# SCTF* Overview

## * Super charm-tau factory

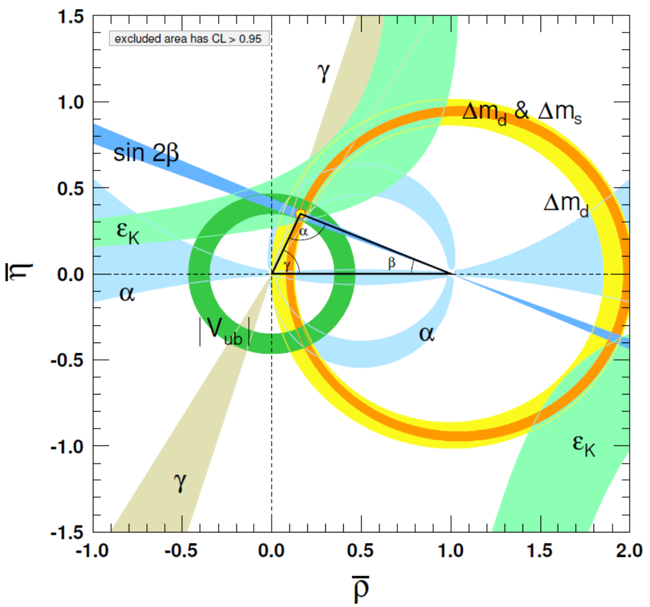
IVAN LOGASHENKO

*BUDKER INSTITUTE OF NUCLEAR PHYSICS (NOVOSIBIRSK, RUSSIA)*

# Flavor physics

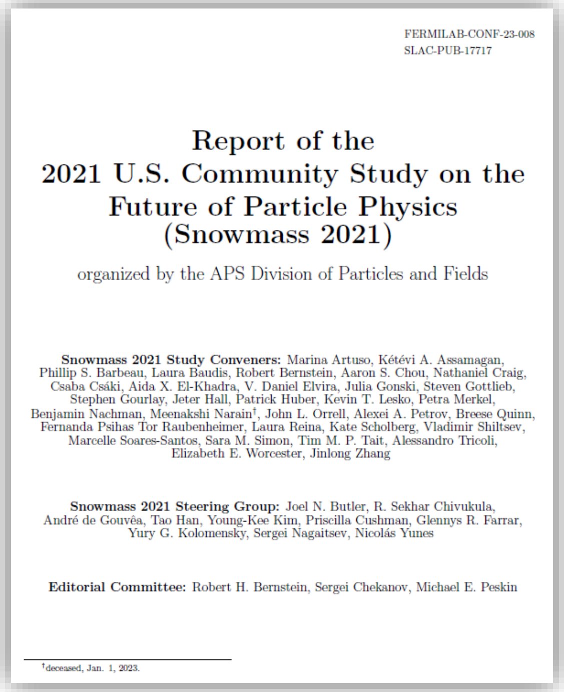
**Flavor physics** – precise measurement of properties of (heavy) leptons and quarks (CP violation, rare decays, CLFV, magnetic moments,…) – one of key directions for understanding SM and searched beyond SM.

Unitarity triangle




Snowmass 2023 Report: HEP science drivers

1. Use the **Higgs Boson** as a Tool for Discovery
2. Pursue the Physics Associated with **Neutrino Mass**
3. Identify the New Physics of **Dark Matter**
4. Understand **Cosmic Acceleration**: Dark Energy and Inflation
5. Explore the Unknown: New Particles, Interactions, and Physical Principles
6. **Flavor physics as a tool for discovery**



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SLAC-PUB-17717

Report of the
2021 U.S. Community Study on the
Future of Particle Physics
(Snowmass 2021)

organized by the APS Division of Particles and Fields

**Snowmass 2021 Study Conveners:** Marina Artuso, Kétévi A. Assamagan, Phillip S. Barbeau, Laura Baudis, Robert Bernstein, Aaron S. Chou, Nathaniel Craig, Csaba Csáki, Aida X. El-Khadra, V. Daniel Elvira, Julia Gonski, Steven Gottlieb, Stephen Gourlay, Jeter Hall, Patrick Huber, Kevin T. Lesko, Petra Merkel, Benjamin Nachman, Meenakshi Narain†, John L. Orrell, Alexei A. Petrov, Breese Quinn, Fernanda Psihas Tor Raubenheimer, Laura Reina, Kate Scholberg, Vladimir Shiltsev, Marcelle Soares-Santos, Sara M. Simon, Tim M. P. Tait, Alessandro Tricoli, Elizabeth E. Worcester, Jinlong Zhang

**Snowmass 2021 Steering Group:** Joel N. Butler, R. Sekhar Chivukula, André de Gouvêa, Tao Han, Young-Kee Kim, Priscilla Cushman, Glennys R. Farrar, Yury G. Kolomensky, Sergei Nagaitsev, Nicolás Yunes

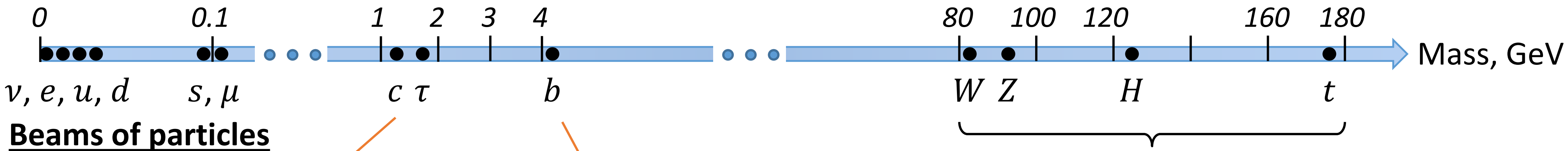
**Editorial Committee:** Robert H. Bernstein, Sergei Chekanov, Michael E. Peskin

†deceased, Jan. 1, 2023.

**Precision is everything: The higher precision, the higher equivalent energies are reached**

# Colliders-Factories

Energy ranges of high luminosity colliders (factories) correspond to production thresholds of known particles.




**Beams of particles**

**cτ-factories**

BEPC-II (China)

*x100 gain in luminosity*

**Super $c\tau$ factory**
SCTF (Russia), STCF (China)

**B-factories**

PEP-II (USA), KEK-B (Japan)

Super KEK-B (Japan)
LHCb (CERN)

**Z- and H-factories**

LEP, LEP-2 (CERN)

FCC-ee (CERN)
CEPC (China)

Ultimate performance (precision) is determined by luminosity and detector quality

# Generations of factories

Today:

LHCb: 5 fb$^{-1}$ —x10-60→ Tomorrow: LHCb: 50/300 fb$^{-1}$ (Run 3/4)

B-factories: 1 ab$^{-1}$ —x50→ Super KEK-B: 50 ab$^{-1}$

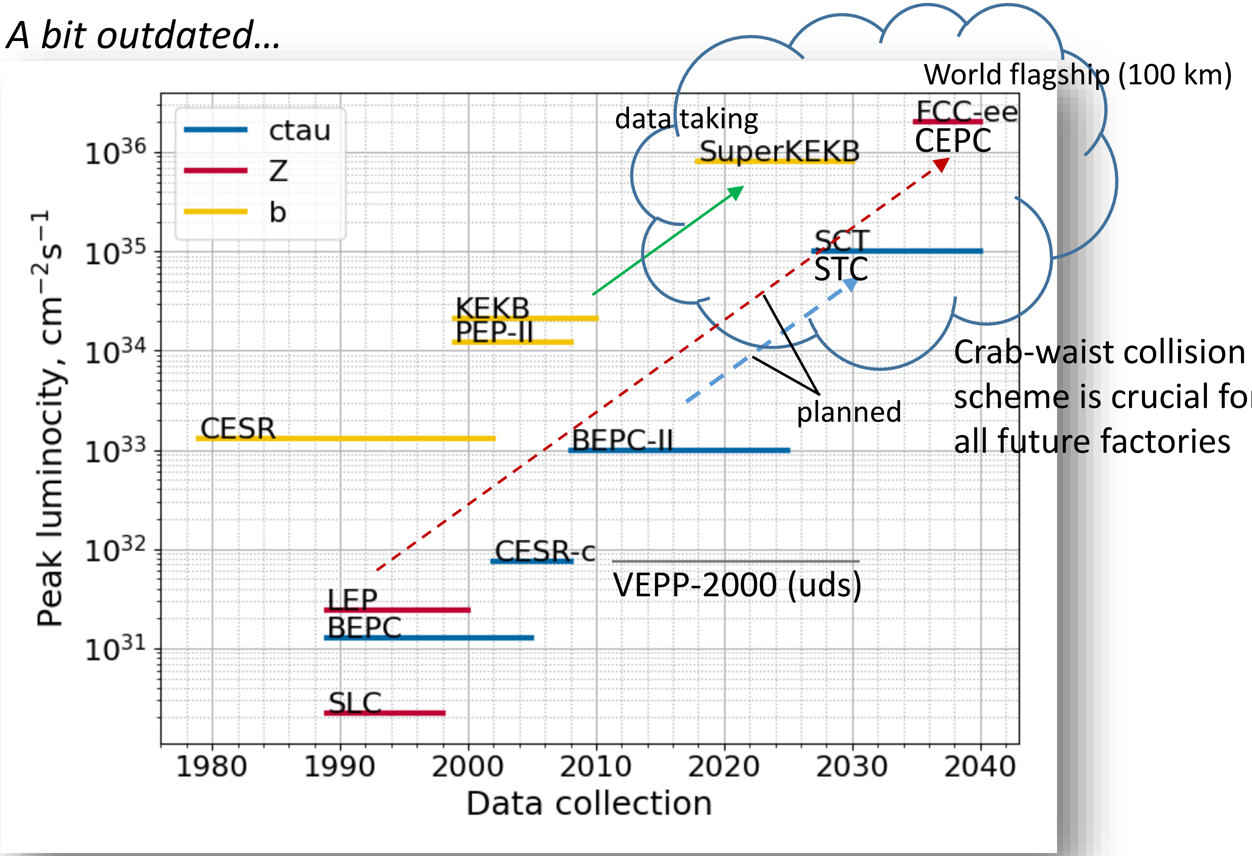
BES-III: ~100 fb$^{-1}$ —x100→ Super c-tau factory: ~10 ab$^{-1}$

- There is delicate balance between existing $c\tau$-factory and $B$-factories (BES-III, BABAR, BELLE, LHCb)
- Need to keep the same balance for the next generation of colliders

Super $c\tau$-factory is the natural element of global HEP strategy

Super factories today and tomorrow

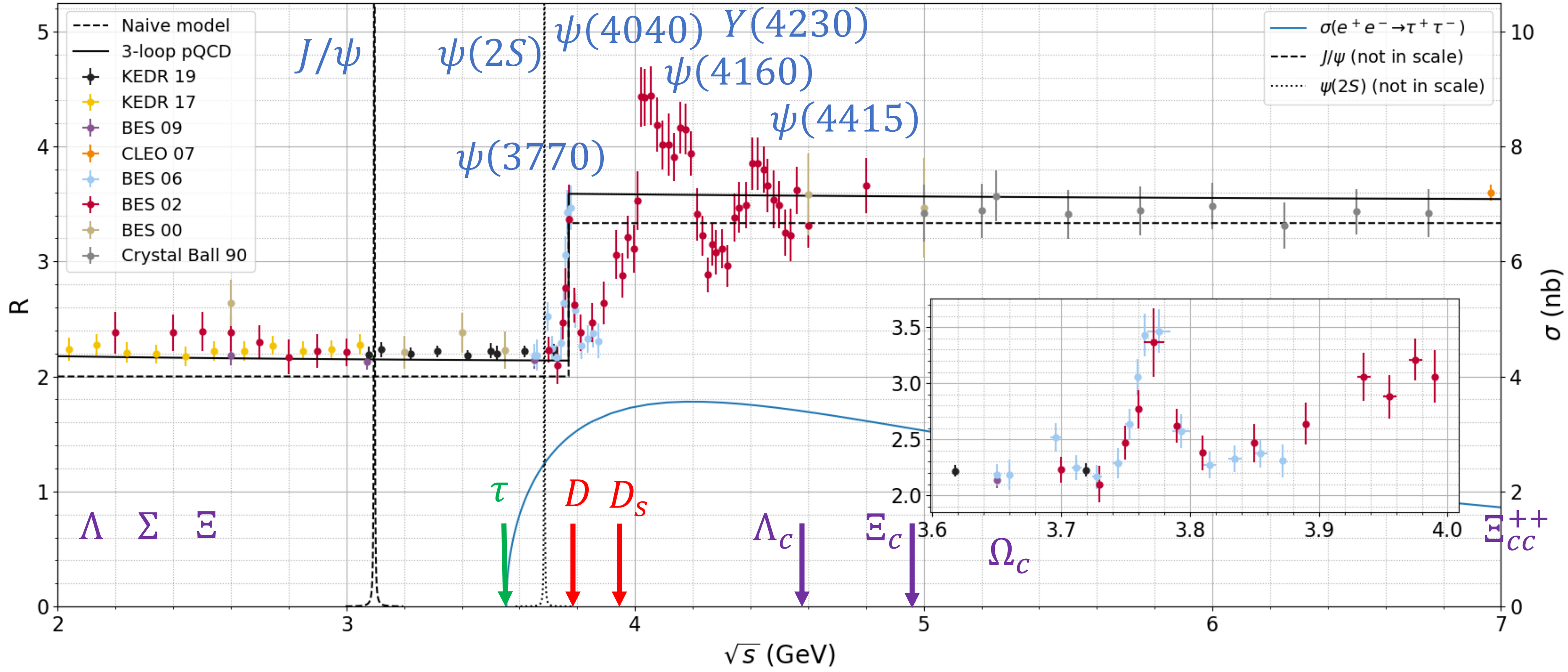
*A bit outdated…*




Crab-waist collision scheme is crucial for all future factories

# Energy range of SCTF

$$R \equiv \frac{\sigma(e^+e^- \to \text{hadrons})}{\sigma_0(e^+e^- \to \mu^+\mu^-)}$$




$\mathcal{L} = 10^{35}\ \text{cm}^{-2}s^{-1}$

A one-year dataset

| $2E$, GeV | Events recorded |
|---|---|
| 3.1 | $10^{12}\,J/\psi$ |
| 3.69 | $10^{11}\,\psi(2S)$ |
| 3.77 | $10^{9}\,D\bar{D}$ |
| 4.17 | $10^{8}\,D_s\bar{D}_s$ |
| 3.55 ÷ 4.3 | $10^{10}\,\tau\,\tau$ |
| 4.65 | $10^{8}\,\Lambda_c^+\Lambda_c^-$ |

Threshold kinematics!

