Hands-on and Computer aided Labs for the International Summer School INFIERI held at USP

(◆) Hands-on labs (✱) Computer-aided labs

#	Topic	People in charge	Title	Outline
Institute of Astrophysics by and/or at Institute of Astronomy (IAP)				
1 (✱)	Radio astronomy	Prof. Jacques Lepine, IAG-USP	Identification of molecules responsible for Rays in spectrum	The exercise starts from spectra obtained by a radio-telescope such as IRAM30m, and using the GILDAS software, the student studies the ray frequency and compare with the rays already in the catalogue etc…
2 (◆)	Radio frequency	Prof. Jacques Lepine, IAG-USP	Demonstration of a low frequency receptor.	Mounting of a low frequency radio receptor and show its sensibility to temperature (for illustrating calibration of these devices)
3 (◆)	Telescopes and adaptative Optics	Prof. Stephen Eikenberry (Florida U., USA) and Prof. Claudia Mendes de Oliveira IAG-USP, BR.	Adaptative Optics based on robotic arms	This laboratory will focus on the operational testing of cryogenic robotic optical probe arms developed for the MIRADAS astronomical spectrograph. These precision cryogenic mechanisms, placed at the focal plane of the world's largest telescope - the 10.4-meter Gran Telescopio Canarias, are used to intercept astronomical signals for multiple targets of interest on the sky. They then feed these signals into the remaining spectrograph optical systems for parallel processing, increasing the telescope's efficiency by a factor of >10. Two of these probes have been developed at USP in the IAG. In this lab, participants will learn to operate and control

				the robotic probe arms. They will then carry out a sequence of tests of the probe arms performance, including range of operability, repeatability, and reliability. This will include optical and mechanical performance metrics, and an analysis of probe arm characterization.
4(✱)	Experiment with data of the Fermi Gamma Ray Observatory on Spacelab	Prof. Rodrigo Nemmen, IAG-USP	Fermi Gamma-ray Space Telescope: Observing Black Holes, Dark Matter and Other High-Energy Astrophysical Phenomena	The Universe is populated by numerous exotic and violent phenomena: colossal explosions, super massive black holes, rapidly rotating neutron stars, and shock waves of gas moving at relativistic speeds. Many of these astrophysical objects can accelerate particles to energies way beyond those accessible in human-made accelerators. The *Fermi Space Telescope* was launched in 2008 and uses particle physics techniques to image the whole sky in gamma-rays every three hours. *Fermi* has opened a previously unexplored window on a wide variety of astrophysical phenomena in the "extreme Universe". I will describe the characteristics, technology and current status of the *Fermi* observatory and review the science highlights -- including possible observations of the exotic, unknown dark matter. Finally, I will lead a lab activity in which the students will learn to analyze *Fermi* observations of a supermassive black hole in a distant galaxy.

Labs organized by and/or at the Institute of Physics (IF)				
1 (◆)	Introduction to MPGD - the Gas Electron Multiplier (GEM)	Prof. Marco Bregant and Prof. Marcelo Munhoz (IF-USP)	Introduction to MPGD - the Gas Electron Multiplier (GEM)	In this activity the students will be introduced to the GEM. A cascade of two GEMs will be used to study some important concepts related to this micropattern detector. The basic electronic chain will be described both in current and pulsed mode. The detector will be characterized in terms of charge gain and energy resolution. The detector behaviour is described in terms of collection and extraction efficiencies, as a function of drift and induction fields, quantities that will be discussed and evaluated.
Labs organized by and/or at the Institute of mathematics and Statistics and the Computing Science Department: IME/DCC				
1 (✱)	Advanced filtering techniques	Prof. Junior Barrera et al. (CEPID-CeTICS)	Introduction to advanced Filtering techniques	This course is about the design of lattice operators from machine learning. The main part of the applications will be on digital images, but the theory may be applied to any kind of digital signal. The lab section will focus on a particular technique for the design of filters: combination of multi-resolution lattice filters. The student will do practical experiments using MATLAB, with the Mathematical Morphology Toolbox, environment. In the practical section, he or she will create training and testing images corrupted with multi-resolution noise, write the programs to design multi-resolution filters, design filters and test them.
2 (✱)	GPGPU based computer Labs	Profs Marco Dimas Gubitoso and Alfredo Goldman (IME/DCC)	Introduction to GPGPU	This Lab will introduce the students to the use and programming of GPGPU's

