

# **X-FEL Beam Dynamics Meeting**

## **Minutes #4                      15.10.03**

### **Topics:**

- Review of XFEL beam transport and distribution work
- Microbunching instability in TTF 2
- Next meeting

### **Review of beam distribution work**

Vladimir Balandin reviews what has been done for the design the XFEL beam transport and distribution. He points out that many solutions were driven by site constraints.

The beam distribution needs a review especially in view of:

- New site considerations
- Kicker/septum switch considerations
- 25 GeV maximum energy
- Incorporation of 2<sup>nd</sup> stage X-FEL laboratory
- Commissioning beamline and dump
- Low energy beamline
- Maximum allowable separation angle

The present design (TDR-supplement) will be used as a reference design for the time being. The capability of a kicker/septum switch (instead of the present slow magnet) should be incorporated soon. For the detailed layout a simple scaling of CSR effects versus maximum bending radii would be helpful, although the feeling is that at 20 GeV incoherent SR will play a bigger role.

The collimation section in the present design consists of long FODO cells to allow for high enough beta-functions. This solution is too long for the envisioned sites and needs to be reviewed. A lot of work on collimation has been done for the LC. Nick Walker agreed to share his knowledge. A separate meeting on collimation issues will be organized next week. To estimate the DC load on the collimation system, a calculation of the expected dark current at 20 GeV is needed. The emergency scenarios have to be revisited to estimate the maximum number of bunches the collimation system has to take.

### **Microbunching Instability in TTF 2**

Yujong Kim reports on full S2E simulations for TTF 2.

Here all important impedances impacting on the micro bunching instability such as CSR, space charge force, and geometrical short-range wake fields are considered.

Depending on the initial density modulations at the cathode, the gain of micro bunching instability after BC3 is within 20 for 2.0 ps density modulation. When modulation amplitude is small ( $\sim 5\%$ ), the gain is somewhat overestimated due to the numerical noise.

Following aspects have to be taken into account:

- After reducing the numerical noise by increasing the particle number, the gain of 2.0 ps, 5% density modulation should be re-estimated.
- Since theoretical gain estimation does not consider the damping of the initial density modulation at the gun region, the damping effect there should be considered in estimating the gain theoretically.

### **Next meeting:**

Next meeting October 29<sup>th</sup>, 15:30.

Tentative program:

