Status of the JENNIFER project

Japan and Europe Network for Neutrino and Intensity Frontier Experimental Research

Mid term Review
Queen Mary University of London
September 23rd 2016

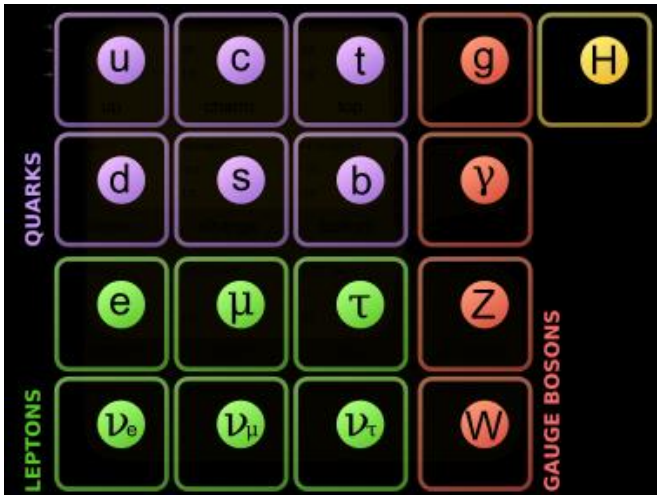
JENNIFER
EU grant n.644294

Outline of the Report:

- JENNIFER objectives
- General status of the 5 WPs
- Highlights of the scientific results achieved up to now
- Critical items and planned actions
- Secondments' implementation and monitoring
- Impact on the individuals' scientific careers
- Dissemination and Impact on society

JENNIFER objectives

The Fundamental Interactions between Elementary Particles are described by a coherent theory called Standard Model (SM)



Despite its success, such theory does not explain some important facts:

- Dark Matter
- Absence of Anti-Matter in the Universe
- Mass spectrum of the fermions

Particle Physicists are looking for signals of new phaenomena which would help explaining these misterys. Direct observation require high energies → **LHC**

However there are two other complementary tool to look for new physics:

- Neutrinos, which ARE already beyond the minimal SM
- Flavour physics, where high intensity is required to detect tiny SM violations

THIS IS JENNIFER'S DOMAIN !

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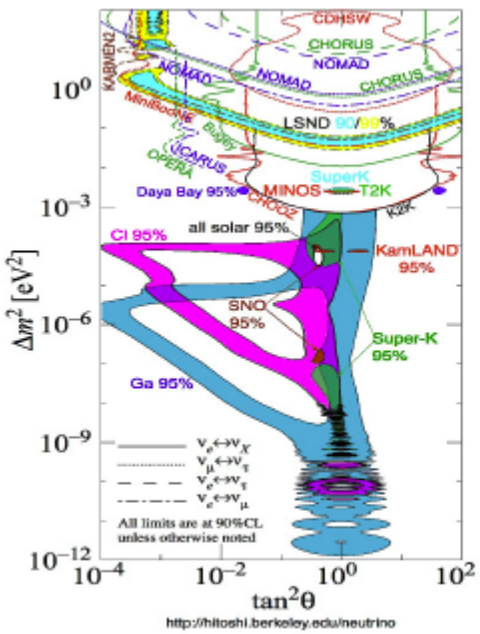
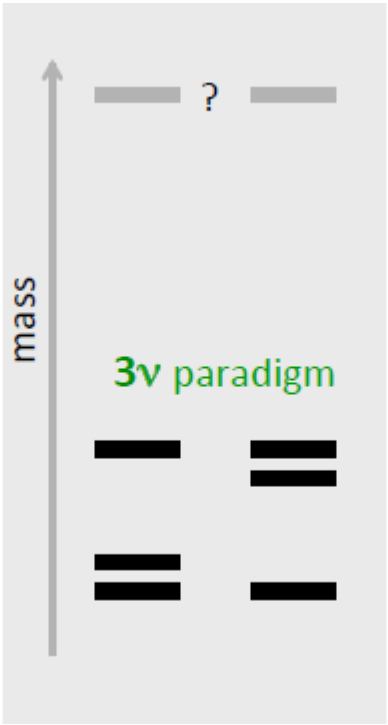
JENNIFER objectives

Neutrinos are massless in the SM, while they actually show mass and they do transmute to each other:





Unknowns:
Absol. masses and nature:
→ beyond Higgs mech.?
CPV phase(s)
→ beyond CKM / PMNS ?
New states, interactions?
→ beyond SM ?

Knowns	(accuracy)
Δm^2	1.8 %
δm^2	2.4 %
$\sin^2\theta_{13}$	4.7 %
$\sin^2\theta_{12}$	5.8 %
$\sin^2\theta_{23}$	~ 9 %

T2K is one of the best performing experiments active in this field.
HyperK is the challenging upgrade project of Kamiokande detector.
Both are located in Japan and involve a large international collaboration, Including many european groups.

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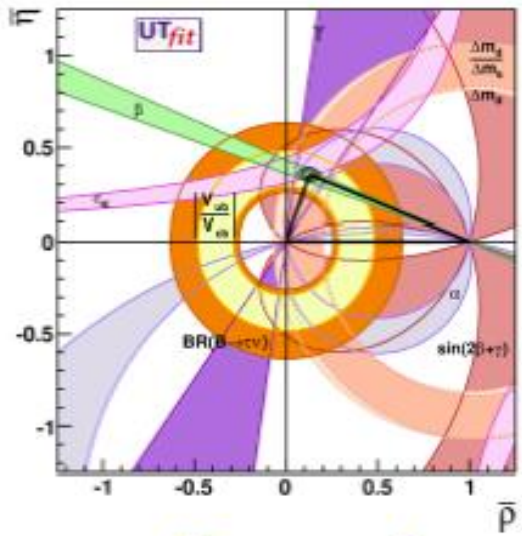
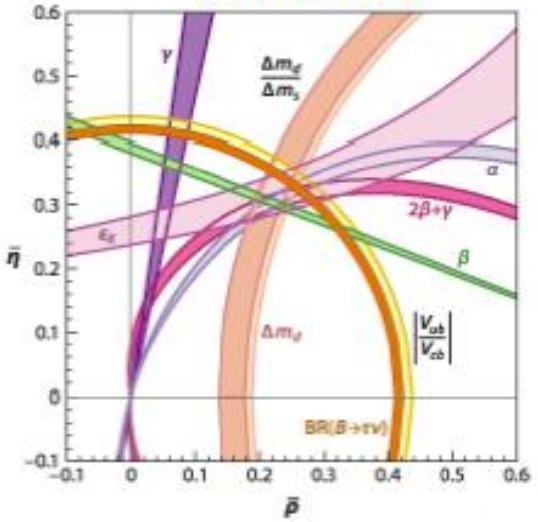
JENNIFER objectives

Today



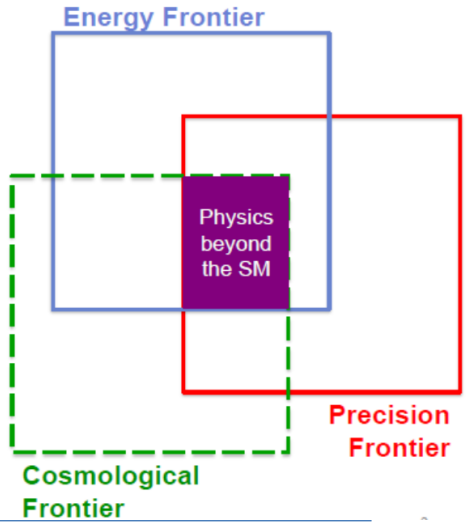
Tomorrow?



Flavour Physics measure with high precision all quark mixing and decay properties, summerized into the Cabibbo Kobayashi Maskawa matrix.

Thank to the virtual effects of higher mass particles, deviations from the SM expectations may signal new physics processes up to energy scales much larger than what is accessible with direct searches.

Belle II experiment will start running in 2017 on the SuperKEKB beauty factory which will produce an unprecedented statistics of flavour events



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JENNIFER objectives

JENNIFER Consortium is formed by most european groups involved in Belle II, T2K and HyperK:

BELLE II

Beneficiaries:
INFN - IT
DESY - DE
OEAW-HEPHY - A
IJS - SL
IFJ PAN - PL
UKP - CZ
CNRS - FR
METU - TK

Partners:
KEK - JP

T2K, HyperK

Beneficiaries:
INFN - IT
QMUL - UK
STFC RAL - UK
CEA - FR
NCBJ - PL
IFAE - ES

Partners:
KEK - JP
U Tokyo - JP

SME Beneficiary:
CAEN – IT

Technology collaboration with both experiments

JENNIFER objectives

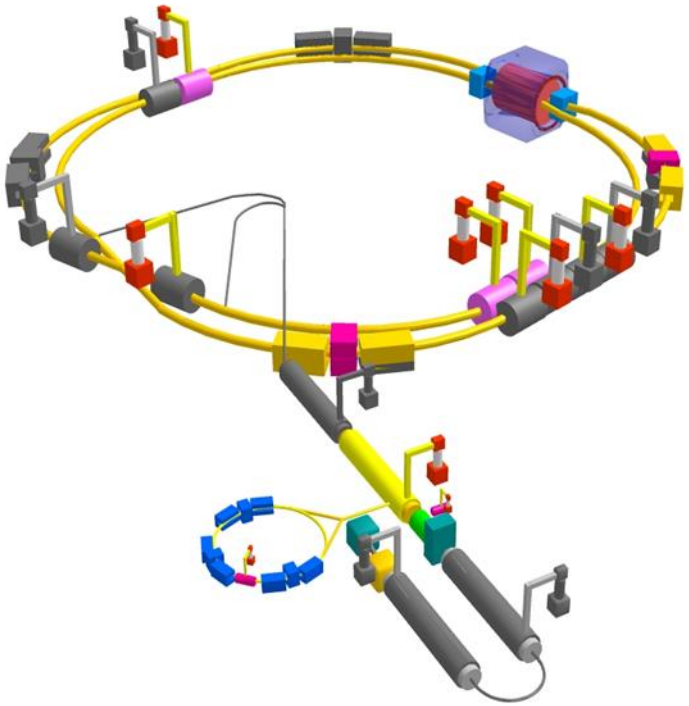
JENNIFER shares the **scientific objectives** of its member Institutions during the project's life:

- Build and operate the Belle II detector
- Prepare and start Belle II data analysis
- Run T2K and complete its measurements of neutrino properties
- Develop techniques and detectors for HyperK

But JENIFFER adds **more ambitious objectives**:

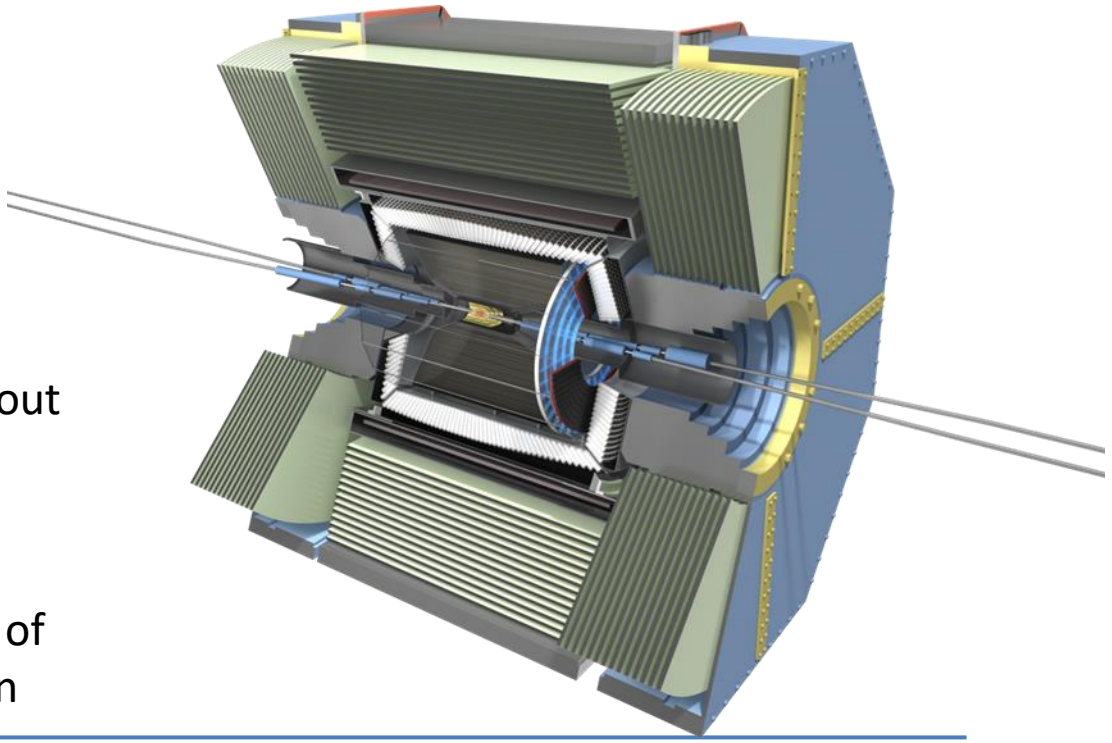
- Foster the scientific collaboration between Europe and Japan by bringing more european researchers for a longer time in japanese labs.
- Cross fertilize neutrino and flavour physics communities through comparison and share of technologies and tools.
- Spread through european society the results in neutrino and flavour physics and of the Europe-Japan scientific partnership.

The Belle II experiment



Works at SuperKEKB accelerator,Tsukuba, Japan
Upgrade of KEKB, 40x luminosity: 8 x 10^{35} $cm^{-2}s^{-1}$

First beam: February 2016
First Physics: End of 2018



Large experimental collaboration (about 100 institutions, 600 physicists)
Major upgrade of previous Belle experiment. Aims to collect 50 times more statistics and improve by order of magnitude its measurement precision

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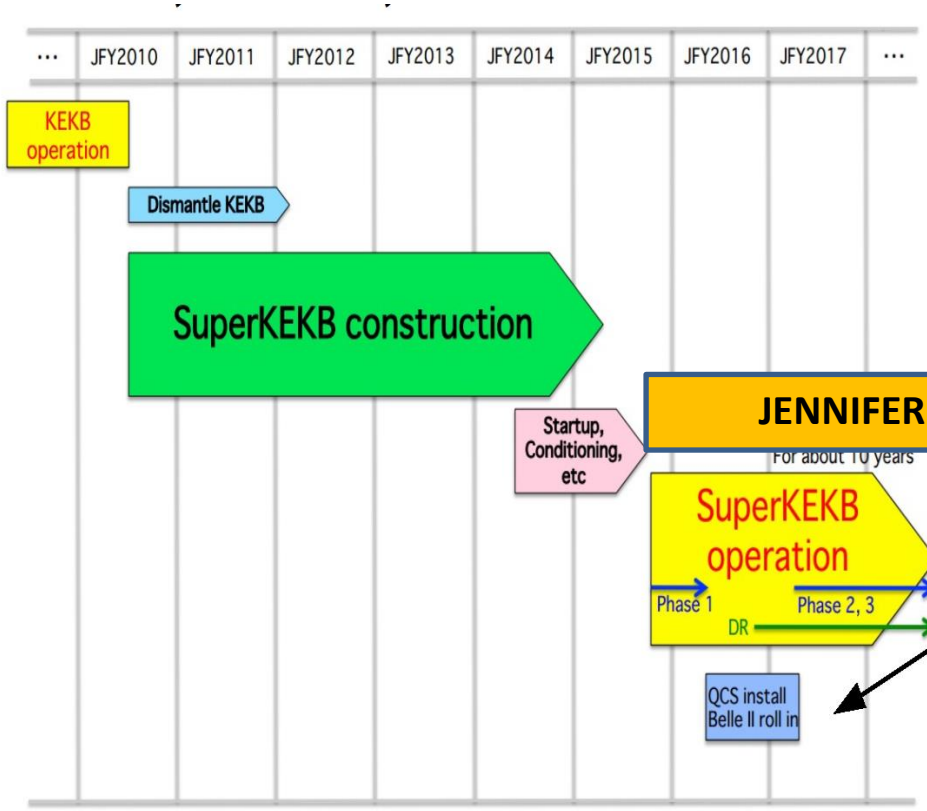
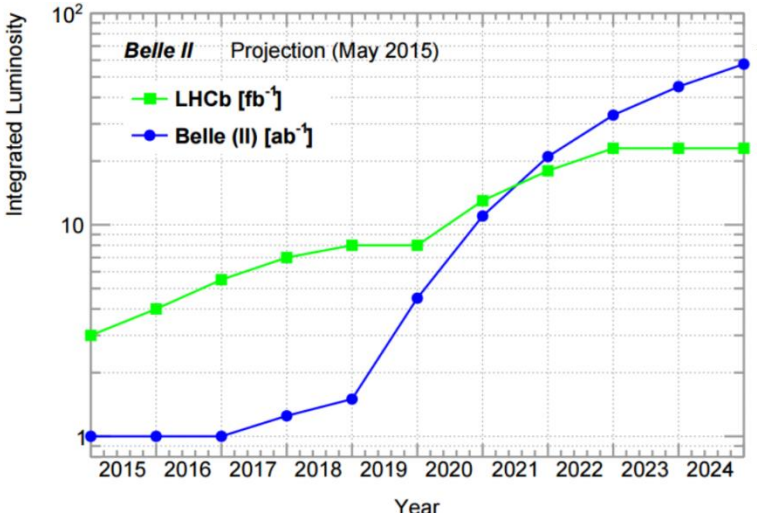
Belle II Schedule



First roll-in without silicon detectors;
s program for
ken in that mode is under investigation;

Silicon
2018;



Main competitor is LHCB, but there are many channels unique to Belle I, and for the other statistics will be at the end higher.

