HERA-B
Target Group Meeting
DESY, Hamburg
13th December, 2001

V.M. Pugatch
Kiev INR
and MPIfK(Heidelberg)
pugatch@mail.desy.de

Charge Integrators Performance for HERA-B Luminosity Monitoring. Target and Metal Foil Detectors - firts results from data-2001 analysis.

Introduction.

- Charge Integrators (ChI) are in use at HERA-B Target setup since 1996. Few modifications (N. Tkatch(KINR) and MPIfK (Hd) Electronic Workshop) improved their sensitivity by more than 3 orders of magnitude.

  ⇒ This made ChIs a standard tool to steer targets under the request of equal contribution, as well as to measure contribution of every target (partial luminosity) into the overall luminosity.

- Based on the ChIs performance connected to the HERA-B targets the idea has been formulated to build the so-called Metal Foil Detectors for the mesurements of MIP fluences:

  ⇒ exploring the method of a charge integration generated in a thin metal foil being irradiated by the MIP flux - positive charge due to the seconadry electrons emission.

  ⇒ The fluences at HERA-B as well as at LHCb have to reach few times 10^{14} MIP/cm^2

  ◇ the need for a long term reliably running Luminosity and Background Monitors has been more than once discussed.

- Among many options the Metal Foil Detector (MFD)-option has been discussed.

  ⇒ Prototypes were built and tested at the Tandem Generator MPIfK(HD) at 21 MeV proton beam as well as at the test beam facilities X7 and T7 at CERN.

  ◇ Have demonstrated the expected and really good(!) performance.

  ⇒ The next prototype has been built for the tests at HERA-B environment.

  ◇ MFD Luminosity Monitor was installed on May 2nd '00 at the exit window of the VDS vessel.

  ◇ MFD BACKGROUND Monitor was installed on June 6th '00 at the Entrance window of the VDS vessel.

⇒ The results have shown an expected good performance.

◇ The decision has followed to build a full-size MFD Luminosity monitor.

- This has been realized by building and installing MFD Luminosity monitor by this Summer at the VDS SL-8 position.

  ◇ The first results from the data-2001 analysis illustrating the Charge Integrators performance in Target Setup as well as in the MFD Luminosity monitor will be discussed below.

Charge Integrators performance: First results from the data-2001 analysis at HERA-B '2001.

- An important notice:

  ◇ There are two sets of Charge Integrators presently in use:

  ⇒ 1. Charge Integrators (10 units) connected to the Targets have a sensitivity of 80 Hz/pA. There is a permanently running calibrating current of 250 pA flowing through the targets to the ChI input.

  ⇒ 2. Charge Integrators (10 units) connected to the MFD (Luminosity monitor foils) - with a sensitivity of 1000 Hz/pA. The permanently running calibrating current in this case is by an order of magnitude lower (25 pA) flowing in parallel to the signal from the MFD to the ChI input.

- Those calibrating currents create a baseline readout of ChIs at the level of 20-25 kHz, with a rather good long term stability of +/- 20 Hz for the target's ChIs and respectively +/- 200 Hz for the MFD foil.

1. Charge Integrators connected to the Targets.

- Those ChIs are the same which were used last year, thus allowing to cross-check the Luminosity determination by the scintillator hodoscopes after the long shutdown.

Target Station 1 (Dec. 5th, '01)

Target	Material	Shape	ChI Baseline , Hz	Conversion factors Hz/MHz	pA/MHz
Above 1	Al	ribbon 50 x 500 mum			
Below 1	C	ribbon 100 x 500 mum	19760 (20)	7580	96 (5)
Inner 1	W	round 50 mum diameter			
Outer 1	Ti	round 50 mum diameter			

Target Station 2

Target	Material	Shape	ChI Baseline , Hz	Conversion factors Hz/MHz	pA/MHz
Above 2	Pd	round 50 mum diameter	22676 (20)	4170	46 (1.5)
Below 2	Ti	round 50 mum diameter	22711 (20)	12 440	137 (3)
Inner 2	C	ribbon 100 x 500 mum	22676 (20)	9340	103 (2)
Outer 2	C	ribbon 100 x 500 mum	22480 (20)	8270	92 (2)

- Table 1 shows the baselines as well as the conversion factors for the Charge Integrators connected to the Targets. The data used for the analysis were taken on the Dec. 5th, '01 (at 3-5 am). As far as the data were taken at very low Interaction Rate (IR=0.5 MHz) it was essential to subtract the background to the IR (Hodoscopes rate without any inserted target) to calculate the conversion factors.

- Comparison with the similar data obtained in the year 2000 one notices higher specific currents by factor of 1.5 - 2.

