# Design and implementation of space environment simulator for CubeSat and PocketQubeSat

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Universidad Católica San Pablo, Arequipa – Perú

**UN/Brazil BSTI Symposium 11-14 September 2018, Natal - Brazil**

# Outline

- The motivation
  - Teaching Engineering
  - Approaching STEM
  - Project Based Learning
  - CubeSat technology
- The propose
- Perspectives

# The motivation

| 1997 | 1999 | 2000 | 2003 | 2004 | 2005 | 2006 | 2008 | 2009 | 2010 | 2012 | 2016 | 2018 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Technical education | | | | | | | | | | | | |
| | Undergraduate | | | Internship | Engineer (Peru) | | | | | | | |
| | | | | | | Master (UnB - Brazil) | | Doctorate (UnB - Brazil) | | | | |
| | | | | | | | | | Engineering assistant | Lecturer / Researcher (Brazil) | | |
| | | | | | | | | | | | Lecturer / Researcher (Peru) | |


IPEA - Instituto de Pesquisa Econômica Aplicada
ABENGE - Associação Brasileira de Educação de Engenharia

- From 3.5 graduates in engineering, only one was formally employed.
- Increased avoidance of engineering students.
- The engineering undergraduates feel the math very hard and without relation with his future professional activities.

# The motivation

| 1997 | 1999 | 2000 | 2003 | 2004 | 2005 | 2006 | 2008 | 2009 | 2010 | 2012 | 2016 | 2018 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Technical education | | | | | | | | | | | | |
| | Undergraduate | | | Internship | Engineer (Peru) | | | | | | | |
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| | | | | | | | | | Engineering assistant | Lecturer / Researcher (Brazil) | | |
| | | | | | | | | | | | Lecturer / | |

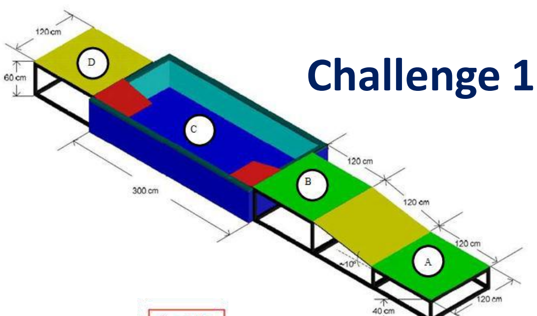

| | Mathematics | | | | Reading | | Science | |
|---|---|---|---|---|---|---|---|---|
| | Mean score in PISA 2012 | Share of low achievers in mathematics (Below Level 2) | Share of top performers in mathematics (Level 5 or 6) | Annualised change in score points | Mean score in PISA 2012 | Annualised change in score points | Mean score in PISA 2012 | Annualised change in score points |
| Thailand | 427 | 49.7 | 2.6 | 1.0 | 441 | **1.1** | 444 | **3.9** |
| Chile | 423 | 51.5 | 1.6 | **1.9** | 441 | **3.1** | 445 | 1.1 |
| Malaysia | 421 | 51.8 | 1.3 | **8.1** | 398 | **-7.8** | 420 | -1.4 |
| Mexico | 413 | 54.7 | 0.6 | **3.1** | 424 | **1.1** | 415 | 0.9 |
| Montenegro | 410 | 56.6 | 1.0 | **1.7** | 422 | **5.0** | 410 | -0.3 |
| Uruguay | 409 | 55.8 | 1.4 | **-1.4** | 411 | **-1.8** | 416 | **-2.1** |
| Costa Rica | 407 | 59.9 | 0.6 | -1.2 | 441 | -1.0 | 429 | -0.6 |
| Albania | 394 | 60.7 | 0.8 | **5.6** | 394 | **4.1** | 397 | 2.2 |
| Brazil | 391 | 67.1 | 0.8 | **4.1** | 410 | **1.2** | 405 | **2.3** |
| Argentina | 388 | 66.5 | 0.3 | 1.2 | 396 | -1.6 | 406 | 2.4 |
| Tunisia | 388 | 67.7 | 0.8 | **3.1** | 404 | **3.8** | 398 | **2.2** |
| Jordan | 386 | 68.6 | 0.6 | 0.2 | 399 | -0.3 | 409 | **-2.1** |
| Colombia | 376 | 73.8 | 0.3 | 1.1 | 403 | **3.0** | 399 | 1.8 |
| Qatar | 376 | 69.6 | 2.0 | **9.2** | 388 | **12.0** | 384 | **5.4** |
| Indonesia | 375 | 75.7 | 0.3 | 0.7 | 396 | **2.3** | 382 | -1.9 |
| Peru | 368 | 74.6 | 0.6 | 1.0 | 384 | **5.2** | 373 | 1.3 |

The botton one: 65th of 65 countries.

PISA - Programme for International Student Assessment (2012)

