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Installation Procedure

INSTALLATION OF THE ATLAS BEAMPIPE

Abstract

This note describes the baseline procedure for installing the ATLAS beam pipe in the experiment. Access tooling and configurations are discussed. A preliminary division of responsibility is also given.

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History of Changes

Rev. No.	*Date*	*Pages*	*Description of Changes*
0.3	2004-03-02	all	Update for internal discussion with Lissauer and Hedberg.
0.4	2004-04-23	all	Update of figures and figure captions.
0.5	2004-08-06	all	Updated following meeting Open issues: EM coil for ion pump? CDD cameras, light and services
0.6	2004-09-30	all	Completed with durations for activities

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0. INTRODUCTION

This note describes the baseline procedure for the installation of the beam pipe [1], from integration with the pixels on the surface to the conditioning of the chambers for first beam. It does not cover later interventions or removal of the beam pipe.

It is not intended as a detailed installation procedure, rather as an overview document in order to allow detailed scheduling, procedures and tooling to be developed. A preliminary division of responsibility is also provided, to allow estimations of human resources to be made.

Acronyms refer to the ATLAS Product Breakdown Structure (PBS).

The general sequence of installation of the beam pipe is as follows:

1. The VT beam pipe supports are pre-installed in the end cap toroids;
2. The VI beam pipe is integrated into the pixel package and installed in the ID;
3. The VA Beam Pipe section is installed and connected to VI;
4. The VT Beam pipe is installed and connected to VA;
5. The VJ beam pipe is installed;
6. Operations 4-6 are repeated on the other side;
7. The assembled beam pipe is baked out.

With the exception of operation 2, access is only required from one side of the experiment. Therefore the exact order of chamber installation on the two sides can be changed to optimise the overall detector installation plan.

1. INSTALLATION OF THE VT BEAM PIPE SUPPORT

The Endcap Toroid (TE) is brought down onto the truck. The turret is connected and all the Cryolines, power etc. are connected to the turret.

The TE is then moved into the barrel. The Toroid Shielding (JT) installation platform is built up (Figure 1.1). The JT is inserted into the TE. The three Toroid Beampipe (VT) rail supports are then installed from the non-IP end of JT (Figure 1.2). The baseline is that this installation takes place from one side only.

The JT installation platform is removed and the TE is moved away from the IP onto the HF truck.

The TE is moved sideways into the garage position with the HF truck.

1.1.1 SUMMARY OF TOOLING

The JT installation rails and tooling are designed by ATLAS (I. Hooton).

The support rails are supplied by AT-VAC (R.Veness), funded by ATLAS.

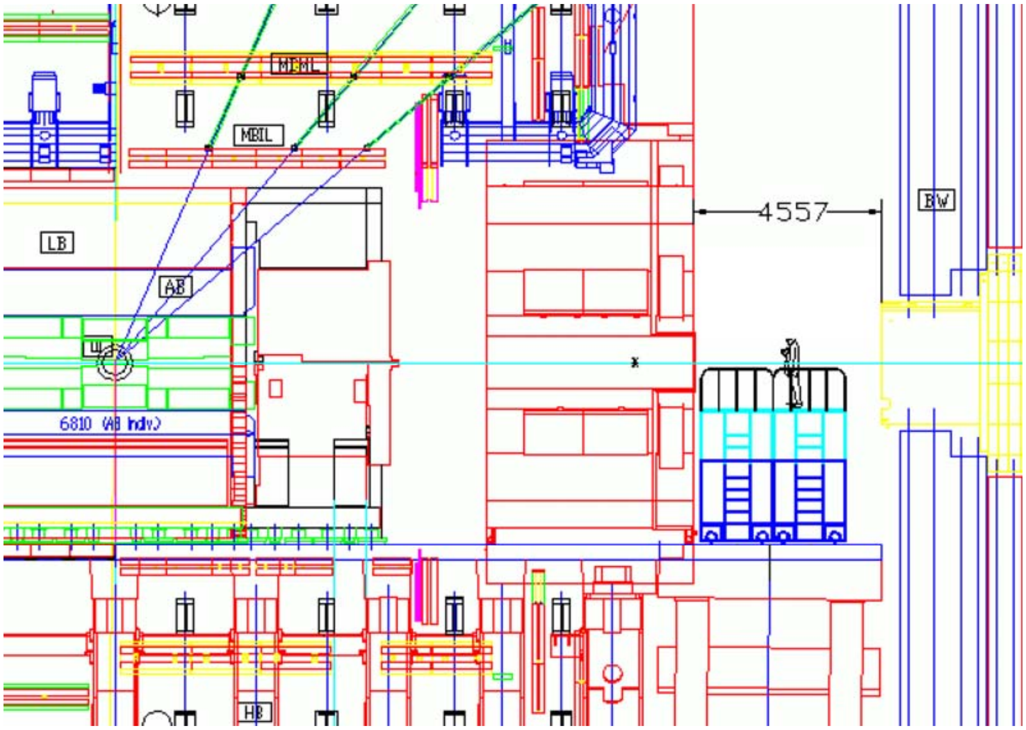

Figure 1.1: Configuration of the scaffolding for the JT support rail installation.

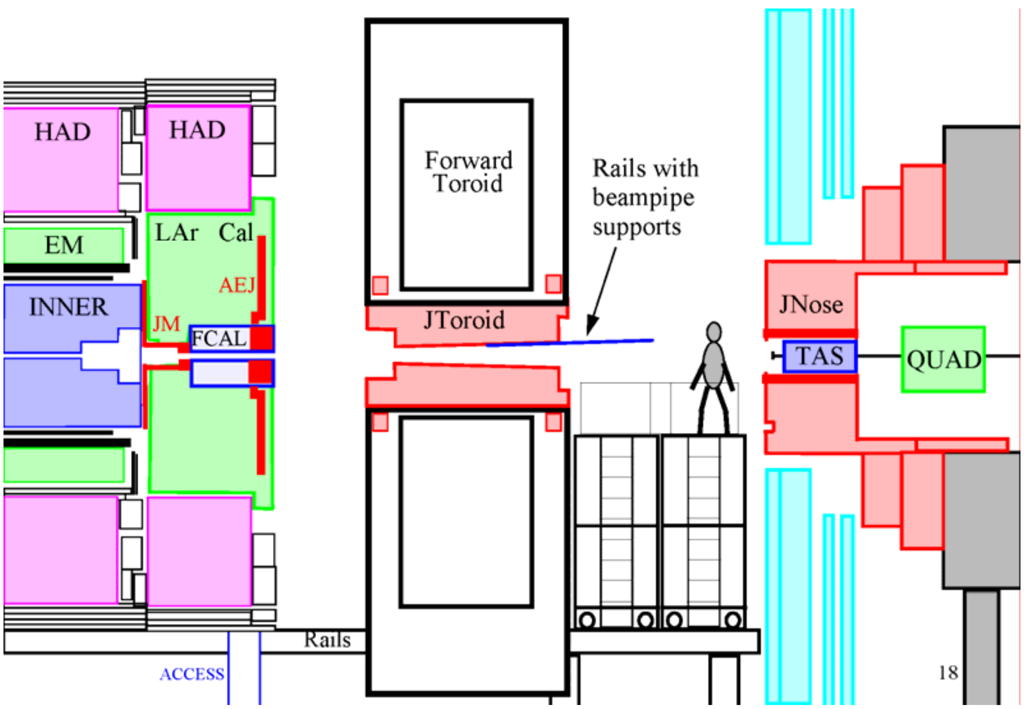

Figure 1.2: Conceptual drawing showing the support rails for the VT beampipe being inserted in to the JT shield.

2. VI BEAM PIPE INSTALLATION

The Inner detector beampipe (VI) (Figure 2.1) is installed in the Pixel package in the SR building. It is transported as a package with the pixel detector and is inserted in the Pixel Tube. This procedure is described in document [2].

The VI is supported during the run at two planes per side, one per side from the pixel support tube, and the other from the Inner Detector (ID) end plate.

In addition there are temporary supports on the transport tube and possibly the Pixel tube that are used only during installation and transport. They will not be used during the run.

The beam pipe and pixel package is installed in the ID as described in [3] (Figures 2.2 and 2.3). The VI is then transferred from temporary to final support systems and the beampipe adjustment mechanism tested. VI is then aligned to the nominal beam axis by TS-SU according to procedure [4]. This will require access to both sides of VI.

Bakeout services for the VI chamber are connected, and the bakeout system tested.

2.1.1 SUMMARY OF TOOLING

Tooling for installation of VI in the pixel package is defined in [1].

The adjustment system for the support at the edge of the pixel detector is designed and supplied by Hartman et al. at LBL (ATLAS).

The wire support adjustors and fixed support on the ID end plate are supplied by M.Olcese et al. (ATLAS).

Collars on the beam pipe and support wires are supplied by AT-VAC (R.Veness), funded by ATLAS.

Temporary supports for transport to the tunnel are designed by Hartman et al. at LBL (ATLAS).

The installation platform is designed by A. Gordeev (ATLAS).

The installation cradle for Pixel installation and its handling is designed and supplied by D.Giugni et al. (ATLAS).

VI alignment tooling is supplied by AT-VAC (R.Veness).

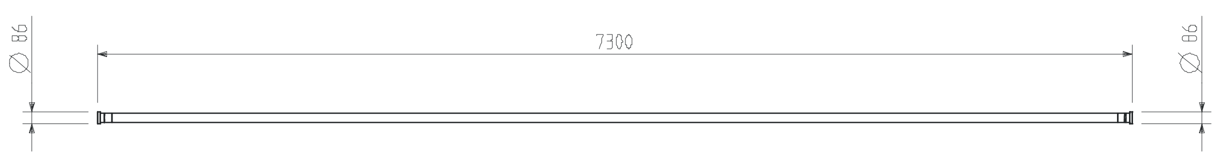

Figure 2.1: The VI beampipe overall nominal dimensions.

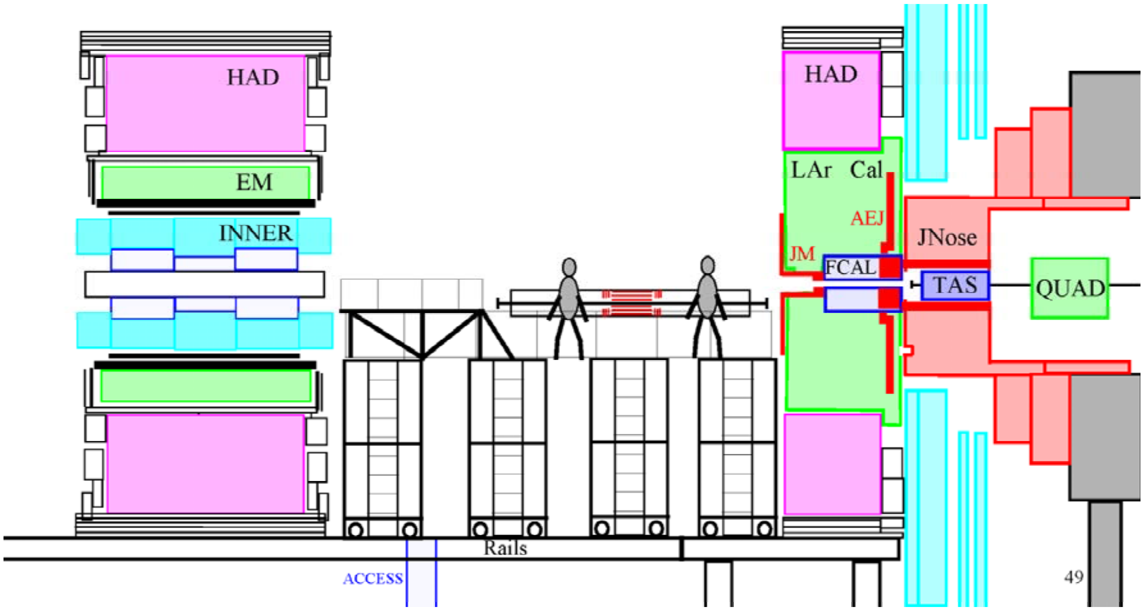

Figure 2.2: Conceptual view of the Pixel installation.