  $\Rightarrow$ It has to be clarified whether this belongs to the improved beam performance (lower background or/and Hodoscopes tuning.

- What is essential for the further HERA-B running (concerning the non-target background contribution) that once established highest values for the ChIs conversion factors have to be taken as a reference ones for the 'best' running conditions (beam orbit, magnet settings, collimator as well as Roman pots positions etc.

  $\Rightarrow$ There is no reason to doubt in the ChIs performance -it is a well proven fact - they are extremely stable at the ‘Luminosity Run’ conditions. If the conversion factors vary with time - look immediately at the changed background contribution.

- Charge Integrators connected to the targets are the only detectors in HERA-B which are (till now) monitoring the partial (as well as an overall) luminosity on-line! This is due to the principle of their operation - an ammount of the emmited electrons by each contributing target is strictly proportional to the partial luminosity. There is no interference between charge integrators connected to different targets.

- Another essential advantage of the Luminosity Monitoring by the Target Charge Integrators - this is the only background free Monitor. Indeed, due to the small size of the targets there is no response of the Charge Integrators to the MIP fluxes originated somewhere out of the target.

2. Charge Integrators connected to the MFDs- Luminosity Monitor.

- The MFD Luminosity Monitor for the HERA-B has been designed and built at the MPIfK (Hd):

  $\Rightarrow$ 50 μm thick Al-foils were used for.

  ◇ The read-out foils were mounted on the 0.5 mm thick Isolating Epoxy Frame and connected to the Charge Integrator (ChI) with an output frequency of (22 685 +/- 5) Hz per 25 pA input calibrating current.

  ◇ The read-out foil was placed between 2 shielding-foils and +24 V was applied to them to improve the collection of low energy secondary electrons.

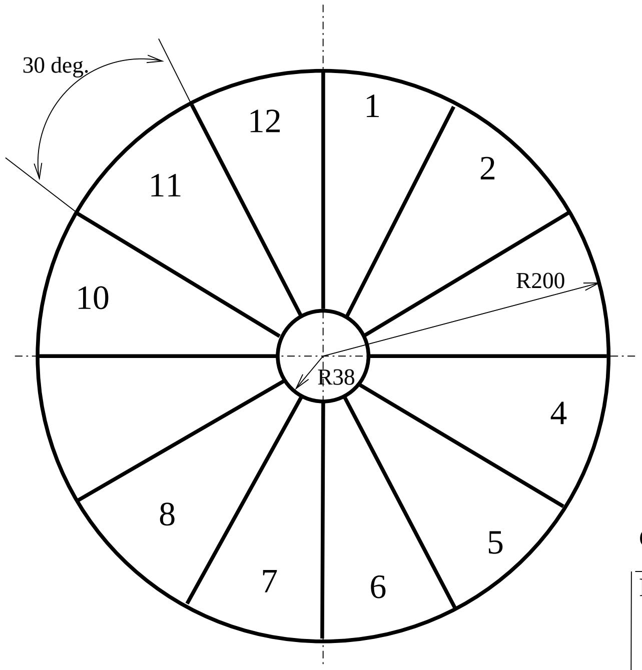
  ◇ Those 3 foils were placed between 2 shielding foils.

  ◇ MFD Luminosity Monitor was mounted in July 2001 (thanks to Christian, Bernhard, Toersten and Tasso) at the VDS SL-8 frame from the ITR side. Later it was connected to the read-out chain.

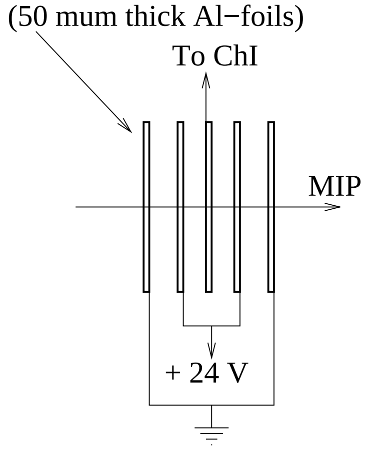
Luminosity Foil Monitor (LFM).

LFM is fixed at the VDS exit window
(downstream side of the SL−8 box).

There are 10 sectors of the Luminosity Foil Monitor.
Numbering is clockwise (looking into the beam).
No. 3 and No.9 do not exist.



Cross−section of the LFM sector.



