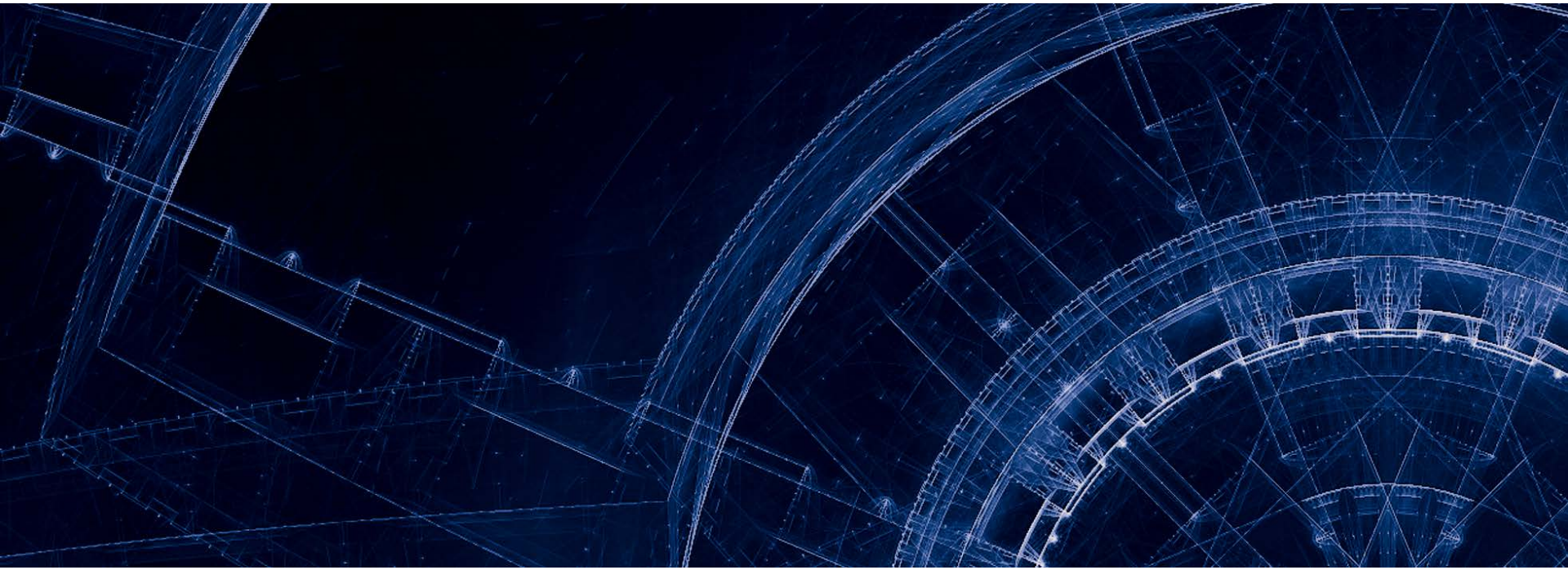
November 2017



WHT Corrector System
FDR - MRR

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Agenda - 30th November 2017

Session	Time	Subject	Lead
00	08:30-08:45	Arrival and welcome	
01	08:45-09:00	Introduction, Project overview and review context	G.Dalton and/or D.Abrams
02	09:00-09.30	Closed Panel Session	P. Doel
03	09:30-12:00	PFC integration and alignment and other issues (23, 26, 32, 41,45, 51-55, 72, 73, 81, 35,30, 19,17)	M.Canchado
	12:00-12:15	Break	
04	12:15-13:15	Stray light results and Optical issues (4, 27, 29, 56, 60)	E.Lhomé
	13:15-14:15	Lunch	
05	14:15-15:15	Schedule & critical issues (50, 57, 58, 80,70)	F.Dalmases
06	15:15-16:00	NCR process, Lens inspection (65, 66)	B.Carceles, D.Gil
	16:00-16:15	Break	
07	16:15-17:00	Closed Panel Session MRR	P. Doel F.Dalmases
08	17:00-17:30	Feedback and Recommendations, Close	P. Doel

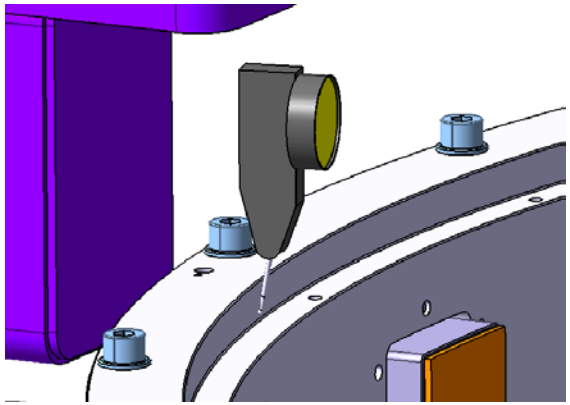
PFC integration and alignment and other issues

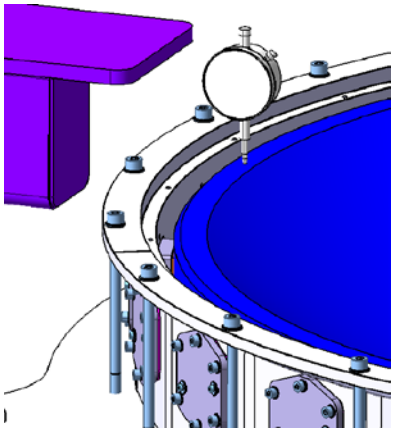
Key	Summary	Description	Comments	
			Author	Text
WEAVEWCSFDR-23	Lens lifting sequence	Pg83 step 2: I think this step should be carried out after step 4. It is safer to lift the lens only when needed. This applies to step 31 (L3 assembly) and step 48 as well.	Francesc Dalmases	Not clear to move the step. Fliping will take time and so requiring two manipulations to prevent curing of pads glue.
			Paul Jolley	open The point I'm trying to make is that you need to apply the primer, wait 30 mins, apply the RTV to pads, place pads in cell and finally adjust the screw jacks all before lowering the lens. So it makes sense to lift the lens only when you have somewhere safe to put it down.

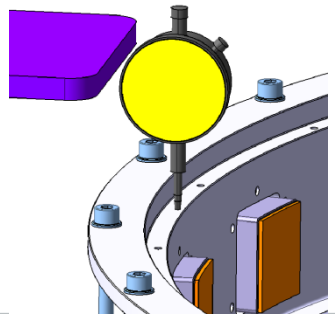
To further discuss. Maybe we can lift the lens and put it on a safe support while installing the pads to minimize risks.

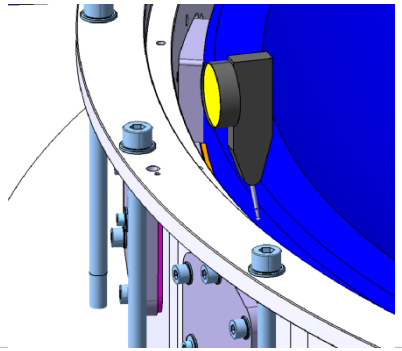
PFC integration and alignment and other issues

Key	Summary	Due Date	Description	Comments	
				Author	Text
WEAVEWCSFDR-26	Gauge mounting		Pg94 step 16/17: Can you show how the gauges are mounted on the L1 cell? I'd like to see where they are mounted/grounded and where they are picking up on the lens or cell.	Francesc Dalmases	This is presented in section 6,7
				Paul Jolley	Open - just for comments Section 6.7 does indicate the gauge positions, but only symbolically. What I'd prefer to see is a model of the actual gauge on the structure to better see what is happening and how much space is needed.





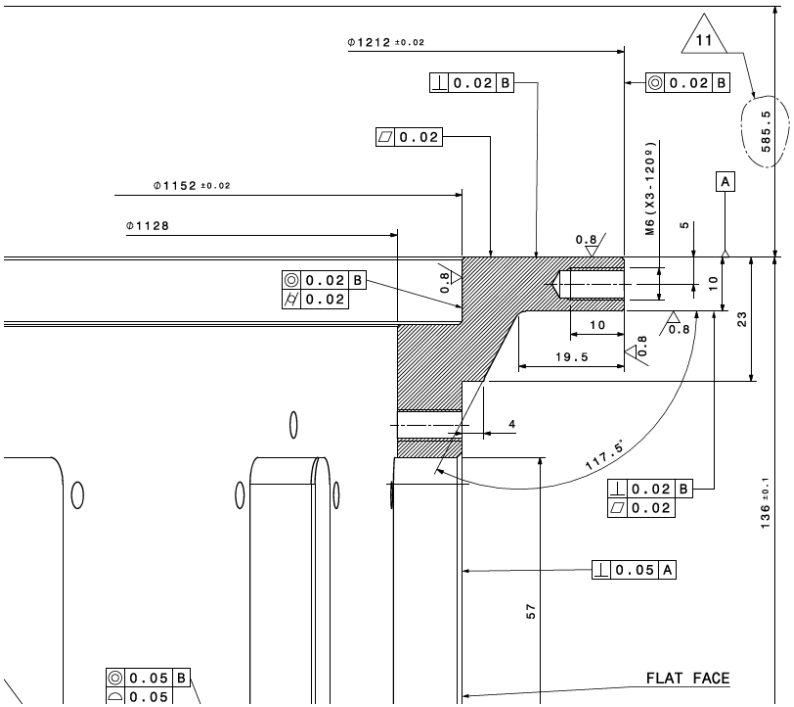




PFC integration and alignment and other issues

Key	Summary	Due Date	Description	Comments	
				Author	Text
WEAVEWCSFDR-30	Missing picture/information on mechanical references		Pg111 step 39: There is no picture showing the mechanical references (step 56 as well). Need this to determine if this step is OK. This also applies to step 40 - to determine what the gauges are actually measuring.	Francesc Dalmases	OK to include details. Document will be updated
				Paul Jolley	Open Would just like to see/review the picture before closing this action.

