DOWNLOAD PDF CHARGED PARTICLE BEAMS

Chapter 1 : Charged Particle Beams by Stanley Humphries - Download link

A charged particle beam is a spatially localized group of electrically charged particles that have approximately the same position, kinetic energy (resulting in the same velocity), and direction.

One way to accomplish this is to compute a cumulative distribution function starting from Eq. Another possible method is using Eq. In this case, the normalization is done automatically. Screenshot showing how to input the particle density in the Inlet feature. Still, the most convenient approach is using the Particle Beam feature available in the Charged Particle Tracing physics interface. The Particle Beam feature automatically distributes the particles in phase space, allowing you to specify the location of the beam center, emittance, and Twiss parameters. Screenshot showing how to input the particle density in the Particle Beam feature. However, real beams propagate in 3D space and only extend a finite distance in both transverse directions. Particle beam propagating in 3D space. The reason why simulating the release of particle beams in 3D is more complicated than in 2D is that the degrees of freedom for the two transverse directions are often coupled in real-world beams. For example, suppose two particles are released at the same transverse position i. The particle with the large inclination angle in the x direction is more likely to have a small inclination angle in the y direction and vice versa. To phrase this problem in a more abstract sense: Instead of considering the two transverse directions as separate 2D phase space ellipses, we actually need to think about the transverse particle motion using distributions of phase space in four dimensions! This is where the Particle Beam feature is most useful. It includes settings for sampling the initial particle positions and inclination angles from a variety of built-in 4D transverse phase space distributions. Some common distributions are the Kapchinskij-Vladimirskij KV distribution, waterbag distribution, parabolic distribution, and Gaussian distribution. Mathematically, the KV distribution considers the beam particles to be uniformly distributed on an infinitesimally thin, 4D hyperellipsoid in phase space. Because it is more difficult to visualize 4D probability distribution functions than functions of lower dimensions, it is often convenient to visualize the distribution indirectly by plotting its projection onto lower dimensions. An interesting property of the KV distribution is that its projection onto any 2D plane is an ellipse of uniform density. The projections onto six such planes are shown below. The KV distribution projected onto six 2D planes. Compare the distributions shown above to the following alternatives. The waterbag, parabolic, and Gaussian distributions projected onto six 2D planes. We see that the projection onto any 2D plane forms an ellipse-shaped distribution in all cases, but the ellipses are only uniformly filled in the KV distribution. Concluding Thoughts on Modeling Charged Particle Beams Even as this blog series on modeling charged particle beams comes to a close, we have only scratched the surface of the intricate and highly technical field of beam physics. This series is meant to be an introduction to the way in which random or pseudorandom sampling from probability distribution functions plays an important role in capturing the real-world physics of high-energy ion and electron beams. For a more comprehensive overview of beam physics, references provide an excellent starting point. More technical details about each of the 4D transverse phase space distributions described above, including algorithms for sampling pseudorandom numbers from these distributions, can be found in references Other Posts in This Series.

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Chapter 2 : Charged particle beam - Wikipedia

Theory and Design of Charged Particle Beams Martin Reiser. The Author Prof. Dr. Martin Reiser Institute for Research in Electronics and Applied Physics University of.