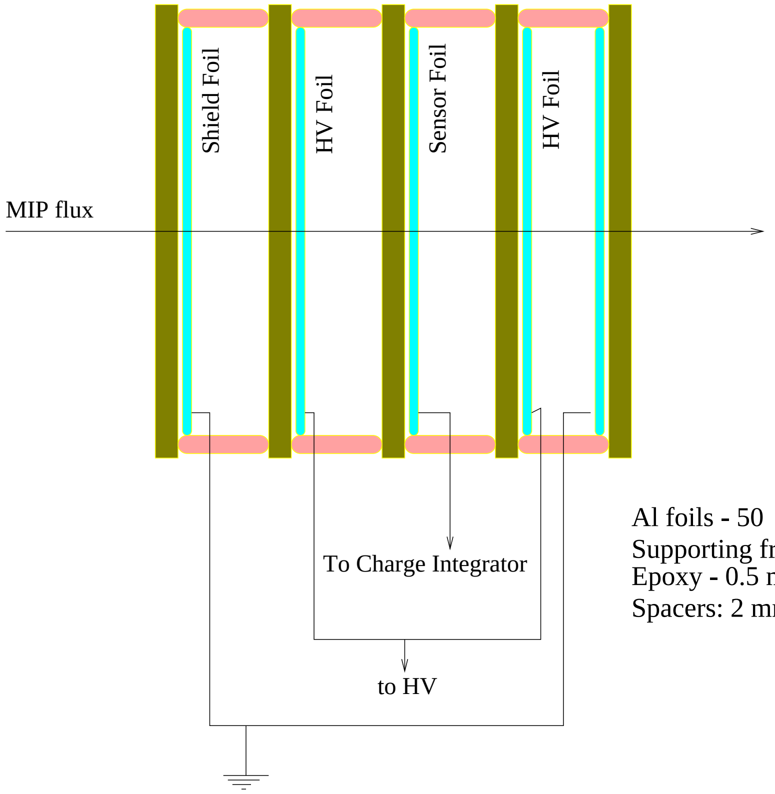
Cable connections:

Foil sector	Cable	ChI−input	BNC cable
1	FM1	1 − 1	41
2	FM2	1 − 2	42
4	FM4	1 − 3	43
5	FM5	1 − 4	44
6	FM6	1 − 5	45
7	FM7	7 − 1	46
8	FM8	7 − 2	47
10	FM10	7 − 3	48
11	FM11	7 − 4	49
12	FM12	7 − 5	51

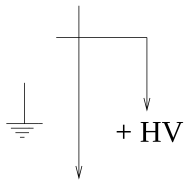
