Update on wakefield calculations for ATF2

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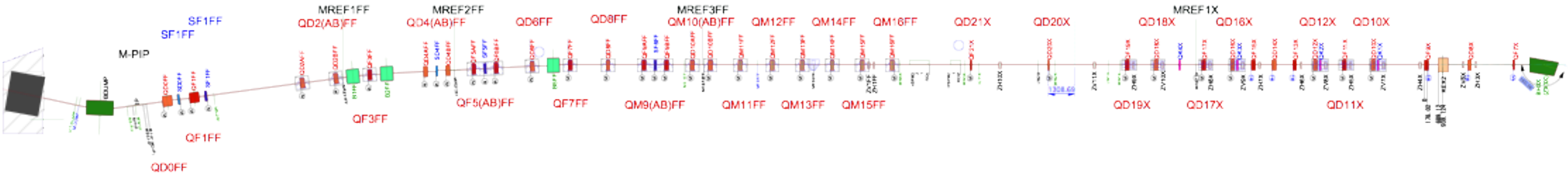
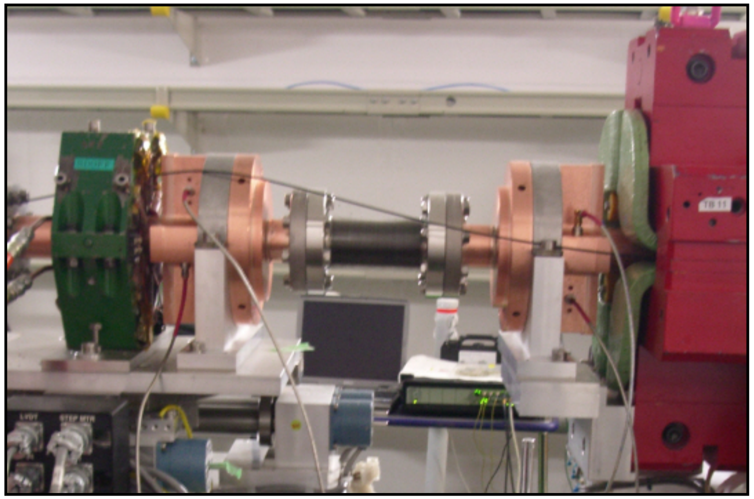
Problem history

- Difficulties achieving < 100 nm vertical beam size at the IP
- Low charge operation yields better results
- Suspected wakefield effects – head to tail offset may appear as beam size blow up
- Long bunch: typically 7 mm
- Investigations started with cavity BPMs and soon extended onto other beamline components
- Only reviewing EM simulation results here, beam dynamics issues are discussed in other talks

