Beam Profile Measuring System (Grid, Harp)

Type DG 070

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Beam Profile Measuring System (Grid, Harp)

Application:

Measurement of intensity distribution of an accelerated ion or electron beam in two transverse directions (X and Y). Optional grids are available that permit measurement of additional planes.

Principle:

Wires to be used for X and Y planes collect charged particles; the collected charge is then converted to a given energy level, which represents beam profile intensity. For particles having a range which is greater than the thickness of harp wires themselves, secondary e1ectrons can be measured. Custom units are available for specific measurements.

Configuration of Complete System:

- Compressed air actuated high vacuum feedthrough (permits **harp** to move ‘in’ and ‘out’ of the beam path)
- Harp and frame with adapter (permits unit to be connected to compressed air actuated feedthrough)
- Signal processing electronics.

Technical Specifications:

Supporting flange	:	CF-100 flange (6 inches O.D.)
Stroke	:	3.15 ± 0.01 inches
Drive	:	compressed air actuator
Pressure	:	60-90 psi
Pressure control	:	solenoid valves (24 V D.C.; 0.5 A)
Locking	:	In the event of air pressure failure, unit will remain outside of beam line. As an option, the measurement system can be designed to move into the beam path at time of air pressure of power failure.
Damping of the ‘in’ and ‘out’ movement of harp	:	adjustable

Cover Photograph: *Back side of a harp. To be seen: 2 x 48 wires, ceramic insulation, Cannon-connector, nut and pin for hook-up to a compressed air actuator.*

Technical Specifications (continued):

Adjustment of actuator shaft orientation	:	Mounting plate provides variable tilt by way of a leveling screw, allowing adjustment of actuator shaft orientation.
Vacuum sealing	:	Conflat flange and membrane bellow.
Electrical feedthrough	:	32 pins with UHV connector on a CF-35 mini-conflat flange (standard). Other options are available.
Materials		
Inside vacuum	:	Stainless steel
Outside vacuum	:	Nickel-plated mild steel

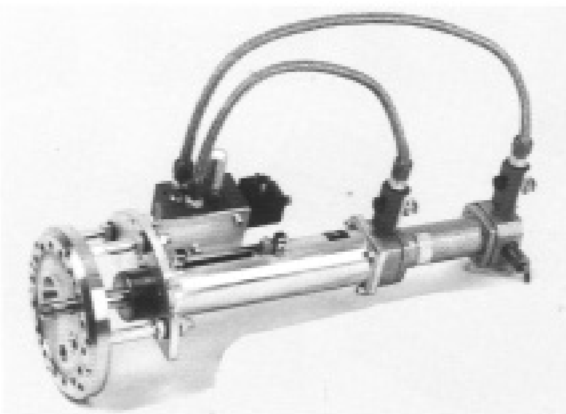


Fig. 1.

Single version compressed air actuated feedthrough. Actuator cylinder with locking mechanism, magnetic control valves, end switches, membrane bellow, CF-100 flange, shaft with thread for harp connection (or other elements).

Harps are available in several different configurations: the following parameters should be specified at time of inquiry:

- number of wires (typically N x 8, N = 1-10)
- spacing between wires (minimum 1mm)
- thickness of wires (typically 0.1mm)
- length of wires (norm: 40 - 60mm).

Additional Specifications:

Material	:	W-Re
Tension on wires	:	Spring (Duratherm-600) each wire
Insulation (wire against wire)	:	$A1_2O_3$
Frame	:	$A1_2O_3$

Technical Specifications (continued):

Protection against sputtering	:	Ta shielding
Connector (on harp)	:	Cannon
Vacuum performance	:	Approx. 10^{-7} Torrs

NOTE:
Connector with ceramic insulation is available; thus, bakeout up to max. 200°C is possible.

Electrical feedthroughs	:	See specifications for compressed air actuated feedthrough.
Hook-up to compressed air actuated feedthrough	:	Thread/bolt fitting and twist lock
Maximum tolerable power dissipation	:	Approx. 1 watt/mm length of wire.
Protection against thermal damage (optional)	:	Light-sensitive diode (triggers arbitrary beam attenuator).

Fig. 2 Different harp configurations available

SIGNAL PROCESSING ELECTRONICS FOR BEAM PROFILE MONITORS

The high standards of performance for harps installed on linear accelerators are outlined below:

- Broad range of currents can be processed due to the large spectrum of ions which are accelerated.
- High sensitivity (in the lowest current range) to detect very small currents of highly charged ions (or even ions of rare isotopes), extracted from the ion source by using natural isotope mixtures as sputtering materials or gas, respectively.
- A rather short signal integration time (approx. 0.5 - 10 msec.) as given by the duty cycle of the machine.
- Fast signal processing in order to monitor the profiles of various ions with respect to a possible time-shared operation of machine.
- Fast range setting: pulse-to-pulse variation in intensity in time-shared mode.
- Fast switching to various grids of the complete analog signaling electronics to enable user to observe multiple profiles along the machine, almost simultaneously, during such procedures as beam alignment.
- Modular design with respect to number of channels (i.e. wires in grid) which have to be implemented.
- Universal interfaces in the control system, including local intelligence, enabling control of electronics by simple commands.
- Automatic set-off adjustments to avoid time consuming maintenance and service.