Example for L1



PFC integration and alignment and other issues

Key	Summary	Description	Comments	
			Author	Text
WEAVEWCSFDR-32	Gear centring requirements?	Pg129 step 63: Does the gear need centring to ensure consistent tooth engagement?	Francesc Dalmases	This has been previously determined using shiming for the pinion
			Paul Jolley	Open Shimming the pinion sets the tooth engagement at one position of the crown gear. If the crown gear is eccentric then the tooth engagement will keep changing. The question is whether changing tooth engagement affects the performance and if so by how much?

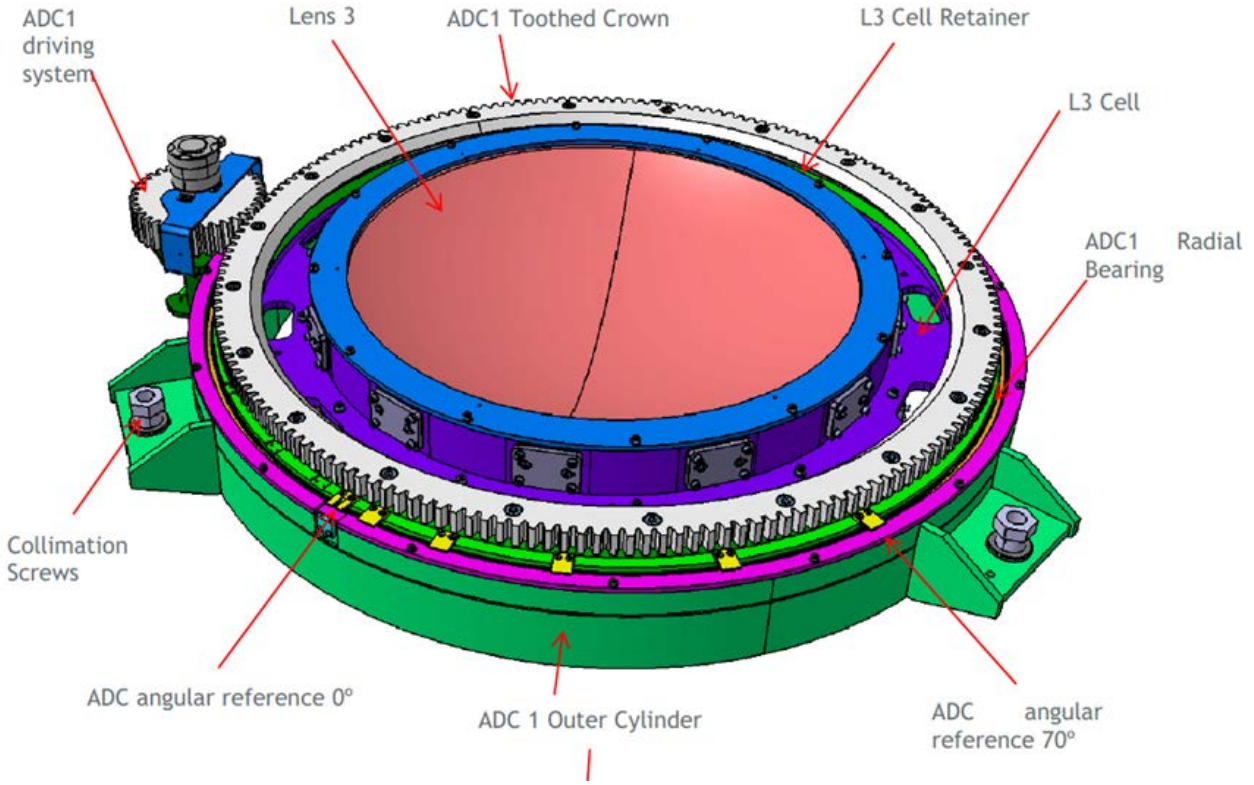
The effect of eccentricity is negligible. Requirement is 0,1º:

- Crown eccentricity estimated 0,2mm + radial runout bearing 0,02mm. Total 0,22mm => 0,028º
- Pinion eccentricity estimated 0,1mm + radial runout bearing 0,05mm. Total 0,15mm => 0,03mm on the crown due to gear ratio => 0,003º
- Pininion pitch error 0,043mm =>0,005º in the crown
- Crown pitch error (estimated): 0,2mm =>0,026º
- Total error (RSS) = 0,038º

On top of that the rotation accuracy will be calibrated

PFC integration and alignment and other issues

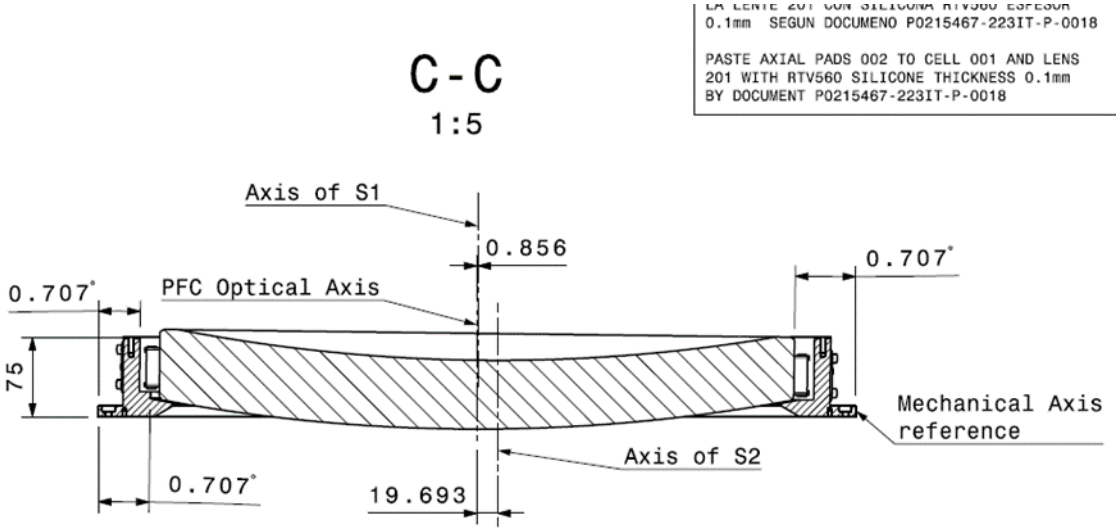
Rotation accuracy will be measured / calibrated



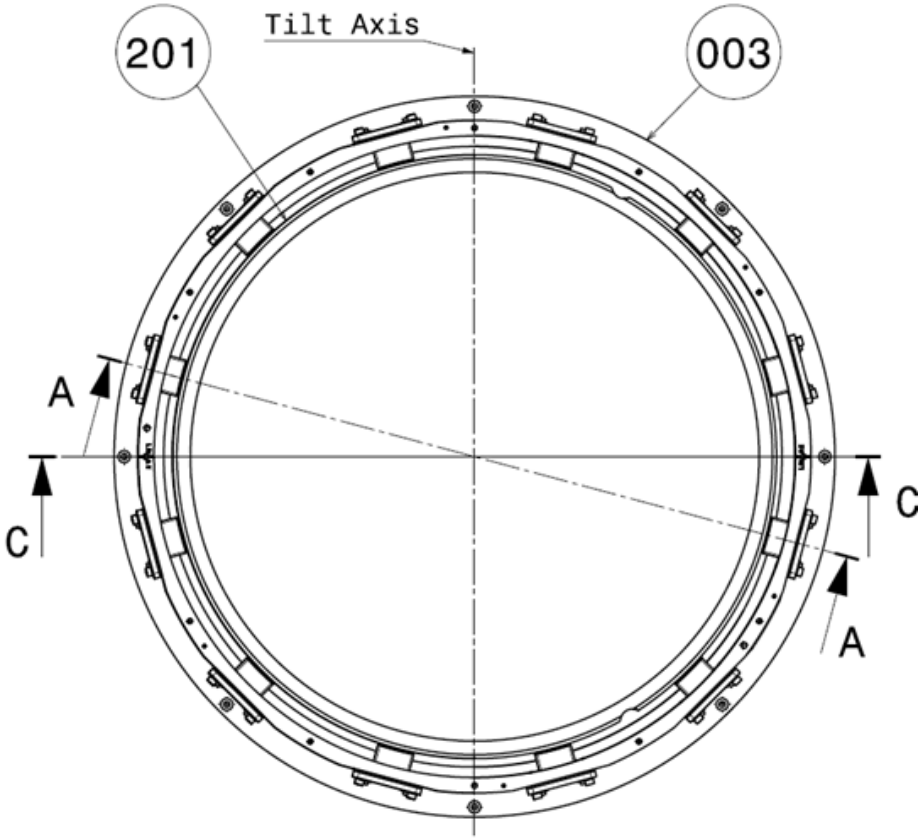
PFC integration and alignment and other issues

