

# Thin Films for the Transport of Polarized Ultracold Neutrons for Fundamental Symmetry Study

Russell R. Mammei

Dissertation submitted to the Faculty of the  
Virginia Polytechnic Institute and State University  
in partial fulfillment of the requirements for the degree of

Doctor of Philosophy  
in  
Physics

Robert Bruce Vogelaar, Chair  
Jean Heremans  
Giti Khodaparast  
Mark L. Pitt

August 11, 2010  
Blacksburg, Virginia

Keywords: Polarized Ultracold Neutrons, Neutron Beta Decay, Standard Model Tests,  
Polarized Neutron Guides, Diamond-Like Carbon, Pulsed Laser Deposition, Ebeam  
Evaporation, Electropolishing, Mechanical Polishing, Surface Roughness

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# Albert Young(co-PI) representing the UCNA collaboration

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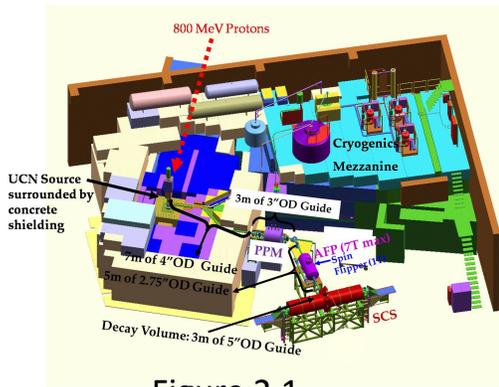


Figure 2.1

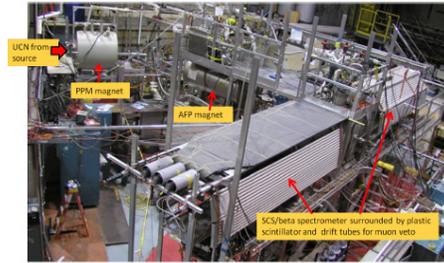


Figure 2.2

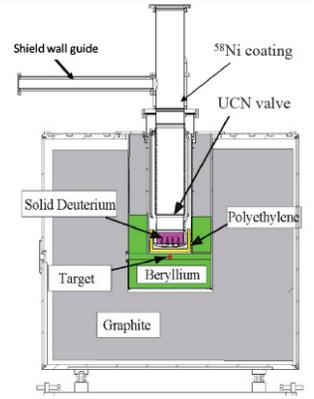


Figure 2.3: LANL UCN source

Figure 2.3

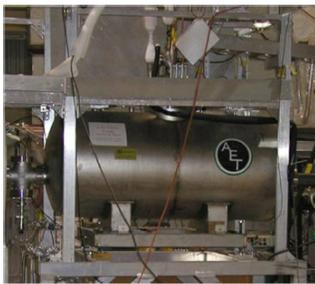


Figure 2.4



Figure 2.12

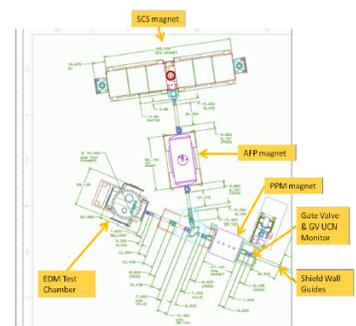
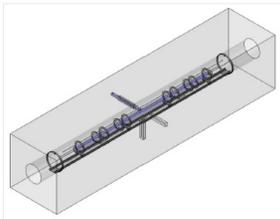


Figure 2.14



(a) Practice square quartz guide mating to the center decay trap guide. (b) The three decay trap guides in their rail system.



(c) CAD drawing of the quartz decay trap inside the bore of the SCS magnet.

