Nanobeams will be the basis of the FCC-ee accelerator and its rich physics program. The world's only running nanobeam particle collider is SuperKEKB.

We understand the *current difficult situation and the constraints*, but we would like to move the science forward with a few creative ideas and exciting results about nanobeams at Belle II/SuperKEKB.

The US DOE has recently announced a *moratorium* on R&D for a Belle II upgrade in ~2032. US Belle II groups will follow this guidance and eliminate any activities in this direction.

(T. Browder, University of Hawaii)

SuperKEKB Status in 2026:

World's highest luminosity particle collider,

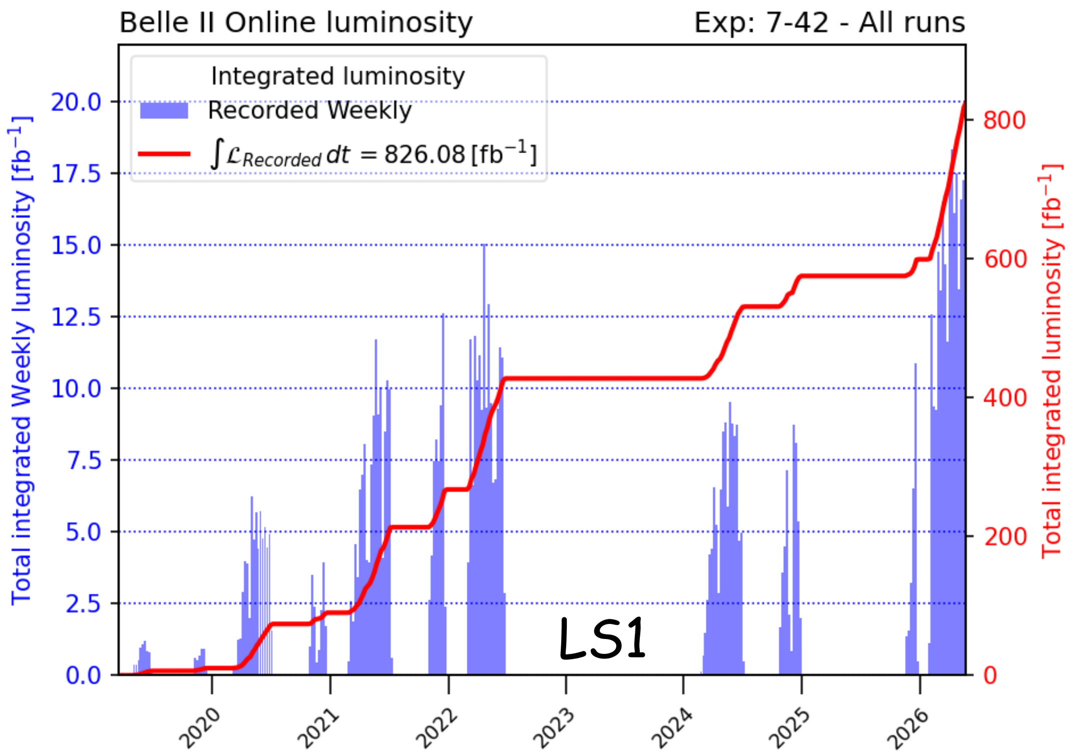
Peak luminosity 5.2 x 10^{34}/cm^2/sec, vertical spot size~200 nm.

SuperKEKB is now operating stably.

