Wire Scanner Mechanics

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Overview

- Operational Scanners
  - PS and PSB
  - SPS and LHC
  - Wire developments
  - Who does what?
- LIU BWSRA Project
  - SPS prototype from LS1
  - PSB prototype scanner for EYETS
  - Potential PS prototype
  - Series for LS2
  - Who does what?
- Summary and Conclusions

Operational PS and PSB scanners

- PS spares and consolidation
  - 2 spare instruments are ready for installation
  - All scanner bellows were upgraded for 100 kScans before LS1 and scan logs initiated
- PSB spares and consolidation
  - 2 spare instruments are ready for installation (one each of H and V variants) with 2 more under preparation
  - No information on bellows cycles to date (probably installed 2003)
  - Ideally all 8 instruments should be upgraded during EYETS (swap-out with spares), but this is considerable work
  - Tank corrosion issue: One (the worst) tank replaced. Spare chamber available. No other work planned for now

Operational SPS and LHC scanners

- SPS rotary scanners spares and consolidation
  - Complete unit with tank and 2 instruments exists. Some components for other instruments exist. All need renovation (electrical and mechanical) plus verification by VSC
  - No data on bellows cycles to-date or on expected lifetime
  - Ideally, bellows should be re-designed as-per PS and all units changed
- SPS and LHC linear scanner spares and consolidation
  - 2 spare instruments ready for installation. Some components for other instruments exist.
  - LHC bellows for all 8 were upgraded for 40 kCycles during LS1. SPS linear have not been changed and expected lifetime is not known.
  - Ideally SPS linear bellows should be upgraded as-per LHC during EYETS
  - Ferrite aperture in LHC beam 1 scanners was increased during YETS'15-16. Beam 2 should follow in EYETS

Wire developments

- Wire material quality
  - How to validate wires before installation
  - Technical student (Matthew Worthington) working on this upto August 2016
- Wire developments
  - What are the wires we are using today, and how can we improve them
  - Collaboration with Oxford University (4th Year Undergraduate projects)

Operational scanners: Who does what?

- ML
  - Design/manufacture/assemble consolidation and spares
  - Organise and perform machine in-vacuum interventions
  - Change wires in-situ or in lab
- BL (PM)
  - Calibrate scanners
  - Participate in machine in-vacuum interventions (test wires and operation)
  - Organise or perform all activities related to PMs, scintillators, filters, electronics, software, operations

