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AD TRANSVERSE DAMPERS

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In the AD, the beam will be submitted to electron-cooling at an intermediate level of 300 MeV/c and at the flat bottom at 100 MeV/c. At the resulting high final densities the beam may become unstable. In this note a damper is proposed for the suppression of coherent transverse instabilities.

1. BASIC FEATURES

The damper shall cover the following needs:

a) Damping of coherent instabilities in the energy range 300 – 100 MeV/c antiproton and proton beams circulating in the clockwise direction. Bunched and unbunched beams with a maximum intensity of 5×10^8 particles. Damping is needed on the intermediate level at 300 MeV/c, during further ramping down, and at the flat bottom at 100 MeV/c.

b) Fast transverse blow-up for acceptance measurements.

2. POSITION MONITORS AND DEFLECTORS

The 50 Ω strip-line deflectors, one for each plane, installed in sector 16 (DAV1605, DAH1607) will be used to deflect the beam. The coherent signal to be damped will be taken from one of the closed orbit electrostatic PUs. The betatron phase advance must satisfy the condition $\mu \cong (2n+1)\pi/2$ and the beam flight time between PU and deflector must be as small as possible to minimise phase distortion in the cables. UHZ04 for the horizontal plane and UVT03 for the vertical plane satisfy both criteria's very well. The phase advance and flight times are summarised in Table 1 below.

Table 1: Relationship PU-deflector with Q_H = 5.39 and Q_V = 5.37.

	UHZ04	**UVT03**
Betatron phase advance PU-Deflector (deg.)	425	474
Sin(μ)	0.91	0.91
Distance between PU-deflector ($\Delta S/S$)	0.228	0.240
Time of flight PU-deflector @300 MeV/c (ns)	455.5	471.5
Time of flight PU-deflector @100 MeV/c (ns)	1310.3	1379.3
Flight time change from 300 to 100 MeV/c (ns)	854.8	899.4

3. SPECIFICATION OF ELECTRONICS

In Table 2 below is a list of the electronics foreseen for the damper. It will physically be located in a rack to be installed in the hall close to section 13. A block diagram of the system can be seen on page 5. All modules except the head amplifier are identical to those of the Booster. The table describes the modules needed for one plane only. Note that since we use two separate PUs, 2 word generators are needed.

Table 2: Description of damper electronics.

	Gain [dB]	**3dB Bandwidth**	**Length [ns]**	**Function**	**Remarks**
Head amplifier	47	10 kHz-20 MHz	16	Low noise amplifier	AD Closed orbit amplifier
Cables PU-deflector	-0.5	DC-2 GHz	244	Bring signals to and from rack	Calculated for Vertical plane
Reception amplifier	0	10 kHz-80 MHz	10	Differential to single ended	Same as for AD orbit measurements
Delay switching unit (Variable delay)	-16	DC-500 MHz	7-2055	Delay signal	Same as Booster and Lear TFB. LSB = 2 ns MSB = 1024 ns
Delay word generator	***	***	***	Control delay switching unit	Same as Booster TFB Input: RF H=1 Anal.
Control module	0; -16	50 kHz-100 MHz	12	Controls attenuator and mode ie. BTF, blow-up	Same as Booster TFB
Power amplifiers	50	20 kHz-100 MHz	14	100W water cooled power amplifier	Same as Booster TFB
Sense switching	0	DC-2 GHz	12	Relays to switch deflector to match sense of beam	Exists but will have to be changed to handle 100 W

Adding up we have the following specifications:

Table 3: Overall specifications

Maximum gain	80 dB
3dB bandwidth	50kHz –20 MHz
Minimum length	315 ns
Output power	100 W into 50 Ω

The dynamic range of this system is capable of handling a fully offset, bunched beam of 5×10^8 particles. The betatron line frequencies are given by $(N-Q)\times Frev_{300Mev}$. So in the range N =6 - 45 damping should be efficient.

