1. Specific events and activities which took place during your CRG in 2010

    a. PIMS-CRG Launch: Held in Calgary 6-7 April 2010. This two-day event kicked off the new PIMS collaborative research group. The event featured talks by Drs Eval Goren and Gilles Brassard.
    b. 10th Canadian Summer School on Quantum Information, University of British Columbia, 17-30 July 2010

2. List of CRG participants in 2010:

    a. PIMS Faculty - Leaders
        i. Barry Sanders – University of Calgary
        ii. Robert Raußendorf – University of British Columbia
        iii. Petr Lisonek – Simon Fraser University
        iv. Dave Bacon – University of Washington

    b. Other faculty
        i. Philip Stamp – University of British Columbia
        ii. William Unruh – University of British Columbia
        iii. David Feder – University of Calgary
        iv. Gilad Gour – University of Calgary
        v. Peter Høyer – University of Calgary
        vi. Alex Lvovsky – University of Calgary
        vii. Christoph Simon – University of Calgary
        viii. Wolfgang Tittel – University of Calgary
        ix. Leslie Ballentine – Simon Fraser University
        x. Paul Haljan – Simon Fraser University
        xi. Boris Blinov – University of Washington
        xii. Subhadeep Gupta – University of Washington
        xiii. Mark Oskin – University of Washington
        xiv. Aram Harrow – University of Washington

    c. Visitors (including dates)
        i. 29 November 2010 to 3 December 2010. David Kribs – University of Guelph. Visiting University of Calgary.

    d. PDF's and graduate students who were part of your CRG. Where are they now?
        Too soon to respond to this question.

3. Brief summaries of research projects fostered by your CRG.

    a. Quantum secret sharing: The groups of Raußendorf and Sanders are investigating quantum secret sharing from two points of view: matroids and graph states, respectively. Exchanges will commence between the two groups to share ideas.

b. Feedback iterative decoding of sparse: The Sanders group is developed enhanced syndrome-based decoding using a belief-propagation algorithm exploiting frustrated checks on individual qubits. Preliminary discussions with Lisonek suggest a possible collaboration on this decoding project.

c. Efficient decoders for topological quantum codes:
Topological quantum codes have a number of very desirable properties. Namely, they have a high error threshold, all necessary operation at the physical level can be accomplished by short-range quantum gates. These properties make such codes particularly suited for fault-tolerant quantum computation in geometrically restricted scenarios, such as qubits placed on a two-dimensional lattice. The flip side is that, until recently, for most such codes no efficient decoding algorithm was known. This changed with a paper entitled ``Fast Decoders for Topological Quantum Codes" by Guillaume Duclos-Cianci, David Poulin [Phys. Rev. Lett. 104 050504 (2010)]. We are planning to apply similar ideas to a particular class of topological quantum codes, so-called color codes.

d. Measurement-based quantum computation with Affleck-Kennedy-Lieb-Tasaki (AKLT) states, and percolation:
We demonstrate that the two-dimensional AKLT state on a honeycomb lattice is a universal resource for measurement-based quantum computation. Our argument proceeds by reduction of the AKLT state to a 2D cluster state, which is already known to be universal, and consists of two steps. First, we devise a local POVM by which the AKLT state is mapped to a random 2D graph state. Second, we show by Monte Carlo simulations that the connectivity properties of these random graphs are governed by percolation, and that typical graphs are in the connected phase. The corresponding graph states can then be transformed to 2D cluster states, which are already known to be computationally universal.

Due to the percolation aspect of the problem, it would be good to involve a mathematician working on percolation theory. However, we have not done that yet.

-- Both of the above projects are just starting out

e. UW has developed a general method for turning any stabilizer code into a subsystem stabilizer code that has spatially local syndrome measurements. These codes are related to measurement based quantum computing schemes and so collaboration with UBC on these codes will be pursued. The distance properties of these codes are similar to those in surface and color codes, while the threshold properties are significantly different due to the highly degenerate nature of the codes. Validation of these codes has been performed using a program developed at UW for analyzing subsystem codes. This code is freely available to the larger community and can be used by all teams involved in quantum error correcting codes.

4. Main scientific accomplishments derived from your CRG: any noteworthy theorems or breakthroughs? Lists of 2010 publications.

a. T. C. Wei, I. Affleck, R. Raussendorf (UBC) ``The 2D AKLT state is a universal quantum computational resource" arXiv:1009.2840 (2010)
b. G. M. Crosswhite and D. Bacon, "Automated Searching for Quantum Subsystem Codes" arXiv:1009.2203 (2010)
c. S. Rahimi-Keshari, A. Scherer, A. Mann, A. T. Rezakhani, A. I. Lvovsky and B. C. Sanders, "Quantum process tomography with coherent states" arXiv.org:1009.3307 (2010) Accepted by *New Journal of Physics*.

5. Examples of networking which can be directly attributed to your CRG.

   a. Conference talk: 17 November 2010: University of Calgary MSc student Saleh Rahimi Keshari at Quantum Optics V in Cozumel, Mexico. Title of talk: Quantum process tomography with coherent states.

6. Did you obtain other sources of funding for events connected to your CRG? If so, please list them.

   a. Funds for 10th Canadian Summer School on Quantum Information at UBC July 2010

      i.

Mitacs:	20,000 CAD
QuantumWorks:	13,000 CAD
CIFAR:	7,500 CAD
D - Wave Inc.	2,000 CAD
UBC Physics Dept.	1,500 CAD
PITP	1,500 CAD

7. Did your CRG help attract new faculty to Western Canada in 2010? Can you give some examples?

   Not yet.