FFAG diagnostics…

Report from ‘Beam Dynamics meets Diagnostics’ workshop

(Florence, 4-6th November 2016)

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- I tried to ask/provoke ideas for FFAG diagnostics
- For current (KURRI-FFAG) experiments
- AND for future (high intensity) hadron FFAGs
- I also presented ‘challenges’ or lessons from EMMA and other machines (eRHIC)
- Slides available online:

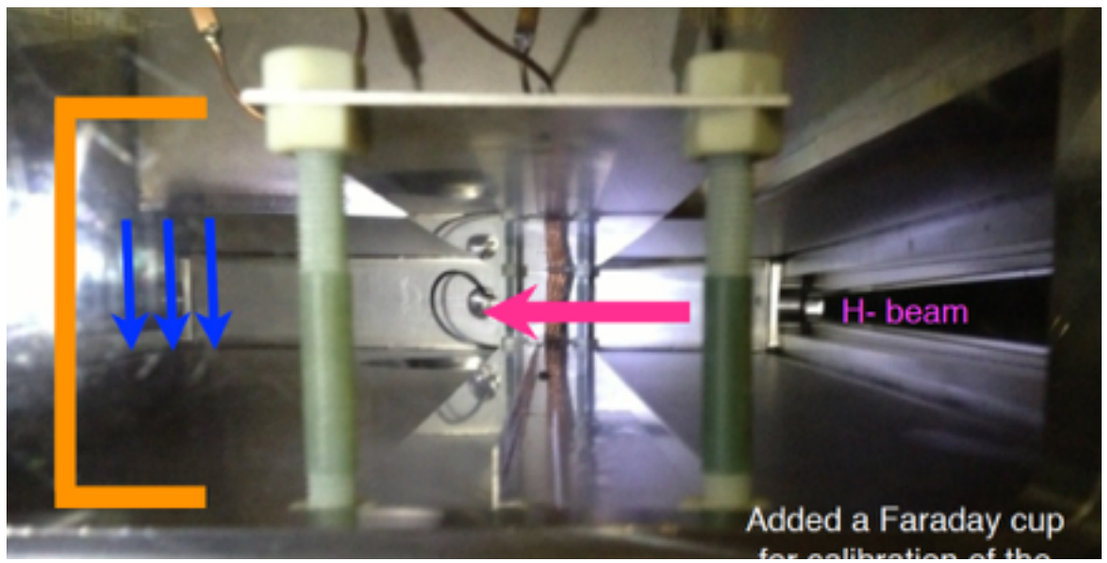
https://indico.gsi.de/conferenceTimeTable.py?confId=3509#20151104

‘Perpendicular stripline’ BPM

- For horizontal position measurement, use TOF difference between signals in different directions to determine beam position.

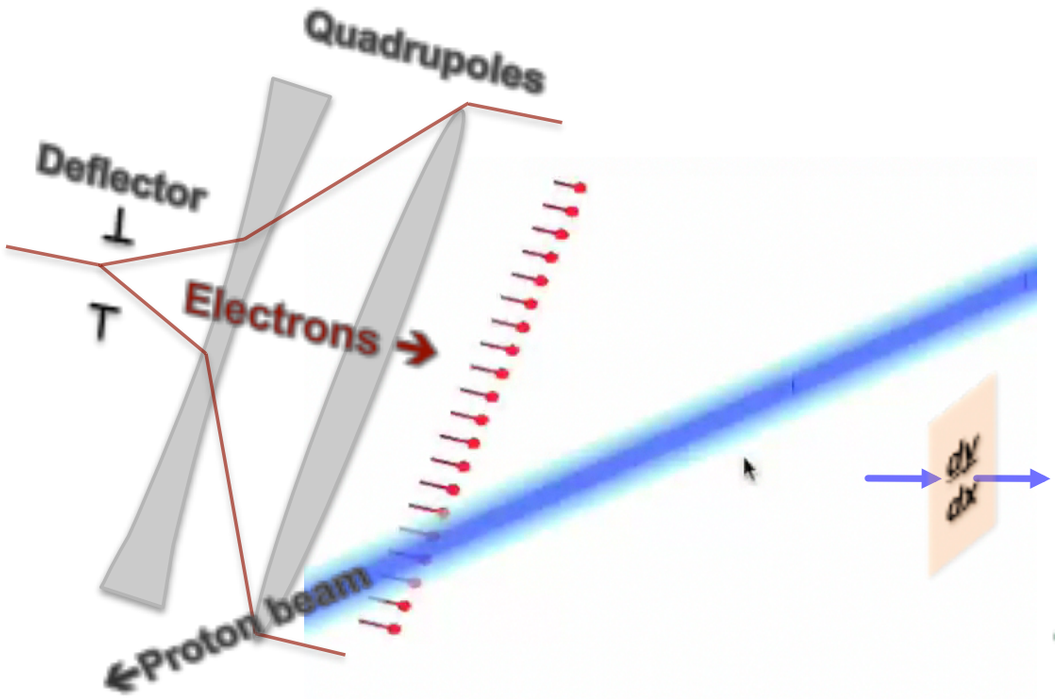
- Suggestion to read out bunch monitors from two sides & check what we can see?