4. BLOW-UP

It is foreseen to use the existing signal generator in the Equipment room. The FM-signal will excite the beam via the stimulus input on the control module. A relay will switch the blow-up signal between the horizontal and vertical control modules. Two cables between the ACR and the rack will provide signal transmission for the blow-up and BTF measurement.

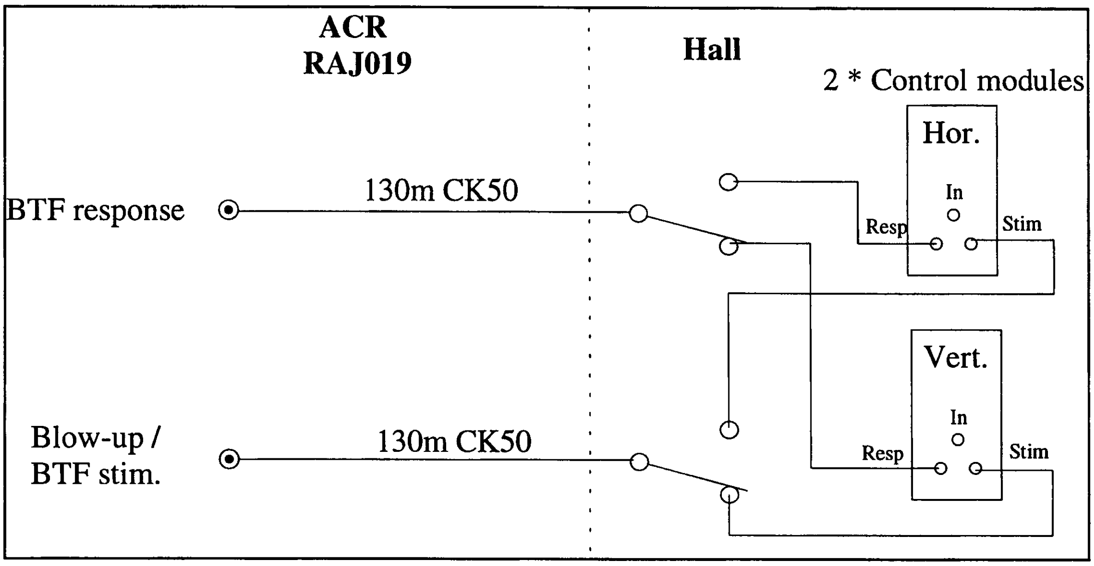


Fig. 1: Blow-up layout

5. LAYOUT AND CONTROLS

As mentioned earlier most of the hardware will be installed in the hall. An emplacement has been found close to section 13 just outside the ring (DEM line). This is important to minimise cable lengths. A layout of the rack is seen in Fig. 2 below.

