Proposed replacement of QM7 by TOKIN 3581

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Building on the work by:

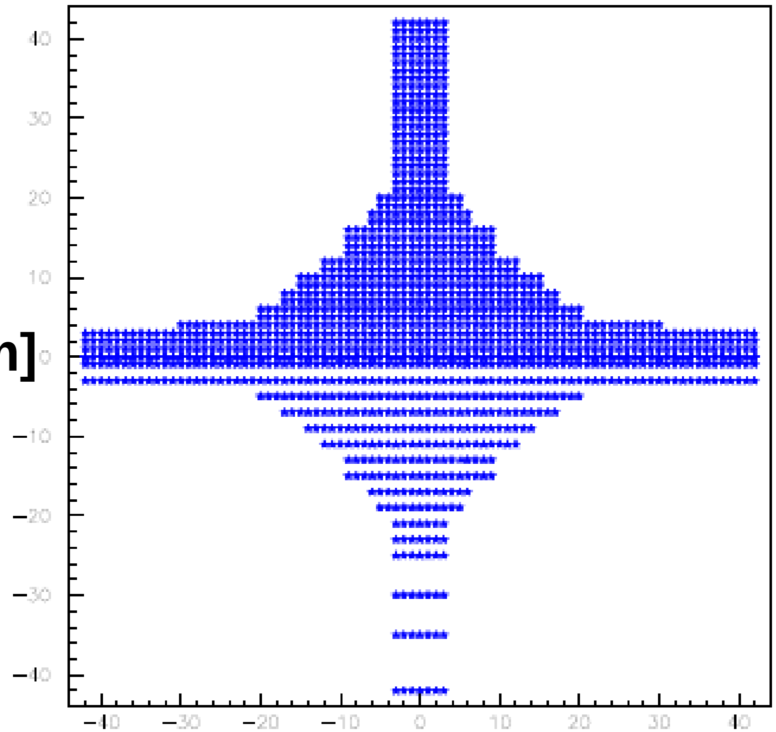
M. Alabau, A. Faus-Golfe (IFIC) and many others at SLAC, LAL, KEK and in the UK

7th ATF2 Project Meeting KEK December 15-18, 2008

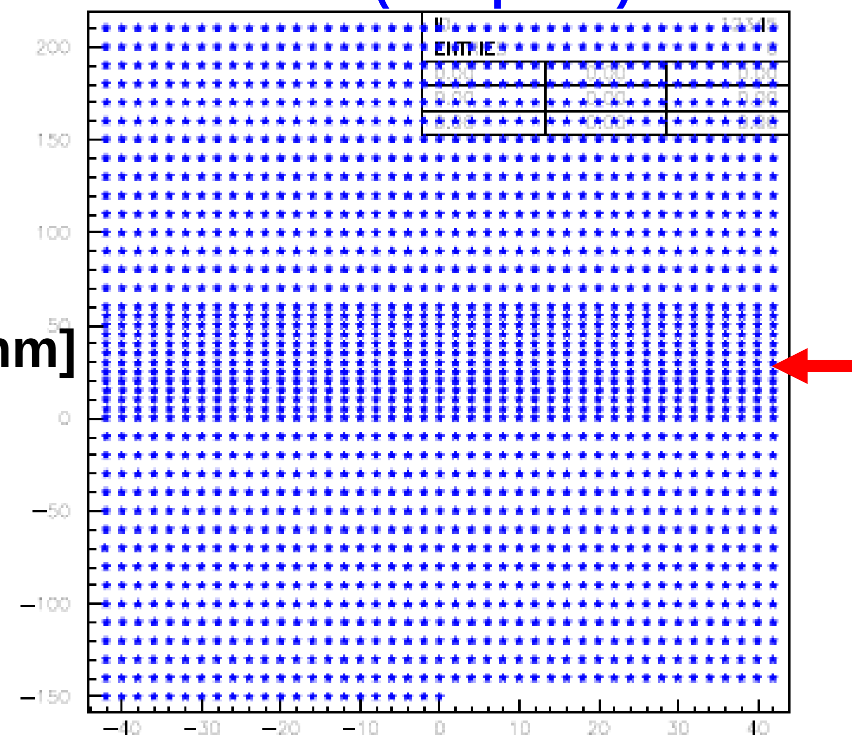
Measured TOKIN 3581 X-Y and X-Z $B_{x,y,z}$ field map

