Goniometer Control System for Coherent Bremsstrahlung Production

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Why use Coherent Bremsstrahlung?

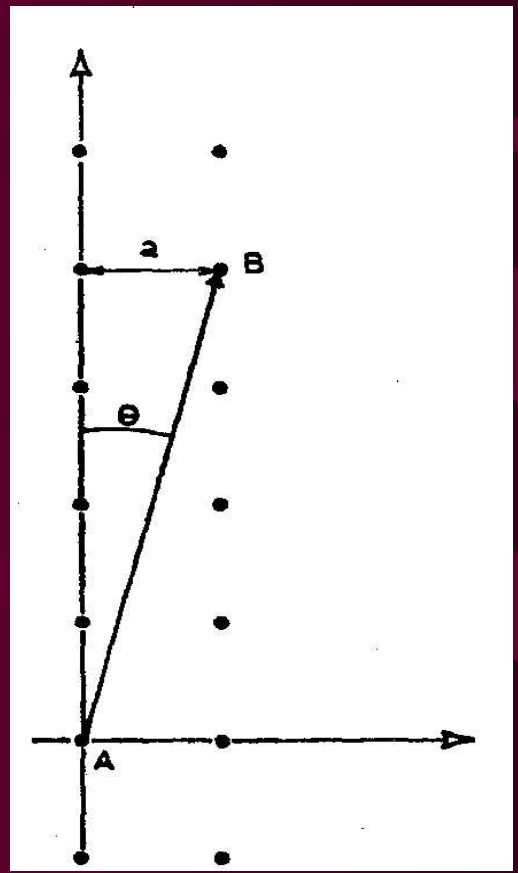
- **End result is a quasi-monochromatic, high intensity photon beam**
- **Upcoming experiments will then use the beam to study (among others) the A-dependence of J/Ψ formation**

What is Coherent Bremsstrahlung?

- Bombard crystalline structure (diamond) with electron beam.
- If crystal is oriented at certain quantized angles, quasi-monochromatic, high intensity photon beam is emitted.
- This effect is coherent bremsstrahlung