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Flavour physics at an e^+e^- collider

- Develop, implement and optimize the software tools and algorithms needed for performing physics analysis at the Belle II experiment
- Re-examine and strengthen the physics case of the Belle II experiment through collaboration with theorists
- Share knowledge about software tools and physics opportunities at Belle II amongst participants, provide training on these topics

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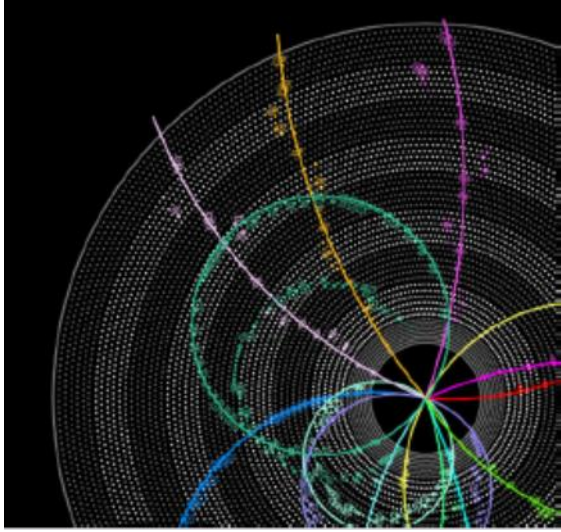
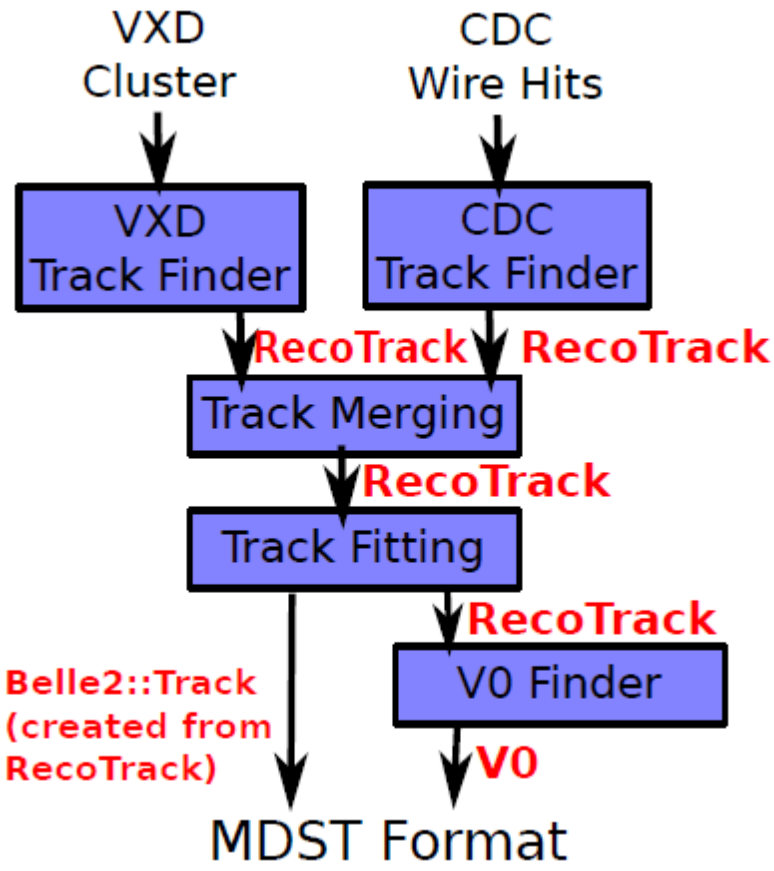


Task 1.1: Detector related software



Advances in all subdetectors and in their combination/merging

1st Software workshop (**Deliverable 1.1**) organized in october 2015 with strong support from JENNIFER.

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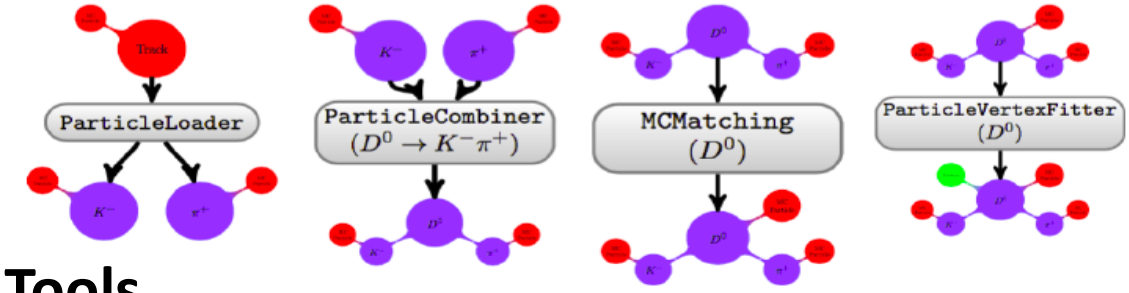
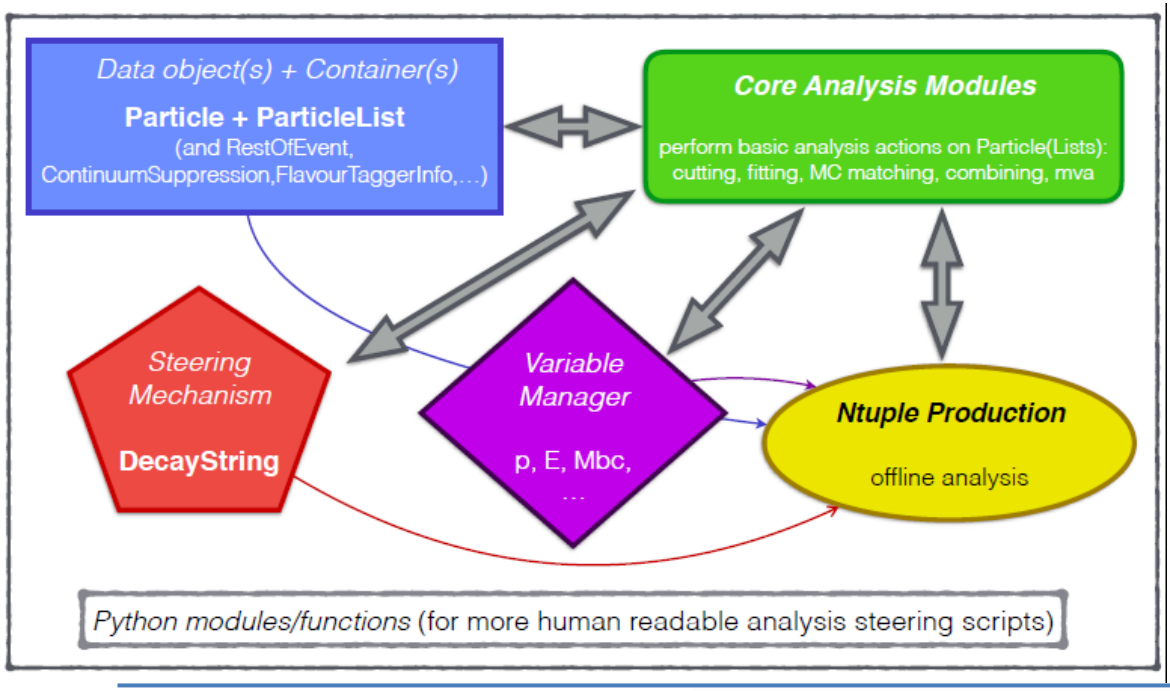
WP1 status



Task 1.2: Physics Analysis Tools

- General Architecture fully designed
- Core Analysis modules developed
- Execution path being tested in details



Tools and services being tested and refined .
Users' training is a key task!

2 Analysis tutorials (**Deliverable 1.2**) organized in january and june 2016 with strong support from JENNIFER.

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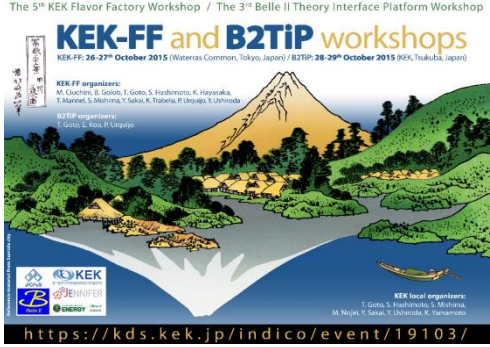
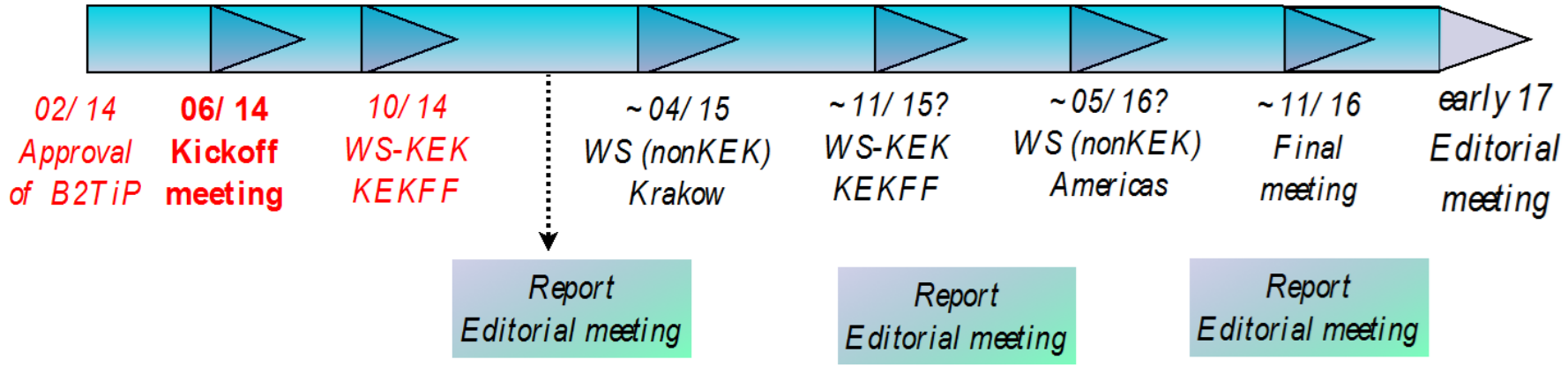


Task 1.3: Belle II - Theory interface platform

A series of workshops putting together theorist and experimentalists to identify the most sensitive physics channels and to prepare the analysis techniques.