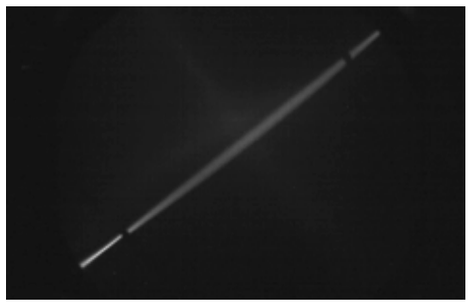
- I am awaiting further info (M. Wendt, CERN has offered some simulations!)



E- beam profile monitor - W. Blockland

Electron Scanner Principle





Multiple scans

Look at the deflected projection of a tilted sheet of electrons:

- Neglect magnetic field (small displacement of projection)
- Assume path of electrons is straight (they are almost straight)
- Assume net electron energy change is zero

→ $\frac{d\theta_0(x)}{dx} = \int_L \frac{e}{mv^2} \frac{\delta(x,y)}{\varepsilon_0} dy$ → take the derivative of curve to get the profile

Discussions with William Blokland:
In FFAG need long straight with no stray field to put this in? Need space with optical port?
Take spatial derivative of the e- curve to get profile. 10-100keV.
May require a very low momentum spread e beam in our case as the interaction with the p beam induces divergence.

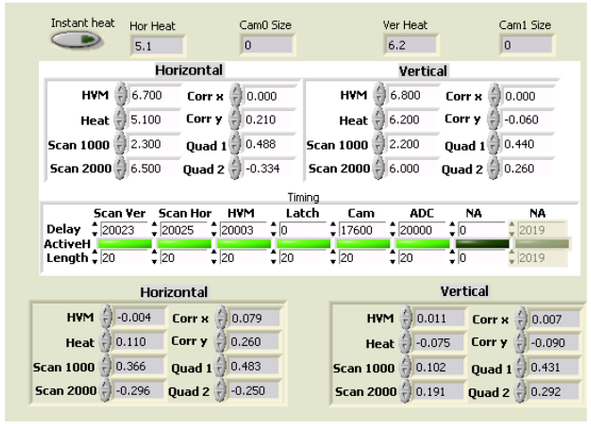
Electron Scanner Capabilities

The SNS Ring presents a good operational spot for the electron scanner:

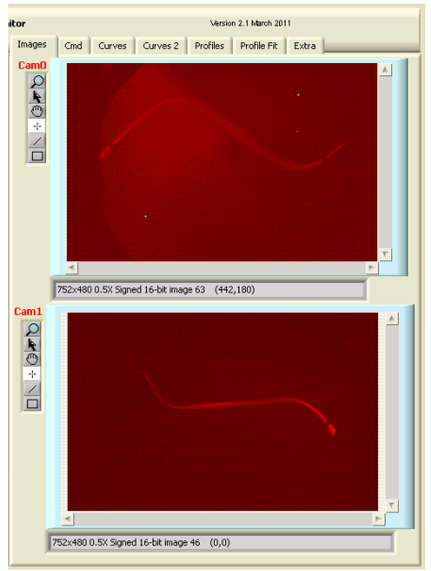
- A lower kV setting requires better magnetic shielding
- A higher beam potential requires higher kVs (expensive)
- Shorter bunch lengths require faster scans e.g. cavity and result in less electrons
- A smaller beam size requires lower electron emittance and projection and better sensor resolution and/or diverging projection
- A faster rep rate requires a more expensive electron gun HV supply

