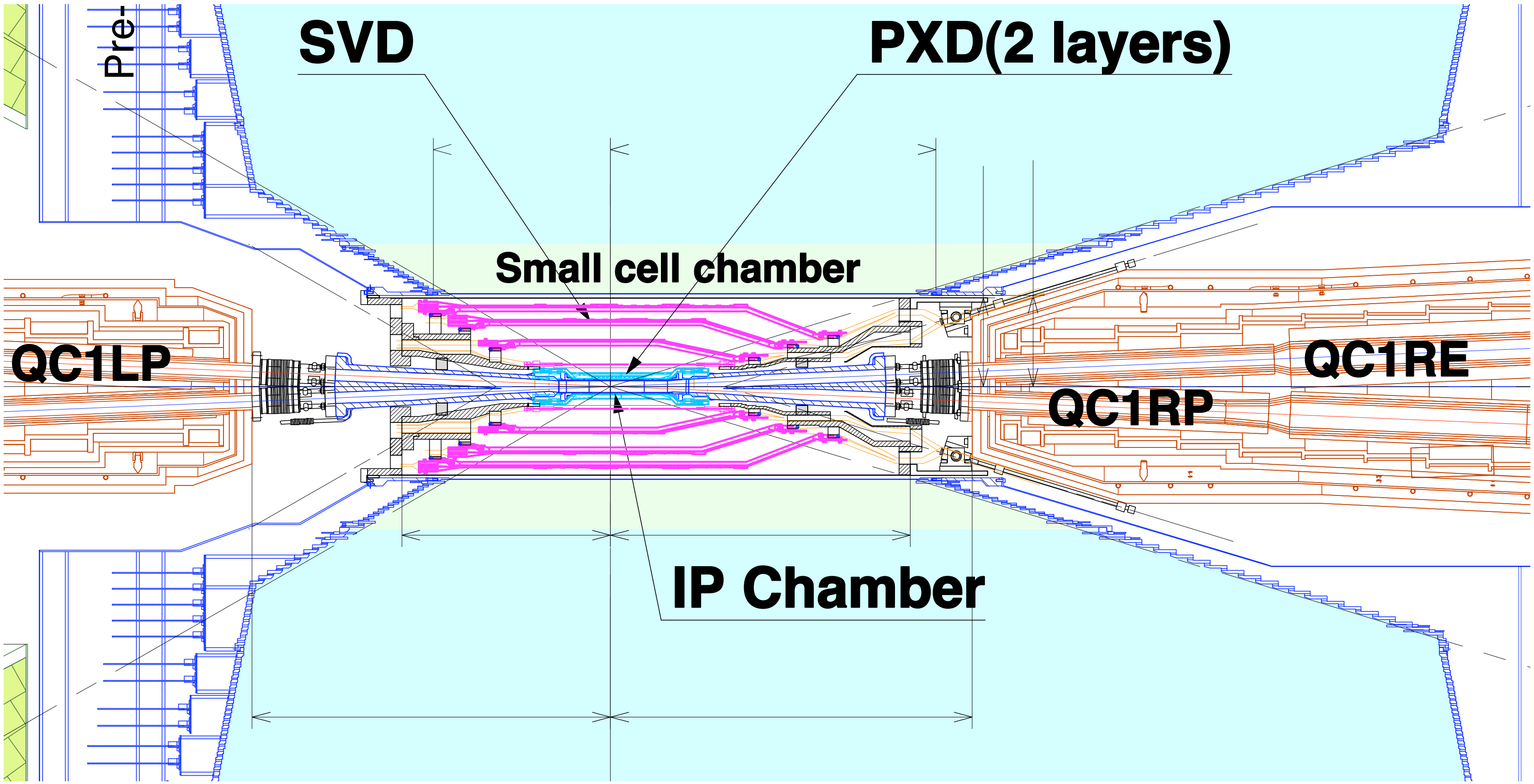
VXD Installation

carsten.niebuhr@desy.de

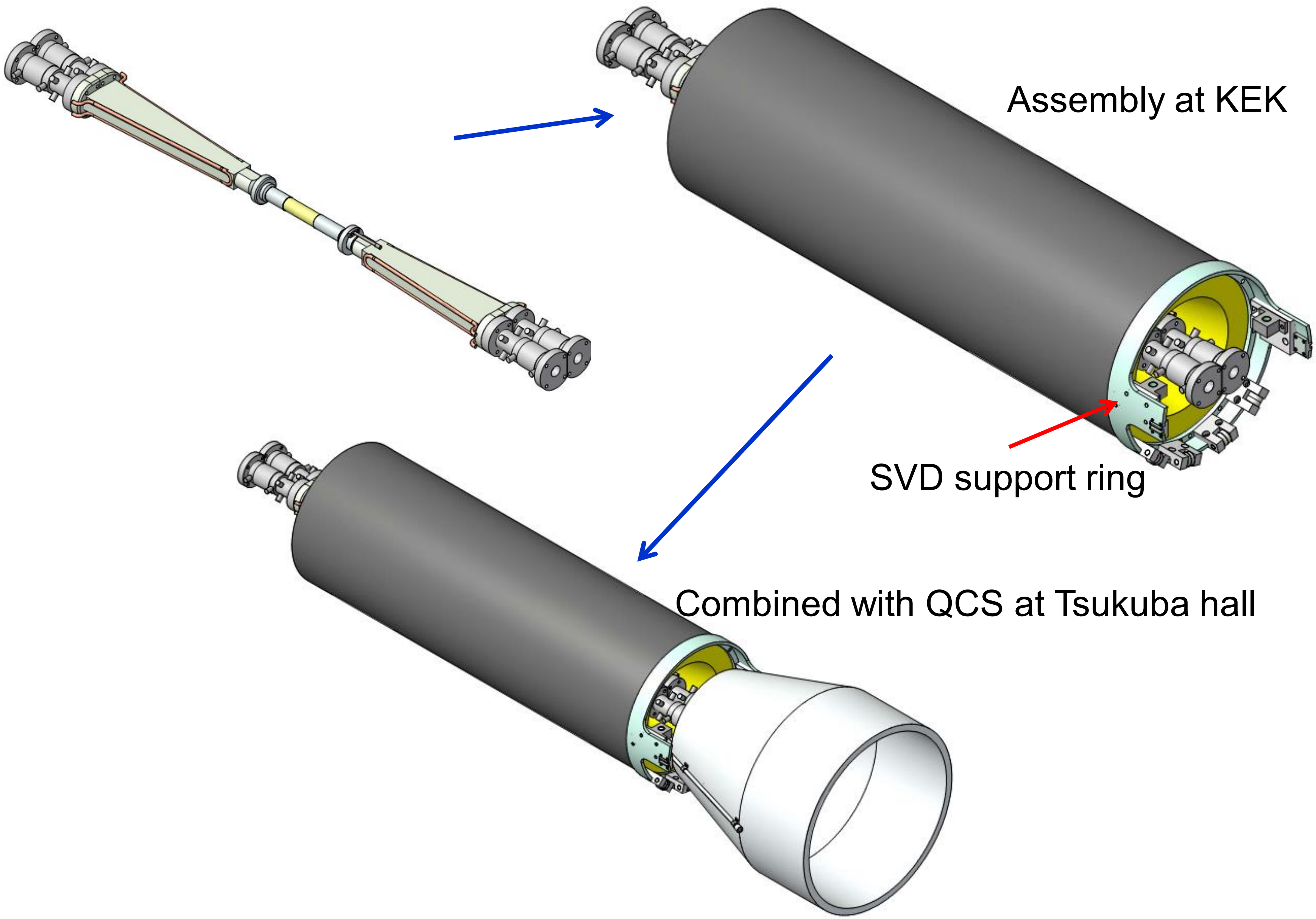
Interaction Region



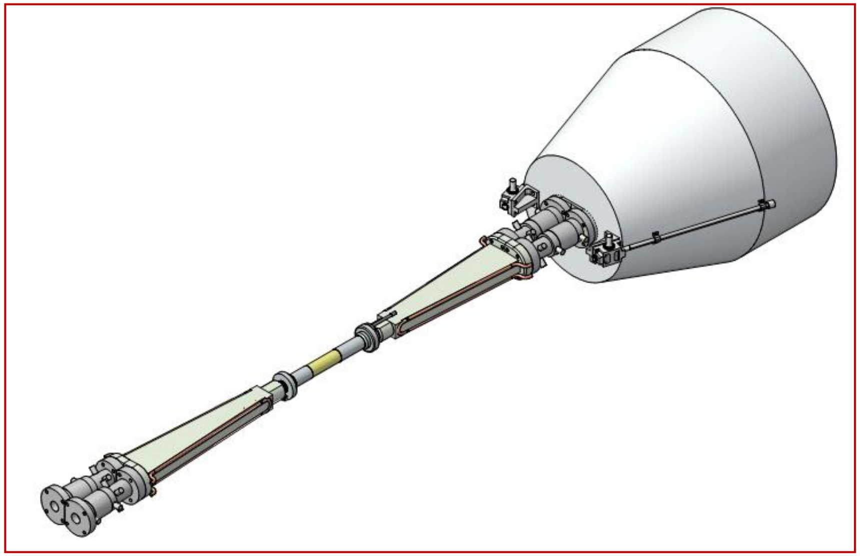
Baseline Installation Procedure

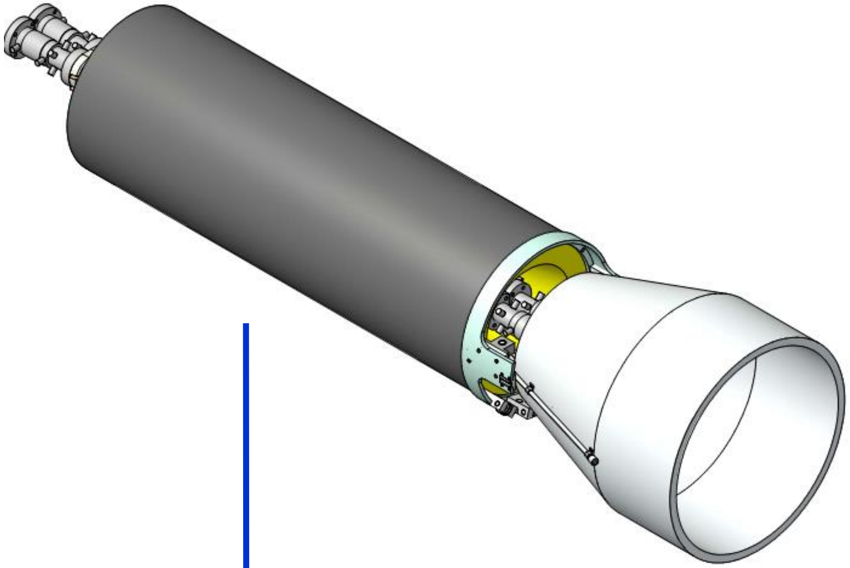
carsten.niebuhr@desy.de

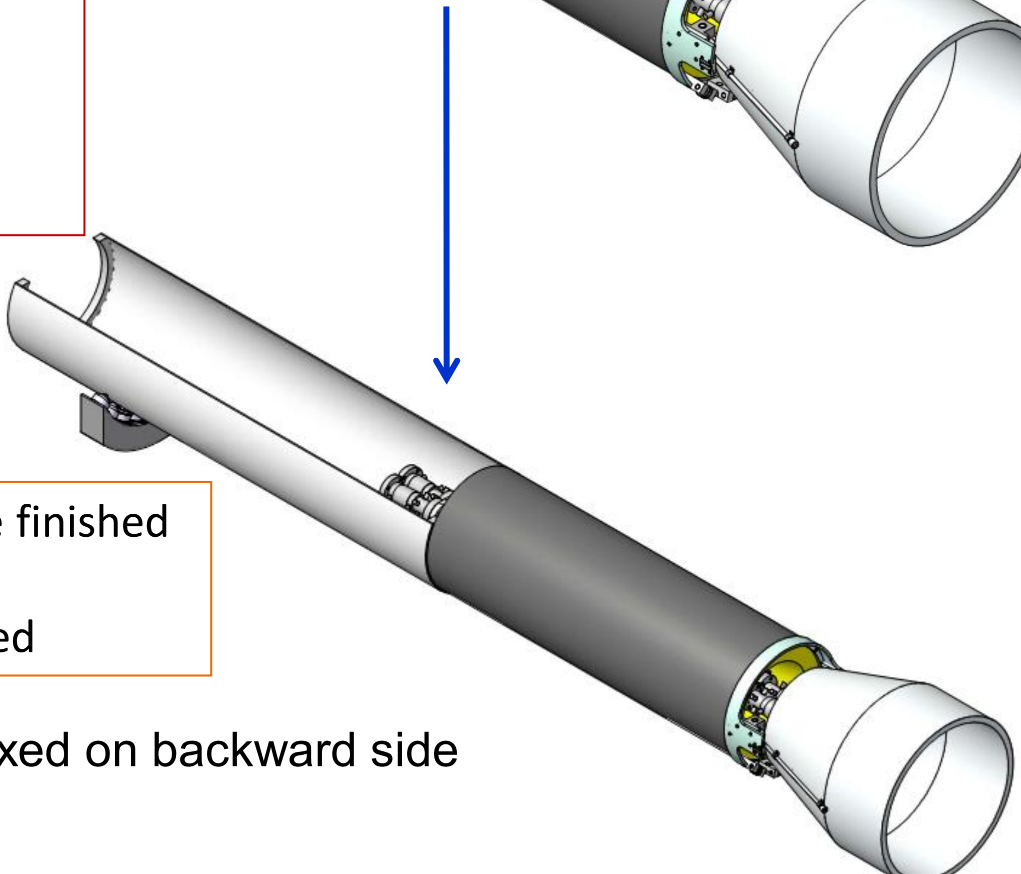
Baseline Installation



Baseline Installation



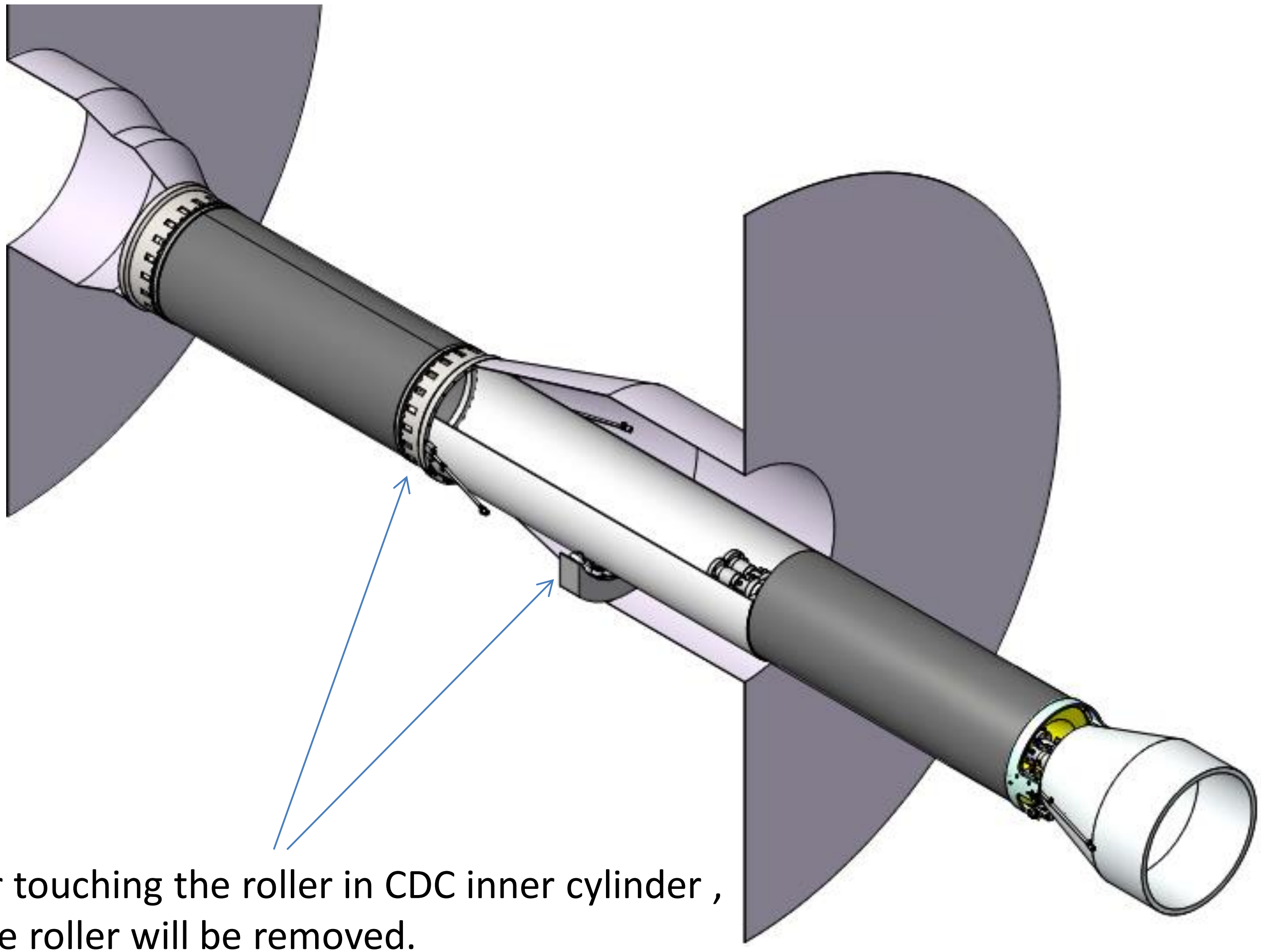




The cabling and piping work should be finished before installation.
The cables on backward are put on sled

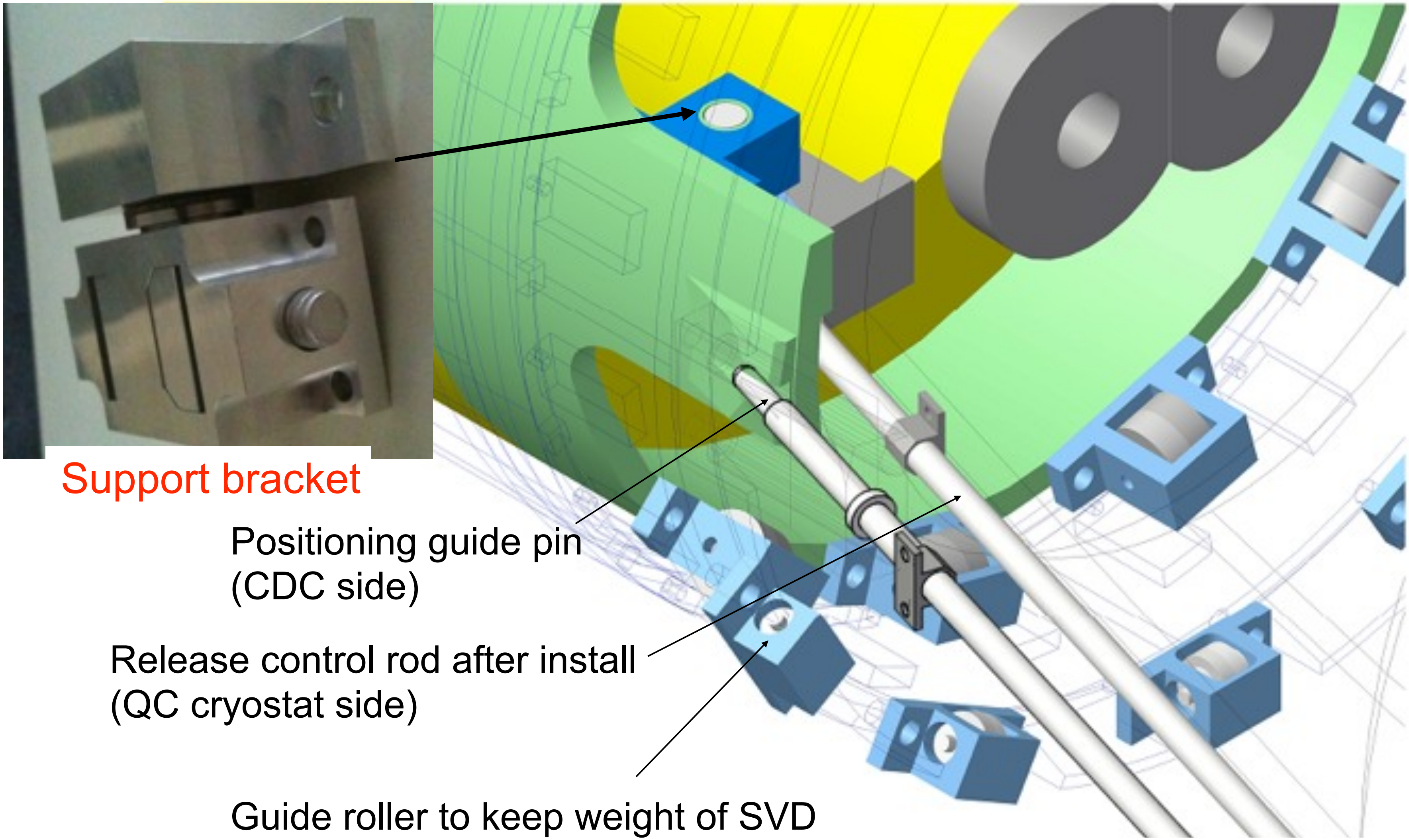
The sled guide is fixed on backward side

