

XFEL High Power RF Status

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Eints**

Outline

- **Vertical MBKs**
- **Horizontal MBKs**
- **Cooling**
- **Modulator**
- **Waveguide**

Status vertical MBKs

3 klystron vendors have developed MBKs during the last years



THALES TH1801



CPI VKL8301



TOSHIBA E3736

RF High Power Source

- 8 THALES TH1801 have been built
Prototype had been in use at Flash for 20kh, now stored at DESY
#1 and #4 in use at PITZ
#2 did not pass acceptance test some years ago, will be rebuild as #8
#3 has been in use at FLASH with very high voltage (119kV), failure after 17000h gun arcing
#5 in use at FLASH
#6 passed acceptance test at Thales, in test at DESY
#7 passed acceptance test at Thales, delivered to DESY
stable operation of last tubes, efficiency is less than 65% (ca. 60%)
- 1 TOSHIBA E3736 at DESY
 - 10.4MW, 1.5ms, 10Hz, 66%
 - 750h, ~80% at full power
 - stored for further use
- 1 CPI VKL8301 at DESY
 - 8.1MW, 1.3ms, 10Hz, 53.5% in use at CMTB at DESY

RF High Power Source

Horizontal MBK prototypes

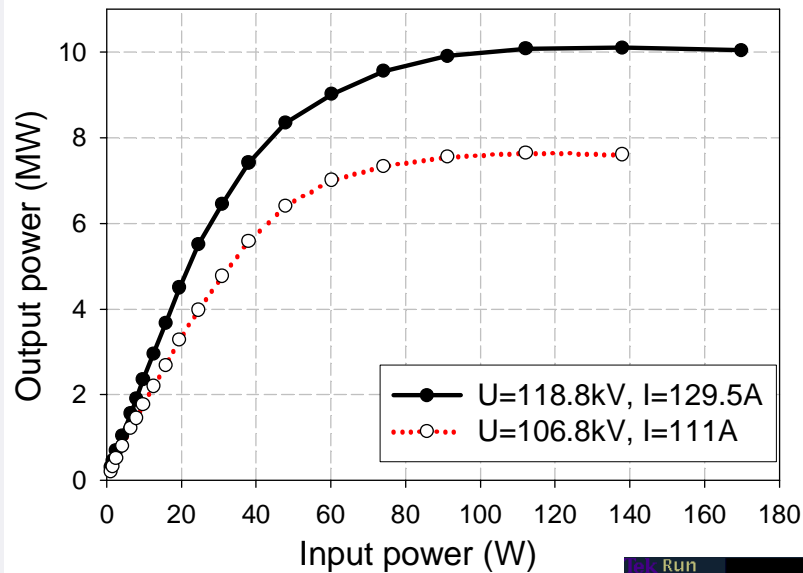
- Horizontal versions of MBKs by all 3 vendors are under construction (THALES, TOSHIBA, CPI)
- First klystron has been tested at DESY (Toshiba, December 07 to February 08)

TOSHIBA E3736H

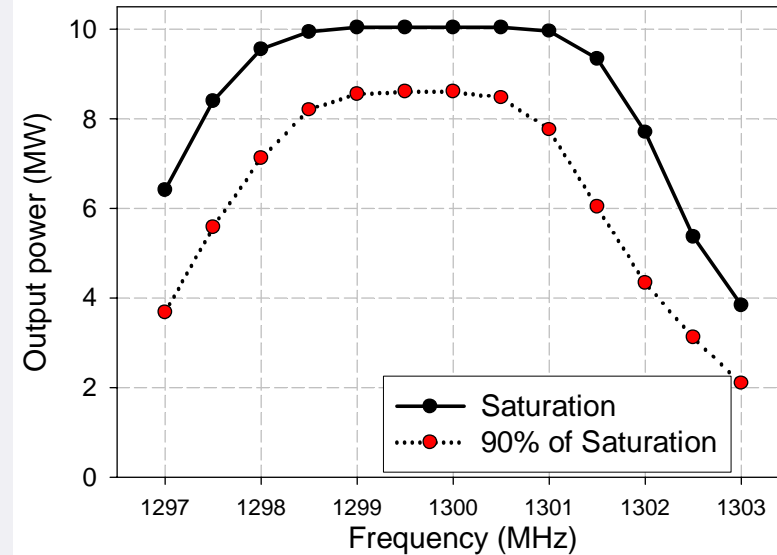


Toshiba E37365H

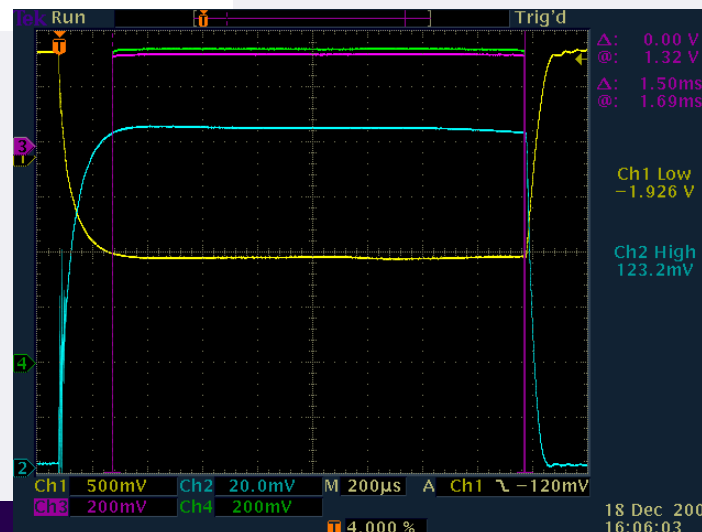
Toshiba MBK, February 4, 2008. Acceptance test in DESY