Remark: It is worthwhile to connect calibrating current at the ChI inputs (~ 20 kHz) in parallel to the FM cable (using T− BNC connector). There will be always control of the ChI baseline , which has to be updated.

Please, check ChI 7−3 (it didn't work)...

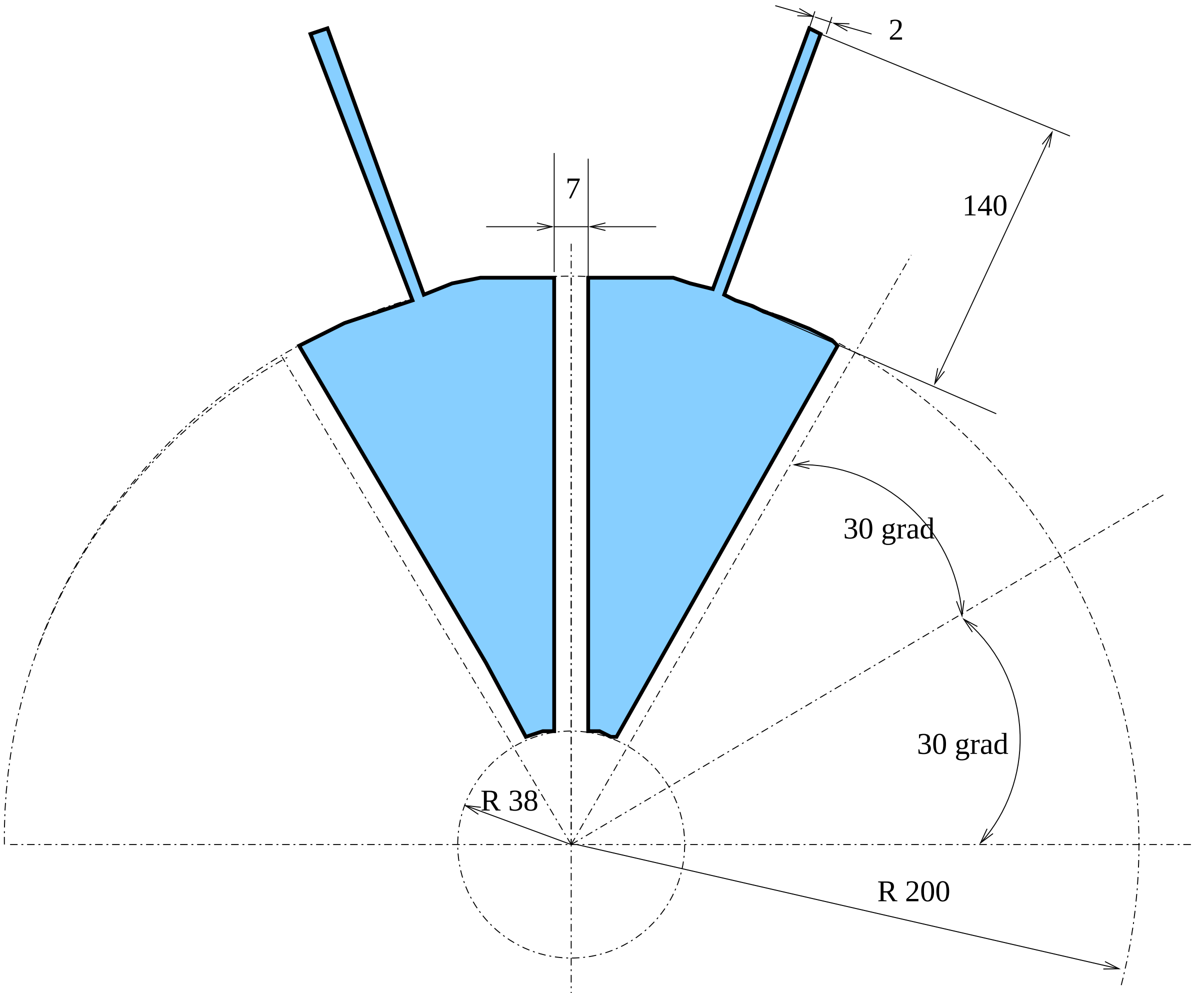
Metal-Foil Luminosity Monitor
(a single quadrant structure).