Baseline Installation



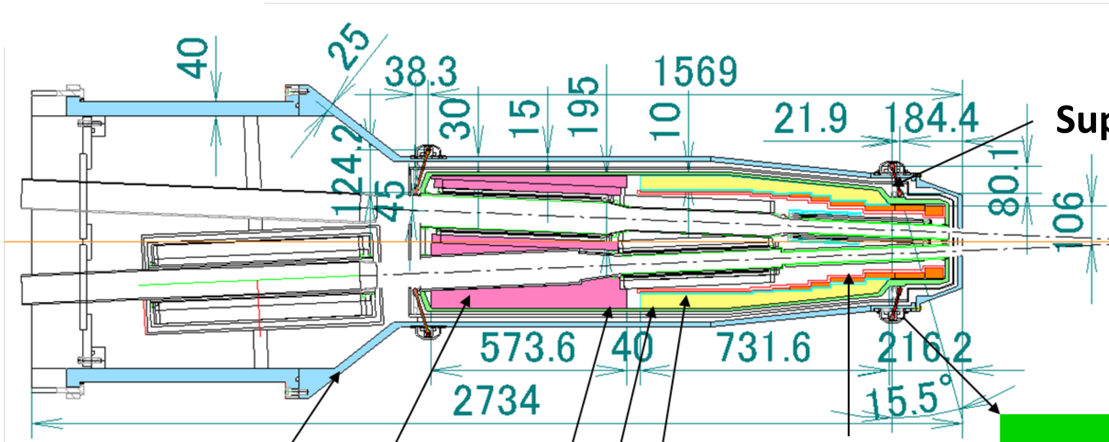
After touching the roller in CDC inner cylinder , Guide roller will be removed.

VXD Support Structure

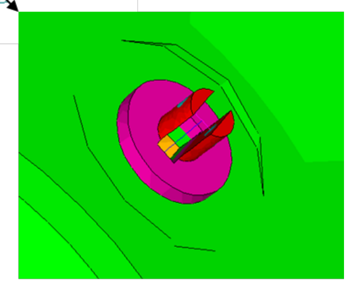


QCS Weight and Forces

Model for mechanical calculation by ANSYS



Support Rod (Ti alloy)



Vacuum vessel : 1142 kg

Fe shield: 490kg

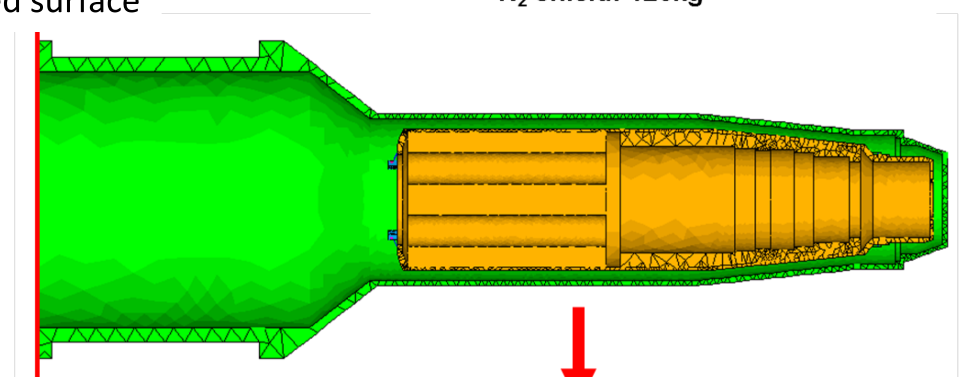
He-tank: 170kg

Coil+ supp. cyl.: 100kg

Heavy metal: 482kg

N_2 shield: 126kg

Fixed surface



EMF=7 tons

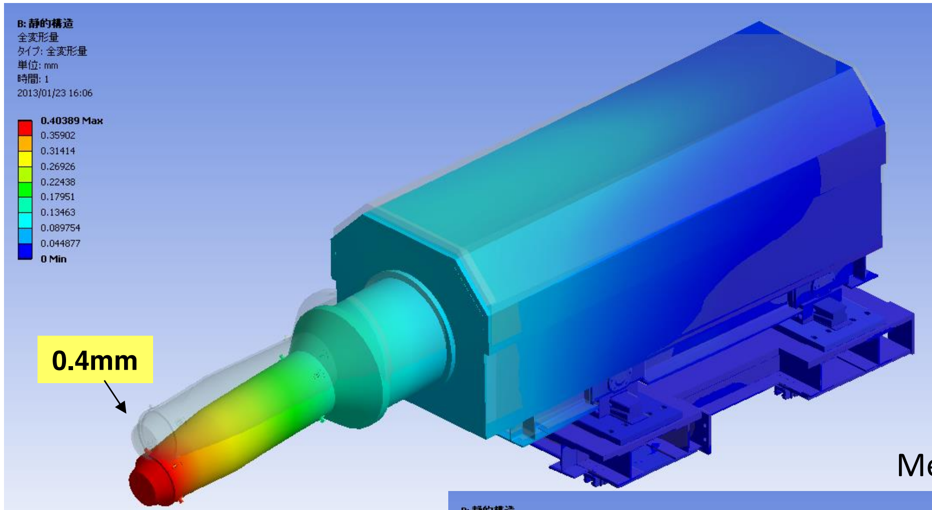
Total weight of the QCSL cryostat and magnets = 2510 kg

Cold mass = 1400 kg

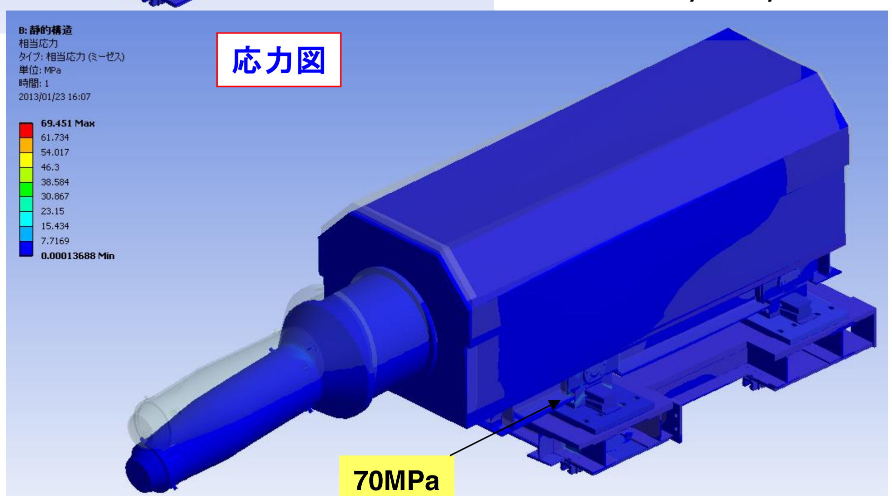
3/03/04

2:

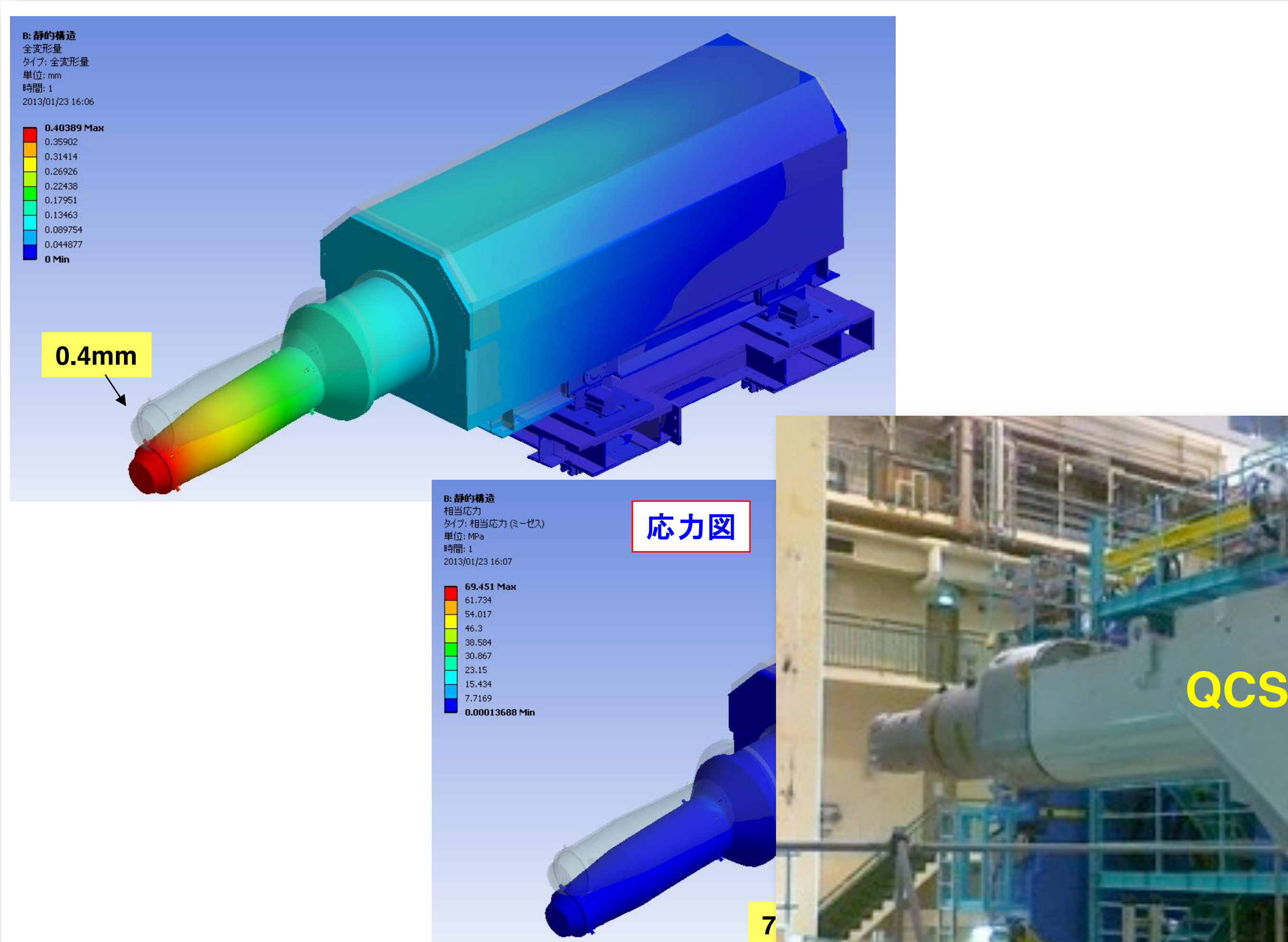
QCS



Mechanical analysis by Yamaoka



QCS



B: 静的構造
全変形量
タイプ: 全変形量
単位: mm
時間: 1
2013/01/23 16:06
0.40389 Max
0.35902
0.31414
0.26926
0.22438
0.17951
0.13463
0.089754
0.044877
0 Min
0.4mm
B: 静的構造
相当応力
タイプ: 相当応力 (ミーゼス)
単位: MPa
時間: 1
2013/01/23 16:07
応力図
69.451 Max
61.734
54.017
46.3
38.584
30.867
23.15
15.434
7.7169
0.00013688 Min

QCS at KEKB

Questions to the Baseline VXD Installation procedure

Basic principle: VXD is mounted onto the FWD-QCS and pushed through the CDC by the QCS. The backward side (BWD) of the VXD will be connected to a cable holding tray (CT) which will slide on rollers through the CDC together with the VXD, being pushed by the QCS. On the forward side (FWD) the cables will be arranged on the QCS and in the final position be fixed to the docks.

Main worries:

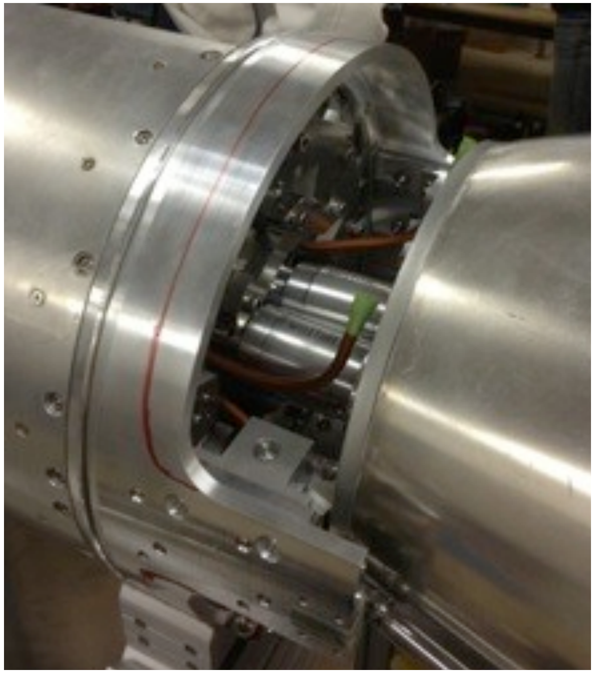
1. The baseline solution results in several changes in load stress on the VXD: we counted at least seven such changes (with entailing undetermined constraints) , e.g
– VXD supported by CT and QCS – CT first contact with FWD rollers of CDC – release support of CT- CT reaches BWD CDC rollers – VXD BWD end ring reaches FWD CDC rollers – add temporary support of CT on BWD side – VXD reaches final position, roller contact on both ends
2. Mechanical stress on the carbon fibre cover of the VXD: For physics performance reasons it has to be a very low mass two-half shell construction, fixed to the end rings. No finite element calculation has been shown for this configuration yet. Presently it is unclear how the VXD shell can be made stable enough not to exhibit excessive deflection under the stress changes listed in point 1.
3. There is the danger that the VXD shell could touch a roller during roll-in. Pressure on a small region of the carbon fibre shell will severely damage it rendering its function useless.
4. Connection between QCS and VXD end ring is mechanically not precise enough to guarantee correct alignment of VXD on CDC axis. The large lever arm furthermore amplifies an even small misalignment of the QCS. As a result it is not clear how to control the direction of the movement in space of the assembly "CT-VXD-QCS" in particular once the VXD enters the CDC.
5. Installation procedure is hard to train in a mockup situation, forces of the QCS cannot be simulated, roll and pitch of the QCS multiplied by a large lever arm cannot be simulated and controlled in practice.
6. It seems very difficult to seal the vacuum connections on the BWD side by hand, given the tiny space with lots of cables coming out of the VXD already and the recently enlarged envelope of QCSL.
7. Space through the CDC is very tight, rollers are installed on the front and back side of the CDC inner shell, limiting the free diameter. There is no easy "tactile" control of the actual moving process, when the heavy-weight QCS is being moved, even if it is moved under manual control. The large force required to move this very heavy object will act in an uncontrolled manner on the fragile VXD in case of unforeseen resistance with a high risk to damage the entire structure. This is our biggest concern in the baseline scenario.
8. In the Baseline Scenario the cables for SVD and PXD are fixed to the QCS. This fixation establishes a solid connection between the PXD, the SVD and the QCS, whereas, on the other hand, the PXD and the SVD are supposed to be supported by independent structures (CDC for the SVD, beam pipe for the PXD). In the case of a possible movement of the QCS, which should in principle be compensated by the bellows, this solid cable connection would exert uncontrollable forces on the PXD as well as on the SVD.

