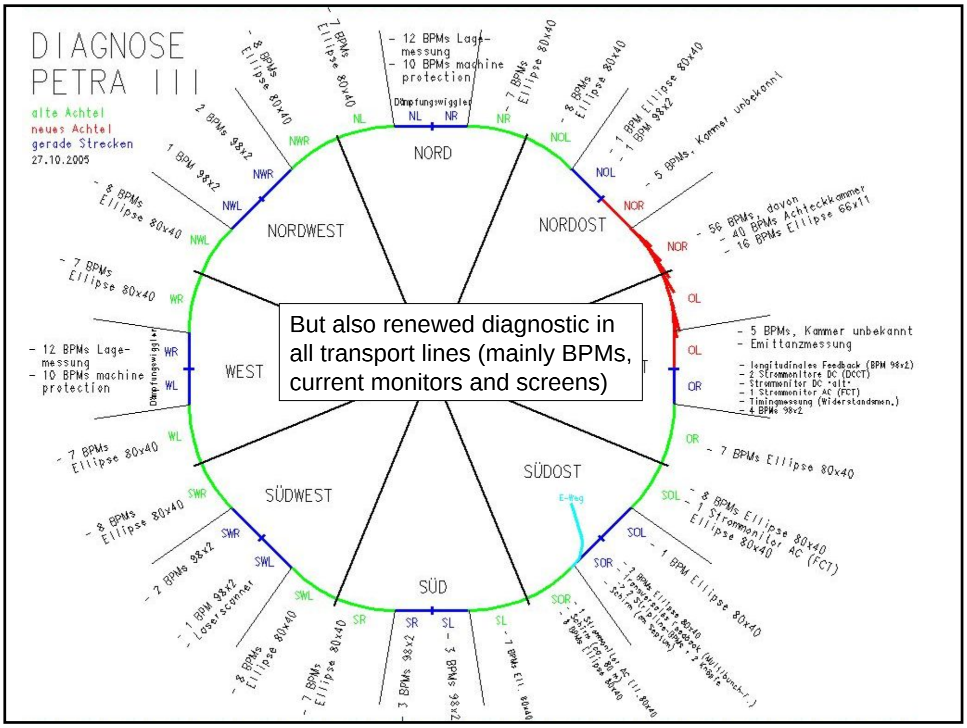
Instrumentation and Diagnostics in PETRAIII:

by K. Wittenburg; MDI

Tasks:

- **BPM System**
- **Beam Current:**
  a) Bunch current AC   b) DC current
- **Emittance**:
  a) Synchrotron radiation   b) Laser Wire Scanner
- **Controlling of movement and readout of Collimators/Scraper/ Mover/Screen Monitors/Beam Stoppers**
- **Machine Protection System (MPS)**
- **Temperature-Alarm-Systems**
- **Pilotherm- und water-flow-guarder Alarm-Systems**
- **Disassembly und reconstruction of the cabling for PETRAIII**.
- Note: Tune measurement and feedback systems are linked to the "Feedback" colleagues.



1. **BPM Systems** ………………………………………………………………………

2. **Beam Current:**
   - **a) Bunch current AC** ………………………………………………………
   - **b) DC current** …………………………………………………………………

   In preaccelerators: Transport lines: AC-Monitors (partially renewed); PIA: AC und DC Monitors; DESYII: AC Monitor.

2. **Emittance**:
   - **a) Synchrotron radiation** ………………………………………………
   - **b) Laser wire Scanner** ……………………………………………………

   Decision: no solid wire scanners, 15 micron Quartz-wire (non conducting) will burn at 0.7 mA (horizontal) and 7 mA (vertical) at 1 m/s wire speed. Up to now a faster scanner with appropriate resolution (~1μm) and reliability does not exist. Long term development at DESY has started.

3. **Controlling of movement of Collimators/Scraper/Mover/…** ………………
   Screen monitors and beam stoppers Collaboration with various DESY groups

4. **Machine Protection System (MPS)** ………………………………………………
   Signals from: Beam current, Beam position, beam pipe temperature, beam - stopper, HF, … (**up to now, a complete list of alarm signals is still missing. But the system will be flexible to add much more signals**)

5. **Temperature-Alarm-Systems** (1500 channels) …………………………………
   Defining positions and installation of PT100 sensors by MVA, readout by MDI.

6. **Pilotherm- und water flow guarder- readout Systems** ……………………
   Defining positions and installation of sensors by MKK/MEA, readout by MDI.

7. **Disassembly und reconstruction of the cabling for PETRAIII**.
   Already on the way

BPM requirements for fast orbit correction

	Low β insertion			High β insertion			
	β(m)	σ(μm)	σ'(μrad)	β(m)	σ(μm)	σ'(μrad)	
Horizontal	1.2	34.6	28.9	20.0	141	7.1	
Vertical	3.9	6.2	1.6	2.4	4.9	2.0	

Stab. Requirement 0.1 * σ
→Sub micron orbit stability
150 Hz BW for feedback
(BW 300 Hz if possible)

Three parts:
1) Readout electronic
2) Design of pick-ups
3) BPM supports

monitor (resolution)

monitors	#	Hor. (μm)	Ver. (μm)
Old octant	148	10	10
New octant	40	2	0.5
Next to ID	18	2	0.2

Part 1: Readout electronics

Instrumentation Technologies

IWBS 2004

7 Dec, 2004

Same System also planned for Diamond und Soleil

Libera

rok@i-tech.si ; www.i-tech.si

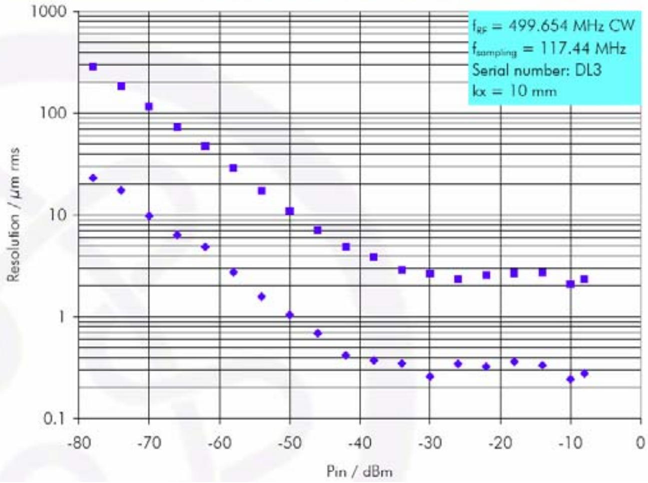
Rok Uršič

Instrumentation Technologies

IWBS 2004

7 Dec, 2004

Resolution - CW



PETRA III:
130 kHz =
rev. freq.

