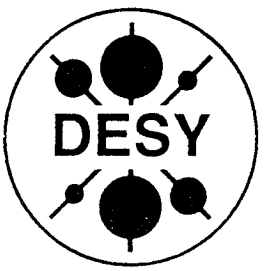
Status of the Vacuum System of the TTF-Linac

Kirsten Zapfe, DESY Hamburg

TESLA-Collaboration Meeting, Nov. 8-10, 1999

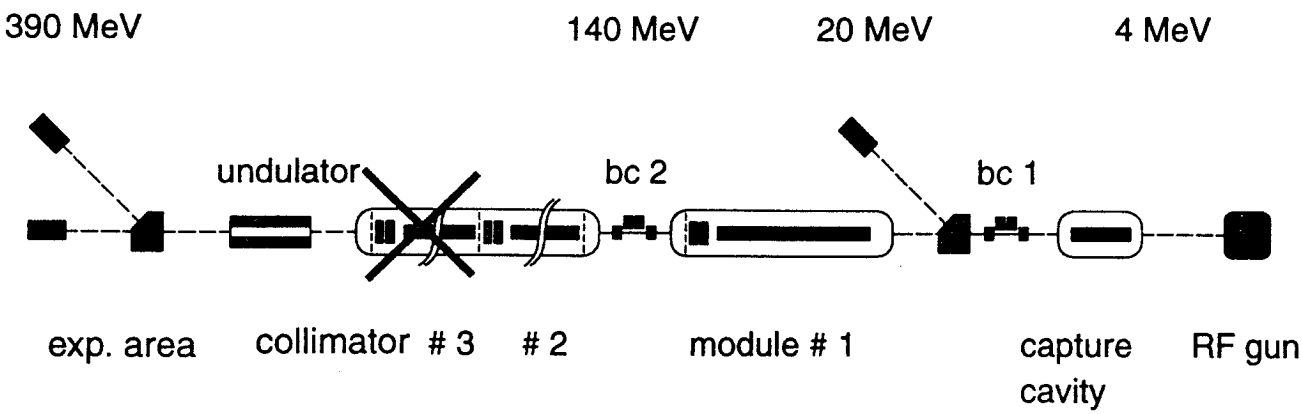
Content

- Overview
- Cleaning and Installation Procedures
- Running Experience
- Summary and Outlook



Overview

About 120 m of beam pipe



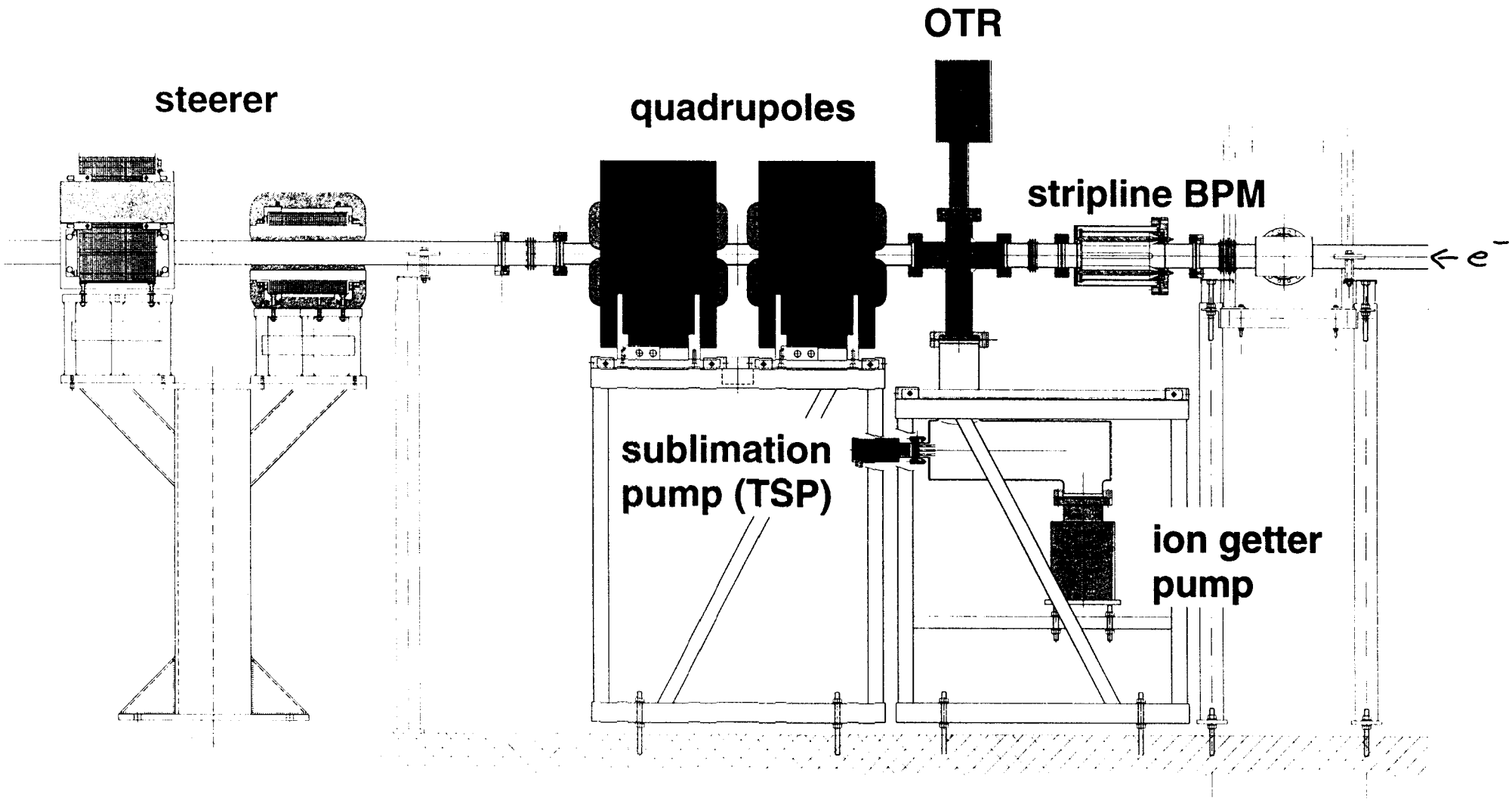
- **Cold system (2 K) with isolation vacuum and separate warm coupler vacuum**
  - Capture cavity
  - Cryo modules ACC1 and ACC2
- **Warm beam pipe**
  - RF-gun
  - Sectors 400 (bunch compressor I) - 600
  - Bunch compressor II
  - ACC3 (temporary beam line)
  - Collimator
  - Undulator
  - Experimental area incl. FEL diagnostic

