The BEPCII Project

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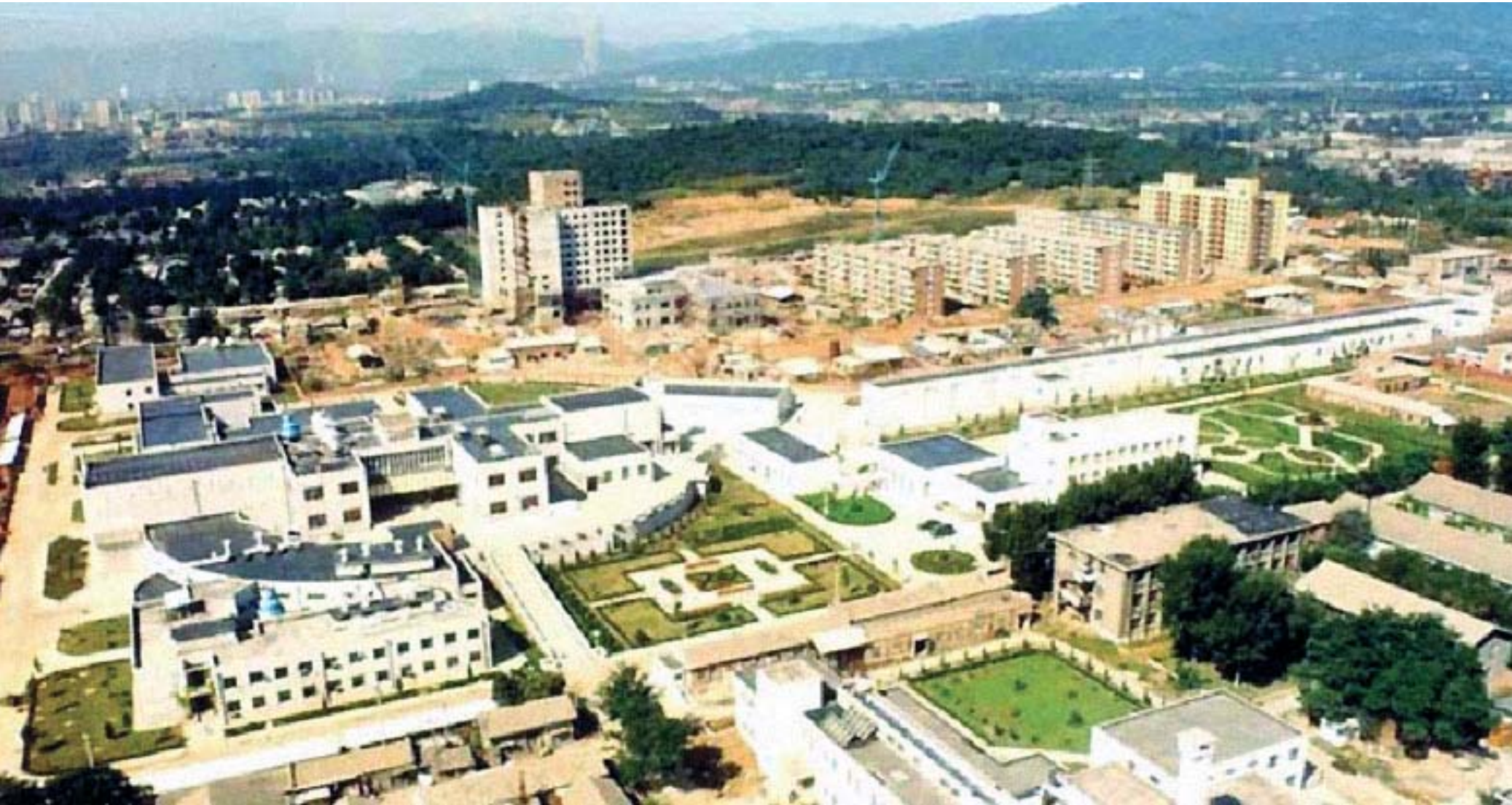
Outline

1. **BEPC/BES and physics results**
2. **BEPCII**
3. **BESIII**
4. **Budget and Schedule**
5. **Summary**