# Key directions of the physics program

- ✓ Measurement of the strong phases of $D$ decay amplitudes
- ✓ Measurement of absolute branching fractions
- ✓ Searches for rare and forbidden decays of the charm quark
- ✓ $CP$ violation in charm
- ✓ …

Input for $B$ meson studies at LHC$b$ and Belle II

charm

QCD

- ✓ Physics of highly-excited quarkonium
- ✓ Molecular states (XYZ)
- ✓ Baryon interaction at threshold
- ✓ Search for glueballs in decays of $J/\psi$ and $\psi(2S)$
- ✓ Searches for rare and forbidden decays of $J/\psi$
- ✓ Measurement of $\sin^2\Theta_W$ at $J/\psi$
- ✓ …

tau

- ✓ Precision measurement of the $\tau$ lepton properties
- ✓ Michel parameters, tests of lepton universality
- ✓ Precision measurement of hadronic $\tau$ decays
- ✓ Search for $CP$ and T violation in $\tau$ decays
- ✓ Searches for rare and forbidden decays of $\tau$

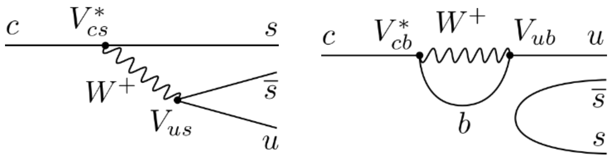
Test of the electroweak sector of the SM

QCD, $\alpha_s$, $V_{us}$. Test of the electroweak model, searches for non-standard contributions

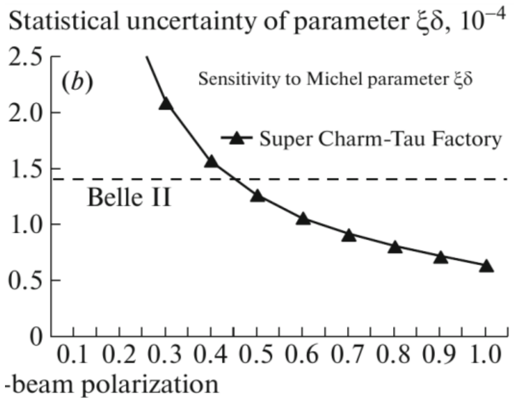
Test of the electroweak sector of the SM

# Some key results expected from SCTF

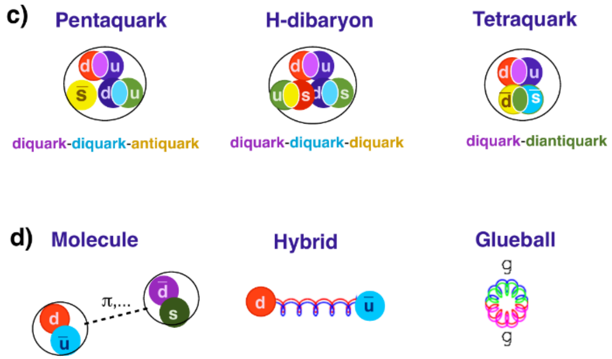
Systematic study of $CP$-violation in decays of $D$-mesons



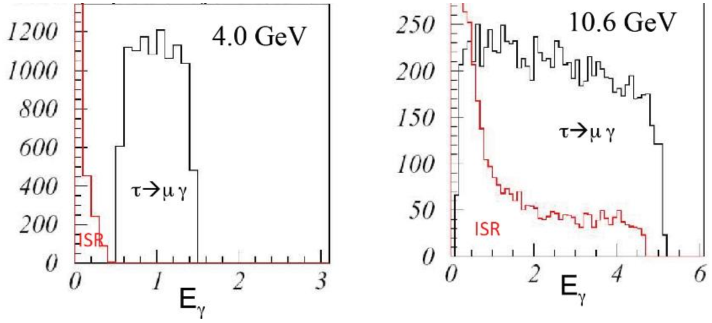

Lorentz-structure of weak currents in $\tau \to l\bar{\nu}\nu$



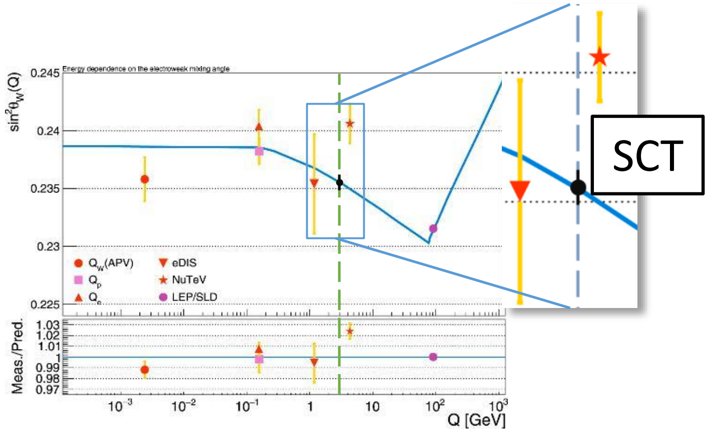

XYZ physics




Search of LFV decay $\tau \to \mu\gamma$



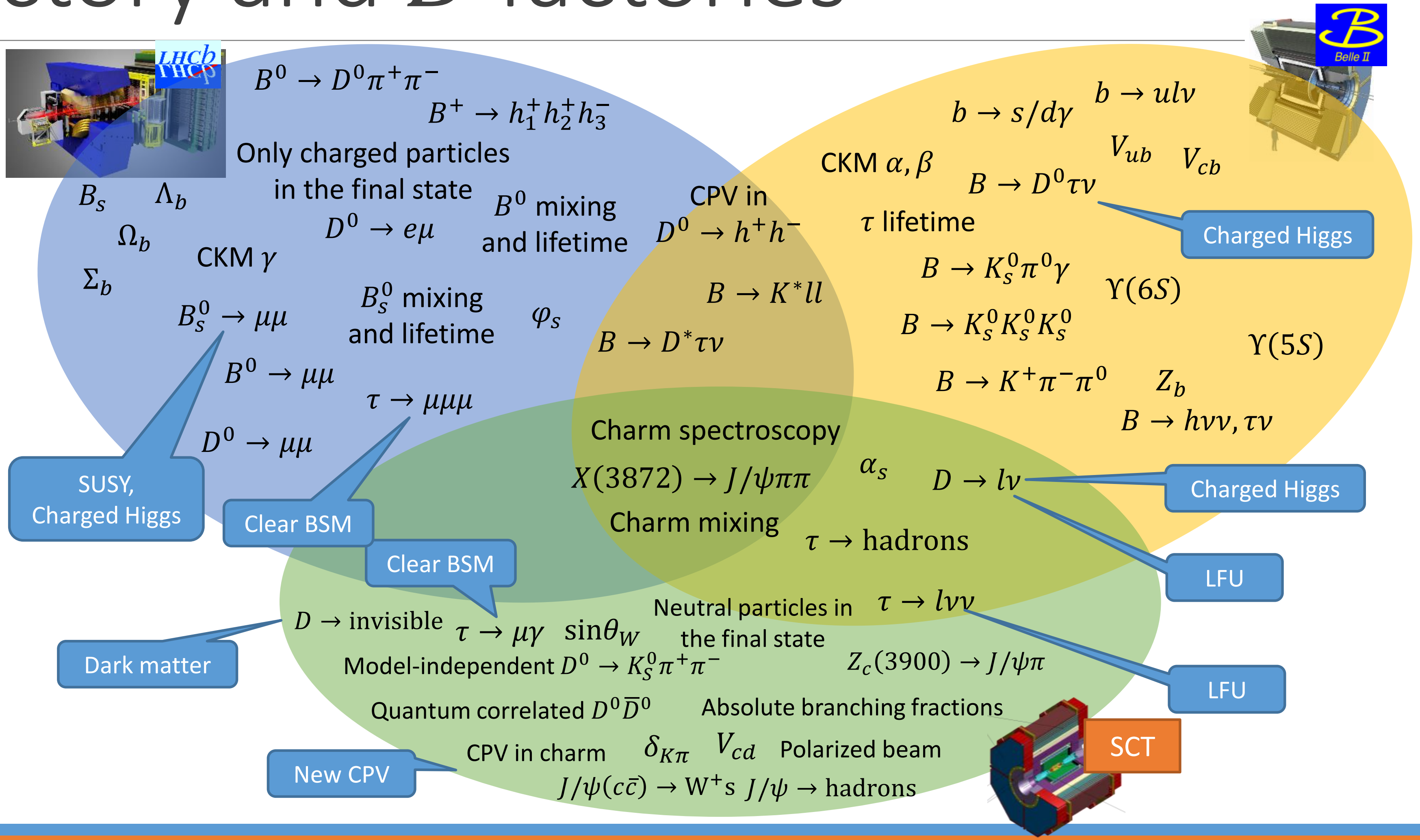

Measurement of $\sin^2 \Theta_W$ at $J/\psi$ energy



# Super $c\tau$ factory and $B$ factories

The experiments at Super charm-tau factory are complement to experiments at Super KEK-B and LHCb, with unique possibilities:

- Threshold production of particles
- Pair production
- Quantum correlations in $D^0\overline{D}^0$ production
- Low multiplicity, full reconstruction of decay chain
- Polarization of electron beam



# Physics program: UFN paper (2024)

**Experiments at the Super Charm-Tau factory**

**M.N. Achasov**[1,2], **V.E. Blinov**[1,2], **A.V. Bobrov**[1,2], **D.A. Bodrov**[3], **A.E. Bondar'**[1,2], **V.S. Vorobiev**[1], **D.S. Gorbunov**[4], **V.P. Druzhinin**[1,2], **D.A. Epifanov**[1,2], **A.S. Kuzmin**[1,2], **I.B. Logashenko**[1,2], **D.V. Matvienko**[1,2], **A.V. Nefediev**[5], **P.N. Pakhlov**[3,5], **G.V. Pakhlova**[5], **V.E. Popov**[6], **T.V. Uglov**[5,*]

[1] *Budker Institute of Nuclear Physics, Siberian Branch of the Russian Academy of Sciences, prosp. Akademika Lavrenteva 11, 630090 Novosibirsk, Russian Federation*
[2] *Novosibirsk State University, ul. Pirogova 2, 630090 Novosibirsk, Russian Federation*
[3] *National Research University Higher School of Economics, ul. Myasnitskaya 20, 101000 Moscow, Russian Federation*
[4] *Institute for Nuclear Research, Russian Academy of Sciences, prosp. 60-letiya Oktyabrya 7a, 117312 Moscow, Russian Federation*
[5] *Lebedev Physical Institute, Russian Academy of Sciences, Leninskii prosp. 53, 119991 Moscow, Russian Federation*
[6] *Tel-Aviv University, Raymond and Beverly Sackler School of Physics and Astronomy, 69978 Tel-Aviv, Israel*
*E-mail:* [*] *timofey.uglov@gmail.com*

The review discusses the physical program of a new experiment at the Super Charm-Tau factory, the basis of which will be a powerful electron-positron collider with a luminosity of $\sim 10^{35}$ cm$^{-2}$ s$^{-1}$ and an energy in the center of mass system in the range from 3 to 5 GeV. A modern detector located around the beam collision point will provide a new level of measurement accuracy. The longitudinal polarization of the electron beam, along with record luminosity, will allow the unique experiment to successfully compete with the existing Super B-factories Belle II and LHC*b*. The extensive physical program includes the study of the properties and measurement of physical parameters of charmed hadrons, the τ-lepton, the charmonium, and exotic states, as well as the study of the production of light hadrons in $e^+e^-$-annihilation and in two-photon processes. In addition to testing the Standard Model and precisely measuring its parameters, a comprehensive search for New Physics beyond its boundaries is planned.

**Keywords:** $e^+e^-$-collider, polarized beams, quantum chromodynamics, τ-lepton, physics of charmed hadrons, New Physics

PACS numbers: **12.38.–t, 12.60.–i,** 29.20.db

Bibliography — 199 references
*Uspekhi Fizicheskikh Nauk* **194** (1) 60–76 (2024)
DOI: https://doi.org/10.3367/UFNr.2023.10.039583

*Received 11 April 2023, revised 22 October 2023*
*Physics – Uspekhi* **67** (1) (2024)
DOI: https://doi.org/10.3367/UFNe.2023.10.039583

A review of the SCTF physics program has just been published in the Russian top physics journal "Physics-Uspekhi."

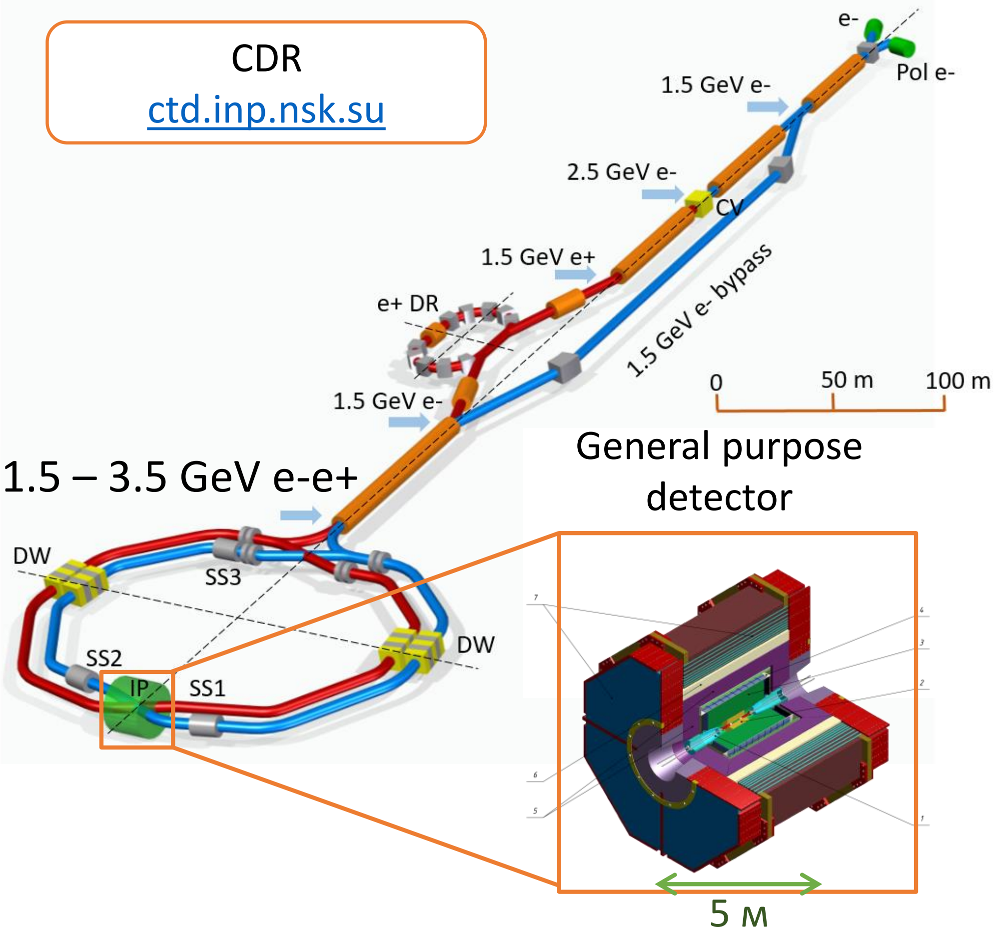
Feasibility studies with realistic detectors and background descriptions are crucial to the further development of a physics program.

https://doi.org/10.3367/UFNe.2023.10.039583

# Super charm-tau factory

- Super charm-tau factory is $e^+e^-$ collider, dedicated to precision study of properties of charm-quark, tau-lepton, study of strong interactions, search of BSM physics
  - Beam energy from 1.5 to 3.5 GeV
  - Luminosity $\mathcal{L} = 10^{35}\ cm^{-2}c^{-1}$ @ 2.5 GeV
  - Longitudinally polarized electron beam
- Experiments will be conducted using state-of-the-art general purpose detector
  - Tracking (including low $p_t$)
  - Calorimetry (high resolution, fast, $\pi^0/\gamma$ sep.)
  - Particle ID ($\mu/\pi/K/p$ up to 1.5 GeV/c)