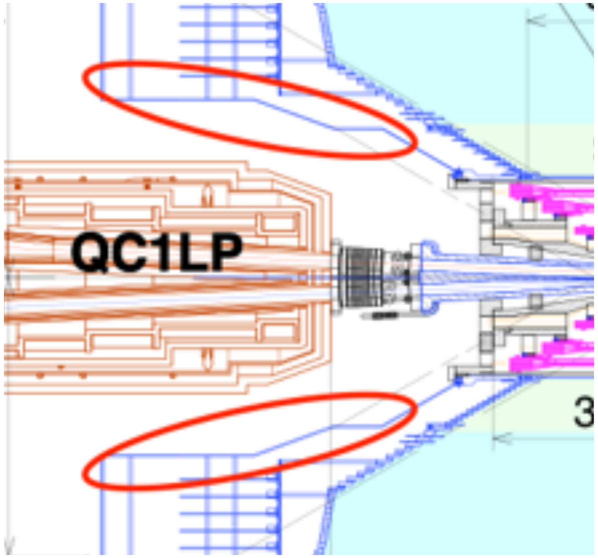
K. Ackermann, M. Friedl, C. Kiesling, C. Niebuhr, H.-G. Moser, 23.11.12

Ongoing Modifications at KEK

- Forward
  - make support ring slimmer to leave more space for services
  - add load cell and damping element between QCS and VXD

- Backward
  - try to gain space by relocating CDC electronics to allow manual closure of vacuum seal



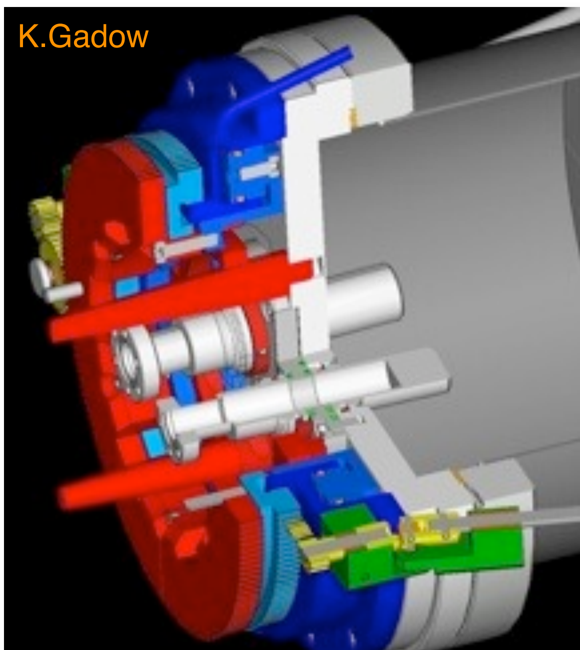


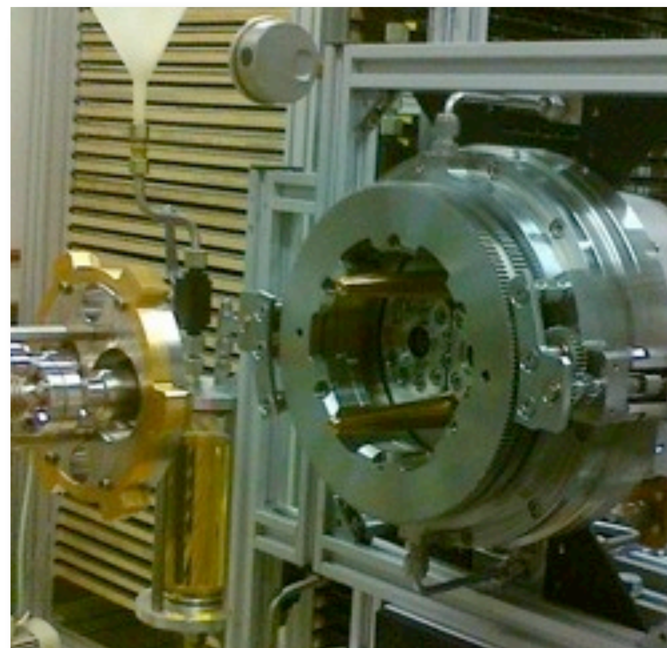
Remote Vacuum Connection

carsten.niebuhr@desy.de

Hydraulic Remote Vacuum Connection

- Proposal for alternative installation procedure based on hydraulic system: RVC
  - requires very careful tests and close interaction with SuperKEKB machine group
- Integration of RVC has significant impact on design of
  - SVD support cone (CFRP), VXD end flange, PXD patch panels
- RVC may act as additional shielding against background
- Decision on installation scenario will be taken after careful evaluation in autumn 2013
  - dedicated meeting on VXD mechanics @ KEK in May





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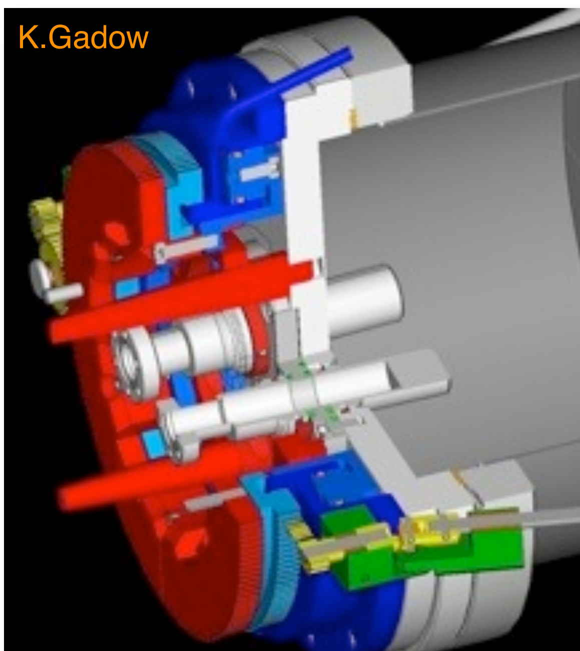

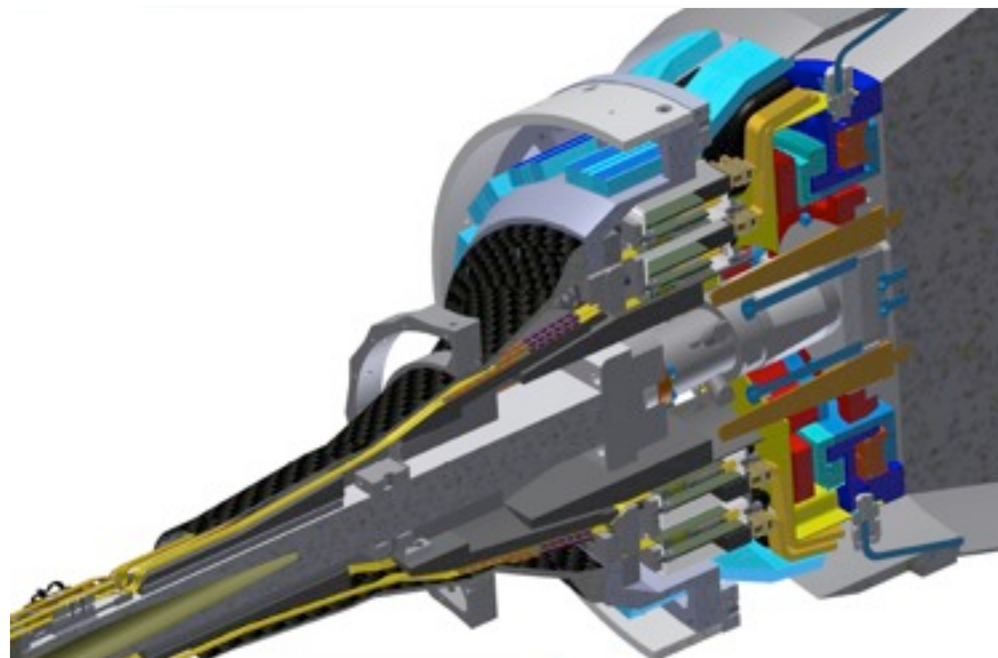

Hydraulic Remote Vacuum Connection

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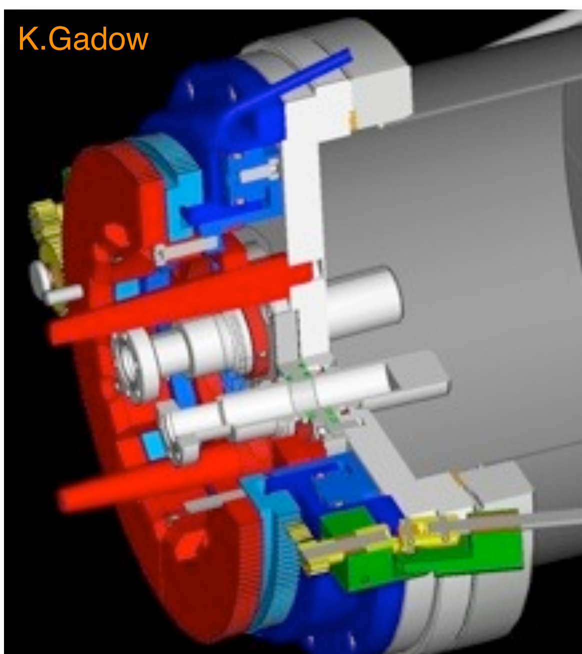
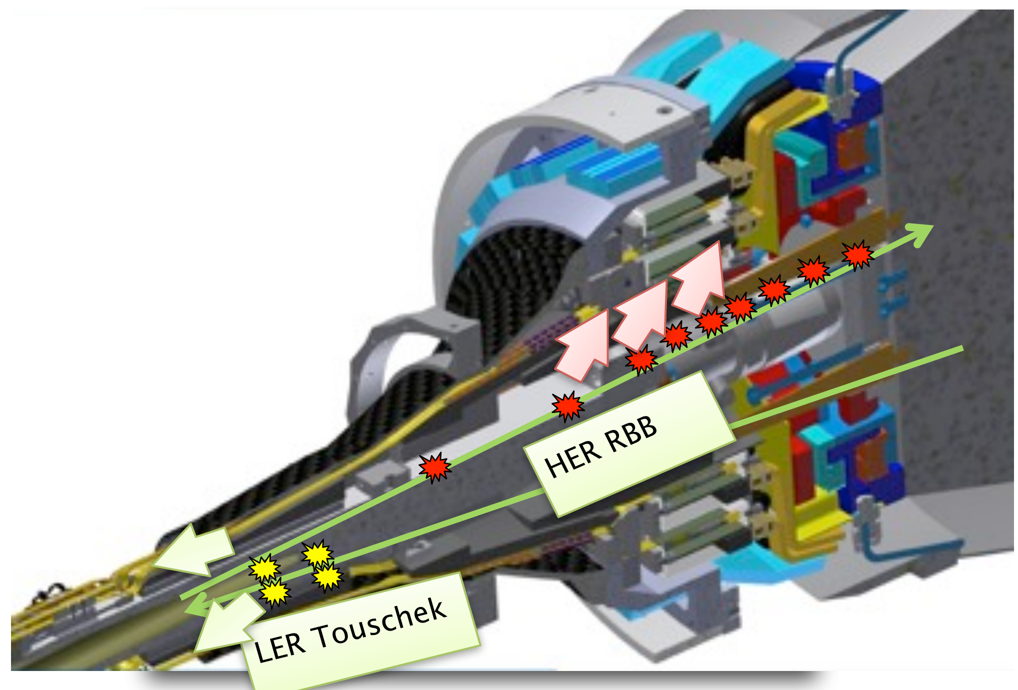
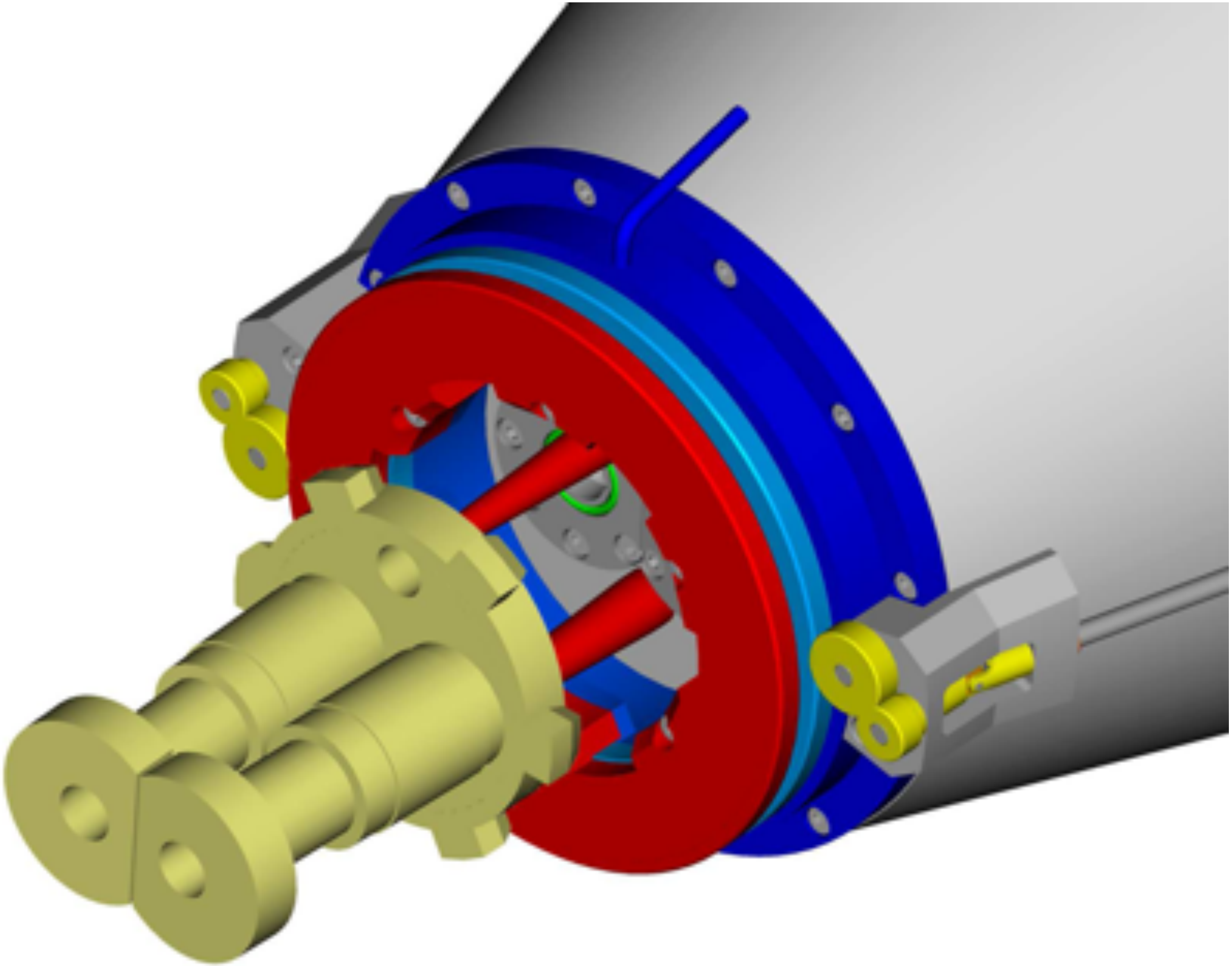