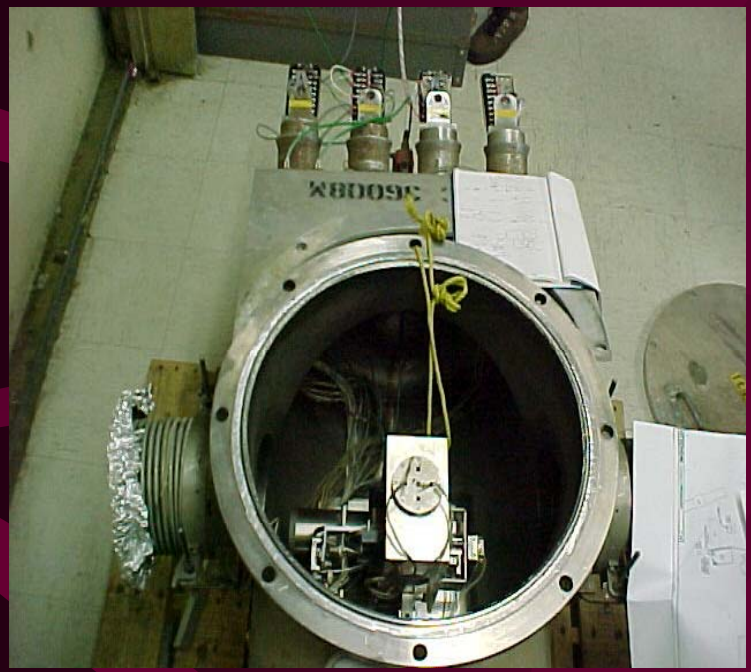
Theoretical Considerations

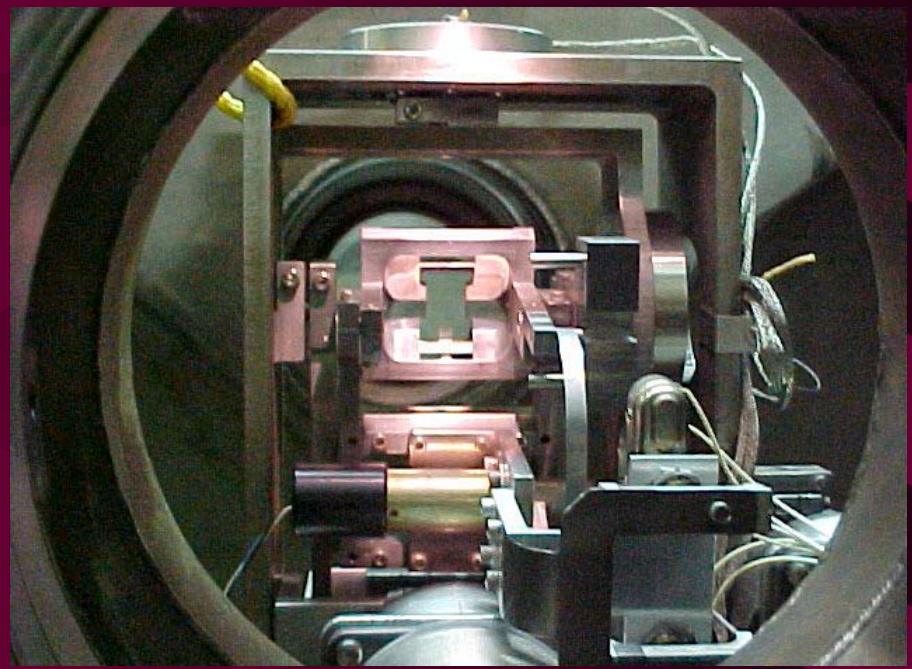
- **Effect is created by constructive interference between electrons and atoms in parallel lattice planes**
- **Constructive Interference:**
  $2\pi n/a = \delta/\theta$
- **Minimum momentum transfer:**
  $\delta = K/(2E^2(1-K/E))$
- **Therefore:**
  If we know K and E, then we should be able to create coherent bremsstrahlung by altering diamond angle, θ.



What is a Goniometer?

Goniometer sets and holds diamond at precise angles with respect to electron beam