### **Attachments:**

- Transparencies Vladimir Balandin

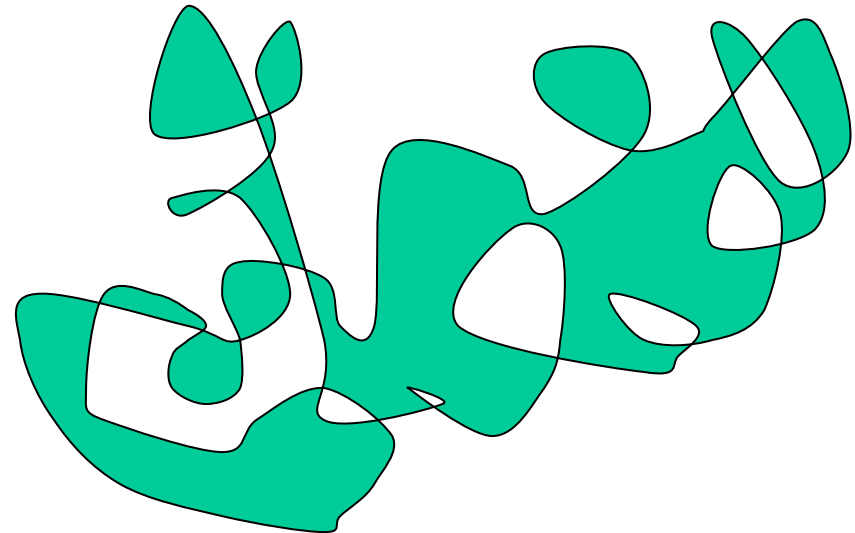
### **Related:**

- Transparencies Yujong Kim

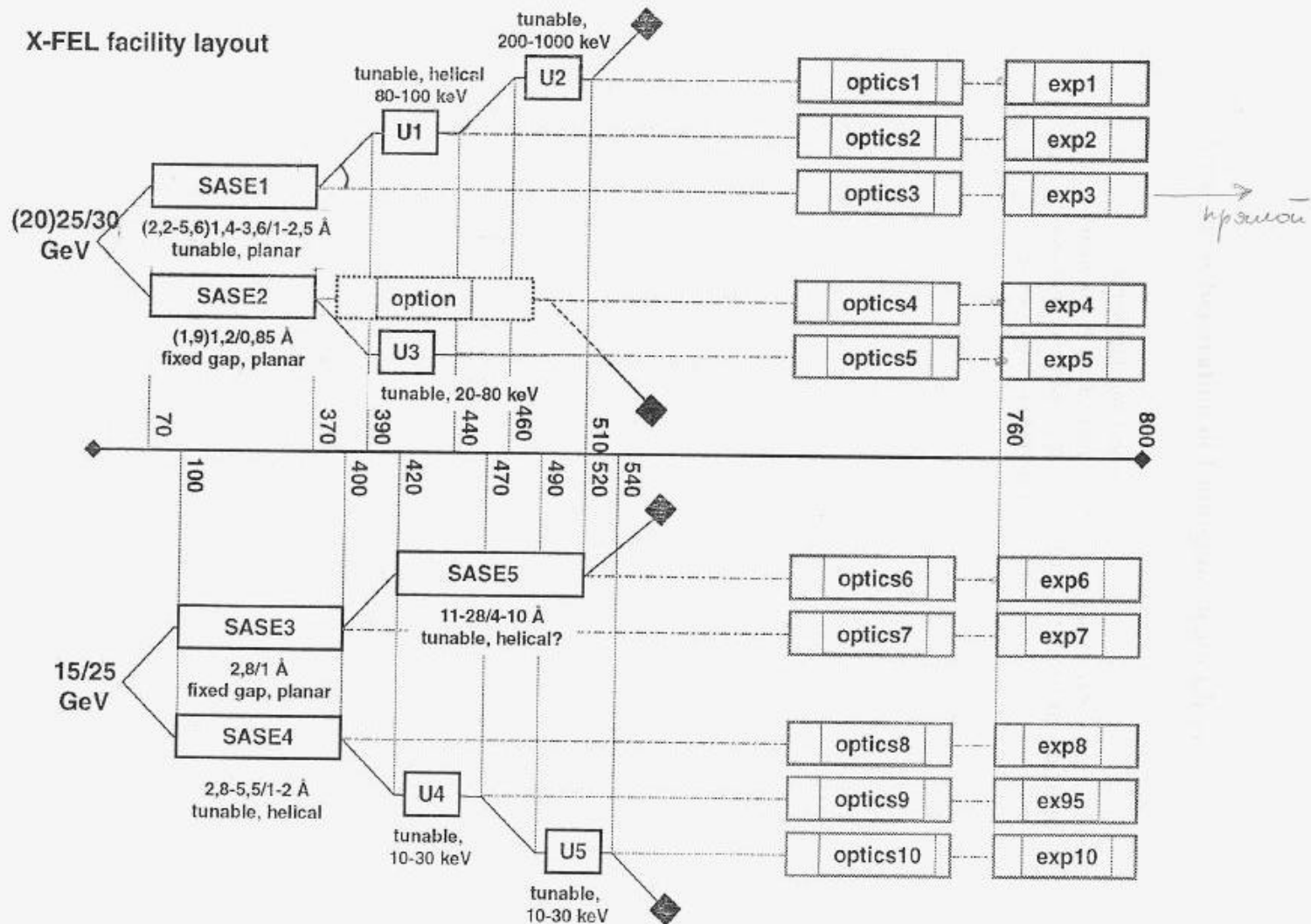
# **XFEL Beam Transport and Distribution**