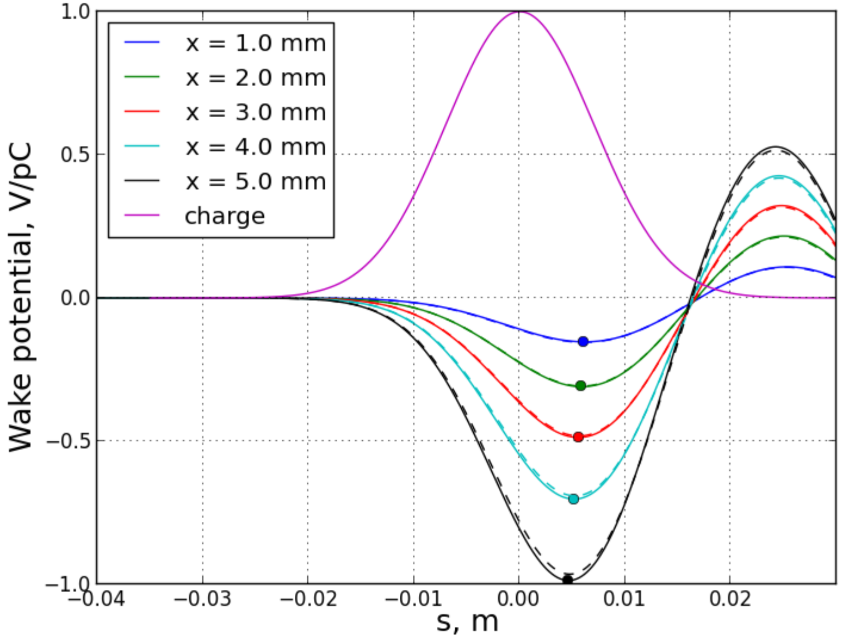
ATF2 extraction beamline

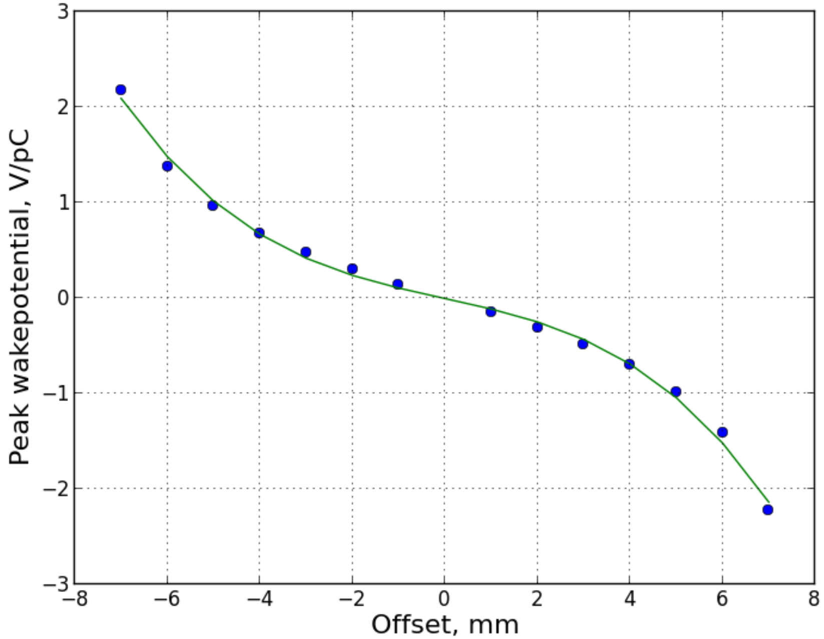


- 100s of elements, need to take quantities into account
- Some known high impedance devices (for example cavity BPMs)
- High-β locations more important (typically larger offset)
- Alignment is important (the whole beamline recently re-aligned)
- Example: 2 cavities + **2 flanges + bellows**



