XXVI Russian Particle Accelerator Conference (RuPAC-2018)
October 1–5 2018, Protvino, Russia

Start VEPP-4M facility operation at high energy

P.Piminov for the VEPP-4 team
Budker Institute of Nuclear Physics
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VEPP-4 team

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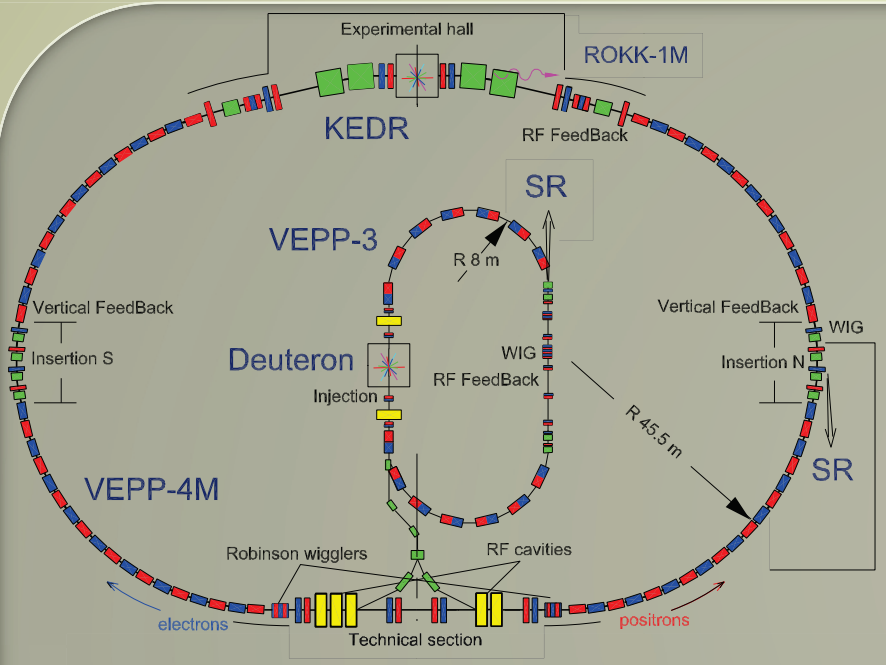
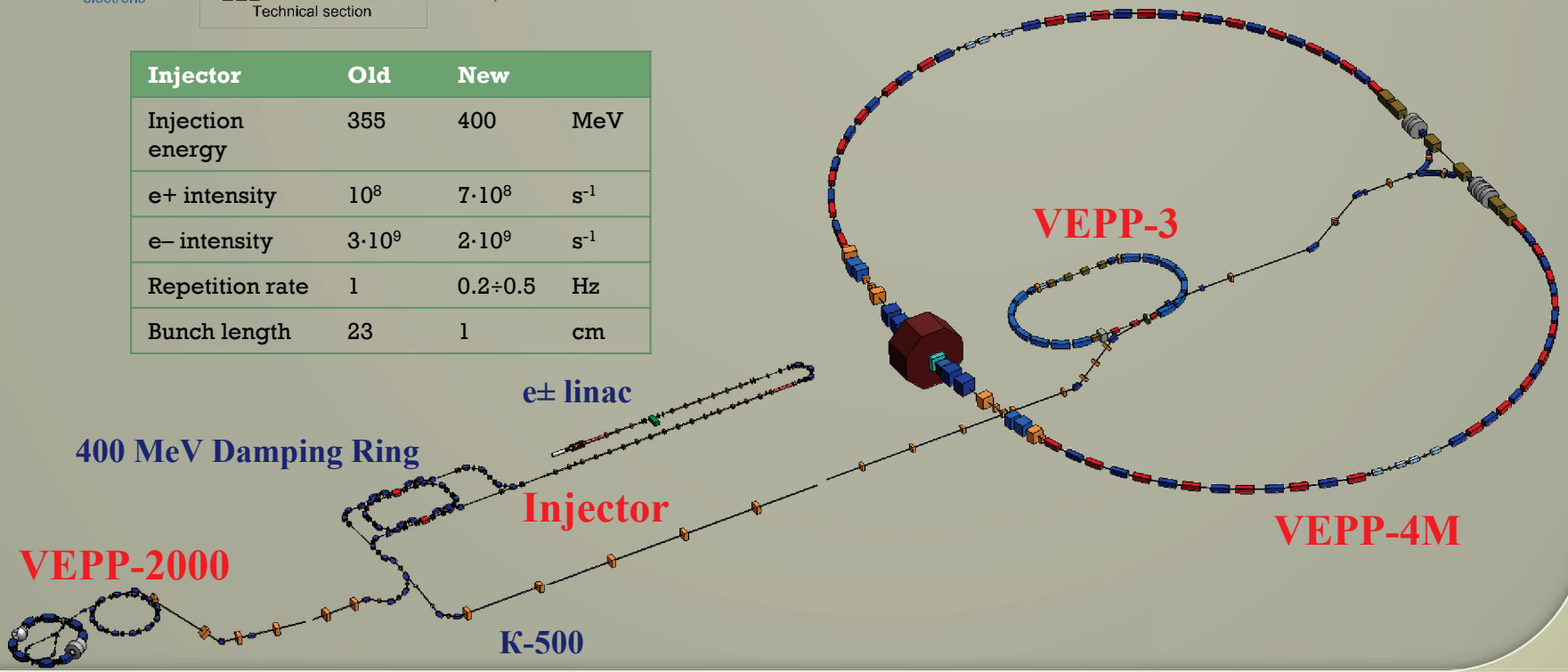
VEPP-4 layout



	VEPP-2000	VEPP-3	VEPP-4M	
Circumference	24.4	74.4	366	m
Energy	0.1÷1	0.3÷2	1÷4.7 (5.3)	GeV
Bunches	1e+x1e–	2e±	2e+x2e–, 16e±	
Current	200	150	15 (40)	mA
Luminosity	$1 \cdot 10^{32}$		$3 \cdot 10^{30}$ ($2 \cdot 10^{31}$)	$cm^{-2} \cdot s^{-1}$

Injector	Old	New	
Injection energy	355	400	MeV
e+ intensity	10^8	$7 \cdot 10^8$	s^{-1}
e– intensity	$3 \cdot 10^9$	$2 \cdot 10^9$	s^{-1}
Repetition rate	1	0.2÷0.5	Hz
Bunch length	23	1	cm

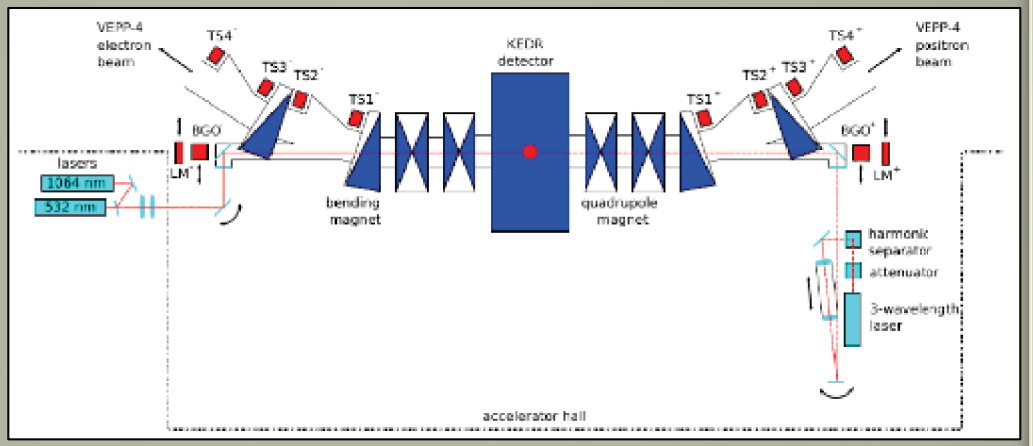


physics program

- high energy physics at VEPP-4M with detector KEDR
- synchrotron radiation at VEPP-3 & VEPP-4M
- nuclear physics at VEPP-3 with Deuteron facility
- test beam facility at VEPP-4M
- accelerator physics activity

vepp-4m & kedr @ low energy

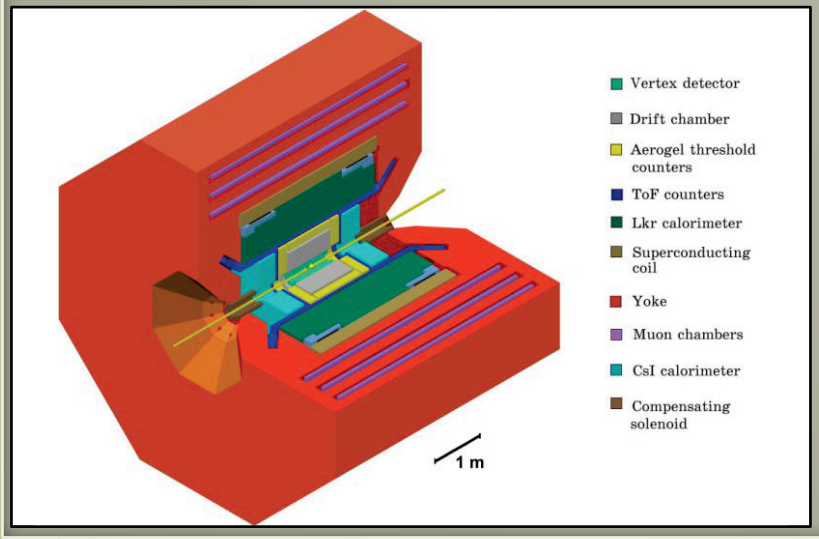
- ★ Universal magnetic detector KEDR
- ★ Electron-positron tagging system
- ★ Wide energy range 0.9÷6 GeV
- ★ Energy spread control
- ★ Precision beam energy calibration by resonance depolarization
- ★ First collider with beam energy monitoring by Compton backscattering