300 Hz BW
for feedback

Laboratory measurements at Diamond at two different bandwidth

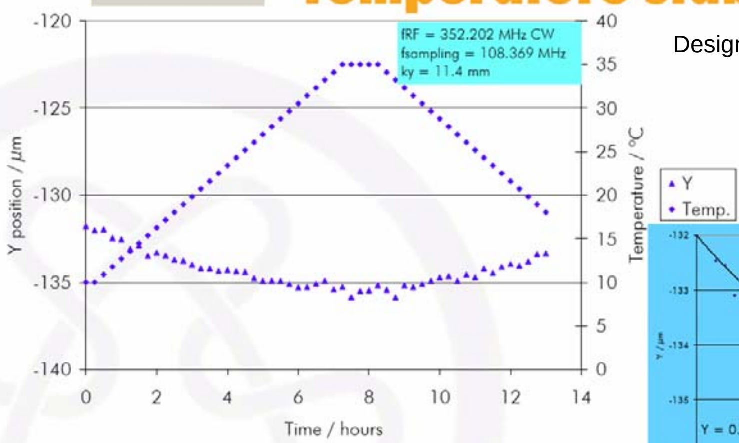
Instrumentation Technologies

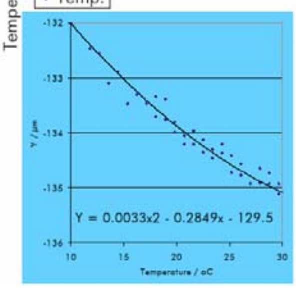
IWBS 2004

7 Dec, 2004

Temperature stability

Design: 0.2 µm/^{0}C

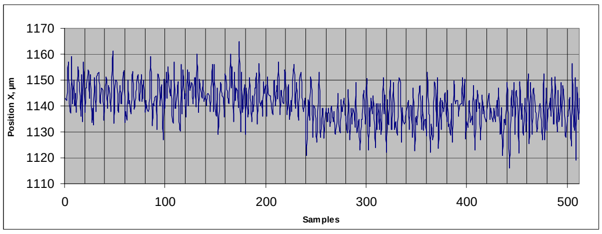




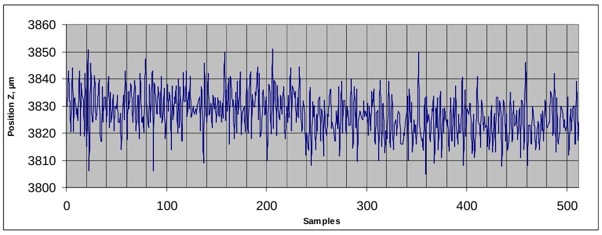
Electronic will be located in temperature stabilized racks (new octant) Goal: Temperature stabilization <1^{0}C

Measurements in PETRAII with Libera

4 channels of Libera were connected in parallel to the position pickup. PETRA status: e-: 32mA, 42 bunches, monitor constant kx=ky=20. The data are acquired at the revolution frequency of PETRA (130 kHz).



Position X at sensitivity -26dBm, number of samples 512. Mean position = 1140.672µm, RMS = 7 µm



Position Z at sensitivity -26dBm, number of samples 512. Mean position = 3826.885µm, RMS = 8 µm

Some conclusions.

Comparing the measured data shows that there is no big difference between the values of RMS in case of supplying identical signals to four channels (laboratory, σ = 6 µm) and in case of supplying real signals from the pickup's buttons. Minimal RMS for the vertical and horizontal position is in about 7 µm an a bandwidth of 130kHz. The RMS for a bandwidth of 300Hz (required for the fast feedback of PETRA III) results in 7µm/(sqrt(130kHz:300Hz)) = **<u>0,33 µm</u>**, which already meets the requirements with a monitor constant of k = 20. (new -> k ≈ 16)

Spec. (I-tech): RMS = 0.7 nm/sqrt(Hz) * k = 0.24 µm (at 300 Hz and k=20)

<u>Some Problems (waiting for firmware from I-tech)</u>:

Temperature stabilization, data acquisition, timing, ….

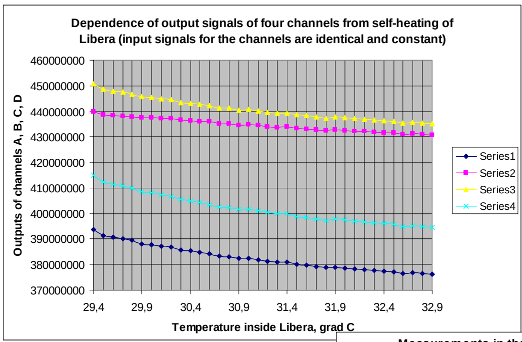
I-tech wrote on 12.Oct.2005:

The following is the definitive schedule to get to Version 1.0 of Libera software:

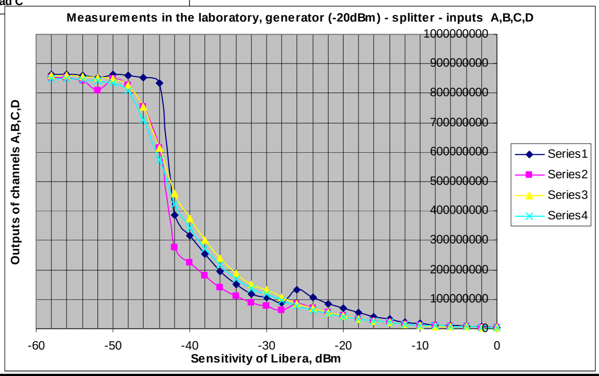
1.The Libera software version 1.0 will be available not later than 31.12.2005.

2. The Libera software version 1.0 will include the following functionality:

- Fast acquisition
- Slow acquisition
- Fast application interface (FAI) implemented
- Complete timing
- ADC rate buffer



Cooling rack from Knürr



Libera was connected to an RF signal generator through a power splitter. A signal with the fixed power was applied. The figure shows the dependence of levels of the output signals of four channels from setting of sensitivity of Libera. One can see strange behavior of the channels A and B in the range of -28 -54 dBm - the jump of 3dB. Perhaps something is wrong with the analogue board gain control. This point is under investigation in contact with the I-tech.

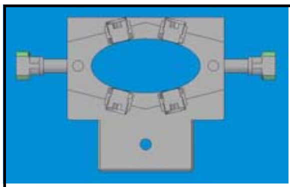
Part 2: Pickup design

We will use commercial RF button feedthroughs with SMA connectors from Meggit (Ø 15mm) and PMB (Ø 11mm) already in use at TTF, HERA and transport lines. The BPM pickup stations will be located very close to the quadrupoles. Encoders are foreseen, to track all movements between pickup and quadrupole due to thermal expansion processes. The 18 pickup stations with ultimate resolution requirements, located at the undulators, will be realized as separate, rigid BPM block between bellows, fixed with Invar-supports on resonant-free girders.

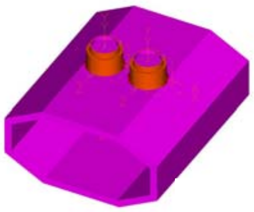
Meggit

PMB

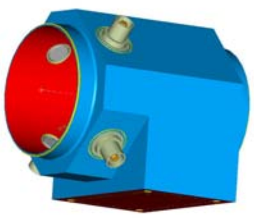
Assuming a operating frequency of f = 500 Mhz of the read-out electronics and a moderate beam current of 50 mA a level of -28.2 dBm (8.73 mV) can be expected. A more precise numerical analysis of the transfer characteristics has to be done for the final geometries of all different button pickup stations of Petra III.