U = 118.8kV, I = 129.5A



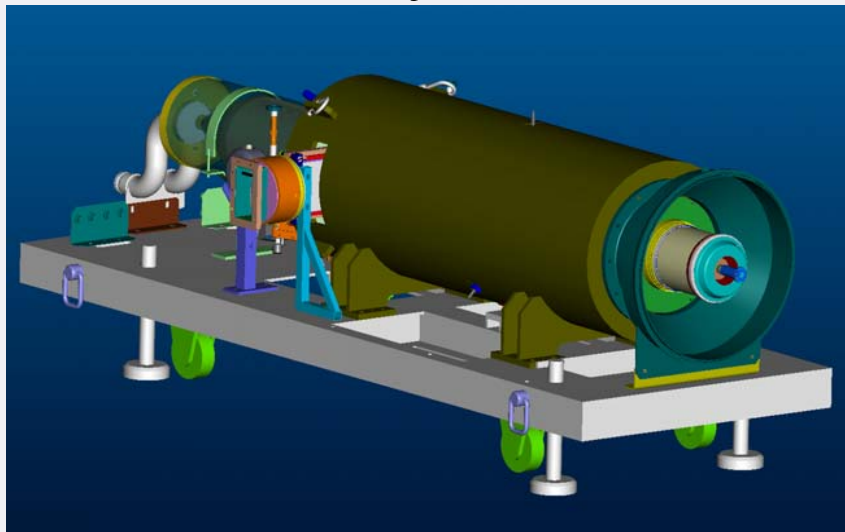
Efficiency 65.4%



Thales horizontal MBK TH1802

Status

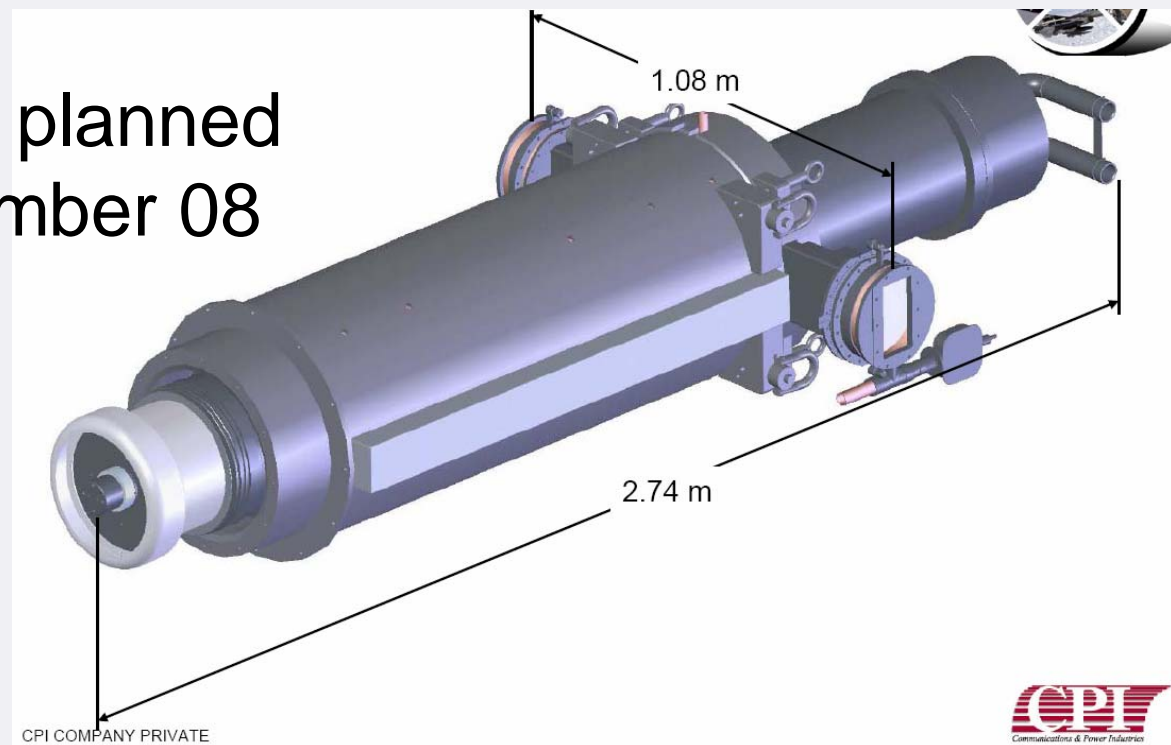
- now being conditioned at Thales
- delivery to DESY planned for July 08



