

Mechanics & production

Florian Pithan

AGIPD meeting 15.10.13



- Redesign Vacuum board
- Mechanics
- Wing design
- Cabling
- Front end modules
- Material availability
- Module production
- Personnel
- Summary



Redesign Vacuum board

Redesign Vacuum board

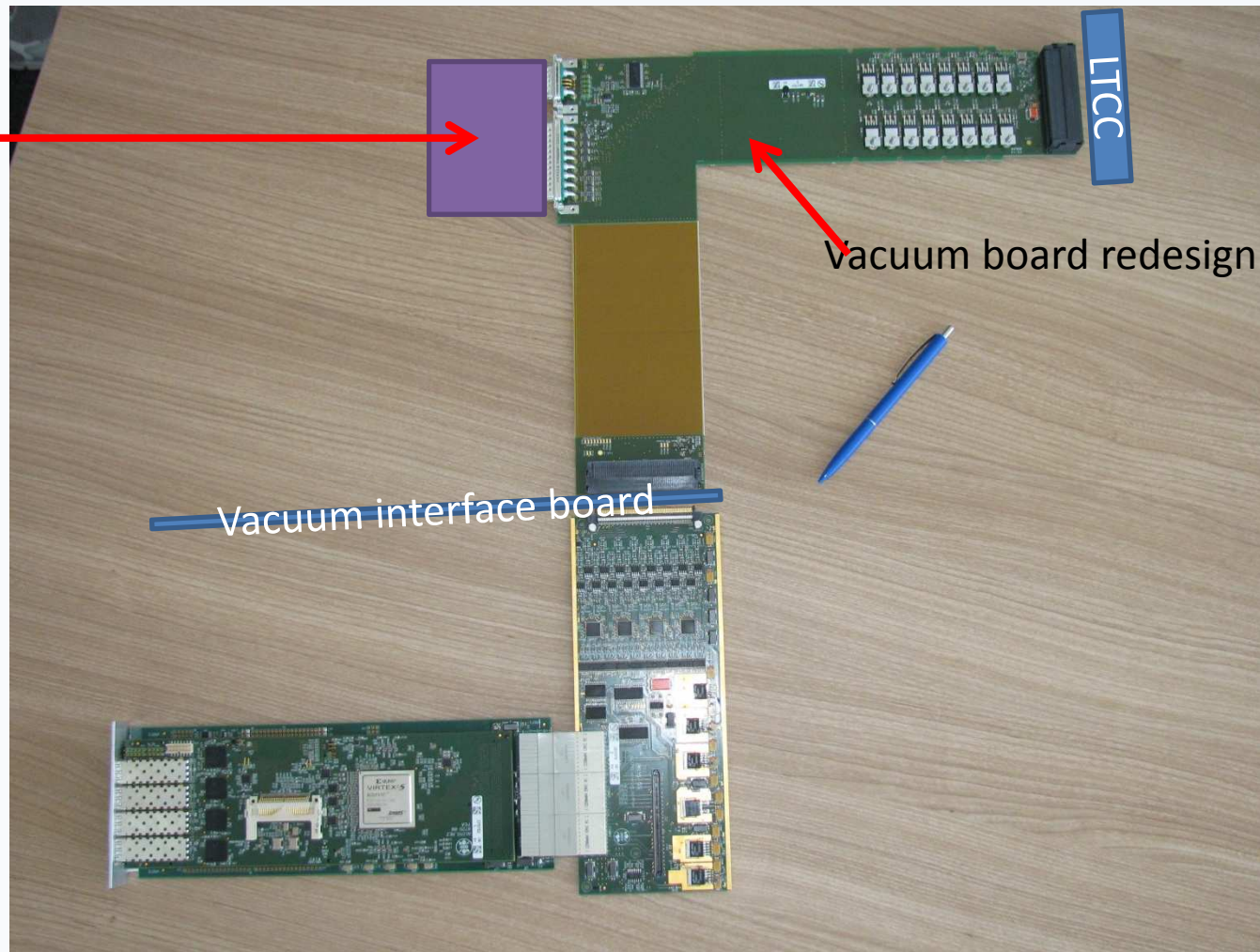


- Critical error in vacuum board detected
- 2 out of 16 layers missing on PCB
- Not functional, therefore: redesign
- Opportunity to fix additional non-critical errors:
 - I²C powering on board (less vacuum feed-throughs, eliminates power interface board)

