Linac4 Commissioning strategy

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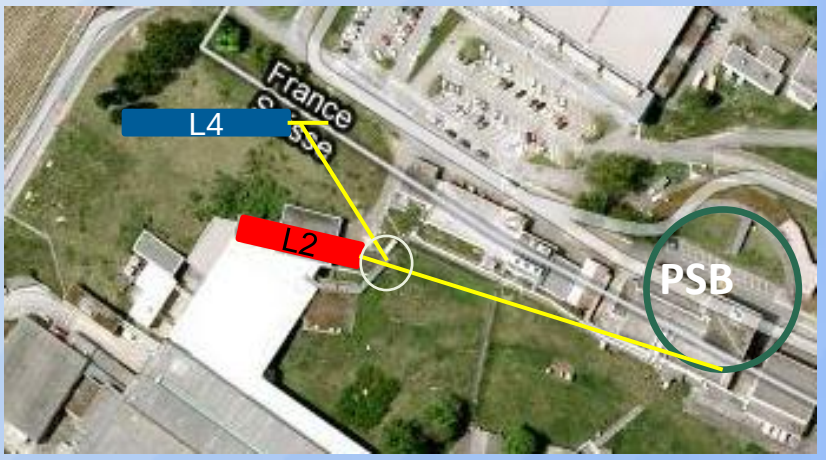
Linac4 Layout

- 45 keV H^- volume source.
- 2 Solenoids Low Energy Beam Transport.
- 4 vanes RFQ at 352.2 MHz.
- Medium Energy Beam Transport housing a beam chopper.
- Drift Tube Linac: 3 tanks.
- CCDTL : 7 modules × 3 coupled cavities.
- Pi Mode Structures : 12 tanks.



Beam Dynamics Design Performances

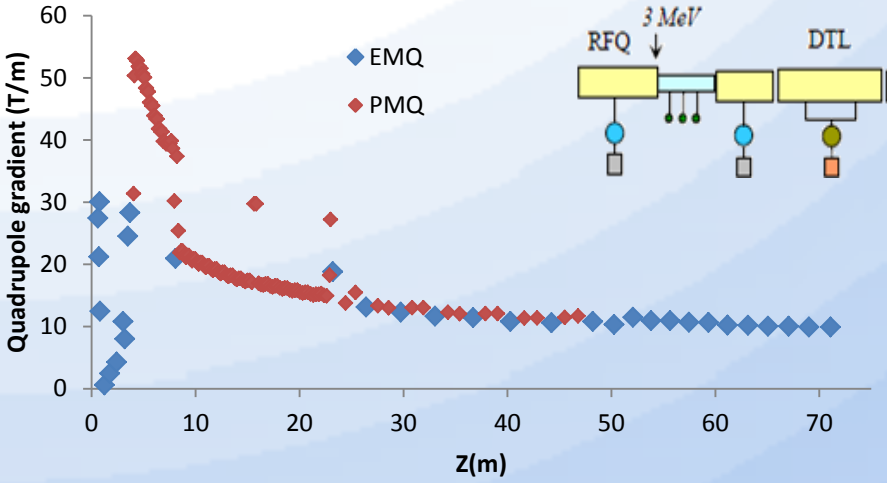
Beam Parameters	Current (mA)	Trans.Emitt. (mm.mrad)	Long. Emitt. (deg.MeV)
LEBT	70	0.25	--
RFQ	65	0.24	0.13
MEBT	62.5	0.275	0.14
DTL	62.5	0.285	0.16
CCDTL	62.5	0.29	0.16
PIMS	62.5	0.30	0.16

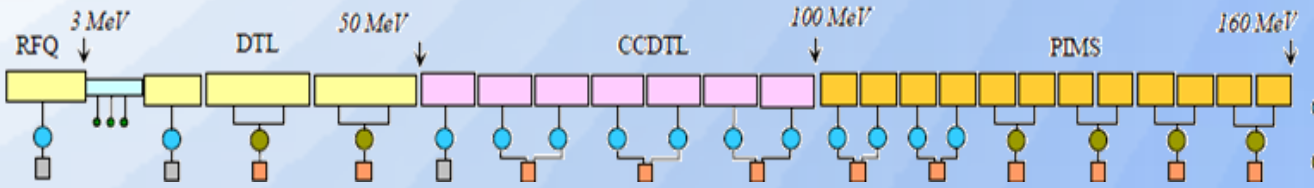
Commissioning Strategy

- Commissioning will start next year and will be divided into 6 stages.
  - Stage1: 3MeV test stand. Commissioning of the source, LEBT, RFQ and MEBT in the PS south hall (2011).
  - Stage2: Re-commissioning of the 3MeV line in the tunnel (2013).
  - Stage3: First DTL tank (12 MeV).
  - Stage4: DTL tank 2&3 (50 MeV).
  - Stage5: CCDTL (100 MeV).
  - Stage6: PIMS (160 MeV).