- **Pumping and pressure readout**
  - > 30 ion getter pumps (60 l/s)
    ➥ also used for pressure read out (min. $3 \cdot 10^{-11}$ mbar)
  - > 30 titanium sublimation pumps (1000 l/s)

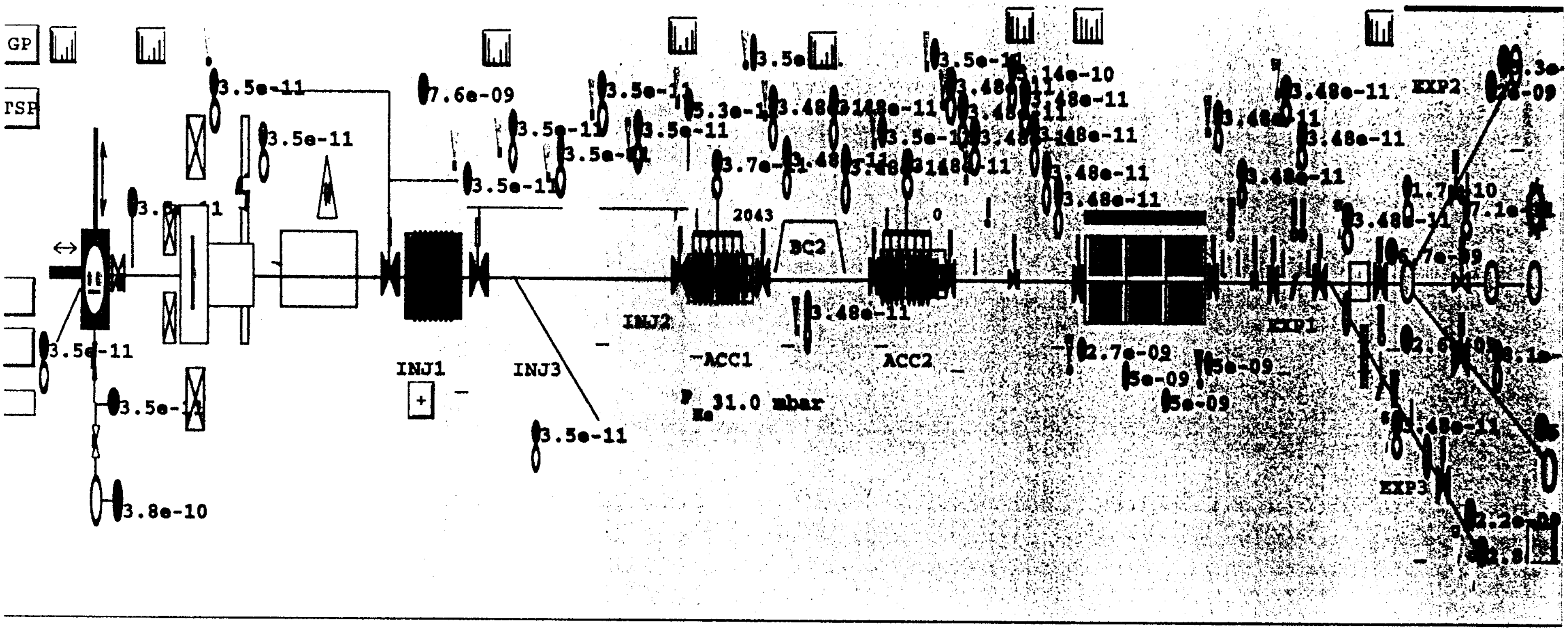
- **Segmentation**
  - 12 all metal gate valves
    valves automatically closed if
    ➥ pressure p > 10^{-7} mbar
    ➥ cryo ok missing
    ➥ failure of compressed air
  - 2 fast shutters downstream of second module
    ➥ trigger signal from additional small ion getter pumps with fast readout (undulator, FEL diagnostic)
    ➥ total closing time of ≈ 20 ms corresponds to distance of 20 m

