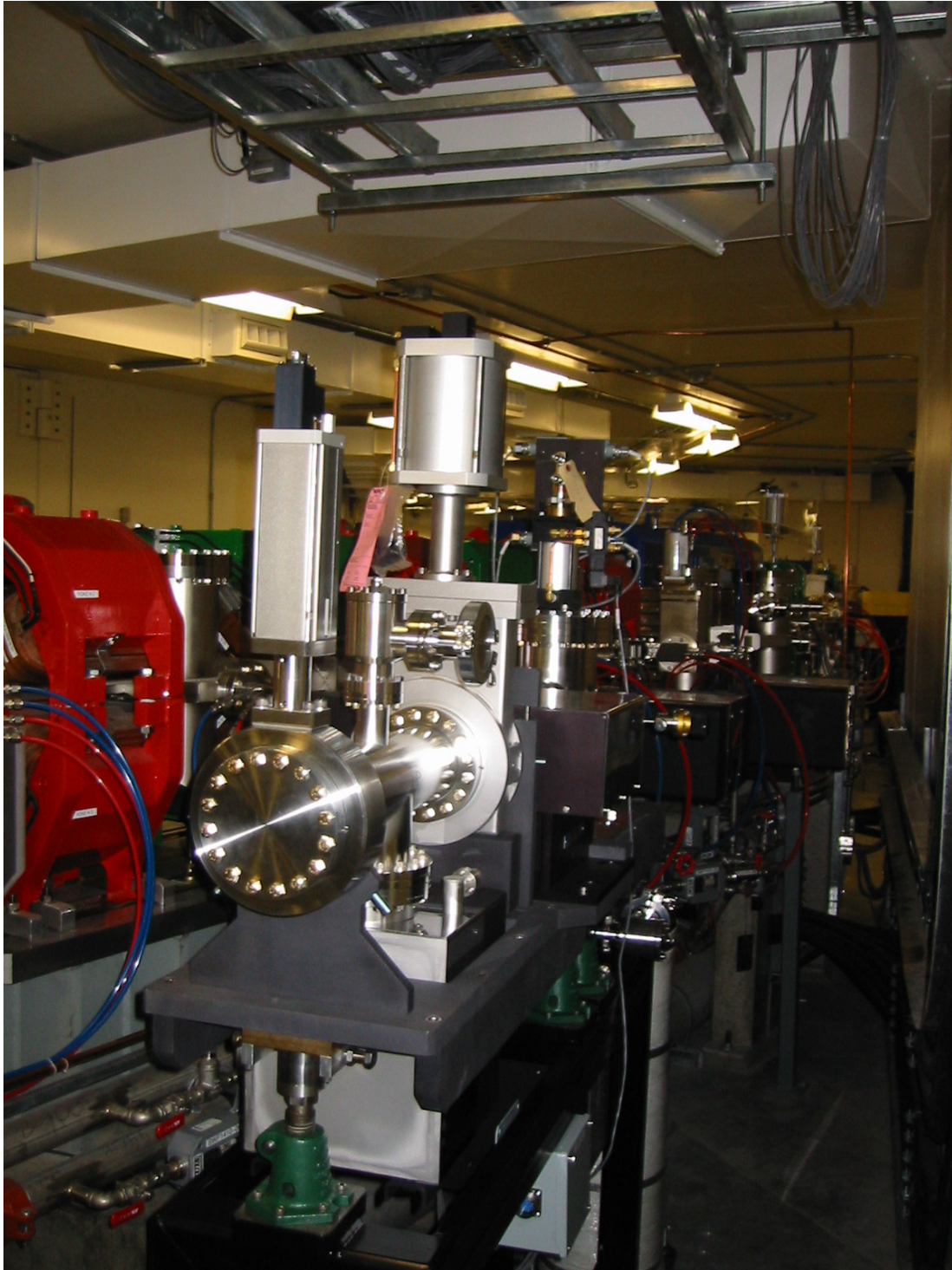


Single and Canted Undulator Front-Ends



JUV Front End - Installation stage photo (ID11-1/ Duplex FE, pictures courtesy of CLS)

