

Experimental Studies: Status and Goals




4-5 Feb 2016
10th FCC-ee physics workshop

2-3 Feb 2016
FCC-ee mini-workshop: Physics behind precision

Filtration plant
 (222-R-001)
 CERN, Geneva,
 Switzerland



What physics
 can be discovered
 with the FCC-ee
 unequalled precision?

Note:
 every day from 10:30 to 12:30
FCC academic training
<http://indico.cern.ch/e/472105/>

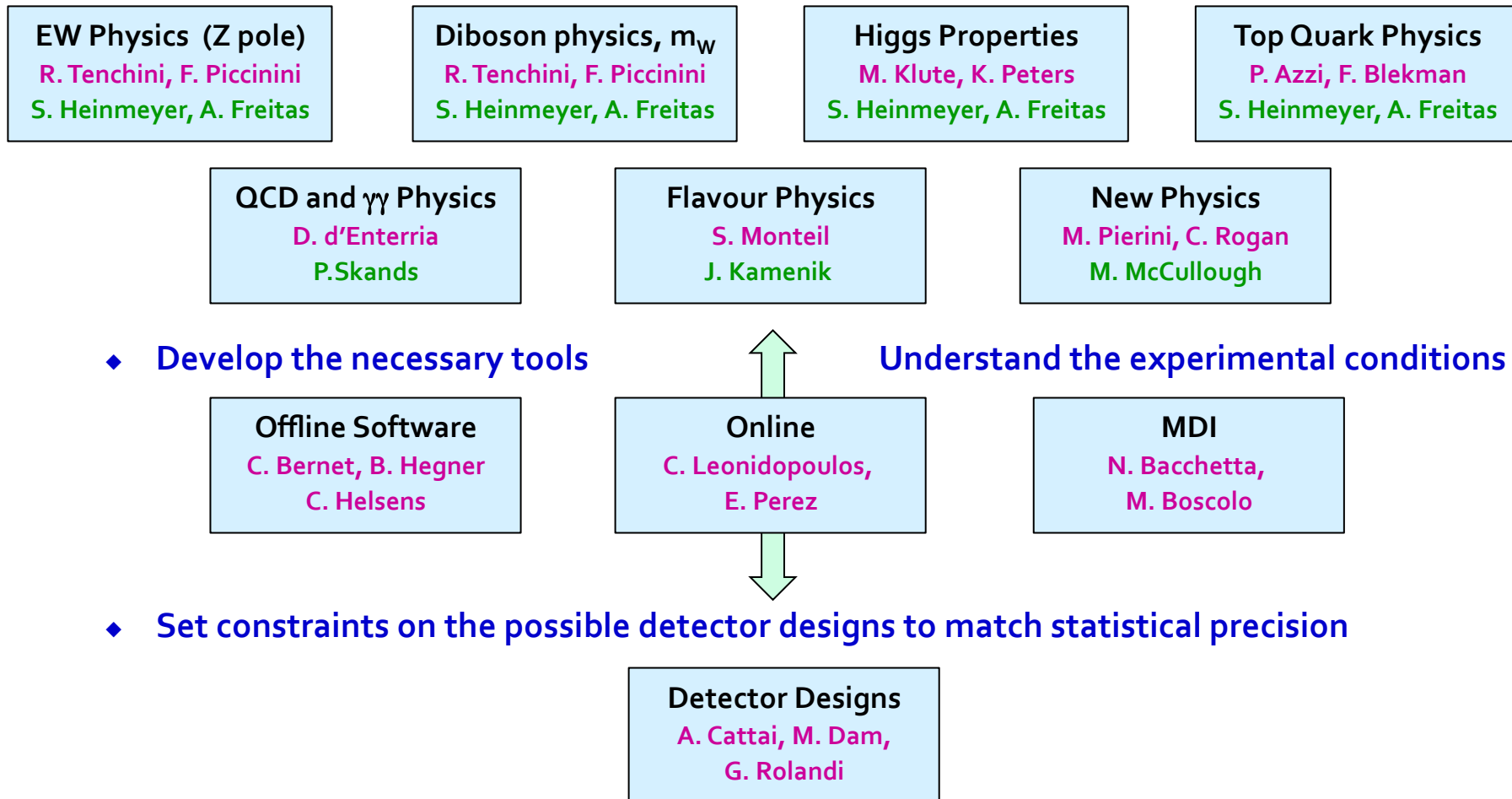
Registration
 10th FCC-ee general workshop
<http://indico.cern.ch/e/FCCee10>
 FCC-ee mini-workshop
<http://indico.cern.ch/e/FCCeePrecision>