## **What Was Done**

V. Balandin and N. Golubeva, Oct. 2003



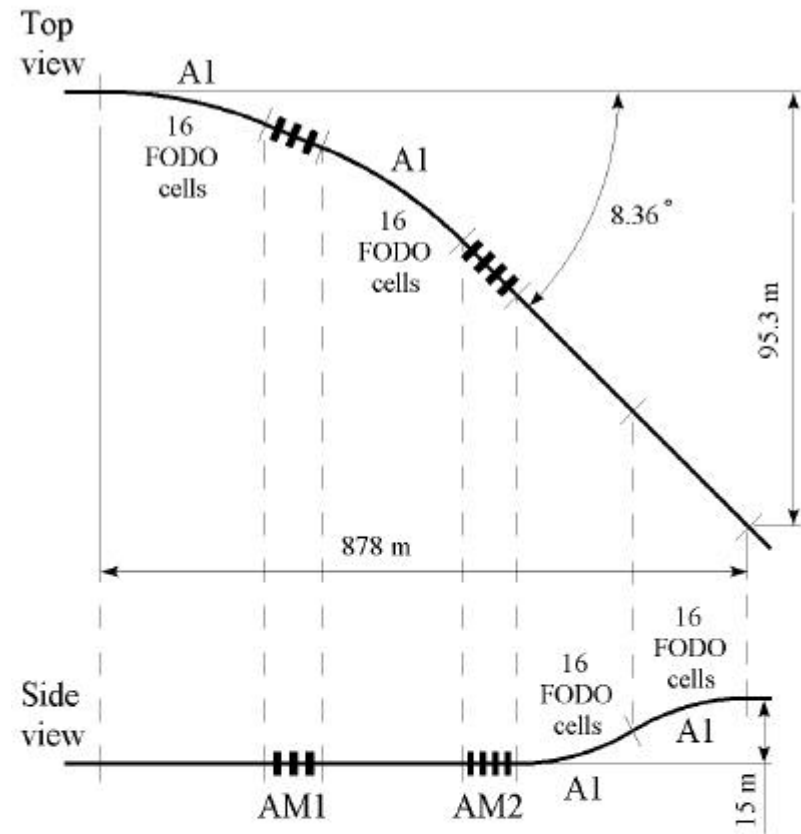
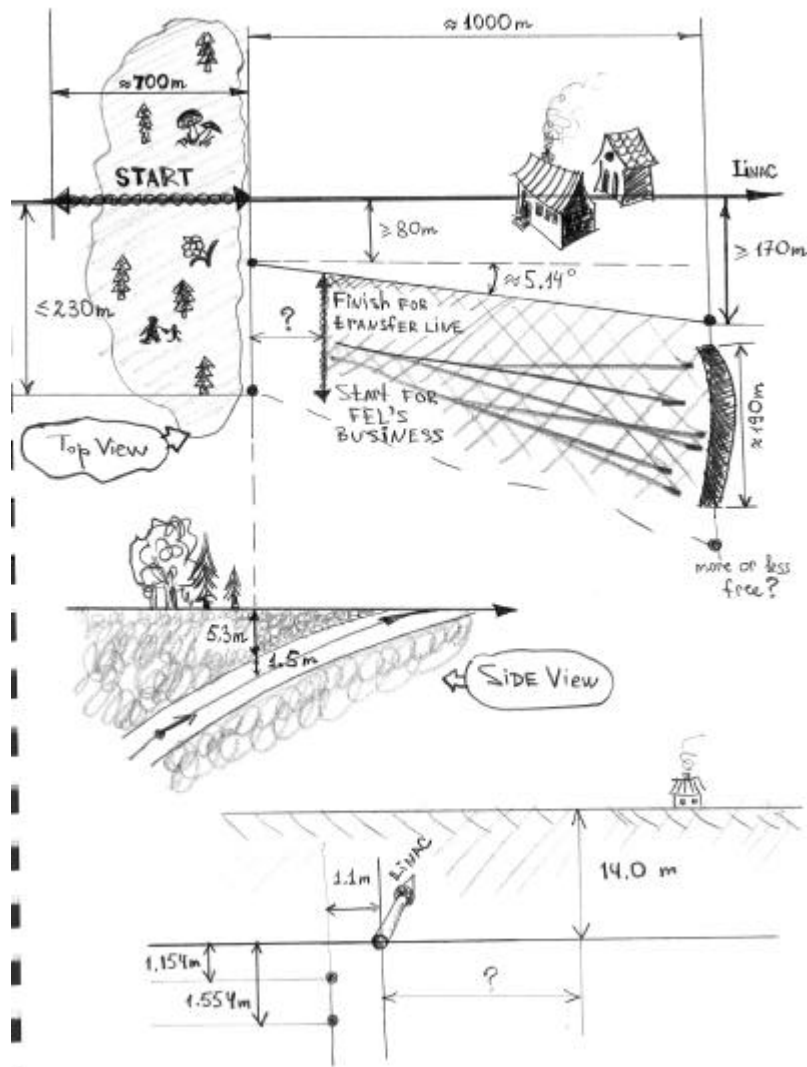
# TESLA-FEL 2000-21



Thomas Tschentscher, 15.06.00

*Picture from which design of optic started*

# TESLA-FEL 2000-21



FODO :