CPI horizontal MBK

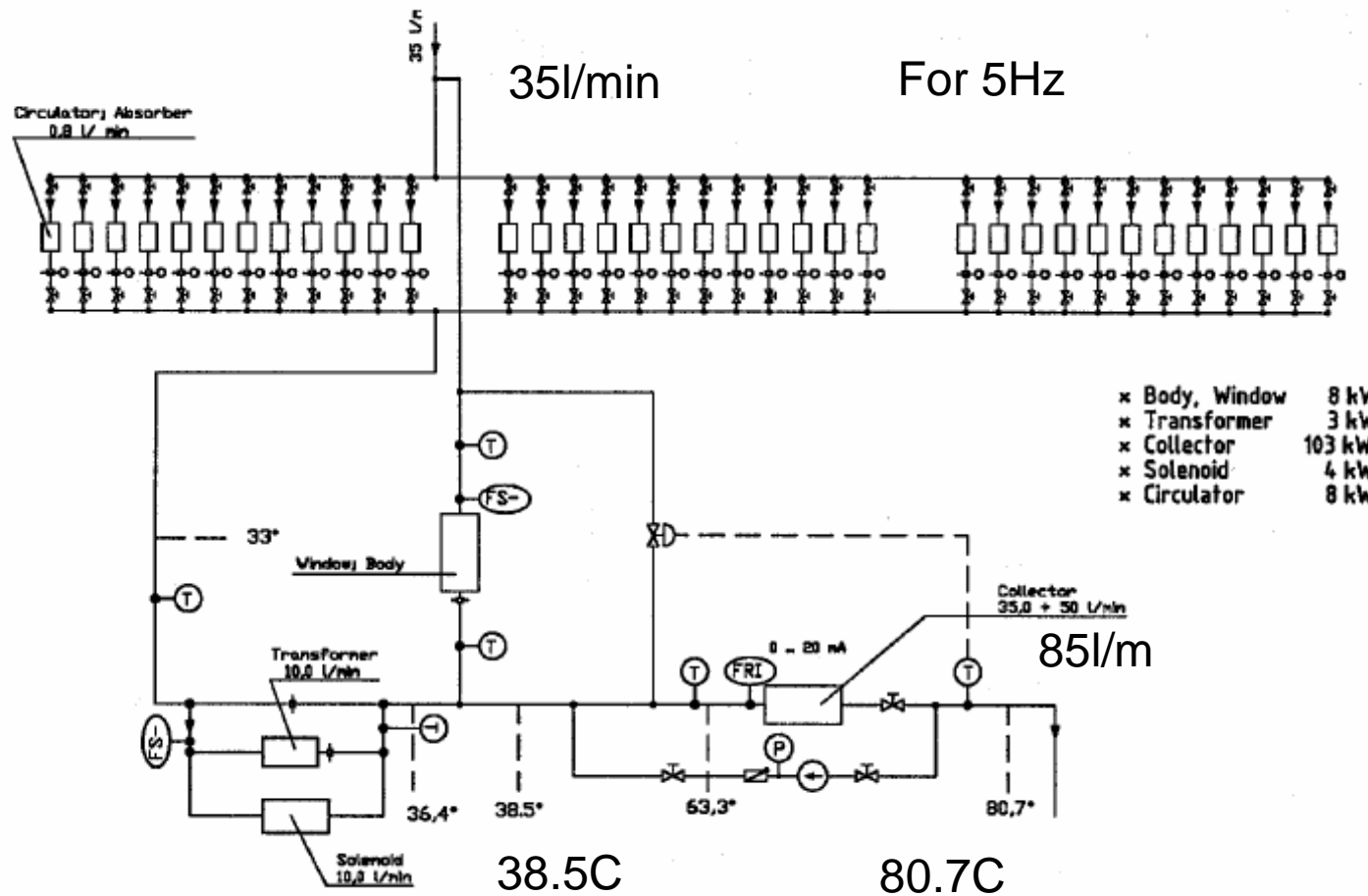
Status

- In construction
- delivery to DESY planned
- for August/September 08



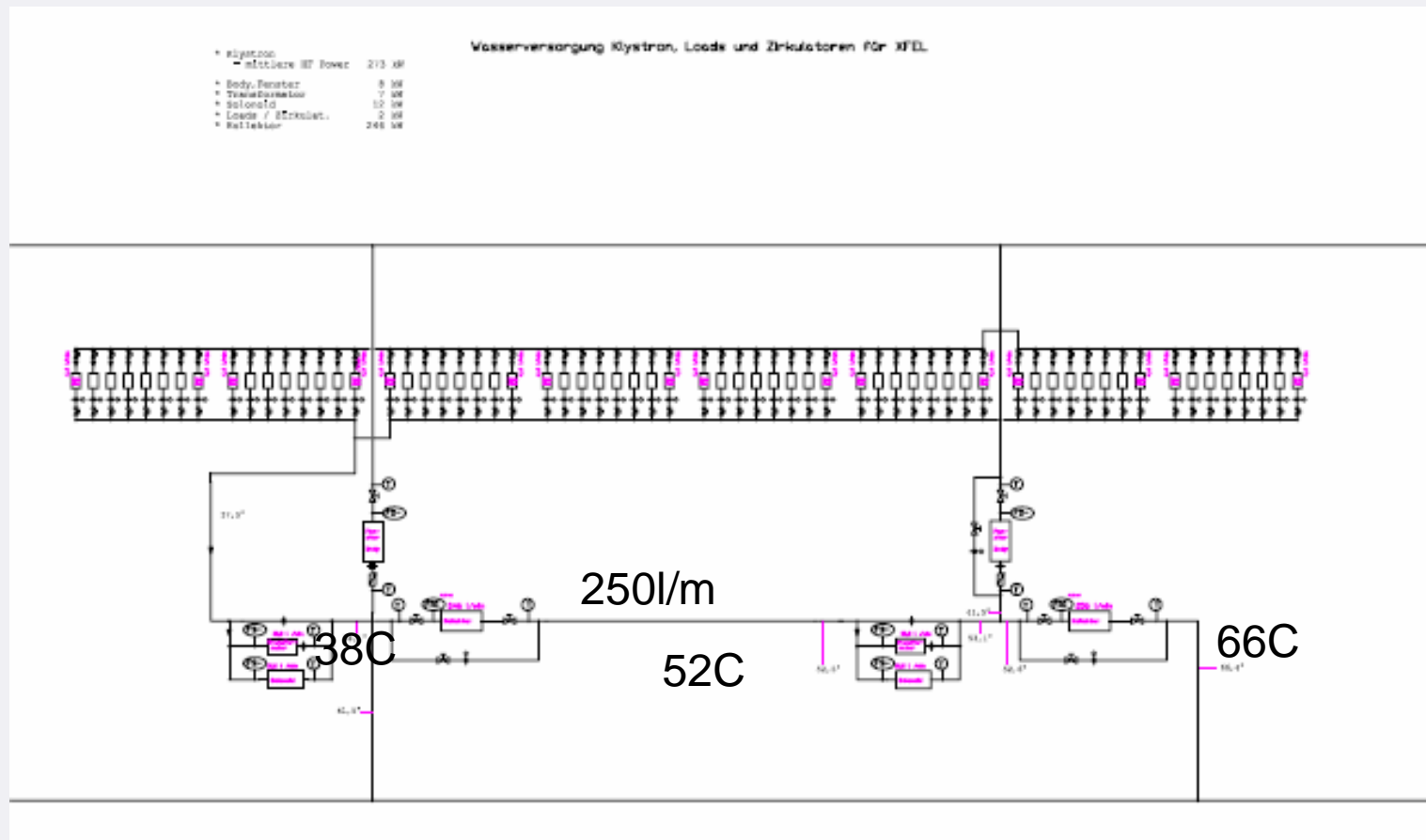
Cooling

TESLA TDR



Cooling

XFEL



Cooling

MBK Prototype Specification

2.3 Collector cooling water Inlet temperature 25°- 51°C

Outlet temperature $\leq 75^\circ\text{C}$

- Inlet pressure 3.5 bar, typical 10bar, max.
- Differential pressure 0.1 bar, typical
- 0.5 bar, max
 - Test pressure 16 bar

Water flow:

- ≤ 85 l/min at 5Hz repetition rate
- ≤ 170 l/min at 10Hz repetition rate
- The klystron must be capable to be operated as diode under these parameters.

