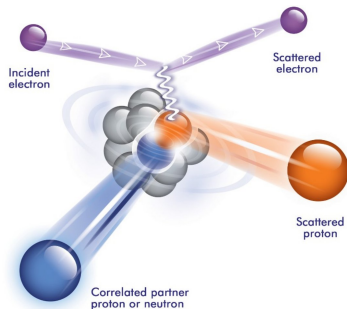
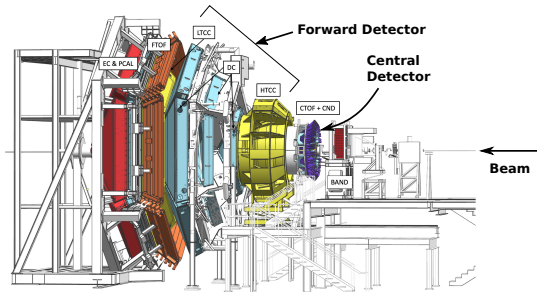


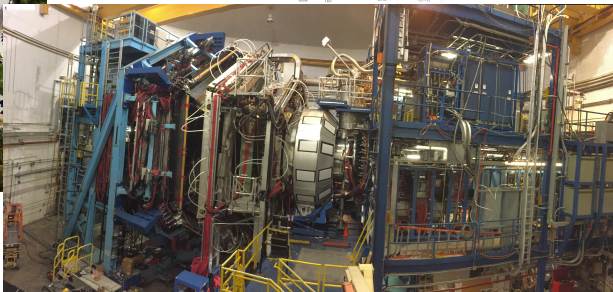
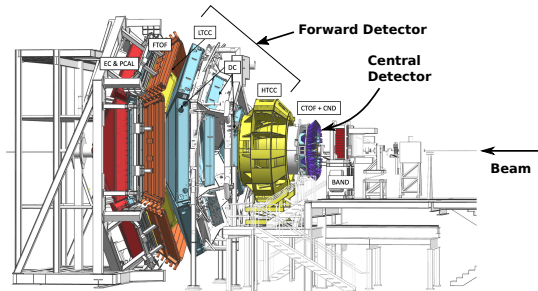
One of the essential tools for probing the structure of matter is scattering. Two sub-atomic particles collide and the properties of the debris tell us about the forces. In the figure an incident electron knocks a proton out of an atomic nucleus along with some other particles. If we can select events that are elastic (no kinetic energy lost in the collision), then we can 'see' the internal structure of the nucleon.

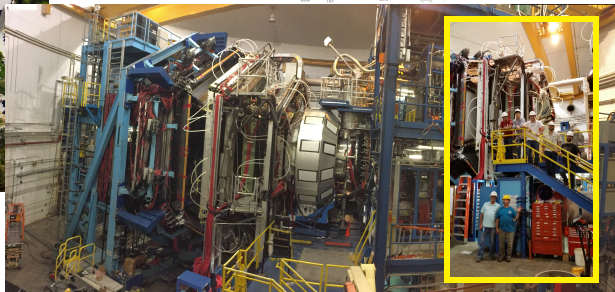
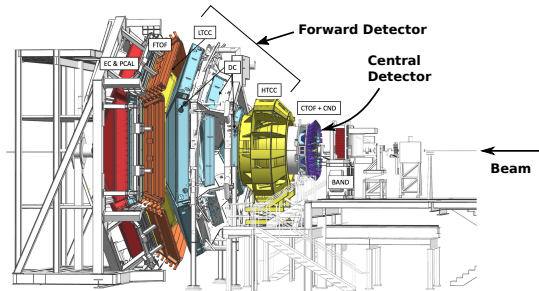


What is the energy of the scattered electron in terms of the incident/beam energy of the electron and angle θ with respect to the beam direction? How would you select these particles?









Two particles of identical mass m collide perfectly inelastically in one dimension. The initial momentum of one particle is $v_i = 0.5c$. The other is stationary. What is the final velocity in the Home frame in terms of v_i ?

If the Other frame is moving with the projectile is the 3-momentum still conserved?

primes refer to the frame moving with velocity v .

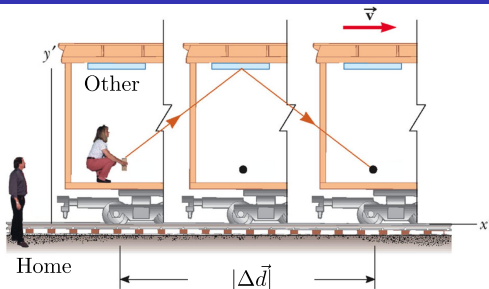
v - velocity of moving frame.

$u_i - i^{th}$ component of the velocity of an object in the stationary frame.

$u'_i - i^{th}$ component of the velocity of an object in the moving frame.

$\gamma = \frac{1}{\sqrt{1-v^2/c^2}}$ where c is the speed of light.