2001-2017 low energy luminosity run 2x(0.9÷1.9) GeV

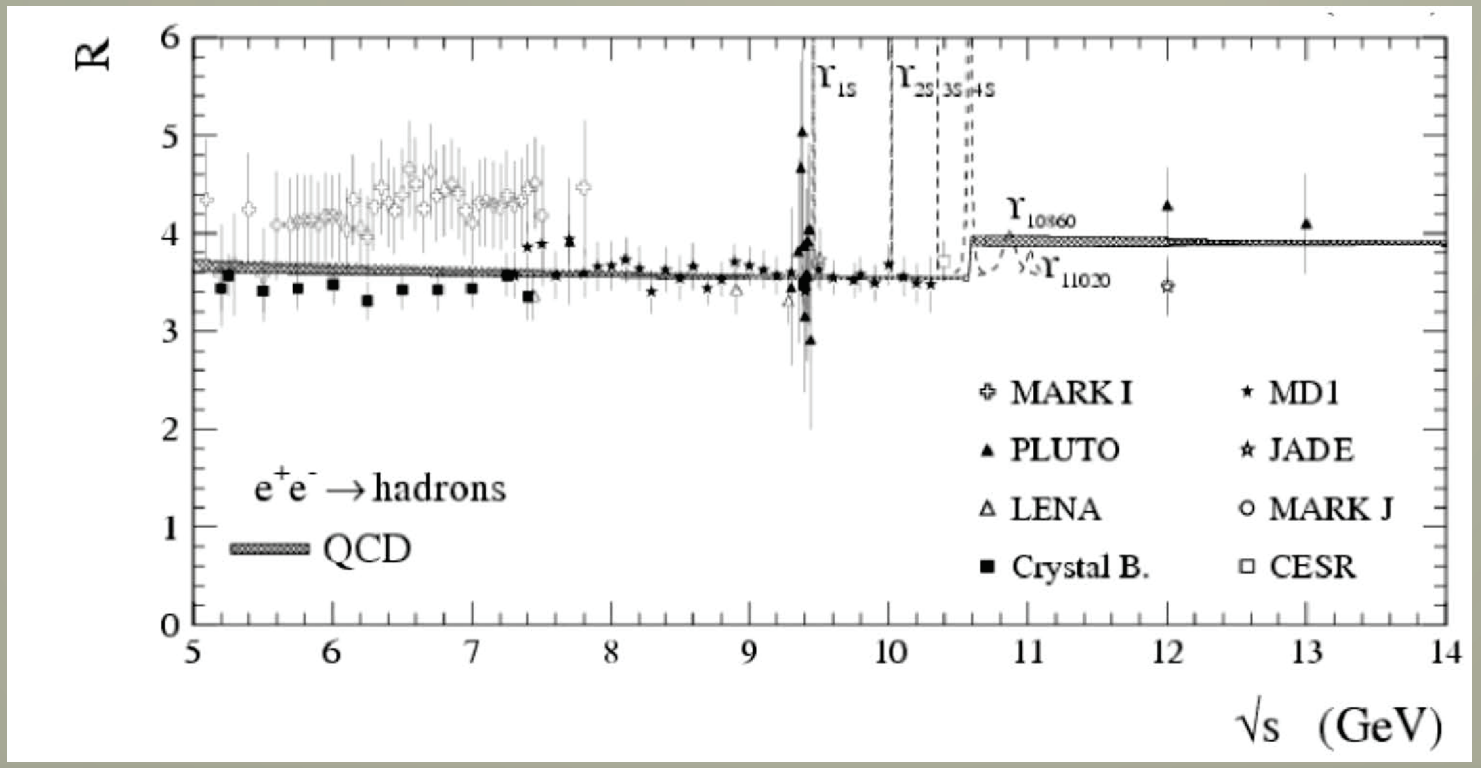
- ✓ $J/\psi, \psi', \psi'', \psi(3770)$ meson masses WR
- ✓ τ lepton mass WR
- ✓ D^0 mesons masses
- ✓ $D^{\pm}$ mesons masses WR
- ✓ Search for narrow resonances 1.85÷3.1 GeV WR
- ✓ R-scan 1.85÷3.1 GeV WR
- ✓ Ruds- and R- scan 3.12÷3.72 GeV WR
- ✓ $J/\psi \to \gamma\eta_c$ WR
- ✓ ψ-mesons, η_c, … parameters WR

WR = World Record



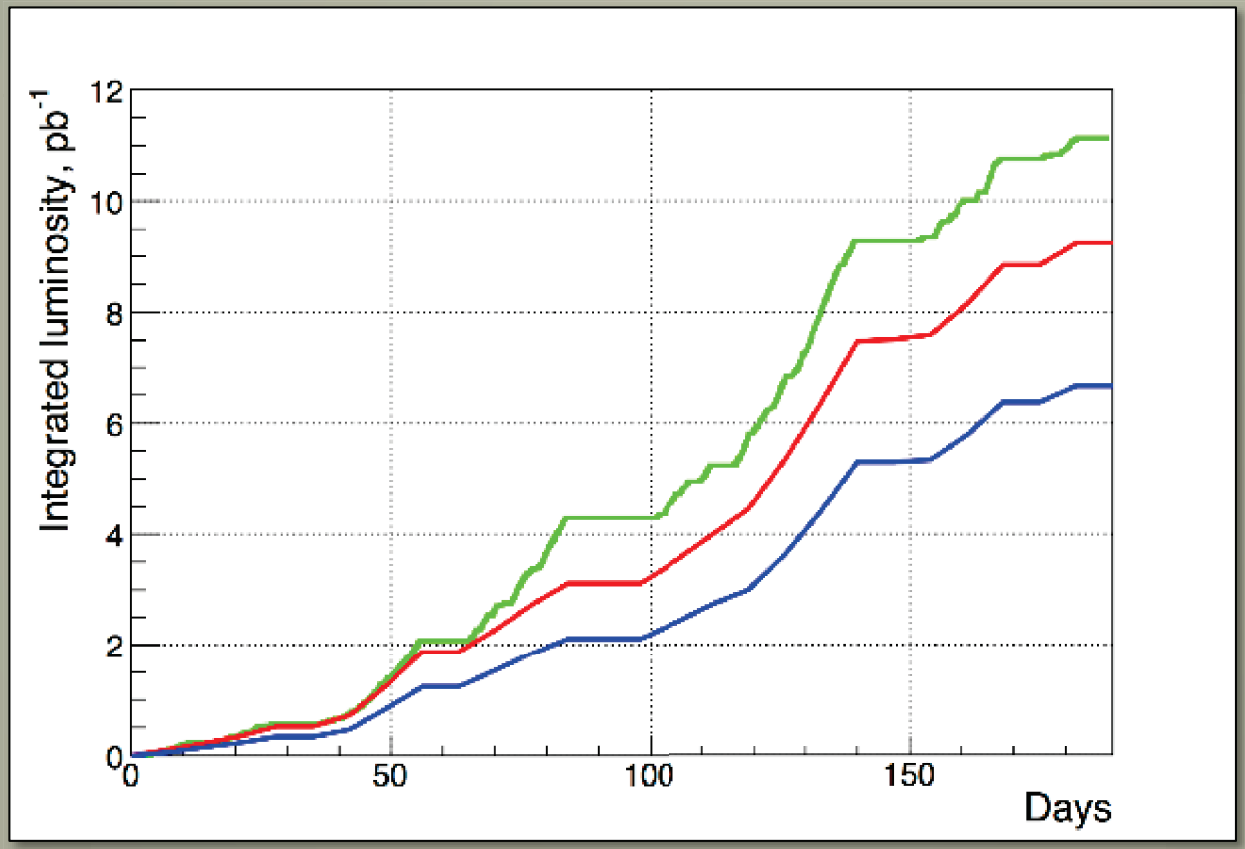
vepp4m & kedr @ high energy

- ✓ R scan 2x(2.3÷3.5) GeV (~ 10 bp^{-1})
- ✓ Υ-mesons study (~ 50 pb^{-1})
- ✓ $\gamma\gamma$ physics (~ 200 pb^{-1})