Beijing Electron Positron Collider: beam energy 1 – 2.8 GeV

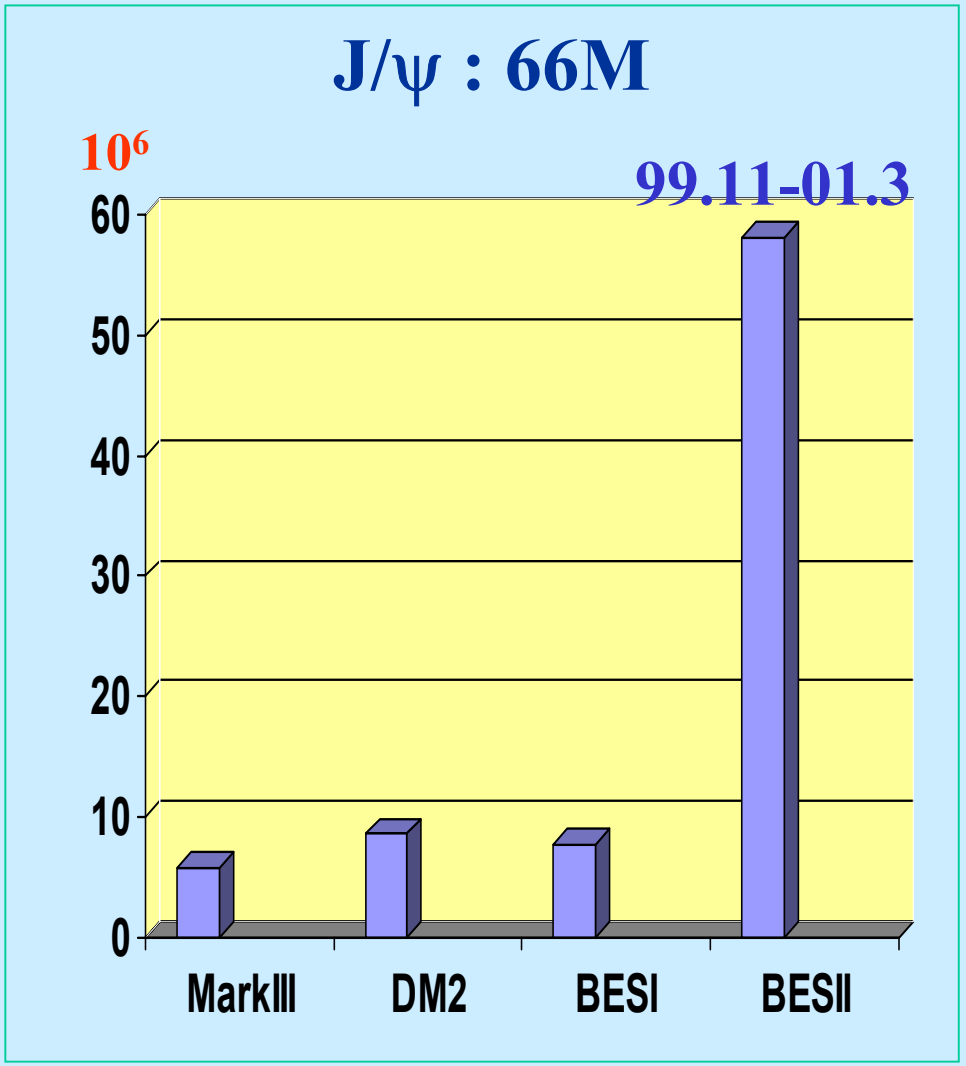
Physics Run：Luminosity $10^{31}cm^{-2}s^{-1}$ @ 1.89GeV, 5 month/year

