Simulation

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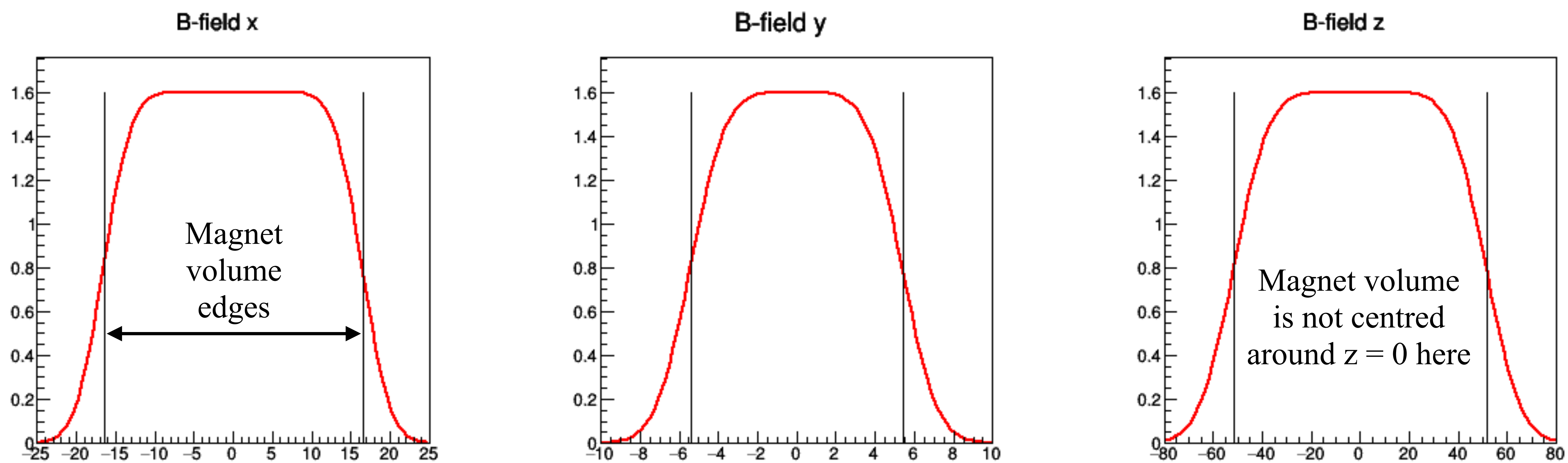
Realistic *B*-field?

- See last week's intro talk for examples
- Propose to implement as 3D symmetrical product of two-sided error functions (in each dimension) at the edges of the dipole's active volume
- 1D two-sided error function (smooth turn-on between 0 and 1):

$$f(x_i\,|\,p_i^0, p_i^1) = \frac{1}{4} \times \left[2 - \mathrm{Erf}\left(\frac{p_i^0/2 + x_i}{p_i^1}\right)\right] \times \left[2 - \mathrm{Erf}\left(\frac{p_i^0/2 - x_i}{p_i^1}\right)\right]$$

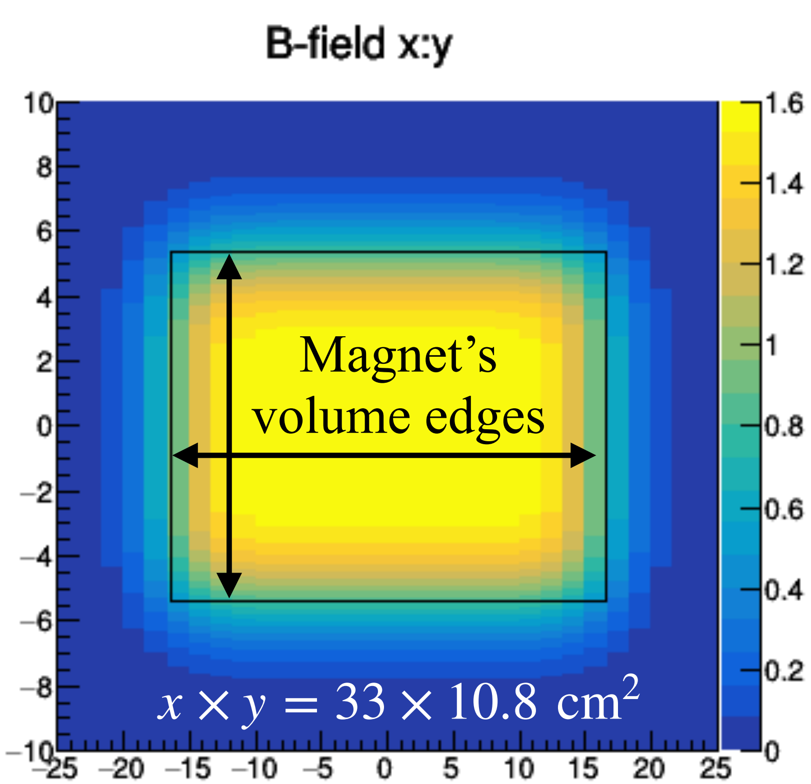
, where p^0 determines where the drop ends, while p^1 determines how fast it drops to 0