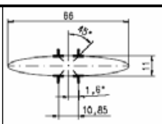
Ort: Alte Achtel und gerade Strecken
Rohr: Ellipse 80 x 40
BPM: ø11
Anzahl: 105 Positionen in den Bögen
3 Positionen in gerader Strecke SO



Ort: Neues Achtel
Rohr: Achteckprofil
BPM: ø11
Anzahl: 40 Positionen

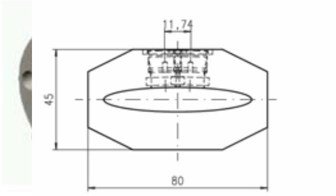


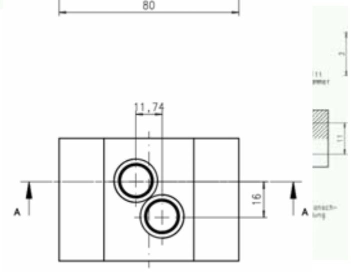
Ort: Gerade Strecken und L-Weg (E-Weg)
Rohr: ø94
BPM: ø15
Anzahl: ca. 20 Positionen PETRA III
13 Positionen L-Weg
(evtl. einige Positionen E-Weg)



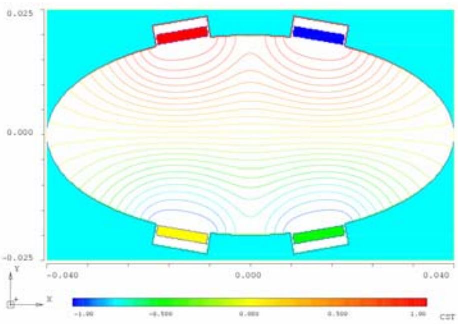
Ort: Neues Achtel, vor/hinter Undulatoren
Rohr: Ellipse 66 x 11
BPM: ca. ø5
Anzahl: 16 Positionen

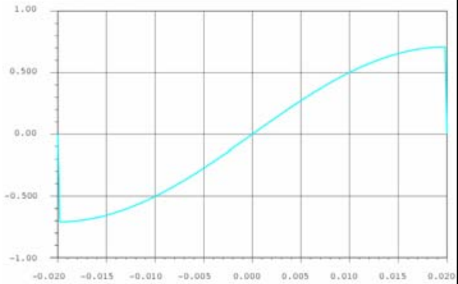
Meggitt, Dual-pickups for Argonne (Ø= 6mm) might not have sufficient signals and resolution. Calculations ongoing.





Just now: Calculating BPM constants, signals, linearity and resonances. Measurements with a PETRAIII test chamber will be done in 2006 enabling to proof the calculations.





Arc	a=40 mm	b=20 mm	button d= 10 mm	
angle	Kx /mm	Ky /mm	Kx^{-1} / μm^{-1}	Ky^{-1} / μm^{-1}
45	14.3	23.3	6.99 10^{-5}	4.29 10^{-5}
55	16.9	17.7	5.90 10^{-5}	5.64 10^{-5}

3D calculation (frequency domain)

Modes (BPM 45 deg angle)

(Univ. Magdeburg
Ayan K. Bandyopadhyay)

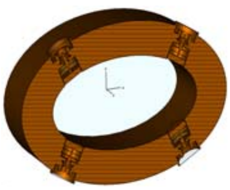


Fig. 1 MWS model of the BPM

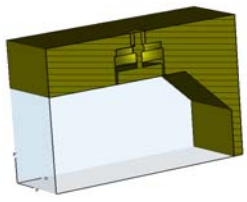
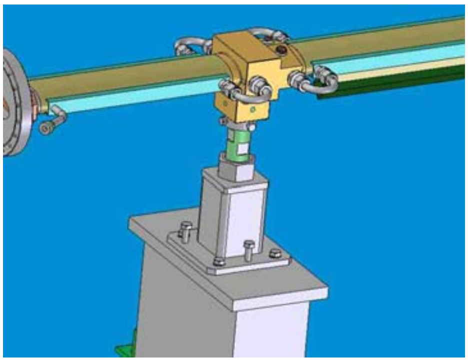


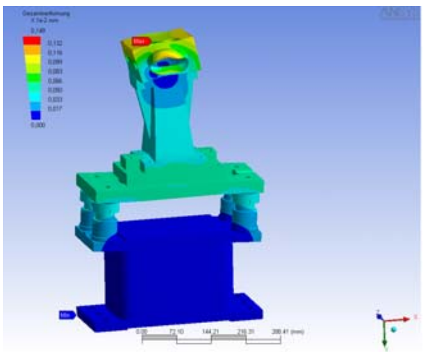
Fig. 2Simplified model (MAFIA)

summary of all modes found

mode	frequency/hz	maxwell's laws =div(d)= max norm	maxwell's laws =div(b)= max norm	maxwell's laws =curlcurl(e)= max norm	maxwell's laws =curlcurl(e)= l2 norm	solver accuracy /Ax-lx/ /Ax/
1	1.887509E+09	7.5E-15	2.1E-14	1.3E-10	3.8E-12	2.2E-10
2	4.576678E+09	1.3E-14	2.8E-16	2.2E-11	1.8E-12	1.1E-11
3	7.277170E+09	3.1E-13	2.3E-15	2.8E-10	3.4E-11	5.1E-10
4	7.432736E+09	1.5E-13	2.9E-16	1.4E-10	1.7E-11	1.4E-10
5	7.549143E+09	1.8E-13	2.5E-16	2.0E-10	2.0E-11	1.3E-10
6	8.670643E+09	9.8E-13	4.1E-15	9.2E-10	1.3E-10	1.1E-08
7	8.701316E+09	4.4E-12	3.7E-15	4.4E-09	6.5E-10	5.5E-08
8	9.188983E+09	2.3E-12	2.7E-15	2.1E-09	3.3E-10	8.3E-09
9	9.587748E+09	2.8E-11	3.3E-16	4.5E-08	7.3E-09	1.6E-07
10	1.023401E+10	1.1E-07	1.1E-15	6.6E-04	1.1E-04	6.3E-03

Part3: BPM Support





The design of all BPM supports is under way by MVA in cooperation with MDI and ZM1. The BPM should be rigid fixed to the ground floor. Mechanical and thermal stress will be calculated by ZM1. May be built in invar to guarantee thermal independence, especially in the new octant.

The movement between of the BPMs (relative to ground) should be measured with a resolution of about 1 μm (near undulators). Different technical solutions are under study. Two systems had arrived last week. Test are under way. Also an alternative solution by using a wire alignment system like in HERA will be studied.