- **Control system**
  - all vacuum equipment (pumps, valves, pump stations, ...) integrated into TTF-control system

Section of the Temporary Beam Line



K.Z-D. 4/9/96



K. Zapfe. 4.11.99

Cleaning and Installation Procedures

Goal:

minimize risc of particle/gas contamination of s.c. cavities from other vacuum components

- **Careful cleaning of all vacuum components**
  - vacuum firing at 950 °C (2 h)
    ➥ reduce outgassing of H_2
  - cleaning of all vacuum components in clean room
    ultrasonic bath
    rinsing with ultra pure water
    drying in class 10-100
    pumping with high gas flow ("pump and purge")
    assembly of diagnostic elements in clean room

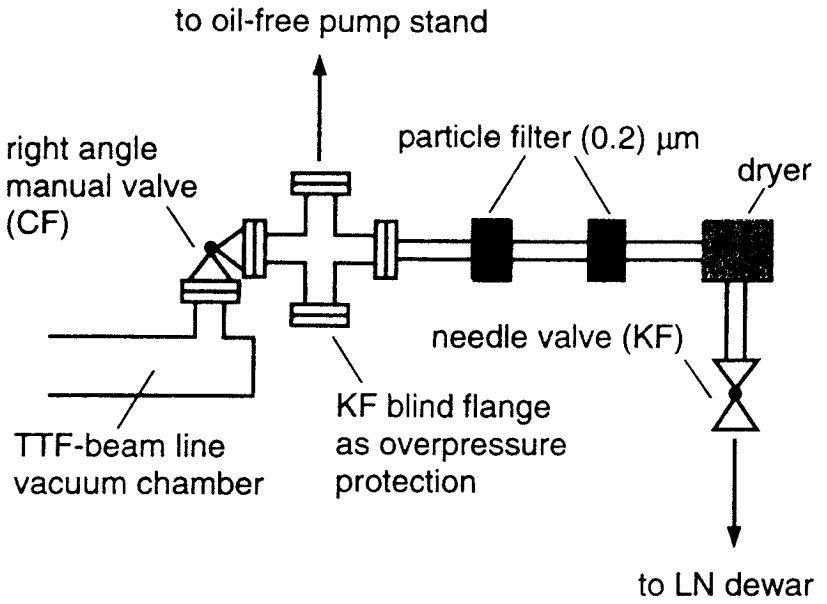
    time consuming!

    ➥ careful planning with other clean room activities

- **Installation in linac using local clean rooms**
  - movable clean rooms
  - filter elements for variable geometry

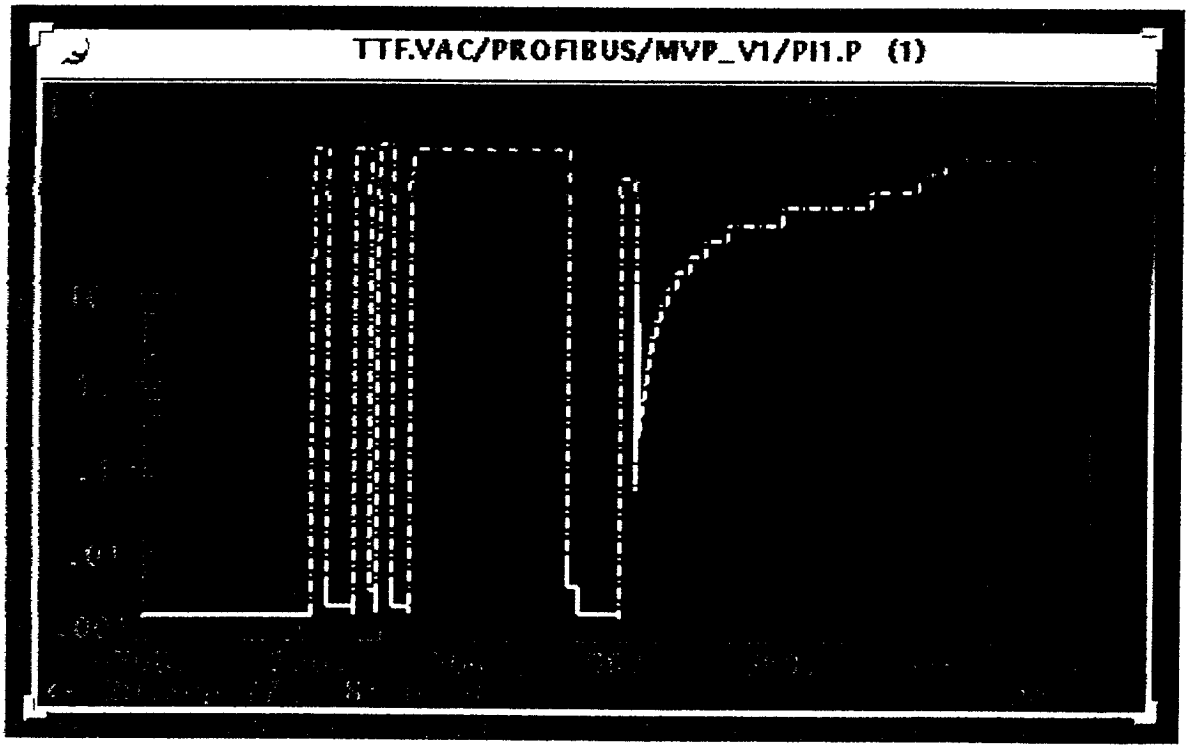
- **Special pump down/venting procedures**
  - movable oilfree pump stations for pump down
  - laminar gas flow directed away from cavities
    ➥ slower than standard procedures
  - ultra clean gas for venting

