Future experiments @ DAΦNE

- The DAΦNE machine and present experiments
- Machine improvement and near future physics program
- The DANAE project and the nucleon form factor measurement
- Outlook and Conclusions

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MAMI and Beyond
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Schloss Waldthausen, Mainz (Germany)
LNF : Frascati National Laboratory (Rome)

DAΦNE
**DAΦNE: the Frascati φ-factory**

$e^+e^-$ collider @ $\sqrt{s} = M_\phi = 1019.4$ MeV

2 interaction regions

Separate $e^+$, $e^-$ rings
Experiments @ DAΦNE

Three experiments running at DAFNE

- KLOE: study of kaon and hadronic physics
- DEAR/SIDDHARTA: study of kaonic atoms
- FINUDA: study of hypernuclei
Physics Program:

- DAΦNE is a ‘Kaon Factory’
- CP, CPT – Tests
- Strong source of r, η, η’ and scalars f_0(980), a_0(980)
- Continuum physics: e^+e^- → π^+π^-

σ_p/p = 0.4% (for 90° tracks)
σ_{xy} ~ 150mm, σ_z ~ 2 mm
Excellent momentum resolution

σ_E/E = 5.7% / √E(GeV)
σ_T = 57 ps / √E(GeV) + 100 ps
(Bunch length contribution subtracted from constant term)
Excellent timing resolution

• Data taking finished on 03/2006
• Integrated $\mathcal{L} \sim 2.5$ fb^{-1}

A lot of important results....
- measurement of the kaon lifetime and decays with an accuracy of fraction of %
  ⇒ significantly changed the listing of PDG kaon branching ratios
  ⇒ more precise test of the unitarity of CKM matrix
- $K_s \rightarrow 3\pi^0$: BR ≤ 1.2x 10^{-7} @ 90% C.L. most stringent limit at present (CPT test - BR ~ 1.9 x 10^{-9})
- most stringent limit in the BR ($\eta \rightarrow 3\gamma$) and ($\eta \rightarrow \pi^+\pi^-$) - probe of mesons properties & structures
The K\(^-\) can be stopped in thin targets (~ 0.2 \(\text{g cm}^{-2}\))

\(\Delta E \sim 1.3 \text{ MeV FWHM}\)

\(1^2\text{C}(K^-_{\text{stop}},\pi)^{12}_K\text{C}\)

\(\text{FINUDA}\)

- Data taking finished on 2007
- Integrated \(\hat{\mathcal{L}} \sim 1.2 \text{ fb}^{-1}\)
  - \(^{12}\text{C}, ^{6}\text{Li}, ^{7}\text{Li}, ^{27}\text{Al}, ^{9}\text{Be}, ^{13}\text{C}, D_2O\) nuclear targets

\(\text{Hypernuclear decay}\)

\(\text{Hypernuclear spectroscopy}\)

\(\frac{p\Lambda}{(13\%)}\)

\(2\Lambda\text{K}\)

\(\frac{K_0\text{K}_1}{(34\%)}\)

\(~16 \text{ MeV}\)

\(1^2\text{C\text{stop}} + \Lambda^\text{Z} \rightarrow \Lambda^\text{Z} + \pi^-\)

- study of baryon-baryon weak processes in nuclear matter:
  - \(\Lambda \rightarrow \pi N\) and \(\Delta N \rightarrow NN\) and \(\Delta NN \rightarrow NNN\)
  - Neutron-rich hypernuclei

- essential tool for testing:
  - theoretical models of \(\Lambda\text{-N potentials}\)
  - single particle nuclear model predictions
  - bound states with strangeness

Possible Kaon nuclear bound state formation:

\(K^- (pp) \rightarrow X \rightarrow \Lambda p\)

\(\rightarrow \Sigma^0 p \rightarrow \Lambda \gamma p\)
**SIDDHARTA**

*Silicon Drift Detector for Hadronic Atom Research by Timing Applications*

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**DEAR Results on the Shift and Width**