3 (✱)	Neural simulation and Neural net identification	Prof. Antonio C. Roque and Prof. Marco Dimas Gubitoso, Dr. Nilton Kamiji, Dr. Rodrigo Pena and Cecilia Romaro. (CEPID Neuromat)	Introduction to Neuro-Mathematics	This course will give a brief introduction on the structure and function of neurons and neural networks, and the basic concepts of modeling single neurons and neural networks. It will emphasize on the leaky integrate-and-fire model (Lapicque 1907; Stein 1967; Tuckwell 1988), and on an Erdos-Renyi model of sparsely connected neural network (Brunel, 2000). Three major simulators will be introduced: 1) NEURON simulation environment (http://neuron.yale.edu/neuron/) 2) nest: The Neural Simulation Technology (http://www.nest-simulator.org/) 3) BRIAN spiking neural network simulator (http://briansimulator.org/) It will also demonstrate how to install one of the simulators in Linux, and how to simulate the above mentioned neural network model (Brunel, 2000) available at the Open Source Brain database (http://www.opensourcebrain.org/projects/brunel2000).
Labs organized by and/or the Polytechnic School at USP				
1(◆)	Use of micro-controllers	Held by ST Microelectronics and Prof. Gustavo Rehder (Poli-USP)	Initiation to the use of Micro-controllers	Introductory hands-on laboratory will allow students to learn how to create simple code, using a development kit in the MBed environment.Students will learn to implement analog-to-digital and digital-to-analog conversion, work with timers, interrupts and pwm.
2 (◆)	Introduction to Imaging	Dr. Joao Moreira (BRADAR, BR)	SAR: theoretical and practical Lab	This is just a one day in two steps Lab (3h + 3h): the

	based on radars.			first session will be a 3 h course on SAR (Synthetic aperture radars, used to create images of objects followed by 3h on radar raw data processing based on Matlab.
3(◆)	Introduction to basic components in various VDSM technologies	Contact: Prof. Gustavo Rehder et al.	Introduction to basic components in several VDSM technology	Introduction to basic components in new Very Deep Sub Micron Technologies (VDSM) by characterizing and comparing the different techno performances.
Labs organized by or in collaboration with the School of Medicine, FM-USP, that will be host at the Institute of Radiology (InRad) at FM-USP				
1 (◆)	Hands-on Labs in Medical Imaging: Positron Emission Tomography (PET)	Dr. Alexandre Teles Garcez (InRad-FMUSP) and Dr. Bruno Fraccini Pastorello (InRad-FMUSP)	Introduction to PET instrument	The students will be introduced to basic PET concepts of instrumentation and signal detection by acquiring PET calibration images with a Ge-68 phantom. Important technical concepts like activity quantification issues, spatial resolution, partial volume correction and signal to noise ratio will be discussed based on previously acquired phantom and human PET images. Since this hands-on session will be based on an advanced PET/MRI instrument, there will be an opportunity to demonstrate also the gain in spatial resolution and diagnosis specificity obtained by combining both techniques.
2 (◆)	Hands-on Lab in Medical Imaging: Ultra High Field (UHF) Magnetic Resonance Imaging (MRI)	Dr. Maria Concepción Garcia Otaduy (InRad-FMUSP) and Khallil Taverna Chaim (InRad-FMUSP)	Introduction to High Field MRI instrument	The MRI hands on session will be performed on the 7T PISA site, the highest MRI field available in Latin America for human medical imaging. Students will be introduced to basic concepts of MRI safety, instrumentation and image formation by acquiring