MICRO-EPSILON

Funktionsbeschreibung, Technische Daten

2.3 Technische Daten

Modell		S601-0,2	S600-0,5	S600-1	S601-1[1]	CS2	CS3	CS5	CS10
Messbereich MB	mm	0,2	0,5	1	1	2	3	5	10
Linearität		Standard <0,3 % d.M. Einzelabgleich[2] <0,1 % d.M.							
Auflösung		<0,015 % d.M.							
Messwerkstoffe		Elektrisch leitende Werkstoffe, Referenz: Aluminium							
Aktive Sensormessfläche	ø, mm	2,3	3,9	5,5	5,5	7,9	9,8	12,6	17,8
Mindestdurchmesser Messobjekt		5	7	9	9	17	27	37	57
Betriebstemperatur	Sensor	-50 ... +150 °C			bis +200 °C	-50 ... +150 °C			
	Controller	+10 ... +50 °C							
Luftfeuchtigkeit		5 ... 95 %, nicht kondensierend							
Lagertemperatur		-10 ... +75 °C							
Empfindlichkeit	V/mm	50	20	10	10	5	3,33	2	1
Ausgang	Standard	0 ... +10 VDC (kurzschlussfest) Min. Lastwiderstand 1,2 kOhm Max. Lastkapazität 1 nF							
	Option I	4 ... 20 mA, Bürde max. 400 Ohm							

d.M. = des Messbereichs

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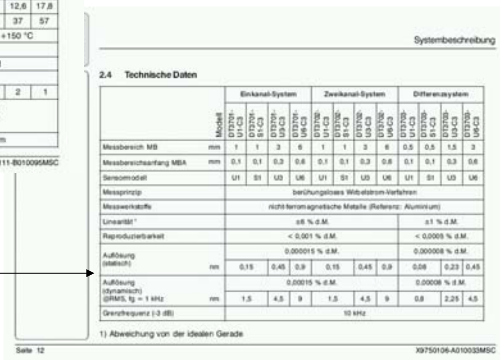

Systembeschreibung

2.4 Technische Daten

		Einkanal-System				Zweikanal-System				Differenzsystem			
Modell		DT3701-U1-C3	DT3701-S1-C3	DT3701-U3-C3	DT3701-U6-C3	DT3702-U1-C3	DT3702-S1-C3	DT3702-U3-C3	DT3702-U6-C3	DT3703-U1-C3	DT3703-S1-C3	DT3703-U3-C3	DT3703-U6-C3
Messbereich MB	mm	1	1	3	6	1	1	3	6	0,5	0,5	1,5	3
Messbereichsanfang MBA	mm	0,1	0,1	0,3	0,6	0,1	0,1	0,3	0,6	0,1	0,1	0,3	0,6
Sensormodell		U1	S1	U3	U6	U1	S1	U3	U6	U1	S1	U3	U6
Messprinzip		berührungsloses Wirbelstrom-Verfahren											
Messwerkstoffe		nicht ferromagnetische Metalle (Referenz: Aluminium)											
Linearität[1]		±6 % d.M.								±1 % d.M.			
Reproduzierbarkeit		< 0,001 % d.M.								< 0,0005 % d.M.			
Auflösung (statisch)		0,000015 % d.M.								0,000008 % d.M.			
	nm	0,15		0,45	0,9	0,15		0,45	0,9	0,08		0,23	0,45
Auflösung (dynamisch)		0,00015 % d.M.								0,00008 % d.M.			
@RMS, fg = 1 kHz	nm	1,5		4,5	9	1,5		4,5	9	0,8		2,25	4,5
Grenzfrequenz (-3 dB)		10 kHz											

1) Abweichung von der idealen Gerade

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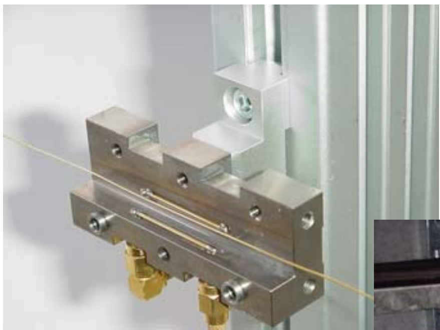
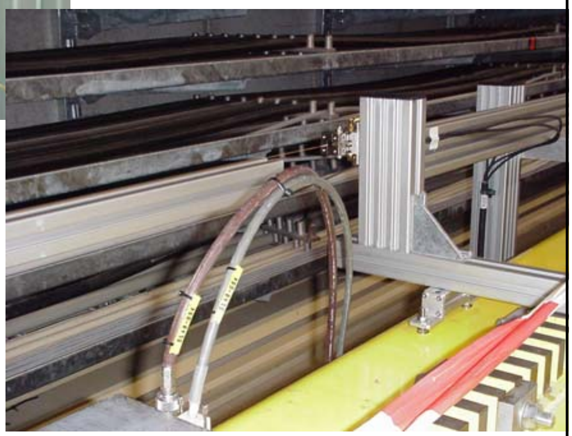
Wire alignment system in HERA





Beam current Monitors

Position: Long straight section East 3-4 DCCT + 1 ACCT) and at injection SO (2 ACCT)

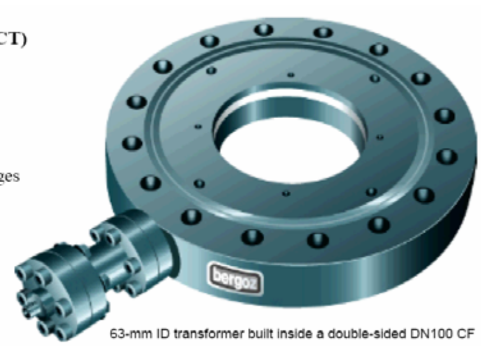
- DCCT for precise DC-current and lifetime meas. (incl. reserve)
- ACCT east: precise single bunch current meas.,
  SO: injection efficiency studies (incl. reserve)
- Wall current or Phase probe (east): Fast timing signals.

- **Fast Current Transformer (FCT)**
- **Integrating Current Transformer (ICT)**
- **AC Current Transformer (ACCT)**
  can be built inside a Conflat flange

Simple installation between two existing flanges

Big time and money savings:
- Ceramic gap: eliminated
- Bellows: eliminated
- Mechanical holder: eliminated
- Wall current bypass: eliminated

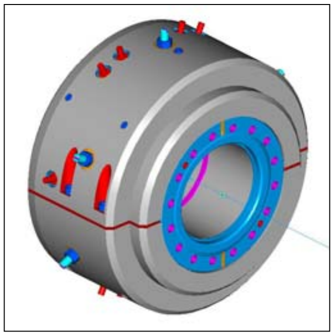
Assurance that instrument will perform on beam, same as it performs on bench

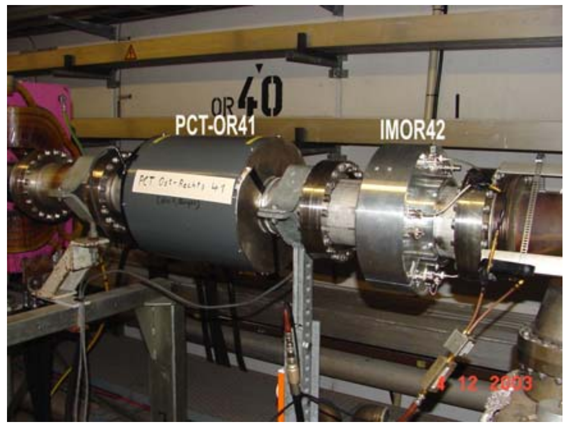


63-mm ID transformer built inside a double-sided DN100 CF

Prototype should be delivered from BERGOZ (still under design at BERGOZ)
Technical data sheet meets our requirements (200ps rise time, 1.75 GHz bandwidth)
Prototype will be tested in PETRAII in 2006.

