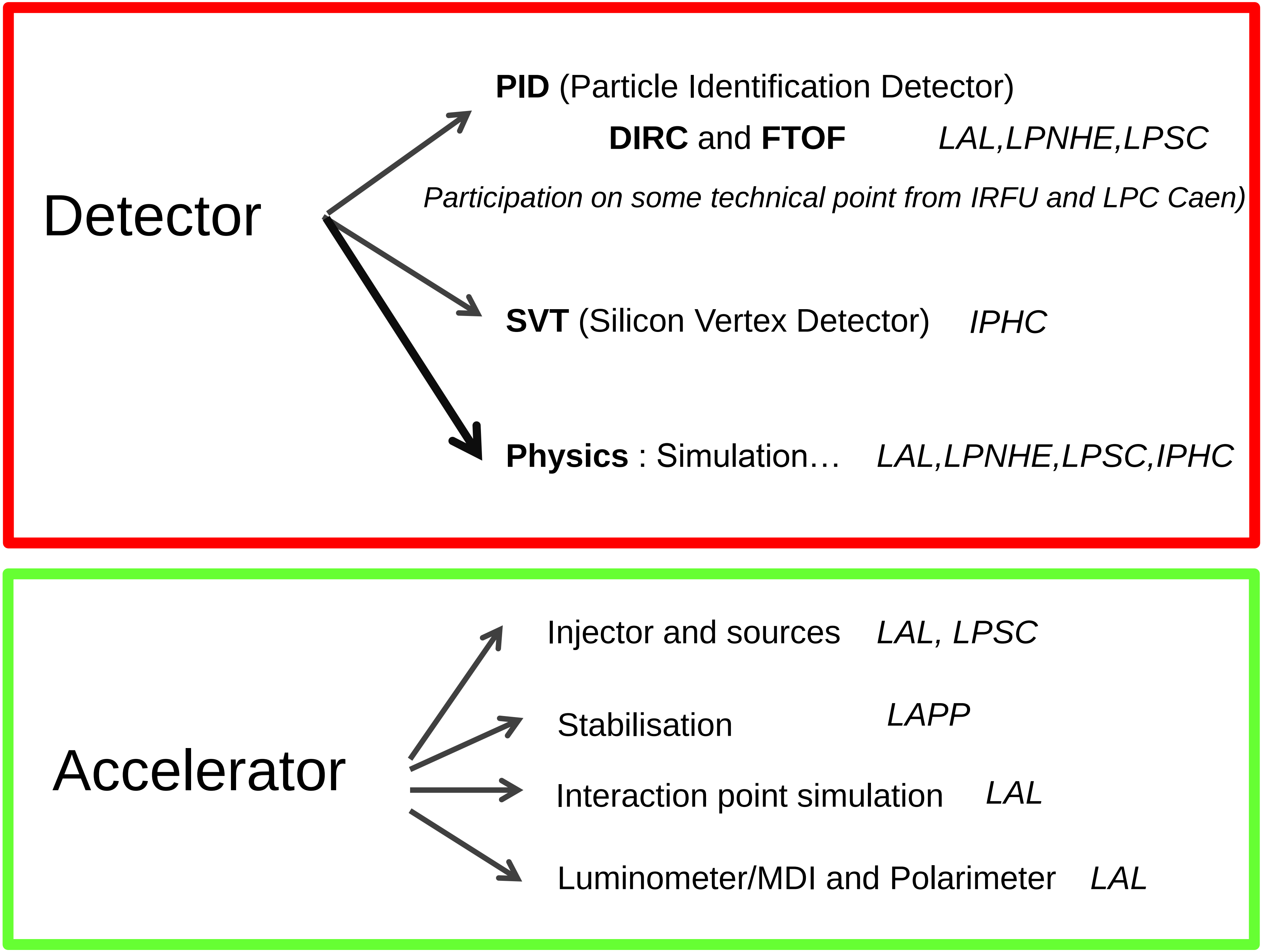
Tome II

The requests to the Scientific Council

SuperB

Achille Stocchi - LAL (Université Paris-Sud / IN2P3)


Detector
PID (Particle Identification Detector)
DIRC and FTOF
LAL,LPNHE,LPSC
Participation on some technical point from IRFU and LPC Caen)
SVT (Silicon Vertex Detector)
IPHC
Physics : Simulation…
LAL,LPNHE,LPSC,IPHC
Accelerator
Injector and sources
LAL, LPSC
Stabilisation
LAPP
Interaction point simulation
LAL
Luminometer/MDI and Polarimeter
LAL

Global Picture - Detector

t_0 — 2012 — "R&D"-like year.
Some of the work done could be used/taken on the construction budget of the following years

2 — 2013 — R&D to enter in the construction phase

3 — 2014 — Construction. Need an important financial Support (TGIR/TGE)

4 — 2015

5 — 2016

<u>We present our request in a 5+1 years</u>

2012-2013 R&D and preparation for construction
2014-2016 Construction
2017 Installation/Commissioning
→ implying data taking in 2018.

6 — 2017 — Installation of the detectors

2018 — Data taking

Global Picture - Machine

t_0 — 2012 — "R&D"-like year + equipement to be prepare to the construction phase

2 — 2013 — R&D to enter in the construction phase

3 — 2014 — R&D to enter in the construction phase.
Start of the production phase

4 — 2015 — Production phase

5 — 2016 — Production phase

6 — 2017 — Installation

2018 — Data taking

In2p3/Labs
- Equipement
- Personals

Partially could be negociated with SuperB project

Money from SuperB project

In2p3/Labs
- Personals

We present our request in a 5+1 years

2012-mid 2014 2 ½ years R&D and preparation for construction
2014-2016 2 ½ years Construction
2017 Installation/Commissioning
→ implying data taking in 2018.

WE ASK THE CONSEIL SCIENTIFIQUE TO

→ State about the scientific and strategic importance of the project

→ Approval for the phase preparatory to the SUPERB construction

→ Support for the requirements

LAL : équipe qui a déjà travaillé sur les phases précédentes

Nicolas Arnaud, Cyril Bazin, Christophe Beigbeder, Frédéric Bogard, Dominique Breton, Leonid Burmistrov, Daniel Charlet, Vincent Chaumat, Abdelmowafak El Berni, Emi Kou, Jihane Maalmi di Bello, Véronique Puill, Achille Stocchi, Vanessa Tocut, Sandry Wallon, Guy Wormser

+ nouvelles personnes à définir et volontaires

LPNHE : équipe qui a déjà travaillé sur les phases précédentes

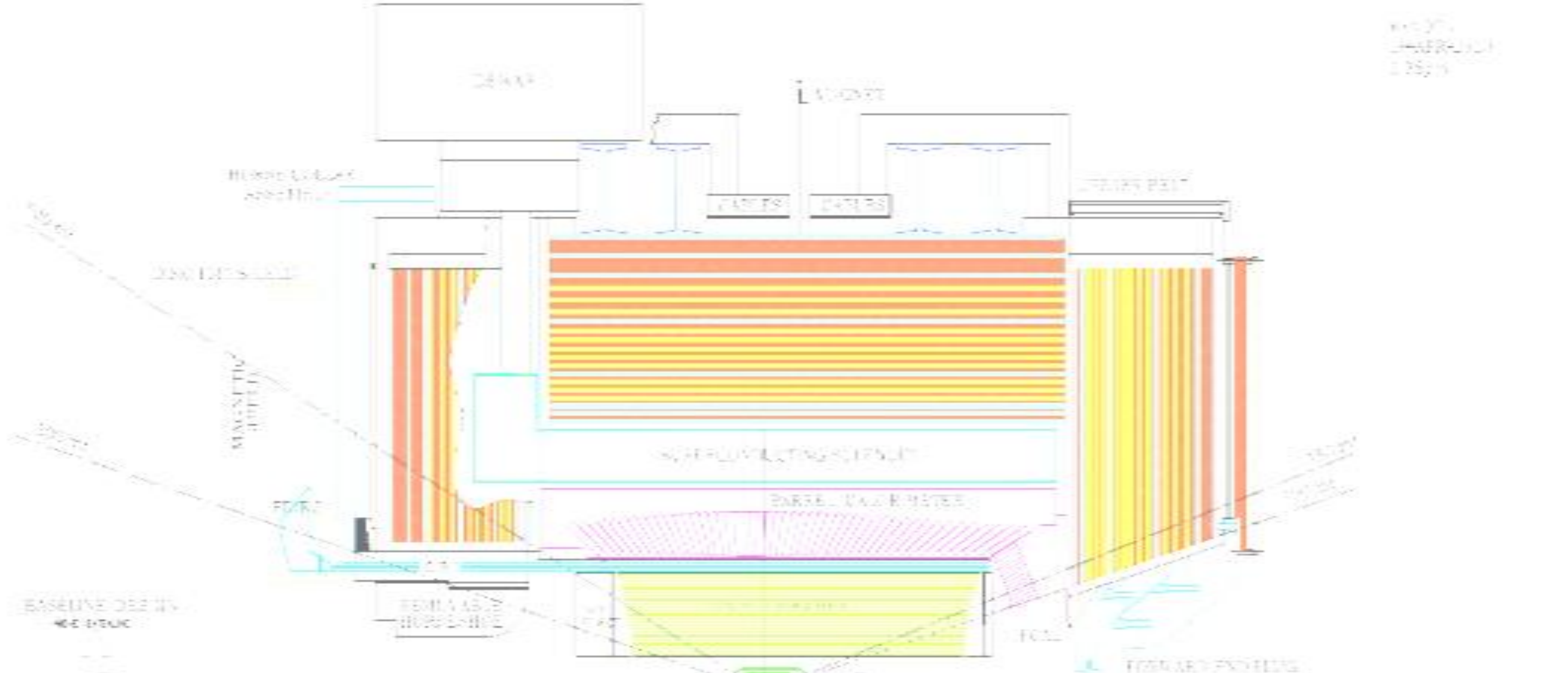
Eli Ben Haim, Herve Lebollo

LPSC : nouvelle equipe

Jean-Sebastien Real + ingénieurs (à définir)

IPHC : nouvelle equipe

J. Baudot, A. Besson, I. Ripp-Baudot, M. Winter + ingénieurs (à définir)



Contribution to The SuperB Detector

SuperB detector activities

- Current activities
- The future: 2012 and beyond
  (end of TDR and start of construction)

The following slides are very very detailed for completeness
and to give the possibility to be quietly examine them
(some I skip/some I'll go quickly through)

Barrel PID Front-end Electronics

Goal: measurement of the arrival time of the photons with a precision of 100 ps RMS

- The main chip (« SCATS », based on the SuperNEMO « SNATS » chip) combines
  - a 16-channel TDC with a high count rate input/output capability
  - an analog part designed to discriminate and output the analog signal thanks to a analog pipeline

- A 12-bit ADC can provide an amplitude measurement – at least for calibration, monitoring and survey – which is transmitted with the hit time.

- Chip connected to a radiation-tolerant FPGA which handles the hit readout sequence and push data into the L1-trigger latency buffers

- Two solutions still being studied in parallel
  - Electronics right behind the Ma-PMT connectors on the camera support: baseline
  - Data transfered through cables to front-end crates located outside the detector

- Crate readout controller: concentrate and pack the data received from the front end boards and send them to the DAQ

- Test and validate electronics prototypes locally and also at SLAC CRT (FDIRC proto)

- Collaboration with LPNHE and LPC Caen

Status and Next Steps

- First version of the SCATS to be submitted in early November
  $\rightarrow$ Analog front-end part not included

- Design of the analog part
  $\rightarrow$ Dedicated ASIC early next year

- In addition to attenuation effects, study how the signal-to-noise ratios change in the 'long cables' solution and how this may affect the hit resolution

- Front-end board prototype scheduled for 2012

- Dedicaded DAQ foreseen at SLAC to take data with the FDIRC prototype

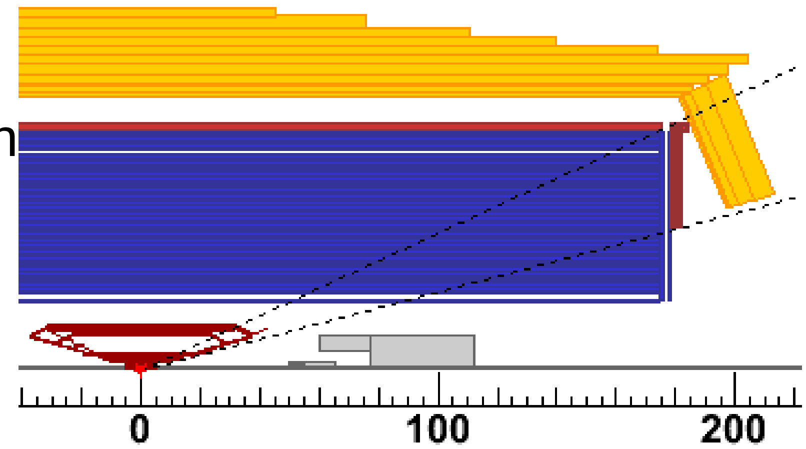
- Local test bench to learn the main characteristics of the MaPMTs and to test electronics

(In collaboration with Padova and Bari SuperB groups)

- Chip and board productions in 2014-2015

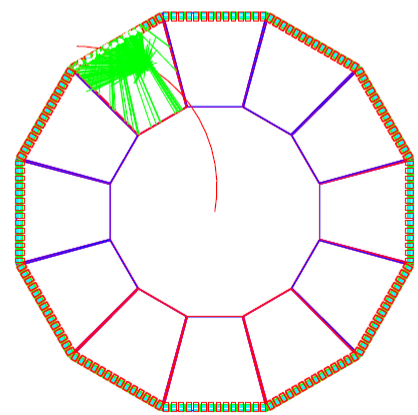
Forward PID: the FTOF

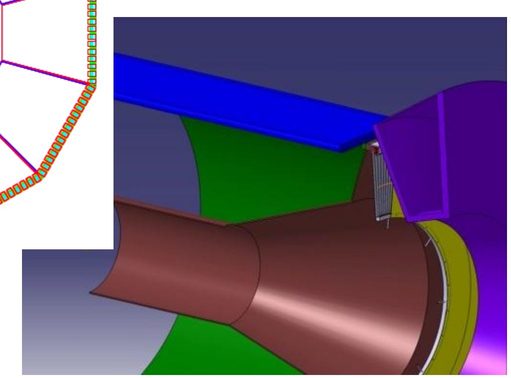
- Reminder of the forward PID requirements
  - Good K/π separation in 0.8-3.5 GeV/c ran
  - Space limited on the forward side
    - $\rightarrow$ Compact device (thickness < 10 cm)
  - X_0 as low as possible in front of the EMC
  - Radiation-hard



- LAL solution, in collaboration with SLAC: « Forward Time-Of-Flight »
  - Flight length ~ 2 m from IP $\Rightarrow$ required timing resolution of 30 ps
  - At least 10 photons / track $\Rightarrow$ timing resolution per photon around 100 ps

- Layout
  - 12 thin (15 mm thick) quartz tiles
  - Production of Cherenkov light
  - Detected by fast PMTs on outer radius
  - Ultra-accurate electronics mandatory

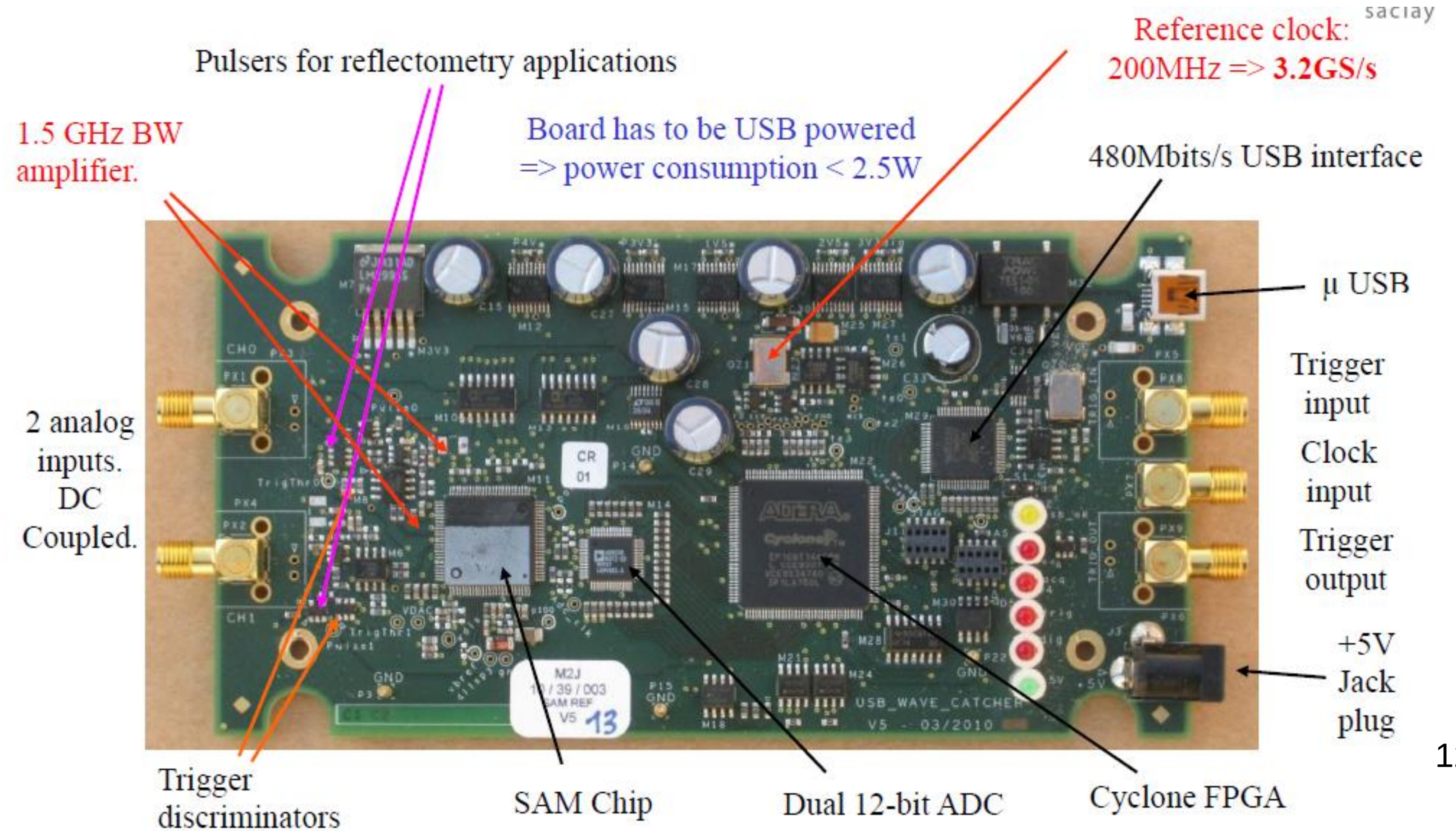




- Core of Leonid Burmistrov's PhD thesis
  - $\rightarrow$ To be defended on December 9th

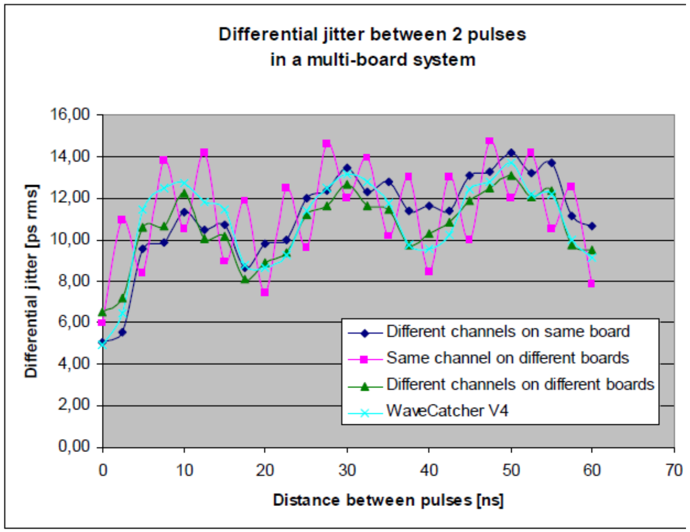
USB WaveCatcher Electronics (USBWC)