**Note: in AM1 must be 4 quadrupoles**

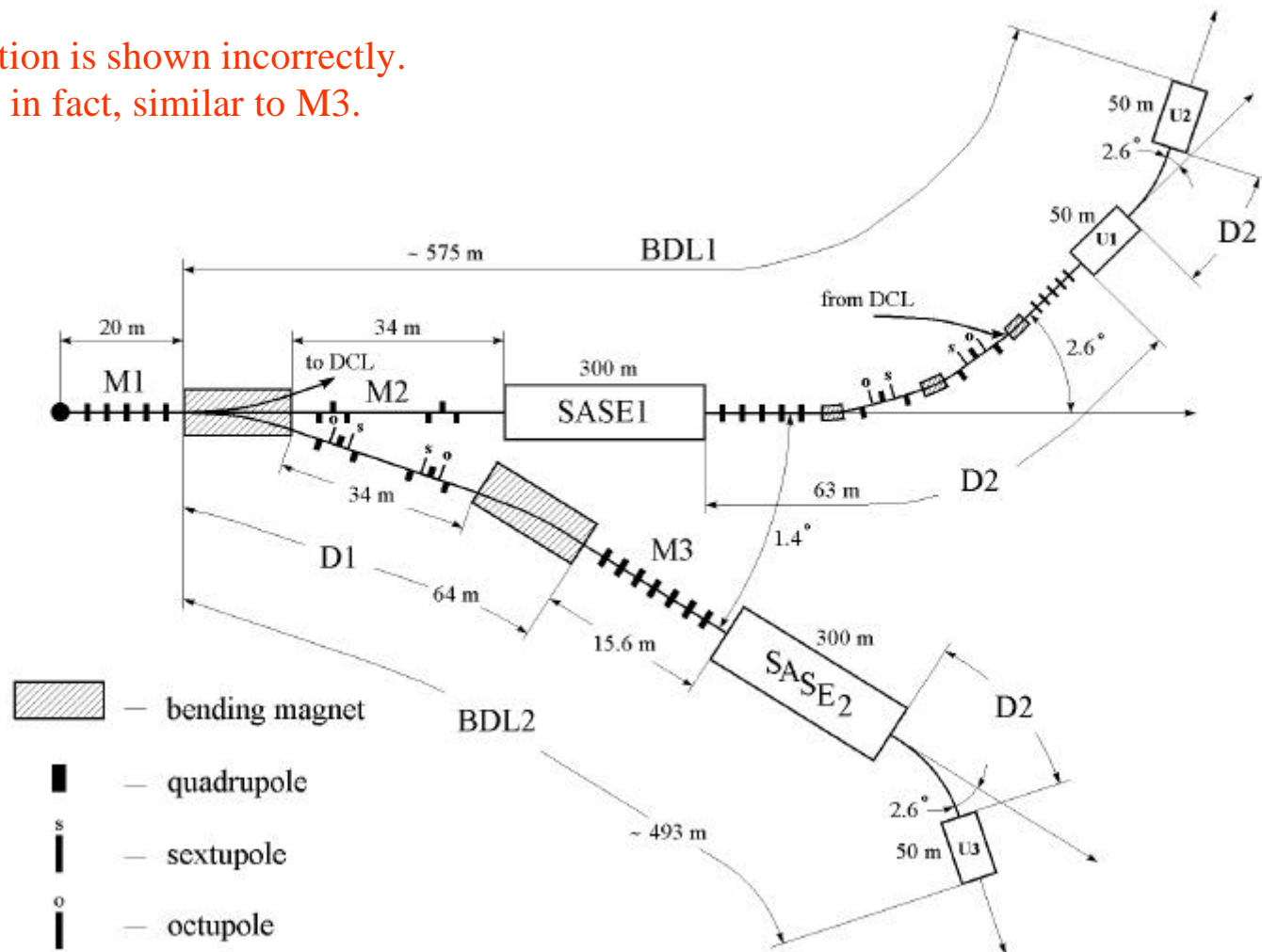
— bending magnet

— quadrupole

Elevation of the beam to ground level

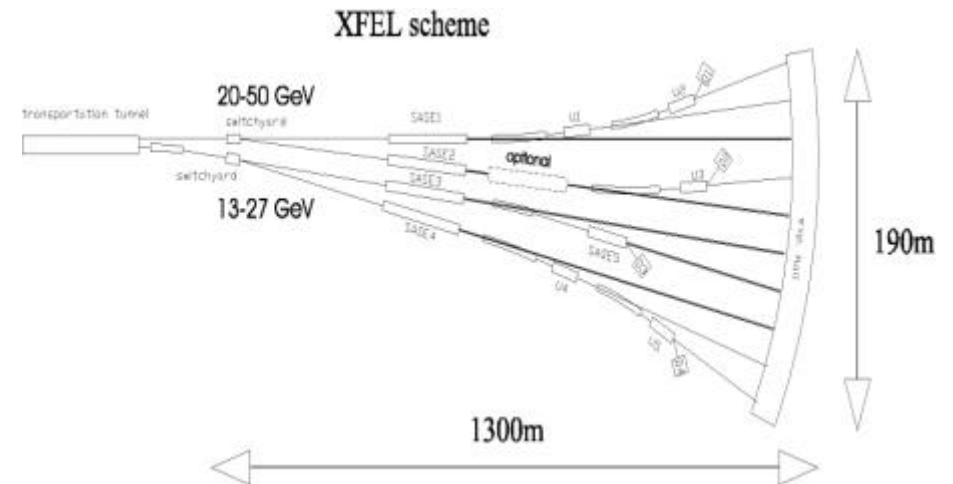
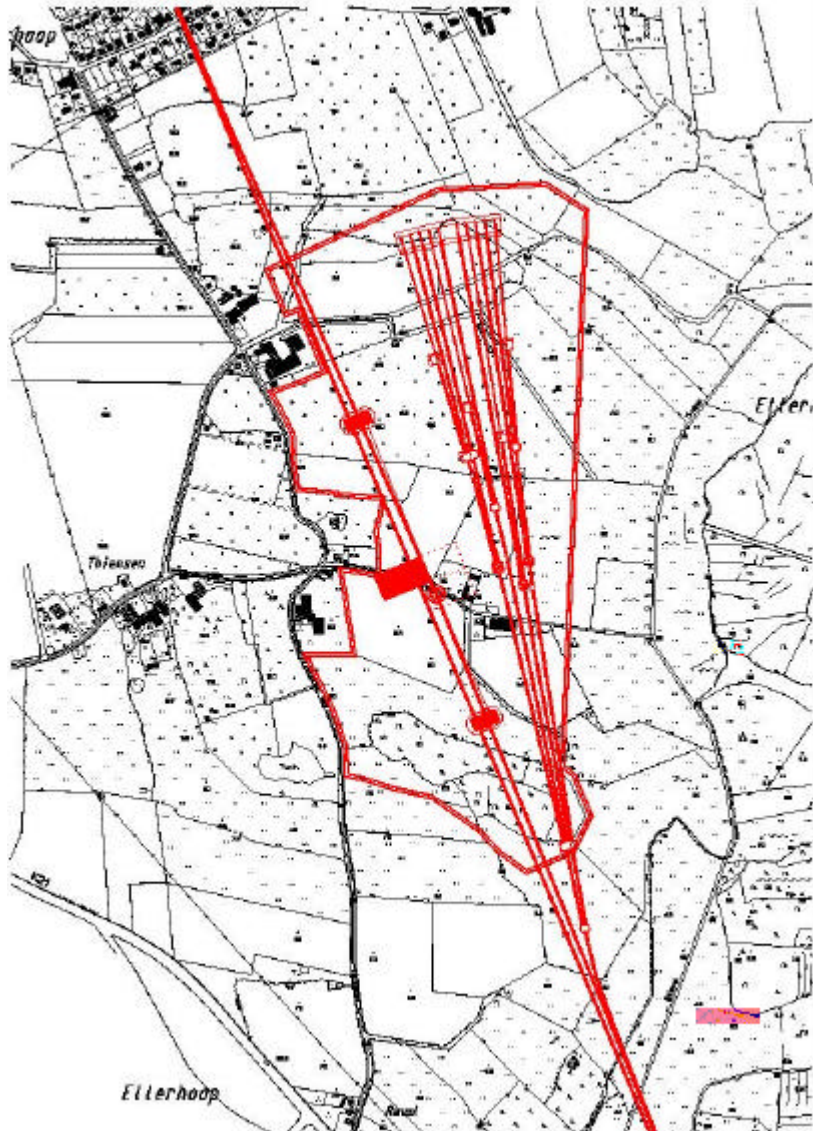
# TESLA-FEL 2000-21

M2 section is shown incorrectly.  
It is, in fact, similar to M3.



The electron beam distribution system

# TDR-2001



**Warning:**

Drawings in the TDR-2001  
do not correspond to the optical  
solutions of the TESLA-FEL 2000-21



# Between TDR-2001 & TDR-Supplement

## Beam extraction out of the LINAC

It was found that TDR-2001 extraction line has good chromatic properties, but does not satisfy geometrical requirements. Two new solutions were proposed: with normally oriented quadrupoles and with skew quadrupoles.