CDR
[ctd.inp.nsk.su](ctd.inp.nsk.su)



# Detector at SCTF

Momentum resolution $\sigma_p/p \leq 0.4\%$ at 1 GeV

Very symmetric and hermetic

Able to detect soft tracks ($p_t \geq 50\ MeV/c$)
- Inner tracker should be able to handle $10^4$ tracks/cm$^2$s

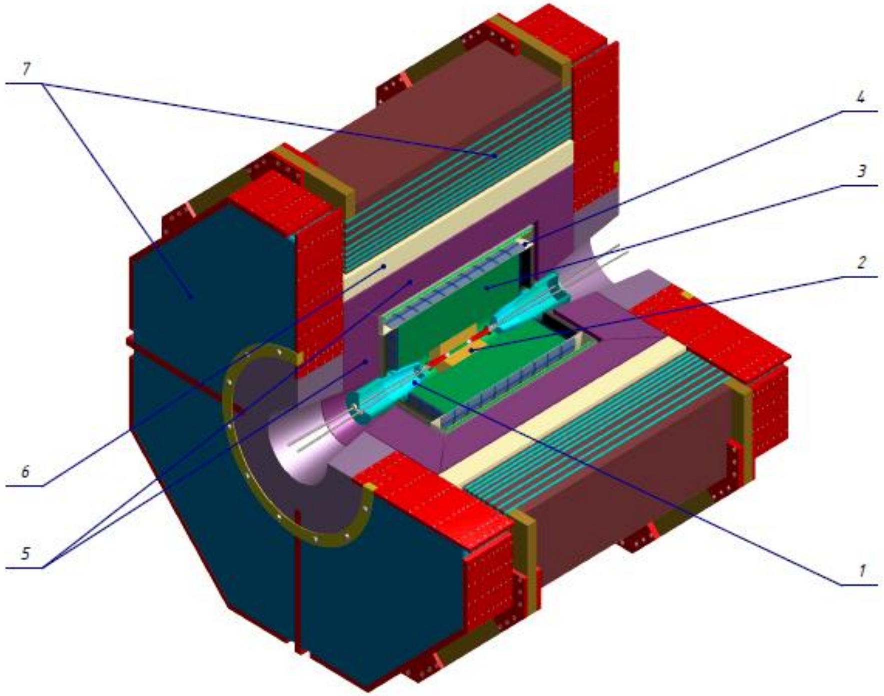
Very good particle identification: $e/\mu/\pi/K$
- $\pi/K$ in the whole energy range, e.g. for $D\overline{D}$ mixing
- $\mu/\pi$ up to 1.5 GeV, e.g. for $\tau \to \mu\gamma$ search
- $dE/dx$ better than 7%

Able to detect $\gamma$ from 10 MeV to 3 GeV, good $\pi^0/\gamma$ separation
- Calorimeter energy resolution $\sigma_E/E \leq 1.8\%$ at 1 GeV
- Calorimeter time resolution $\sigma_t \leq 1$ ns

Efficient "soft" trigger

Ability to operate at high luminosity, up to 300 kHz at $J/\psi$

1. Vacuum pipe
2. Inner tracker
3. Drift chamber
4. PID
5. Calorimeter
6. SC magnet
7. Muon system




5.6 x 5.6 x 5.3 m$^3$

# Brief history of $c\tau$-factories

1993, Dubna JINR ($E_{cm} = 2\ \text{GeV}, L = 9.4 \times 10^{32}\ \text{cm}^{-2}\text{s}^{-1}$)

1994, Argonne National Laboratory ($E_{cm} = 3 - 5\ \text{GeV}$,
$L = 10^{33}\ \text{cm}^{-2}\text{s}^{-1}$)

1995, BINP (VEPP-5), round beams ($E_{cm} = 2 - 4.2\ \text{GeV}$,
$L = 10^{33}\ \text{cm}^{-2}\text{s}^{-1}$)

1996, Spain & France ($E_{cm} = 4\ \text{GeV}, L = 10^{33}\ \text{cm}^{-2}\text{s}^{-1}$)

**1997, Beijing IHEP ($\boldsymbol{E_{cm} = 2.0 - 4.2\ \text{GeV}, L = 10^{33}\ \text{cm}^{-2}\text{s}^{-1}}$)**

The only one running

2006: Crab waist collision scheme (P.Raimondi):

$$10^{33} \to 10^{35}$$


VEPP-5 CDR

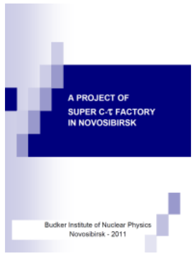
# History of SCTF project

~1995
Several proposals for $c\tau$ colliders: BINP, JINR, ANL, IHEP,…
$L = 10^{33} - 10^{34}$
The only running is: BEPC-II

2006
Crab-waist invented
Potential x10-100 increase in luminosity

2009
First version of SCTF proposal

2011
CDR published
SCTF selected as one of six mega-science projects to be built in Russia




2017
IAC established.
Regular international meetings started

2020
CREMLINplus started
Collaboration with EU institutions

2021
NCPM (National Center of Physics and Mathematics) is established in Sarov.
SCTF is considered as key facility

2022
CREMLINplus terminated

2024
NCPM switched to Compton gamma source as key facility.
SCTF is considered as possible future project.

# R&D program

At the moment there is no clear path and timeline for SCTF approval for construction.

The project is supported by collaboration of Russian institutions, under BINP leadership, with partial support from NCPM

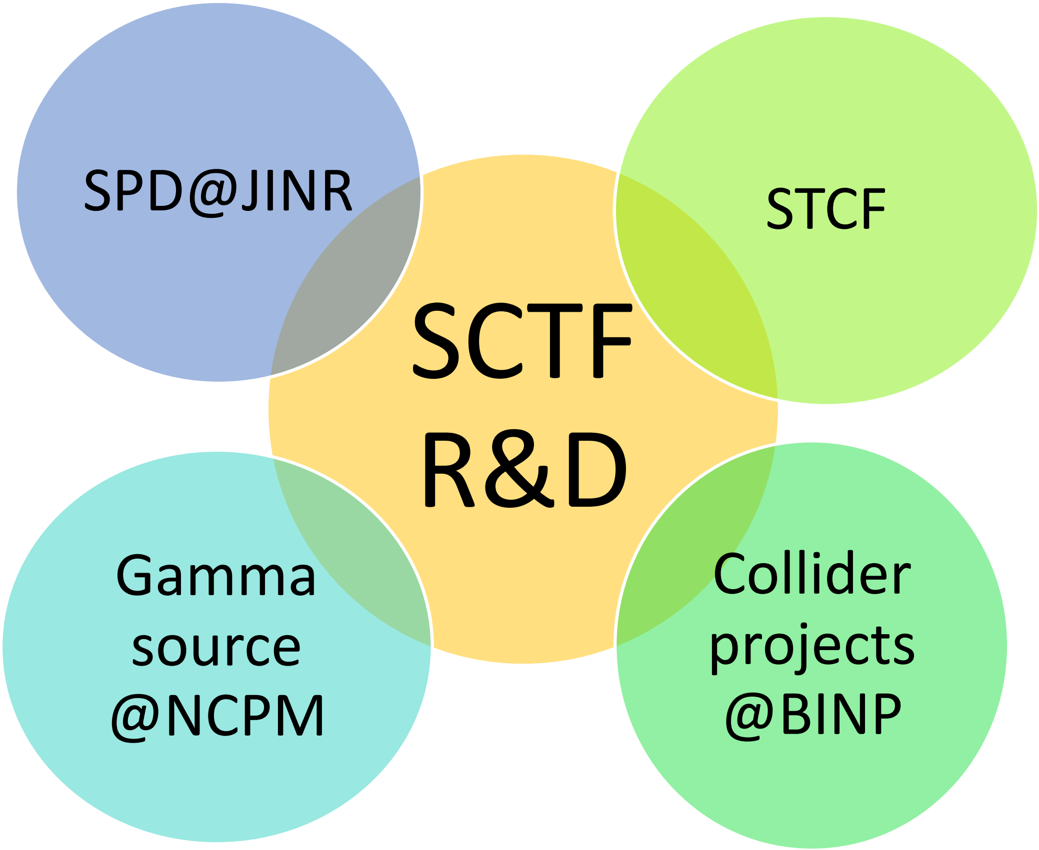
We are focusing on some key R&D studies

1. Collider studies
   - Simulations (design and ultimate luminosity)
   - R&D for final focus
   - R&D for electron source/linac (synergy with Compton source)
2. Detector studies
   - Inner tracker
   - Drift chamber
   - PID
   - Calorimeter
   - Magnet
3. Simulations and feasibility studies

# Synergy between SCTF R&D and other projects

Detector technologies
(FARICH, magnet)
Software

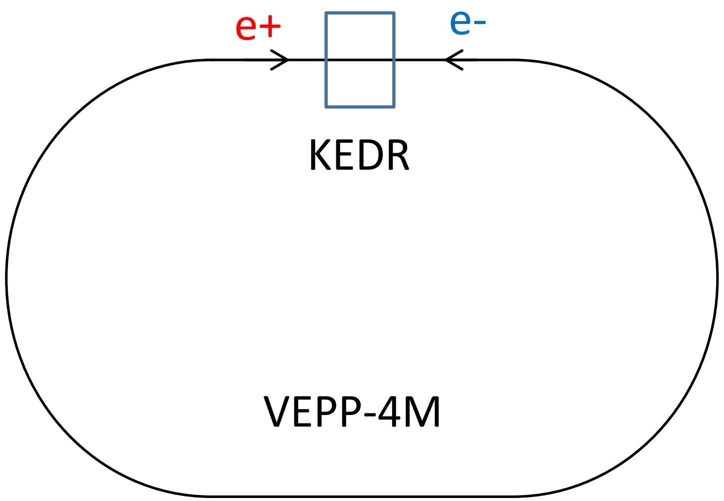
Projects are deeply related

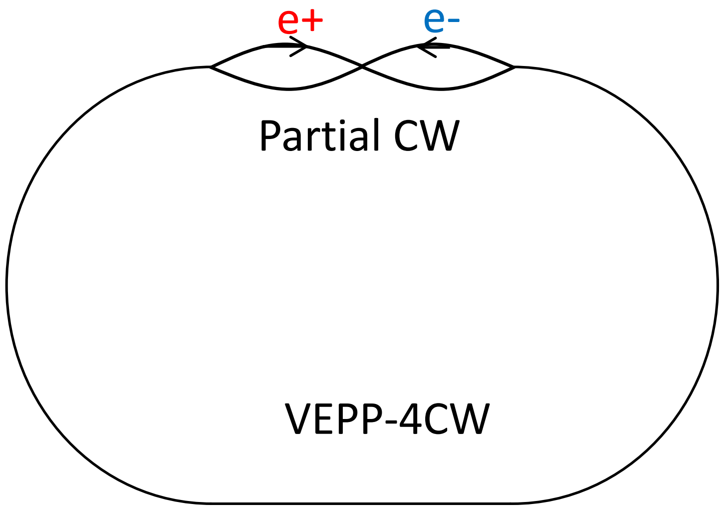


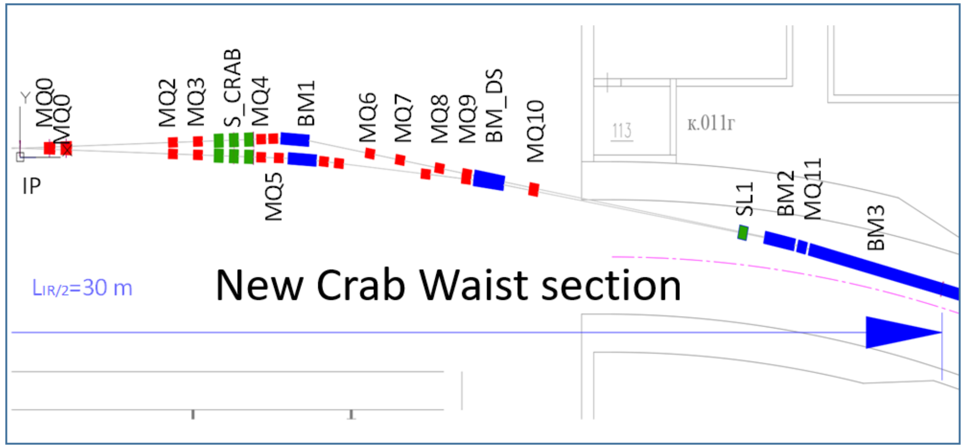

Linac development
Common infrastructure

CW studies
Detector technologies
Software

# Under consideration: CW at VEPP-4M




There is proposal to make a test of CW at VEPP-4M

What can be tested: final focus elements, nonlinear beam dynamics, beam-beam effects, backgrounds,…

Under discussion

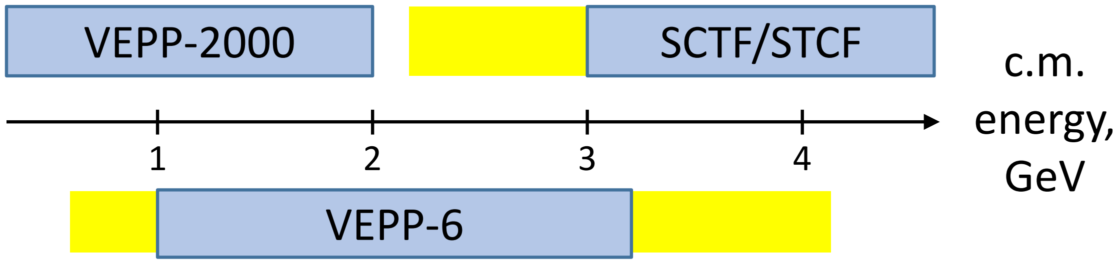
VEPP-4M straight section is modified.
Electrostatic separation of colliding beams.

