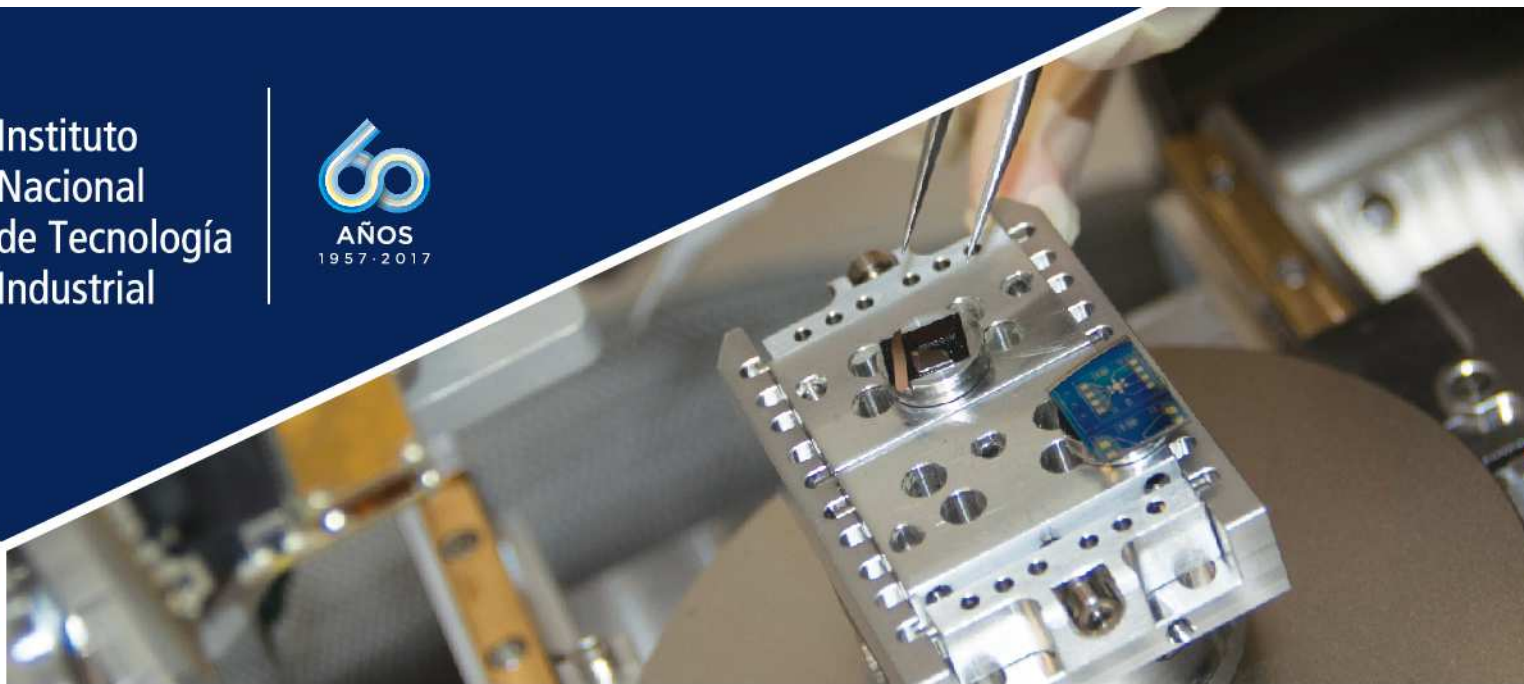




Instituto
Nacional
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Los desafíos metrológicos y sus
perspectivas para Argentina

Mariano Real
2017



Ministerio de Producción
Presidencia de la Nación



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Industrial



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Collaboration

Dr. Liliana Arrachea (ICAS-UNSAM-CONICET)

Dr. Alejandra Tonina (INTI – UNSAM)

Dr. Paula Giudici (CNEA-CONICET)

Lic. Daniel Gresta (now CONICET-INTI-UNSAM)



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Alejandra Tonina
Ricardo Iuzzolino
Marcos Bierzychudek
Martin Curras

Prof. Dr. K. von Klitzing

Collaboration history

2015

Dr. Franz J. Ahlers was invited as plenary speaker at AFA 2015

On this trip several discussions on research at INTI and PTB were held.

Common points:

- cryo free systems
- 2D systems (QHE) studies and development: magnetotransport, thermal transport, samples processing.



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AFA 2015 – Tandil
Dr. Franz J. Ahlers (PTB)

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Travell stated for mid-late 2016

2016-08

Three months mission to PTB (M. Real) under Guest Researcher program.