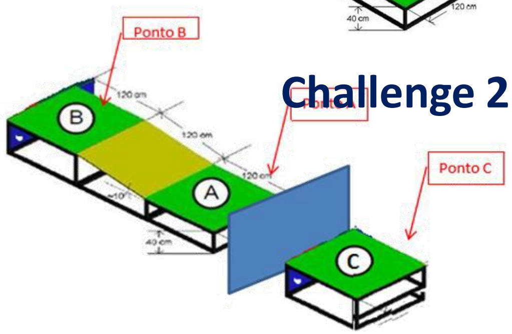
# The motivation

– Teaching Engineering
– Project Based Learning
– Approaching STEM




**Challenge 1: catch cans**

Integrative project 2014 - 1



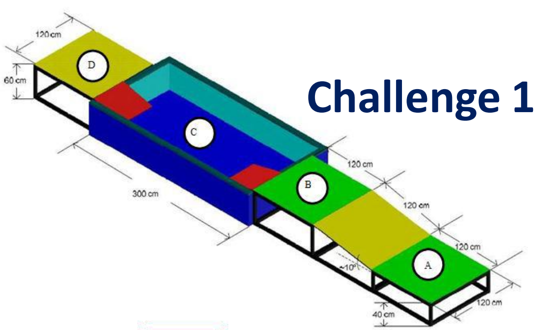

**Challenge 2: Throw cans**

Integrative project 2015 - 2

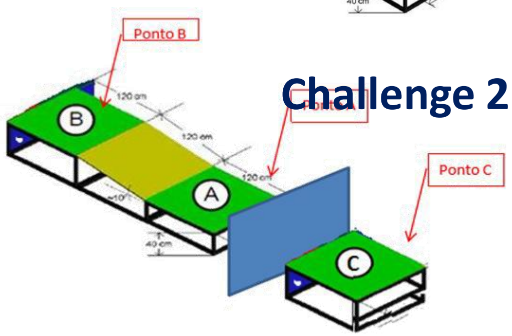
# The motivation

- Teaching Engineering
- Project Based Learning
- Approaching STEM

Scientific Initiation 2014 - 2



Challenge 1: catch cans




Challenge 2: Throw cans

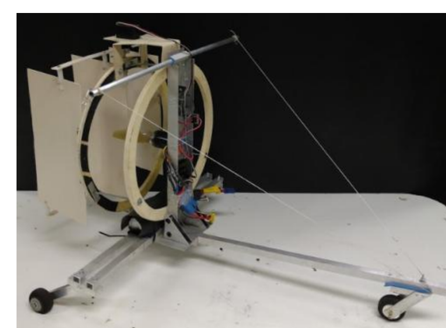
Integrative project 2015 - 2

# The motivation

- Teaching Engineering
- Project Based Learning
- Approaching STEM
- CanSat and CubeSat technology

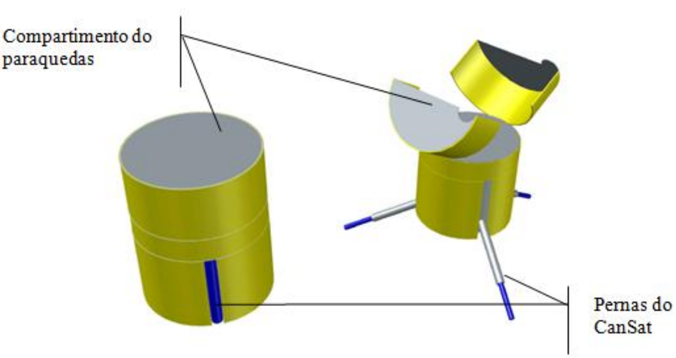
-How to drop a CanSat?
 > Paraglider (2014)

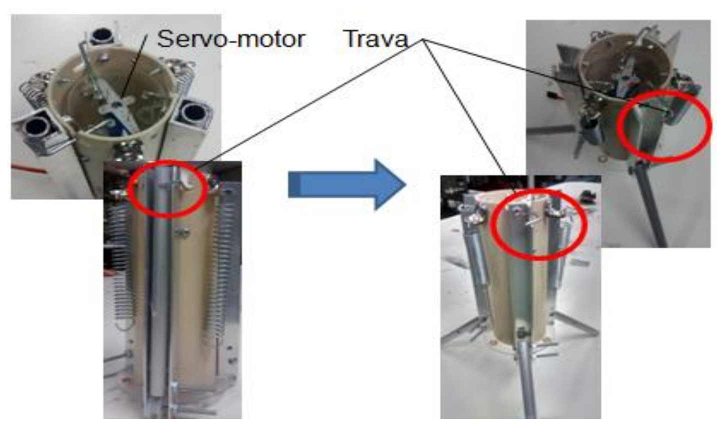
AEB Escola
Viaje nesta idéia!

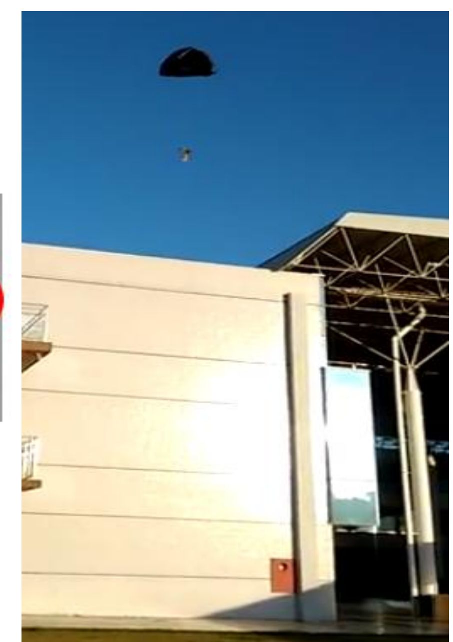


# The motivation

- Teaching Engineering
- Project Based Learning
- Approaching STEM
- CanSat and CubeSat technology



# The motivation

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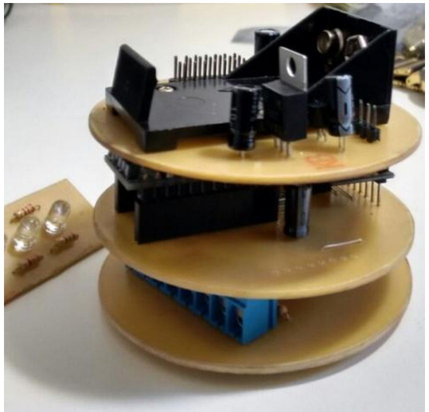
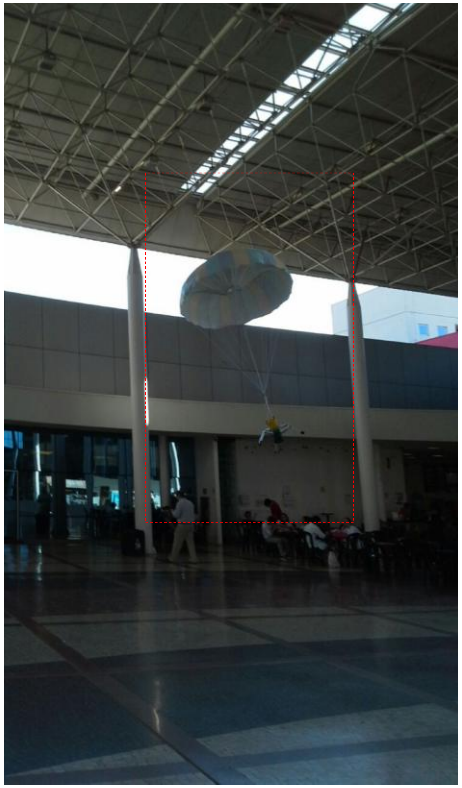
- Approaching STEM
- CanSat and CubeSat technology