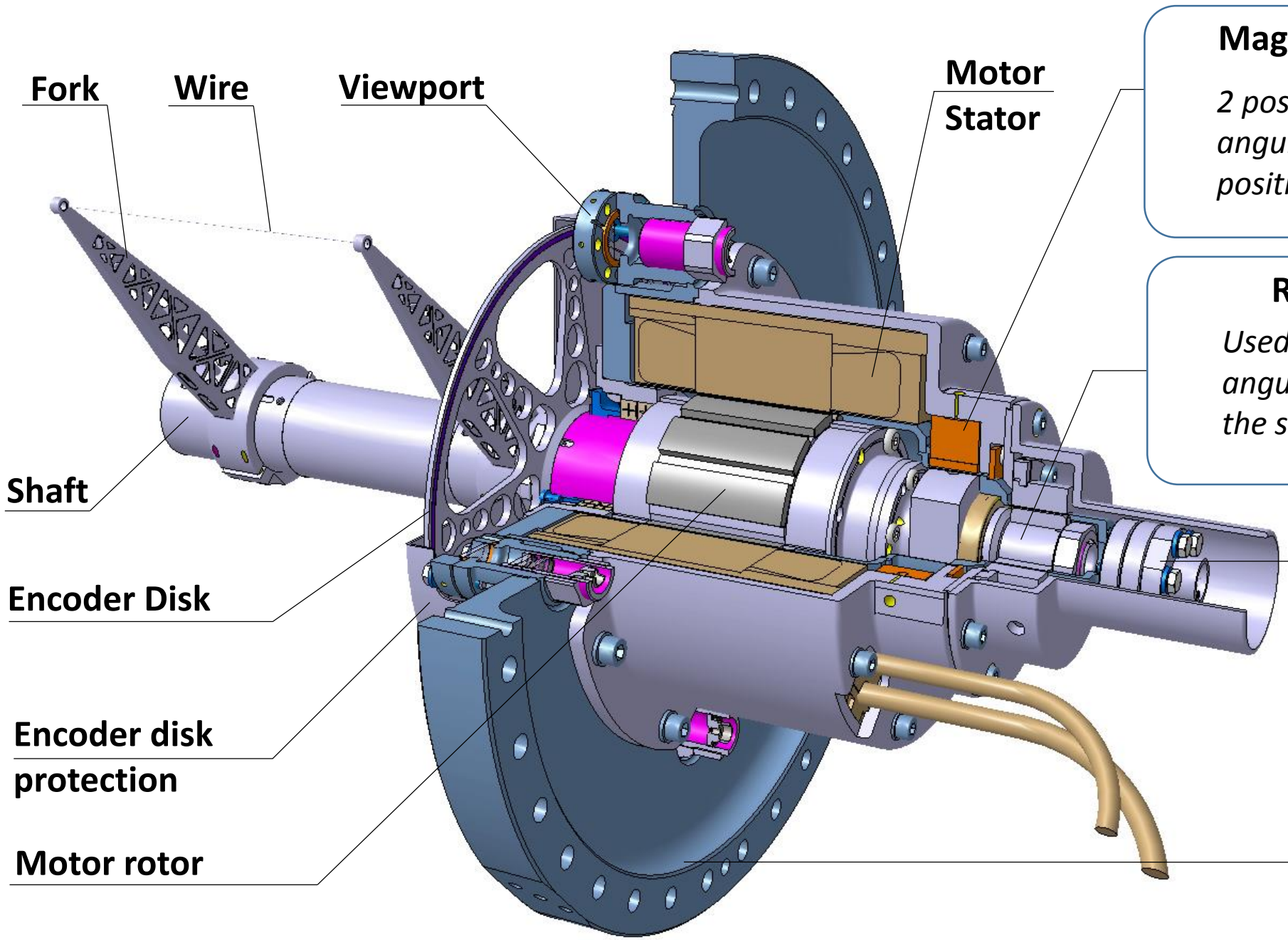
SPS prototype of LIU scanner

- Current status
  - One instrument + tank installed in SPS LSS5: “Prototype-I”
  - One instrument + tank in 867: “Prototype-II”
  - One instrument installed in B.865 test bench
- Activities required by ML
  - Reliability tests and outgassing tests under vacuum and movement
    - Requested 7/8/15, initially planned autumn 2015
    - Needs to take place in B.867 to use VSC equipment and personnel
    - Needs a control system that can be operated independently
  - Will we make Prototype-I operational in the SPS?
    - Testing of impedance and wire in real beam environment

PSB prototype for EYETS

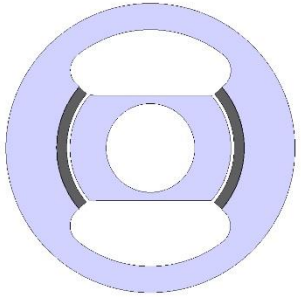
- Current status
  - Design agreed by impedance WG and VSC design meeting
    - Impedance ‘police’ would like to test the prototype
  - All main mechanical parts for 3 instruments + 2 tanks in production
    - Due for delivery 1/8/16
  - Motor qualification in progress
    - The motor qualification was removed from the critical path (by me) to prevent the whole project from becoming delayed. I hope there are no major issues
    - Alxiom ‘standard’ motor, then Alxiom ‘UHV’ motor
    - Motor prototype series procurement will start when qualification complete
  - Other parts (forks, feedthoughs, etc) being prepared for tender
- Next steps
  - 1 instrument + tank reserved for preparation for EYETS installation
  - 1 instrument + tank for test
    - Impedance, reliability, outgassing, ++
  - 1 instrument for lab and control system testing