2015-2016

- Study and discussion of possible cryo-free cryostat to be implemented for QHE systems
- FQHE-IQHE PTB measurements, QHE universality tests

2015-2017

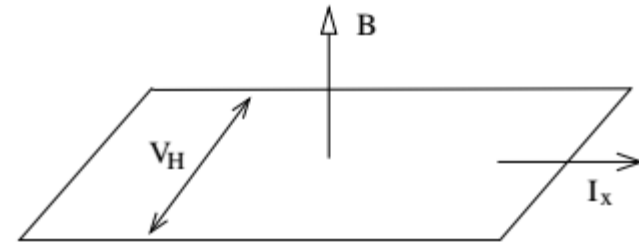
- INTI-ICAS(UNSAM)-CNEA samples processing for IQHE, FQHE and thermal transport studies in the context of PICT 2049. Substrates kindly supplied by PTB (Dr. Klaus Pierz and Dr. Frank Hohlz)

Efecto Hall cuántico (IQHE)

2DEG + magnetic field + low temperatures

$$\rho = \frac{V_{Hall}}{I_{canal}} = \frac{1}{\nu} \frac{h}{e^2} = \frac{1}{\nu} R_{K90} \quad \nu \text{ entero}$$

GaAs – grafeno \rightarrow 9 partes en 10^{11}



Fraccionario (FQHE)

Interacciones e-e \rightarrow Fermiones compuestos

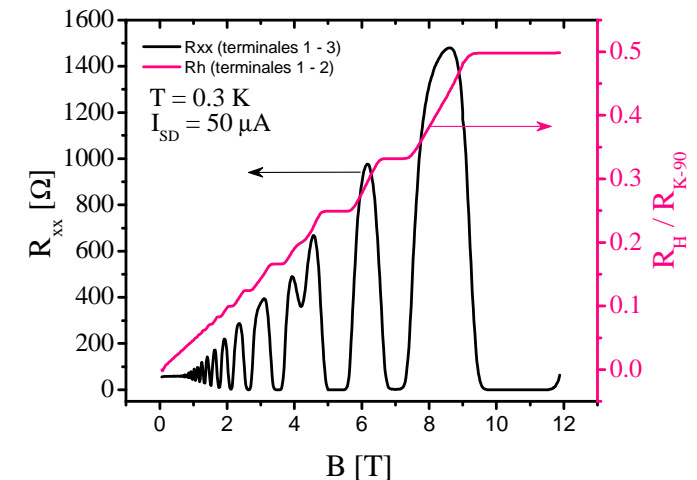
ν fraccionario

Integral quantum Hall effect (IQHE)

2DEG + magnetic field + low temperatures

$$\rho = \frac{V_{Hall}}{I_{canal}} = \frac{1}{\nu} \frac{h}{e^2} = \frac{1}{\nu} R_{K90} \quad \nu \text{ integral}$$

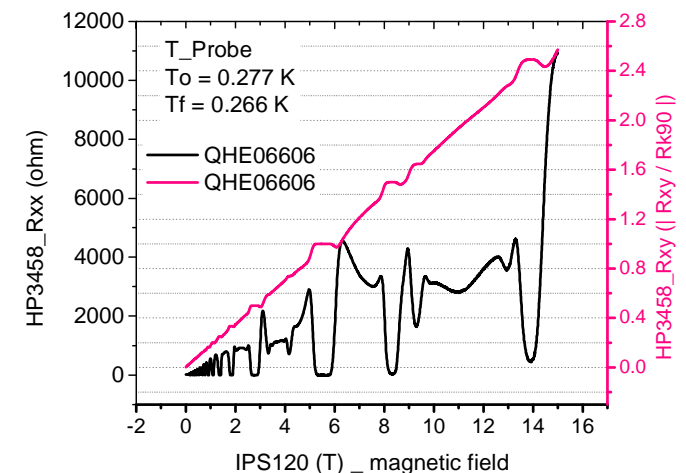
GaAs – grafene → parts in 10^{11}



Fractional (FQHE)

e-e interactions → composite Fermions

ν fractional



Integral quantum Hall effect (IQHE)