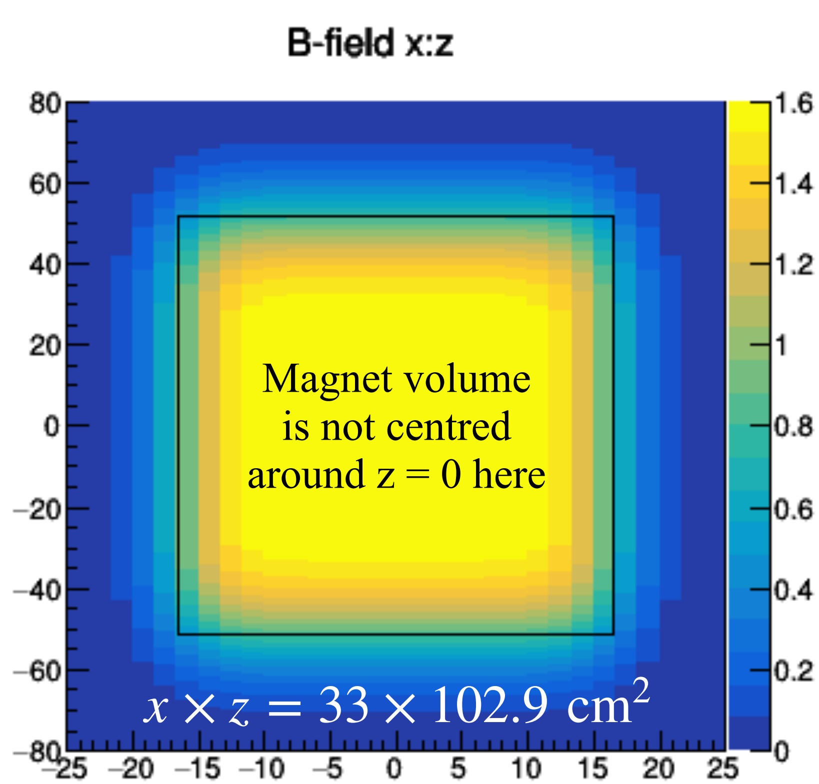


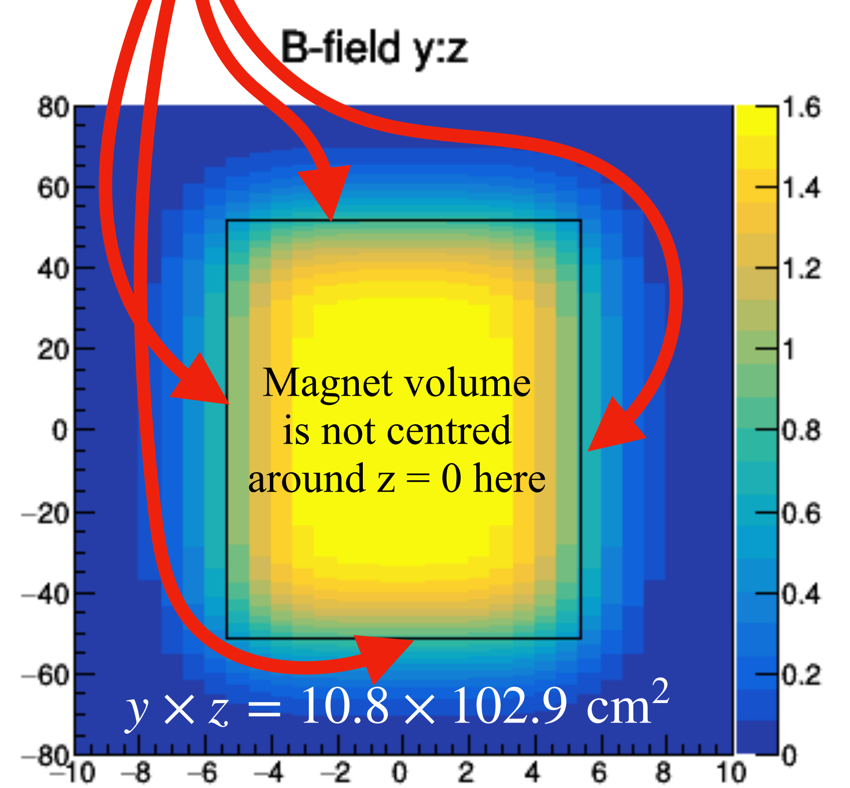
Realistic B-field?