Will finish in march 2017 producing a written report

JENNIFER members participation and financial support to the last 2 meetings.



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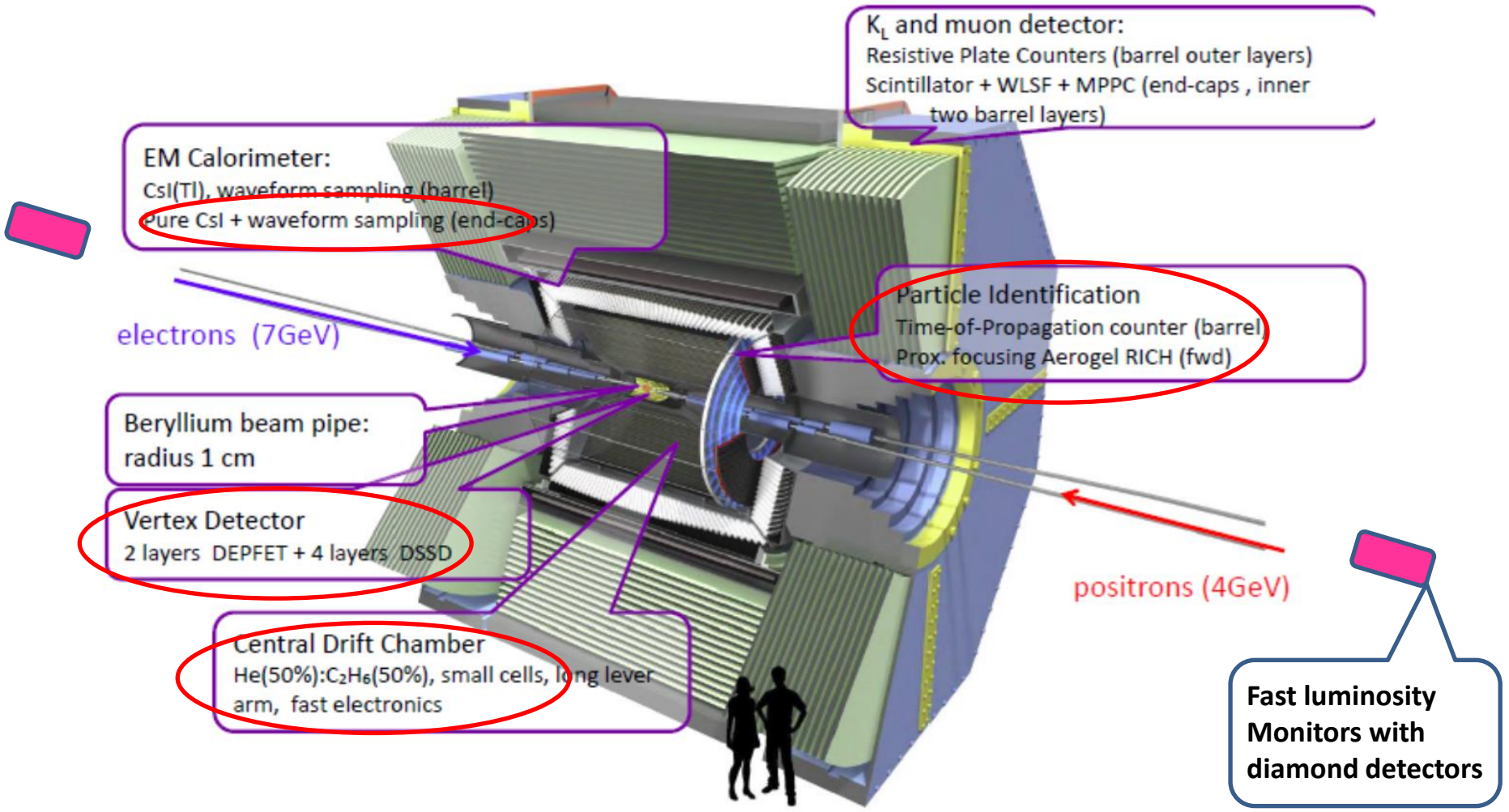
Building and operating the Belle II detector



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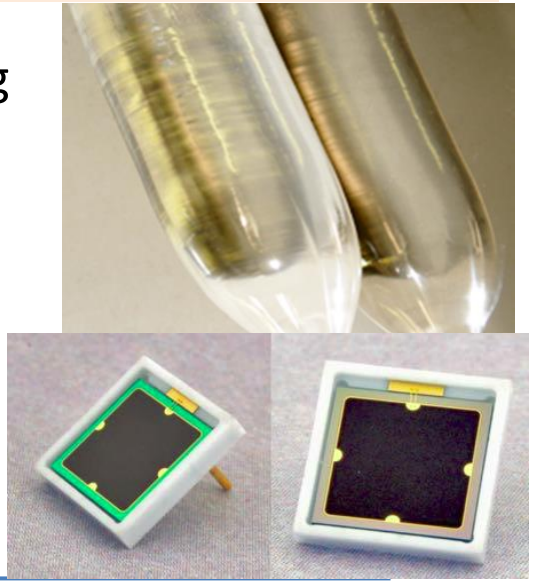
Task 2.1 Forward ECL

Belle II is using the same crystal calorimeter of previous Belle experiment, but such detector in the forward region cannot sustain the increased event rate and radiation flow which SuperKEKB will reach.

Pure CsI crystals meet the needed time and radiation-hardness performances, but at the price of a very low light yeld. They need accurate tests.

A wide R&D campaign has been carried on by JENNIFER to test crystals properties and performances, with different photodetectors and different electronics.

18 crystals tested in the SuperKEKB interaction region during machine commissioning , in the BEAST I framework.



Belle II delayed schedule and the accuracy required to the R&D moved the final decision on the upgrade solution fo beginninf of 2017. The initial task 2.1 deliverables need to be adjusted in time and redefined.

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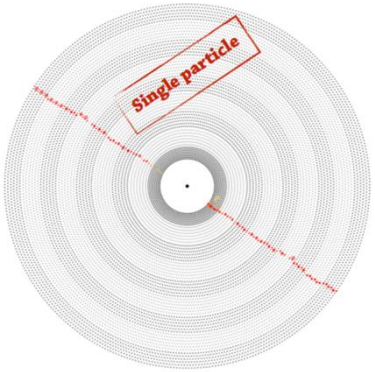
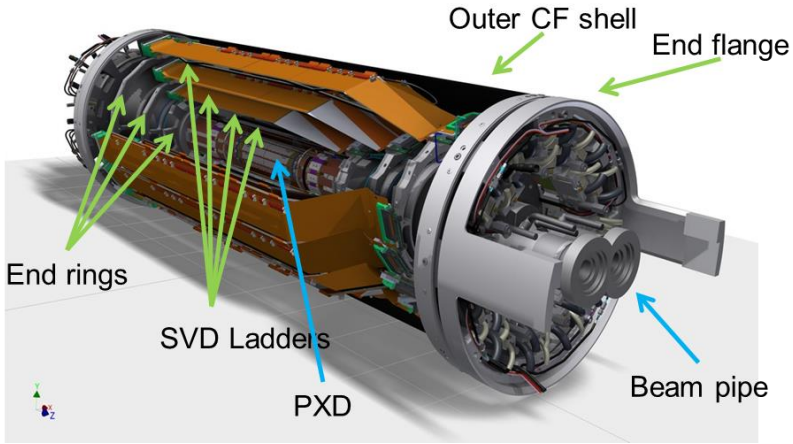
Task 2.2 Tracking



CDC drift chamber installed and started tests with cosmics, but without JENNIFER participation, due to a person-power problem in METU group. Solution has now been found, but activity and deliverables have to be reassessed.

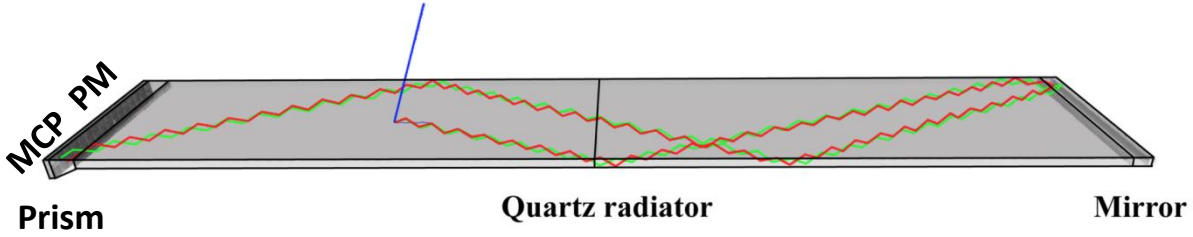


PXD + SVD silicon trackers are being produced in Europe.
Will be completed, assembled and integrated in 2017, mainly at KEK.
A pioneering common test beam has been performed at DESY, to prepare final integration.

The delayed Belle II schedule produce a shift in the PXD+SVD deliverable timing, but apart from this the project is on track and milestones are being met.

Task 2.3 Particle Identification

Time Of Propagation (TOP) detector produced and fully installed at KEK. Cosmic calibration started.