2DEG + magnetic field + low temperatures

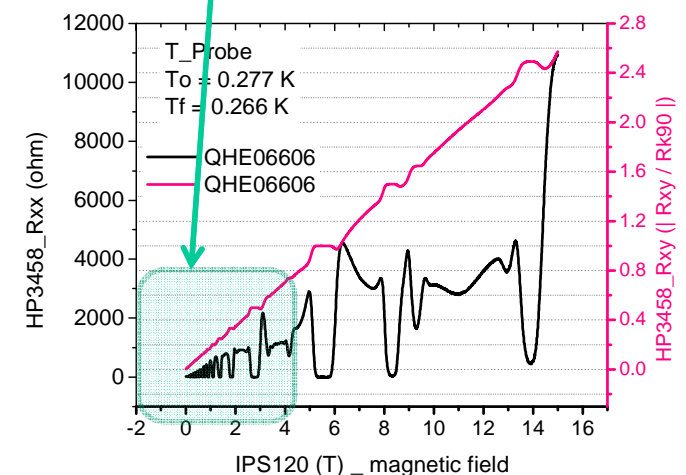
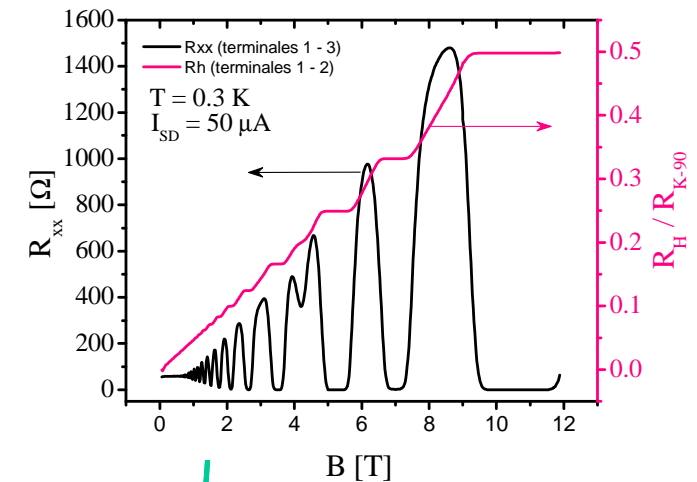
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GaAs – grafene \rightarrow parts in 10^{11}

Fractional (FQHE)

e-e interactions \rightarrow composite Fermions

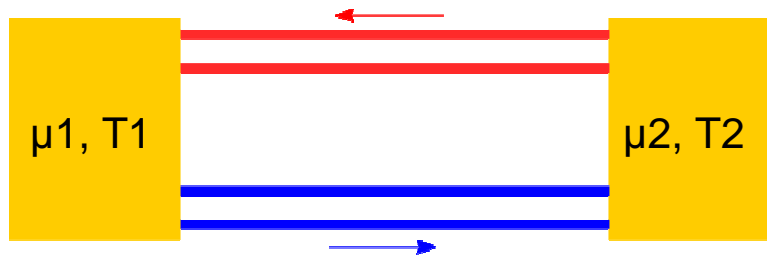
ν fractional



Quantum conductors

Quantum conductor \Leftrightarrow parallel waveguide

(Landauer, Büttiker)



Quirality (direction)