Cooling

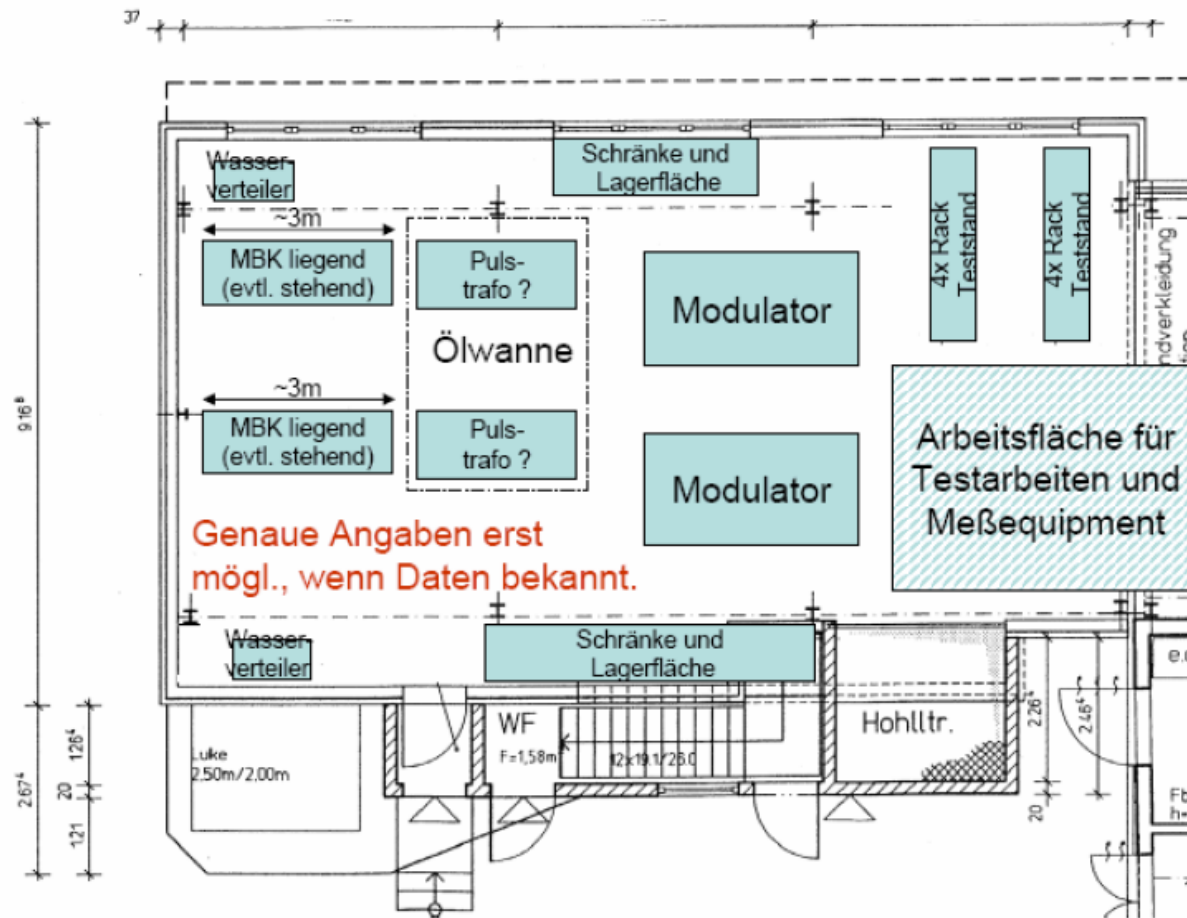
MBK Test Stand



Collector cooling water return bypass

Modulator

Planned Modulator Test Facility at DESY in Zeuthen

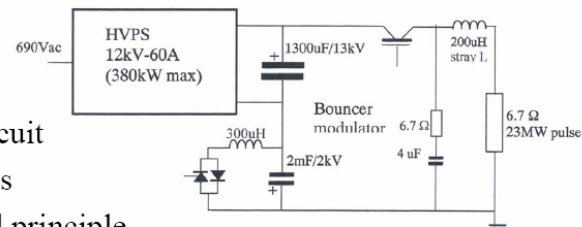


Modulator

Qualification of additional vendors

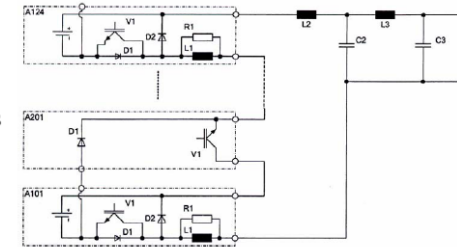
Bouncer Modulator by Imtech/Vonk

- Bouncer Type, as specified by DESY
 - 12kV HVPS
 - Bouncer 300uH/4.6kA
- 7st IGCT main switch
- Digital Regulation Circuit