## Transfer line of ~12 km long

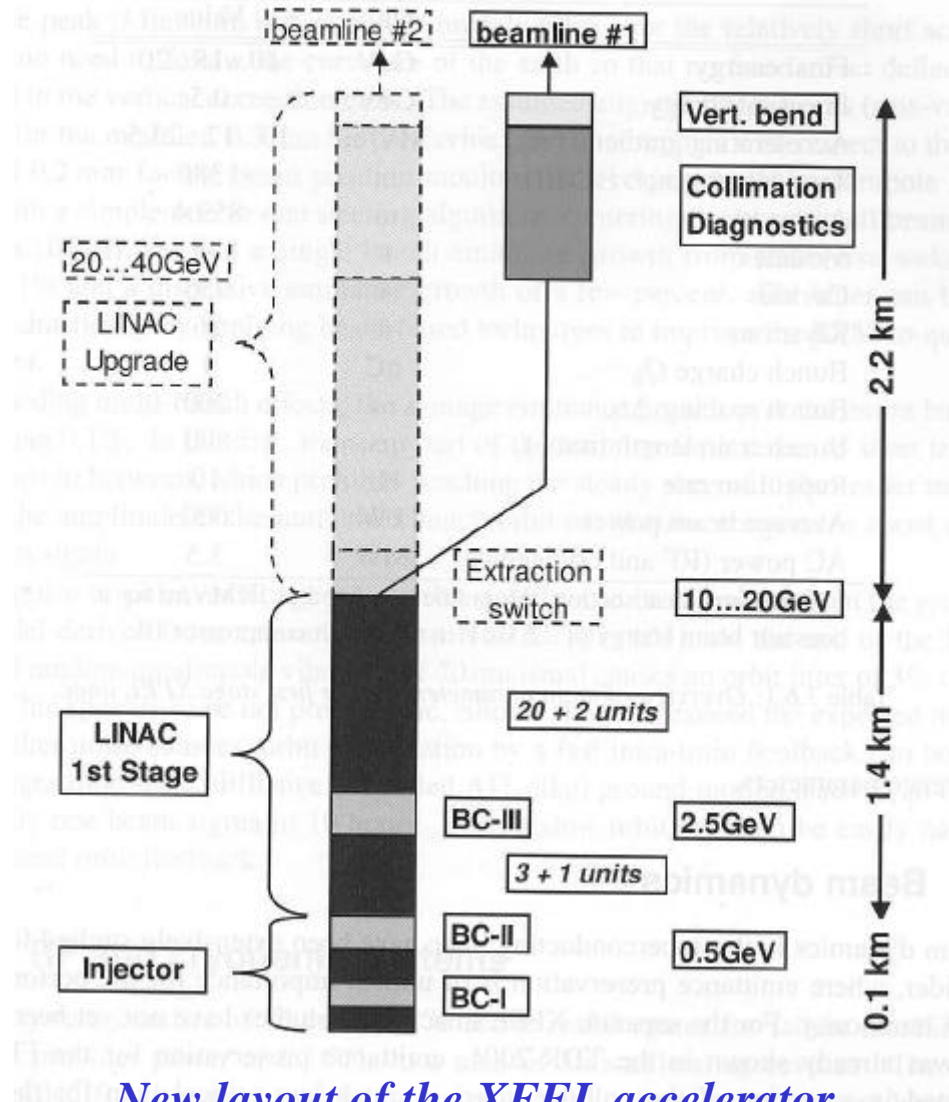
Instead of two lines (for low and high energies separately, each about 12 km long) single line (operated by fixed field quadrupoles) was designed, which allows beam transport in the full energy range 10-50 GeV with energy acceptance ~10%.

## Simultaneous collimation of two beams in the same optic

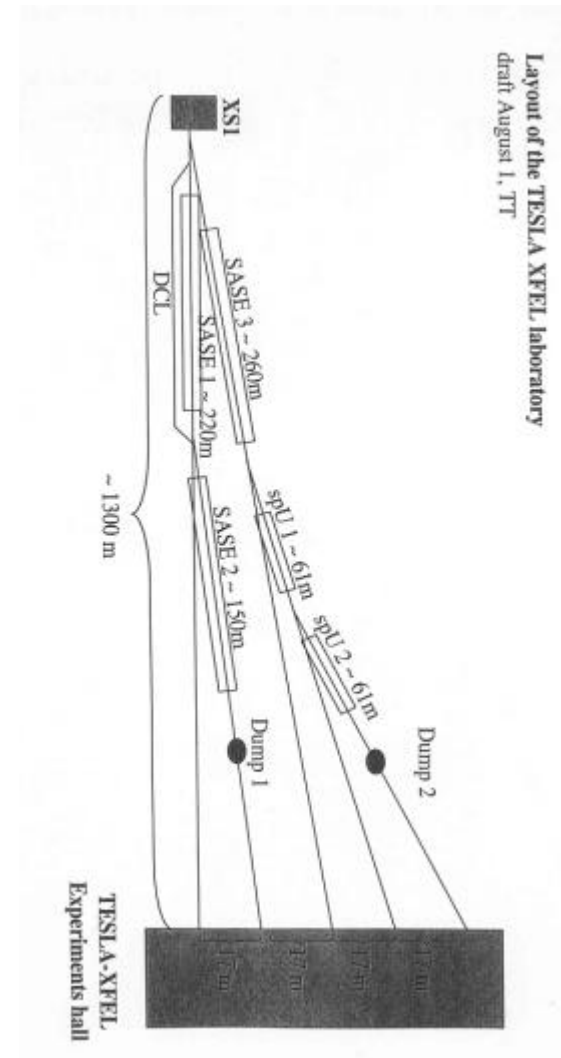
Was not finished due to the loss of actuality .....



