Appendix H: Floorplan and placement constraints of dilution refrigerator and peripherals.

The refrigerator should be placed in an optics laboratory which houses multiple other working setups. This puts constraints on the maximal sizes of the components of the system, and their placement in the laboratory and the technical room above it. This Appendix details the constraints on size, relative placement, and installation of the components. It is assumed that the main components of the offered system include the dilution refrigerator, a control unit (CU), a gas handling system (GHS), a compressor, and a liquid nitrogen (LN2) dewar.

Laboratory floorplan

The installation location of the refrigerator is situated on the ground floor of the building. Figure 1 shows the floorplan of the laboratory where the refrigerator is required to be installed.

Refrigerator placement – Area (A) is allocated for the position of the refrigerator within the lab, indicating its maximum width and depth. It is strongly preferred to position the refrigerator as close to the bottom-right corner as possible within area (A) as indicated in Fig. 1. Areas (B) and (C) are designated walking spaces directly adjacent to the refrigerator. The refrigerator in (A) can be accessed from both the side connected to (B) and the side connected to (C) after installation, to allow regular operation (opening and closing of the refrigerator, sample exchange, maintenance, etc.). Both short sides of area (A) will only be accessible during installation. After installation, i.e. during operation of the refrigerator, the short sides will be blocked by a wall on one side, and an optical table that will be installed next to the cryostat on the other side. The entrance towards the lab (F) has WxH dimensions of 1170x2580 mm and restricts the maximum size of parts/packages that can be moved into the lab.

Control unit – If the control unit (CU) is not incorporated in the gas handling system (GHS), it is strongly preferred to place it in the designated area (D) in Fig. 1. Area (E) is designated walking space for accessing the CU, if it is placed in area (D). If for technical reasons it is not possible to place the CU in area (D), e.g. because it must be placed closer to the refrigerator, the CU could also be placed in areas (B) or (C), preferably as close to the wall as possible within the designated areas.

Ceiling feedthrough port – The GHS and compressor should be placed in the technical room directly above the main laboratory. The ceiling of the laboratory is at a height of 4.77 above the laboratory floor. Area (G), depicted by the red boundary in Fig. 1, depicts the location and dimensions of a feedthrough port in the concrete ceiling of the laboratory, which provides access to the technical room on the floor above. The lines (electrical, vacuum, gas, etc.) connecting the refrigerator to the compressor and GHS should pass through this feedthrough port. The port is shared with a duct for the laboratory air-conditioning system. A technical drawing of the position of the duct In the port, and of the available space for feedthrough of the cryostat lines next to it, is shown in Fig. 2a. The duct (tube) of the air-conditioning system can be temporarily removed during installation of the cryostat and peripherals if needed. If the lines cannot fit through the space within the port that is currently available next to the air-conditioning duct, the position of the air-conditioning duct within the port can be altered to increase the available space next to it. Figure 2b shows this alternative configuration of the duct in the feedthrough port.

Alternative mounting of turbo pumps – If it is necessary to position the turbo pump of the still line closer to the refrigerator than the location of the GHS to reach the specified performance, the turbo pump can be placed directly next to the port in the technical room above the ceiling, as described below. If that is also not possible, the turbo pump can alternatively be mounted to the ceiling in the laboratory next to the feedthrough port (G). If the latter option is chosen, the turbo is strongly preferred to be equipped with fully magnetic bearings.