- In collaboration with Eric Delagnes (CEA/IRFU)
- Based on fast analog memories
  → 12 bits - 3.2 GS/s Waveform sampling + digital treatment of digitized signal



Performances and Next Steps

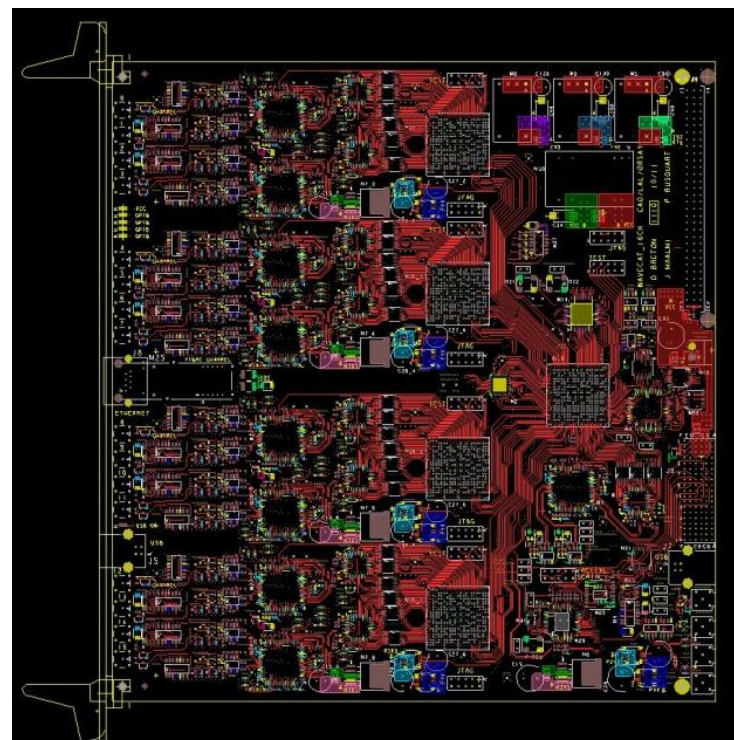
- Crate hosting 8 x 2-channel V5 boards
  → Configuration used in the test of the FTOF prototype at SLAC CRT



Mean differential jitter is of about 12ps rms which corresponds to **8.5 ps rms** of time precision per pulse

- New chip: SAM → SAMLONG
  - Buffer 4 times longer

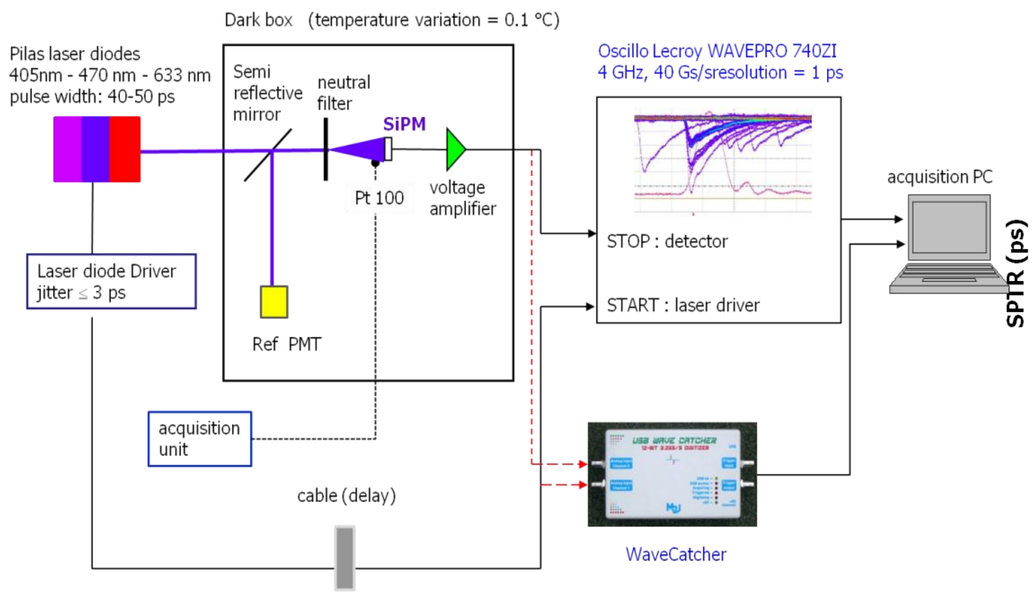
- Next: 16-channel board soon available

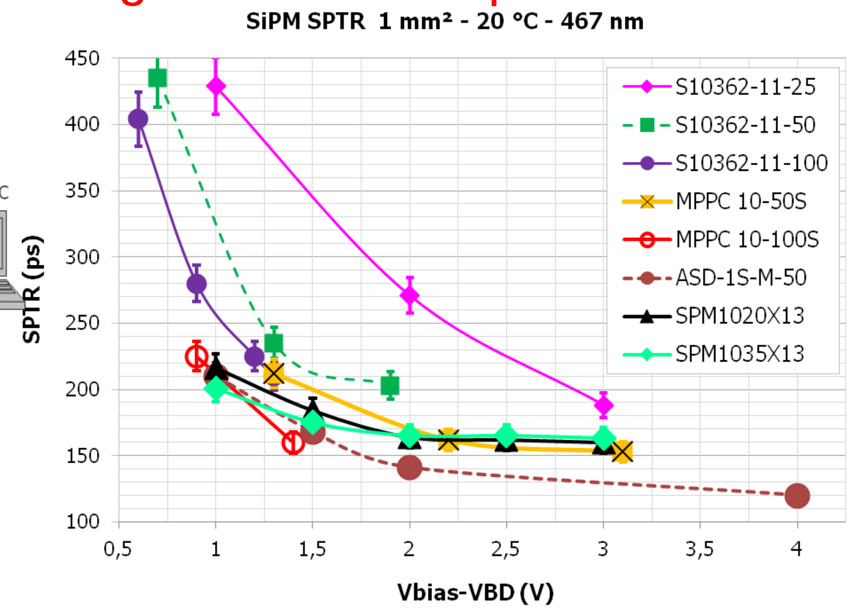


- Longer term:
  up to 20 such boards in a full crate!

Photodetector studies: SiPMs

- Use of the optical test bench developed for SiPMs studies at LAL
- Single photon Timing Resolution (SPTR) of different SiPMs as a function of the bias voltage, the wavelength and the temperature*





- Precision on the timing resolution measurement :
  WavePro 740ZI ≈ 1 ps; Wavecatcher ≈ 8 ps

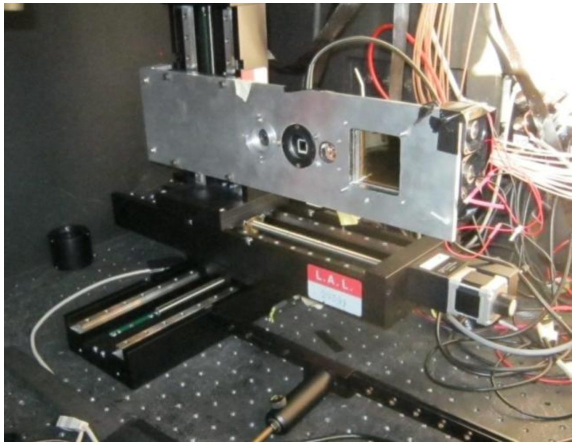
- □ Best SPTR (FWHM) = 120 ps and very poor radiation hardness
  → SiPM not good enough for the FTOF

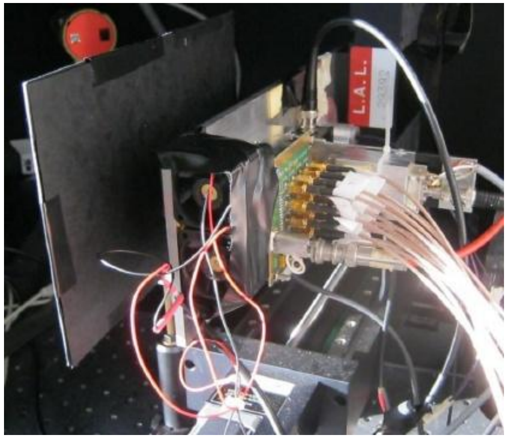
* To be published in the NIM A Proceedings of the NDIP11 Conference

Photodetector studies: MCP-PMTs

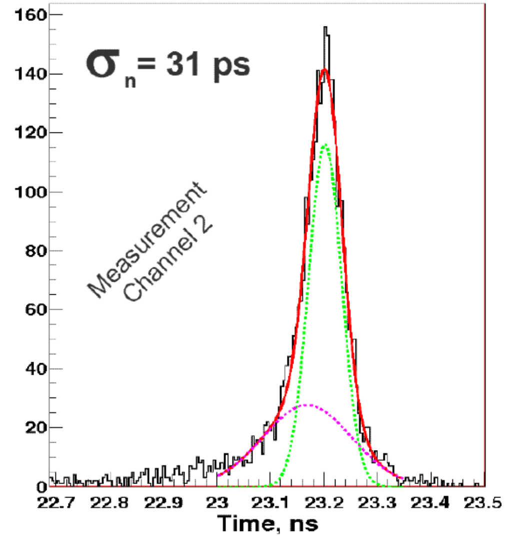
Detectors studied
- PHOTONIS XP85012
- Hamamatsu R10754-01 (SL10) 4 & 16 channels

Measurements of gain, SPTR and cross-talk





SL10 SPTR @ 405 nm – 3.5 kV
LAL Wavecatcher measurement



MCP-PMT	SPTR FWHM (ps)	Lifetime (Cb/cm²/year)	Gain max @ 1,5 T
Photonis XP85012	100	< 1 ??	< 1x 10^4
Hamamatsu SL10	70	2.5	1 x 10^6

Good SPTR but very poor lifetime and resistance to integrated charge

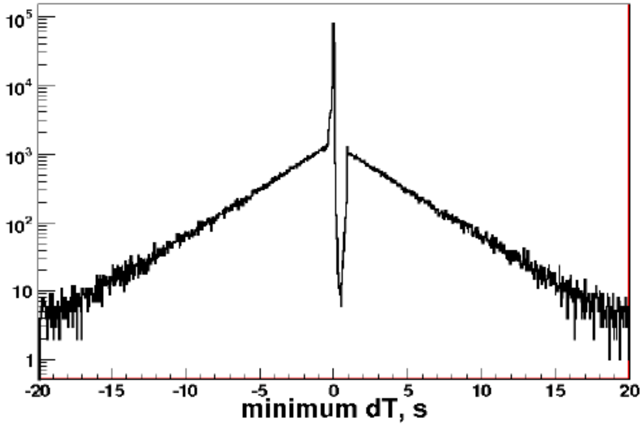
The best device + high quality technical interactions between LAL & HAMAMATSU
⇒ Baseline for the FTOF prototype

FWHM ≈ 2.35 σ

Test at the SLAC Cosmic Ray Telescope

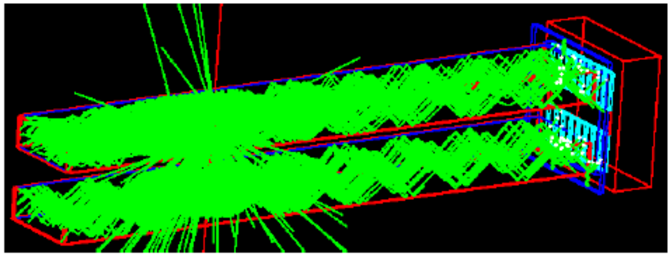
Goal: estimate single photon time resolution using the full detector chain
→ Quartz bars, photon detector (Photonis MCP-PMT), USBWC electronics

Installation and commissioning in Fall 2010
Data taking until Spring 2011
→ Used SLAC CRT to trigger on cosmic muons



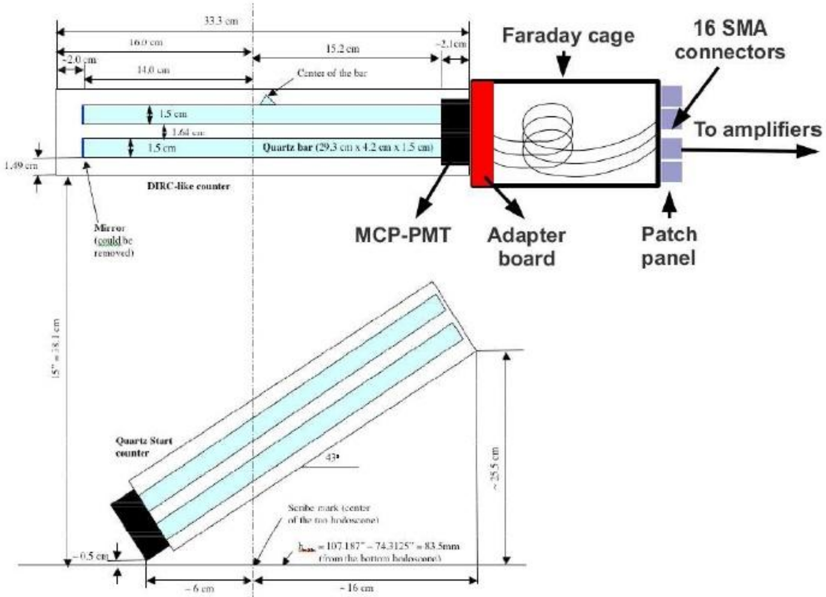
Two DAQ systems: CRT and USBWC
→ Use Unix time to match events

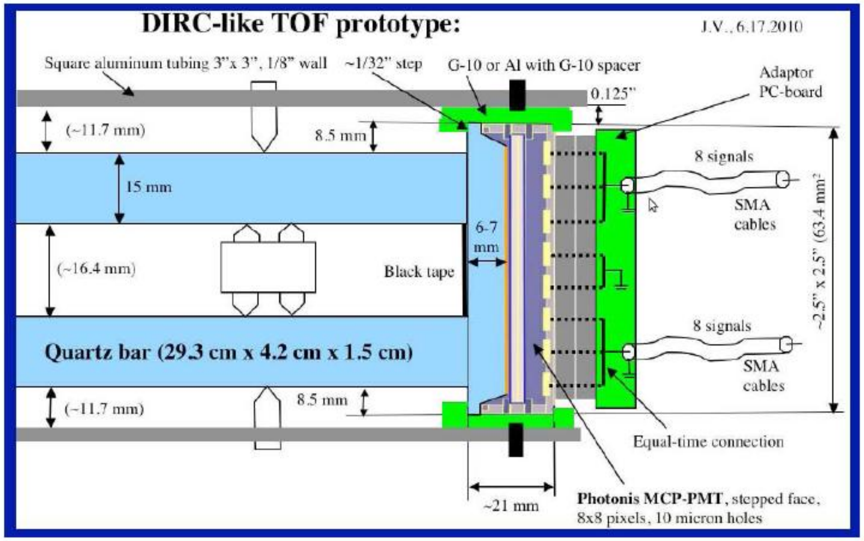
Analysis based on a detailled Geant4 simulation of the apparatus

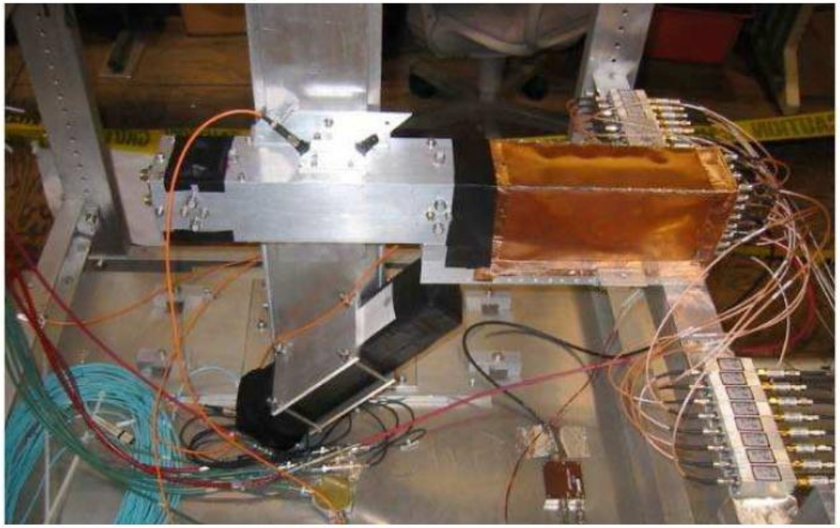


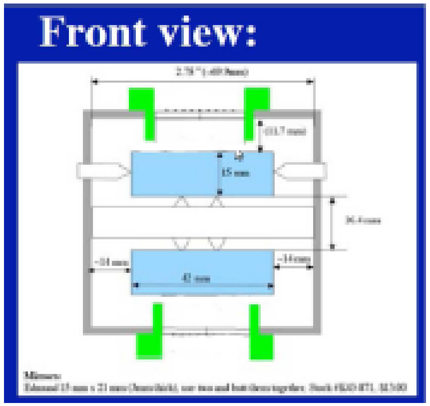
Prototype geometry different from the SuperB FTOF
But proof of principle achieved and main timing effects understood and studied

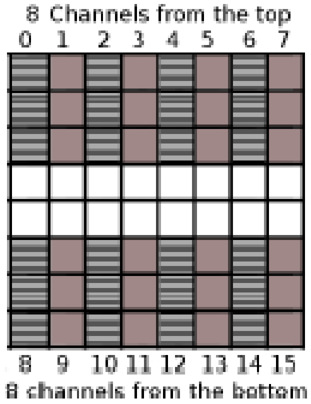
FTOF prototype in SLAC CRT



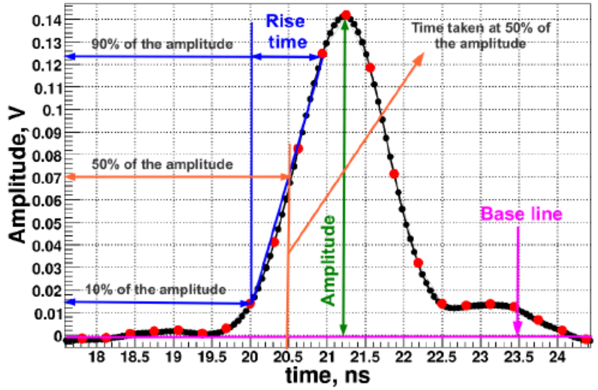








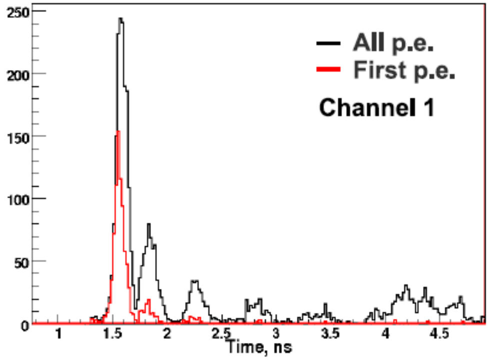
Data analysis in a nutshell



CRT and USBWC events merged using Unix times provided by the 2 DAQ systems

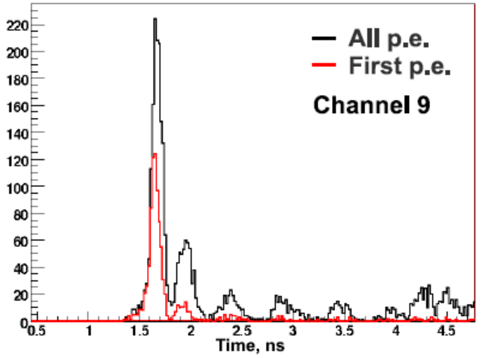
Require muon track to be reconstructed

Timing measurements based on a constant-fraction discriminator algorithm
$\rightarrow$ No reference time: compute histograms of differences between two channe



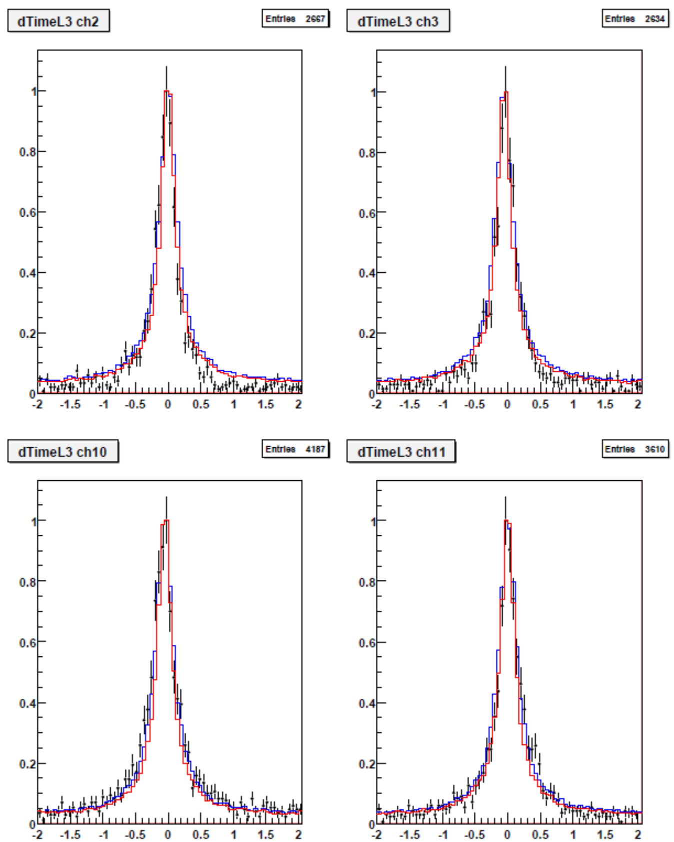
Need to account for / to study many effects
- Multiple photon detection
- Crosstalk, charge sharing, noise

An important contribution to the timing resolution: multiple photon paths
$\rightarrow$ For a given track and a given MCP-PMT channel times can vary a lot!