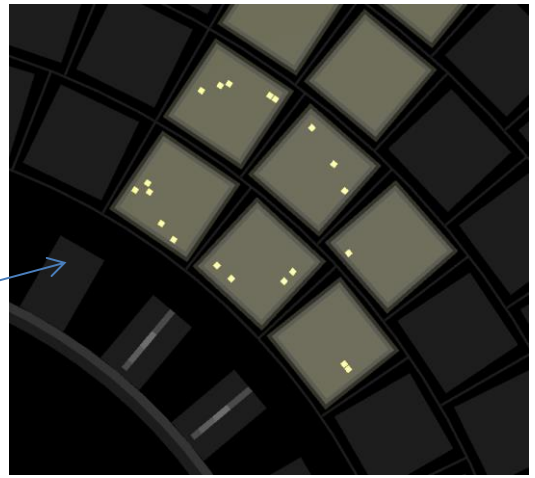


Cerenkov light produced in quartz bars is detected by Micro channel plate photodetectors which provide excellent time resolution (40 ps).

JENNIFER secondments were essential to allow longer stays at KEK for installation.

ARICH is the PID detector in the forward region, made of aerogel radiator + Hybryd APD.

Installation is going on and is on schedule. Cosmics test of partially installed detectors already show nice Cerenkov rings.



Task 2.4 Fast Luminosity monitor

Diamond sensors have excellent radiation tolerance and good time resolution.
Developed and tested at CNRS are installed on SuperKEKB to count very low angle Bhabhas to accurately measure instantaneous luminosity.

Sensors are installed 30 m from IP on electron ring and
11.9 m from IP in positron ring.

Tested during phase 1 beam commissioning in 2016 and found good agreement with simulation.

Project is on schedule.

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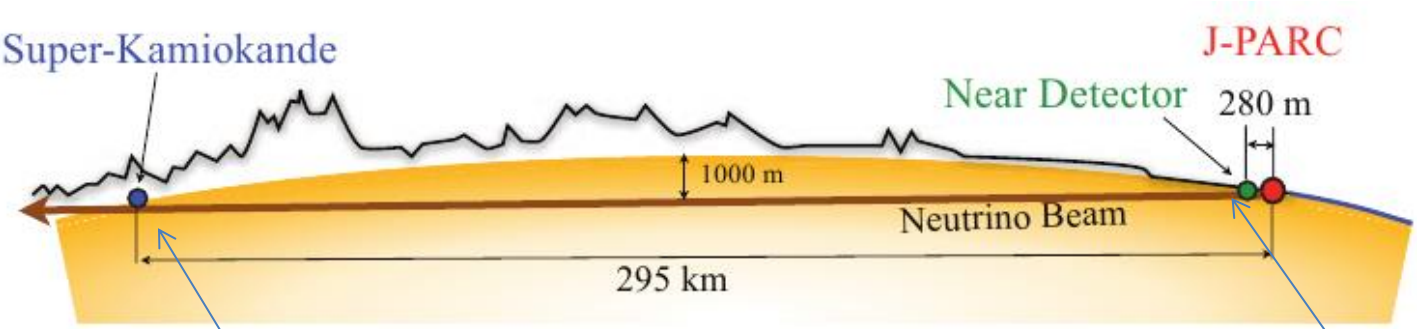
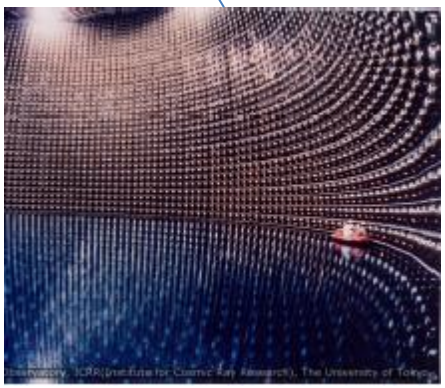
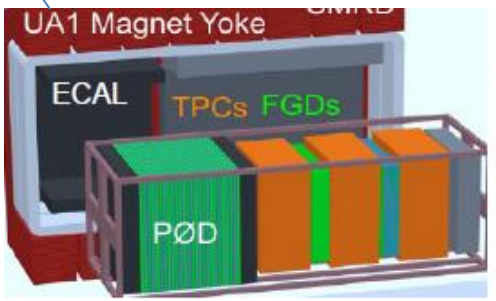
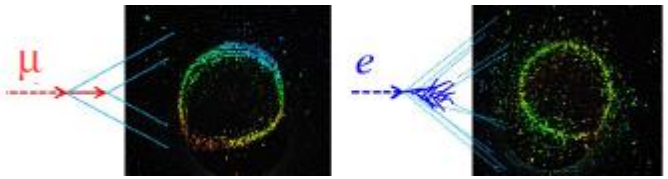




The T2K experiment





Intense high purity muon (anti)neutrino beam from J-PARC to Super-K to study:

- Muon (anti) neutrino disappearance
- Electron (anti) neutrino appearance $\nu_\mu \rightarrow \nu_e$ ($\bar{\nu}_\mu \rightarrow \bar{\nu}_e$)
- Rich program of:
- neutrino cross sections studies with near detectors
- "exotic" physics: sterile neutrinos, etc…

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Nobel Prize 2015 to Takaaki Kajita, T2K member and father of SuperK

"for the discovery of neutrino oscillations ...

... which shows that neutrinos have mass"

November 2015: All members of T2K Collaboration are awarded the Breakthrough Prize in Physics !

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Neutrino Oscillation Physics

- Asses the contribution of neutrino interaction in the sand and rock surrounding the near detector;
- Study of neutrino-nuclei and Meson Exchange Current interactions;
- Study of anti-neutrino interactions;
- Share the analysis techniques among the project participants and provide opportunities for the ESR to increase the interaction with KEK scientists.

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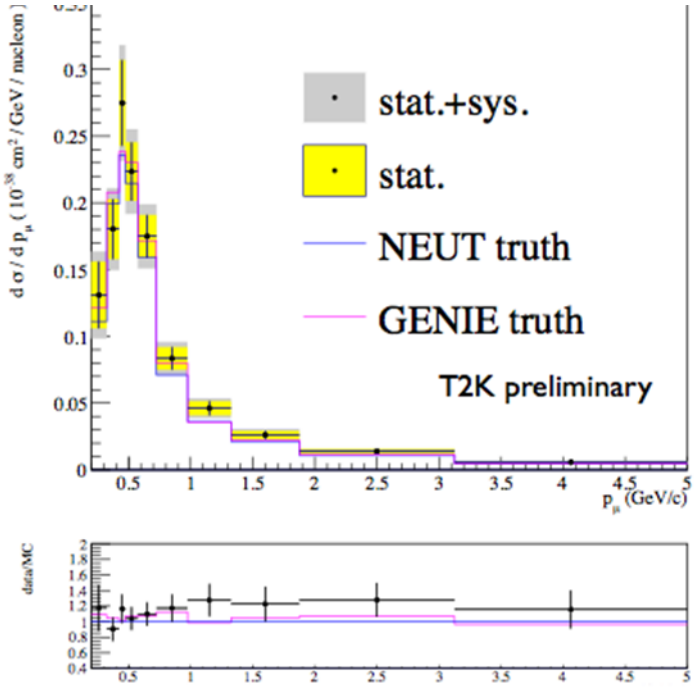
Task 3.1 Neutrino interactions and cross sections

A large data analysis campaign is being carried on:

- Study of antineutrinos CC interactions in near detector
- Measurement of 2 nucleons background
- Inclusive anti-neutrino charged current cross section measured !

Key ingredient for CP violation.

- More studies on single π CC events



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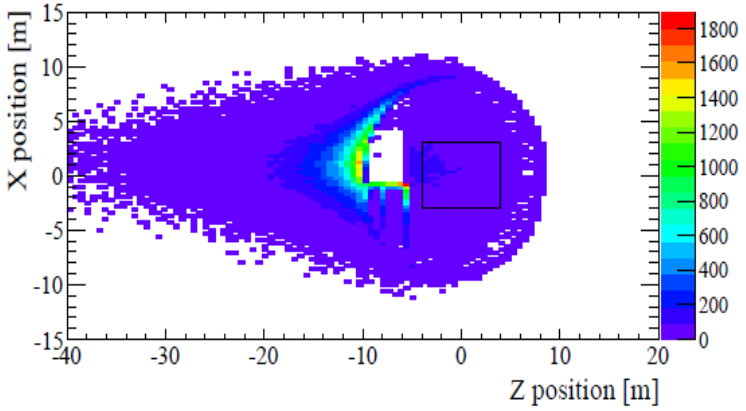
Task 3.2 External background studies

Detailed evaluation of the contribution of particles coming from neutrino interaction in sand.