1 channel electrical conductance

$$G_{el} = v \frac{e^2}{h}$$

↓

independent of material and geometry

Particle dependent

1 channel thermal conductance

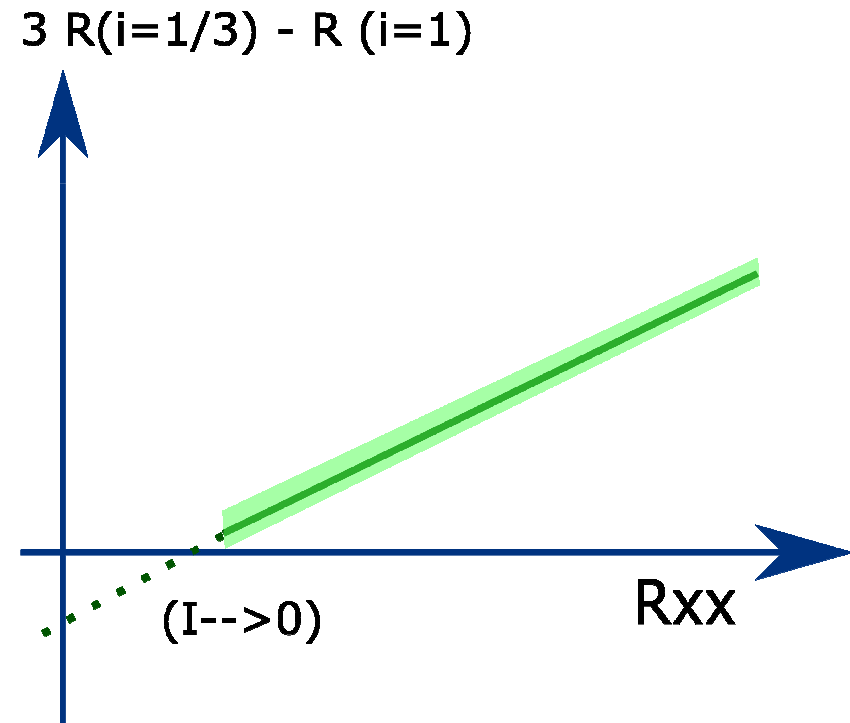
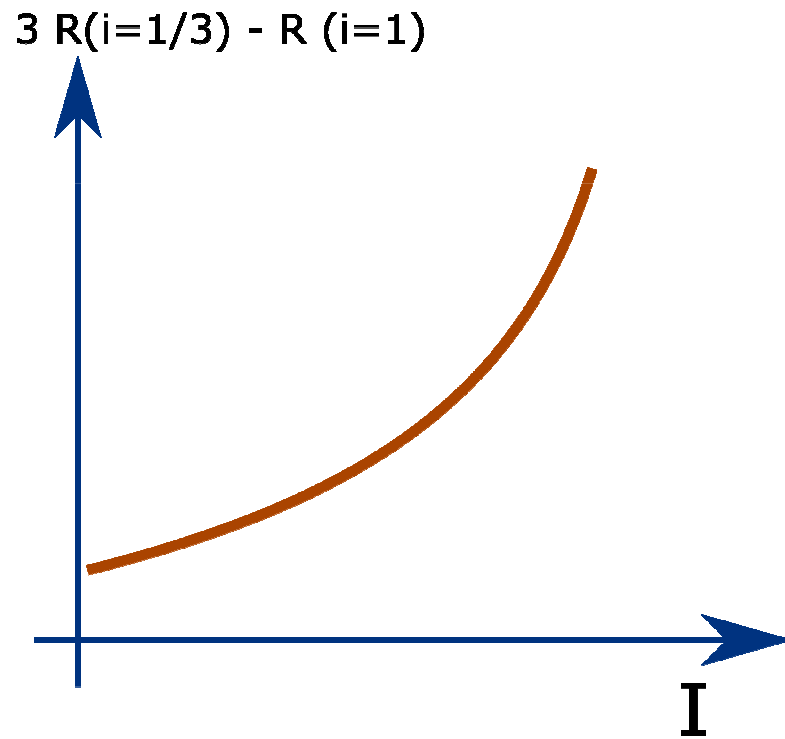
$$G_{termica} = \frac{\pi^2 k_B^2}{3h} T$$

Universal for every known particle

Original plan:

- Define the cryo-free system for QHE measurements.
- High precision (CCC) measurements FQHE vs IQHE, universality tests between $i=1/3$, $i=1$, study of transition of fractional states from mK to K.