ACCT for transport lines (same as for VUV-FEL)





DCCT:
2 PCT (high resolution) and
2 MPCT from PETRA II
exist.
(1 PCT in DESY III (spare))

Bunch current:
AC monitor
HERAe:
Noise σ = 0.3 μA
(BW=680 Hz)

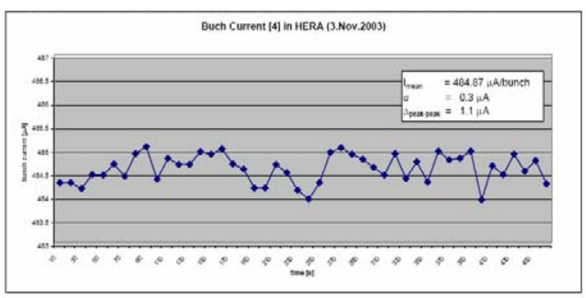


Fig: 3.10.3/1: Plot of the current of the 4th bunch in HERA. The resolution is limited by statistical fluctuations to about σ = 0.3 μA of the bunch current of 484.87 μA. Each data point is averaged over 70 turns in HERA.

DC Beam current:
PCT HERAe
Noise σ = 3 μA
(BW = 6 Hz)

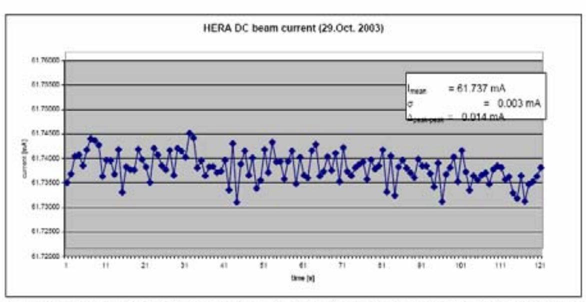
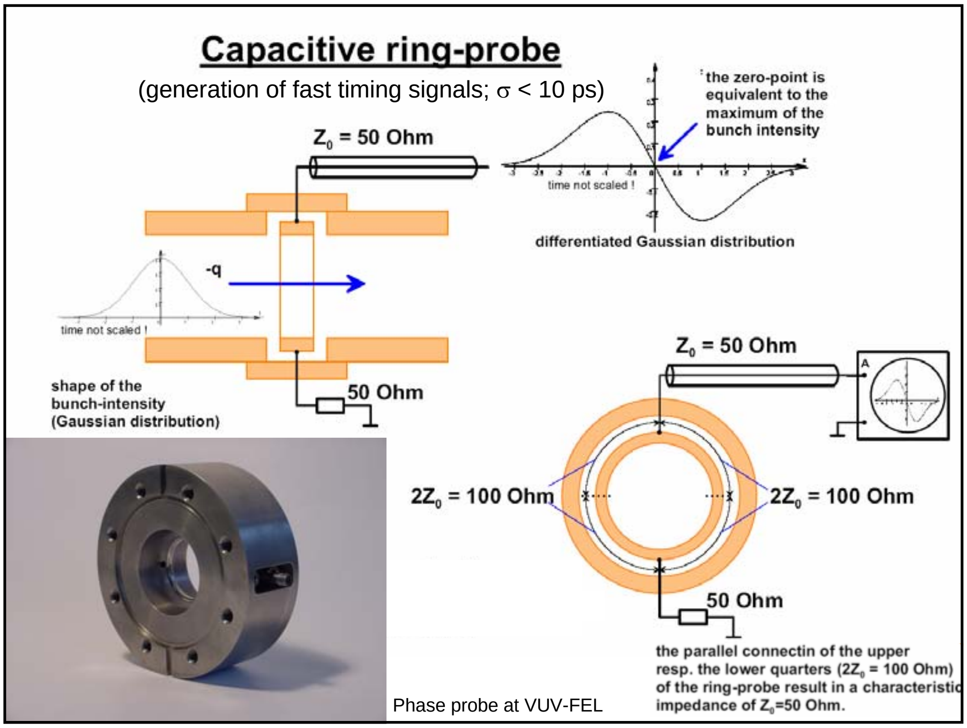
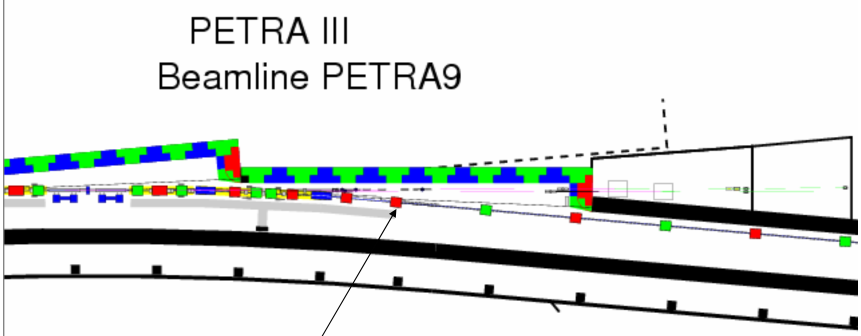


Fig. 3.10.3/2: Plot of the measured DC beam current of HERA over 2 minutes. The resolution is limited by statistical fluctuations to about σ = 0.046 ‰ (first 80 seconds) of the beam current of 61.736 mA. The integration time of each data point is 160 ms. The small slope is due to the decaying beam current in HERA.


Capacitive ring-probe
(generation of fast timing signals; σ < 10 ps)
Z0 = 50 Ohm
the zero-point is equivalent to the maximum of the bunch intensity
time not scaled !
differentiated Gaussian distribution
-q
time not scaled !
shape of the bunch-intensity (Gaussian distribution)
50 Ohm
Z0 = 50 Ohm
A
2Z0 = 100 Ohm
2Z0 = 100 Ohm
50 Ohm
the parallel connectin of the upper resp. the lower quarters (2Z0 = 100 Ohm) of the ring-probe result in a characteristic impedance of Z0=50 Ohm.
Phase probe at VUV-FEL

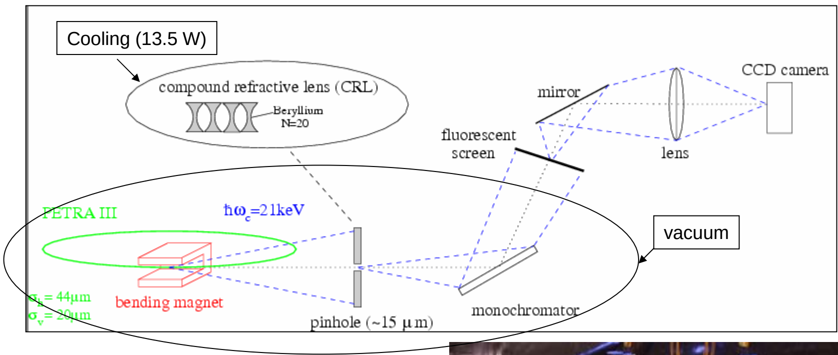
Synchrotron Radiation for diagnostic:

Diagnostic beam line at the end of the new PETRA Hall using bending magnet behind last undulator



Special vacuum pipe necessary for light separation.