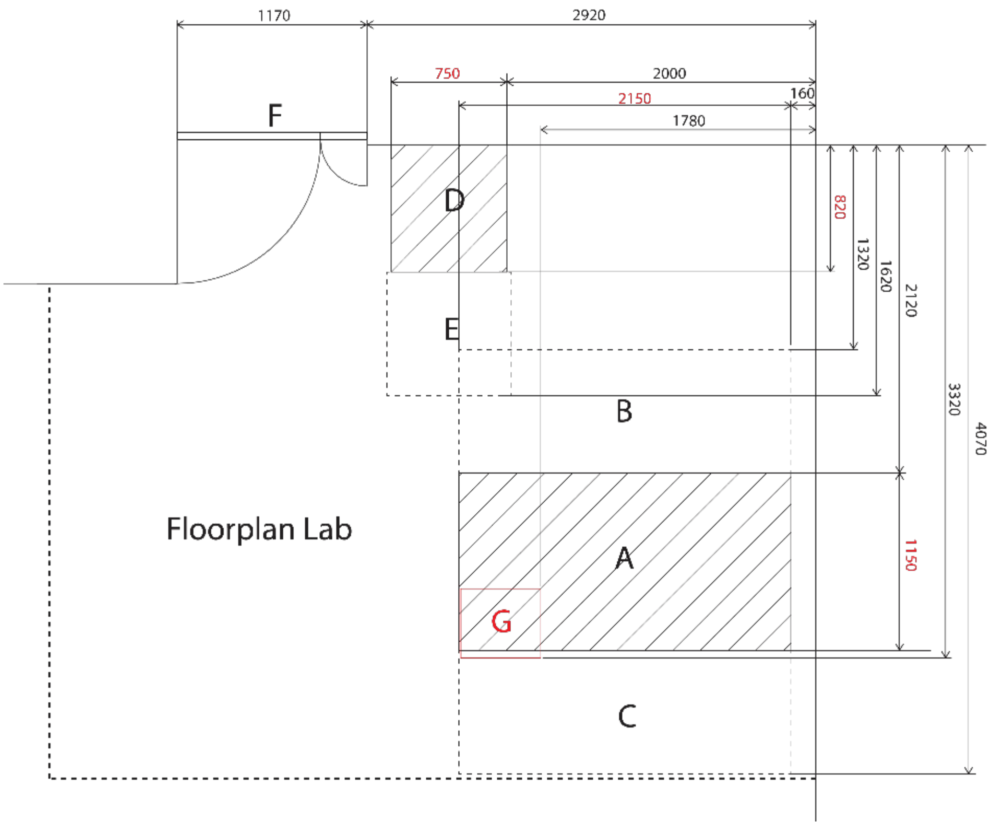

Figure 1: Description of floor plan in main laboratory (ground floor). Items labelled A-G are explained in the text.

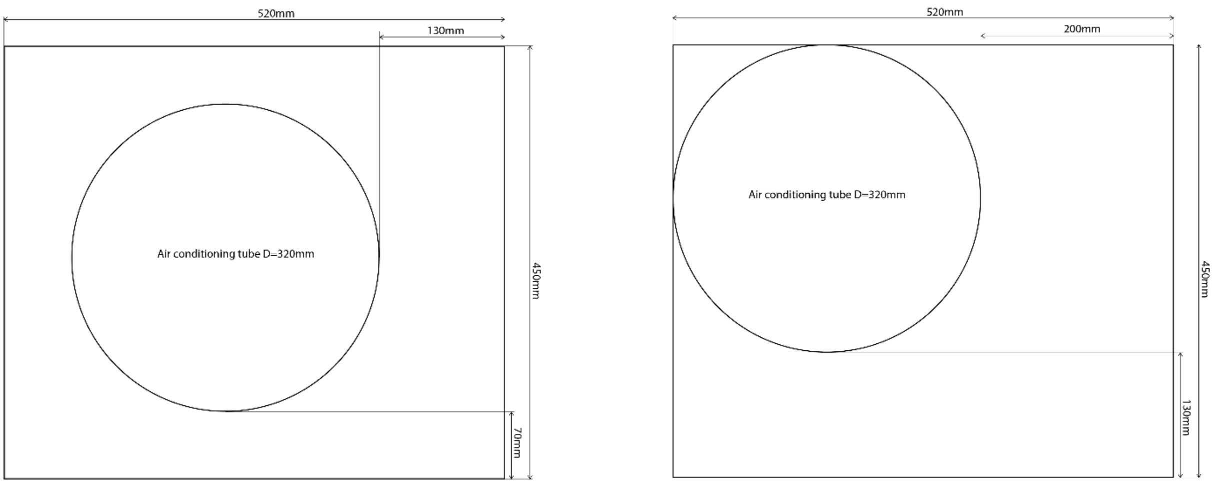

Figure 2. Sketch of the feedthrough port in the ceiling, through which the lines connecting the refrigerator and control unit in the main laboratory space to the compressor and GHS in the technical room on the floor above should run. The port has rectangular dimensions of 520×450 mm, and hosts a cylindrical air-conditioning duct (indicated, diameter D=320 mm). Lines can be placed outside the duct, within the port. The left panel shows the current configuration of the air-conditioning duct in the port. The right panel shows an alternative placement of the air-conditioning duct, which could be realized if a larger space is needed next to the duct for the lines that are to be added for the refrigerator.