Parameter	Range	Implementation	Dependency
Beam Intensity	50 nC-25 μC (1*600ns) 10's mA – 10's A	10-100 keV	Geometry (deflection)
Beam Potential	Up to ~20kV	Requires 100 keV electrons	Electron momentum
Bunch Length	> 10's ns < 10's ns	Deflector single shot profile Cavity or step per position	Amount of electrons to screen
Beam size	> 5 mm < 5 mm	Parallel projection & screen diverging projection & MCP	Geometry
Rep Rate	< 10's Hz	Screen and Camera	Fluorescent T_c and power supply

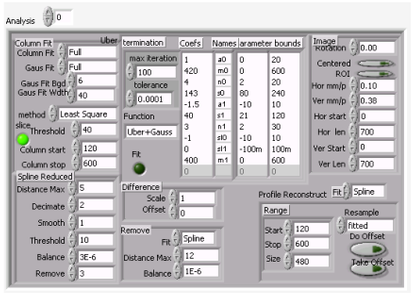
ES: Profile generation

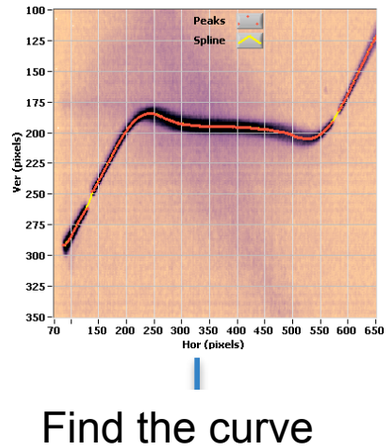


Setup of accelerating voltages, cathode current, deflector voltages, dipoles, quadrupoles, and timing.

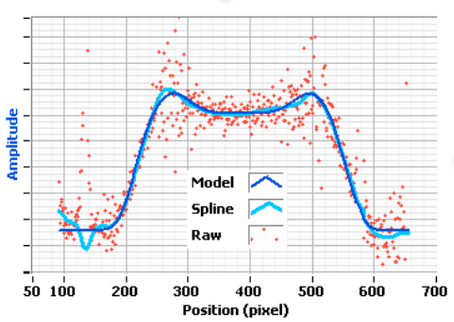


Images

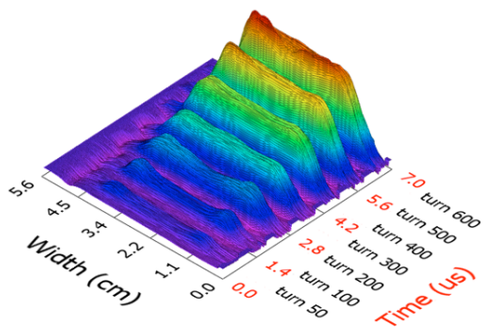




Find the curve



Take derivative to generate profile



Multi profiles show bunches in the ring during accumulation

But for beam dynamics more is needed:

- Automatic acquisition of defined turns and slices
- Offline quantitative analysis
- Visualize large amounts of data

Other discussions…

Tune measurement: Base Band Tune (BBQ) method

R. Jones, CERN

Not sure how these would work horizontally over wide aperture?

But if some version would work, this method would allow a tune measurement over the whole energy range dynamically, without flat-tops etc. (ie. very fast & accurate)

Q. do we need a deflector or not?

See eg. http://accelconf.web.cern.ch/AccelConf/BIW2010/papers/tupsm071.pdf

CIVIDEC Diamond Detectors

IBA, LLN

CERN spinoff CIVIDEC - diamond detectors are fast, and radiation hard.

- Used in IBA to do isochronicity feedback and optimisati can be used to detect neutrons directly also.
- They also made X-ray BPMs for Diamond light source.
- 20 ps time resolution (however very small surface area - they suitable as beam loss monitors?)

RF Structure