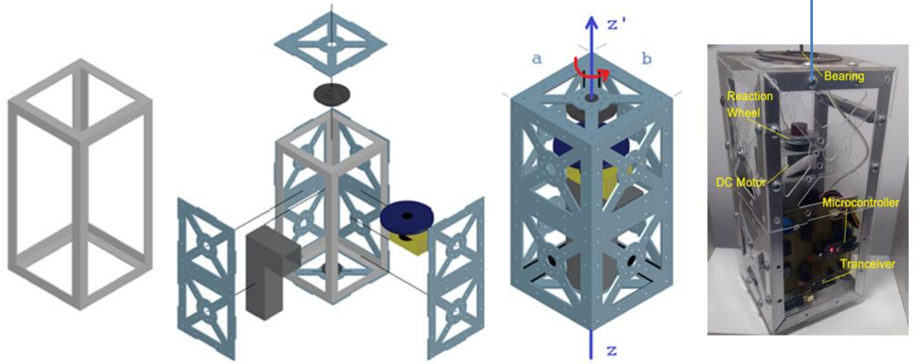


# The motivation

- First CubeSat mockup
  - Structures
  - COMM
  - OBDH
  - TT&C
  - EPS
  - ADCS

Reaction wheel
Magnetotorquer

Low Cost **Yaw** Controller for CubeSat Oriented to Education and Entertainment (ISCE - IEEE 2016)

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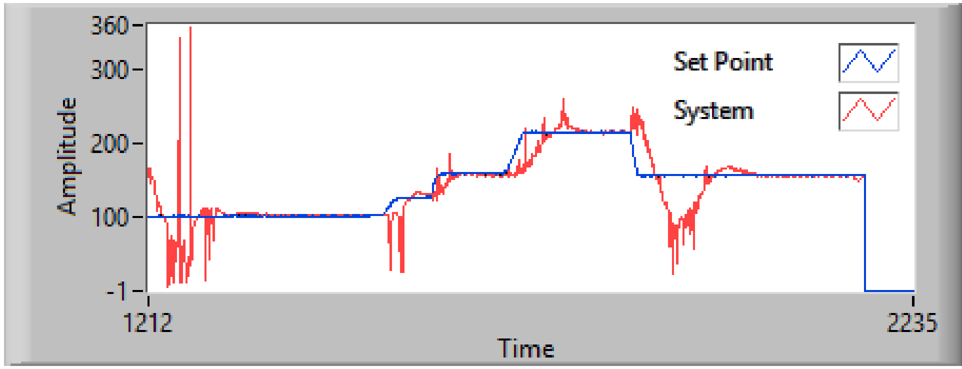


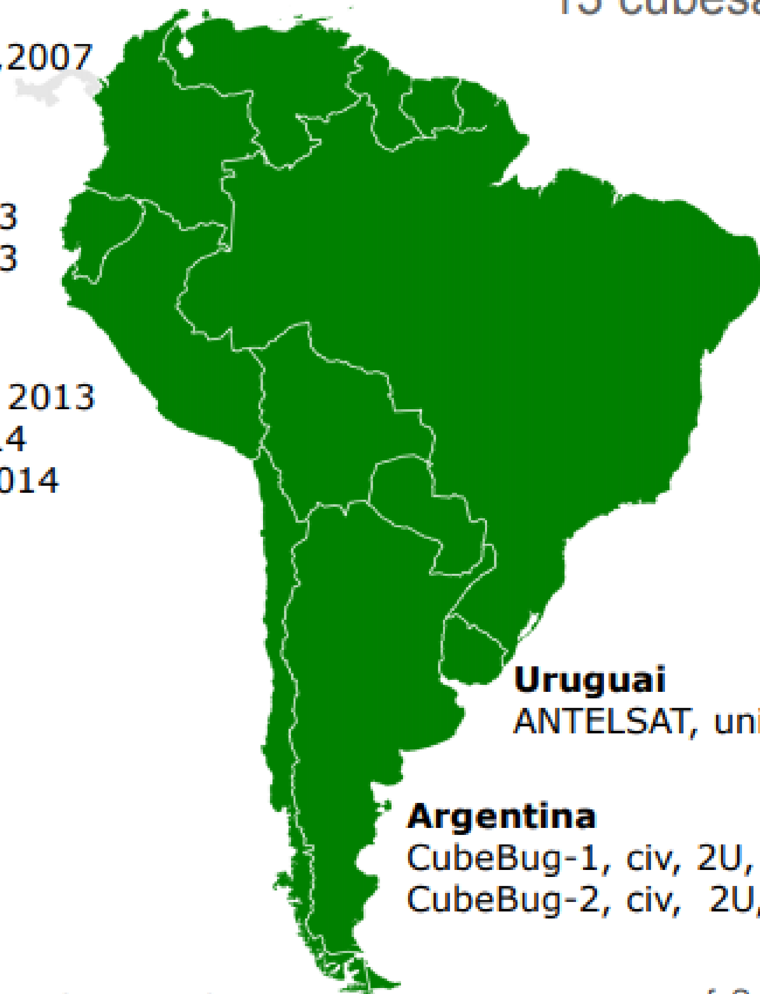
# The motivation: CubeSats in South America

13 cubesats lançados até 2015

**Colômbia**
Libertad 1, uni, 1U,2007

**Equador**
NEE 01, civ, 1U, 2013
NEE 02, civ, 1U, 2013

**Peru**
PUCP-SAT 1, uni, 1U, 2013
UAPSat, uni, 1U, 2014
Chasqui 1, uni, 1U, 2014



**Brasil**
NanosatC-BR1, civ, 1U, 2014
AESP-14, uni, 1U, 2015
Serpens, civ, 3U, 2015

**Uruguai**
ANTELSAT, uni, 2U, 2014

**Argentina**
CubeBug-1, civ, 2U, 2013
CubeBug-2, civ, 2U, 2013

R. Leonardi, SERFA2016, outubro 2016, São José dos Campos

cf. Swartwout, M., JoSS, 2, 2, 2013

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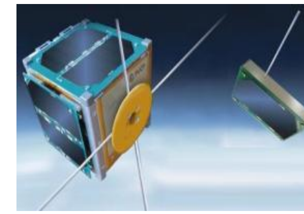
# The motivation: Peruvian context