Key	Summary	Due Date	Description	Comments	
				Author	Text
WEAVEWCSFDR-35	L4 tilt centre		Pg145 step 86: It is difficult to see where the centre of rotation (tilt) of L4 is from the manufacturing drawing. Can you please provide a sketch so I can check this?		I think the best is the information included in the L4 manufacturing drawing, which is gernerated by ING
				Francesc Dalmases	attahced
				Paul Jolley	Open The drawing you refer to details where the center of rotation should be. What I'd like to see is a sketch of the lens in the cell with an indication of where the center actually is in the final design. Is the lens tilted about the correct surface/point while maintaining it's axial alignment? This is just to double check that everything is OK.

The drawing is updated. Clocking tolerance L4 to L4 Cell to be defined:

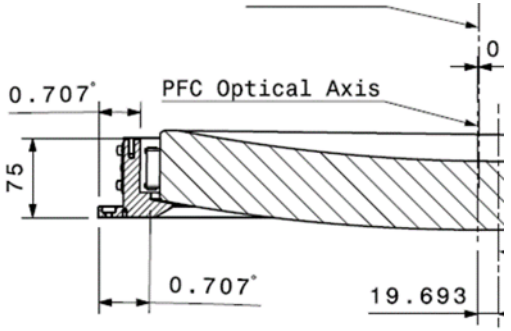


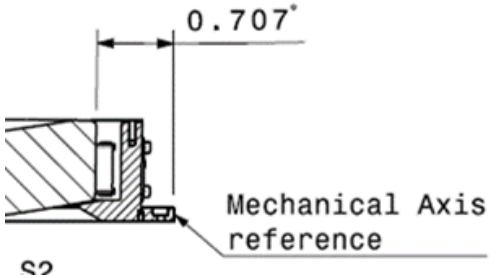
PFC integration and alignment and other issues



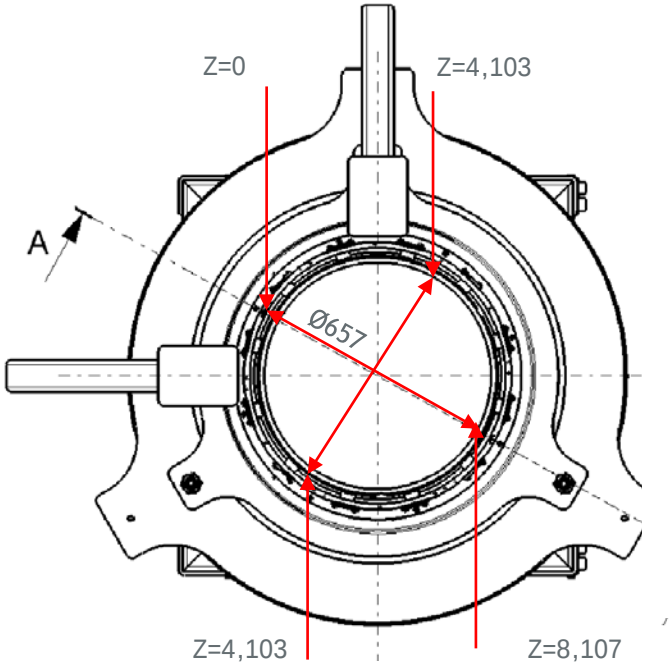
PFC integration and alignment and other issues

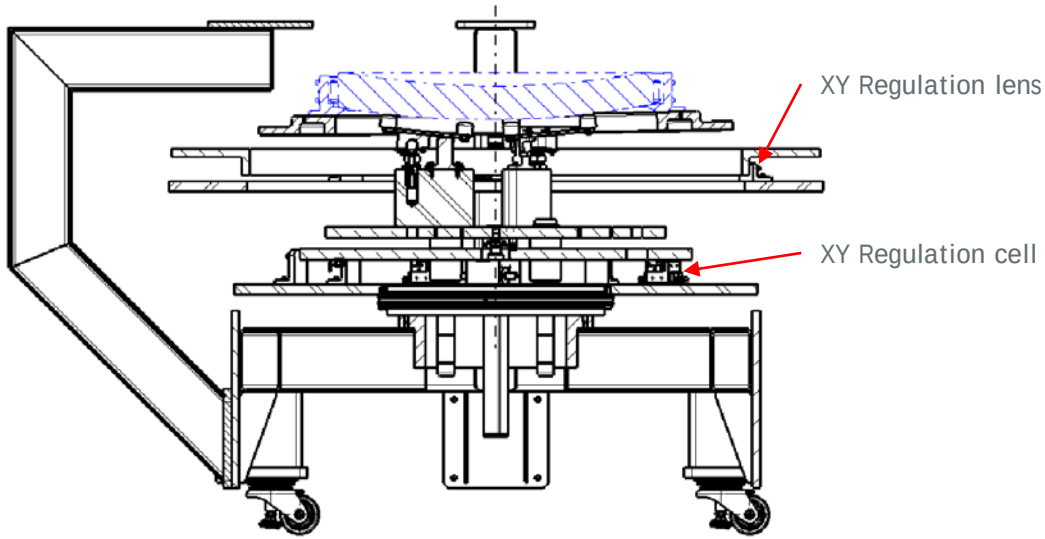
L4 Alignment process:
1- Tilt the L4 cell in the rotary table to have the inner diameter parallel to rotary axis (8mm approx. of height difference).
2- Center the L4 cell using its internal diameter
3- put the L4 inside and do the radial and axial alignment vs the rotary table: Its outer cylindrical surface shall be parallel to rotary axis and the flat surface of L4S2 perpendicular to rotary axis.
4- L4 cell is previously measured to check that the tilt for the surface to L4 is correct vs its mechanical reference (outer diameter)





PFC integration and alignment and other issues

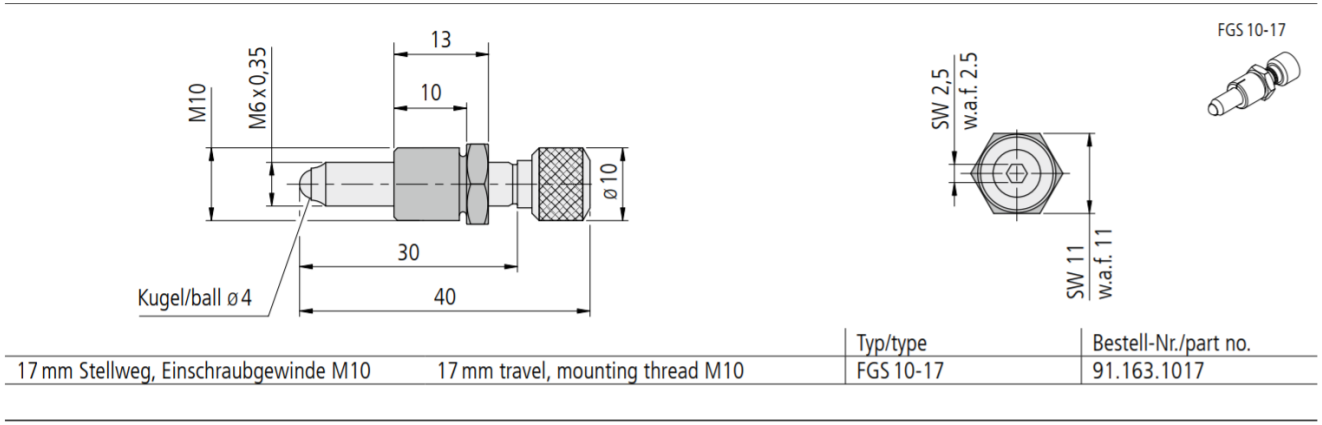




PFC integration and alignment and other issues

Key	Summary	Description	Comments	
			Author	Text
WEAVEWCSFDR-41	Adjustment resolution/accuracy	Pg81: Can you please provide details on all the adjustment screw resolutions and how they compare to the alignment requirements.	Francesc Dalmases	pitch is 0,5mm so 15º is 20 micron.
				Open Can you provide a table stating all the adjustments (both translations and tilts) and how this resolution compares to the required alignment tolerances/resolution?
			Paul Jolley	