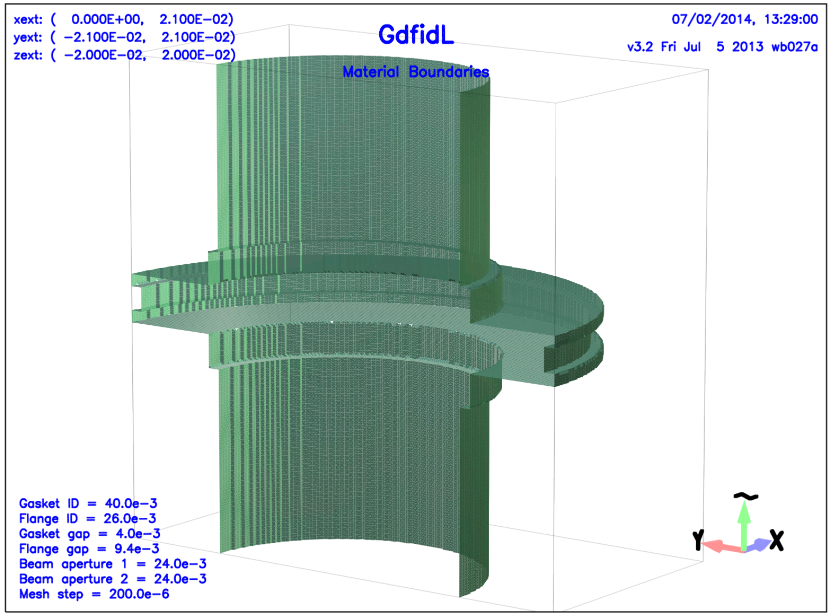
Typical shape and x-dependency

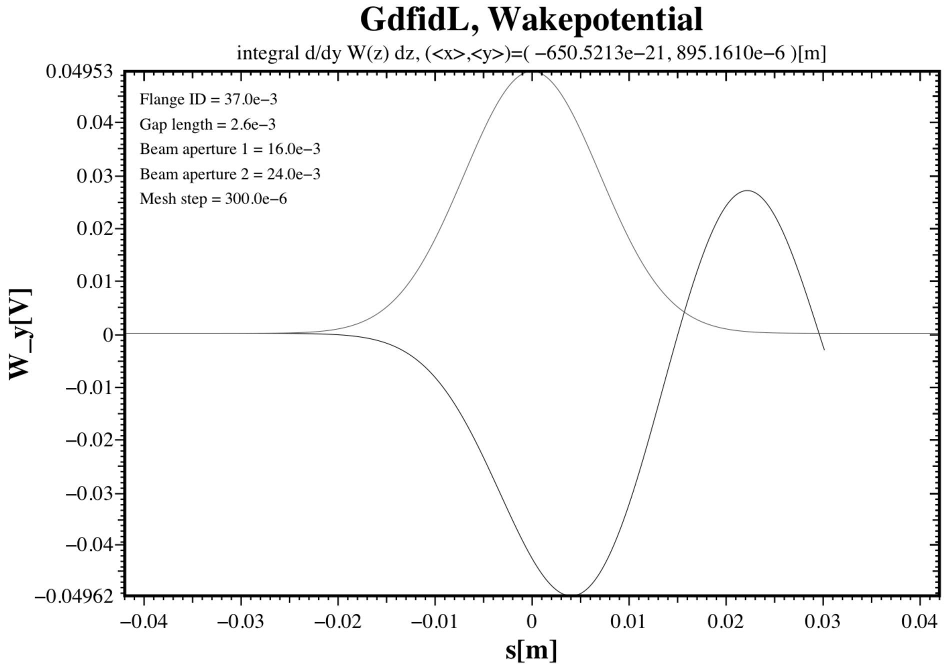




- GdfidL (solid) and ACE3P (dashed) results agree very well
- First oscillation peak grows non-linearly (coaxial modes present?)
- Even reasonable alignment helps a lot

New simulations - typical flange





- Flanges produce wakes (acting as cavities)
- Amplitude not negligible
- Geometries vary, but the basic gap dimensions are similar and so are the wakes

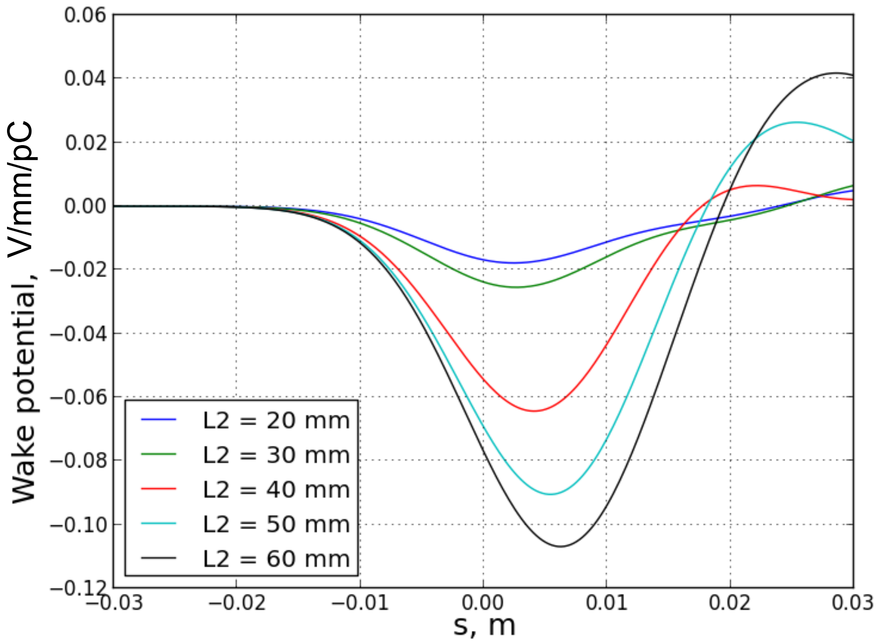
Naïve totals

Element	Peak wake, V/pC/mm	Assumed offset, mm	Quantity	Contribution, V/pC
Bellows	0.1	0.5	100	5 (0)
Flanges	0.05	0.5	200	5 (2.5)
C-band position	0.11	0.2	40	0.88
C-band reference	0.15	1	4 (1)	0.6 (0.15)
Vacuum ports (X)	0.07	1	6	0.42 (<0.1)
24-20 mm transitions	0.008	0.5	100	0.4