New fast wire scanner for PSB. Engineering Design



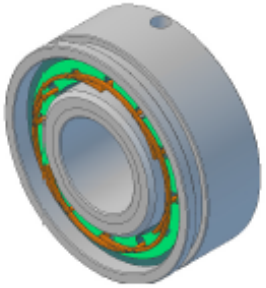
Magnetic Brake

2 possible "home" angular shaft positions



Resolver

Used to measure angular position of the shaft



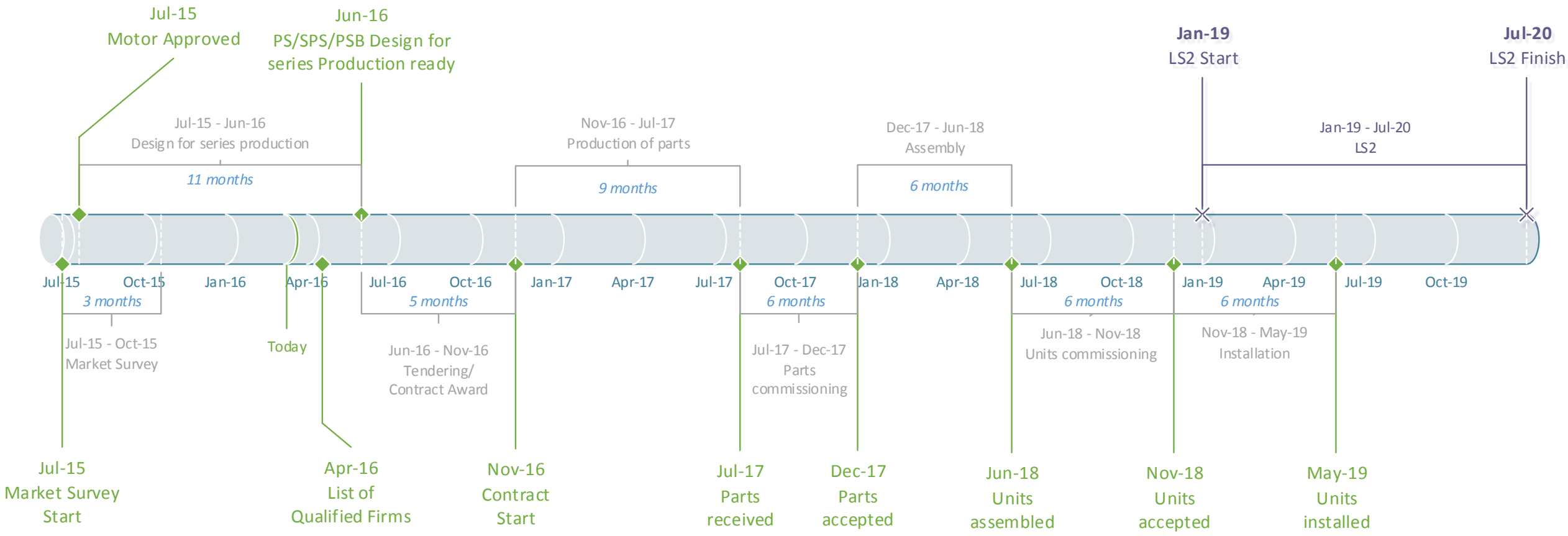
PS prototype of LIU scanner

- What is the status of this request?
  - Re-iterated during BI days, but I have not seen an formal request
  - No budget estimate has been supplied to LIU
- Work required
  - Design and integration of a vacuum tank in the PS
  - ECR and other documentation
  - Re-evaluation of the design by the impedance WG
  - Some re-design of the PSB scanner (forks, shaft, assembly drawings)
  - Production, assembly, qualification, cabling etc
- Schedule?
  - Realistically, could be done during YETS 17-18 if manpower available
  - Would be very good to benefit from experience with PSB prototype

Series for LS2

- Context
  - We will need a series of ~20 instruments + tanks (3 different designs) ready for installation early 2019
  - Assume no new instruments in the LHC during LS2
  - Assume ‘old’ instruments should remain in place and operational after LS2
- Production strategy
  - Produce main mechanical parts with MME (in-house and subcontracting)
    - MME are aware and keen, but would like to start ASAP
  - Other parts + assembly by ML
    - Fellow request for November 2016 board plus FSU from 2018

New fast wire scanner for LIU. Series production Planning



LIU scanners: Who does what?

- ML
  - Mechanical design, production, assembly, mechanical and vacuum test
  - All components on the instrument, except for ex-vacuum optics (Jose) and resolver (Jonathan)
  - Technical specification (?), ECR, integration into machines,
- BL/PM
  - Calibrate scanners
  - Participate in installations (test wires and operation)
  - Organise or perform all activities related to PMs, scintillators, filters, electronics, cabling, software, operations
  - Provide a control system for reliability and vacuum tests and make acceptance tests on series motors
  - Provide design input for: patch panels mounted on-instrument, test and calibration mechanics,

Summary for operational scanners

- Lots of consolidation work required
  - All 8 PSB scanners need upgrading with new bellows. When do we do this?
  - Do we leave the PSB corrosion as-is, or do more work?
  - SPS rotary scanners need spares assembly and qualification plus upgraded bellows
  - SPS linear scanners need upgraded bellows
  - LHC linear scanners need ferrite upgrade for beam 2
- Next steps for consolidation?
  - Budget exists (Critical spares – this is priority #1)
  - Manpower very limited in ML – extend/re-prioritise the FSU?
  - What are our priorities?
- Collaboration with other sections
  - Generally works well from the ML perspective
  - All agree that operational scanners are the priority

Summary for LIU BWSRA project

- Status
  - Mechanics currently on-track for PSB and series production
    - Approval from VSC and impedance (for the PSB version)
  - Design of the encoder disc is advancing and collaboration here working very well with Jose
  - Motor qualification is in progress – we are (optimistically?) assuming that there will be no problem…
  - Installation in the PS is currently not baseline or resourced
- What we need
  - An operating control system for the SPS ‘Prototype-II (and then for the PSB proto)
  - Link people for electrical design, control and testing with time to commit to the project
  - Programme for qualification of performance (precision, impedance heating…)