Set up used for venting



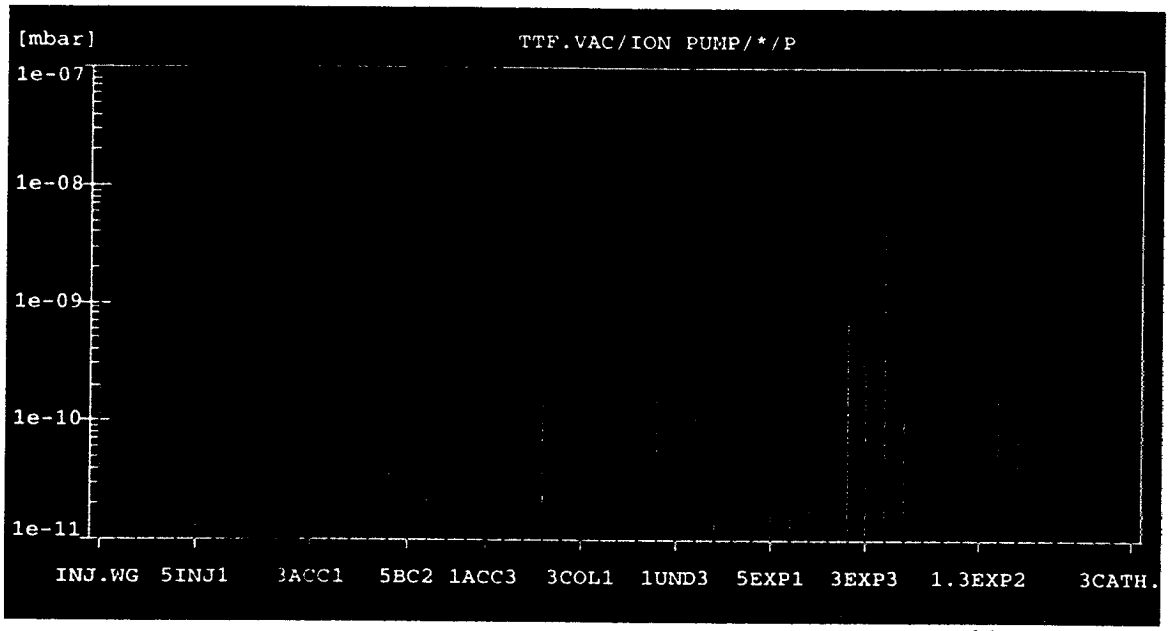
➥ pump and purge vent line several times before venting