More light exits in old octant are foreseen for further (future) diagnostics (e.g. steak camera). Position not yet defined. Easy maintenance required.

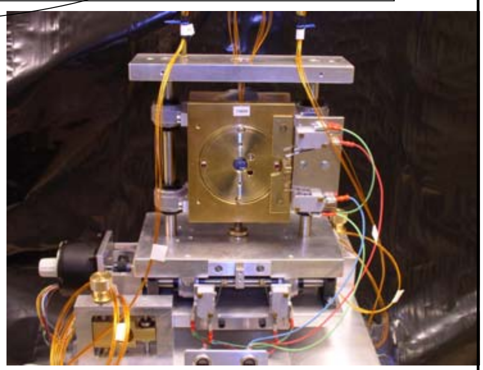


For PETRA-III the most promising scheme is electron beam imaging in the X-ray region with synchrotron radiation from a bending magnet. This method gives a fast and direct information about the beam sizes with high accuracy.

The resolution for a x-ray pinhole Pinhole camera is calculated to about σ_m = 10μm, but

$$\sigma_{beam} = \sqrt{\sigma_{meas}^2 - \sigma_m^2}$$

Under study:
A compound refractive lens might improve the resolution down to σ_m < 2μm.
A collaboration with HASYLAB had started.



Pinhole Camera in DORIS

Laser-wire Beam Profile Monitor

Position: short straight section SW

People of LBBD Collaboration

Royal Holloway (UL)

G. Blair, G. Boorman, J. Carter, F. Poirier, M. Price, C. Driouichi

University College London (UL)

S. Boogert, S. Malton

BESSY

T. Kamps *

DESY

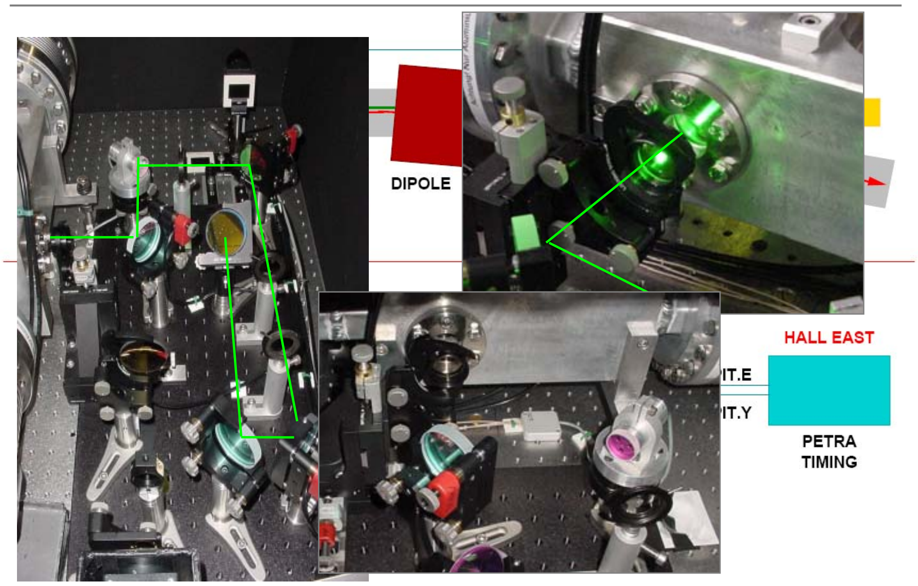
K. Balewski, H. C. Lewin, S. Schreiber, K. Wittenburg

We are also part of and

The aim of the Laser Based Beam Diagnostics (LBBD) Collaboration is to study the feasibility of laser based diagnostics tools for future linear electron positron collider (FLC). The objectives of the laserwire project are to develop laser based techniques for determining the dimensions of electron (positron) bunches in a FLC and optimising their application using simulations.

*Following slides mainly from T. Kamps (BESSY) for the LBBD Collaboration PAHB Workshop, Erice, October 2005

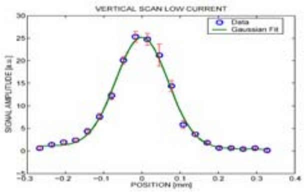
Setup of Laser-wire at PETRA2

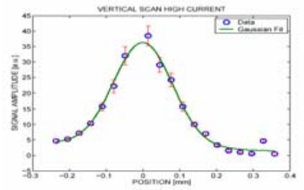


LBBD Laserwire

Results from Operation at PETRA2

- **Dec 2003**: two runs at 7 GeV
- Bunch pattern 14 x 1 bunch evenly filled
- Low current with 7.1 mA, 1st bunch 0.46 mA
- High current with 40.5 mA, 1st bunch 2.69 mA
- Gaussian approximation with constant and slopey background
  - $\sigma_m = (68 \pm 3 \pm 14)\ \mu m$
  - $\sigma_m = (80 \pm 6 \pm 16)\ \mu m$
- Manual control of scanner and DAQ system:
- Single scan 30 min
- **Feb 2005**: same setting for PETRA, but
- New exit chamber at dipole before detector
- Upgrade in DAQ system
  - Trigger for all components and readout derived from PETRA timing system
  - Synchronisation jitter Δt_{rms}< 300 ps from PETRA timing
- Single scan 30 sec



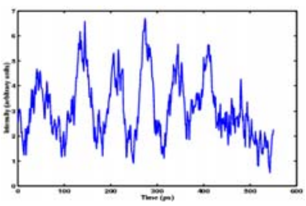


LBBD Laserwire

Lessons from Laserwire Operation at PETRA2

- Reliable operation of laser mandatory to concentrate on laserwire issues
  - Transverse profile: measured with knife edge scans showed M^2 [4.8]
  - Longitudinal profile: measured with streak camera, envelope Δt = 12 ns with mode-beating of 70 ps peak to peak distance

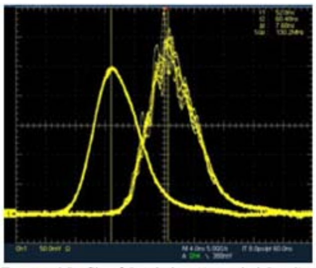
Need of new laser



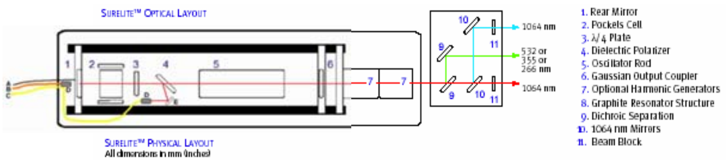
- Operational DAQ system essential to take mass data
- Calibration of detector for all settings mandatory to compare data with simulations, test beam at DESY around the corner
- Add second dimension
- CCD cameras and firewire infrastructure prone to failure under operation in PETRA2 tunnel
- Coarse scanning to find electron limited affair
- Change of laser spot size for different operation conditions would be nice
- ▶ Items will be addressed by upgrade of the current system and with the laserwire at PETRA3
- ▶ Deliver the standard diagnostic tool

