(TT)OSC Bypass 2

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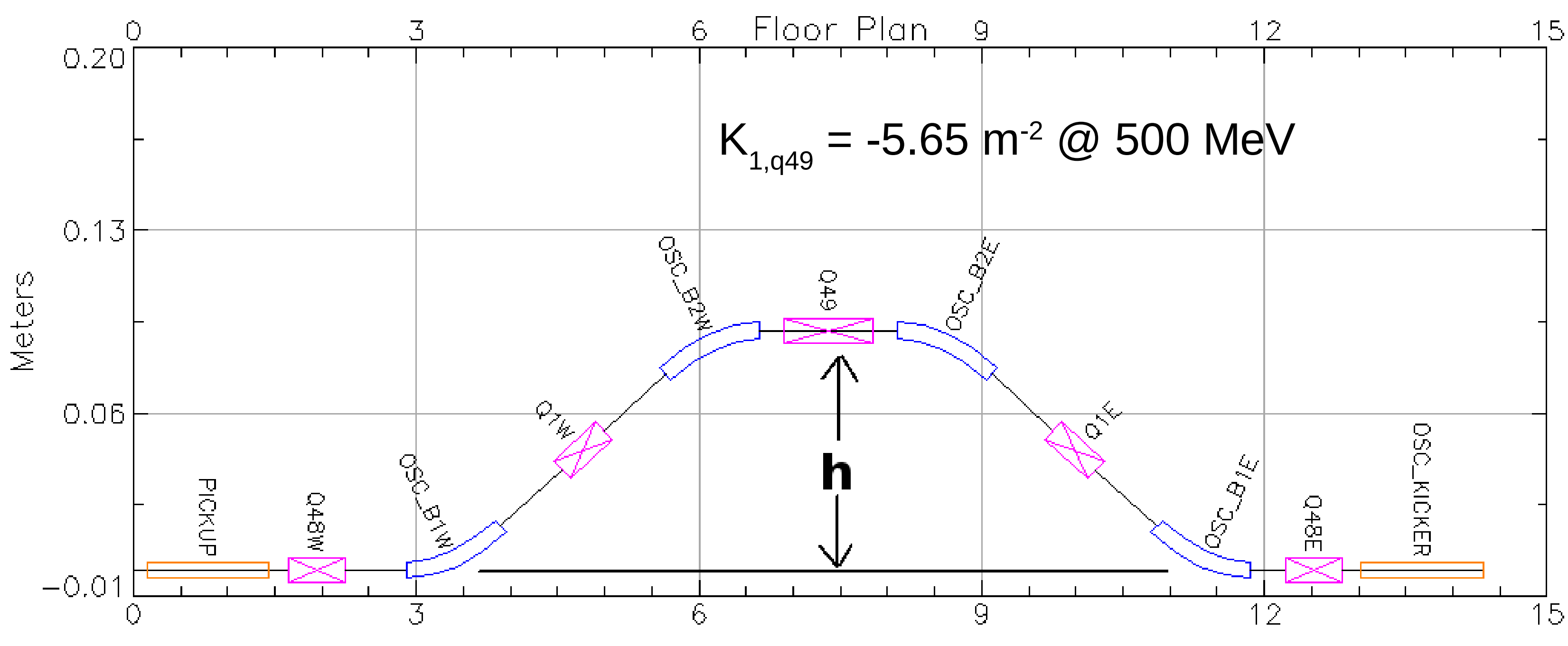
Physical considerations

- The physical dimensions of center magnet (currently Q49) effect h, and so path length Δs.
- Bypass below is an *archtype*
  - Good for setting up bypass design environment & developing familiarity with relevant quantities.
  - Actual bypass may have fewer/rearranged quads, zig-zag, sextupoles, bend angle through center quad, non-symmetric layout.
    - May be optimized differently depending on OSC technique