- Analog In- and Outputs
- Well known and tested principle
- delivery time: 12 month



PSM Modulator by Thomson BM

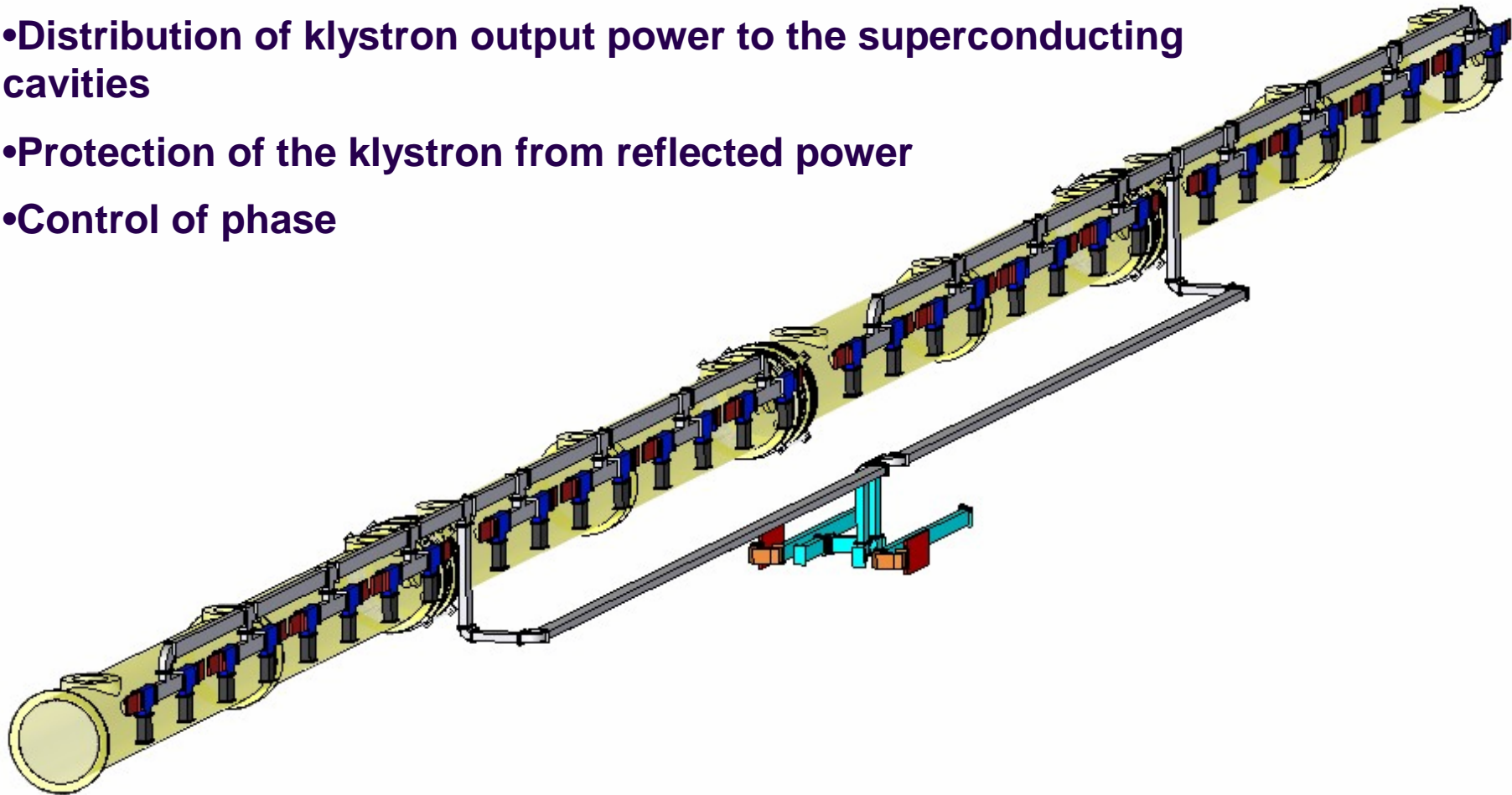
- Different Type:
 - 12kV/2kA w. transformer
 - Pulse Width Modulation
 - 24 switching stages in series
 - FPGA based control
 - 2 stages for redundancy
- Slew rate and pulse shape controllable
- detailed description available, principle already successfully tested (worldwide, i.e. W7/X)
- delivery time: 14 month