- 2D two-sided error function: $f(x_i, x_j) = f(x_i \,|\, p_0^i, p_1^i) \times f(x_j \,|\, p_0^j, p_1^j)$
- 3D two-sided error function: $f(x, y, z) = f(x, y) \times f(x, z) \times f(y, z)$
- 2D field map: $B \times f(x_i, y_j)$ since f asymptotes to 1
- 3D field map: $B \times f(x, y, z)$

Magnet's material: field should be set to zero manually







Implementation with PyROOT

```
### dipole parameters
zActiveDipoleLengh    = 102.9 # cm
zActiveDipoleEntrance = 100   # cm
zActiveDipoleExit     = 202.9 # cm
xActiveDipoleWidth    = 33    # cm
yActiveDipoleHeight   = 10.8  # cm
BfieldGamLaser        = 1.6   # T
BfieldEleLaser        = 1     # T

### dipole field strength differs
strength = BfieldGamLaser


### in 1D (for simplicity assuming here the dipole centred at z=0)
s1func = '[0] * ((2-ROOT::Math::erfc(([1]/2+x)/[2]))/2) * ((2-ROOT::Math::erfc(([1]/2-x)/[2]))/2)'
fieldx = TF1("fieldx", s1func, -25,+25)
fieldy = TF1("fieldy", s1func, -10,+10)
fieldz = TF1("fieldz", s1func, -80,+80)
fieldx.SetParameter('p0', strength)
fieldx.SetParameter('p1', xActiveDipoleWidth)
fieldx.SetParameter('p2', 4)
fieldy.SetParameter('p0', strength)
fieldy.SetParameter('p1', yActiveDipoleHeight)
fieldy.SetParameter('p2', 2)
fieldz.SetParameter('p0', strength)
fieldz.SetParameter('p1', zActiveDipoleLengh)
fieldz.SetParameter('p2', 16)

### evaluate a certain point
B = fieldz.Eval(50) ### field strength at z=50 cm
```

Implementation with PyROOT

```
### in 2D (for simplicity assuming here the dipole centred at z=0)
s2func = '[0] * ((2-ROOT::Math::erfc(([1]/2+x)/[2]))/2) * ((2-ROOT::Math::erfc(([1]/2-x)/[2]))/2)\
              * ((2-ROOT::Math::erfc(([3]/2+y)/[4]))/2) * ((2-ROOT::Math::erfc(([3]/2-y)/[4]))/2)'
fieldxy = TF2("fieldxy", s2func, -25,+25, -10,+10)
fieldxz = TF2("fieldxz", s2func, -25,+25, -80,+80)
fieldyz = TF2("fieldyz", s2func, -10,+10, -80,+80)
fieldxy.SetParameter('p0', strength)
fieldxy.SetParameter('p1', xActiveDipoleWidth)
fieldxy.SetParameter('p2', 4)
fieldxy.SetParameter('p3', yActiveDipoleHeight)
fieldxy.SetParameter('p4', 2)
fieldxz.SetParameter('p0', strength)
fieldxz.SetParameter('p1', xActiveDipoleWidth)
fieldxz.SetParameter('p2', 4)
fieldxz.SetParameter('p3', zActiveDipoleLengh)
fieldxz.SetParameter('p4', 16)
fieldyz.SetParameter('p0', strength)
fieldyz.SetParameter('p1', yActiveDipoleHeight)
fieldyz.SetParameter('p2', 2)
fieldyz.SetParameter('p3', zActiveDipoleLengh)
fieldyz.SetParameter('p4', 16)
```