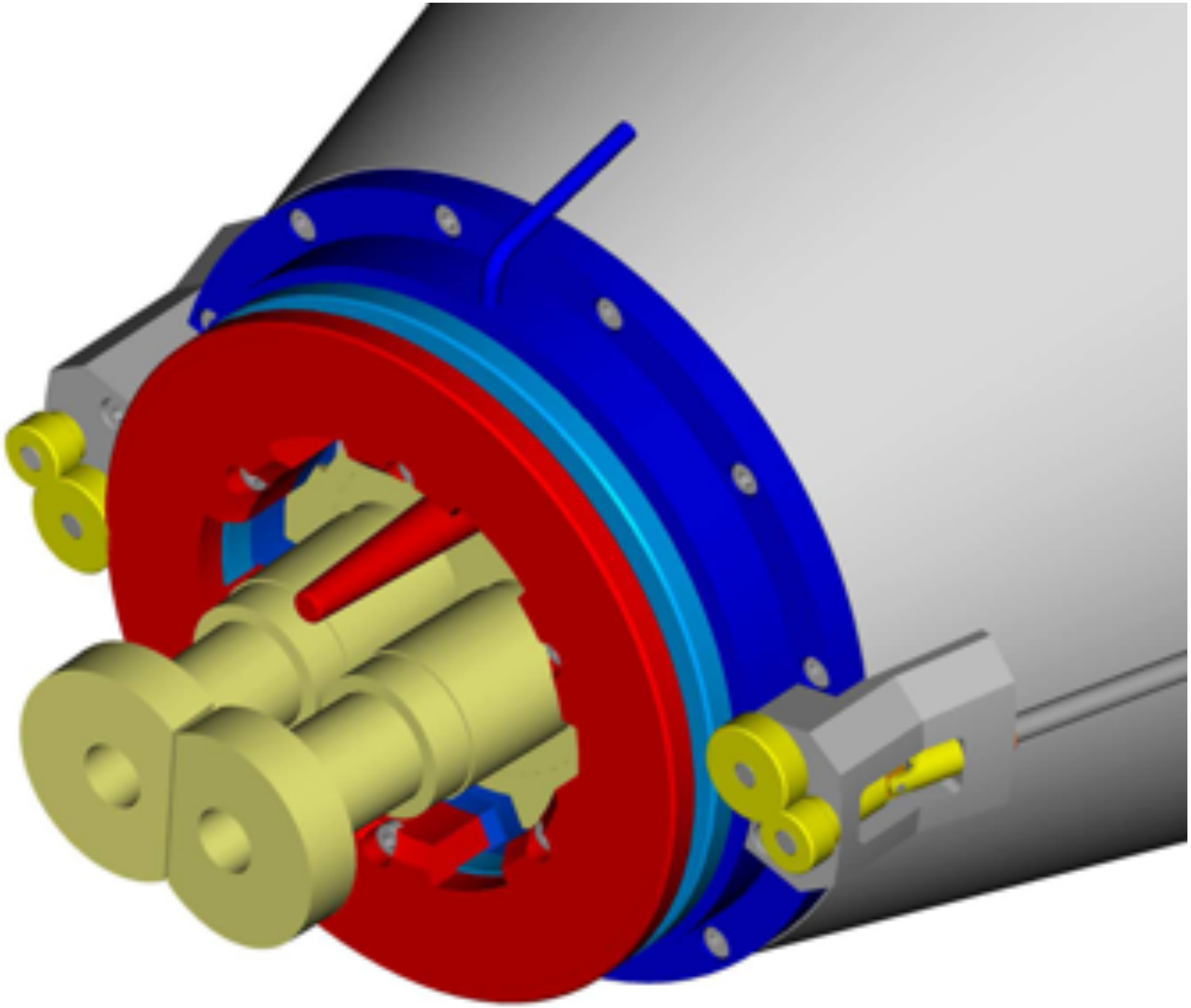


Basic Principle

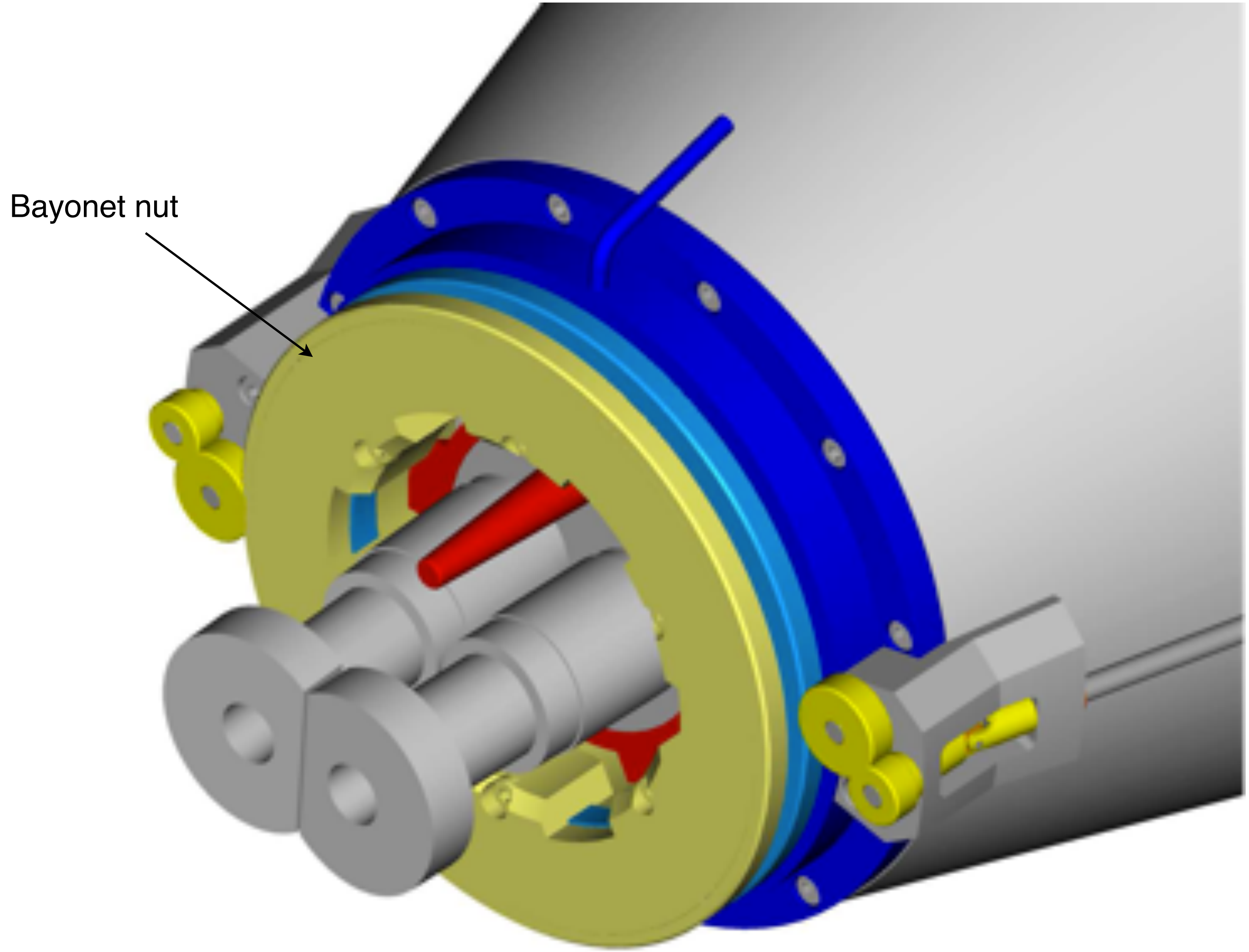


Basic Principle

Moving QCS in

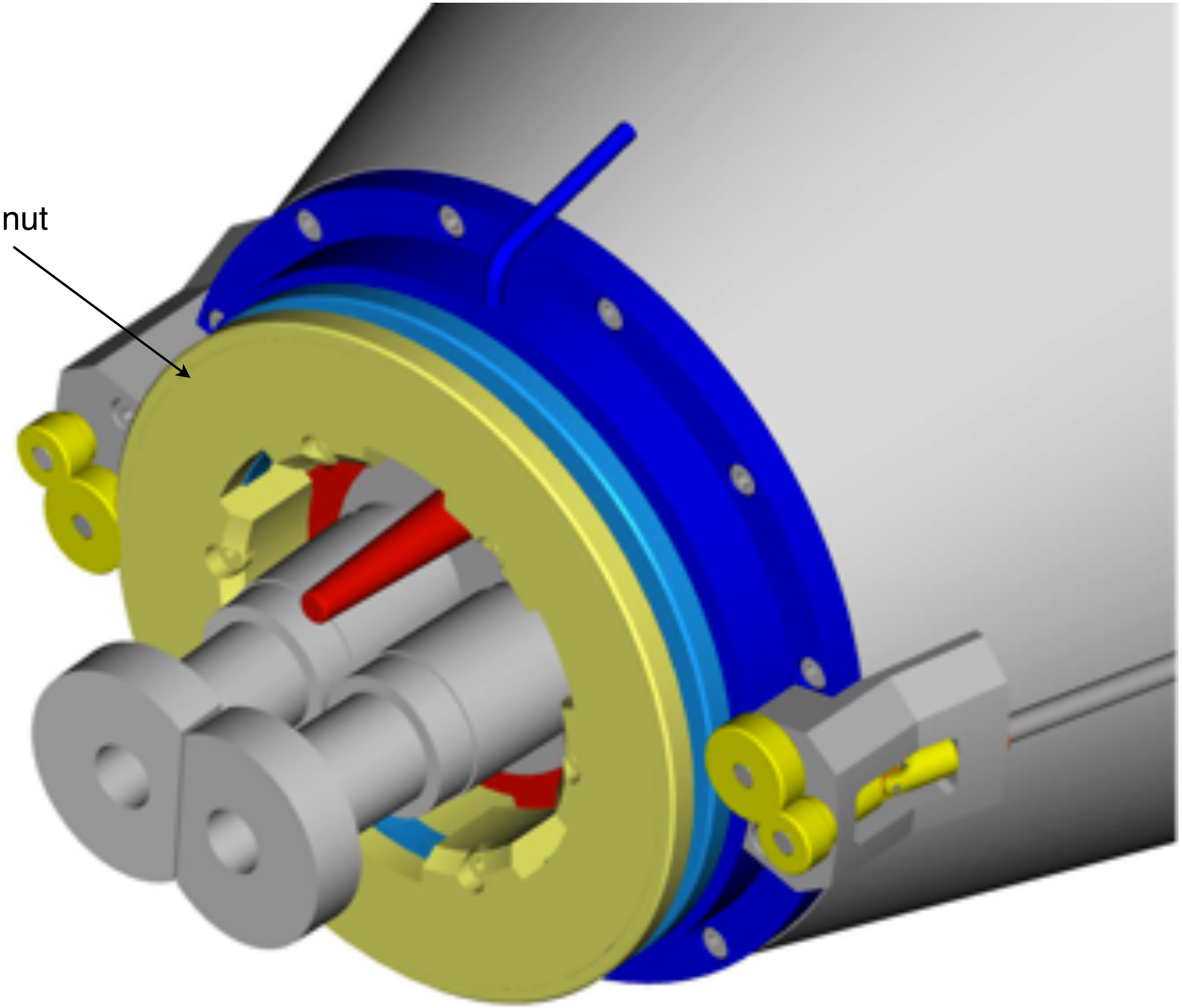


Basic Principle



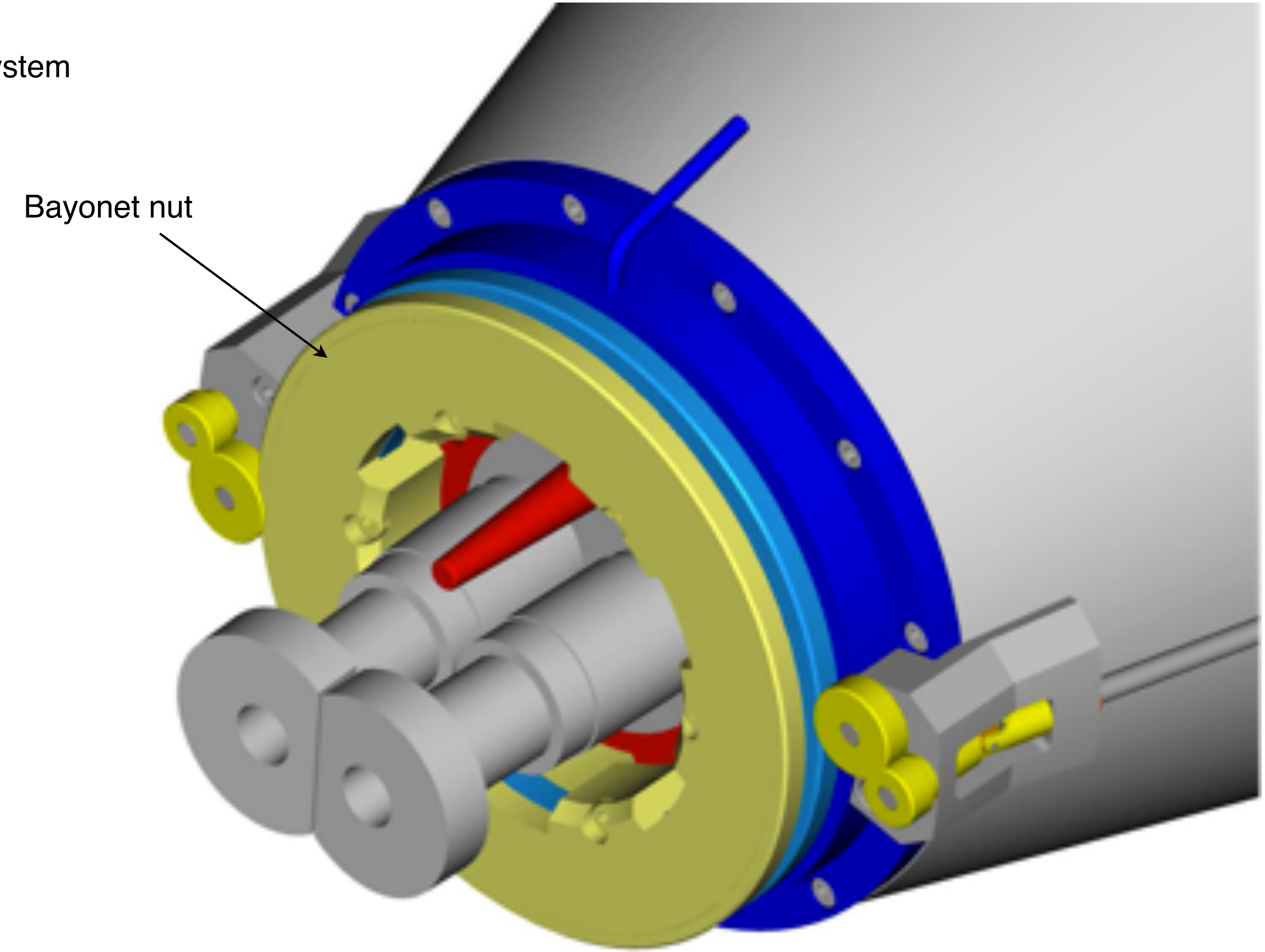
Basic Principle

Closing bayonet mechanism

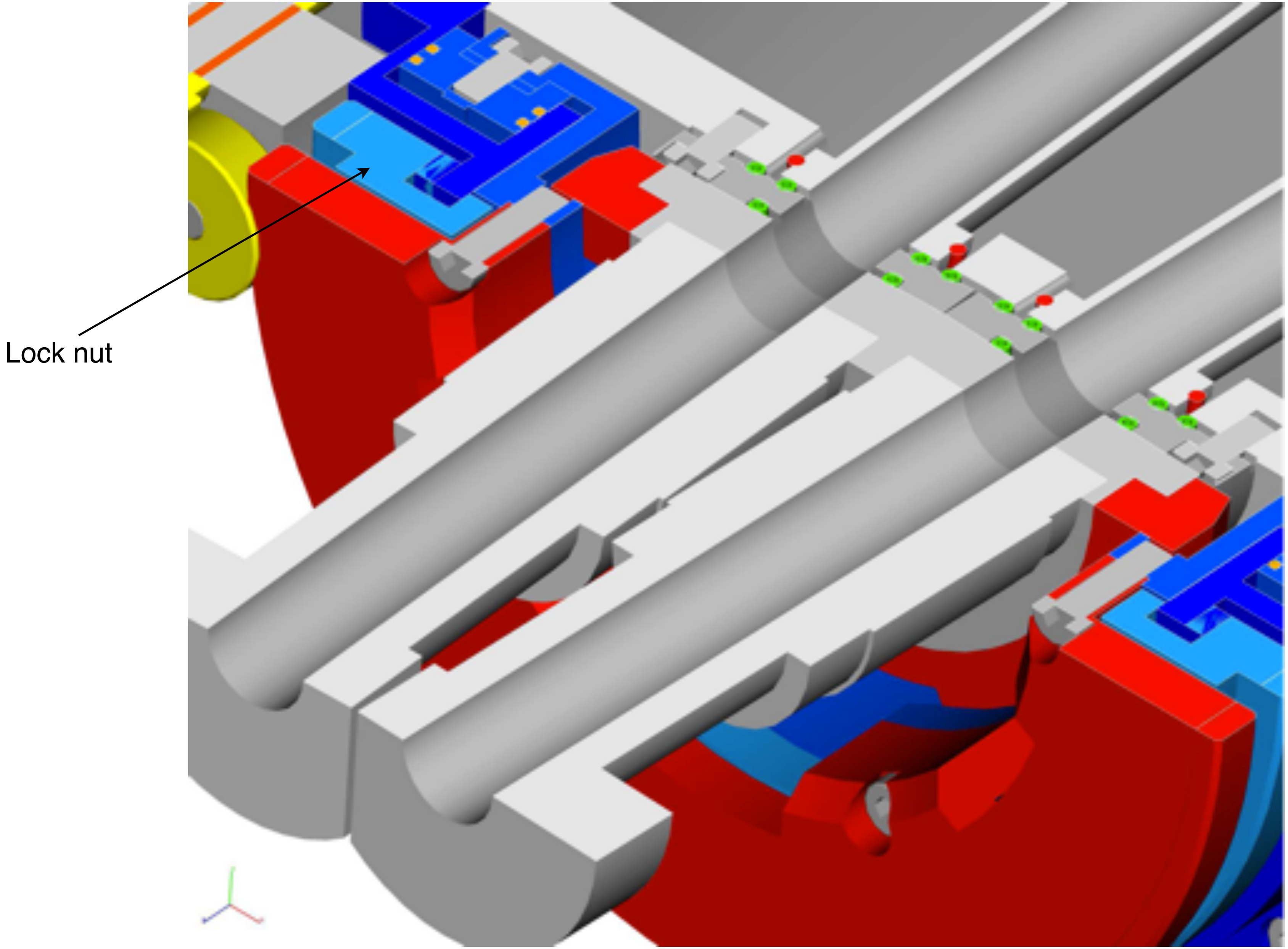


Basic Principle

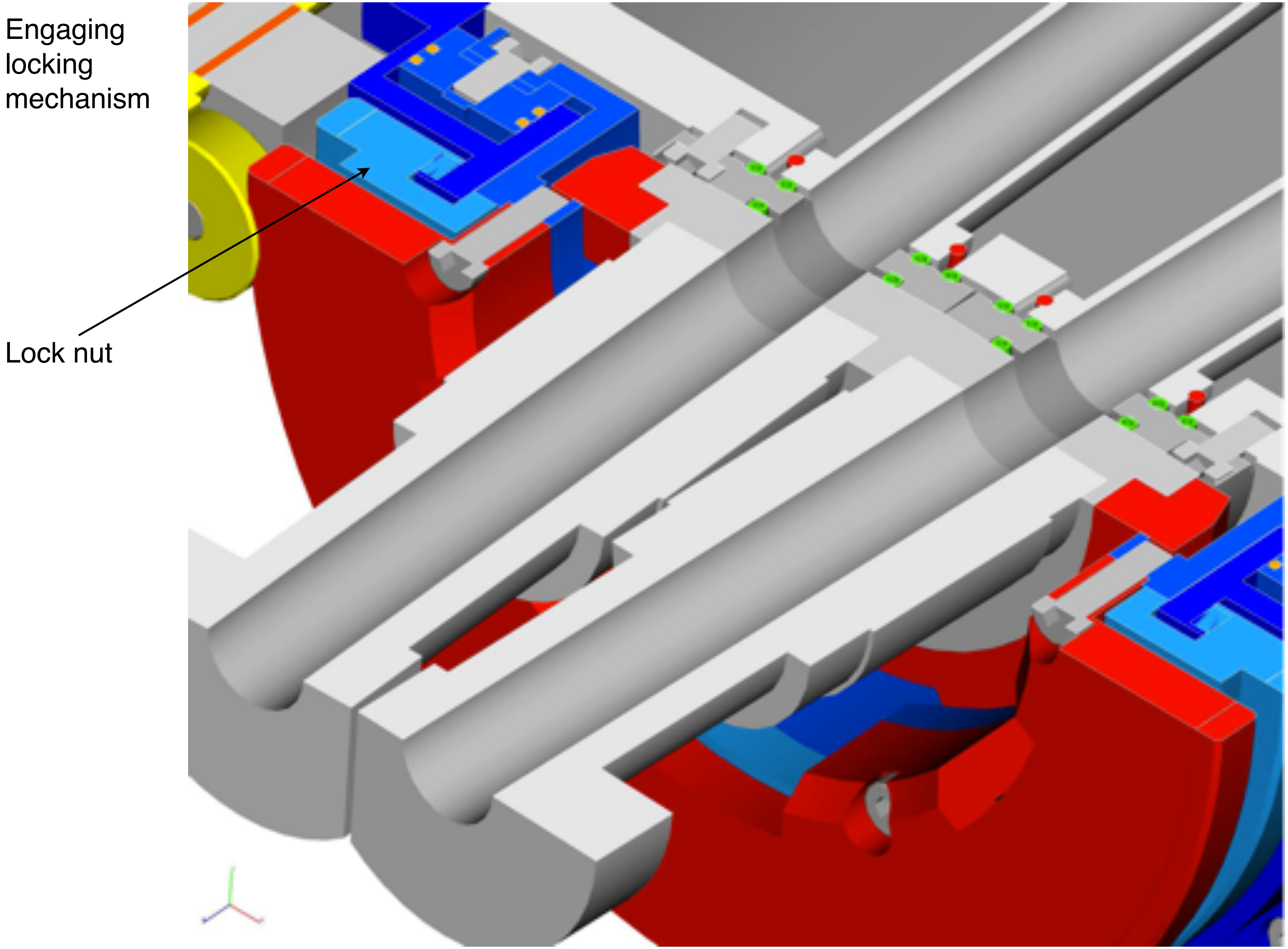
Activating hydraulic system



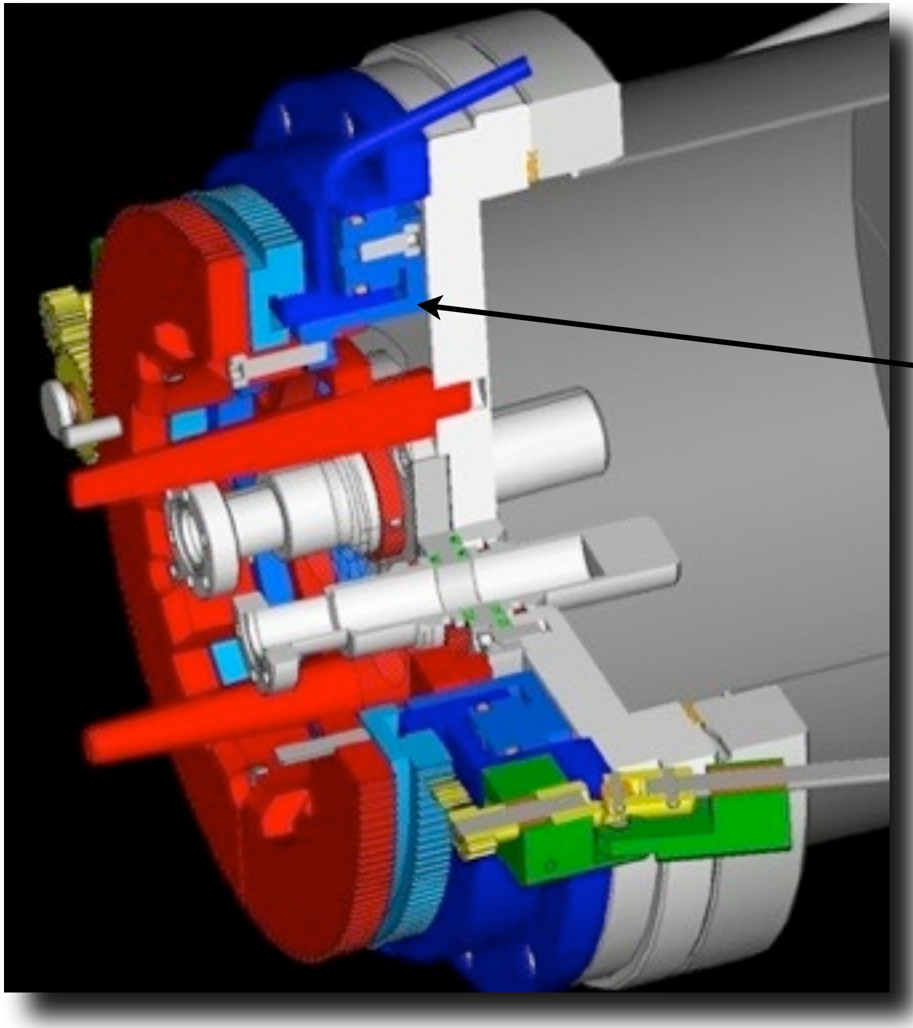
Basic Principle

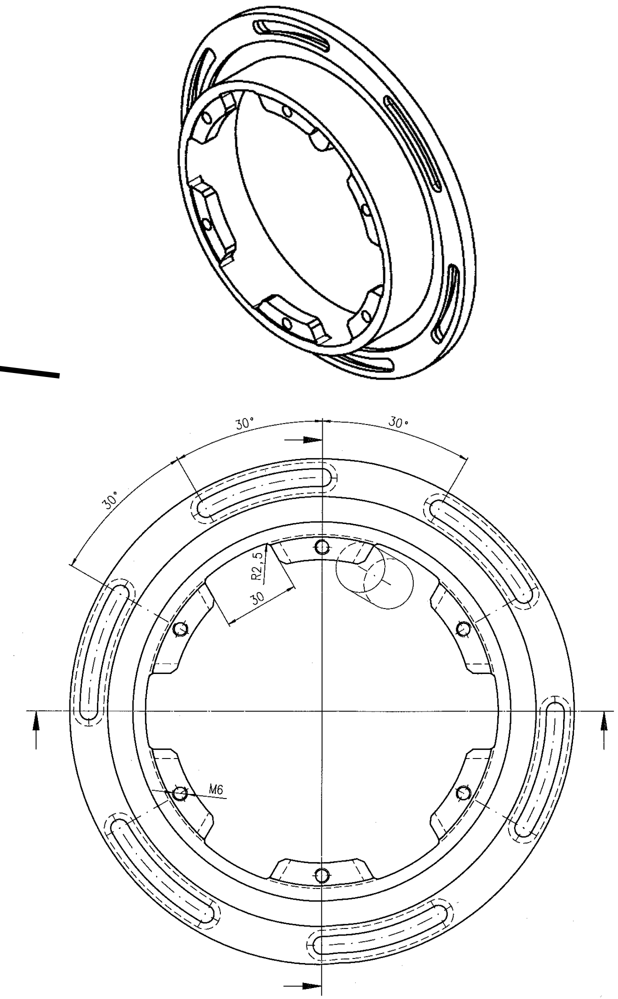


Basic Principle



Modified Bayonet Structure

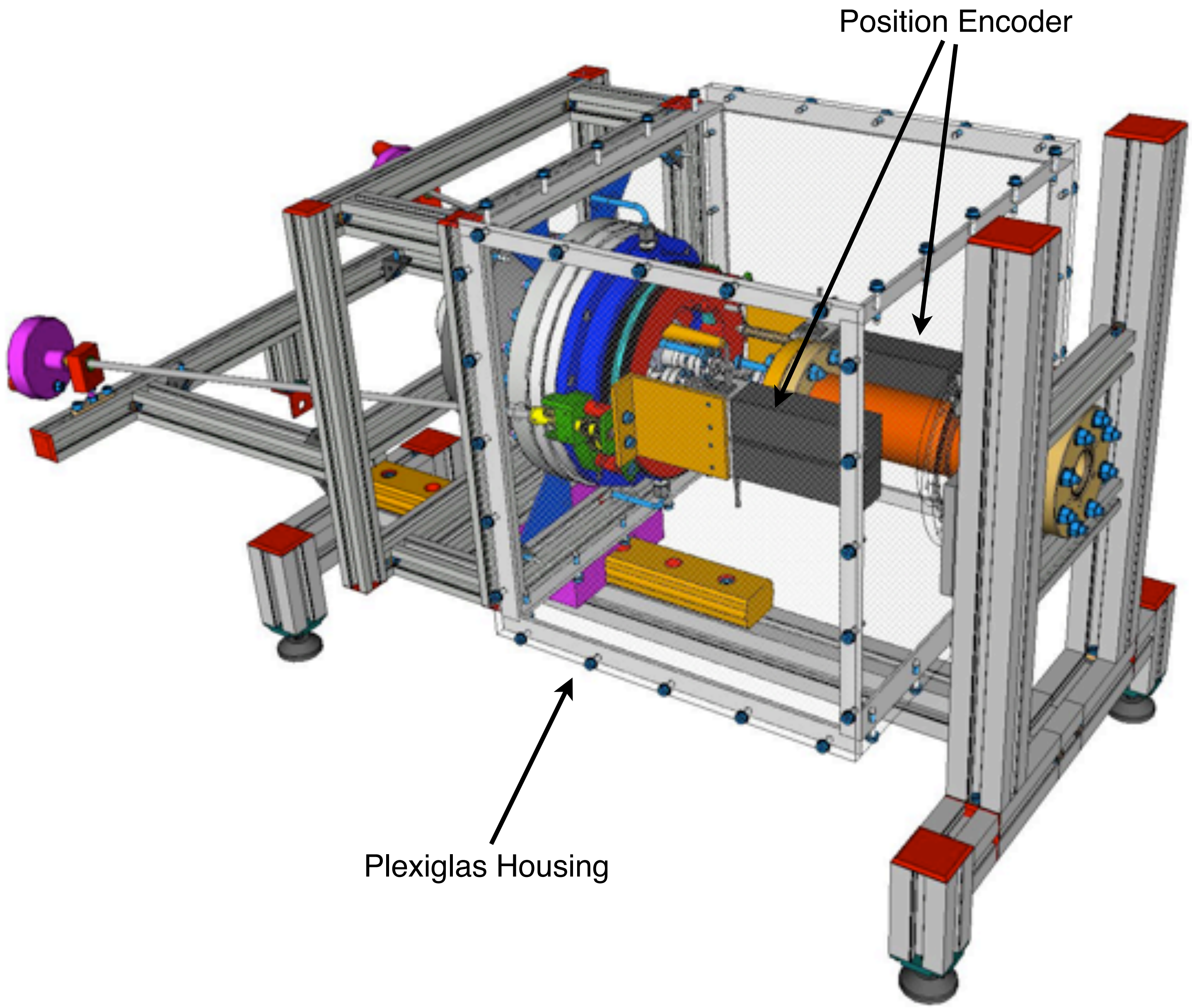




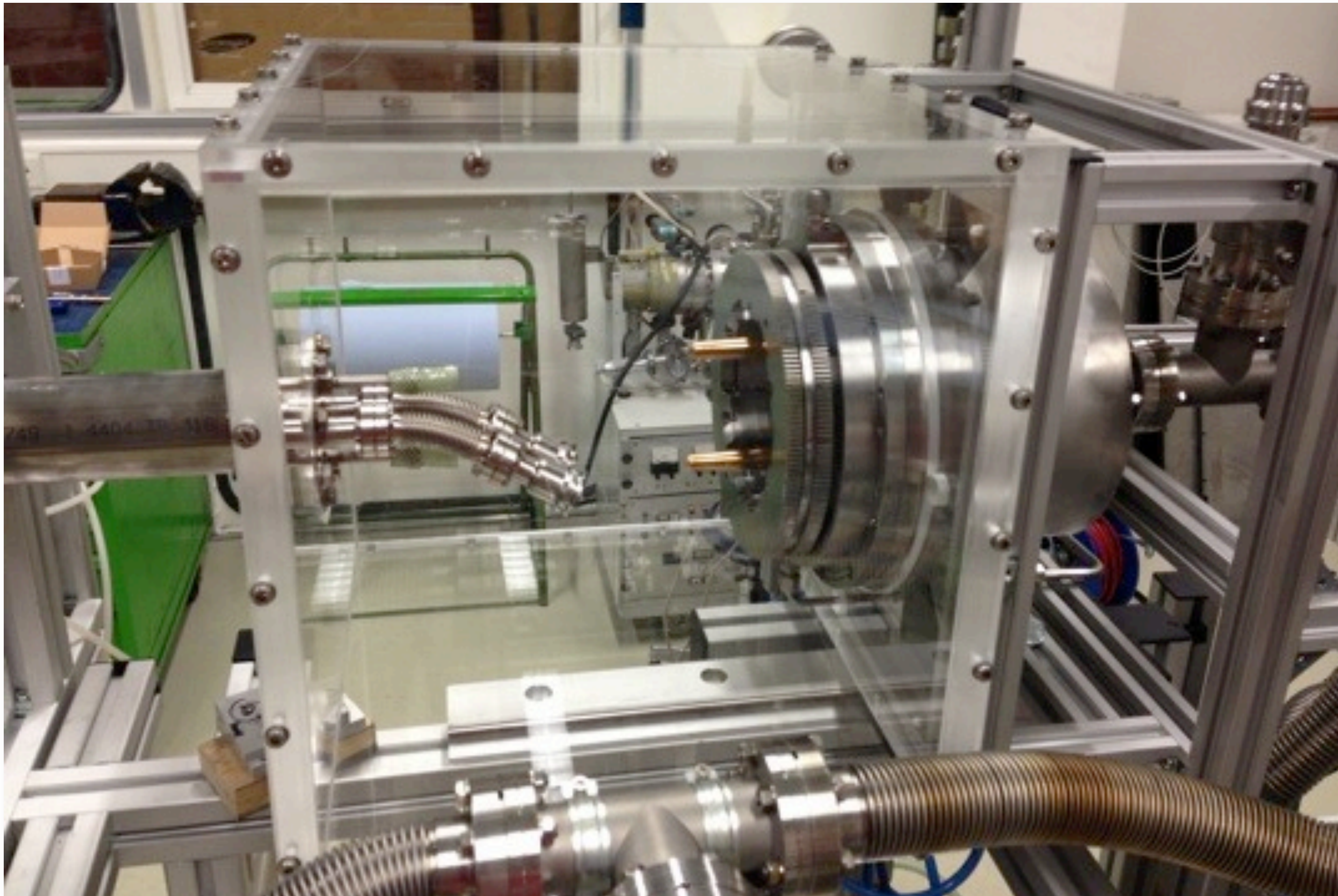