Organizing committee
 10th FCC-ee general workshop: Alain Blondel, John Ellis, Christophe Grojean, Patrick Janot
 FCC-ee mini-workshop: Patrizia Azzi, Freya Blekman, Elizabeth Locci, Fulvio Piccinini, Roberto Tenchini

Poster designer: Cristina Martin Perez

Reminder: Groups, conveners, meetings, ...

- Physics studies: A. Blondel, P. Janot (Exp); J. Ellis, C. Grojean (Th)
 - Study the properties of the Higgs and other particles with unprecedented precision



Reminder: Groups, conveners, meetings, ...

▣ Meetings

- ◆ Physics coordination meetings: <https://indico.cern.ch/category/5692/>
 - Monthly, every 2nd Thursday, 10:30am – discuss plans, organization, news, ...
- ◆ Physics vidyo meetings: <https://indico.cern.ch/category/5307/>
 - Monthly, every last Monday, 3pm – discuss interesting topics, recent work, ...
- ◆ Physics group meetings: <https://indico.cern.ch/category/5259/>
 - Organized by the group conveners on demand
- ◆ Physics workshops: <https://indico.cern.ch/category/5684/>
 - Five mini-workshops since June, organized by convener subsets
 - Detector requirements
 - Theoretical predictions and precision
 - Higgs physics
 - α_s from LHC to FCC-ee
 - Physics behind precision
 - Yearly general physics workshops
 - In Pisa (Feb. 2015)
 - At CERN (Feb. 2016)

Some have led to written documents
e.g., arXiv:1512.05194 for α_s : 145 pp

Reminder: Groups, conveners, meetings, ...

□ Outcome

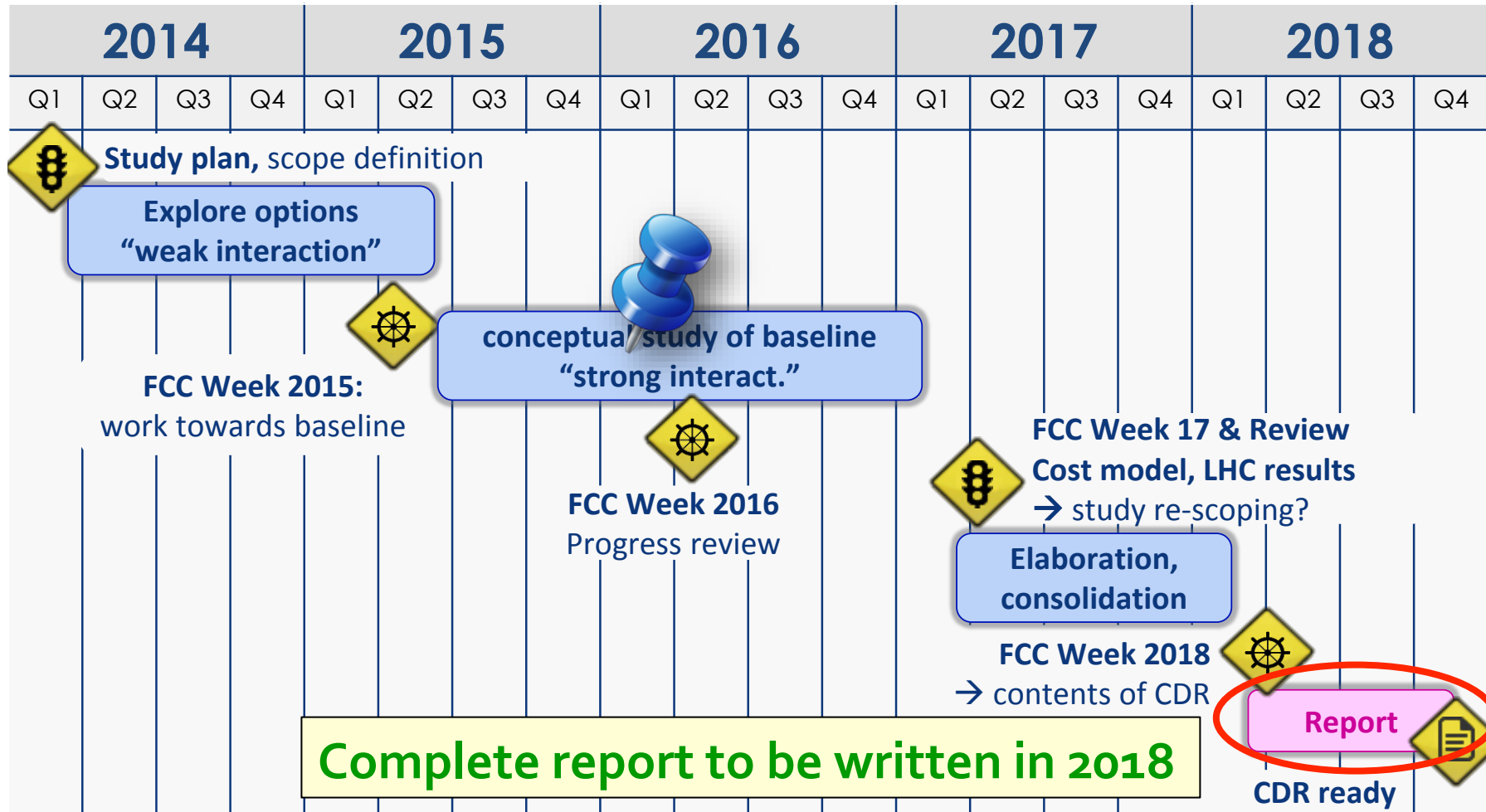
- ◆ Each group will present the outcome of this year during this 2-day workshop
 - As well as their plans for the year(s) to come