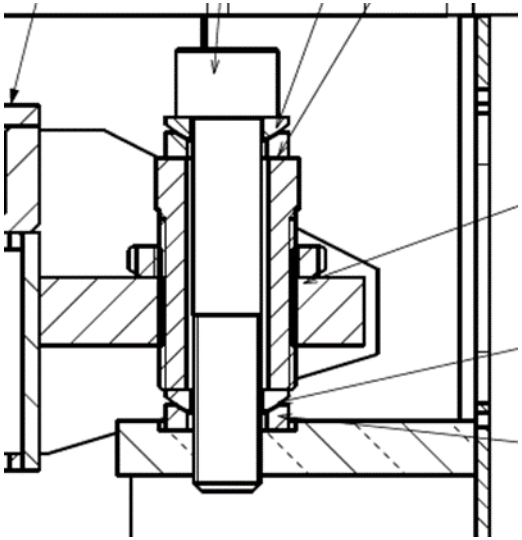
XY adjustment for ADC1, ADC2 and L6 vs L1 is OWIS FGS 10-17. 0,35mm pitch. 10º rotation is 10 micron < 45 /50 micron

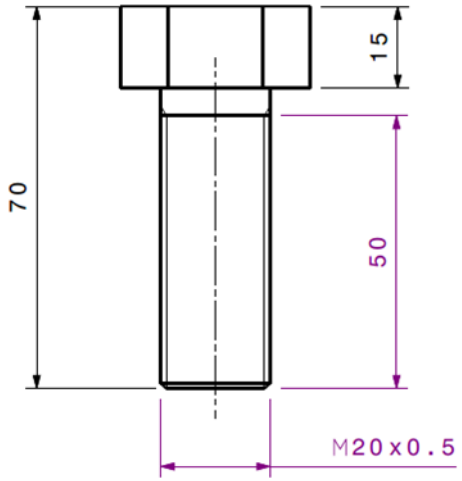


		Typ/type	Bestell-Nr./part no.
17 mm Stellweg, Einschraubgewinde M10	17 mm travel, mounting thread M10	FGS 10-17	91.163.1017

PFC integration and alignment and other issues

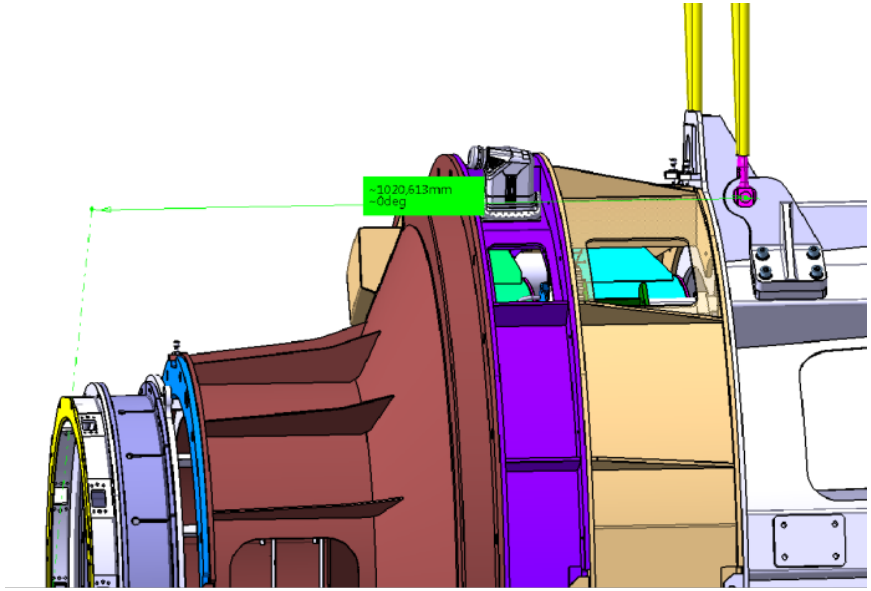
Z adjustment (piston and tip tilt) for ADC1, ADC2 are M40x0,5mm and L6 vs L1 is M20x0,5mm pitch. 10º rotation is 14 micron < 25 (L6) /50 (the rest) micron.
Option to reduce down to 0,25mm the pitch for L6 collimation screw to provide better adjustment capability.





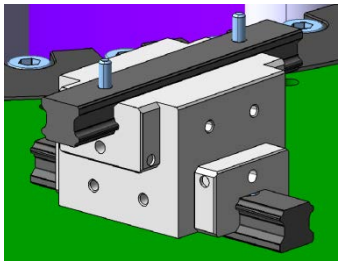
PFC integration and alignment and other issues

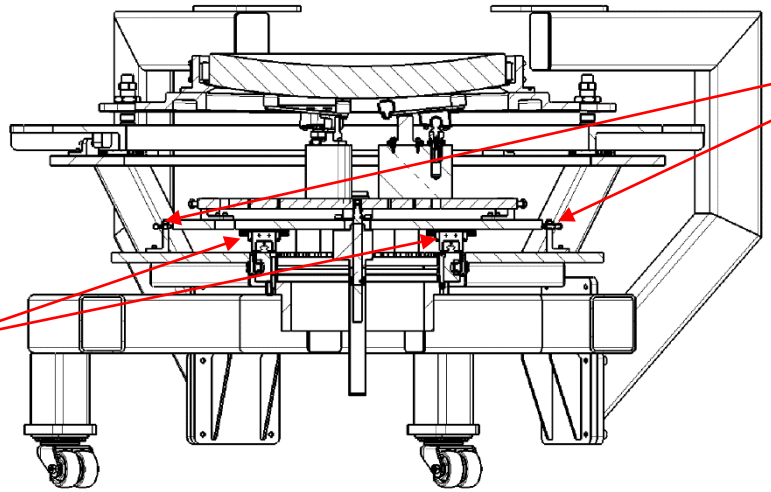
Key	Summary	Due Date	Description	Comments	
				Author	Text
WEAVEWCSFDR-45	Safer lifting of WCS		Pg125: Lifting the WCS horizontal using just 2 points as shown does not seem to be a good idea. There is a danger of the WCS rotating. Can you use a third point to prevent this?	Francesc Dalmases	the lifting is at the center of gravity, no risk for flipping
					open The center of the lifting points are 58mm from the CoG (1080-1022). This would result in a 1700*9.81*0.058 = 967Nm out of balance torque IF the estimate of the CoG is correct. In fact, the requirement is for the CoG to be at 1017 from L6S2 which makes the out of balance torque even worse. Please show how you intend to lift in more detail. How will you adjust the lifting points to balance the WCS sufficiently to move it safely?
				Paul Jolley	Could you tell me when and how often a horizontal lift is carried out? Maybe there's no issue.....



PFC integration and alignment and other issues

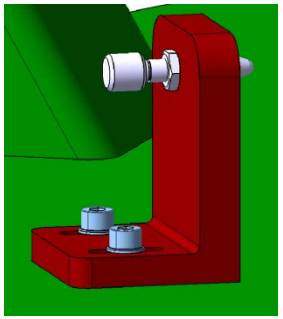
Key	Summary	Due Date	Description	Comments	
				Author	Text
WEAVEWCSFDR-51	Cell support on alignment table		How is the XY baseplate (for the cell) supported on the alignment table – I can't tell from the figures.	Francesc Dalmases	We can include more detail in the procedure
					I would like to see this at the meeting.
			The cells are bolted to the cell tilt adjust plate – what is the expected distortion of the tilt plate as it support at three points (coupled with distortion of XY plate below). This is an issue as it will feed back to the axial support heights as the cell is clamped to the support.	Peter Doel	





LINEAR GUIDE XY

MICROMETRIC SCREW



PFC integration and alignment and other issues

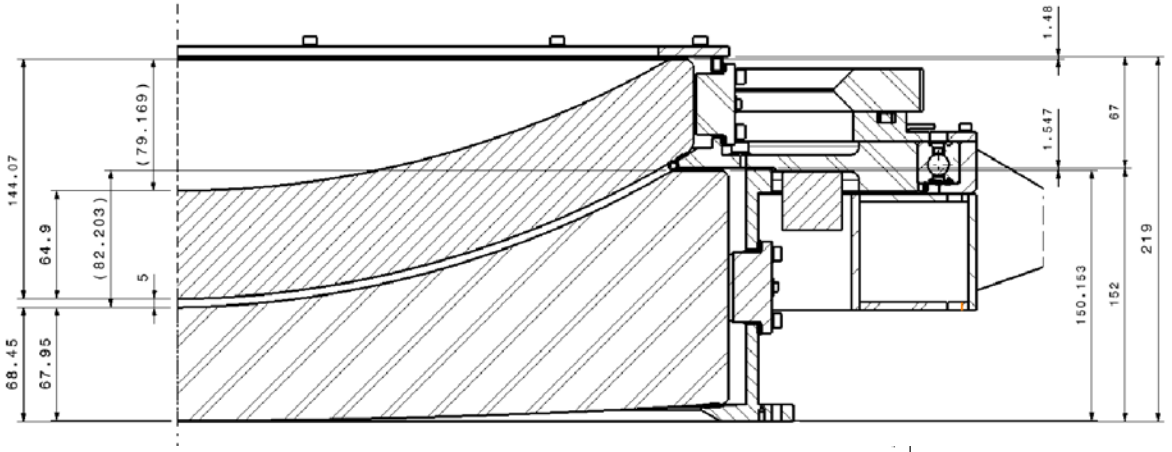
Key	Summary	Description	Comments	
			Author	Text
WEAVEWCSFDR-52	L1 vertex measurement page 93	Page 93 shows the measurement of the L1 cell base (top surface) to the L1 lens flat - the text states this gives distance to L1 vertex - how is the vertex distance calculated? (is there a previous lens measurement stage?)	Francesc Dalmases	we plan to use the measurements performed on lenses. Yes, we plan to measure it previously. To be clarified in the procedure
				I would like to go over this in the meeting as it is a key point. In fact the whole alignment procedure should be presented.
		The vertex seems to be referenced from the top surface of the cell flange - when the alignment of the full assembly is done with the laser tracker the reference is the underside of the cell flange - the difference is recorded in the previous cell metrology report?		
		Can you clarify the specification of the flatness of these cell surfaces?	Peter Doel	

