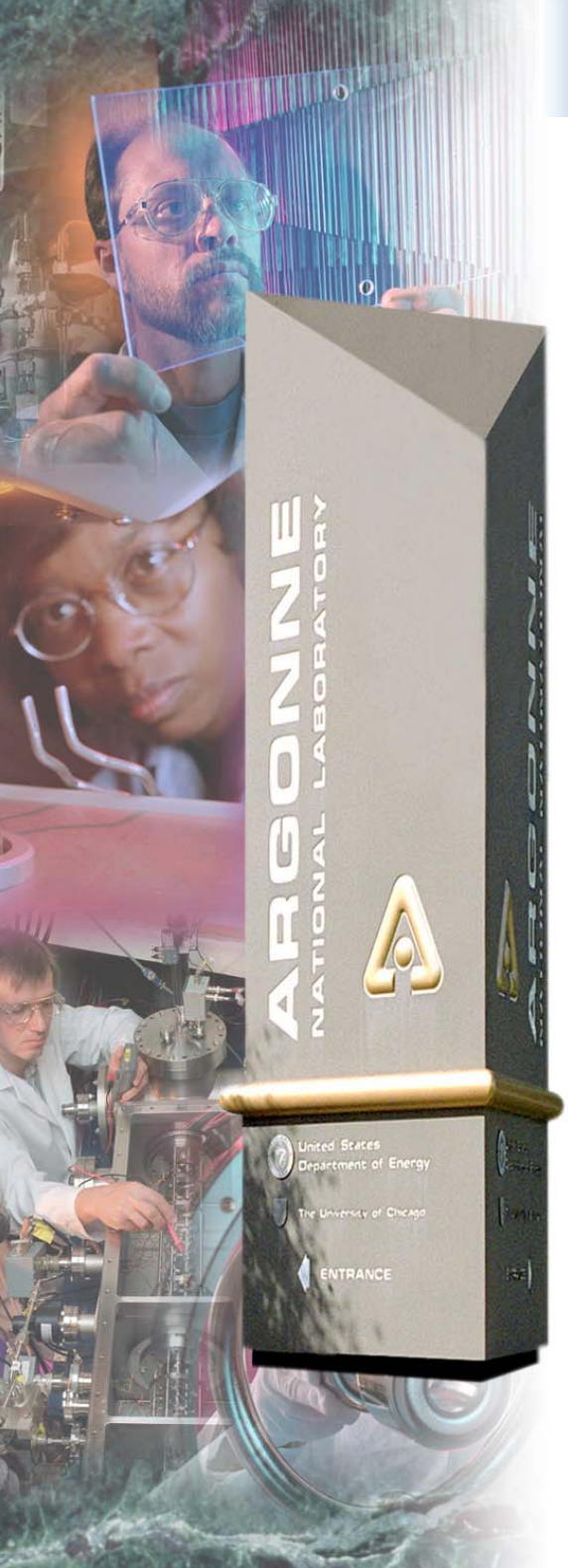

ARGONNE NATIONAL LABORATORY

SHMS optics: standard and alternate designs

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Office of Science
U.S. DEPARTMENT OF ENERGY