AGENCIA ESPACIAL
DEL PERU CONIDA

PUCP: PUCP-Sat 1 (2013)
UNI: Chasqui I (2014)
UAP: UAPsat (2014)



Firt peruvian observation setellite
(PeruSat 1, launched in 2016)

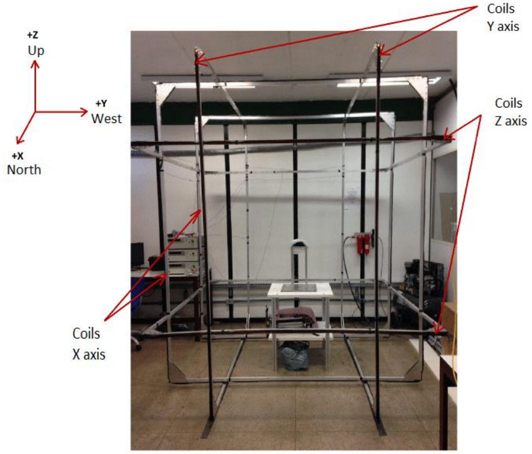
CONIDA - UNSAAC (2017): QB50
CONIDA - UDEP (2017): I. satelitales
CONIDA – UTP (2018): 2 nanosatelites
CONIDA – UCH (2018): I. s
CONIDA –UNI (2018)
CONIDA –UNSA (2018)
**CONIDA –UCSP (2018)**

# The proposal

- What about test?
  - Mechanical test
  - Thermal test
- What about torque perturbations?
  - Gravity gradient
  - Aerodynamics
  - Solar radiation
  - Earth magnetic field
- How to simulate CubeSat Enviroment?

# The proposal

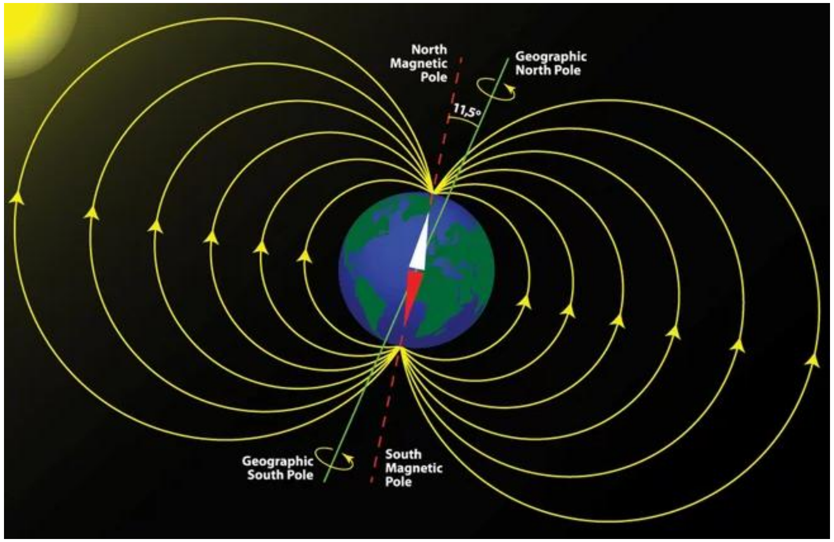
- Implementation of Tri Axis square Helmholtz's cage
- Implementation of Hemispherical Air Bearing



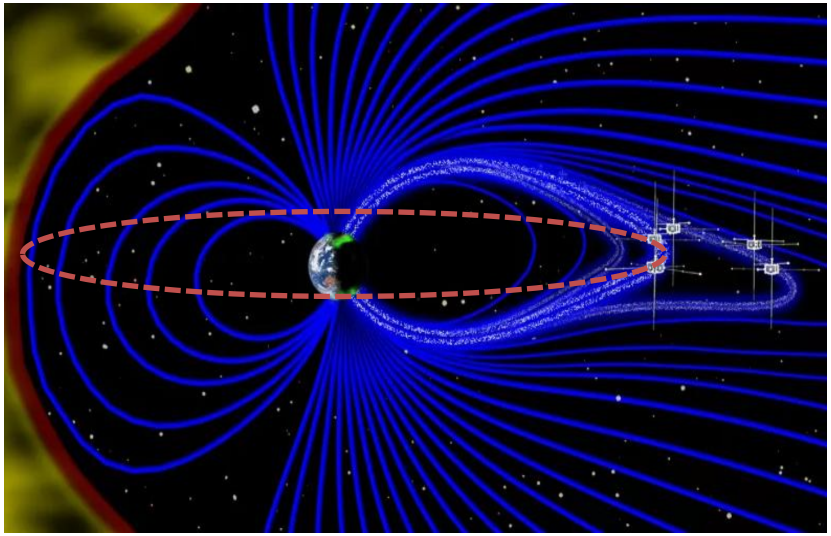

- Based on UnB initiatives (Helmholtz's cage developed by LAICA/UNB (2m X 2m X 2m))