Mika Masuzawa and co-workers

Z = 0 (center)



Y = 0 (mid-plane)

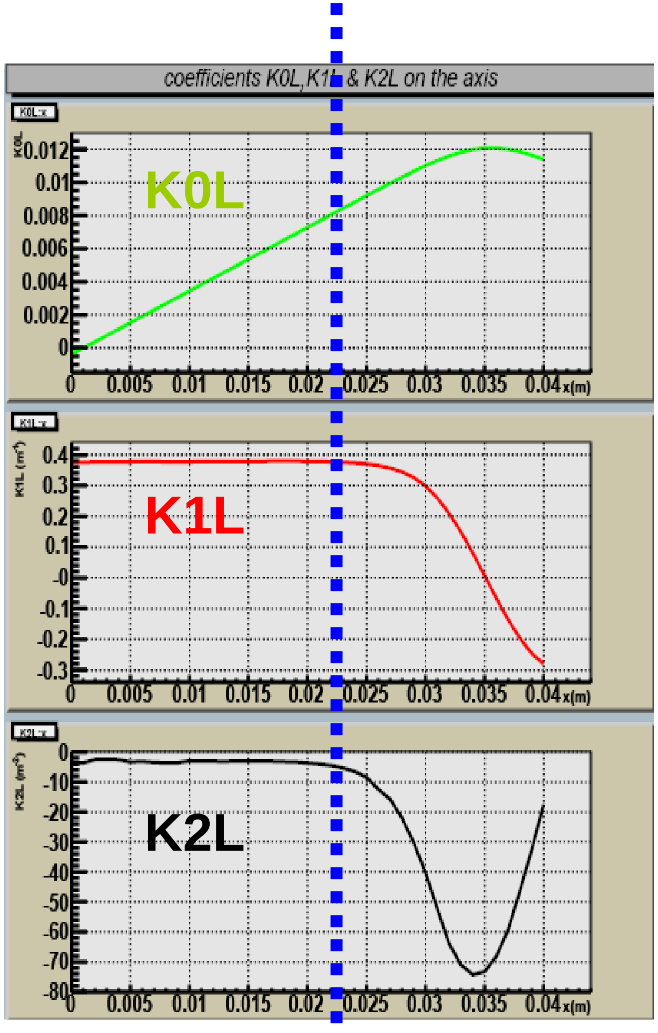


1) Fit KnL from measured $B_{x,y}(x,y,z=0)$ + compare with PRIAM 2D (TOKIN & QM7)

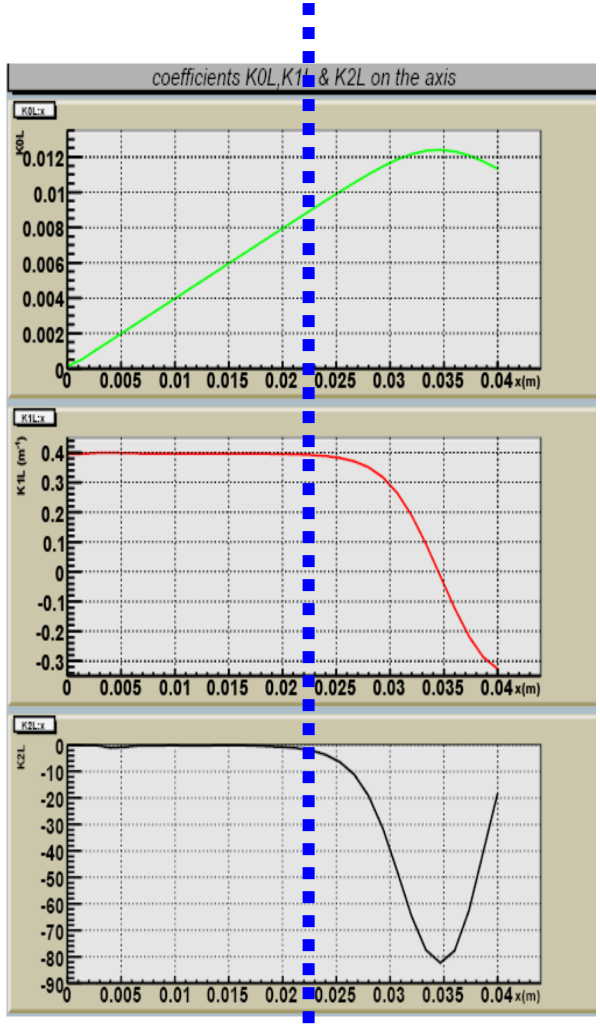
2) Compare measured $B_y(x,y=0)$ = K0L integrated over Z with PRIAM 2D result