FRONT ENDS: SPECIFICATION/ DESCRIPTION OF SYSTEM COMPONENTS

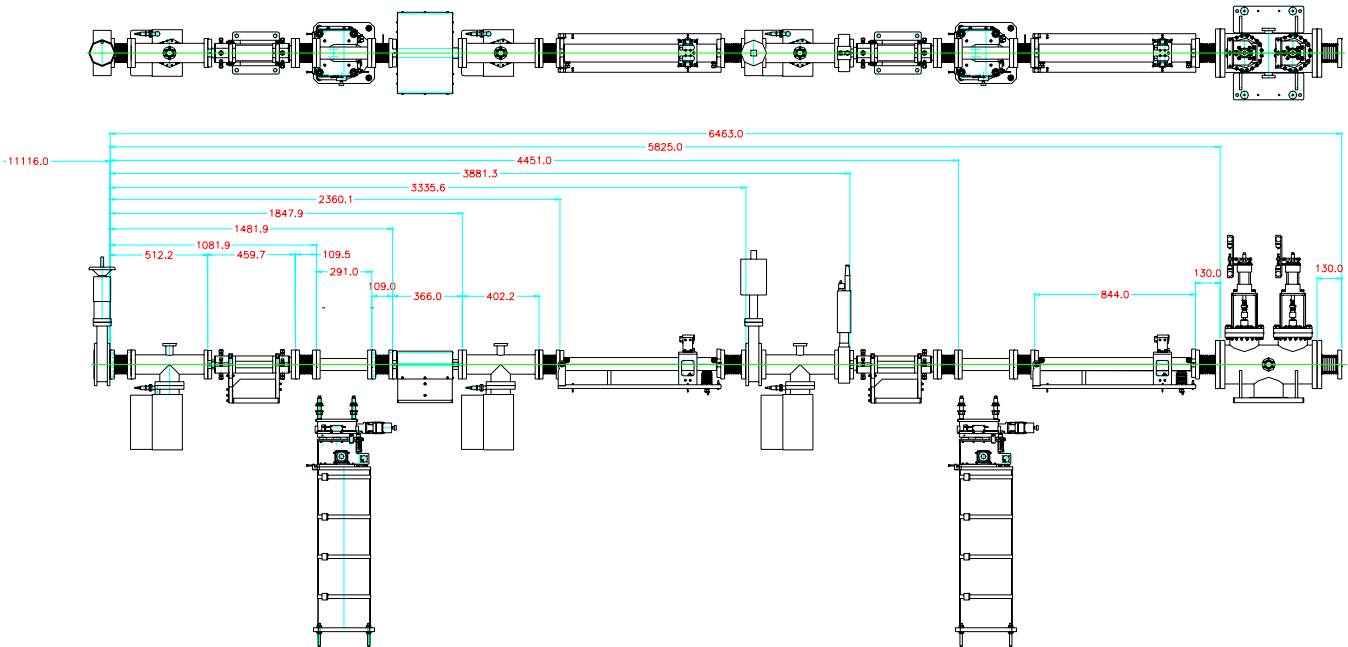
1. Introduction

- ✓ Johnsen Ultravac Inc. (JUV) has acquired since the mid 1990's an extensive expertise in fabricating and testing a large variety of Front End components For Third Generation Synchrotron Radiation Light Sources. Products include Photon Shutters, Integral Shutters, Fixed and Exit Masks, Collimators, Insertion Devices etc.
- ✓ The JUV FE approach is to provide a much simpler design which is fully compatible with the technical requirements implied by the power load and the angular emittance of Third Generation SR Light Sources. This will result in a more **robust** componentry, and therefore a **safer operation** and cost savings in long term maintenance. It will also lead to a substantial **reduction of the price** of standard components, reduction of cost for further orders of FE or their upgrades.
- ✓ The JUV technical solution is based on a **proven technology** and leads to a "failure safe" operation of the accelerator complex.
- ✓ JUV is constantly improving its production version of FE components. For instance, following the original order placed by APS for the manufacture of Photon Shutters based on the so called "hockey stick design" the JUV version evolved into a more robust, out of vacuum water cooled movable mask/ photon shutter.
- ✓ JUV is highly recognized for its quality of workmanship, timely delivery and virtual zero failure rate of its components in beam line operation. JUV is in close and ongoing collaboration with leading scientists and engineers who are extensively using SR or involved in SR instrumentation design, so their expertise can be available to the global SRI community at large.
- ✓ JUV is committed to a long term relation and has a proven reputation as a reliable vendor. Sales records show that JUV has **managed to keep its cost advantage over a long period**, which is the best insurance to support such a commitment.