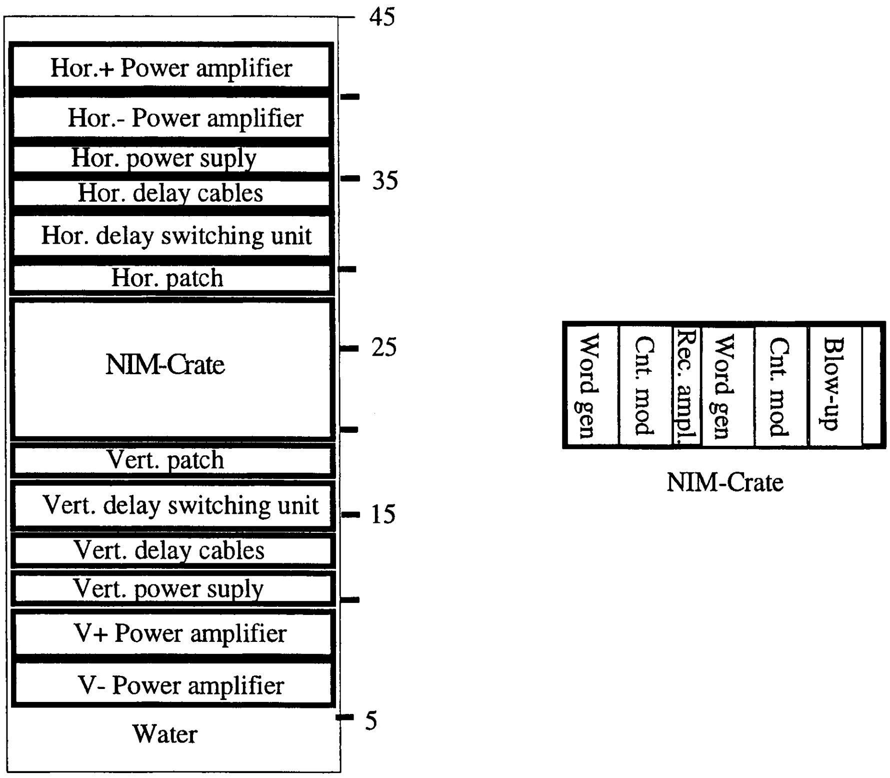


Fig. 2: Rack layout

To control the system 2 ICV196 are foreseen. The location of the modules is not yet defined. Also 1 TG8 module is needed to switch the damper on/off. A summary of the control bits needed for one plane is given in Table 4 below. The shaded cell is common for both planes.

Table 4: Control bits for 1 plane.

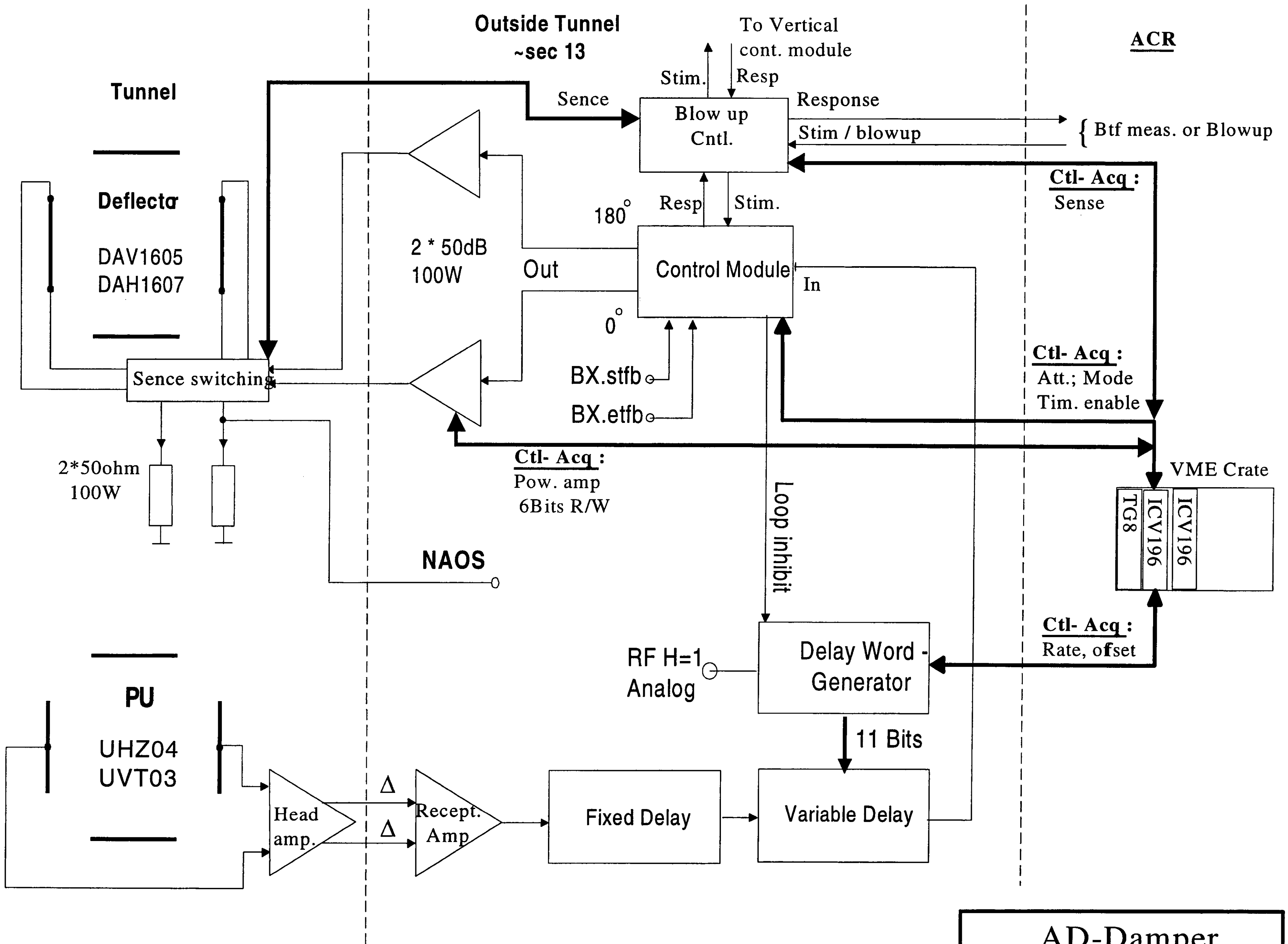
Module	Function	Nb. of control bits	Nb. of acquisition bits
Delay word generator	Rate	7	7
Delay word generator	Offset	7	7
Control module	Variable attenuator	4	4
Control module	BTF/Blow-up on/off	1	1
Control module	Timing enable	1	1
Control module	Loop open/closed	1	1
Control module	Water OK		1
Control module	Local/Remote		1
Power amplifiers	On/Off	2	2
Power amplifiers	Reset	2	
Power amplifiers	Interlock		2
Power amplifiers	Local/Remote		2
Blow-up	Sense: PBAR/Proton	1	1
Blow-up	Plane select	1	1
Blow-up	Local/Remote		1
Total / plane		27	32