Technical room floorplan

The GHS, LN2-dewar and compressor are to be installed in the technical room which is located directly above the laboratory. A detailed floorplan of the technical room is given in Fig. 3. If the compressor of the PT does not exceed WxDxH of 850x1000x1000 mm, the compressor can be positioned on multiple suitable locations close to 3-phase power outlets and connections to cooling water. If the LN2-dewar does not exceed WxDxH of 500x500x1000 mm, the LN2-trap can be positioned directly next to the GHS in area (B) or to the left of area (B) in Fig. 3. If either one exceeds these constraints, additional information can be provided to find alternative options.

Placement of GHS – The GHS should be placed in the area (A). A more detailed drawing of area (A) is shown in Fig. 4. This drawing details also the height profile of area (A). The indicated measures constrain the maximum height that is available for installation of the GHS. Locations (B) and (E) depicted by the red solid and red dashed lines in Fig. 3, respectively, are accessible for servicing and operation of the GHS. It is required that the GHS can be fully operated when installed at location (A) for normal functioning of the cryostat.

Possibility to displace the GHS – It must be possible for the GHS to be occasionally disconnected and relocated out of area (A), such that area (C) remains accessible for maintenance or repairs of the air-conditioning systems that are placed within area (C). Servicing of the air-conditioning system in area (C) is infrequent and typically occurs once every few years. The available space to relocate the GHS is depicted by area (B). The measures indicated within area B detail the available height profile for the relocation of the GHS in each of the areas demarked by the dashed lines. In case service areas (B) and (E) do not provide sufficient access for full maintenance of the GHS, the GHS can be disconnected and relocated to any position in area (A) and (B) to allow full maintenance. It is however strongly preferred that the GHS can be fully accessed for maintenance without disconnecting and relocation of the GHS.

Connection between GHS and lab – The feedthrough port from the laboratory to the technical room above is depicted by area (D) in Fig. 3. Area (F) marked by the black dashed lines is a line of sight opening from area (D) to location (A) which can be used for the various lines between the cryostat and GHS. Area (H) depicts space in the technical room that is available for installing the turbo pump of the still line, in case it cannot be housed inside the GHS for technical reasons.

Moving components into the technical room – To reach location (A) the GHS and any other peripherals need to be manoeuvred through a small corridor with obstacles. The various obstacles that the GHS and other components needs to pass, and the available height and width constraints are depicted in the floorplan of the technical room. A test showed that objects with a rectangular L×W footprint of maximally 750x1000 mm can pass through the corridor. One of the obstacles along the corridor is the cover of a feedthrough port, which rises 80 mm above the floor of the corridor, indicated as area (G) in Fig. 3. A ramp will be built by AMOLF for the GHS to cross over this feedthrough.