Beneficial for all future collider projects

# Under consideration: future collider at BINP ("VEPP-6")

- $e^+e^-$ collider
  - Beam energy from <0.5 to 1.6 GeV ($J/\psi$) (2.0 GeV)
  - Luminosity $\mathcal{L} \approx 10^{34}\ cm^{-2}c^{-1}$ @ 1.6 GeV
- General purpose detector
  - Tracking
  - Calorimetry
  - Particle ID
- Physics
  - $J/\psi$ decays, light hadrons
  - Baryon thresholds
  - Measurement of R
  - … Complementary to SCTF

500 МэВ: 1÷3·$10^{32}\ cm^{-2}c^{-1}$
$\approx$ 1 · DAPHNE
1000 МэВ: 1÷2·$10^{33}\ cm^{-2}c^{-1}$
$\approx$ 10 · VEPP-2000
1550 МэВ: 0.5÷1·$10^{34}\ cm^{-2}c^{-1}$
$\approx$ 30 · BEPCII

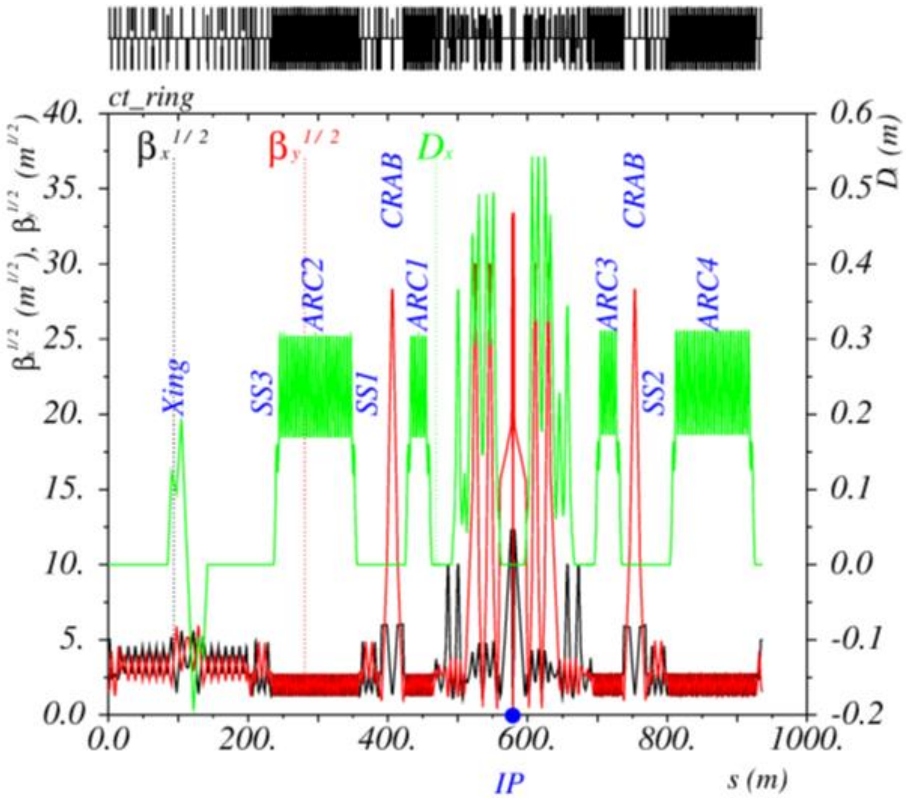


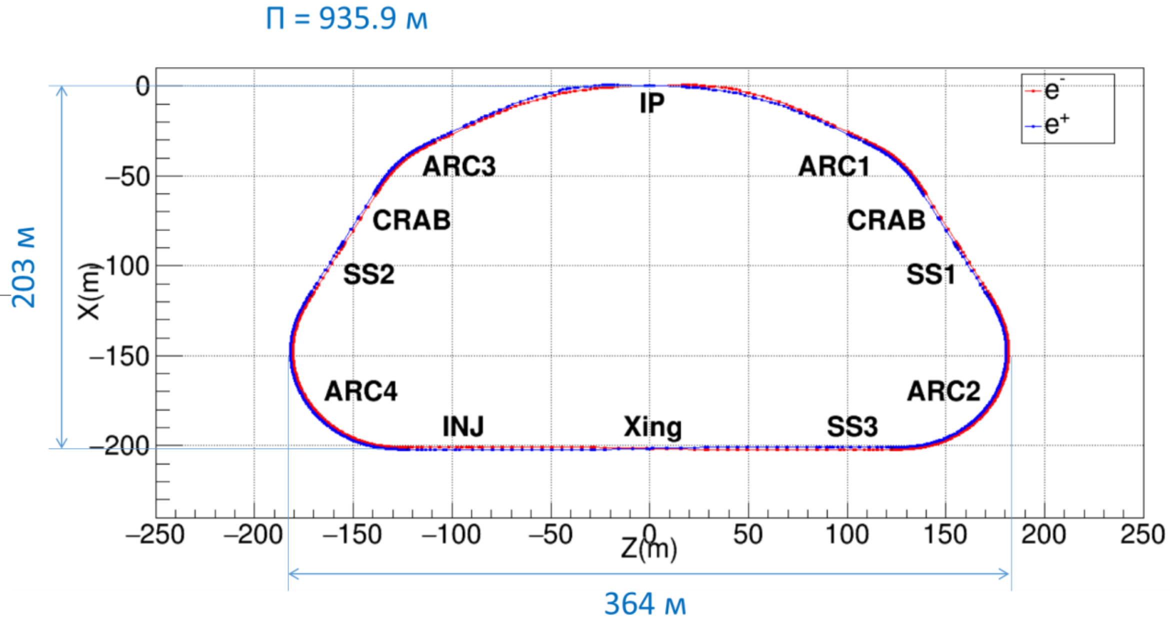

Full-scale test of Crab-waist final focus!
Under discussion

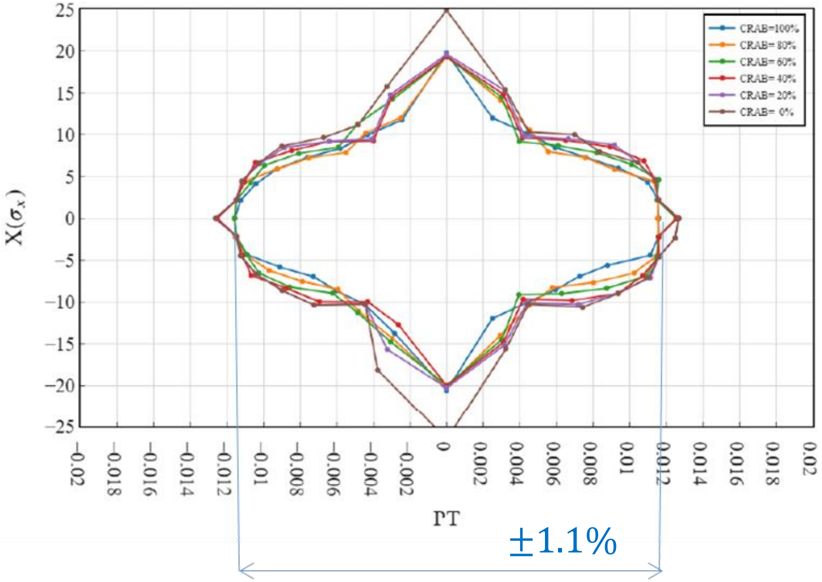
# Collider studies

Understanding limitations and ways to bypass them

*Talks by A.Bogomyagkov, M.Skamaroha and E.Bedarev*




Dynamic aperture

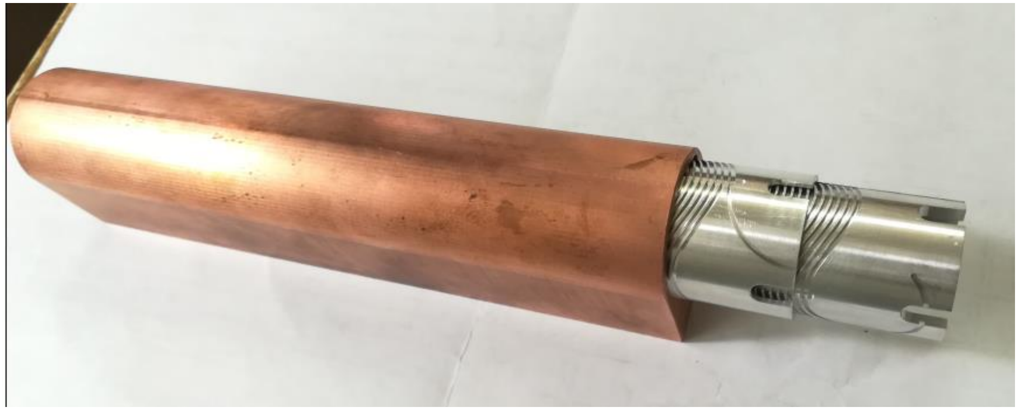
# Collider parameters

| $E$, GeV | 1.5 | 2.0 | 2.5 | 3.0 | 3.5 |
|---|---|---|---|---|---|
| $\Pi$, m | 935.874 | | | | |
| $2\theta$, mrad | 60 | | | | |
| $\beta_x^*/\beta_y^*$, cm | 10/0.1 | | | | |
| $Q_x/Q_y$ | 30.545/29.61 | | | | |
| $C_x/C_y$ | −64/−328 | | | | |
| $\alpha \times 10^3$ | 1.35 | | | | |
| $I$, A $/N_b$ | 2.9/941 | 1.64/983 | 2.5/983 | 2.7/983 | 2.9/974 |
| $N_p \times 10^{-10}$ | 6 | 3.25 | 5 | 5.3 | 5.8 |
| $\varepsilon_y/\varepsilon_x$ (%) | 10 | 0.5 | 0.5 | 0.5 | 0.5 |
| $\varepsilon_x(SR/IBS+WG)$, nm | 2/2.9 | 3.5/3.5 | 5.5/3.2 | 7.9/4.1 | 10.7/5.7 |
| $\sigma_e \times 10^3(SR/IBS+WG)$ | 0.3/0.9 | 0.4/1.1 | 0.45/1.2 | 0.5/1.2 | 0.6/1.3 |
| $\sigma_s$, mm | 17 | 15 | 14 | 14 | 14 |
| $\xi_x/\xi_y$ | 0.003/0.03 | 0.002/0.06 | 0.002/0.08 | 0.002/0.065 | 0.002/0.053 |
| $\nu_s/\xi_x$ | 3 | 8 | 6.8 | 8 | 8 |
| $\tau_x/\tau_y/\tau_e$, ms | 102/102/51 | 43/43/22 | 31/31/15 | 23/23/11 | 17/17/9 |
| $\mathcal{L} \times 10^{-35}$, cm$^{-2}$s$^{-1}$ | 0.29 | 0.4 | 1 | 1 | 1 |
| $T_t$, s | 304 | 304 | 302 | 560 | 1100 |

Limited by beams lifetime >300 s

# Prototypes FF quadrupoles

~~*Talk by N.Mezensev*~~



**Concept design of SC FF lens**
Direct Double Helical (DDH) technology
*2 concentric coil at 2 cylinders*

The FF design is critical to reach design luminosity

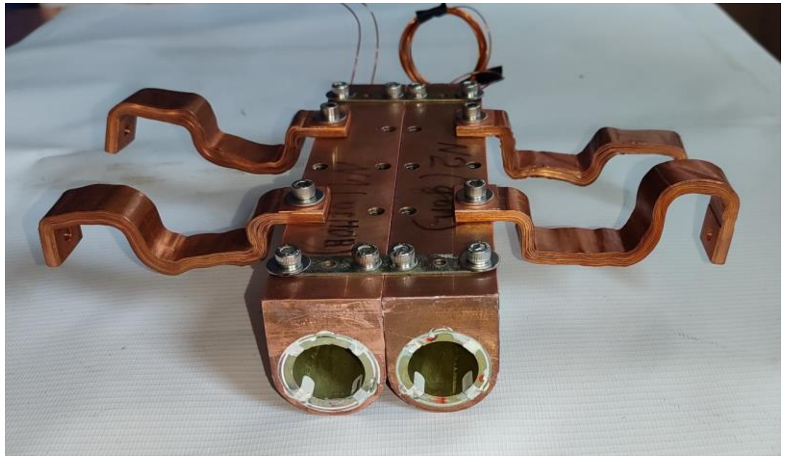
We are working on prototyping and testing the key elements of FF

FF SC quadrupole lenses were designed and built.

Single quadrupole tests done, **40 T/m gradient achieved**!

Fringe fields measured, their effect is studied with simulations

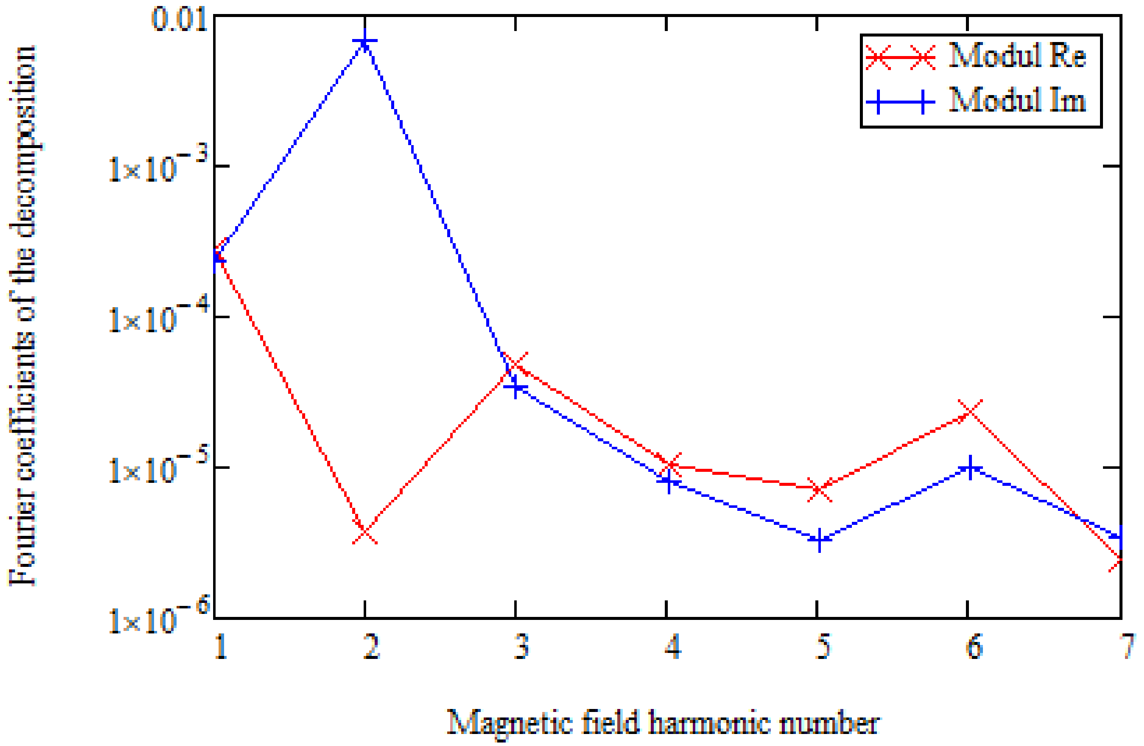
Double quadrupoles tests are ongoing



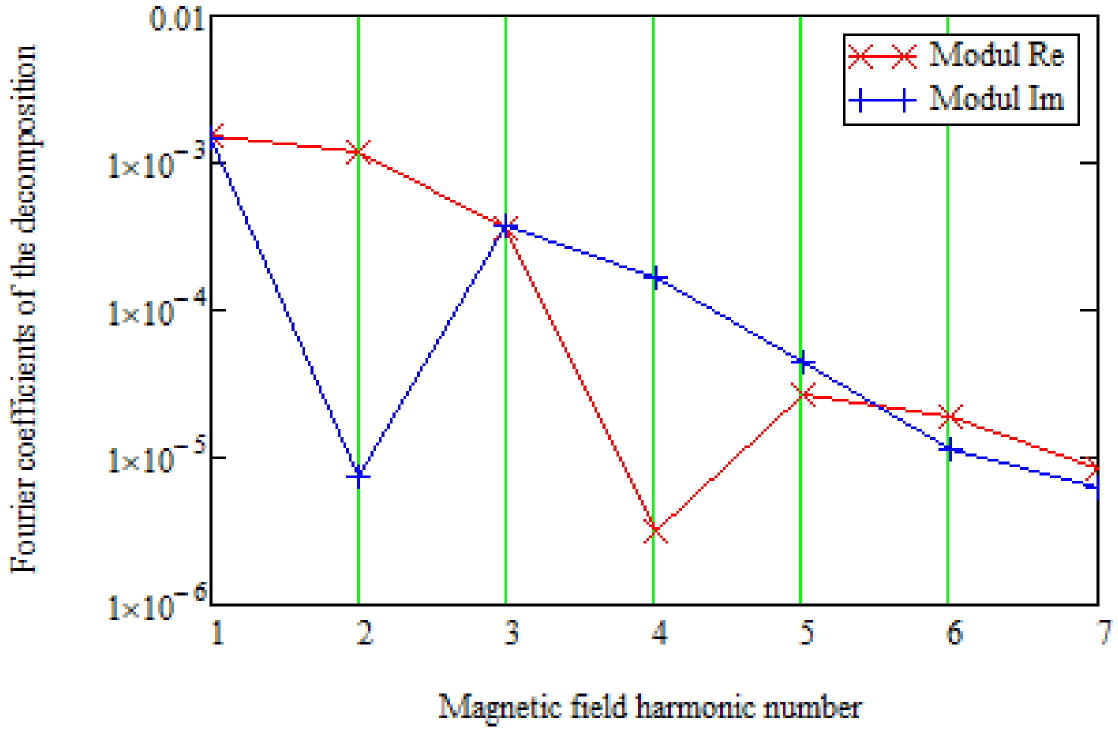
# Cold testing of CCT quadrupole in indirect cooling cryostat

- "Cold" tests of the CCT lens prototype were carried out in a "dry" cryostat with indirect cooling with cryocoolers through copper heat conductors in a vacuum.
- The maximum current in the cryostat of 1600 A is provided by 4 Danfysik power supplies of 400 A each.
- First step: only one lens is powered.