venting of beam line segment



Running Experience

- **Overall performance**
  - low pressure (<10^{-10} mbar) in most areas



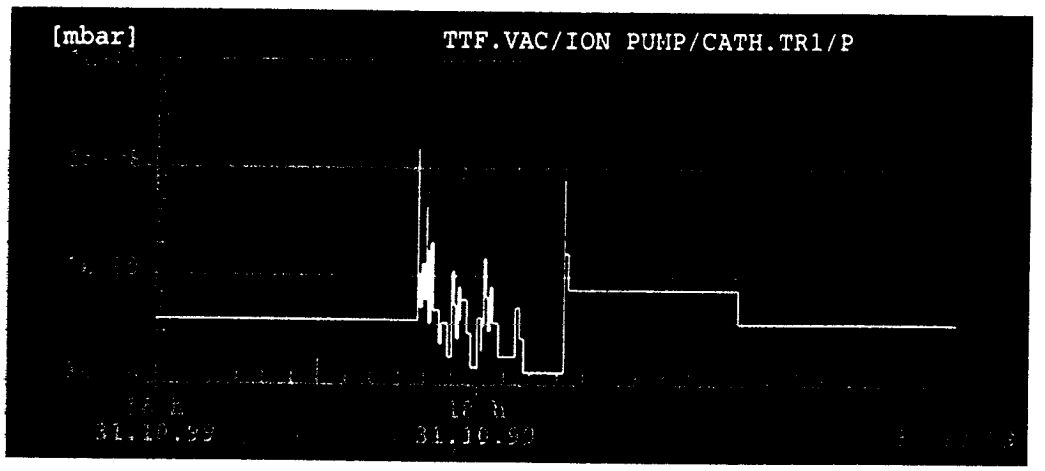
Nov. 4, 10:30 am

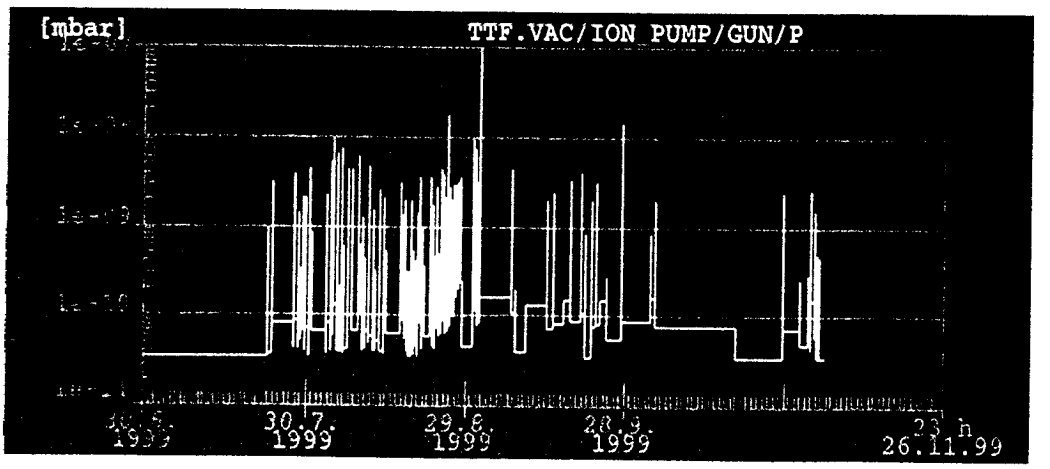
  - low gas load
    - ➥ activation of titanium sublimation pumps every few weeks
  - 3 leaks in present system known
    - ➥ beam vacuum - isolation vacuum ACC2 (module 2)
    - ➥ Helium line - isolation vacuum ACC1 (module 3)
    - ➥ toroid in exp. station 5 (ceramics)

- **Safety system**
  - several times closing of gate valves due to strong pressure rise
  - fast shutters not yet activated by vacuum problems

Injector

- installation of RF injector in autumn 98
  - ➥ FERMILAB gun
  - ➥ cathode exchange system (INFN Milano)
  - ➥ "quick" exchange of FERMILAB and DESY gun possible
- Cs_2Te cathodes should never see bad vacuum (H_2O, O_2)
  - ➥ preparation of cathodes under vacuum in Milano
  - ➥ transport to DESY in special vacuum chamber with ion getter pump
    (penning power supply connected to car battery)
  - ➥ connection to loading chamber at DESY under vacuum
- some vacuum activites during exchange of cathodes
- slow degradation of gun vacuum during beam operation