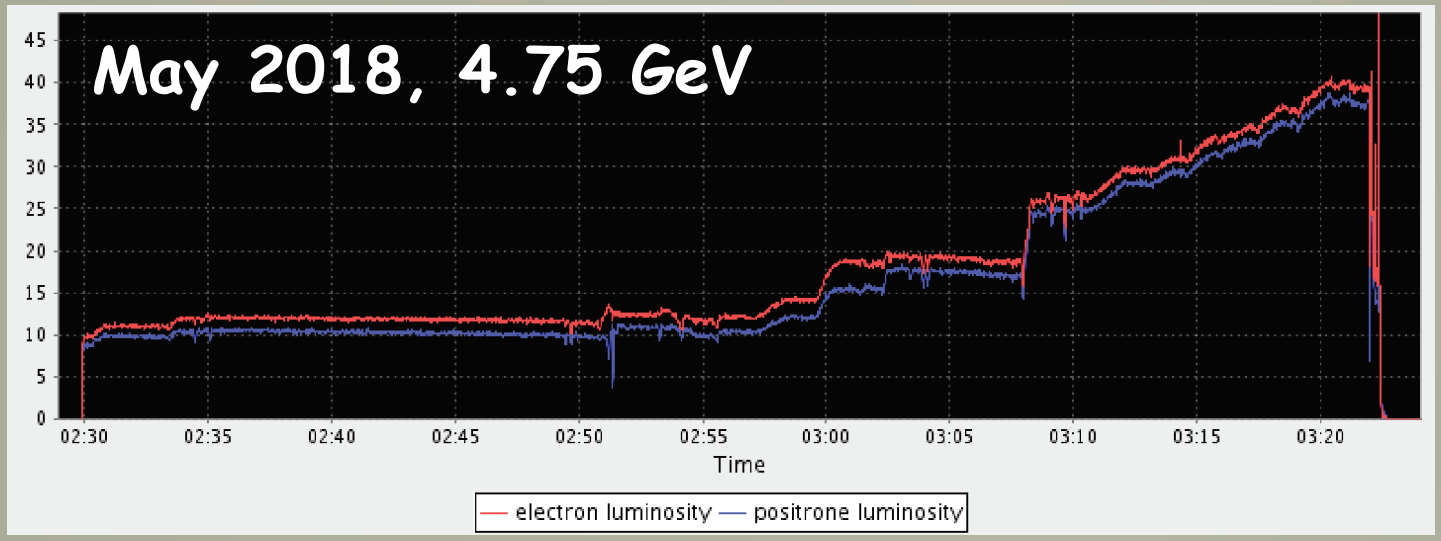
r-scan 2x(2.3÷3.5) gev

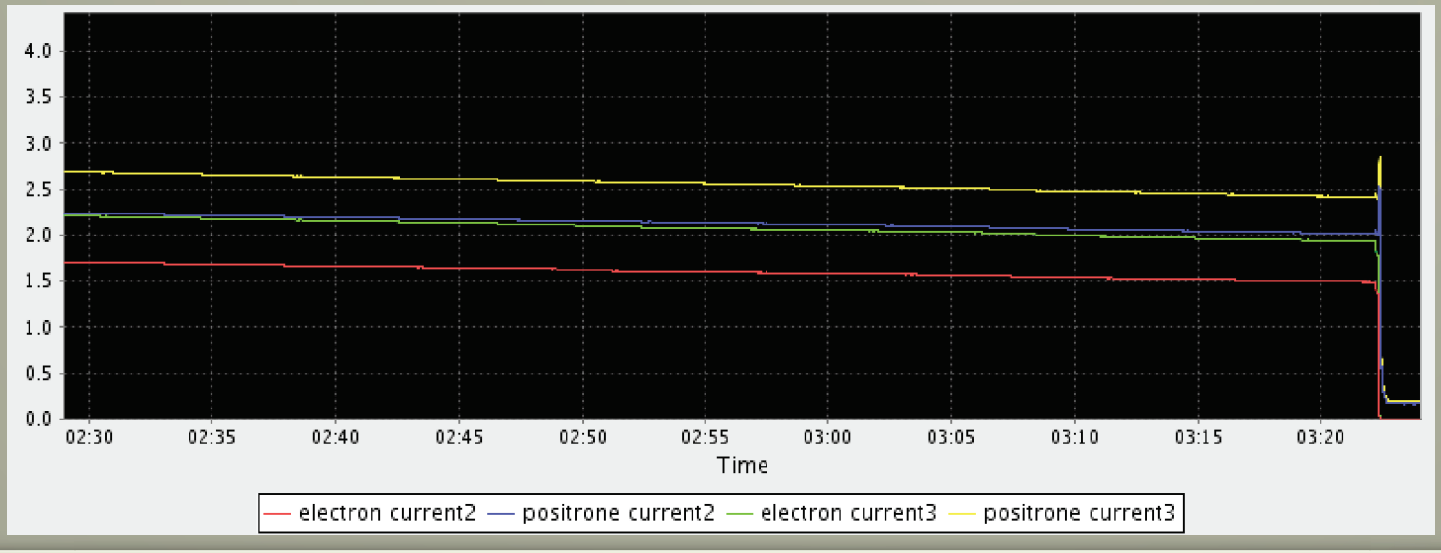
В декабре 2017 начат эксперимент по измерению сечения рождения адронов в диапазоне энергии пучка от 2.3 до 3.5 ГэВ в 17 точках в двух заходах



В настоящий момент закончено первое сканирование (четные точки) ~ 6 пб$^{-1}$

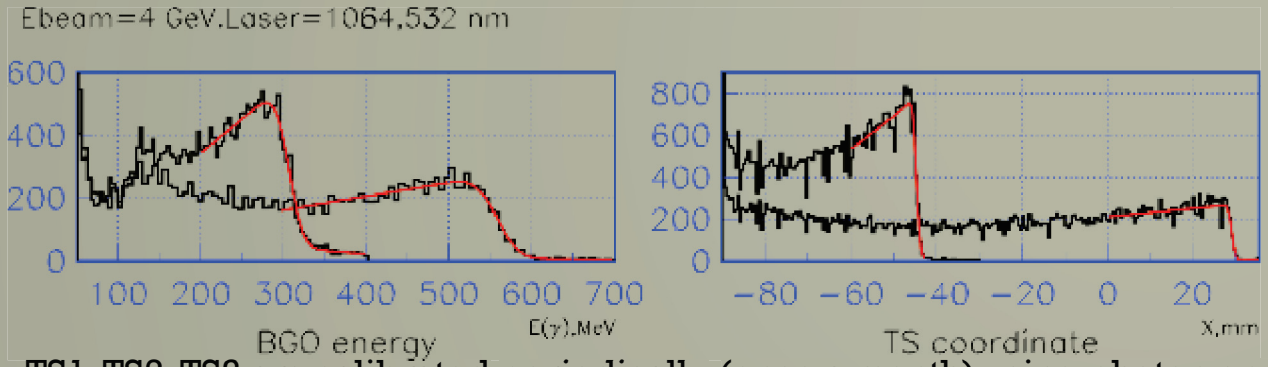
first luminosity @ Υ(1S)



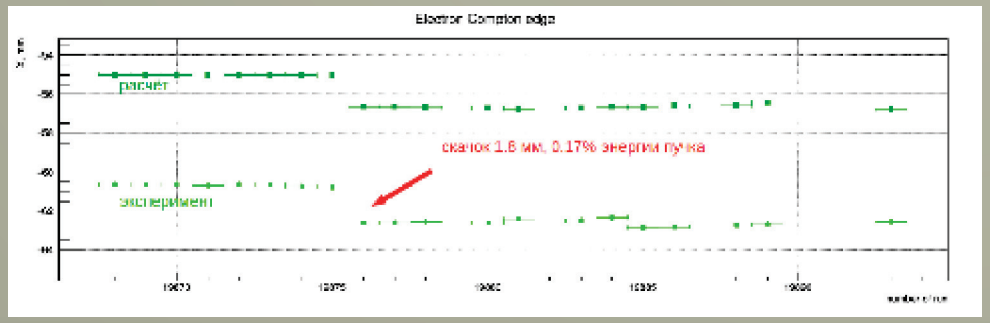


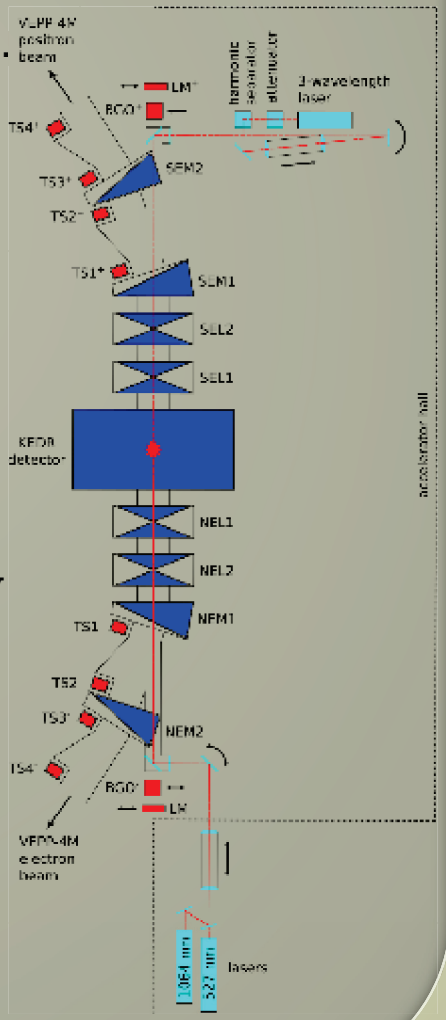
kedr detector tagging system

- TS is a focusing magnetic spectrometer built in VEPP-4M lattice. TS is intended to measure two-photon system parameters using scattered electrons/positrons.
- Coordinate detectors TS4 are calibrated <u>continuously</u> using Compton spectra edges of electrons/positrons (two laser wavelengths).