Harmonics of the magnetic field in a quadrupole with the current turned on

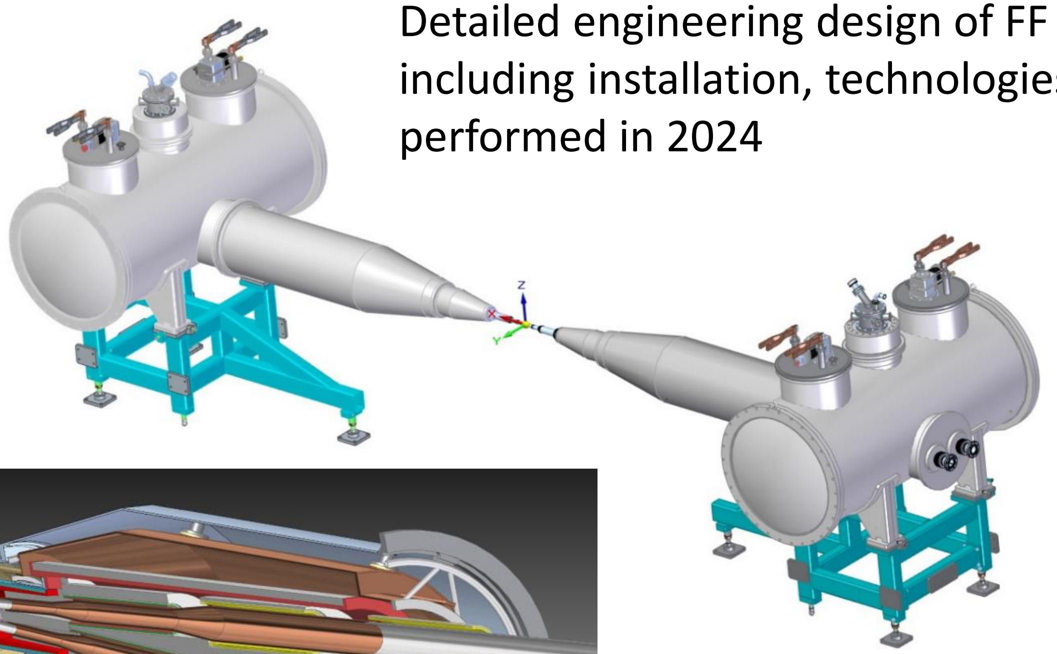


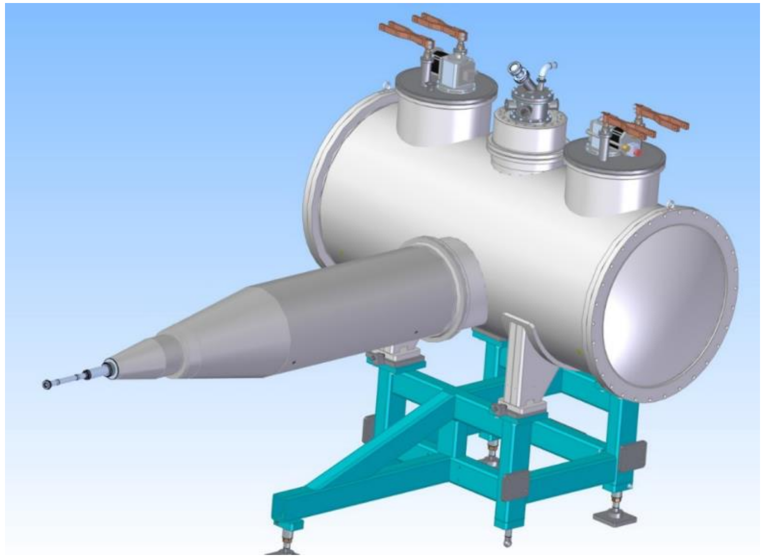

Harmonics of the magnetic field in a neighboring quadrupole in which there is no current

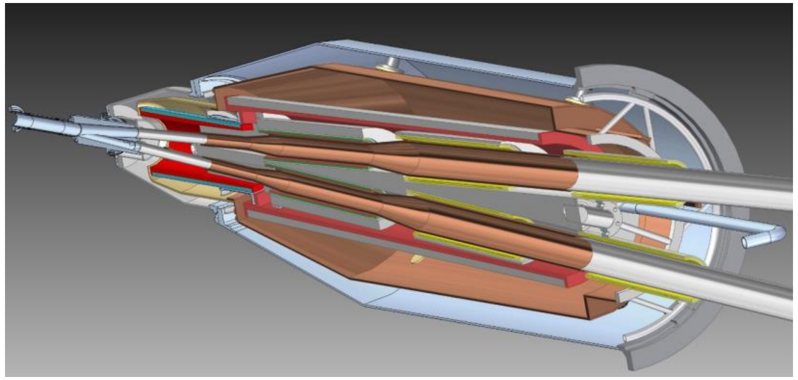


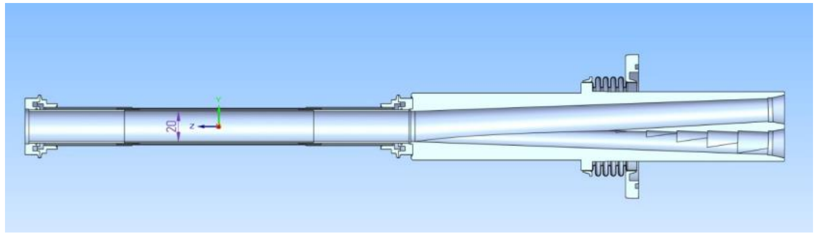
# Design of cryo system for FF

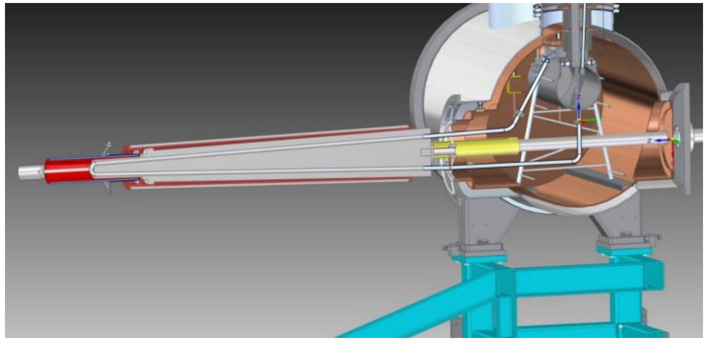
Detailed engineering design of FF cryo system, including installation, technologies etc., performed in 2024







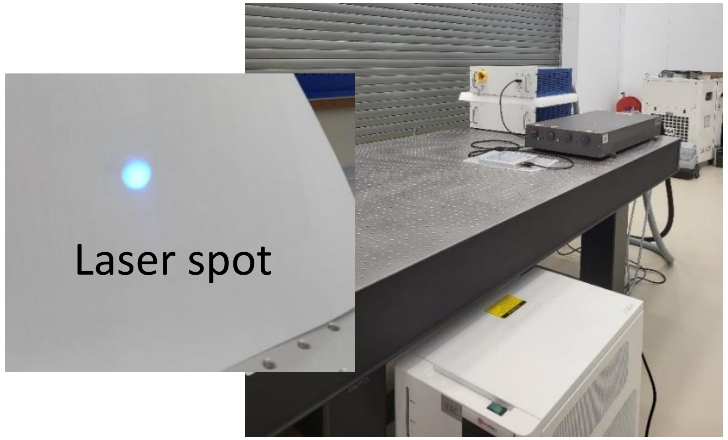




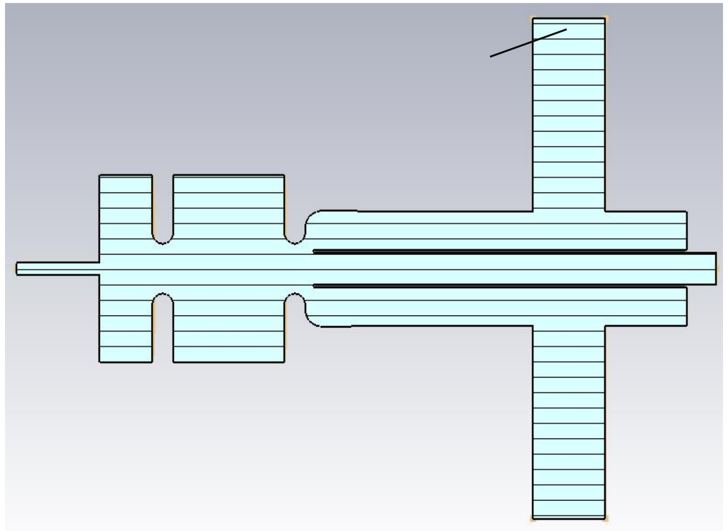
# RF electron gun studies

| | |
|---|---|
| **Number of the particles in the bunch** | **$2 \cdot 10^{11}$ /s** |
| **Emittance** | **10 nm** |
| **RMS energy spread** | **0.1%** |

RF photogun is the main candidate as source of electrons.

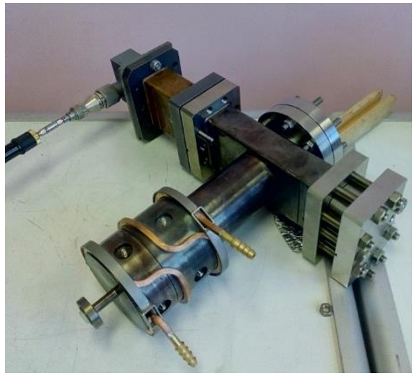


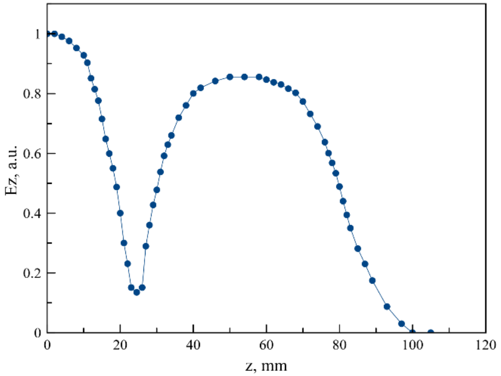

DUV PS laser



Basic layout of the RF photogun :

*1-accelerating cavity with a photocathode*
*2 - accelerating cavity*
*3-RF power input*
*4-cavity for laser input and beam output*






The measured on-axial electric field amplitude profile of the RF gun. Frequency is 2856 MHz

# Cathode R&D

*Talk by O.Tereschenko*

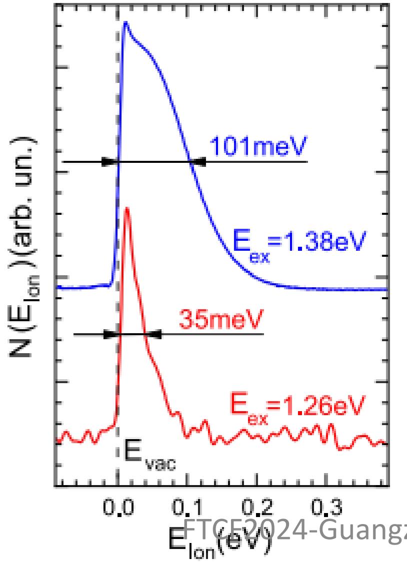
**Photocathodes which are of interest for RF electron gun**

- Sb-based “green” photocathodes such as Cs3Sb, Cs2KSb, Na2KSb, CsNaKSb and others
- Widely used in industry in PMT
- Enough robust for operation with high average current
- Laser systems are available

- Technology under development for accelerator applications
- Optimization of deposition procedure to obtain high **QE>15%**
- Optimization of growth procedure to obtain high polarization **P>60%**
- Lifetime at high average current
- Operation at cryogenic temperature
- Mean Transverse Energy

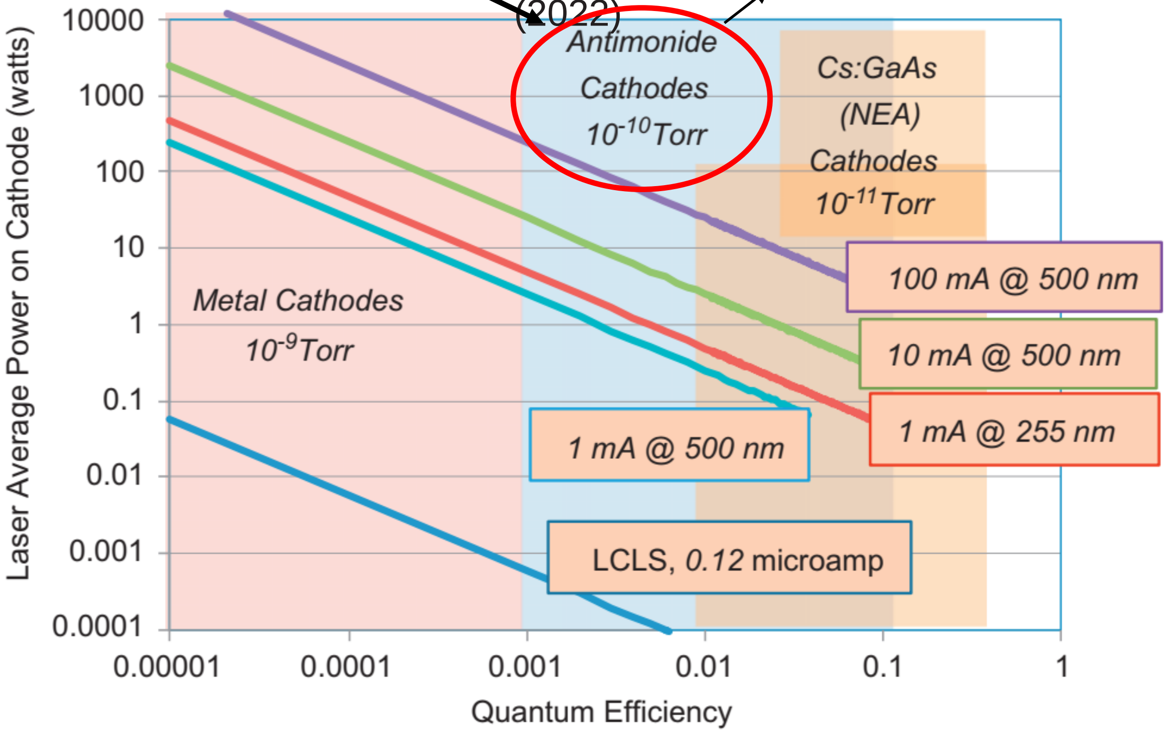
Energy distribution curves measured at photon excitation energies of 1.38 and 1.26 eV.