Why universality tests

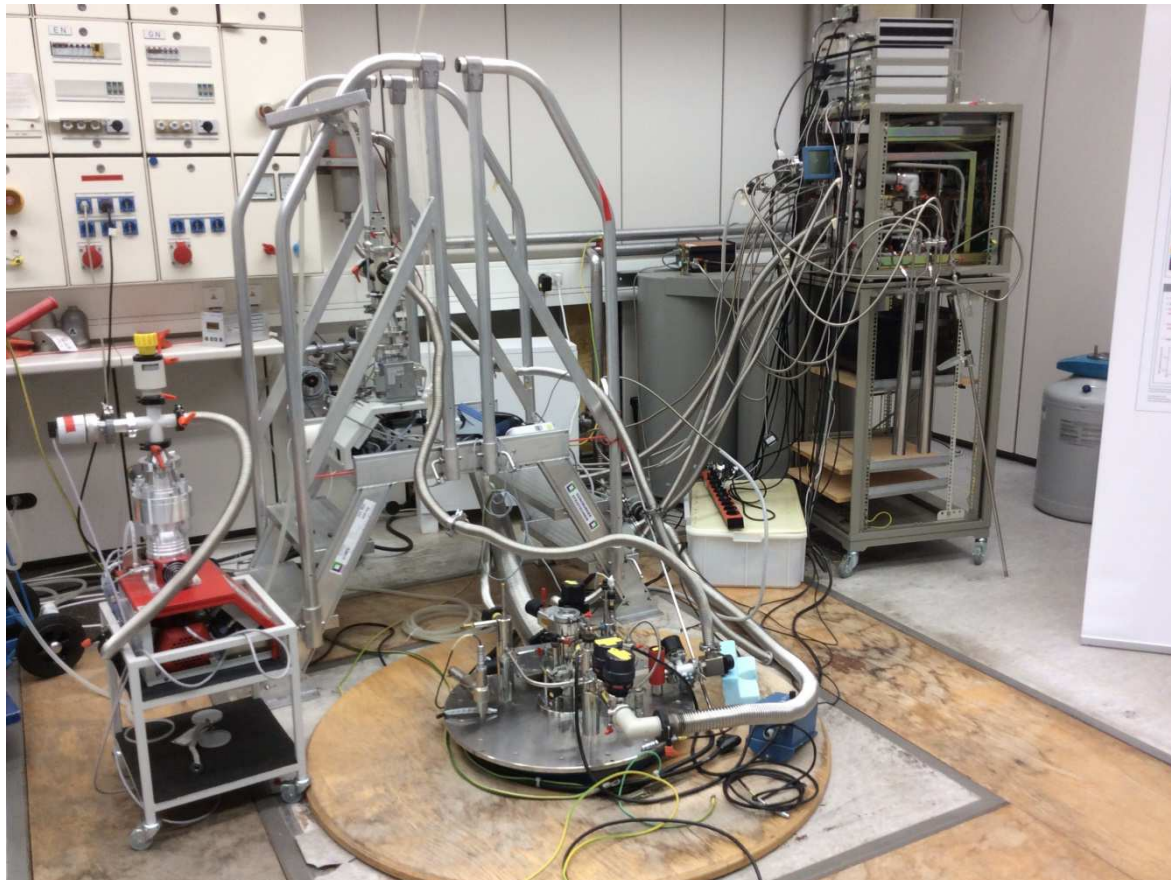


Original plan:

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Problems on dilution cryostat...

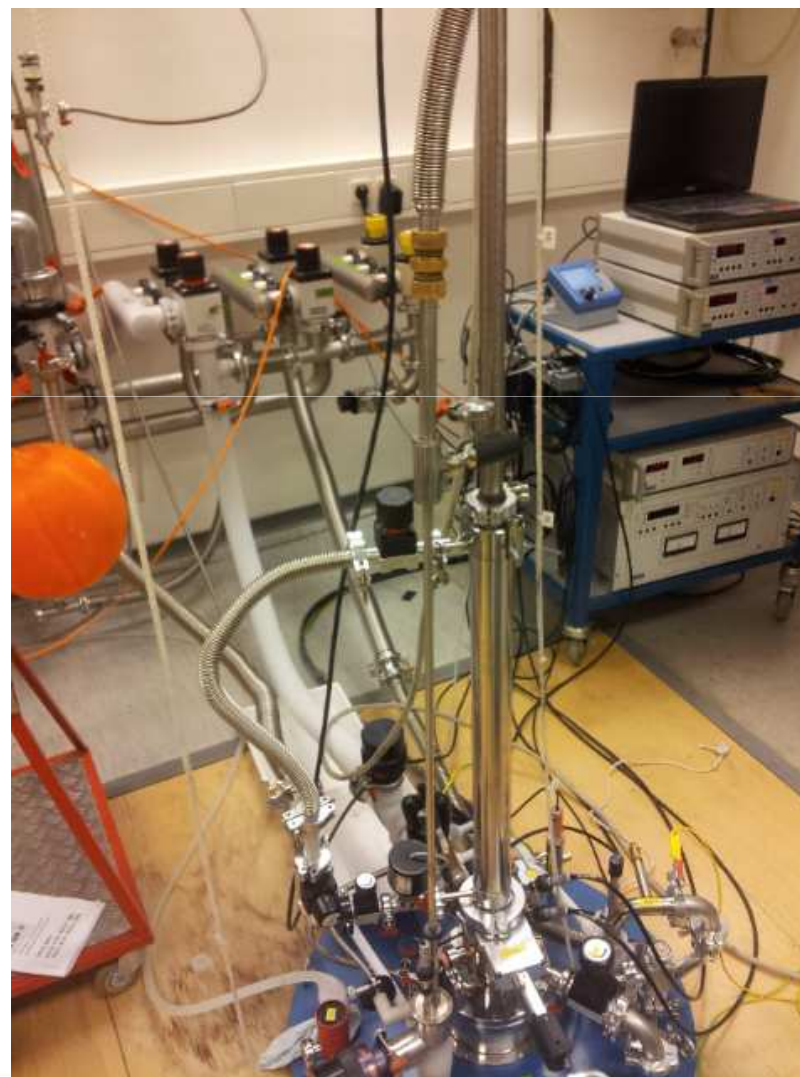
Dilution refrigerators



Modified plan:

- Definition of cryo free system.
- Improve SPIESS-2 on ^3He system to try to make FQHE-IQHE measurements.
- If FQHE-IQHE not possible, test samples produced in Arg. and study stability of FQHE of PTB-samples of interest.

Oxford Heliox TS (3He)



Tests and rewiring of SPIESS-02 to try to be able to be use on 3He system at 300 mK.