Vacuum board redesign



Power interface board eliminated



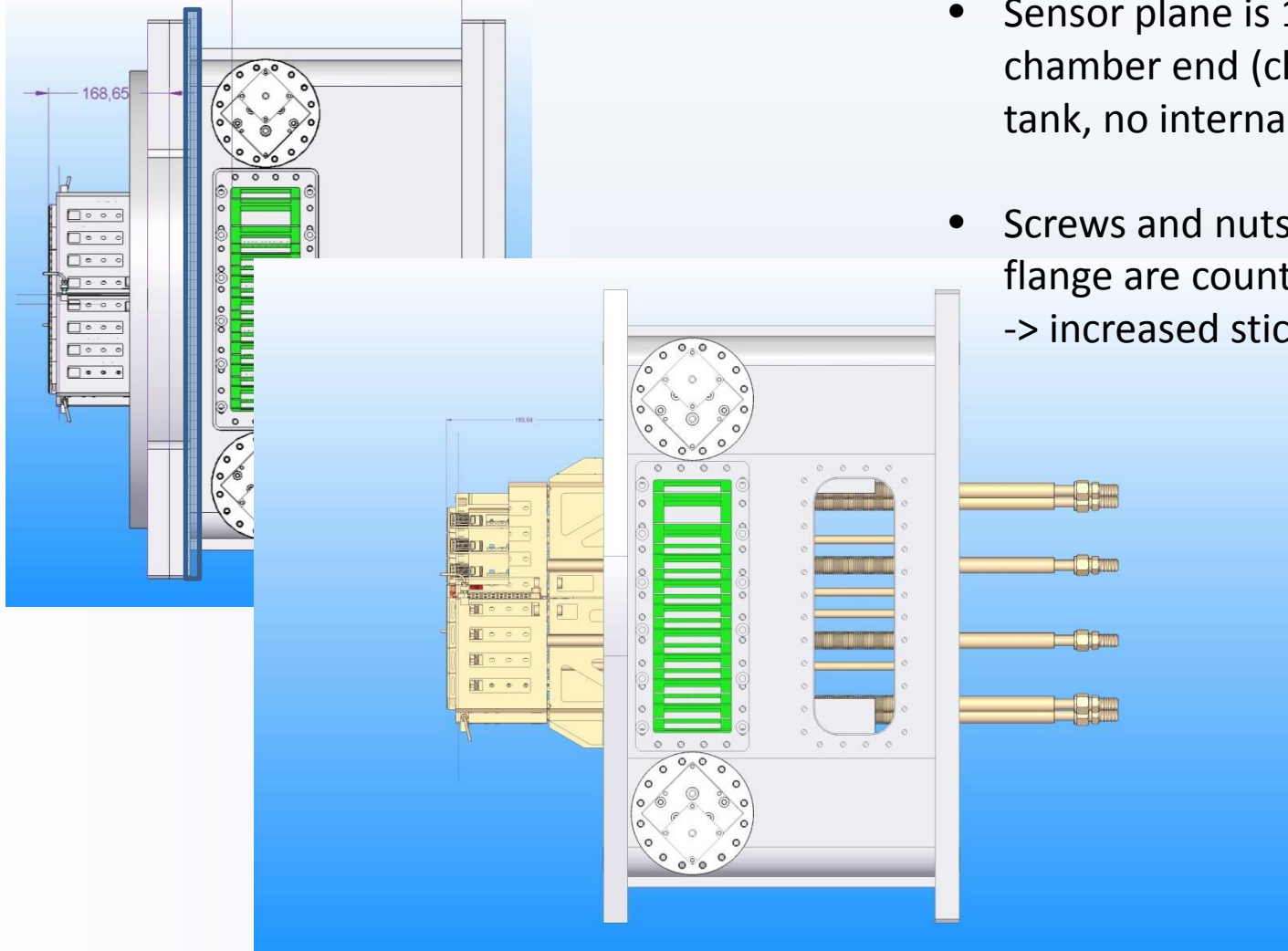


Mechanics

'Stick out' layout, update

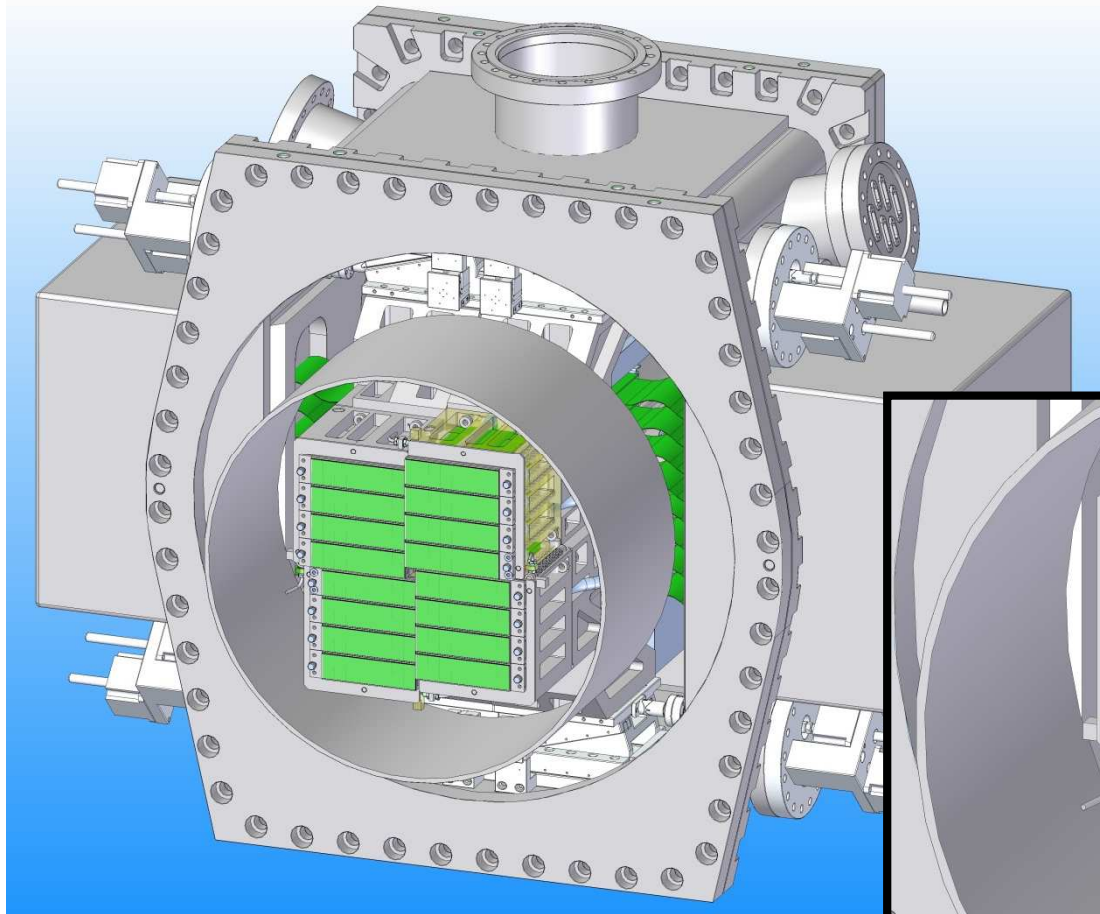


Space where nuts go



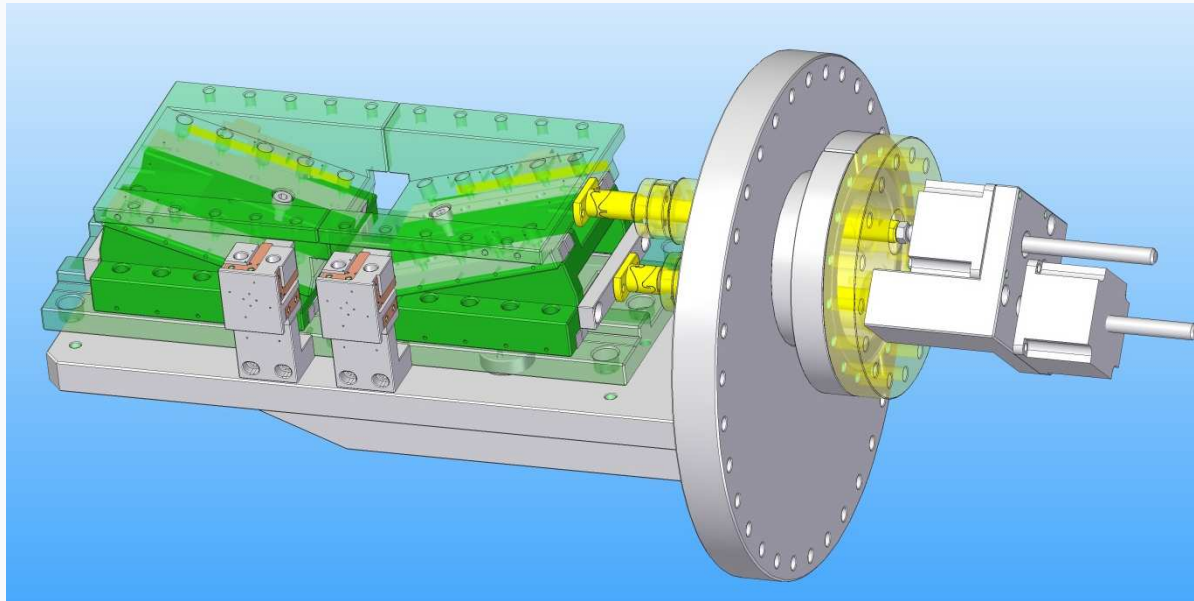
- Sensor plane is 193mm from chamber end (change of vacuum tank, no internal change)
- Screws and nuts of large diameter flange are countersunk
-> increased stick out distance

View as of 27.09.2013



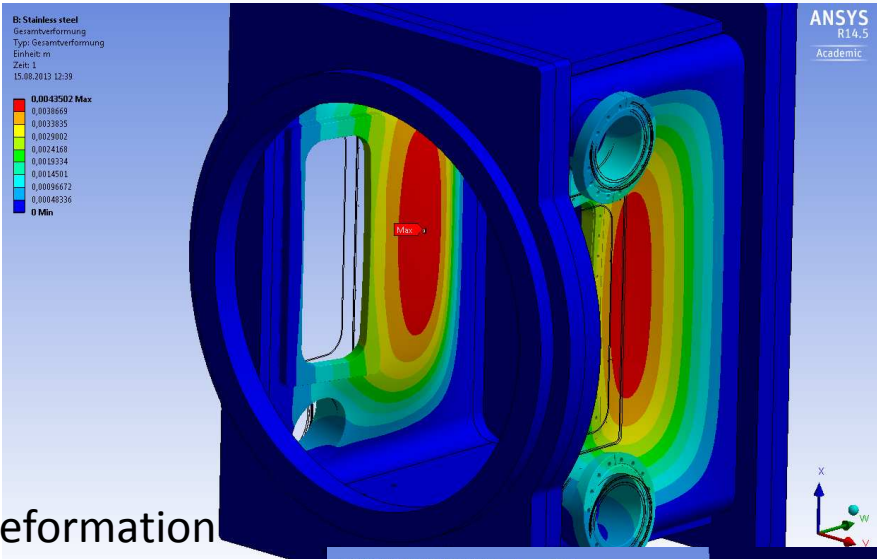
Seesaw type module holder
(more details later)





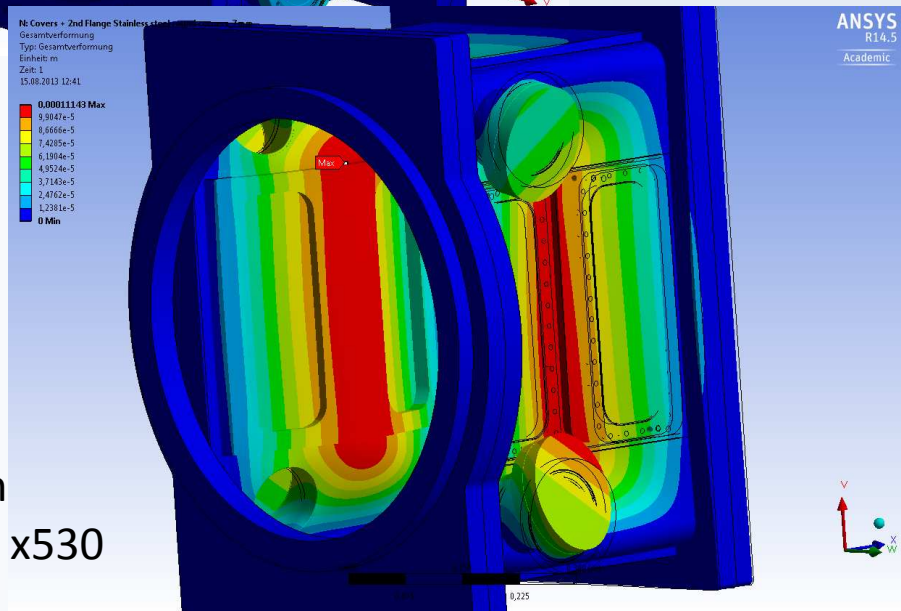
- First set of motion stages scheduled to arrive end of October
- Beckhoff components and motors already handed over to XFEL (Nicola Coppola)

Simulations of vacuum vessel



Deformation exaggerated x13

Initial layout:
Deformation: 4.4 mm max
Stress: 4.2 x maximum yield
-> Vacuum vessel failure

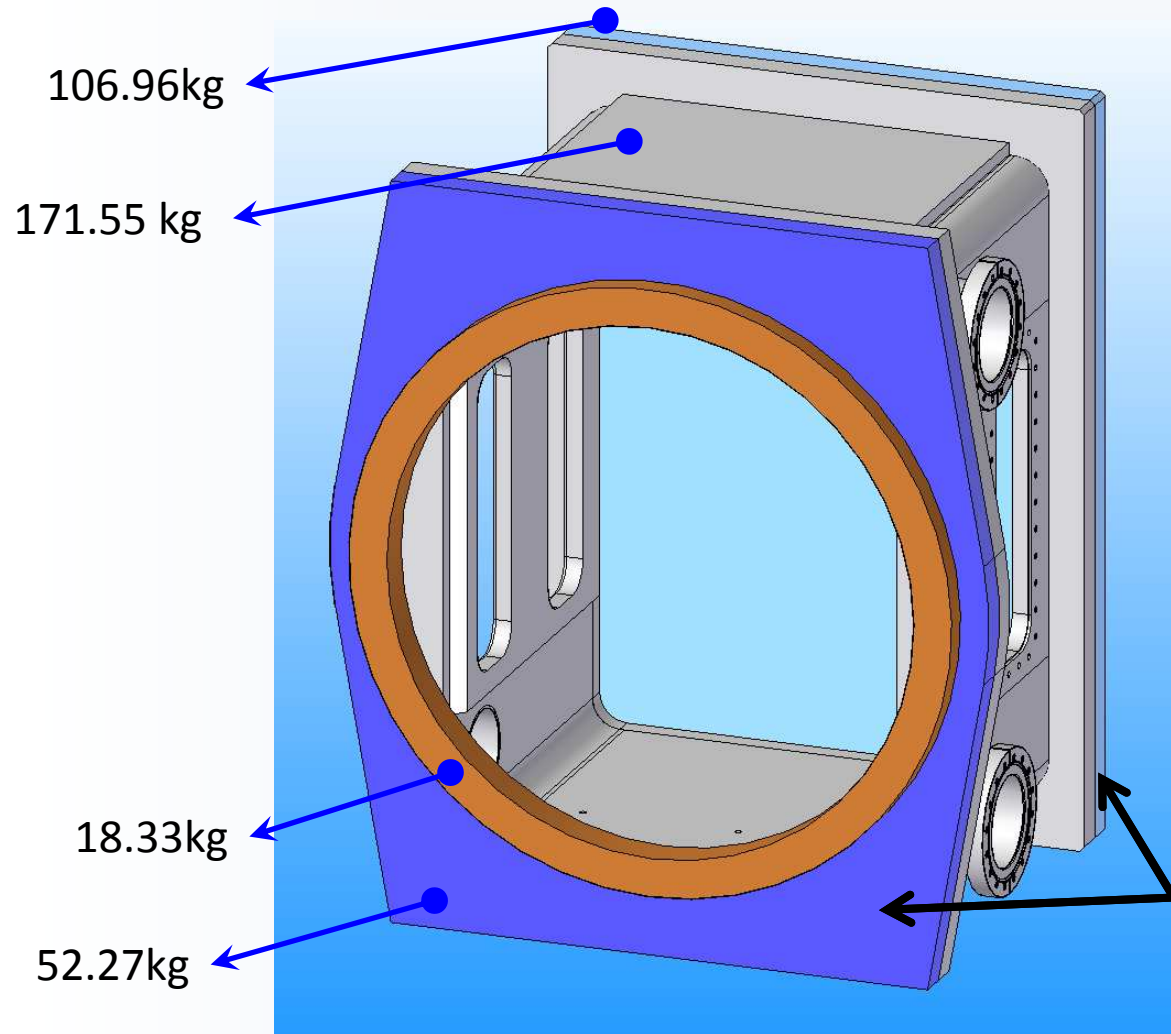


Deformation exaggerated x530

Revised layout:
deformation: 0.1 mm
Stress: 0.25 x maximum yield

Simulations for all AI-vessel:
Deformation about x3, similar stress

Current vacuum vessel



- Made from stainless steel
- 7mm side wall thickness
- FEA analysis passed
- Older versions did not pass FEA

Interface flanges (70 / 107 kg)
Jointly defined with XFEL

Updated weight (531 kg +)