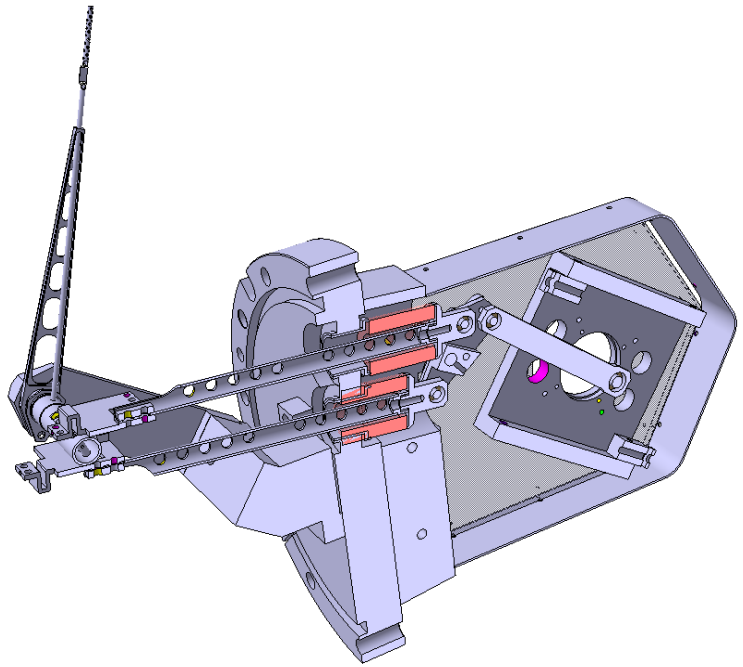
General conclusions

- For the operational scanners, the collaboration between sections generally works well.
- There are a number of ‘accidents waiting to happen’ for operational scanners that require mainly missing ML manpower to resolve
- For the LIU project, we need much more support from the electrical/electronics side, or we will not meet the schedules for EYETS and LS2
- This is a very high profile project for BI with extended time needed for manufacture and qualification. We must commit the resources now to ensure success in 2019.

Backup Material

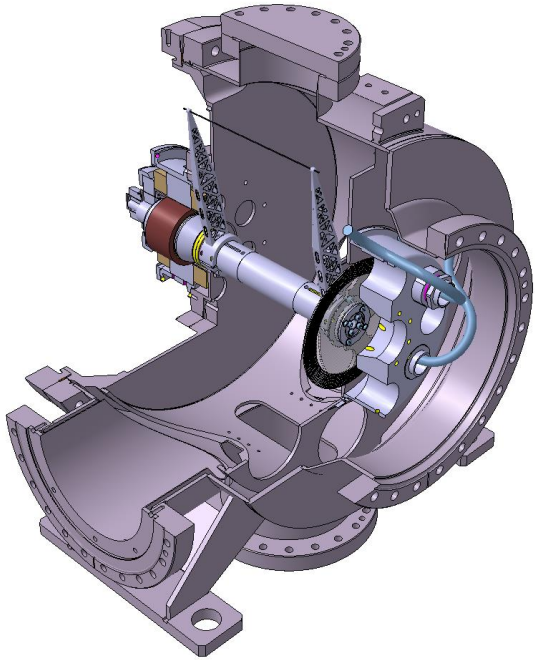
Fast Wire Scanners at CERN

Wire scanners currently in use



- motor which is mounted outside the vacuum pipe
- motion is then transmitted through bellows
- inaccuracies due to the relatively complex mechanics

SPS BWS Prototype (2014)



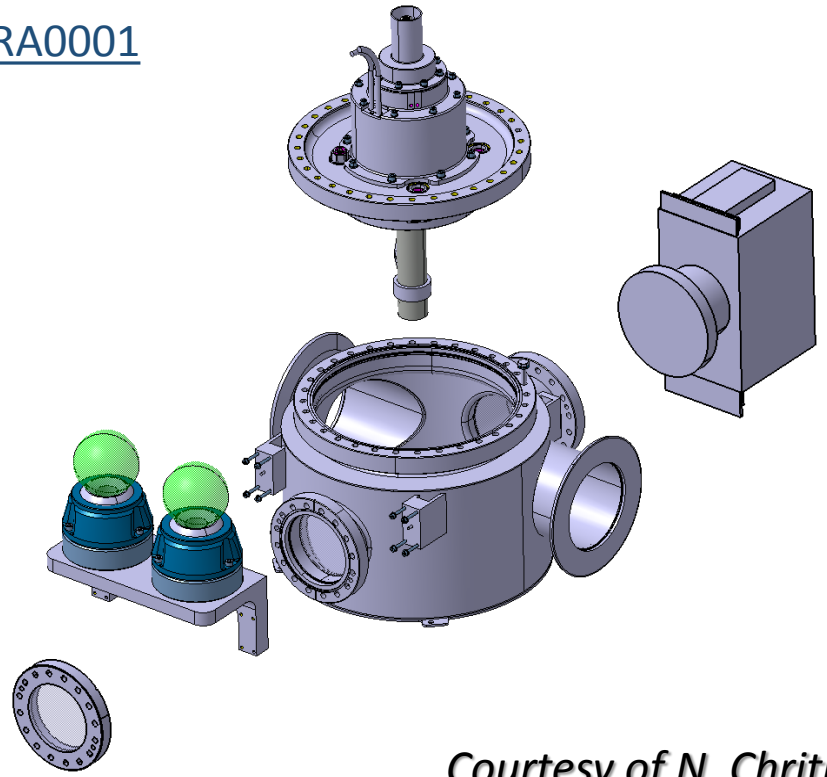
- motor with vacuum compatible rotor
- no bellows
- two supports for the shaft which leads to drum-based design, complicated and expensive for production

New fast wire scanner for PSB

Comparison with previous Beam Wire Scanners:

- Direct drive (no bellows used)
- Compactness
  - biggest vacuum flange CF273 (CF400 for SPS type)
- Weight
  - 17 kg kinematic assembly (SPS type ~40 kg)
  - 23 kg tank (SPS type ~50 kg)
- No optical fibers or lenses inside vacuum volume