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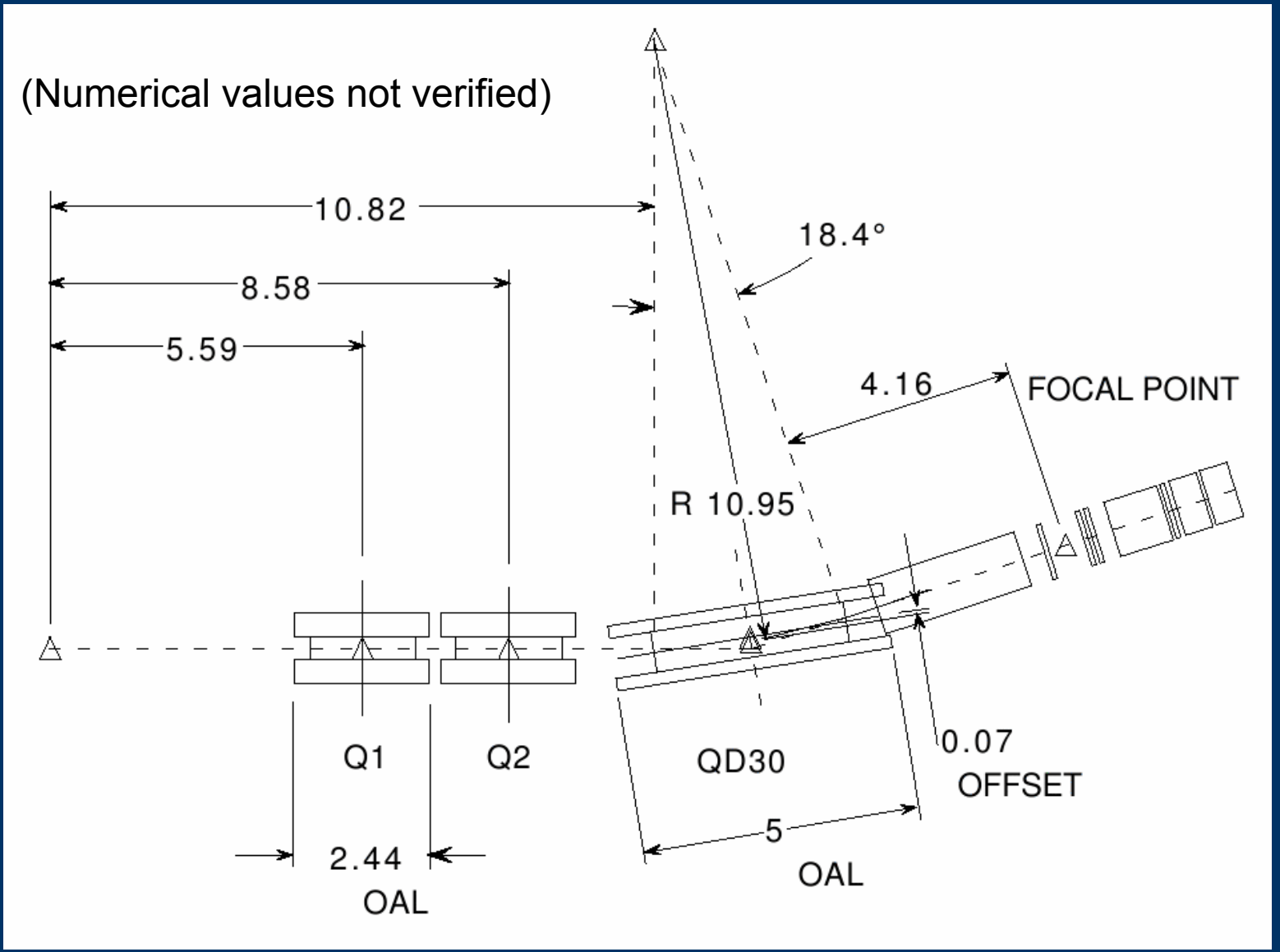