Parameters to be set

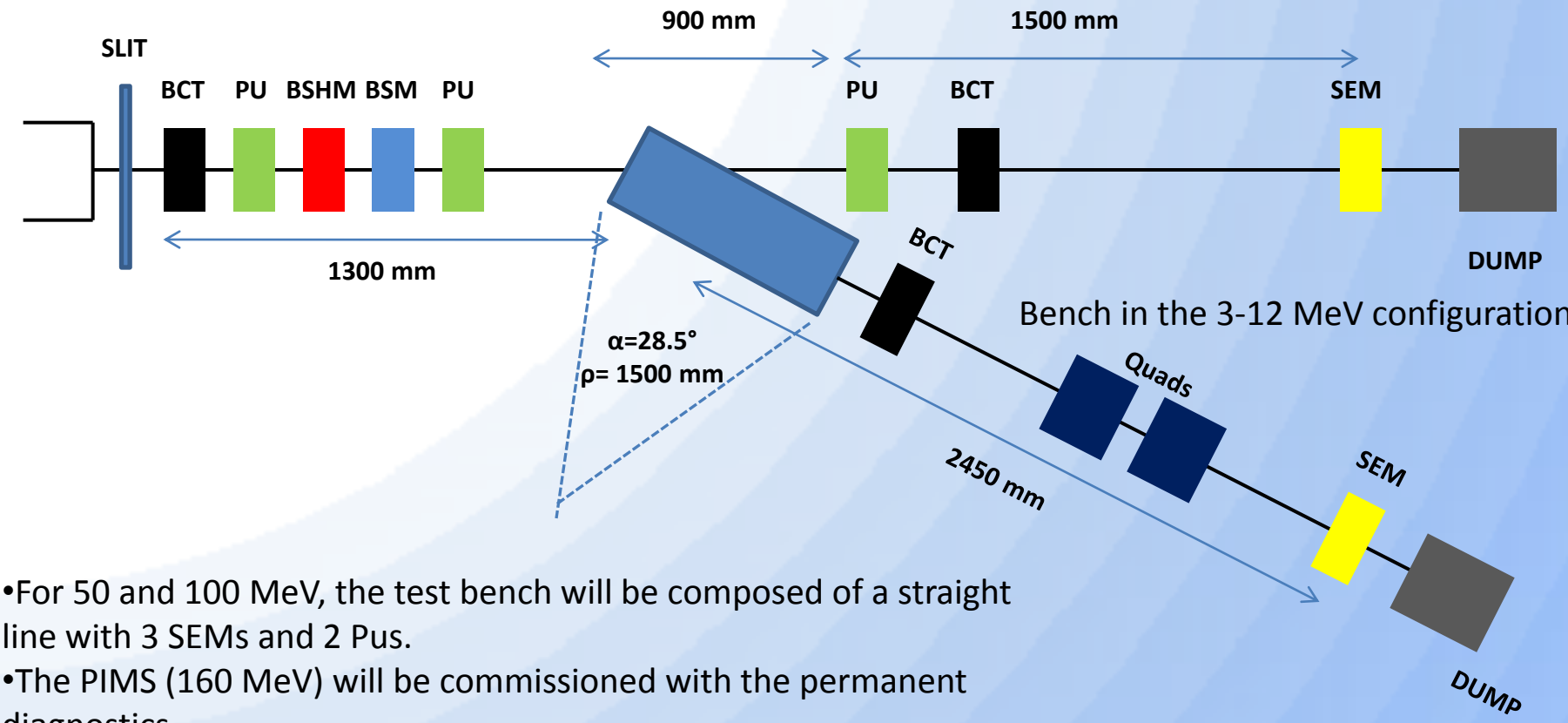
	Focusing Magnets	RF Phases	RF Amplitude	Steering Magnets
LEBT	2 Solenoids	--	--	2
RFQ	--	--	1	--
MEBT	11	3 (+ chopper)	3 (+ chopper)	2
DTL	2 (out of 115)	3	3	3
CCDTL	7 (out of 21)	7	7	4
PIMS	11	12	8	6
Linac	33	25	22	17





Available Diagnostics (1)

We will use a diagnostics bench to commission the Linac



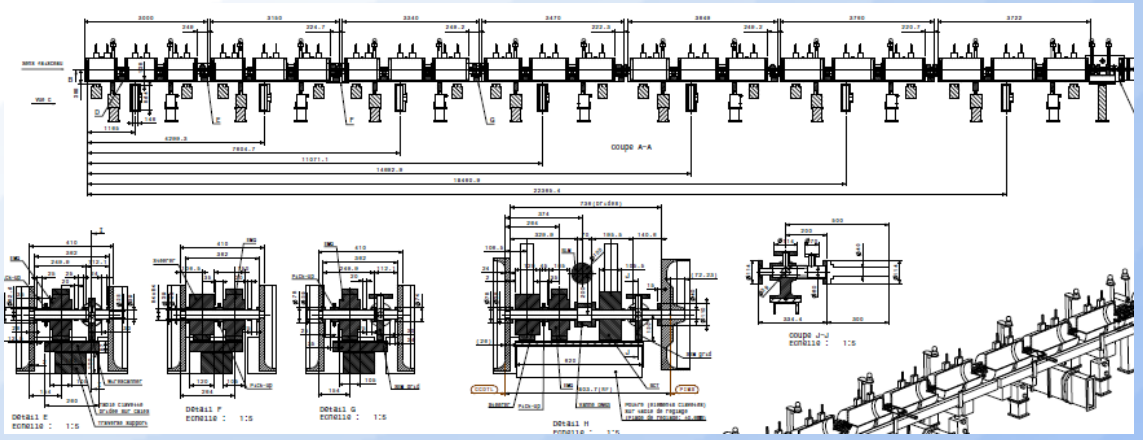
- For 50 and 100 MeV, the test bench will be composed of a straight line with 3 SEMs and 2 Pus.
- The PIMS (160 MeV) will be commissioned with the permanent diagnostics.
- The bench in this configuration will also be a test bed for the Time Of Flitgh measurments.

Available Diagnostics (2)

Permanent diagnostics.

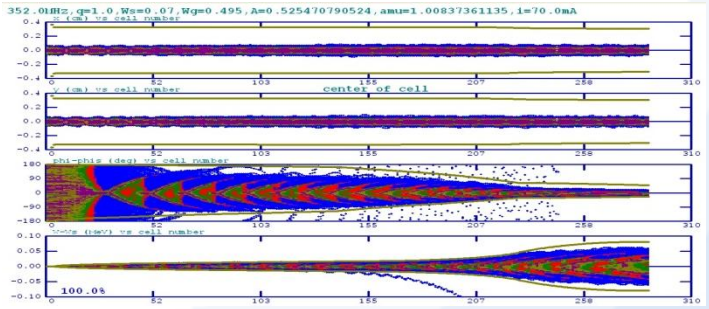
	BCT	PickUp	WireScanner	SEMGrid	BLM
LEBT	1	--	--	1	--
MEBT	2	--	2	--	--
DTL	1	3	--	1	3
CCDTL	1	7	2	2	1
PIMS	1	6	3	1	1

They are installed in the inter-tank and inter-structure areas.