**Shift:** \( \epsilon_{1s} = -193 \pm 37 \text{ (stat.)} \pm 6 \text{ (syst.)} \text{ eV} \)

**Width:** \( \Gamma_{1s} = 249 \pm 111 \text{ (stat.)} \pm 30 \text{ (syst.)} \text{ eV} \)


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- Data taking will finish middle 2009

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Determination of the *isospin dependent KN scattering lengths* through a \(~\text{few eV measurement of the shift and of the width of the } K_\alpha \text{ line of kaonic hydrogen and the first (similar) measurement of kaonic deuterium}~\) (improving by about one order of magnitude the DEAR results)

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\[ \Gamma \]

\[ K_\alpha \sim 6.3 \text{ keV} \]

\[ = \Delta E_{2p \rightarrow 1s} \]

---

\[ E_{1s} \]

---

\[ E_{2p} \]

---

\[ n \]

\[ s \]

\[ p \]

\[ d \]
Prospects

Prospect_1:
DAΦNE-2: DAΦNE @ higher luminosity \((5 \cdot 10^{32} \text{ cm}^{-2}\text{s}^{-1})\)

KLOE-2: Extension/completion of KLOE physics program with ~ 10 times more statistics

Amadeus: deeply bound kaonic states

Prospect_2:
DANAE project: high luminosity - high energy program (center of mass energy up to 2.5 GeV)

KLOE-2: hadronic cross-section \((g-2, \alpha_{\text{em}}), \gamma\gamma\) physics

DANTE: baryon time-like form factors

Prospect_3:
SuperB factory
DAΦNE luminosity history

Total KLOE $\int L \, dt \sim 2400 \, \text{pb}^{-1}$ (2001,02,04,05)

Day performance: 7-8 \text{pb}^{-1}

Best month $\int L \, dt \sim 200 \, \text{pb}^{-1}$

KLOE: max peak luminosity: $1.5 \times 10^{32} \, \text{cm}^{-2}\text{s}^{-1}$

FINUDA: max peak luminosity: $1.6 \times 10^{32} \, \text{cm}^{-2}\text{s}^{-1}$

111 bunches, $\beta_y^* = 1.8 \, \text{cm}$, $\beta_x^* = 1.5 \, \text{m}$

106 bunches, $\beta_y^* = 1.9 \, \text{cm}$, $\beta_x^* = 2.0 \, \text{m}$
DAΦNE is testing now a new scheme to increase luminosity:

The DAΦNE upgrade aims at increasing the peak luminosity by a factor 2÷6 exploiting the novel concepts of

- low emittance beams
- large Piwinsky angle
- crab waist

The achievement of the DAΦNE luminosity goal is a crucial milestone in the SuperB program.
New concepts for high luminosity

1) Large Piwisky angle $\Phi$

$\Phi \approx \frac{\sigma_z}{\sigma_x} \frac{\theta}{2}$

obtained by small $\sigma_x$, large $\theta$

$\Sigma \propto \frac{\sigma_x}{\theta}$

$\Rightarrow$ overlapping area getting smaller $\Rightarrow$ higher luminosity

$\beta_y \propto \frac{\sigma_x}{\theta} \ll \sigma_z$ $\Rightarrow$ suppression of the vertical syncrobetatron resonances

2) Crab-Waist compensation obtained by 2 sextupole (before and after the IP)

Boost of the luminosity
DAΦNE Luminosity versus colliding currents

- Commissioning started at the end of November 2007
- February 2008 Crab-Waist sextupoles in operation

NEW COLLISION SCHEME:
Large Piwinski angle
Crab-Waist compensation SXTs ON
\( \theta_{PW} = 1.9 \) \( \beta_y = 9.0 \) [mm]

original collision scheme
KLOE 2005 \( \theta_{PW} = 0.6 \) \( \beta_y = 18. \) [mm]
KLOE 2002 \( \theta_{PW} = 0.3 \) \( \beta_y = 25. \) [mm]