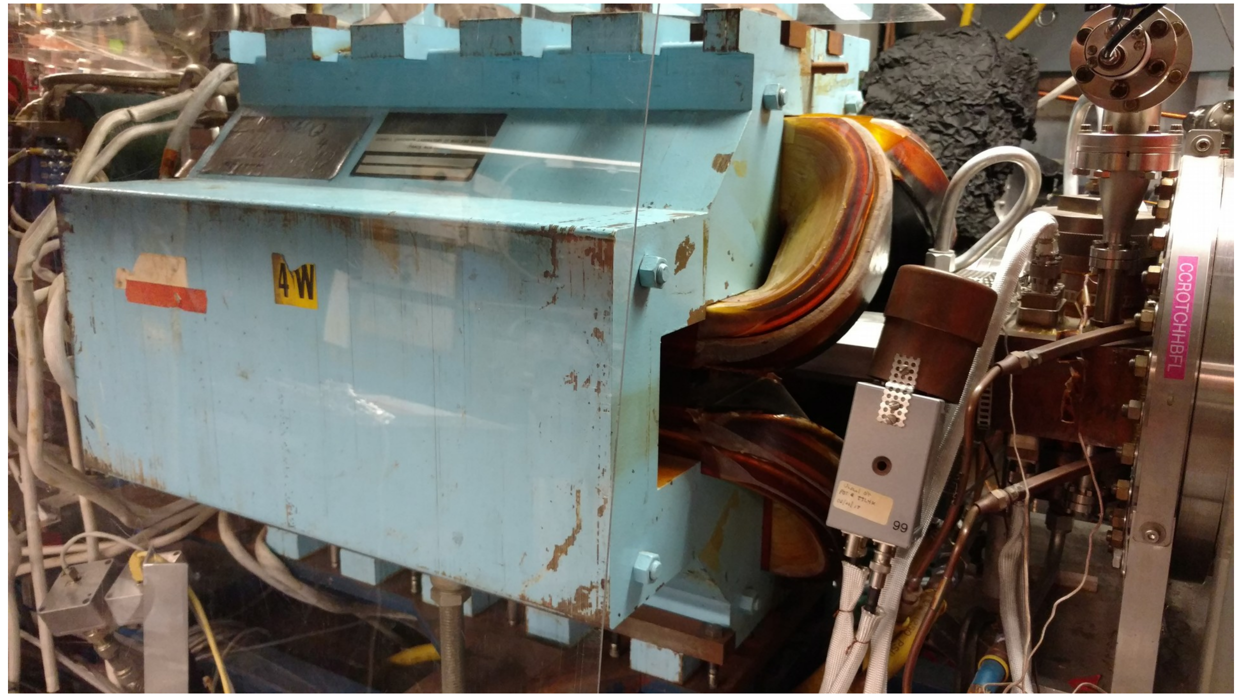
Example Q49 in L3

- Bore center to magnet edge is approximately 36 cm.
- Pipe inside diameter is 10.86 cm.

- The magnet iron creates two situations:
  - Beam off-axes & ph in pipe
    - h < ~9.2 cm,
      $\Delta s < 2.7$ mm
  - Beam centered, photons travel outside magnet
    - h > ~40.0 cm,
      $\Delta s > 5.8$ cm
      - Assuming only lateral adjustment to bends.

Example Q4W

- Q4W to be in storage after CHESS-U.
- Iron has opening in plane of ring, as shown.

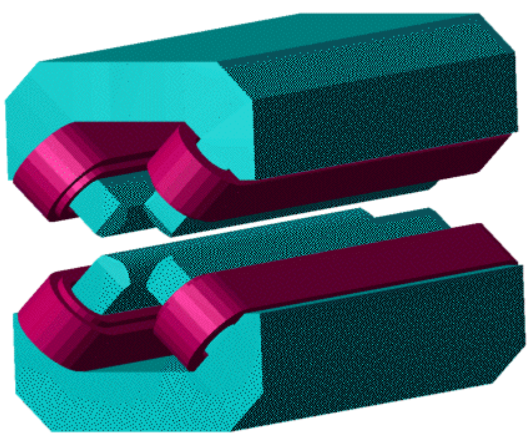


- Allows for beam centered in pipe, photons through opening

- $h < 26$ cm,
  $\Delta s < 24.5$ mm

Other Magnet Ideas

- Off-the-shelf quad with open yoke available from ASG.
- Similar design for sextupoles exists.



- **Author of the Magnetic Design** : M. Lieuvin, ESRF
- **Author of the Radia Simulation** : B. Lamballa, J Chavanne, ESRF
- **Description** : This is a 3D view of a quadrupole of the Storage Ring of the ESRF which as been simulated with Radia and compared with magnetic field measurment.