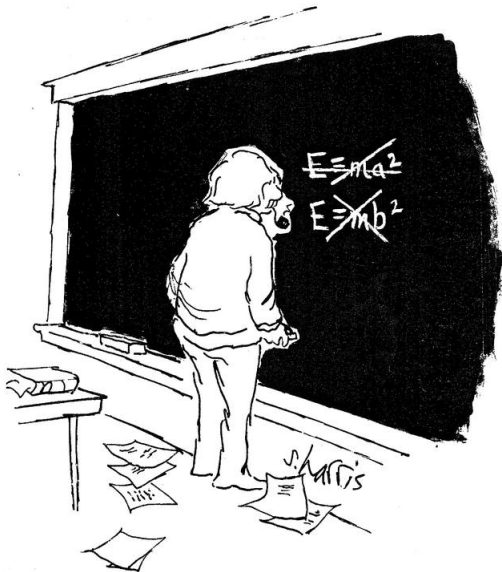
Galilean	Lorentz
$x' = x - vt$	$x' = \gamma(x - vt)$
$y' = y$	$y' = y$
$z' = z$	$z' = z$
$t' = t$	$t' = \gamma(t - vx/c^2)$
$u'_x = u_x - v$	$u'_x = \frac{u_x - v}{1 - u_x v / c^2}$
$u'_y = u_y$	$u'_y = u_y$
$u'_z = u_z$	$u'_z = u_z$



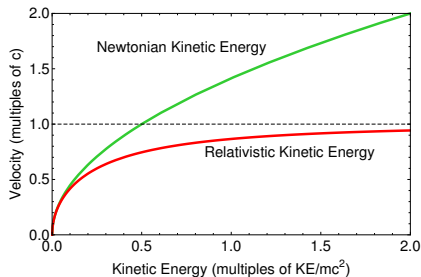
unprimed - Home
primed - Other

Metric Equation: $\Delta s^2 = c^2 \Delta t^2 - \Delta d^2 = \Delta s'^2 = c^2 \Delta t'^2$ (SI units)

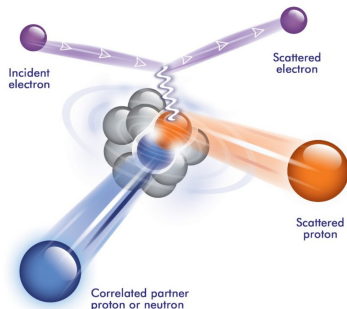
Coordinate Time	Proper Time	Spacetime Interval
Time between two events in an inertial frame measured with synchronized clocks	Time between two events measured by the same clock at both events.	Time between two events measured by the same, inertial clock at both events.
Δt	$\Delta \tau_{SI} = \int_{t_A}^{t_B} \sqrt{1 - v^2/c^2} dt$	$\Delta s_{SI}^2 = c^2 \Delta t^2 - \Delta \vec{d} ^2$
Frame dependent	Frame independent	Frame independent



An electron is accelerated to an energy $E = 6 \text{ GeV}$ where $1 \text{ GeV} = 10^9 \text{ eV}$ at the Thomas Jefferson National Accelerator Facility in Newport News. What is the electron's speed, relativistic mass, and kinetic energy?

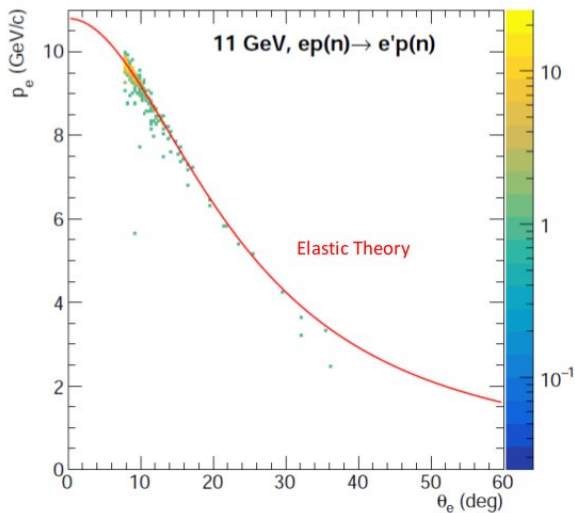


One of the essential tools for probing the structure of matter is scattering. Two sub-atomic particles collide and the properties of the debris tell us about the forces. In the figure an incident electron knocks a proton out of an atomic nucleus along with some other particles. If we can select events that are elastic (no kinetic energy lost in the collision), then we can 'see' the internal structure of the nucleon.



What is the energy of the scattered electron in terms of the incident/beam energy of the electron and angle θ with respect to the beam direction? What is the energy of a scattered electron at $\theta = 10^\circ$? How would you select these particles?

p_e vs θ_e



What is the energy and angle of the scattered proton?