# The proposal

- Earth magnetic field

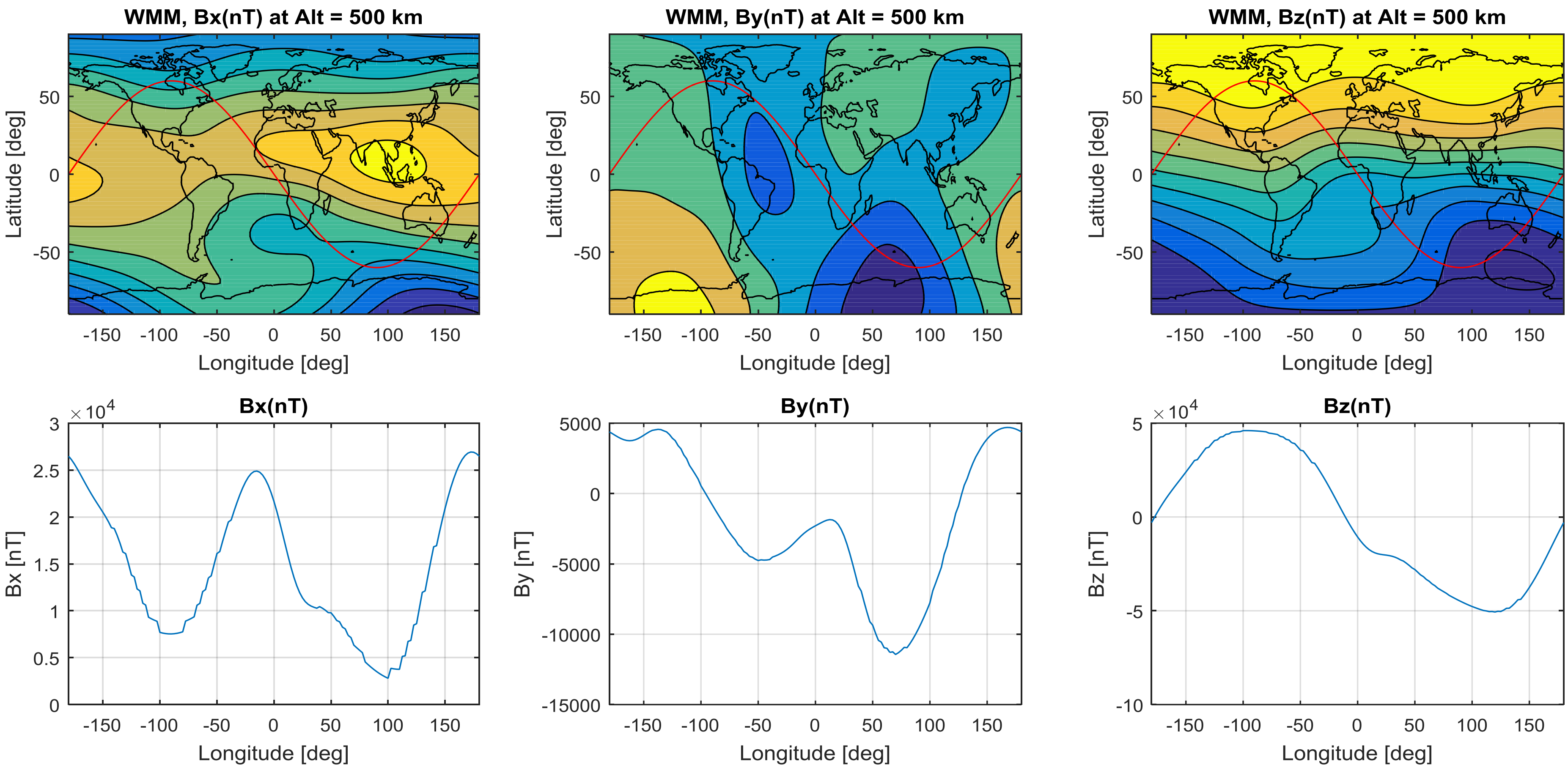



Ideal

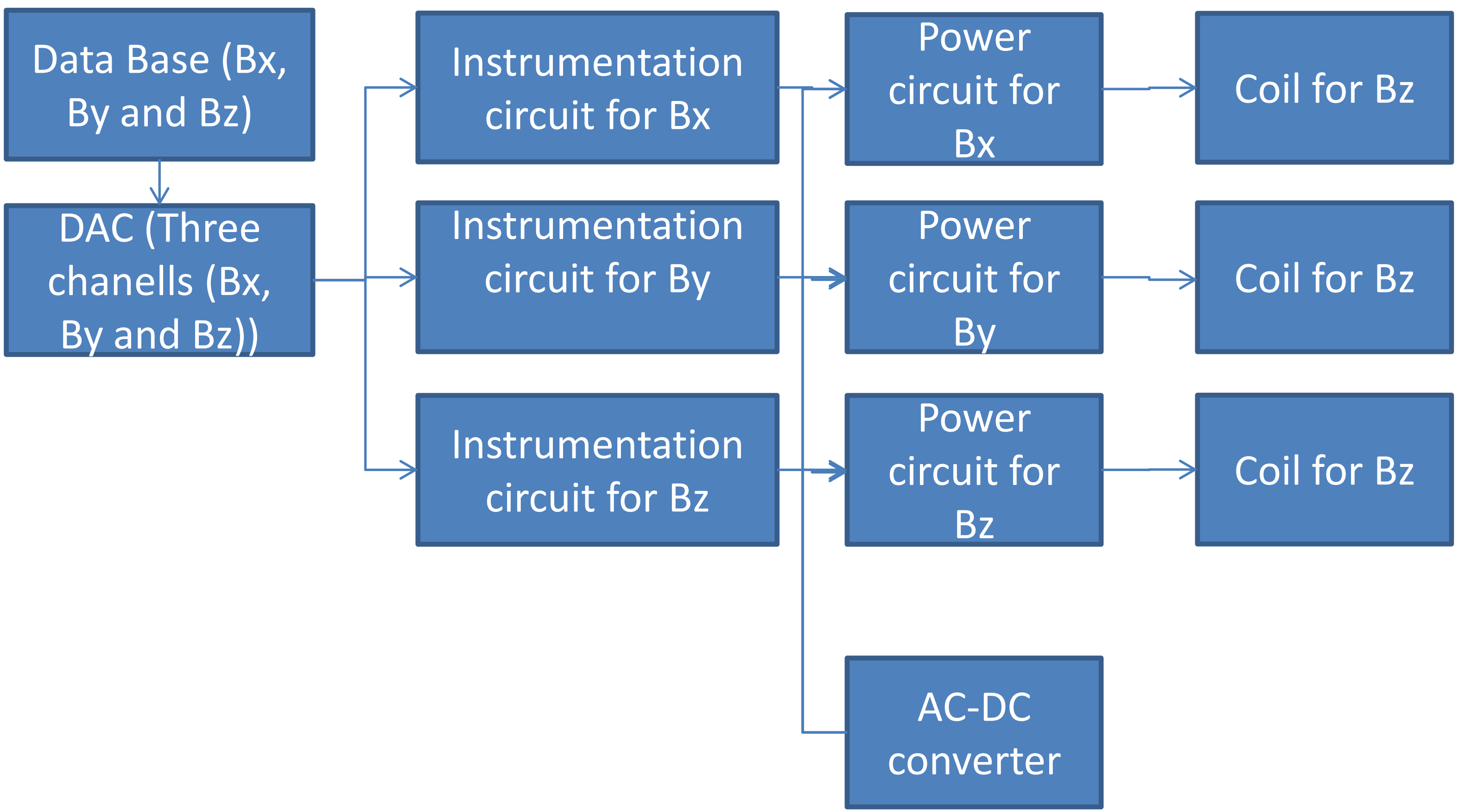


Real

# The proposal



# The proposal: Helmholtz's cage