MTE ≈ kT




Since 2022 known as highly polarized e-sources

V.S. Rusetsky et al. Phys.Rev.Lett. 129 (2022)




Plot of the average laser power vs. quantum efficiency to produce various average beam currents. The QE ranges for the general cathode types are shown along with their vacuum requirements.

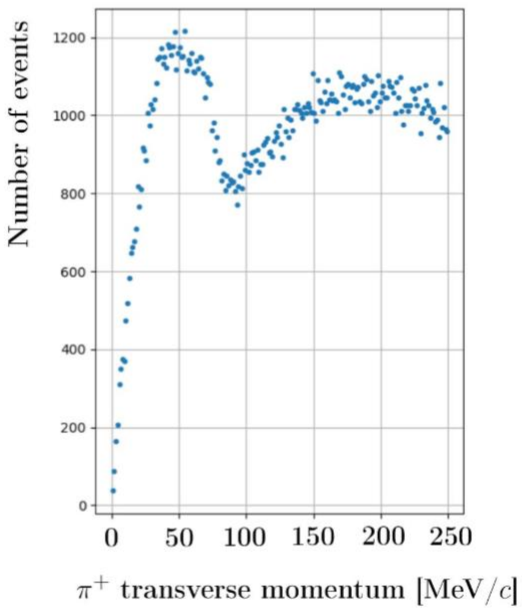
D.H. Dowell et al. / Nuclear Instruments and Methods in Physics Research A 622 (2010) 685–697

# Inner tracker: TPC option

Considerations

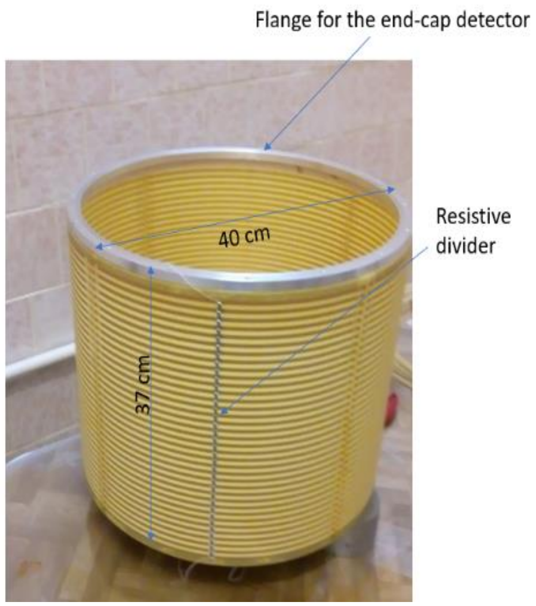
**Tasks**
- Measure soft $\pi^{\pm}$ mesons momentum ($p < 100$ MeV/c)
- Complement the drift chamber in measuring the momenta
- Detect secondary vertices from the decays of short-lived particles ($K_S$, $\Lambda$)

**Requirements**
- Cover angle close to $4\pi$
- Handle with high particle flux – luminosity of $10^{35}$ cm$^{-2}$ s$^{-1}$
- Provide spatial resolution ~ 100 μm



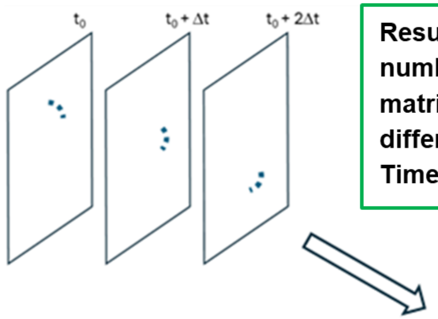

Simulation of $\pi^+$ transverse momentum distribution in $e^+e^- \to DD^*$ (V. Vorobyev)

We are developing TPC option for IT



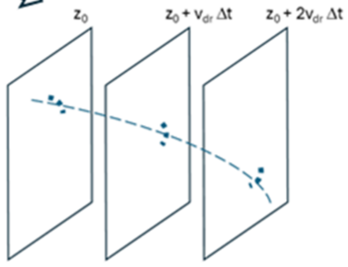

Prototype

# Inner tracker: simulations



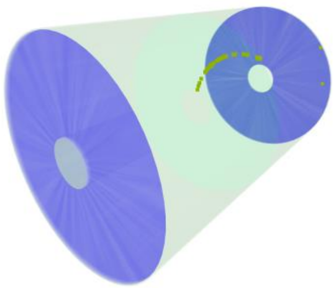

**Result of the digitization: number of pad signal matrices, corresponding to different times.**
**Time window Δt = 50 ns.**

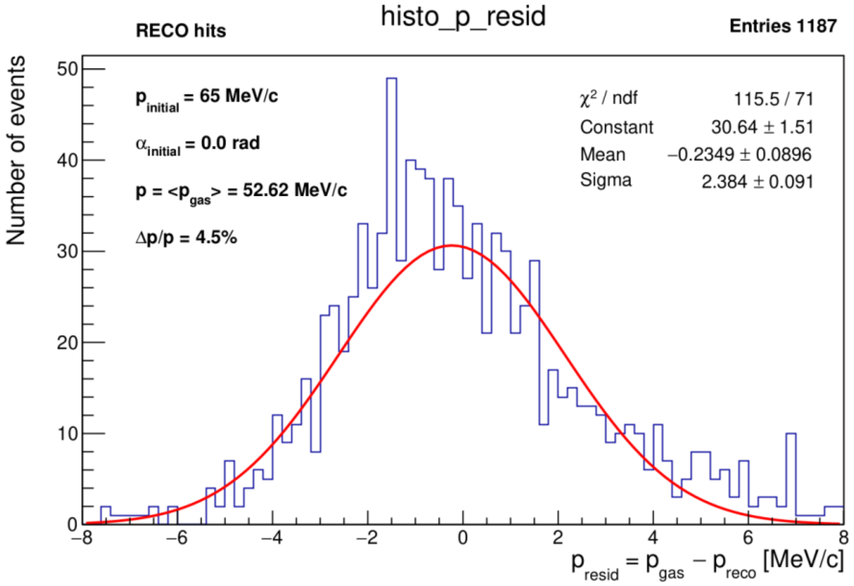
**Clusterization of triggered pads and association them with one track.**



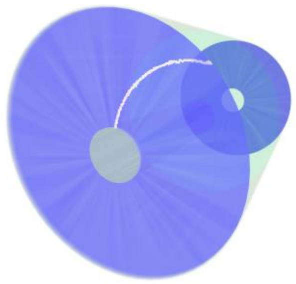

**Track parameters are determined by reconstructed 3D hits**

**Center-of-Gravity cluster XY-coordinates calculation. Cluster Z-coordinate calculation is based on time information.**






$\pi$, 65 MeV/c
@1.5T



Hits from digitization, clusterization and hit-reconstruction

# Drift chamber

~40000 wires
- 11k sensitive, W-Rh(Au)
- 29k field, Al(Au)

Hexagonal cell, 6.3-7.5 mm

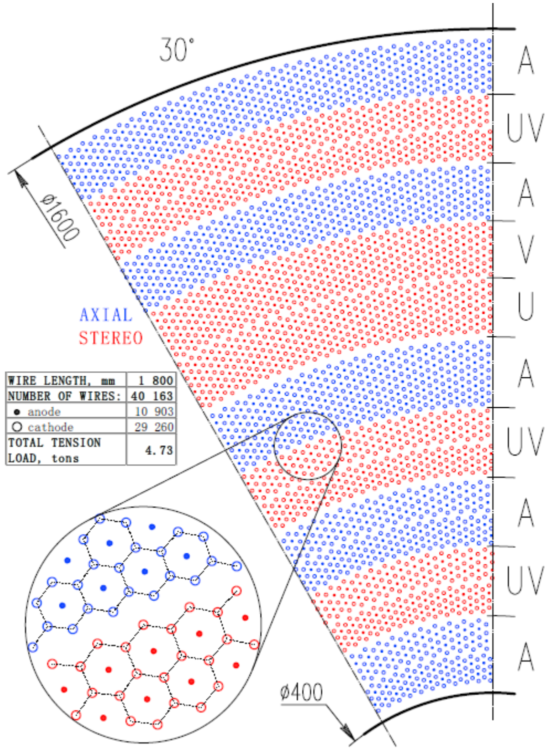
41 layers

60% He + 40% $C_3H_8$

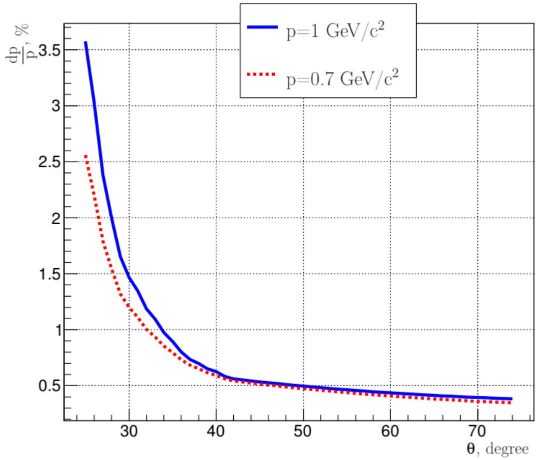
$$\frac{\sigma_{p_t}}{p_t} \approx 0.4\% \text{ at } 1 \text{ GeV}$$

$$\frac{\sigma_{dE/dx}}{dE/dx} \approx 6.9\%$$

I.Yu.Basok et al., NIM A1009 (2021) 165490

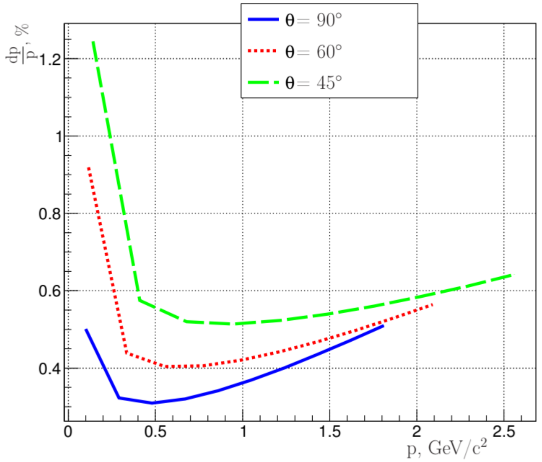



| WIRE LENGTH, mm | 1 800 |
|---|---|
| NUMBER OF WIRES: | 40 163 |
| ● anode | 10 903 |
| ○ cathode | 29 260 |
| TOTAL TENSION LOAD, tons | 4.73 |




Momentum resolution

vs Θ




vs $p$

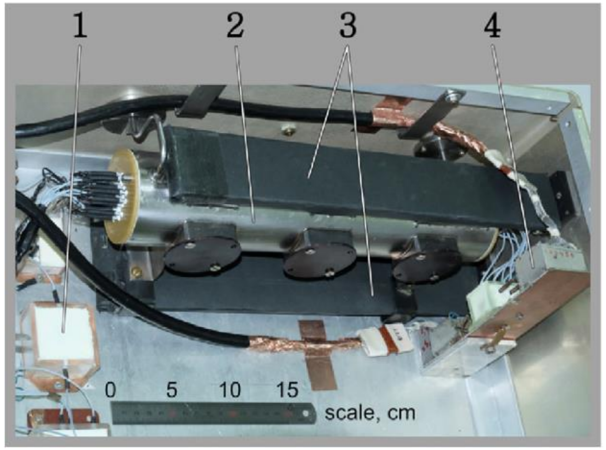
# Drift chamber: prototyping

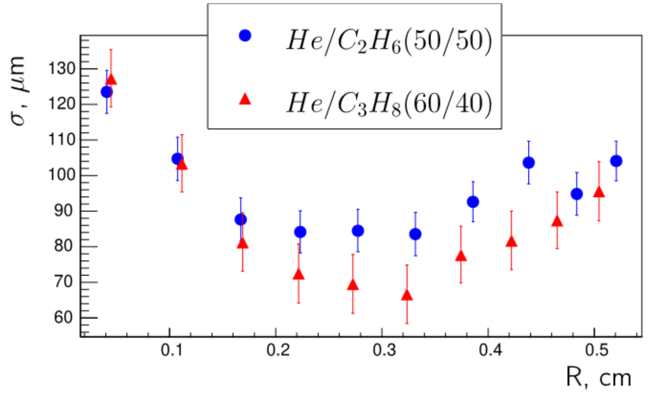
Studies with small prototype

I.Yu.Basok et al., NIM A1064 (2024) 169419

Spatial resolution, test of materials and wires, tests of radiation hardness

Synergy with the development of the new drift chamber for CMD-3




Spatial resolution vs R

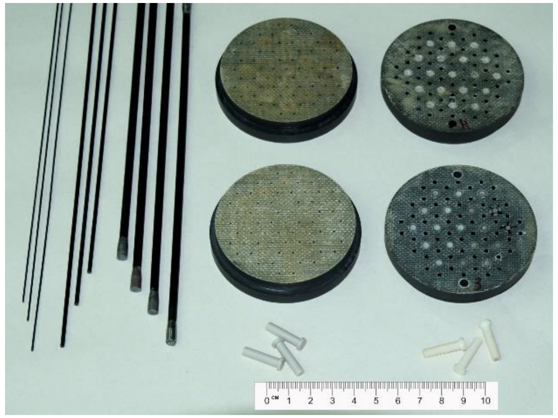
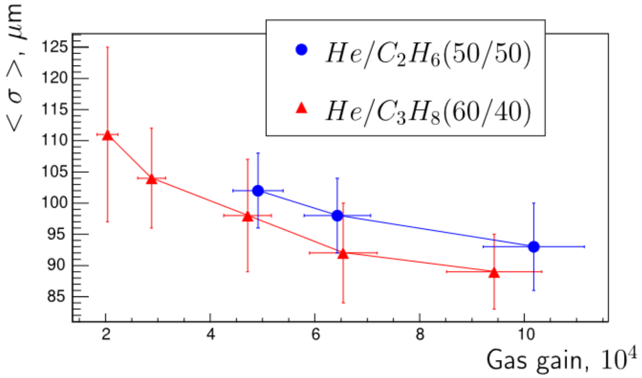


Photo of the small prototype. *The numbers indicate: 1 — high-voltage low-pass filter, 2 — small prototype, 3 — scintillators, 4 — preamplifiers.*

Results of average spatial resolutions for gas mixtures $He/C_3H_8$ (60/40) and $He/C_2H_6$ (50/50).

| Gas gain | $He/C_3H_8$ (60/40) | $He/C_2H_6$ (50/50) |
|---|---|---|
| | $\langle\sigma\rangle$ , μm | $\langle\sigma\rangle$ , μm |
| $2 \cdot 10^4$ | $111 \pm 14$ | – |
| $3 \cdot 10^4$ | $104 \pm 8$ | – |
| $5 \cdot 10^4$ | $98 \pm 9$ | $102 \pm 6$ |
| $7 \cdot 10^4$ | $92 \pm 8$ | $98 \pm 6$ |
| $10^5$ | $89 \pm 6$ | $93 \pm 7$ |




Spatial resolution vs gain

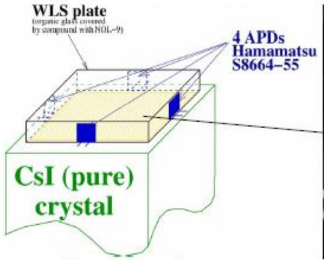
# Calorimeter: prototype of pCsI option

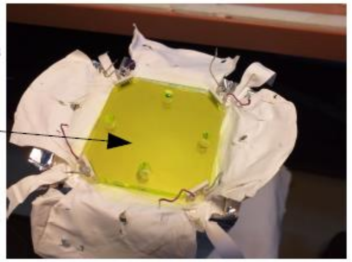
*Talk by D.Epifanov*

**The calorimeter prototype is made of 16 counters:**

- CsI(pure) crystal (6x6x30 $cm^3$)
- WLS plate with NOL-9
- 4 APDs (Hamamatsu S8664-55)
- 4ch preamp.