3) → under way : check for any coupling from $B_z(x \sim 22.5, y > 0, z > 0)$

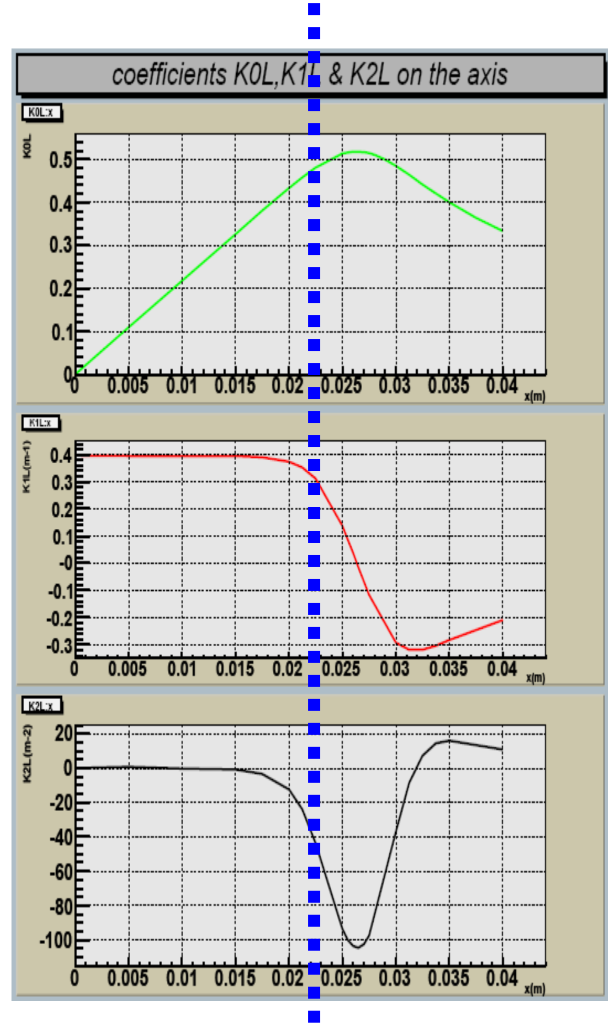
TOKIN 3581 measurement



TOKIN 3581 PRIAM simulation



QM7 PRIAM simulation



$X_{extraction} \cong 22.5$ mm

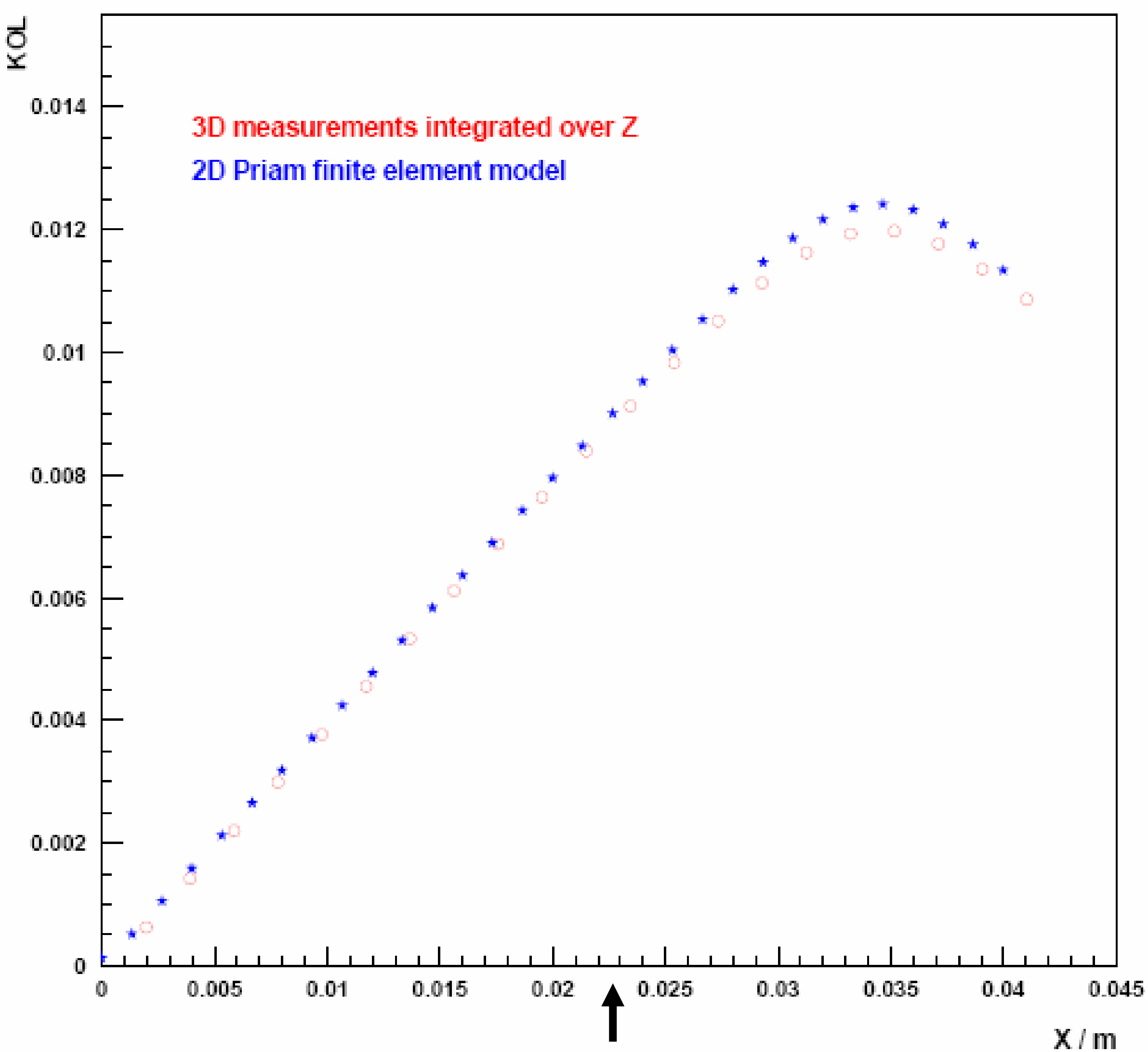
$R_{TOKIN} = 21$ mm

$R_{QM7} = 16$ mm

TOKIN 3581:
K1L = 0.99 × nominal
K2L = 1 m^{-2}

QM7:
K1L = 0.76 × nominal
K2L = 47 m^{-2}

Compare Z-integrated B_y (x,y=0) with PRIAM 2D model to assess TOKIN 3581 finite length effect



$X_{extraction} \cong 22.5$ mm

Slopes match exactly at origin (within few 10^{-3})

Max. distortion < 3 %

➔ This sets the level of uncertainty from the finite length effect when using the 2D result to estimate KnL

K1L ~ 0.392 m^{-1}
= 0.99 × nominal

(present QM7 = 0.76 × nominal)

K2L ~ 1 m^{-2}

(present QM7 = 47 m^{-2})

Discussion

Measurements and PRIAM 2D compare within a few %

➔ good enough to predict order-of-magnitude improvement from QM7 → TOKIN 3581 change

Present ATF2 EXT non-linearity ➔ make 4D beam phase-space (beta-match and x-y coupling) depend on X & Y injection orbits !

