Perforated Rotating Graphite Disk as Ion Polarimeter

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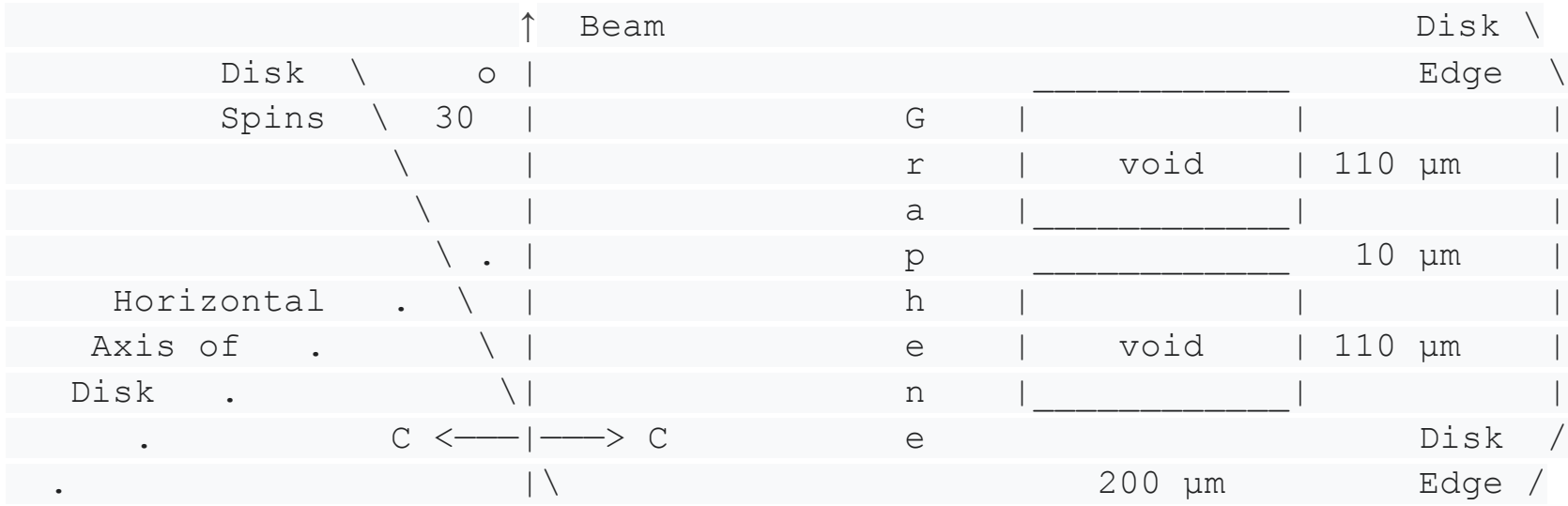
A modest proposal to detect the polarization of each bunch and to address C heating.

A thin graphite disk has evenly spaced holes close to its edge. Each 110 μm square hole is separated from the next by 10 μm of graphite just within the edge, 83 times repeatedly.



Polarimeter view from vertically above

Carbon ions recoiling at near 90 degree

Enlarged view along axis of disk at 3 o'clock

Axis of disk truncated at disk to avoid beam

The spinning disk’s axis is in the horizontal plane of the beam, at angle 30 degrees to it.

The bunch to bunch gap is 11 ns; if the speed of each square hole on the rotating disk is 0.9 mm/ns, a suitably timed size 10 μm bunch will cross 10 μm of graphite in 0.2 ns.

The following 11 bunches of size 10 μm by 100 μm will sail through the void, allowing 121 ns for the detection of the recoiling carbon nuclei, similar to RHIC’s detector time.

The polarization of every twelfth succeeding bunch may be evaluated, 89 altogether.

The abort gap will then have been reached, each related to the time of 92 bunches.

Appropriate voids can be selected in each gap to ensure that, in the next revolution of the beam, a different set of 89 bunches will collide with the graphite targets.

If the disk rotates at 6516 Hz, a twelfth of the beam rate 78193 Hz, 12 abort gaps can be arranged as follows so as to provide polarizations for all the 1068 bunches.

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 Bh  V-o-i-d  Bh  V-o-i-d  Bh  V-o-i-d ..... Bh  V-o-i-d  Abort Gap  V-o-i-d

  0 [ 1...11] 12 [13...23] 24 [25...35] ... 1056 [1057-68] 1069-1149 [1150- 0]
  1 [ 2...12] 13 [14...24] 25 [26...36] ... 1057 [1058-69] 1070-1150 [1151- 1]
 . . .
 10 [11...21] 22 [23...33] 34 [35...45] ... 1066 [1067-78] 1079-1159 [ 0...10]
 11 [12...22] 23 [24...34] 35 [36...46] ... 1067 [1068-79] 1080-1160 [ 1...11]
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Numbering bunches from 0 to 1056, every 12th bunch after bunch n, for $0< n <11$, that is, $n, n + 12, \ldots, n + 1056$, would be detected in 121 ns.