ASG Superconductors — ACCELERATORS — ELETTRA *Sincrotrone Trieste*

Quadrupole, Sextupole and Bending Magnets for ELETTRA Project

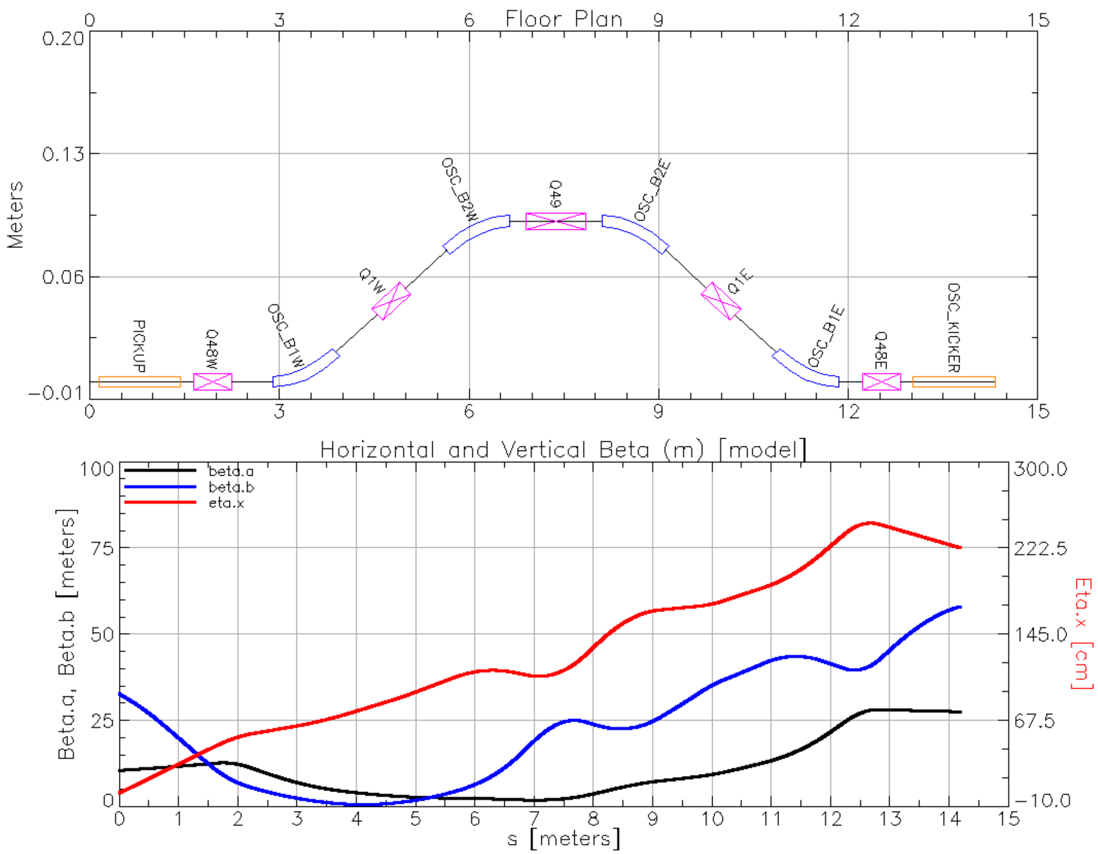
114 quadrupole, 76 sextupole and 26 dipole resistive magnets were delivered to the consortium SINCROTRONE Trieste in 1991. These magnets are now working in the ELETTRA Project to produce synchrotron light to be used for industrial and research applications.