- ◆ Highlights
 - Physics software getting operational (needs users!)
 - Unique flavour physics potential
 - Evaluation of theoretical efforts needed to match exp'tal precision
 - α_s document
 - No pressing need of longitudinal polarization (top EW couplings, $\sin^2\theta_W$, m_W , ...)
 - Higgs width better than with a muon collider
 - $\alpha_{\text{QED}}(m_Z)$ direct measurement
 - Run plan
 - Many presentations at international conferences
 - Several publications
 - ...

- ◆ Quite a productive year, in spite of the limited team, time, or political support

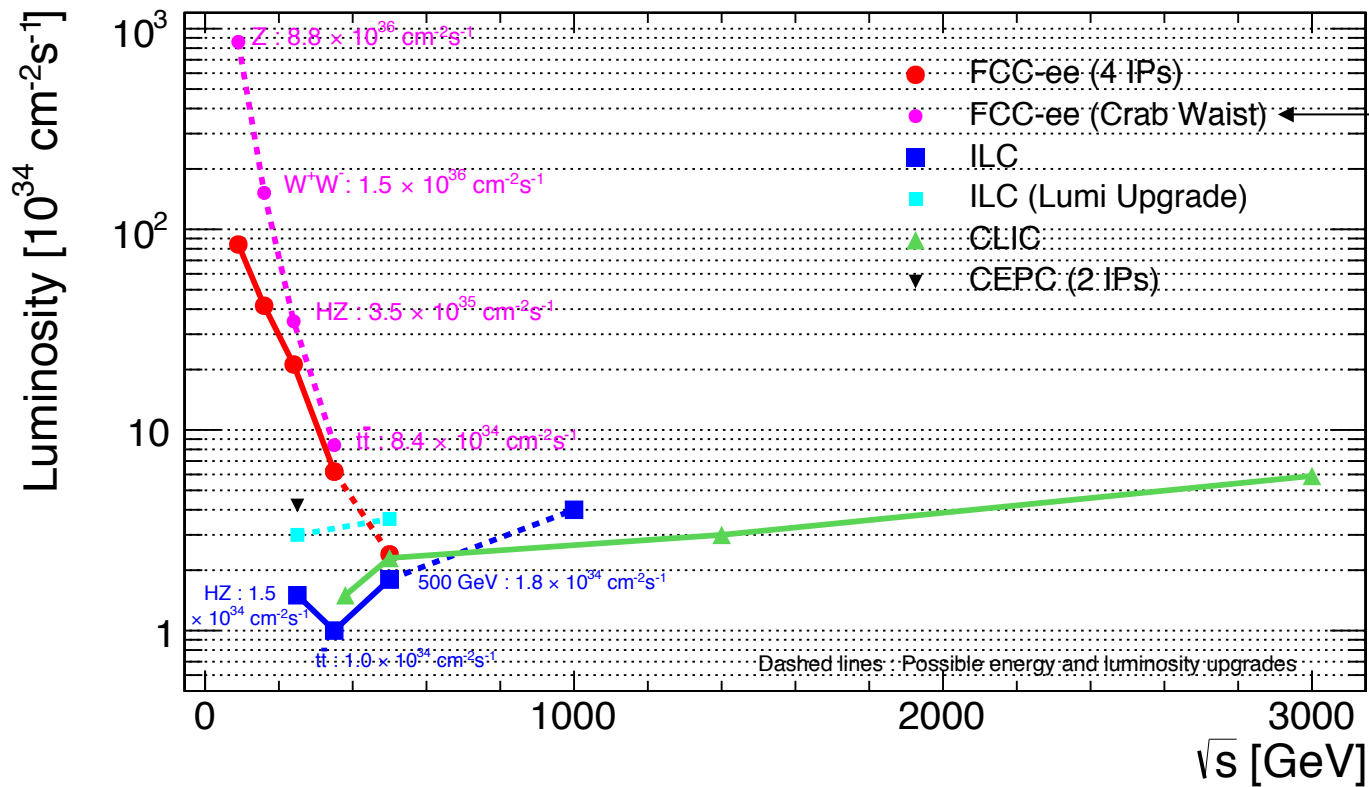
FCC Design Study Time Line

- **Our physics studies are part of the FCC design study**
 - ◆ We are half way of the conceptual study period – “Conclusion” expected within a year



Baseline Luminosity

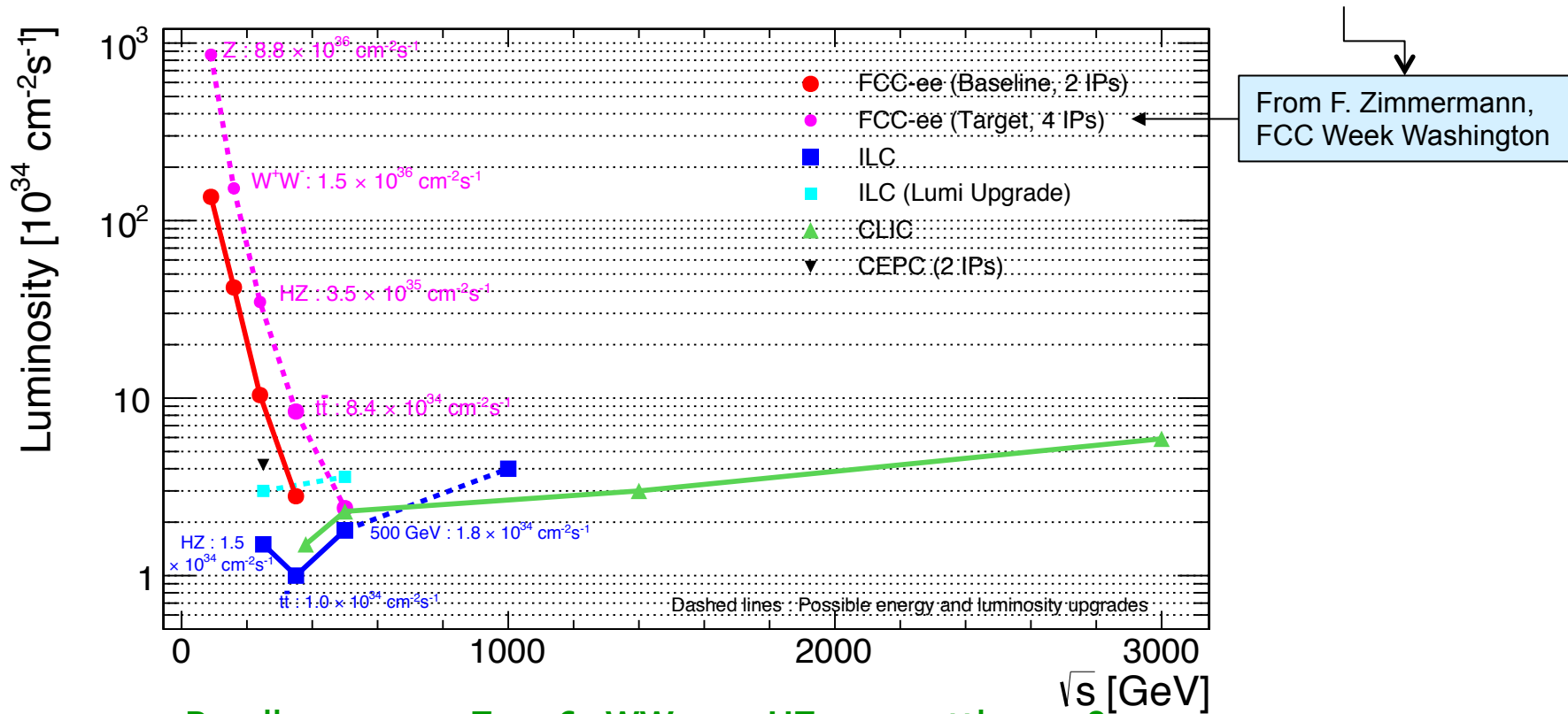
- Until now, we were using this celebrated plot
 - ◆ Without a realistic optics to back it up