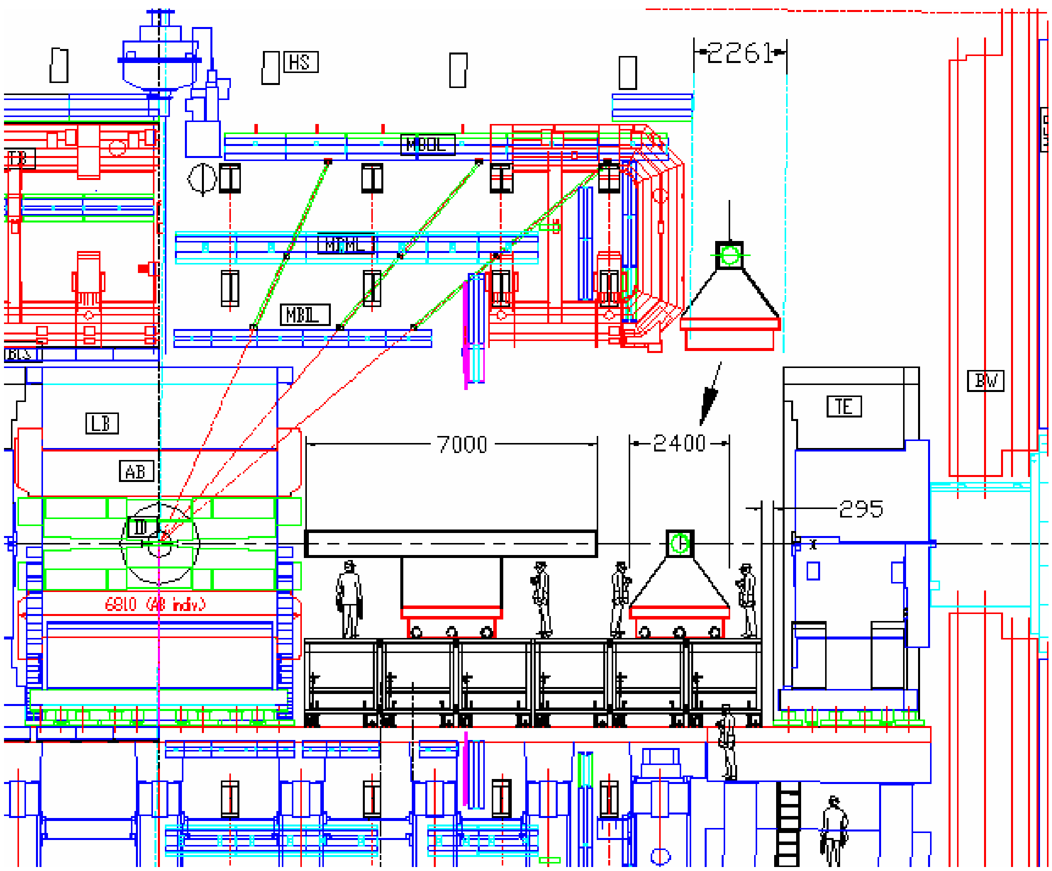

Figure 2.3: Drawing of the pixel installation.

3. VA BEAM PIPE INSTALLATION

Stage 3 is divided in to two parts. The first step is the insertion of the Argon Endcap Beampipe (VA) (Figure 3.1) into the AE while it is on the HF truck. The second part involves moving the AE so that the VA and VI can be connected.

3.1 VA BEAM PIPE INSTALLATION IN THE AE

Most of the pixel installation platform is removed since it is more difficult to do after the VA has been installed in the calorimeter. Two Minivans remain for use in the VA installation.

The VA is transported to the Pit and lowered to the hall using a cradle. The VA beam pipe is then inserted in to the AE cavity and supported temporarily by a support bar off the Moderator Shield (JM) disc cover (Figure 3.2 and 3.3).

3.1.1 SUMMARY OF TOOLING

VA transport cradle is supplied by AT-VAC (R.Veness).

Design and supply of the insertion tooling and support bar by AT-VAC (R. Veness). Shielding interface with I. Hooten and V. Hedberg.

Access tooling is supplied by ATLAS (A. Gordeev/T. Nymann et al.).

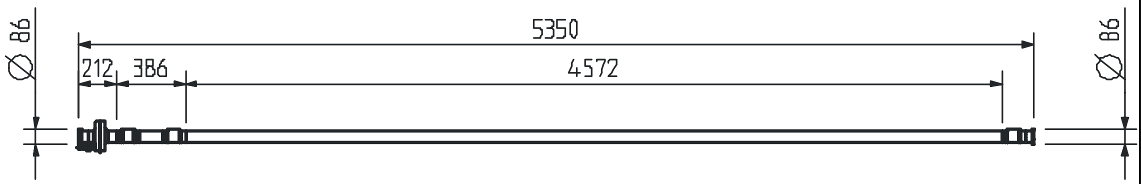

Figure 3.1: The VA beampipe overall nominal dimension.

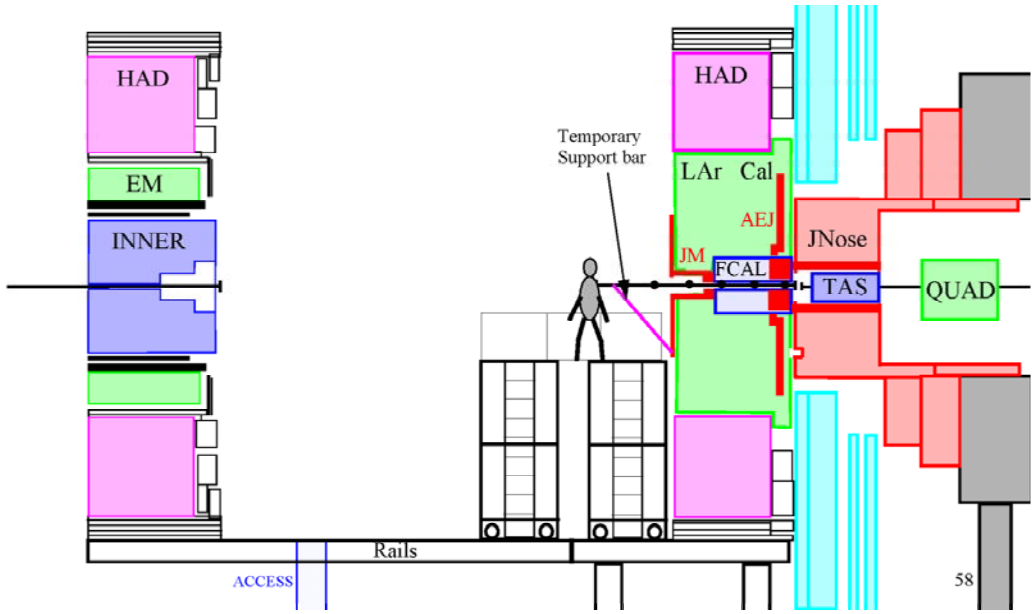

Figure 3.2: Conceptual drawing showing the VA insertion into the AE.

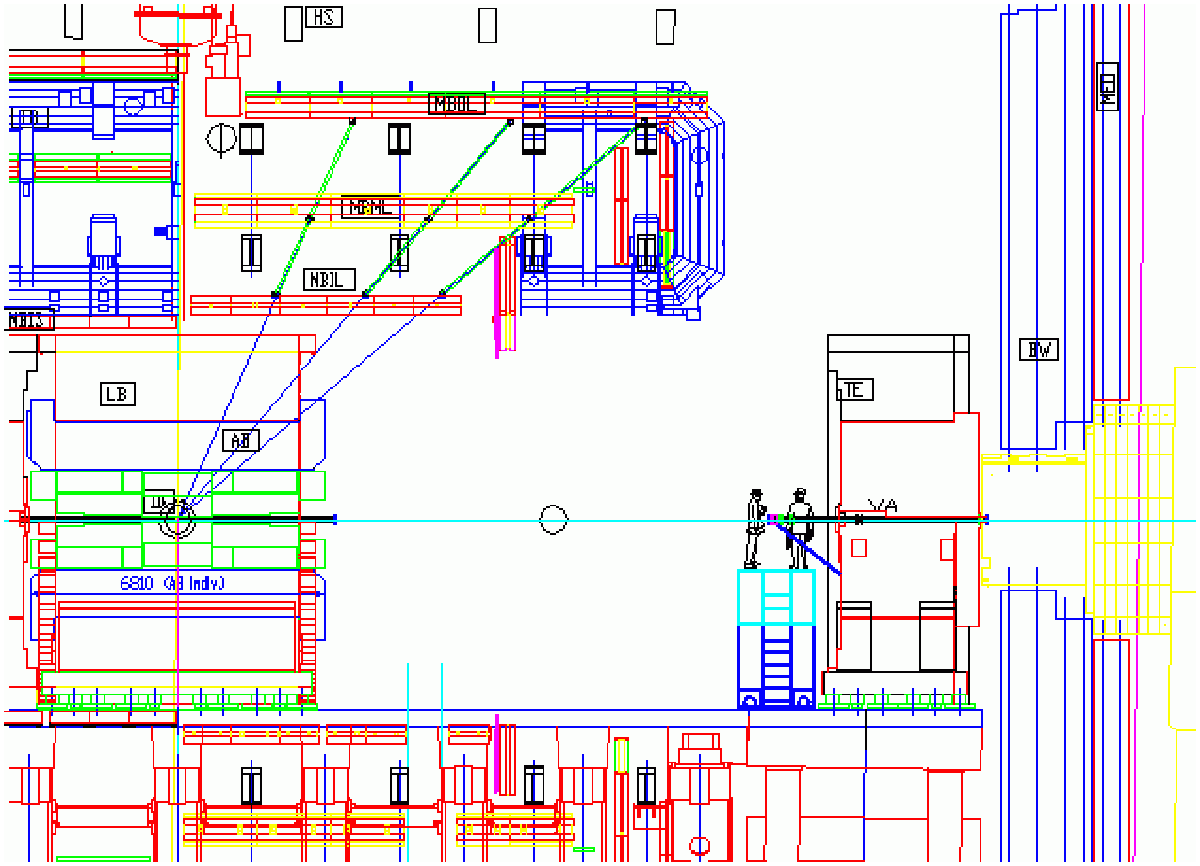

Figure 3.3: Drawing of the VA insertion into the AE.

3.2 CONNECTING VA AND VI

3.2.1 INSTALL SCAFFOLDING.

The scaffolding used to install the VA into the AE is removed and the scaffolding based on the “bridge” concept is installed via the elevator shaft (Figure 3.4).

Scaffolding is installed behind the AE (Figure 3.5).

A wire support is attached from the VA to a structure on the scaffolding. The purpose of this wire support is to prevent the bellows from collapsing during the final closing (Figure 3.6).

The AE is moved into access position and the temporary support bar is removed with the help of a ladder.