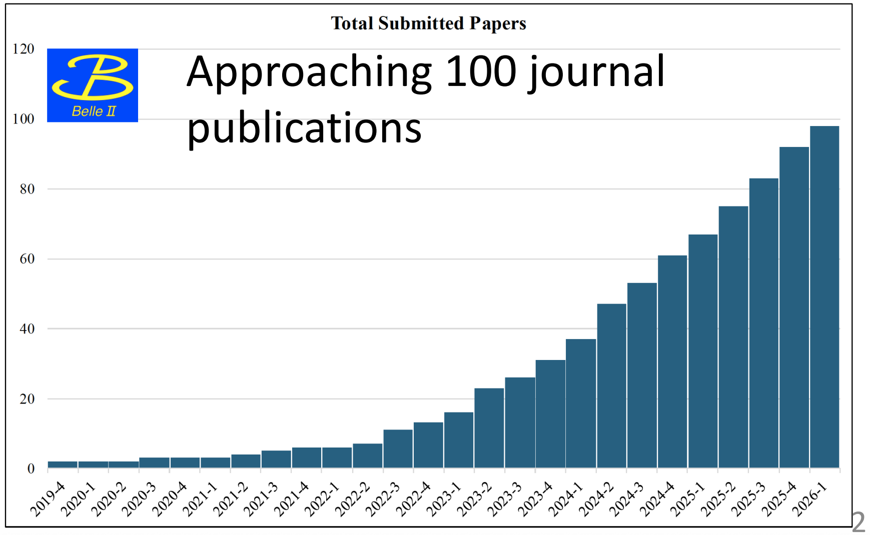
Belle II integrates up to 3.35 fb^{-1}/day, with weekly averages ~17.5 fb^{-1} . As of May 20, integrated 826 fb^{-1} , and on track to integrate ~first inverse attobarn by the end of June.

Fermilab, BNL, and SLAC each contribute to R&D.

US contributions to Belle II include the core operations of iTOP (Cherenkov detector with timing), KLM (muons +KL's), MDI (Machine-Detector Interface), and GRID computing. Detector operations are carried out by U.S. universities while BNL plays a major role in GRID computing and hosts the Belle II conditions database.



> Robust and unique physics output on the P5 theme of "*Quantum Imprints of New Phenomena*" e.g.
> Fundamental Q: Is there BSM physics in $B \to K^{(*)}\nu\bar{\nu}$
> Or Fundamental Q: Is there tau lepton LFV or CPV?



Numerous visible US contributions including current Physics Coordinator, last Publications Committee chair,….

Not bad for a sub-percent component of the OHEP budget

World Nanobeam Status in a few slides that follow

Direct quotes:

Frank Zimmermann, APS Global Physics Summit, Denver, March 2026

summary in a nutshell

SuperKEKB is world's highest luminosity particle collider

so far it has reached a peak luminosity of $5.115 \times 10^{34}\ \mathrm{cm}^{-2}\mathrm{s}^{-1}$

machine stability has improved, and Belle II can now integrate ~3 fb^{-1} /day

SuperKEKB is a unique e^+e^- testbed for FCC-ee, allowing benchmarking and developing new software tools, such as Xsuite, on a real machine

advanced simulations with Xsuite start to reproduce observations, which should enable further luminosity gains

Comments:

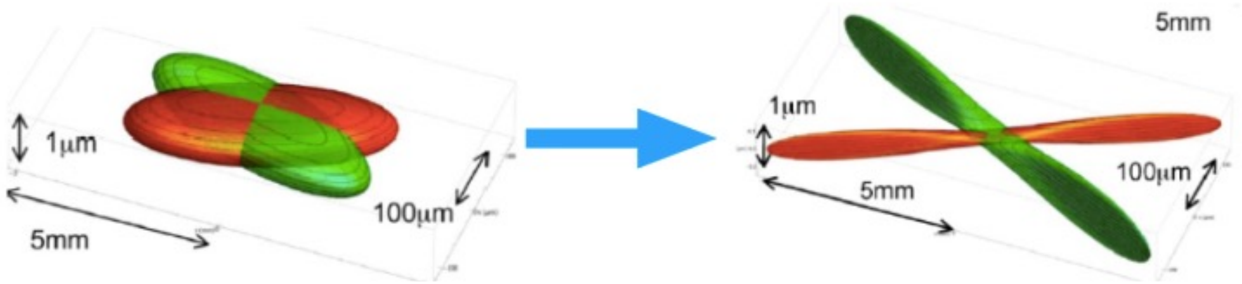
Now 5.2 x $10^{34}/\mathrm{cm}^2/\mathrm{sec}$

Now average 17.5 fb^{-1}/week

Hitoshi Murayama, US-Japan meeting, BNL, April 2026

US involvement in SuperKEKB seems even more important now, both for nano-beams and to develop an $e^+ e^-$ community in the US

Physics News:



To obtain 40X the luminosity of KEKB, reduce vertical beam size to 50 nanometers (O(100 atomic layers) !