● Baseline before Z: 84; WW: 42; HZ: 21.2; ttbar: 6.1 x 10³⁴ cm⁻²s⁻¹

Baseline Luminosity

- **We have now coherent and sound optics for the first time !**
 - ◆ Conservative parameters (see backup slides) but sound base towards the target



- **Baseline now** Z : 136 ; WW : 42 ; HZ : 10.4 ; ttbar : 2.8
- **Baseline before** Z : 84 ; WW : 42 ; HZ : 21.2 ; ttbar : 6.1 $\times 10^{34} \text{ cm}^{-2}\text{s}^{-1}$
- ➔ **Target luminosities typically 5-6 times larger than baseline**

Run plan (in preparation)

- We are preparing a written document for the FCC-ee run plan
 - ◆ With the target luminosities and 4 IPs, the run plan is as follows
 - Number of events expected per year of running

\sqrt{s} (GeV)	90 (Z)	160 (WW)	240 (Higgs)	350 (tt)	365 top EW couplings
Lumi (ab ⁻¹ /yr)	86.0	15.2	3.5	1.0	1.0
Events/year	3.7×10^{12}	6.1×10^7	7.0×10^5	4.2×10^5	2×10^6

- Number of years needed to finish the program

1 year = 10⁷ s

# years	2.5	1	3	0.5	3
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- The FCC-ee core programme can be finished in about 10 years
 - m_Z to 100 keV, α_{QED} to 3×10^{-5} , α_S to 0.0001, $\sin^2 \theta_W$ to 6×10^{-4}
 - m_W to 0.5 MeV
 - Higgs couplings/width to sub per cent, top EW couplings to per cent
 - ...
- ◆ These precisions (i.e., these luminosities) are needed for the new physics sensitivity
 - The conservative baseline parameters are a first giant step on this way.

Goals for 2016 – and beyond (selection)

- **Increase the effort wherever needed, with a team of new fellows/students**
 - ◆ **Machine-Detector interface (MDI)**
 - **Brand new task force created (see afternoon session)**
 - **Applied fellows being recruited**
 - Anna Kolano (01/03/16): Understanding/simulation of beam backgrounds
 - NN (09/16?): Detector integration in the IR, luminosity measurement ...
 - ◆ **Synergy with CLIC detector group**
 - **Adapt CLIC detector concept to FCC-ee (see first ideas tomorrow)**
 - **High granularity calorimetry, Si Tracker, ... etc**
 - **Doctoral student project being prepared (09/16?)**
 - **Also synergy with CMS calorimeter upgrade**
 - **Import geometry / simulation / reconstruction / generators in the FCC software**
 - **Great synergy with CLIC group** (participation to FCC-ee physics much welcome!)
 - **Applied fellow project being prepared (09/16?)**
 - ◆ **FCC physics software: USE IT !**
 - **Reproduce (full simulation) analysis in the FCC software, and complete if needed**
 - **E.g., b-tagging, event display, generators, beam backgrounds, ...**
 - **Applied fellow project being prepared**

Goals for 2016 – and beyond (selection)