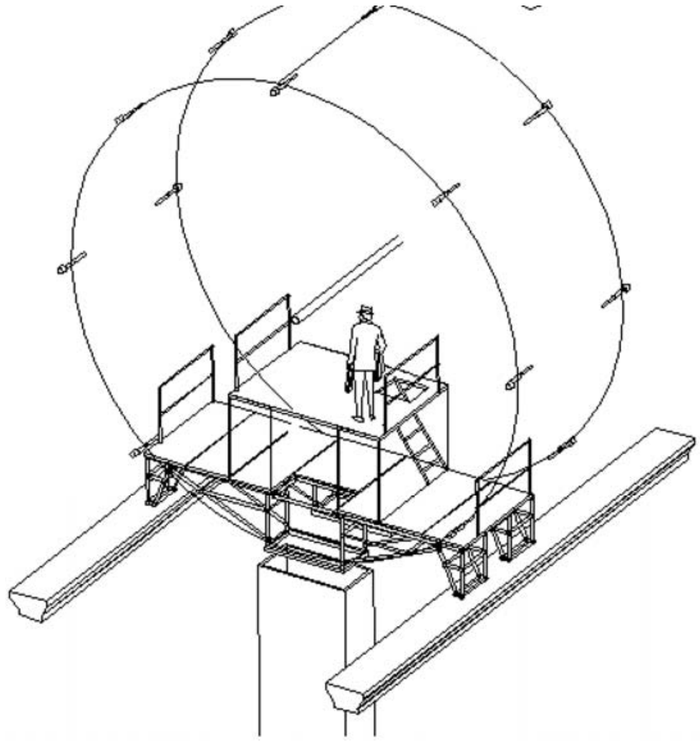

Figure 3.4: Scaffolding based on the Bridge concept.

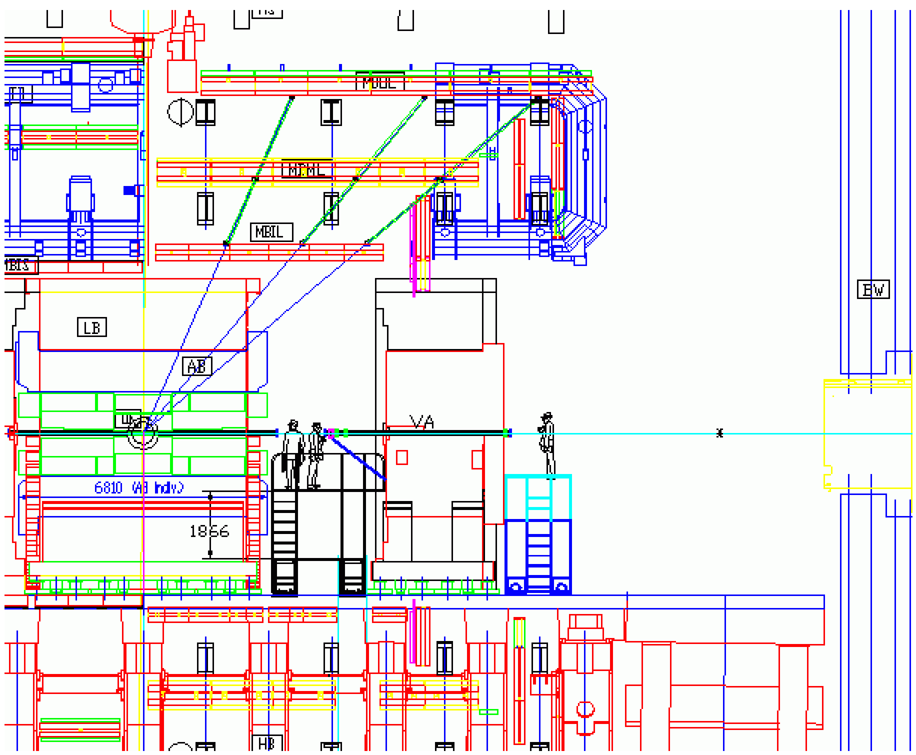

Figure 3.5: Drawing showing the location of the scaffolding on both sides of the AE.

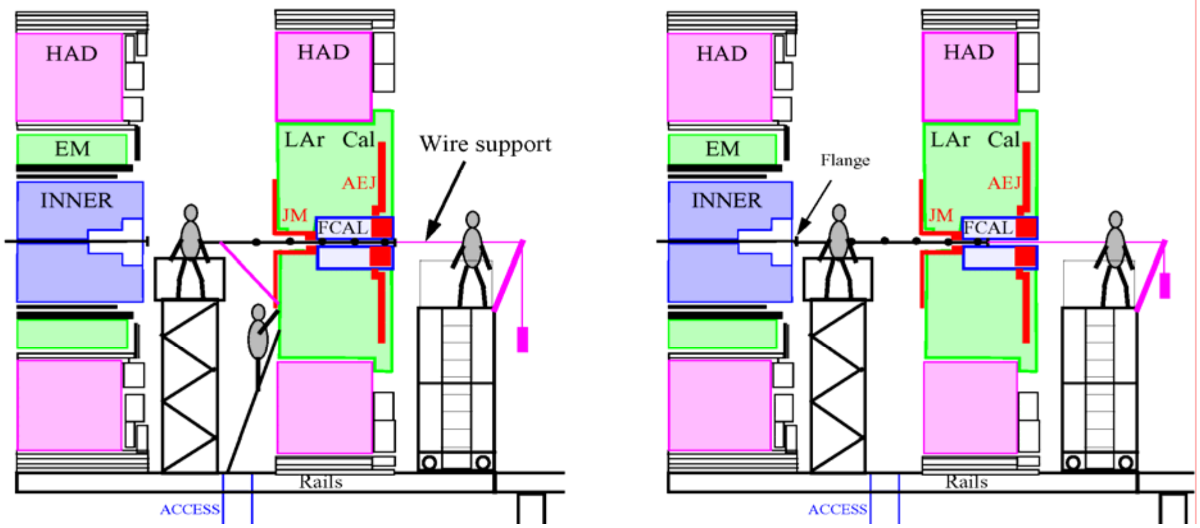

Figure 3.6: A wire support is attached to the end of the VA beampipe (left) and the temporary support bar is removed. The beampipe is pulled out of the AE (right) and attached to the VI flange.

3.2.2 ATTACH VA AND VI & VACUUM CHECK

The VA beampipe is pulled out of the AE and attached to the VI beampipe at the flange (Figure 3.6). A special support structure is installed to support the beam pipe.

The beam pipe is pumped-down with a mobile pumping station installed on a flexible hoze behind the AE and the VI/VA assembly is leak checked. The magnets required to operate the ion pump with the solenoid magnet off are installed from the ID end plate. Bakeout and ion pump services for VA are connected in the gap and tested.

The ion pump operation is tested.

IMPORTANT NOTE: The ion pump magnets must be removed before final close of the experiment.

The clamps around the VA bellows are removed.

The support off the AE face is removed.

The wire support behind AE is tensioned, and the tension limiter activated to avoid damage to VI or VA in case of blockage of the VA sliding supports during closure. Note: this wire needs to be replaced with a rigid rod for the long opening, to prevent damage to the VA bellows.

Detailed operation specification and design by R. Veness et al.

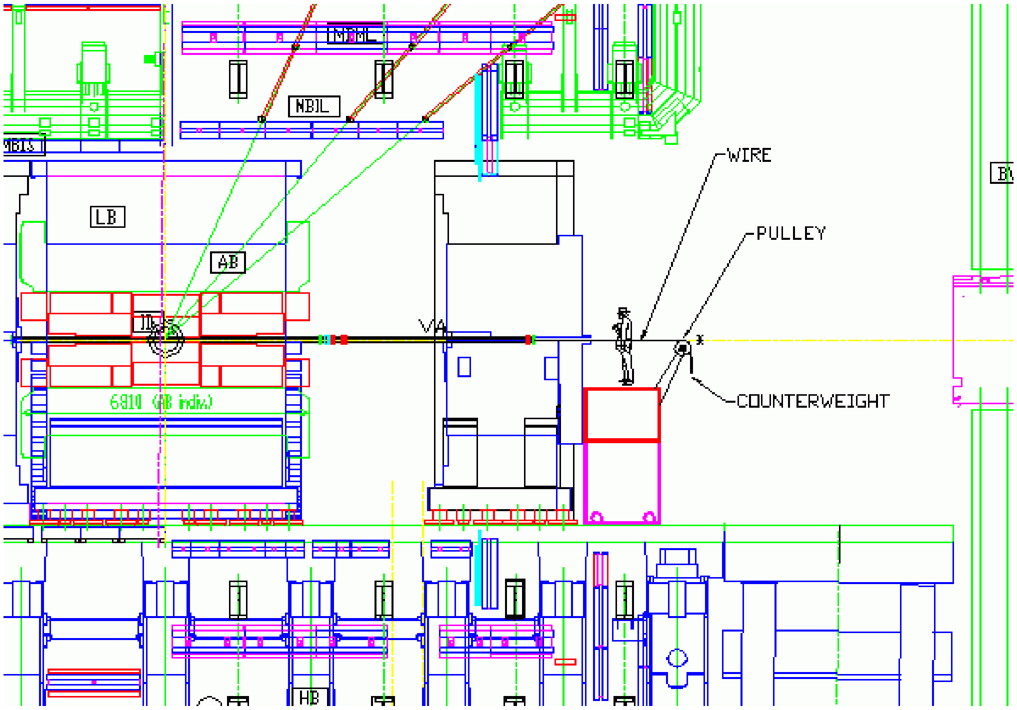

Figure 3.7: The situation after the scaffolding in the gap in front of the AE has been removed and before the AE is moved into the run position.

3.2.3 MOVE AE TO RUN POSITION

A CCD camera is connected in the ID/AE gap to observe the beampipe during closure.

The scaffolding between the ID and the AE is removed through the small access elevator shaft (Figure 3.4 and 3.7).

The AE is moved into its final run position (Figure 3.8 and 3.9). If possible, the VI/VA beampipe is directly observed by someone from the 'escape hatch' to minimise the risk of damage to the beampipe. This must be approved from a safety point of view.

3.2.4 SUMMARY OF TOOLING

Bridge scaffolding to be designed and supplied by ATLAS-TC (A. Gordeev) with specifications given by R. Veness.

Scaffolding behind AE to be designed and supplied by ATLAS (A. Gordeev).

Wire support with tension limiter and flexible hose assembly to be supplied by AT-VAC (R. Veness).

Special VA support to be designed and supplied by AT-VAC (R.Veness).

Ion pump Magnets and support structure to be supplied by AT-VAC (R.Veness), using supports on the ID end plate supplied by M.Olcese (ATLAS).

Mobile pumping equipment supplied by AT-VAC.

Bellows clamps supplied by AT-VAC.

Access design by ATLAS (A. Gordeev/T. Nymann et al.)

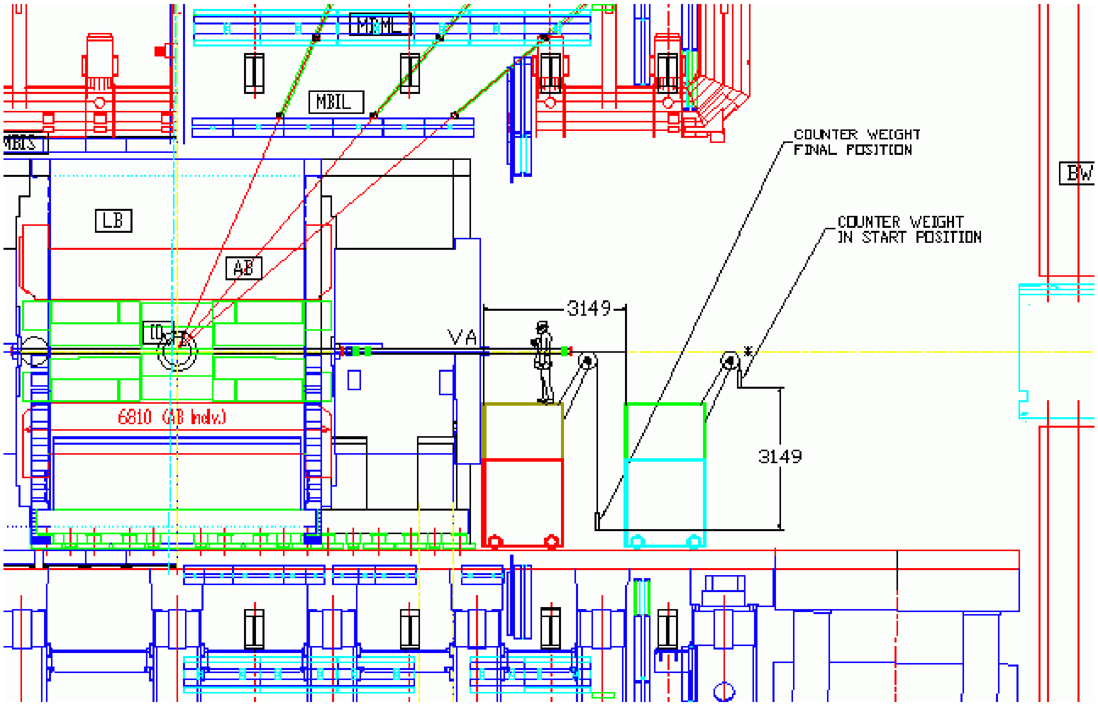

Figure 3.8: Drawing of the situation after the AE has been moved into the run position.