New Laser for the Laserwire at PETRA2 & PETRAIII

- Q-switched Nd:YAG laser with diode pumped injection seeding
- Second harmonic generation for 532 nm
- Smooth transverse and longitudinal profile
- Peak power 1 MW for single mode and 16 MW for multi-mode laser
- **Financed by EUROTeV!**

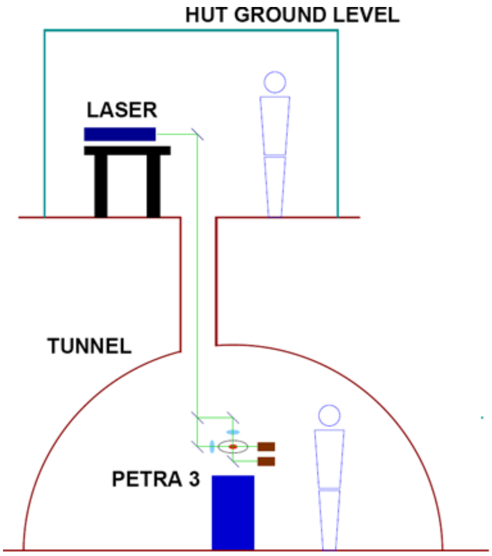


Temporal Profile of Seeded vs Unseeded Surelite



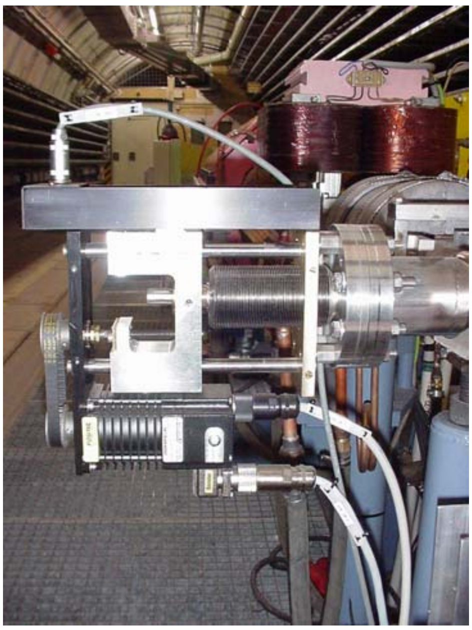
Transition to PETRA3

- PETRA2 stops operation until June 2007 (end of HERA)
- Turning the accelerator into a high brilliance synchrotron radiation source (2009/2010)
- PETRA3 crew want laser-wire to measure transverse beam profile and emittance in straight section, in absence of dispersion
- Beam sizes are in the order of several ten µm
- Re-cycle laser and vertical board solution from upgrade
- New optical beam path and focusing lens
- Move all sensitive diagnostics in hut and only robust technology in tunnel
- **Planning and setup of hut and infrastructure started March 2005**
- **Operation of PETRA2 laserwire and setup of new one in parallel**



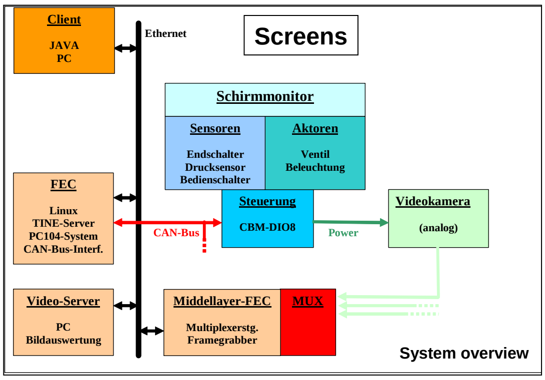
Screen monitor, beam stopper, scrapers in PETRAII

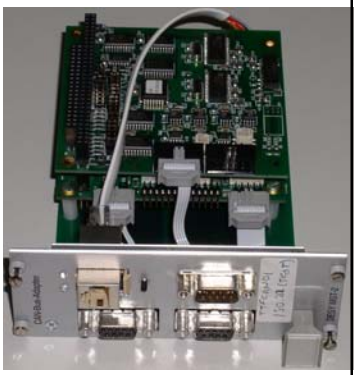
Position: short straight section SO and transport lines; mechanical design by MDI



Scraper in HERAe. Mechanical design by MVA

Position in PETARIII: short straight section SW

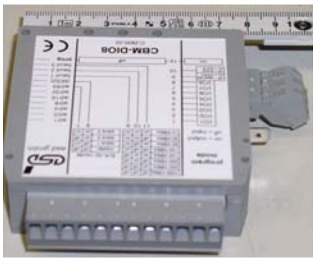




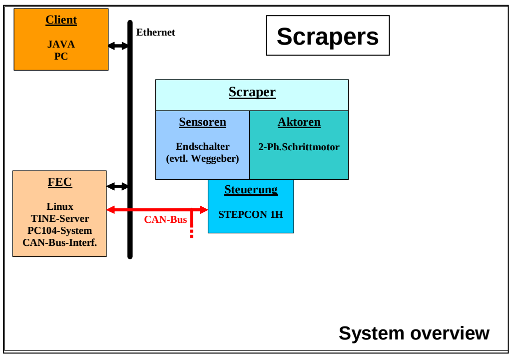
PC104-module (Linux) with CAN-Bus-interface

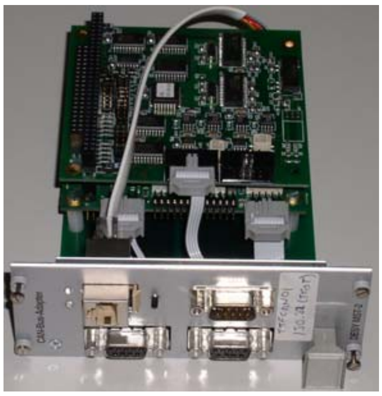
New readout electronic for PETRAIII

We will use **old fashion analog video cameras** to observe the screens because of their much better radiation hardness.
In collaboration with MST and Zeuthen, **a new (general) video server** will be developed.
Controlling of motion with commercial **CAN BUS modules and PC104** based Servers (Linux).



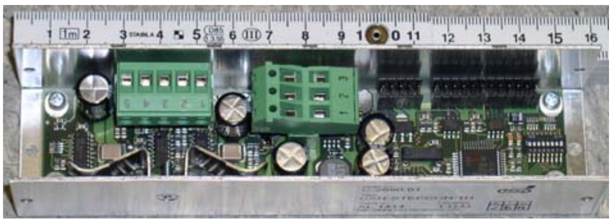
CBM-DIO8-Modul der Fa. ESD





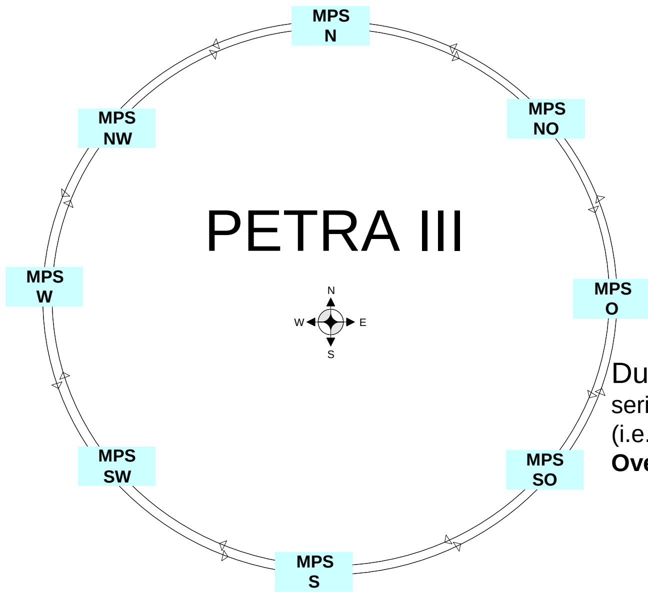
PC104-module (Linux) with CAN-Bus-interface