Such knowledge of PDFs is necessary to understand how ion and electron beams propagate within real-world systems. Ion and Electron Beams A beam of ions or electrons is a group of particles with about the same kinetic energy that move in about the same direction. Let the positive z-axis denote the direction of beam propagation the axial direction and the x-axis denote the direction perpendicular to the direction of propagation the transverse direction. No real-world beam will have perfectly uniform velocities for all particles. In fact, almost all of the interesting mathematics involved in beam release and propagation relates to the small variations in position and velocity among the beam particles. If the beam has a sharp cutoff â€" that is, the number density of particles in the beam abruptly decreases to zero at a well-defined location â€" the beam envelope may simply be a curve or surface that encompasses all of the particle trajectories. A beam is converging if its envelope becomes smaller as the beam propagates forward; diverging if the beam envelope becomes larger; and at a waist if the beam has just finished converging and is about to start diverging. This is illustrated below. Comparing Laminar and Nonlaminar Beams The next plot shows some representative particle trajectories in a simple 2D beam. For now, space charge effects and external forces are neglected. Coordinate axis labels are shown to indicate the axial and transverse directions. The lines indicate the paths of beam electrons, with arrows indicating their velocities. The color expression along each line is the change in the x-coordinate, or transverse position, of an electron, also called its transverse displacement. Note that the origin has been chosen so that the x-coordinates are measured from the center of the beam. The rate of change of the transverse position is the transverse velocity vx. In the previous image and the following ones, the transverse displacement and velocity are rather exaggerated so they are easier to see. In practice, they are usually extremely small compared to the displacement and velocity along the beam axis. The beam shown above is called a laminar beam because it has the following properties: At any transverse position, the beam particles are not crossing paths. The one exception is for converging beams, where all particles will cross at exactly the same point. The transverse position and velocity are linearly proportional. The latter of these properties is important because it prevents the initial property from being violated later on. See the following diagram of a converging beam in which the transverse position and velocity have a quadratic relationship instead of a linear one. At any one of these intersection points, there are multiple transverse velocity values possible for a single transverse position, and thus the first property is violated. In contrast, for a laminar beam, the particles never cross, unless the beam is converging so that all trajectories cross at a single point, as shown below. In practice, there is usually a distribution of transverse velocity values at any transverse position. Particle trajectories are constantly crossing each other. Thus, real-world beams are nonlaminar, and the laminar beam discussed earlier is just an idealization. A more realistic transverse velocity distribution for a nonlaminar beam is illustrated below. We could alternatively use position and momentum as the two axes. As expected, the points form a straight line that passes through the origin. Remember that, by definition, the transverse position and velocity in a laminar beam have a linear relationship. The next plot is a phase portrait for the nonlaminar beam. The points no longer lie in a line but instead form a vaguely shaped cloud in phase space centered about the origin. Now it has become much clearer; the particles form a phase space ellipse. Such ellipse-shaped distributions are extremely common in beam physics, although the proportions and orientation of the ellipse and the exact placement of particles relative to it can vary. As was the case when describing the beam envelope, the phase space ellipse may either have a sharp cutoff or gradual decrease in number density. In practice, most charged particle beams are paraxial, meaning that the transverse velocity components are very small relative to the longitudinal velocity. Evolution of Phase Space Ellipses The ellipse shown in the previous image was approximately symmetric about the x-axis and vx-axis. Similarly, particles with negative transverse velocity will move to the left. The following animation shows the evolution of a phase space ellipse over time for a drifting beam without space charge effects. An upright phase space ellipse corresponds to a waist along the beam trajectory. It describes the proportions of the beam. Although beam emittance describes the size of the ellipse, there are several different conventions as to how the emittance and ellipse area are actually related. This is illustrated in the following diagram, which further shows how the Twiss parameters are related to the ellipse proportions and orientation. The root-mean-square emittance or RMS emittance can be defined as 2.

Chapter 3 : D-Beam â€" Advanced diagnostics for charged particle beams

Welcome to the Charged Particle Beams download site. The text was originally published by John Wiley and Sons (ISBN , QCH86) in A hardcopy edition of the text is available for $ from Dover Publications.