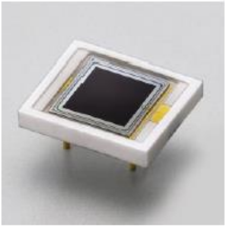
The UV scint. light (315 nm) from CsI(pure) is shifted to 590 nm by NOL-9 (nanostructured organic luminophore) where the QE of APD is maximal. The re-emitted light is captured in the plate and detected by 4 APDs.

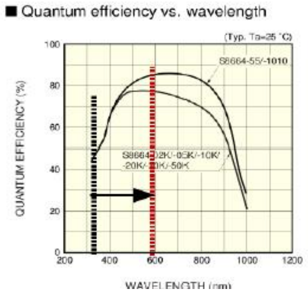


4ch preamp

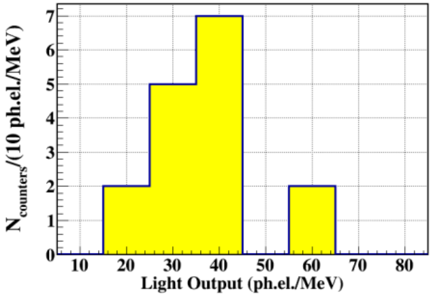
Hamamatsu APD S8664-55



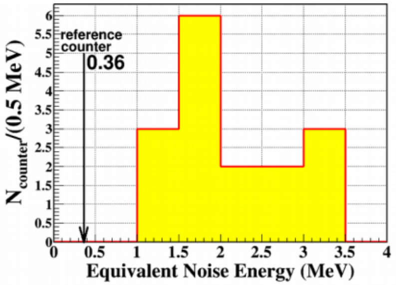



40 MHz 12-bit CAMAC shaper-ADC

L.O.
62 pe/MeV

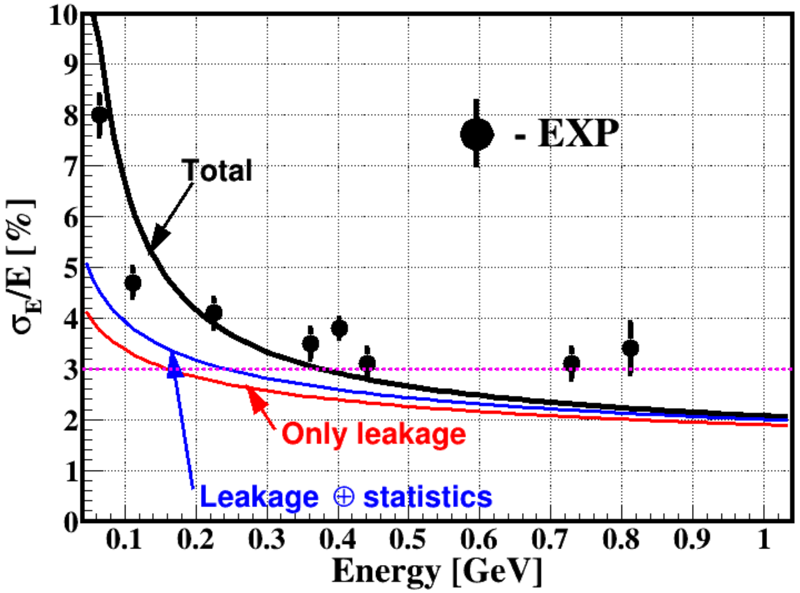


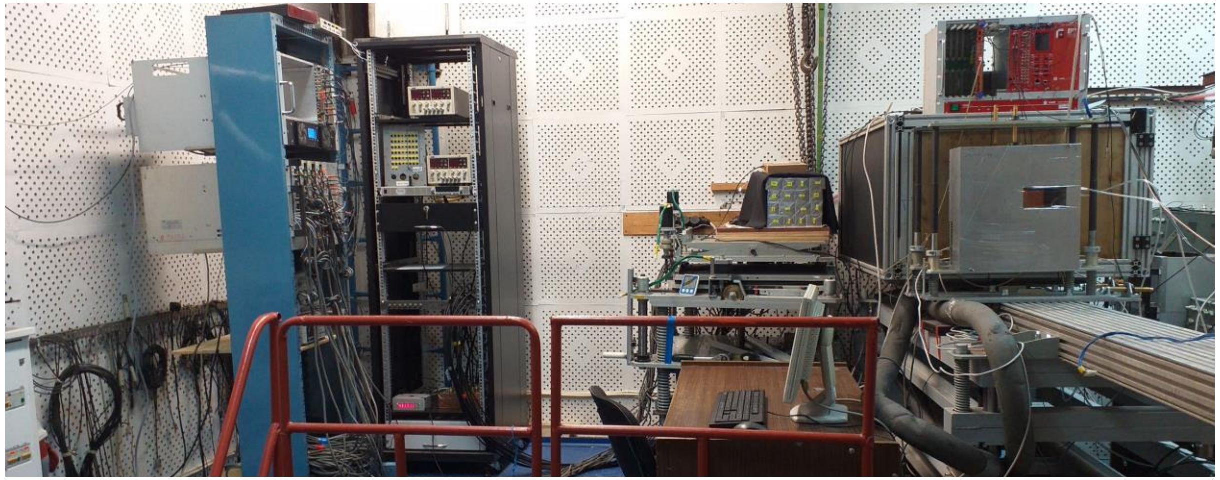

ENE
1.2 MeV

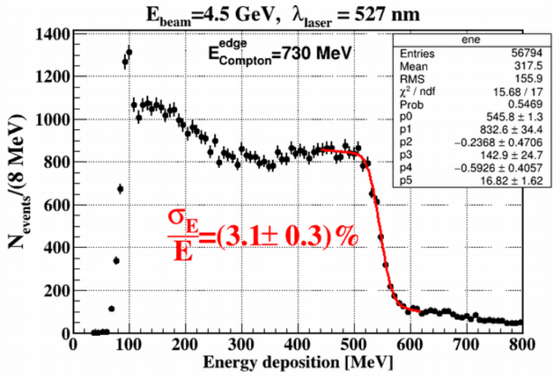


# Calorimeter: test beam studies

Test beam studies at BINP:
Compton $\gamma$ with edge energies at 64, 111, 225, 361, 402, 441, 730, 812 MeV

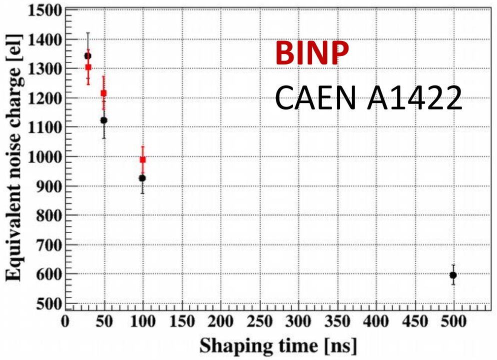


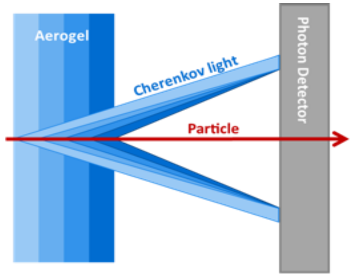



Measurement of resolution

Comparison of dedicated electronics with CAEN

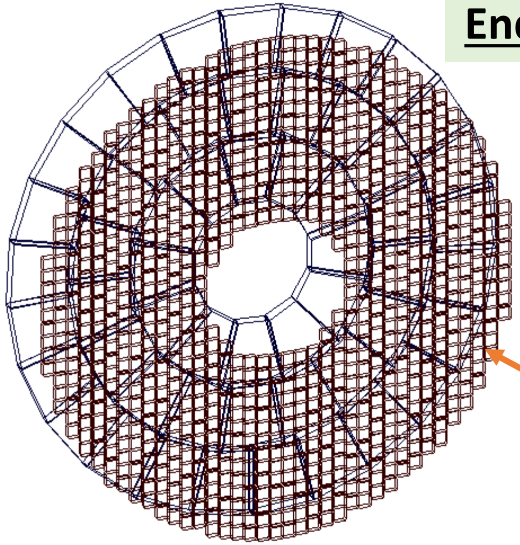


# FARICH system construction optimisation

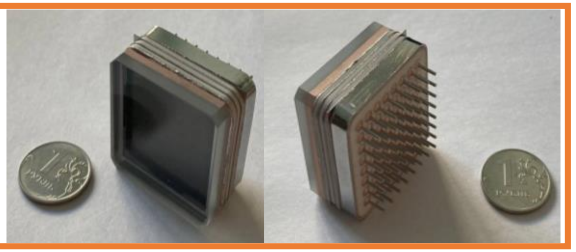


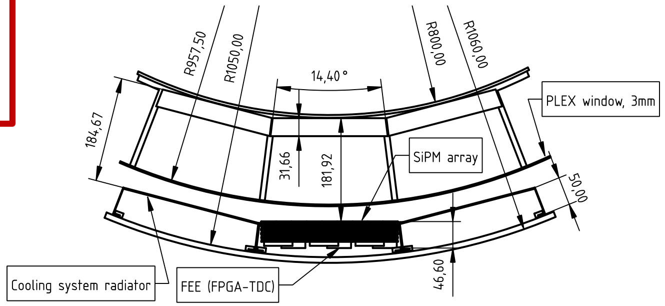

## Endcap part Sketchs & key elements

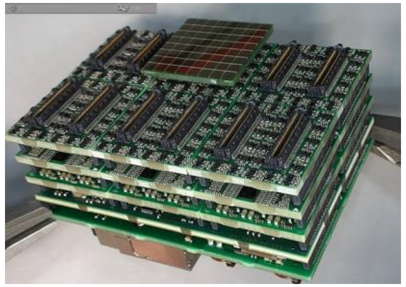
*Talks by A.Barnyakov and P.Rogozhin*



- 2x55 trapezoidal aerogel tiles in end caps:
- 2x1000 MCP PMTs 34x34mm$^2$ from “Ekran FEP”
- MCP PMTs can operate without cooling

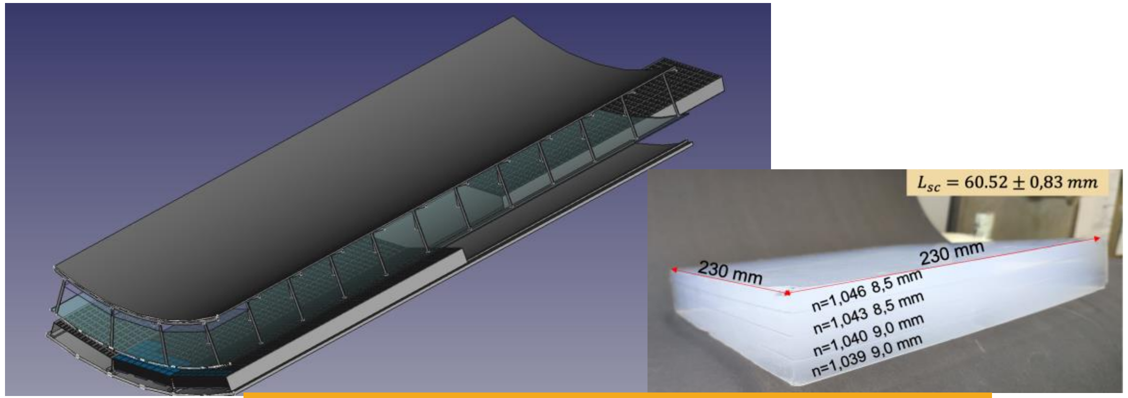




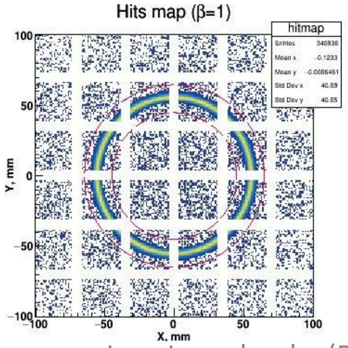



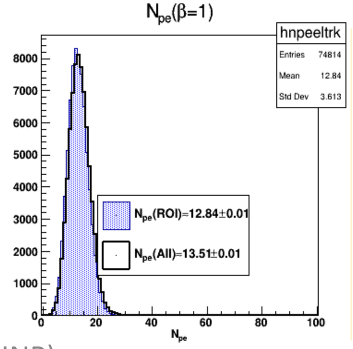
## The first square MCP PMT produced in Russia:

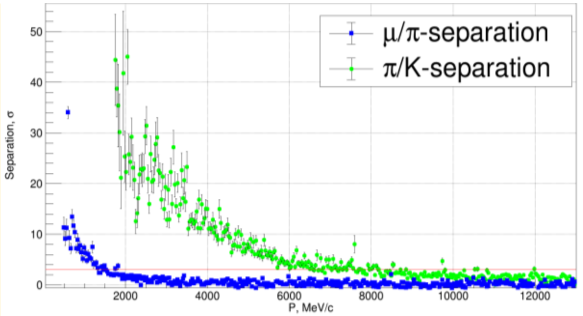
- All details and components are produced in Russia
- First samples for test will be available until the end of 2024