6. COST ESTIMATE AND PLANNING

Table 5: Cost estimate.

	CHF	Status
Head amplifier	0	Exists
Cables	7000	To be ordered
Reception amplifier	0	Exists. Use AD closed orbit spare
Delay switching units	3000	All parts ordered, modules to be build
Delay word generators	4000	Parts to be ordered, modules to be build
Control modules	4000	Parts to be ordered, modules to be build
Power amplifiers	10000	All parts ordered. Construction has started.
Power supplies	3337	Ordered.
Sense switching	4000	New relays ordered. New switch box to be build
4 * 50Ω, 20 dB, 100 W attenuators for deflectors	4292	Ordered
Demineralised water instal.	3000	To be ordered
VME modules: 2* ICV196 +1 TG8	6000	To be ordered from controls group.
Rack installation	2000	Rack recuperated, installation to be done.
Total	**~50000**	

The production of the hardware will continue until August where we expect to install it during the 1 month shut down of the AD. Also cables and water will be installed during that period. The damper should be ready for September.


Outside Tunnel
~sec 13
ACR
Tunnel
To Vertical
cont. module
Stim.
Resp
Sence
Blow up
Cntl.
Response
Stim / blowup
{ Btf meas. or Blowup
Ctl- Acq :
Sense
Deflecta
DAV1605
DAH1607
2 * 50dB
100W
Out
180°
Resp
Stim.
Control Module
In
0°
BX.stfb
BX.etfb
Ctl- Acq :
Att.; Mode
Tim. enable
Sence switching
2*50ohm
100W
Ctl- Acq :
Pow. amp
6Bits R/W
VME Crate
TG8
ICV196
ICV196
Loop inhibit
NAOS
Ctl- Acq :
Rate, ofset
RF H=1
Analog
Delay Word -
Generator
PU
UHZ04
UVT03
11 Bits
Δ
Δ
Head
amp.
Recept.
Amp
Fixed Delay
Variable Delay

AD-Damper