Slide notes

Slide 1
This is simply the introduction slide
I apologise for my absence.

Slide 2
This slide provides an introduction to the Cassini spacecraft.
The points are self explanatory
Points of interest on the space craft for this talk are the
High Gain Antenna (HGA). This is the big dish at the top.
The Fields and Particle Pallet, mid way on the right hand side. This is where the Electron Spectrometer is.
The Radioisotope Thermoelectric Generators (RTG) and in particular the heat shades that lie above them. There are 3 RTG's and the shades are just above them. They are there to protect the infra red camera from hot spots on the RTG's.
These three elements (RTG, HGA, ELS) are the main topics of this talk.

Slide 3
Okay, so now we show the electron spectrometer ELS.
The right hand image just shows the whole spacecraft with people next to it to show the size.
The left hand image shows the complete Cassini Plasma Spectrometer CAPS.
The ELS is the silver part on the left hand side.
The rest of the CAPS is the IMS and the IBS.

Slide 4
The upper image shows the micro channel plate inside the ELS.
The first point refers to the dark semi circular plate shown in the image. Notice it spans 160 degrees. It is split into 8 sectors called anodes. Each anode is therefore 20 degrees.
The second point refers to the Actuator. This is located where the ELS joins the main bulk of the CAPS. The actuator rotates through 200 degrees (-100 to +100).
The third point: Because the instrument moves and where the instrument is located on the sc, the field of view is sometimes affected.
And so the most clear view is to be found on anode 4, the central anode, and when the actuator is at 0 degrees

Slide 5
So in this slide the new image shows the effect of the instrument movement and the location on the field of view.
We can see the anodes on the vertical axis and the actuator on the horizontal axis. And the image shows parts of the sc that enter the ELS field of view.

Slide 6
Here we show a typical example of some ELS data.
The vertical axis shows energy in eV. The energy scale of the instrument is a 63 logarithmically spaced scale from 0.5 eV to 26,000eV

The horizontal axis shows time in hours, radial distance in Saturn radii, latitude in degrees and local time in hours.
The entire plot spans two days (48 hours) and shows a periapsis pass.
The colors in the plot show electron counts with a color scale to the right.

[Might want to go to the next slide here]

At the start of day we see hot electrons at about 1000eV, these then become very dense and cold (down to 1eV) at the closest approach. Then as the sc moves away from the planet the electrons become hotter and less dense.
At the bottom right and left corners we see photoelectrons. These vanish as the plasma becomes dense and the sc potential becomes negative.

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Slide 8
This slide is intended to show some examples of the various types of plasma that we can see using the ELS
So we have magnetosheath electrons……..

Slide 9
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And electrons from the outer magnetosphere……..

Slide 10
This slide is intended to show some examples of the various types of plasma that we can see using the ELS
So we have magnetosheath electrons……..

And electrons from the outer magnetosphere……..

And here photoelectrons vanishing again as we fly past Titan. Titan has a dense ionosphere, so the sc potential will become negative.

Slide 11
Now, here is where my main point starts.
The plot shows photoelectrons shortly before periapsis seen on the far right.
But there is structure in these photoelectrons as seen in the middle of the plot where they simply disappear.
But also notice the thin band at about 20eV that continues.
What is this?
Is it ionospheric photoelectrons maybe?

Slide 12
Well No.
I see this kind of thing happening almost everyday, so it happens away from Saturn as well as near indicating that this narrow band is not ionospheric in origin.
So what is it?

Slide 13

Slide 14
Well here I show three plots. The top is the spectrogram as before.
The middle plot is the actuator value. We can see that it is constantly moving.
Now the lower plot, is the xyz components of the direction vector from the sc to the sun.
As shown x is blue, y is green, and z is red.
So if z = -1, then the sc is orientated such that the HGA is pointed to the sun.
If this happens, the main body of the sc is in shadow and so the sc potential will be low or even negative.
When z is not equal to -1 then the sun is shining on the main sc body and so the potential will probably be positive.

Slide 15
So I have taken two sample periods. First between 6-7 o'clock
Then between 7-8.
I have averaged the data in these two periods.

Slide 16
And here I plot the averaged data.
The x-axis shows energy in eV
The y-axis is the counts of the averaged data.
The black lines are the average data from 7-8 o'clock
The coloured lines (red, green , blue) is the averaged data from 6-7.
The panels are laid out thus; left to right show the data from actuator value from -100, 0, 100 degrees.
Top to bottom show the data from anodes from 1,4,8

Slide 17
And so we see that there is some common points.
It would appear that the thin band that we saw at 20 eV, shown in this plots as a bump at 20eV, is only shown in the red squared plots.
So we only see the thin beam, when the sc is in shadow from the HGA, when the anodes are looking in a certain direction.
We don't see it on anode 8,
We don't see it on anode 1 if the actuator is at 100 degrees.
So let's see what these anodes are looking at.

Slide 18
These are the engineering drawings of the sc.
There is a yellow mark on each diagram that shows the ELS.
In the central diagram I have put a piece of paper that shows the anode look direction.
We can see that anode 8 looks largely up to the HGA.
But anode 1-4 are looking down to the shades on the RTG's.

Also notice that the shades over the RTG's are actually wider than the HGA, so if the HGA is shading the sc then the tips of the shades will still be sunlit. This is best seen in the central diagram.

Slide 19
In these diagrams an actuator value of 0 would be looking straight up on the right hand diagram, and it would be -100 to the right and +100 to the left. So if the actuator is at -100 then we will be looking at the shade seen at the top of the right hand diagram.

Slide 20
Right so here is my model of the cassini sc that I have made using the SPINE. It shows the three heat shades over the RTG's, it has the HGA, and I have put the mag instrument boom on. This is obviously, work in progress, and I am still building this.
The measurements of this model are taken from the diagrams shown previously.

Slide 21
And here are my results. I'm still learning how to use the software so I'm no expert on this bit, but they do show some pleasing results. These were done on the model before the mag boom was added.
I have put in an electron and ion density of 800 m^-3. This is what we would get from the electron data shown before.
I have put on some materials as listed. I'm still trying to track down someone at NASA to tell me what the actual materials are.

So we can see in the upper plot that when the sc is in shade from the HGA, the sc potential of the sc body is low, as expected. But the potential on the tips of the shades is high.

Then when we move the sc so that the sun illuminates the body we can see the potential increase as expected.

Slide 22

So I think this is self explanatory.
It is work in progress, and I am still learning the software.
I have some more plans to use the SPINE software with other projects, such as, the negative potential problem with Cassini. We could use it on VEX, because the ELS anodes sweep past the solar panels as the actuator moves. Very interesting.
I'm keen to know how to use the particle trajectories in SPINE.

Slide 25
These are some of the other data products I got out of SPINE from the work so far.