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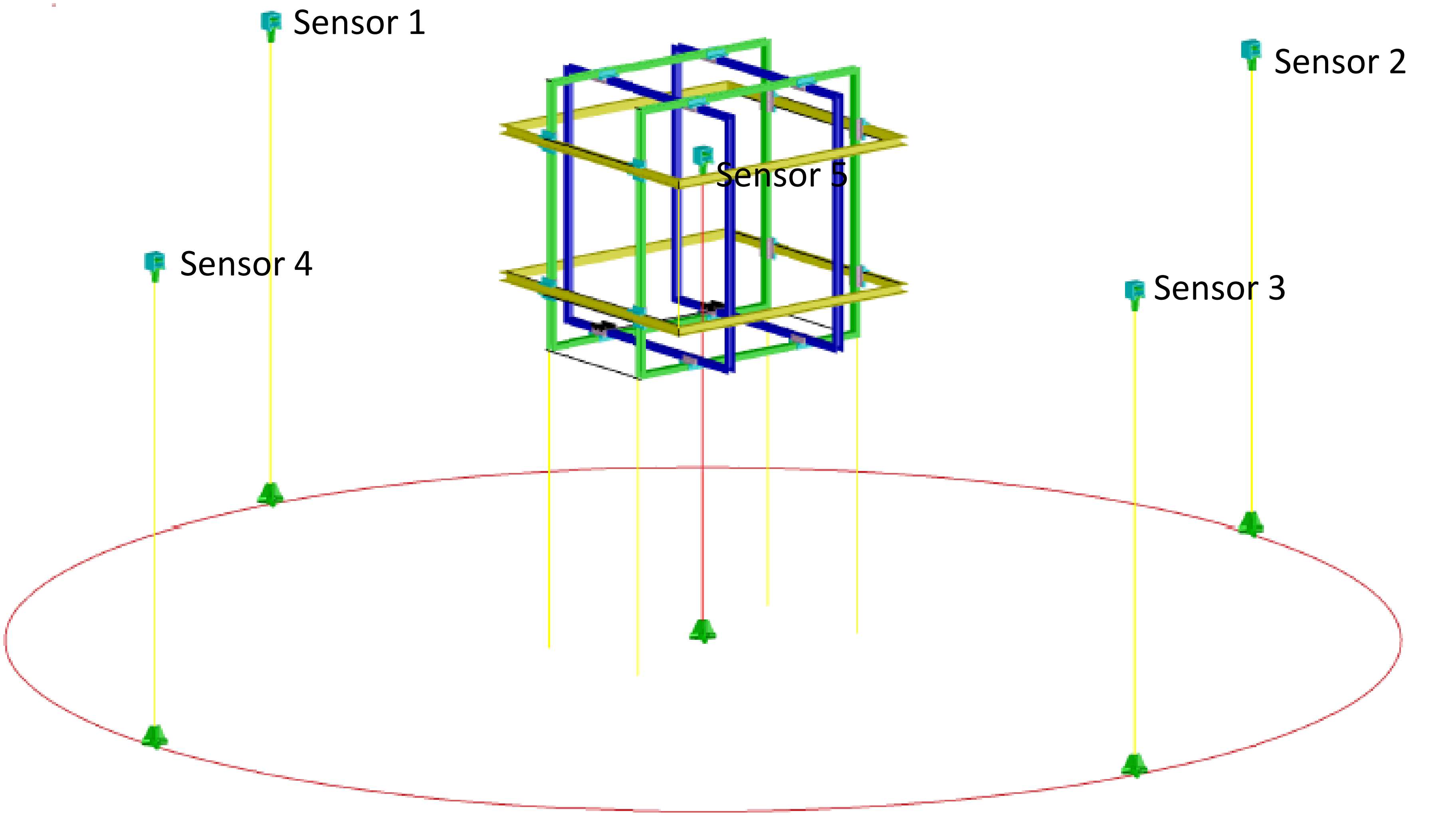


# The proposal: Helmholtz's cage

Data Base (Bx, By and Bz)

DAC (Three chanells (Bx, By and Bz))