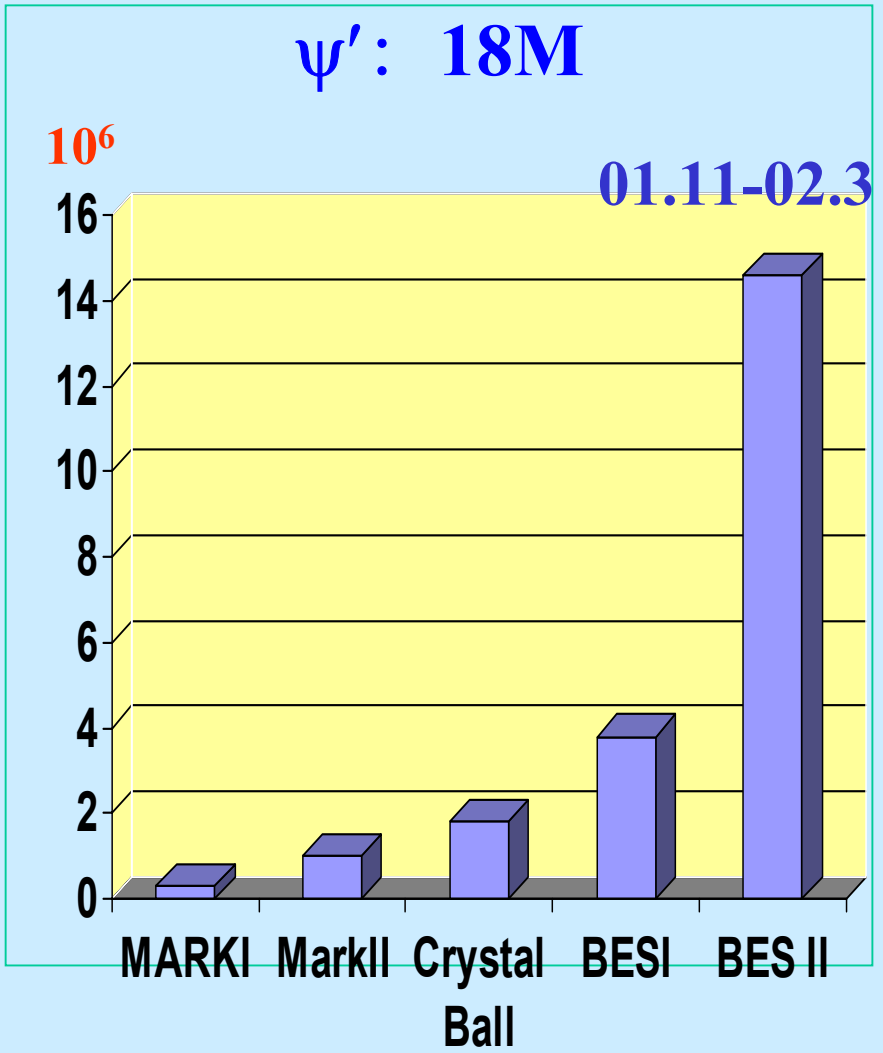
Synchrotron Radiation Run：140mA @ 2.2 GeV, 3 month/year



BES has the world largest J/ψ and ψ′ samples

plus: 2-5 GeV R scan, τ threshold, 8 pb^{-1} ψ″, 22.3pb^{-1} Ds …





Main Physics Results from BES

- **Precision measurement of τ mass:** 3 σ changed, factor of 10 improved in accuracy. $\rightarrow$ lepton universality.
- **Systematic study of ψ' decays:** new VT suppressed decay modes and First measurement of B(ψ(2S)$\rightarrow\tau+\tau-$).
- **Precision R Measurement at 2-5GeV:** ΔR/R: 15-20 % $\rightarrow$ 6.6%. Large impact on the SM Fit for Higgs mass, α (M_z^2) and g-2 experiment
- **Measurement of f_{Ds}** from pure leptonic decay of Ds.
- **Measure Br($D_S \rightarrow \varphi\pi$)** in a model independent way.
- 116 entries in PDG from BES.

Future of BEPC: High precision measurements in charm energy region (2-4 GeV)

- Test of Standard Model with high statistics
- QCD and hadron production mechanism
- Search for new phenomena

Major Upgrade: BEPCII

– High luminosity machine → High statistics

increasing by two orders of magnitudes

– High performance detector → Small systematic errors

- improve γ measurement, PID, $\Delta P/P$ and acceptance
- adapt to high event rate and short bunch spacing