Implementation with PyROOT

```
### in 3D (for simplicity assuming here the dipole centred at z=0)
s3func = '[0] * ((2-ROOT::Math::erfc(([1]/2+x)/[2]))/2)*((2-ROOT::Math::erfc(([1]/2-x)/[2]))/2)\
              * ((2-ROOT::Math::erfc(([3]/2+y)/[4]))/2)*((2-ROOT::Math::erfc(([3]/2-y)/[4]))/2)\
              * ((2-ROOT::Math::erfc(([5]/2+z)/[6]))/2)*((2-ROOT::Math::erfc(([5]/2-z)/[6]))/2)'
fieldxyz = TF3("fieldxyz", s3func, -25,+25, -10,+10, -80,+80)
fieldxyz.SetParameter('p0', strength)
fieldxyz.SetParameter('p1', xActiveDipoleWidth)
fieldxyz.SetParameter('p2', 4)
fieldxyz.SetParameter('p3', yActiveDipoleHeight)
fieldxyz.SetParameter('p4', 2)
fieldxyz.SetParameter('p5', zActiveDipoleLengh)
fieldxyz.SetParameter('p6', 16)

### get the field strength at any xyz
print("field at r=(0.0,0.0,50.0): %.3f [T]" % fieldxyz.Eval(0,0,50))
print("field at r=(0.5,8.0,60.0): %.3f [T]" % fieldxyz.Eval(0.5,8,60))
print("field at r=(0.0,0.0,0.0) : %.3f [T]" % fieldxyz.Eval(0.0,0,0))

### output should be:
field at r=(0.0,0.0,50.0): 0.881 [T]
field at r=(0.5,8.0,60.0): 0.012 [T]
field at r=(0.0,0.0,0.0) : 1.600 [T]
```

Magnet doc #1

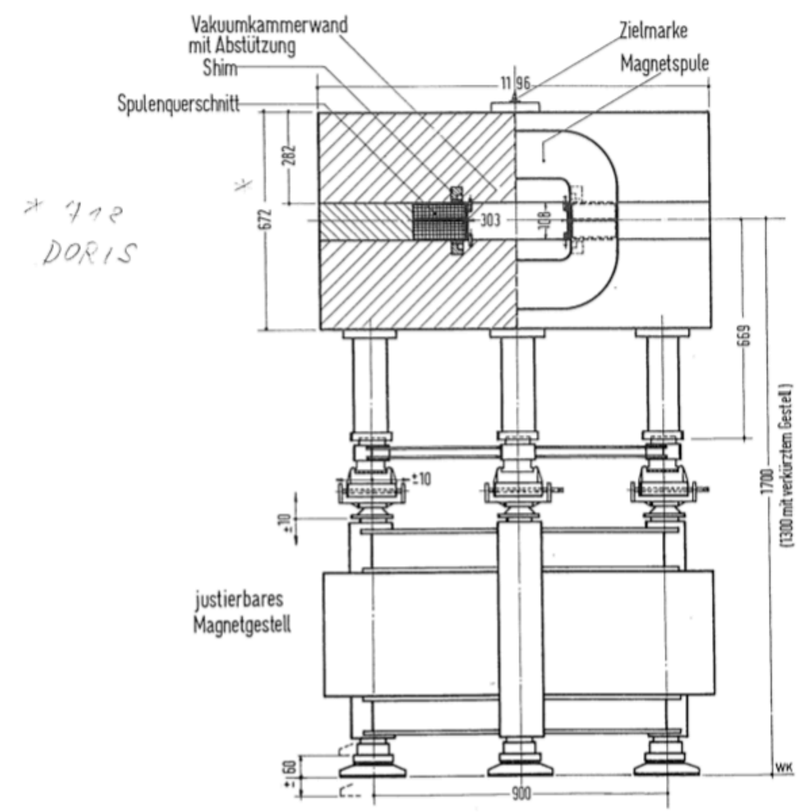
DESY-Strahlführungsmagnete
Blatt: K 12
Datum: 1.4.66
Auskunft: K. Holm
H. Wümpelmann