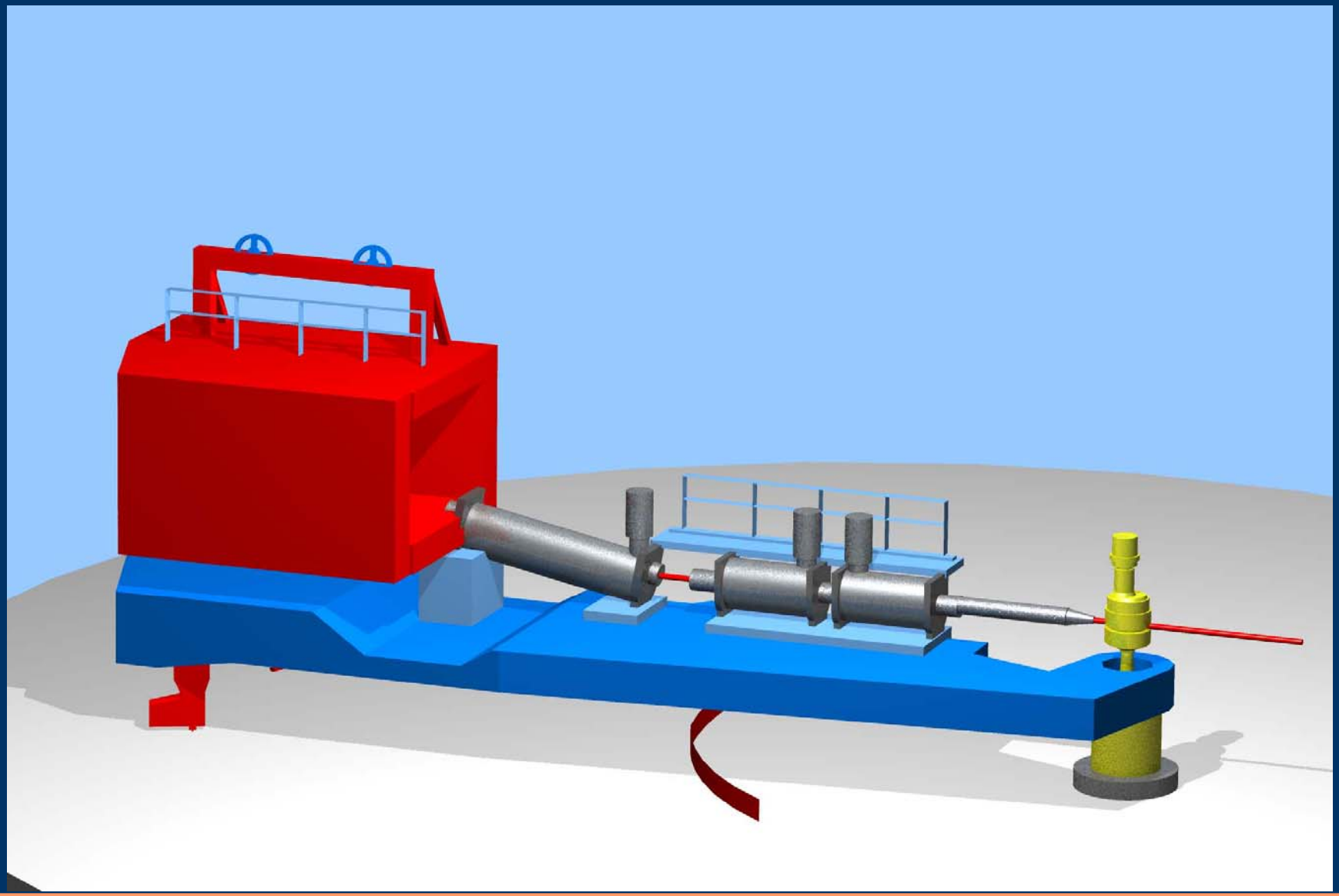
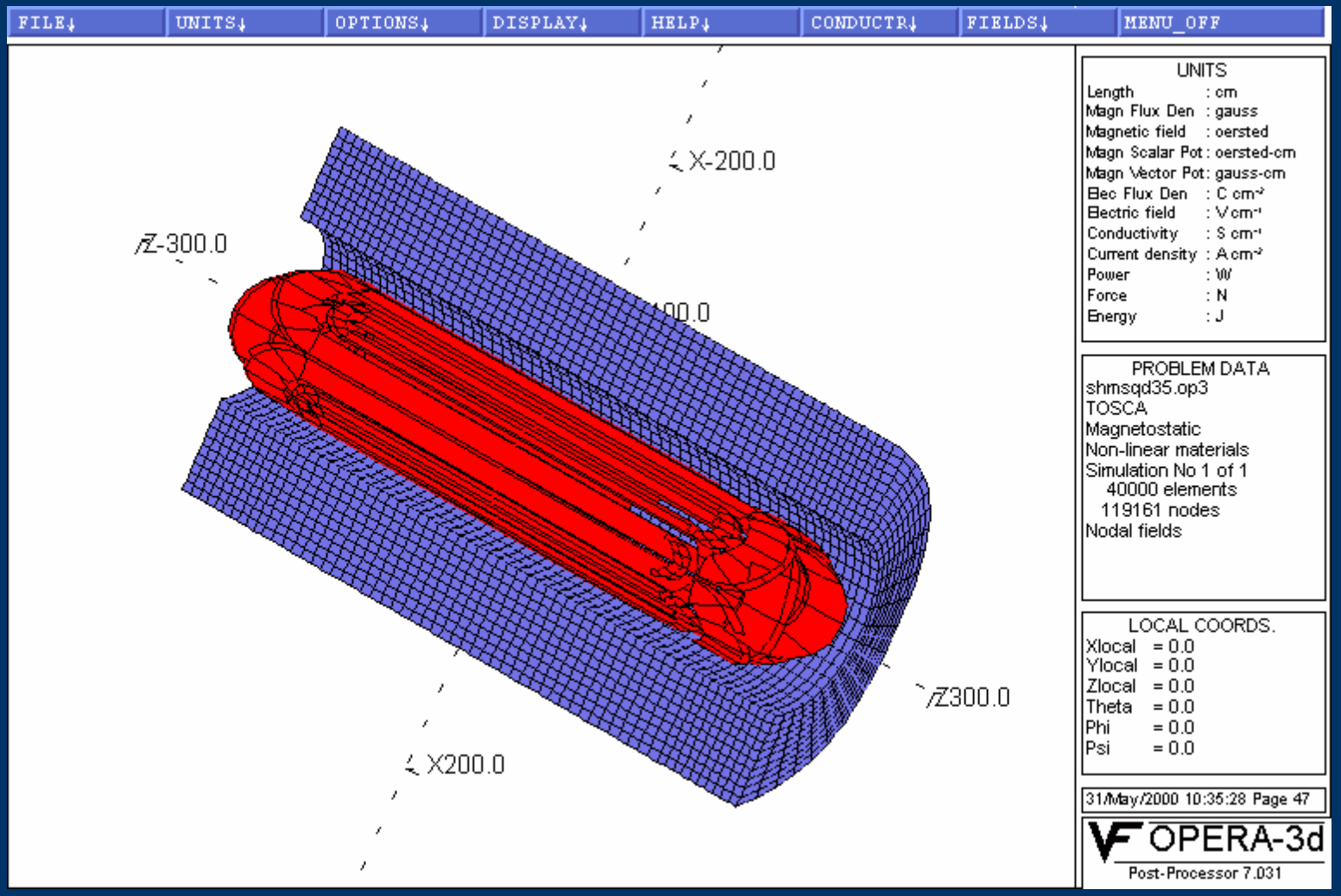
SHMS layout from CDR



