DW220293

Mechanical Concept of TESLA Main coupler development at DESY

The DESY coupler design for TESLA actually reached a status where most mechanical details are getting clear. Especially those details influencing cryostat dimensions and the environment where to mount the coupler are defined now.
Hence in the following mainly mechanical aspects are described :
Parts of the coupler, main characteristics of the design, mounting procedure, coupler diagnostics and sensors which have to be taken into account.
In addition a set of drawings and data concerning heat loss and coupling behaviour are attached.

1. Parts :

The coupler is consisting of 8 parts

1.1 Outer-conductor -cold with 70K window, Inner-conductor-cold, Tuning-rod-cold and flange connections for cavity and for warm part of coupler
1.2 Inner-conductor-warm with bellows and tuning-rod-warm and Waveguide-w-head-flange
1.3 Outer-conductor-warm with window (300 K), pumping port, bellows and flange connection for waveguide, (70 K) Window-cold and cryostat connection (via hat flange)
1.4 Hat flange for cryostat connection
1.5 Clamping ring for contacting waveguide to Outer-conductor-waveguide flange
1.6 Clamping ring for contacting waveguide to Window-W-head-flange
1.7 Tuning-nut and its support
1.8 Tapered waveguide transition with two compensating rods

2. Essential characteristics of mechanical conception

a) Minimum cross section of 4 cm diameter (corresponds to about 1 5/8 ") , 50 Ohm coax continuously in warm and cold part
b) Two windows : 300 K (with flat 'Doorknob') area and 70 K , both highly resistant against mechanical and thermal load , coupler separable at 70 K window
Windows mechanically decoupled from environment by weak copper collars

which provide good thermal contact at the same time
Rem. : Alternative conception with a 300 K waveguide pillbox window (wich is available from a tube manufacturer) under preparation ; dimensions and weight in the waveguide feed area are much less handy

c) Bellows in inner conductor and outer conductor (warm part) to compensate up to +-15 mm transverse displacement of the cavity flange for at least 1000 cycles
d) Coupler ext. Q tuning; from outside adjustable very easy by tuning nut which moves the tuning rod inside the inner conductor
e) Bends for transverse motion of tuning rod are realized by strong wire helices, which practically should show no length change within axial forces of a few kg The tuning rod screw connection should be loose enough to avoid torque forces during mounting

f) Bellow at antenna end for ext. Q compensation of (actually drawn) +- 3 mm for 1000 cycles (range is enough for
factor of roughly 4 -> /2 .. *2 ;
for factor of 10-> /3 .. *3 +-5mm necessary)
Bellow is operated via tuning rod. Axial stop against pressure difference and wrong operations from outside is provided as well as stability against getting off axis
g) Two separate vacua : beam vacuum and vacuum of warm coupler part
The vacuum of the warm part has its own pumping connection. Pumping port of tuning rod area is at opposite side of pump connection in order to avoid outgassing into critical areas. RF excitation of coaxial tuning rod geometry is prevented
h) Coupler outer construction (outside cryostat) very rigid; protection of ceramic against bending of waveguide transition box by weak "doorknob" area which is realized by grooves concentric to the head flange
i) Hat like sheet metals for heat radiation screening at 4 K and 70K level (to close the radiation shield at coupler position)
j) 70 K intercept connection to cold window (via shielding hat) necessary for coupler operation; 4.2 K intercept connection , not necessary for coupler operation

3. Mounting procedure

a) Mounting of cold coupler part in clean room
b) Outside clean room mounting of sensors to Coupler-cavity-flange, mount Outer-conductor-cold and 70K-flange
c) Mounting of shielding hats, feed through of measurement cables, mounting into the cryostat
e) Mount Inner-conductor-warm via cryostat flange, connect Tuning-rod by screwing before fastening flange screws
f) Put on warm outer conductor part and screw it to 70 K flange;
rem. : The horizontal position and flexibility of inner and outer conductor makes a

mounting tool necessary

g) Feed cable connections to outside cryostat
h) Connect coupler to cryostat by mounting hat flange; this makes the coupler stable
i) Supply pumping connection and view port to CF16 flanges
k) Diagnostic system connections