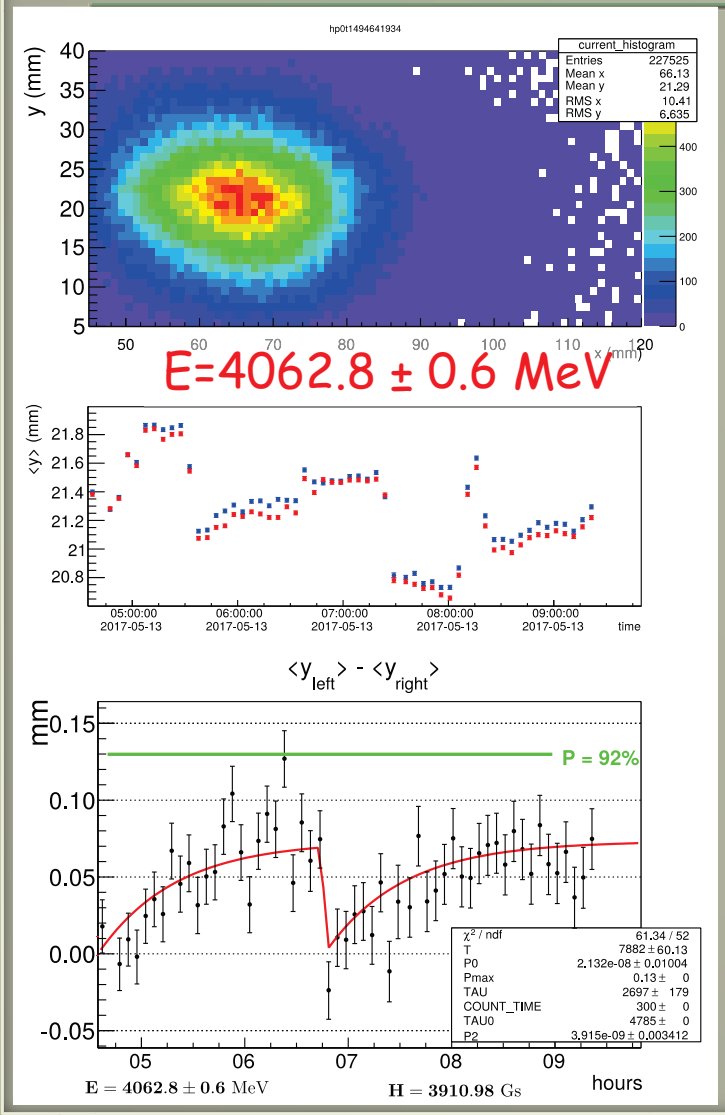


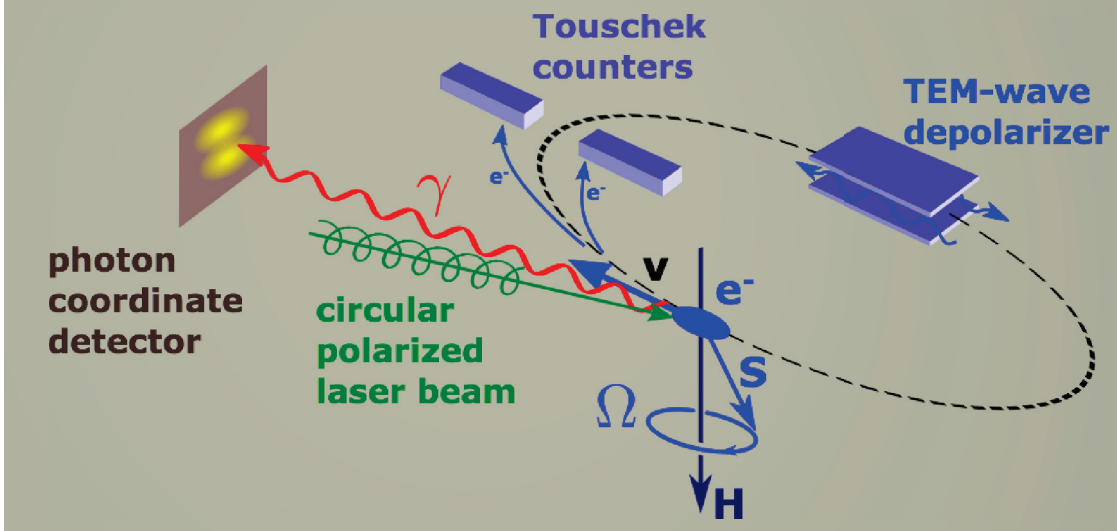
- TS1, TS2, TS3 are calibrated <u>periodically</u> (once a month) using photon energy tagged electrons/positrons from single-photon bremsstrahlung. Photon energy is measured by BGO calorimeters (calibrated by Compton backscattering and bremsstrahlung).
- TS scale is calculated using VEPP-4M lattice model. Precision $\Delta E/E_0 \approx 0.03\%$.

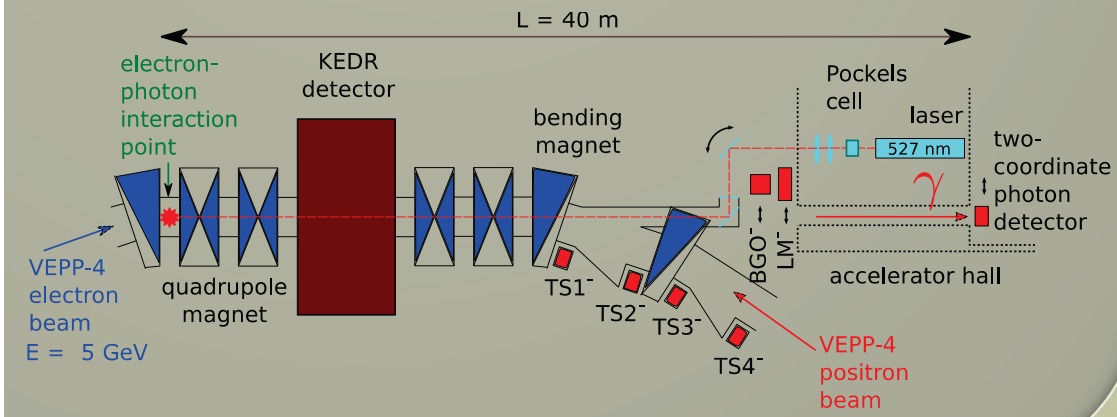




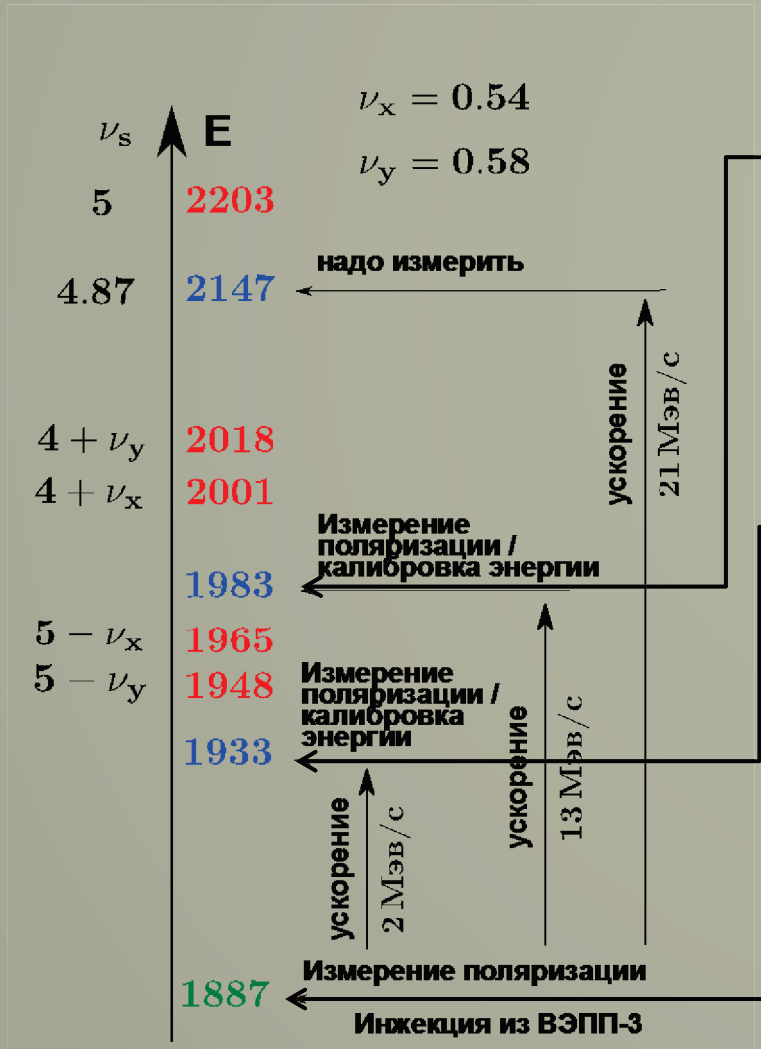
beam energy calibration
laser polarimeter