Examples of Results

Very good data-simulation agreement

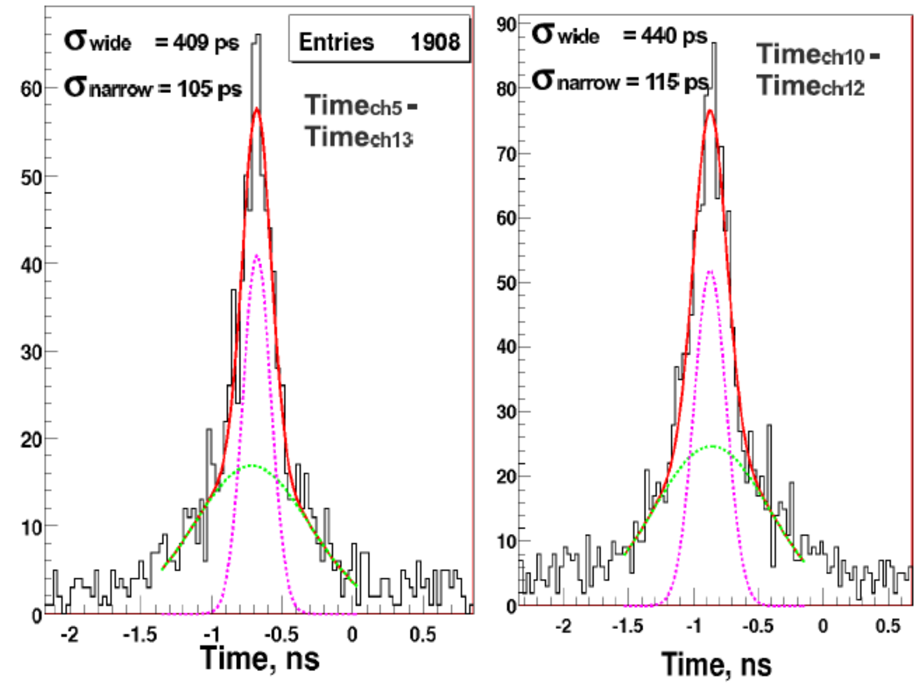


Histograms normalized by amplitud

Black dots: data

Red and blue solid lines: simulations

Timing precision at the level of ~80 ps / photon



Two Gaussian fits

→ Resolution ≈ narrow component RMS

Division by √2 to get result / channel

FTOF status in SuperB

Technology selected in May by the SuperB Forward PID taskforce

Summary/Recommendations

- The importance of hermeticity [and redundancy] in PID coverage will increase as we approach systematic dominated era in the SuperB physics program. Hence, the taskforce members believe- independently of the outcome of the current technology evaluation- that there is physics merit to allowing a gap in the forward region for a Forward PID device as an upgrade option.

Summary/Recommendations: Focusing TOF

- Simulation studies & cosmic ray tests have demonstrated that key aspects of this technique can be attained- including time resolution of ~90 ps/hit.
- There remains significant uncertainties on the expected background level and its impact on PMT lifetime.
- The taskforce believes this technique could be appropriate for the Forward PID system provided:
  - Background issues are understood- which may require further studies of the IR design and shielding
  - A full prototype of the system is developed and tested, to verify the expected performance, in particular the pattern recognition in presence of background hits.

22#

⇒ Consequences

Empty space allocated on the SuperB forward side to build this device

Required to demonstrate that a full-scale prototype of a FTOF sector (1/12th of the total) works as expected in simulation prior to moving to construction

⇒ Two main activities for the coming year(s)

Build and test the sector prototype

Computing developments parallel to the technical work to support it

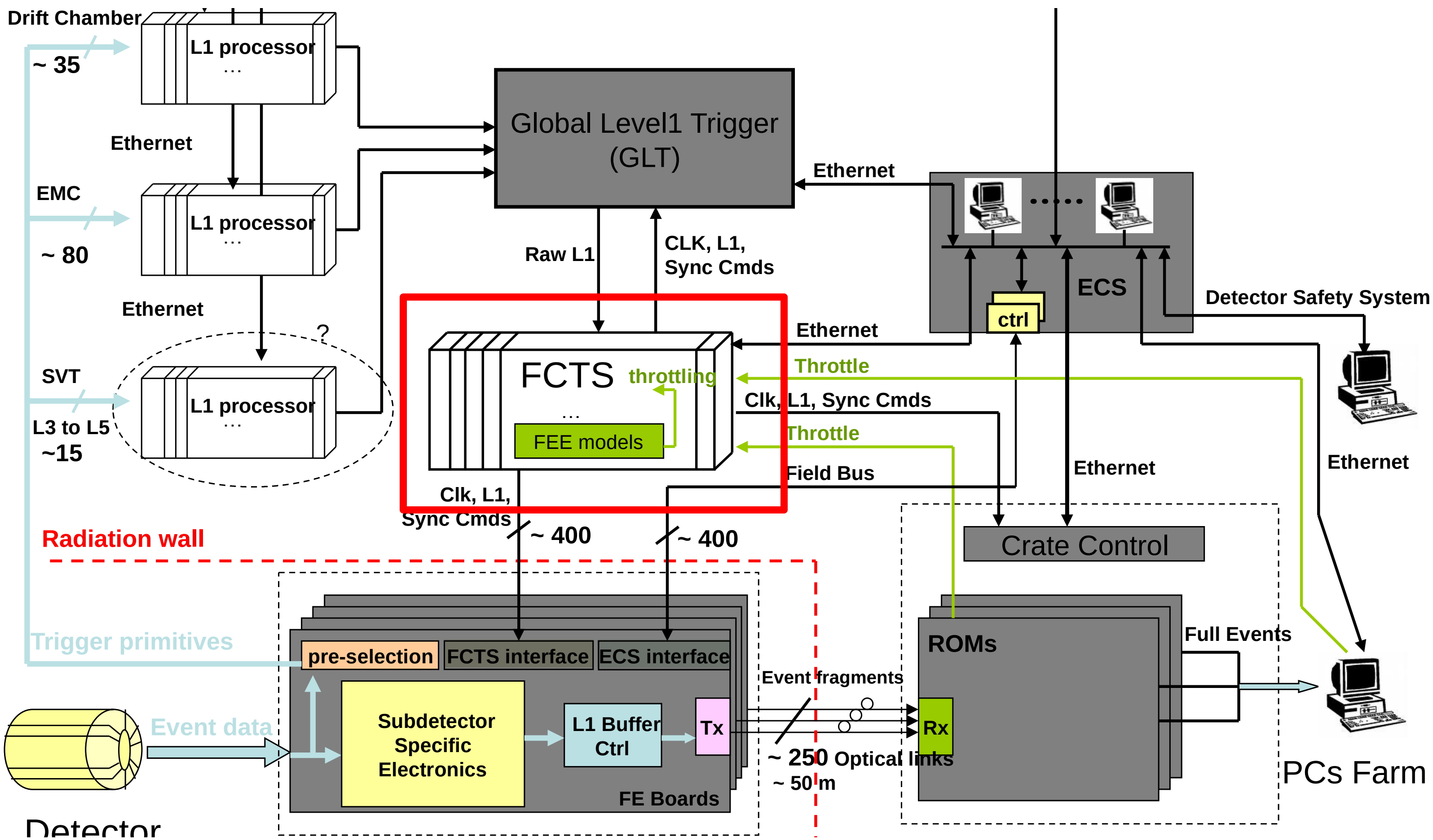
- Simulation – in particular background estimation and mitigation
- Reconstruction

Electronics, Trigger and DAQ activities

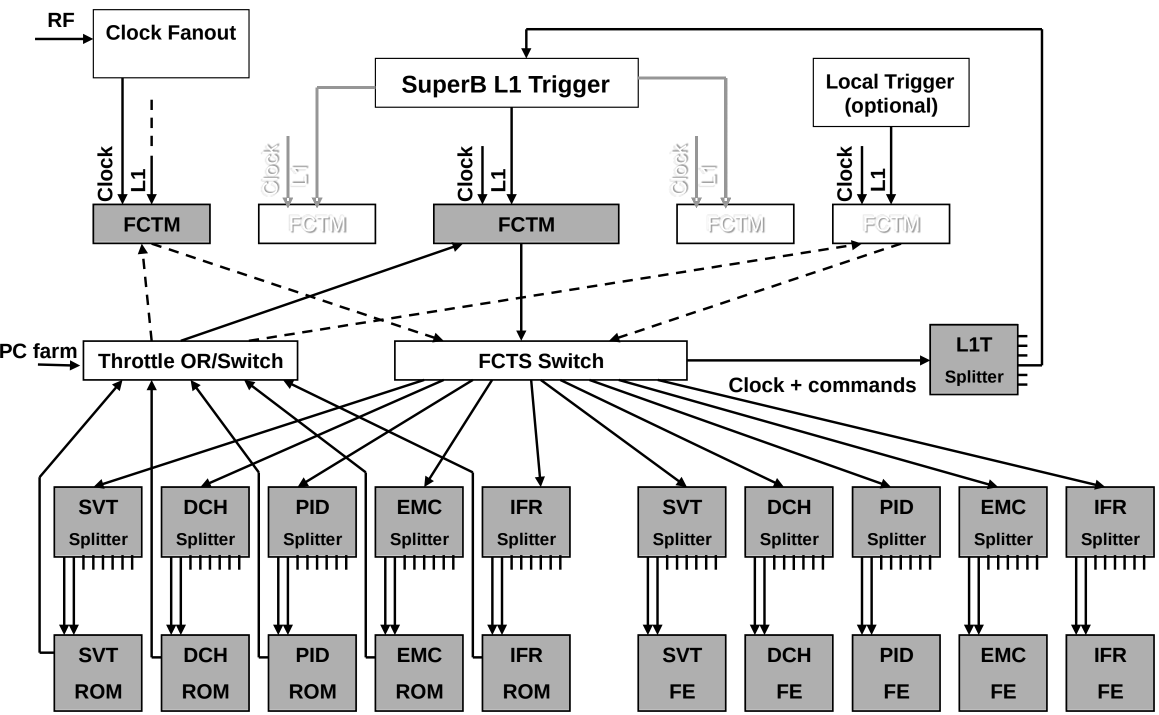
Fast Control and Timing System (FCTS)

Experiment Control System (ECS)

Common front-end electronics



Fast Control and Timing System (FCTS)



- Links carrying trigger data, clocks and commands need to be synchronous & fixed latency: ≈ 1GBit/s
- Readout data links can be asynchronous, variable latency and even packetized: ≈ 2 Gbit/s but may improve

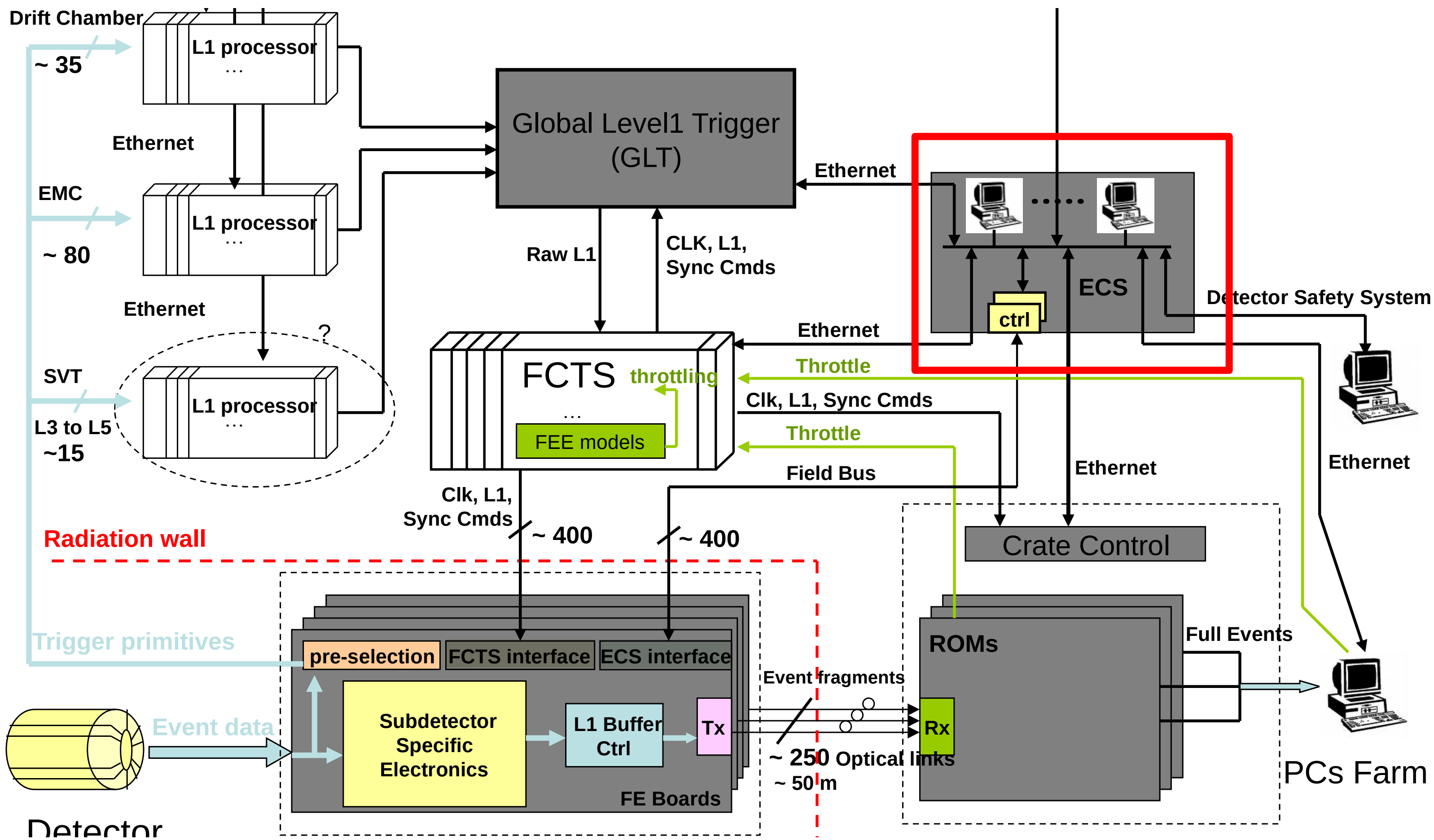
- Clock distribution
- System synchronization
- Command distribution
  → L1-Accept
- Receive L1 trigger decisions
- Participate in pile-up and overlapping event handling
- Dead time management
  - Fast and slow throttles
- System partition
  → 1 partition / subdetector
- Event management
  → Determine event destination in event builder / high level trigger farm

Electronics, Trigger and DAQ activities

Fast Control and Timing System (FCTS)

Experiment Control System (ECS)

Common front-end electronics



Experiment Control System (ECS)

Configure the system
- Upload configuration into FEE
- Should be fast!

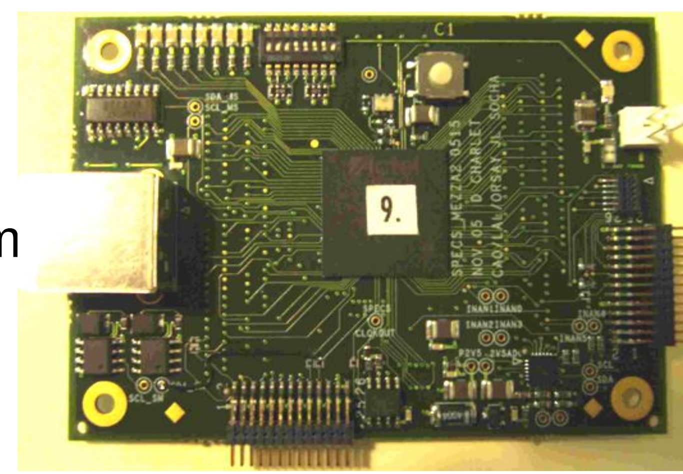
Monitor the system
- Spy on event data
- Monitor power supply, temperatures, etc.