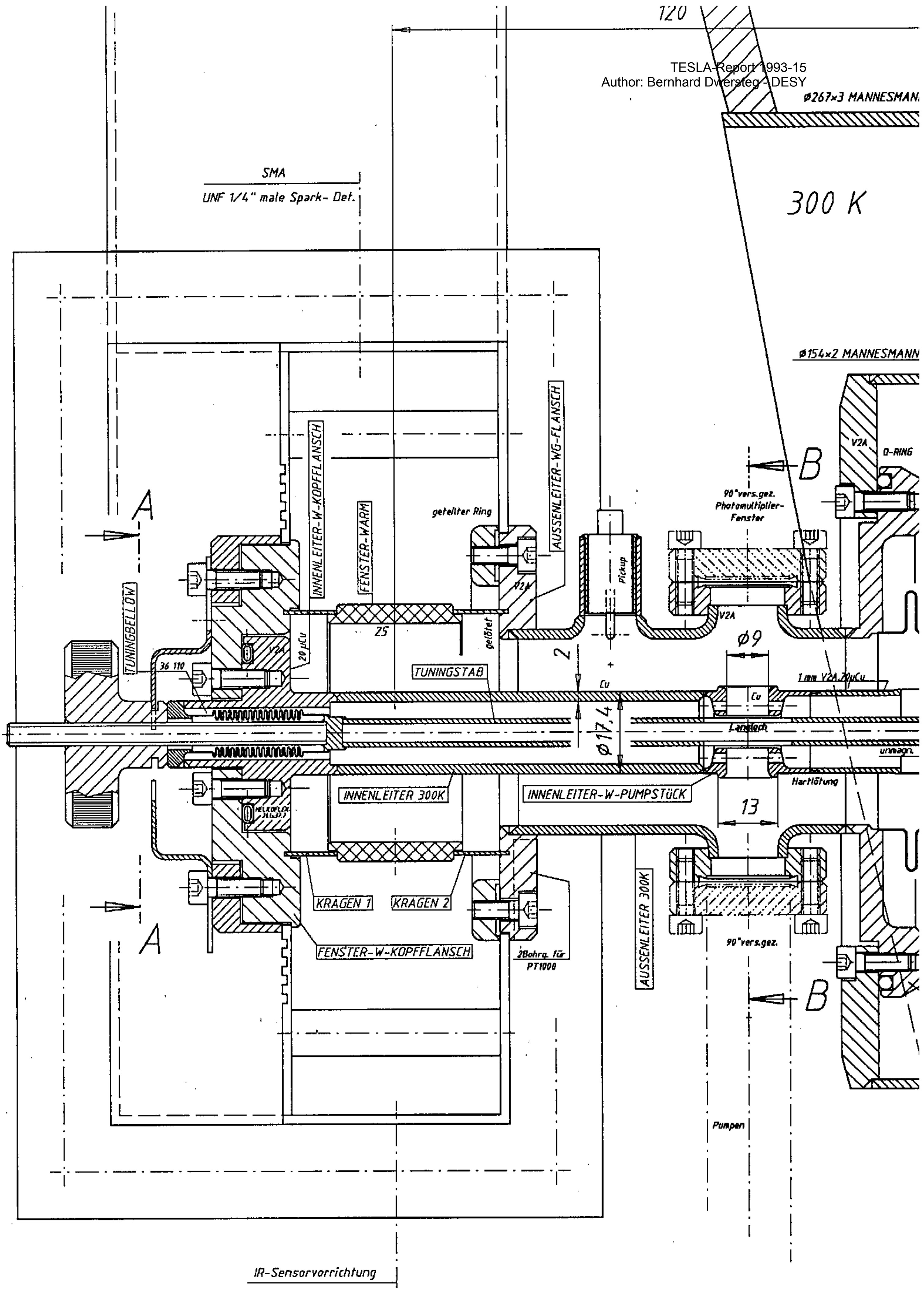
4. Diagnostics for first test purposes

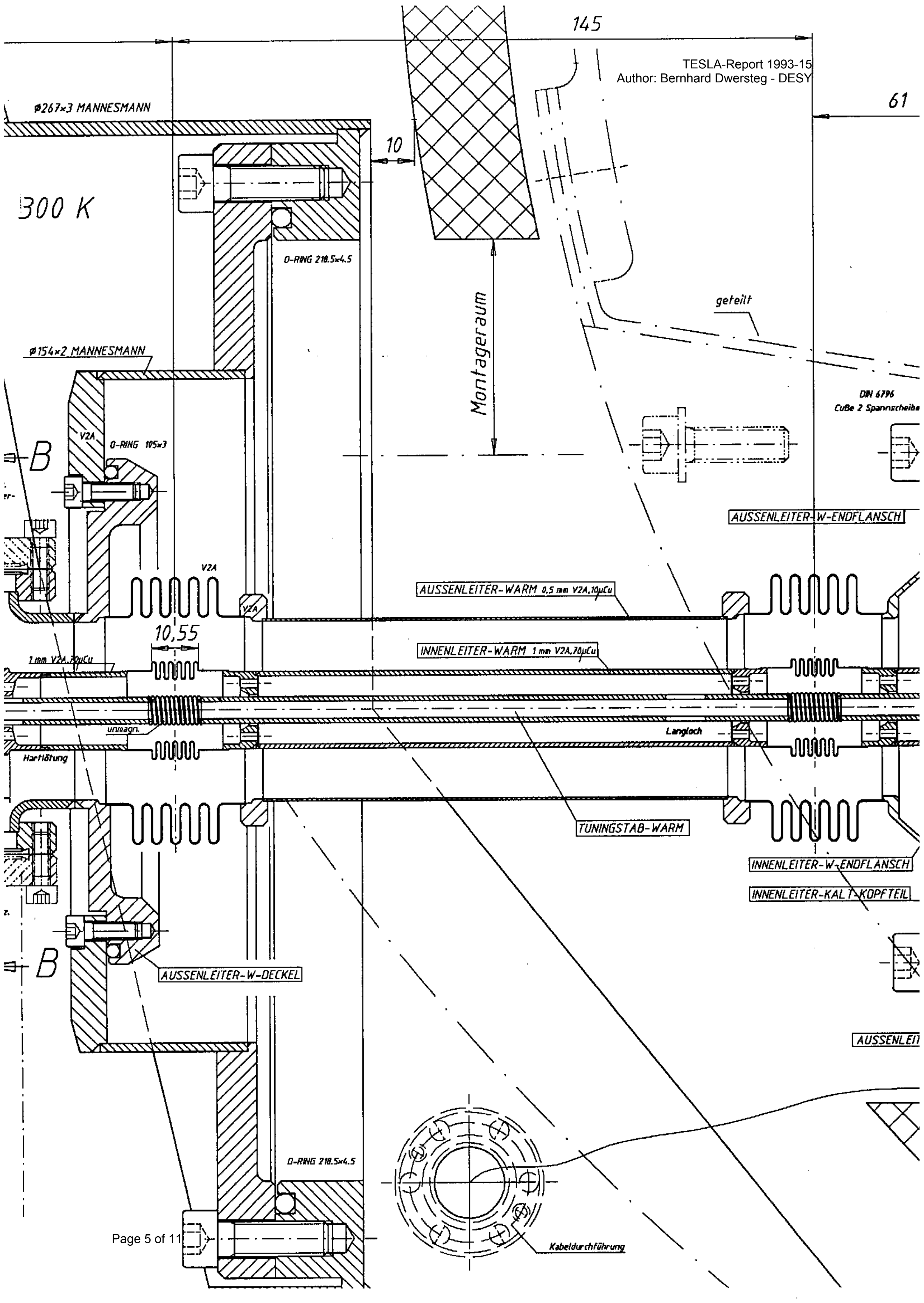
a) At 4K Cavity flange 2 Allan bradley resistors for monitoring temperature changes during RF operation
b) e- -pick ups on both sides of 70K window (commercially available SMA feed throughs for 70 K application, to be welded)
c) Heat flow measurement at 70 K window (near copper collars of cold window) by Pt1000
d) CF16 flange at 300 K outer conductor for view port (opposite side of pumping port), to be equipped with photomultiplier or photo transistor
e) e- -pick up near warm window (to be welded)
f) Heat flow measurement at warm window (near copper collar) by Pt1000

