Beam Analysis Dry Run
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Measure the beam energy

The dipole was set to -10579 G-cm for the 2D spectrometer. Using the calibration on the EDM screen the beam momentum was 6.323 MeV/c

Measure the beam emittance

For one condition under study (slit=25mm, prebuncher off, qcm crested, 20uA @ 250MHz) the qsUtility tool was used to measure the horizontal and vertical emittance at MQJ0L02 using harp IHA0L03:

> https://logbooks.jlab.org/entry/3566392

After de-selecting bad scans, here are good fits (note qsUtility using 6.28 MeV/c, so good <1%):

> 11:05 - Horizontal: https://logbooks.jlab.org/entry/3567520
> 11:53 - Vertical: https://logbooks.jlab.org/entry/3567527

Measure the beam energy spread

In Elegant define the conditions to measure the energy spread at dispersive element IHA2D00.

In BubbleChamber.lte be certain intervening quads are correctly set, e.g. in this case:

    MQJ0L02= -164 G => -5.23 1/m2
    MQJ0L02A= +160 G => +5.10 1/m2

In energyspread.ele initial emittance/twiss in front of MQJ0L02 and generate output:

ElementName	s	betax	alphax	etax
	m	m		m
BEG	0.000000e+00	1.210000e+01	-2.600000e+00	0.000000e+00
MQJ0L02	1.500000e-01	1.443825e+01	-1.359507e+01	0.000000e+00
D9	3.418950e-01	2.012984e+01	-1.606484e+01	0.000000e+00
IPM0L02	3.418950e-01	2.012984e+01	-1.606484e+01	0.000000e+00
D3	3.418950e-01	2.012984e+01	-1.606484e+01	0.000000e+00
MQS0L02	4.218950e-01	2.278259e+01	-1.709447e+01	0.000000e+00
D10	5.547470e-01	2.755181e+01	-1.880433e+01	0.000000e+00
MBH0L02H	5.547470e-01	2.755181e+01	-1.880433e+01	0.000000e+00
MBH0L02V	5.547470e-01	2.755181e+01	-1.880433e+01	0.000000e+00
D11	6.098056e-01	2.966151e+01	-1.951295e+01	0.000000e+00
MQJ0L02A	7.598056e-01	3.208097e+01	4.004949e+00	0.000000e+00
D12	1.769916e+00	2.453203e+01	3.468435e+00	0.000000e+00
MDL0L02_2D	1.890841e+00	1.771239e+01	3.397613e+00	-3.094140e-02
D2D1	5.208541e+00	2.963034e+00	1.048044e+00	-1.946416e+00
IHA2D00	5.208541e+00	2.963034e+00	1.048044e+00	-1.946416e+00

The momentum spread is related to these parameters by:

$(dp/p) = $ Sqrt [(MeasuredSize)^2 – (betax*emitx)] / etax

(Elegant defines MeasuredSize = Sqrt [<(x-<x>)^2>])

For the case under study at IHA2D00:

MeasuredSize = 5.46E-4 m (sigma=0.546 mm is from fit of IHA2D00)
Betax = 2.96 m
Emitx = 3.07E-8 m-rad
Etax = -1.95 m

Results in

$(dp/p) = 4.55E-4$

To be explicit about energy (E), momentum (P) and kinetic energy (T)

P = 6.323 MeV/c
E = 6.344 MeV
T = 5.833 MeV

Consequently the relative energy spread and energy spread are:

dT/T = (1+m/E) dp/p = 4.92E-4

dT = 2.9 keV

Note that this setup aimed to reduced energy spread below previous value of about 10-14 keV.

Setting the Beam Size

In BubbleChamber_FIT.ele configure the following:

Beam energy
Emittance and Twiss at starting quad (MQJ0L02)
Momentum spread
Desired beam size at the radiator (in this case 0.5mm ROUND)

The optimizer computes the following solution:

```
MQJ0L02:  KQUAD,L=0.15,K1=-14.77 => I= -7.86 Amps
MQJ0L02A: KQUAD,L=0.15,K1=4.53 => I= +2.41 Amps
MQD5D00:  KQUAD,L=0.15,K1=1.33  => will be OK, need to look up QD field map
MQD5D01:  KQUAD,L=0.15,K1=5.04 => will be OK, need to look up QD field map
```

The beam envelope up to radiator (s=5.1m) and and the viewer image ITV5D01 are shown in the Bubble logbook:

https://logbooks.jlab.org/entry/3567592

An important takeaway is the viewer ITV5D01 at 4.4m can be deceptive.   Once the new harp IHA5D01 is installed will add the lattice file, and we can then optimize for the radiator and use the harp to verify the beam size.