The nano-beam scheme and large crossing angle have also (unexpectedly) enabled a new class of Belle II physics analyses; the more focused beam spot removes previous uncertainty regarding where each B meson pair was produced. While at Belle we could only measure B Bbar meson decay time differences (Δt), now we can measure the decay time of each B individually.

Every Upsilon(4S)-> neutral B Bbar decay produces an entangled Einstein-Podolsky-Rosen (EPR) QM state.

Time-dependent CPV for final states *without* charged tracks in the signal B! (e.g. B→π^0 π^0) by using the decay time of the tag B. (We used to think this required huge datasets and photon conversions i.e. $\pi^0 \to e^+e^- \gamma$).

Quantum decoherence studies of B meson entanglement, which depends on individual B meson decay times in the B-Bbar pair.

News I:

China *charges ahead on nanobeams* with a plan for a new tau-charm facility in the Hefei Science City.

https://arxiv.org/pdf/2509.11522

Aims for L~ 1 x 10^{35} in the tau-charm region (N.B. L~Ecm^2)

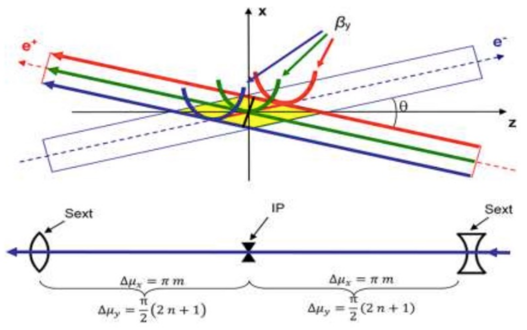


Figure 2.1-1: Illustration of the principle of the crab-waist scheme [3]

Crab Waist at SCTF

Closely Modeled on SuperKEKB

Crossing Angle, 2θ	mrad		60		
L^*	m		0.9		
Relativistic Factor, γ		3913.9	1956.9	2935.4	6849.3
Revolution Period, T_0	μs		2.87		
Revolution Frequency, f_0	kHz		348.47		
Ratio, $\varepsilon_y/\varepsilon_x$		1%	15%	10%	0.5%
Horizontal Emittance (SR/DW, IBS), ε_x	nm	8.79/4.63	2.20/5.42	4.94/3.82	26.9/26.91
Vertical Emittance (SR/DW, IBS), ε_y	pm	87.9/46.3	330/813	494/382	134.5/134.55
β Functions at IP, β_x/β_y	mm		60/0.8		
Beam Size at IP, σ_x/σ_y	μm	16.67/0.19	18.03/0.81	15.14/0.55	40.18/0.33
Betatron Tunes, ν_x/ν_y		30.54/34.58	30.555/34.57		
Momentum Compaction Factor, α_p	10^{-4}	13.49	12.63	13.24	13.73
Energy Spread (SR/DW, IBS), σ_e	10^{-4}	5.72/7.82	2.86/6.18	4.29/6.93	10.01/10.02
Beam Current, I	A	2	1.1	1.7	2

A little beyond the current state of the art at SuperKEKB.

Many advanced technologies required:

Superconducting magnets (CCT magnets) and RF, State of the Art Feedback, Vacuum, ….

Many similar MDI issues in the detector.

News II:

China moves ahead with detector R&D for their spectrometer at their nanobeam particle accelerator.

https://arxiv.org/pdf/2303.15790

Aims for L~ 1 x 10^{35} in the tau-charm region. Runs at up to a 400 kHz trigger rate at the J/psi.