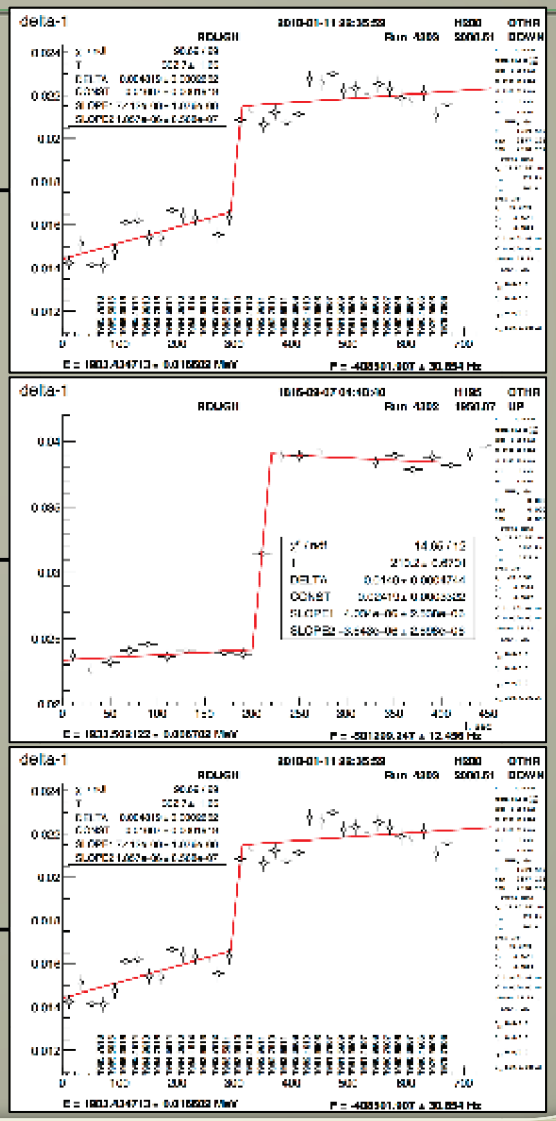




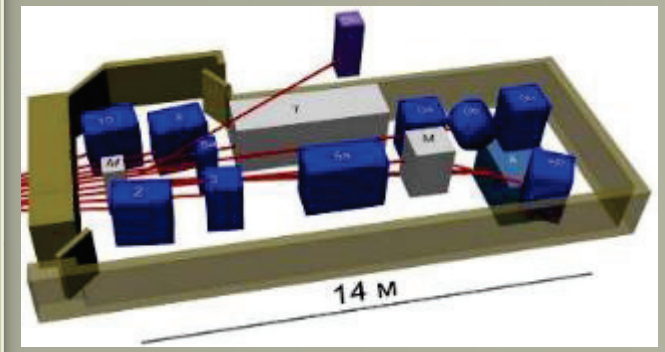


beam energy calibration spin resonances crossing

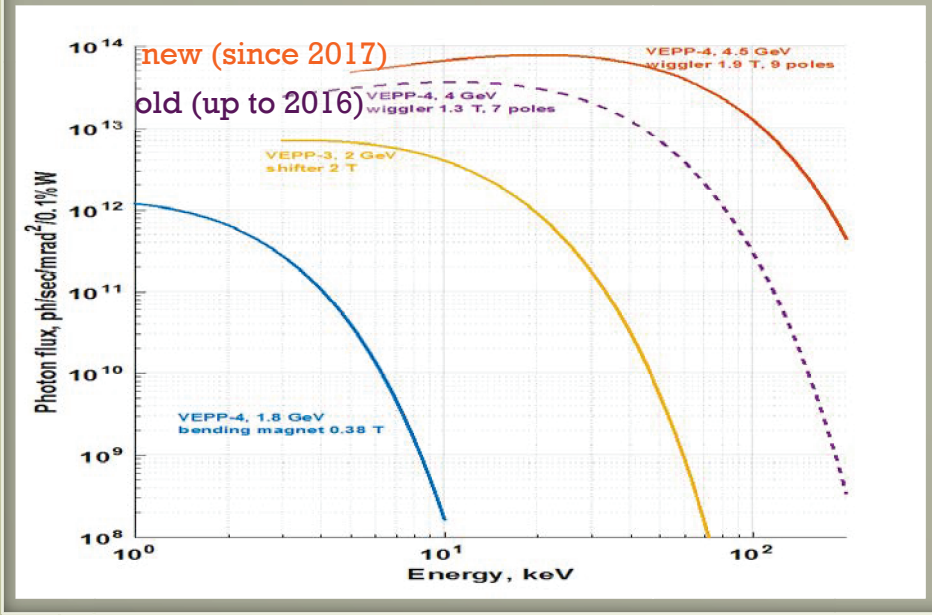


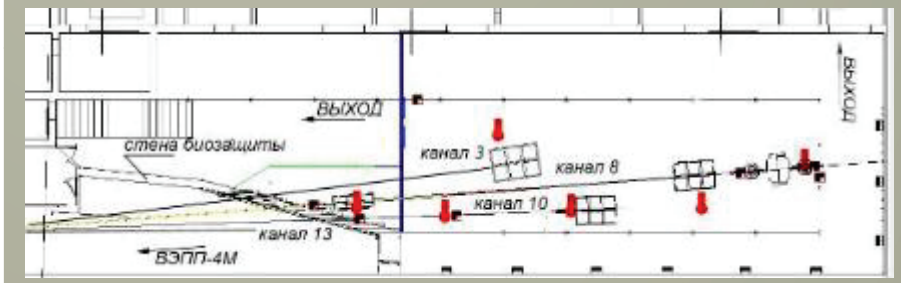


synchrotron radiation

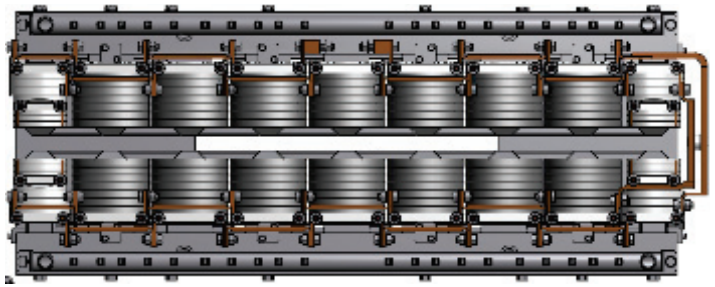


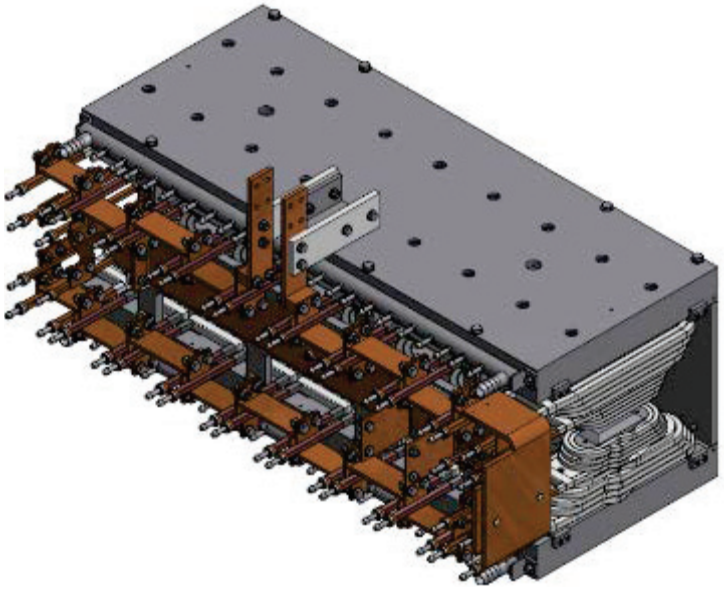
	VEPP-3	VEPP-4M
1	LIGA-technology and X-ray lithography.	Metrology experiments.
2	Fast dynamic process.	Phase contrast microscopy, micro-tomography and hard X-ray fluorescence.
3	Precise diffraction and anomalous scattering.	Nanosecond spectroscopy of fast processes.
4	X-ray fluorescence analysis.	Material study under extremal conditions
5	High pressure diffraction.	Material study for thermonuclear applications
6	X-ray microscopy and micro-tomography.	
7	Time resolved diffraction.	
8	Time resolved luminescence.	
9	Precise diffraction.	