- **Detector and physics studies are an endless source of inspiration**
 - ◆ We have only started to scratch the surface, with (smart) guesswork
 - Each specific study leads to interesting/unexpected conclusions
 - Because the FCC-ee luminosities are nothing like anything before
 - This guesswork needs to be extended, and consolidated by more in-depth studies
 - Use of FCC physics software, realistic detectors, ...
 - We need to involve young physicists in our studies
 - At CERN (research fellows) and outside institutes (students)
Be it for only a fraction of their time
 - ◆ Our mission: transfer our e^+e^- knowledge and form a new generation of physicists
 - They are going to run and exploit this collider !
 - They are actually going to continue these studies in the next decade

- **Of special importance: precision of theoretical calculations**
 - ◆ We repeatedly saw in the past two days the crying needs for higher-order calculations
 - Their current lack is often the only obstacle towards new physics interpretation
 - (Beside building the collider of course, and providing the target luminosities)
 - ◆ We need to set up an international effort in this direction, to last several decades

Goals for 2016 – and beyond (selection)

- Give presentations to conferences, and document them !
 - ◆ Example: ICHEP 2016, 3-10 Aug, proposed abstracts
 - Mass measurements at FCC-ee
 - Asymmetry measurements at FCC-ee: is longitudinal polarization needed ?
 - Higgs measurements at the FCC-ee, complementarity with FCC-hh
 - Top-quark physics at FCC-ee, complementarity with FCC-hh
 - New physics with FCC-ee: Impact on precision measurement and direct searches
 - QCD studies at FCC-ee
 - Flavour studies at FCC-ee
 - Physics at FCC-ee and run plan
 - MDI at FCC-ee
 - ◆ Everybody is very much welcome to give any of these talks, at any conference
 - Volunteer ! Be proactive ! Support the FCC-ee by showing its physics case !
 - ◆ It is then important to upload your slides, your proceedings, your publications, ...
 - On the FCC-ee web site

Goals for 2016 – and beyond (selection)

- ❑ **Communication: We have a beautiful web site (<https://cern.ch/fcc-ee>)**
 - ◆ It certainly depends on the contribution of each and all of us : upload your studies !

The screenshot shows the FCC-ee website interface. At the top, there is a navigation bar with links for Dashboard, Content, Structure, Appearance, People, Modules, Configuration, Reports, and Help. Below this is a search bar and a user profile for Patrick Janot. The main content area features the FCC-ee logo and the title 'The FCC-ee design study'. A red box highlights the 'Register to the FCC-ee' link in the navigation menu. Another red box highlights the 'Contact/join us' link in the same menu. The main content area includes a large image of a particle detector, a map of the LHC tunnel, and a section titled 'FCC: Future Circular Collider Study' with introductory text. Below this, there are sections for 'Follow us' (Facebook and Twitter), 'Stay aware...' (upcoming workshops and the 2016 FCC Week), and 'FCC-ee' (a list of recent updates and events).