Test the system
- Using software specifically written for the FEE
- We do not foresee ECS-less self-test capabilities for the front-end electronics

Proposed implementation
- SPECS: Serial Protocol for Experiment Control System
- Bidirectional 10MBit/s bus designed for LHCb

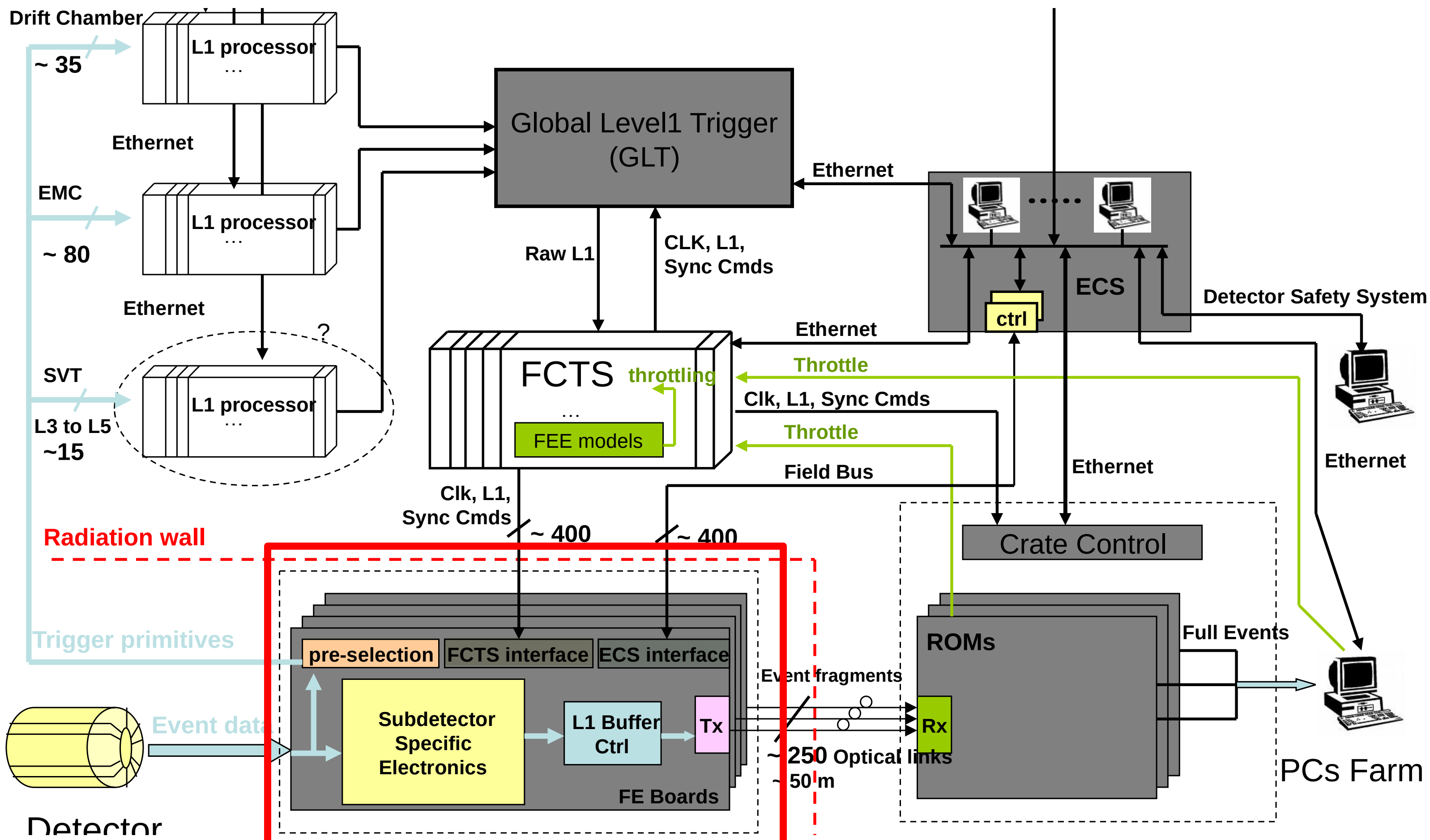
SPECS master board

SPECS Slave mezzanine

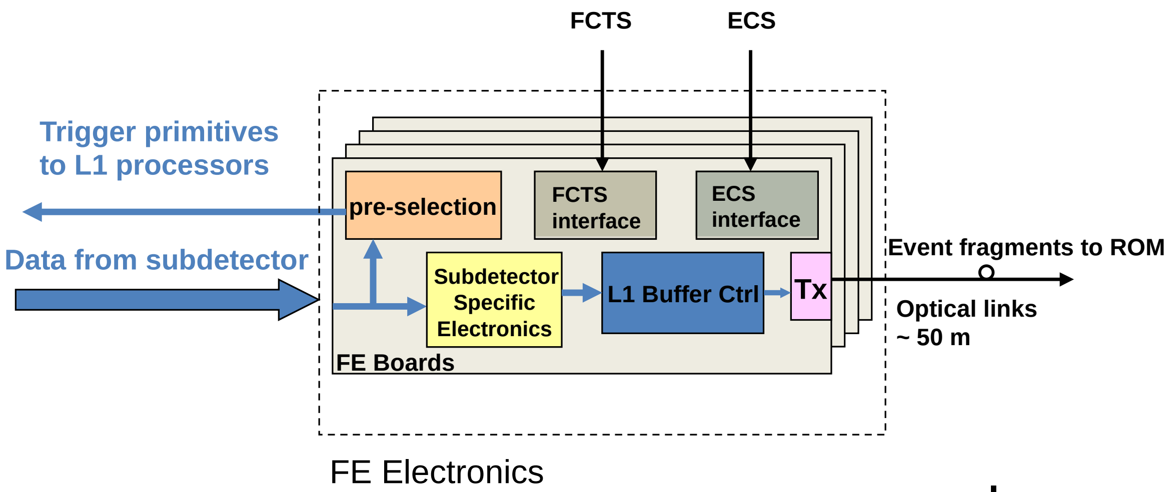


Electronics, Trigger and DAQ activities

Fast Control and Timing System (FCTS)
Experiment Control System (ECS)
Common front-end electronics



Common Front-End Electronics



- Provide standardized building blocks
  to all sub-detectors, such as:
  - Schematics and FPGA "IP"
  - Daughter boards
  - Interface & protocol descriptions
  - Recommendations
  - Performance specifications
  - Software

- Digitize
- Maintain latency buffer
- Maintain derandomizer buffers, output mux and data link transmitter
- Generate reduced-data streams for L1 trigger
- Interface to FCTS
  - Receive clock
  - Receive commands
- Interface to ECS
  - Configure
  - Calibrate
  - Spy
  - Test
  - etc.

Positions inside the SuperB collaboration

Guy Wormser: Senior Management Team

Achille Stocchi: SuperB France Detector + Physics coordinator
Former co-convener of the Physics group
Co-chair of the Detector Geometry Working Group
Member of the Governance Comittee

Alessandro Variola: SuperB France Accelerator coordinator

Dominique Breton: co-chair of the Electronics, Trigger and DAQ Group

Nicolas Arnaud: co-chair of the PID group

Project responsabilities

PID

Group management
Barrel front-end electronics
FTOF detector design, development and tests; front-end electronics

ETD

Group management
Fast Control and Timing System
Environmental Control System
Common front-end electronics

Senior management

Responsable of the « Tour bureau » – contact with countries willing to join SuperB

Transverse activities

Simulation – both fast/parametric and full/Geant4
Developments for physics analysis: « Breco » algorithm, PID selectors, etc.
Background analysis and mitigation

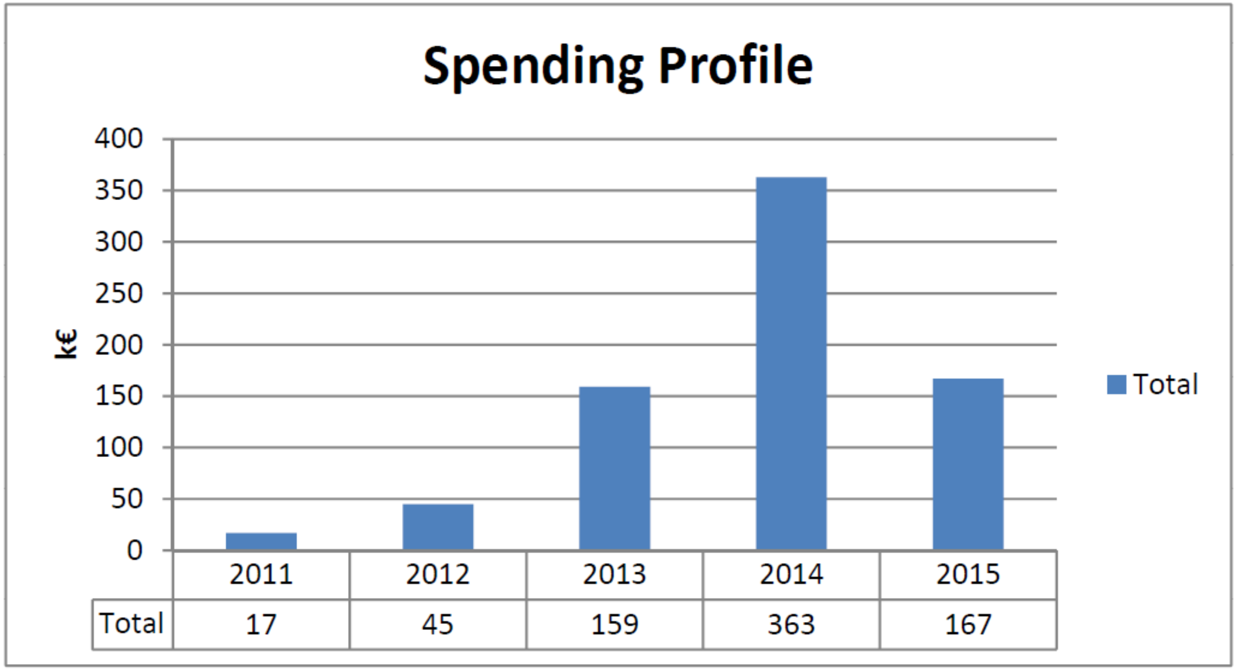
SuperB detector activities

- Current activities
- The future: 2012 and beyond
  (end of TDR and start of construction)

Barrel PID

- Electronics: R&D, development and production; tests at SLAC CRT
  →Spending profile

LAL + LPNHE
[+ LPC Caen]



- Mechanics
  - Needed for the electronics integration
  - Other important projects not covered so far in the FDIRC system electronics integration, background and magnetic shields, transport of the DIRC quartz bars from SLAC to Italy, etc.

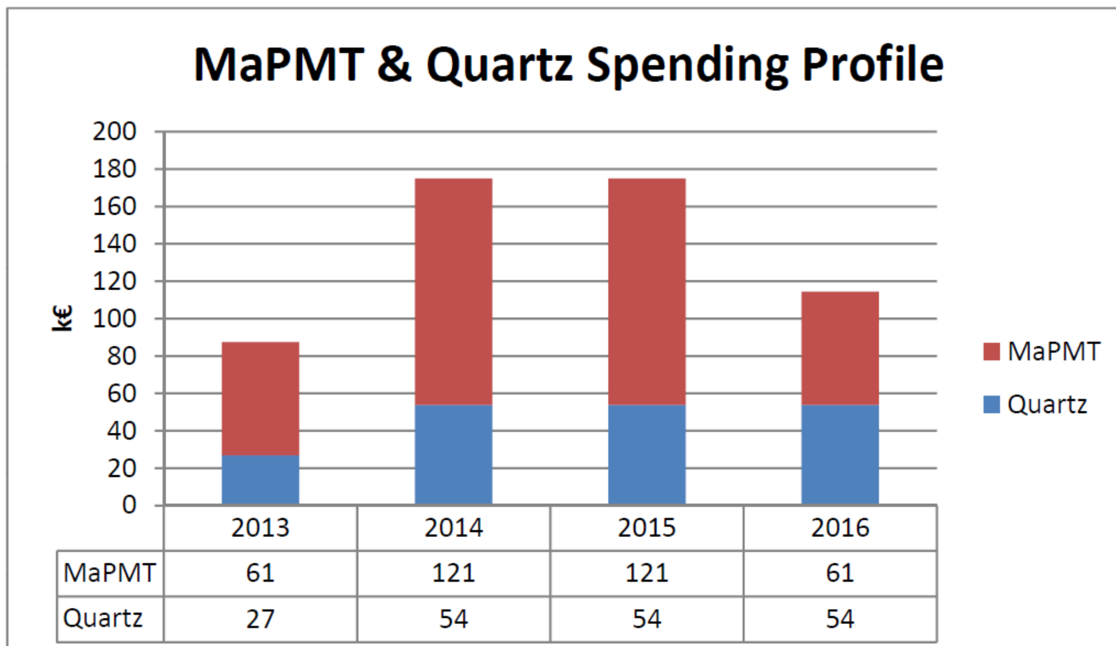
  → Ongoing discussion with the LAL mechanics department
  - Spendings will depend on the tasks for which the LAL will be responsible

Barrel PID ‘SuperB France Common Funds’

- As a leading group in the PID system we want to contribute to its two main costs
  - The quartz cameras (12 sectors + 2 spare sectors)
  - The H-8500 MaPMTs (~630 in total including 10% spares)
- Hypothesis
  - Delivery starts mid-2013
  - Quartz: 70 k$ per sector including polishing;1 sector delivered every 3 months
  - MaPMTs: 3 k$ / tube, flat delivery over 3 years
  - 1 € ⇔ 1.3 $
- French contribution: 25% of the total cost

→ Numbers in the graph scale directly when the fraction changes

- Manpower and equipment needed to test all these components currently not accounted for



Total **88** **175** **175** **115**

Forward PID

- Two-step process
- 2012-2013: FTOF prototype
- 2014-2016: Purchase and assembly of the SuperB FTOF detector
  $\rightarrow$ Assumes FTOF prototype is successfully tested

(LAL + LPSC)

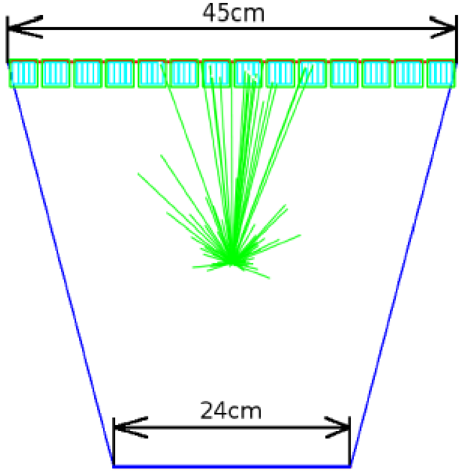
FTOF prototype

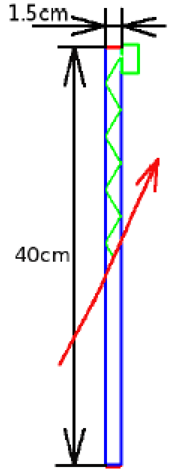
- Quartz tile with the real dimensions and shape
  width = 1.5 cm ⇔ 12% of X_0

- 14 SL10 4-channel MCP-PMTs
  from HAMAMATSU

- 4 new 16-channel USBWC boards
  for the readout

- FTOF prototype building cost (2012)
  → See Table in two slides





- FTOF test in cosmics (2012-2013)
  → Different possibilities still under study
  - LAL: application to the P2IO R&D call in order to build a local muon telescope
  - LPSC muon telescope

A possible organization of the work

- Test of the new 16 channels Wavecatcher (LAL)
- Design of a thin MCP-PMT socket (LAL)
- Measurement of all the MCP-PMTs with pulsed blue laser (LAL + LPSC)
- Lifetime study of one MCP-PMT (LAL + LPSC)
- Gluing of the MCP-PMTs with optical grease and mechanical support (LAL)
- Mechanics (LAL + LPSC)
  - Barbox with N_2 flow
  - Support to transport the sector and hold it during the tests
- Tests with magnetic field (LPSC)
- Test of the proto with muons (LAL + LPSC)

FTOF prototype (cont'd)

produit	prix unitaire (€)	nombre de pièces	prix total (k€)
MCP-PMT	8800	15	132.0
embase MCP-PMT	500	15	7.5
câbles SMA-SMA 2 m	17.5	60	1.1
carte preamplificateur	5000	1	5.0
tuile quartz	8462	2	16.9
chassis alimentation HT	5720	1	5.7
carte alimentation HT 12 voies	3181	2	6.4
colle optique	500	1	0.5
absorbeur de lumière	250	1	0.3
barbox avec circulation azote	3500	1	3.5
wavecatcher 16 voies	3000	5	15.0
fournitures informatique	200	1	0.2
fournitures électroniques	500	1	0.5
frais de port	1000	1	1.0
TOTAL proto FTOF			195.5

- Missions will be needed as well
  → Request: 20k€ in 2012 and 30k€ in 2013
- In addition a beam test will be organized at the end of the process if all the previous steps are successfully completed

FTOF Detector for SuperB

- Preliminary cost estimate
  $\rightarrow$ See table on the right

- Assumptions
  - Paid in three years:
    2014 $\rightarrow$ 2016
  - Flat profile
  - French contribution: 50%

$\Rightarrow$ Total cost for France:
~300 k€ / year

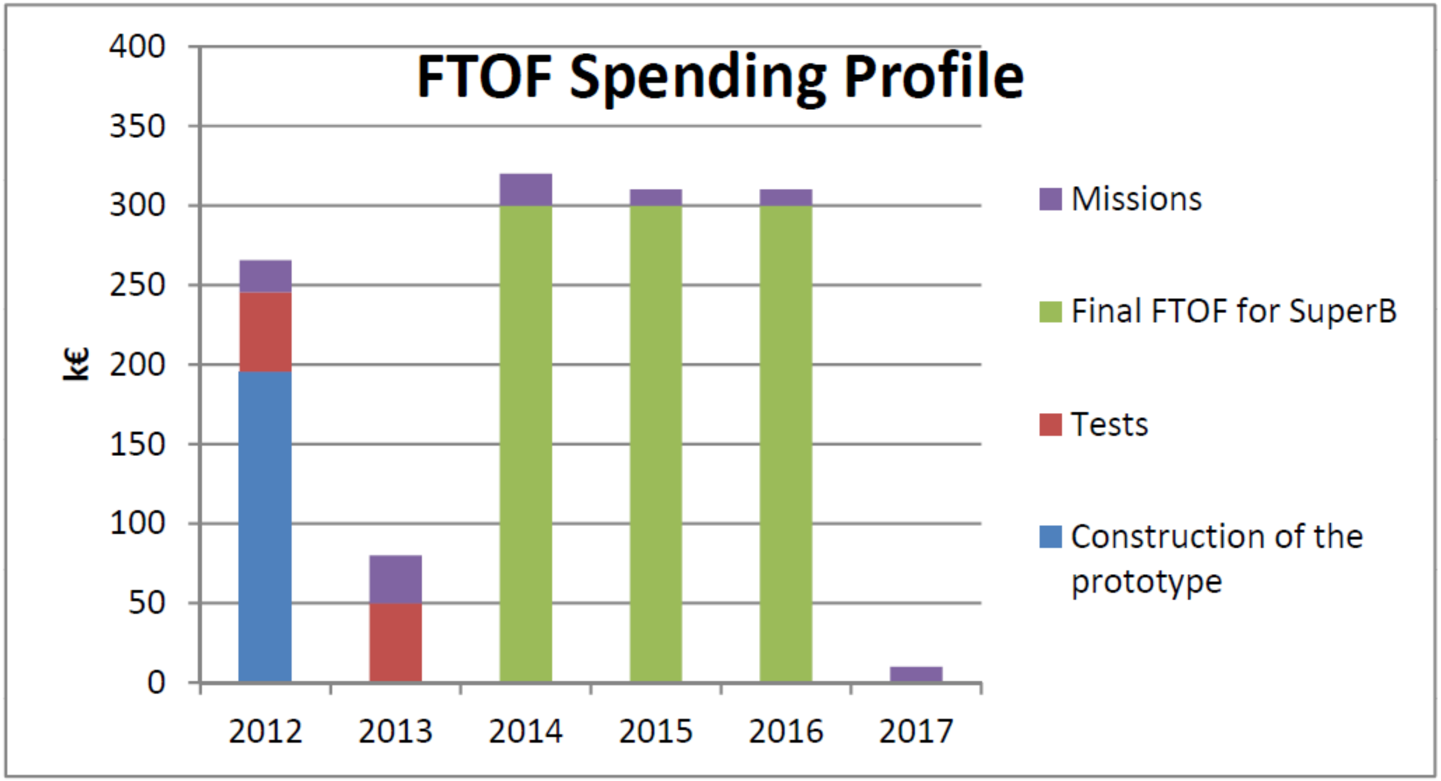
produit	prix unitaire (€)	nombre de pièces	prix total (k€)
MCP-PMT	6500	196	1274.0
embase MCP-PMT	300	196	58.8
câbles SMA-SMA 5 m	50	840	42.0
carte preamplificateur	5000	14	70.0
tuile quartz	7692	14	107.7
chassis alimentation HT	5720	1	5.7
carte alimentation HT 12 voies	3021	16	48.3
colle optique	500	12	6.0
absorbeur de lumière	250	12	3.0
barbox	1500	12	18.0
wavecatcher 16 voies	3000	48	144.0
fournitures informatique	200	5	1.0
fournitures électroniques	500	5	2.5
Mécanique			50.0
frais de port	1500	2	3.0
TOTAL FTOF complet			1834.0

- Missions requested in addition for about 20 k€ per year

- Manpower for the USBWC-based FTOF front-end electronics is accounted for in the coming ETD slide

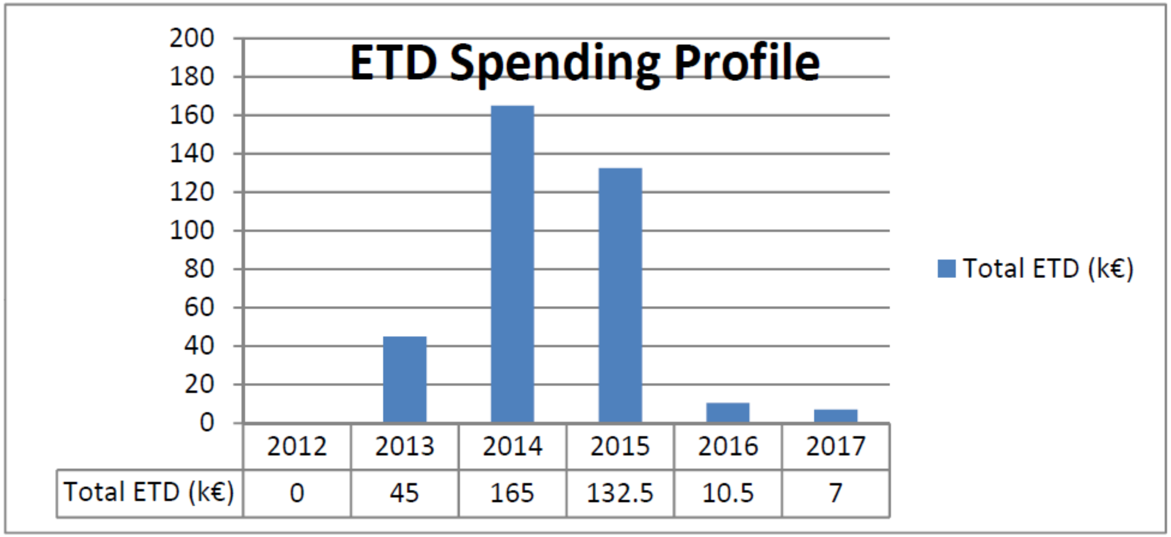
FTOF Cost Profile

- LAL + LPSC
- This chart includes 4 different items
  - FTOF prototype
  - Following tests
  - FTOF detector for SuperB
  - Missions



ETD

- ECS contribution is manpower only (no budget) as the work consists of consulting and software development
- For all ETD items, the LAL task is to provide and commission deliverables which will then be operated by the DAQ/online group with the help of physicists willing to take part in these operations
- Namely
  - The FCTS crate(s) and their various boards
  - The ECS system: ethernet master boards, cables and detector mezzanines
  - Simulation and advices for the Common Front-End Electronics
- Spending profile
  → FCTS + ECS



SuperB involvement at IPHC

- **Contribution proposed for SuperB:**

Outcome of a long R&D development program for the ILC.