- Modification allows independent rotation of bayonet part and piston

carsten.niebuhr@desy.de

Improved Set-up for Integral Leaktest



New Plexiglas Housing



- Test results will be available by mechanics meeting in May

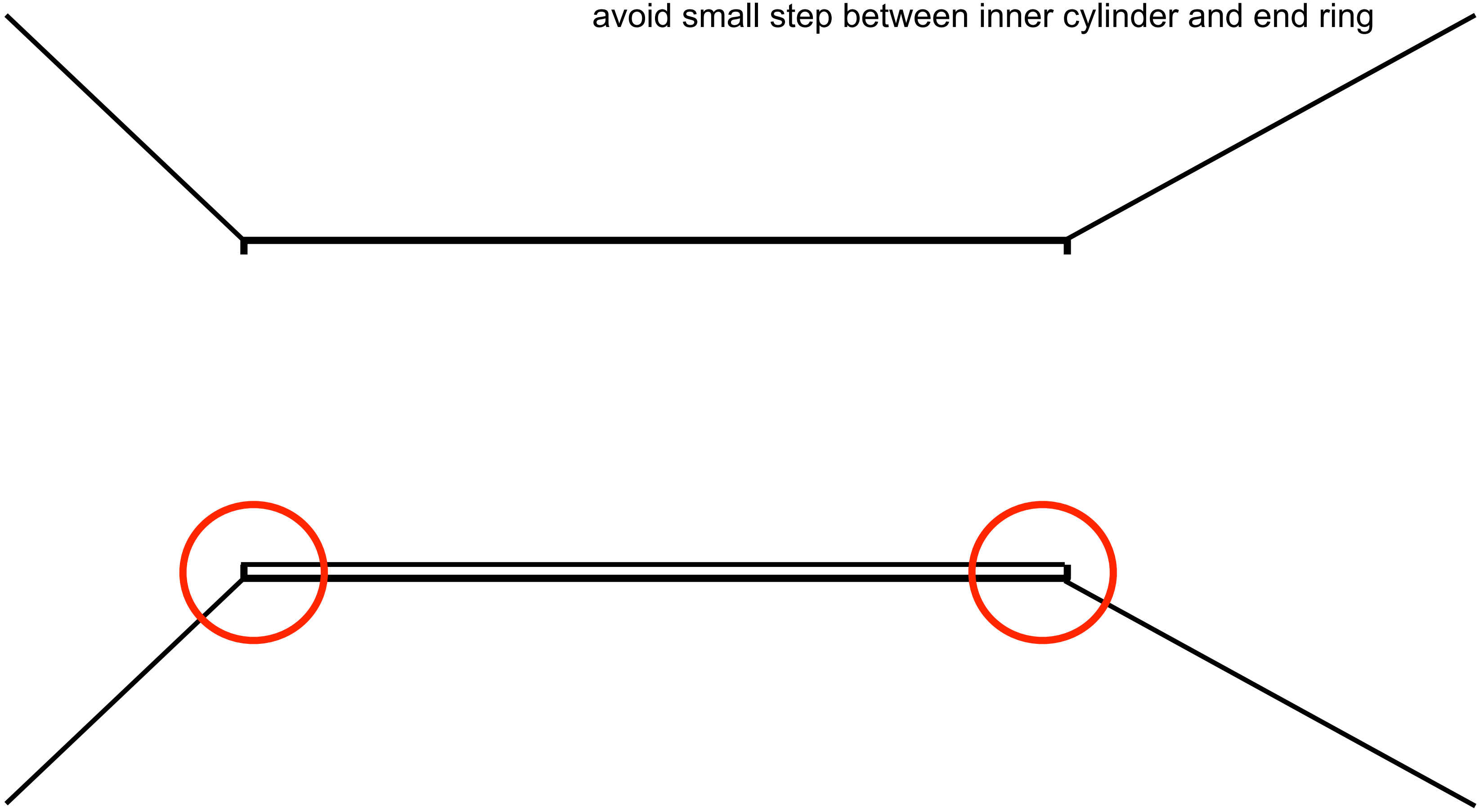
Sketch of Alternative Installation Procedure

carsten.niebuhr@desy.de

Alternative VXD Installation

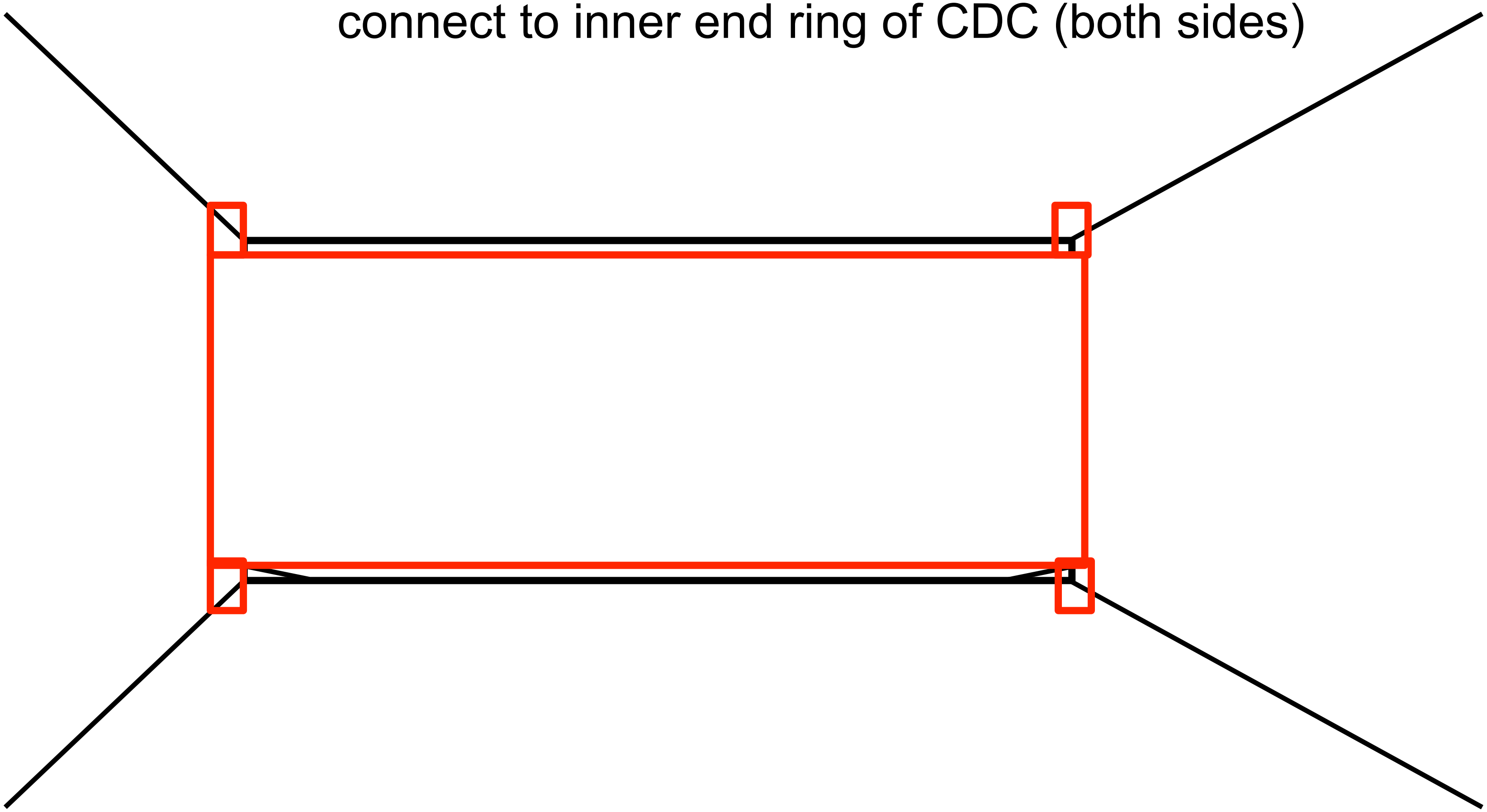
Step 1: glue gliding strips in lower part of CDC inner wall

avoid small step between inner cylinder and end ring



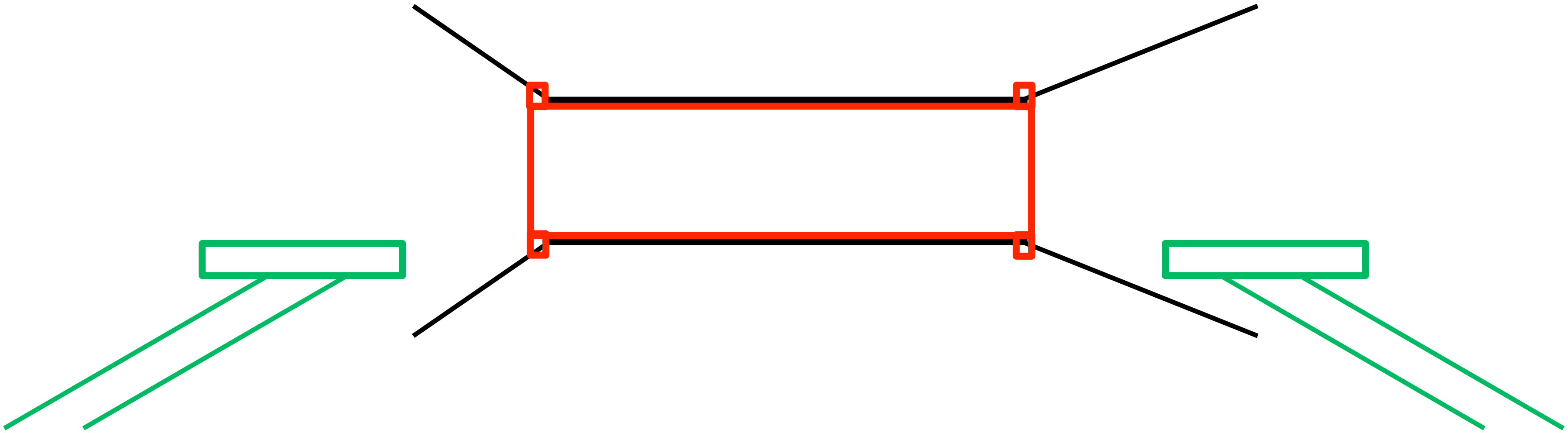
Alternative VXD Installation

Step 2: install mounting tube (stainless steel) and connect to inner end ring of CDC (both sides)