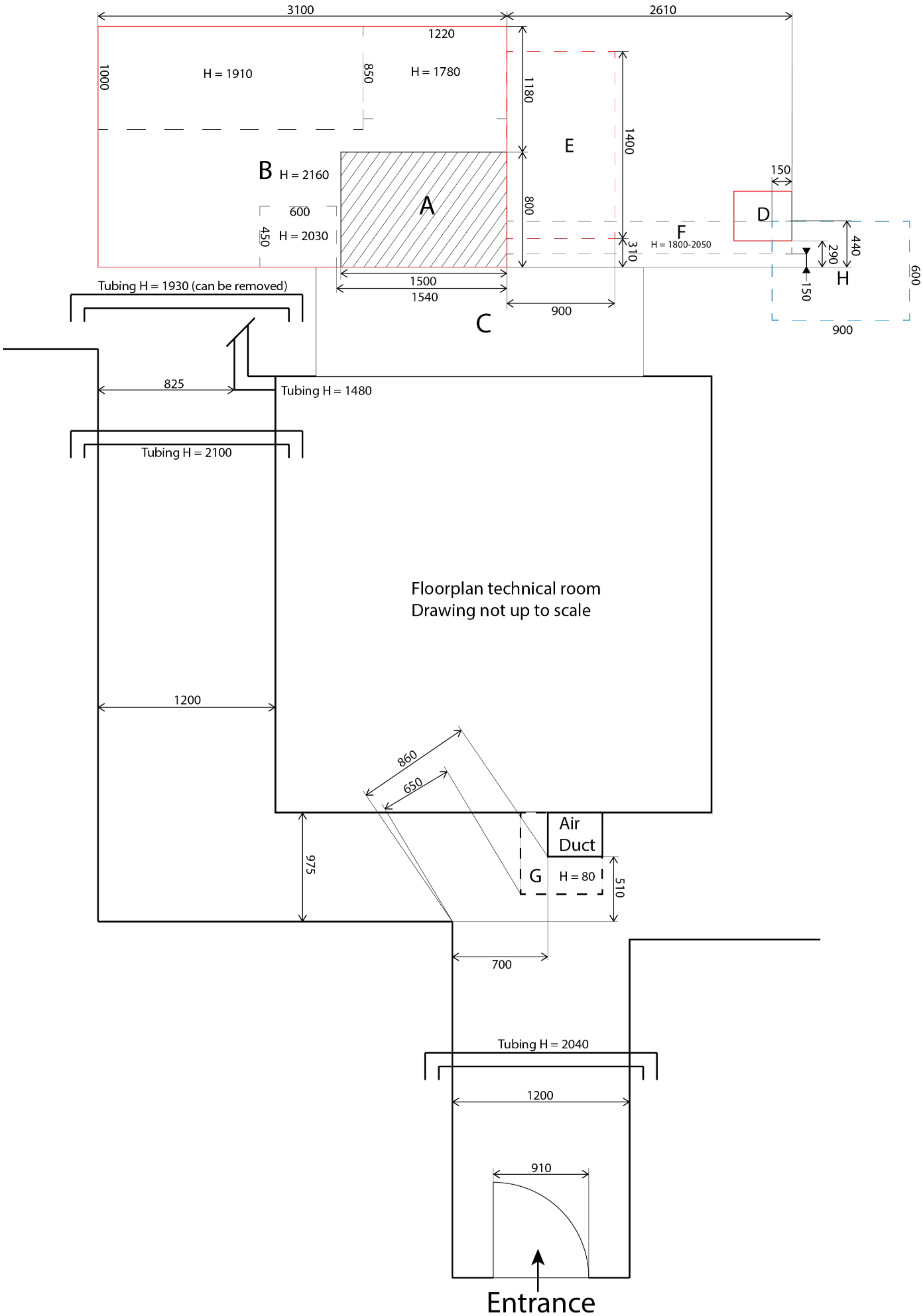

Figure 3. Description of floor plan in technical room (floor above the main laboratory). Items labelled A-H are explained in the text. Indicated measures are in mm, heights are indicated as "H = …" in mm.

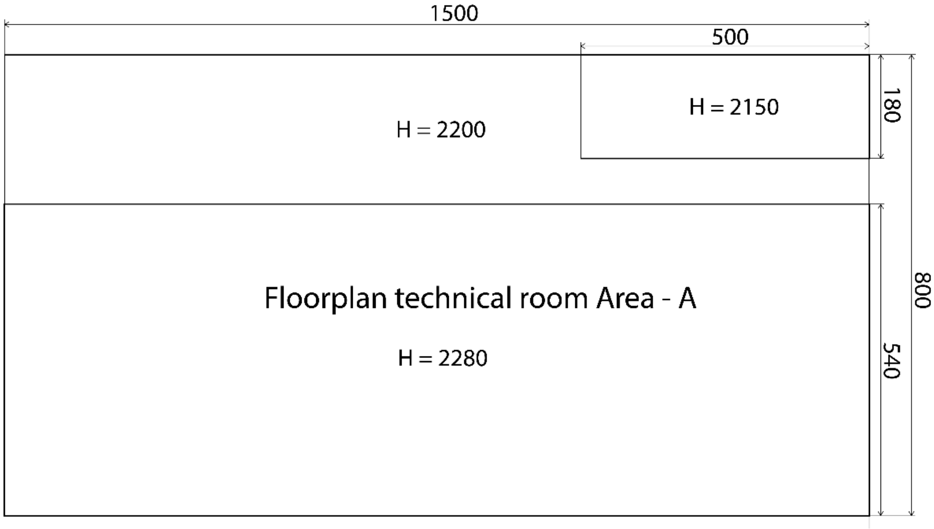

Figure 4 Zoom-in of area (A) in Fig. 3 where the GHS is to be placed. Heights in different sections of the area are indicated as "H = …".

Figure 5: Photo taken in the technical room from right upper corner in Fig. 3; white area in the bottom right of this photo is the feedthrough with air conditioning vent ((D) in Fig. 3) that can be used to pass the lines between the cryostat and peripherals placed in the technical room. The photo also shows a clear LOS towards the intended GHS position.

Figure 6: Photo taken in the technical room on opposite side of figure 5, from top left position in figure 3; Space available for placement of the GHS depicted by area (A) and area (B). Area (C) which requires periodical access resides between the wall and the cable tray.