Further Reading Charged Particle Beam [CPB] Particle beam weapons differ from other instruments of war that carry destructive energy to the target in the form of explosive warheads in ponderous containers such as artillery shells or missile casings. Particle beam weapons, of which electron beams are just one possibility, increase the kinetic energy of a large number of individual atomic or subatomic particles and then direct them collectively against a target. Every particle in the beam that strikes the target will transfer a fraction of its kinetic energy to the target material. If enough particles hit the target in a short time, the deposited energy would be sufficient to burn a hole in the skin of the device, detonate the chemical explosives or disrupt the electronics inside including software. The most significant advantage of high-energy particle beam weapons over missiles is that, like lasers, they propagate at essentially the speed of light. The project was discontinued because of insurmountable problems in physics. Some research continued, but the emphasis was on lasers rather than particle beam weapons. During the past few years, beam weapon research has been resumed by the Armed Services and is now being coordinated by the Department of Defense as a nationally directed program. Because its particle accelerator is the best mechanism for testing beam propagation, the Chair Heritage program was given a higher priority than other beam weapon programs. The weapons would be located below deck, and the beams would be magnetically routed to small firing turrets located at strategic points on the hull and deck. The system would be capable of firing six shots per second and engaging targets at ranges out to 4. Deployment of this system depends on beam propagation. Lethality tests in used two particle accelerators developed at the Lawrence Livermore Laboratories in California. It was based on an autoresonant particle accelerator being developed under contract from the Army Ballistic Missile Defense Command. The accelerator is a proof-of-principle device and is not intended for direct weapon application. The design has the potential of generating single pulses with 1 to 10 megajoules of beam energy. The United States conducted beam weapon research for several years, but until the late s it was a low priority effort. With the seeming risk of a Soviet technological breakthrough, the US program picked up momentum and direction. Parmentola and Tsipis presented a landmark paper on this subject in Scientific American in J. The authors presented scientific reasons why such weapons would be highly useful, but also dramatized the fundamental reasons why these weapons could never work. The authors presented many small but practical problems of particle-beam weapons such as how to generate sufficient power in space, how to deal with countermeasures, and how to find targets among decoys. They also discussed two problems that they considered unsolvable. That is, the smaller problems may be considered very difficult scientific and engineering problems that may challenge practical implementation. However, even if all those could be dealt with, two significant problems remained that were unsolvable due to fundamental physical limitations that no amount of Herculean engineering could resolve. These fundamental problems are 1 that Coulomb repulsion of a particle beam spreads the energy over a large area at reasonable distances to targets, and 2 that the near-earth magnetic field deflects the beam and is somewhat variable. The beam is steered electrically by magnetic fields or electric fields. Mechanical steering would not be fast enough. A practical electron beam weapon would need to hit a target that is 1, km away with a amp beam having an energy of 1 GeV for 0. Furthermore, the beam needs to be 1 cm or so in diameter at the target in order for the deposited energy to be sufficiently intense. Parmentola and Tsipis indicate that a 1 GeV electron beam of amps would spread from an initial 1 cm diameter to a 5 meter diameter at 1, km due to Coulomb repulsion. Under such unstable conditions, it would be close to impossible to make a workable weapon that could reliably hit a target km away with enough energy to destroy it. There is more time, however, near the apogee section of travel in which to detect and destroy the missile compared to its ascent and reentry phases. The mission was to interactively discriminate between reentry vehicles and decoys and then destroy the reentry vehicles. When the funding available for particle beam work both charged and neutral declined in fiscal year , SDIO decided to cancel the charged particle beam work because the technical risk for the charged particle beam was greater than for the neutral particle beam.

Chapter 4 : Charged Particle Beam [CPB]

Charged Particle Beams is an upgrade available to the Black Hand subfaction of calendrierdelascience.com grants Confessor Cabals with a significant power boost and shredder turrets with increased rate of fire and accuracy in the form of green particle beams.

Introduction Photon Beam Radiotherapy Most types of cancer radiotherapy use ionizing photon X-ray or gamma-ray beams for the local or regional treatment of disease. Ionizing radiation damages the DNA of tumor and healthy cells alike, triggering complex biochemical reactions and eventually resulting in prolonged abnormal cell function and cellular death. Cellular damage increases with absorbed radiation dose measured in Gray units, Gy â€" the amount of energy that ionizing radiation deposits to a volume of tissue. Ionizing radiation is harmful to all tissues, malignant or healthy. In clinical practice, lethal tumor doses are not always achievable because of radiation-induced morbidity to normal tissues. This is generally achieved by targeting the beam to the tumor area through paths that spare nearby critical and radiosensitive anatomic structures; selecting multiple fields that cross in the tumor area through different paths, to avoid overexposing the same healthy tissues as would be done by using a single field ; and by partitioning the total dose in fractions small amounts over successive sessions. Because healthy tissues recover better and faster than malignant ones, with each radiotherapy session the accumulated cellular damage in the targeted tumor increases, while normal tissues are given the opportunity to repair. Appropriate targeting of the beam is particularly important for tumors that are anatomically adjacent to critical body structures. To date, advances in imaging and radiation treatment planning technologies allow much more precise targeting of radiation therapy, compared to earlier years. The most advanced method for the delivery of high radiation doses with photon beams is intensity modulated radiation therapy IMRT. IMRT and other radiotherapy delivery methods i. Charged Particle Beam Radiotherapy An alternative treatment modality is charged particle radiotherapy, which uses beams of protons or other charged particles such as helium, carbon or other ions instead of photons. They deposit most of their energy in the last final millimeters of their trajectory when their speed slows. This results in a sharp and localized peak of dose, known as the Bragg peak. Figure 1 Depth-dose distributions for a spread-out Bragg peak of a particle beam for a single entry port. The SOBP dose distribution is created by adding the contributions more The initial energy speed of the charged particles determines how deep in the body the Bragg peak will form. The intensity of the beam determines the dose that will be deposited to the tissues. To irradiate a whole tumor area, multiple Bragg peaks of different energies and intensities are combined Figure 1. As with photon therapy, the biological effects of charged particle beams increase with absorbed radiation dose. Because charged particles interact with tissues in different ways than photons, the same amount of radiation can have more pronounced biologic effects result in greater cellular damage when delivered as charged particles. The relative biological effectiveness RBE is the ratio of the dose required to produce a specific biological effect with Co photons reference radiation , to the charged particle dose that is required to achieve the same biological effect. The general RBE of protons is approximately 1. For example, carbon ions were reported to have an RBE around 3 in several tissues and experiments. In practice, more than one entry port may be required with charged particles, especially when it is important to achieve adequate skin sparing. We discuss advantages and the disadvantages of charged particle therapy and other radiotherapy options e. Ongoing research explores even more advanced methods to deliver charged particle beam radiotherapy. Key Questions Key question 1 1. What are the different particle beam radiation therapies that have been proposed to be used on cancer? What are the theoretical advantages and disadvantages of these therapies compared to other radiation therapies that are currently used for cancer treatment? What are the potential safety issues and harms of the use of particle beam radiation therapy? Key question 2 2. What instrumentation is needed for particle beam radiation and what is the Food and Drug Administration FDA status of this instrumentation? What is an estimate of the number of hospitals that currently have the instrumentation or are planning to build instrumentation for these therapies in the US? What instrumentation technologies are in development? Key question 3 Perform a systematic literature scan on studies on the use and safety of these therapies in cancer, with a synthesis of the following variables: Type of cancer and patient eligibility criteria 3. Type of radiation, instrumentation and algorithms used 3. Study design and size 3. Comparator used in comparative studies. Length of followup 3. Concurrent or prior treatments 3.