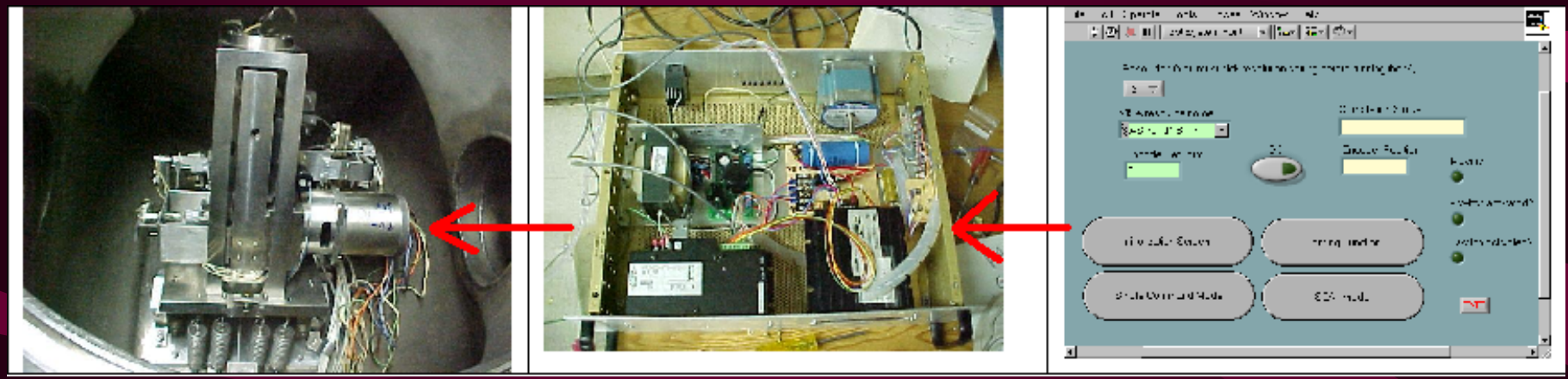
The Goniometer Team

Mentor:
Perry
Anthony

Engineer:
Paul Stiles

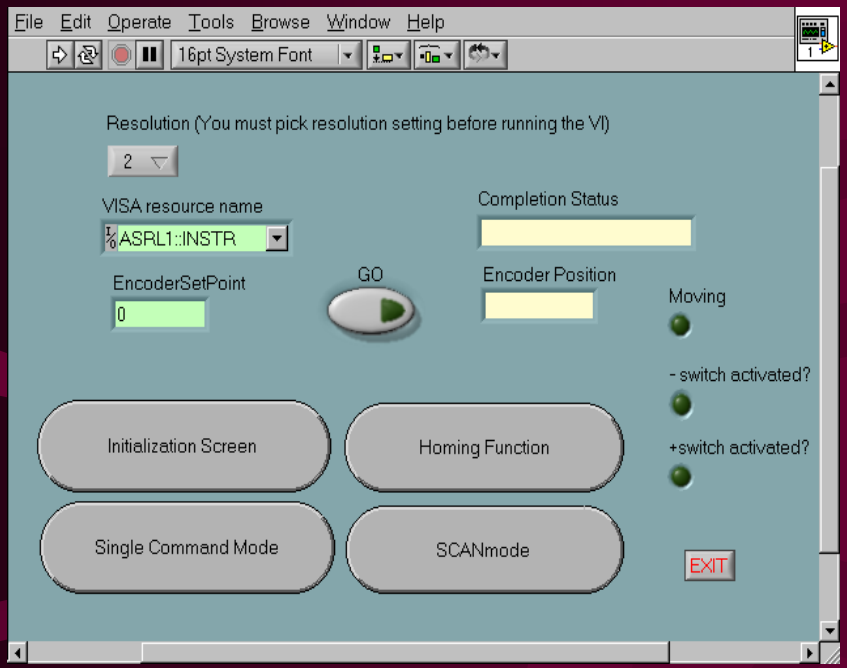
ME

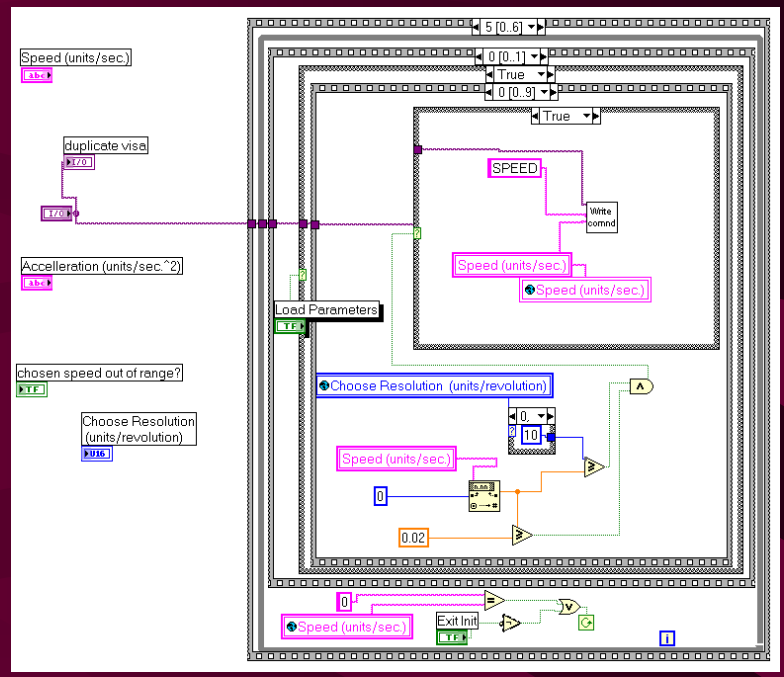
Overview of Goniometer Control System



- The goniometer is controlled by two stepping motors which rotate the diamond about the θ_v and θ_h axes.
- The stepping motors are connected to a control box which is communicated to via a LabVIEW program.