Figure 2.15

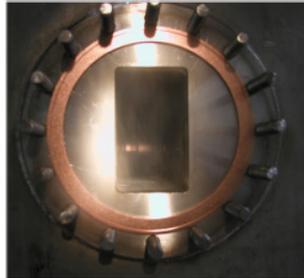


Figure 2.16



Figure 2.23

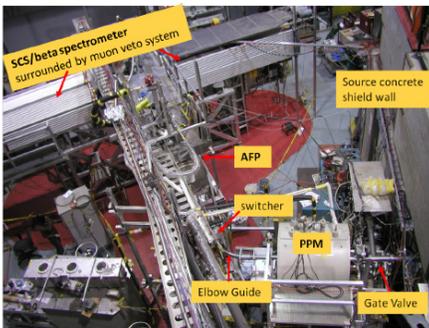


Figure 2.20

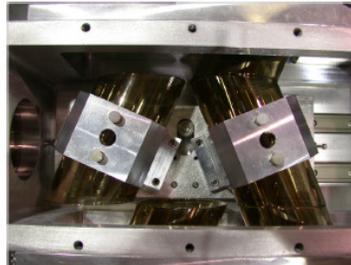


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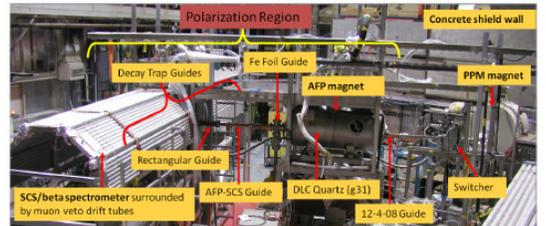