- R&D developments for the SVT Layer-0: pixels and system integration,
- Physics analyses: SVT global geometry optimization, time dependent analyses in the charm sector,
- Computing: IPHC Tier-2 involvement.

- **Human resources:** (not exhaustive)

➛ 4 physicists,

- Jérôme Baudot (MCF university), Auguste Besson (MCF university) and Marc Winter (DR CNRS), members of the PICSEL research team,
- Isabelle Ripp-Baudot (CR CNRS), member of the Dø research team.

➛ 2 to 2.5 FTE engineers currently working in the PICSEL team and microtechniques service: chip designers and test connectics and instrumentation experts (17 engineers in total).

➛ students:

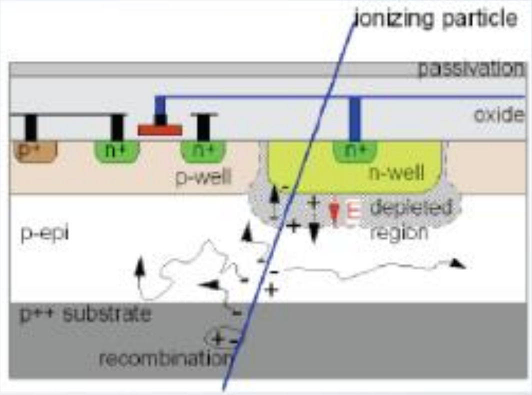
- 1 PhD student may join in oct. 2012.

➛ post-doc:

- 1 post-doc expected in 2014/2015 (?)

CMOS pixel sensors for the SVT Layer-0

- Prominent advantages w.r.t. LHC-type pixels:
  - **granularity**: CMOS pixels 10-100 times smaller than hybrid pixels
    ➛ excellent (micrometric) spatial resolution in Rφ and z
  - **monolithic**: signal processing within the sensor
    ➛ easier to integrate, cost savings
  - **material budget**: total thickness < 50 µm
  - and also: room T° operation, power consumption, manufacturing, ...



Readout electronics iintegrated in the sensitive volume
→low effectif cost

➛ CMOS pixel sensors appear as a natural solution for the SuperB SVT Layer-0,

but developments are needed to optimise them according to **SuperB requirements:**

- occupancy < a few % under hit rate of 20x5 MHz/cm² (safety factor)
- ladder material budget < 1 % of X_0
- single hit resolution ~ 10 µm
- radiation tolerance

CMOS pixel sensor design at IPHC

- IPHC develops CMOS pixel sensors since 1998 (motivated by LC), with responsibilities in several HEP projects: EUDET→AIDA, STAR→ALICE→CBM.
Pixels developed in 0.35 μm technology. Two new technologies investigated in parallel:
    1) **Migration to 0.18 μm technology: to improve the ionizing radiation tolerance, ...**
        - first real scale prototype for ALICE and CBM in 2013, with read-out time ~20-40 μs.
        - investigate 0.18 μm features and improve the read-out time to a few μs by 2016.
    2) **Exploration of 3D Integration Technologies (since 2009):**
        - participation to the 3D Integration Consortium (coordinated by FNAL): CAIRN chips (CMOS Active pixel sensors with vertically Integrated Read-out and Networking functionalities).
        - high expectations.
        - longer term program (first chips just back from foundry now).
- Italian groups follow the same development path and same technologies. **Collaboration with Italian groups** (V. Re, Bergamo and Pavia, in charge of the SuperB sensor design) **already in place.** *
- **Important synergy** between developments needed for all these projects and for SuperB.

➔ for SuperB, IPHC focuses on optimising performances of the charge collection system and the in-pixel pre-amplification (S/N, noise reduction).

(*) Complementarity in the architecture : low dissipated power (Strasbourg) / Readout speed (Italy) → common effort to converge to best solution

system integration activities at IPHC

- IPHC concentrates expertise and infrastructures and is part of a network for addressing system integration issues : electrical services, mechanical support, data transmission, cooling.

- **Pixelated ladder development with ultra-low material embedding:** the PLUME project.
  see http://www.iphc.cnrs.fr/PLUME.html
  First double-sided ladders equipped with 12 EUDET sensors (0.35 μm) have been constructed and will be tested on beam at CERN in November 2011:
  - 8×10^6 pixels,
  - resolution 3 μm,
  - total power cosumption 6 W,
  - total material budget 0.6 % X_0 (next: 0.35 % X_0).

- **Workshop on System Integration of Highly Granular and Thin Vertex Detector**, organised by IPHC-PICSEL and Frankfurt, 6-9 September 2011, Mont Sainte-Odile, France.
  see http://indico.cern.ch/conferenceDisplay.py?confId=144152
  Main goal: exchange experiences and foster synergies between the different vertex detector projects. This workshop is first of a series (every year or two years).

→ for SuperB, IPHC focuses on evaluating the added value of double-sided layers, and on designing + testing the low-mass flex cable of Layer-0 (SERNWIETE project).

physics analysis

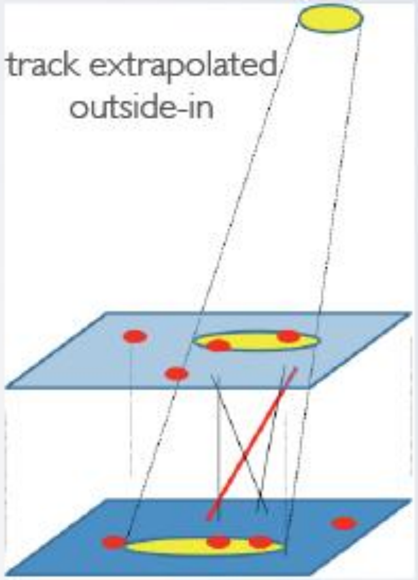
The first steps on which IPHC will focus, towards a wider participation to physics analyses in SuperB, are the following:

1) **SVT global geometry optimization:** study tracking and vertexing performances with heterogeneous layers. These studies exploit expertise gained in other projects

- **Assessment of the added value from double-sided layers:**
  - better pointing accuracy,
  - improved track reconstruction efficiency in high occupancy environment (mini-vector, track link),
  - improved alignment,
  - combination of time stamping on one side and spatial resolution on the other side.

  ➛ of particular interest in **high hit density conditions.**

- **Importance of the accuracy of the outside-in extrapolated track** on Layer-0.



2) **Time dependant analyses in the charm sector:**
Particles from charm decays are particularly sensitive to material budget due to low momenta.
➛ study the impact of the Layer-0 on physics performances, e.g. time-dependent asymmetries measurements using $D^0 \rightarrow \pi^+\pi^-$ and $D^0 \rightarrow K^+K^-$ decays.

Other Funding Requests to IN2P3

- CC-IN2P3 – Participation of the SuperB computing effort
  - One of the two copies of the raw data
  - 10% of the SuperB computing needs – Storage and CPU

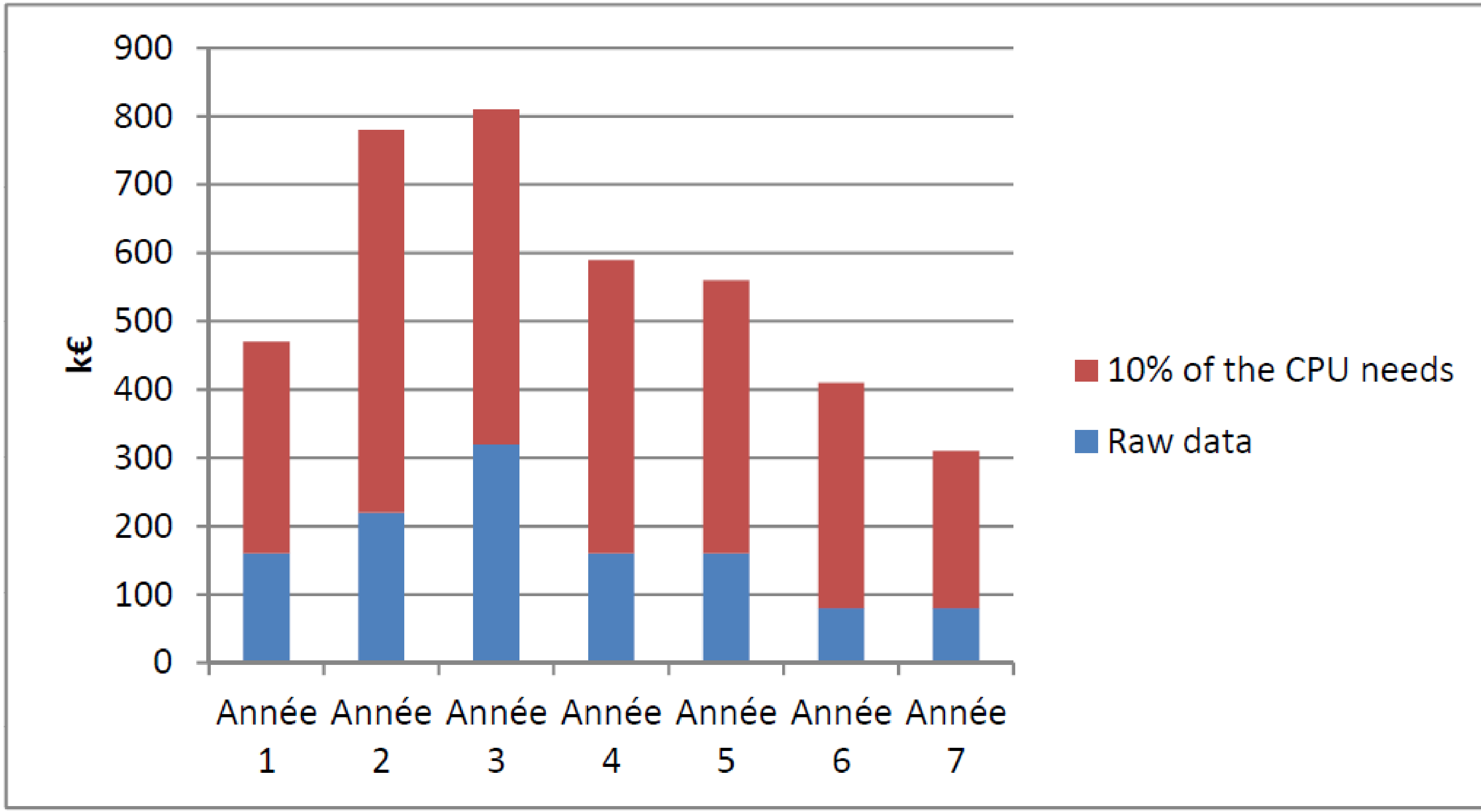
	Année 1 (commissioning)	Année 2 (montée 1/2)	Année 3 (montée 2/2)	Année 4 (nominale 1/5)	Année 5 (nominale 2/5)	Année 6 (nominale 3/5)	Année 7 (nominale 4/5)	Année 8 (nominale 5/5)
Données brutes intégrées (PB)	0	10	40	80	120	160	200	240
Coût annuel (k€)	160	220	320	160	160	80	80	
Stockage sur bande intégré (PB, sans les données brutes)	0	0.5	2	4	7	9	12	14
Coût annuel (k€)	10	10	20	10	10	10	10	
Stockage disque (PB)	0	1	3	5	7	8	9	11
Coût annuel (k€)	140	220	140	130	110	90	60	
CPU (kHEPspec)	0	45	175	360	550	750	940	1130
Coût annuel (k€)	160	330	330	290	280	230	160	
Total sans les données brutes (k€)	310	560	490	430	400	330	230	
Grand total (k€)	470	780	810	590	560	410	310	

Tableau résumant une première estimation de la participation du CC-IN2P3 à l'expérience SuperB. Dans ce modèle, le CC-IN2P3 recevrait une copie des données brutes et contribuerait pour 10% à l'effort computing de SuperB (stockage et CPU).

- Extracted from the SuperB section in the Computing chapter of the document being written for the Prospectives IN2P3/IRFU 2012

- Input data from the Ferrara R&D workshop 2011

Cost Profile CC-IN2P3

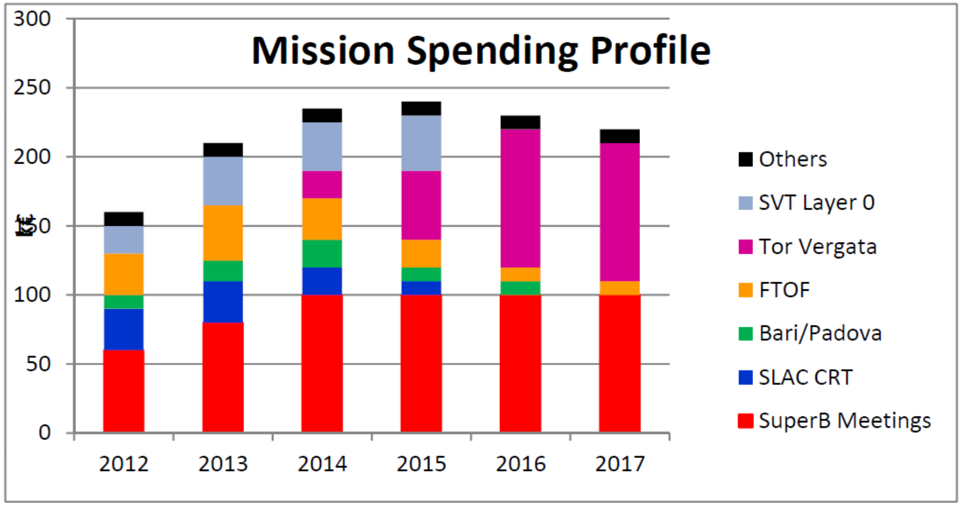


Année 1 (commissioning)	Année 2 (montée 1/2)	Année 3 (montée 2/2)	Année 4 (nominale 1/5)	Année 5 (nominale 2/5)	Année 6 (nominale 3/5)	Année 7 (nominale 4/5)

Missions, Equipment and Running Cost

- LAL, LPNHE, LPSC, IPHC

- 6 different types of missions identified
  - Regular SuperB meetings
  - Tests in SLAC Cosmic Ray Telescope
  - Trips to Padova, Bari, Pavia…
  - FTOF-related missions
  - Missions at the Tor Vergata site
  - Others missions



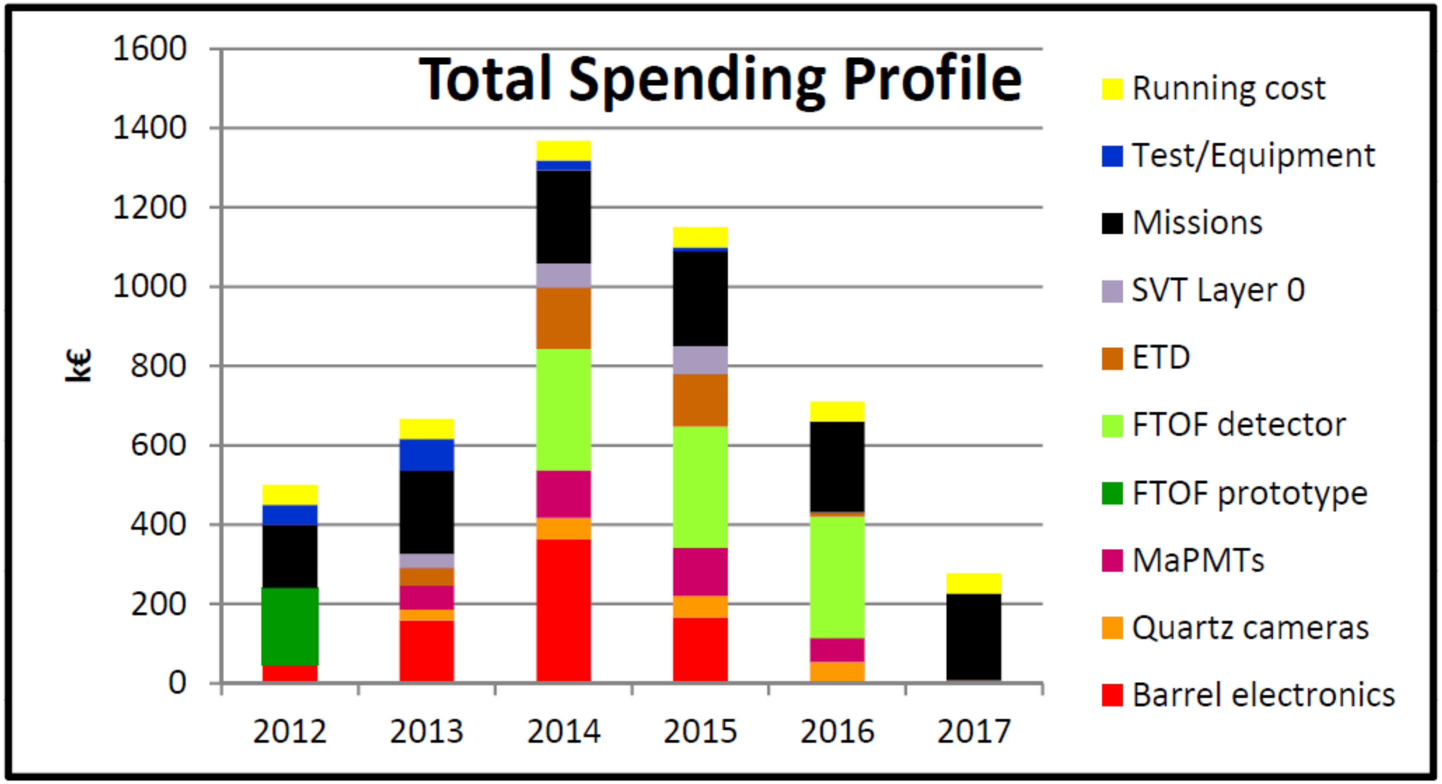
Year	2012	2013	2014	2015	2016	2017
Missions (k€)	160	210	235	240	230	220

+

- Equipment for local test facilities
  → Cosmics, B-field, MCP-PMT characterization
  - 50 k€ in 2012 and 2013
- Running cost
  - 50 k€ per year

Total Cost Profile

- Excluding CC-IN2P3 and Common Funds for the experiment (these two things maybe related)