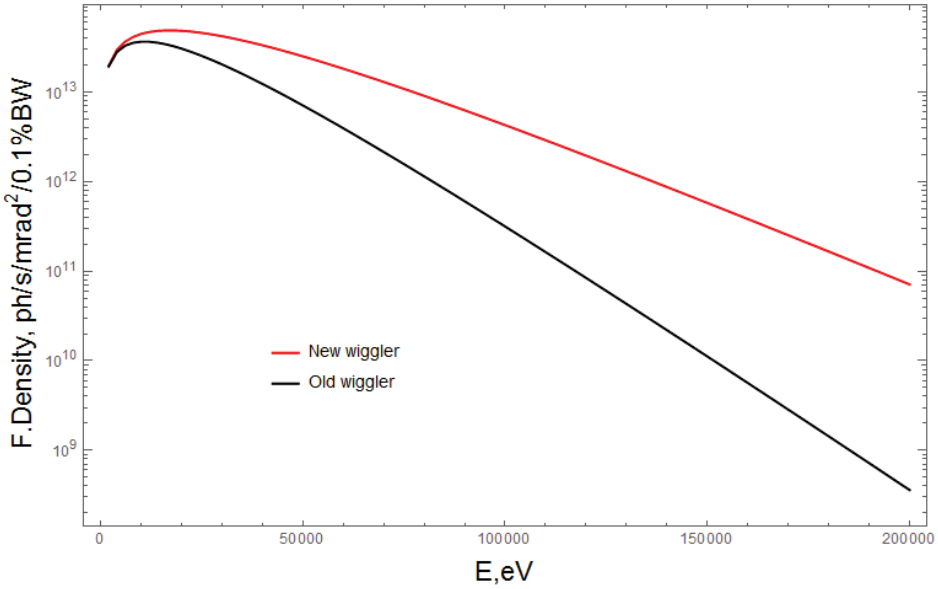


new wiggler @ VEPP-4M

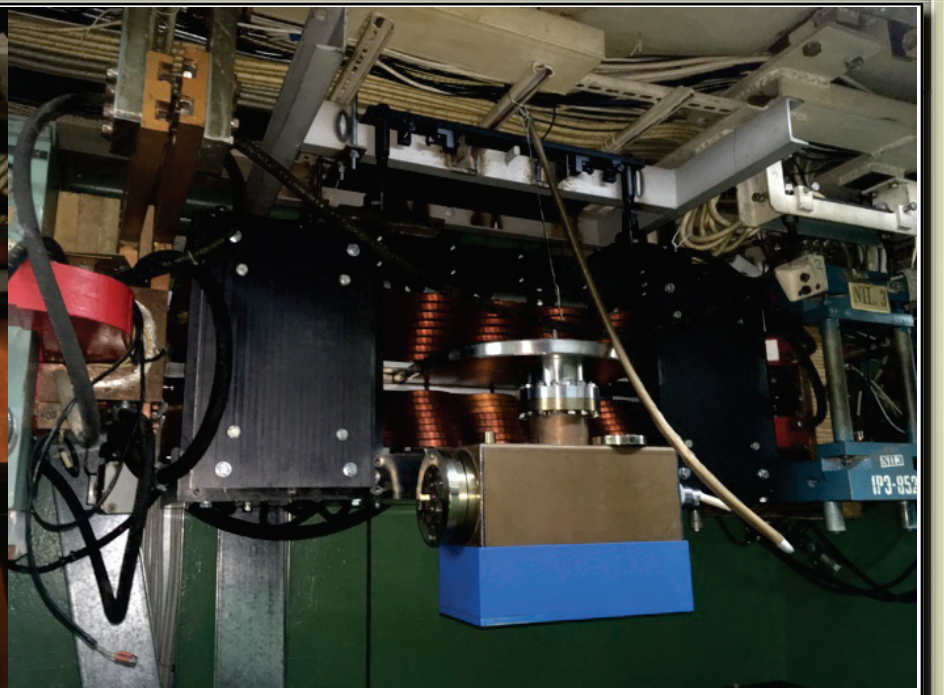


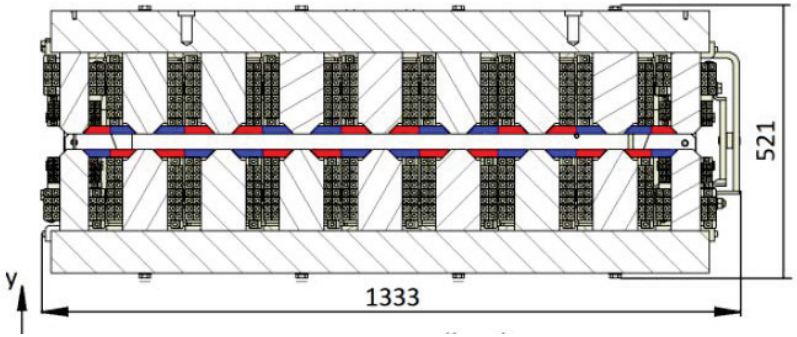


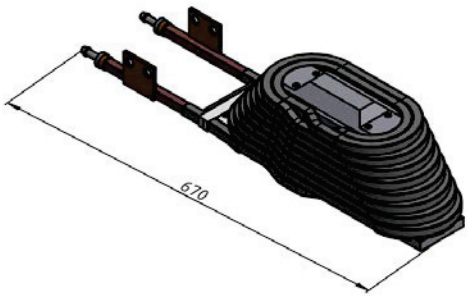
	Old	New	Unit
Field	13	19	kGs
Period	40	28	cm
Number of poles	5+2	7+2	
Gap	4	3	cm