Figure 2.22



Figure 2.23

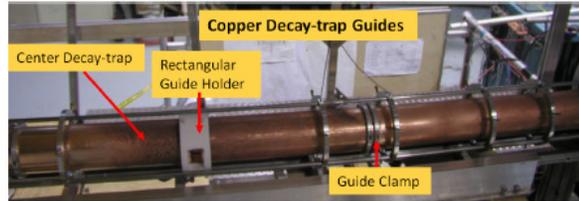


Figure 2.24



Figure 2.25

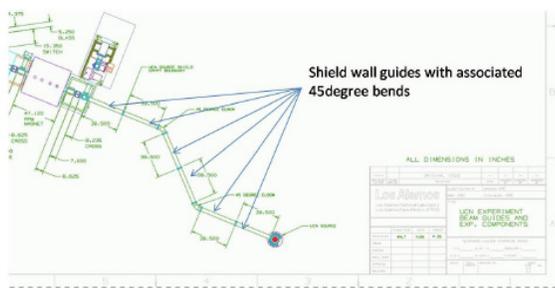


Figure 6.1

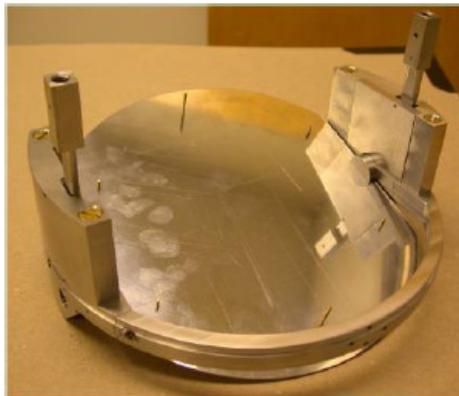


Figure 6.8



Figure 6.4

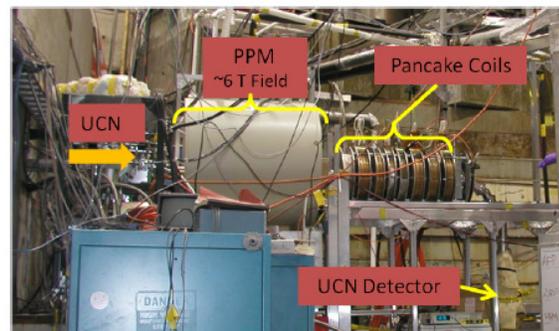


Figure 7.16

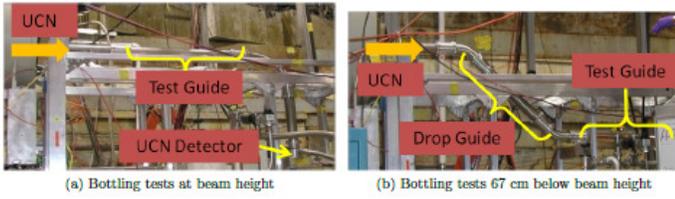


Figure 7.17

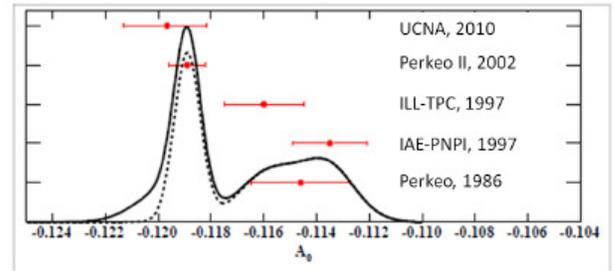


Figure 8.2

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**From:** Albert Young <albertr.young@gmail.com>  
**Date:** Wed, 11 Aug 2010 11:53:58 -0400  
**To:** Russell Mammei <rrmammei@vt.edu>

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On behalf of the UCNA collaboration, I give you permission to use the figures you've selected for your thesis.

Thanks  
Albert

On Tue, Aug 10, 2010 at 9:34 PM, Russell Mammei <[rrmammei@vt.edu](mailto:rrmammei@vt.edu)> wrote:

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I hope everything is going well with you.

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Attached is a list of figures that I am using in my thesis, that are associated with the UCNA experiment.

On behalf of the UCNA experiment, may I have your permission to use this figures?

Thanks.

Russ

--  
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Blacksburg, VA 24061-0435  
Phone: (540)-231-3078  
Fax: (540) 231-7511  
e-mail: [rrmammei@vt.edu](mailto:rrmammei@vt.edu)

**A. T. Holley**

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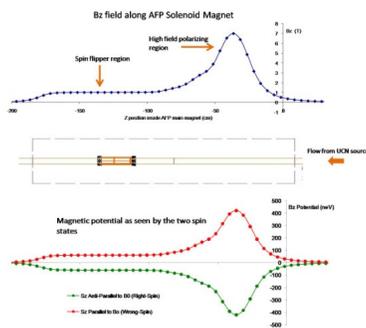


Figure 2.5

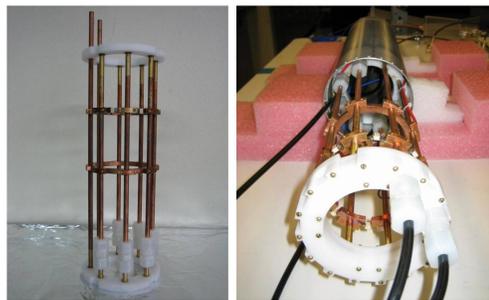


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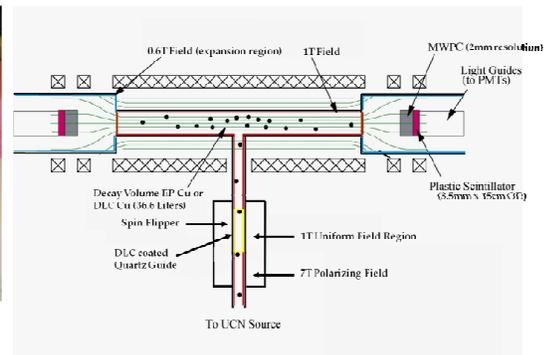


Figure 2.7

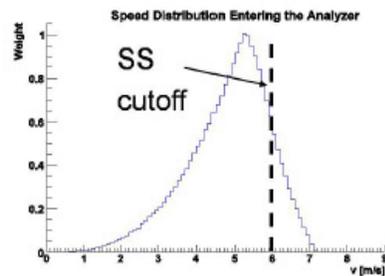


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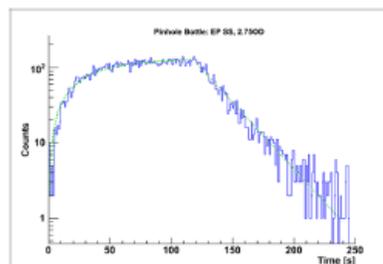