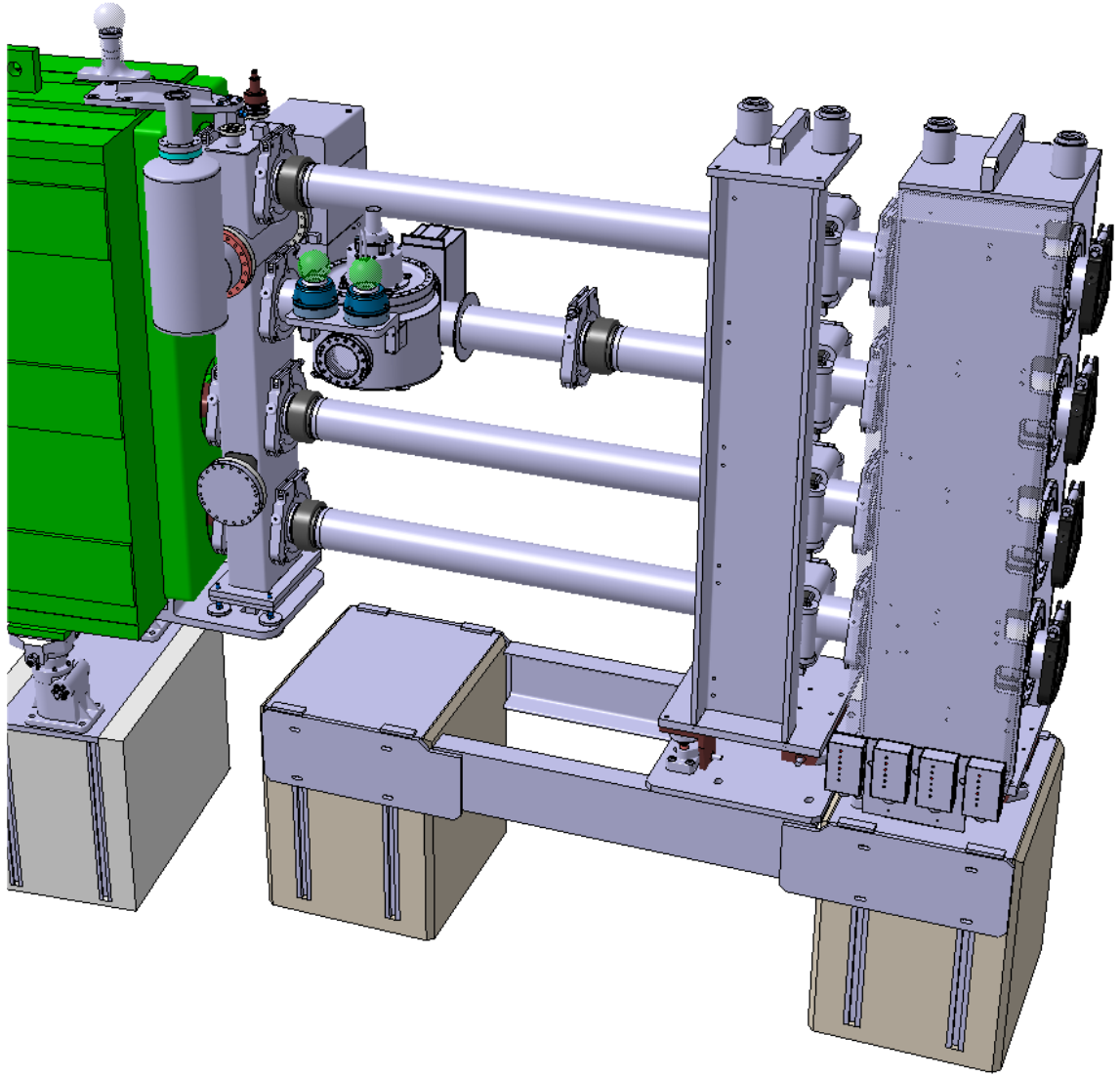
CDD: PSBBWSRA0001



Courtesy of N. Chritin

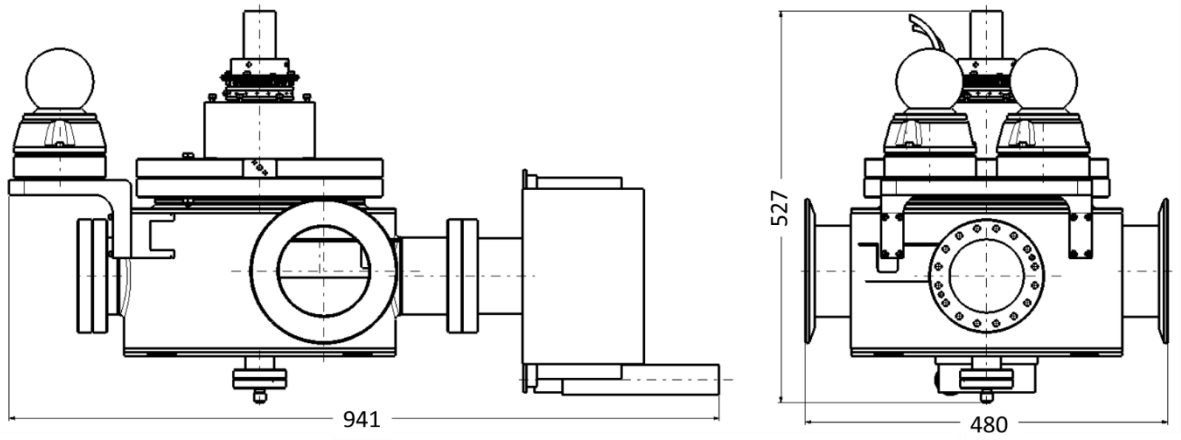
First Prototype in the PSB

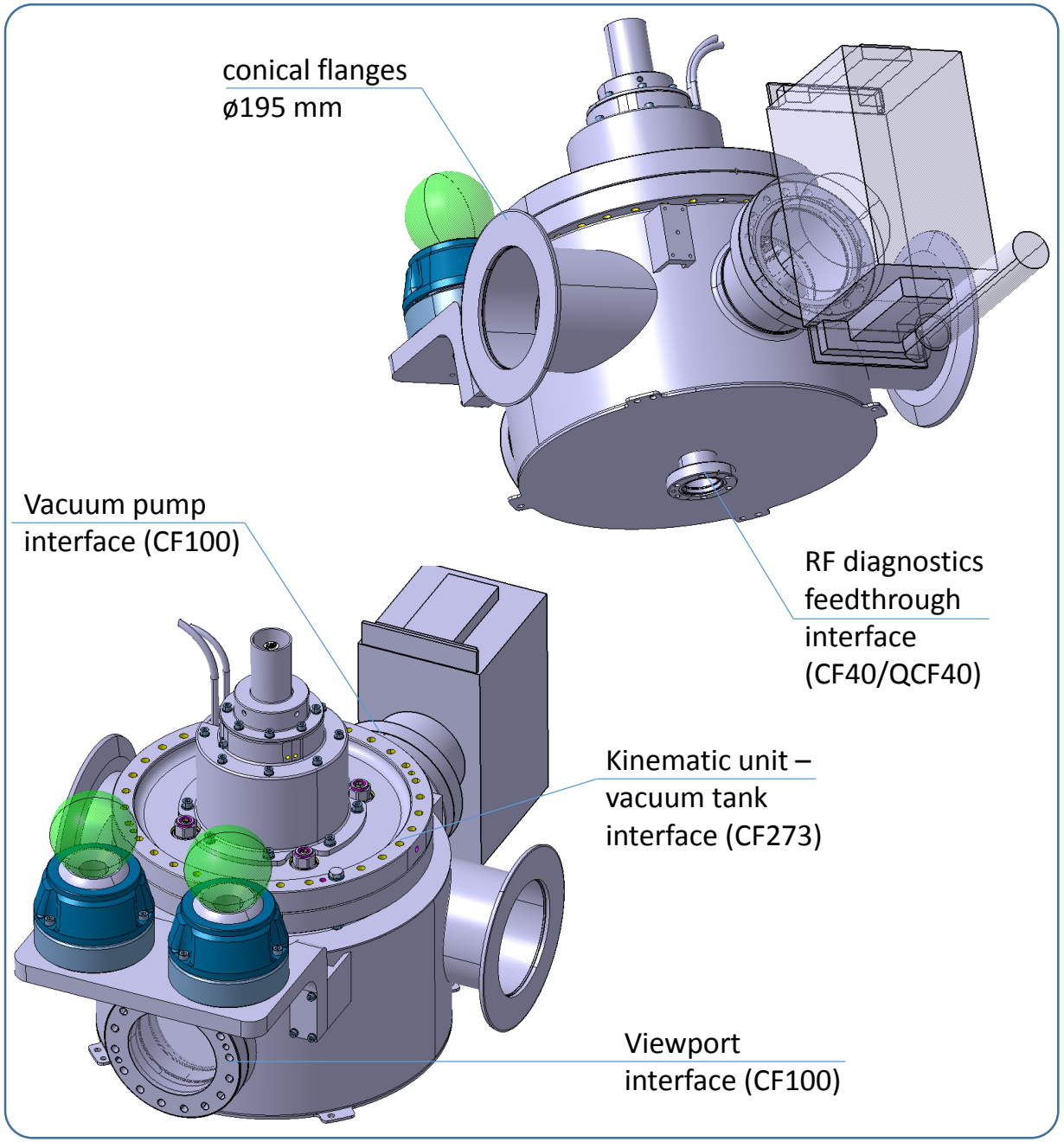
PSB 4L1



New fast wire scanner for PSB. Engineering Design