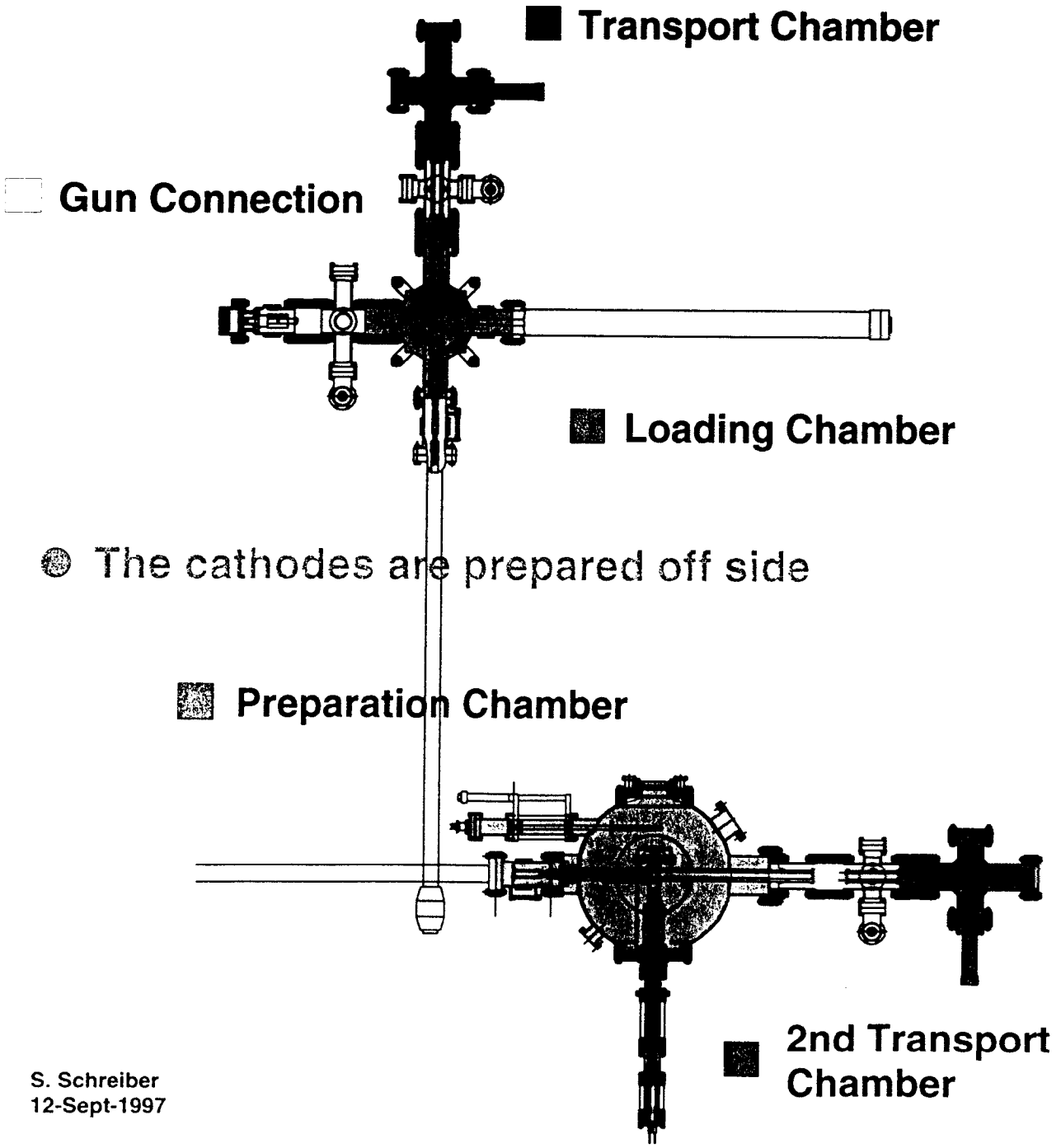




Cathode System

INFN Milano LASA
DESY (Vacuum equ.)

- Cs_2Te cathode: high QE (>1 % over months)
- **The cathode system allows to change the cathode without breaking the vacuum**
  This is essential to maintain the high quantum efficiency of the Cs_2Te cathode



S. Schreiber
12-Sept-1997

● Sector 400-600

➥ vacuum system originally built and installed by Orsay

- most parts of sector 400 exchanged by bunch compressor I and diagnostic for RF-injector
- several monitors improved, changed or added
- original ion getter pumps (read out limited to 10^{-9} mbar) exchanged by standard pump combination (GP+TSP)
  ➥ improvement of pumping speed and pressure read out

● Bunch compressor II

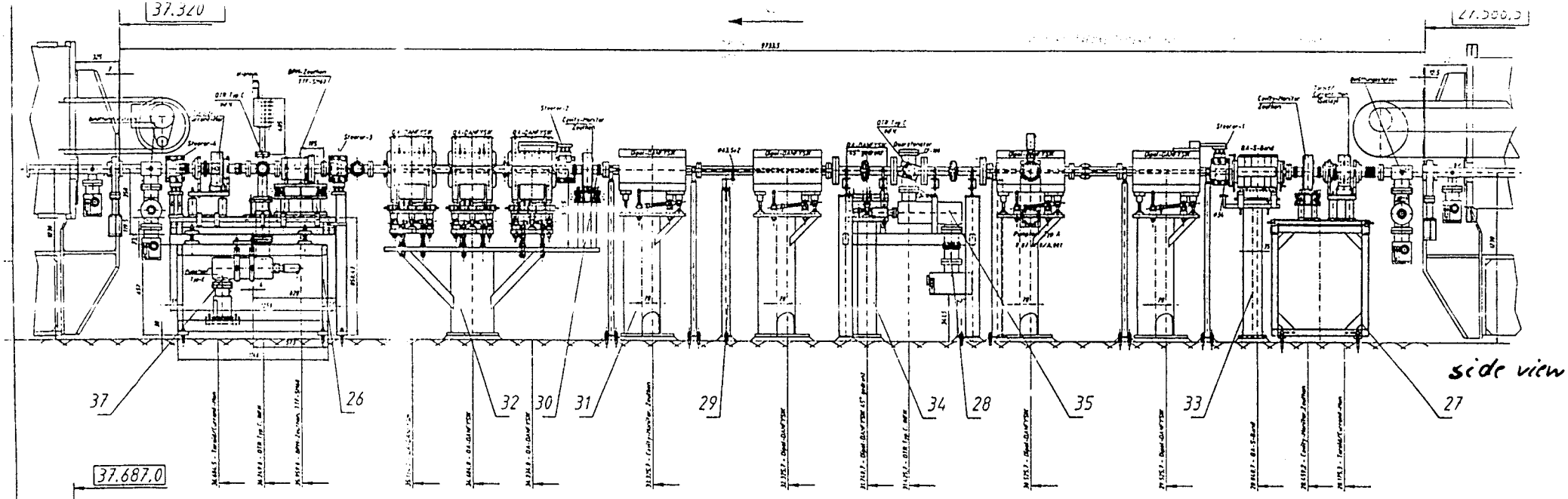
- installed in autumn 98
- dipole chambers with 17 mm gap heigth
- future plans
  ➥ installation of dipol chamber with 8 mm gap height
  ➥ installation of RAFEL experiment in straight section