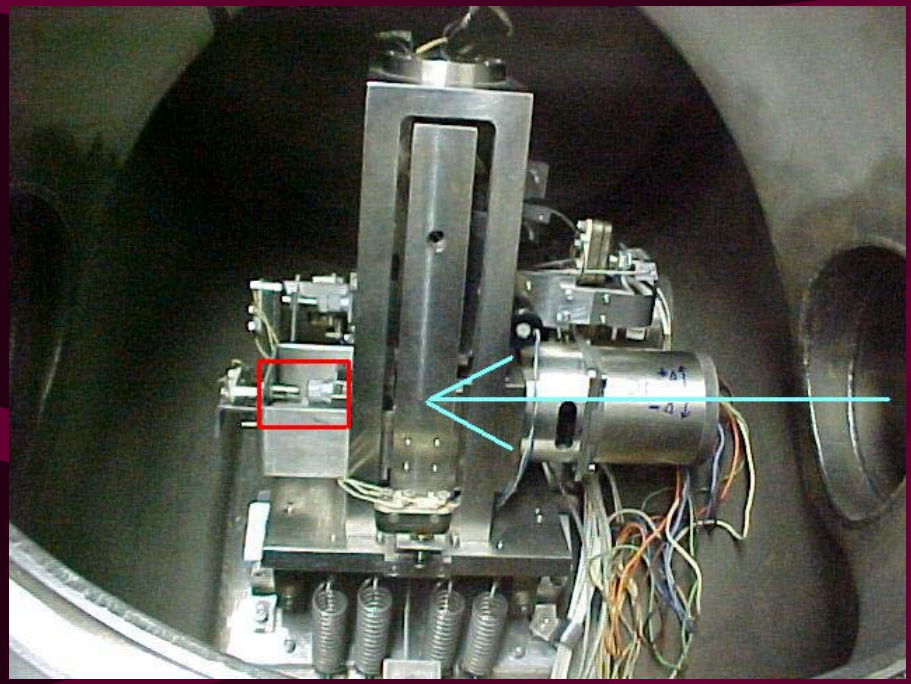
LabVIEW Control System

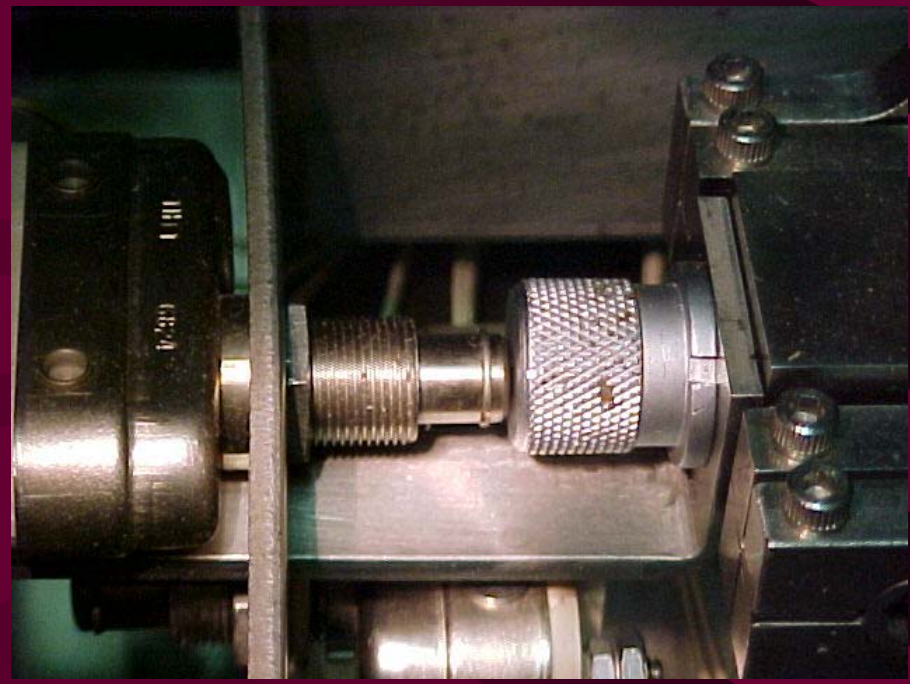




- The goniometer was connected to a LabVIEW control program.
- The program is able to move the goniometer along both axes.