# TDR-Supplement: starting point



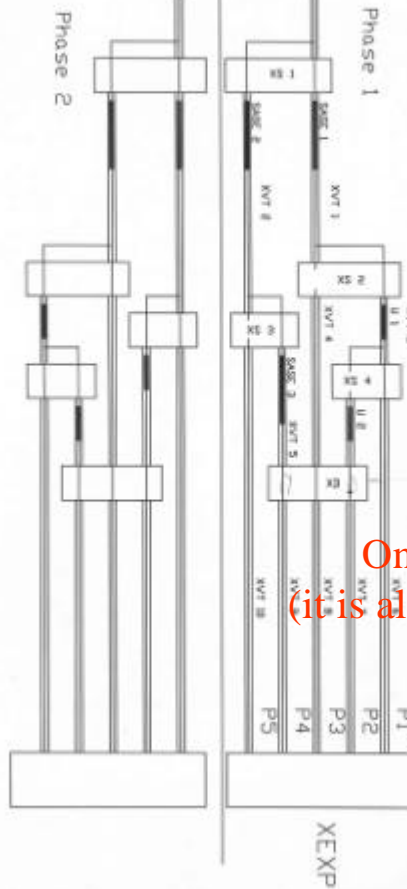
*New layout of the XFEL accelerator  
(R.Brinkmann)*



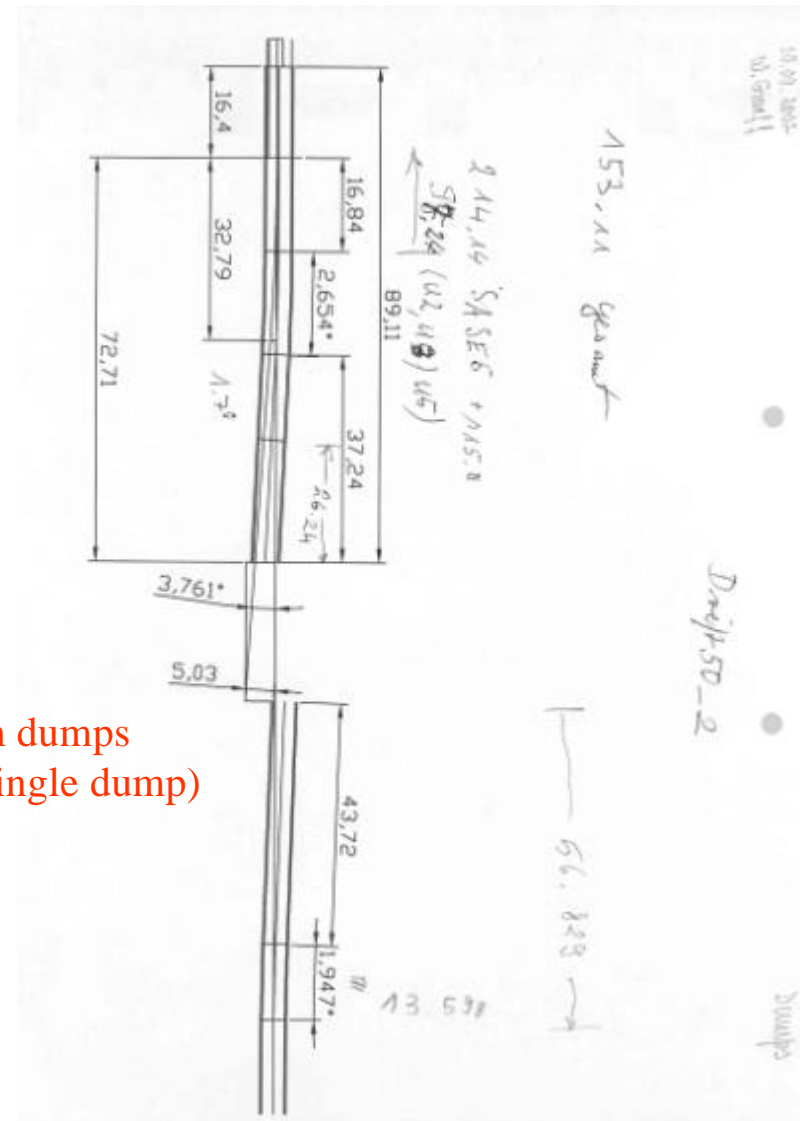
*New layout of the beam switchyard  
(Th.Tschentscher)*

# TDR-Supplement : work in progress

One may see rearrangement of angles between beam lines: it saves space!