An abort gap is located where 92 bunches would have been at numbers 1068—1160

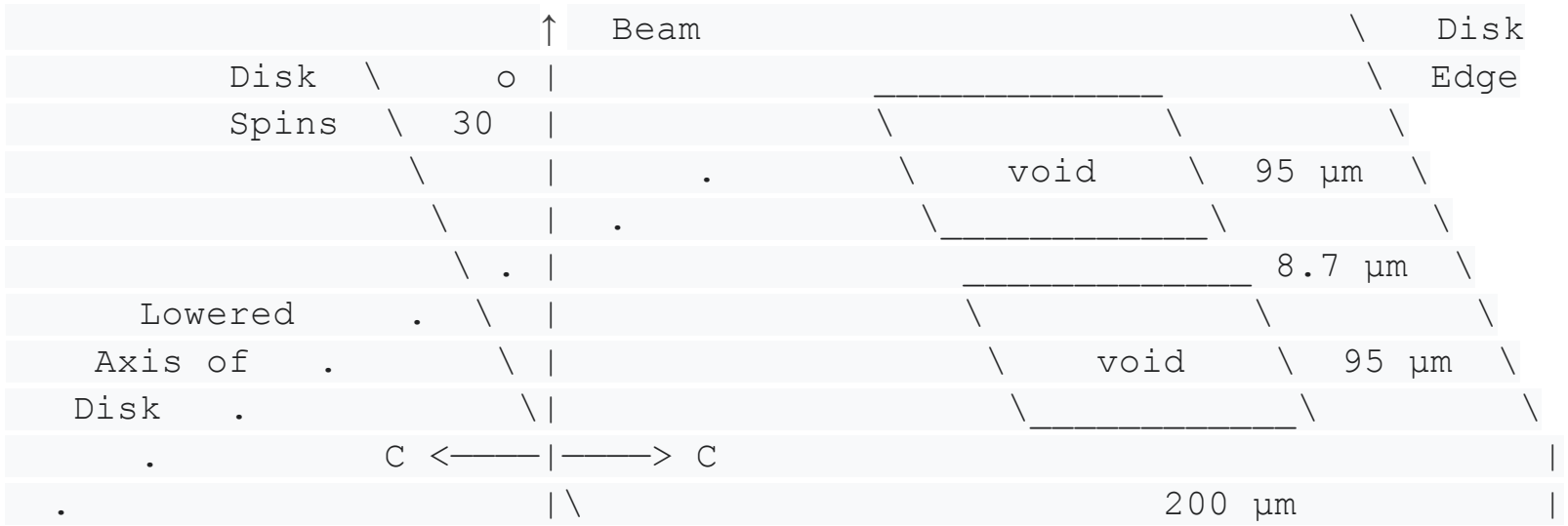
The diameter of the disk with 12 sectors is: $12(11.6)/\pi = 44.31$ mm at a rotation rate 6.516 kHz; and a double diameter of 8.86 cm for 24 sectors at rate 3.258 kHz

Extra graphite to stabilize the holes would indicate diameters of 45 mm and 9 cm.

High-speed spinning disks have reached 3.3 kHz using flexible threads passing through two central holes on the disk, *Zhao ZL et al., Sci Rep* 7, 13111 (2017)

https://doi.org/10.1038/s41598-017-13137-1

May need a beam crossing the disk at 2 o'clock or 4 o'c by relocating its axis.



Polarimeter viewed from vertically above

The Carbon ions recoil at near 90 degrees

Looking along the axis at 2 o'clock on disk

Axis of disk is lower by quarter of diameter

Disk could get a push if every even bunch had ions with spin-up at 2 o’clock

A separate disk gets a push if every odd bunch were spin-down at 4 o’clock.

Methods used by AI in Astronomy may be helpful in optimizing the polarimetry parameters :

https://deepmind.google/discover/blog/using-ai-to-perceive-the-universe-in-greater-depth/

Possible difficulties with a disk-based polarimeter rotating at a rate of around 0.9 km / s :

The edge of the disk may be unstable if its squared velocity > Young’s modulus / density

The critical speed of the edge ranges from 1 to 8 km/s for graphite and layered graphene.

The axis of the disk may be too close to the beam and detectors of the recoil carbon ions.

Reaching and maintaining the required rotation rate of the disk will be a major challenge.

Thank you.