Many advanced technologies required for high-lumi e+ e-: cylindrical MPGDs or μ -RWell gas detectors; CMOS MAPS pixel detectors; DIRC with MPGD photon readout (barrel); RPCs or scintillators for muons; State-of-the-Art ASICs, Streaming readout.
(Annual R&D budget: 25M RMB or $3.7 M)

Gemini output:

Detector R&D for the Super τ-Charm Facility (STCF) in China is a comprehensive, ongoing program focused on developing high-precision, high-rate capable components for an electron-positron collider operating at 2–7 GeV. Key efforts include, but are not limited to, developing advanced trackers, PID (Particle Identification) systems, calorimetry, and muon detectors capable of handling high luminosities ($\geq 0.5 \times 10^{35}$ cm^{-2}s^{-1}) and managing intense radiation backgrounds, aiming to provide a data sample 100 times larger than BESIII. Harvard University +4

Modeled on the current Belle II, but using newer more modern technologies.

(See their CDR for details.)

Q: Is this another "DeepSeek Moment" (or an *old-school "Sputnik Moment"*) for the US?

Backup slides

Hitoshi Murayama, US-Japan meeting, April 2026

The European Strategy for Particle Physics:
2026 Update

Recommendations

by the European Strategy Group

3. The next CERN flagship collider project

A. The electron–positron Future Circular Collider (FCC-ee) is recommended as the preferred option for the next flagship collider at CERN.

The FCC-ee would deliver the world's broadest high-precision particle physics programme, with an outstanding discovery potential through the Higgs, electroweak, flavour and top-quark sectors, as well as advances in quantum chromodynamics (QCD). Its technical feasibility is demonstrated by the comprehensive FCC Feasibility Study, its scope and cost are well defined, plausible funding scenarios have been developed and its schedule enables first beams within five to seven years after the end of HL-LHC operations. The FCC-ee would maintain European leadership in high-energy particle physics, as well as advancing technology and providing significant societal benefits.

The FCC-ee would also pave the way towards a hadron collider reusing the tunnel and much of the infrastructure, providing direct discovery reach well beyond the 10 TeV parton energy scale, in line with the community's ambition for exploration at the highest achievable energy. The overwhelming endorsement of the FCC-ee by the particle physics communities of CERN's Member and Associate Member States further reinforces it as the preferred path.

B. A descoped FCC-ee is the preferred alternative option for the next flagship collider at CERN.

Descoping scenarios include removing the top-quark run, constructing two rather than four interaction regions and experiments and decreasing the radiofrequency (RF) system power. These measures would reduce the construction cost by approximately 15%. Although this would have a significant impact on the breadth of the physics programme and the precision achieved, the descoped FCC-ee would still provide a very strong physics programme and a viable path towards high energies, compared to the alternative collider options. Should additional resources become available, these descoping scenarios would be reversible.

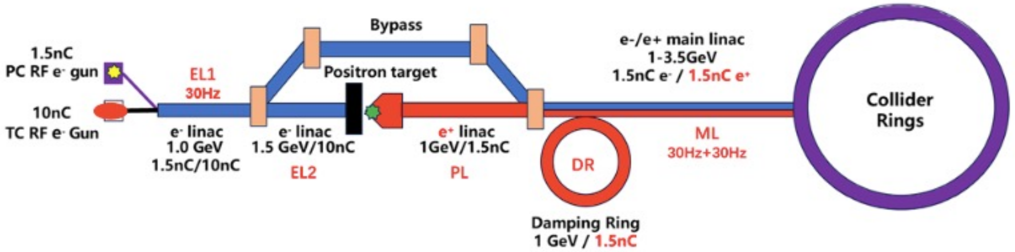
US involvement in SuperKEKB seems even more important now both for nano beam and develop e^+e^- community in the US

FCC-ee aims for L~ 1.4 x 10^{36} /cm^2/sec and 68 ab^{-1}/year at the Z pole

Table 1. The FCC-ee operation model with four interaction points, showing the centre-of-mass energies, design instantaneous luminosities for each IP, and integrated luminosity per year summed over 4 IPs. The last two rows indicate the total integrated luminosity and number of events expected to be produced in the four detectors. The number of WW events includes all $\sqrt{s}$ values from 157GeV up.