Collab with Ekart Pessel





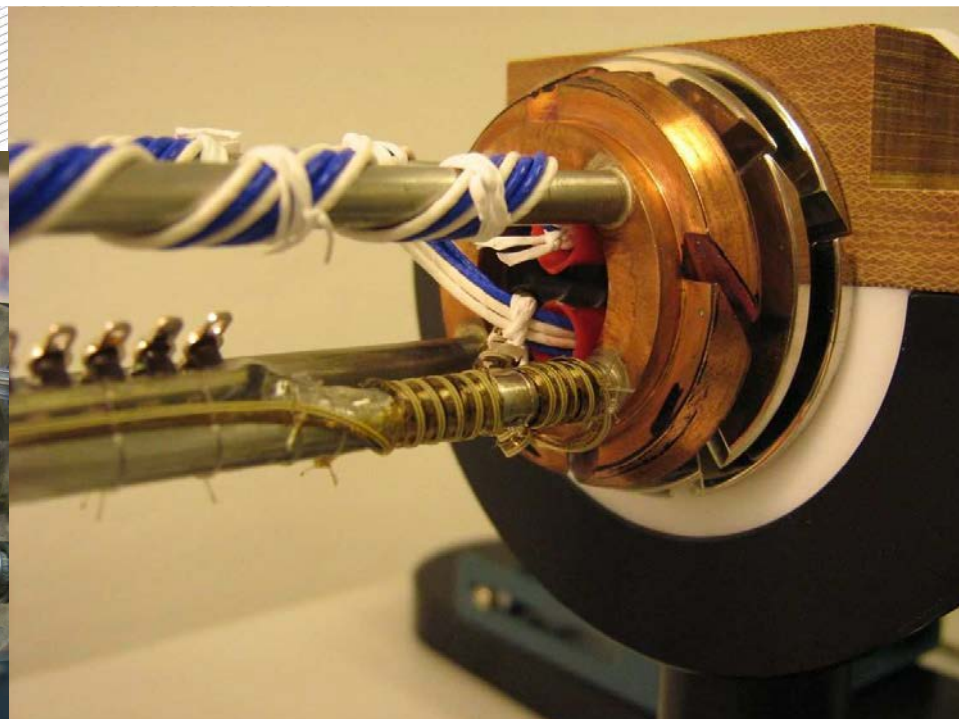
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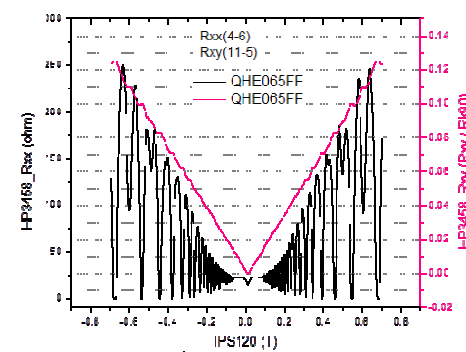
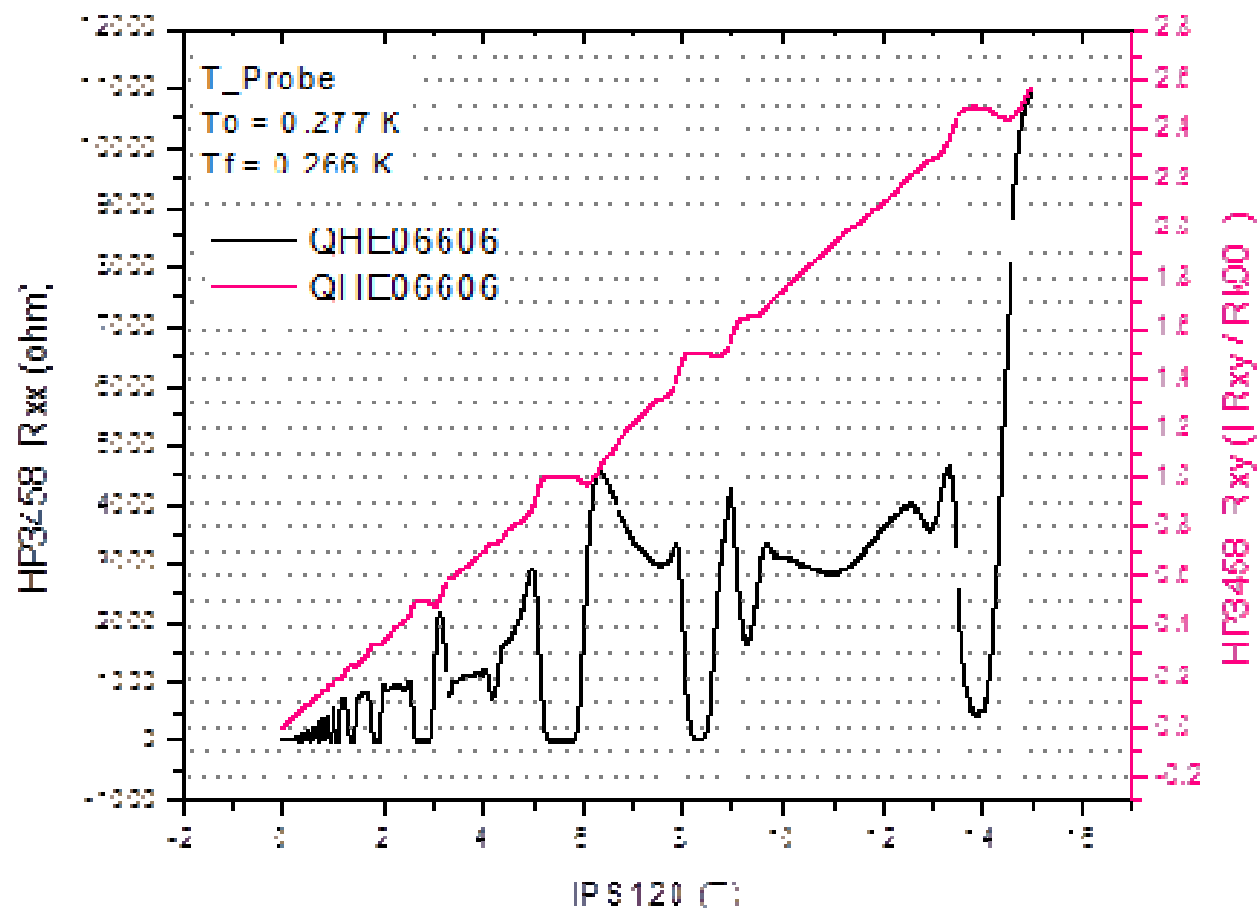
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AÑOS