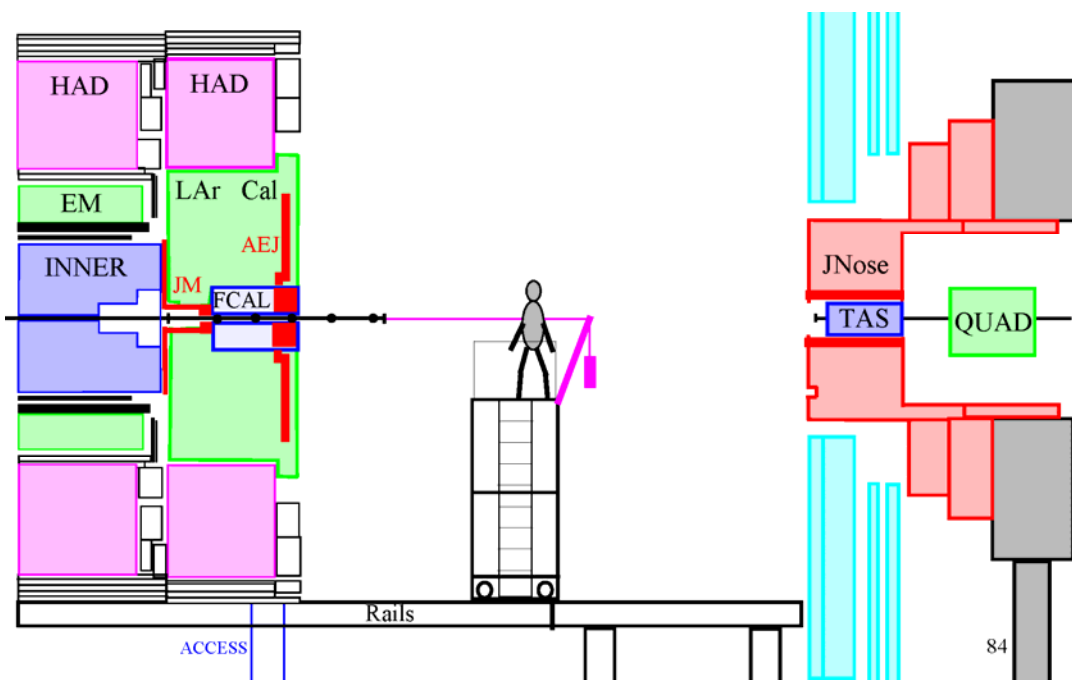

Figure 3.9: Schematic of the AE after it has been moved into the run position.

3.3 INSTALLATION OF THE JD/SW

The scaffolding and the wire support is removed.

The small wheel (SW) is brought down and moved into its final position (Figure 3.10).

A scaffolding is being designed for the JD/SW Services installation (Figure 3.11 and 3.12). This scaffolding needs to be removed before the toroid is along the beam line. The design is based on the use of 2-3 Minivans plus standard scaffolding.

Once the JD/SW Sevices have been installed we remove the "minivans" and the scaffolding. We are now ready to move the JD/SW to the run position.

3.3.1 SUMMARY OF TOOLING

Design of access scaffolding to be done by ATLAS (A.Gordeev).

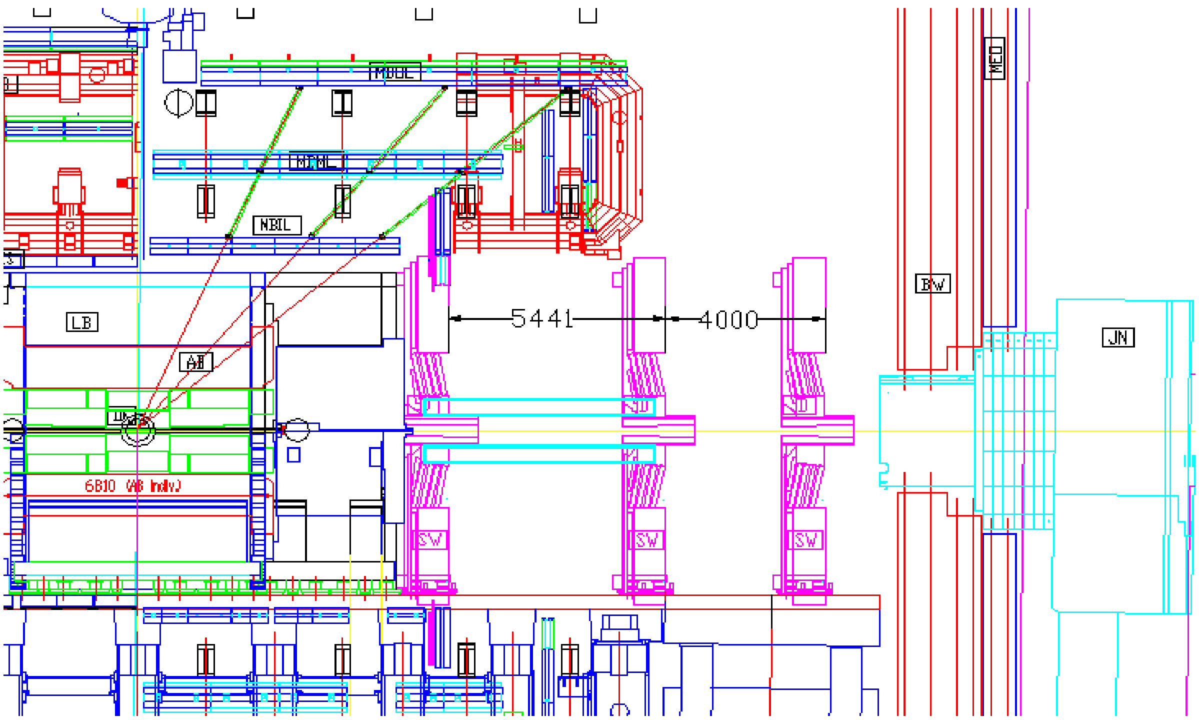

Figure 3.10: The SW is brought down and the sevices need to be attached.

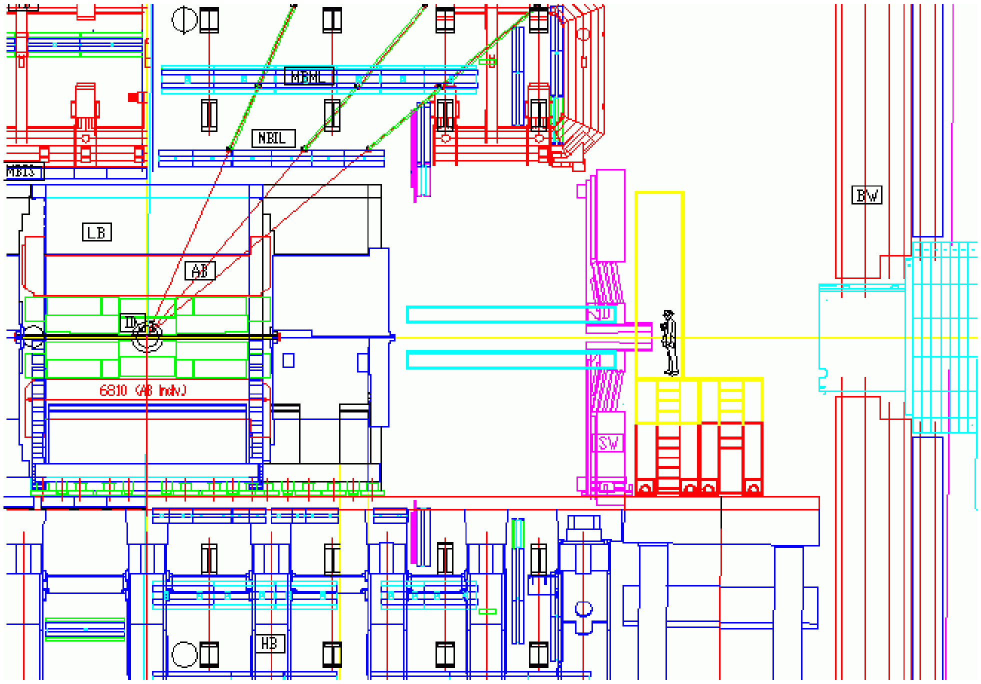

Figure 3.11: Connecting JD / SW services.

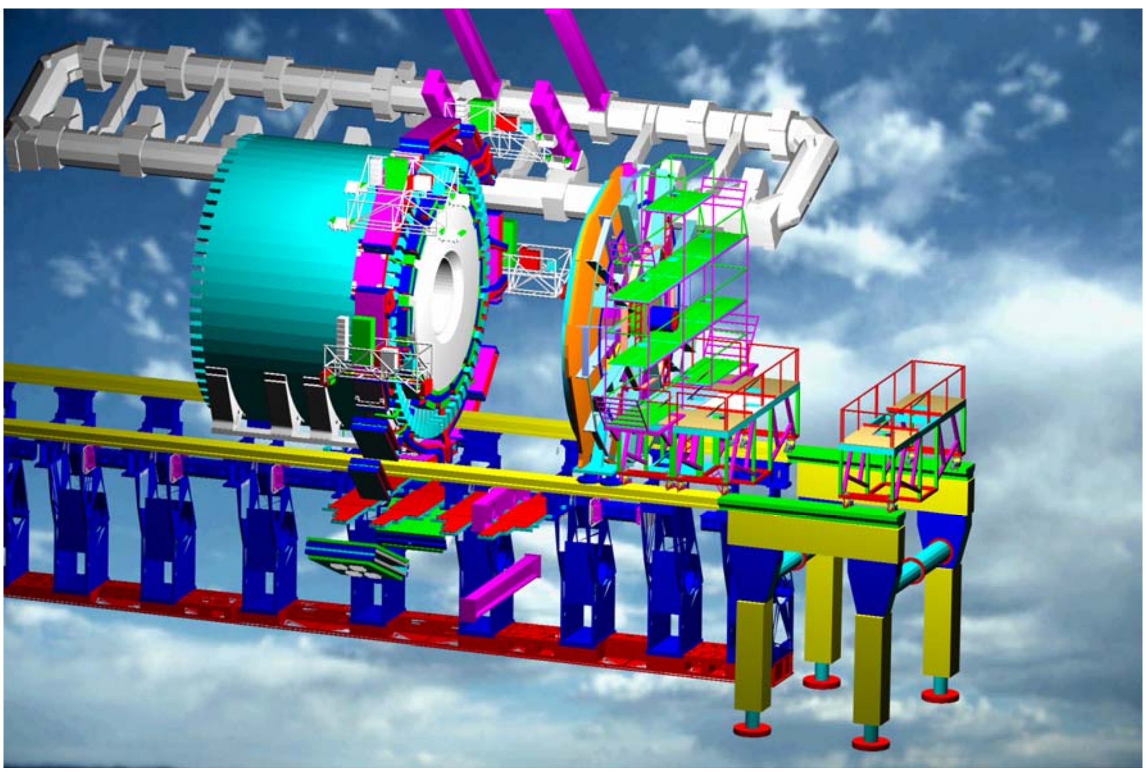

Figure 3.12: 3D View of the JD / SW scaffolding used for the connection of the services.