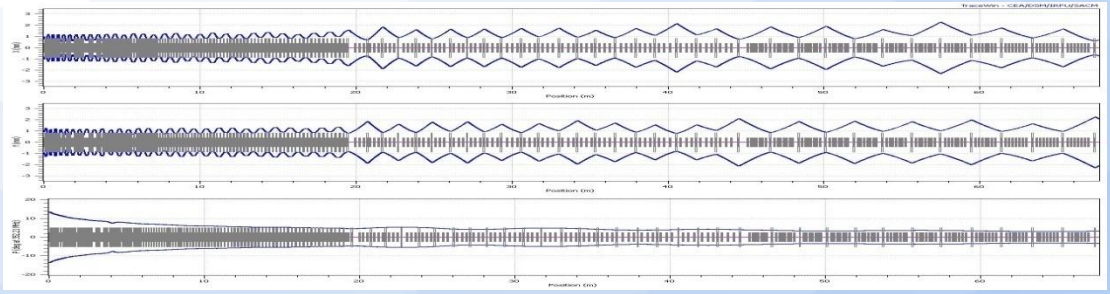


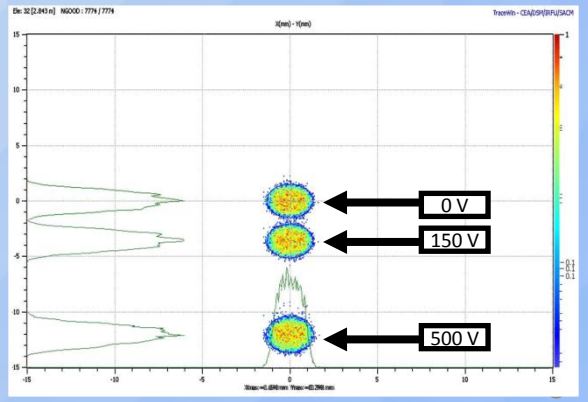
Pencil Beam

- A pencil beam is characterized by its low current and low transverse emittances.
- It will be used during the commissioning in order to reduce space charge effects and potential losses.
- We can generate such a beam by placing an iris in the LEBT (low energy, no activation).
- The pencil beam can be transmitted along all the Linac, and keep its characteristics provided that it is matched to the different structures.

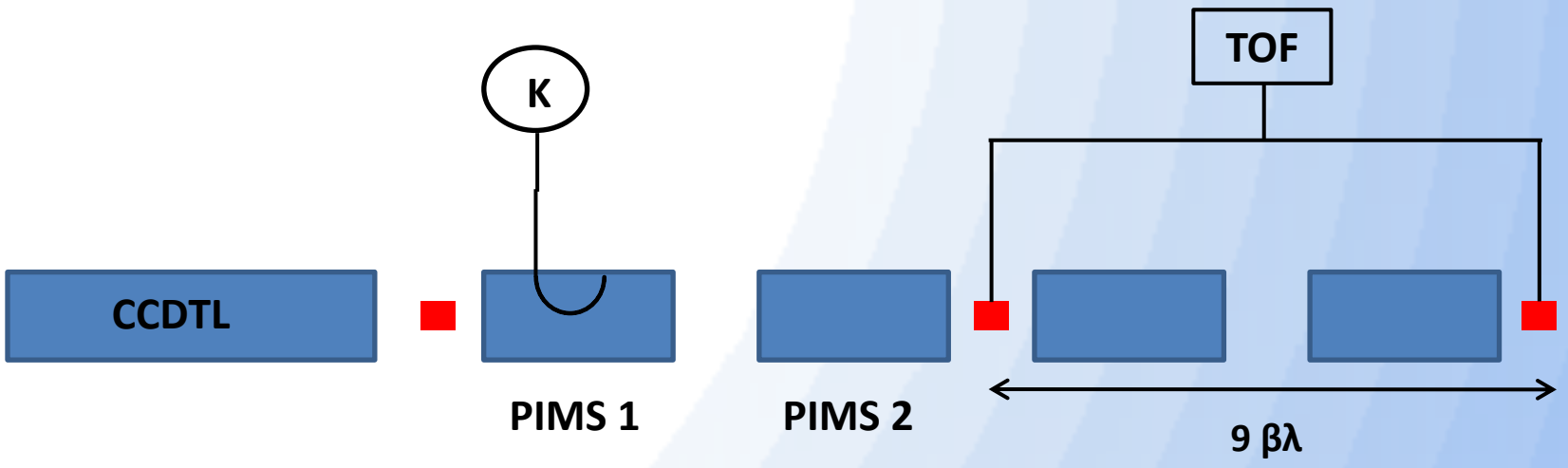


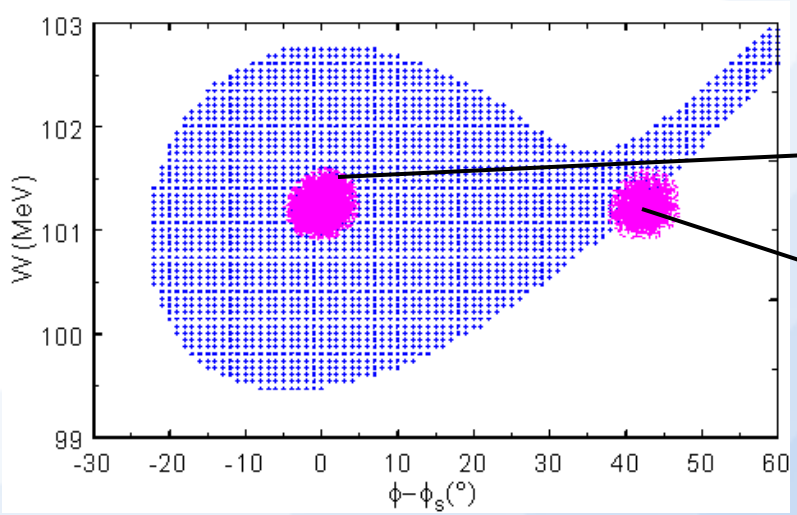
	Nominal	Pencil (1)	Pencil (2)
Current	65 mA	7 mA	1 mA
Trans. Emitt	0.27 mm.mrad	0.16 mm.mrad	0.05 mm.mrad

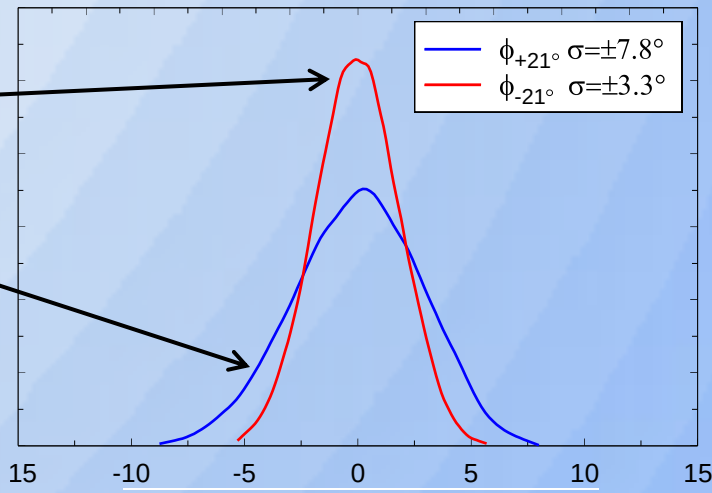




PIMS RF characteristic (1)







Beam phase distribution at the 2nd TOF PU (°)