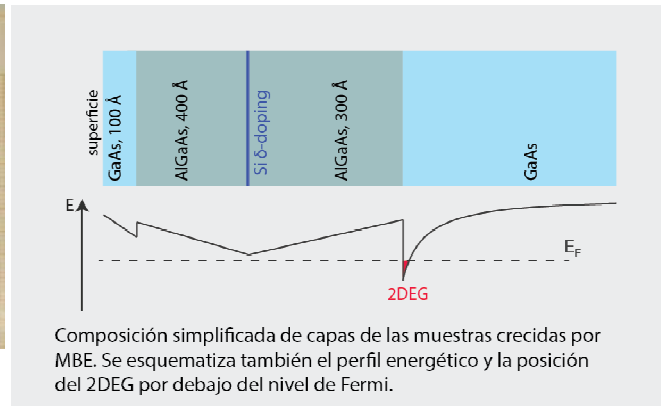
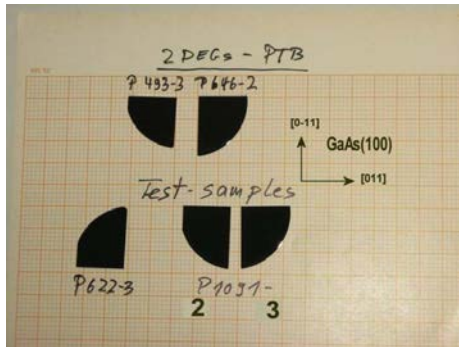
1957-2017



PTB stability samples



Argentina's samples

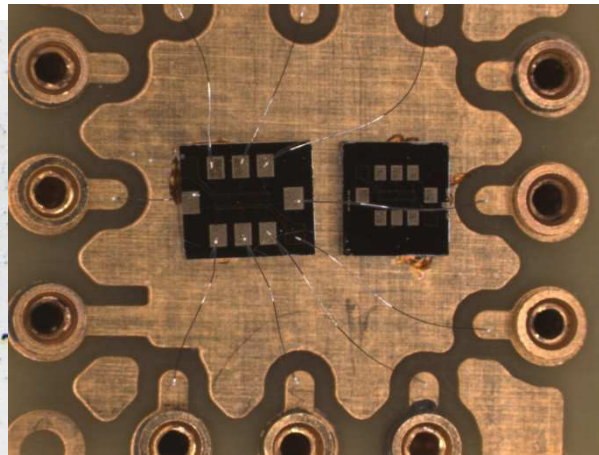
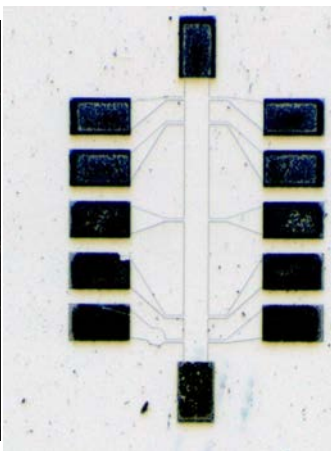
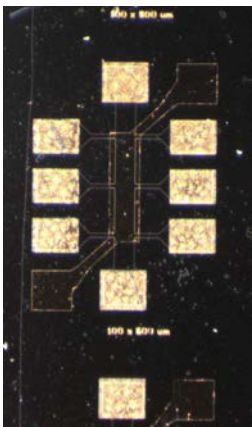


Samples were produced at PTB and processed in Argentina between INTI and CNEA's clean room.