SHMS concept



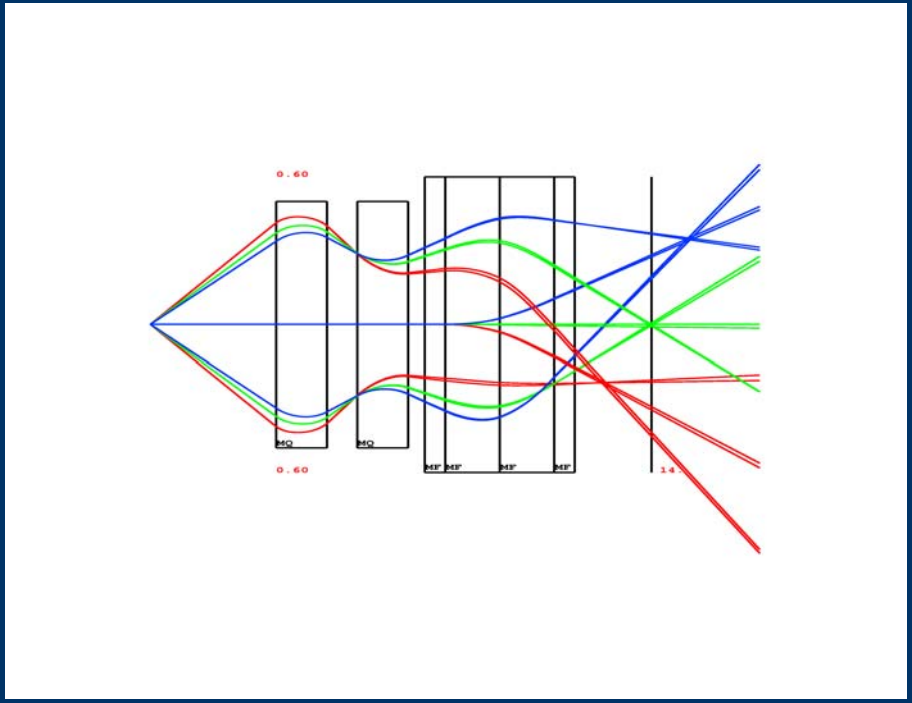
Combined function bend magnet

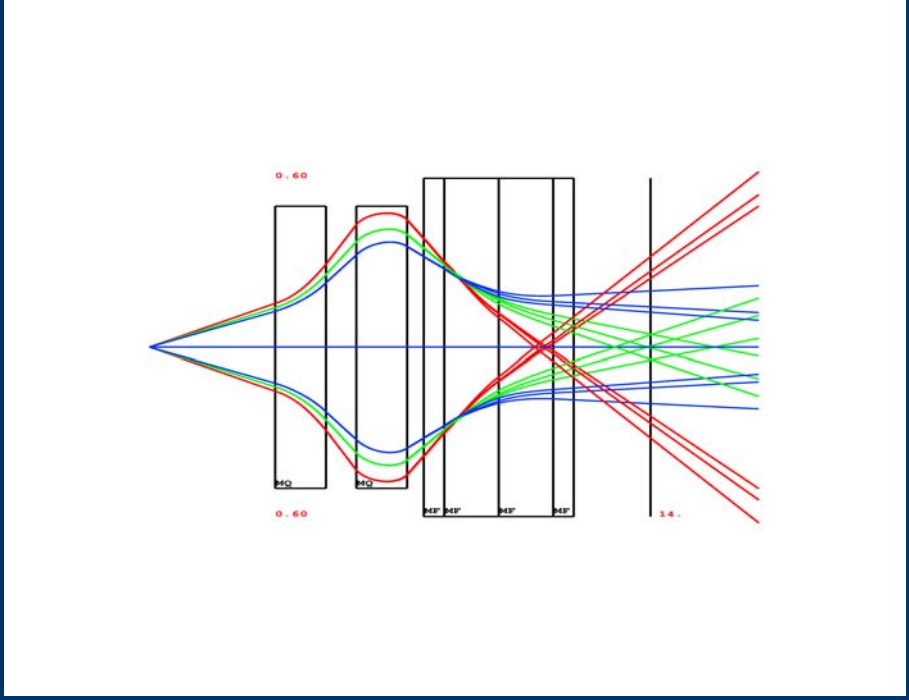


Optics design and optimization

- Determine ‘central ray’ through spectrometer
  - Numerically integrate path through bending element
  - Find best trajectory
  - Adjust fields for desired bend angle and iterate if needed.
  - Align asymptotic (straight) path with quads
- Use COSY to calculate forward transformations, trace rays, adjust quad fields and geometry to optimize focal objective
- M.C. to fit reconstruction transformation, study performance