3.4 ATTACH VA TO JD

The VA beampipe is attached to the disk shield with a fixed support (Figure 3.13). This support is then aligned relative to the nominal beam axis by TS-SU.

3.4.1 SUMMARY OF TOOLING

Fixed Support to be supplied by AT-VAC, funded by ATLAS.

The supply of the sliding "rollers" for the beam pipe to be done by AT-VAC, funded by ATLAS.

The Scaffolding that is being used for the connection of the VA to the JD disc is discussed in more detail in section 4 – VT installation phase II.

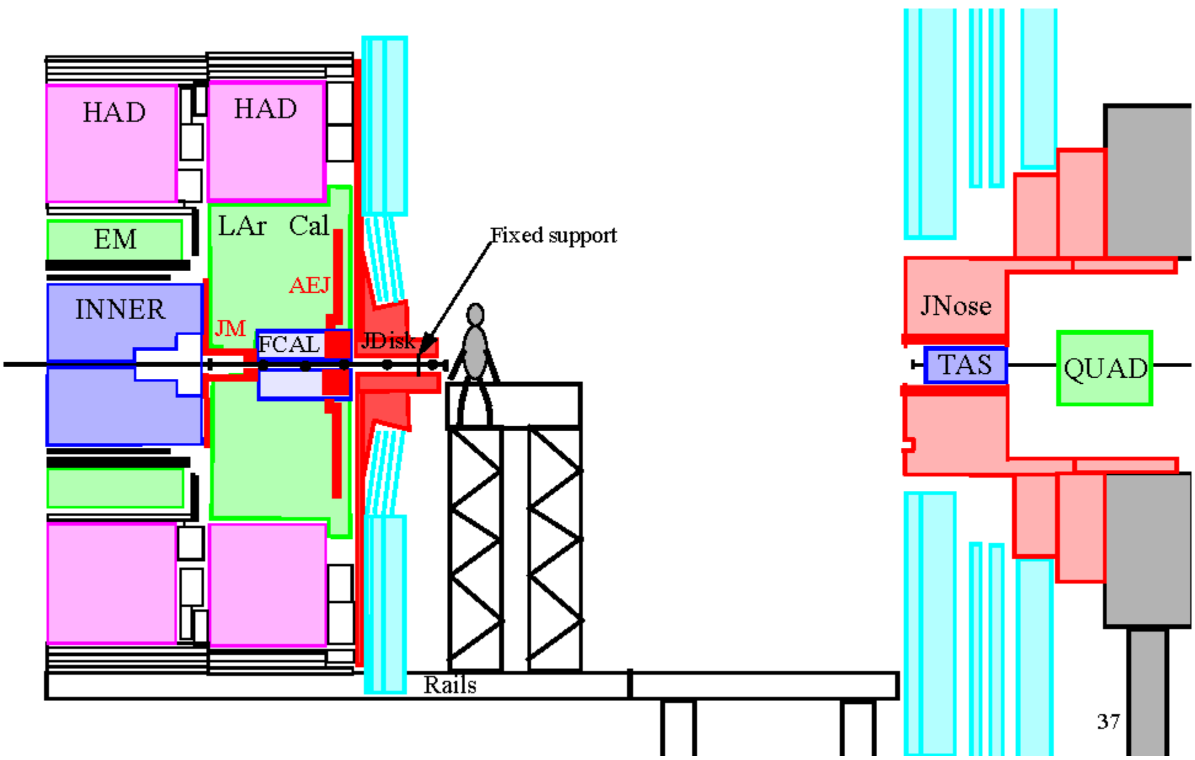

Figure 3.13: Conceptual design of the VA fixation on the JD/SW.

4. INSTALL VT PLUS EXTENSION INSIDE JT

4.1 INSTALLATION OF SCAFFOLDING

The TE is moved sideways by the HF truck back on to the beam line.

The scaffolding for access to the VA-VT interface is based on the “Bridge” design. The Bridge will have to be evacuated via the top “cage” as shown in Figures 4.1, 4.2 and 4.3. This is because there is no other large enough access route. The installation of the Bridge and the scaffolding can be done before the AE is moved to the run position and in that case it can be installed from the standard access shaft. Alternatively it can be installed after the AE has moved along the beam line – in this case it has to be installed from the cage.

4.1.1 SUMMARY OF TOOLING

Bridge and cage are designed and supplied by ATLAS.

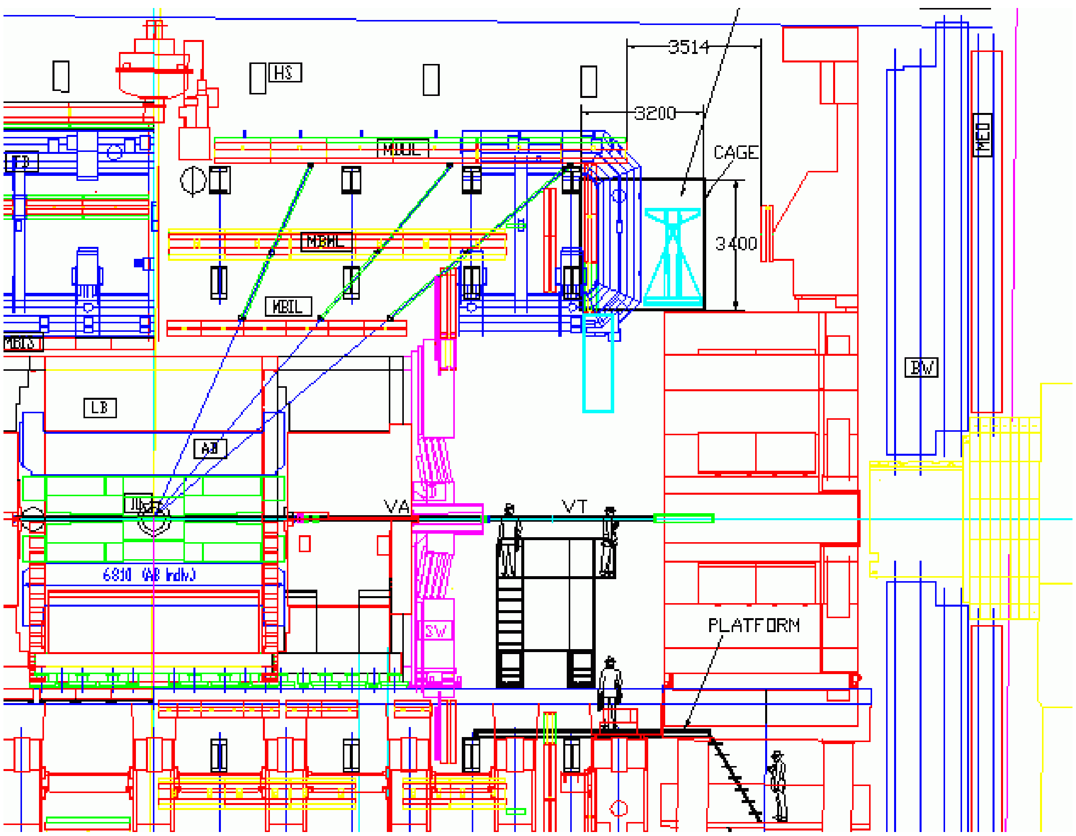

Figure 4.1 Drawing showing the access to the VA-VT interface and the JD.

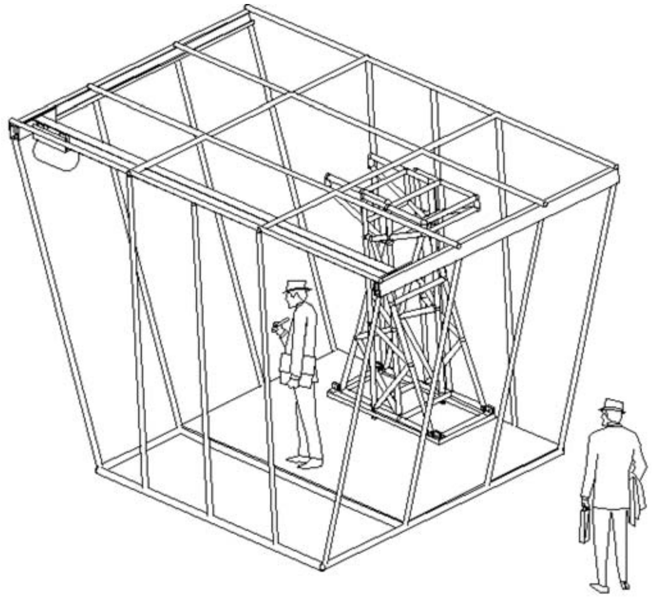

Figure 4.2: The Cage

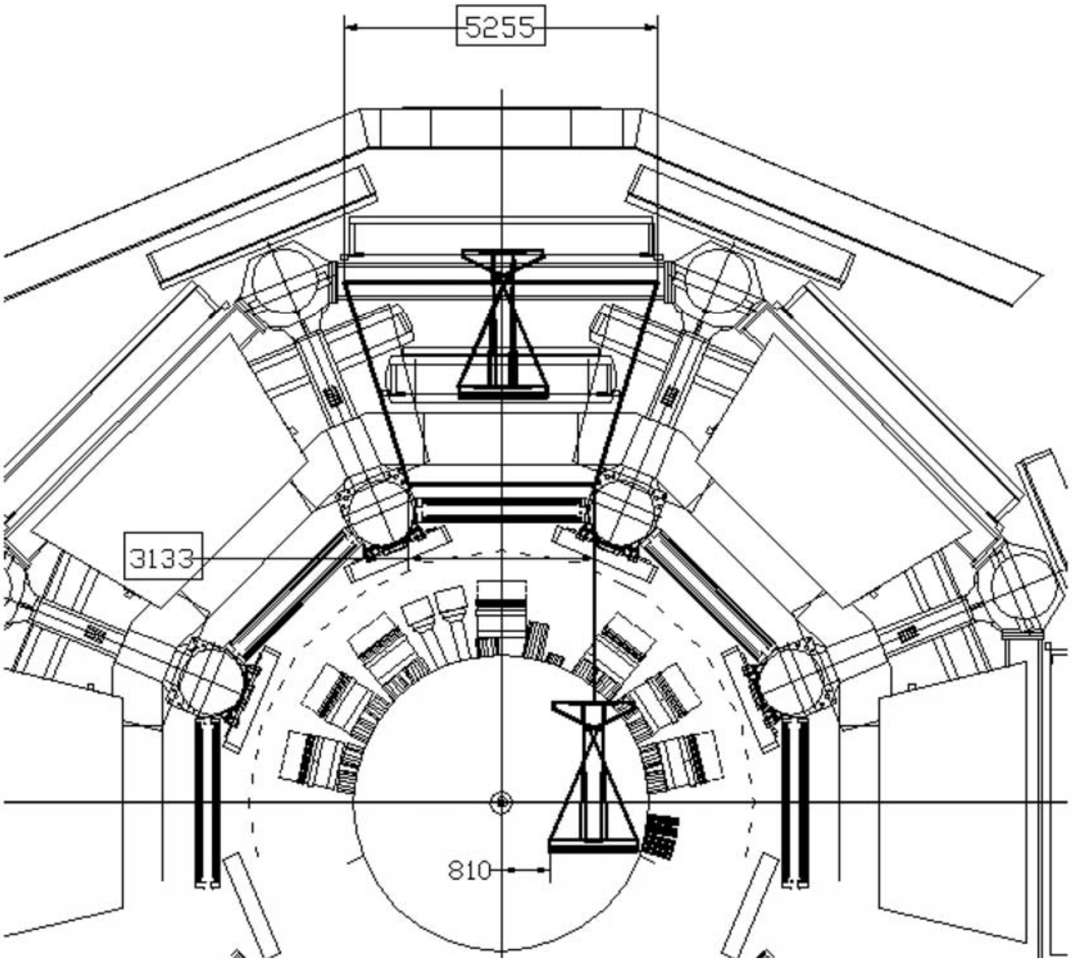

Figure 4.3: End View of the Cage and the lowering of the bridge-type scaffolding.