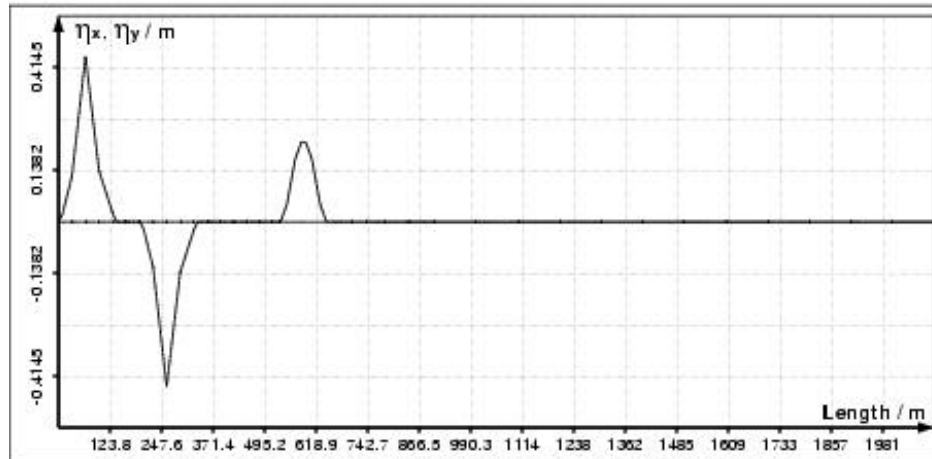
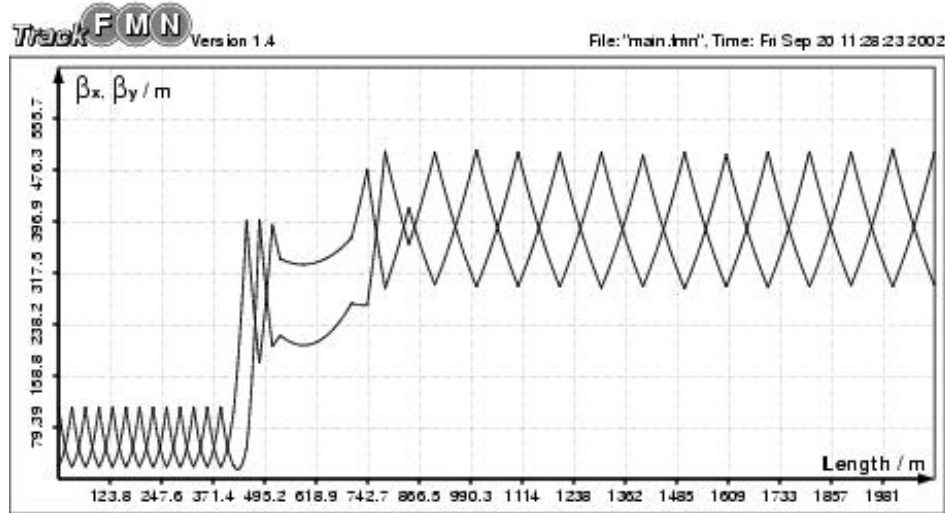


One hall for two beam dumps  
(it is also possible to use single dump)

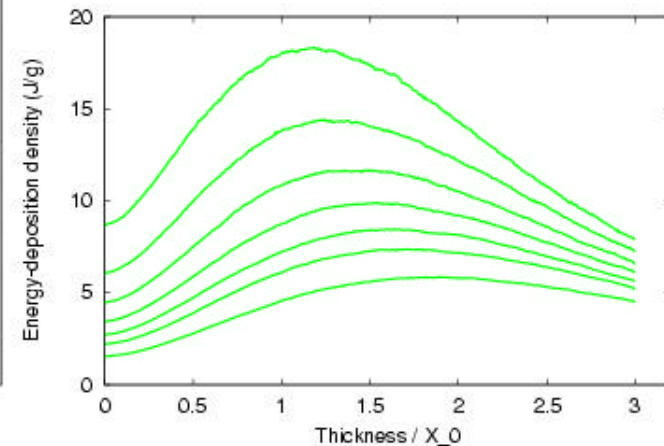
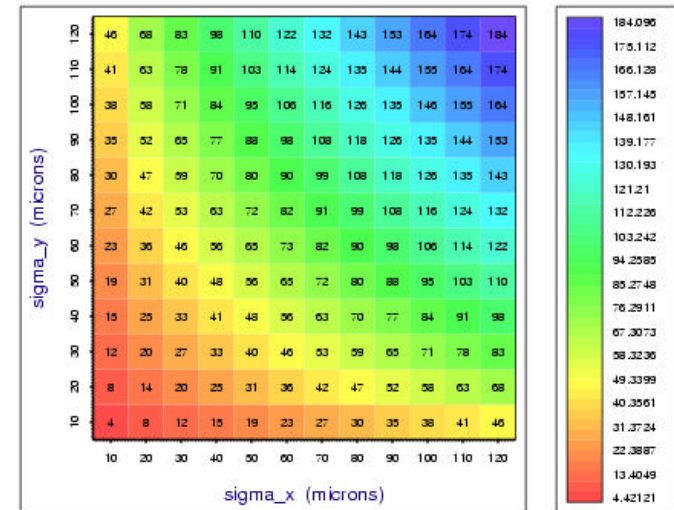


Some drawings obtained as result of discussions with W.Graeff

# TDR-Supplement



*Transport line, including collimation and diagnostic section:*  
**Dogleg+Matching+Chicane+FODO**



*Tolerable beam-spot size estimation (EGS4 code)*