Simulation and tuning on data allowed to reduce uncertainty on anti-neutrino cross section

Studied the use of such events for beam monitoring



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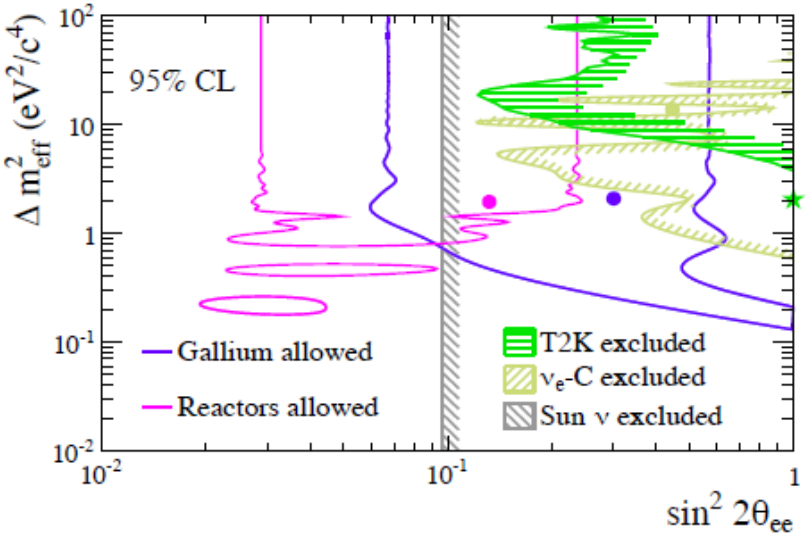
Task 3.3 Exotic Physics

Performed a search for Lorentz violation effects (predicted by several SM extention models).

Search for sterile neutrinos which appear only through mixing with the 3 weak interacting ones.

Done with ν_e disapperance,
To be completed with ν_μ .



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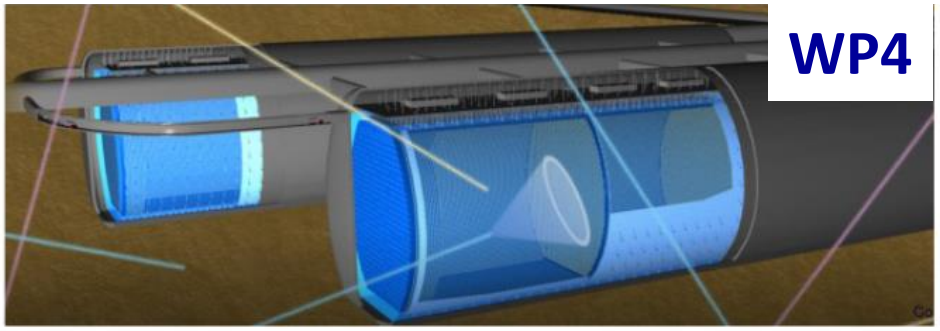
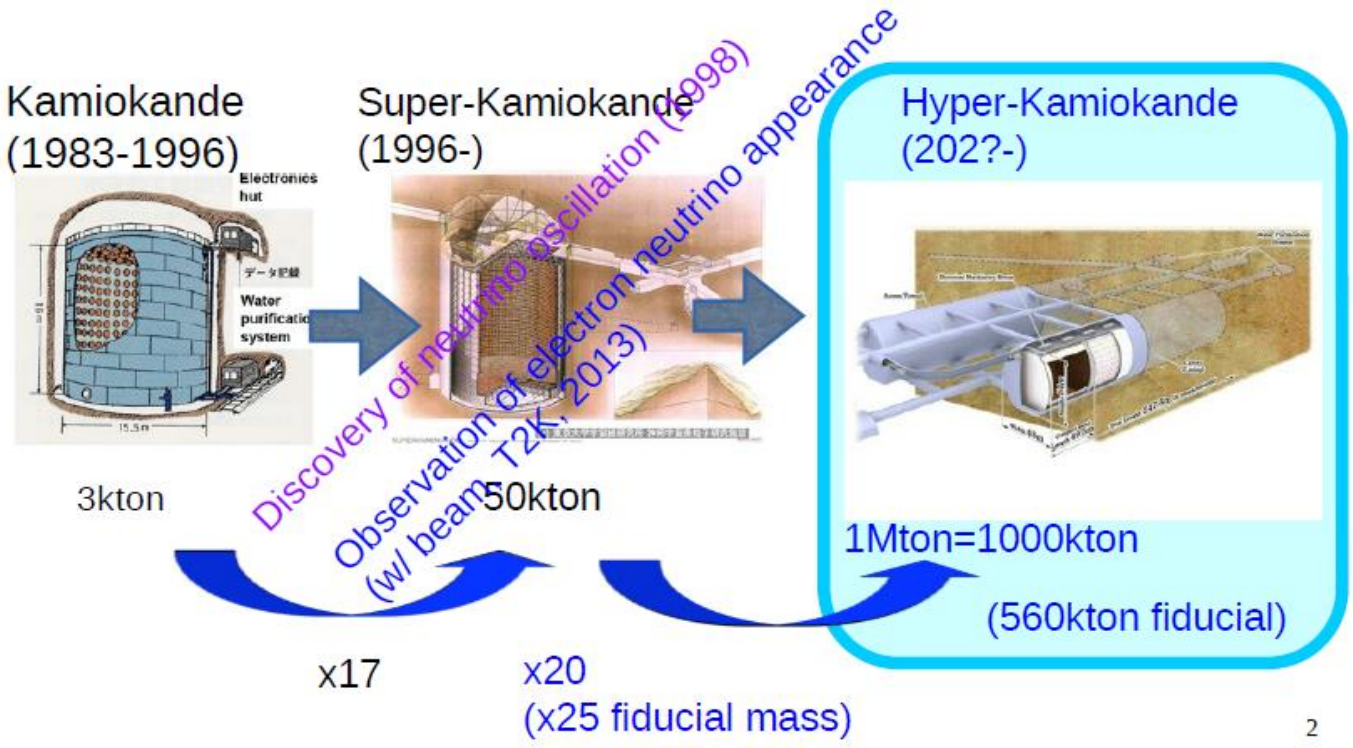
The Hyper-Kamiokande project



Sensitive to neutrinos: Solar
Atmospheric
Supernova
Accelerator



A multi-purpose neutrino detector!

- Oscillations
- Astrophysics
- Proton decay

2

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WP4 objectives

JENNIFER groups interested in accelerator neutrino experiment with HK:

- Design of the DAQ for near and far Water Cerenkov detectors.
- Test of photosensors at the prototype.
- Test of new calibration methods for a Water Cerenkov detector.
- Study of near detector design
- Optimization of the parameters of a High Pressure TPC and measurement of parameters.
- Study towards a 750kW beam and more generally a multi W beam.

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Task 4.1 Water Cerenkov detectors

A new intermediate W. C. detector at 2 km from beam generation is being designed: a 2 kton water volume doped with Gadolinium (TITUS)

Gadolinium allows neutron detection through capture.

Sinergy with HK larger Water Cerenkov in many items:

- Data acquisition
- Photodetectors
- Laser Calibration
- electronics

Several progresses in each item, for the moment mainly in EU labs. Combined tests at JPARC will happen in the next years.

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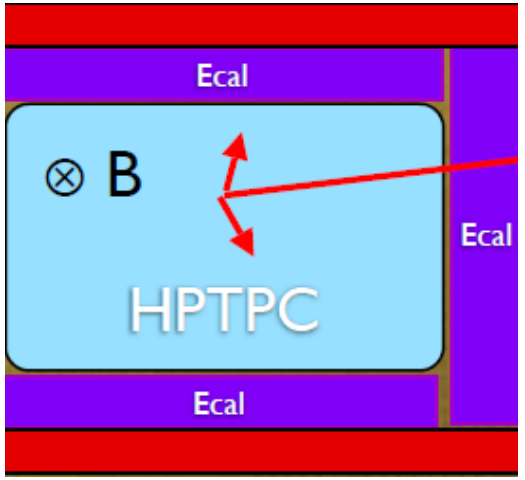
Task 4.2 High pressure TPC



TPC tracking and PID capabilities would be well suited for neutrino cross section measurement

Low density in the main issue. Simulations studies are being carried on to clearly define the requirements. Prototyping is th next step.

Task 4.3 Beam studies

Increasing Neutrino beam flux requires to rise proton beam power to few MW. This is a challenging target where collaboration between RAL and KEK had started already with T2K beam.

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Management of the project

- Manage secondments according to project needs in its various stages and components.
- Organize annual meetings and foster the cross fertilization between different project activities
- Organize and coordinate the outreach activities

Task 5.1 Management of the Secondments

WP Coordinators have been appointed and Executive Commettee formed (**Deliverable 5.1**)

Defined **internal procedure for secondment validation and monitoring**:

- Secondment is notified to central project secretariat before it starts
- Hosting japanese institutions certify the secondment
- Seconded staff writes an activity report
- Sending institution is responsible to keep all documentation

An internal Database, accessible via the project web page, is kept up to date with planned and actually performed secondments (**Deliverable 5.2**)

Experience has shown that secondment planning has to be changed frequently due to experimental need and schedule changes. Flexibility is mandatory.

Task 5.2 Organization of common events

A yearly project meeting has been organized, with participation of the representative of all beneficiaries and partners:

Rome 11-12 june 2015
London 22 september 2016

Deliverable 5.3

These are the best events to trigger cross fertilization and new ideas.

The Consortium has agreed to set up a common fund to cover the costs of such events and of the outreach. Every beneficiary contributes with a fixed fraction of its project funds.