				images on specific MRI phantoms (spectroscopy and spatial resolution phantoms). During acquisition and image analysis MRI technical issues like spatial and spectral resolution, signal to noise ration, B0 and B1 shimming, and flip angle optimization will be discussed. This session will not cover only basic concepts of MRI but it will address also challenges specific to Ultra High Field MRI.
3 (◆)	Hands-on Labs in Medical Imaging: Ultra Sound (US)	Dr. Mateus Aranha (InRad-FMUSP) and Eugenio Marinetto (UC3M, Spain)	Introduction to the Ultra-Sound equipment	Students will be introduced to basic ultra sound (US) instrumentation and imaging concepts by operating an US equipment on specific phantoms, mimicking real patient conditions (i.e. cysts, calcification, flow). Students will be allowed to observe the effects on the image by using different types of probes, different probe angulation, and there will an emphasis in explaining the origin of artifacts that can often mislead medical diagnosis. Finally there will be also a chance to explain the Doppler effect used in US.
Labs organized by contributors from abroad and/or not from USP				
1 (✱)	Introduction to new CCD technology & applications	Drs Guillermo Fernandez Moroni Uni. Nacional Del Sur (Ar) and Miguel Sofo-Haro (Univ of Cuyo, Ar) Drs Javier Tiffenberg (FNAL), Yann Guardincerri (FNAL, USA),	Introduction to new CCD technology and applications	Introduction of the students to the fundamental aspects of scientific CCDs as particle detectors. We will discuss the way CCDs record and read out the energy deposited by ionizing particles; the students will use an oscilloscope to explore the signals produced by the readout electronics to understand the basic ideas of the signal processing involved. Later,

				the background cosmic radiation will be used to demonstrate the particle identification capabilities of these sensors. The students will use a set of software tools to develop selection cuts to identify muon tracks and use these events to measure the energy loss of Minimum Ionizing Particles (MIPs) in silicon.
2(◆)	Introduction to the Pixel technology (with experience on Medipix technology and vertex detector for LHCb)	Prof. Kazuyoshi Carvalho Akiba, and Prof Irina Nasteva (UFRJ) and Prof. Franciole da Cunha Marinho (UF-Sao Carlos)	Medipix Pixels read out with TimePix	A prototype set-up using Medipix Pixels read out with TimePix for evaluating Si pixels devices performances and including measurements with various Radioactive to initiate the students to this more and more used technology.
3(◆)	DUNE LBNE instrumentation based Lab	Prof. Ettore Segreto (UNICAMP)	Liquid Argon Demonstrator for the Long Baseline Neutrino DUNE project	Introduction to the LAr technology in the cold for the next generation of neutrino experiments
4(◆)	Crossed Octagonal Ring Antenna (C-ORA) Array & Analogue Beamformer Demonstration	**Dr Laith Danoon & Prof David Zhang** , Manchester U. (UK), and Dr. Steve Torchinsky, Observatoire de Paris and Nancay (FR)	SKA- Intelligent Front End for Medium Array Antennas: Crossed Octagonal Ring Antenna (C-ORA) Array & Analogue Beamformer Demonstration	After a brief tutorial on the Compact Aperture Array based on Antennas developed for SKA, the student will be introduced to the Front-End processing chain from the Antenna to the beam-former. This Lab is to demonstrate the basic capability of the dense aperture array. The Agilent Field-box Vector Network Analyser (VNA) will be used to measure the actual gain of the finite array. An analogue beamformer and a reference high gain antenna will be used to measure the front-end system. The calibration method of the beam-former loss will be investigated and a LNA will be used to compensate the beamformer loss. The derivation method of the actual gain of the front-end system from the measurements will be demonstrated.

5(◆)	High Rate and High Speed Data transmission for HL-LHC	Enrico SCHIOPPA and Antonio D' AMICO, (NIKHEF, NL) with Prof. Antonio PELLEGRINO (NIKHEF, NL), Mauricio FEO, Andre MASSAFFERRI & (CBPF, RJ, BR)	Advanced High Rate and High Speed Data transmission for HL-LHC	Data rates in the multi-Gb/s regime require a careful assessment of the signal integrity and tests in realistic conditions, including several hundreds of meters long optical fibers. The student will study the behaviour of data transmission at 4.8 Gb/s in the presence of signal attenuation, quantifying the transmission quality in terms of eye patterns and Bit-Error-Ratios. The course is based on the AMC40 mini-DAQ system designed for the LHCb experiment. It is a hands-on self-tuition course. The Course objectives are: - Provide hands-on experience with data-transmission devices (serializers and transceivers) - Acquaint students with optical fibers, networks, connectors, etc. - Introduce data-transmission test procedures and tools (pseudo-random bit sequences) - Understand the issue of signal integrity and introduce concepts of Eye Pattern and Bit Error Ratio
6(✱)	Introduction to new GEANT V simulation, based on new tools of MPC and HPC	Dr. Daniel Elvira and Dr. Guilherme Lima (FNAL, USA)	Introduction to new GEANT V simulation	The lab activities will include installation of dependency external packages, cloning of code repositories, local configuration, as well as building and running simple examples. Performance comparisons between GeantV andGeant4 will be demonstrated, and vectorization exercises will be suggested, with expert support at hand.
7◆)	Introduction to Si PM's technology	Dr. Giovanni Franchi, ACE Scientific SrL, IT.	Introduction to the Silicon Photomultiplier (Si PMT) technology	The use of SiPMTs is growing in many applications of Astrophysics (ex. CTA and Auger) and in Particle Physics (in application to several types of detectors: calorimeters, tracking devices). Its use is also