2. Single JUV Front End – Typical Layout

Although JUV can supply individual FE components, we believe that the following schematic addresses the optimum Front-end lay-out. It can be modified to serve both canted and single FE needs, and by selecting the fixed mask opening (aperture) it can be fitted to a different angular acceptance, specific to each ID.

Although the sequence of the components is from right to left, their actual position will be further defined based on the available access space, power load analysis and tracing analysis.



Following the manual valve and the prefixed mask (this water cooled mask is not shown, but will be included in an actual design proposal), the FE starts with the flexible bellows, which mechanically decouples the FE from the storage ring main chamber.

The pumping unit will provide sufficient pumping capacity to prevent the gas desorption propagation towards the ring if miss steered SR beam strikes the first fixed mask. It will be equipped with a cold cathode gauge to monitor the FE upstream pressure.

The first fixed mask will be customized from an APS designed fixed mask and could be up to 600mm long.

The front opening of the mask shall be equal to the opening of the prefixed mask, but the cone will reduce the SR pencil close to the ID emittance.

The main purpose of the fixed mask is the confinement of the miss steered beam and the safe termination of its power load.

The SR tracing analysis will define the FM aperture and such analysis will be carried once the e-beam and power load information is made available.

Our calculations indicate that for a 2.5mm e-beam miss-steering and 550mm long fixed mask an angular miss-steering shall be within 1mrad. Based on the APS design, we envision, that although such tracing will define the FM opening, the FM design will be adequate and single FM layout will be sufficient for beam movement. The xBPM is the next downstream component. JUV suggests to use a stable mounting platform with Z (vertical) X(horizontal) table mounted on the top and flex bellows for independent movement. JUV will supply the housing for the xBPM.

A similar unit at APS shows the following performance:

CVD diamond blades sustain the power load, associated with 2mm range of travel and lead to $\sim 0.25\%$ accuracy of SR profile reconstruction. This performance results in e-beam determination $\pm 3.5\ \mu\text{m}$ in the position and $\pm 0.15\ \mu\text{rad}$ in the angle.

The support structure with auto-motorized XZ table is an optional separate component. JUV will provide mechanical assembly and wiring to a distribution box and can supply for drivers, stepper motor control and total integration for a complete turn-key installation.

Fixed lead filled collimator is a first BS collimator and together with the BS safety shutter and wall penetration collimator defines the BS tracing.

The BS tracing analysis will be available as soon as the BS range of e-beam movement is provided.

First collimator to BS shutter separation of $\sim 4.5\text{m}$ results in effective BS cone reduction to $\sim 15(\text{h}) * 2.5(\text{v})\text{mrad}$.

The pumping unit upfront of the first photon shutter will take care of the gas load due to the SR stimulated desorption, when the first photon shutter is closed. The first photon shutter, a customized version of an APS 1.5° tapered pneumatic shutter (contact JUV for technical details) shall be sufficient to terminate ID power load and to safely close the FE even with ID at maximum magnetic field position.

The first pumping unit and fixed mask will be supported by a common support platform, while the collimator, the second pumping unit and the first photon shutter will be placed on a second platform. The final design will be based on the local tunnel requirements (available space, installation procedure, etc.).

JUV will ship each section pre-aligned with Laser beam.

In addition, each SR defining components will have fiducial marks (currently assumed 8H7 drilled holes to hold back reflected target), for verification of their accurate position. All the support structures have manual alignment flexibility to 1" in space and need to be grouted to the floor during installation. The first section is identical to all FE's. Considering that the JUV proposed design is more compact, the spool pieces will be added to position the FE components, as defined by BS and SR tracing analysis and to specific customer's requirements for easy access and maintenance.