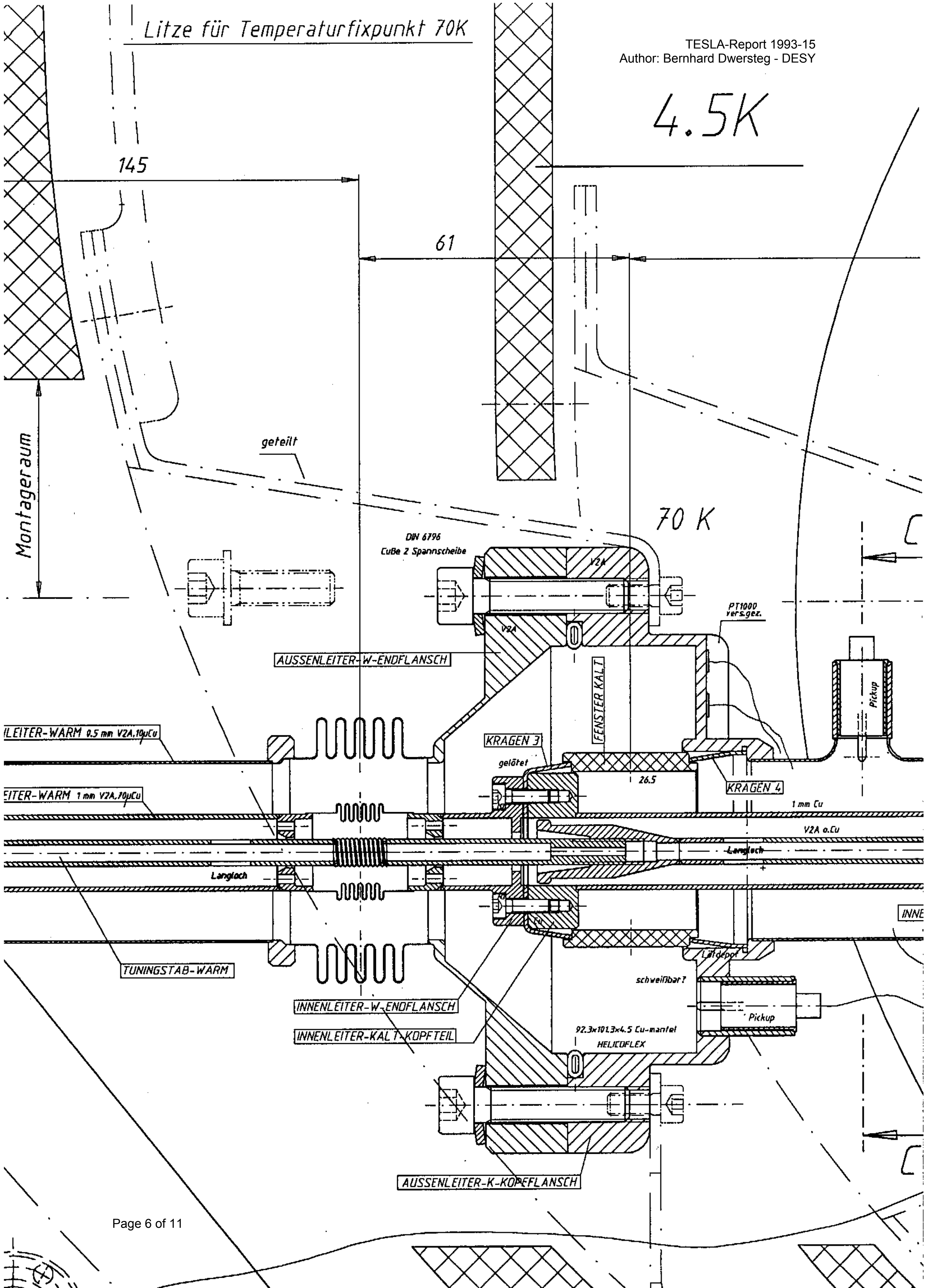
Additional remarks

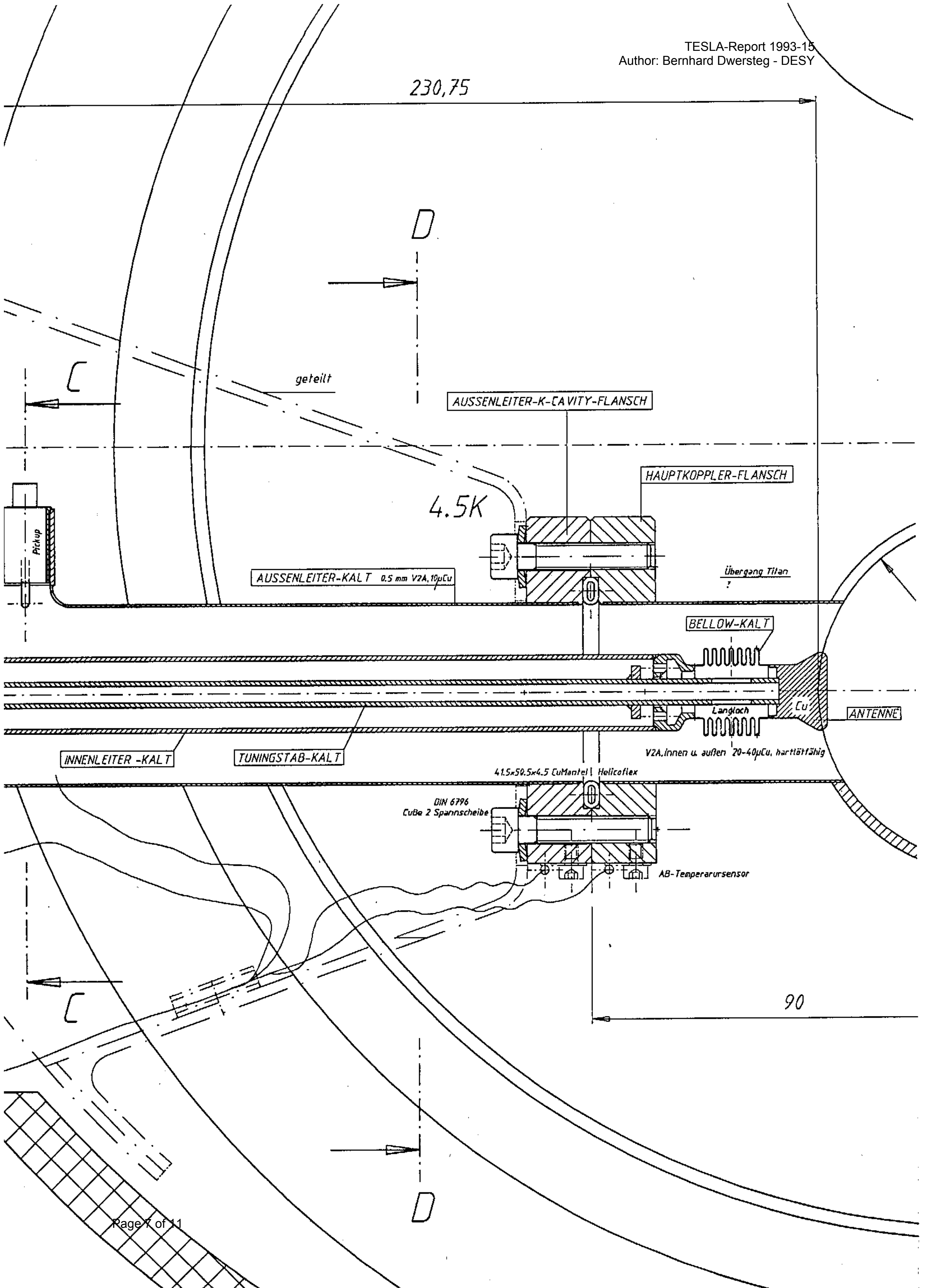
Final decisions about the technologies of realizing the coupler in detail are still under work. Hence the heat loads at the intercept points cannot yet be fixed precisely. They depend on quality and thickness of copper coating. Especially the coating quality of the bellows und thus their contribution to losses and heat conductivity is not yet clear. A rough estimate of heat loss behaviour is given by the graph : TESLA coupler losses. It describes static and RF dynamic losses depending on distance between two temperature levels at given outer and inner conductor.
The 70K loss includes ceramic and total inner conductor losses.

The sensitivity of Qext vs antenna length protruding into the beam tube is given in the graph Qext(TESLA Main Coupler). It shows that for proper coupling a thickened antenna tip is reasonable for reduction of antenna length. The measurement was performed at a distance of 44 mm between coupler axis and first iris of a 9-cell TESLA copper cavity model.