Trajectories: Short quads, CF, SSA

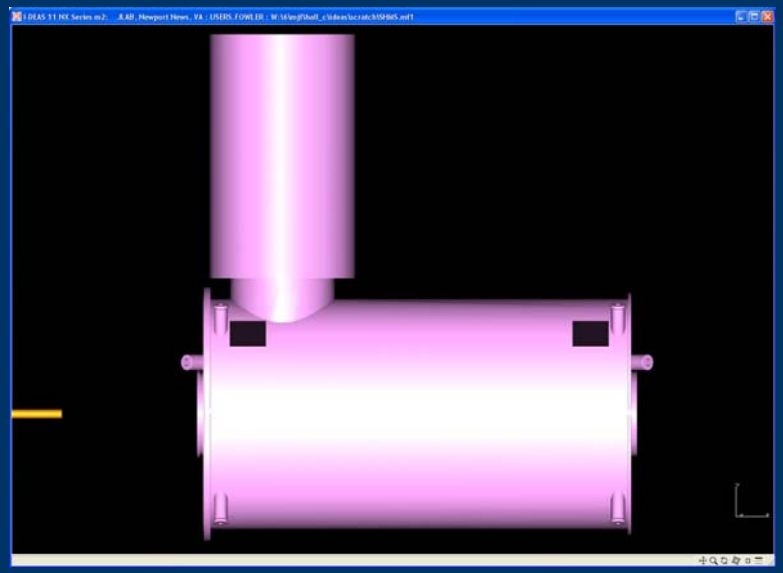


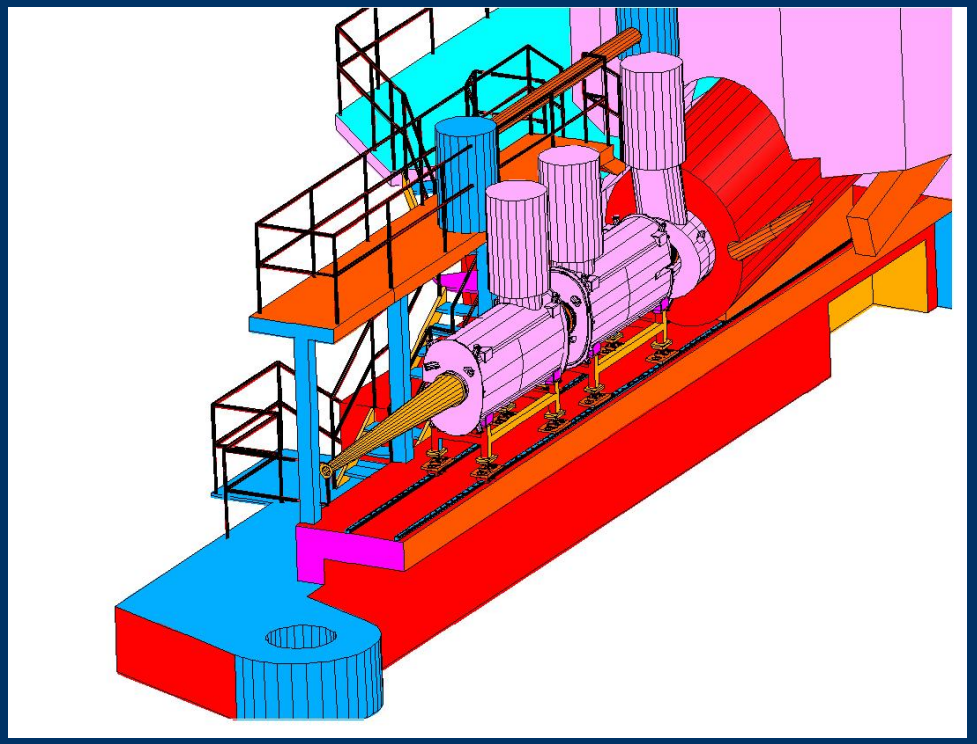


SHMS Variations

- QUAD TYPE:
  - Short (duplicates of HMS Q1)
  - Long (2 quads in 1 cryostat)
- BEND MAGNET:
  - CF - Combined function (simultaneous D and Q fields)
  - QDI (Separate Q and D, in one return yoke)
- MODE:
  - SSA (Small solid angle)
  - LSA (Large solid angle, entire spectrometer slides forward)
  - MSA (Medium solid angle, only Q1+Q2 slide forward)
- SPLITTER:
  - Like LSA, but with 1m, 3 degree horizontal bend before Q1