Al foils - 50 µm
Supporting frames
Epoxy - 0.5 mm thick
Spacers: 2 mm wide

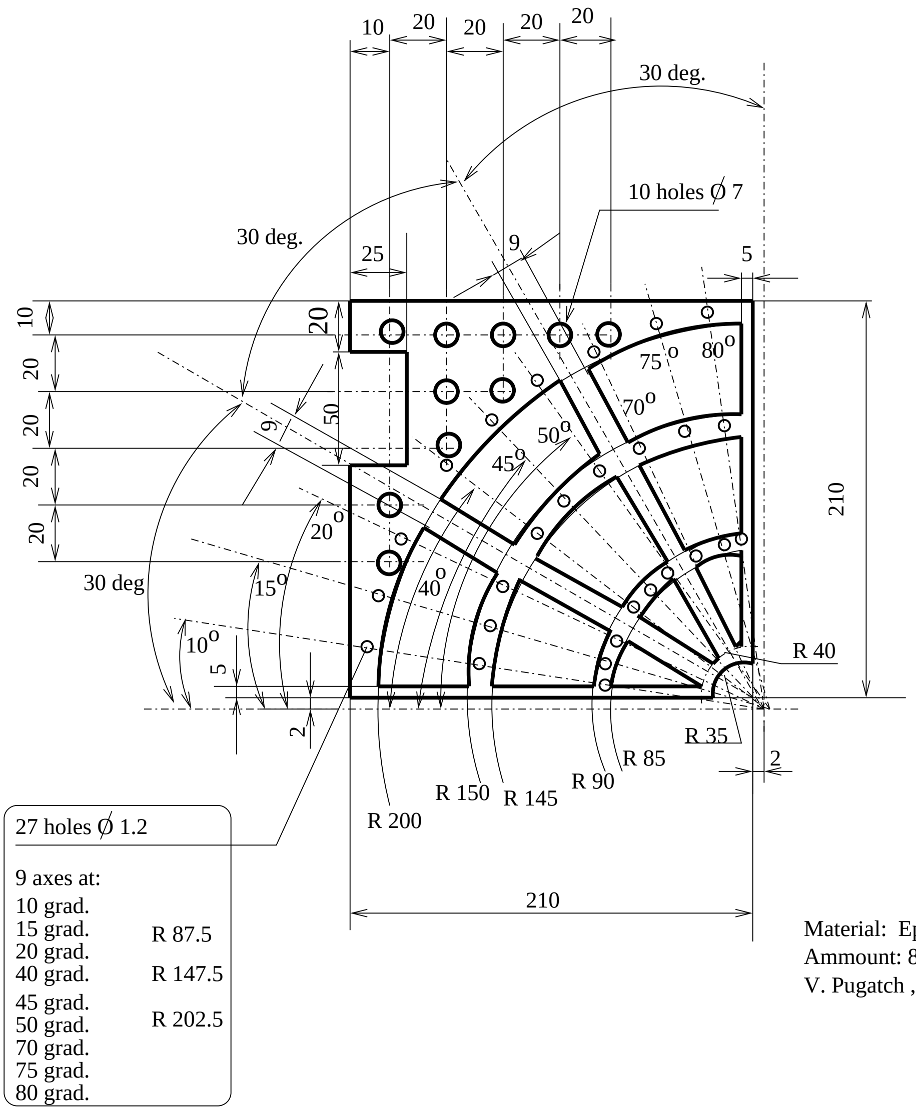


Sensor − foils



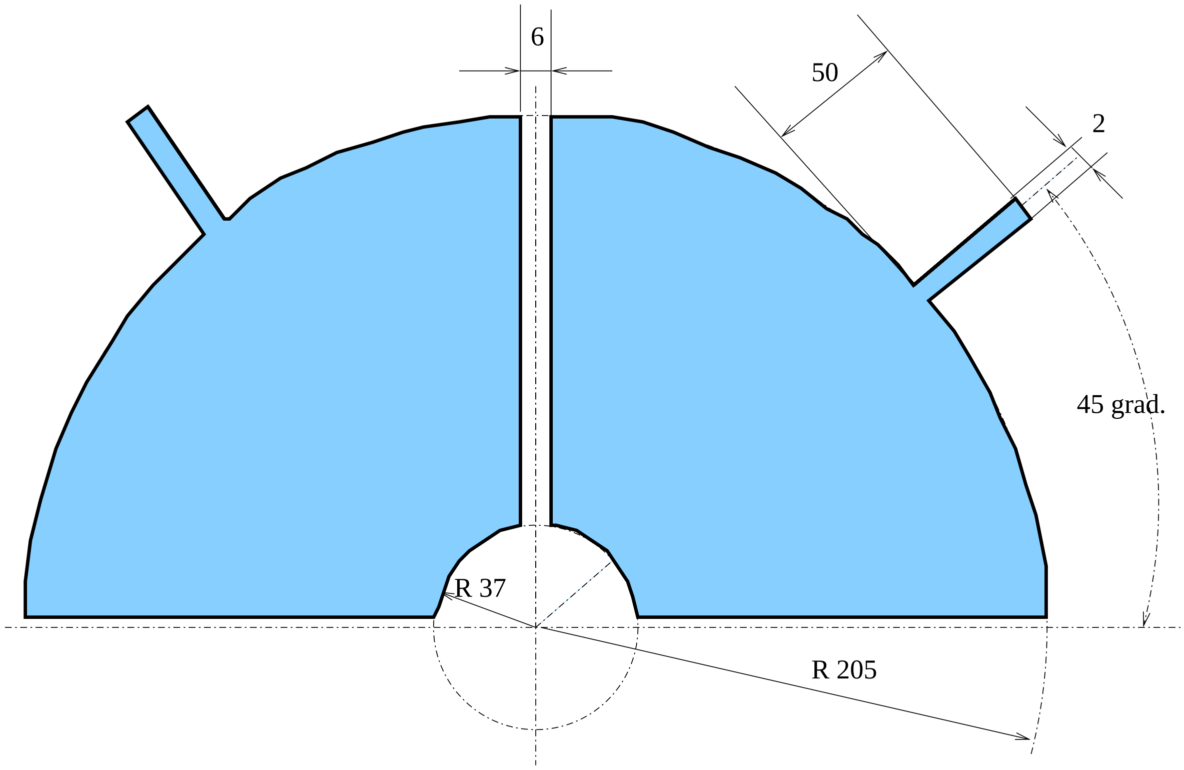
Material: Al (25 − 50 μ m)
Ammount: 24 pieces
V. Pugatch, tel. 506