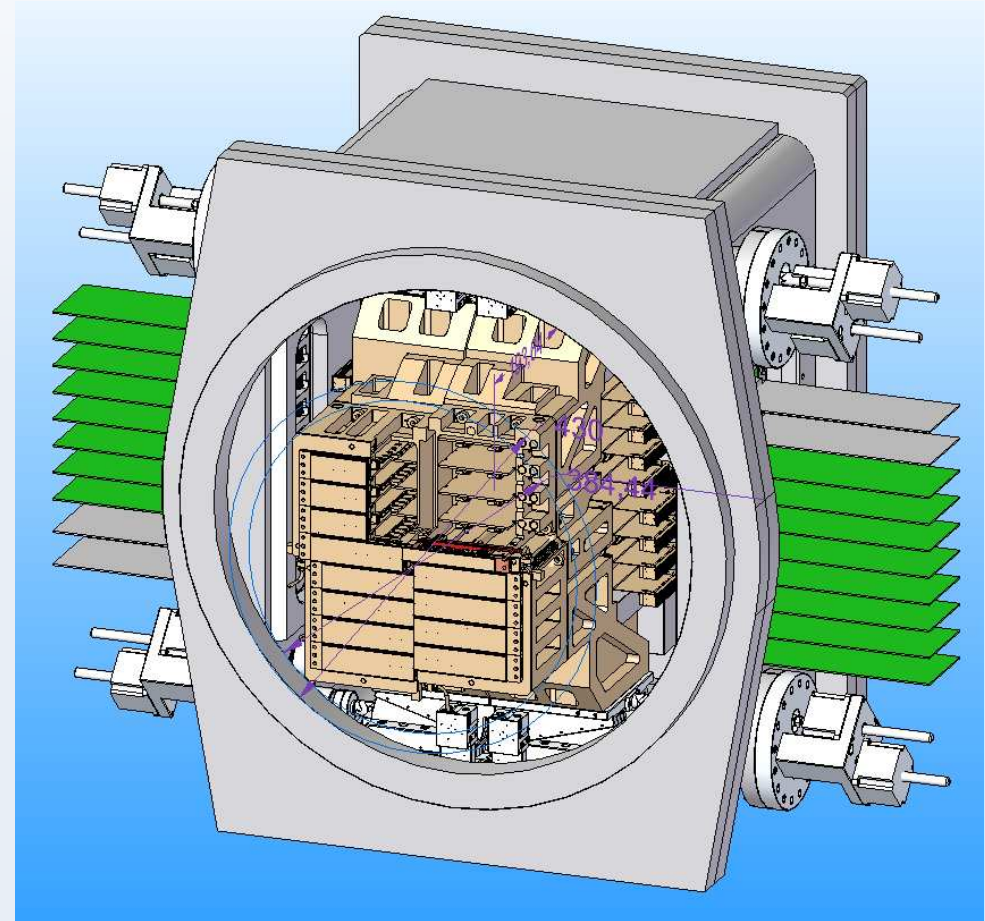
Chamber : 349.11 kg

External system:

- Vacuum interface board 7.8 x 2 = 15.6 kg
- much more (wings, etc.)

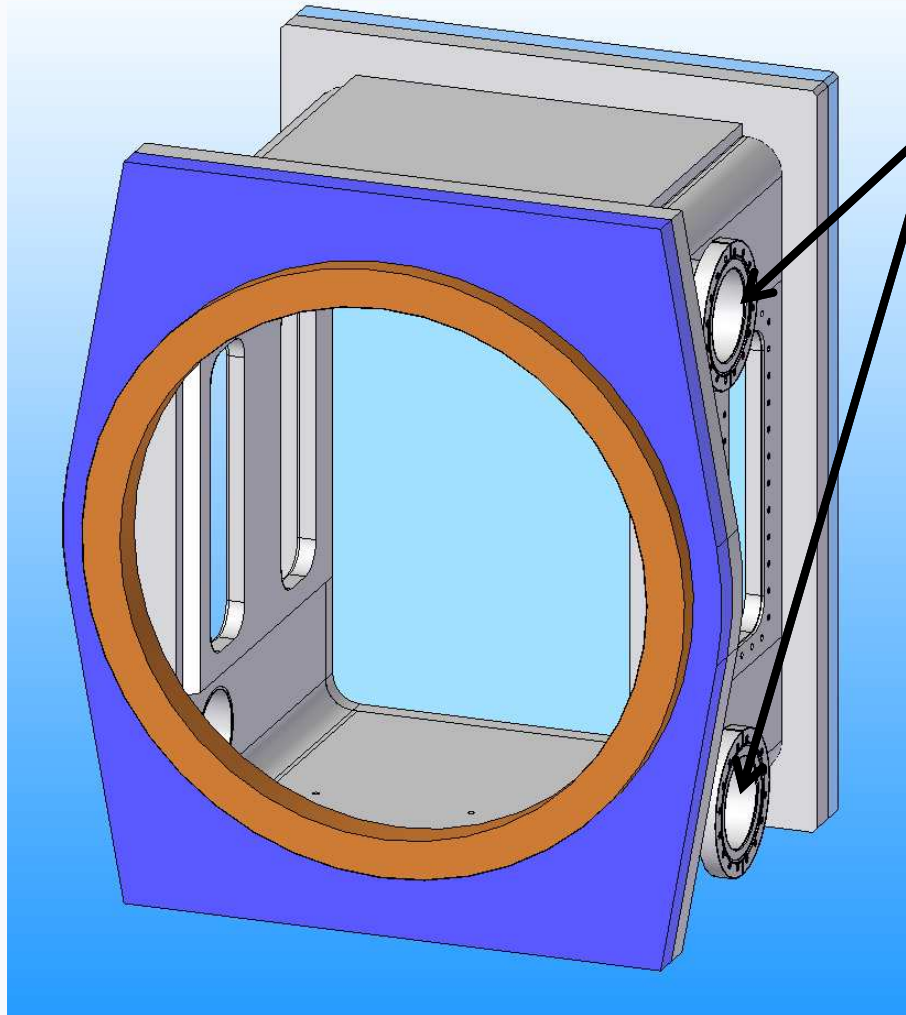
Detector Mechanics : 166.66 kg

- Motion Stage 18.41 x 2 = 36.82kg
- Actuator : 5.97 x 4 = 23.88kg
- Quadrant : 26.49 x 4 = 105.96



Still missing: **wings** + **pumps** + gaskets + screws + cables (only fraction) + etc.

Aluminum option

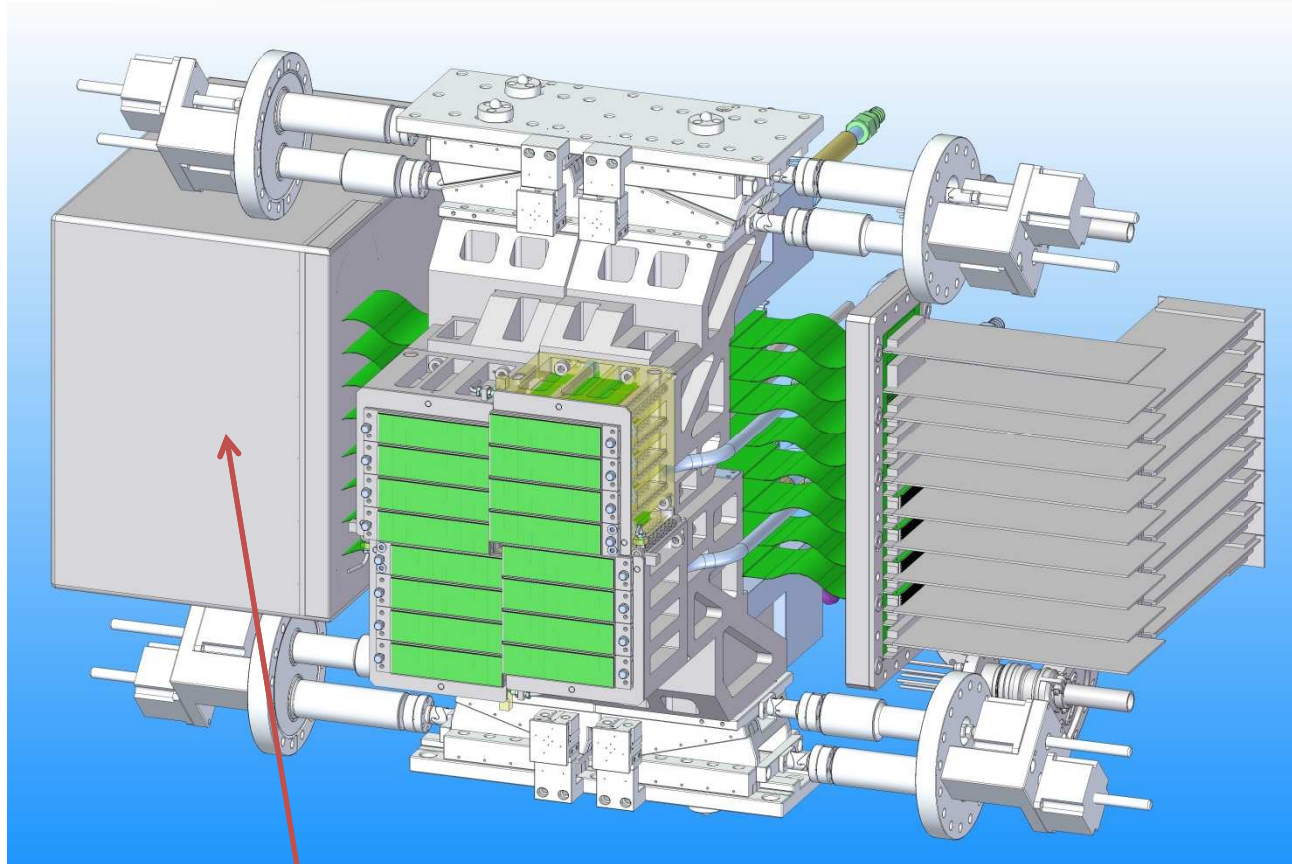


- Replace parts of vessel by aluminum
- Main challenge: round flanges will still be stainless steel
- Aluminum-Steel welding not a standard process
-> less suppliers, higher cost
- Estimated weight reduction: 50kg
- Alternative: all-aluminum vessel
- Redesign needed (thicker walls)



Wing design

Wings



Box

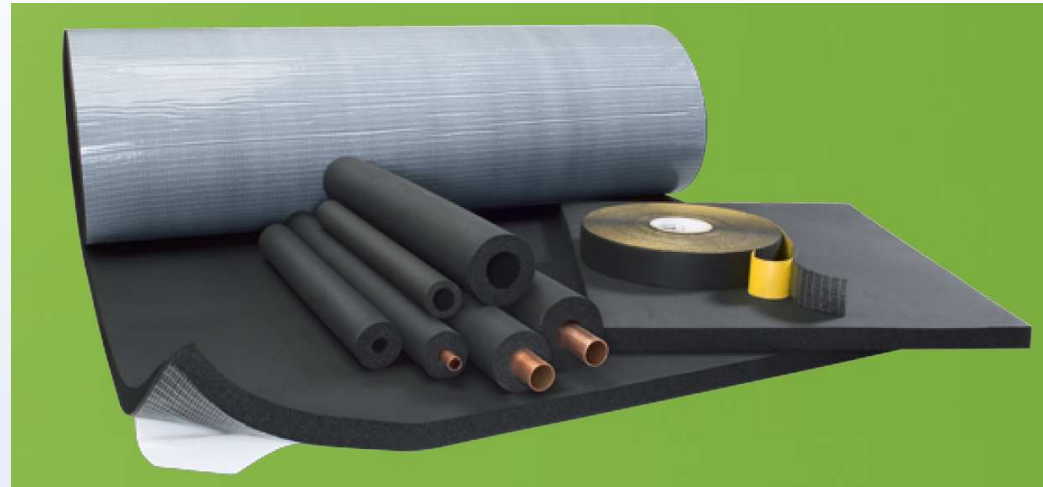
- Box-like enclosure
- All connectivity on single plate at the back
- Problematic to get 100% air-tight
- Needs Isolation to reduce power dissipation to experimental hutch