Year	2012	2013	2014	2015	2016	2017
Total Cost (k€)	501	667	1369	1150	711	277

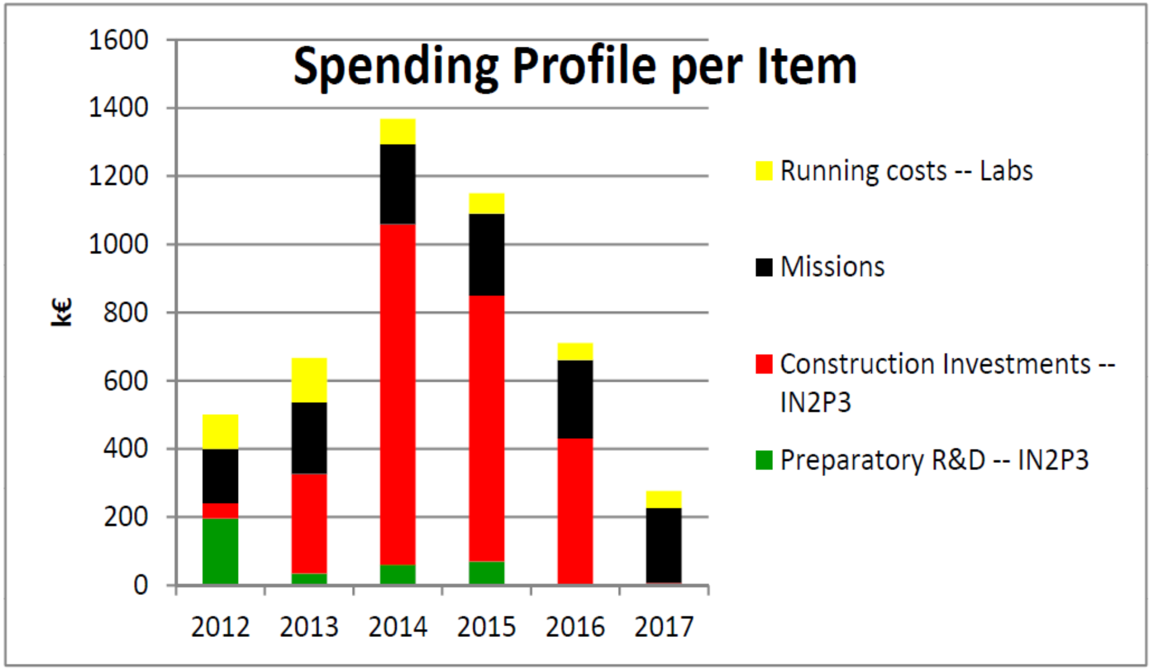
Cost Profile split by Items

4 Items identified
- Preparatory R&D
- Investments for the SuperB construction
- Missions
- Running costs

(Preparatory R&D and Investments for the SuperB construction: IN2P3 (also TGIR))

(Missions and Running costs: Laboratories)

Numbers don't include
- CC-IN2P3
- Common funds



→ Main funding should come from TGIR/TGE for years 2014 and following

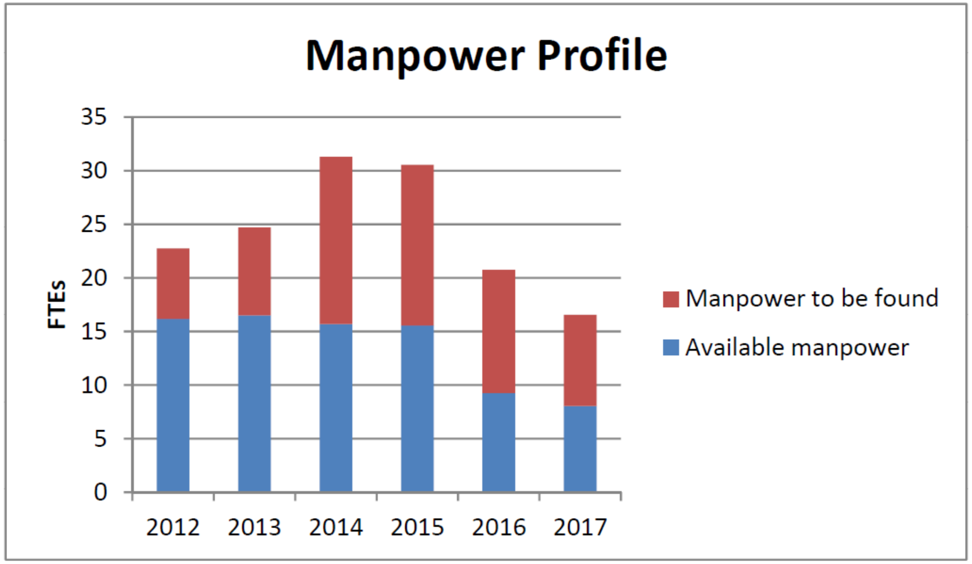
→ Preliminary numbers based on the assumptions described in the previous slides

k€	2012	2013	2014	2015	2016	2017
IN2P3	241	327	1059	850	431	7
Missions	160	210	235	240	230	220
Labs	100	130	75	60	50	50

Total IN2P3-AP + TGIR/TGE: 2913 k€

Total Manpower Profile

- Manpower needs are the following
  - ~4 FTEs in electronics
  - ~2 FTEs in instrumentation
  - ~2-3 FTEs in mechanics
  - ~1-2 FTEs for assembly on site
  - ~4 FTEs in physics

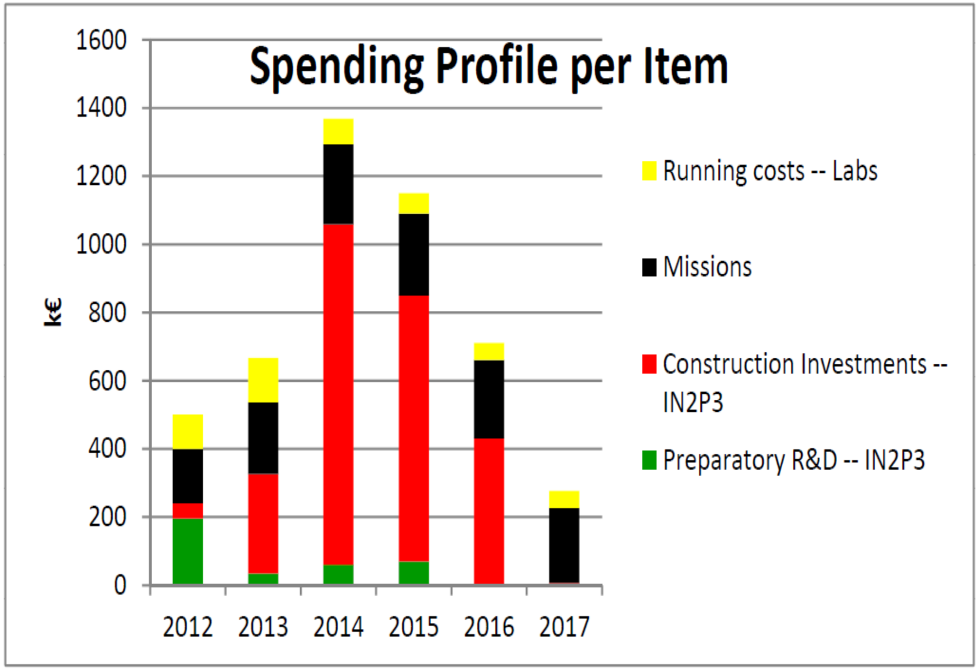


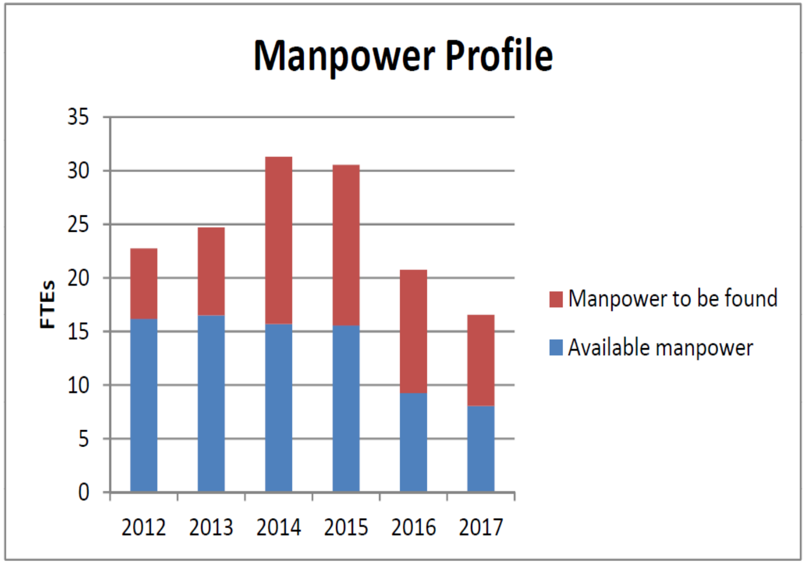
- No profile missing in the labs
  → Most of the ITA FTEs can be found internally
  → A few temporary positions needed as well

FTEs	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**
Available	16.2	16.5	15.7	15.6	9.3	8.1
To be found	6.6	8.2	15.6	15	11.5	8.5

- Like for BaBar will request ~2 permanent entries
  → One during the construction, the other when the data taking starts
- Hope to grow by internal recruitment within laboratories and by migration of some individual physicists from other laboratories
- Will benefit from PhD students and postdocs in addition to temporary recruitments

Summary : in two tables





FTEs	2012	2013	2014	2015	2016	2017
Available	16.2	16.5	15.7	15.6	9.3	8.1
To be found	6.6	8.2	15.6	15	11.5	8.5

PhaseTGE

k€	2012	2013	2014	2015	2016	2017
IN2P3	241	327	1059	850	431	7
Missions	160	210	235	240	230	220
Labs	100	130	75	60	50	50

Phase 2012-2013

Total IN2P3-AP + TGIR/TGE: 2913 k€

Contribution to the SuperB Machine

The following slides are very very detailed for completeness and to give the possibility to be quietly examine them (often I'll go quickly through)

LAL : équipe qui a déjà travaillé sur les phases précédentes

A.Variola, O.Dadoun, F Poirier, J.Brossard , C.Rimbault ,R.Chehab
S.Cavalier, P.Bambade, B.Mercier, C.Prevost, F. Zomer
+ nouvelles personnes à définir et volontaires

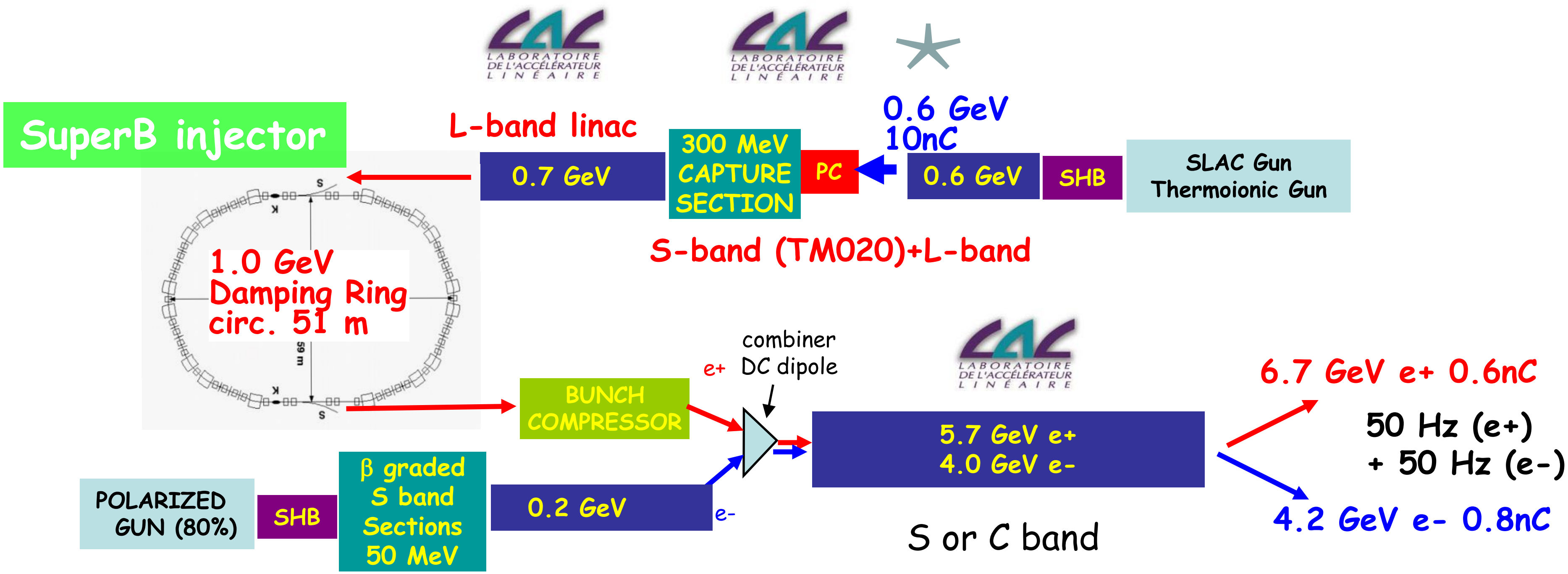
LPSC : équipe qui a déjà travaillé sur les phases précédentes
M.Baylac, O. Bourrion, J.M De Conto, Y.Gomez Martinez, N.Monseu,
D. Tourres, Ch. Vescovi,

LAPP : équipe qui a déjà travaillé sur les phases précédentes
B. Bolzon , L.Brunetti, G. Deleglise, A. Jeremie

- 1) Injector and positron source

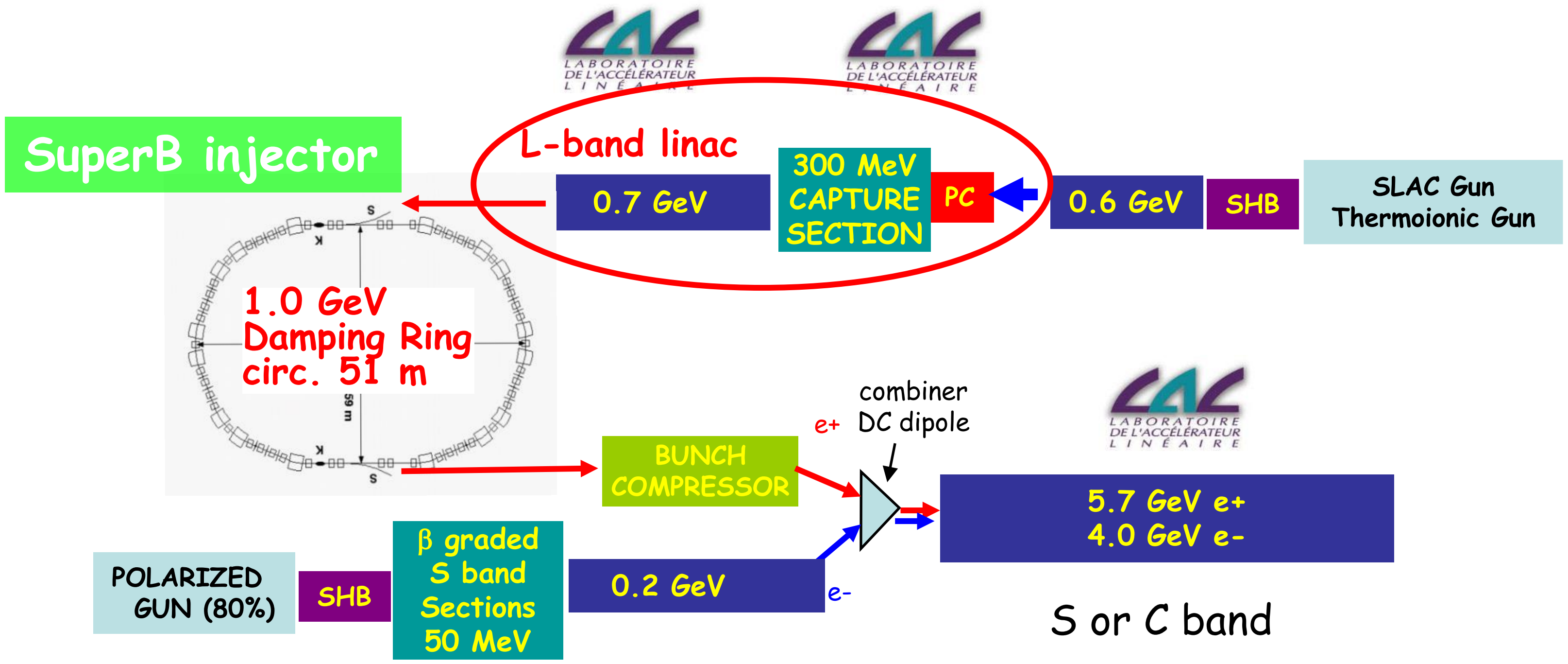
Luminosity lifetime is very short. To assure the collider performances a performing injector system has to be designed and realized

SuperB injector Scheme



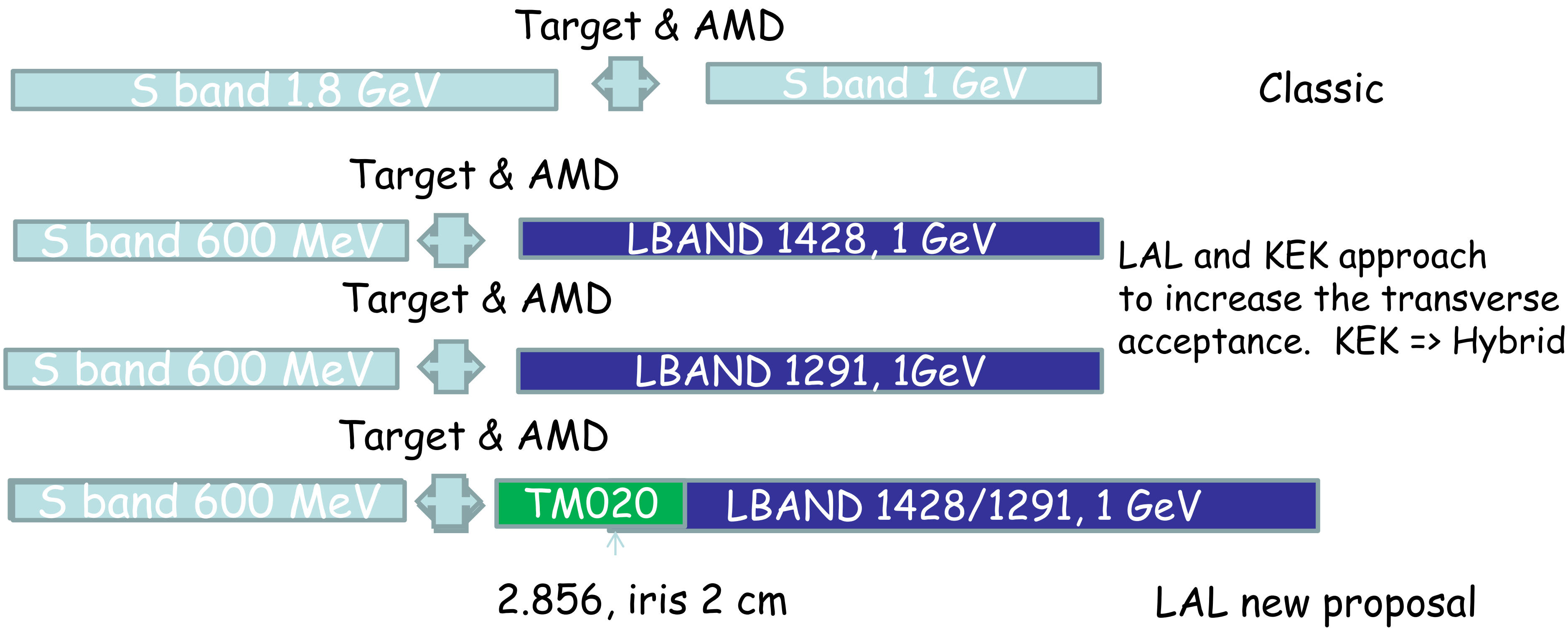
* The injector system is a major effort for the SuperB Project. The LAL proposal, As far as the positron sources are concerned, reduce drastically the primary Beam energy at the conversion target (From 1.5 / 1.8 GeV to 600 MeV)

Positron source



Positron sources : CAPTURE SCHEMES

Reduce the bunch length and so the asymptotic energy spread to match the damping ring acceptance.