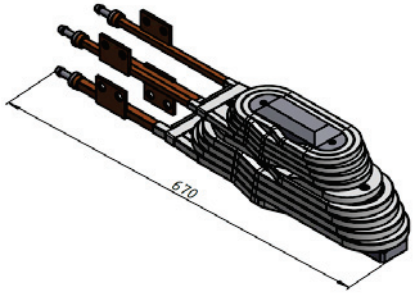


new wiggler @ VEPP-4M



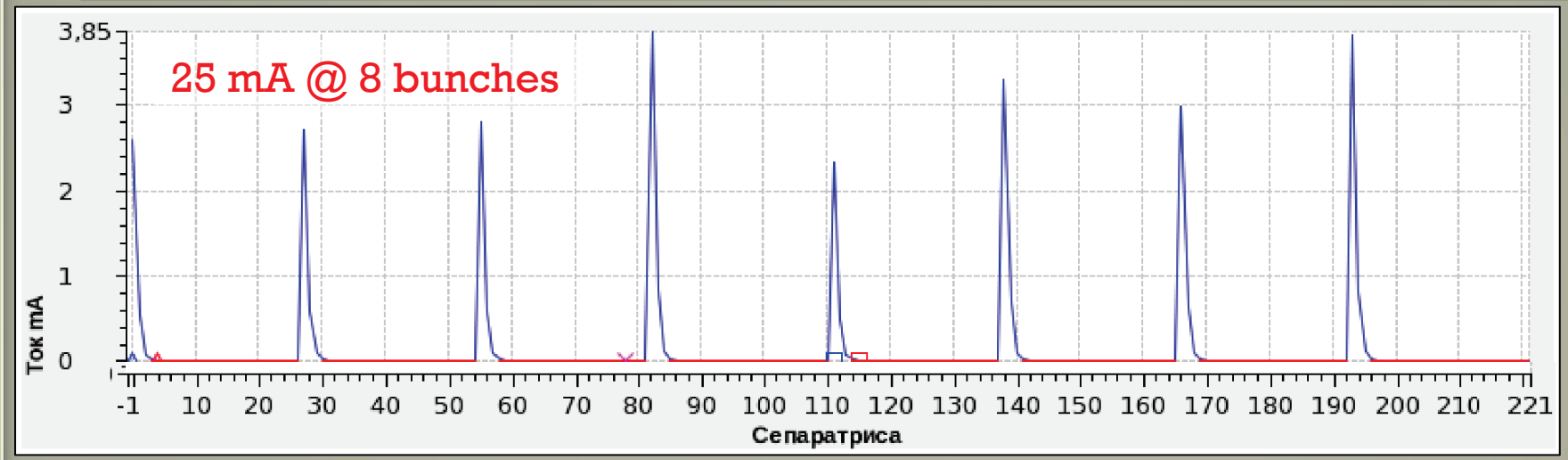


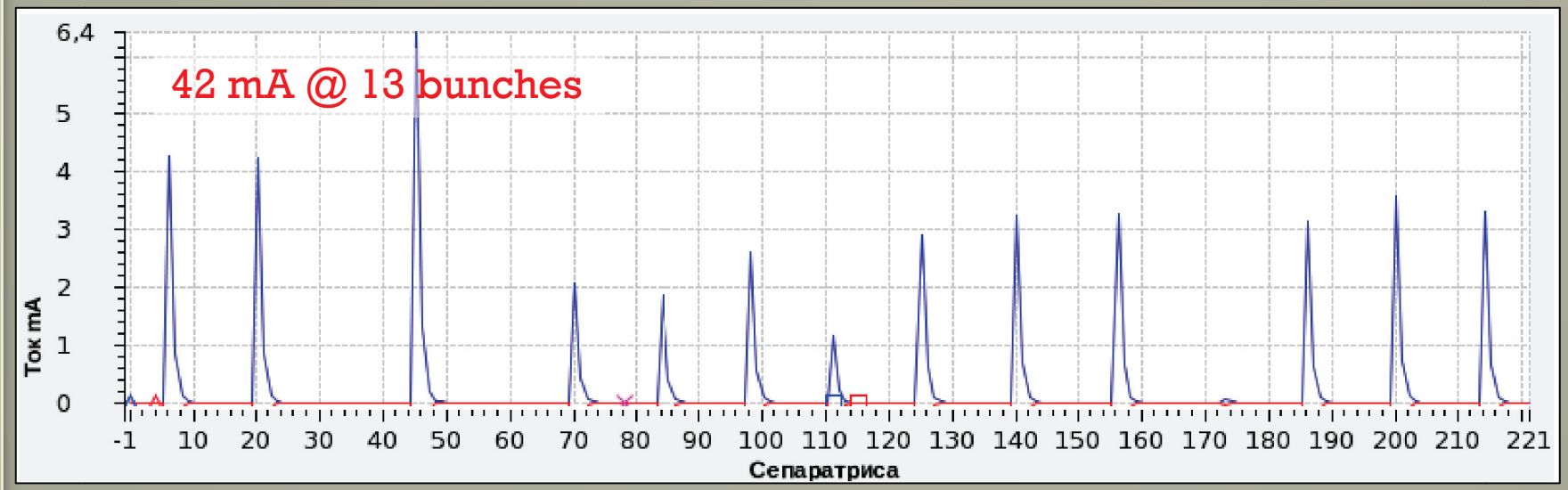




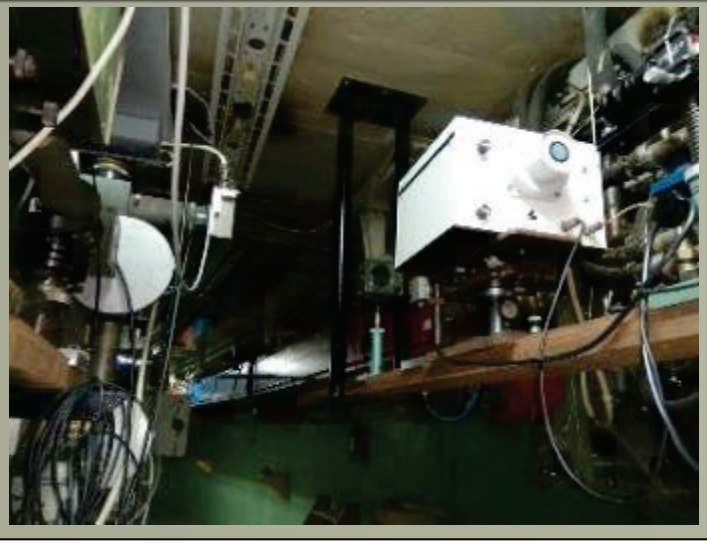
2 kA 60V 120 kW

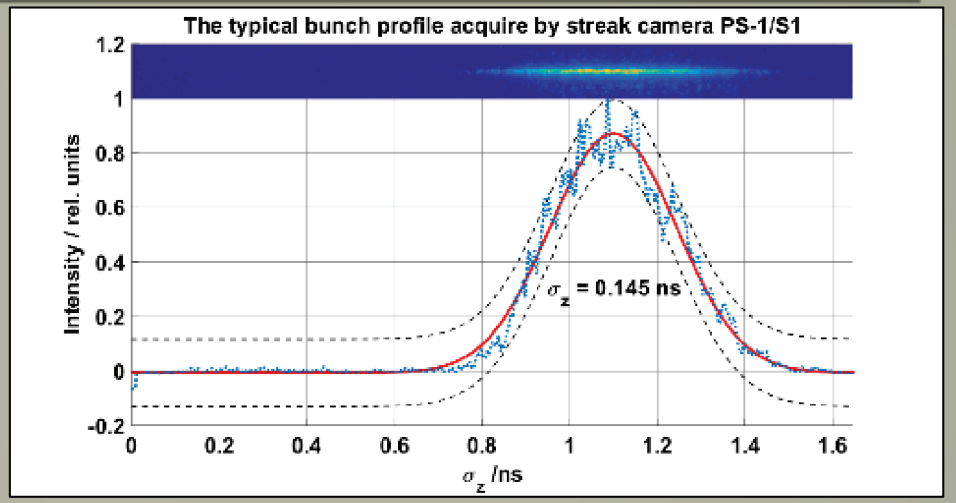
multi-bunch mode @ VEPP-4M

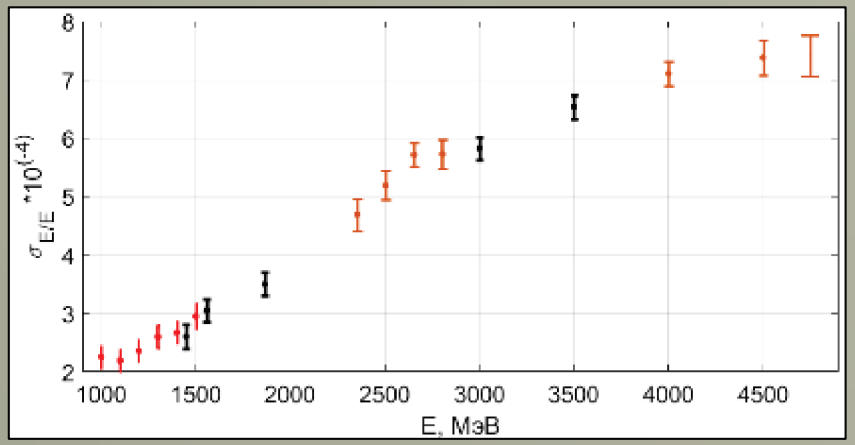




Streak-camera @ VEPP-4M





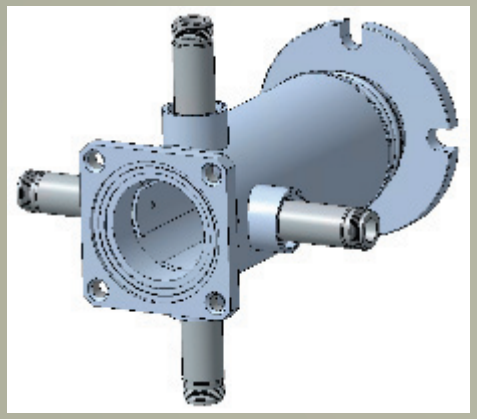


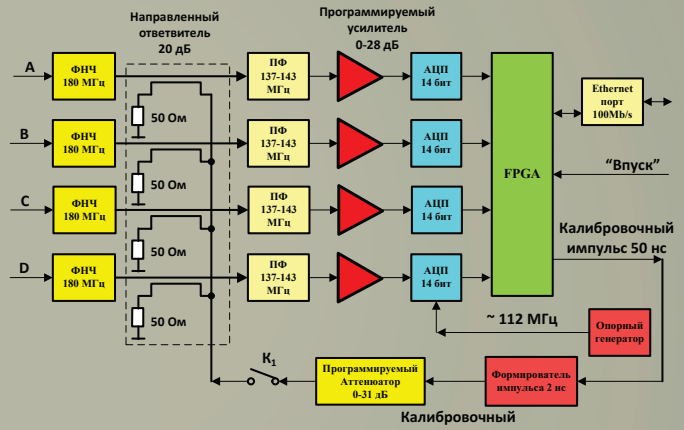
Parameter	Value
Time scan ranges	0.25, 0.75, 1,5, 10, 30, 100, 200 ns
Time nonlinearity of scans	less than 10%
Temporal resolution	1,5 ps
Spectral response	200-1300 ns
Maximum spectral sensitivity	800 nm
Effective photocathode diameter	6 mm
Effective phosphor screen diameter	25 mm
Maximum of the phosphor emission spectrum	540 nm
Sweep repetition frequency	no more than 100 Hz

See poster WEPSB35 "Measurements of energy spread at VEPP-4M" by V. Borin (BINP SB RAS) on Thursday, October 4

beam diagnostics

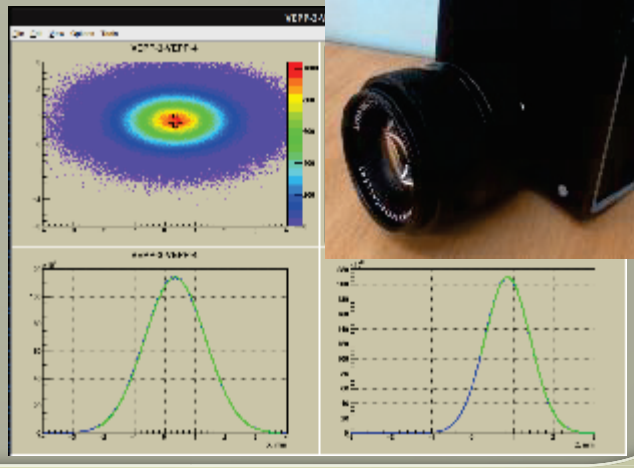
15 BPM
Длинна – 150 мм
Апертура – 40 мм
Соединение – N-type
Электроника
Формат – Евромеханика 1U
Питание – 220В
Управление – Ethernet
Разрешение – 10÷20 мкм