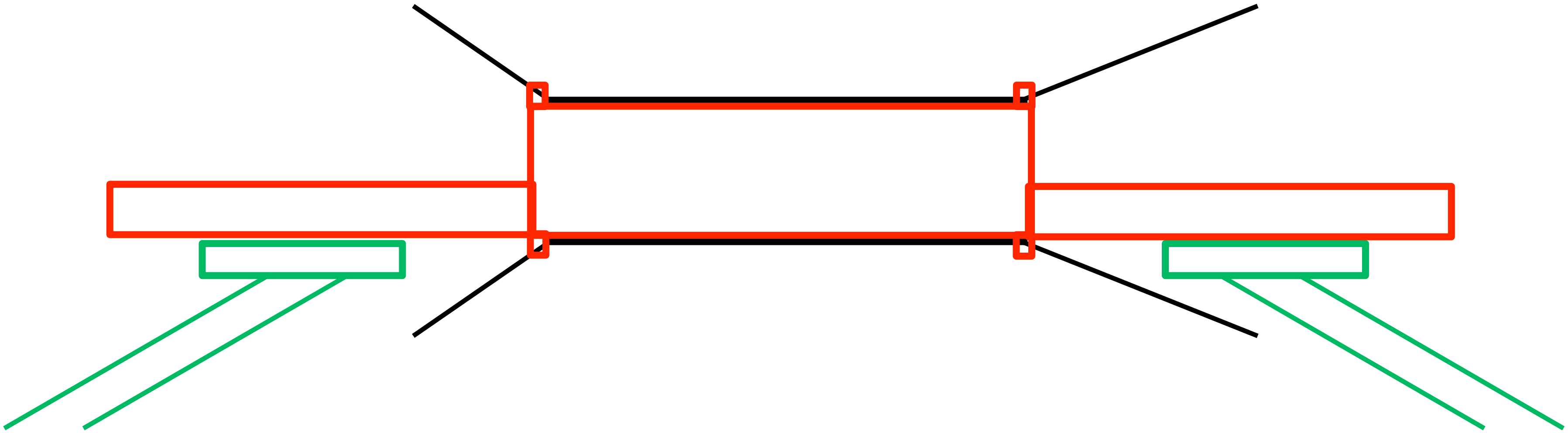
Alternative VXD Installation

Step 3: install support structures on both sides



Alternative VXD Installation

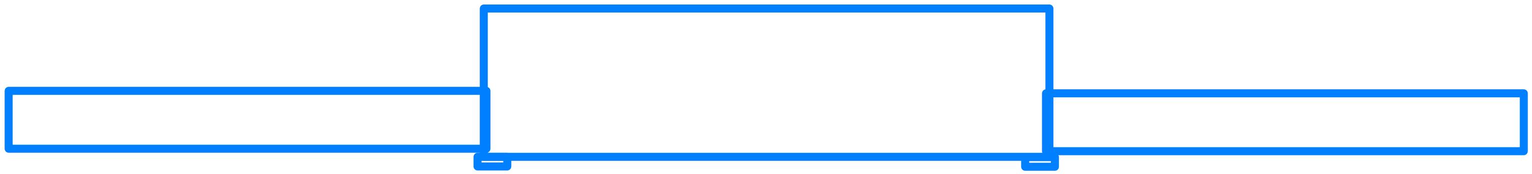
Step 4: install mounting tube extensions on both sides



Alternative VXD Installation

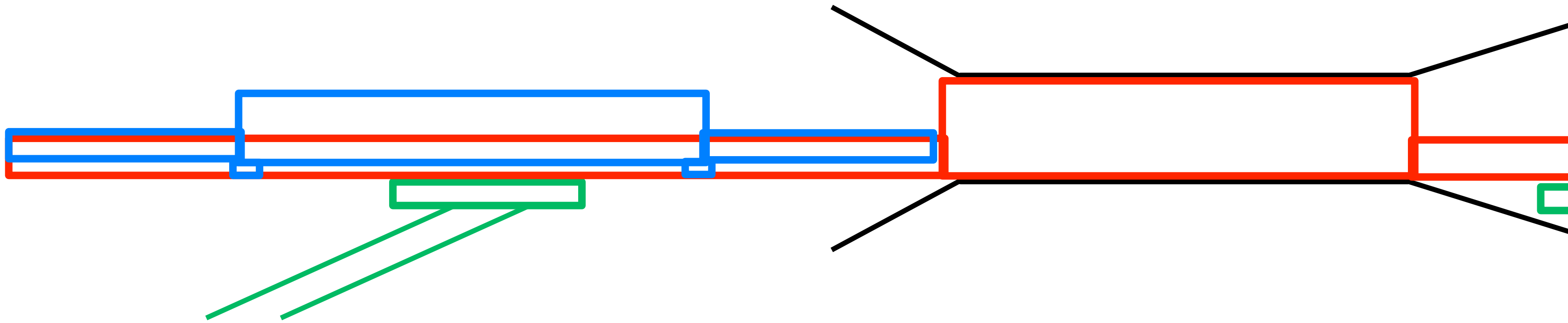
Step 5: connect cable trays on both sides of VXD

incl. ~7m CO_2 lines on both sides



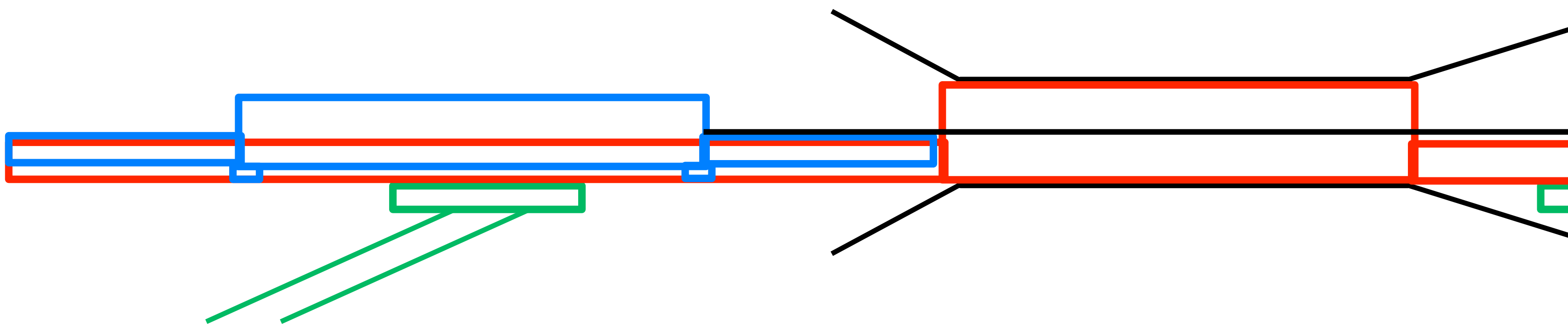
Step 6: lower VXD system to mounting tube extension

can in principle be done on either side



Alternative VXD Installation

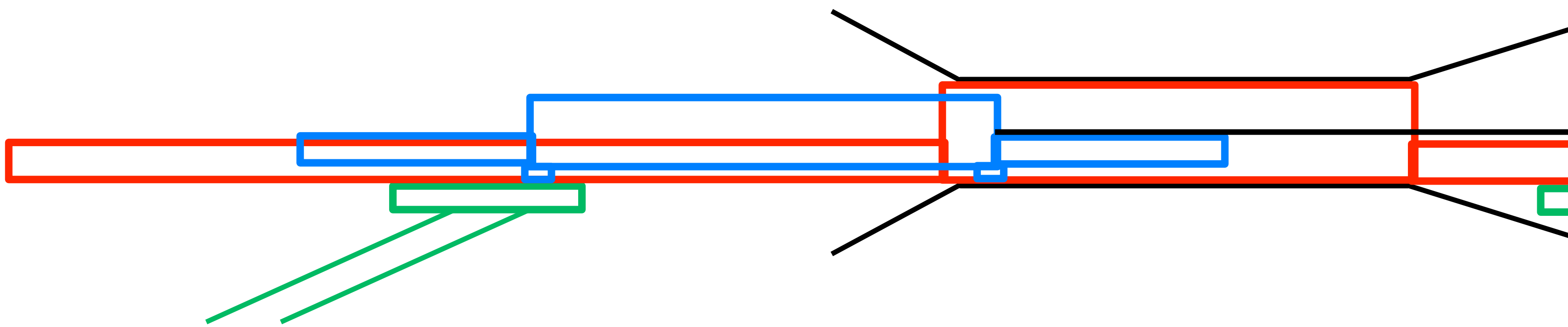
Step 7: unroll CO2 pipes and guide through CDC



Alternative VXD Installation

Step 8: push VXD system **by hand** through mounting tube

VXD rests on 2 gliding shoes fixed to end flange



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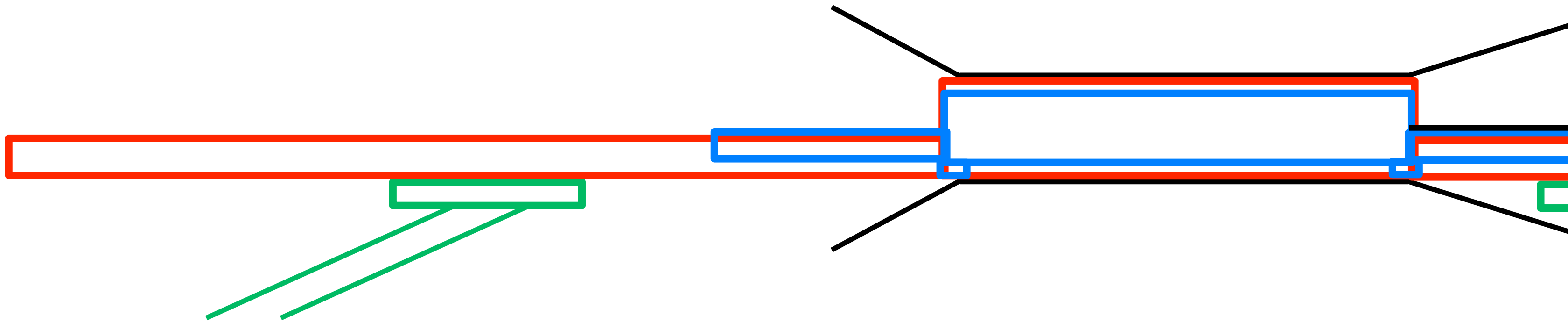
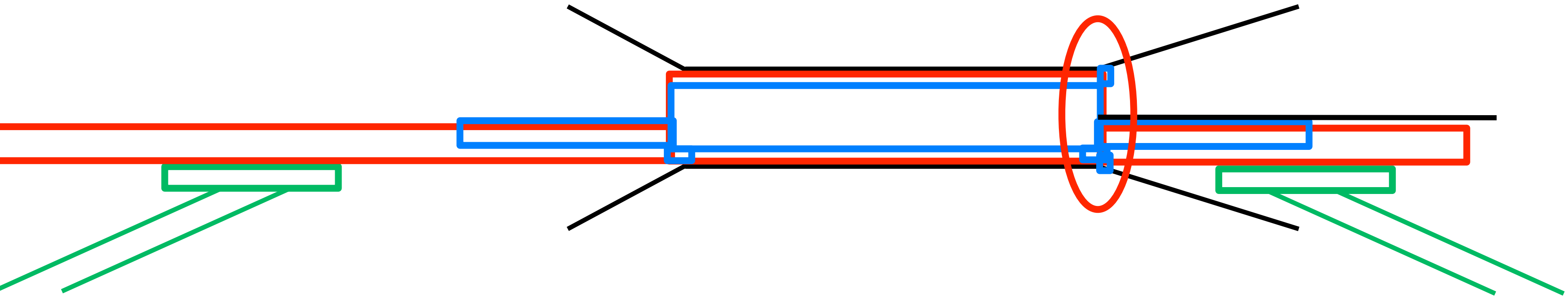
VXD rests on 2 gliding shoes fixed to end flange

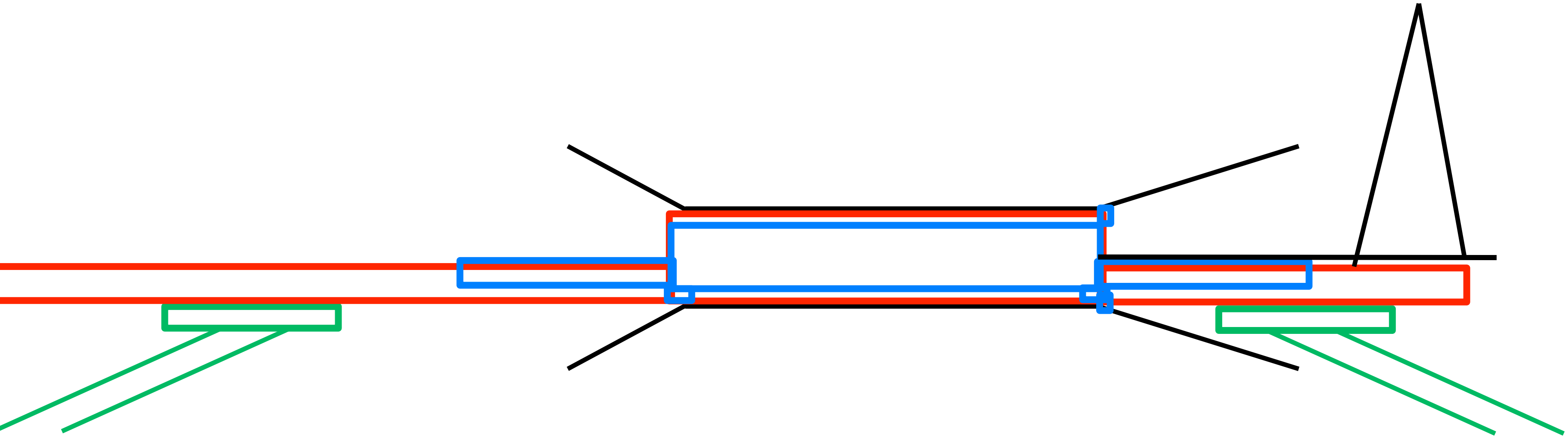


Step 9: fix far end of VXD to CDC end ring

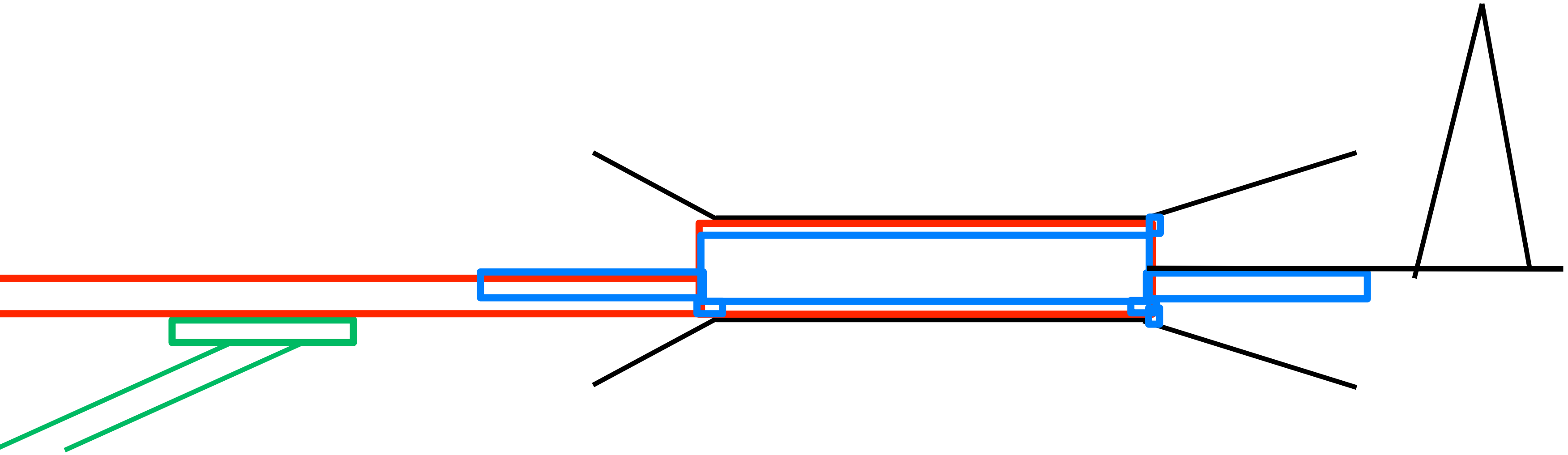


Alternative VXD Installation

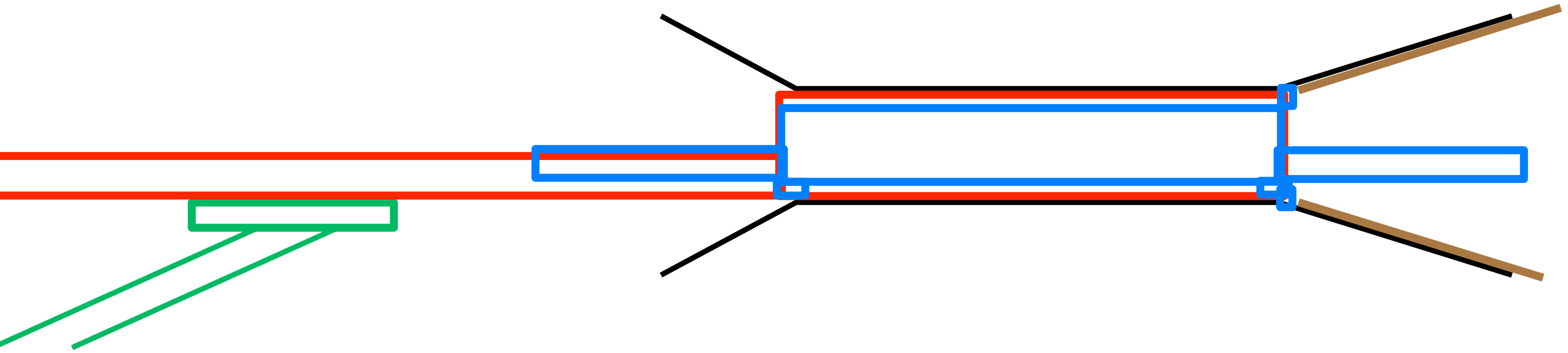
Step 10: temporarily suspend cables/pipes on far end