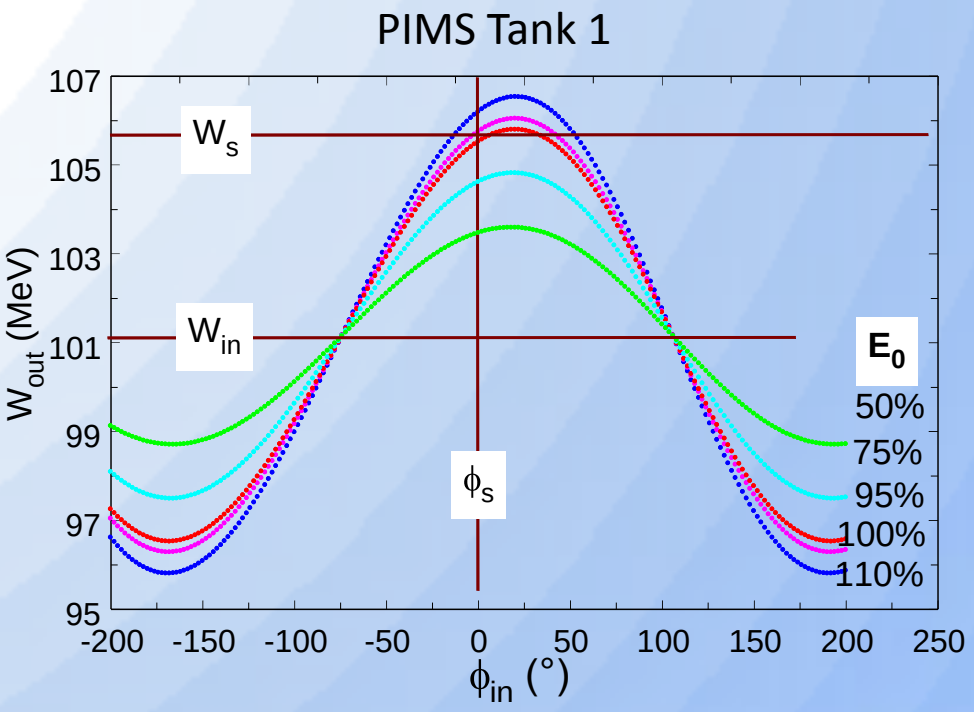
PIMS RF characteristic (2)

$$\frac{\Delta W}{W} \approx 2\frac{\Delta\beta}{\beta} = 2\sqrt{\left(\frac{\Delta L}{L}\right)^2 + \left(\frac{\Delta t}{NT + t_{scope}}\right)^2}$$

$\Delta L = 1mm$

$\Delta t = 1°(352MHz)$

$$\frac{\Delta W}{W} \approx 0.1\% \approx 100keV$$



Summary

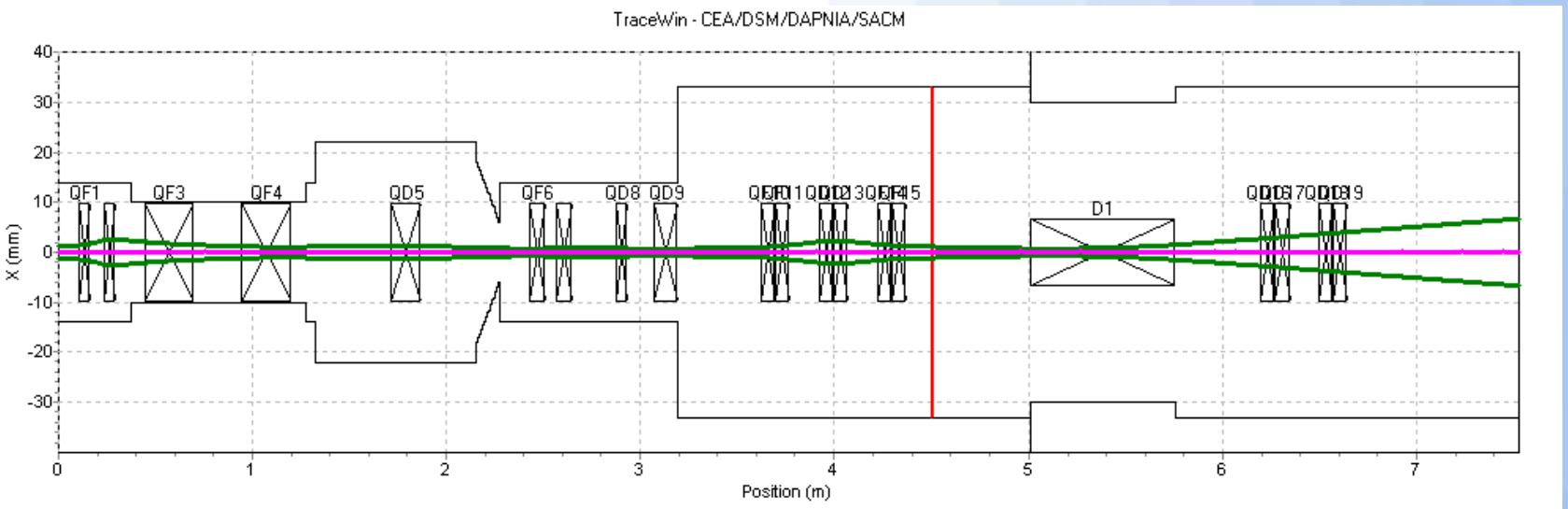
- The Linac4 commissioning will start next year (mid 2011) with the 3 MeV test stand.
- A lot of simulation work is already done.
- The design of the machine is now frozen, all our effort will be focused on commissioning preparation.
- We have enough diagnostic to set the Linac parameters to their design values.