This information is taken from lens as-built manufacturing drawings

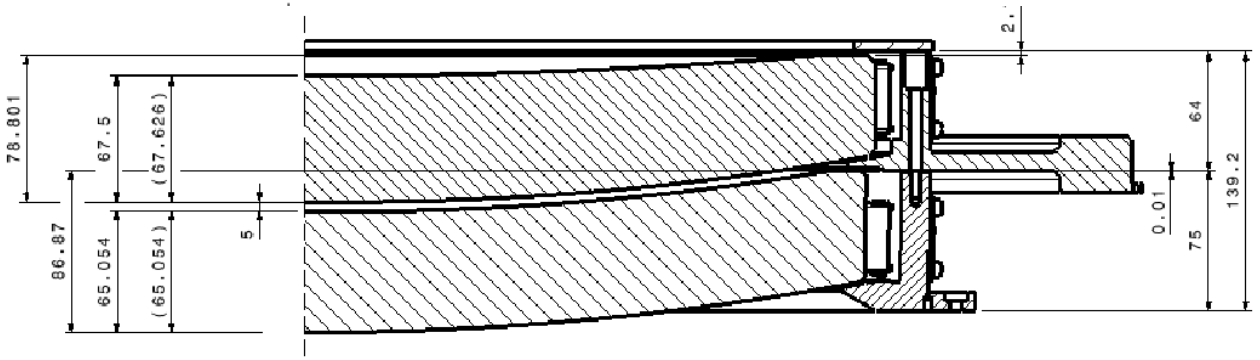
PFC integration and alignment and other issues

Key	Summary	Due Date	Description	Comments	
				Author	Text
WEAVEWCSFDR-53	Separation of Lenses in ADCs		Can you clarify how the correct spacing of L2 to L3 and L4 to L5 in the ADCs is confirmed/measured and adjusted?	Francesc Dalmases	This is to be done by measuring the lenses
				Peter Doel	More detail is needed on this procedure

ADC1: measuring distances between L2 and L3 to their cells in axial we can estimate the spacing between L2 and L3 according their manufacturing as built info. Additional machining or shimming would be required but this can be previously estimated using the dummies.



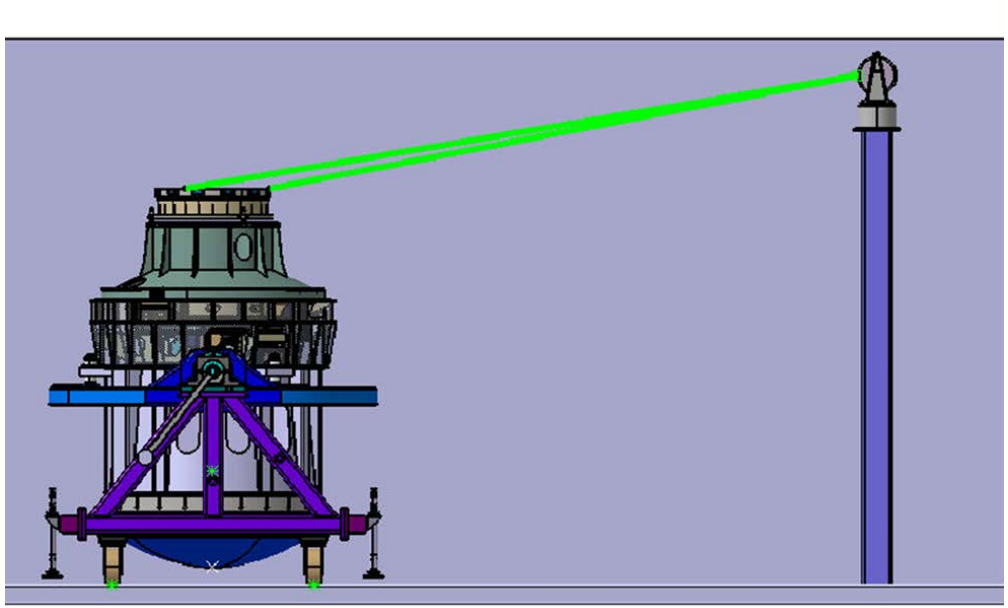
ADC2



PFC integration and alignment and other issues

Key	Summary	Due Date	Description	Comments	
				Author	Text
WEAVEWCSFDR-54	Laser tracker		The laser tracker is a key part of the alignment but there seems to be little information on its set up and operation - is more detail available? (perhaps I've missed it!)	Francesc Dalmases	this is to be done by a external measument company
				Peter Doel	I would like to explore this at the meeting - it is a key part of the alignment

Laser tracker visibility inside the clean room is checked for the worst case (L6).



PFC integration and alignment and other issues

Key	Summary	Due Date	Description	Comments	
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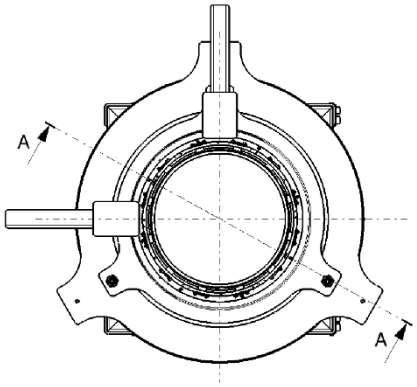
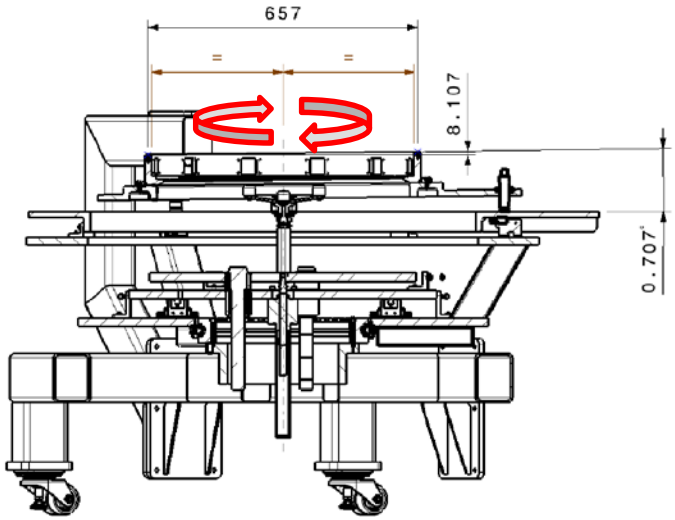
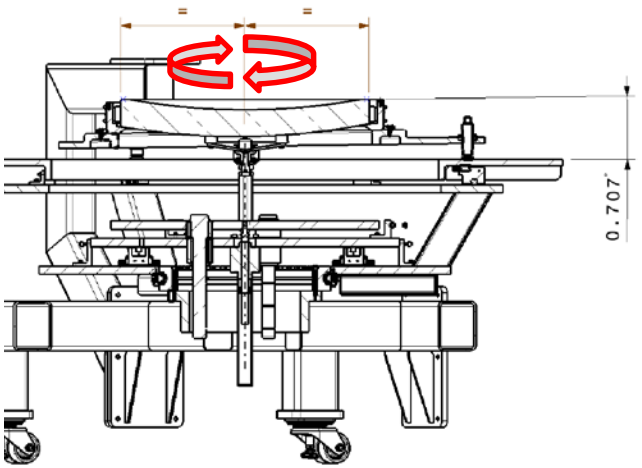
WEAVEWCSFDR-55	Statement on page 151		I don't understand the following statement on page 151 can you clarify "IMPORTANT: L4 is tilted 0.707º wrt optical axis, so the L4 cell axial support is tilted by 0.07º (rest is lens manufacturing). The centring of L4 cell will be done tilting it wrt rotary table to aling the L4 cell axial support surface to the the rotation axis".	Francesc Dalmases	We can include clarifications. We have proposed to tilt the rotation table support to be able to measure. I would like this clarified







PFC integration and alignment and other issues

Key	Summary	Description	Comments	
			Author	Text
WEAVEWCSFDR-72	Laser tracker accuarcy	11.2 states that the laser tracker has an uncertainty of 15 microns.	Francesc Dalmases	is in a distance of 3 to 4m. Not clear the way to calculate. For us max is 15 microns because there are'nt cummulated distances
				I consider this to be the single most critical issue, please discuss at the FDR.
		Is this a single measurement accuracy ? (over what distance ?)		
				Clarify the tolerance build-up during the MAIT process.
		Say, 3 measurements are required per lens then the single surface measurement accuracy is 26 microns.		Ian
		This results in a measurement uncertainty for 1 lens w.r.t another of 37 microns not ~20 microns		
			Ian Tosh	

To further discuss.