Working point	**Z pole**	**WW threshold**	**ZH**	$t\bar{t}$	
$\sqrt{s}$ (GeV)	88, 91, 94	157, 163	240	340–350	365
Lumi/IP (10^{34} cm^{-2} s^{-1})	140	20	7.5	1.8	1.4
Lumi/year (ab^{-1})	68	9.6	3.6	0.83	0.67
Run time (year)	4	2	3	1	4
Integrated lumi. (ab^{-1})	205	19.2	10.8	0.42	2.70
Number of events	6×10^{12} Z	2.4×10^{8} WW	2.2×10^{6} ZH + 65k WW $\rightarrow$ H	2×10^{6} $t\bar{t}$ + 370k ZH + 92k WW $\rightarrow$ H	

Source NIMA 1080 (2025), 170648



AI Overview Gemini

Hefei, the capital of Anhui Province, has transformed into a globally renowned "Science City" and premier hub for high-tech innovation in eastern China. Anchored by the University of Science and Technology of China (USTC) and "Science Island," it leads in quantum technology, artificial intelligence, nuclear fusion energy, and new-energy vehicles. PowerCon 2025 +3

arXiv: 2509.11522v1 [physics.acc-ph] 15 Sep 2025

Conceptual Design Report of Super Tau-Charm Facility: The Accelerator

Jiancong Bao[1], Anton Bogomyagkov[12], Zexin Cao[1], Mingxuan Chang[4], Fangzhou Chen[2], Guanghua Chen[2], Qi Chen[1], Qushan Chen[6], Zhi Chen[1], Kuanjun Fan[6], Hailiang Gong[8], Duan Gu[2], Hao Guo[3], Tengjun Guo[1], Chongchao He[9], Tianlong He[1], Kaiwen Hou[7], Hao Hu[6], Tongning Hu[6], Xiaocheng Hu[1], Dazhang Huang[2], Pengwei Huang[7], Ruixuan Huang[1], Zhicheng Huang[1], Hangzhou Li[1], Renkai Li[7], Sangya Li[1], Weiwei Li[1], Xuan Li[2], Xunfeng Li[5], Yu Liang[1], Chao Liu[1], Tao Liu[1], Xiaoyu Liu[1], Xuyang Liu[10], Yuan Liu[6], Huihui Lv[2], Qing Luo[1], Tao Luo[9], Mikhail Skamarokha[12], Shaohang Ma[1], Wenbin Ma[3], Masahito Hosaka[11], Xuece Miao[9], Yihao Mo[1], Kazuhito Ohmi[11], Jian Pang[1], Guoxi Pei[1], Zhijun Qi[9], Fenglei Shang[1], Lei Shang[1], Caitu Shi[1], Kun Sun[8], Li Sun[1], Jingyu Tang[1*], Anxin Wang[1], Chengzhe Wang[1], Hongjin Wang[1], Lei Wang[4], Qian Wang[1], Shengyuan Wang[1], Shikang Wang[1], Ziyu Wang[1], Shaoqing Wei[3], Yelong Wei[1], Jun Wu[2], Sang Wu[2], Chunjie Xie[1], Ziyu Xiong[1], Xin Xu[1], Jun Yang[6], Penghui Yang[1], Tao Yang[3], Lixin Yin[2], Chen Yu[1], Ze Yu[1], Youjin Yuan[4], Yifeng Zeng[6], Ailin Zhang[1], Haiyan Zhang[1], Jialian Zhang[6], Linhao Zhang[1], Ning Zhang[2], Ruiyang Zhang[8], Xiaoyang Zhang[7], Yihao Zhang[1], Yangcheng Zhao[1], Jingxin Zheng[3], Demin Zhou[11], Hao Zhou[1], Yimei Zhou[2], Zeran Zhou[1], Bing Zhu[6], Xinghao Zhu[1], Zi'an Zhu[1], Ye Zou[1]