Instrumentation circuit for Bx

Instrumentation circuit for By

Instrumentation circuit for Bz

Power circuit for Bx

Power circuit for By

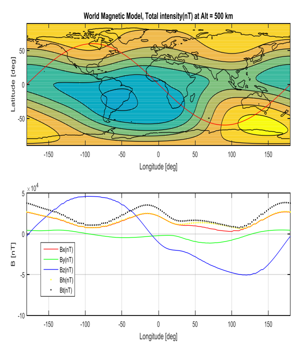
Power circuit for Bz

AC-DC converter

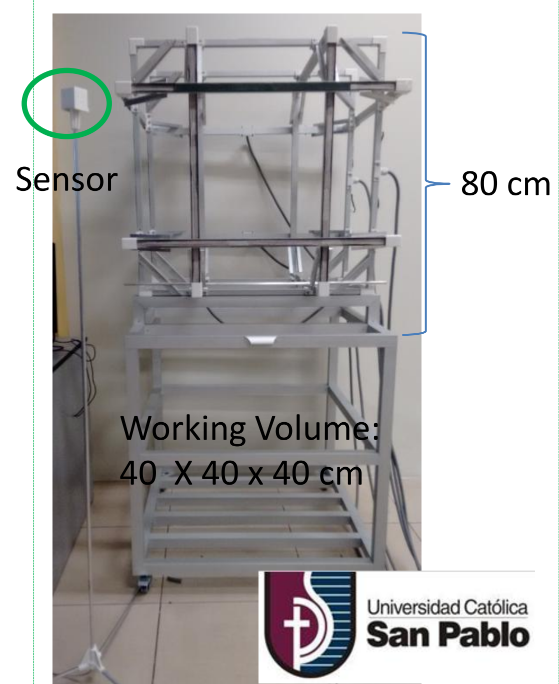
Coil for Bz

Coil for Bz

Coil for Bz





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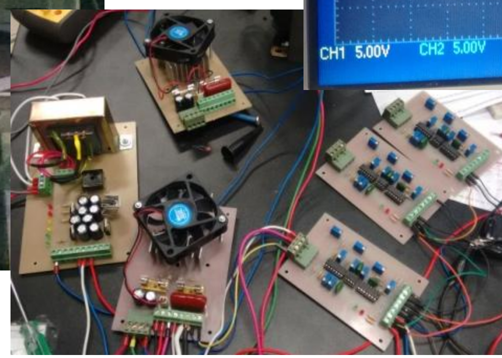
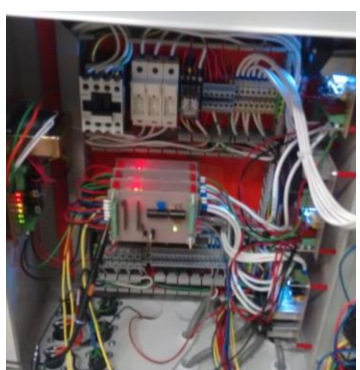
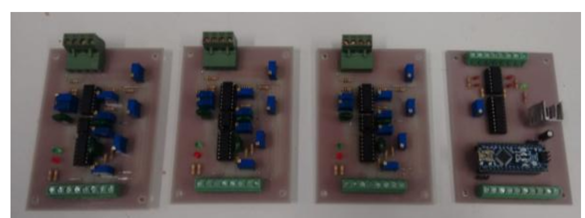
# The proposal: Helmholtz's cage



In materials ~ $ 2000.00

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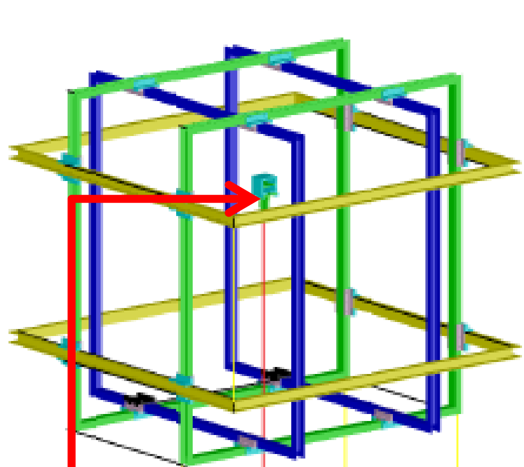
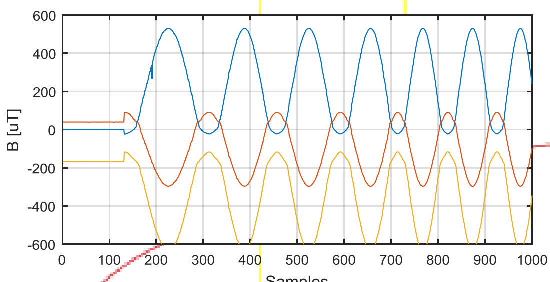
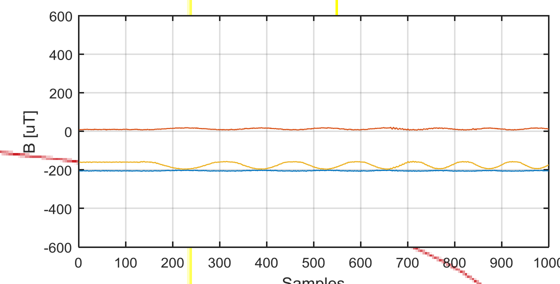
# The proposal: Helmholtz's cage




Inside Cage (till 500 uT)




Outside Cage

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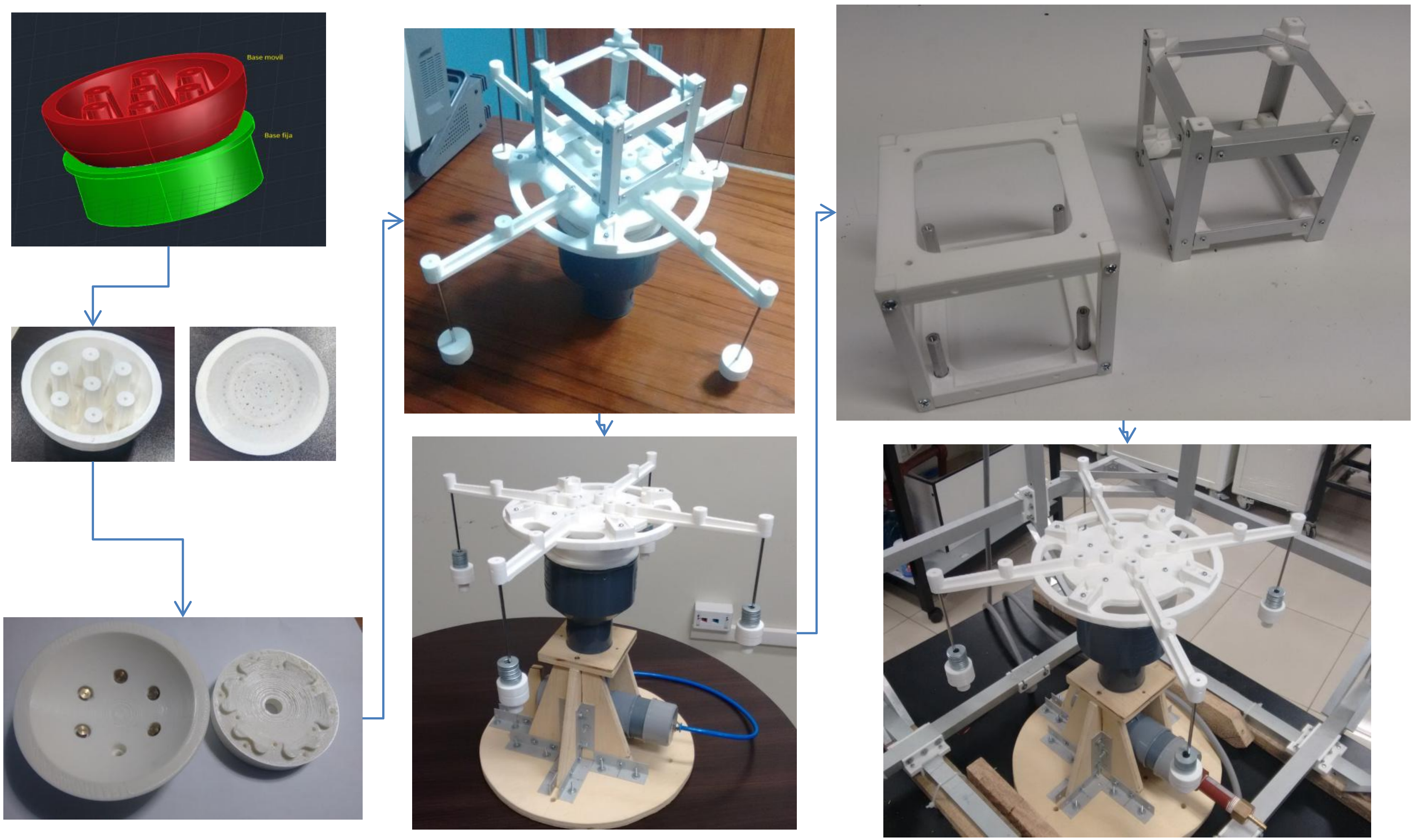
Universidade de Brasília