ABLENKMAGNET TYP MB

Technische Daten

Vorhandene Anzahl		18	
Magnetgewicht		7,5	t
Gesamtlänge zwischen den Vakuumkammerflanschen		1520	mm
nutzbare Apertur in der Vakuumkammer	Höhe Breite	108 303	mm mm
Polabstand		108	mm
Spulenöffnung		330	mm
Polendabrundung	z·s =	120·120	mm^2
max. Stromstärke		1500	A
Feldstärke bei 1500 A		22,4	Kr
Leistungsverbrauch bei 1500 A		400	KW
Gesamtwiderstand bei 20°C		0,165	Ω
integrierte magnetische Länge		1029	mm
Zeitkonstante L/R (berechnet für 50°C)		0,6	sec
Gesamtwindungszahl	2·70	140	
mittlere Windungslänge		3700	mm
Leiterquerschnitt	Quadrat mit Loch	9·9 5,5ϕ	mm^2 mm
Zahl der Kühlkreise pro Spule		14	
Kühlwassermenge bei 1500 A und ΔT = 40°C		146	l/min
erforderl. Differenzdruck für 146 l/min		9,0	at

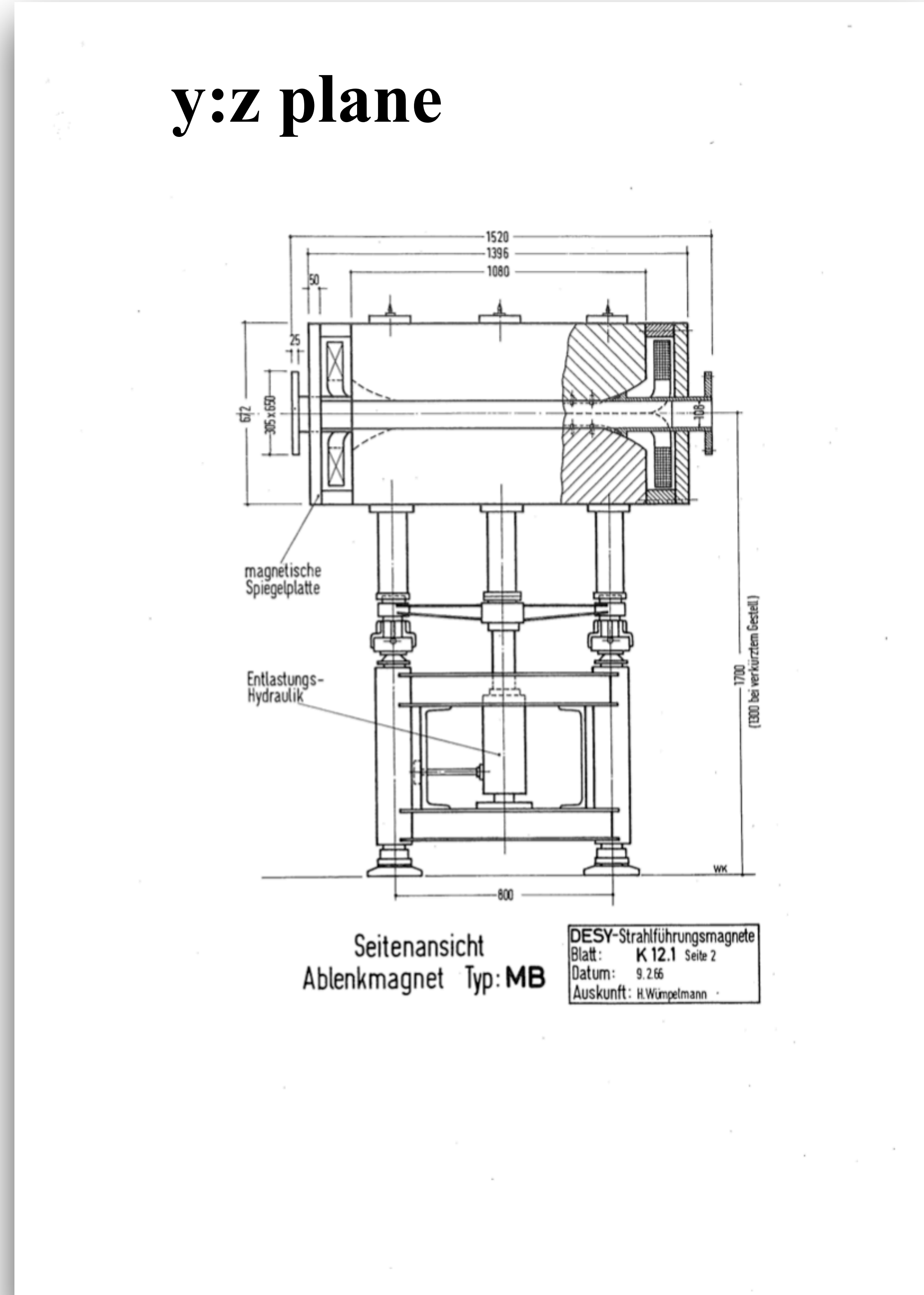
x:y plane



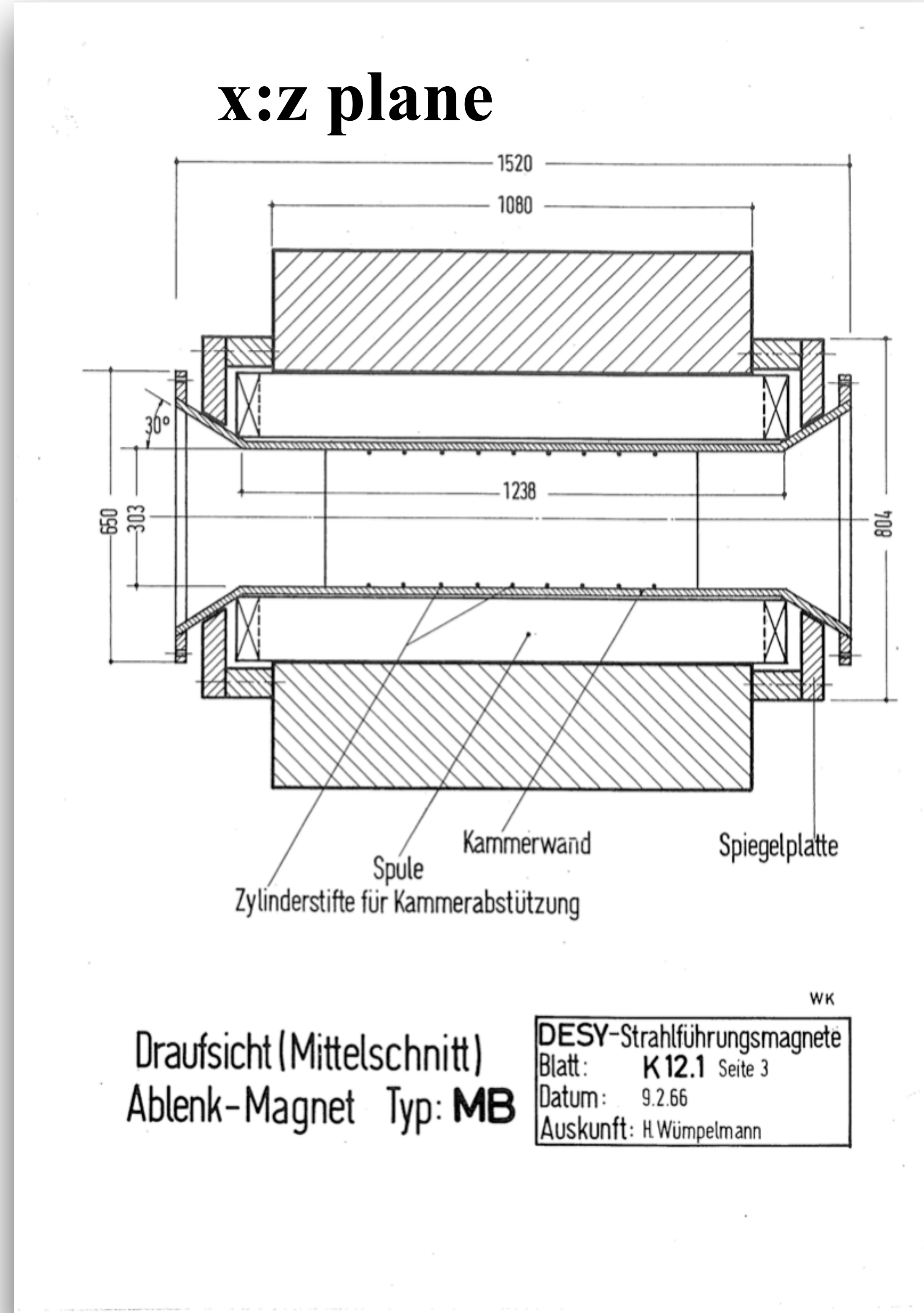
Querschnitt
Ablenkmagnet Typ: MB

DESY-Strahlführungsmagnete
Blatt: K 12.1 Seite 1
Datum: 9.2.66
Auskunft H.Wümpelmann