General Description:

We have provided a block diagram of the electronics on the following page (Fig.3). Note that up to four (4) individual harps, with a maximum of 2 x 48 wires each, can be connected to our newly developed fast FET-multiplexer. Signals of selected harp are fed to current and then to voltage converters, followed by integrators. The integrated output signals are scanned by an analog multiplexer and digitized by the ADC.

A microprocessor controls range selection, timing, and multiplexer unit. Digitized data, including appropriate range information, is stored in a RAM integrated into the system. The interface to the main control system is also controlled by the microprocessor; customer should specify parameters for control system.

The total system can be synchronized by timing pulses or even coding.

To observe analog signals, as well as to provide trouble-shooting capabilities, an oscilloscope (connected to remote terminal) is used for implementation of test and command procedures.

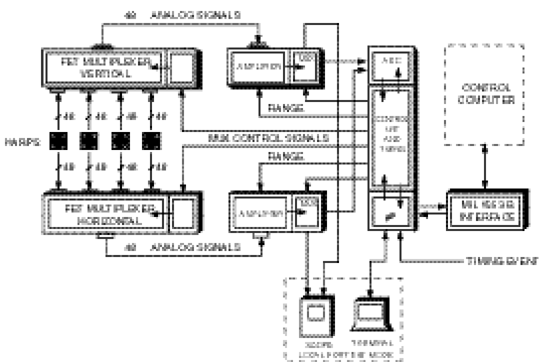
FET-Multiplexer:

We have developed a *fast, solid-state* multiplexer capable of switching currents down to 100 µA with good linearity. Application of this unit is especially useful for time-shared operation (pulse-to-pulse ion or energy switching), and for the increasing need for simultaneous display of several beam profiles.

The FET-multiplexer uses newly available elements of bilateral FET switches which are controlled by infrared light from an on-chip LED. The optical isolation of the FET switch from the LED ensures low current losses in the µA-range.

Two switches are driven in a complimentary mode to ensure that a low impedance path to ground is always established. Otherwise, the ion beam current would build-up exceedingly high voltages. The impedance ratio of the two paths is larger than 10, so that current losses during measurement, or current leakage to the output at off-times, are both negligible.

For use with profile grids, a reconfigurable multiplexer unit of 4 x 48 input channels has been developed.



FET-multiplexer can handle input currents of 100 µA to 100 µA and accommodates current errors of approx. less than 10 µA. Switching times are less than 50 µs.

Fig. 3 Block diagram of grid electronics

Analog Signal Processing:

Twelve (12) ranges are possible in steps of 1:2:5. These may be selected for current-to-voltage converters (I/V) by hexadecimal-coded commands. Including the constant gain of the following stages, and in consideration of the integration time of 5 msec., conversion ratios from 20µA/10 V up to 100 µA/10 V, can be obtained. The time between pulses is utilized for automatic drift compensation.

Two (2) amplifiers (3 V and 5 V), together with two (2) capacitors, are provided to act as compensation and hold stages. This is accomplished by forcing outputs of circuits to zero between beam pulses, and maintaining correct voltage constant during subsequent phases. Switches S4 and S7 control this operation.

Signal processing for one (1) wire of harp requires seven (7) chips packed onto a small board; eight (8) boards attached to motherboard in a plug-in housing.