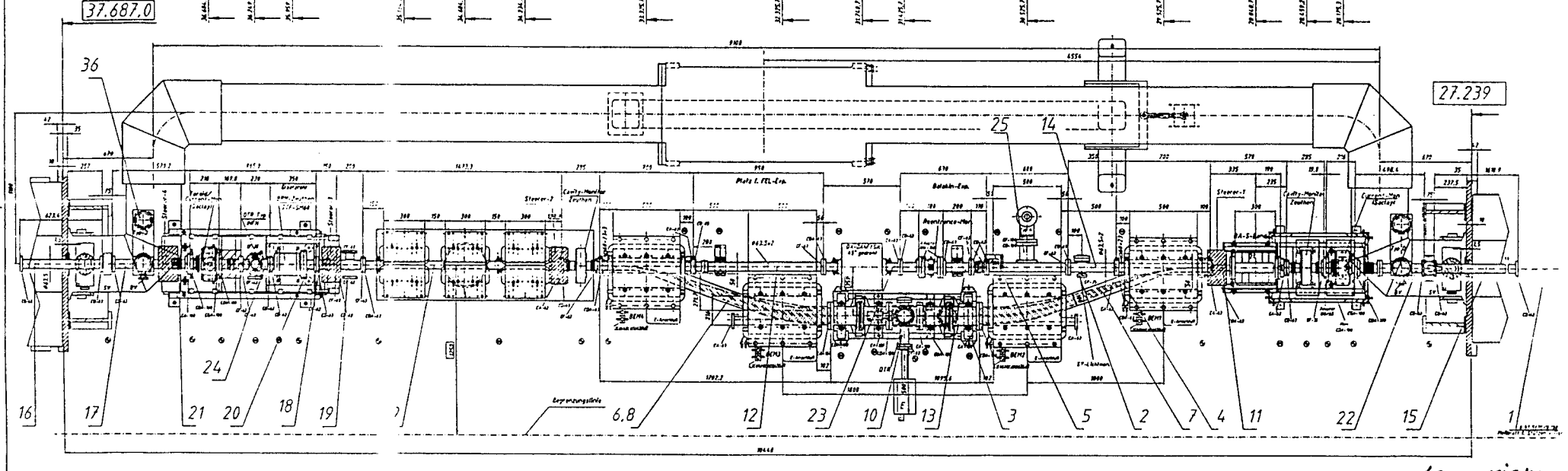
◉ ACC3

- still temporary beamline
  ➥ space for additional experiments, e.g. feedback kicker

◌ Collimator section

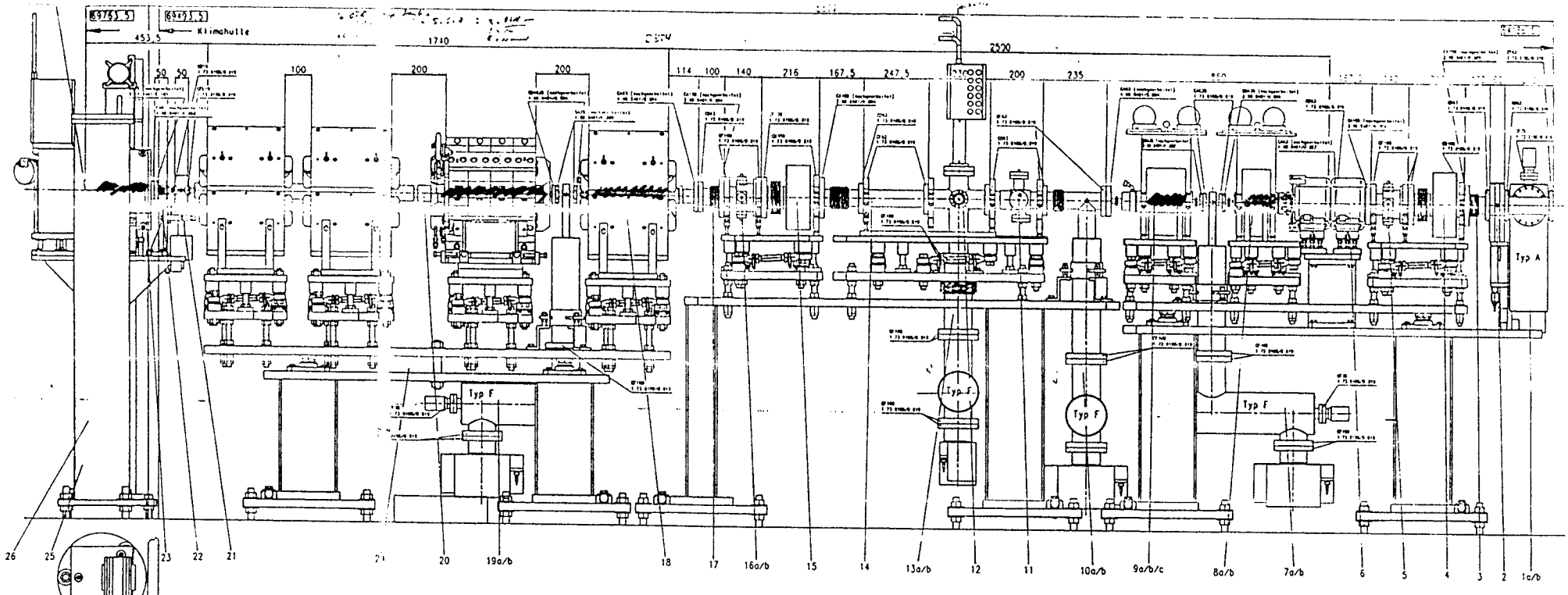
- 2 spoiler (Φ = 6 mm, several cm long), 3 absorbers
  ➥ necessary for protection of undulator vacuum chamber
- high filling factor with spoilers, absorbers, magnets and monitors
- exact positioning of components critical
  ➥ many difficulties to align components correctly