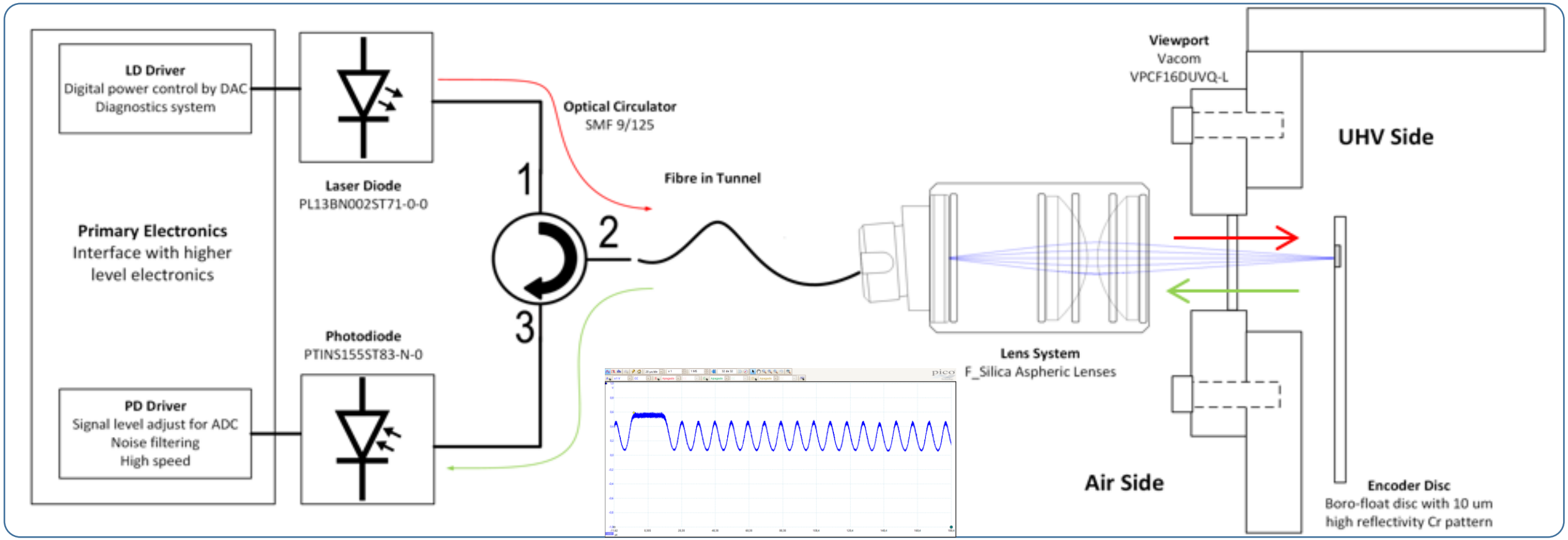
- The kinematic subassembly unit is designed so that it can be integrated in the following machines: PS, SPS, PSB
- First prototype will be installed in PSB Sector 4L1 line 3
- Beam scans in horizontal plane
- Kinematic unit – vacuum tank interface (CF273)