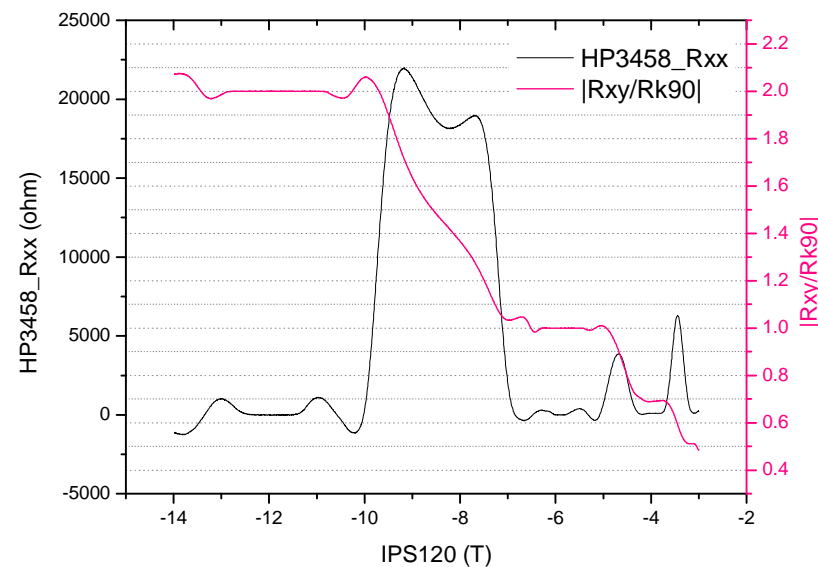
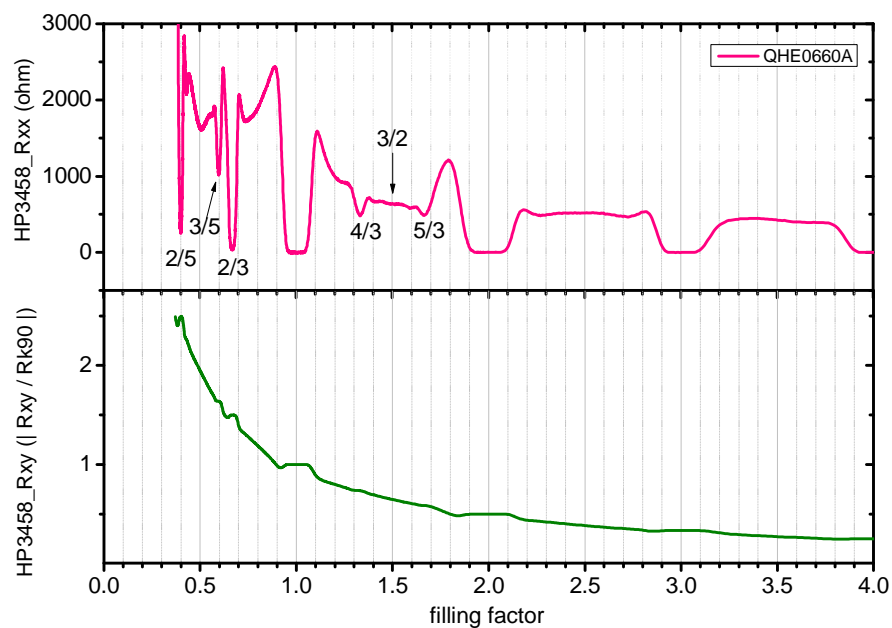
Cut and mounted at PTB with kind help from

Mattias Kruskopf
Thomas Gerster

Measured at 3He Cryostat



Samples processed in Argentina



Studies on cryo free systems were held

A particular system was determined, it will be used for graphene QHE samples specially.

Graphene carrier density stabilization was discussed and some ideas are now been developed at PTB.

FQHE-IQHE universality checks was not possible

SPIESS-02 did not work with the modifications, but we believe we found a way to produce a working probe, this means extra modifications on the system which implies a major stop, will be done on the near future.

Measurment of FQHE PTB samples were performed, did not show major changes.

Samples from Argentina were cut, mounted and tested at 300 mK.



INTI



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1957 - 2017

Thank you!

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