The second section of the FE starts with slow/ fast valve block, separated by a pumping unit. The electronics and sensors for the fast valve could be supplied by Customer. JUV will wire them to a distribution box. JUV recommends mounting fast acting sensors on the BS main safety shutter vacuum vessel. APS experience shows that low conductivity of FE section between BS safety shutter and fast valve provides adequate time delay to breach a shock wave in the case of a vacuum accident.

The second fixed mask will define the FE beam opening and could be customized to reflect a specific beam line (ID) choice. As it can be seen on the SR tracing, this mask defines the FE angular acceptance, the opening as large as 2 mrad needs an additional verification based on Customer's power load and its range of miss steering. The second xBPM is separated by $\sim 3.5\text{m}$ from first xBPM, so a performance similar to the one at APS can be reached. JUV will supply the xBPM spools as per Customer's specification.

The second photon shutter is a main user control photon shutter of the FE. For single FE design it is deemed to be sufficient and the APS operational experience proves it has stable operation (low failure) even at high closing repetition rate. It is mounted on the same support as the BS safety shutter. Wall mounted collimator and the exit pneumatic wall mounted valves are omitted but will be supplied by JUV.

Additional FE sub components that JUV could also supply are the differential pumping unit and/ or beryllium foils mounting block. They should be placed outside of ratchet wall after the FE termination valve.

To monitor the FE partial pressure and simplify the FE trouble shooting and maintenance, JUV is recommending mounting a RGA on the safety shutter side port.

3. Canted Undulator JUV Front End

The main differences between the single and canted FE are:

- The second fixed mask will have two built in slots with the openings specific to each branch and central fin.
- The second photon shutter will be modified. It will have tapered shape (compare to “dog bone” as for single FE) and its downstream part will be mounted on an X linear stage.

In addition to a vertical actuation (pneumatic cylinder, ~1sec actuation time), as required for the safe closing of the FE (both branches) and the protection of the downstream BS safety shutter, such a canted photon shutter will be capable of closing off individual branches by employing a side movement (yaw pivoting against fixed upstream point, ~10sec actuation time) of the photon shutter body (and expose its internal side wall).

According to preliminary FEA analysis, the maximum stress build in the photon shutter taper will be ~30% higher for the exposure of the corner, and such a shutter can withstand a less powerful SR beam.

JUV expects to perform the FEA analysis and report back the power load limitation pruned for such a photon shutter.

Also the logic of the FE safe operation could be modified to prevent miss-steering of two beams in one branch at full power, exposure of downstream components with partially closed photon shutter, etc.

JUV will supply a single set of end of travel switches and home switch and the wiring to the distribution box for such a shutter. Customer will have to supply the controls and complete integration but can also be supplied by Johnsen Ultravac.

The photon beam position monitor system represents a challenge for the canted FE, especially if two IDs have very different angular distributions. Like on the single FE, JUV will supply a spool piece representing the xBPM.