Chapter 5 : Charged Particle Cannon | Zoids Wiki | FANDOM powered by Wikia

Presents a unified description of charged particle beams that is detailed enough for use as a text and comprehensive enough to stand as a reference. This treatment of particle beam physics prepares students to read the literature and to use accelerators effectively.

Edit The Charged Particle Cannon is, as its name implies, a cannon that shoots charged particles. The particles are accelerated until they reach high speeds, carrying enough energy to melt anything it comes in contact with. The Charged Particle Cannon was first mounted on the Death Saurer in the original Battle Story for the purpose of countering the heavily-armored Ultrasaurus. Some of the smaller Zoids, like the Geno Saurer , are required to anchor themselves down onto the ground via footlocks or similar objects in order to successfully fire the weapon. This is due to immense kickback from firing the cannon, and without firm grounding, a smaller Zoid would either have its projection steered off target or even be thrown back. The Death Saurer and similarly-sized Zoids could fire without anchoring primarily because of their great size and mass. The only exception is the Mega Death Saurer, which can walk about freely while exploiting its Charged Particle Cannon. In the Zoids Saga series, a large variety of particle cannons exist, and have different traits depending on the Zoid wielding it. These differences are often coupled with varying descriptions, such as the diffused particle cannon mentioned above. Zoids such as the Madthunder can resist particle cannons. Usage The following Zoids all possess Charged Particle Cannons, with some using variants of the weapon: Its only real weakness was the Particle Intake fan on its back, which, if destroyed, would prevent the use of the weapon. The revived Death Saurer in Guardian Force replaced the Particle Intake Fan with an armored Charged Particle Converter, and was therefore a much greater threat than the "standard" model. This ties in with its role in shock warfare, as it appears usable on the move; it can also be boosted with the Gyrocrafter Grade-Up weapon. The Zoids must raise vents along their tails and neck to fire the weapon. The vents release heat generated from the cannon, allowing the Zoids to fire without fear of inflicting self-harm through extreme overheating. The Geno Breaker can use its boosters to counteract the recoil, allowing the Zoid to fire its Focused Particle Cannon while hovering, which allows it to easily fire in almost any direction it wishes while in mid-air. It can also fire repeatedly without the use of any form of Converter or Intake Fan. However, when equipped with its standard CAS, it can also channel energy through its Buster Claws, using them to fire two additional Particle beams in sync with its original for tremendous destructive power in an attack known as the Diffused Particle Cannon. This feat was never replicated in any previous battles, nor does it occur in Fuzors. These can absorb energy from energy weapons and sunlight , but most notably also from other Charged Particle Cannons, and use them to power up its own Charged Particle Cannon. In the Battle Story, the Gairyuki was specifically designed to counter the Seismosaurus by absorbing its attacks and returning fire. It is also capable of channeling Charged Particle energy into its many small beam guns, increasing their penetration and power. In the Genesis anime, the Bio Volcano is shown to use this weapon both on the ground and in the air. Unlike the earlier versions mounted on the similarly-sized Geno Saurer or Berserk Fury, the Bio Volcano has no heat exhaust vents nor footlocks. In the anime, it was seen to be able to be fired in midair, and is capable of incredible destructive power. In the Genesis anime, this gun is built from data collected from the Bio Volcano, but is upgraded to sport more power. Gravity Edit Although not a strict Anti-Particle defense, on at least two occasions gravity it has been shown to affect the trajectory of Particle beams. The attack was launched at a high angle into space, and curved back to strike a target on the ground. Also of note is that it is stated in Guardian Force that the Dibison has power equivalent to that of a Charged Particle Cannon. This claim is put to the test, and although the Megalomax Attack does match the Charged Particle Cannon initially, the Dibison overheats and explodes, allowing the Charged Particle Cannon to overpower it. In Fuzors , Charged Particle Cannons are used quite frequently, but rarely do significant damage. There are no specific Anti-Particle defenses in Fuzors. Offense-wise, Genesis had the Bio Volcano and Bio Tyranno use their cannons against each other, with varying results at least in part due to the Tyranno upgrading its cannon after the initial conflict , although in both instances, both Zoids survive with minimal-to-no damage, but in the latter of the two instances, both cannons were disabled by the action.