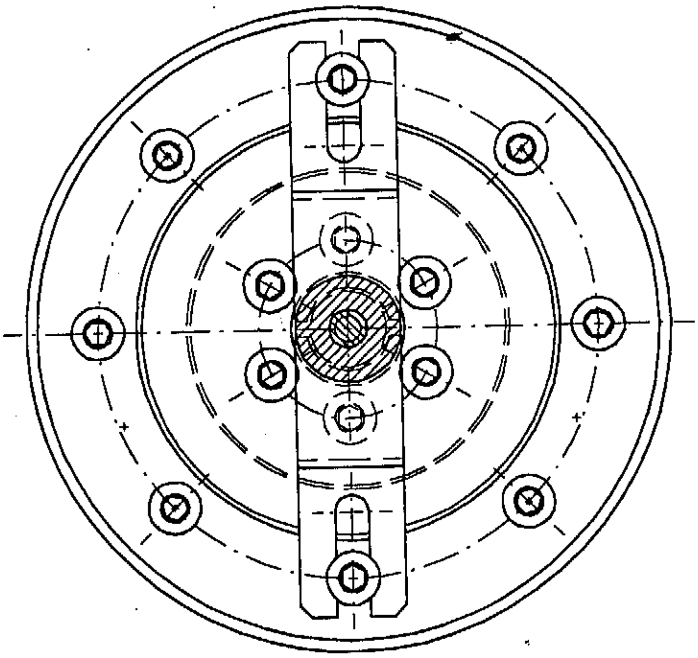

120
Ø267×3 MANNESMANN
300 K
SMA
UNF 1/4" male Spark- Det.
Ø154×2 MANNESMANN
V2A
O-RING
B
90°vers.gez.
Photomultiplier-
Fenster
A
INNENLEITER-W-KOPFFLANSCH
FENSTER-WARM
geteilter Ring
AUSSENLEITER-WG-FLANSCH
Pickup
TUNINGBELLOW
V2A
20 µCu
25
gelötet
2
Ø9
36 110
TUNINGSTAB
Cu
1 mm V2A,70µCu
Ø17,4
Langloch
unmagn.
INNENLEITER 300K
INNENLEITER-W-PUMPSTÜCK
Hartlötung
13
KRAGEN 1
KRAGEN 2
AUSSENLEITER 300K
FENSTER-W-KOPFFLANSCH
2Bohrg. für
PT1000
90°vers.gez.
Pumpen
IR-Sensorvorrichtung

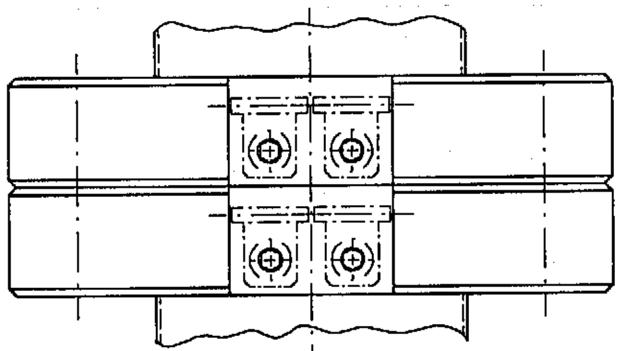

145
61
Ø267×3 MANNESMANN
10
300 K
O-RING 218.5×4.5
geteilt
Montageraum
Ø154×2 MANNESMANN
DIN 6796
CuBe 2 Spannscheibe
V2A
O-RING 105×3
B
AUSSENLEITER-W-ENDFLANSCH
V2A
AUSSENLEITER-WARM 0,5 mm V2A,10μCu
V2A
10,55
INNENLEITER-WARM 1 mm V2A,70μCu
1 mm V2A,70μCu
unmagn.
Langloch
Hartlötung
TUNINGSTAB-WARM
INNENLEITER-W-ENDFLANSCH
INNENLEITER-KALT-KOPFTEIL
B
AUSSENLEITER-W-DECKEL
AUSSENLEI
O-RING 218.5×4.5
Kabeldurchführung


Litze für Temperaturfixpunkt 70K
4.5K
145
61
Montageraum
geteilt
70 K
DIN 6796
CuBe 2 Spannscheibe
V2A
PT1000
vers.gez.
AUSSENLEITER-W-ENDFLANSCH
FENSTER KALT
Pickup
ILEITER-WARM 0.5 mm V2A,10µCu
KRAGEN 3
gelötet
26.5
KRAGEN 4
EITER-WARM 1 mm V2A,70µCu
1 mm Cu
V2A o.Cu
Langloch
TUNINGSTAB-WARM
Lötdepot
schweißbar?
INNENLEITER-W-ENDFLANSCH
INNENLEITER-KALT-KOPFTEIL
92.3x101.3x4.5 Cu-mantel
HELICOFLEX
AUSSENLEITER-K-KOPFFLANSCH