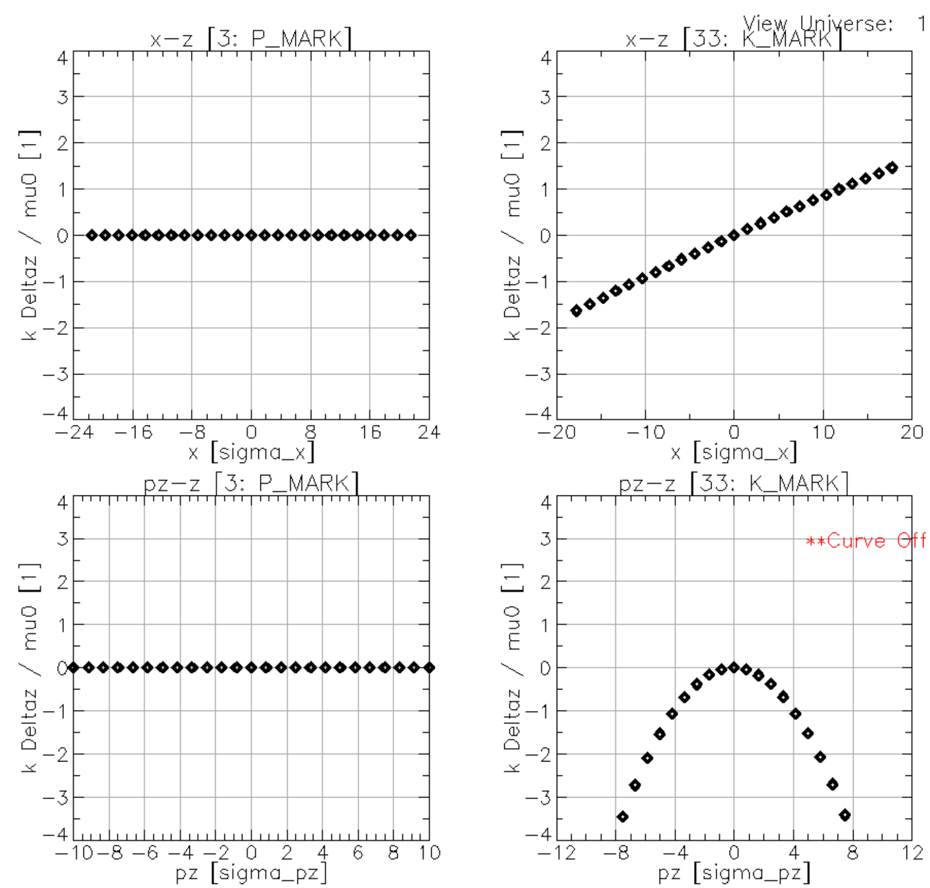
Type:	**Laminated Yoke - Quadrupole**
Yoke:	**low carbon steel**
Conductor:	**OFHC copper**
Energy	2 GeV
Gradient	20 T/m
Magnet Bore Diameter	75 mm
Field Quality	$< 10^{-3}$
Magnetic Length	470 – 230 mm
Ampere-Turns per Pole	12800
Current	320 A
Conductor Size	9 x 6.8 mm^2
Coolant Hole Diam.	4.6 mm
Power	8.6 – 5.4 KW
Water Circuits per Magnet	4
Magnet Weight	1400 – 840 Kg

Appearance of Nonlinearities

- Emphasize pz dependence of sample lengthening
  - Still get 10-σ_x envelope (compared to ~20)
  - Gain 4-σ_p envelope (compared to ~1)
    - distortion in z-p_z is nonlinear, sextupole would be beneficial

σ_x metric	$4.95\ 10^{-5}$
σ_p metric	$1.05\ 10^{-6}$





Damping distribution (TTOSC)

- Recall sample lengthening metrics:

action: $$\sigma^2_{\Delta s\epsilon} = J\left(\beta_p M_{51}^2 - 2\alpha_p M_{51} M_{52} + \gamma_p M_{52}^2\right)$$

energy: $$\sigma^2_{\Delta sp} = \left(\frac{\Delta p}{p}\right)^2 \underbrace{\left(M_{51} D_p + M_{52} D'_p + M_{56}\right)}_{\tilde{M}_{56}}^2$$

Damping times:

$$\lambda_x = \frac{k\xi_0}{2}\left(M_{56} - \tilde{M}_{56}\right)$$

$$\lambda_s = \frac{k\xi_0}{2}\tilde{M}_{56}$$

Distribution of Damping:

$$\frac{\lambda_x}{\lambda_s} = \frac{M_{56} - \tilde{M}_{56}}{\tilde{M}_{56}} = 118.9...$$

Comments & (Un)constraints

- Do not currently see value in symmetry
  - Not in Layout
  - Not in Optics
    - q.v. May want disp. small at pickup, perhaps big at kicker.
      - Depends on technique.
- Flexible Δs is prudent.
  - Avoid burdening Optical Amplifier development.
  - Remain open to late-stage design adjustments.
- Actual design of bypass will depend on many yet-to-be settled factors.
  - fewer/rearranged quads, zig-zag, sextupoles, bend angle through center quad, non-symmetric layout.