PFC integration and alignment and other issues

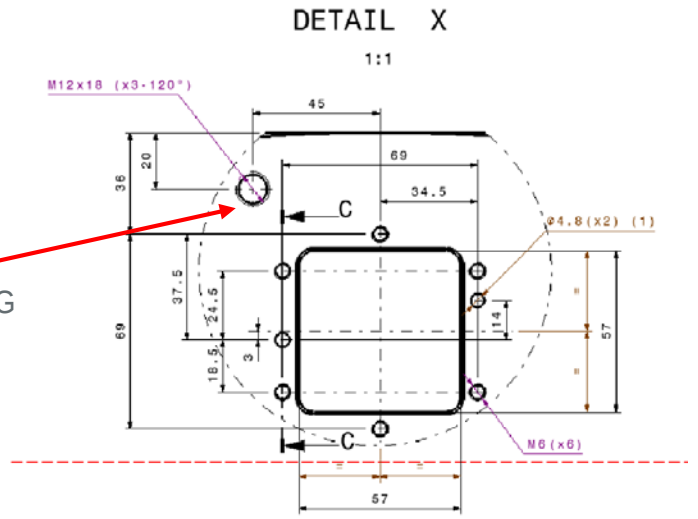
Key	Summary	Description	Comments	
			Author	Text
WEAVEWCSFDR-73	L1 reference optical or mechanical axis	11.4 doesn't have any values in the error budget (Table 11-3)	Francesc Dalmases	L1 is the reference for WCS
				I don't think the response answers the question.
		It is understood that the WCS is aligned from the mechanical axis of the lens.		This is probably related to WEAVEWCSFDR-72 and can be discussed at that point in the FDR.
		Have the lens manufacturing errors been included for the error (offset and uncertainty) of the L1 optical axis w.r.t its mechanical axis ?		The optical axis of L1 is the reference for the WCS not the mechanical axis - the lens manufacturer's measurements need to be taken in to account.
				Ian
			Ian Tosh	

L1 has been defined as the optical axis. There is no requirement about L1 displacement vs M1, See RID 4

PFC integration and alignment and other issues

Key	Summary	Due Date	Description	Comments	
				Author	Text
WEAVEWCSFDR-7	Missing holes		Pg28 step 4: There are no M6 lifting holes in the manufacturing drawing of the flexure ring (they are in the CAD model).	Francesc Dalmases	Agreed. Typo in procedure. Should be M8. Procedure will be corrected
				Paul Jolley	Open You have 3 M6 holes in the CAD model specifically for this lift. Are you now changing the CAD model to M8? The manufacturing drawing does not have any holes in it, M6 or M8. You need to add the hole details to the drawing and make it consistent with the procedure.

M12x18 (x3) USED FOR LIFTING



PFC integration and alignment and other issues

Key	Summary	Due Date	Description	Comments	
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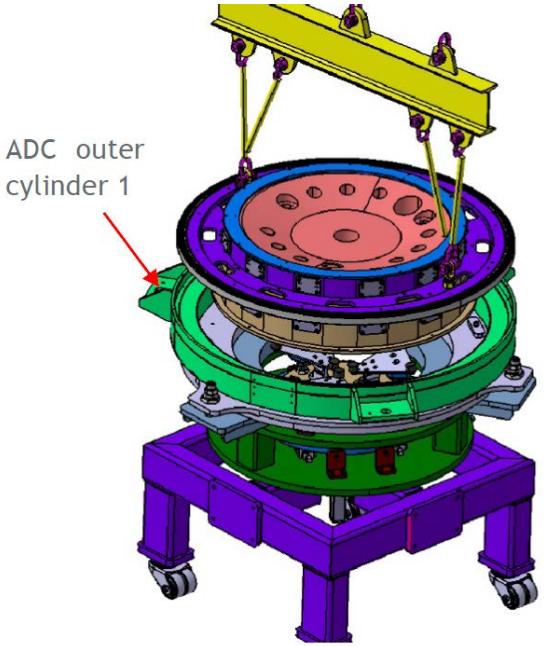
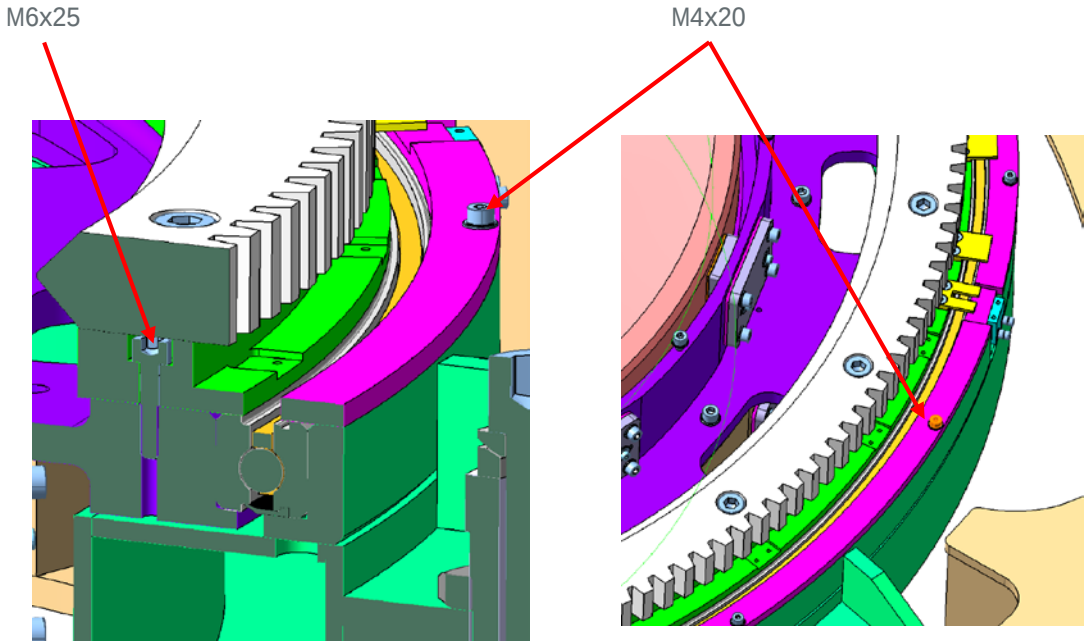
WEAVEWCSFDR-17	Clarification on bearing assembly		Pg42 step 20: I don't understand what is meant by the 4th paragraph. The CAD model shows the bearing press-fitted into the outer cylinder. There is a bearing retainer bolted to the L3 cell, but this is held with M6x25 bolts.	Francesc Dalmases	We will check in detail. Retainer is fixed by M4 bolts. We will check consistency of drawings.
				Paul Jolley	Open A simple slide at the meeting to present the process would be good to see. Not a show stopper for the project.

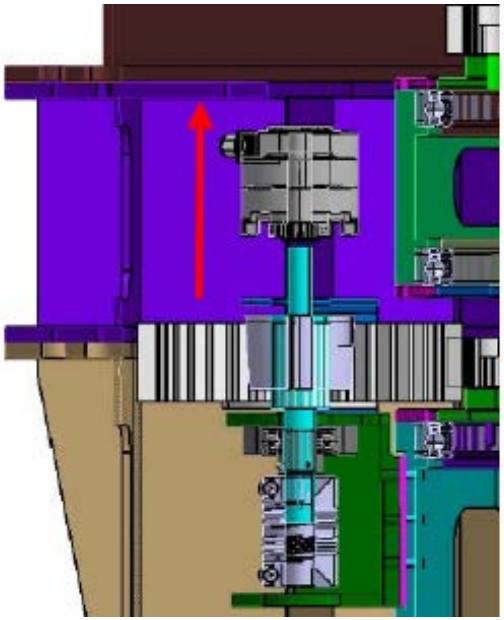


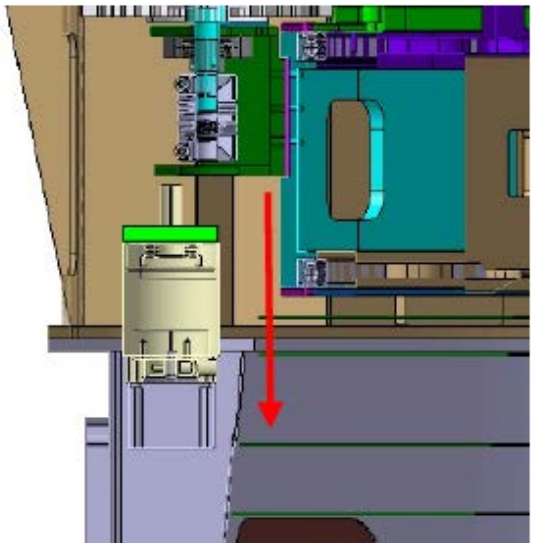


PFC integration and alignment and other issues

Key	Summary	Description	Comments	
			Author	Text
WEAVEWCSFDR-19	Drive units - LRU's?	Pg43 step 21: Are the drive units pre-assembled and pre-tested?	Francesc Dalmases	Yes. All are COTS
			Paul Jolley	Open My question was if the drive unit as a whole is an LRU and not if it consists of individual COTS items. Please Clarify. Not a show stopper.