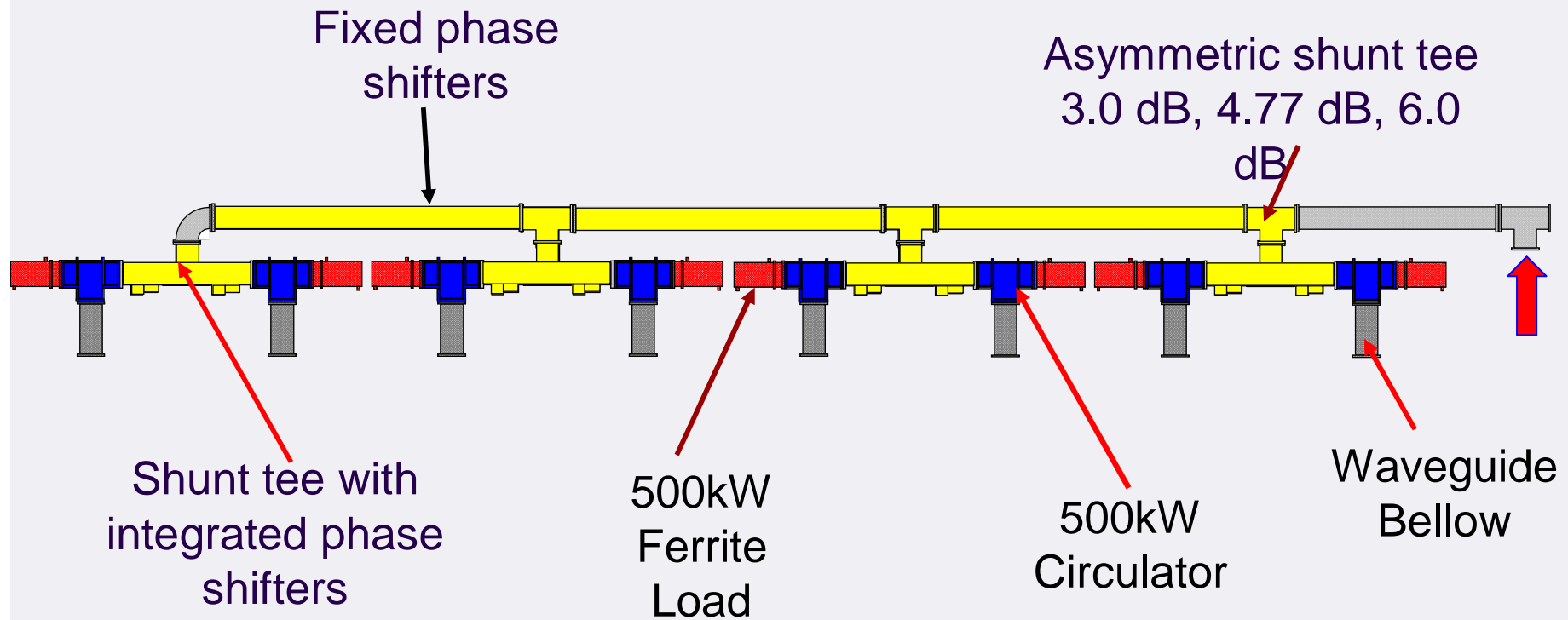
- Installation at DESY, location Zeuthen, scheduled for spring 2008
- Preparation work at Zeuthen
- Thomson BM will be tested at DESY in July/August 08
- Imtech/Vonk not before spring 09

Waveguide Distribution

- Distribution of klystron output power to the superconducting cavities
- Protection of the klystron from reflected power
- Control of phase

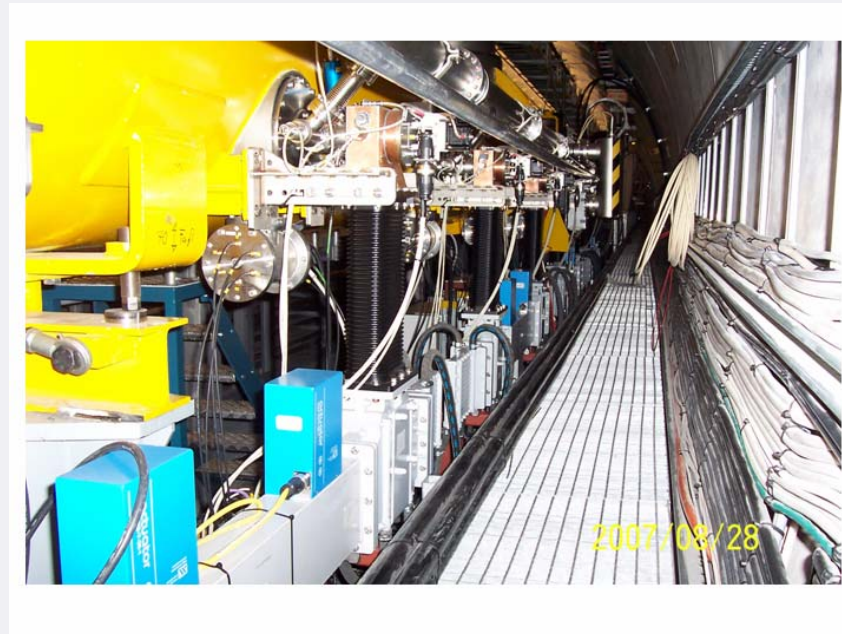
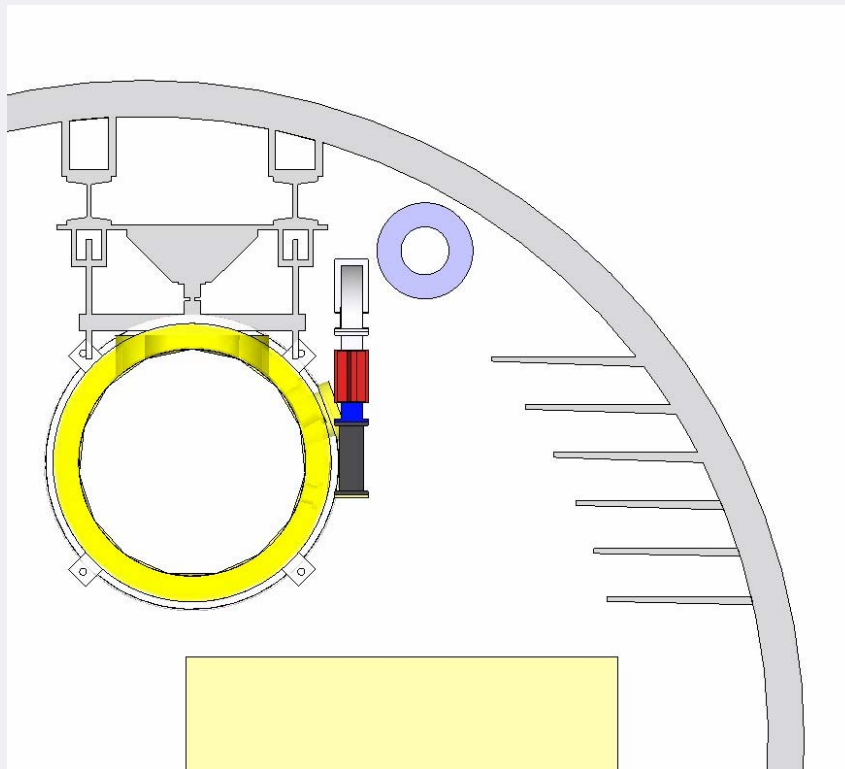