For the controlling of stepping motors we are on the way to develop a **DESY wide general solution with a commercial CAN-Bus-interface**. So far: VUV-FEL, Hasylab, MDI, MST, …



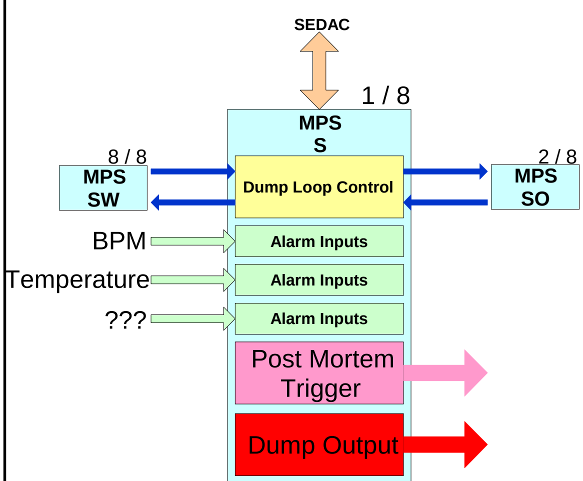
2-Phase-Stepping motor control card with CAN-Bus-interface

Machine Protection System for PETRA III



Dump-Loop
serial-differential signaling
(i.e. RS-422/EIA-422)
Overall reaction time <100 μs

Machine Protection Crate



- write/read registers via SEDAC
- Maskable Errors
- Save Input States (Post Mortem)
- Post Mortem Trigger for other devices
- Dump Loop for synchronization and signaling
- Overall reaction time <100 μs

Since 1.Oct. 05 a new engineer has started to design the system

Temperature Modules for Petra III

All beam pipe sections which might be exposed by huge Synchrotron Radiation will be equipped with temperature sensors. To avoid local overheating of the pipe, each sensor will have an **individual threshold**. Exceeding the threshold will generate an alarm which will be delivered to the Machine Protection System MPS. The **huge number of channels (≈1500**, defined by MVA) generates a need for a low cost solution but in conjunction with a high reliability and availability while the precision is not important.

Sensors: PT100 (less sensitive to EMI than Thermocouplers)
Readout in 4-wire technique with shielded and twisted wires.

Readout electronic: In house development with our In-house SEDAC field bus, Cost: ≈150 EURO/ 8 channel (cheap, reliable, simple to maintain, modular, applicable for long distances (few km), huge experience)
A survey through commercial products had shown that all examined products couldn't satisfy the requirements of low cost, high reliability and availability.

Accuracy and range: Accuracy of +/- 5°C between 0°C to 200°C was demanded. Missing sensors, broken cables and short circuits will be detected automatically.

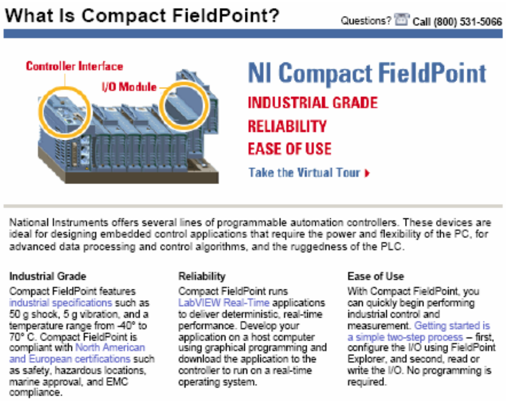
Interlock und post mortem memory: As soon as the temperature exceeds the threshold, a potential-free contact (open) will be sent to the MPS. Each threshold can be adjusted and readout individually via fieldbus connection. Various checkups and test functions will be implemented in the module. A power fail safe design is required. In case of an alarm the last 60 s are stored in the memory of the modules. The alarm needs a reset. The interlock function works independently and does not need a fieldbus/computer connection to work properly.

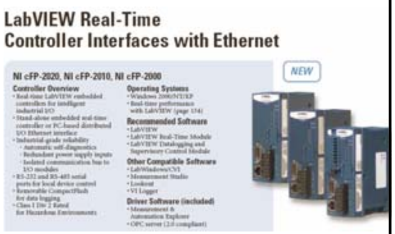
Schedule: Development has started, no serious problems will be expected.
First prototype already successfully tested in laboratory.
First tests in PETRA/DORIS in 2006 are foreseen.

Magnet protection with pilotherm sensors and water flow guarder.

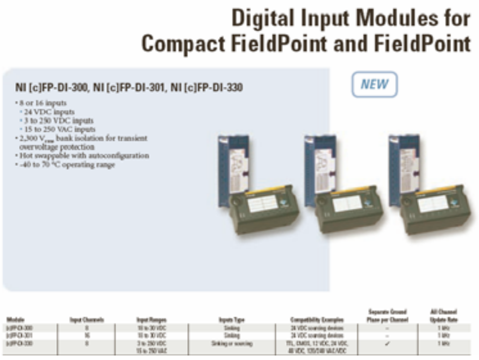
Each PETRAIII main magnet will be equipped with some pilotherm sensors to protect the magnet coils against too high temperatures in case of cooling failures. The sensor opens a contact at a certain threshold (fixed, depends on sensor type). The sensor type selection and its mounting on the magnets will be organized by MEA. The readout and the alarm generation is part of MDI.

DESY solution up to now: In-house system, developed more than 20 years ago.
PETRAIII (and future) solution: Commercial system from National Instruments: cFP

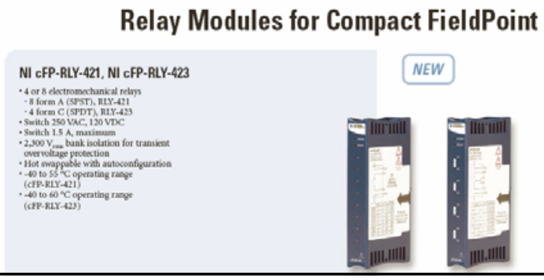




IO Modules for pilotherm sensor (≈ 800) and water flow guarder (≈ 600) readout and alarm signal generation (-> to power supplies), located in the 8 PETRA halls



56 channels / crate. Crates are connected via Ethernet with LabView server



Test of the system are foreseen in 2006 in DESY III.

Experience: In case of a pilotherm alarm one needs to proof the temperature increase (real or maybe broken cable). Therefore temperature sensors for each magnet are foreseen (790 pieces), to proof the temperature increase in case of an alarm. This path is NOT part of the security loop.
However, the same readout system as for the vacuum pipe temperature will be used.