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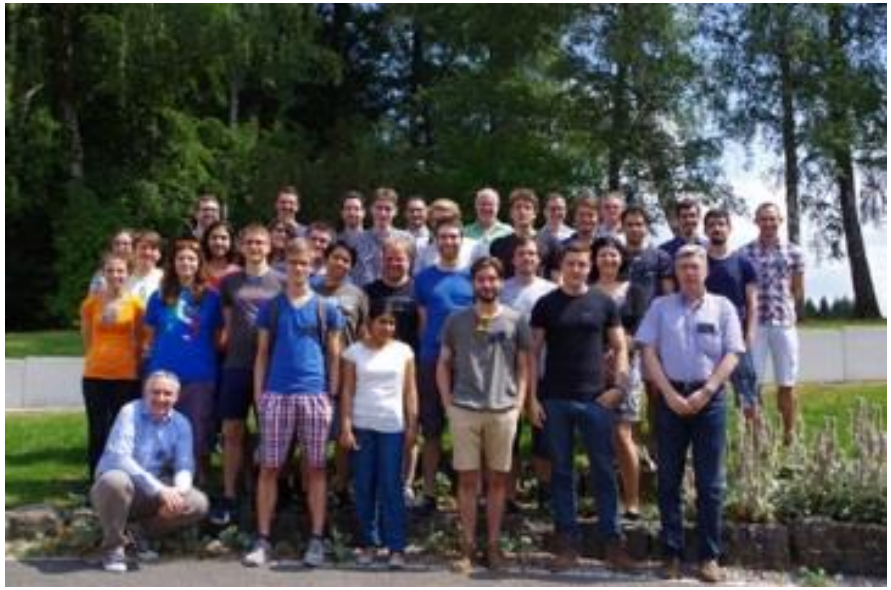
Task 5.3 Outreach activities

Two physics lectures for the general public organized together with the annual project meeting (**Deliverable 5.4**).

First JENNIFER summer school for degree students successfully organized in july 2016 (**Deliverable 5.5**)



Masterclass preparation for high-school students is the next step.

JENNIFER critical items

WP1, WP3 and WP5 are fully on schedule and do not show problems.

WP2 suffered from Belle II schedule change, due to a redefinition of funding profile to KEK by the japanese R&T ministry.

- For **PXD+SVD** this simply imply a deliverables and milestones re-schedule, as stated in the dedicated WP2 presentation. In any case they are kept inside JENNIFER life.
- For **ECL** the R&D for the technology choice does also require more time. First deliverable has to be replaced by R&D report and move to march 2017. Detector production and commissioning will finish after JENNIFER life. Second deliverable should be replaced with the TDR writing and moved to month 48 .

A different problem happened in **CDC**, where METU group lost the post-doc who should give the most important contribution. The group is now getting 2 new staff who will work on CDC reconstruction and calibration.

JENNIFER critical items/2

WP4 has a different timing with respect to expectation, due to the process of HyperK project approval and international collaboration setup.

Research activities have been mainly carried out in home labs up to now, while collaborative work in Japan is delayed with respect to secondment plan.

Moreover, there is a large overlap between HK project and the recently proposed T2K upgrade.

No change in deliverables is necessary, only the secondments timing has changed.

Secondments implementation

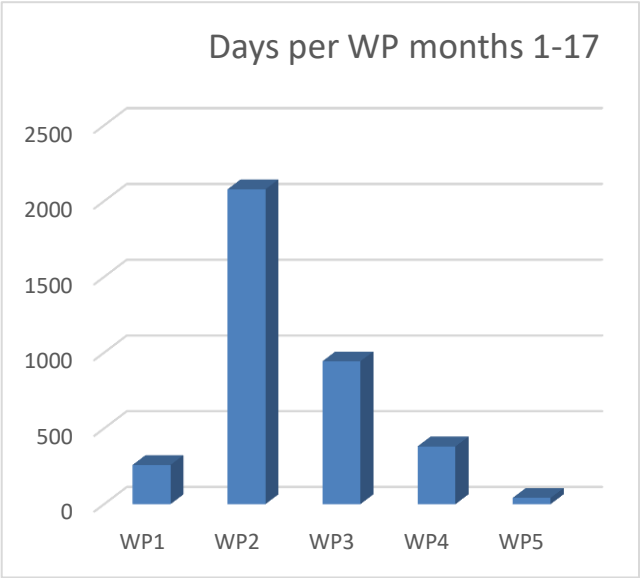
General statistics up to august 31:

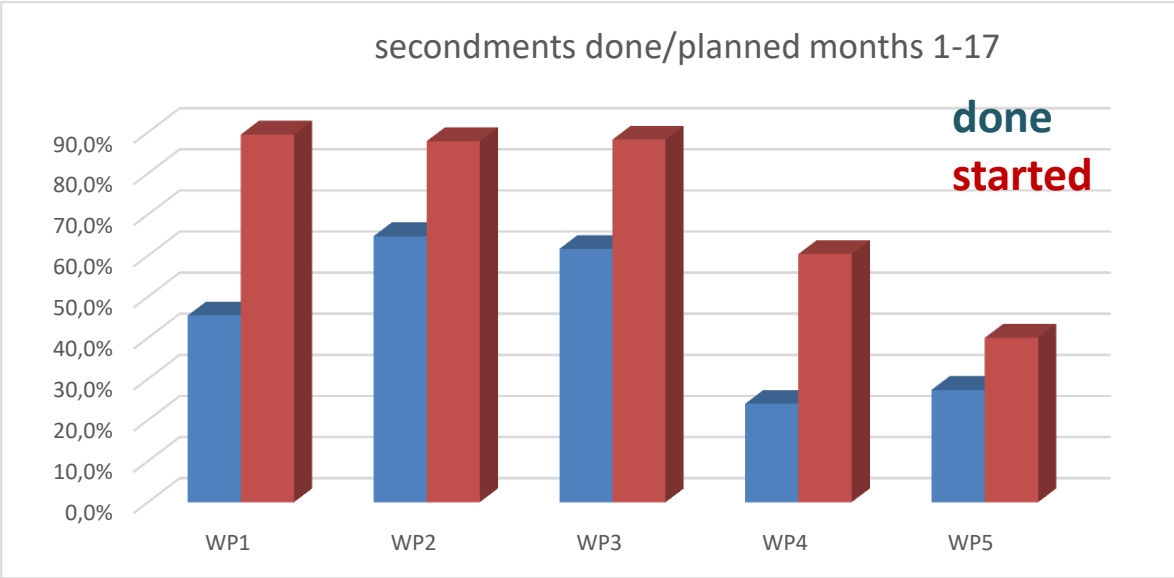
WP	Days total	months	Planned months	fraction	Started secondmts (months)	fraction started	planned in 4 years (months)
WP1	259	8,6	19	45,4%	17	89,5%	65
WP2	2078	69,3	107	64,7%	94	87,9%	227
WP3	943	31,4	51	61,6%	45	88,2%	113
WP4	381	12,7	53	24,0%	32	60,4%	98
WP5	41	1,4	5	27,3%	2	40,0%	10
Total	**3702**	**123,4**	**235**	**52,5%**	**190**	**80,9%**	**513**

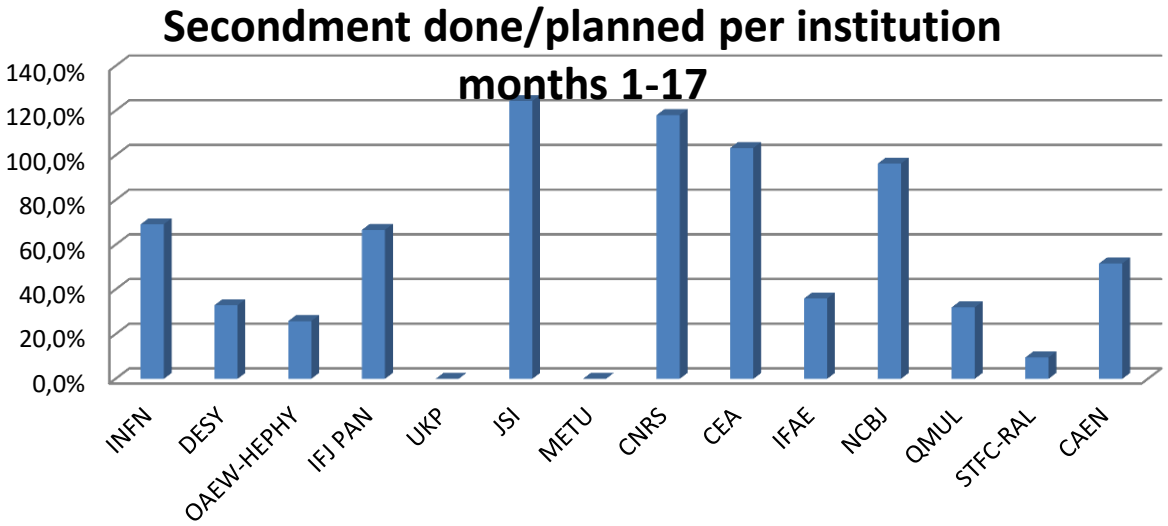
Secondments are usually split in more periods, while the planned ones include full duration.
Comparison with planned is more meaningful when using the number of started secondments, completed or not.

Secondments per institution until august 31st 2016

Istitution sending	Days total	months	planned	fraction	planned in 4 years
INFN	1661	55,4	80	69,2%	166
DESY	168	5,6	17	32,9%	95
OAEW-HEPHY	31	1,0	4	25,8%	24
IFJ PAN	140	4,7	7	66,7%	9
UKP	0	0,0	6	0,0%	10
JSI	485	16,2	13	124,4%	27
METU	0	0,0	14	0,0%	14
CNRS	425	14,2	12	118,1%	17
CEA	217	7,2	7	103,3%	28
IFAE	97	3,2	9	35,9%	23
NCBJ	289	9,6	10	96,3%	28
QMUL	211	7,0	22	32,0%	30
STFC-RAL	92	3,1	32	9,6%	38
CAEN	31	1,0	2	51,7%	4
Total	3847	128,2	235,0	54,6%	513







JENNIFER
EU grant n.644294

Gender issues

Gender	n. of seconded staff	Average secondment duration
Female	23	1.2 months
Male	84	1.1 months
Total	107	

No preference is given to staff gender for access to JENNIFER funds.