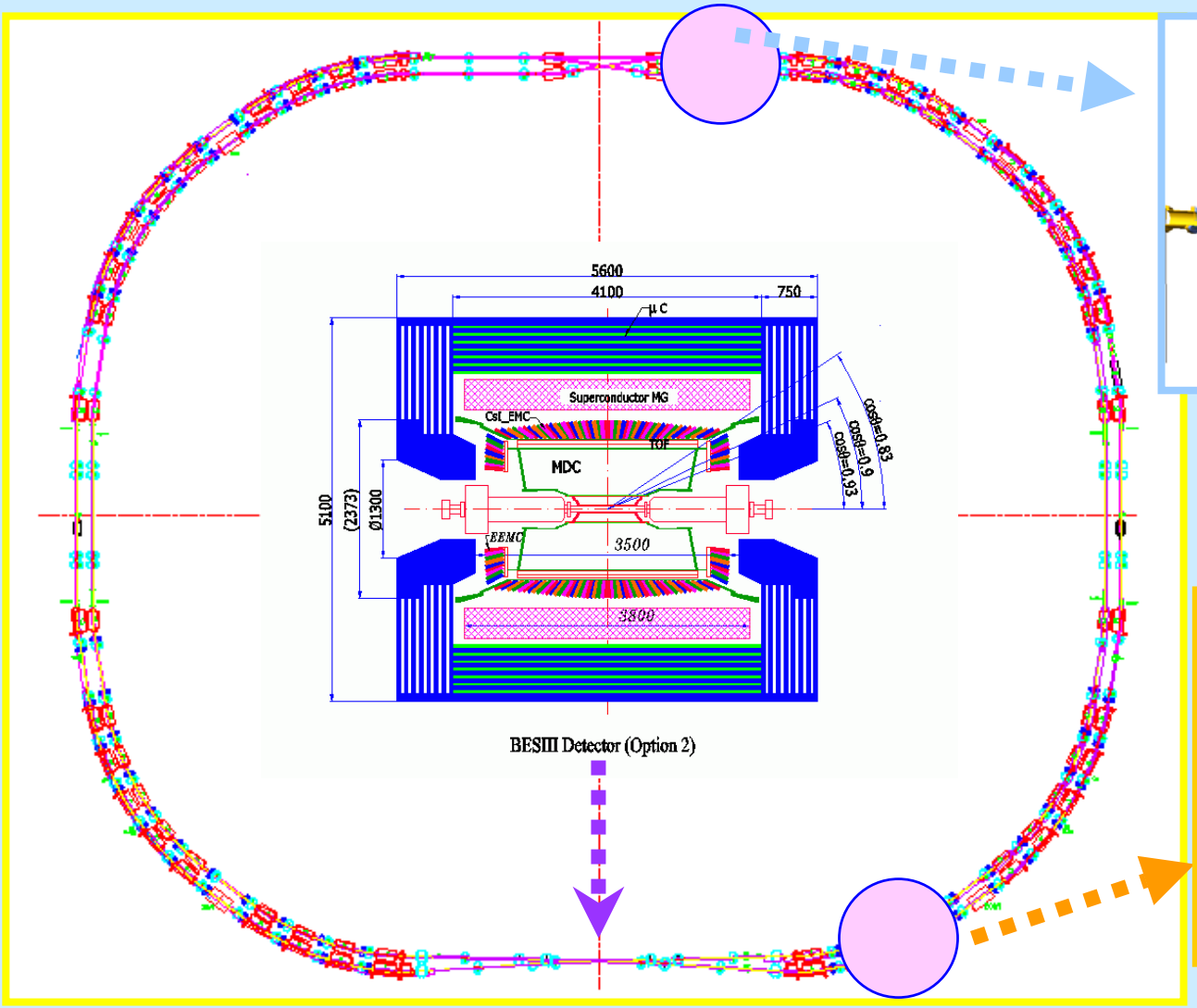
Physics Features in BEPCII

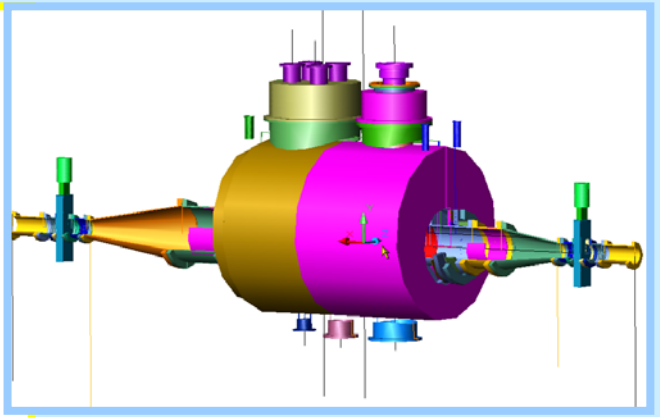
- **Transition between continuum and resonance's, perturbative and non-perturbative QCD**
- **Rich of resonance's, charmonium and charmed mesons.**
- **New type of hadronic matter predicted:**
  glueball and quark-gluon hybrid
- **Advantages at threshold :**
  - **Large production cross section ,**
  - **Low multiplicity,**
  - **Pure initial state,**
  - **Higher S/B**