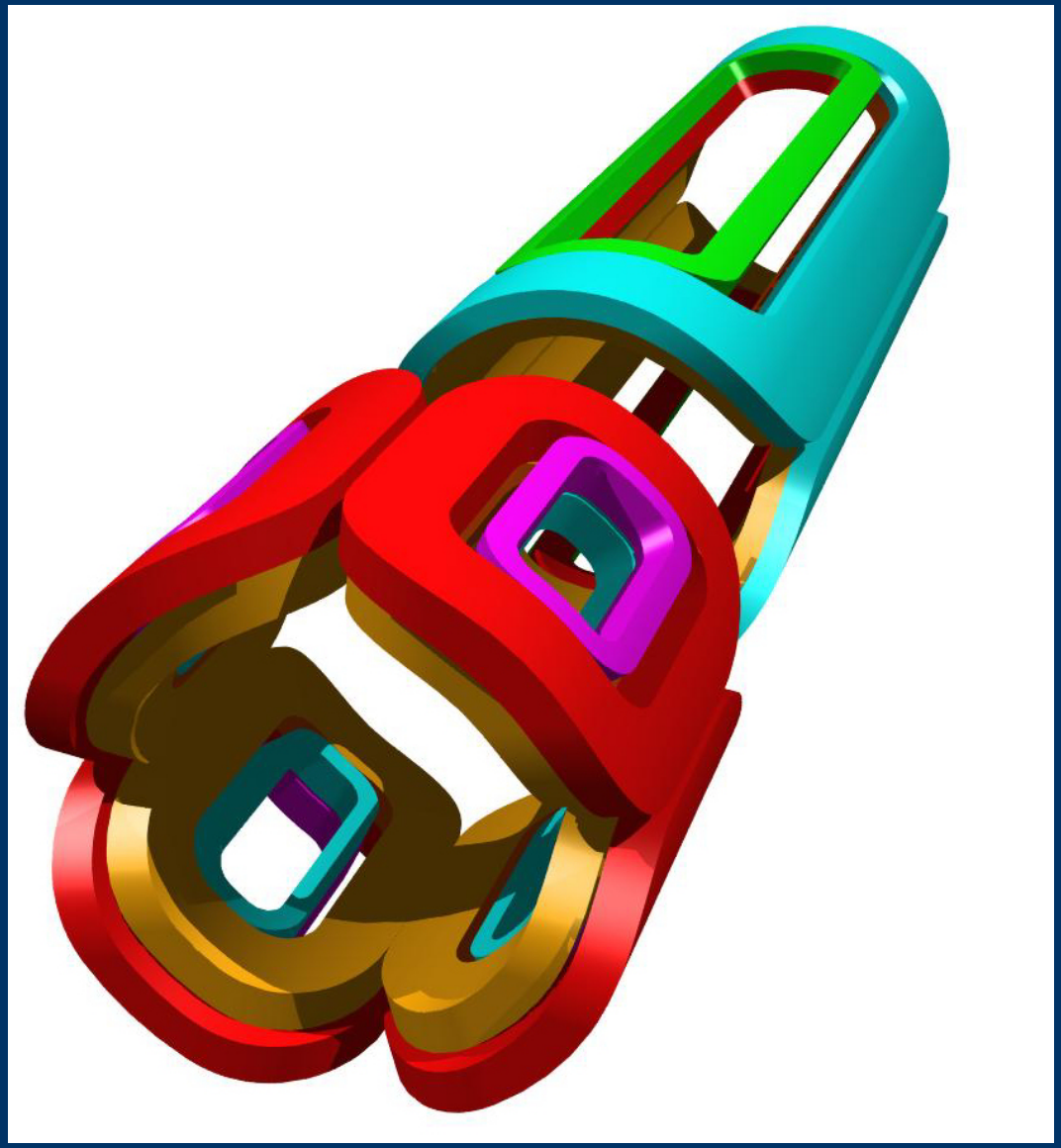
Front Quads





- Short quads – exact copies of HMS Q1
  - 50 cm diam, 1.879 m length, 8.6 T/m max field gradient
- Long quads
  - Coils in single cryostat allow 0.245 m increase in length
  - Q1 entrance, Q2 exit locations unchanged
  - CF bend magnet location unchanged
  - QD variation: Q3, dipole move forward 24 cm