Lumi−Sensors supporting frame



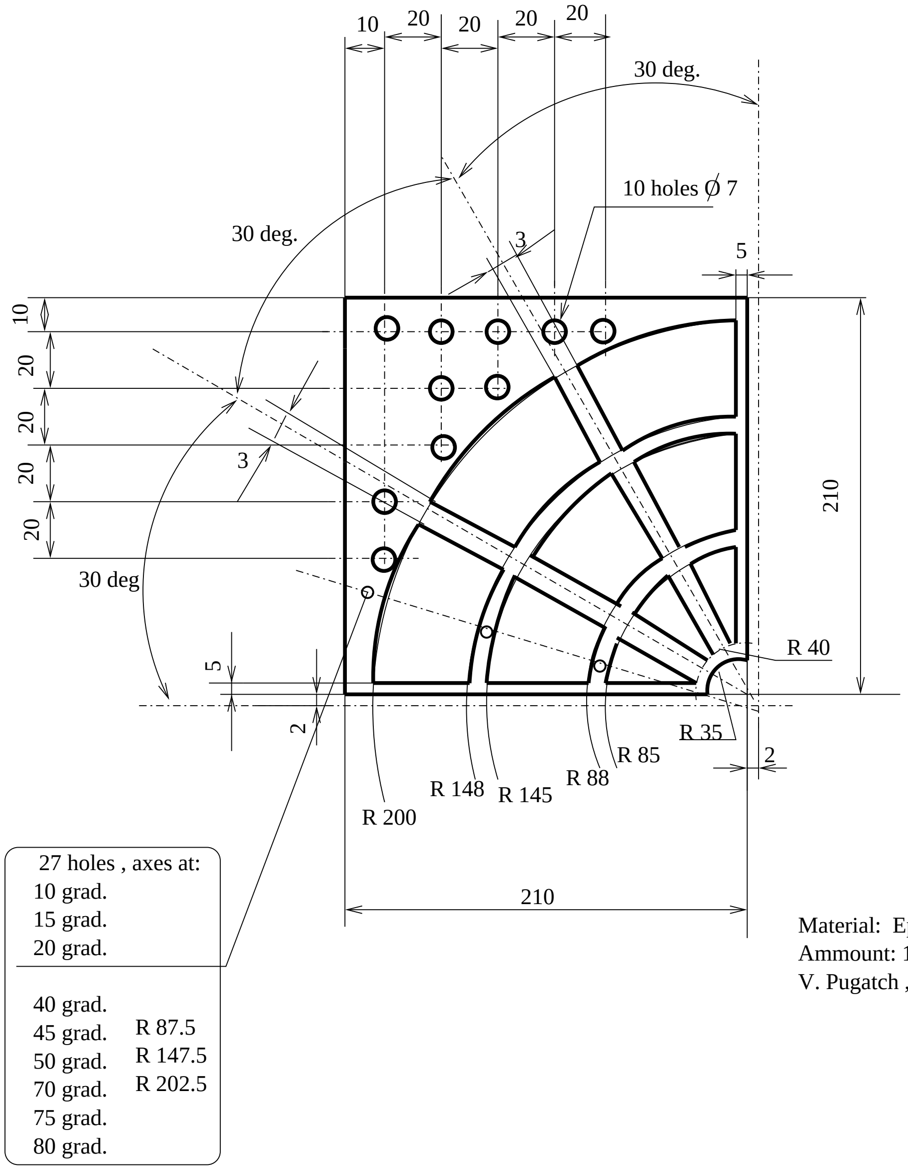
Material: Epoxy (0.5 mm)
Ammount: 8 pieces
V. Pugatch , tel. 506