Waveguide Distribution



Waveguide Distribution

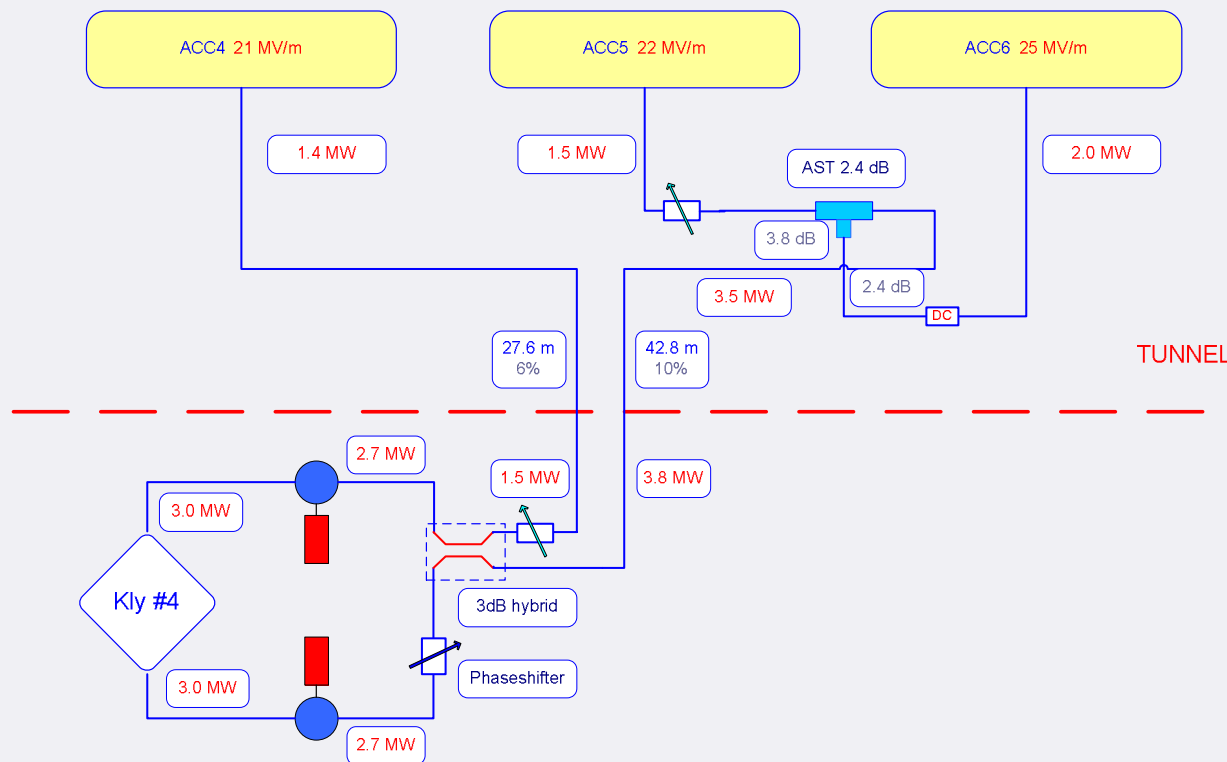
Waveguide in the XFEL Tunnel



XFEL type distribution at FLASH

Last 3 modules at FLASH

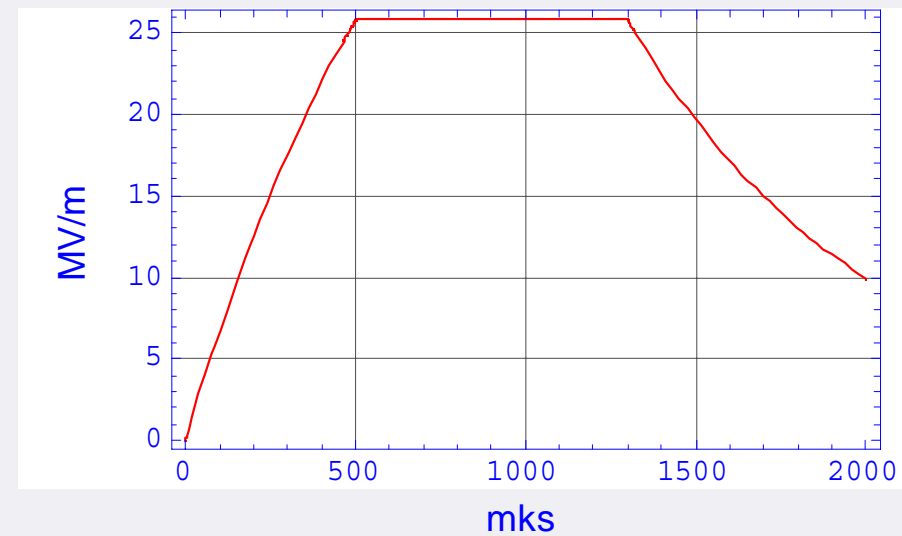
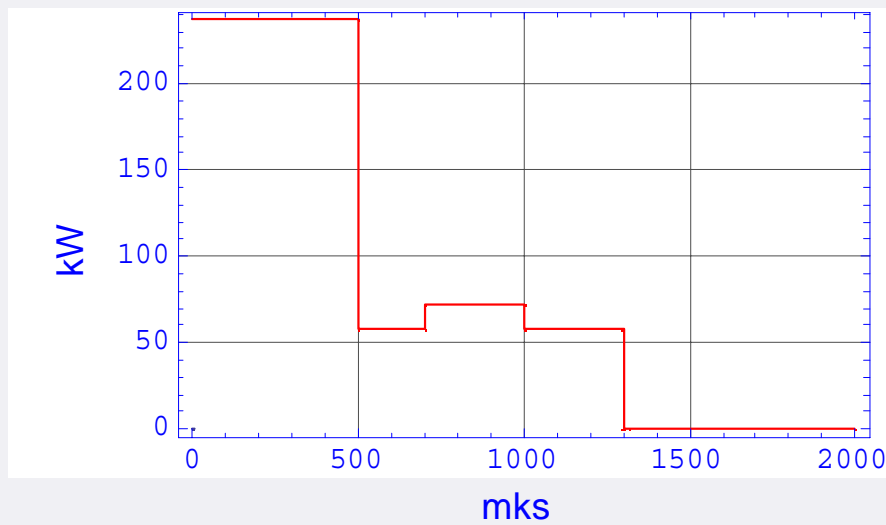
Waveguide distribution for klystron #4 (status 06.08.07)



Last 3 modules at FLASH

Waveguide Distribution for ACC4, ACC5 and ACC6										Klystron 4							
										02.04.2008 V. Katalev							
Eacc, MeV	570			Pkly 4 5.90 MW			without beam			Elinac 1033 Mev							
										6+10% waveguide losses + 10% circulator							
										Assymmetric Shunt Tee							
tinj, mks	k 564			P_ACC4, MW			P_ACC5&6, MW			AST, dB	S32, dB	S12*S12	S32*S32				
500	2.56			1.4			3.5			2.4	3,72	0,575	0,425				
										there are the editing data in green cells							
										Pcirc_max	390	Lcav = 1,038 m					
ACC4		21,2 MV/m			176 MeV			Max	191	Mev		Δ	15				
Pin, MW	1.43			RF power OK													
Qext	3,0	3,0	3,0	3,0	3,0	3,0	3,0	3,0									
A, dB	9,5	9,5	9,5	9,5	9,5	9,5	9,5	9,5	not measured								
Pcav, kW	160,3	160,3	160,3	160,3	160,3	160,3	160,3	160,3			1282,4	146					