Radiator candidate



- Alphacool NexXoS ST30 Full Copper 360mm
- Commercial component for water cooled PCs
- Demonstrator arrived
- Pressure tested to 1.5 bar
- potential problem: XFEL guidelines: 6 bar in, 4 bar out

AF/Armaflex from Armacell

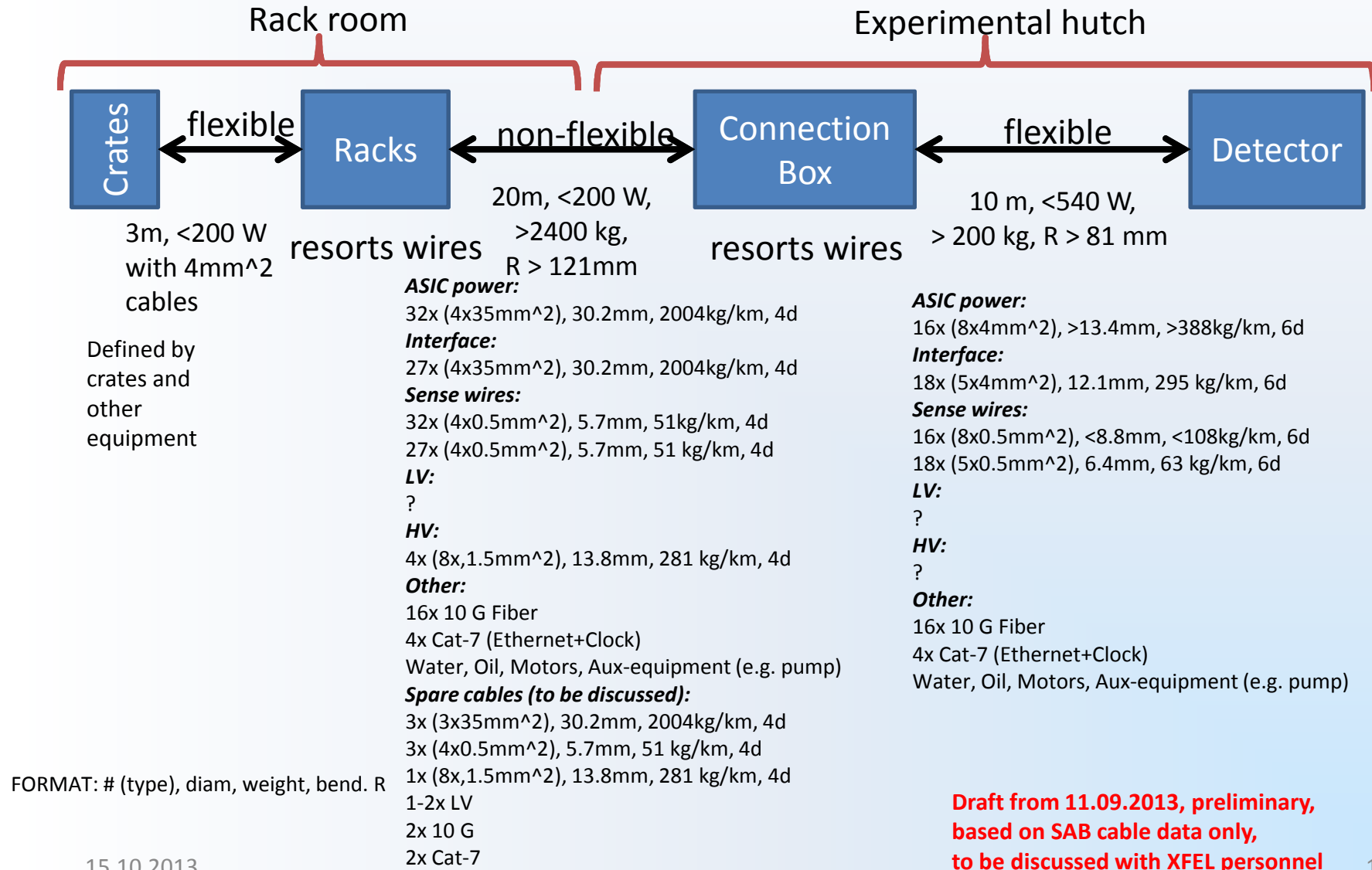


- Available in many different sizes including adhesive 50mm plates
- $\lambda \leq 0.036 \text{ W}/(\text{m} \cdot \text{K})$
- Clean room compatibility under investigation



Cabling

AGIPD Cabling





Amount of power dissipated to experimental environment:

- From cables (head to box) <540 W (MID), <330 W (SPB)
- From cables (box to racks) << 200 W*
- From motors: $8 \times 6W < 50 W$
- From wings < 50 W each (for 50mm isolation)
- **Total: < 890 W (MID), <680 W (SPB)**

*Depends of layout of the hutch, e.g. where the chicane is located



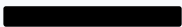


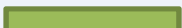
- Cabling has been discussed with XFEL
- Preliminary cable inventory has been submitted
- Market pre-research: cables are available as we need them
- Candidates for cables have been transmitted to XFEL (first idea only)

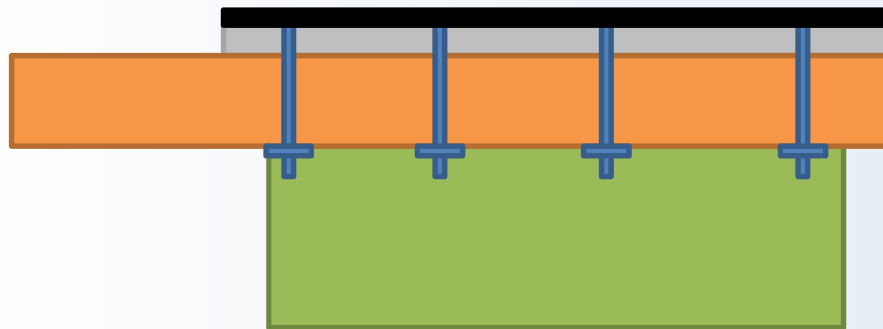


Front end modules

Front end design

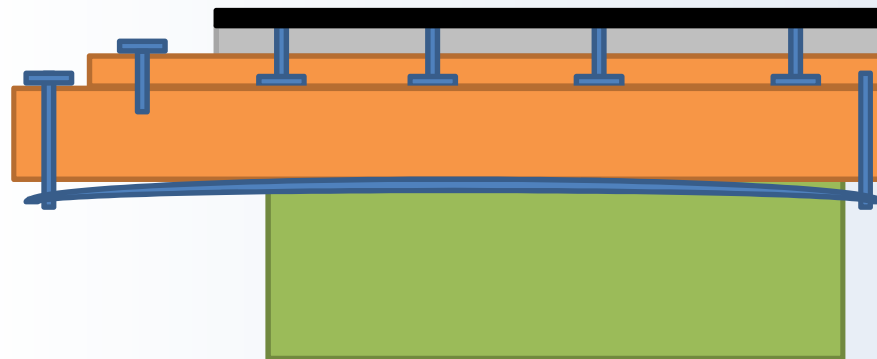


-  Sensor/ASIC
-  LTCC sensor board
-  Cu cooling block / interposer plate
-  Vacuum board



Old design:

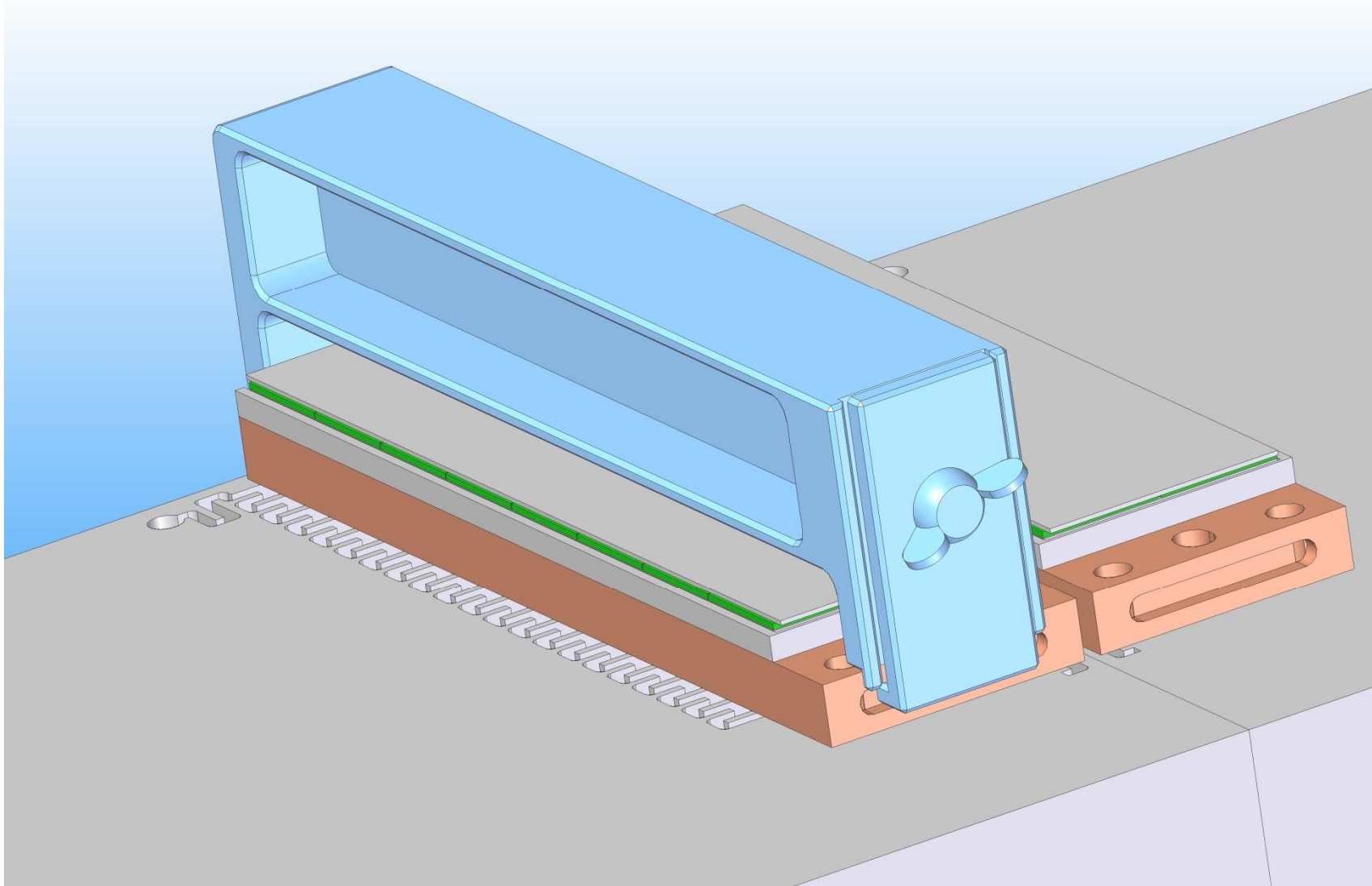
- Screws need to be accessed from back
- Vacuum board needs to be removed
- No space to grab Sensor board
- Minimal thermal interfaces



Current design:

- Screws fixed to interposer plate
- Interposer plate can be grabbed
- All fixtures on front side
- See-saw design