HV − foils



Material: Al (25 − 50μ m)
Ammount: 12 pieces
V. Pugatch, tel. 506

Shielding Plate



Material: Epoxy (0.5 mm)
Ammount: 16 pieces
V. Pugatch , tel. 506

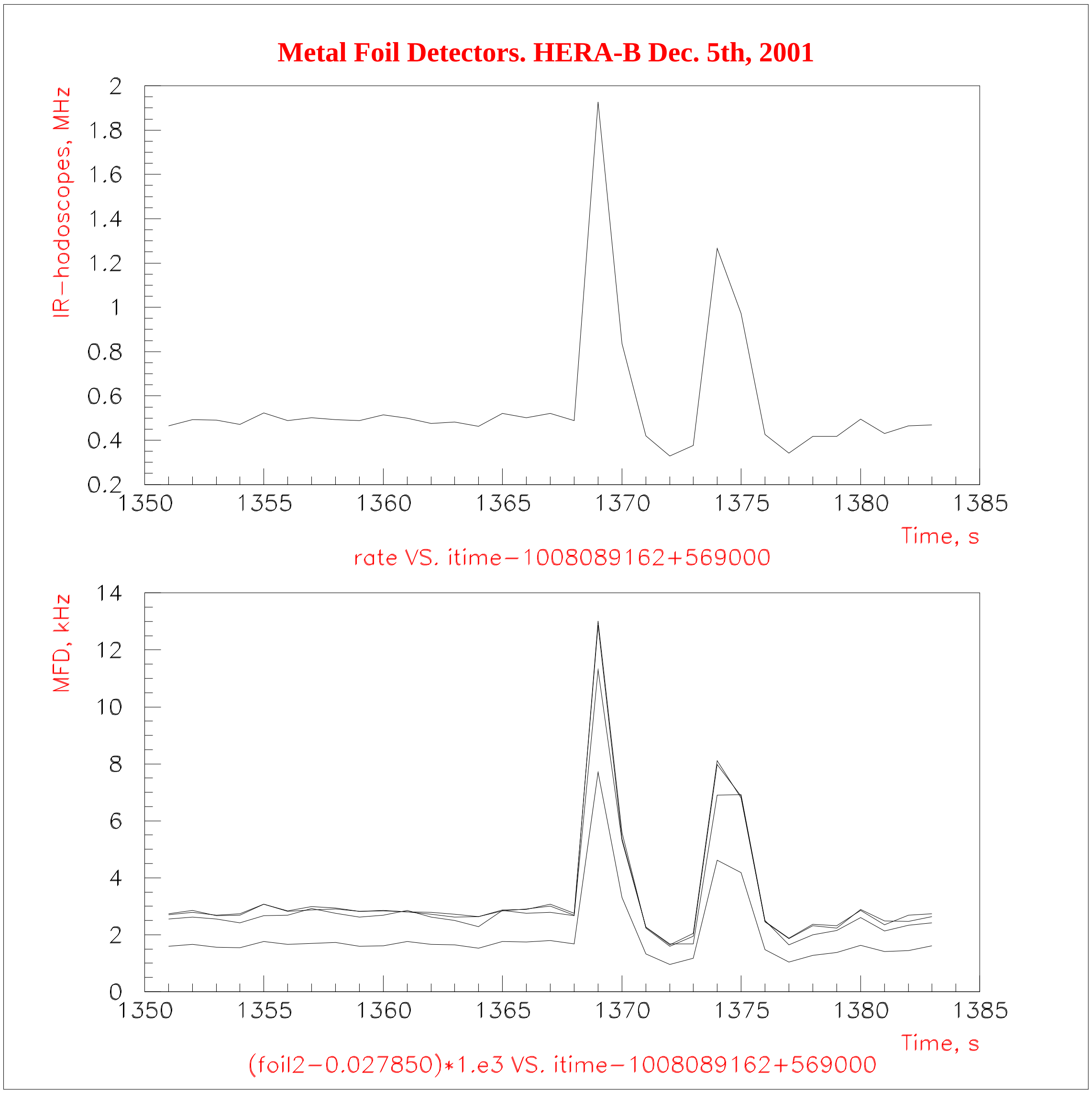
Metal Foil Detector (MFD) Luminosity Monitor

HERA-B , Dec. 5th, ’01 . Inner2. IR- 0.5 MHz

	Baseline, Hz	Sensitivity (assuming M=<7>)&0.85 acceptance		
		Hz/(MHz, IR)	MIP/count	pA/MHz
MFD -1	27805 (44)	6140 (140)	80	5.5
MFD -2	27825 (44)	6240 (160)	79	5.7
MFD -3	Not installed			
MFD -4	27551 (54)	3540 (120)	139	3.2
MFD -5	45800 -?	------		
MFD -6	27 668 (91)	5240 (220)	94	4.7
MFD -7	ChI -.0			
MFD -8	ChI -.0			
MFD -9	ChI -.0			
MFD -10	Not installed			
MFD -11	ChI -.0			
MFD -12	ChI -.0			

⇒ Important. Conversion coefficients are stable and vary from the target to target by few percent reflecting mainly the change of the Hodoscopes acceptance.

⇒ At the nearest access time the repaired Charge Integrator has to be connected to the remainind MFDs. Check the ChI for MFD -5 -> short curcuit ?