Ecav, MV/m	21,23	21,23	21,23	21,23	21,23	21,23	21,23	21,23			21,2	MV/m					
Ecav, max	23	23	23	23	23	23	23	23			23,0						
ACC5		21,8 MV/m			181 MeV			Max	231	Mev		Δ	50				
Pin, MW	1.50			RF power OK													
Qext	3,0	3,0	3,0	3,0	3,0	3,0	3,0	3,0									
A, dB	9,67	9,64	9,61	9,53	9,34	9,35	9,38	9,39	measured								
Pcav, kW	162,0	163,1	164,2	167,3	174,7	174,3	173,1	172,7			1351,5	150					
Ecav, MV/m	21,34	21,42	21,49	21,69	22,17	22,14	22,07	22,04			21,8	MV/m					
Ecav, max	29	27	28	28	29	28	28	26			27,9						
ACC6		25,6 MV/m			213 MeV			Max	238	Mev		Δ	25				
Pin, MW	2.03			RF power OK													
Qext	2,95	2,97	3,00	2,98	3,00	2,98	2,99	2,98	21.11.2007								
A, dB	7,85	7,54	8,16	8,31	12,27	12,03	10,28	10,37	measured								
Pcav, kW	333,8	358,5	310,8	300,2	120,6	127,5	190,7	186,8			1929,0	106					
Ecav, MV/m	30,74	31,82	29,57	29,10	18,42	18,96	23,18	22,95			25,6	MV/m					
Ecav, max	34	32	34	32	21	21	29	26			28,6						
										Cav 1	Cav 2	Cav 3	Cav 4	Cav 5	Cav 6	Cav 7	Cav 8

RF power and cavity gradient for 1 mA beam



Waveguide distribution for ACC6 (XFEL prototype)