Range of Motion





- Limit switches DO work.
- They prevent motor from jamming in both axes.
- The stepping motors move in increments of 1/200 of a revolution.
- This corresponds to ~25 μrad. of diamond motion.

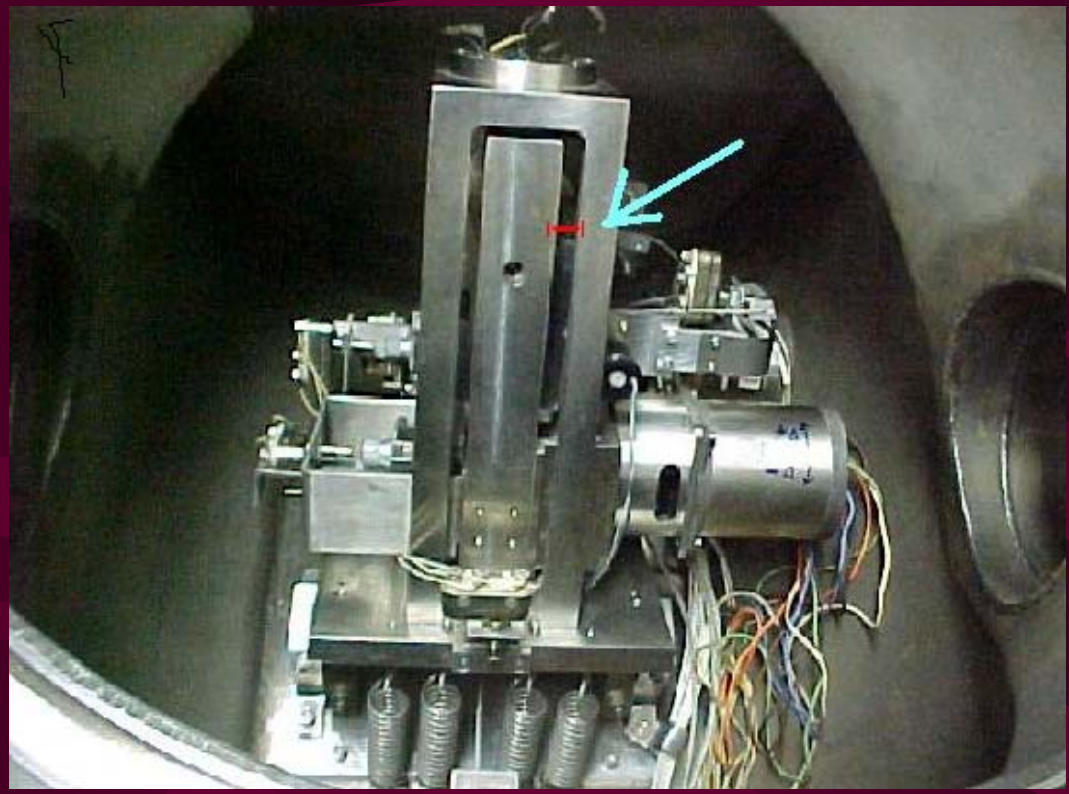
Directional Limits of the Goniometer		
Axis	Stepping Motor Range of Motion	Diamond Range of Motion
θ_h	35 revolutions	.175 rad. = 10 deg.
θ_v	22.5 revolutions	.113 rad. = 6.5 deg.

Measuring Actual Angular Shift/Step of Diamond

E (GeV)	K (GeV)	θ (μrad.)
48.3	35.2	1587
48.3	35	1543
45	25	894
45	26.5	888
45	14.8	305
26.7	15	1360

For proposed photon and electron energies, we need small, precise diamond angular displacements

Measuring Actual Angular Shift/Step of Diamond



- Measured in two different places, two trials each.
- Average angular shift/step = 23.2 μrad.
- Measurements involved linear approximations, so they are expected to underestimate.