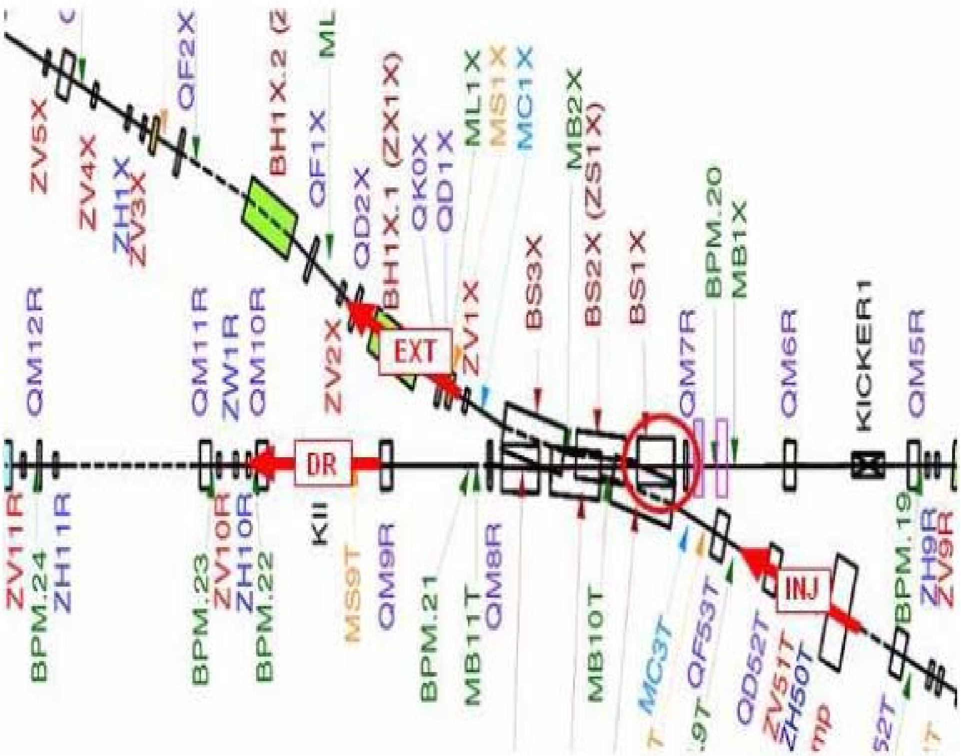
This could in principle be absorbed downstream (re-match, coupling correction, IP optics corrections) or dealt with by ensuring stable injection parameters

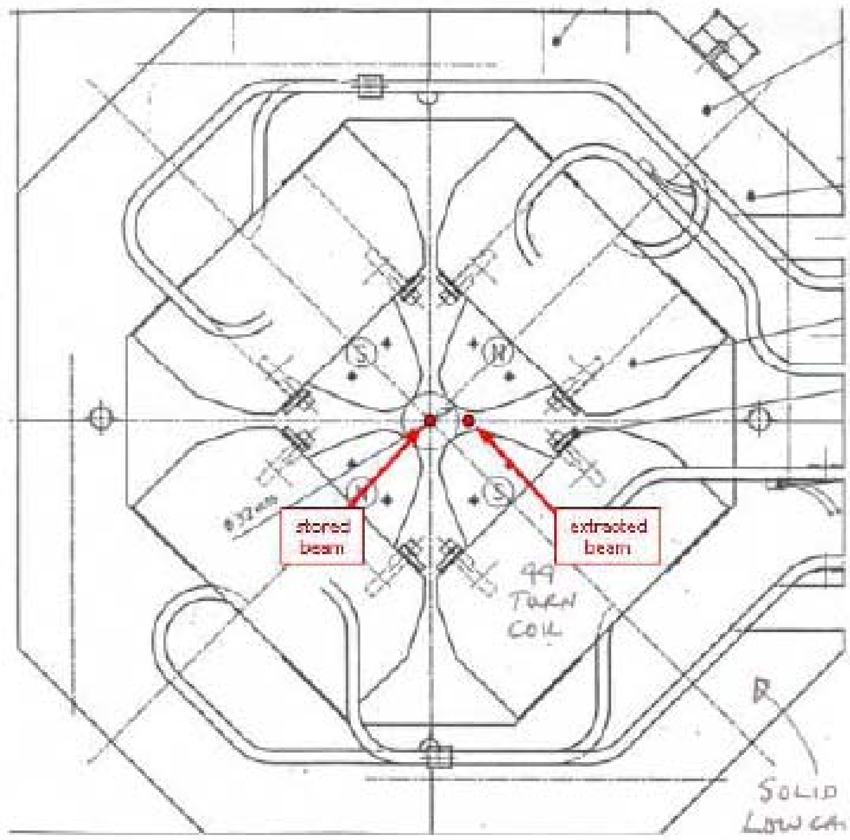
But we're lucky: it's possible to avoid this added complexity :

Present QM7 power supply can be re-used
TOKIN 3581 was in ATF → minor change to support structure
Other QM7 can remain untouched (auxiliary supply exists), so no need to break the vacuum in the RF section