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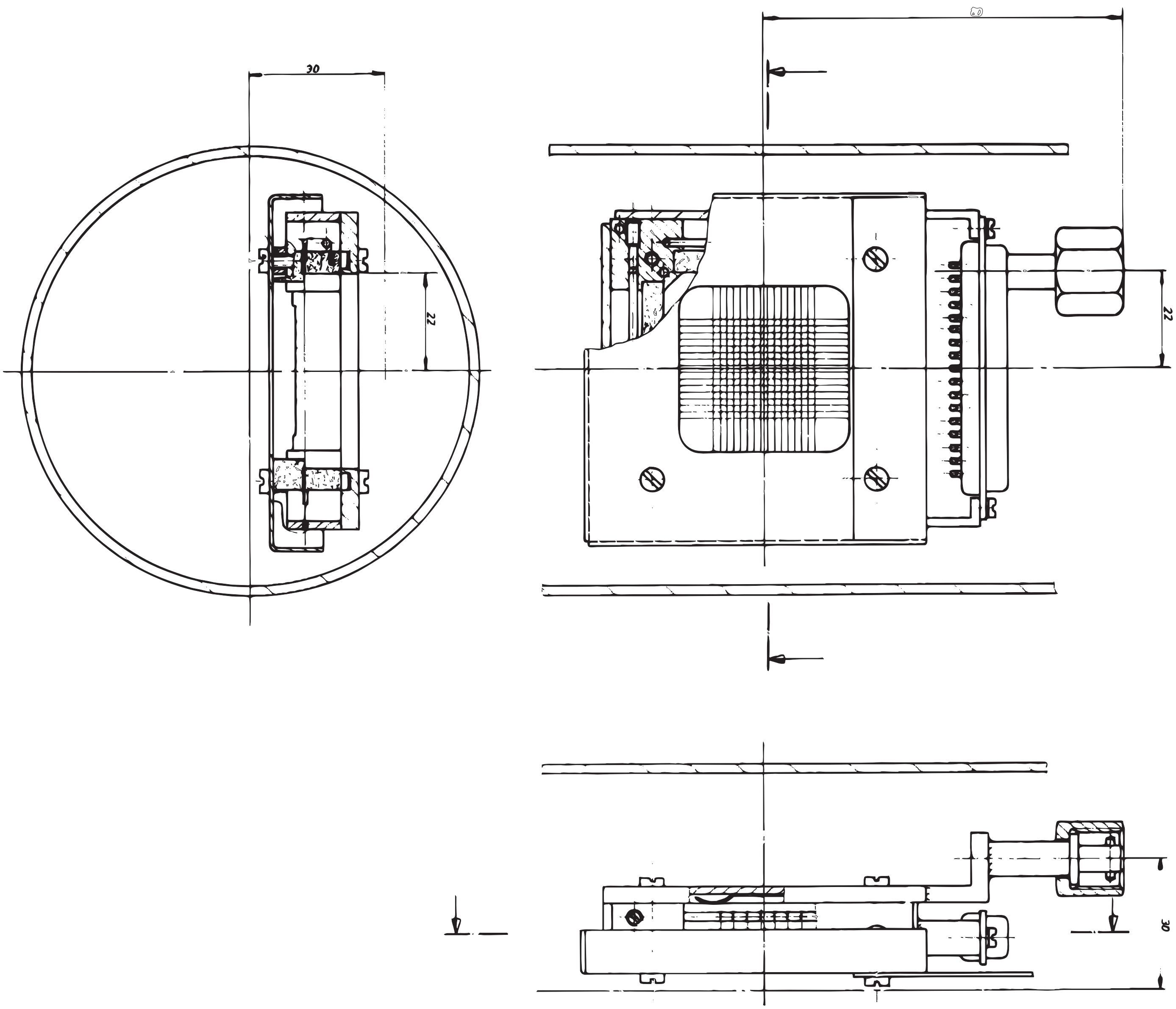

All Dimentions in Millimeters

Luminescent Target with Actuator

Type DF 120

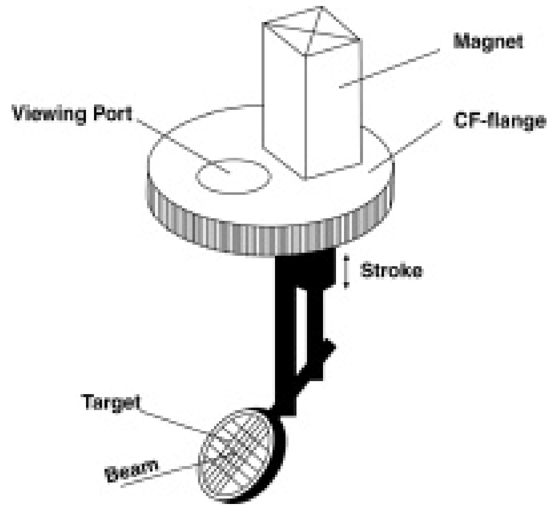

Fig. 4: Target and Actuator Principle

Luminescent Targets are used for a Beam Profile- and Beam Position determination of particle beams. They work best in a low to medium energy range, but are not necessarily linear – in terms of emitted light intensity – over the total energy range. At the same time such targets are adequate for many applications and a lower cost alternative to conventional Harp / Grid designs.

The Luminescent Target is mounted to an actuator system using a solenoid to ‘flip’ the target into and out of the beam path. Emitted light from the target is transmitted through a Viewing Port (mounted within the main flange) to a CCD Camera. Each pixel on the CCD chip can subsequently be used for a readout of the target light intensity versa the light spot cross-sectional area.

The actuator system is bellow sealed and comes with a 6” O.D. (CF-100) conflat flange. Different flange sizes and strokes might be feasible on request.

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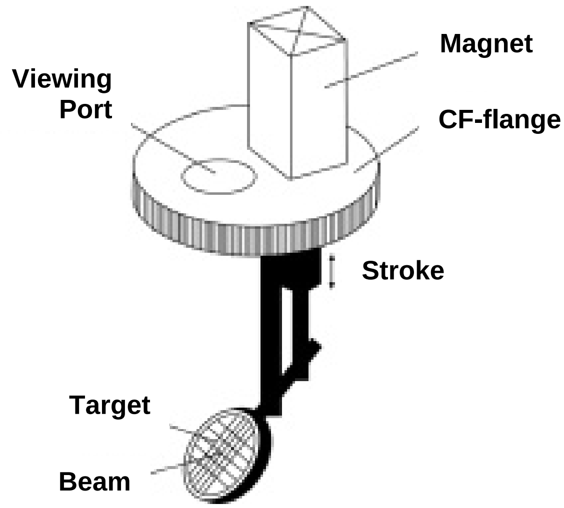

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