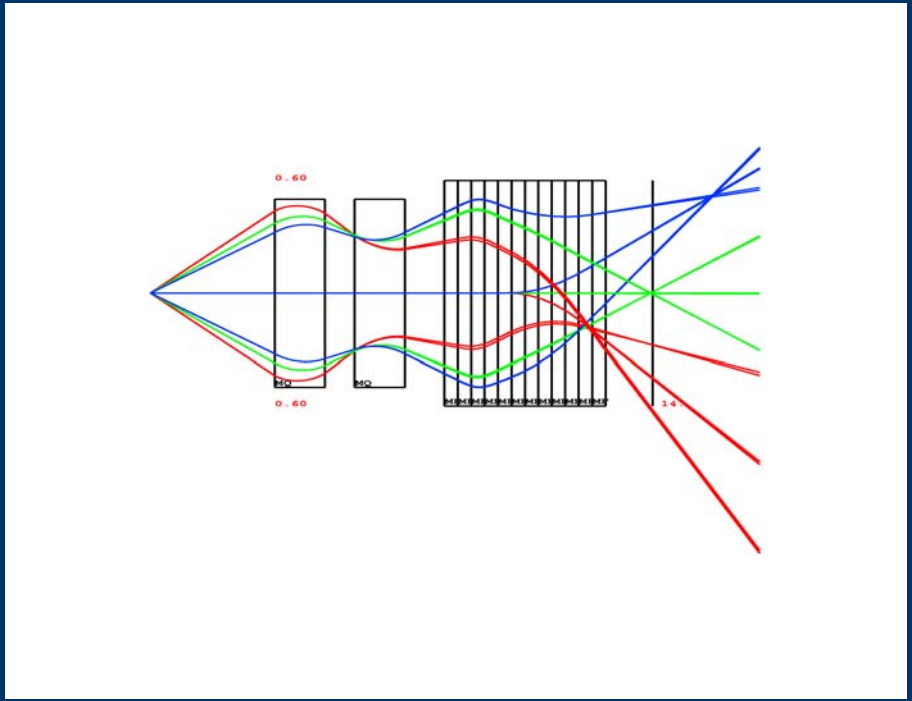
Q/D in common yoke

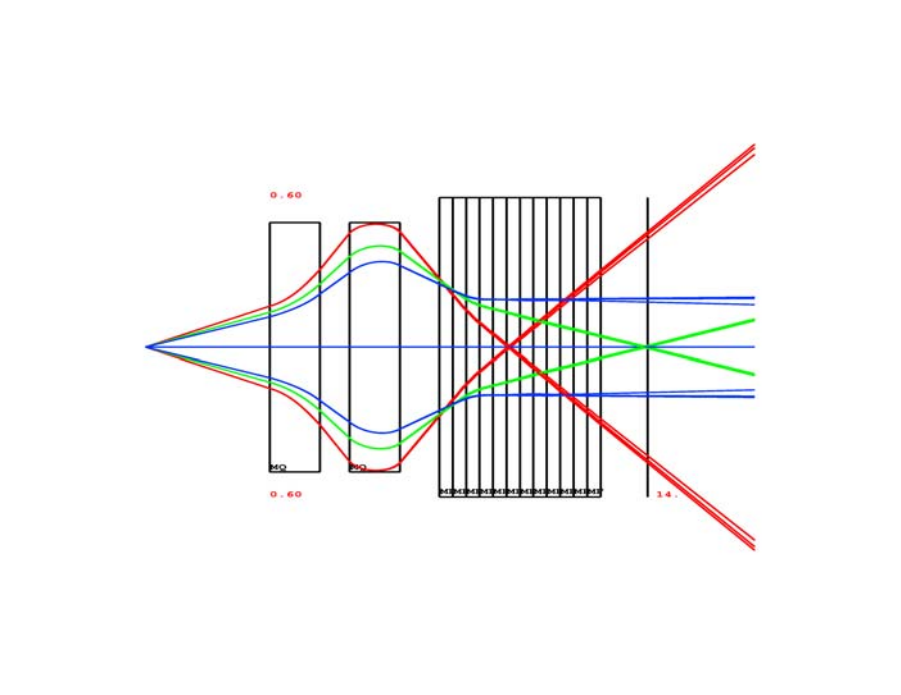


Details

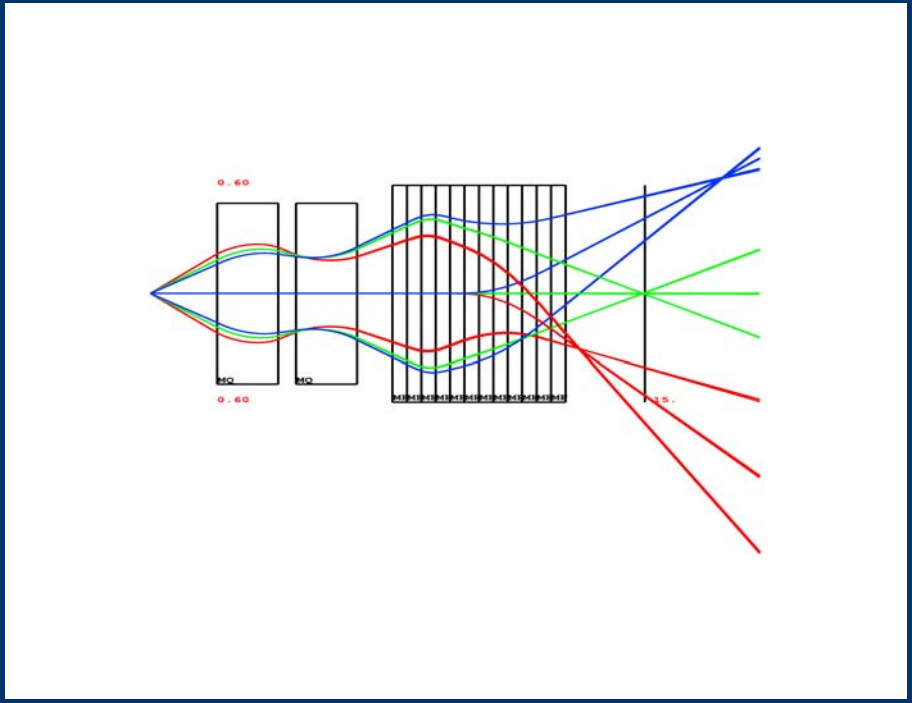
- SSA: Q1 center at 5.585 m, Q2 center at 8.575 m
- MSA: Q1, Q2 slide forward by 2.32 m,
  focal plane 1 m rearward relative to bending magnet
- LSA: Slide everything forward by 2.32 m,
  focal plane 1 m rearward relative to bending magnet
- LONG QUADS: Q1 entrance, Q2 exit are in same place,
  Q1, Q2 lengths increase by 0.245 m,
  Q3 and dipole of QD variation move forward by 24 cm
- SPLITTER: 3 deg bend, 1 m total length, rect poles, 50 cm gap
  50 cm from target axis to splitter entrance