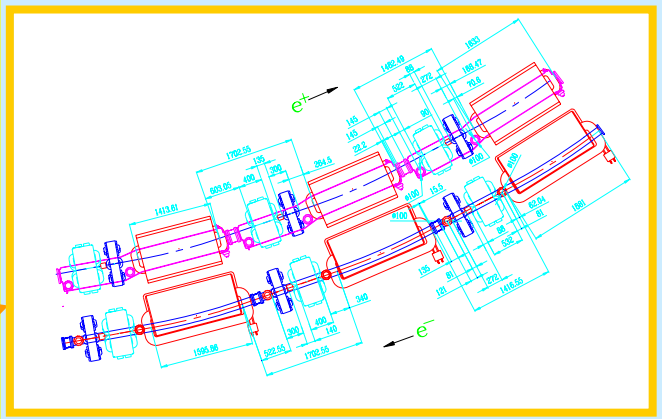
BEPC II: Physic Goals

- Precise measurements of J/ψ、 ψ′ & ψ″ Decays
- Precise measurement of CKM matrix.
- Light hadron spectroscopy & excited baryon
- D & Ds physics: decays, $f_{D,,}$ f_{Ds} , D^0 - $\bar{D}^0$ mixing
- Test VDM, NRQCD, PQCD, study ρπ puzzle
- Mechanism of hadron production，low energy QCD and precision measurement of R
- τ physics：charged current，$m_{\nu\tau}$ and m_τ
- Search for new particles: glueballs, quark-gluon hybrid, $^1P_1$, exotic states…
- Search for new phenomena: rare decays, lepton number violation, CP violation

BEPCII: *high luminosity double–ring collider*







Build new ring inside existing ring, two half new rings and two half old rings cross at two interaction regions, forming a double ring collider.

BEPCII: Double Ring Design

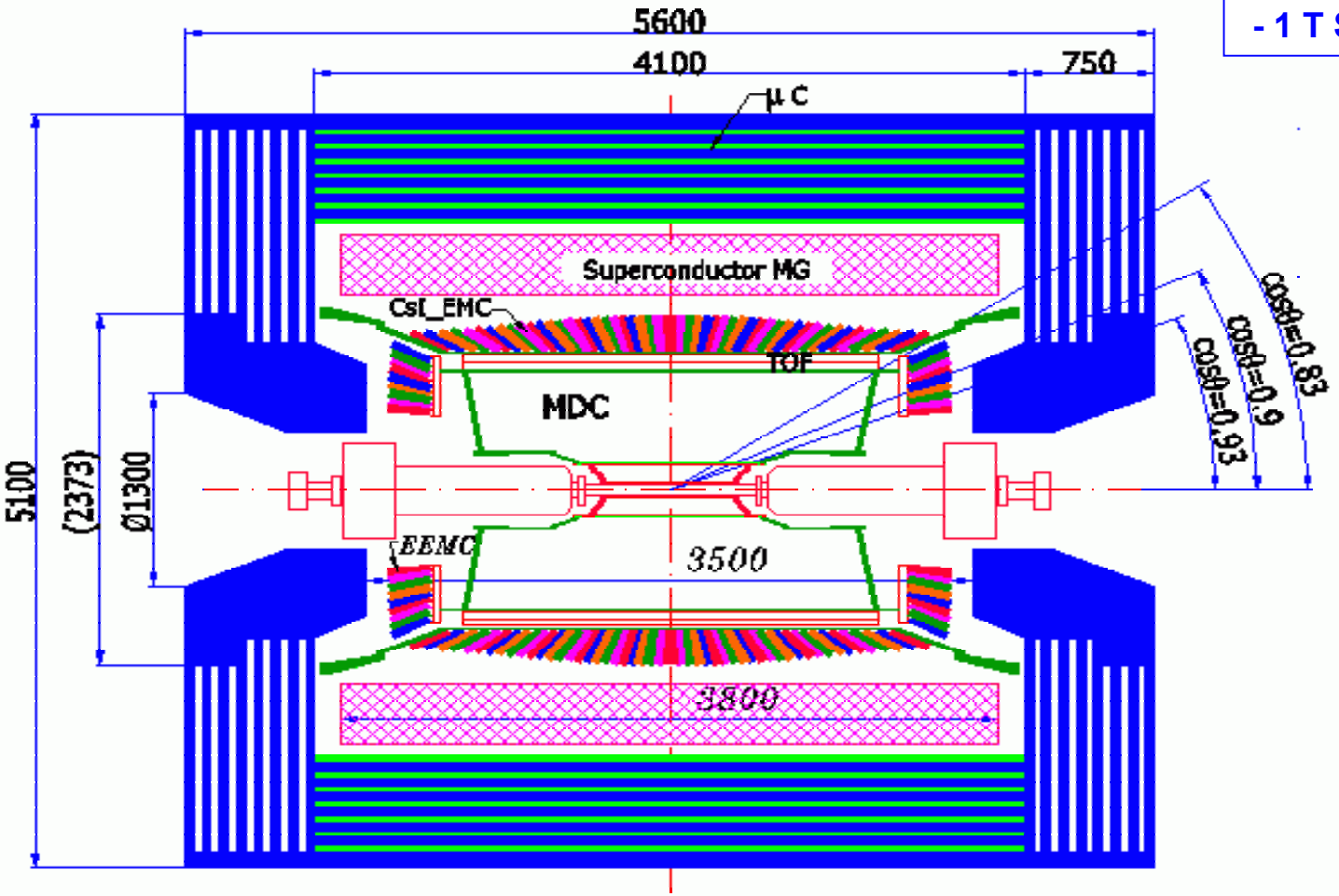
- Horizontal collision with large crossing angle: 11 mrad.
- 93 bunch / ring with total current ~ 1A , increasing from 20mA
- 500MHz RF with SC cavities and micro β magnets:

  reduce β_y 5cm $\rightarrow$ 1.5cm
- Design Luminosity ~ $10^{33}cm^{-2}\ s^{-1}$ @ 1.89GeV
- Dedicated Synchrotron Radiation: 250mA @ 2.5GeV
- e^+ Injection : 50mA/min. @ 1.89 GeV
- Estimated Cost ~ 77 M US$ (640 M Chinese Yuan)
- Lumi. is factors of 3 – 7 higher than CESRc

Event Rates Expected in BES III

Particle	Energy	Single Ring ($1.2f_b^{-1}$)	Double Ring ($4f_b^{-1}$)
D^0	ψ''	7.0×10^6	2.3×10^7
D^+	ψ''	5.0×10^6	1.7×10^7
Ds	4.14GeV	2.0×10^6	4×10^6
$\tau^+\tau^-$	3.57GeV 3.67GeV	0.6×10^6 2.9×10^6	0.2×10^7 0.96×10^7
J/ψ		$3\text{-}4\times10^9$	$6\text{-}10\times10^9$
ψ'		0.6×10^9	2×10^9

BESIII detector



Magnet:
- 0.4-0.5 T existing BESII magnet
- 1 T Super conducting magnet

MDC: small cell & He gas
σ_{xy}=130 μm
σ_p/p = 0.5% @1GeV
dE/dx=6%

TOF:
σ_T = 80 ps Barrel
100 ps Endcap

EMCAL: CsI crystal
σ_E/E = 2.5% @1GeV
σ_z = 0.5 cm/$\sqrt{E}$

Muon ID: 9 layer RPC

Trigger: Tracks & Showers
Pipelined; Latency = 2.4μs

Data Acquisition:
Event rate = 3KHz
Thruput ~ 50 MB/s

- **Adapt to high event rate of BEPCII:**
  10^{33}cm^{-2} s^{-1} and bunch spacing 8ns
- **Reduce sys. errors to match high statistics**
  photon measurement, PID…
- **Increase acceptance**

Expected Physics Results from BESIII

Monte Carlo simulation show: with lum. increasing by two-orders of magnitude, a factor of 3 – 7 higher than CLEOc, BES III can obtain many important results in tau-charm physics

Topics:

- **Precise measure CKM parameters**
- **Precise R measurement**
- **Search for glueballs, determine spin and parity**
- **Search $^1P_1$**

Physics example 1 :

Precise measurement of CKM matrix

- Pure-leptonic and semi-leptonic decay Br. of D mesons to determine V_{cd} & V_{cs} (5 fb^{-1} → accuracy of 0.6 – 1.5%)
- Hadronic decay Br. of D mesons to determine V_{cb}

  (5 fb^{-1} → accuracy of 0.4-0.6%)
- f_D and f_{Ds} (with $\delta f_{Ds}/f_{Ds} \approx 3.5\ \%$) for V_{td} and V_{ts}
- Semi-leptonic shape of D and Ds decay for V_{ub}
- Test unitarity of CKM matrix

Physics exam. 2: R measurement (2-4 GeV)

Error Source	BESII reach(%)	BESIII goal(%)
Luminosity	2 - 3	1
Selection effi.	3 - 4	1 - 2
Trigger effi.	0.5	0.5
Radiation corr.	1 - 2	1
hadron decay model	2 - 3	1 – 2
Statistical	2.5	--
Total error	6 – 7	2 - 3