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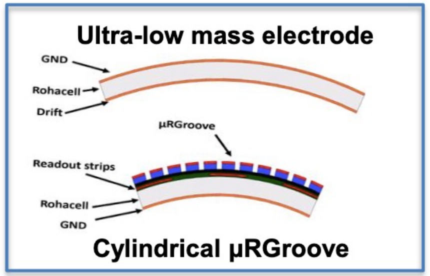
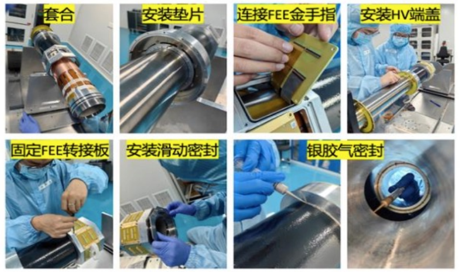
[9] Institute of Advanced Light Source Facilities, Shenzhen, Guangdong, China
[10] Flight Technology Research Institute, Beijing, China, China
[11] High Energy Accelerator Research Organization, Tsukuba, Japan
[12] Budker Institute of Nuclear Physics, Novosibirsk, Russia

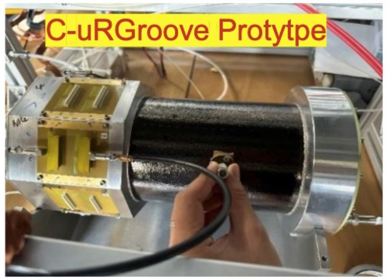
More on STCF Detector R&D

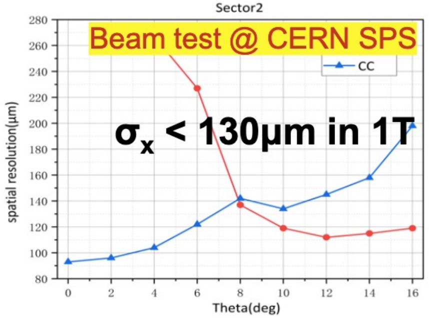
ITK : µRGroove and CMOS MAPS

- **Proposed and developed a novel single-stage MPGD, micro-resistive Groove detector (µRGroove) with larger signals and easier production compared to µRWELL. Developed a low-mass cylindrical µRGroove prototype: material budget ~ 0.23%X0/layer, the best in cylindrical MPGDs.**





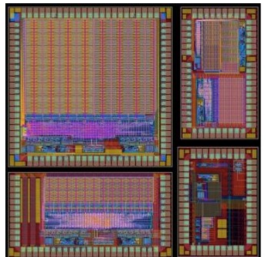




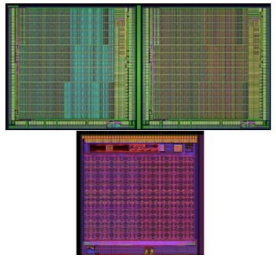
- **Targeting a low-power MAPS with moderate position resolution and both timing and charge measurement capabilities. Exploring strip-like MAPS designs and a super-pixel design**