Well worth the effort → let's do the change end of January

QM7 is shared by DR & EXT

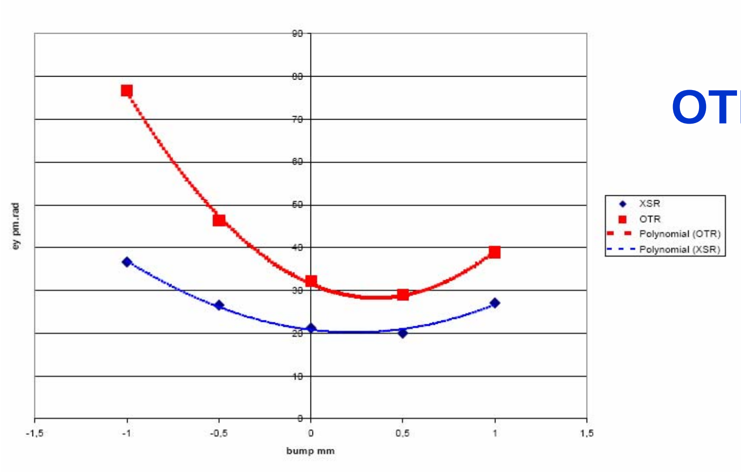




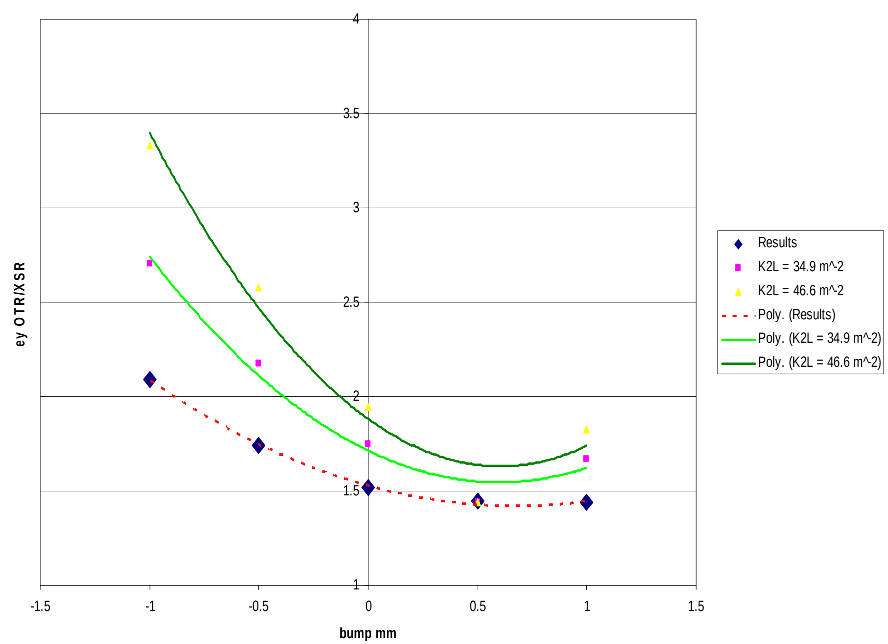
present radius = 16 mm   extracted beam offset = 22.5 mm

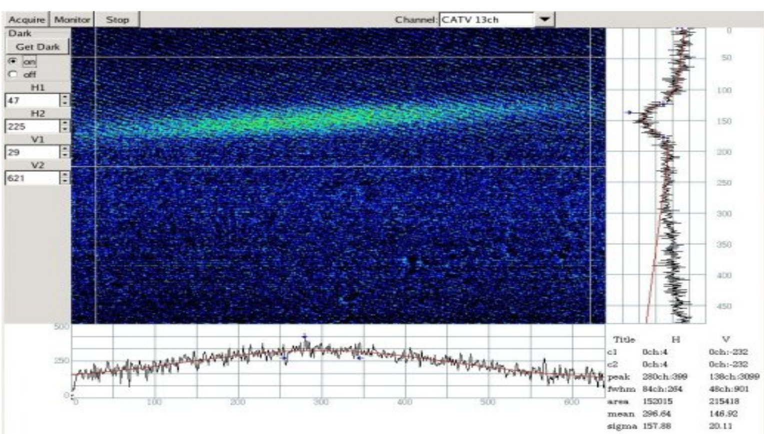
Measurements at OTR behind septum function of vertical bump

→Image of angles out of QM7



OTR / XSR corrected vertical projected emittances





May 28, 2008

$$\varepsilon_{y\text{-proj}}^2 = \varepsilon_{y\text{-in}}^2 + \varepsilon_{x\text{-in}}\, \varepsilon_{y\text{-in}}\, \beta_x\, \beta_y\, K_2L^2 \times (\Delta_y^2 + \varepsilon_{y\text{-in}}\, \beta_y)$$