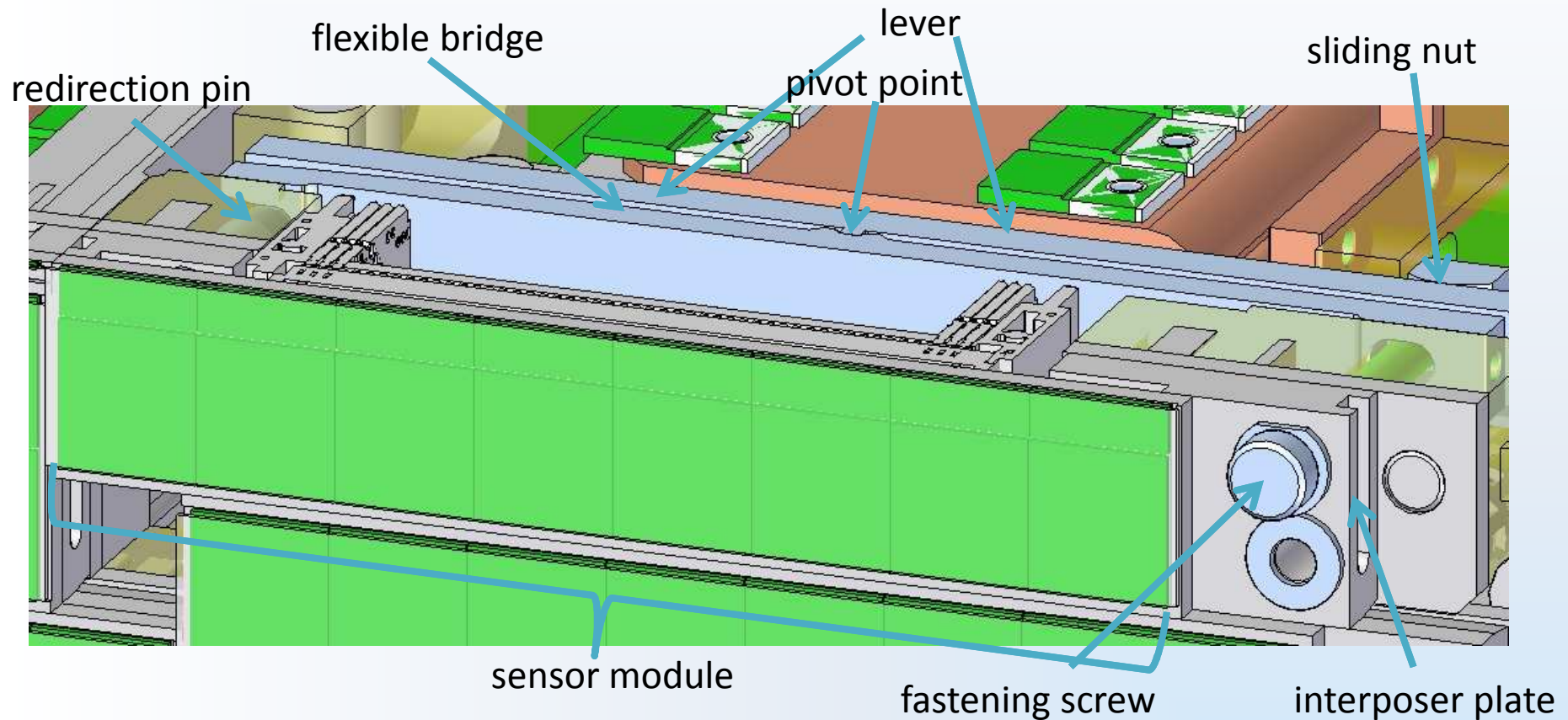
Module placing tool



15.10.2013

Presented at last XDAC (19.5.13) ²⁴

Module fixture



- Lever system with see-saw arrangement
- Connector not suitable to be pushed from back (due to protruding pins)
- Optimized design using FE simulations

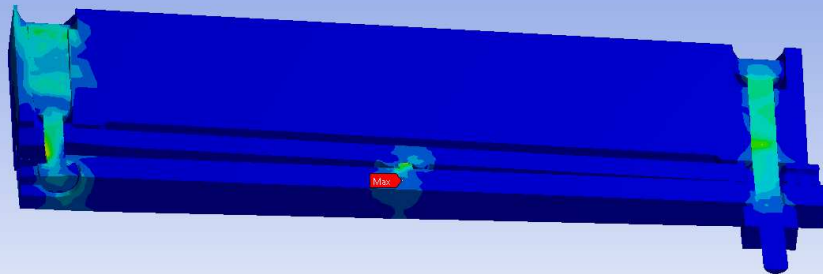
Module fixture



I: R4 new design, steel
Vergleichsspannung
Typ: Vergleichsspannung (von Mises)
Einheit: Pa
Zeit: 0,55556
13.09.2013 11:15

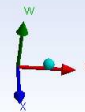
ANSYS
R14.5
Academic

5,0641e8 Max
4e9
2,5e8
2,2917e8
2,0833e8
1,875e8
1,6667e8
1,4583e8
1,25e8
1,0417e8
8,3333e7
6,25e7
4,1667e7
2,0833e7
125,55 Min

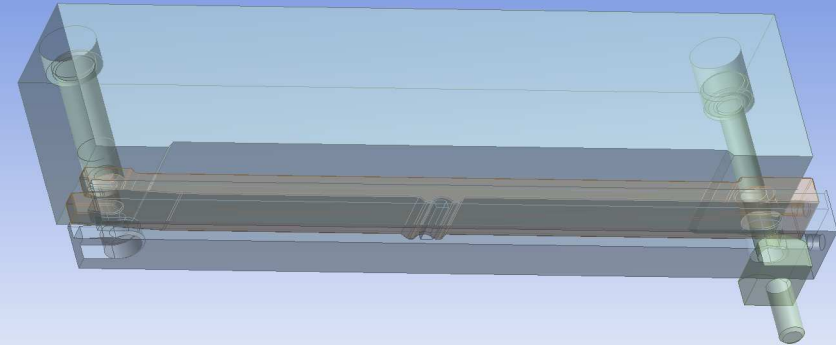


Deformation exaggerated by x50

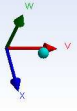
0,000 0,010 0,020 0,030 0,040 (m)



ANSYS
R14.5
Academic



0,000 0,010 0,020 0,030 0,040 (m)



Optimized module fixture breaks at >110 kg pulling force



- Agreement with XFEL to proceed on making manufacturing drawings for components inside the vacuum vessel.
- **Milestone 14b: Final mechanics designed 04.09.2013 (depends on XFEL)**
- Milestone 19: Overall mechanics available 29.04.2014 (depends on 14b)
- 26.08.2014: Full system working
- 01.01.2015: Hand over first 1M to XFEL



Material availability for testing & Production



- Populated LTCC sensor boards received from EFT
- Two dummy modules were made (2 chips each, no sensor)
- 16 remaining LTCC are reserved for first 1M
- Mechanical support frame for first tests made

Material availability



| AGIPD modules stock and orders | | | | | | | | | | | | | | |
|-----------------------------------|-------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--|
| | 5 | 10 | 15 | 20 | 25 | 30 | 35 | 40 | 45 | 50 | 55 | 60 | 65 | |
| ASIC | Green | Green | Green | Green | Green | Green | | | | | | | | |
| Sensors | Green | Green | Green | Green | Green | Yellow | Yellow | Yellow | Yellow | Yellow | Yellow | Yellow | Yellow | |
| LTCC | Green | Green | Green | | | | | | | | | | | |
| Samtec connectors | Green | Green | Green | Green | Green | Green | Green | Green | Green | | | | | |
| Sabine/vacuum board | Red | Red | | | | | | | | | | | | |
| vacuum interface board - 8 planes | | | | | | | | | | | | | | |
| vacuum interface board - 2 planes | Green | Yellow | | | | | | | | | | | | |
| analog motherboard | Green | | | | | | | | | | | | | |
| analog daughterboard | Green | Green | | | | | | | | | | | | |
| FPGA boards | Green | Yellow | Yellow | Yellow | Yellow | Yellow | Yellow | Yellow | Yellow | Yellow | Yellow | Yellow | Yellow | |
| digital carrier board | | | | | | | | | | | | | | |
| micro-controller control board | | | | | | | | | | | | | | |
| FPGA control board | | | | | | | | | | | | | | |
| module fixation | | | | | | | | | | | | | | |
| LTCC special screws | | | | | | | | | | | | | | |
| module handling bar | | | | | | | | | | | | | | |
| motion stages | | | | | | | | | | | | | | |
| cooling block | | | | | | | | | | | | | | |



- So far all production without heatspreader. Do we still want to include it?
- Start of series production beginning of 2014
- Assume average rate of 1 module/week
- 16 modules for first 1M by end of May 2014
- 32 modules (total) for 2nd 1M by September 2014
- Current stockpiles limited → careful planning needed for ordering next component batches (boards, etc.)
- **Bump-bonding capacity and schedule?**

Next steps



- Define and build infrastructure for chip testing (**urgent!?!)**
- **How many complete sets of readout electronics are needed for testing, calibrating and so on?**
- Infrastructure to assemble first modules in place
- Redesign of gluing station by Franka Seeger for series production (master thesis in mechanical engineering)
- **Next milestone M21 14.01.2014: Delivery of 'Prototype AGIPD module for performance/calibration tests'**
- **First calibrated module M23: 06.05.2014**

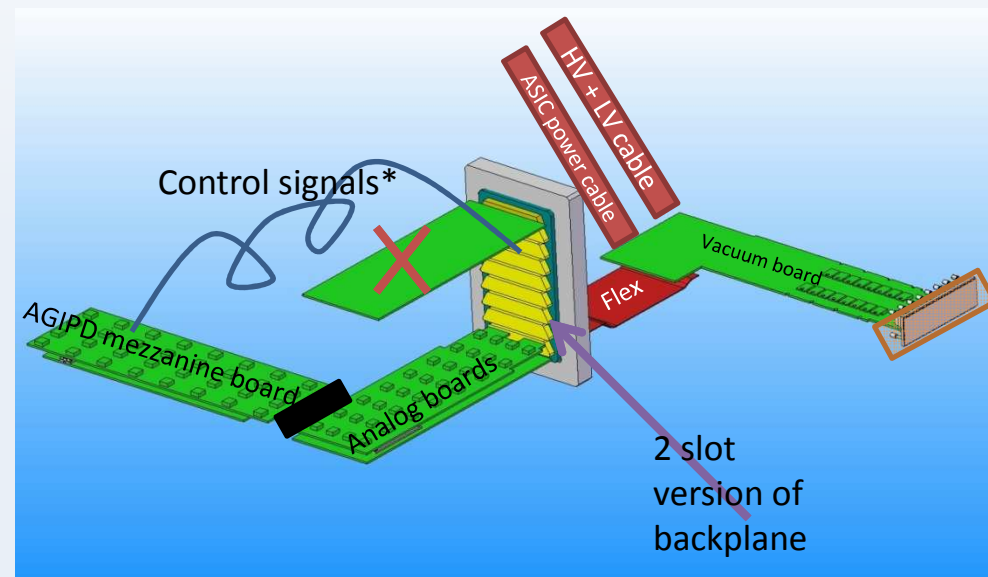
Milestone 21



Components that are missing:

- Module with sensor
- 2 slot backplane
(current copies are in use)
- Vacuum board