There two assemblies: one for the Motor and Gearbox, the second for the Encoder.
Both can be replaced in the telescope

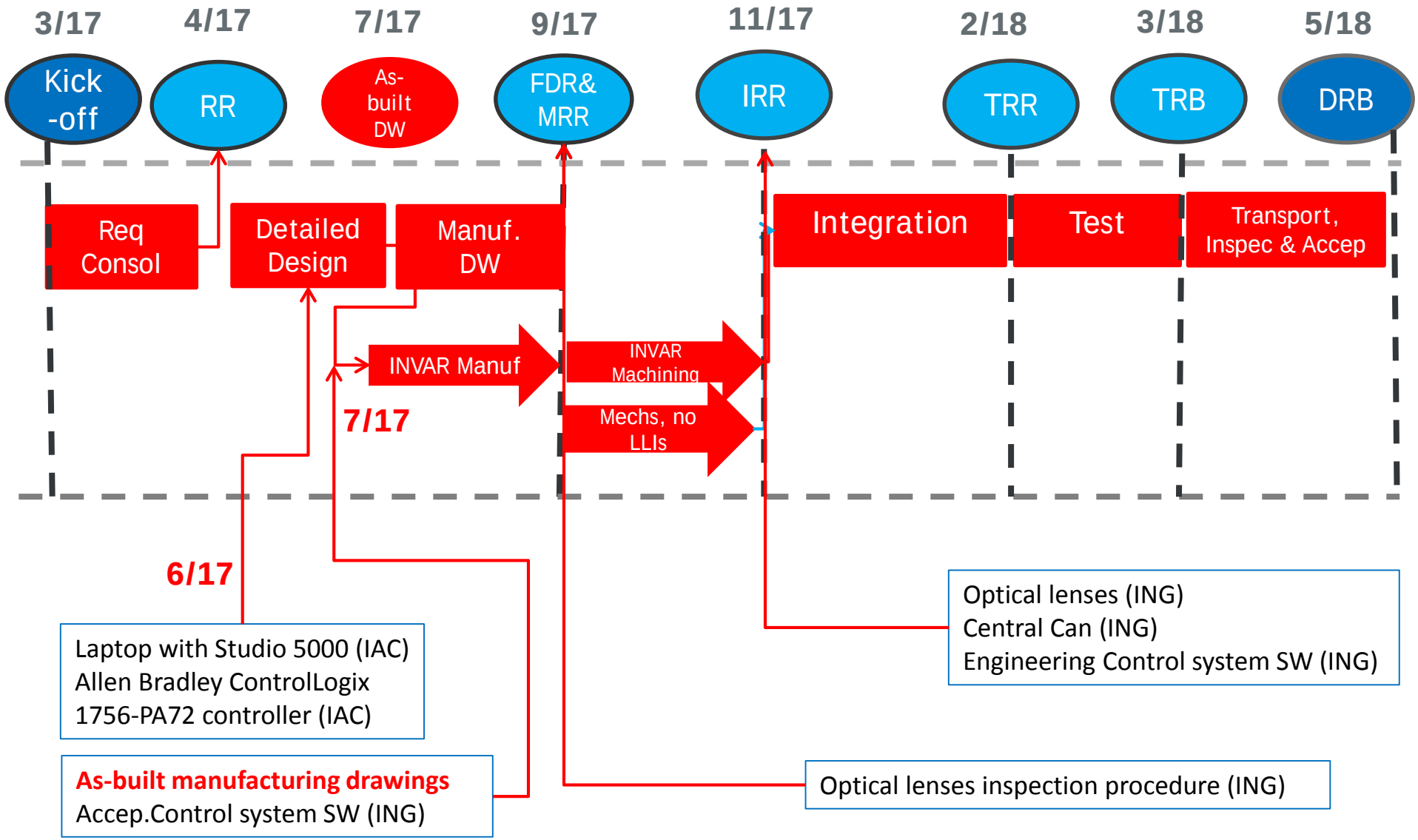




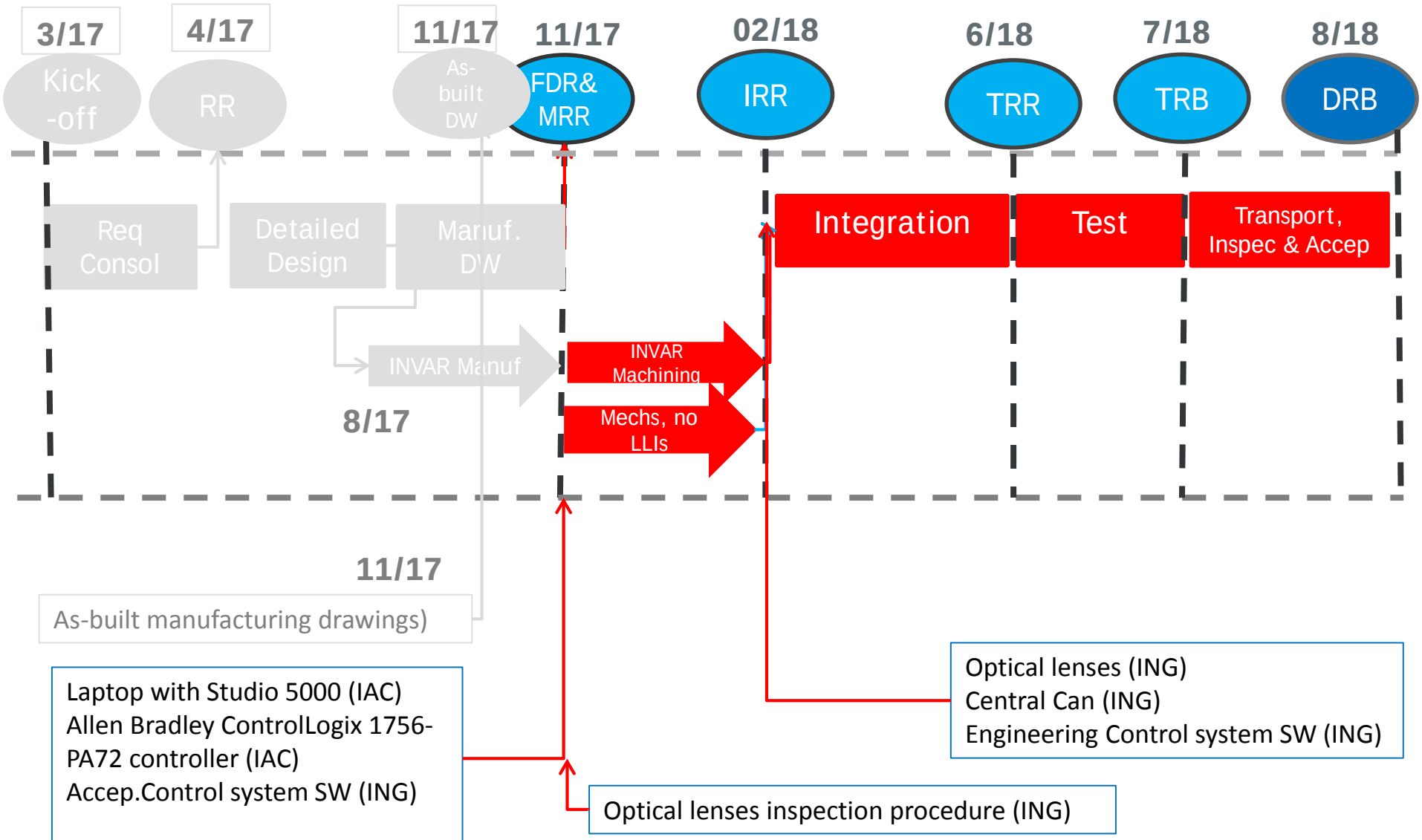
Stray light results and Optical issues

WEAVEWCSFDR-4	L1 stability wrt the WCS interface to the central can
WEAVEWCSFDR-27	Baffle alignment
WEAVEWCSFDR-29	Tolerance on mark alignment
WEAVEWCSFDR-56	Stray light analysis
WEAVEWCSFDR-60	Stray light analysis ?