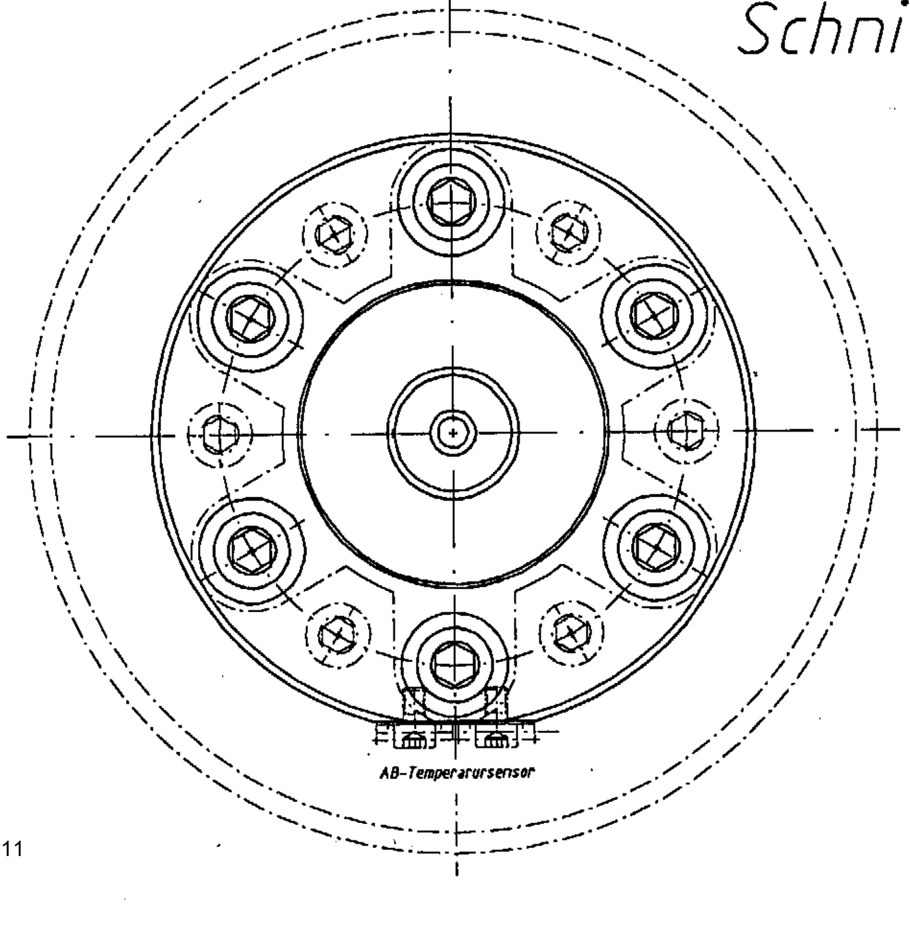

230,75
D
C
geteilt
AUSSENLEITER-K-CAVITY-FLANSCH
HAUPTKOPPLER-FLANSCH
4.5K
Pickup
AUSSENLEITER-KALT 0.5 mm V2A, 10μCu
Übergang Titan
?
BELLOW-KALT
Cu
Langloch
ANTENNE
INNENLEITER -KALT
TUNINGSTAB-KALT
V2A, innen u. außen 20-40μCu, hartlötfähig
41.5x50.5x4.5 CuMantel Helicoflex
DIN 6796
CuBe 2 Spannscheibe
AB-Temperarursensor
90
C
D

