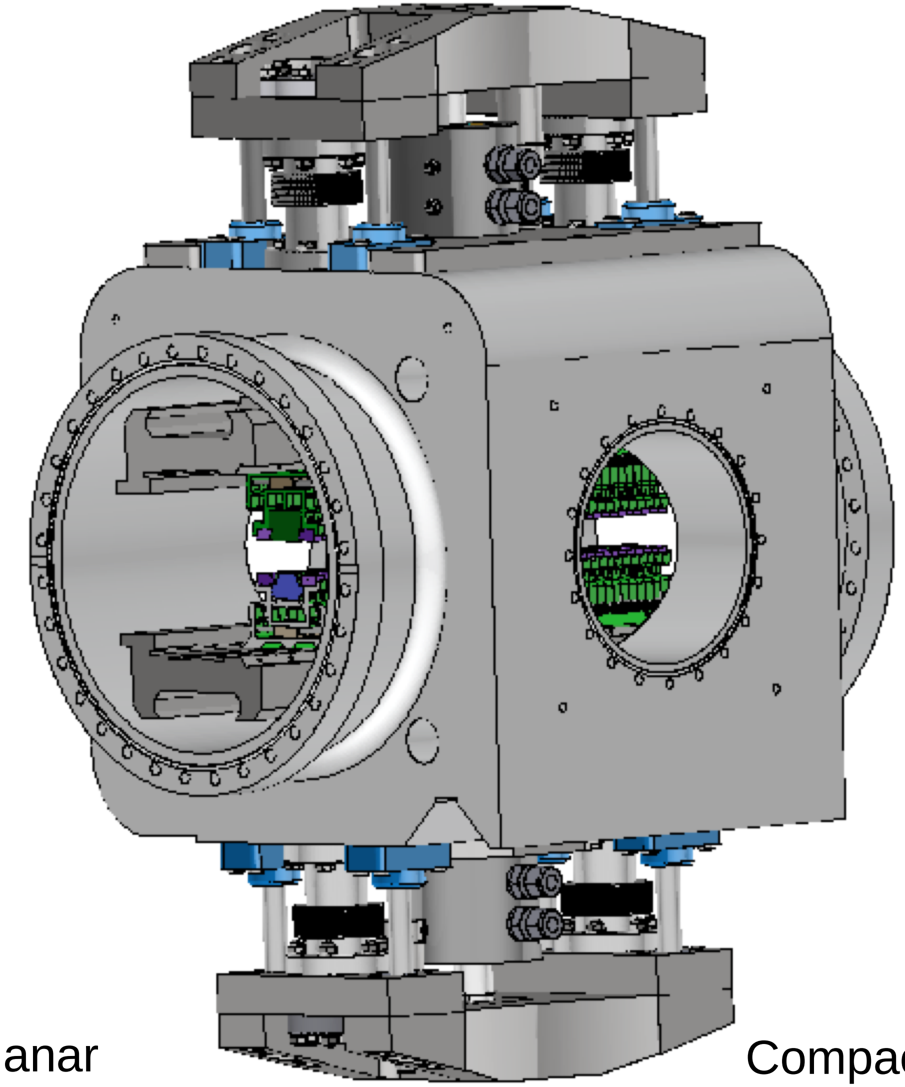
vacuum chamber = support

module length 504mm

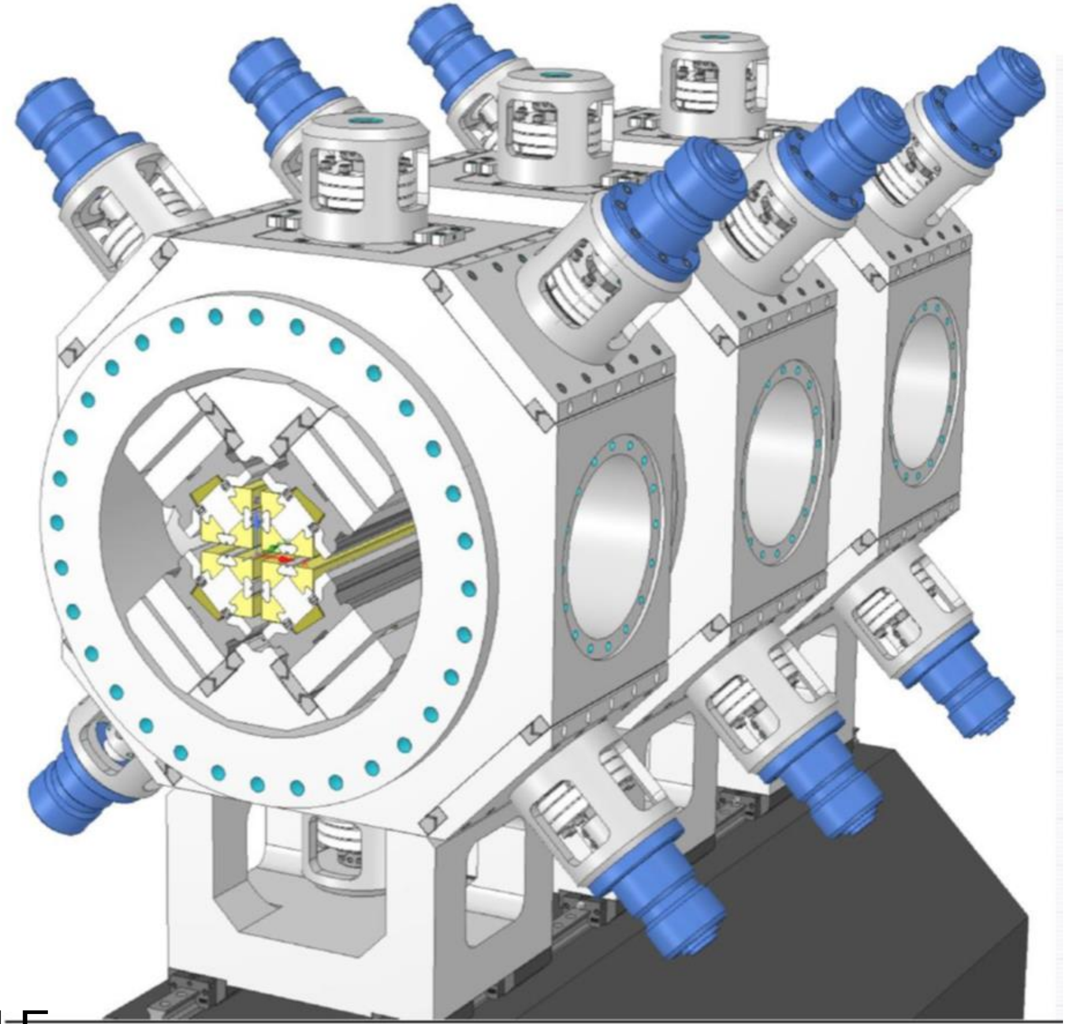
hydraulic drive system

industrial solutions for bearings

Simplified magnet geometry



PSI planar



Compact Light APPLE

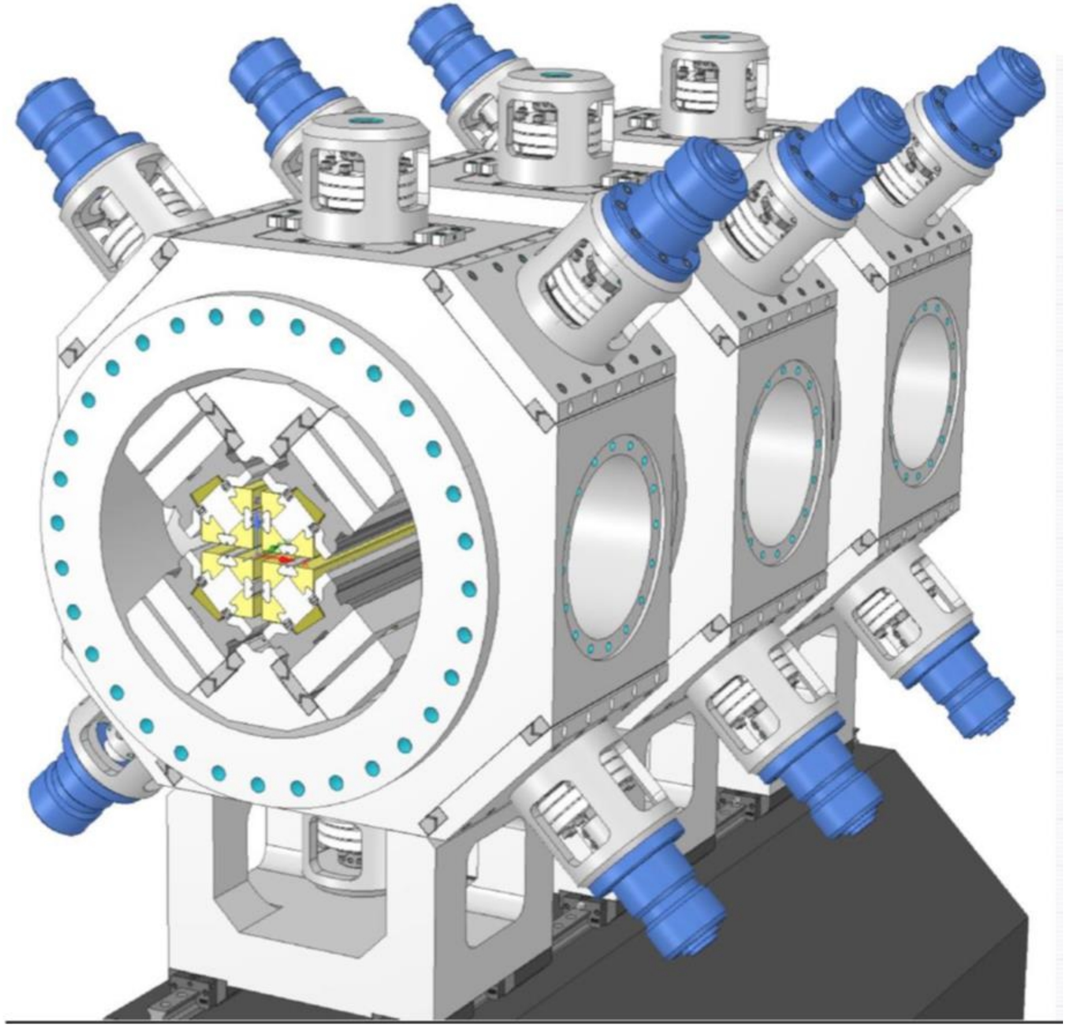
next steps

continue some FEM calculations
(T. Milharcic)

detailed cost summary

start writing CDR

for more detailed design -> TDR
worth to wait for PSI results



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Compact

Thank you!

CompactLight@elettra.eu

www.CompactLight.eu

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