Thank you

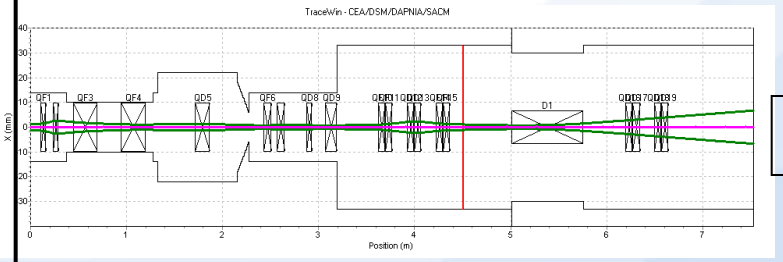
First results next year…

Reserve slides

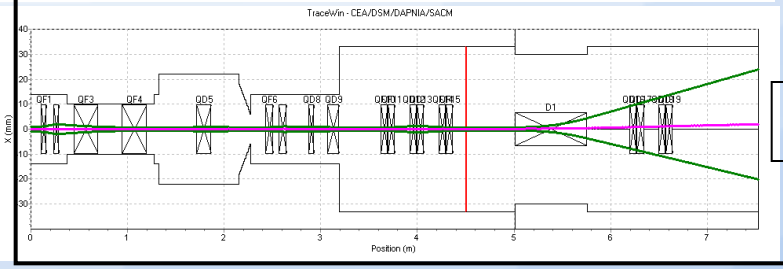
MEBT Buncher Settings



No displacement



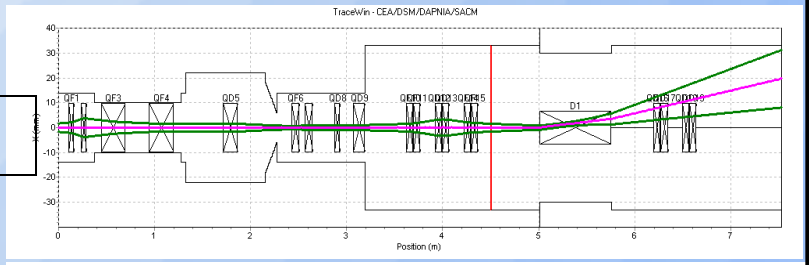
-90°



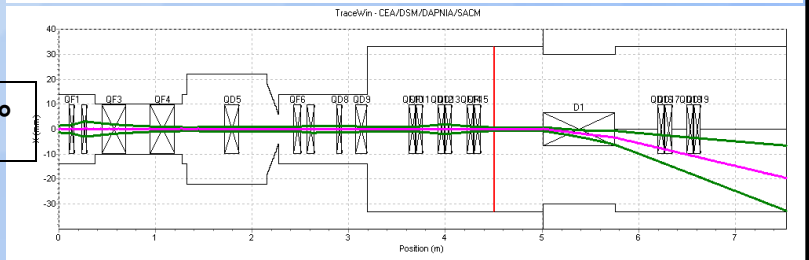
90°

Maximum displacements

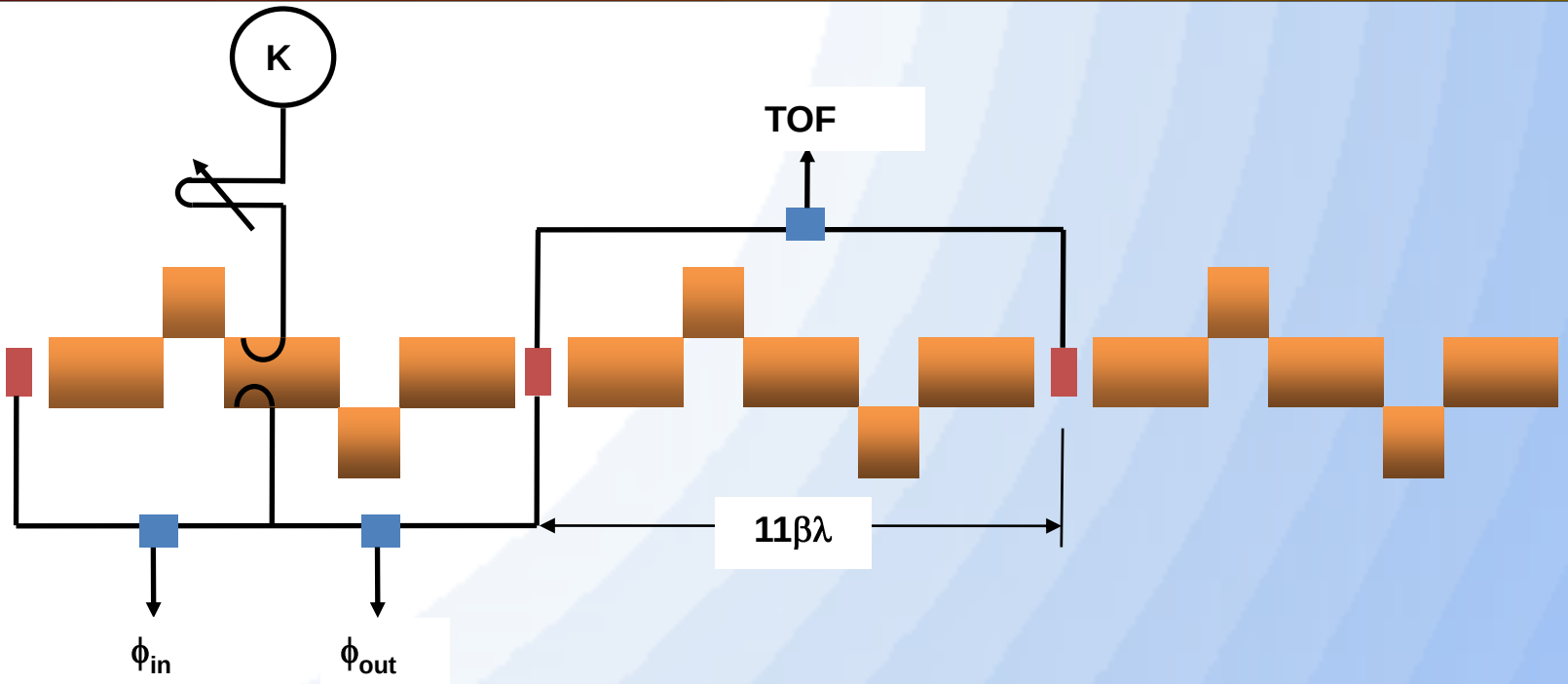
0°



180°



CCDTL longitudinal diagnostics