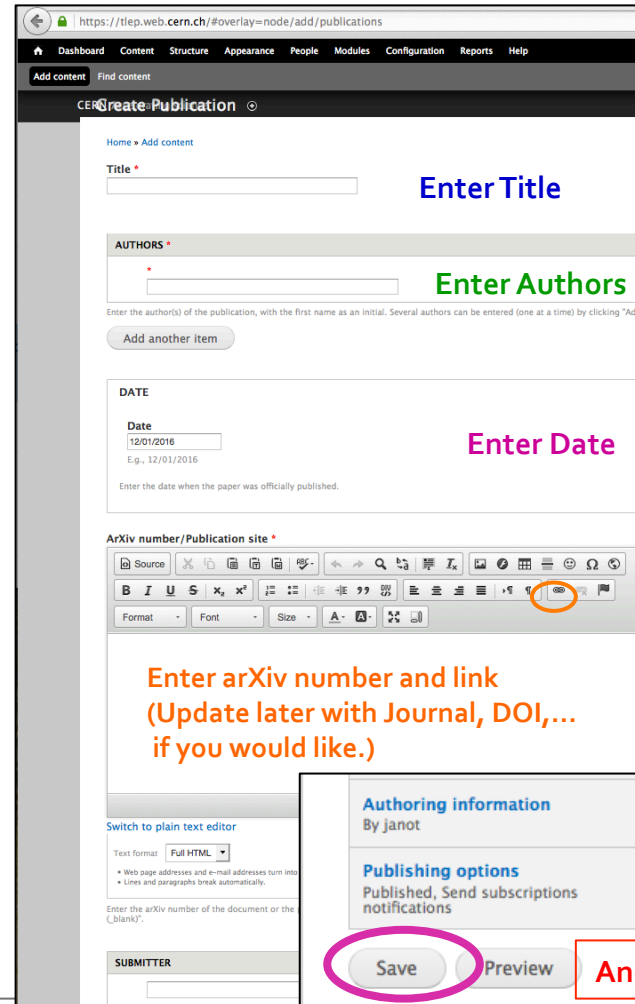
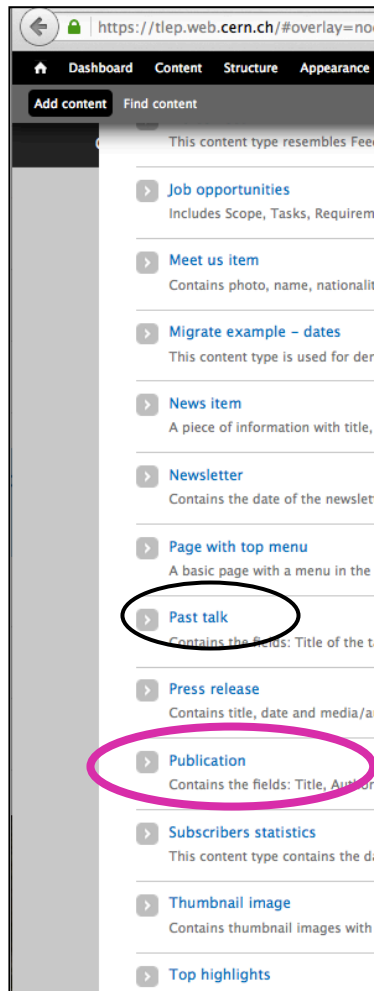
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Follow us

Stay aware...

- Next FCC-ee physics workshops
The next FCC-ee ([mini](#) and [physics](#)) workshops will take place from 2 to 5 February 2016 at CERN. Register and watch the poster!
- The 2016 FCC Week approaches !
The 2016 FCC collaboration week will take place in Rome from 11 to 15 April, with a brand-new [website](#). Registration is now open.

Latest publications

- Direct measurement of $\alpha_{\text{QED}}(m_Z)$ at the FCC-ee
- High-precision α_s measurements from LHC to FCC-ee
- Sensitivities of Prospective Future e^+e^- Colliders to Decoupled New Physics

[Check all publications here.](#)

FCC-ee

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The FCC-ee in a few words

The FCC-ee, formerly known as TLEP, is a high-luminosity, high-precision e^+e^- circular collider envisioned in a new 80-100 km tunnel in the Geneva area. With a centre-of-mass energy from 90 to 400 GeV, the physics program could pave the way towards the discovery of physics beyond the Standard Model, casting light on unanswered questions, such as dark matter, the baryon asymmetry of the Universe, the hierarchy problem, the stability of the Universe or the nonzero neutrino masses.

The FCC-ee project is part and parcel of the Future Circular Collider design study (FCC) at CERN, and would be the first step towards the long-term goal of a 100 TeV proton-proton collider. It is expected to deliver its conclusion in 2018, just prior the next update of the European Strategy. There are many challenges facing the study, starting with a realistic design that allows these promises to be fulfilled, so feel free to [join the design study group](#) if you wish to collaborate with us!

Further reading:

- [An already long history](#)
- [Machine parameters and luminosities](#)
- [Publications](#)
- [Newsletters](#)

Next events

Offline software development
FCC Software Meeting
13 Jan 2016 - 11:00 - CERN - 32-1-A24

FCC-ee Physics Coordination
FCC-ee physics coordination meeting
14 Jan 2016 - 10:30 - CERN - 4-5-030

FCC-ee Physics meetings
FCC-ee Physics Vidyo meeting
25 Jan 2016 - 15:00 - CERN - 222-R-003

FCC-ee Physics Workshops
FCC-ee Mini-Workshop: "Physics Behind Precision"
2 Feb 2016 - 08:00 - CERN - Filtration Plant

FCC-ee Physics Workshops
10th FCC-ee physics workshop
4 Feb 2016 - 08:30 - CERN - Filtration Plant

1 of 2 next >

Your publication is visible from the home page
Note also the automatic meeting announcement

Goals for 2016 – and beyond (selection)

- ❑ **Communication: we also have a fb page** <https://www.facebook.com/tlepdesignstudy>
 - ◆ You can contribute to it by sending us news, anecdotes, etc...