Figure 7.18

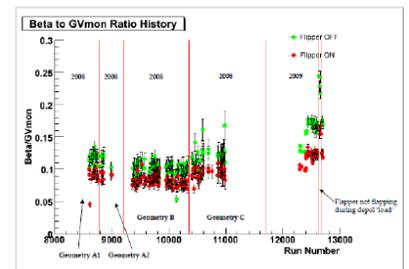


Figure 8.1

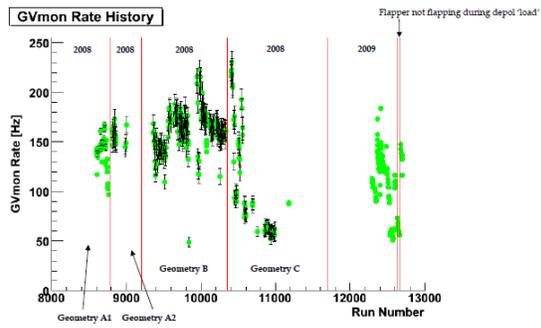


Figure ?

**Subject:** Re: copy write permission to use pictures associated with the UCNA experiment.  
**From:** Adam Holley <atholley@ncsu.edu>  
**Date:** Fri, 06 Aug 2010 09:49:16 -0400  
**To:** Russell Mammei <rrmammei@vt.edu>

Hey Russ,

You may most certainly use any of my pictures that you'd like!

About source performance numbers... unfortunately my cryptocard needs to be replaced (again), which means that I don't have access to the logbook or any data at the moment. As a result, although I do have data from 2007 (crossed polarizer measurement) as well as from the year after we changed the transport in the shield stack from DLC to SS, I can't easily correlate any particular runs I have with the state of the source etc. or download any additional data. If you have any particular runs or a range or runs for which you'd like to know the gate valve rate I can look to see whether I have the data, however. Otherwise, you may be able to find a fairly good history of GVmon rates by just paging through the logbook. Remember to keep in mind that at some point (between 2007 and 2008 I think) we moved the GVmon hole to the upstream side of the GV; after that move one needs to be careful, of course, about whether the rate is a GVopen or GVclosed rate.

Congrats on being so close to finishing your thesis! I'm finally getting towards the end of my primary analysis and have written the bulk of my two main analysis chapters. I plan to start the final writing phase in September... as well as start looking for jobs (which I haven't done yet). So I'm getting there, but it generally feels like a whole lot to do (a feeling I'm sure you know very well).

See 'ya...

Adam

On Thu, Aug 5, 2010 at 12:03 PM, Russell Mammei <[rrmammei@vt.edu](mailto:rrmammei@vt.edu)> wrote:

Hi Adam,  
I hope everything is going well with you.

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Thanks.

Russ

--  
Russell Mammei  
Department of Physics, Robeson Hall  
Virginia Tech  
Blacksburg, VA 24061-0435  
Phone: (540)-231-3078