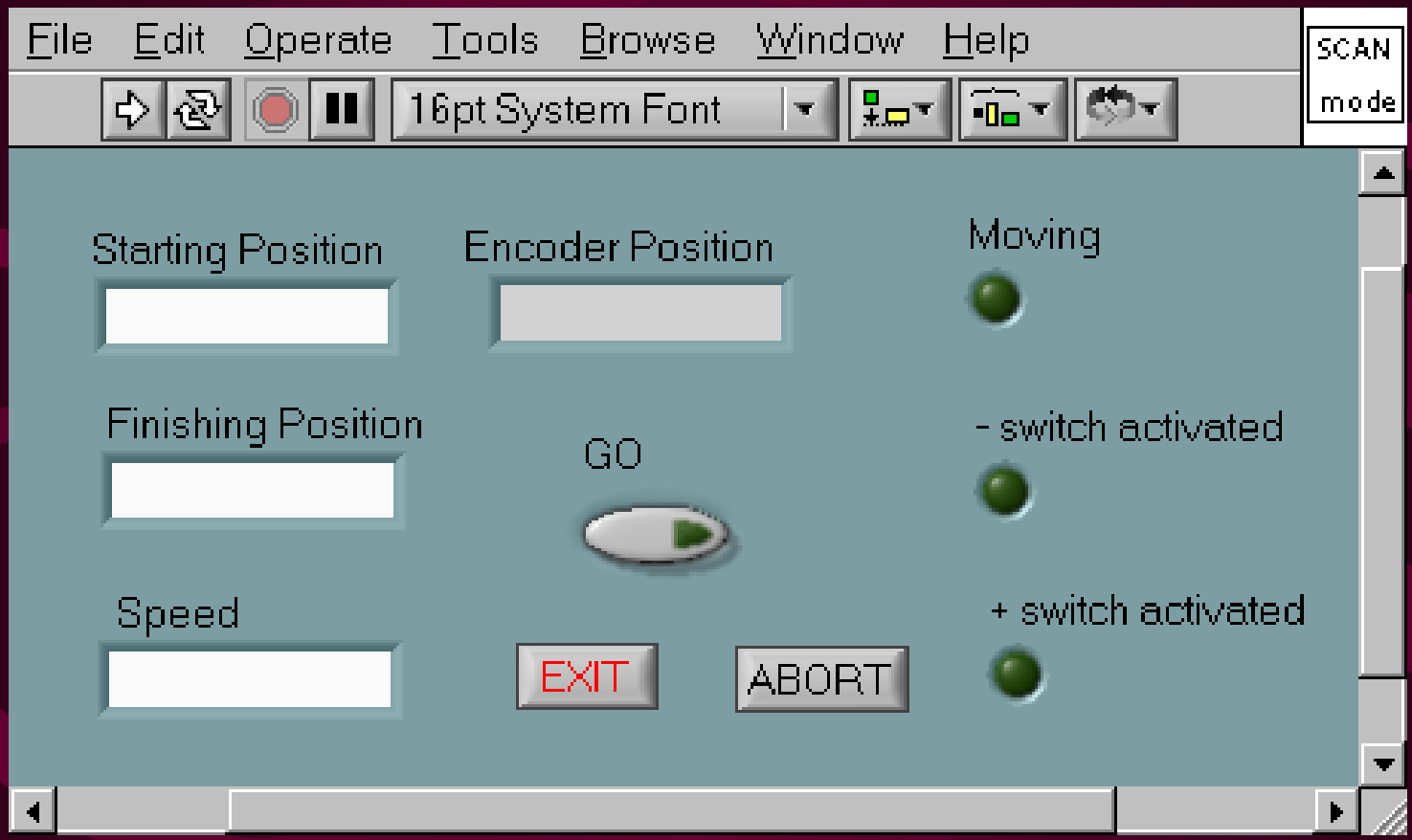
MicroSyn

- Electronic circuit used to place diamond in proper location
- Final circuitry is not ready.
- However, a prototype on a breadboard was tested.
- It appears to give an accurate measurement of the goniometer position.