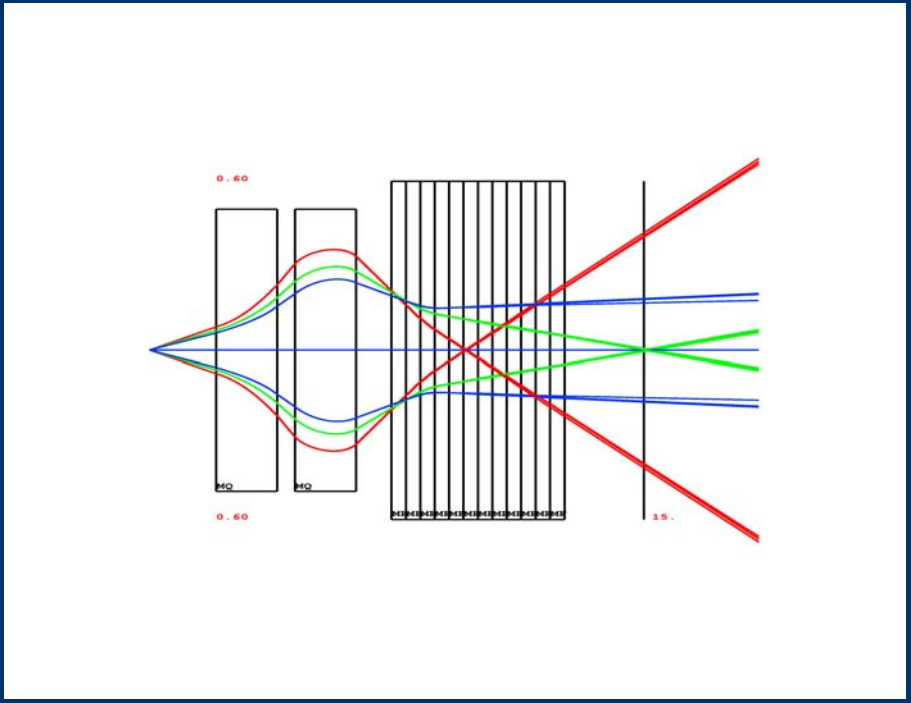
Trajectories: Short quads, QD, SSA



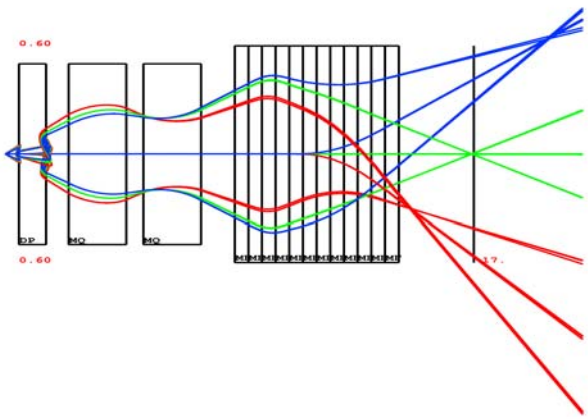


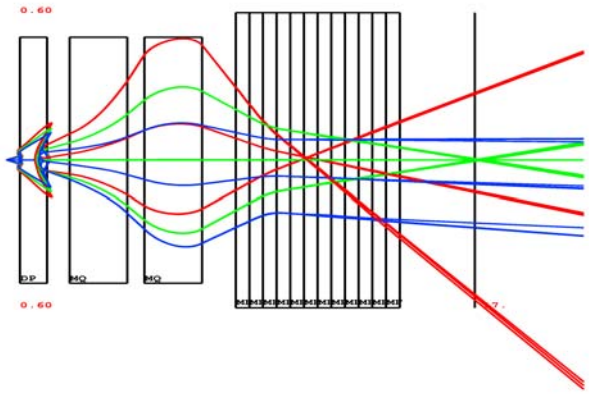
Trajectories: Long quads, QD, LSA



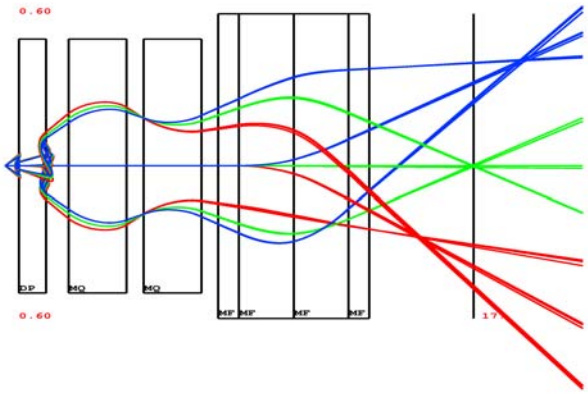


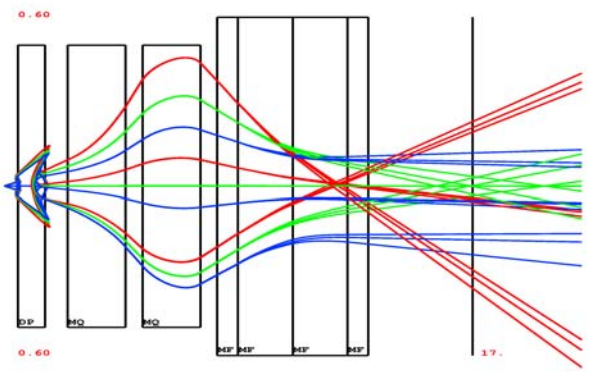
Trajectories: Long quads, QD, LSA, Splitter





Trajectories: Long quads, CF, LSA, Splitter





SHMS performance

Name	P max GeV	L fp meters	FP tilt deg	Ω msr	δP percent	δΘ mr	δΦ mr	δY mm
SQ-CF-SSA	11.0	18.50	5.5	2.1	0.06	0.09	0.6	0.7
SQ-CF-MSA	9.1	18.28	7.3	3.8	0.07	0.10	1.4	0.6
SQ-CF-LSA	8.8	17.18	5.4	4.4	0.08	0.16	1.2	0.8
LQ-CF-SSA	11.7	18.50	5.6	2.1	0.06	0.07	0.5	0.6
LQ-CF-MSA	9.8	18.28	7.4	3.8	0.06	0.09	1.1	0.5
LQ-CF-LSA	9.5	17.18	5.5	4.4	0.08	0.15	1.1	0.8
LQ-CF-SPLIT	9.5	17.18	5.5	4.4	0.07	0.17	1.0	0.8
SQ-QD-SSA	11.0	18.78	4.7	2.1	0.07	0.10	0.5	0.8
SQ-QD-MSA	9.9	19.78	5.5	3.4	0.06	0.11	0.5	0.8
SQ-QD-LSA	10.1	17.46	5.4	3.5	0.07	0.18	0.3	1.1
LQ-QD-SSA	11.3	18.54	4.1	2.1	0.09	0.10	0.6	0.9
LQ-QD-MSA	10.4	19.54	5.4	3.6	0.07	0.10	0.7	0.8
LQ-QD-LSA	10.4	17.22	5.1	3.7	0.08	0.20	0.4	1.2
LQ-QD-SPLIT	10.4	17.22	5.1	3.8	0.08	0.19	0.4	1.0

Conclusions

- CF/LSA still has largest solid angle
- Long quad option seems to help
- QD bend magnet works well (Note: not a ‘co-linear’ design, there must be an angle between Q and D)
- Splitter magnet complicates optics, but appears tractable.
- Need M.C. studies with mult. scattering and detector resolutions to see what happens (especially with splitter).
- Need to consider extended targets and full momentum acceptance.
- LQ, QD, LSA/splitter seems very feasible.