4.2 INSTALLING THE VT

The VT beam pipe (Figure 4.4) is brought in on a cradle from the top (Figure 4.5). It has to be lowered almost vertically since the access hole at the top is limited. Special "rolling" supports are attached. The VT extension is also brought down, and rolling support attached. The VT extension is inserted into JT. The beampipe is connected to the extension and inserted into the JT shield from the IP end.

4.2.1 SUMMARY OF TOOLING

Transport cradle, rollers for VT and extension chamber with pumping port for VT are all supplied by AT-VAC.

Access tooling is designed by ATLAS (A. Gordeev).

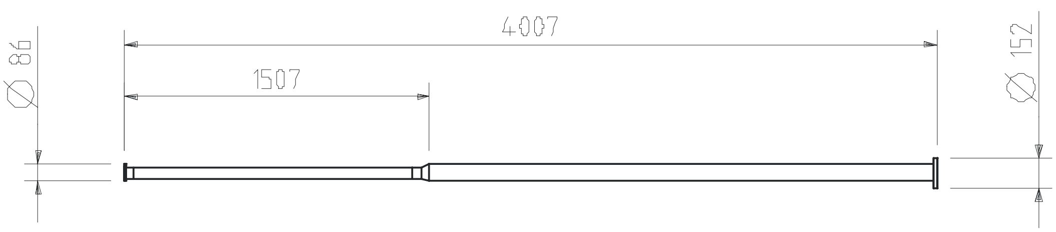

Figure 4.4: The VT beampipe overall nominal dimensions

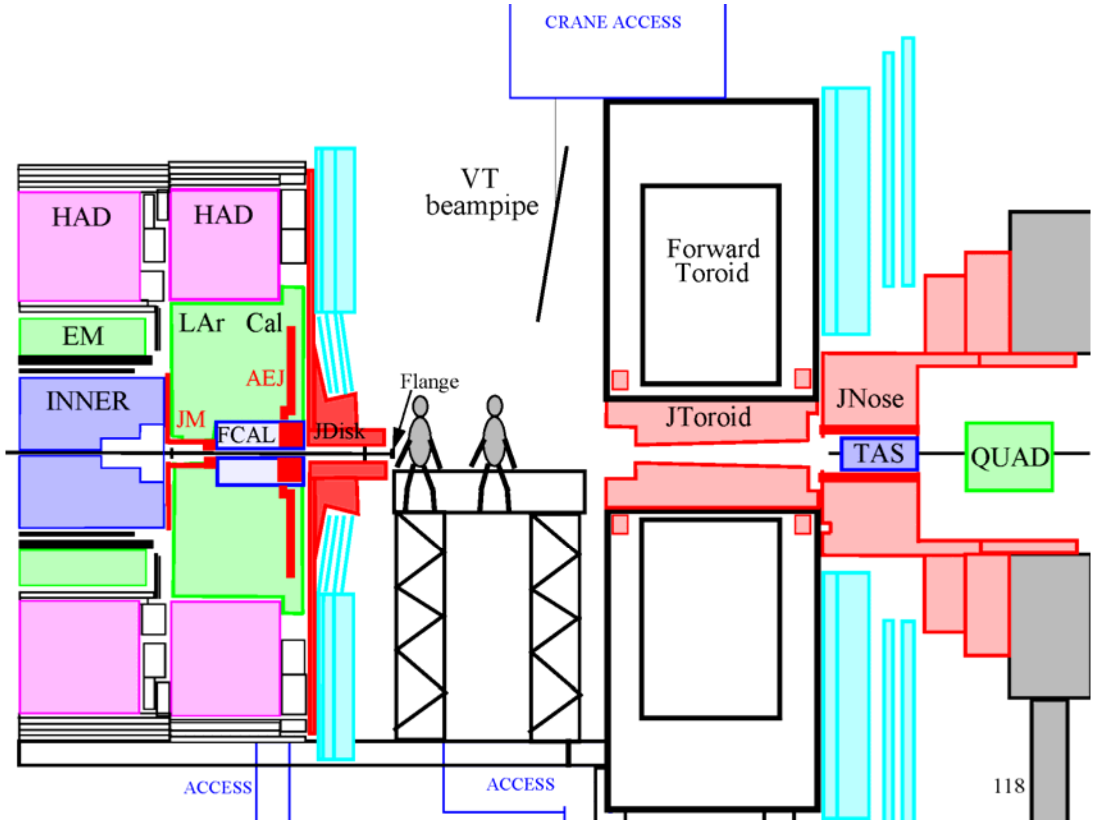

Figure 4.5: Conceptual drawing showing the lowering of the VT beampipe.

4.3 ATTACHING VT TO VA

The VT beampipe and its extension are pulled out of the Toroid Shield (JT) and attached to the VA beampipe at the flange (Figure 4.6).

4.4 TESTING OF THE VA-VT CONNECTION

A temporary support is installed to hold the VT. A mobile pumping group is lowered from the cage and attached to the extension chamber on VT. The VI, VA and VT chambers are pumped down and the VA-VT flange connection is leak tested.

Electrical continuity of the heaters and thermocouples is checked.

The scaffolding is then removed via the cage (Figure 4.7).

4.4.1 SUMMARY OF TOOLING

Temporary support supplied by ATLAS.

Mobile pumping group supplied by AT-VAC

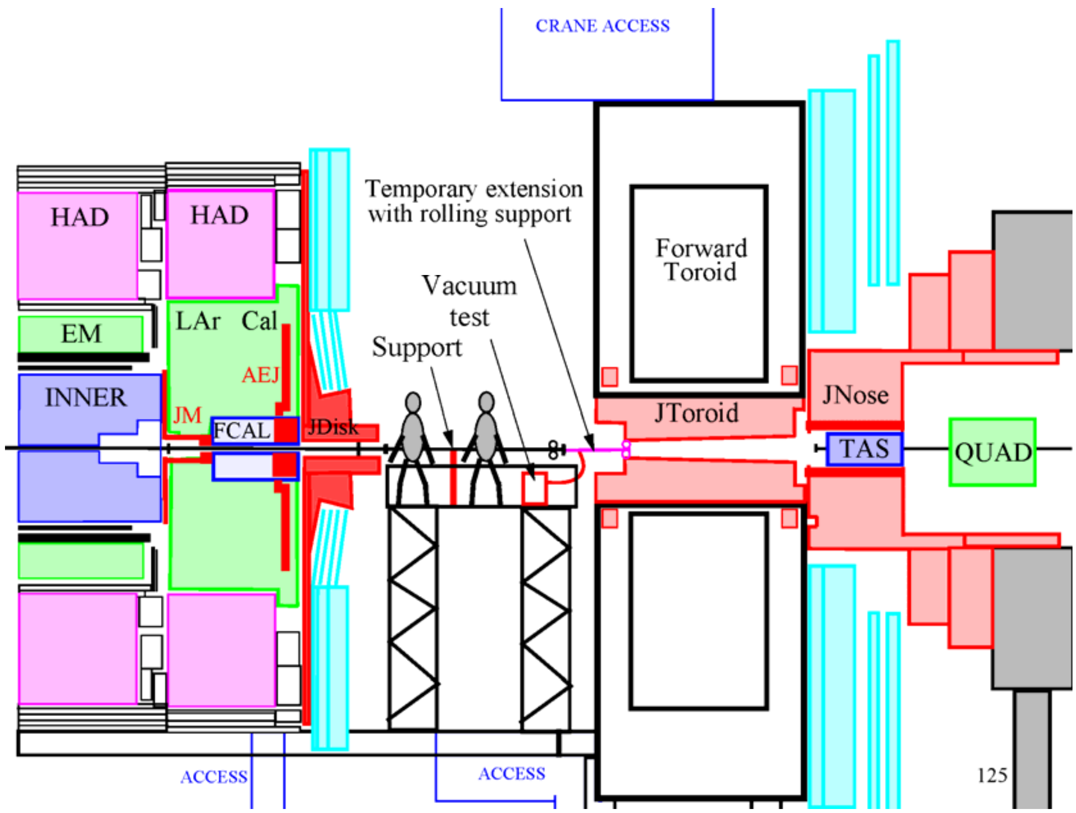

Figure 4.6: Conceptual drawing showing the situation after the connection of the VT and VA beam pipes. The vacuum test requires a special support that is indicated in the plot.

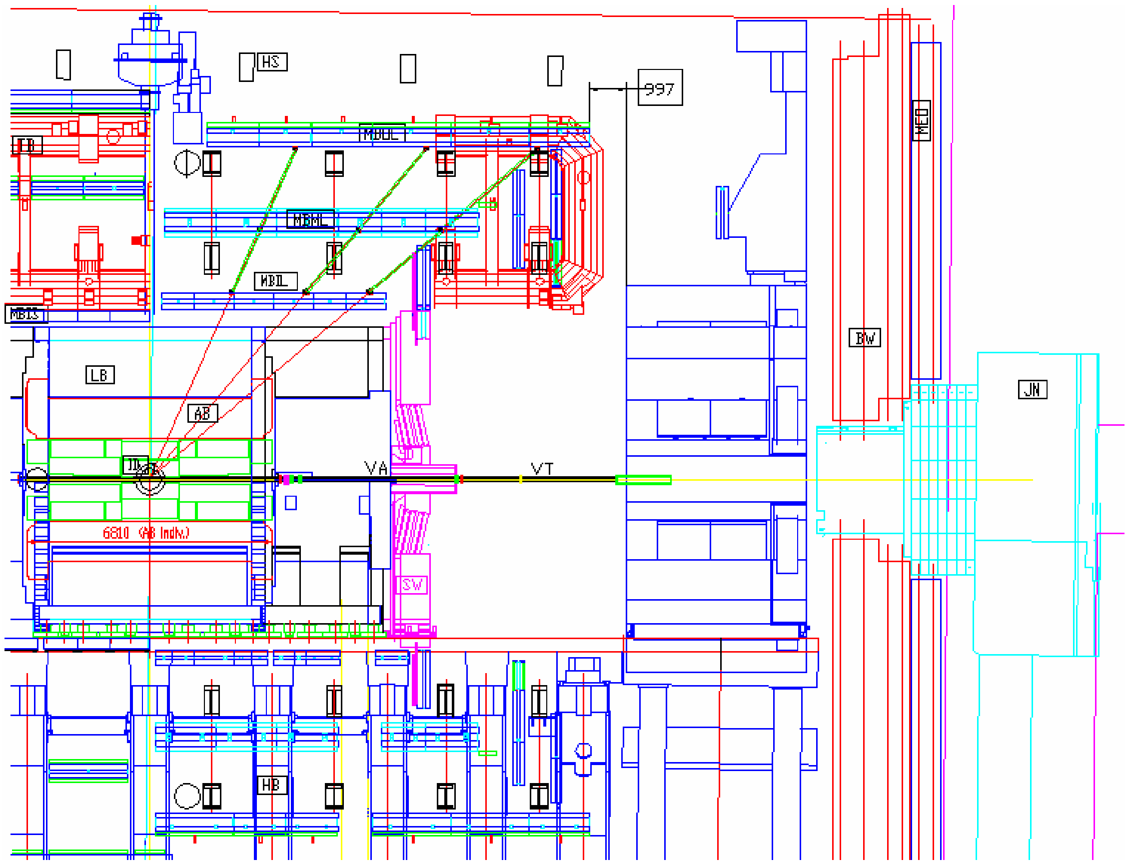

Figure 4.7: Drawing showing the configuration after the VA and VT beam pipes have been attached and the scaffolding removed.

4.5 MOVE TE TO THE RUN POSITION

The TE is moved into its final position after all scaffolding has been removed.