## **B. Plaster**

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Figure 2.9

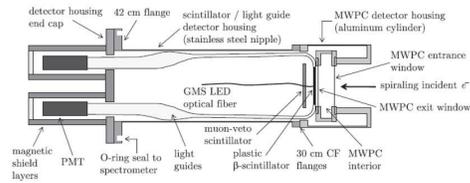


Figure 2.8

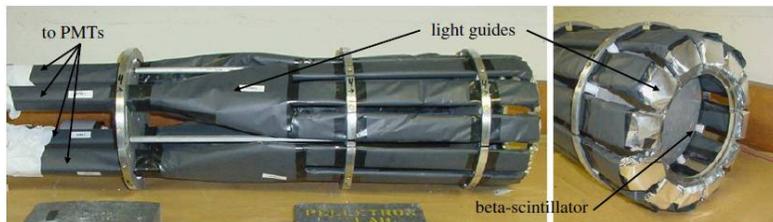


Figure 2.11

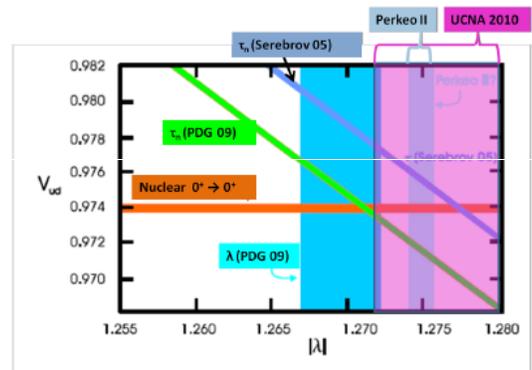


Figure 8.3

**Subject:** Re: [Fwd: copy write permission to use pictures associated with the UCNA experiment.  
**From:** Brad Plaster <brad.plaster@uky.edu>  
**Date:** Thu, 05 Aug 2010 12:44:58 -0600  
**To:** Russell Mammei <rrmammei@vt.edu>

Hi Russ,

Yes, you may certainly use these figures.

Good luck,  
Brad

On Thu, Aug 5, 2010 at 9:58 AM, Russell Mammei <[rrmammei@vt.edu](mailto:rrmammei@vt.edu)> wrote:

Hi Brad,  
I hope everything is going well with you.

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Thanks.

Russ

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**M. Makela**

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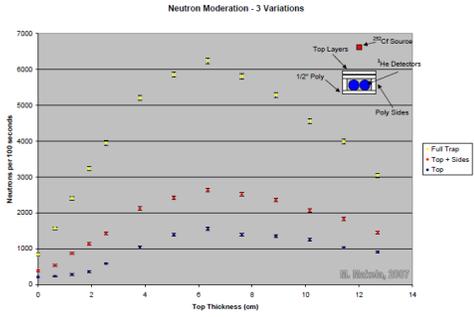


Figure 6.7



Figure 2.18

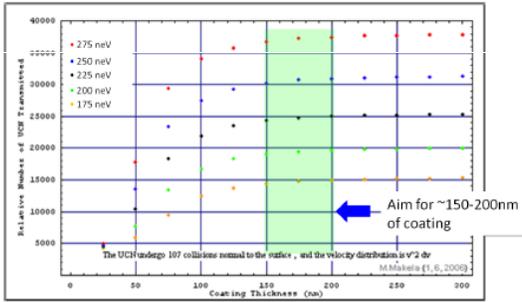


Figure 3.2

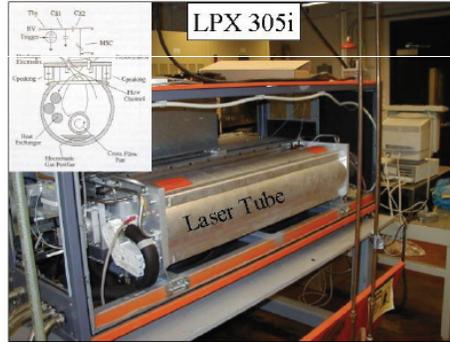


Figure 3.23

**Subject:** Re: copy write permission to use pictures associated with the UCNA experiment.  
**From:** "Mark F. Makela" <makela@lanl.gov>  
**Date:** Thu, 05 Aug 2010 11:01:59 -0600 (MDT)  
**To:** Russell Mammei <rrmammei@vt.edu>

Hello,

You have my permission to use these images. Glad to hear you are about done with this ride, on to the next.

Best of luck; Mark

Hi Mark,  
I hope everything is going well with you.