Schedule & critical issues – Schedule at KOM



Schedule & critical issues – Schedule Today



SENER

Risk of Misalignment during transport – Issues 57, 58

- WCS as it is transported with an **isolation System:** Transport loads should not affect designed to withstand shocks of 10g 7ms,producing less than 2g of peak to WCS

- All **external housings are bolted and pined** between them.

- Not credible decentring of lenses wrt their cells **as lenses are fixed and glued** to the radial pads in a high redundant configuration.

- Possible decentring due to preload loss of the xy centring bolts and collimation screws for ADC's and L6 if a high vibration environment
  - Provision will be included to detect if a displacement has occur.
    - Bolts are visible from outside or removing covers
    - Inspection will be performed unpacking
      - If glue is not broken alignment is maintained.
      - If it is broken alignment could be affected and decisions shall be taken

    - In addition, a test with SMR and laser tracker to check the L1 position wrt WCS IF to central CAN wil be performed before and after transportation.

Acceptance – Issue 50

- **Test Readiness Review (TRR)**
  - Review Test plan & procedure, Inspection plan & procedure
  - Ok to perform tests
- **Functional and Performance Tests (@SENER) –** see P0215467-223IT-P-0020
  - Electrical test (grounding, harness shielding, power supply)
  - Software interface test
  - Performance test: ADC functional performance at 30º, 60º, 90º

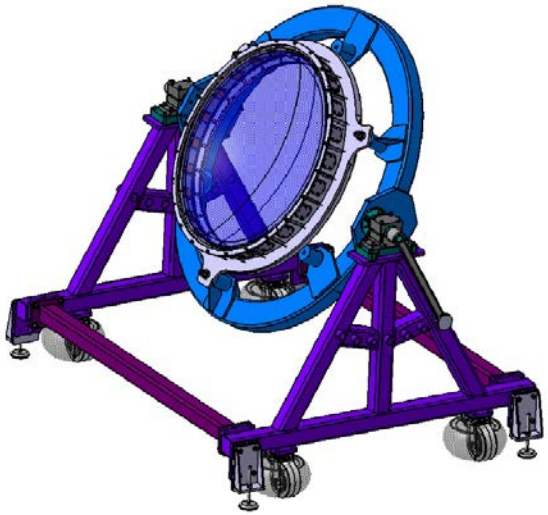
- **Test Review Board (WCS TRB) –** Review of Test results
- **Preliminary Acceptance and Shipment Readiness Review (WCS A1)**
  - Complete Acceptance Data package

- Delivery and **Limited functional test** (**@La Palma**)
  - Safety test: Check provisions and SMR-laser tracker test before and after shipment
  - WCS Functional test

- **Provisional Acceptance (WCS A2) –** Review of Test results
- **Delivery Review Board (WCS DRB) –** EIDP, close-out NCRs, etc.

Gravitational displacement – Issue 80

- **Current baseline considers:**
  - measuring in all dummy lenses assembled in PFC
  - Measure displacement in L1 with final RTV pads with rotator
  - Results extrapolated to rest of lens



- Impact of measuring displacement in rest of lenses (L2 & L3 in ADC1, L4 & L5 in ADC2, L6 in cell):
  - Design of additional tools to adapt cells to rotator(3w)
  - Tools manufacturing
  - Gravitational displacement test in L2-L6 and reporting (min. 1 month)

Types of Non-Conformances

→ **OPENED BY**

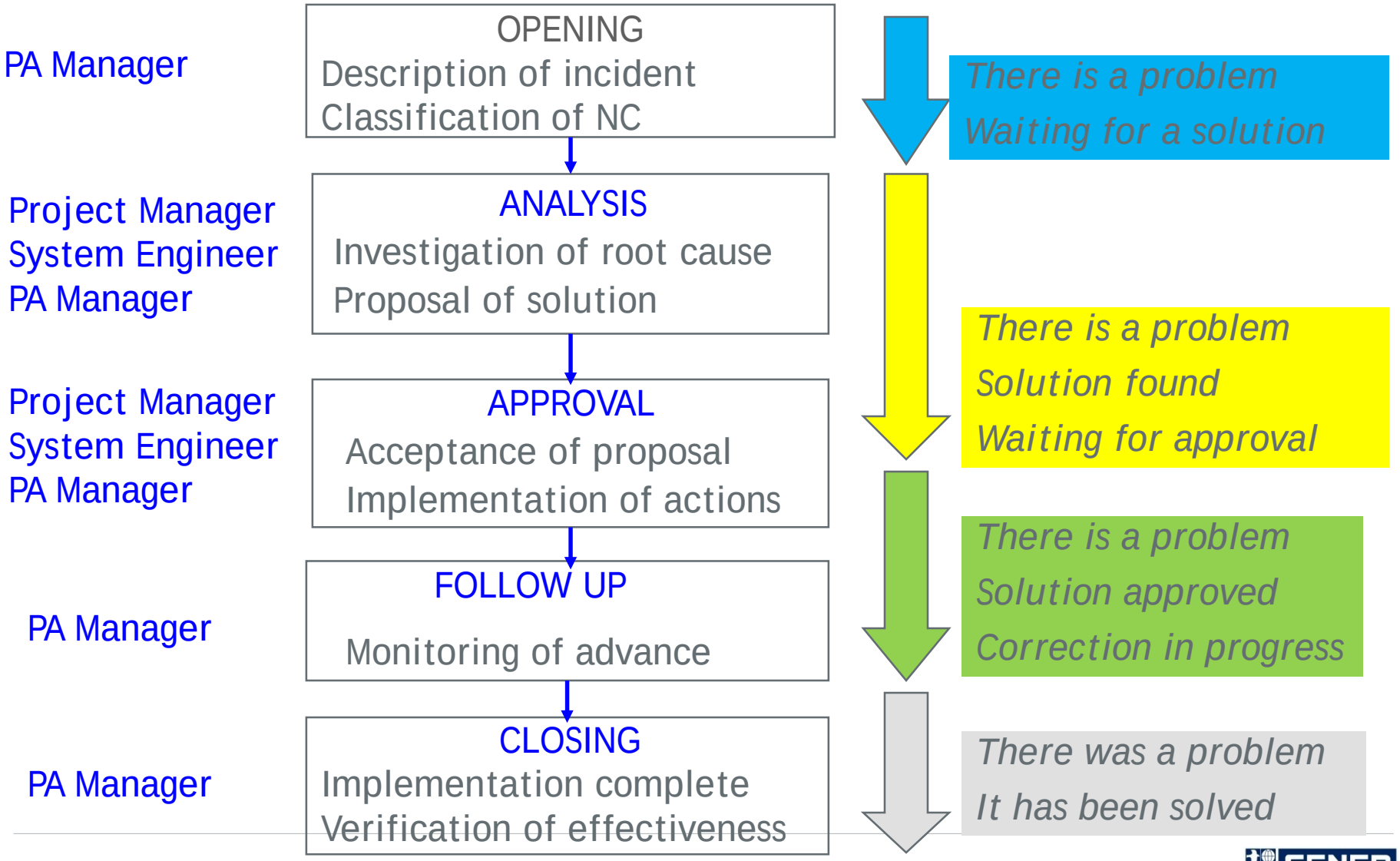
- **CONTRACTOR**
- **VENDORS**
- **CUSTOMER**

→ **ACCORDING TO SEVERITY**

- **MINOR**
- **MAJOR**

NCR system– Issue 65

Non-Conformances Status



Report and Meeting

- MINOR NON-CONFORMANCE
  - Non-Conformances Status List (NCL): paragraph in the monthly project progress report
- MAJOR NON-CONFORMANCE
  - Non-Conformance Report (NCR): 48 hours
  - Non-Conformance Review Board (NRB): with the involvement of Customer

Lens Inspection – Issue 66

- **Inspection report from lens' manufacturer will be a basis to carry out the incoming inspection.**
- **The objective of this visual inspection is to check the equipment for signs of shipping damage focus on the followings points:**

  a) Shipping crate: packaging

  b) Surface imperfections: scratches, pits, broken bubbles, sleeks, scuffs, fixture marks and coating blemishes

  c) Edge chips: defects around the periphery outside the optically effective area

  d) Log records: black box to record shock events, vibrations and climatic conditions together with a time stamp

- **A particulate contamination control will also take place for a surface cleanliness level 500 viewed at grazing incidence using a dark UV lamp.**

Manufacturing Readiness Review (MRR)

- **Objective:**
  Authorize the manufacturing of PFC mechanical pieces and complete the procurement of electrical items

- Manufacturing drawings have been delivered

- P0215467-223IT- P-0018 defines:
  - Manufacturing and Incoming inspections
  - Manufacturing procedures
  - KIPs

defined in P0215467-223IT- P-0018

- RAMS analysis performed and reviewed

Backup slides

WCS project, Issue 70