S band = SLAC type , 0.9 cm iris

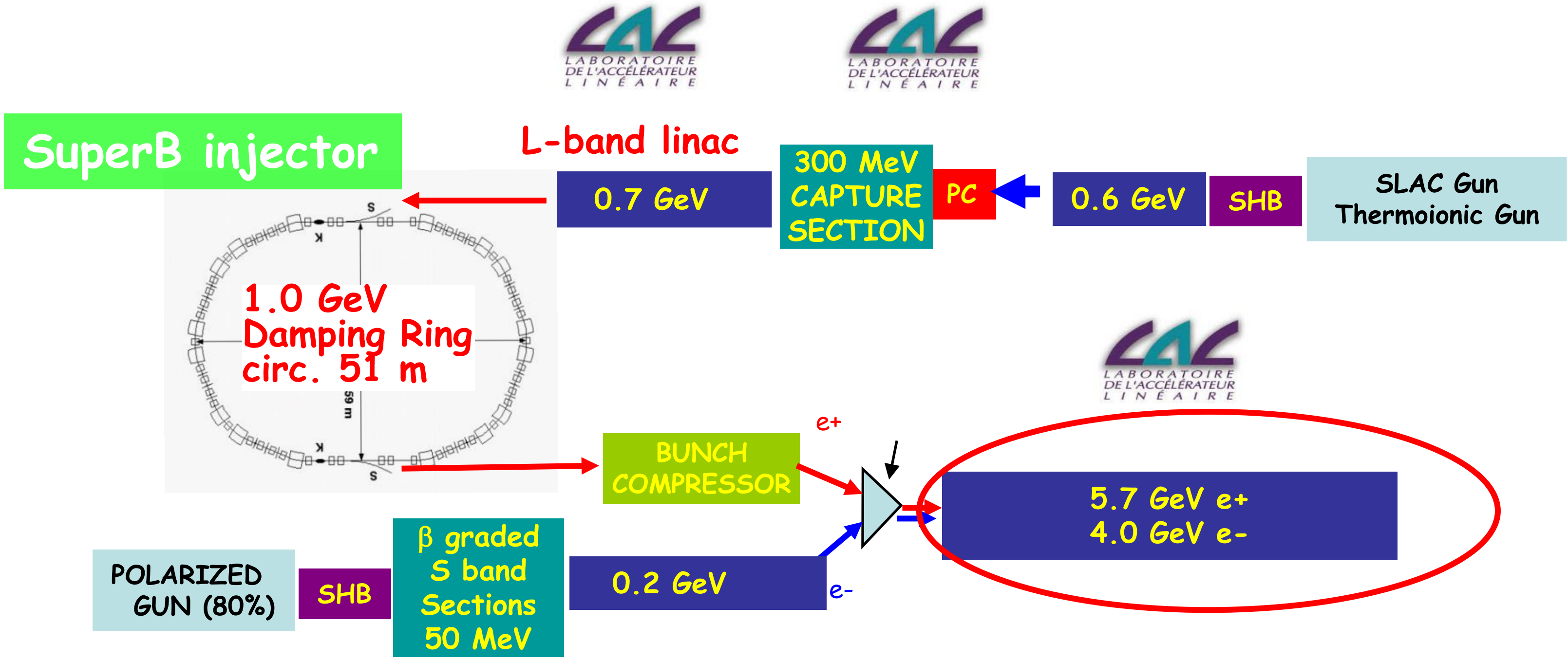
L Band 1.428/1.291=> possible up to 1.3-1.5 cm iris. What gradient?

	S band		L band	
Scenario	**1**	**2**	**3**	**4**
RF (MHz) – strategy	2856 full acc.	2856 decc. + acc	1428 decc. + acc.	3000 decc + 1428 acc.
Mean Energy (MeV)	302	287	295	333
E_{rms} (MeV)	21.4	32.3	16.83	5.2
Z_{rms} (mm)	2.7	6.4	8.89	3.5
X_{rms} (mm)	3.8	4.4	8.0	8.1
X'_{rms} (mrad)	1.02	1.11	1.69	1.4
E_x =X'X (mm.mrad)	3.8	4.6	13.0	11.4
Total Yield (%)	2.8	7.53	32.3	31.9
Yield ±10MeV (%)	1.3	3.9	19.6	29.3

- As far as the longitudinal phase space is concerned the proposed solution is extremely attractive.
- In the DR acceptance we pass from 1.8 GeV primary beam and 1.3% efficiency for the ‘classical’ solution (S band and acceleration mode) to 600 MeV primary beam and 29% efficiency.
- This means that : @ 10 nC we capture longitudinally (transverse has to be optimised) 3 nC, or that we can work @ ~ 2.5 nC
- In this framework the phase of warm L band cavities prototyping is strategic : innovative solution and recuperation of the long structure production know how at LAL. This is an added value that can be applied in future to all the in2p3 lepton linear accelerators projects'

We already started : Design Study of TW TM020 SuperB Prototype

Linac



Linac Lattice

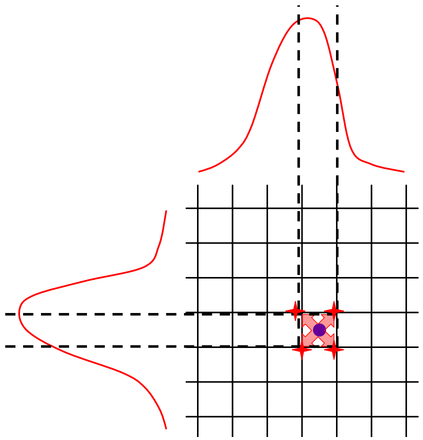
- Matching from the DR
- 1st order FODO. Simple solution with standard Radiabeam Q poles
- Also studies new optic elements for Emittance and ΔE/E measurements stations design

- 3) IR studies
  - Beam-Beam diffusion
  - Beam-beam depolarization effect + Crab-waist
  - Background

Beam-Beam diffusion

Beam-beam diffusion caused by discrete-particle scatterings
with coulomb scattering angle:
(b=impact parameter)

$$\Delta y' = \frac{2r_0}{\gamma b}$$

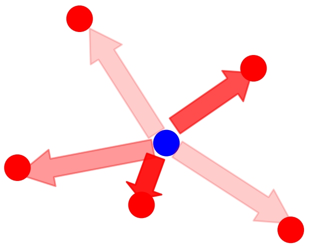


This can leads to:

- Reduction of beam life time (particle loss during collision)
- Emittance growth
- Spin diffusion

Is it a problem for SuperB?

➔ should be studied because SuperB's luminosity comes from colliding a small number of particles which are sharply focused. The small number of colliding particles implies larger statistical effects.



➔tests comparing kick angle from
Gaussian distribution charge (GUINEA-PIG++ simulation)
and discrete point charges

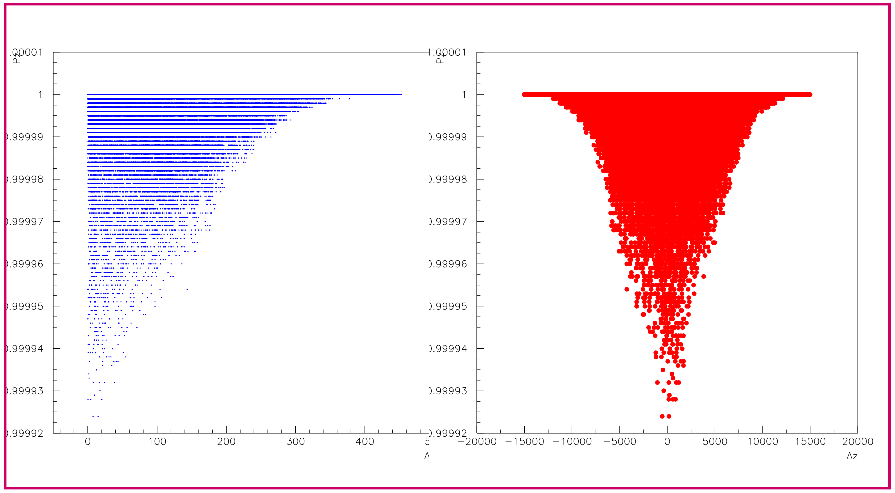
➔ Beam life time due to beam-beam diffusion = 292mn
➔ Emittance diffusion time = 14s
➔ Spin diffusion time = 1.4 h

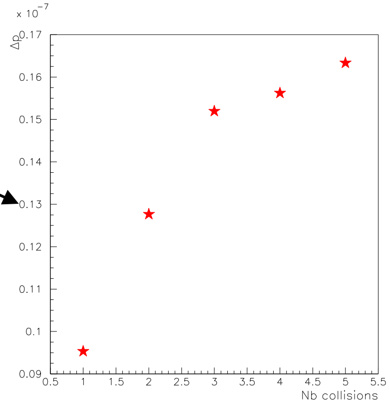
- Small effects, should not be a problem for SuperB

Beam-Beam depolarization & background

1st Goal: estimate of the depolarization due to beam-beam effect.
Tool: GUINEA-PIG++ strong-strong beam-beam interaction simulation.

Several studies:
- Depolarization as a function of the particle position within the bunch: stronger depolarization in the middle of the bunch
- ``Nature" of the effect on subsequent collisions: seems to be logarithmic



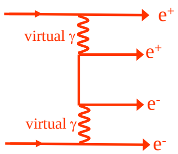


+ Crab-waist transformation: $y \rightarrow y + y'x/2\theta$ induces -20% of depolarization for the low energy beam

LEB	Nominal	Low Emitt	High Current
ΔP_{bbint} NoCrabW	4.10 10^{-7}	1.47 10^{-7}	4.57 10^{-7}
ΔP_{bbint} CrabW	3.29 10^{-7}	1.11 10^{-7}	3.68 10^{-7}
ΔP_{bbint} gain	-19.8%	-24.5%	-19.5%

Main next goal: integration of GP++ with a ring spin tracking code

On-going study: e^+e^- background induced by the Landau-Lifshitz process.

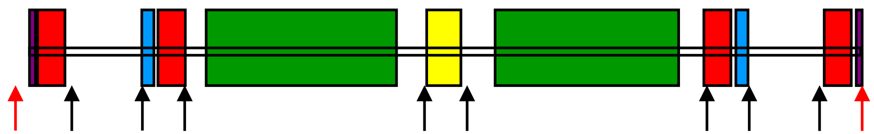


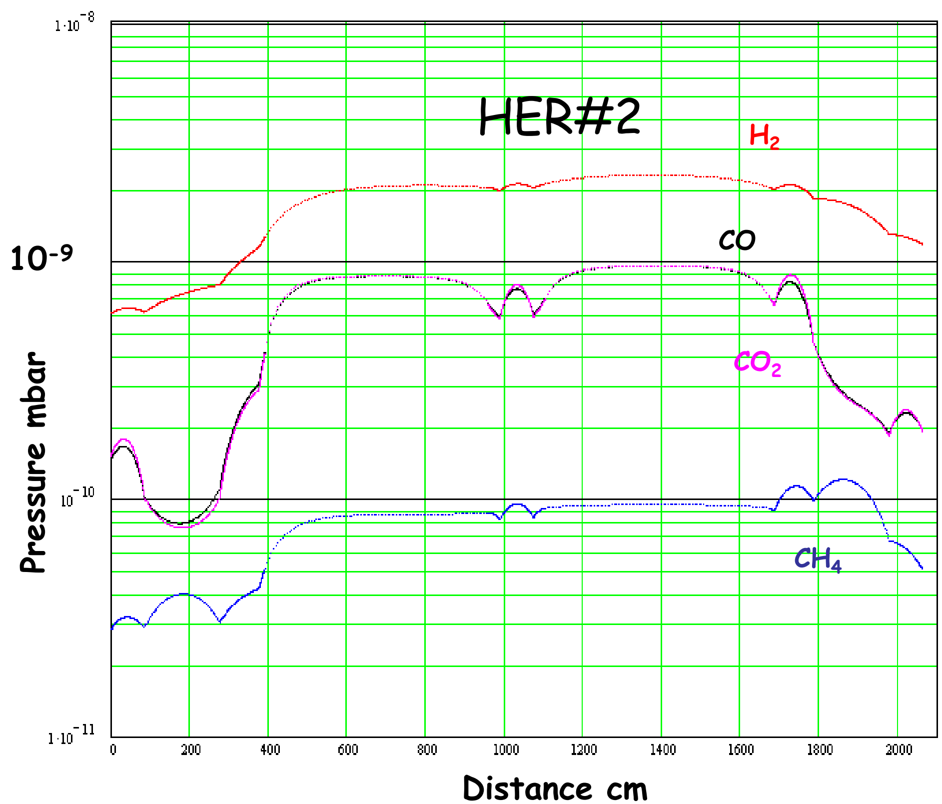
Cross section may be a factor 2 larger than expected.

• 2) Main Ring Vacuum studies

Examples :Studies done on the approximation of the pressure distribution in LER and HER with synchrotron radiation after machine conditioning

With distributed pumping + SR after machine conditioning





Goal $P_m \sim 6.10^{-10}$ mbar

$P_m(H_2)$ = 1.4.10^{-9} mbar

$P_m(CO_2)$ = 5.10^{-10} mbar

Possible improvement

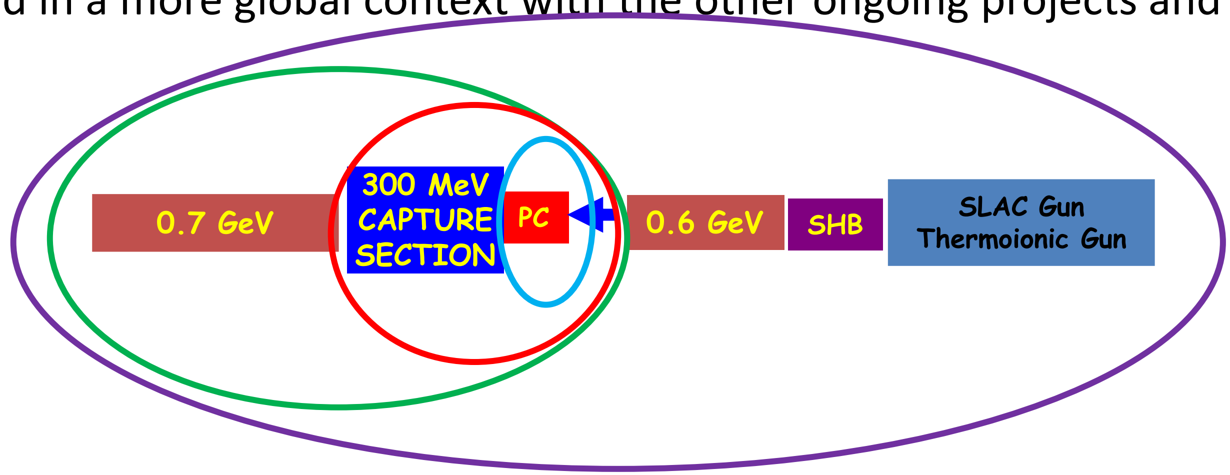
- η (mol/ph) ⟶ ~10^{-7} (PEPII)
  $P_m(H_2)$ = 3.10^{-10} mbar
- Neg coating in the drift tubes
  Pumping speed increase, time conditioning decrease, low secondary emission but impedance chamber ??

Scenarios for participation

- Participation in studies: IR, Spin Dynamics, Vacuum, Background
- Realization (Responsibility?): Fast Luminometer, Polarimeter
- Responsibility and realization: Positron source or relative modules.

1) Only the AMD section
2) Target, AMD and Capture section (200-300 MeV) . Estimated cost for this scenario ~ 15 Meuros
3) Up to 1 GeV
4) Drive beam and up to 1 GeV

More important responsibilities as far as the injector complex is concerned have to be evaluated in a more global context with the other ongoing projects and the scientific strategy

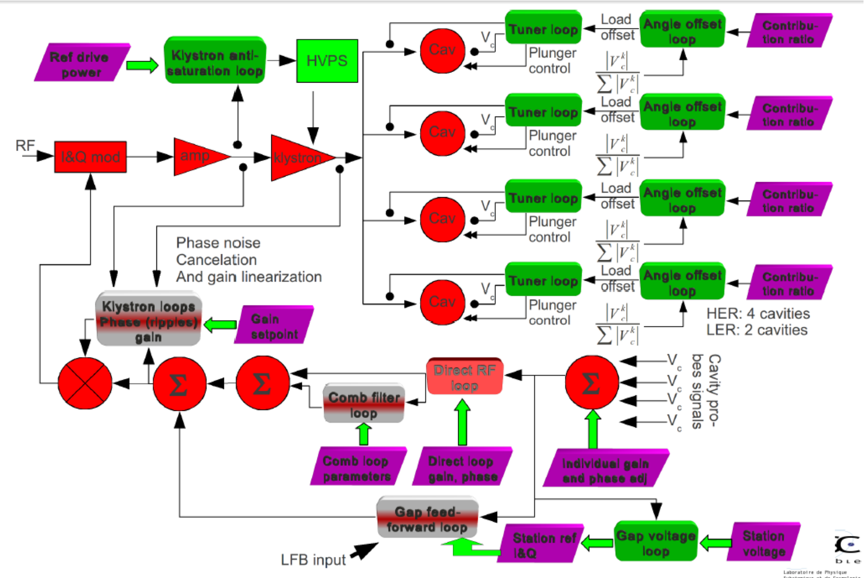


LPSC

M.Baylac, O. Bourrion, J.M De Conto, Y.Gomez Martinez, N.Monseu,
D. Tourres, Ch. Vescovi,

The main application fields are
- LLRF for the main rings
- polarization topics:
  - with the polarized electron gun,
  - low energy polarization measurement at injection
  - spin tracking into the main ring

1) **A full modeling of the RF cavities**, the relations between the instabilities and the cavities impedances, and the beam/cavity interactions has been provided in the frequency and time domain. It includes the klystron load and the cavity coupling. This allows to have at one's disposal a tool to understand the LLRF feedbacks and its limitations.
The operative simulations blocks are ready and they can be adapted to the real elements response (klystrons, driver…). Instabilities growth rate was first estimated in frequency domain and then in the time domain.
The latter, which is still under development, is mandatory to fully understand the effects of the beam stability cavity operating point.
<u>This will produce the essential parameters for the LLRF system</u> and will be used to design an adequate serving electronics.



2) Zgoubi was implemented to simulate spin Tracking in the SuperB lattice. An estimation of the Invariant Spin Field (ISF) evolution has been provided for SuperB.

3) A proposal for the low energy polarimetry has been proposed, discussed and validated: it will consist of a few MeV Mott polarimeter

LPSC participation

- LPSC is ready to assume different responsibilities in the SuperB project with the conditions that the necessary resources (manpower, budget, management and communication channels) are available.
  1) Electron polarized source, low energy polarimetry
  2) Ring LLRF

The spin tracking studies will continue up to the finalization of the present activity and of the ongoing PhD thesis

LAPP

B. Bolzon *, L.Brunetti, G. Deleglise, A. Jeremie

The main applications field are the vibration measurements in the SuperB site and the application to the active stabilization of the final focus and of the interaction region

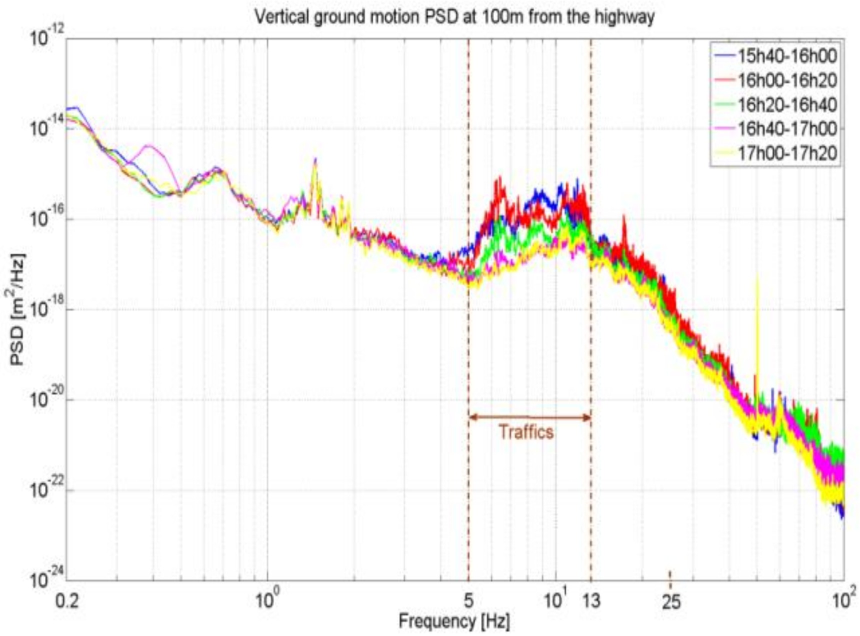
* At present in CERN, Geneva

1) Two campaigns of vibration measurements have been carried out in the site of Frascati and Tor Vergata. SuperB constraints requires nanometer range stability.
Especially the last site was carefully evaluated to understand the close motorway impact on the vibration budget. So different measurements were performed in different region.
Low frequency noise was measured by geophones and accelerometers. A full data analysis allowed a comparison between the different measurement points and between the Frascati and Tor Vergata site. In Frascati, thanks to the deep drilling (50 m), two campaigns were carried out with extensive results (different buildings, coherence measurements..)
- It was noticed that in Tor Vergata, as expected, the maximum vibrations come form the motorway (with the consequent daily oscillation). Thanks to the very soft ground composition this vibrations are rapidly damped in the SuperB site.