Magnet doc #2

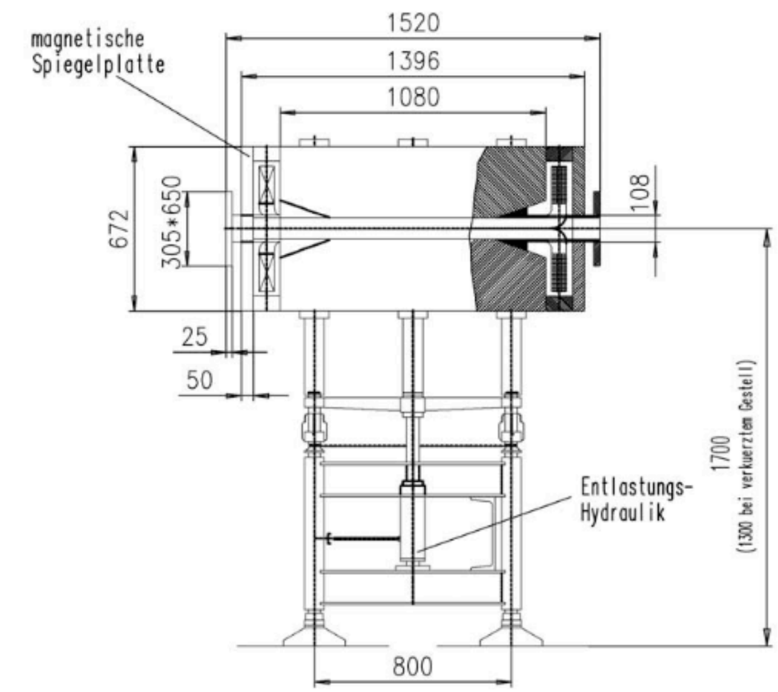


y:z plane
1520
1396
1080
50
25
612
385 x 650
108
magnetische Spiegelplatte
Entlastungs-Hydraulik
1700 (1300 bei verkürztem Gestell)
800
WK
Seitenansicht
Ablenkmagnet Typ: MB
DESY-Strahlführungsmagnete
Blatt: K 12.1 Seite 2
Datum: 9.2.66
Auskunft: H. Wümpelmann



x:z plane
1520
1080
30°
1238
650
303
804
Kammerwand
Spiegelplatte
Spule
Zylinderstifte für Kammerabstützung
WK
Draufsicht (Mittelschnitt)
Ablenk-Magnet Typ: MB
DESY-Strahlführungsmagnete
Blatt: K 12.1 Seite 3
Datum: 9.2.66
Auskunft: H. Wümpelmann

Magnet doc #3



Technische Daten		
Nennstrom	1500	A
Spulen (Anzahl, Querschnitt)	2 / 4007	mm^2
Leiterquerschnitt (Cu)	57.25 (9 x 9 ; ø 5.5)	mm^2
Windungszahl n/Spule	70	
Magnetwiderstand bei 20°C	165	mΩ
Induktivität		mH
Frequenz	DC	
Max. Stromdichte	26.2	A/mm^2
Verlustleistung	400	kW
Anzahl der Kühlkreise	28	
Kühlwassermenge	146	l/min
Δt Kühlwasser	40	°C
Differenzdruck	9.0	bar
Prüfdruck der Spulen		bar
Prüfspannung der Spulen		kV (eff.)
Feld	2.24	T
Luftspalt	108	mm
Eisenlänge	1080	mm
Magnetlänge (eff.)	1029	mm
Gesamtlänge	1520	mm
Gesamtgewicht	7500	kg
Spulengewicht (pro Spule)		kg
Hersteller Fertigungszeichnung	DESY	
Hersteller Eisenjoch/Spule	Firma Oerlikon	
Bearbeitet: A. Jantzen - Stenzel	Geändert:	
MEA Tel. 8998–3271 / 3327		

Alle Angaben bei Nennstrom