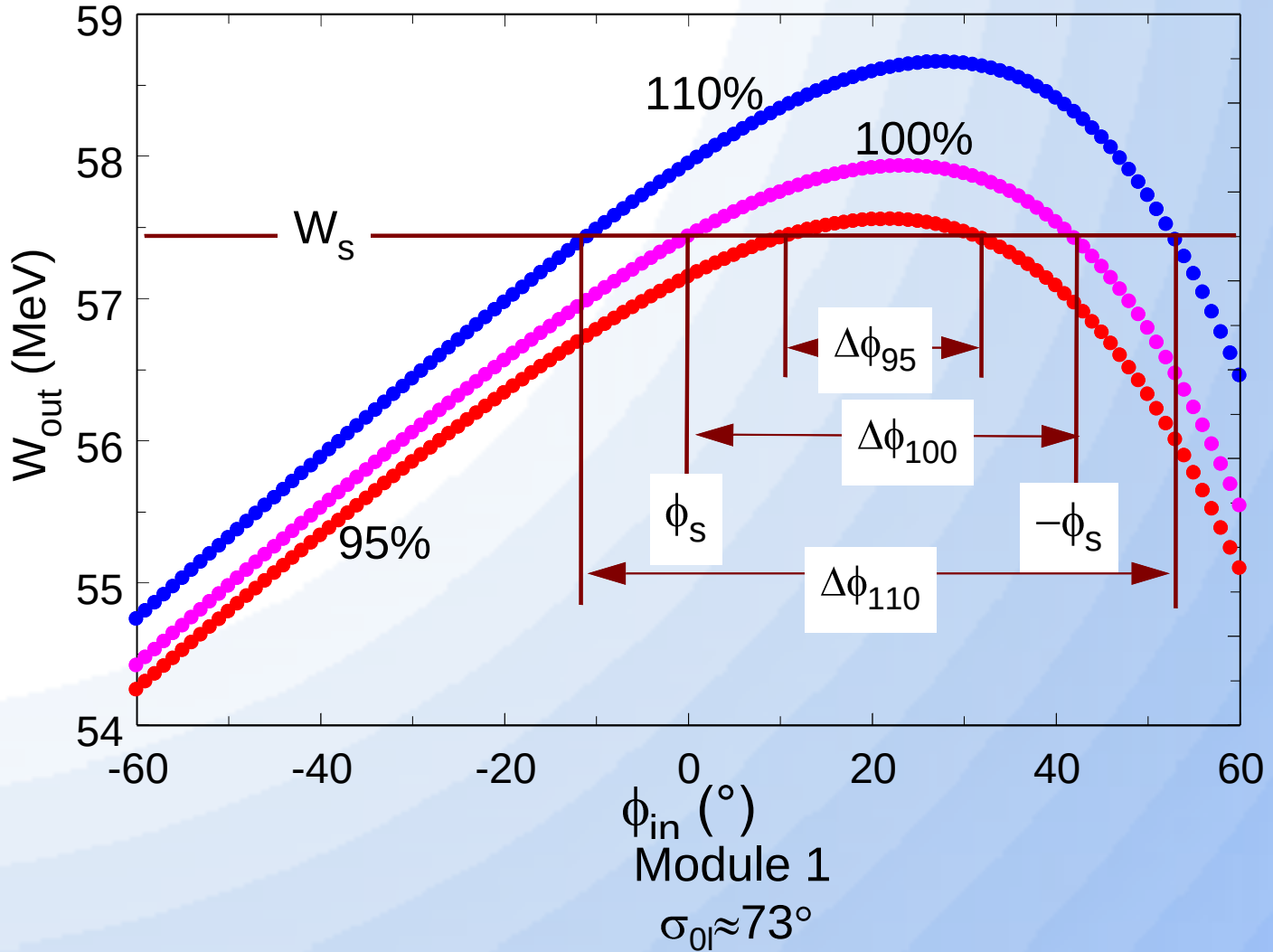


$$\frac{\Delta W}{W} = 2\frac{\Delta \beta}{\beta} = 2\sqrt{\left(\frac{\Delta L}{L}\right)^2 + \left(\frac{\Delta t}{Nt + t_{scope}}\right)^2}$$

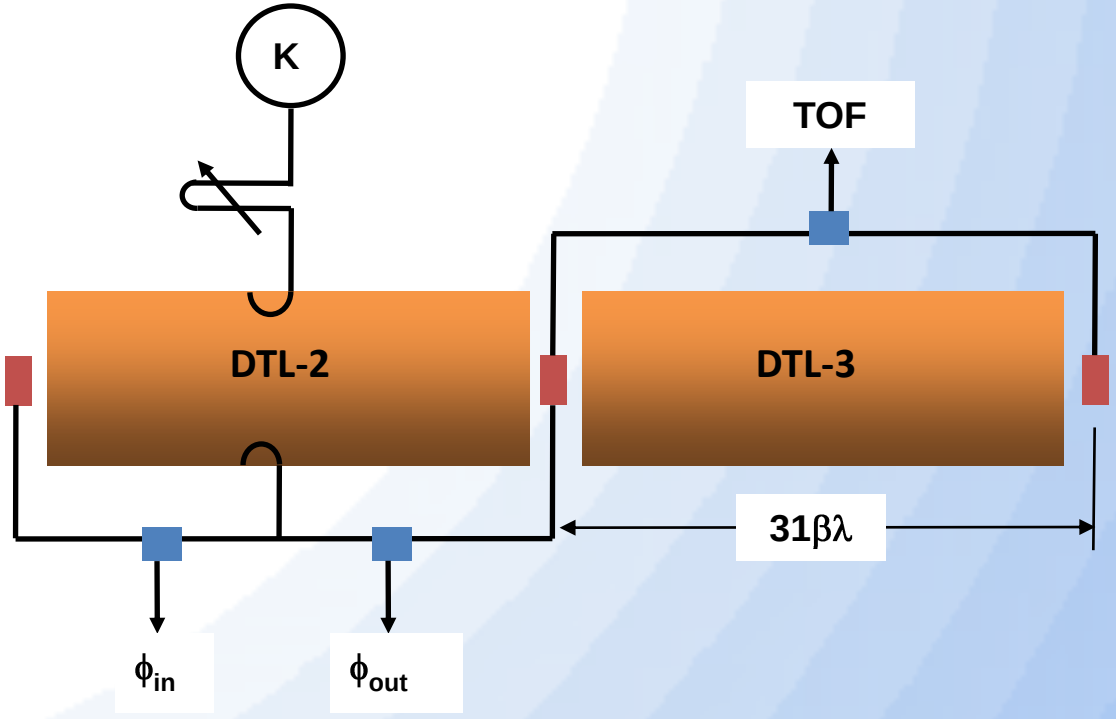
ΔL≈1mm, Δt≈1°(352 MHz) ≈ 8 ps

$$\frac{\Delta W}{W} \approx 1‰ \approx 50keV$$

CCDTL “input” amplitude scans have distinctive peaks & phase widths : ϕ_{in}-W_{out}