ASIC Status

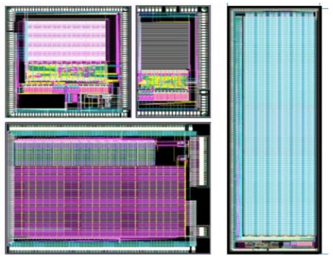
180nm
Chips received, testing underway



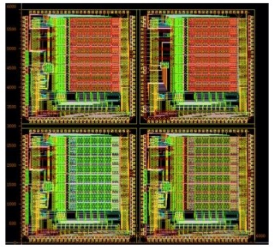
90nm
Chips received, to be tested

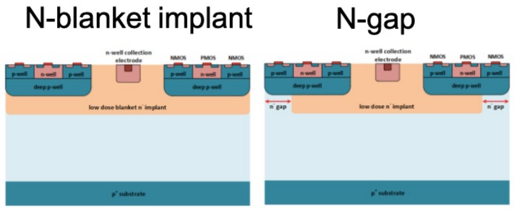


130nm
Chips received, testing underway



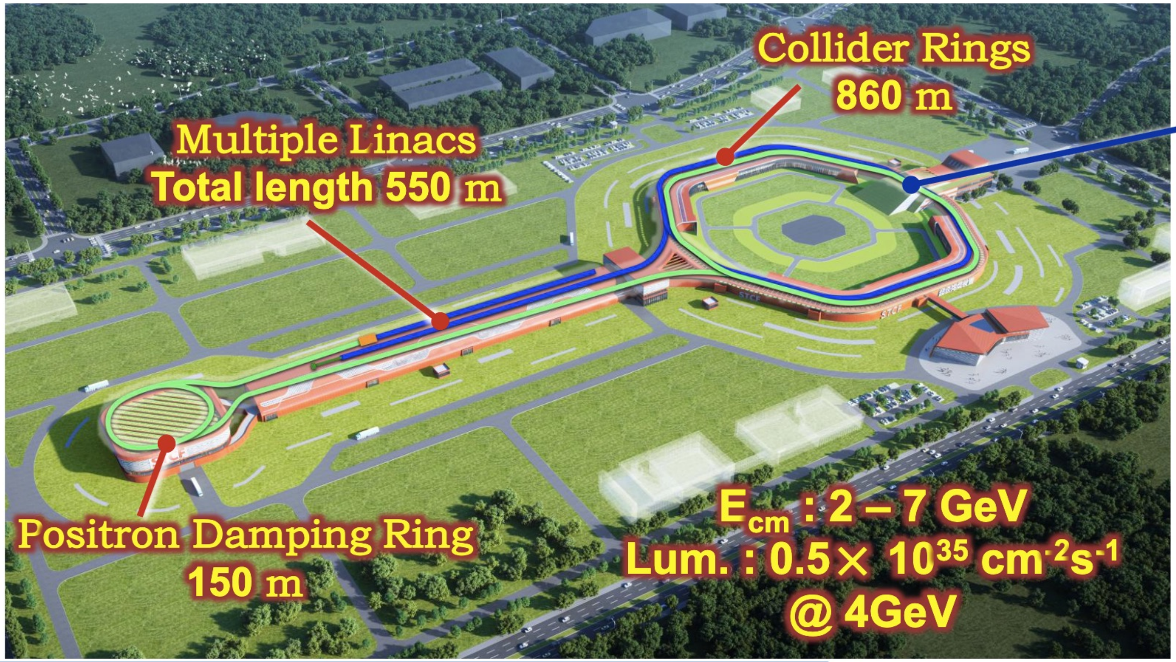
180nm
Supporting quadruple-well with possibility of N-blanket implant and N-gap. Chips received, testing underway