Step 11: remove extension on far end

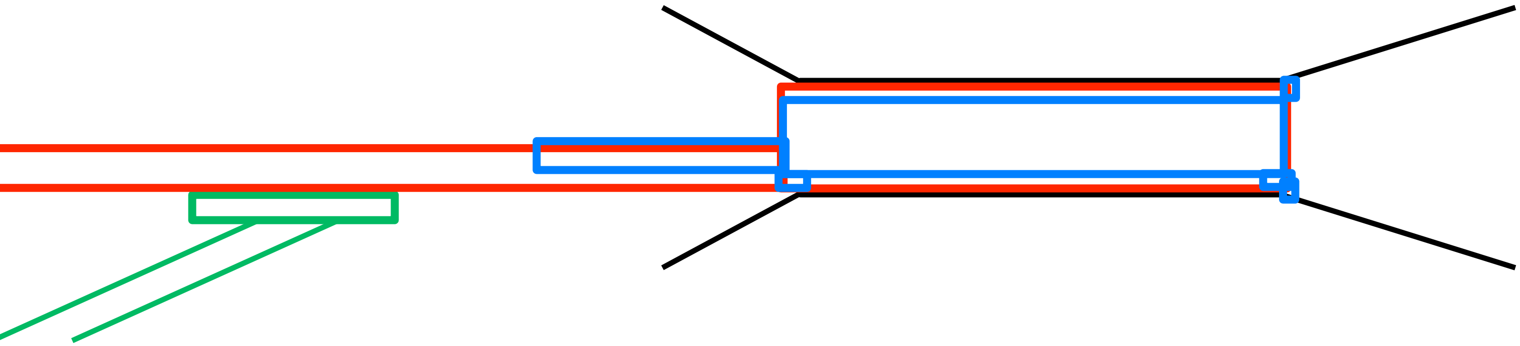


Step 12: install cables on CDC inner wall

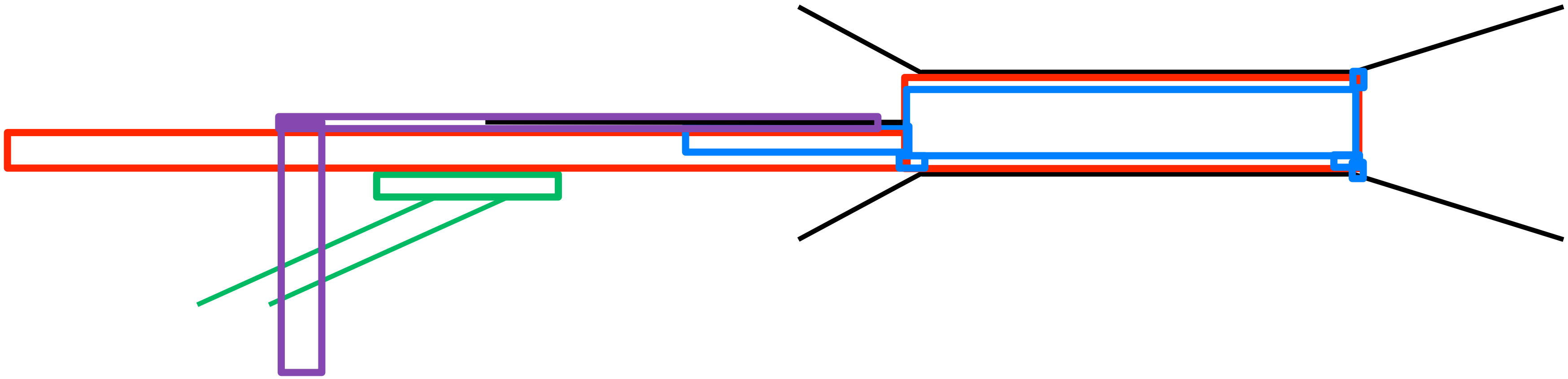


Alternative VXD Installation

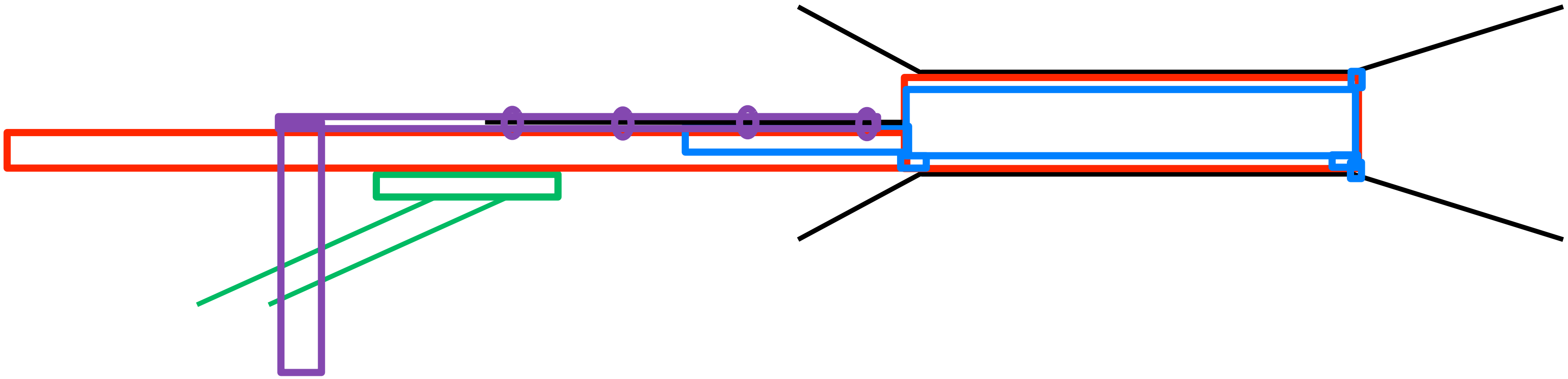
Step 13: remove cable tray on far end



Step 14: on near end install cable suspension system (cantilever arm)

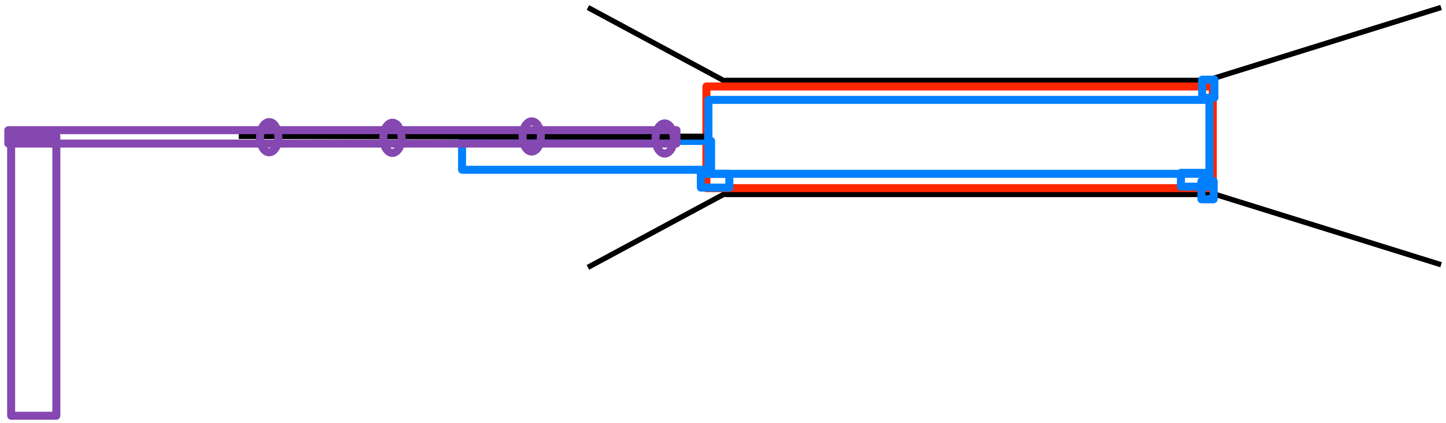


Step 15: fix cables to suspension system on near end



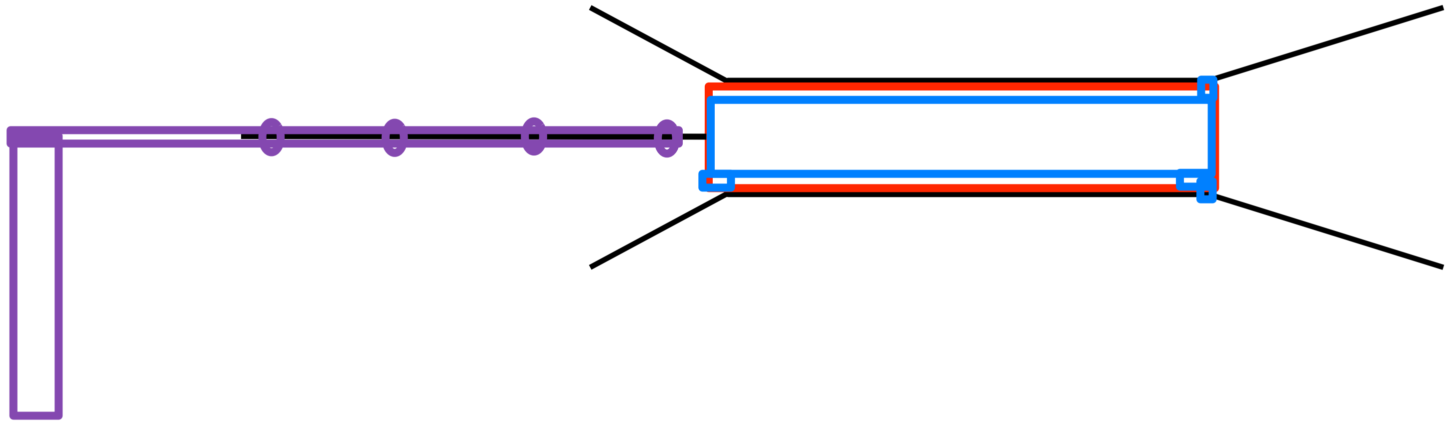
Alternative VXD Installation

Step 16: remove extension on near end



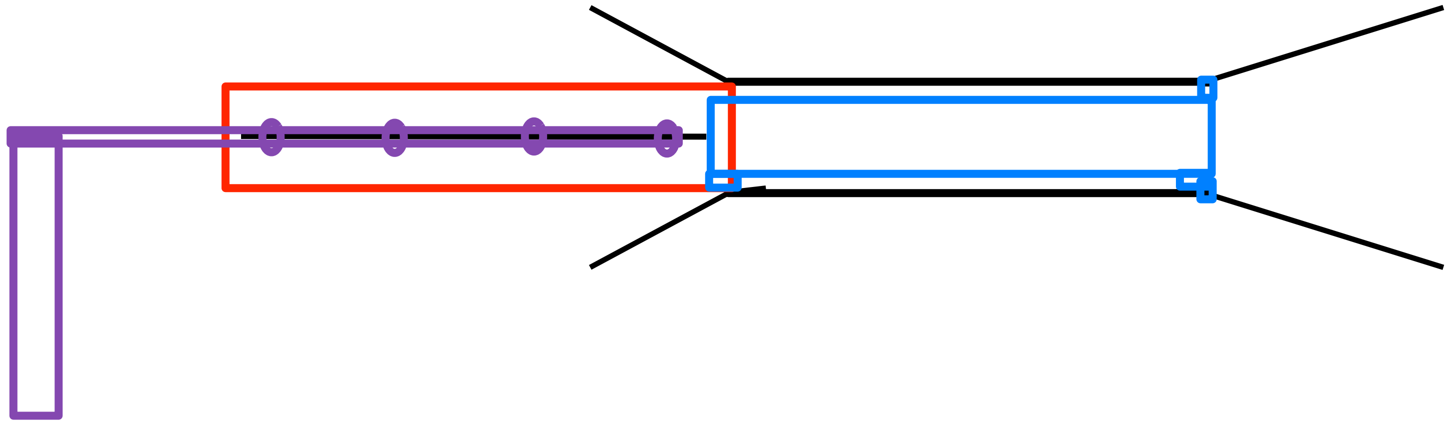
Alternative VXD Installation

Step 17: remove cable tray on near end

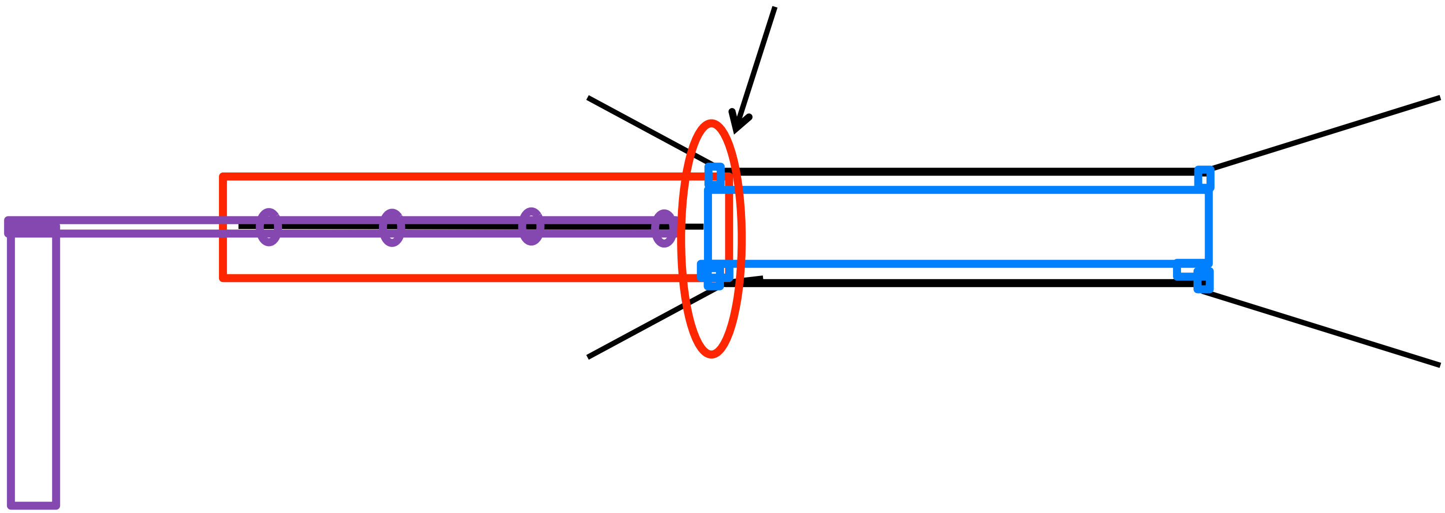


Alternative VXD Installation

Step 18: pull mounting tube to VXD fixation position

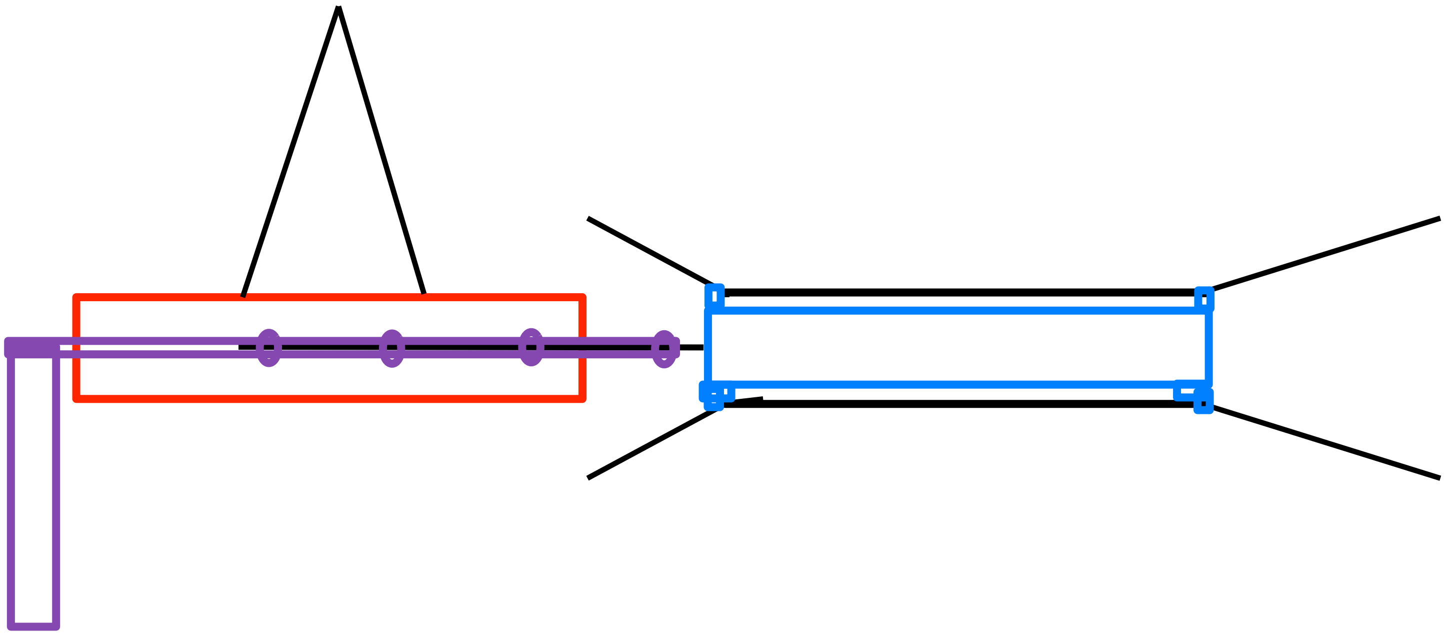


Step 19: fix VXD end flange to CDC end ring at near end
(mounting tube has slits cut out to access the
screw holes on CDC end ring)



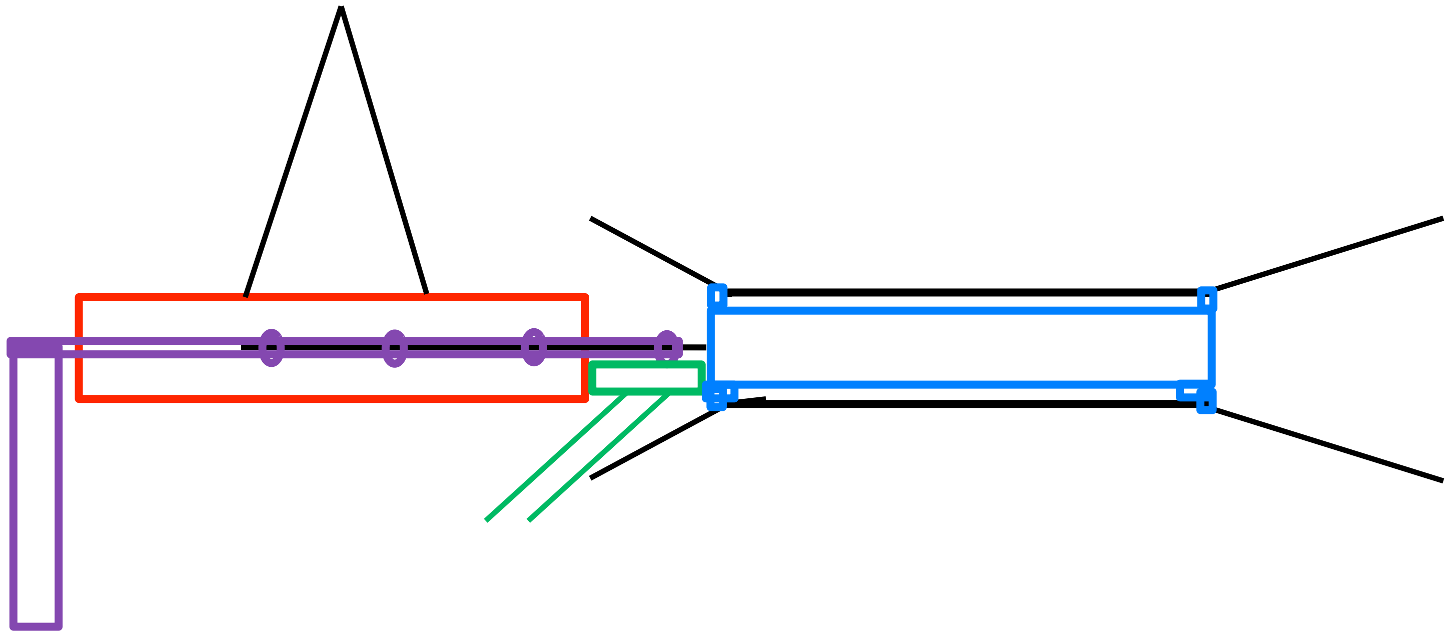
Alternative VXD Installation

Step 20: completely remove mounting tube from CDC and temporarily suspend from crane