Physics example 3: search for glueball

PWA of Spin-parity

- **J/ψ → γ KK**

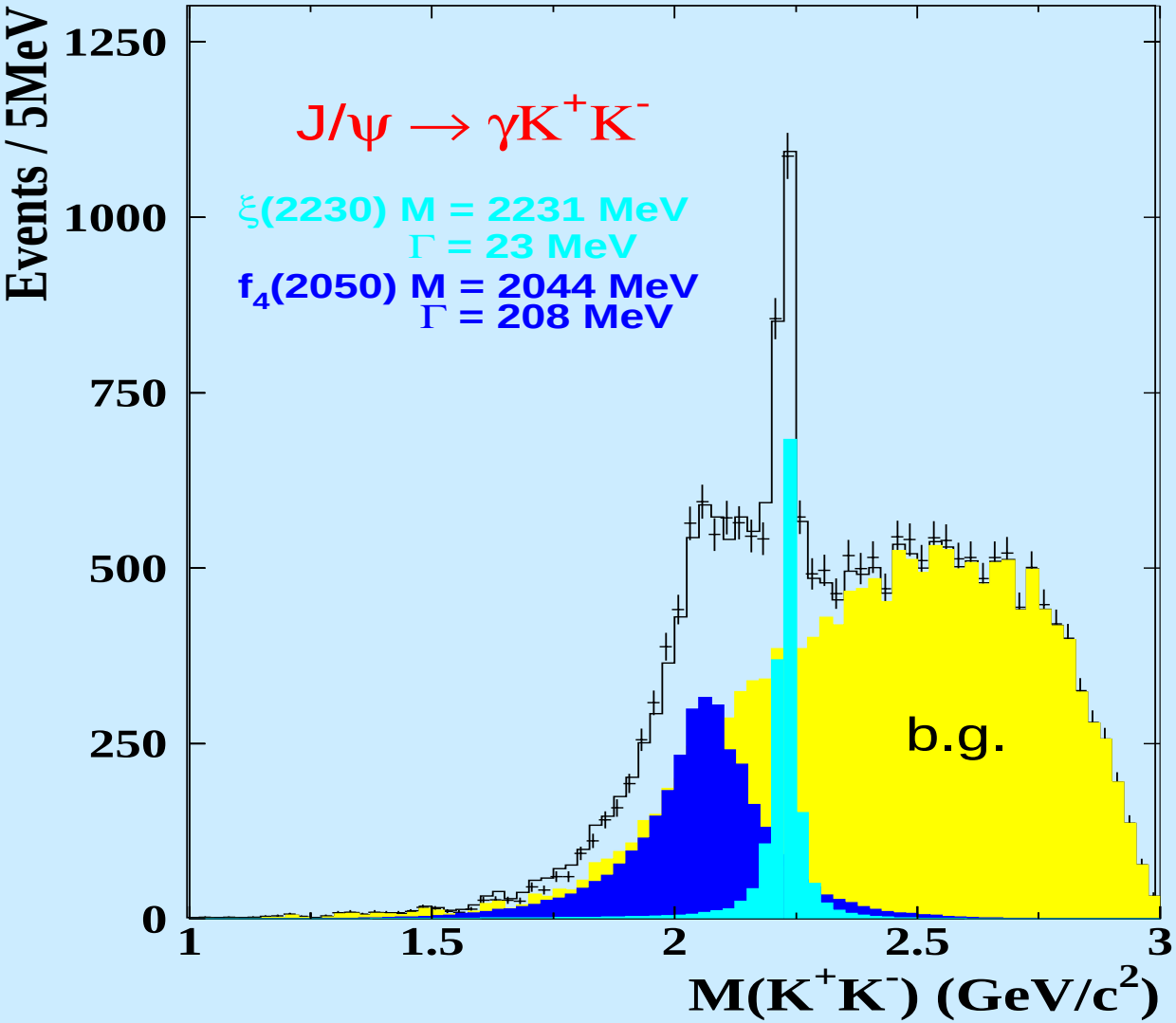
Can determine:

2++ ξ(2230)

4++ f_4(2050)

Background mainly:

K*K



Physics example 4: Search for $^1P_1$

$\psi(2S) \rightarrow \pi^0\ ^1P_1 \rightarrow \gamma\gamma\gamma$

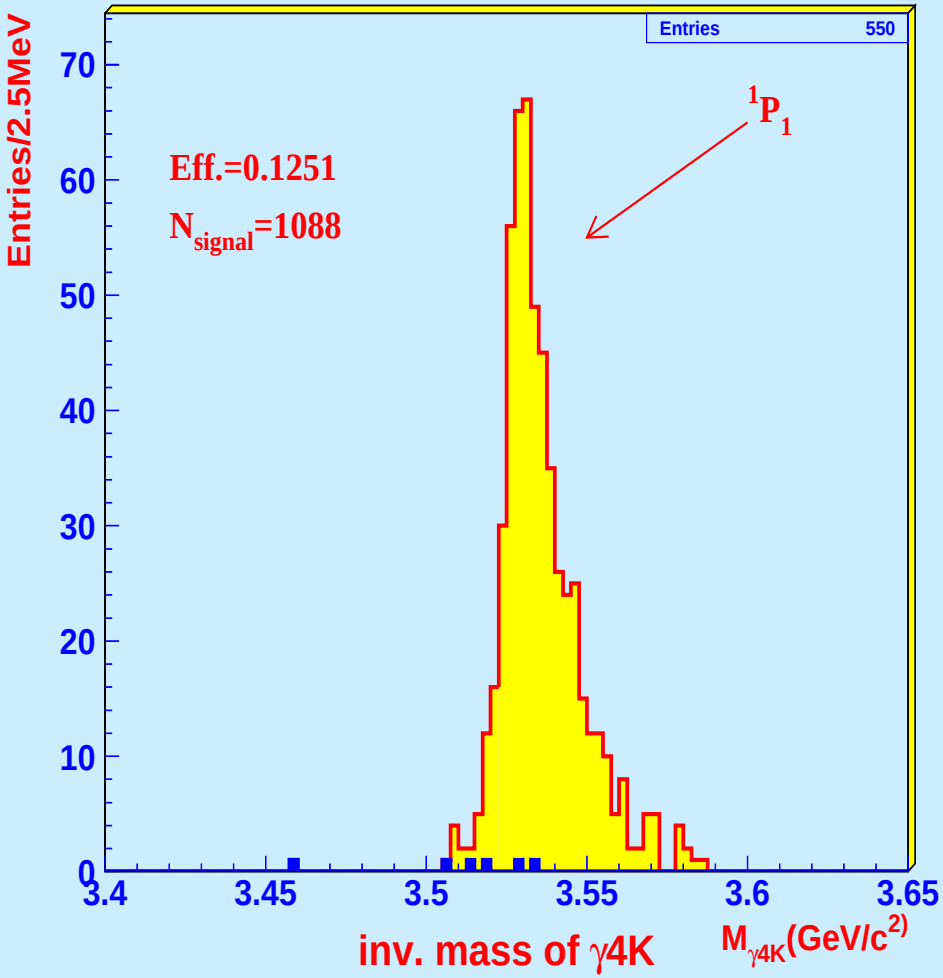
$\eta_c \rightarrow \gamma\gamma\gamma$ 4K

Br = $(1.2 - 3.3) \times 10^{-6}$

450-1200 evts/year

Background:

$\psi(2S) \rightarrow \gamma\ \chi_{c1}, \gamma\chi_{c2}, \eta\psi, \pi^0\pi^0\psi$



Budget

- **The budget estimated is about 640M RMB (77M$)**
  - **Linac: 44 M**
  - **Machine: 229 M**
  - **Detector: 210 M**
  - **Utility and infrastructure: 97 M**
  - **Contingency 60 M**
- **Chinese Government agreed to provide 540M RMB (65M$), covering most of cost of machine and about ¾ of the cost of the detector.**
- **Intl. Contribution and collaboration needed.**
- **Funding paper work is under way.**

Schedule: Physics run by end of 2006

- Feasibility Study Report of BEPC II has been submitted to the funding agency .
- Technical Design Report to be submitted by summer 02.
- Construction started by Autumn 02.
- Linac upgrade + BESII detector removing Summer of 2004.
- Preliminary date of the machine long shutdown for installation : April – Dec. 2005.
- Tuning of Machine without detector : Jan.- May. 2006.
- BESIII detector moved into beam line: June- Aug. 2006.
- Machine-detector tuning: Sept. – Dec. 2006.
- Physics run by end of 2006 .

Intl. Collaboration on BEPCII / BESIII

- **Construction of BEPCII/BESIII and obtaining world class results are big challenge to Chinese HEP physicists**
- **BESIII will be competitive in producing very interesting physics results in the precision measurement frontier, and attract intl. collaborator.**
- **Intl. collaboration could share the cost, help to meet the technical challenges, better detector performance and physics analysis.**
- **Welcome to joint BESII ! Many physicists from Japan, US and Europe show strong interest in both to join the collaboration and technical transfer.**

Summary

- **BEPCII: double-ring collider with micro-β. Lumi. will increased by a factor of 100 in energy range of *J/ψ* and ψ′.**
- **BESIII with High performance (SC magnet, crystal calorimeter, MDCIV…) to adapt high event rate and to provide small systematic errors.**
- **BEPC II / BES III are competitive with CESRc/CLEOc, specially in *J/ψ* and ψ′.**
- **Total cost estimation is 77M$.**
- **Chinese Government approved BEPCII, and provides 65M$.**
- **Schedule: start physics running by the end of 2006.**
- **International collaboration and contribution are essential to accomplish this challenging and exciting project on schedule and budget.**