As you know, I am required by Virginia Tech to obtain permission for every figure that is not my own. Attached is a list of figures that I am using in my thesis, that are associated with your work concerning the UCNA experiment. May I have you permission to use this figures?  
Thanks.  
Russ

--

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Mailing Address:  
Mark Makela

**Chris Morris**

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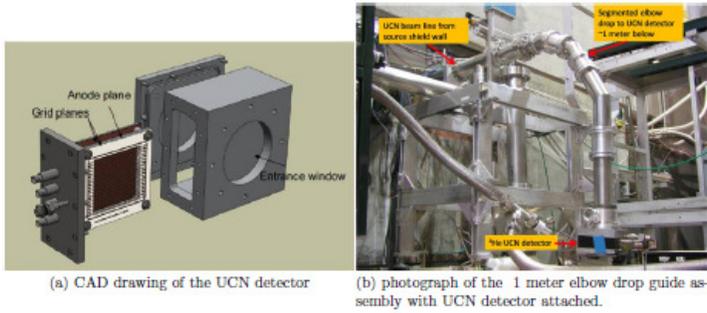


Figure 2.13

**Subject:** RE: copy write permission to use pictures associated with the UCN monitor detector  
**From:** "Morris, Christopher" <cmorris@lanl.gov>  
**Date:** Thu, 05 Aug 2010 11:10:53 -0600  
**To:** Russell Mammei <rrmammei@vt.edu>

Hi Russ,

You have my permission to use these.

Thanks  
Chris

-----Original Message-----

From: Russell Mammei [<mailto:rrmammei@vt.edu>]  
Sent: Thursday, August 05, 2010 9:53 AM  
To: Morris, Christopher  
Subject: copy write permission to use pictures associated with the UCN monitor detector

Hi Chris,  
I hope everything is going well with you.

I am required by Virginia Tech to obtain permission for every figure that is not my own. Attached is a list of figures that I am using in my thesis, that are associated with your UCN monitor. May I have you permission to use this figures?

Thanks.  
Russ

--  
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e-mail: [rrmammei@vt.edu](mailto:rrmammei@vt.edu)

# Steve Irving of Irving Polishing

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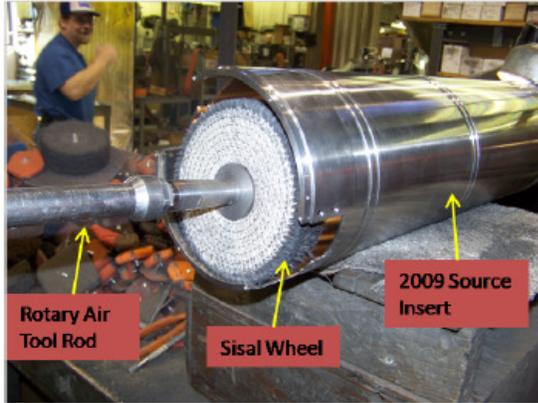


Figure 5.2

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**From:** Steve Irving <steve@irvinginc.com>

**Date:** Thu, 05 Aug 2010 14:12:32 -0500

**To:** Russell Mammei <rrmammei@vt.edu>

Russell Mammei and Virginia Tech has my authorization, as President of IRVING Polishing and Mfg., to use pictures associated with processes at IRVING Polishing, used on the UCNA experiment.



**Stainless Craftsmen**  
**SINCE 1945**

**Stephen C. Irving**

President ChE/ASME

**Irving Polishing & Mfg. Co., Inc.**

5704-46th Street  
Kenosha, WI 53144

1-800-637-8290

Phone: 262.657.6968

Fax: 262-657-6968

[steve@irvinginc.com](mailto:steve@irvinginc.com)

-----Original Message-----

From: Russell Mammei [mailto:rrmammei@vt.edu]

Sent: Thursday, August 05, 2010 11:01 AM

To: Steve Irving

Subject: copy write permission to use pictures associated with the polishing of our components for the UCNA experiment.

Hi Steve,

I hope everything is going well with you.

I am required by Virginia Tech to obtain permission for every figure that is not my own.

Attached is a list of figures that I am using in my thesis, that are associated with the polishing you provided for components for the UCNA experiment. May I have you permission to use this figures?

Thanks.

Russ

--

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