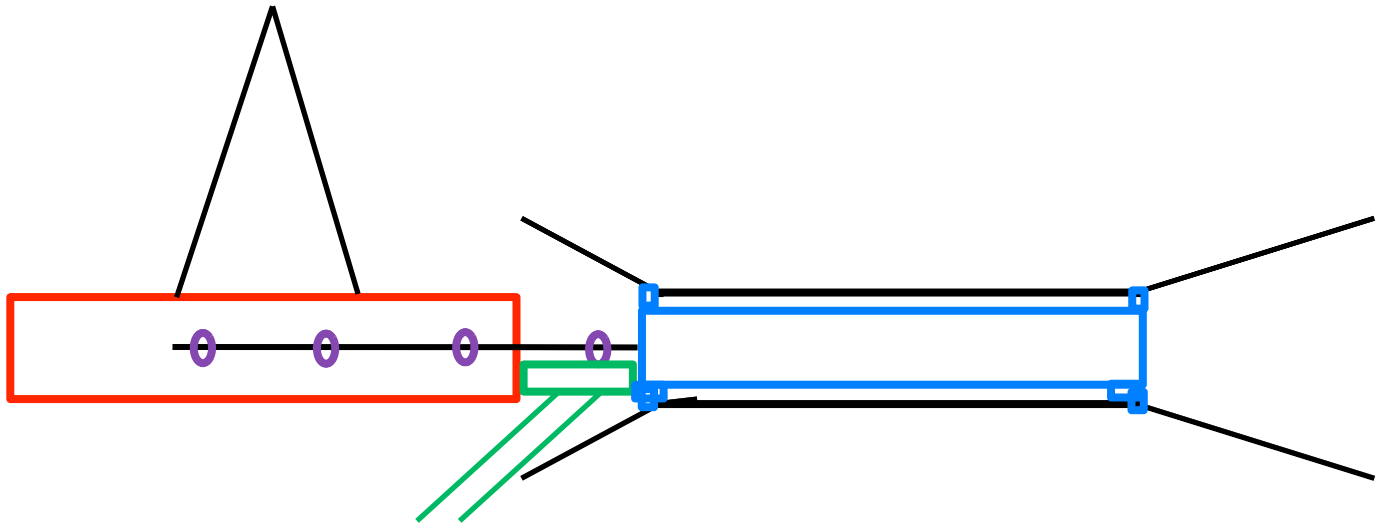
Alternative VXD Installation

Step 21: install near end cable fixation system

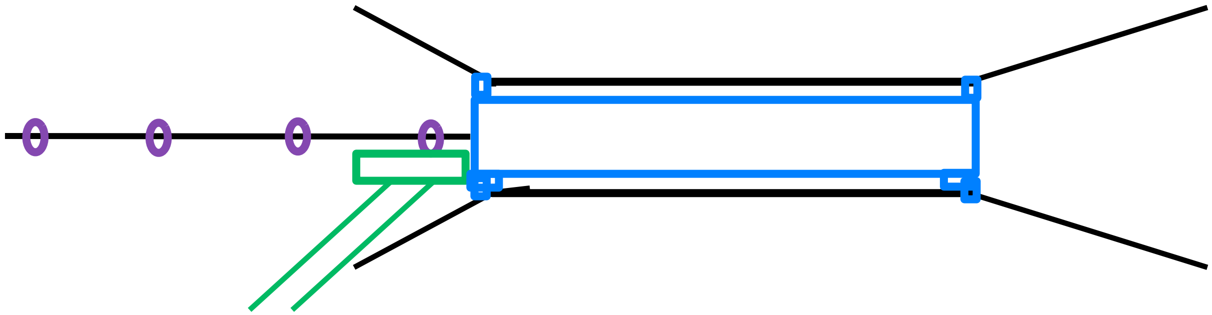


Alternative VXD Installation

Step 22: remove cable suspension system

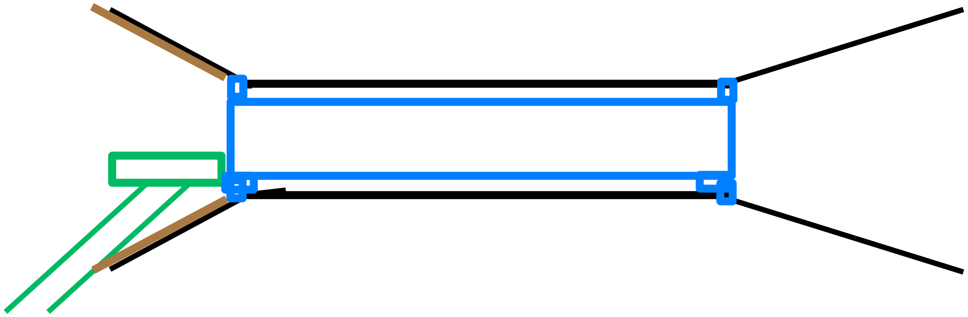


Step 23: remove mounting tube from cables with crane

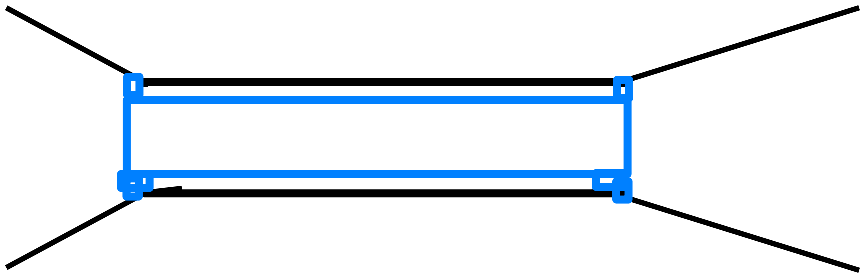


Alternative VXD Installation

Step 24: fix cables on inner wall of CDC



Step 25: remove cable suspension system

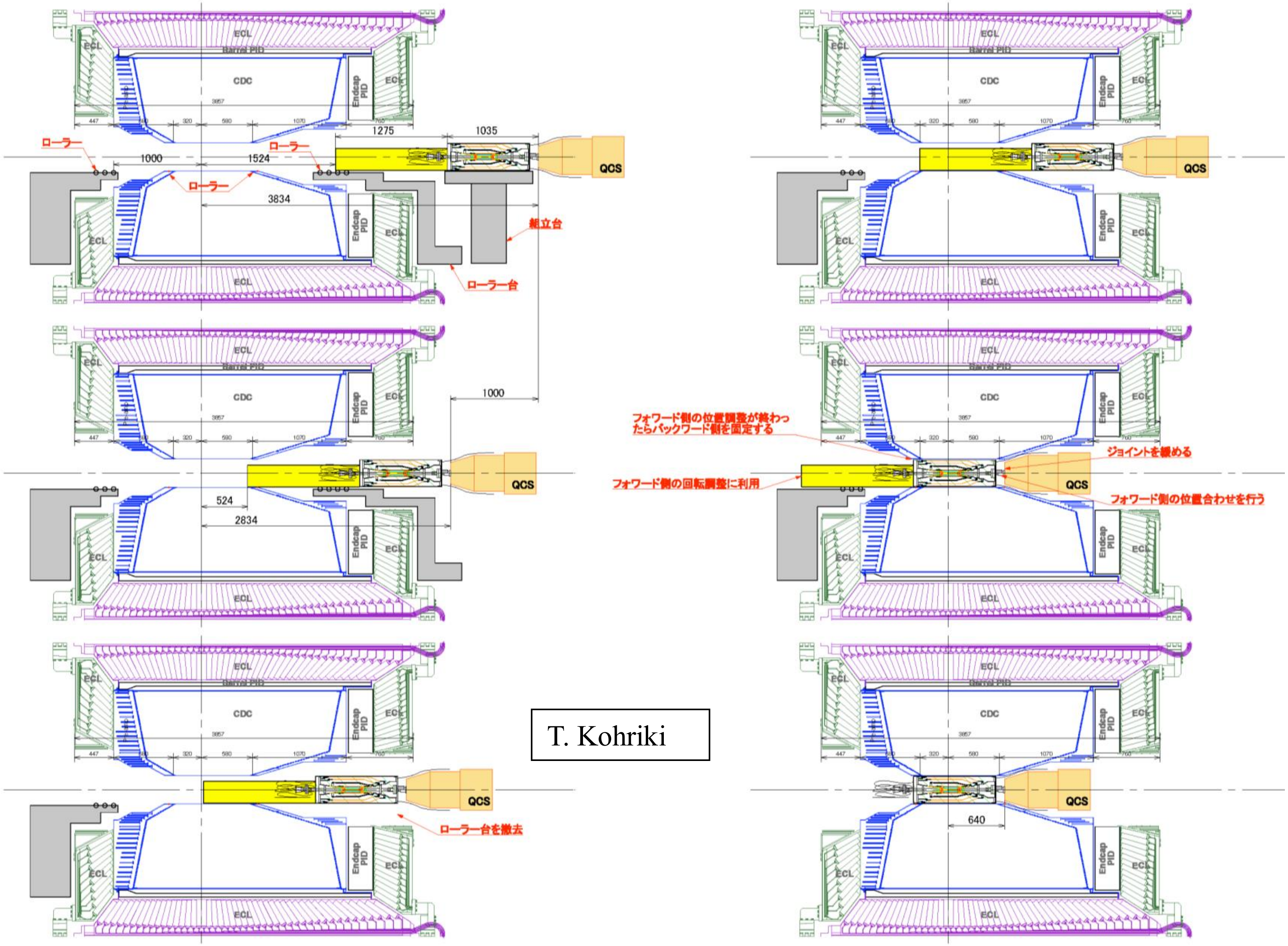


Alternative Installation Procedure

- Advantages
  - avoids „critical points“ of default installation scenario
    - delicate operation of pushing VXD into CDC is done by hand
    - cables/pipes can be fixed to inner wall of CDC and thus don‘t establish „stiff“ connection between QCS and VXD end flange
  - installation independent of other subsystems
    - identical procedure can be used in- and outside beam position
    - in principle installation can be done from either side (fwd/bwd)
  - all connections can be tested before QCS moves in
  - procedure can be fully exercised with mock-up in the lab
- Open issues
  - this is only a sketch of a promising idea
    - no detailed calculation/design effort went into this so far
    - however there seems to be no obvious „show stopper“
      - mounting tube
      - cable fixation at CDC
  - mock-up must be prepared

Backup

carsten.niebuhr@desy.de


ローラー
ローラー
ローラー
1000
1524
1275
1035
3834
組立台
ローラー台
QCS
1000
524
2834
ローラー台を撤去
フォワード側の位置調整が終わったらバックワード側を固定する
ジョイントを緩める
フォワード側の回転調整に利用
フォワード側の位置合わせを行う
640
ECL
Barrel PID
CDC
Endcap PID

T. Kohriki

VXD load test into CDC

- Result,
  The VXD structure sink (CDC structure deform) about

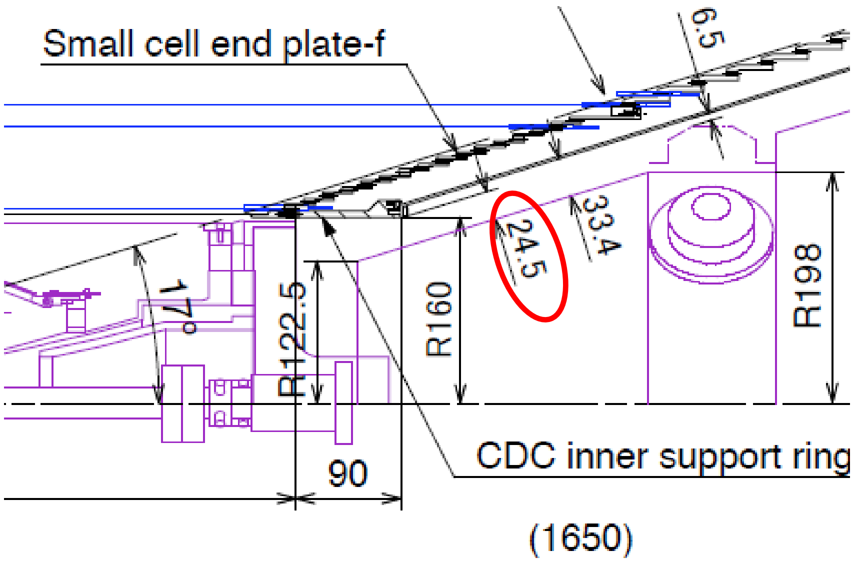
  180-190um (200um was expected)

with 80 kg of VXD mockup structure and additional weight
(This load was applied on both End flange.)

The clearance between CDC and VXD is 5mm for installation.

carsten.niebuhr@desy.de

Service Space



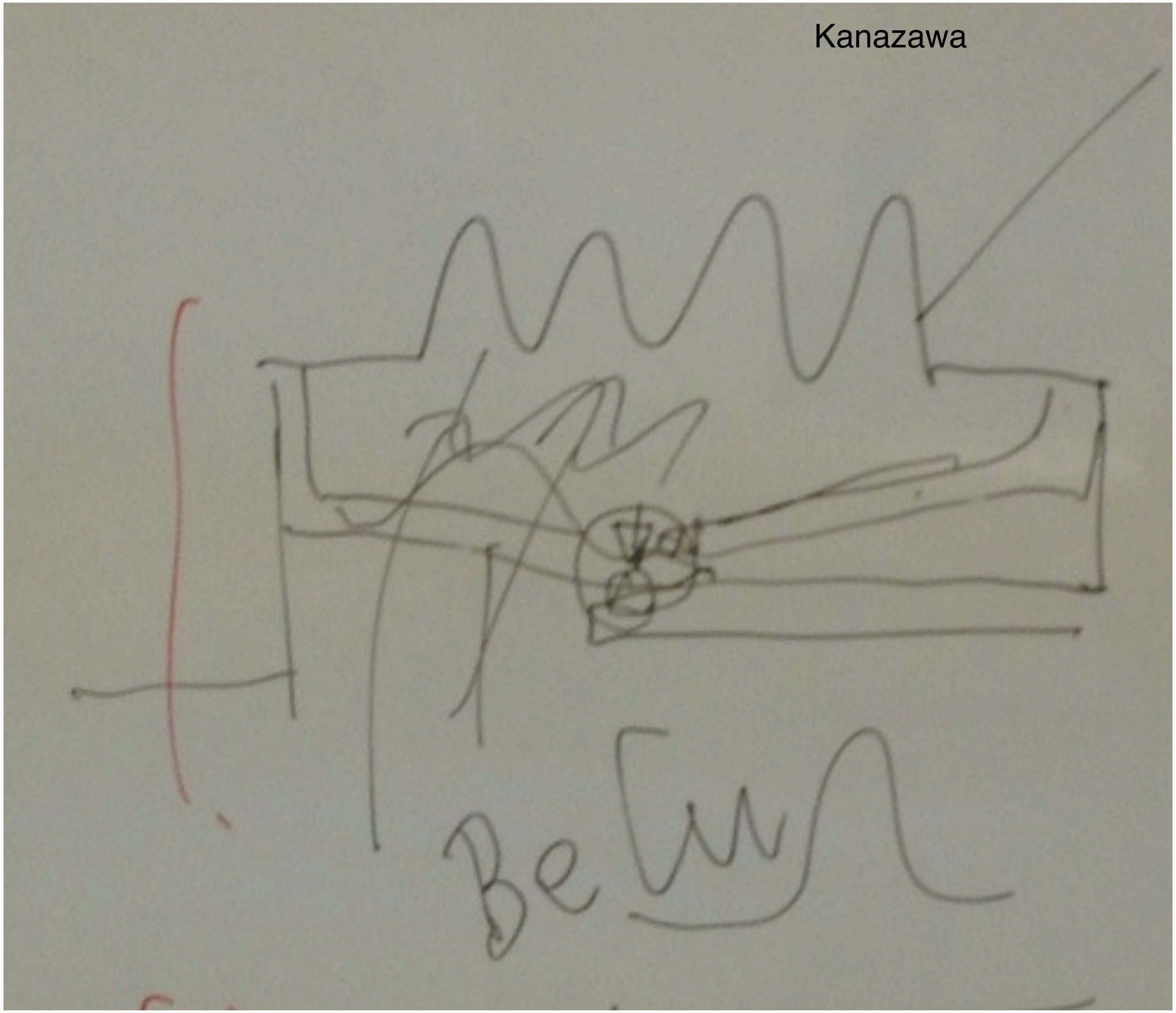
- Target value:
  - SVD cables 30(width)*22.5(height)mm for 15 twist pair sets
  - PXD cable : 9.4mmt
- Measured value:
  - SVD cables **30(width)*17.5(height)mm for 15** and 30*23mm for 20 sets
  - PXD cable : ~9.4mmt

7mmt free space between QCS and CDC on this cable allocation

need to discuss with machine group. Also please keep try to reduce space

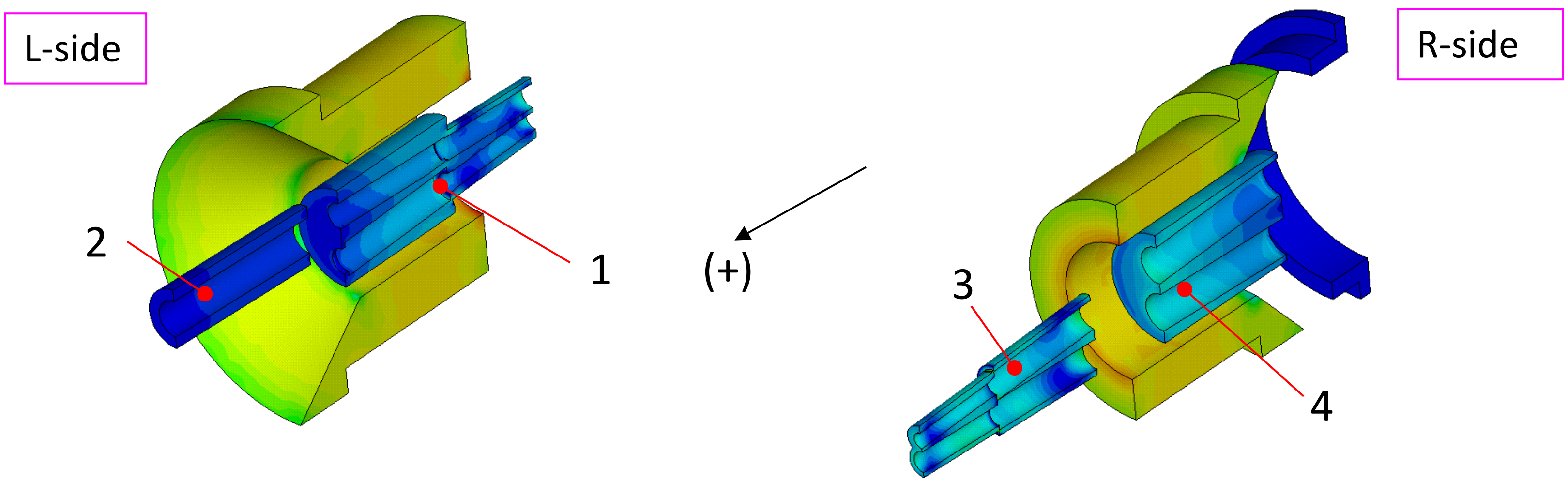
Making pre-bundle set of cables are also preferred before cabling

Bellow and RF Shield



QCS Forces

Electro-magnetic forces on the iron components and solenoids



Electro-magnetic force, kN

	QCSL			QCSR		
	1	Solenoid	2	3	Solenoid	4
Acc. Solenoid ON	-0.81	48.3	-0.05	-1.89	-39.7	8.4
Acc. Solenoid OFF	-60.9	0	-0.15	6.01	0	15.3

<u>The largest EMF for the one He vessel</u>

Magnetic Field Configuration

Magnetic field profile in the Belle II