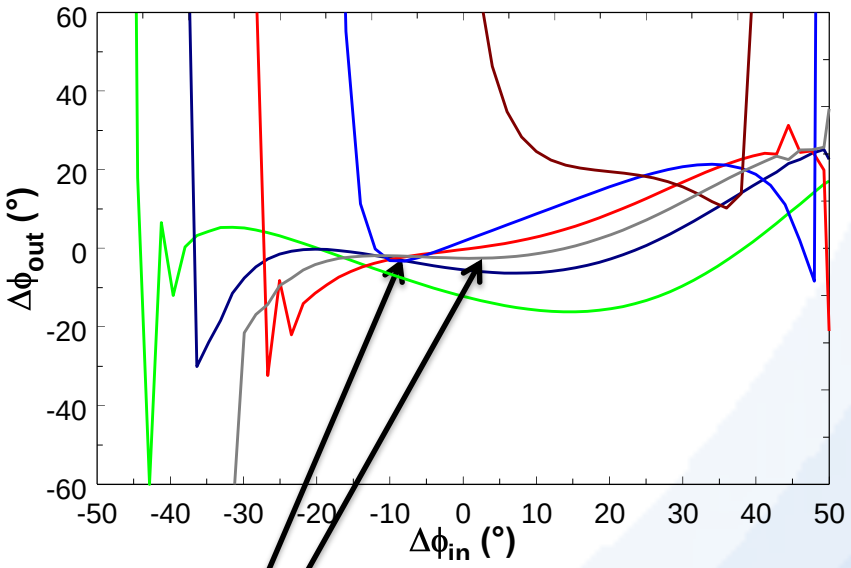


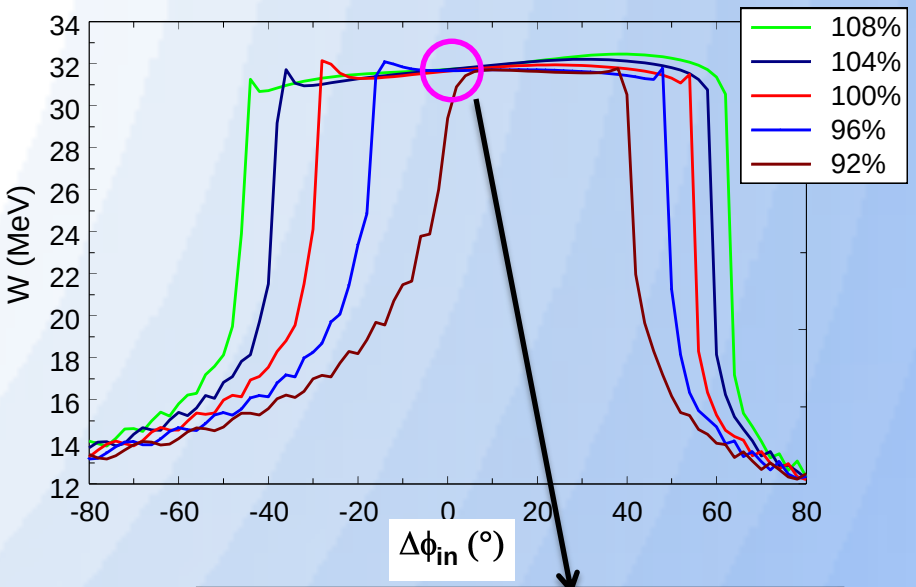
DTL-2 Longitudinal Diagnostics



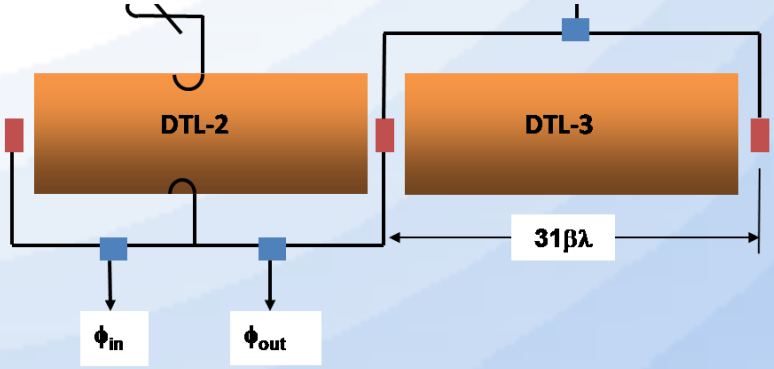
$$\frac{\Delta W}{W} \approx 1‰ \approx 30keV$$

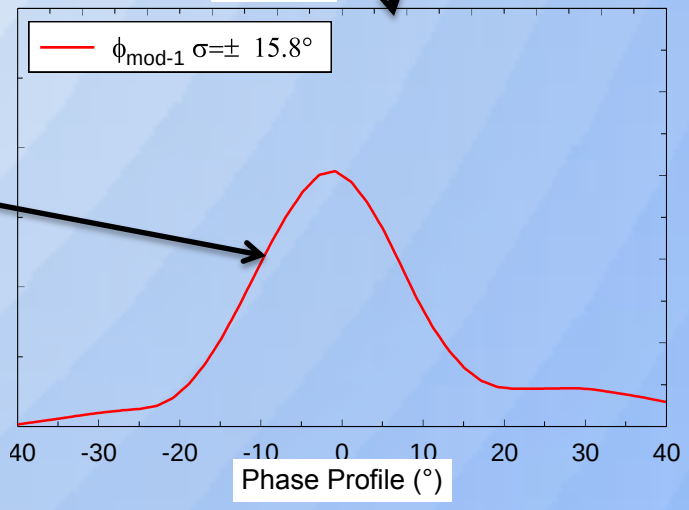
DTL Tank 2 amplitude scans have few distinctive features