4.6 INSTALL VT SUPPORTS AND ALIGN

The access tooling is installed behind the TE. The access during the VJ installation is based on two minivans sitting on top of the HF truck.

The VT extension is removed (Figure 4.8). The two planes of 'jack' supports are moved in to support the beampipe. The fixed support on the back of JT is installed. The roller holding the back end of VT is removed (Figure 4.9).

The VT pipe is then aligned by the TS-SU to the nominal beam axis.

4.6.1 SUMMARY OF TOOLING

Access tooling is to be supplied by ATLAS (A.Gordeev) following a specification by AT-VAC.

Fixed support is supplied by AT-VAC, funded by ATLAS.

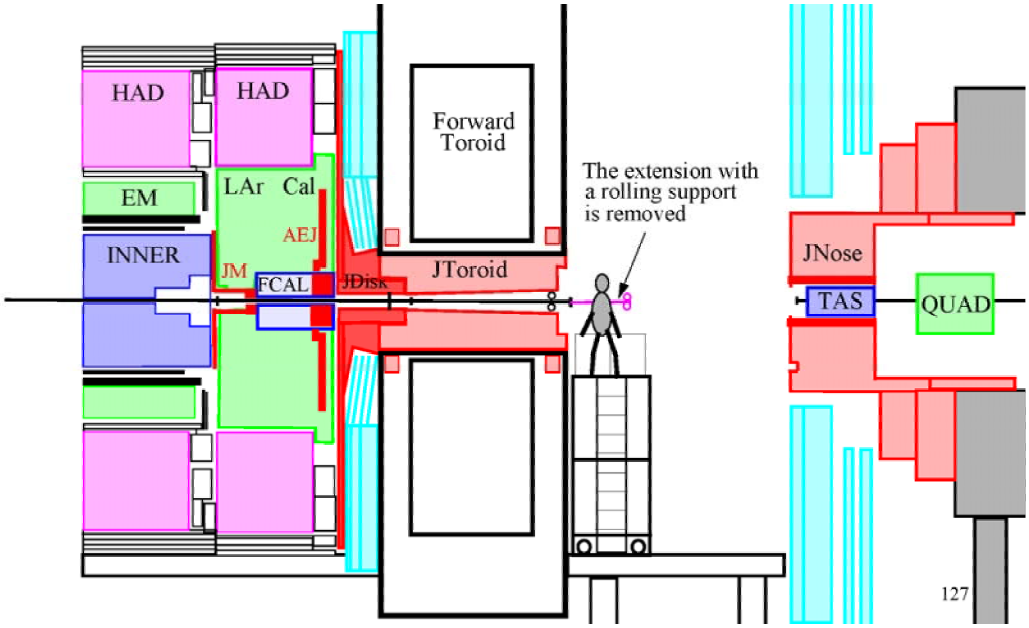

Figure 4.8: Conceptual drawing showing the removal of the VT extension after the TE has been moved to the run position.

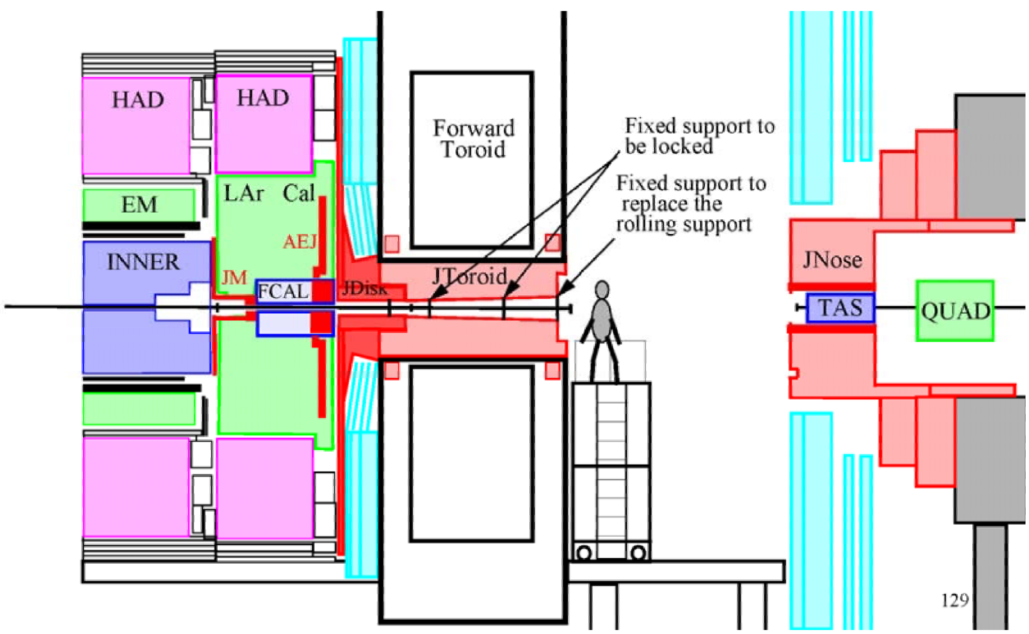

Figure 4.9: Conceptual drawing showing the VT supports locked and the extension removed.

4.7 INSTALL JTV OUTER SHIELDING

Additional scaffolding will be installed to allow for the installation of the polyethylene shield (JTV) on the outside of the TE (Figure 4.10).

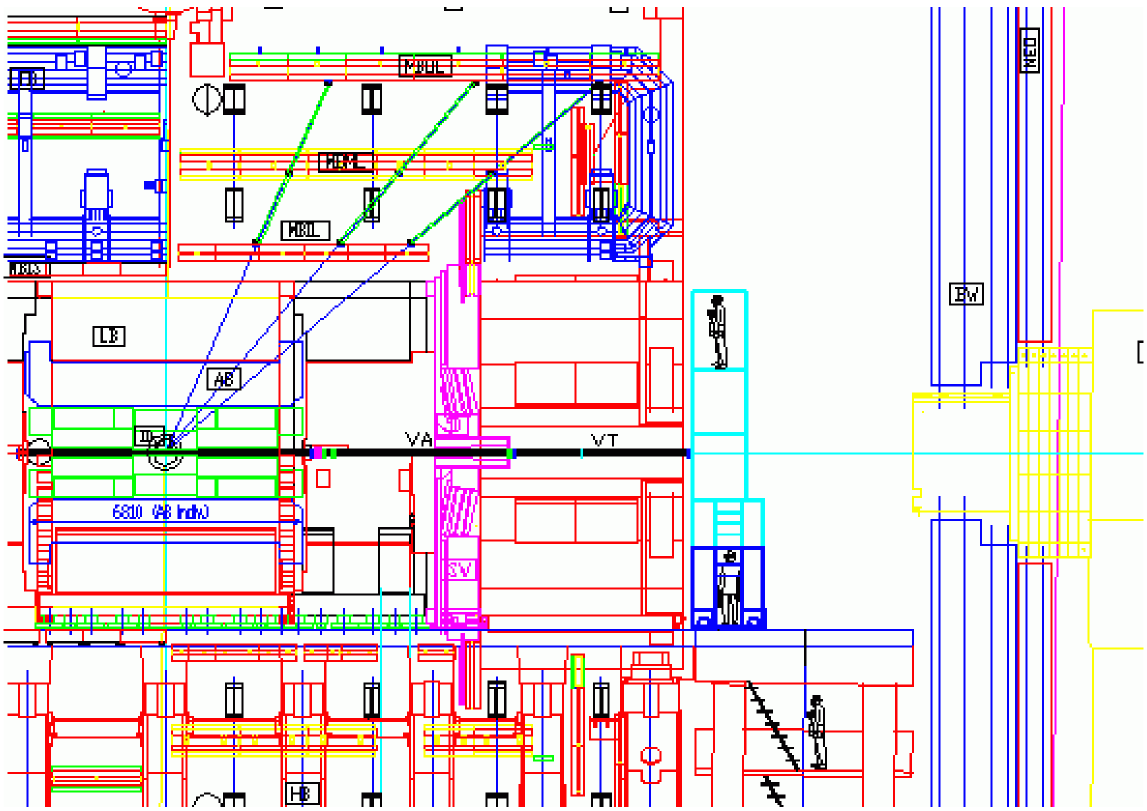

Figure 4.10 Conceptual drawing showing set up for the JTV outer shielding installation.

5. INSTALLATION OF THE VJ BEAM PIPE

5.1 INSTALLATION OF VJ

The Forward Shielding Beampipe (VJ) (Figure 5.1) inside its support cone in a special transport cradle is lowered into its position with the crane (Figure 5.2 and 5.3).

The front flange is connected manually to VT and the back flange remotely closed onto the TAS (see figure 5.4).

The chamber is then aligned inside the support cone by TS-SU.

5.1.1 SUMMARY OF TOOLING

The support cradle is supplied by AT-VAC.

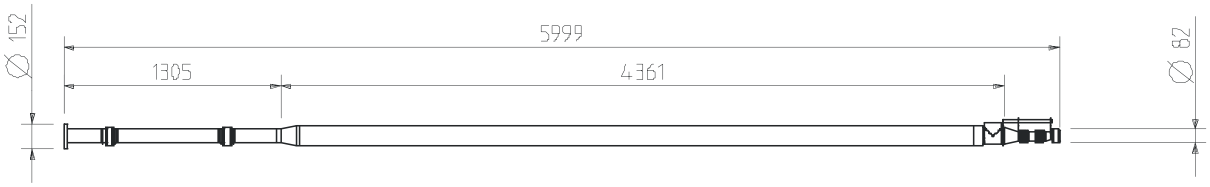

Figure 5.1: The VJ beampipe nominal dimensions (shown here without support cone and pumping station).

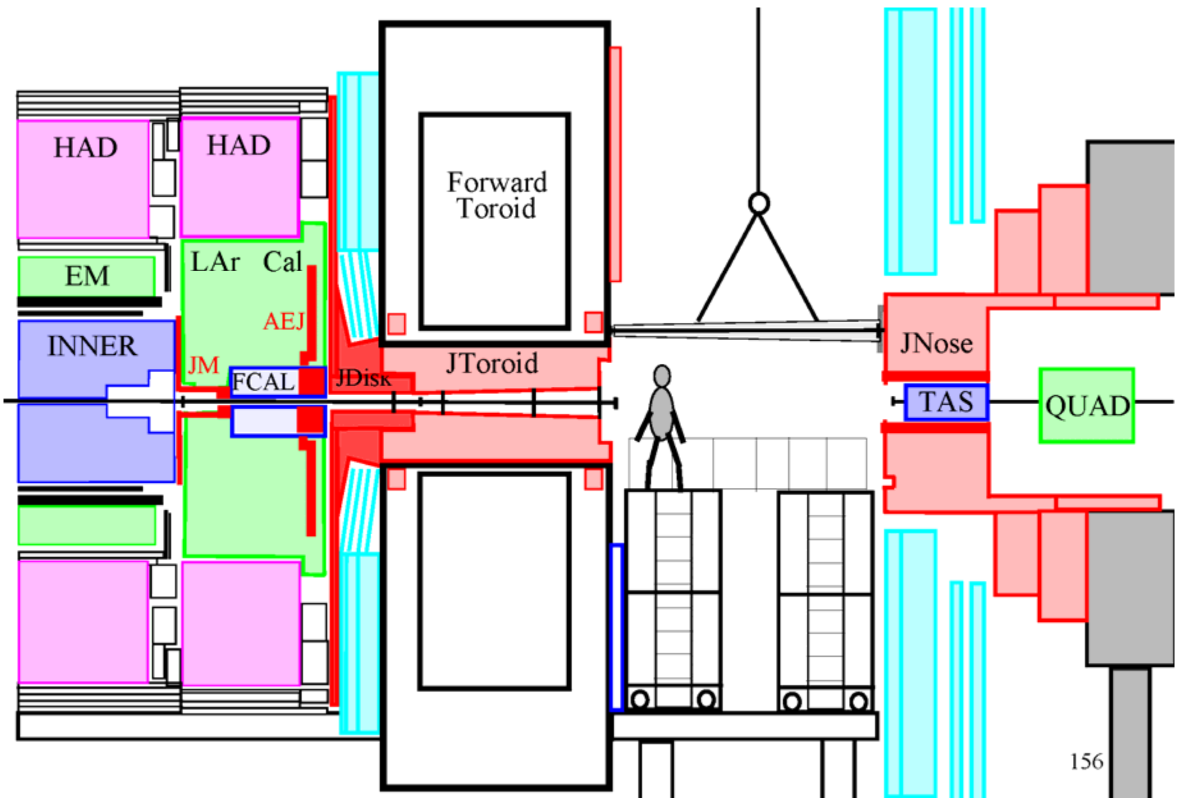

Figure 5.2 Conceptual configuration for the installation of the VJ.