Schnitt AA

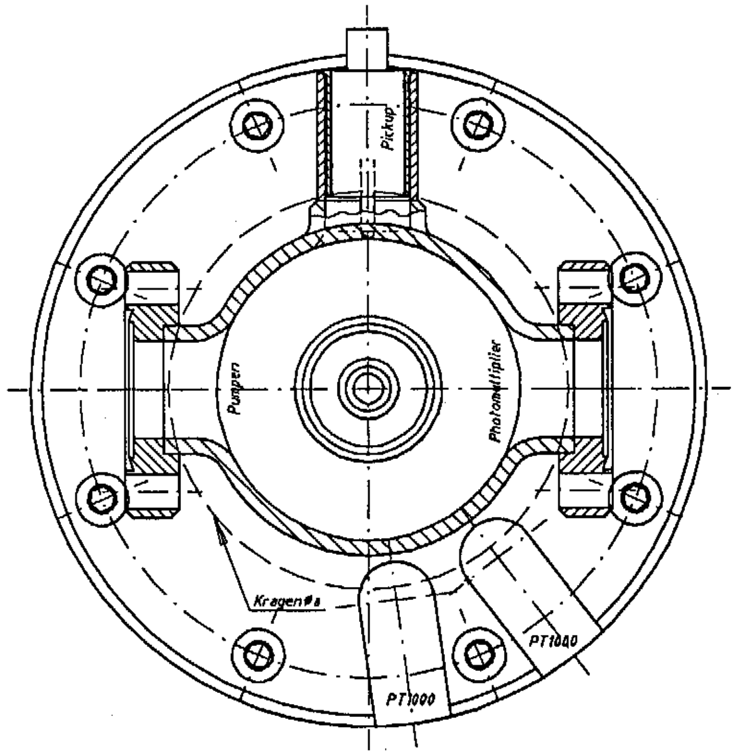




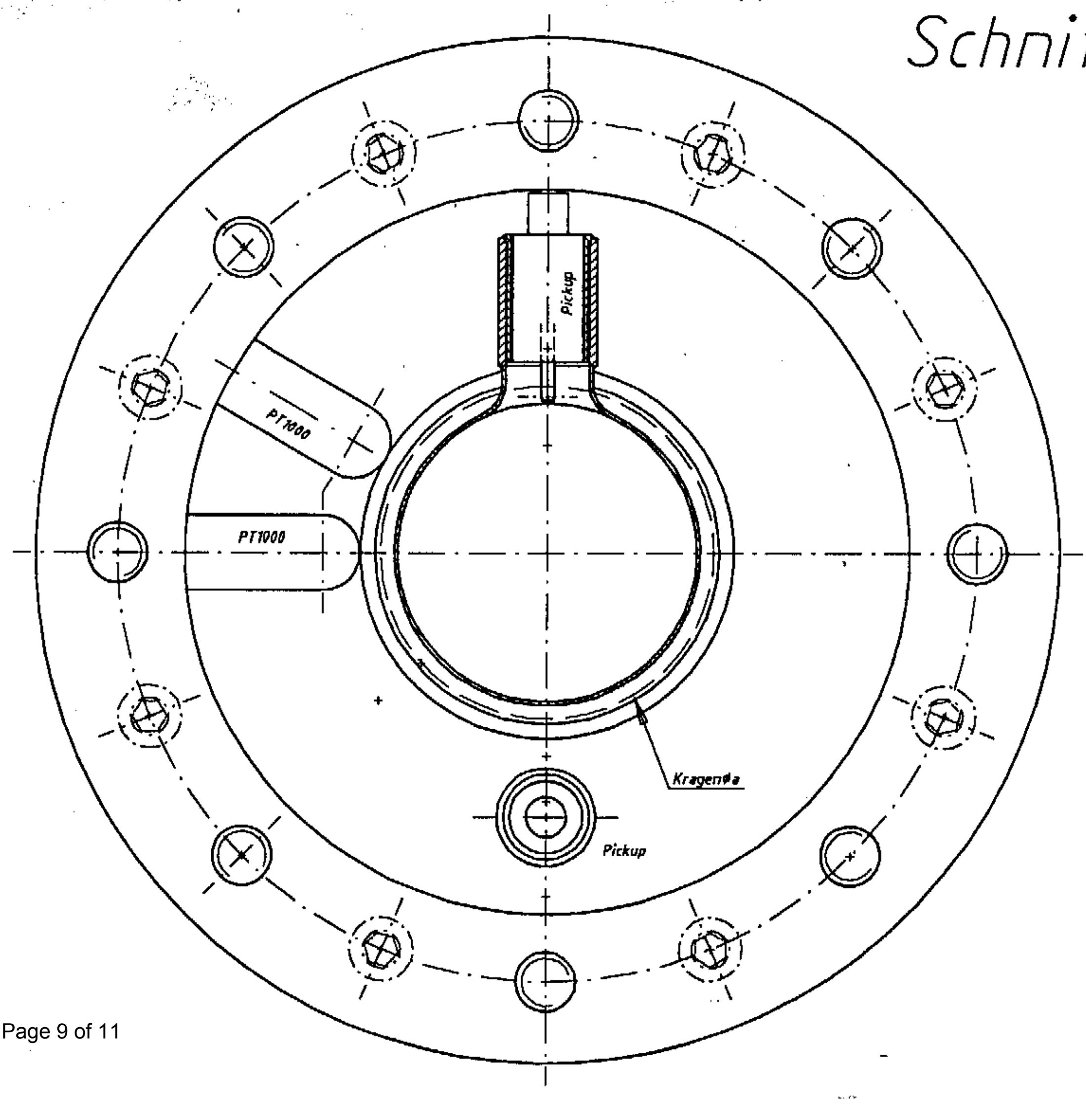
Schnitt DD



Schnitt BB



Schnitt CC