- Viewport interface (CF100)
- Vacuum pump interface (CF100)
- RF diagnostics feedthrough interface (CF40/QCF40)
- Beam Pipe interconnections – conical flanges ø195 mm





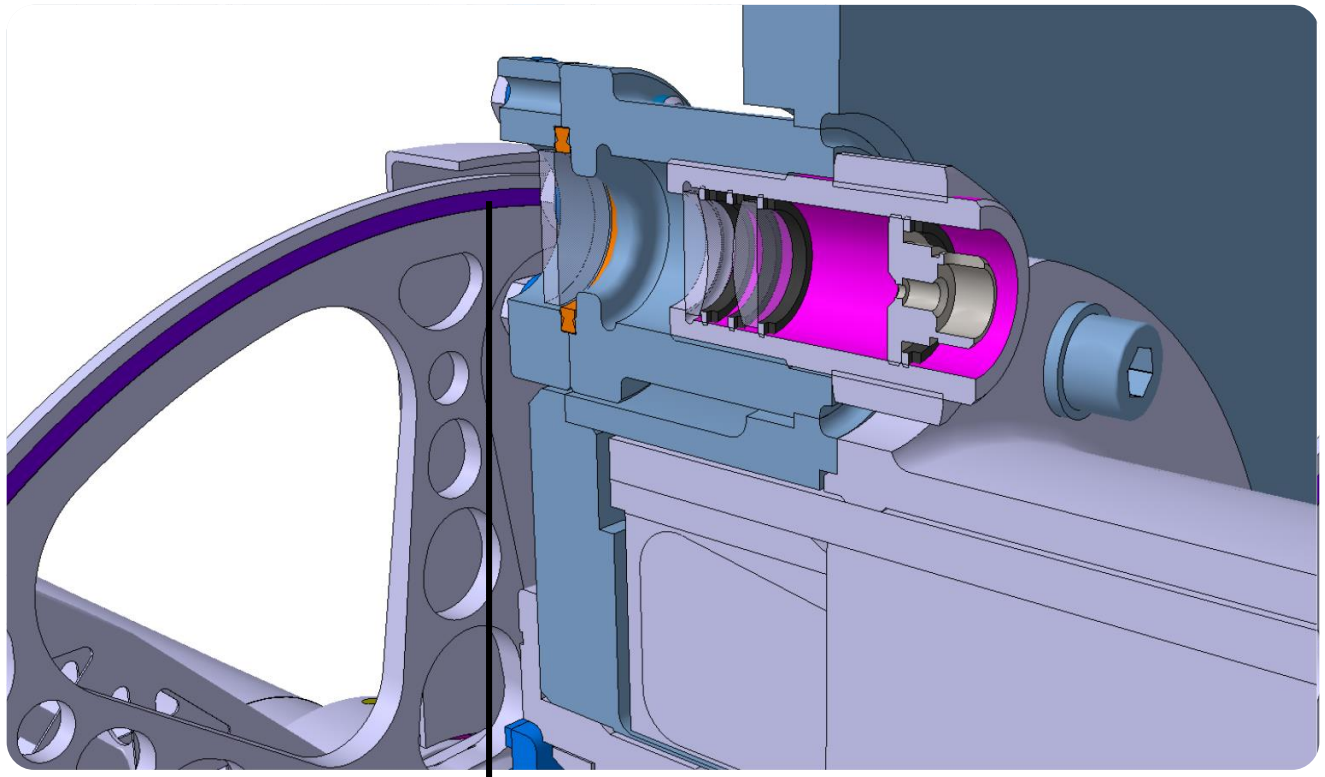
Shaft Angular Position Measurements. Optical Position Sensor