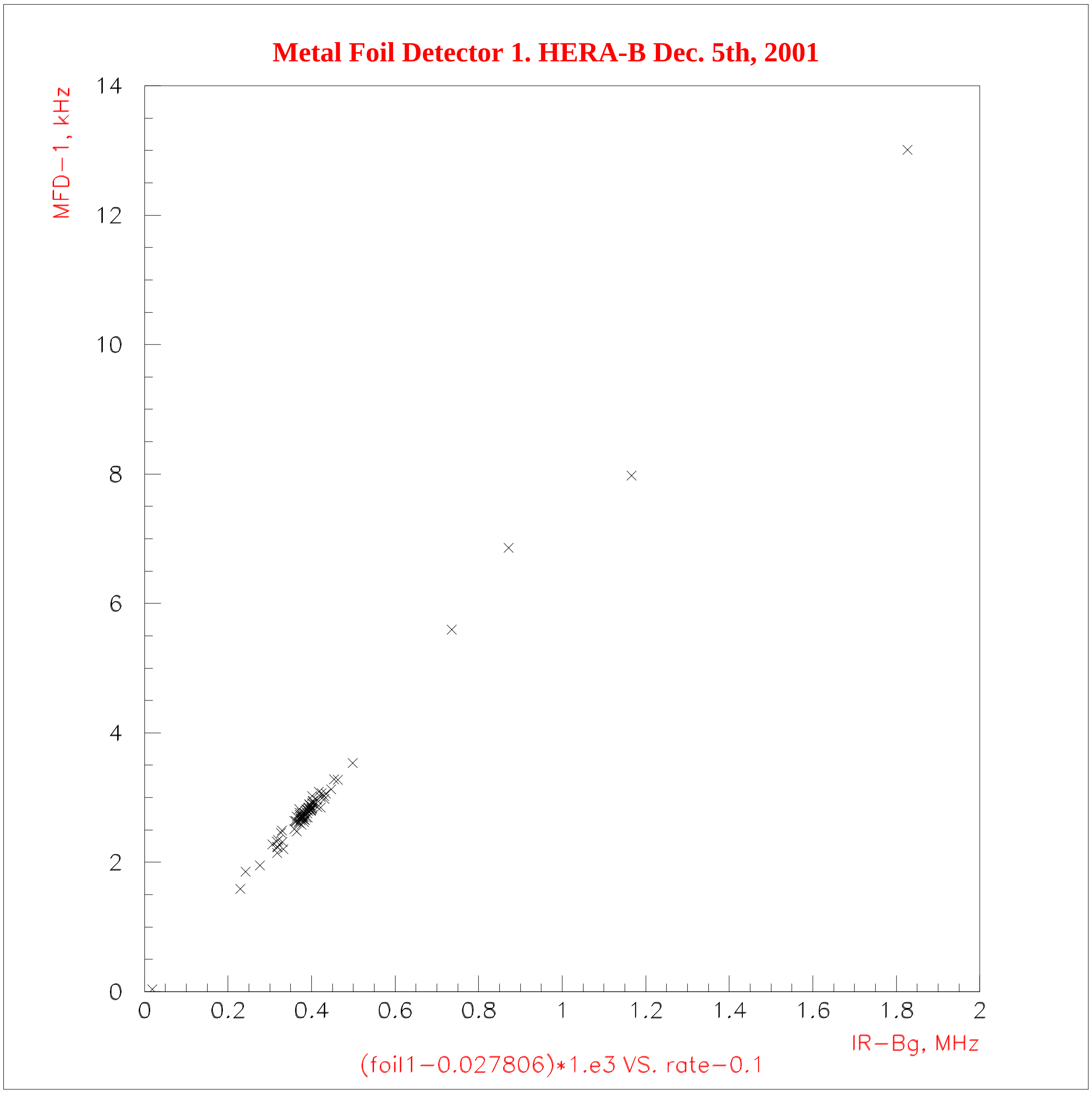
⇒ This plot shows the MFD Lumi-Monitor performance at the HERA-B on Dec. '01.The conversion coefficient for the output frequency of the ChI connected to the LUMI-FOIL1:
(6240 +/- 160) Hz per 1 MHz IR measured by the Hodoscopes.

⋄ Knowing the response of the ChI to the calibrating current of 25 pA :
(27 806 +/- 44) Hz
one can determine the specific current flowing the the input of the ChI, when the IR = 1 MHz:
(5.6 +/- 0.1) pA per 1 MHz IR measured by the Hodoscopes.

⇒ Calculations show that LUMI-foil1 generates (5.6 +/- 0.1) pA per 1 MHz IR (or 33.6×10^6 electrons).

- Taking into account the acceptance and multiplicity that means on average 58 electrons are produced in a foil by a single MIP hit.

⇒ This agrees well with the values observed at the MFD BPM operated this year at CERN.



- Monte-Carlo simulations (Yu. Vasilijev and S. Pristupa) are going to be done soon for the δ- and secondary electrons current from different metal foils of 50 μm thickness .

Conclusion.

- 1. Charge Integrators connected to targets are reliably perfoming devices for the partial and overall HERA-B Luminosity monitoring for running in 2002.

  $\Rightarrow$ It is worthwhile to spend some HERA-B time to get the highest values of the conversion factors (ratio of the ChI output to the IR measured by Hodoscopes) to provide further the reproducable low background running.

- 2. New method of the HERA-B Luminosity Monitoring by Metal Foil Detectors (read-out by charge integrators) proved to be successful.

  $\Rightarrow$ Further study of the MFD (including wide range of their possible applications) is worthwhile to continue also underlying as one of the outcome of the HERA-B detecting technologies.