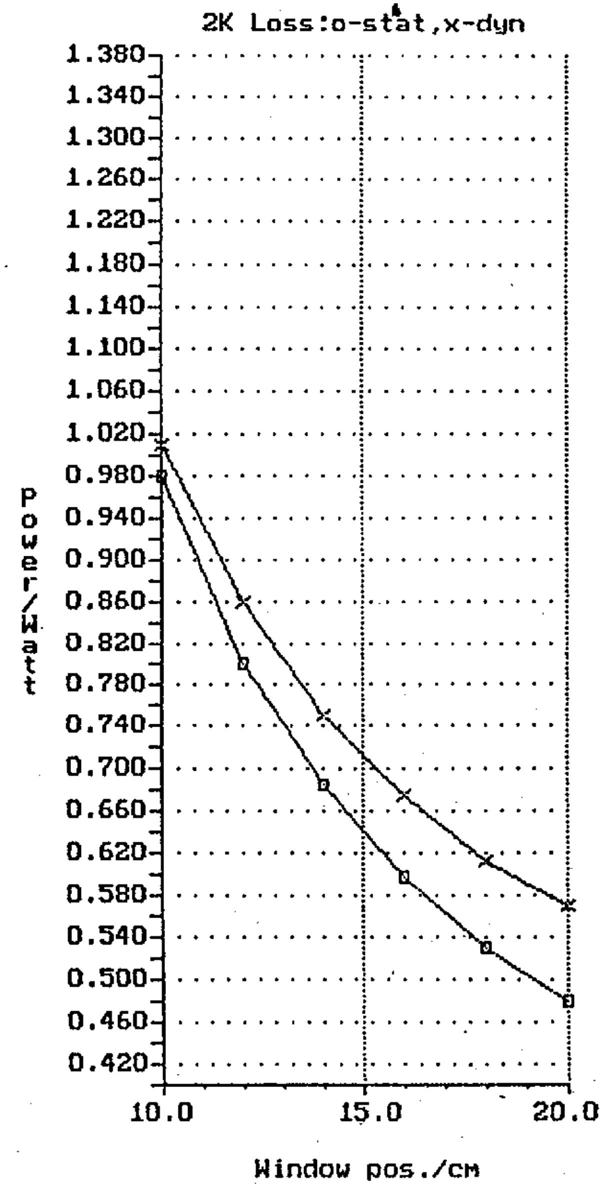


TESLA COUPLER LOSSES

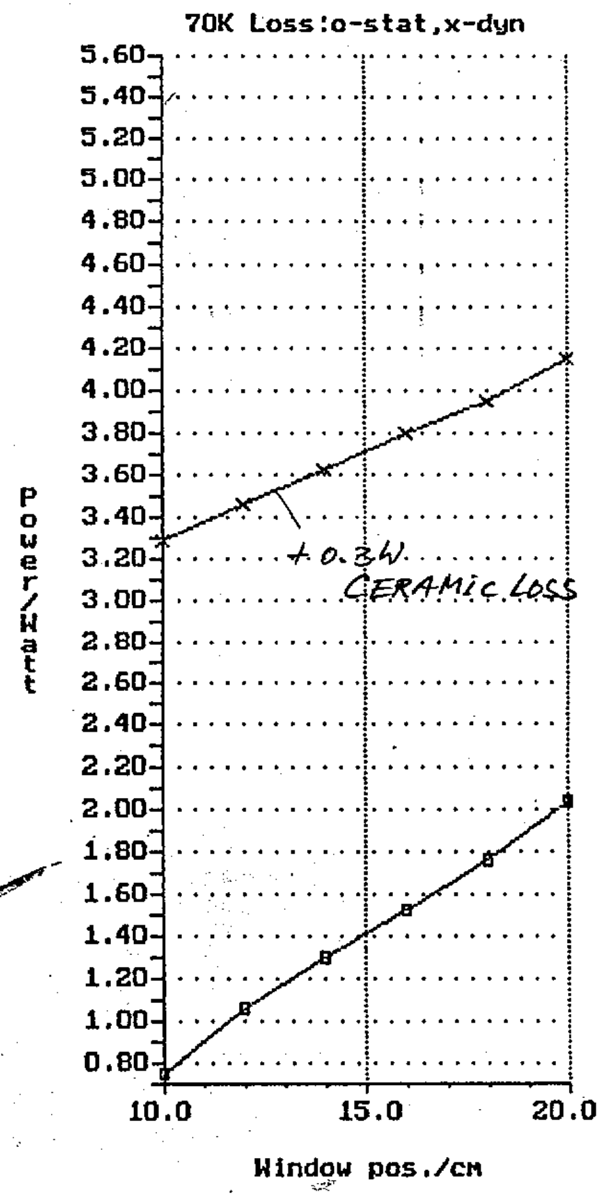
outer conductor:
cold and warm side
0.5 mm SS + 10μ Cu