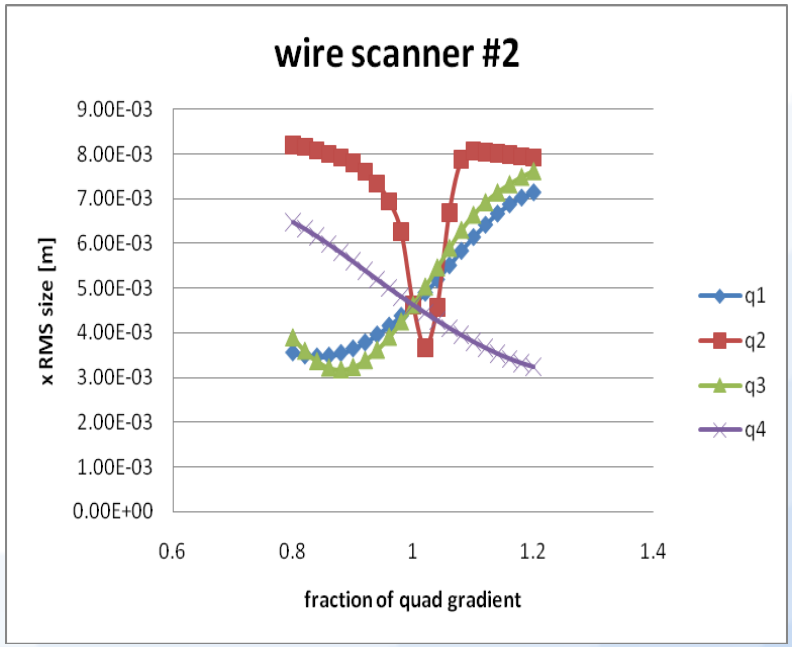
Intersection lat at 102%

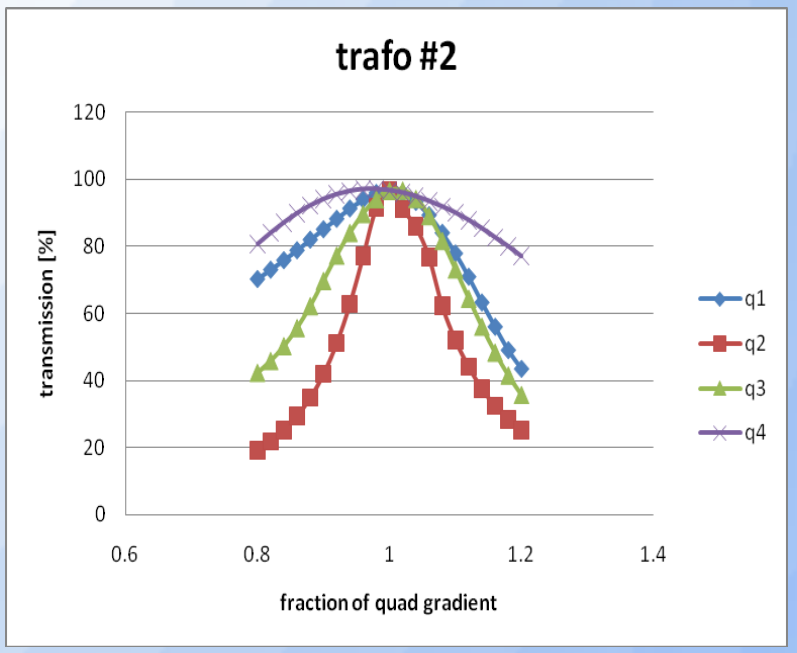




RFQ to MEBT quad gradient scan (±20%)

Beam measured on MEBT diagnostics: WS and BCT
Fairly ideal simulation case, no mismatch, no errors;
only one quad gradient varied at any one time (others assumed at nominal settings)





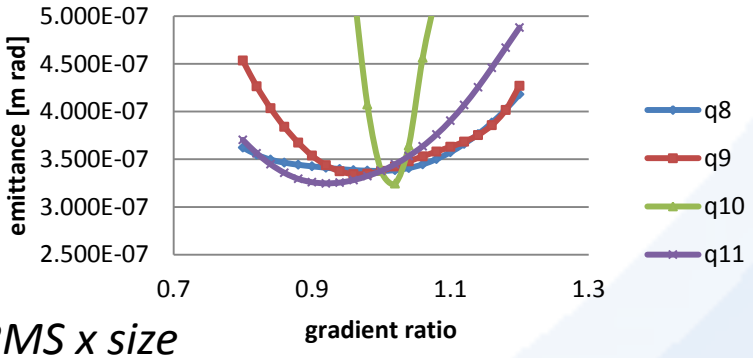
Nice signature for quad2,
not so clear for other quads

Clear peak signature, can tune to few % level if we can resolve 1% in differential beam current with BCT

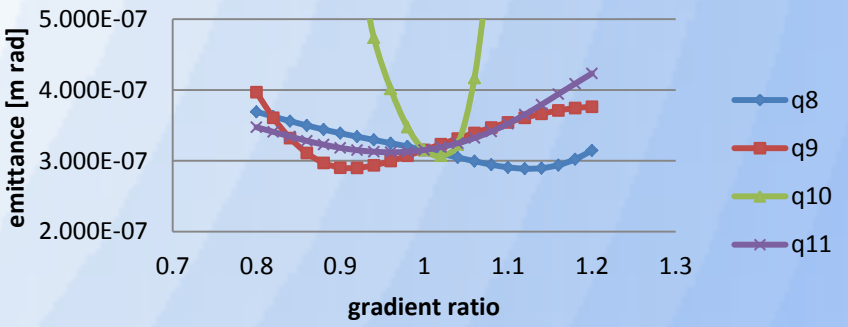
MEBT to DTL classic quad gradient scan (±20%)

Measurements on test bench installed after Tank1
Fairly ideal simulation case, no mismatch, no errors;
only one quad gradient varied at any one time
Good if already close to the solution…

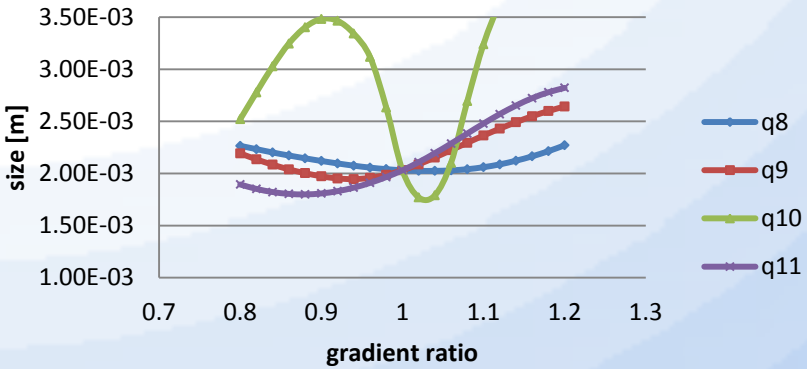
RMS x emittance



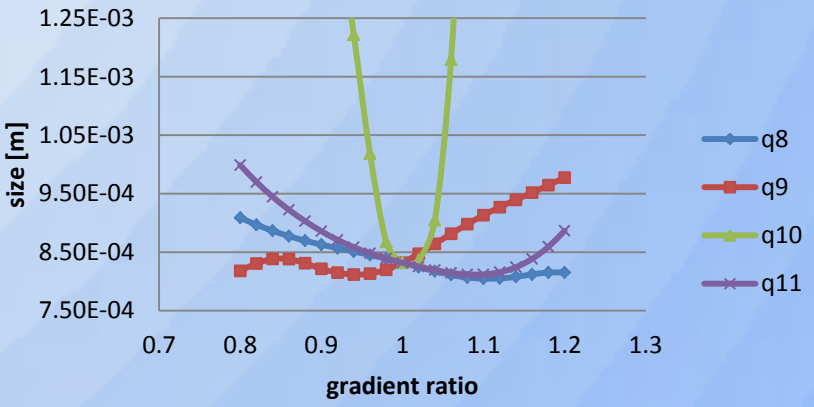
RMS y emittance



RMS x size



RMS y size



No clear signature with available diagnostics resolution [0.1mm mrad / 0.5mm]…