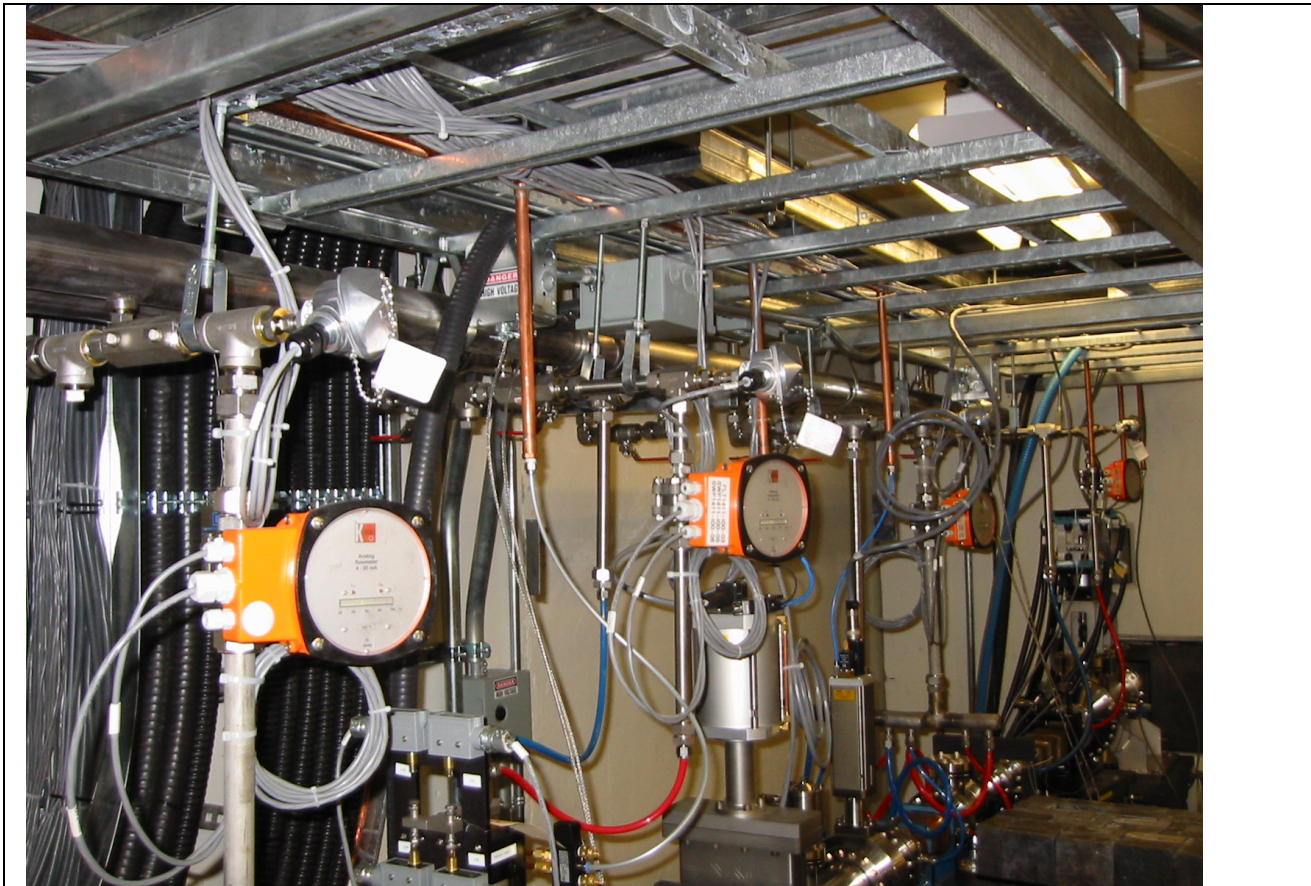
Further components such as Water Flow Switches and return Water Flow meter for the water-cooling manifold that services prefixed aperture, fixed aperture and photon shutters, above (or side way from) the FE along the distribution lines can be supplied by Johnsen Ultravac.

JUV FE components will be terminated with Swagelock connectors and will be ready for on site plumbing.

The requirement for air supply, needed for actuation of photon and safety shutters:

Air pressure: 100 psi (7 bar) constant pressure, failure safe

JUV is willing to consider other options and is ready for a dialog with Customer to define the interfaces for the service lines.



Service lines (above the FE: LCW-2 lines and air-1) installation and plumbing of FE components.

4. Support & Survey

All JUV FE components have 8H7 holes, which can accept back reflector spheres as survey tools. We can accommodate other type survey references. JUV is ready to provide an estimate as soon as more detailed technical specifications are provided.

JUV will provide information on the locations of the photon beam defined surfaces with respect to the survey markers. Test measurements performed at the CLS showed a very good correspondence between the JUV supplied lookup table and real measurements and compliance with imposed accuracy.

5. Bakeout System

As the FE components are rarely taken out of service (not kept in vacuum), JUV recommendations is to use heater tapes rather than permanently mounted heating jackets. The complexity of the external cooling configuration for various FE components, would lead us to a similar remark. Their supply, as well as the thermocouples and other bake out components are usually excluded from a given proposal however, if this is deemed to be a “must”, JUV can provide price estimates and supply.

6. JUV Contact Representatives

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