In the 3 axes: Amplitude varies from 8nm to 30nm for all the points above 1Hz (and from 30nm to 60nm above 0.2Hz)

On the other side the INFN Frascati site is based on a harder ground. Vibration are propagated from the close road and can attain important values, especially in the traffic peak time.

-Tor Vergata was estimated to be a very good site for the Super B project compared to the INFN site where the only choice would have been to build a tunnel in underground.



LAPP participation

- LAPP is ready to assume the responsibility of the work packages related to the stabilization of the interaction region and of the final focus with the conditions that the necessary resources (manpower, budget, management and communication channels) are available.

Some SuperB Work Packages where French groups are involved

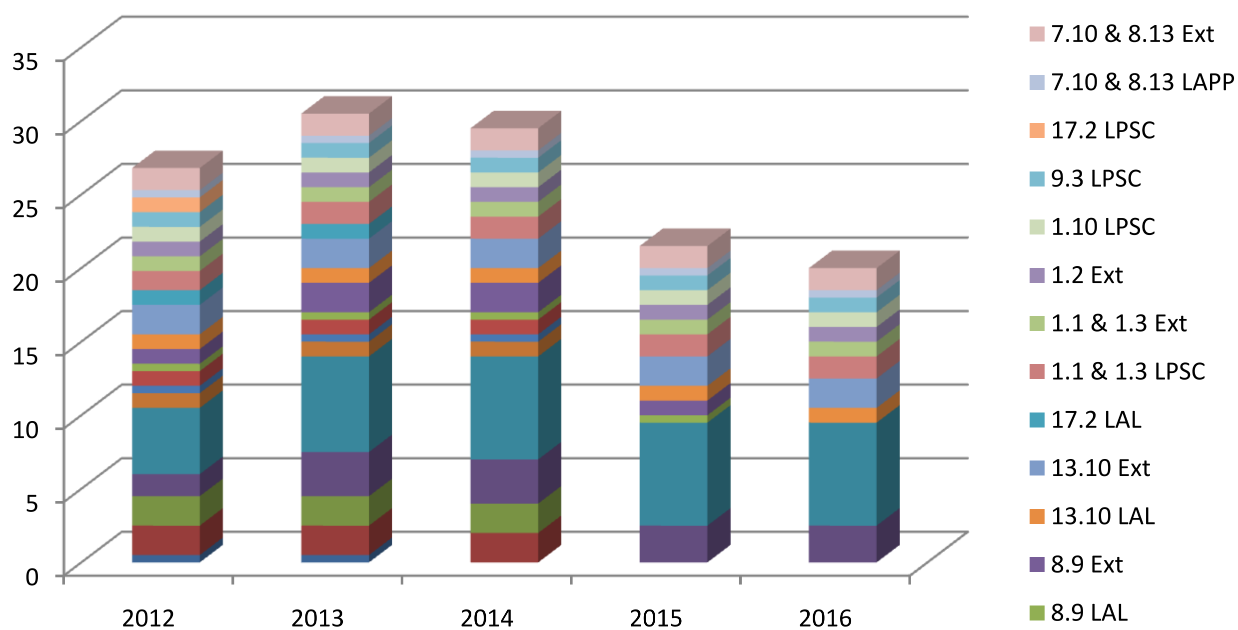
WP2	Injection System - Positron source
1	• Thermo ionic gun
2	• 600 MeV S-BAND LINAC
3	• Positron Converter
4	• flux concentrator
5	• 1 GeV L-band linac
6	• Supports
7	• Magnets
8	• Power supplies
9	• Vacuum
10	• Diagnostics
11	• Control System
12	• LLRF
13	• Integration
14	• Alignment

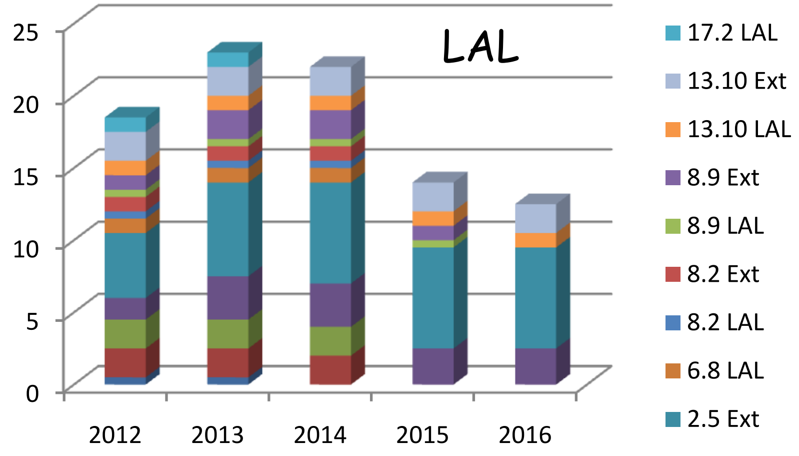
WP6	Main Rings Arcs
1	• Lattice
2	• Rings injection
3	• Insertion devices
4	• Radio Frequency
5	• Supports
6	• Magnets
7	• Power supplies
8	• Vacuum
9	• Diagnostics
10	• Integration
11	• *Alignment*

WP8	Main Rings Interaction Region
1	• Lattice
2	• Background simulation
3	• IR Magnets
4	• IR Vacuum chamber
5	• Supports
6	• Magnets
7	• Power supplies
8	• Vacuum
9	• Luminosity monitor
10	• Cryogenics
11	• Integration
12	• Alignment
13	• Stabilization

WP17	Beam studies
1	• Instabilities and feedback integration
2	• Spin tracking
3	• Beam dynamics

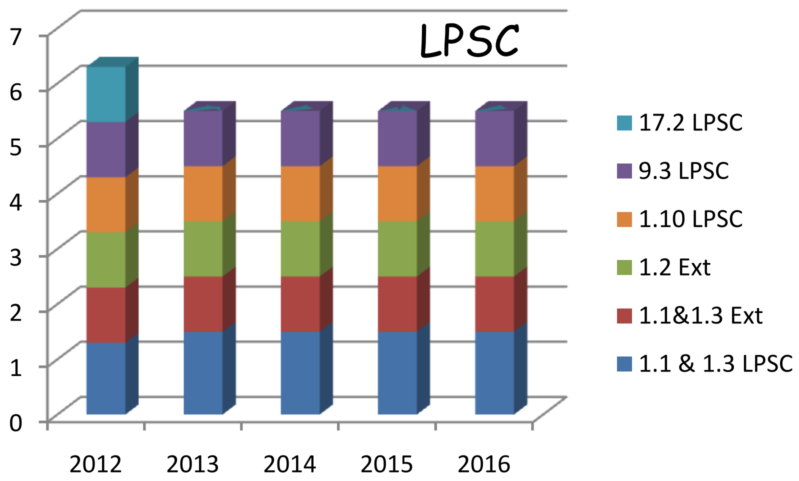
2012	2013	2014	2015	2016	Total		WP			
0.5	0.5				1		2.3	LAL		Positron converter
2	2	2			6		2.4	LAL		Flux concentrator
2	2	2			6		2.4	Ext		Flux concentrator
1.5	3	3	2.5	2.5	12.5		2.5	LAL		Capture section
4.5	6.5	7	7	7	32		2.5	Ext		Capture section
1	1	1			3		6.8	LAL		Main ring vacuum
0.5	0.5	0.5			1.5		8.2	LAL		Background simulations
1	1	1			3		8.2	Ext		Background simulations
0.5	0.5	0.5	0.5		2		8.9	LAL		Luminosity monitor
1	2	2	1		6		8.9	Ext		Luminosity monitor
1	1	1	1	1	5		13.10	LAL		Polarimeter
2	2	2	2	2	10		13.10	Ext		Polarimeter
1	1				2		17.2	LAL		Spin tracking
1.3	1.5	1.5	1.5	1.5	7.3		1.1 & 1.3	LPSC		Photo cathode Gun & High voltage system
1	1	1	1	1	5		1.1 & 1.3	Ext		Photo cathode Gun & High voltage system
0	0	0	0	0	0		1.2	LPSC		Laser system
1	1	1	1	1	5		1.2	Ext		Laser system
1	1	1	1	1	5		1.10	LPSC		Diagnostics-polarimetry
1	1	1	1	1	5		9.3	LPSC		Ring LLRF
1	0	0	0	0	1		17.2	LPSC		Spin tracking
0.5	0.5	0.5	0.5	0.5	2.5		7.10 & 8.13	LAPP		Final Focus & Interaction Region stabilization
1.5	1.5	1.5	1.5	1.5	7.5		7.10 & 8.13	Ext		Interaction Region Stabilization



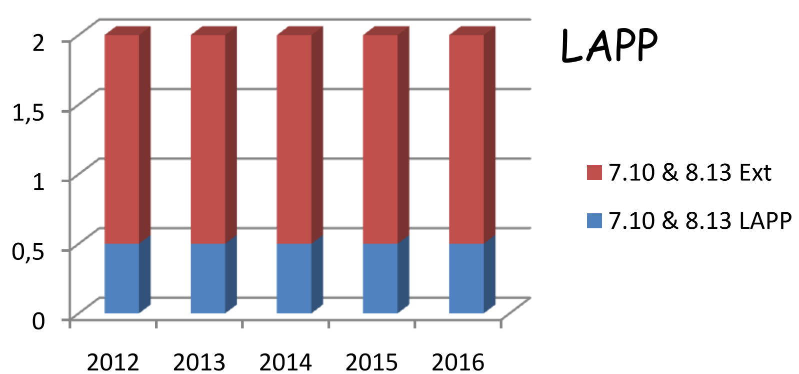


	Lab. Contribution	Ext. Contribution	Total	R&D 2012-2014
LAL	41	49	90	38
LPSC	18.3	10	28.3	12
LAPP	2.5	7.5	10	5
	61.8	66.5	128.3	55

If ALL the requested resources are available and conditions satisfied

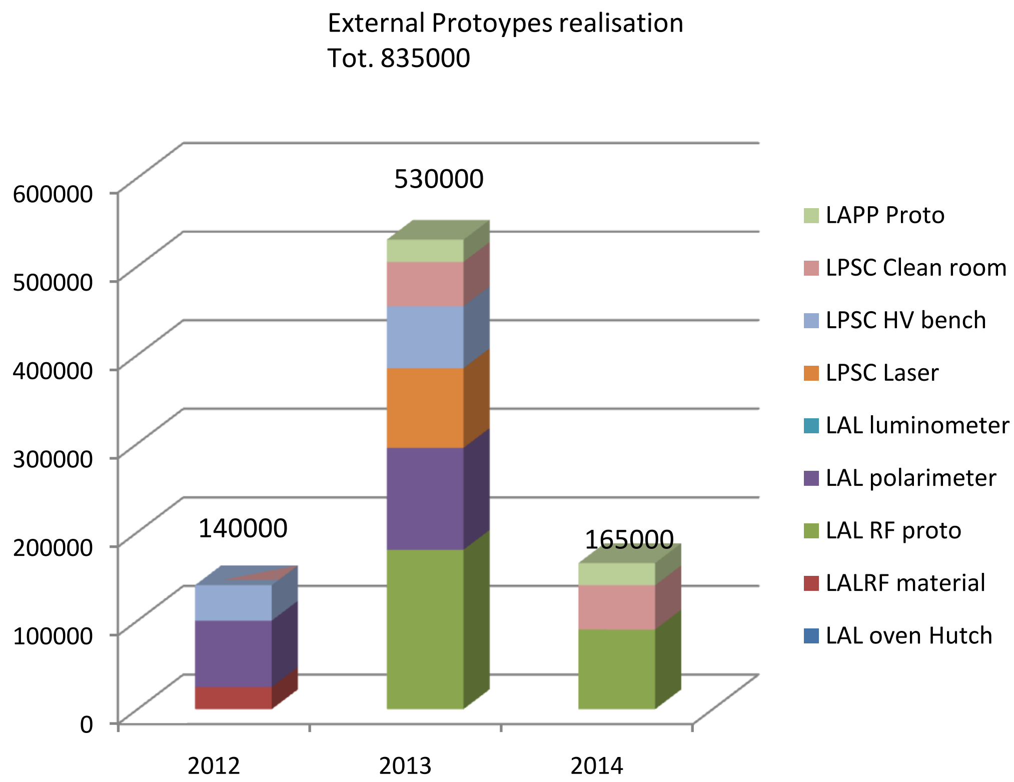


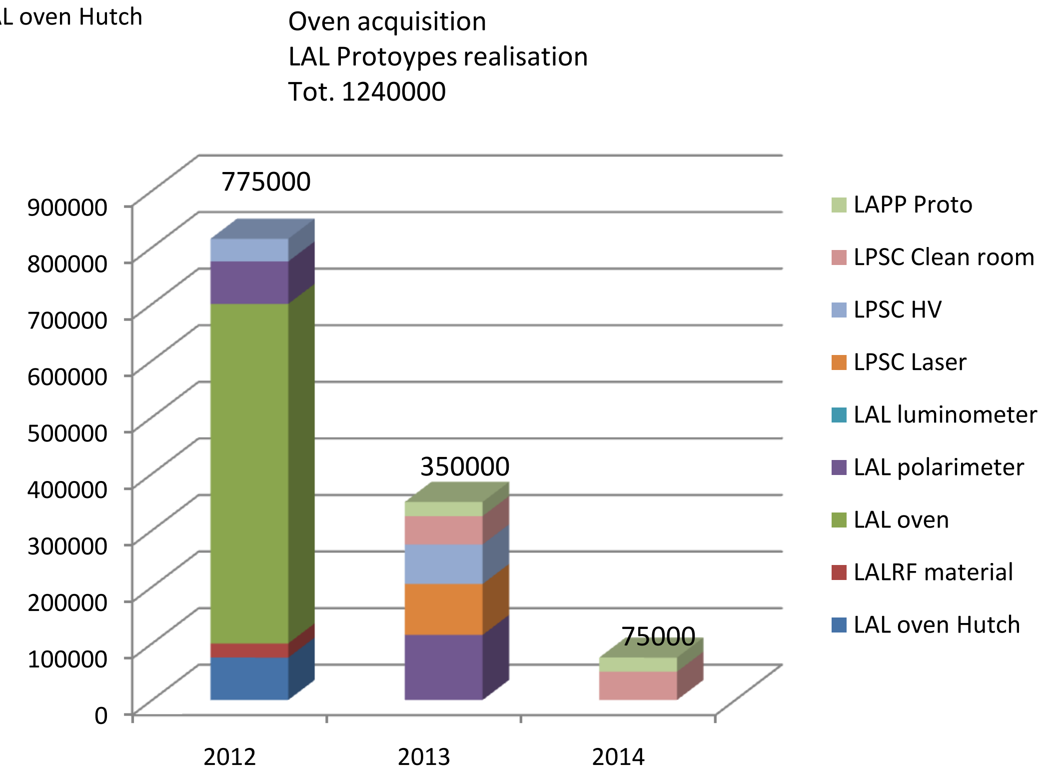
LAL			
WP	Task	Responsibility-Participation	TASK
	2.3	Resp.	Positron converter
	2.4	Resp.	Flux concentrator
	2.5	Resp.	Capture section
	6.8	Part.	Main ring vacuum
	8.2	Part.	Background simulations
	8.9	Part.	Luminosity monitor
	13.1	Resp.	Polarimeter
	17.2	Part.	Spin tracking
LPSC			
	1.1	Resp.	Photo cathode Gun & High voltage system
	1.2	Resp.	Laser system
	1.3	Included in WP1.1	Included in WP1.1
	1.10	Resp.	Diagnostics-polarimetry
	9.3	Resp.	Ring LLRF
	17.2	Part.	Spin tracking
LAPP			
	7.10	Resp.	Final focus stabilization
	8.13	Resp.	Interaction region stabilization



Red = expertise not present in the laboratory
(*)= Priority profile for the R&D phase

Expertize to be injected	WP	Extra possible lab contribution
LAL		
1 IR Magnets design (*)	2,	
3 Mechanical drawings (*)	2 , 6, 8, 13	1
1 Project engineer	All	
3 Assembling and cabling technicians	2, 6, 8, 13	2
2 Mechanical engineers (*)	2, 6, 8, 13	1
1 Expert in radioprotection simulations	2,	
1 Power Supplies engineer (pulsed and CW)	2,	
1 AI maintenance/realization	2, 6, 8, 13	
1 Post Doc Fast luminometer (*)	8,	
1 IE Brazing	2,	1
1 Post doc Polarimeter (*)	13,	
1 Electronic engineer	8, 13,	1
1 Eng/Phys instrumentation	13,	1
LPSC		
1 Laser (*)	1,	
1 Post doc Gun (*)	1,	
LAPP		
1 Ingenieur mecanique (*)	7, 8	1
1 Instrumentation (*)	7, 8	1


External Protoypes realisation
Tot. 835000
600000
500000
400000
300000
200000
100000
0
530000
140000
165000
2012
2013
2014
LAPP Proto
LPSC Clean room
LPSC HV bench
LPSC Laser
LAL luminometer
LAL polarimeter
LAL RF proto
LALRF material
LAL oven Hutch


Oven acquisition
LAL Protoypes realisation
Tot. 1240000
900000
800000
700000
600000
500000
400000
300000
200000
100000
0
775000
350000
75000
2012
2013
2014
LAPP Proto
LPSC Clean room
LPSC HV
LPSC Laser
LAL luminometer
LAL polarimeter
LAL oven
LALRF material
LAL oven Hutch

For LAL.

- Infrastructure and Prototyping Cost

- Positrons (Link with LC). Cost of the ‘core systems’ **~ 15 MEuros / scenario2**
- ***1) L Band high gradient***
- ***2) L Band TM020***
- ***3) S Band large Iris***

Two possibilities:

1) Design in LAL and external realization

Cost: ~ 270,000 euros (no in-house brazing)

- Possibly with solenoids

Cost: ~ ?

2) Infrastructure acquisition (brazing oven) and LAL realization

- Infrastructure => Large brazing oven with relative infrastructure setting up (clean room).

Cost: equipped clean room 75,000 euros, brazing oven 600,000 (but gain for the project…!!!!!)

- This facility will be a determinant step forward to increase the internal skills in RF realizations. It will be consistent with all the other existing LAL and IN2P3 projects (ThomX, PHIL, warm colliders…..)

- Fast Luminometer (Relationship with the ATF2,SLHC R&D and LC activities)

Cost will be estimated

- Polarimeter (Link with ThomX)

Cost: equipped laser room 70,000 euros, Laser system 70,000 euros, infrastructure and instrumentation 40,000 euros

WE ASK THE CONSEIL SCIENTIFIQUE
TO

→ State about the scientific and strategic importance of the project

→ Approval for the R&D phase preparatory to the SUPERB construction

→ Support for the requirements