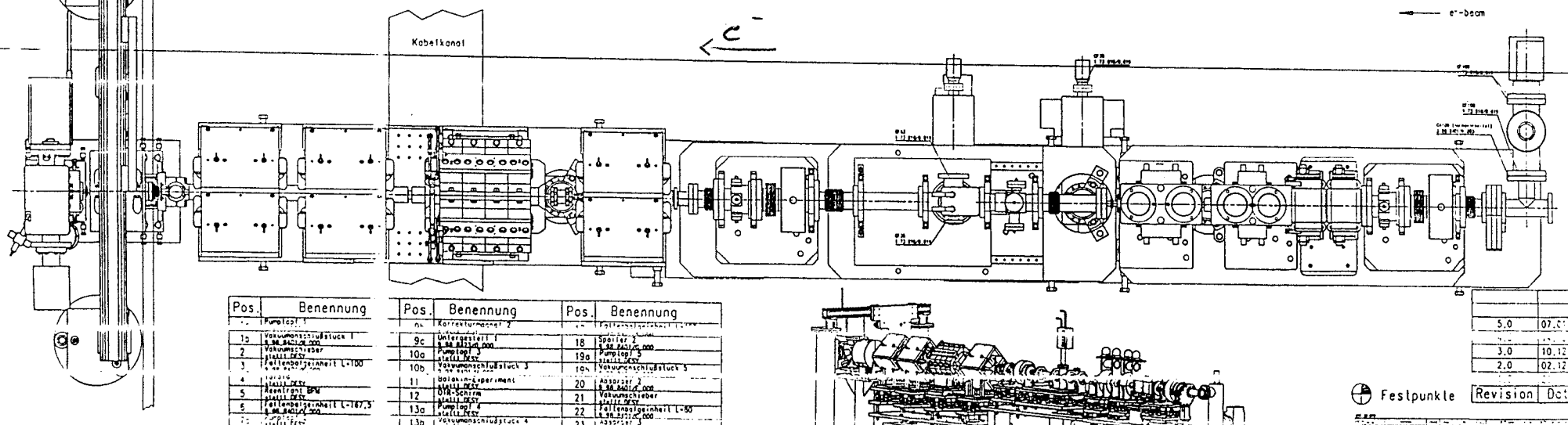




STAND: 16.11.1998

			Bunchkompressor II
		DESY - MVP1	D 97 5670/0.003





Pos.	Benennung
1a	Vakuumanschlußstück 1
2	Vakuumschieber
3	Faltenbalgeinheit L=100
4	Turbo
5	Reinfront BPM
6	Faltenbalgeinheit L=167,5
7a	Vakuumanschlußstück 2
8a	Spoiler 1
8b	Korrekturmagnet 1
9a	Absorber 1
9b	Korrekturmagnet 2
9c	Untergestell 1
10a	Pumpstop 3
10b	Vakuumanschlußstück 3
11	Bolzen-Experiment
12	OTR-Schirm
13a	Pumpstop 4
13b	Vakuumanschlußstück 4
14	Zwischenstück L=247,5
15	Toroid
16a	Reinfront BPM
16b	Untergestell 2
18	Spoiler 2
19a	Pumpstop 5
19b	Vakuumanschlußstück 5
20	Absorber 2
21	Vakuumschieber
22	Faltenbalgeinheit L=50
23	Absorber 3
24	Wagneluntergestell
25	Kamer-Youle
26	Laserpositionssystem

Revision	Date
5.0	07.01.99
3.0	10.12.98
2.0	02.12.98

Festpunkte

TTF-FEL
Kollimatorstrecke

DESY- FDET

0 98 8401/0.000

Undulator section

- difficult connections between undulator chambers and monitor blocks (space)
- pressure limited to $\approx 5 \cdot 10^{-9}$ mbar due to long, narrow beam pipe (Φ = 9.5 mm, 4.5 m distance of pumps)

Experimental area

- FEL-diagnostic installed in straight section
- little free space left
- future installations
  - ➥ wake-field experiment
  - ➥ beam-trajector-monitor

Cold beam vacuum

- leaks in module 1 and 2

Isolation vacuum

- one pump station/module running permanently

Warm coupler vacuum

- 1 ion getter pump + titanium sublimation pump/module
- many vacuum bursts during conditioning
  - ➥ time limiting factor
  - ➥ substantial improvements needed

Summary and Outlook

- **Vacuum system working reliable**
- **Leak in Modules need to be fixed in future**
- **No major vacuum break downs**
- **Space for new components very limited**
- Improvement of injector vac. system
- **Installations during next shut-down**
  - dipol chamber with smaller gap height
  - RAFEL-Experiment (BC II, FEL-diagnostics)
  - feedback kicker (experimental area)
  - wake-field experiment/beam-trajectory-monitor (behind undulator)