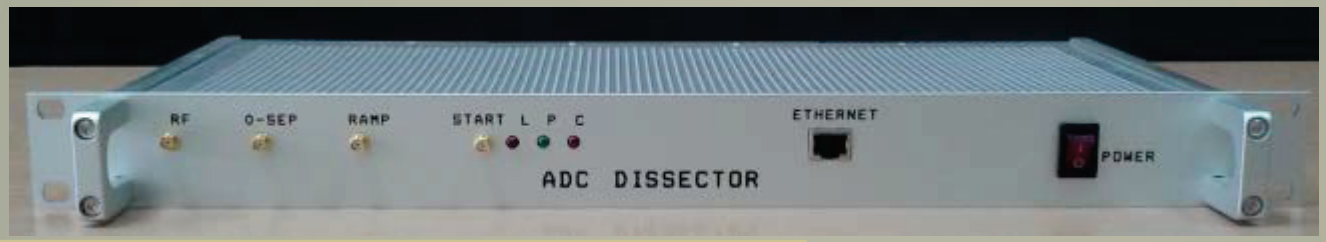


15 CCD-камер (CCD-матрица SONY ICX084AL)

Размер матрицы: 5.84 x 4.94 мм^2
Размер пикселя: 7.4 x 7.4 мкм^2
Разрешение: ~ 700 x 500
Чувствительность: ~ 800 фотонов/пиксель
Насыщение: ~ 10^5 фотонов/пиксель
Время накопления заряда: от 100 мкс до 3 с
Время считывания: 80 мс

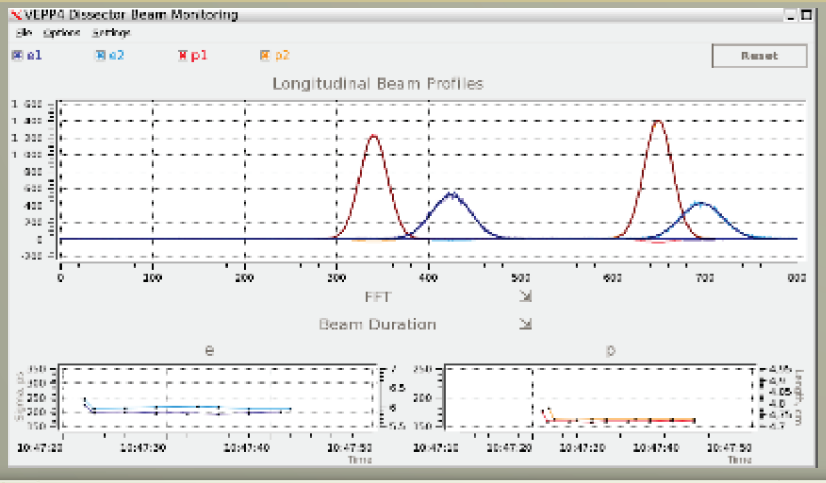


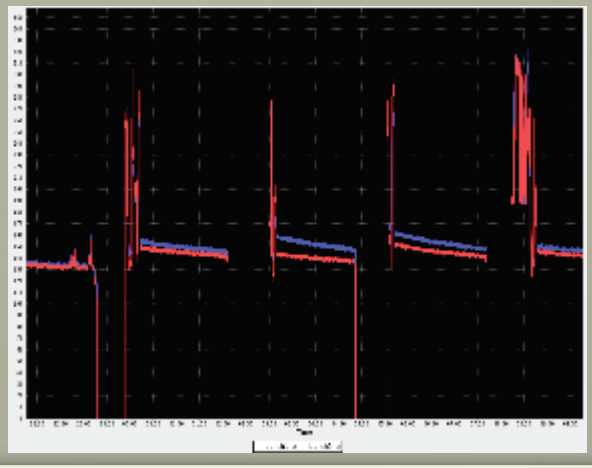
электроника Ф-диссектора



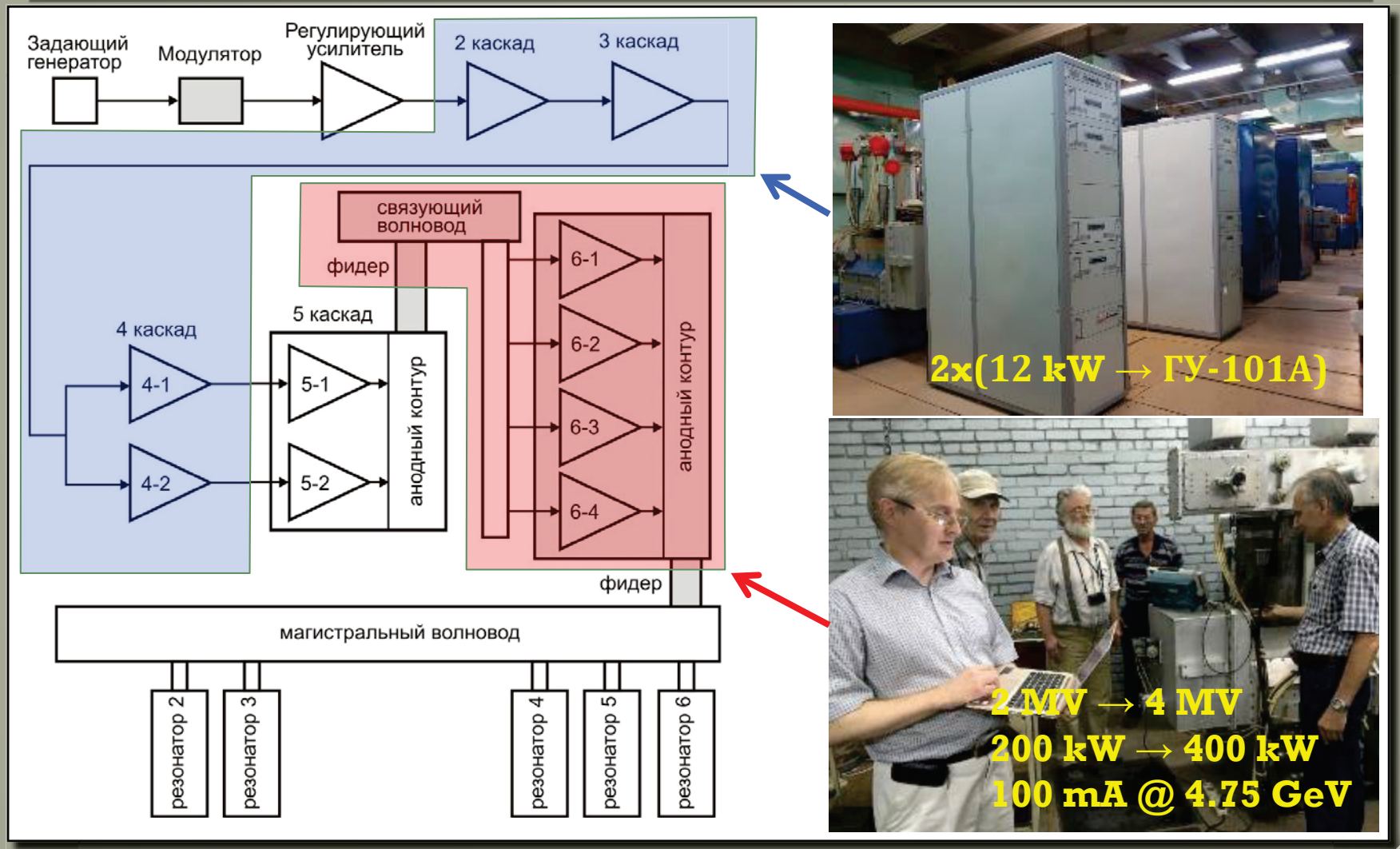
Параметр	Значение
Аналоговая полоса	~10 МГц
Разрядность АЦП	14
Шум, приведенный ко входу	~10 мкВ
Максимальное число точек "профиля" пучка	1024
Емкость буфера пооборотных измерений	1M (2^{20} оборотов)
Связь с блоком	Ethernet 100 Мбит/сек

Измерения "профиля" пучка
Пооборотные измерения сигнала диссектора при фиксированной точке на "профиле" пучка





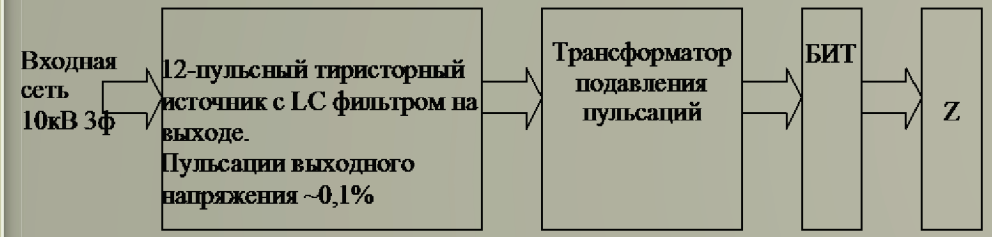
upgrade rf system



power supply upgrade

VEPP-3 ±15 kA 40 V 600 kW → 2 GeV

VEPP-4M +7.5 кА 70 V 525 kW → 6 GeV




ГПН ВЭПП-3


ИП ВЭПП-3


ИП ВЭПП-4М

conclusion

- ✓ New e± injector operates
- ✓ VEPP-4M started HEP program at high energy
- ✓ ½ R-scan 2x(2.3÷3.5) GeV is finished
- ✓ SR experiments at VEPP-3 – 1.2 & 2.0 GeV
- ✓ SR experiments at VEPP-4M – 1.9 & 4.5 GeV
- ✓ New hybrid wiggler is used
- ✓ VEPP-4M 5.2 GeV will be soon
- ✓ 200 pb^{-1} for gamma-gamma physics

thank you for attention