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Chapter 6 : A deeper look into lasers, particle beams, and the future of war - ExtremeTech

Chapter-length topics include beam emittance, beam-generated forces, electron and ion guns, high-power pulsed electron and ion diodes, paraxial beam transport with space charge, high-current electron beam transport under vacuum, and ion beam neutralization.

Ion flow enhancement in magnetically-insulated diodes 9. Paraxial Beam Transport with Space-charge 9. Envelope equation for sheet beams 9. Paraxial ray equation 9. Envelope equation in a quadrupole lens array 9. Limiting current for paraxial beams 9. Multi-beam ion transport 9. Longitudinal space-charge limits in RF accelerators and induction linacs High-current Electron Beam Transport under Vacuum Motion of electrons through a magnetic cusp Propagation of beams from an immersed cathode Brillouin equilibrium of a cylindrical electron beam Interaction of electrons with matter Foil focusing of relativistic electron beams Wall-charge and return-current for a beam in a pipe Drifts of electron beams in a solenoidal field Guiding electron beams with solenoidal fields Electron beam transport in magnetic cusps Ion Beam Neutralization Neutralization by comoving electrons Current neutralization in vacuum Focal limits for neutralized ion beams Acceleration and transport of neutralized ion beams Electron Beams in Plasmas Space-charge neutralization in equilibrium plasmas Oscillations of an un-magnetized plasma Oscillations of a neutralized electron beam Magnetic skin depth Return current in a resistive plasma Limiting current for neutralized electron beams Propagation in low-density plasmas and weakly-ionized gases Instabilities of space-charge-dominated beams in periodic focusing systems Betatron waves on a filamentary beam Frictional forces and phase mixing Transverse resonant modes Transverse resistive wall instability Hose instability of an electron beam in an ion channel Resistive hose instability Filamentation instability of neutralized electron beams Beam-generated axial electric fields Negative mass instability Longitudinal resistive wall instability Generation of Radiation with Electron Beams Driving resonant cavities with electron beams

Chapter 7 : science based - Charged Particle Beam propagation in air - Worldbuilding Stack Exchange

The primary advantage of the charged particle beam type of wea passing through the atmosphere as is the case with a laser beam weap0n.l Thus; a charged particle beam weapon could be employed at a.

Chapter 8 : Introduction - Particle Beam Radiation Therapies for Cancer - NCBI Bookshelf

Understanding the focusing of charged particle beams in a solenoid magnetic ï¬•eld Vinit Kumara Beam Physics and Free Electron Laser Laboratory, Raja Ramanna Centre for Advanced Technology.

Chapter 9 : Charged Particle Beams

Although particle accelerators are the book's main thrust, it offers a broad synoptic description of beams which applies to a wide range of other devices such as low-energy focusing and transport systems and high-power microwave sources.