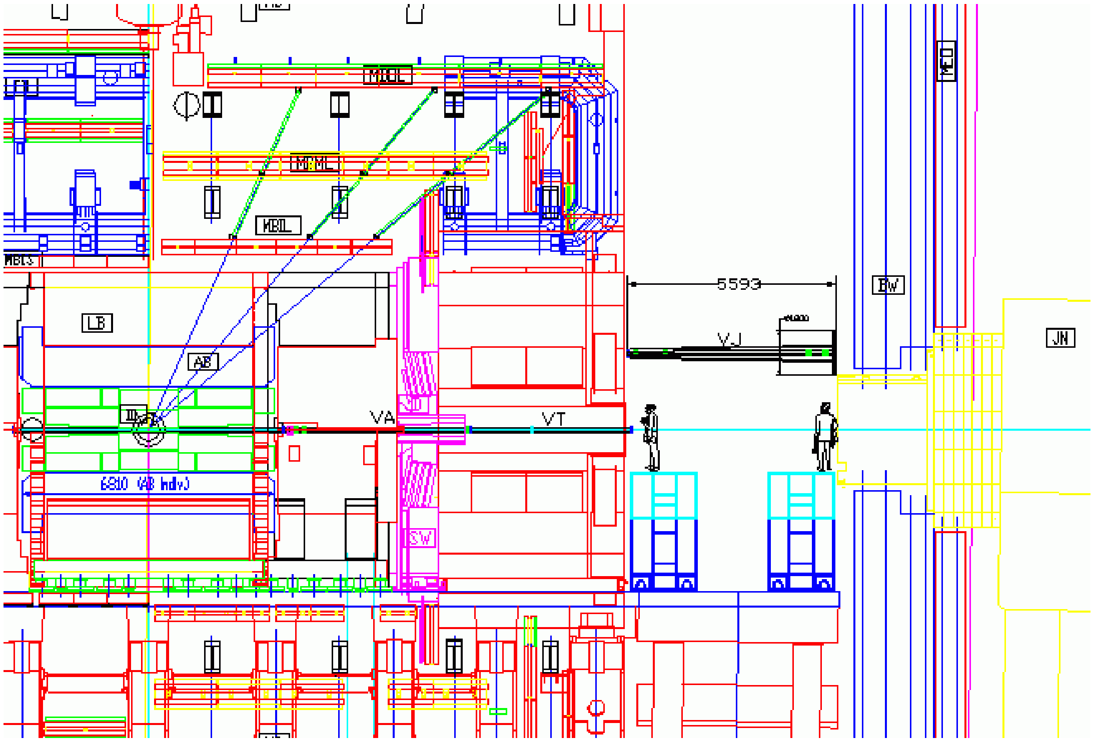

Figure 5.3 Drawing showing access during the VJ installation.

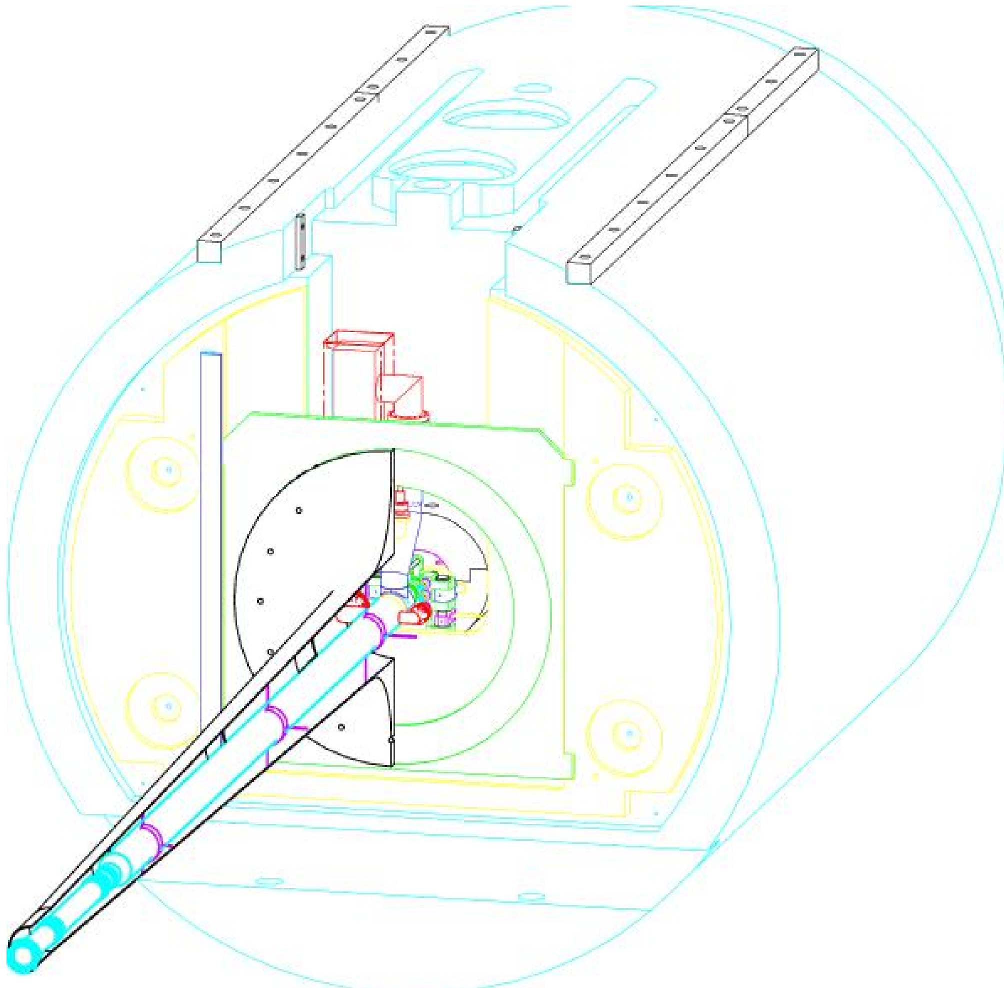

Figure 5.4 Cut through JT support showing remote flange in operating position

5.2 TEST OF THE VJ BEAM PIPE

A mobile pumping group is installed between TAS and Q1 from the machine side. The beam pipe is pumped down and the VT-VJ and VJ-TAS connections are leak tested.

The VT-VJ and VJ-TX1S electrical connectors are attached. The heating system in VT and VJ is tested by heating to 50 C.

The ion pump, NEG cartridge and gauges attached to VJ are tested.

5.2.1 SUMMARY OF TOOLING

The mobile pumping group is supplied by AT-VAC.

6. GLOBAL BEAMPIPE TEST

The entire heating and control system is tested. The entire vacuum sector is pumped down, and all pumps and gauges are verified.

The beam pipe installation is now complete. The JF shielding can now be installed.

Protection will be required for the VJ pipe during this operation.

6.1.1 SUMMARY OF TOOLING

Mobile pumping group supplied by AT-VAC

Beampipe protection to be supplied by ATLAS-TC.

7. BAKE OUT SCENARIO

This scenario is based on the 'bake out in closed position' hypothesis.

A 'NEG activation' pumping group is attached to the roughing valve between TAS and Q1 on either side.

The vacuum sector is pumped down. The thermal cycles required for pump start-up and NEG activation are applied as described in document TBD.

The vacuum sector can either be vented to ultra-pure gas, or left under vacuum for machine start-up.

Should a problem be encountered with the heaters or thermocouples, it will be necessary to pass to 'bake out in access position'.

7.1.1 SUMMARY OF TOOLING

Mobile pumping station and ultra-pure gas injection system supplied by AT-VAC, funded by ATLAS.

8. ESTIMATION OF DURATIONS

Durations are elapsed times (rather than man-hours) spent working in the detector, assuming 8-hour single shift working. Transport to the SX, preparation, documentation, meetings etc are not included.

Operation	**Description**	**Duration (days/hours)**	
		Side A	**Side C**
1	Lower JT platform into cavern	ATLAS (VH)	ATLAS (VH)
	Install JT	ATLAS (VH)	ATLAS (VH)
	Install rails	2/0	2/0
2	Pixel package installation	ATLAS (ID)	-
	Transfer VI to final supports and test	1/0	-
	Align VI	3/0	-
	Connect and test VI services	1/0	1/0
	Leak test VI	1/0	-
3.1	Part-remove platforms	ATLAS (TN)	ATLAS (TN)
	Lower VA into cavern	0/4	0/4
	Insert VA into AE and install temporary support	1/0	1/0
3.2	Assemble scaffolding behind AE	ATLAS (TN)	ATLAS (TN)
	Attach wire support and flexible hose	0/2	0/2
	Advance AE to access position	ATLAS (TN)	ATLAS (TN)
	Remove temporary support	0/2	0/2

3.2.2	Connect VI to VA	0/4	0/4
	Leak test VI – VA connection	1/0	1/0
	Connect and test VA vacuum services and ion pump	1/0	1/0
3.2.3	Remove scaffolding between ID and AE	ATLAS (TN)	ATLAS (TN)
	Install CCD camera and test	0/4	0/4
	Close AE to run position	ATLAS (TN)	ATLAS (TN)
3.3	Remove Scaffolding behind AE	ATLAS (TN)	ATLAS (TN)
	Install JD	ATLAS (TN)	ATLAS (TN)
	Install scaffolding behind JD	ATLAS (TN)	ATLAS (TN)
3.4	Connect VA to JD and align	2/0	2/0
4.2	Lower VT and extension into cavern	0/4	0/4
	Install VT and extension into JT	2/0	2/0
4.3	Connect VT to VA	0/4	0/4
4.4	Leak test VT-VA flange	1/0	1/0
	Test VT services	0/4	0/4
	Remove scaffolding behind JD	ATLAS (TN)	ATLAS (TN)
4.5	Move TE to run position	ATLAS (TN)	ATLAS (TN)
	Install access tooling behind TE	ATLAS (TN)	ATLAS (TN)
4.6	Remove VT extension	0/2	0/2
	Install and align VT supports	3/0	3/0
5.1	Lower VJ and support into cavern	0/4	0/4
	Connect VJ to VT and TAS	0/4	0/4
	Align VJ	2/0	2/0
5.2	Leak test VJ-VT and VJ-TAS flanges	1/0	1/0
	Connect and test VJ and pumping station services	2/0	2/0
6	Global test of V services	2/0	2/0
	Global V leak test	2/0	-
7	Pump down and activate NEG	8/0	-
	Perform clean gas injection	2/0	-
TOTAL Days/Hours		**42/6**	**25/6**

9. REFERENCES

[1] R.Veness "ATLAS Beam Vacuum System Interfaces" LHC-VC1-ES-0002

[2] E.Anderssen et al. "ATLAS Pixel Detector: Assembling and testing the Pixel detector system". ATL-IP-QA-007

[3] A.Smith et al. "Pixel detector installation procedure". ATL-IP-IP-0003

[4] R.Veness "Alignment of the ATLAS VI chamber". LHC-VC1-IP-0001