FCC-ee / TLEP Organisation

Journal À propos Photos Mentions J'aime Vidéos J'aime déjà Mes

PHOTOS

FCC-ee / TLEP Organisation

28 Jan 2016 : First piece of hardware for the FCC-ee
A prototype for the final focussing quadrupole of the FCC-ee was 3D-printed over Xmas, for tests and measurements. Congratulations to Mike Koratzinos and magnet group for this achievement.

Voir la traduction

223 personnes aiment ça
Cristina Martín et 4 autres amis

Inviter des amis à aimer cette Page

KEEP CALM AND LOVE

Patrick Janot

10th FCC-ee Workshop
4-5 February 2016

Forthcoming FCC week

- **FCC week in Rome (11-15 April 2016)**
 - ◆ Prel. agenda: http://fccw2016.web.cern.ch/fccw2016/FCCWeek2016Agenda_v2.pdf
 - ◆ Register at <http://fccw2016.web.cern.ch/fccw2016/>
 - Hotel room booking urgent !
 - ◆ Send abstracts (by 7 Feb) [with cc: to Alain and myself] about
 - Theory
 - Experimental studies
 - MDI
 - Detectors
 - Software
 - Posters

PS: Poster contest

- ❑ Still a few hours to send your interpretation of the poster illustration



- ◆ Winner(s) will be announced tomorrow

Backup slides

parameter	FCC-ee crab waist (2 IPs)			
	Z	W	H	t
E_{beam} [GeV]	45.5	80	120	175
current [mA]	1450	152	30	6.6
$P_{\text{SR,tot}}$ [MW]	100	100	100	100
no. bunches	90300	5162	770	78
N_b [10^{11}]	0.33	0.6	0.8	1.7
ϵ_x [nm]	0.09	0.27	0.61	1.3
ϵ_y [pm]	1.0	1.0	1.2	2.5
β_x^* [m]	1	1	1	1
β_y^* [mm]	2	2	2	2
σ_y^* [nm]	45	45	51	72
σ_x^* [μm]	9.5	16	25	36

FCC-ee baseline parameters (1)

parameter	FCC-ee crab waist (2 IPs)			
	Z	W	H	t
RF frequency [MHz]	400	400	400	400
RF voltage [GV]	0.08	0.8	3.0	10
energy loss / turn [GeV]	0.03	0.33	1.67	7.55
circumference [km]	100	100	100	100
momentum compaction [10^{-5}]	0.7	0.7	0.7	0.7
synchrotron tune	0.015	0.037	0.056	0.075
$\sigma_{z,SR}$ [mm]	2.70	1.98	2.0	2.1
$\sigma_{z,tot}$ [mm] (w beamstr.)	4.97	3.04	2.4	2.5
$\sigma_{\delta,SR}$ [%]	0.037	0.065	0.10	0.14
$\sigma_{\delta,tot}$ [%] (w beamstr.)	0.068	0.10	0.12	0.17
hourglass factor F_{hg}	0.98	0.95	0.91	0.88

FCC-ee baseline parameters (2)

parameter	FCC-ee crab waist (2 IPs)			
	Z	W	H	t
beam-beam par. ξ_y/IP (2 IPs)	0.05,0.13	0.07,0.16	0.08, 0.14	0.08, 0.12
τ_{beam} [min] (2 IPs) [$\theta=1.6\%$]	>10000	>10000	>10000	4600
τ_{Bhabha} [min] (2 IPs)	247	109	78	63
L/IP [$10^{34} \text{ cm}^{-2}\text{s}^{-1}$] (2 IPs)	68	19	4.9	1.3
L/IP [$10^{34} \text{ cm}^{-2}\text{s}^{-1}$] (2 IPs) (Dmitry Shatilov)	68	21	5.2	1.4

comments: beamstrahlung lifetime not critical ;
at 45.5 and 80 GeV more luminosity with smaller β_y^* ;
dynamic beta and dynamic emittance not taken into account

FCC-ee baseline parameters (3)