Unbalanced gender participation to secondments is produced by the average gender population in particle physics.

More detailed studies need to be done, however experience shows that women with children care duties are less available for secondments. MSCA should consider a dedicated support for such cases.

JENNIFER Impact on individual careers

We have already many examples of young researchers who won grants or got new caree opportunities after working in JENNIFER:

A. Longhin was awarded an **ERC consolidator grant for the project ENUBET**
R. Giordano got an italian ministry grant *Scientific Independence for Young Researchers for the project ROAL*
(Both projects are strongly connected to the PI activity in JENNIFER)

L. Magaletti won the INFN prize *Bruno Rossi* for the best PhD thesis in neutrino and astroparticle physics.

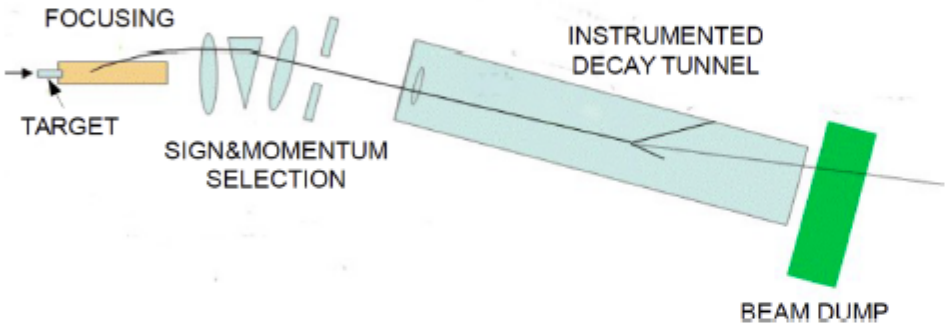
A. Gaz got a professor position at the Nagoya University
G. Casarosa got a post doc position at MAINZ university
S. Bordoni got a fellow at CERN
A.Rossi got a research position at Perugia University to work on CMS
……..

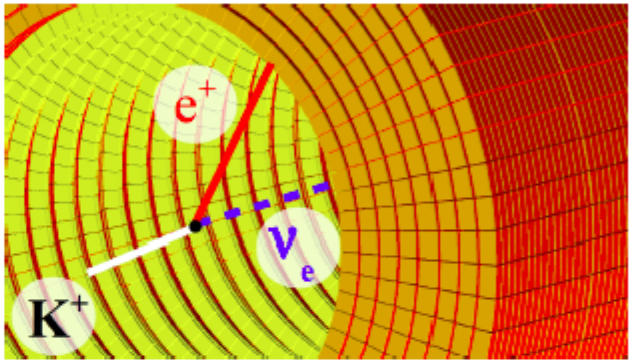
It's just the beginning !

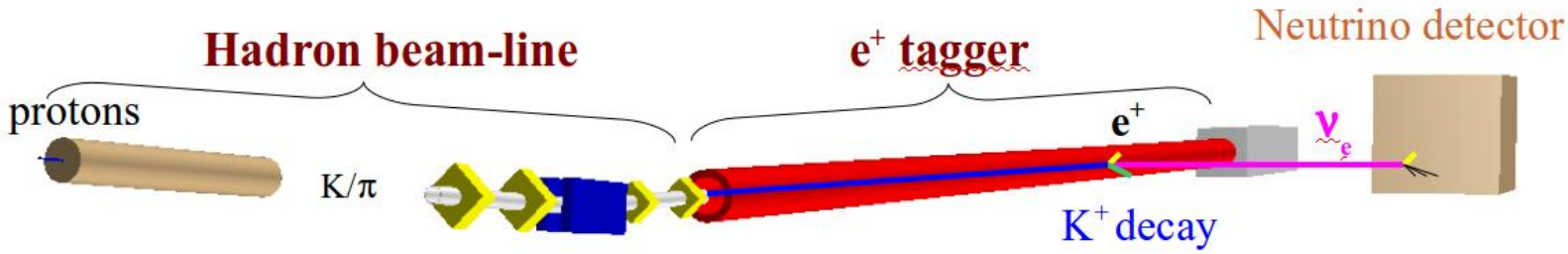
ENUBET

ERC Consolidator Grant 2015. PI: Dr. Andrea Longhin (INFN)

Non conventional technique to measure electron neutrino cross section via the positron rate monitoring in the decay tunnel.







JENNIFER
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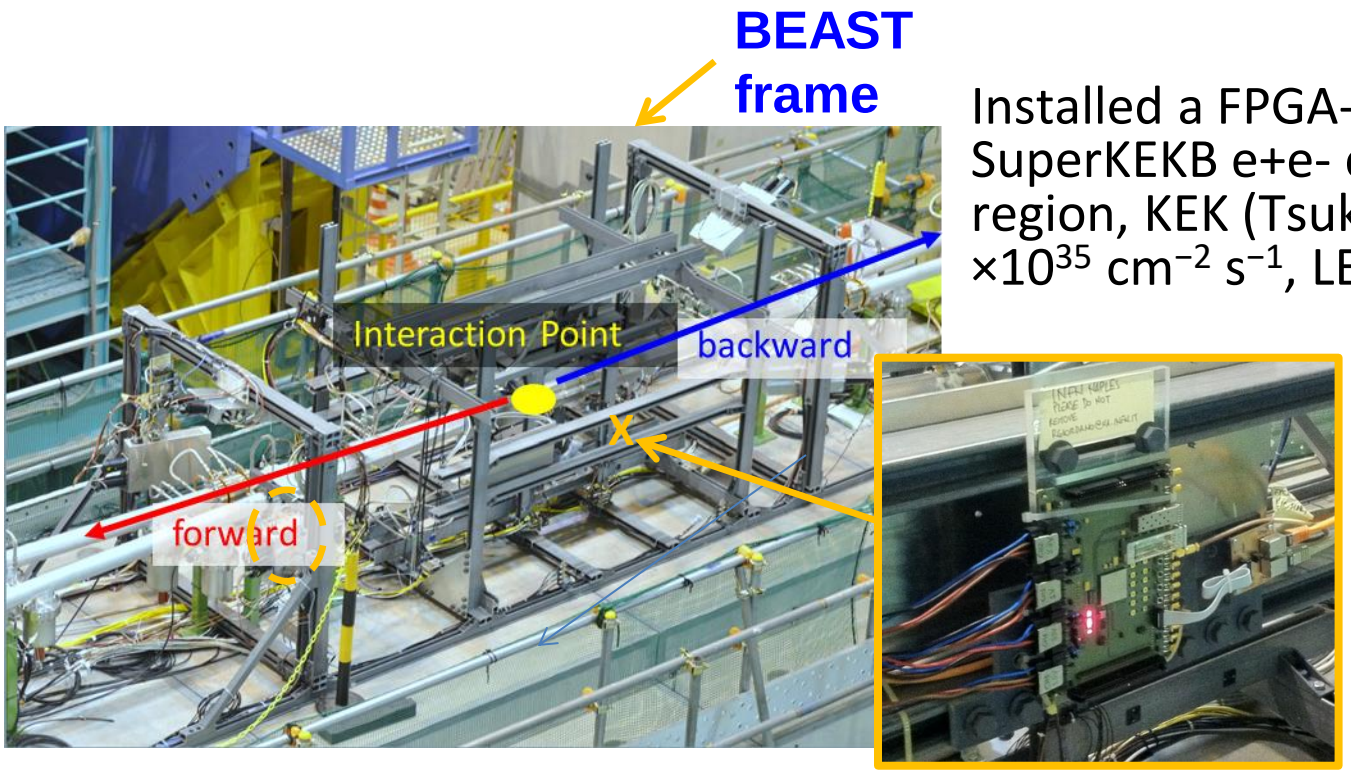
ROAL project tests at Belle II



Installed a FPGA-based board at SuperKEKB e+e- collider interaction region, KEK (Tsukuba, Japan) (L= 8 $\times 10^{35}$ cm^{-2} s^{-1}, LER 4GeV, HER 7 GeV)

- Hosted by the BEAST2 experiment for studying machine backgrounds prior to Belle2 roll in (see C. La Licata talk)
- Board installed behind He3 tube => neutron rates
- Reading back configuration errors
- Activity supported w/ JENNIFER secondments

JENNIFER Dissemination and societal impact

A number of conference talks are being obtained by JENNIFER researchers. Detailed counting of such events will be organized soon.

Some papers on JENNIFER activities are being published. Upload on continous reporting portal not yet really started, but we will take care.

Outreach events, aimed both at the general public and at the young students, allow to share to society the research curiosity and the technology challenges brought by the JENNIFER activities.

Meetings with technology industries are organized at common events to share information on the research needs and new products available.

Conclusions

JENNIFER is a very active and lively comunity which bridge Europe with Japan, neutrino physics with flavour physics, academic research with society and industry.

Apart from few problems in specific items, JENNIFER activities are proceeding well and the staff members are benefitting of secondments essentially as planned.

We look forward for another 31 months of fruitful activity

Thank you !