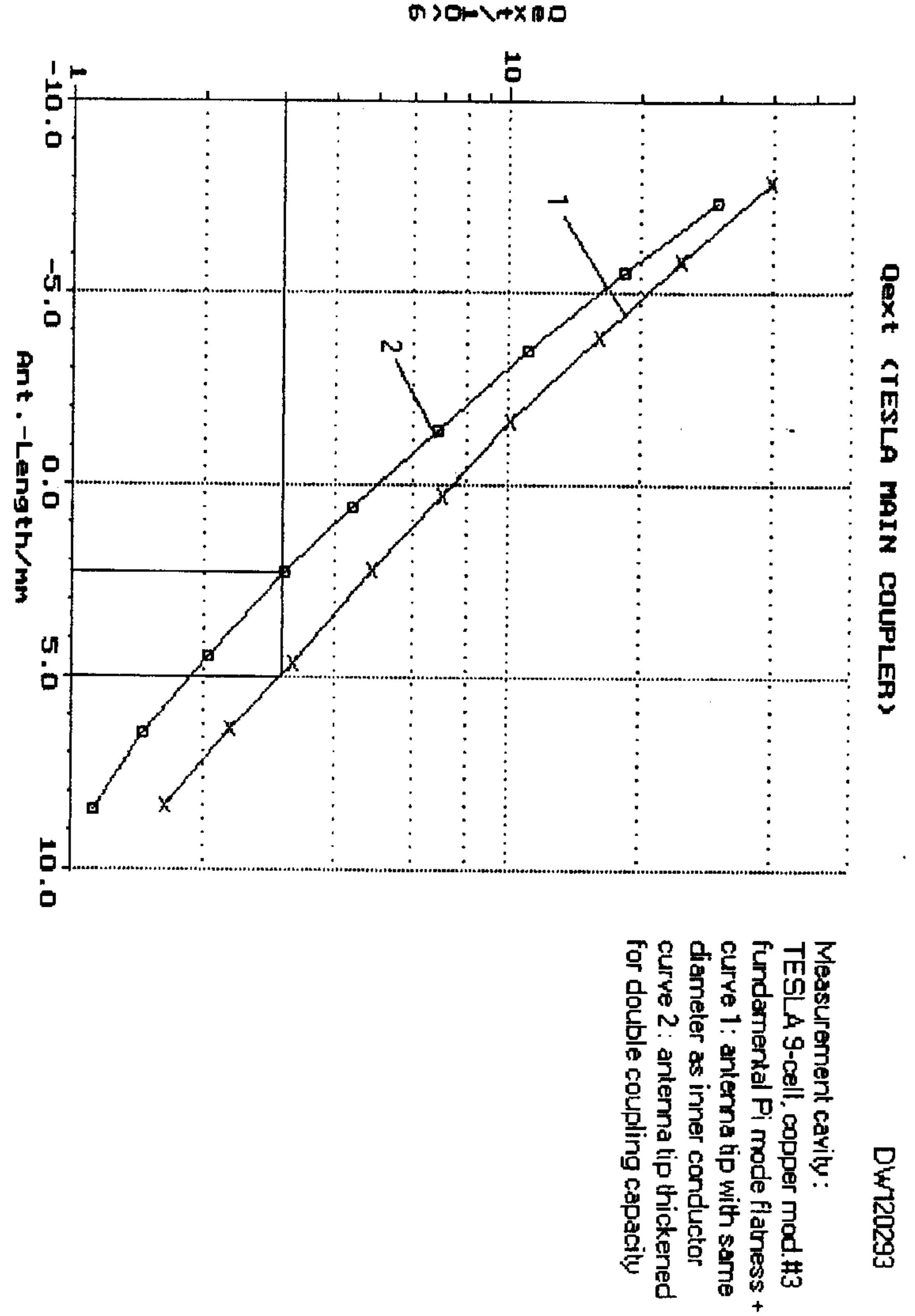
inner conductor
warm side
1 mm SS + 30μ Cu
cold side
1 mm Cu

70k → 2K



300k → 70k




Qext (TESLA MAIN COUPLER)
Qext/10^6
10
1
-10.0
-5.0
0.0
5.0
10.0
Ant.-Length/mm
1
2
DW120293
Measurement cavity :
TESLA 9-cell, copper mod.#3
fundamental Pi mode flatness +-3%
curve 1: antenna tip with same
diameter as inner conductor
curve 2: antenna tip thickened
for double coupling capacity