- Quantities are rough estimates and average offsets are guesses!
- Bellows are now shielded
- Half of the flange gaps also shielded (shield covers one end)
- Vacuum ports must have been changed by now

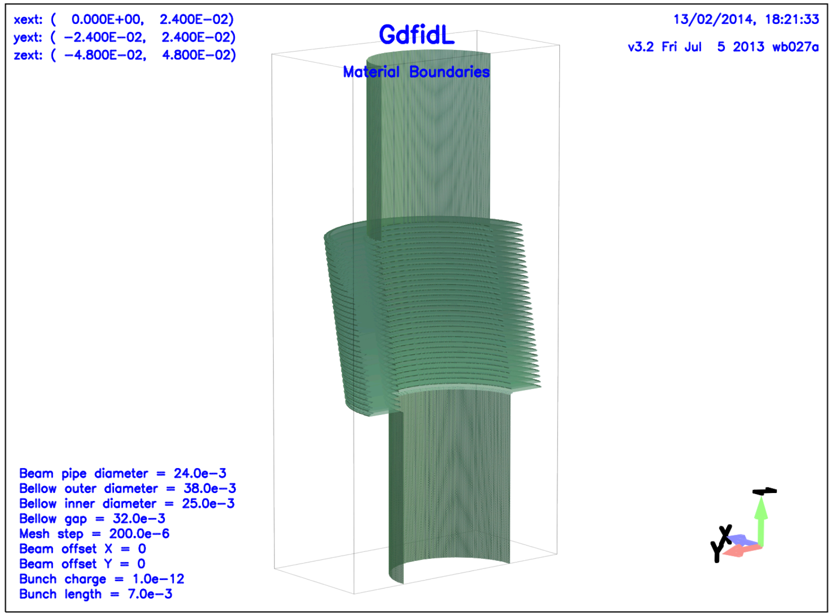
Tuneable wakefield source for compensation

- Compensation of the wakefields has been demonstrated by translating a cavity transversally to an optimum position
- Preliminary study shows that the delay of the wake can be adjusted for optimal compensation
- Requires mechanically complicated controls
- Advantage marginal? Option remains…

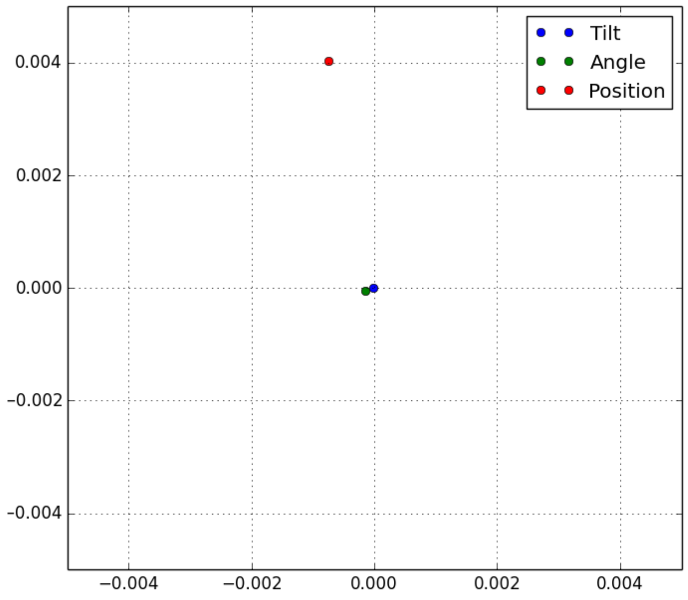


Some conclusions

- Some simple geometries found "guilty" of producing strong wakes
- Quantities matter!
- Wakefield effects can be reduced significantly by relatively simple measures – alignment and shielding of the gaps
- Planning on analysing tilted bellows, and finishing this work



Tilt measurement using CBPMs



- Various analytical calculations of position/angle/tilt sensitivity disagree
- Two-bunch model may be inaccurate for long bunches
- Numerically integrated excitation using a Gaussian distribution (4σ)
- $S_\theta = 0.04\ S_x$ (0.3 μrad ➔ 1.2 nm)
- $S_\alpha = 0.005\ S_x$ (7 μrad ➔ 3.5 nm)
- Angle can be resolved by multiple CBPMs in a line (0.3 μrad x 1 m ➔ 300 nm)
- If this is correct, the required tilt sensitivity will be hard to achieve, would be good if someone cross-checked this