Digital
carrier
board



* For the prototype the clock & control board will be replaced by direct connections to the mezzanine board



- Seungyu will leave end of the month
- Annette Delfs will take over
- Franka Seeger joined last week



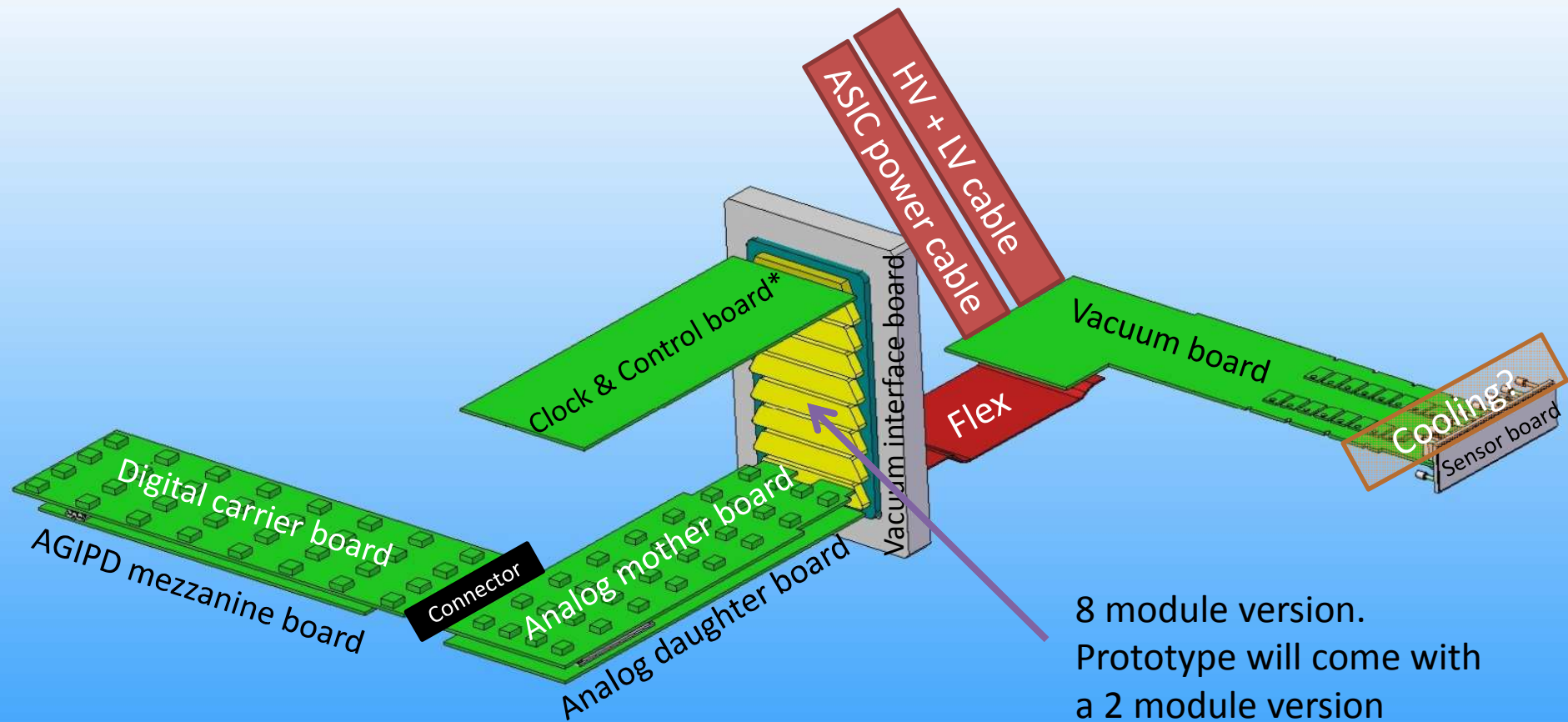
- Mechanics is advanced state
- Detailed drawings of interior components under creation
- Prototype system within reach
- Getting ready for production
- No showstoppers

A lot of hard work ahead



BACKUP

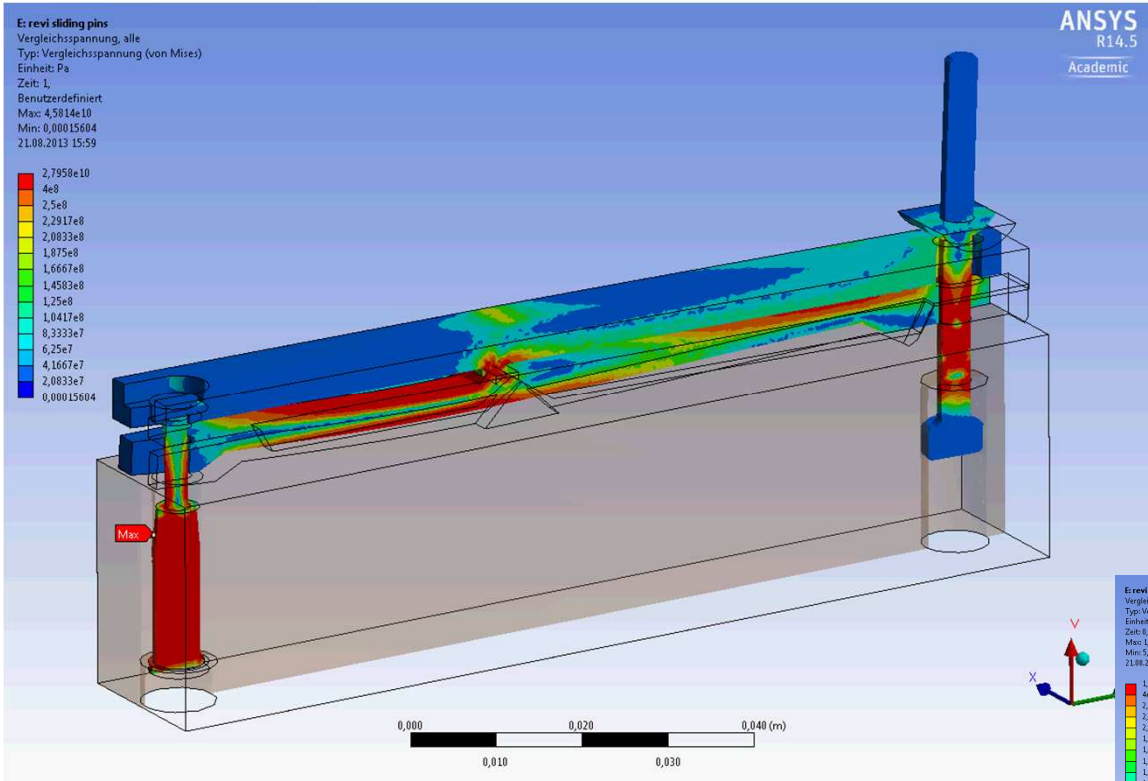
Module prototype



8 module version.
Prototype will come with
a 2 module version

* For the prototype the clock & control board will be replaced by direct connections to the mezzanine board

Deformation analysis



Material:

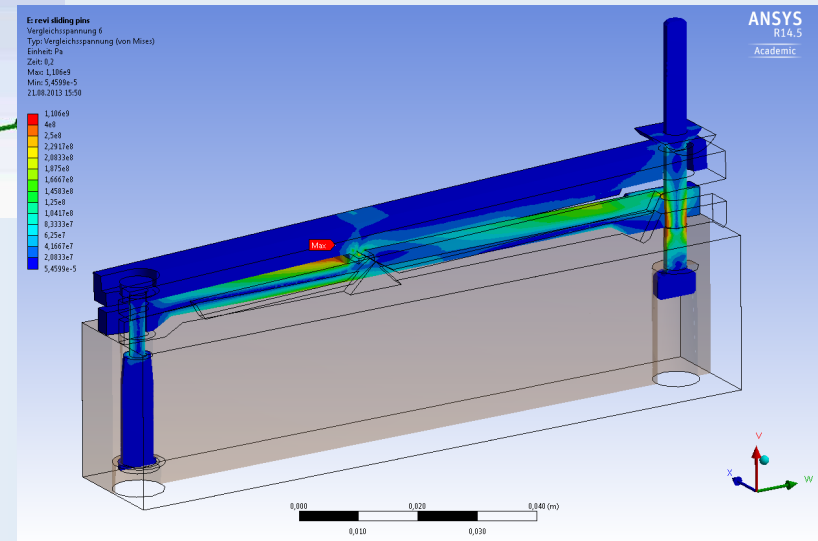
Stainless steel

Current point of failure:

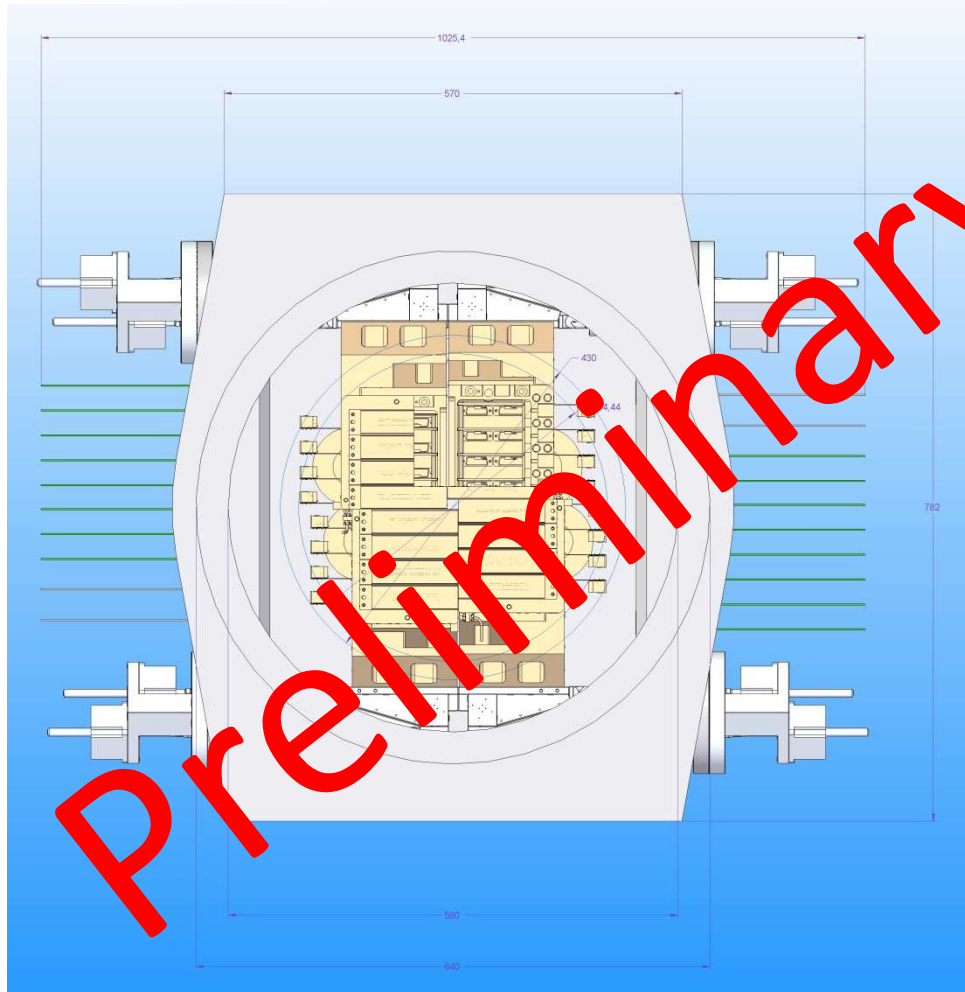
fastening screw at 100 N force

Video: Increasing pulling force from 0 to 500 N

-> design work is ongoing



Current CAD view



Focus on:

- Stick out design
- Mass reduction
- Front interface

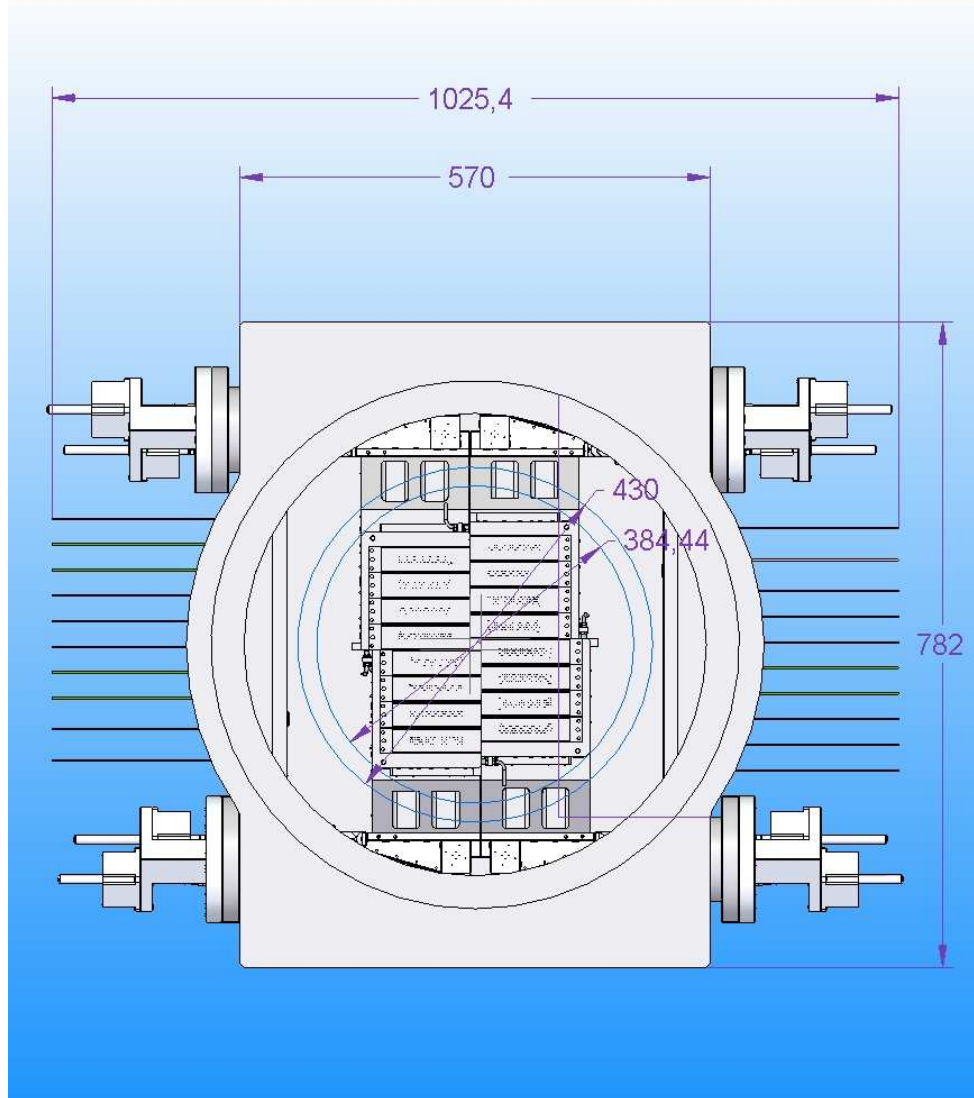
Still missing:

- Detailed wings
- Auxiliary equipment (e.g. pumps)
- Counterweights
- Other components

Important:

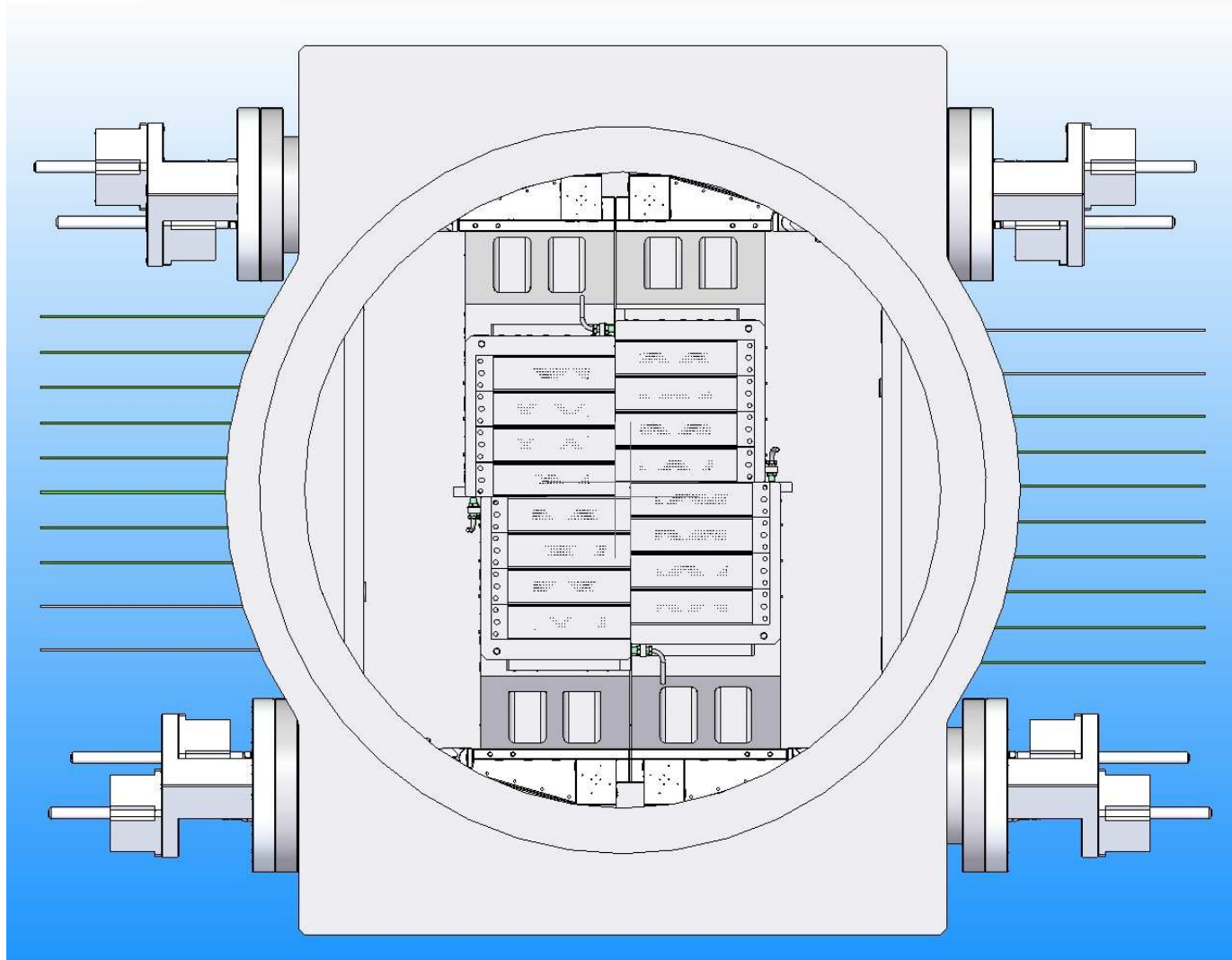
- Change of envelope
- Change of weight, etc.

Changes in envelope



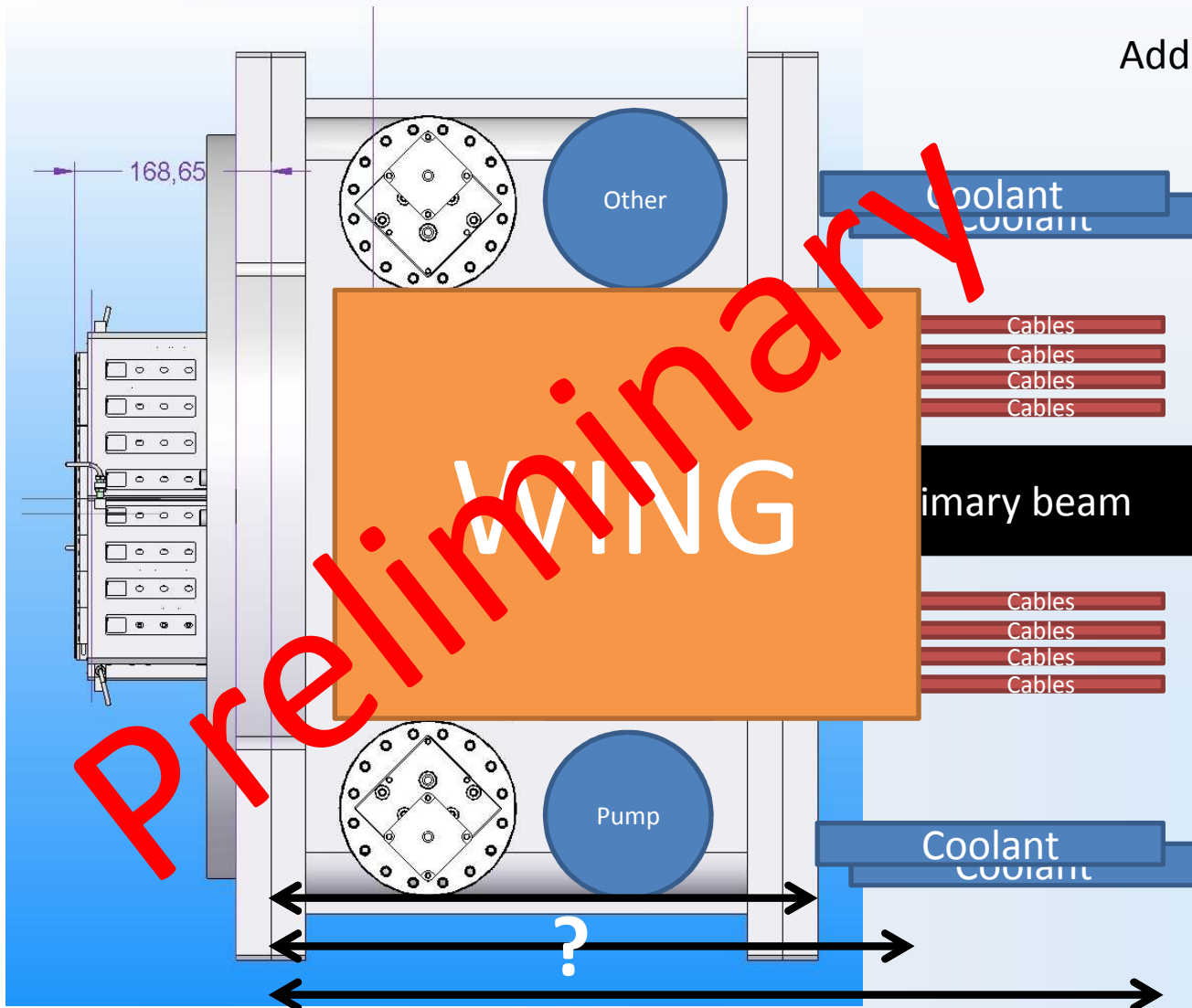
- System got higher, but slimmer
- Add at least ~30 cm laterally for each wing
- Beamaxis-to-end (lateral) ~ 80 cm (<90 cm is MID requirement)
- Sensitive area within OD 350 circle
- Range of motion within OD 430
- Should fit to 500 mm bellow of SPB and allow rail system travel (tbc)