(assumes uncoupled input)

QM7 2D field calculation with PRIAM

X_{ext} = 22.5 mm

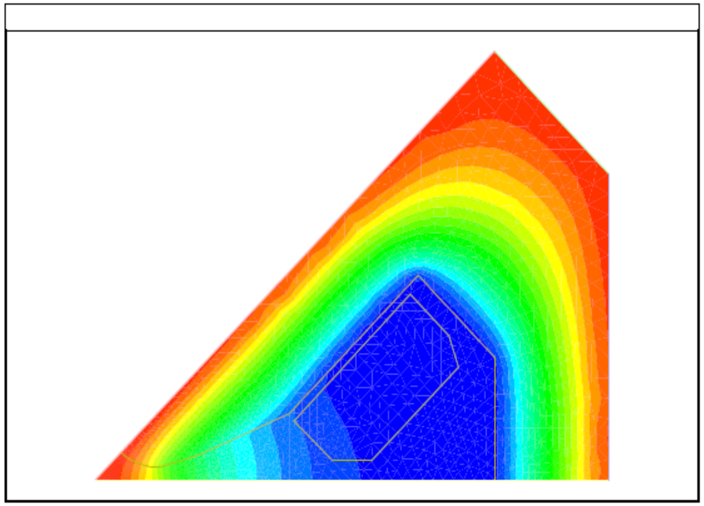
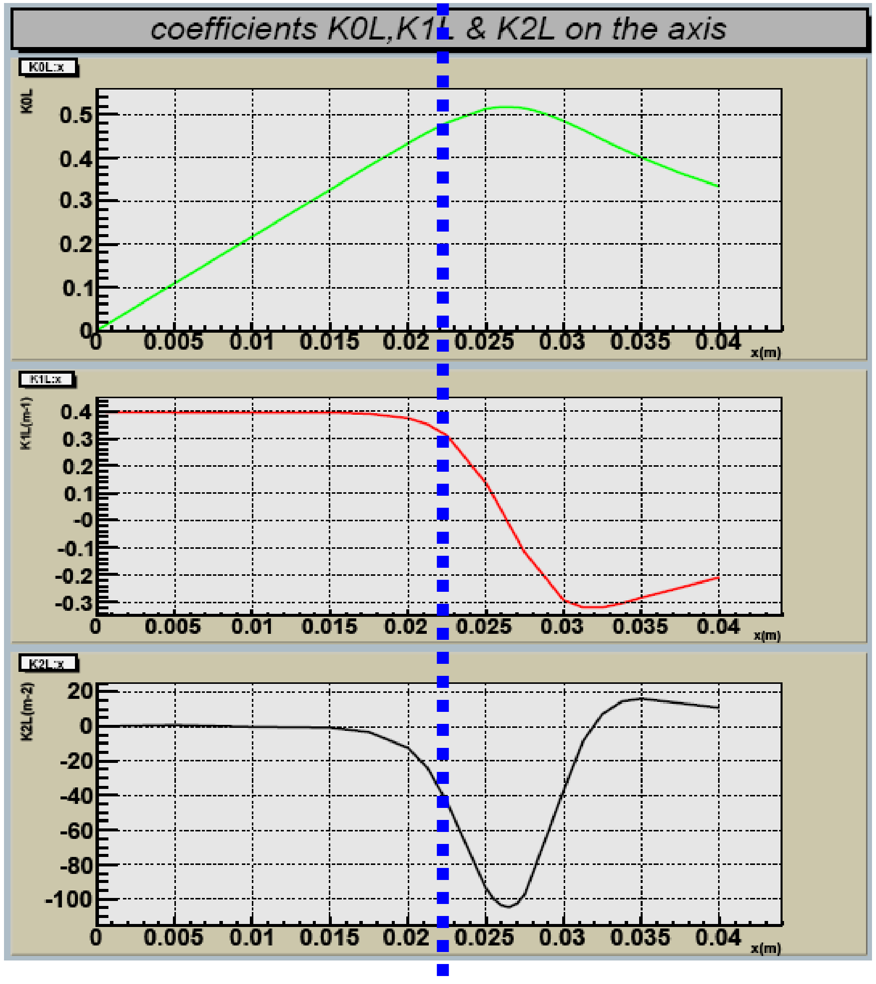


FIG. 5 – QM7 B field lines

K0L

K1L

K2L



extracted beam offset [m]