## Expected system parameters(obtained in G4 simulation)



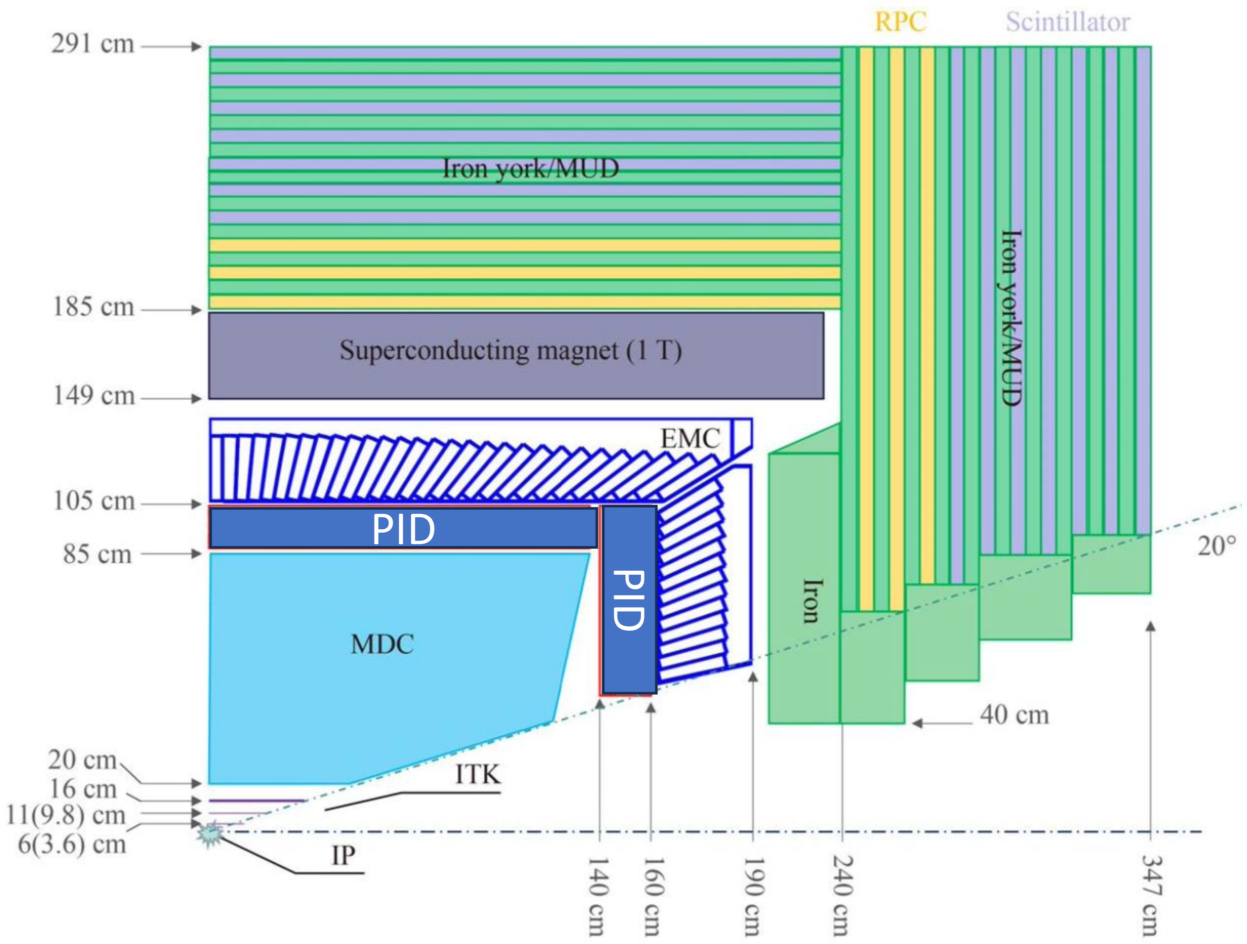



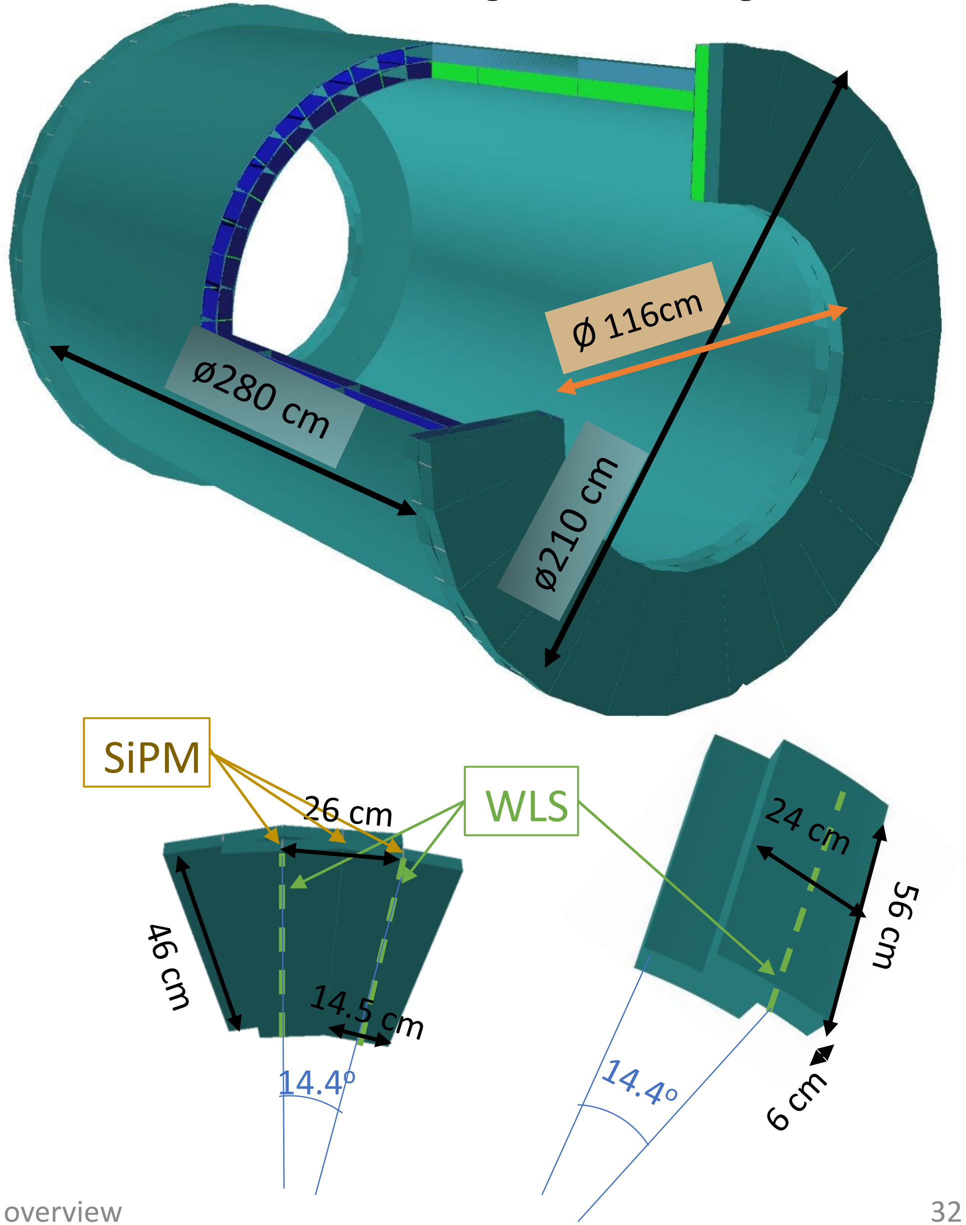

## Barrel part Sketchs & key elements

- 275 aerogel tiles 200x202x35 in barrel part
- only SiPM will operate in magnetic field
- effective cooling system is required

# ASHIPH system proposal for STCF (Hefei)

*Talk by E.Kravchenko*



# Fast simulation

Computing and Software for Big Science (2024) 8:1
https://doi.org/10.1007/s41781-023-00108-7

RESEARCH

Check for updates

## Fast Simulation for the Super Charm-Tau Factory Detector

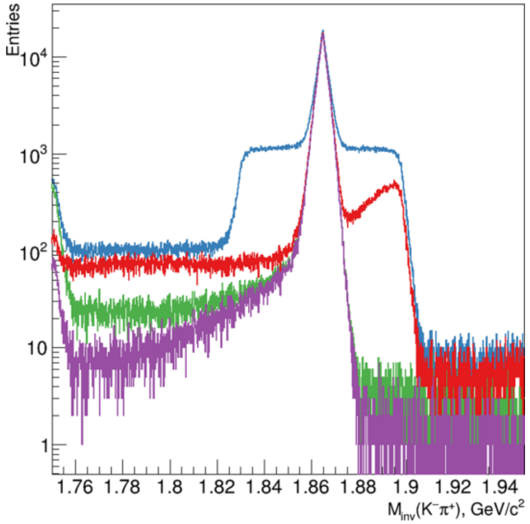
Alexander Barnyakov[1,3] · Maria Belozyorova[2] · Victor Bobrovnikov[1,2] · Sergey Kononov[1,2] · Dmitriy Kyshtymov[1,2] · Dmitry Maksimov[1,2] · Georgiy Razuvaev[1,2] · Andrey Sukharev[1,2] · Korneliy Todyshev[1,2] · Vitaliy Vorobyev[1] · Anastasiia Zhadan[1,2] · Daniil Zhadan[1,2]

Received: 22 November 2022 / Accepted: 7 December 2023


**Abstract**
The Super Charm-Tau factory (high luminosity electron-positron collider with 3–7 GeV center of mass energy range) experiment project is under development by the consortium of Russian scientific and education organizations. The article describes the present status of the Super Charm-Tau detector fast simulation and the algorithms on which it is based, example usage and demonstration of fast simulation results.

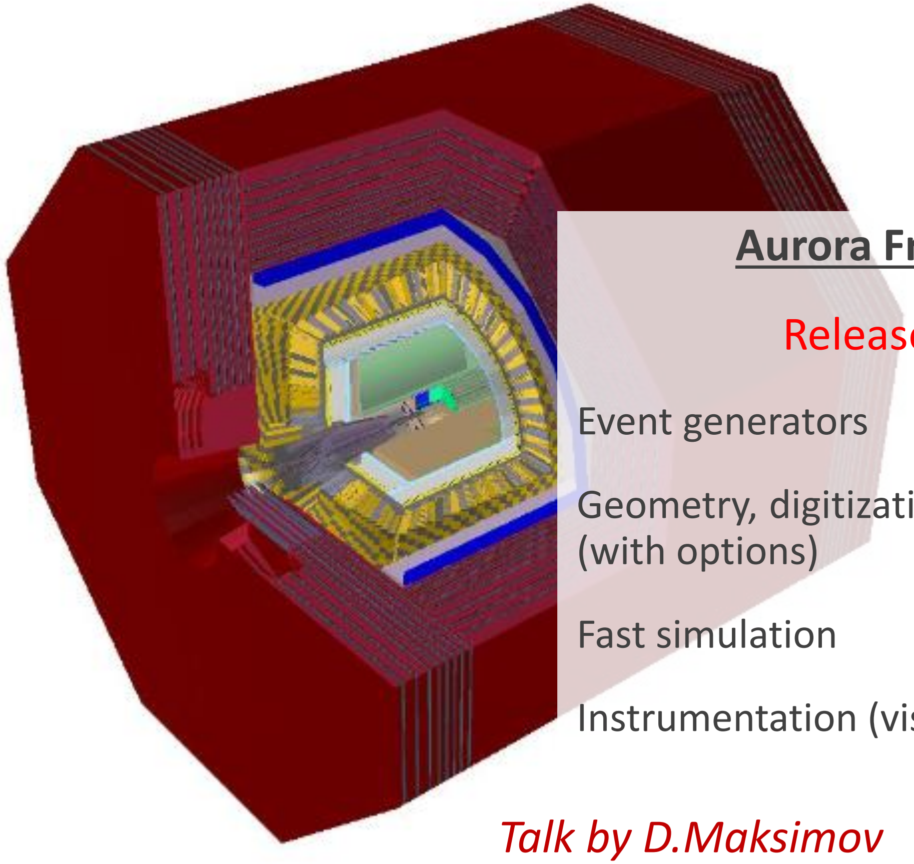
**Keywords** Super Charm-Tau factory · Fast simulation · Parametric simulation

A paper with a description of our model for fast simulation was published in a journal "Computing and Software for Big Science" (2024)




$M_{inv}(K^-\pi^+)$ in $D^0 \rightarrow K^-\pi^+$

# Simulation/reconstruction framework



**Aurora Framefork**

Release 2.1.0

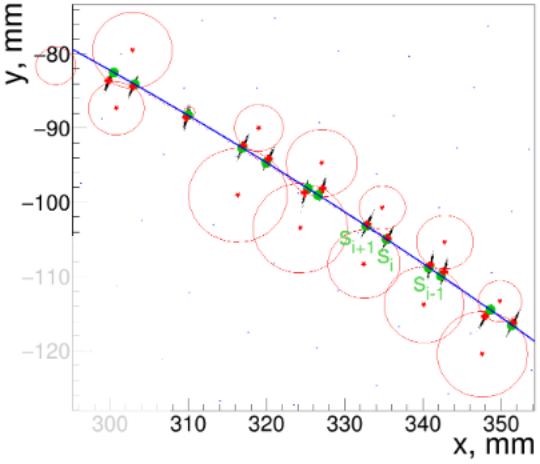
Event generators

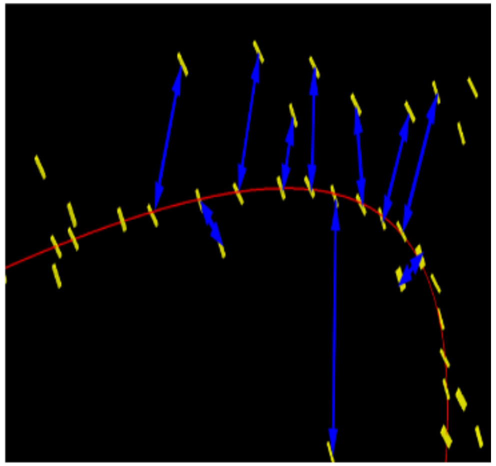
Geometry, digitization, reconstruction (with options)

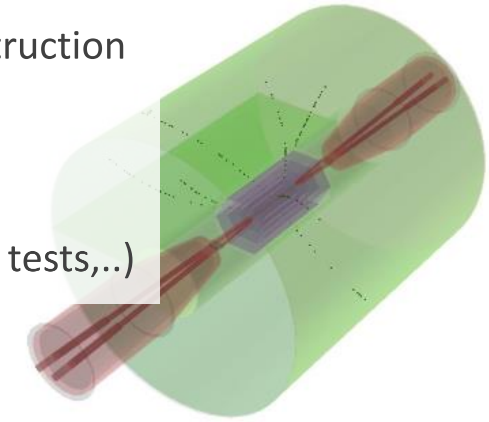
Fast simulation

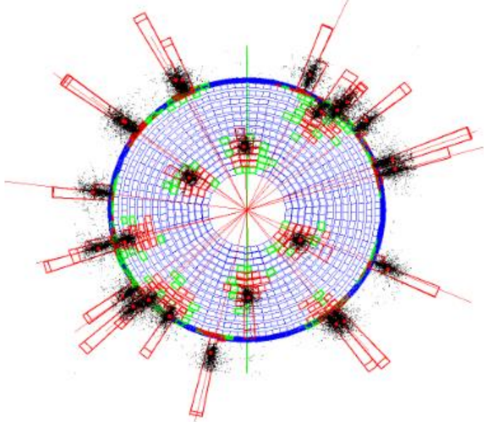
Instrumentation (visualization, tests,..)

*Talk by D.Maksimov*







# Summary

- Super $c\tau$ factory (SCTF/STCF) has great physics potential, both for discoveries and for deep understanding of Standard model
- There is wide program of SCTF R&D studies realized by collaboration of BINP and other institutions
- There is synergy between SCTF R&D and other future and ongoing projects at BINP and elsewhere
- The collaboration between STCF and SCTF is expanding