- 1310nm continuous wave laser located on the surface
- Lens detector system, located in the tunnel (link of Single Mode Optical Fibre)
- Encoder disk (located in vacuum), contain a track, around its circumference, with a pattern of alternated reflective/non reflective slits
- UHV viewport
- Focused spot of light of 20um
- Optical system is able to recover the reflections produced by the slits and couple it back to the fibre optic
- Reflections are sent back to the surface and directed to the system photodiode (thanks to the optical circulator)

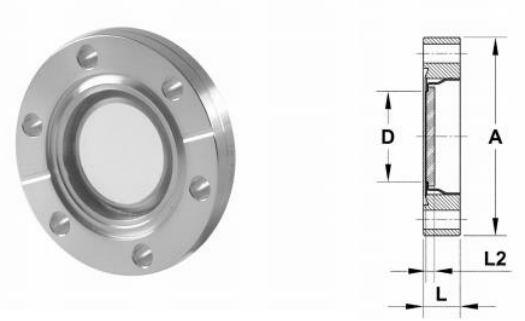


By courtesy of J.L. Silvent Blasco

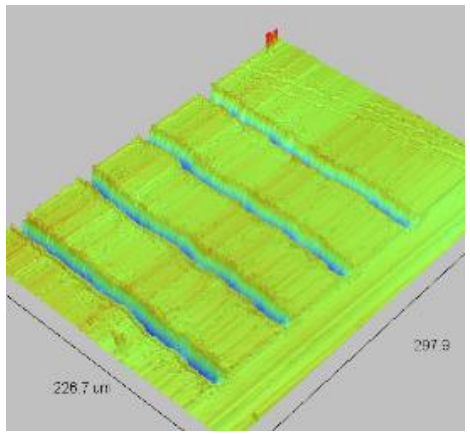
Shaft Angular Position Measurements. Optical Position Sensor

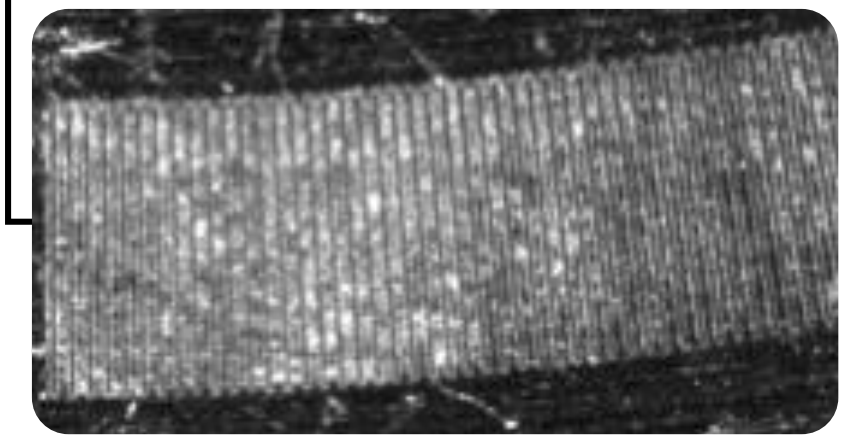


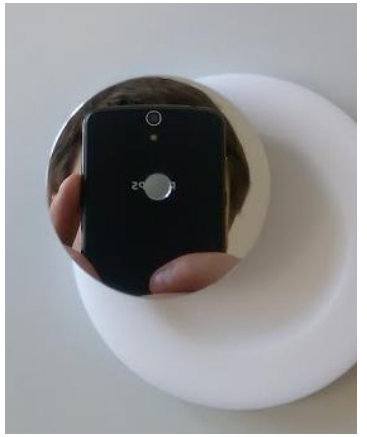
- Optical disk made of Aluminium for lower inertia
- Slits made by laser engraving
- Lens system and optical fiber are located outside the vacuum volume
- Focal distance adjustment possibility by means of fine pitch thread
- Bakable up to 200 ^{o}C



Very good roughness is required on the encoder disk face: Ra0.025







Status / Planning

- All the drawings for main parts are released except assemblies
- Job request submitted, fabrication planned to be finalized by summer 2016
- After fabrication is completed 3 kinematic units will be assembled + 2 vacuum tanks
- Fabrication starts in March 2016