# The proposal: Hemispherical Air Bearing



# Perspectives

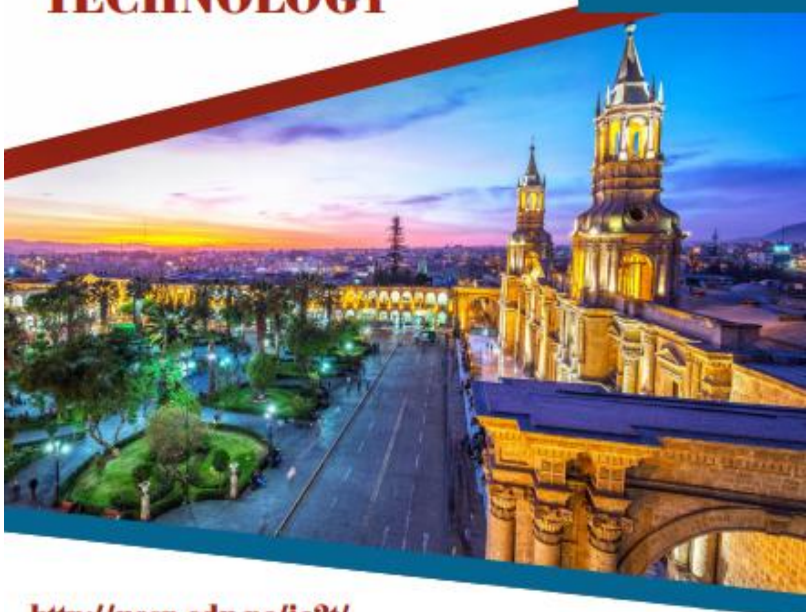
- Technical:
  - Calibrate the Helmholtz's cage
  - Improve the Hemispherical Air Bearing
  - Improve our cubesat mission (earth magnetism verification)
  - Work on perform a real CubeSat
- Social:
  - Perform and/or replicates a workshop based on CanSat for high school and CubeSat for undergraduate and postgraduate.
  - Motivate new generations to study engineering careers.

# The International Conference on CubeSat Technology IC2T - 2018

## INTERNATIONAL CONFERENCE ON CUBESAT TECHNOLOGY

**IC2T 2018 Conference**

Universidad Católica San Pablo Arequipa, Perú



**http://ucsp.edu.pe/ic2t/**

The International Conference on CubeSat Technology IC2T will gather national and international engineers, professors and researchers specialized in CubeSat technology and its applications. The Universidad Católica San Pablo through the School of Electronics and Communications Engineering organizes this event with the aim of promoting the development of research in aerospace technology and provide an environment where participants will get to know and learn about the latest advances in the development of CubeSats.

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AEB AGÊNCIA ESPACIAL BRASILEIRA

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## INSCRIPCIONES

| | Hasta el 28 de julio | Después del 28 de julio |
|---|---|---|
| **Estudiantes** | S/ 110.00 | S/ 160.00 |
| **Profesores e investigadores** | S/ 200.00 | S/ 250.00 |
| **Otros profesionales** | S/ 250.00 | S/ 300.00 |

Si desea registrarse mediante transferencia bancaria, envíe el comprobante de pago y la identidad de su categoría a: ic2tregistration@ucsp.edu.pe

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| | **Nº INTER BANCARIO** | **Nº DE CTA CTE** |
| **BCP $** | 002-215-001063874137-29 | 215-1063874-1-37 |
| **BCP S/** | 002-215-001106015085-28 | 215-1106015-0-85 |
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## CALL FOR PAPERS

The International Conference on CubeSat Technology - IC2T will cover technical novelties and overviews on Cubesat related topics including but not limited to:

- Small Satellites Missions (micro, nano, pico, femto)
- Earth observation
- Disaster monitoring
- Space exploration
- Mission architectures
- Pocketqubesat
- CanSats and TubeSats
- Launcher vehicles
- Radars and tracking systems
- Electrical power systems
- Electronic communications
- Propulsion systems
- Electronic instrumentation
- Signal processing
- Computer vision
- Attitude determination and control
- Embedded systems
- Robotics and automation
- Unmanned aerial vehicles
- Internet of things
- Artificial intelligence
- Machine learning
- Big data
- Education and pedagogy – STEM
- Policies and regulation

Prospective authors should submit a 3-4 pages FULL PAPER, consisting of a complete description of the proposed technical content and applicable research results using online submission system (Submissions based on experimental results, current data, or reports on ongoing missions are especially encouraged): **https://easychair.org/conferences/?conf=ic2t**

## LOCATION AND VENUE

Universidad Católica San Pablo, Campus Universitario San Lázaro, Urb. Campiña Paisajista, Quinta Vivanco s/n, Arequipa, Perú

## IMPORTANT DATES

| | |
|---|---|
| August 05 | Deadline Submission Date |
| September 15 | Acceptance Notification Date |
| October 08 | Final Version Submission Date |
| October 24-27 | Conference |
| August 15 | Early Bird Registration |

**Oct 24 - 27, 2018**

# Thank you very much

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