				developed in Medical Physics as for instances the Digital SiPMTs developed by PHILIPS or in the PET-MRI instrumentation. This Lab will give the opportunity to the attendants to be introduced to this technology.
8(◆)	Deep Sub Micron CMOS electronics	Prof Lodovico Ratti (University of Pavia, and INFN, II)	Introduction to the VDSM technology	The focus of the lab will be the experimental characterization of a front-end channel for pixel detectors in a 65 nm CMOS techno. After a short introduction on the device under test and the set up, students will learn how to use basic electronic instrumentation (power supply, pattern generator, digital scope, pulse/waveform generator) to configure the circuit and measure the main electrical parameters. While no previous experience in pixel front-end characterization is required, basic knowledge on electronic circuit operation and standard bench top instrumentation might help.
9(◆)	Introduction to the advanced 3D Interconnect technology	Dr Robert Patti (CEO Tezzaron Semiconductors, USA)	Advanced 3D interconnect technology for new 3D applications	This Lab will introduce the students to the most advanced 3D interconnect technologies as developed by Tezzaron Semiconductors firm in the USA. This technology is used in new compact stacked 3D multiprocessor for HPC systems, as well as for many applications in the domain of semiconductors based devices.
10(◆)	The SiPMT developed for the Cerenkov Telescope Array (CTA) Cameras	Prof. Francesco Giordano, University of Bari/INFN, IT.	SiPMT for the CTA experiment	In the CTA-SiPM Lab. the measurement of the speed of light is proposed. Silicon Photo-Multipliers (SiPMs) are very recent and challenging devices, able to easily detect light intensity down to single photo-electron

				level. The measurement consists in flashing the SiPM with a laser triggered by an external unit and in visualizing the detected SiPM signal on an oscilloscope. Storing the signal waveforms for different laser-sensor distances, the value of the speed of light can be obtained by the measuring the observed delays. The error on the measurement is only about few percent even with a very compact portable lab set-up (up to 1m) due to excellent timing capabilities of the SiPMs. The intensity of light as a function of the source-device distance will be also determined: fitting the poissonian distribution of the detected number of photons for the different sensors positions, the typical inverse square 1/r2 law will be also verified.
11(◆)	A PET demonstrator for training and as a testing bench for further developments	Dr. Giancarlo Sportelli, University and INFN Pisa, and Prof Giuseppina Bisogni (U. of Pisa) et al. (IT)	A PET demonstrator	The Medical Physics team at the University and INFN Pisa (IT) has developed a PET demonstrator. It is built as a toolkit that allow the students learning about the PET imaging procedure. It will be the object of this Lab. It also gives the researchers and Medical teams a flexible test set-up and demonstrator for experiencing and developing new PET systems features and comparing them.
12(✱)	Fundamentals of Parallel Programming using Intel Many Integrated Core (MIC) Architecture	Dr Rogerio Iope, Dr. Silvio Stanzani, Dr. Raphael Cóbe (Technical Support provided by Jefferson Fialho Coelho), São Paulo Research and	Multi/Many-Core Programming with Intel Xeon Phi Coprocessors	This hands-on training has been designed to be a comprehensive, practical introduction to parallel programming based on the Xeon Phi architecture and programming models, aiming to demonstrate the processing power of the Intel Xeon Phi product family.

		Analysis Center / UNESP Center for Scientific Computing, (BR)		Attendants of these training activities will start issuing simple command-line tools to get basic information about the Intel Xeon Phi coprocessors, then learn how to monitor what resources are being used and access their operating systems by establishing ssh sessions with them. They will thus verify that the Intel Xeon Phi coprocessor is an IP-addressable PCIe device - managed by an independent environment provided by the MIC Platform Software Stack (MPSS) - that runs a Linux-based operating system. This is a two steps (3 hours each) hands on Labs.