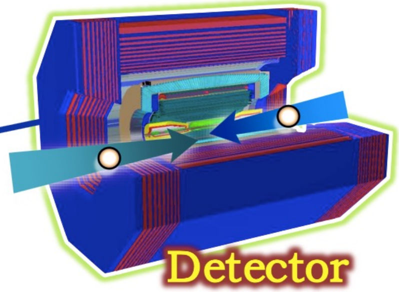


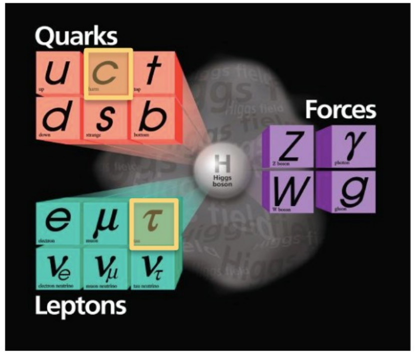


Source: TIPP Conference, Mumbai

STCF in Hefei Science City, China's first nanobeam facility

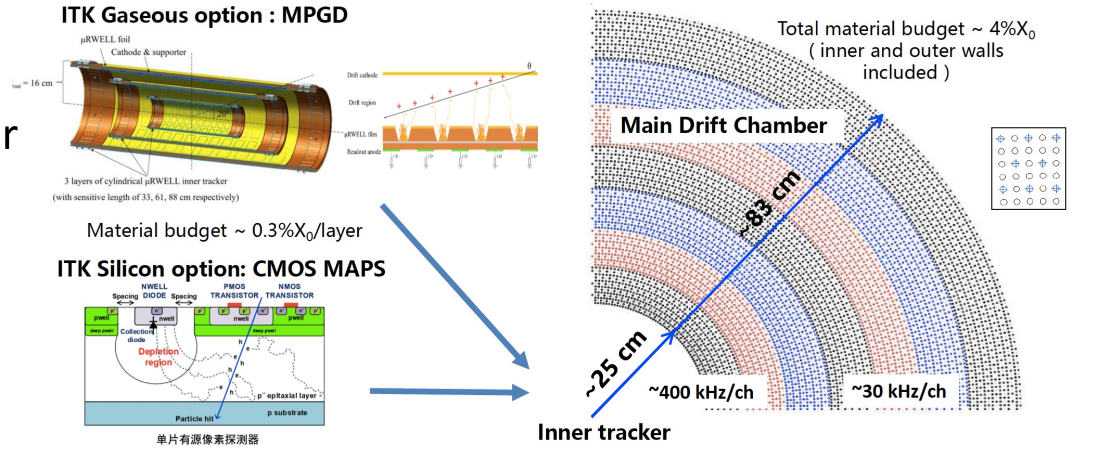






STCF Detector R&D

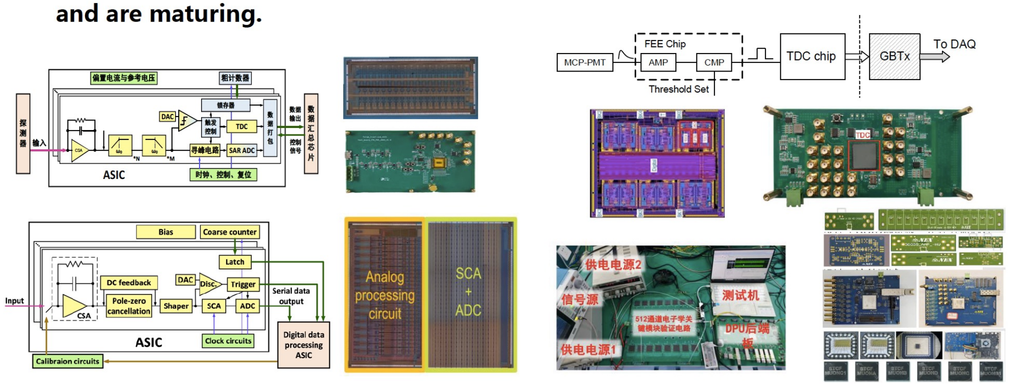
Tracking System : ITK + MDC



Inner-outer separate designs to accommodate different levels of radiation background

Readout Electronics

- Ongoing effort on development of readout ASICs and readout systems for all sub-detectors. Prototype ASIC chips and readout systems have been developed and tested (with detectors). Some ASIC designs have undergone three iterations and are maturing.



Source: TIPP Conference, Mumbai

FAQ on Belle II/SuperKEKB and its upgrade.

Q: What is the planned upgrade, and when does it start?

The upgrade will run in ~2032. The Belle II detector will be upgraded to be more robust to backgrounds (details below). The interaction region will be updated, and the superconducting final focus will be upgraded to allow operation at β_y^* =0.3 mm to reach the target luminosity. Currently, SuperKEKB runs at β_y^* =0.9 mm. Many improvements in MDI (Machine-Detector Interface) and beam monitoring are forseen.

Q: Which Belle II detectors will be upgraded ?

There will be a new vertex detector based on CMOS pixels (groups from Europe), a new CDC (Central Drift Chamber) will be constructed (KEK), which may have an inner timing layer with LGADs. The TOP and KLM readout (US detectors) will be upgraded to handle higher bkg rates/SEUs/ etc. The KLM RPCs will be operated in proportional mode.