Interface flange idea



- Interface to bellows (500 mm) might potentially reduce stick out distance
- Recoverable by special design?
Should be looked at in detail
- Identical layout for SPB and MID still acceptable?
- Flange needs further discussion with beamlines

Auxiliary/Connectivity concept



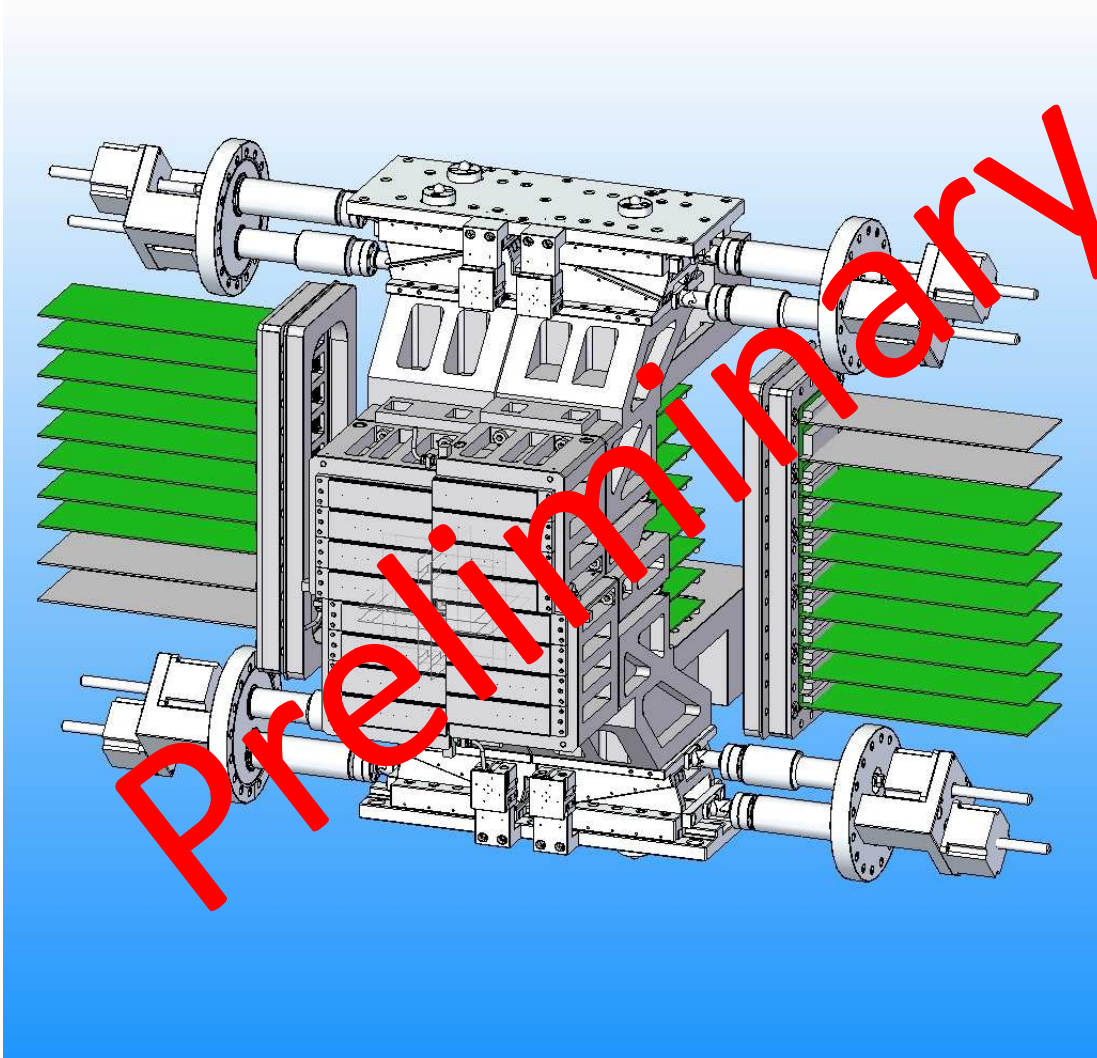
Additional components include:

- Power interface board (x2)
- Pumps
- Other flanges
- Coolant (x8)
- Primary Beam
- Wings (x2)
- Cabling (xN)

PRELIMINARY!

Is this acceptable for the beamlines?

Basic parameters (update)



- Height:** 78 cm + mounting
- Width:** 57 cm (tank)
- Wings:** ~ 50 cm in addition
- Depth:** ? (large uncertainty)
- Weight:** 4.9 kg (single cooling block)
0.2 kg (single quadrant coolant)
9.5 kg (single connecting piece)
11.2 kg (single counter weight)
15.5 kg (single motion stage)
330.2 kg (vacuum tank)
- Total weight:** about 500 kg + **flanges**
+ **wings** + **pumps** + gaskets + screws +
cables (only fraction) + etc.

List of Ports/Flanges



Vacuum purpose

Pumping : 1ea, DN100 or DN160

Angle valve : 1ea, DN40

Leak valve : 1ea DN40

Gauge : 2ea, 1 DN 40+1 DN63

Electrical purpose

Detector control and Data taking : 2 custom design rectangular ports (Design fixed)

Detector power : custom design flanges for 16 FM7W2 and for 16 FM8W8 (Not designed, yet)

Motion system : custom design flanges for linear encoders and for limit switches- (8 dsub-15 male connectors and 21 contact points, not designed, yet)

Cooling purpose

Cryo cooling adaptation : 8 custom design flanges modified from DN40

Photon beam I/O

1 Large input flange : custom design per the requirement

1 Small flange with large diameter bellow

To be updated as required

Milestones



| | | Initial Planning | Updated Planning 26.09.2011 | Updated Planning 04.04.2012 | Updated Planning 27.09.2012 | Updated Planning 15.05.2013 |
|-----|---|---------------------|-----------------------------------|---------------------------------------|-----------------------------------|-----------------------------------|
| M1 | Submission AGIPD-03 | 04.11.2010 | 04.11.2010 | done | done | done |
| M2 | Definition of Interface Electronics Parameters finalized | 29.12.2010 | 29.12.2010 | done | done | done |
| M3 | Go-no-Go decision | 31.12.2010 | 31.12.2010 | done | done | done |
| M4 | Sensor design finalized and approved | 02.02.2011 | 05.05.2011 | 13.04.2012 | done | done |
| M5 | Testing AGIPD-02 finalized | 07.02.2011 | 13.06.2011 | done | done | done |
| M6 | Delivery of Pre-series | 22.06.2011 | 22.03.2012 | No pre-series will be delivered | dito | dito |
| M7 | Delivery first Components Interface Electronics finished | 12.08.2011 | 13.01.2012 | done | done | done |
| M8 | Science simulations XPCS finished | 08.09.2011 | 08.09.2011 | done | done | done |
| M9 | Testing AGIPD-03 finished | 28.09.2011 | 28.09.2011 | done | done | done |
| M10 | Validation of Cooling Concepts finalized | 30.09.2011 | 25.11.2011 | done | done | done |

15.10.2013

Milestones



| | | Initial Planning | Updated Planning 26.09.2011 | Updated Planning 04.04.2012 | Updated Planning 27.09.2012 | Updated Planning 15.05.2013 |
|----------|---|---------------------|-----------------------------------|---------------------------------------|-----------------------------------|--|
| M10 a | Cooling tests of dummy system finalized | | | 31.12.2012 | 31.12.2012 | 04.09.2013 |
| | | Initial Planning | Updated Planning 26.09.2011 | Updated Planning 04.04.2012 | Updated Planning 27.09.2012 | Updated Planning 15.05.2013 |
| M11 | Testing Pre-series finalized | 21.12.2011 | 17.05.2012 | No pre-series will be delivered | dito | dito |
| M12 | Submission AGIPD-1.0 | 20.02.2012 | 11.06.2012 | 28.02.2013 | 28.02.2013 | 25.04.2013 |
| M13 | Design of Front End Module finished | 30.03.2012 | 30.03.2012 | 29.11.2012 | 29.11.2012 | done |
| M14 | First mechanic concept finalized | 19.04.2012 | 19.04.2012 | 31.08.2012 | Done | done |
| M14 a | First mechanics designed | | | 31.12.2012 | 31.01.2013 | done |
| M14 b | Final mechanics designed | | | | | 04.09.2013 depends on XFEL's acceptance |
| M15 | Final Sensor accepted | 20.06.2012 | 15.11.2012 | 15.03.2013 | 15.03.2013 | 01.07.2013 |
| M16 | Delivery of Prototype Interface Electronics | 27.07.2012 | 31.07.2012 | 29.10.2012 | 29.12.2012 | done |
| M17 | First Front End Module available | 28.09.2012 | 16.05.2013 | 30.08.2013 | 30.08.2013 | 30.08.2013 |
| M18 | Testing AGIPD-1.0 finalized | 29.10.2012 | 24.12.2012 | 27.12.2013 | 27.12.2013 | 27.12.2013 |

15.10.2013

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Milestones



| | | Initial Planning | Updated Planning 26.09.2011 | Updated Planning 04.04.2012 | Updated Planning 27.09.2012 | Updated Planning 15.05.2013 |
|-----|--|---------------------|-----------------------------------|-----------------------------------|-----------------------------------|--------------------------------------|
| M19 | Overall Mechanics available | 13.12.2012 | 13.12.2012 | 23.08.2013 | 23.08.2013 | 29.04.2014 8 months after M14b |
| M20 | Interface Electronics System finished | 08.03.2013 | 12.03.2013 | 05.08.2013 | 05.08.2013 | 04.10.2013 |
| M21 | First Module working (full module incl. sensor) | 23.08.2013 | 23.01.2014 | 14.01.2014 | 14.01.2014 | 14.01.2014 |
| M22 | Full System working | 27.12.2013 | 29.05.2014 | 26.08.2014 | 26.08.2014 | 26.08.2014 |
| M23 | First calibrated Modules available | 13.12.2013 | 13.12.2013 | 06.05.2014 | 06.05.2014 | 06.05.2014 |
| M24 | First Experimental Runs at Photon Source | 01.01.2014 | 01.01.2014 | 03.03.2014 | 03.03.2014 | 03.03.2014 |
| M25 | First Experiments at XFEL | 01.01.2015 | 01.01.2015 | XFEL to advise | XFEL to advise | XFEL to advise |
| M26 | Final Implementation Date | 01.07.2015 | 01.07.2015 | XFEL to advise | XFEL to advise | XFEL to advise |
| M27 | AGIPD 04 submitted | | 09.11.2011 | done | done | done |
| M28 | AGIPD 04 tested | | 31.05.2012 | 29.05.2012 | done | done |

15.10.2013