Special Program Functions

Homing Function

ScanMode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SCAN mode
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Starting Position
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Moving
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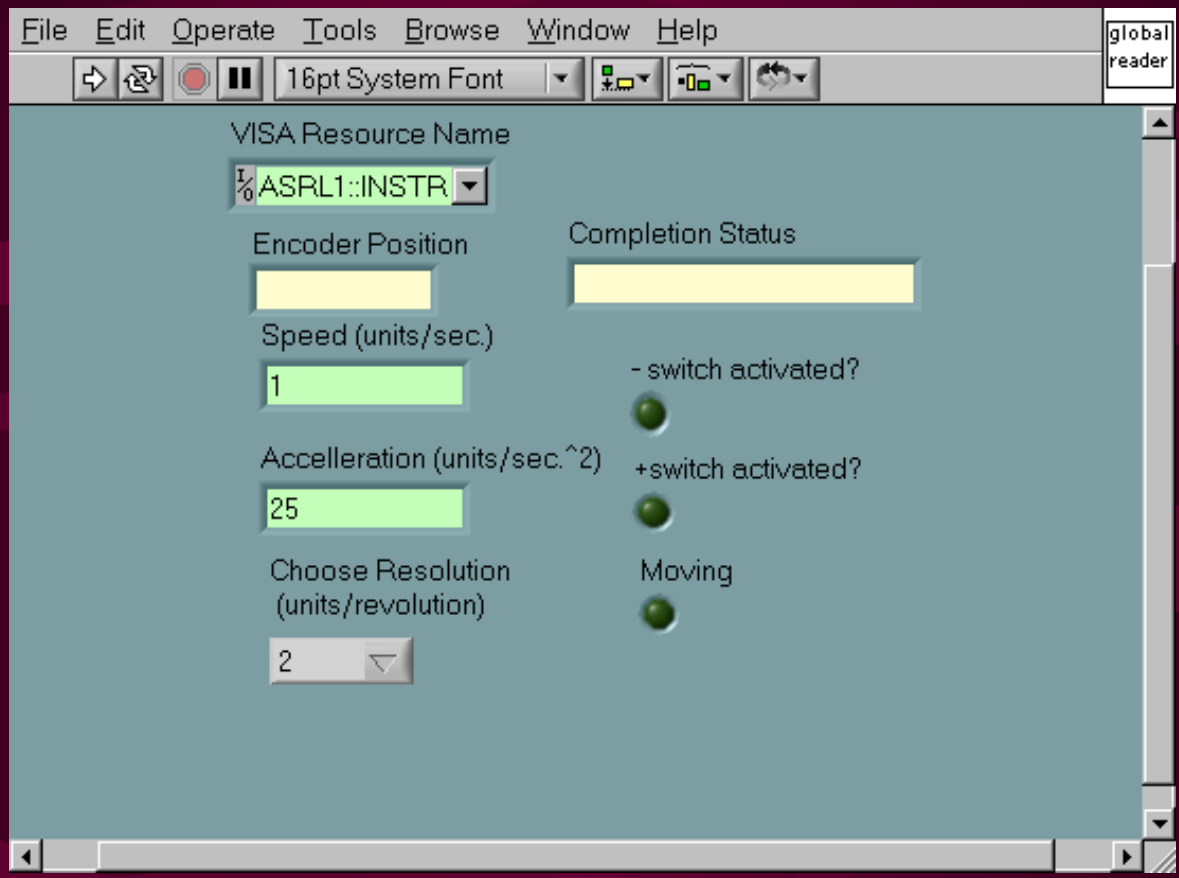
GO
- switch activated
Speed
+ switch activated
EXIT
ABORT

Global Indicators



Acknowledgements

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