K1L = 0.3 m^{-1} = 0.76 × nominal

➔ large rematch of betatron optics

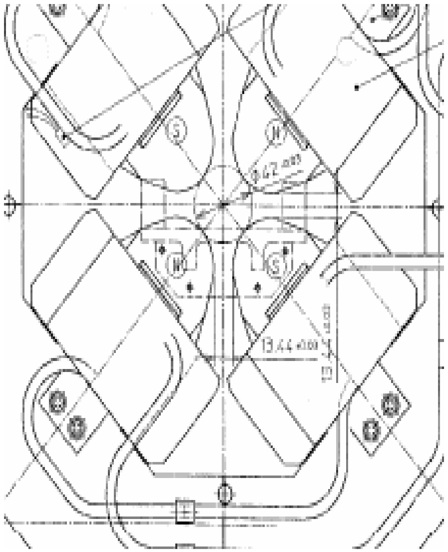
K2L = 46.6 m^{-2}

➔ contributes x-y coupling :
factor ~ 2-3 on $\varepsilon_{y\text{-proj}}$ for Δy = 1 mm

Compares well with POISSON calculation from SLAC

$$\varepsilon_{y\text{-proj}}^2 = \varepsilon_{y\text{-in}}^2 + \varepsilon_{x\text{-in}}\, \varepsilon_{y\text{-in}}\, \beta_x\, \beta_y\, K_2L^2 \times (\Delta_y^2 + \varepsilon_{y\text{-in}}\, \beta_y)$$

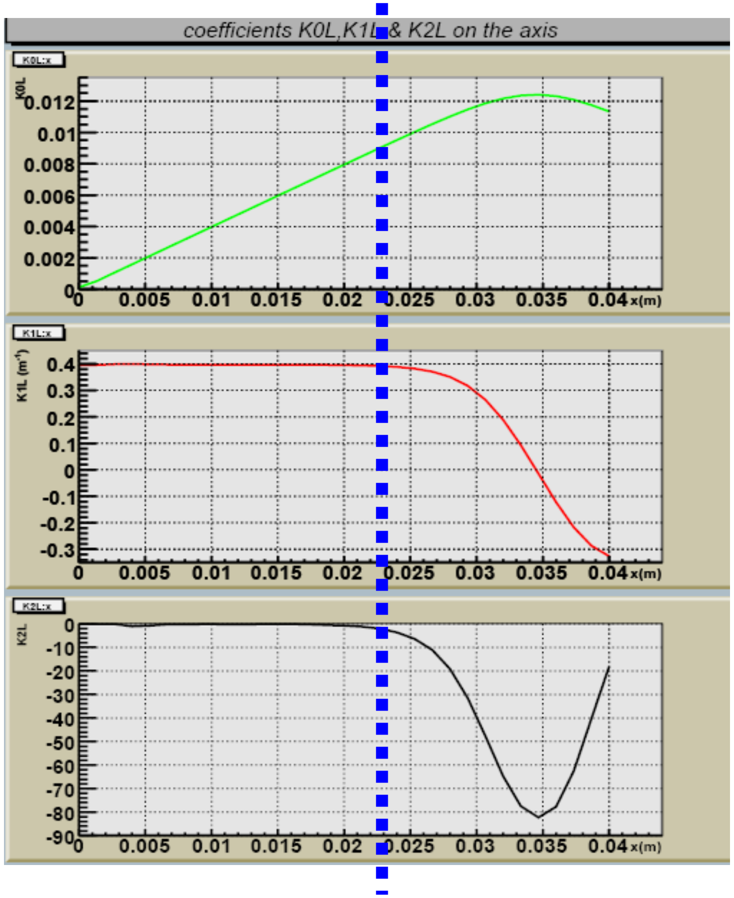
TOKIN 3581 quads available → new PRIAM 2D calc.



→ K1L and K2L error almost disappears !

X_{ext} = 22.5 mm

K0L



extracted beam offset [m]

K1L ~ **0.392 m^{-1}**
= **0.99 × nominal**

(previously = 0.76 × nominal)

K2L ~ **1 m^{-2}**

(previously = 46.6 m^{-2})

	Radius	Turns	Max I	Current needed:
QM7	16mm	17	139 A	130*(42/32)2*17/26= **146 A**
Q-3581	21mm	26	245 A	➔ present PS system sufficient