Courtesy of C. Milardi
# DAΦNE Upgrade

![Graph showing luminosity vs. $I^+ \cdot I^-$](image)

**March 13\(^{th}\) 2009**

**March 15\(^{th}\) 2009**

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**Courtesy of C. Milardi**

<table>
<thead>
<tr>
<th>DAΦNE upgrade SIDDHARTA</th>
<th>DAΦNE KLOE</th>
<th>DAΦNE FINUDA</th>
</tr>
</thead>
<tbody>
<tr>
<td>$L_{\text{peak}}$ [cm$^{-2}$s$^{-1}$]</td>
<td>$4.36 \cdot 10^{32}$</td>
<td>$1.5 \cdot 10^{32}$</td>
</tr>
<tr>
<td>$L_{\text{day}}$ [pb$^{-1}$]</td>
<td>$14.98$</td>
<td>$9.8$</td>
</tr>
<tr>
<td>$L_{\text{1 hour}}$ [pb$^{-1}$]</td>
<td>$1.033$</td>
<td>$0.44$</td>
</tr>
<tr>
<td>$I_{\text{MAX}}$ in collision [A]</td>
<td>$1.4$</td>
<td>$1.4$</td>
</tr>
<tr>
<td>$I^+_{\text{MAX}}$ in collision [A]</td>
<td>$1.1$</td>
<td>$1.2$</td>
</tr>
<tr>
<td>$N_{\text{bunches}}$</td>
<td>$105$</td>
<td>$111$</td>
</tr>
</tbody>
</table>
Scaling the present data from the luminosity monitor:

\[ L_{\text{1 hour}} = 1.033 \text{ pb}^{-1} \]

\[ L_{\text{day}} \geq 20. \text{ pb}^{-1} \text{ seems possible!} \]

Assuming 80% collider uptime \[ \Rightarrow L_{\text{month}} \approx 0.5 \text{ fb}^{-1} \]

\[ L_{\text{year}} \approx 5 \text{ fb}^{-1} \text{ realistic} \]

..... in fact a new KLOE run has been approved, the detector should roll back on this fall
KLOE-2@ DAΦNE-2: Physics goals at the $\phi$ peak

- Discrete symmetries test (C,P,CP,CPT)
- Precise measurement of $V_{us}$
- Test of SM
- QCD low energy + cPT tests
- Scalar and Pseudoscalar meson physics

(http://www.lnf.infn.it/kloe/kloe2)

5 fb$^{-1}$ (step 0)
- Set the best limits on several QM-CPT-violating parameters
- Precision measurements of several $K_S$, $\eta$ and $\eta'$ rare decays
- First observation of $f_0,a_0 \rightarrow KK$ events
- Invariant mass measurement of the $e^+e^- \rightarrow e^+e^-\pi\pi$ reaction for cPT studies

$\geq$ 20 fb$^{-1}$ (step 1)
- Put the ultimate limits on the QM-CPT-violating parameters
- Measurement with a $\sim 0.2\%$ precision of $V_{us}$
- $Re(\epsilon'/\epsilon)$ measurement with a $\sim 10^{-4}$ precision
- ….
KLOE-2: Upgraded detector

- KLOE not fully optimized to detect low momentum tracks coming from IP
- Tracking starts at 25 cm from IP: both tracking and vertex efficiency affected
- at $\phi$ peak, $\gamma\gamma$ physics impossible without small angle $e^\pm$ tagger
- Physics and background rate could be an issue for DAQ and trigger

- Lower B field from 0.5 T to 0.3 T
- Be beam pipe
- Inner tracker at $10 < R < 25$ cm
- HET + LET tagger for $\gamma\gamma$ physics
- DAQ/computing upgrades
- QCAL around beam pipe

Step 0: mid-end 2009-2010
- APPROVED
Step 1: 2011 + 3 years
- TO DISCUSS

Total cost ~ 3-4 ME
Physics case: perform the first full acceptance, high precision measurement of DBKNS both in formation and in the decay processes, by using the stopped (in a target) $K^-$ method, by implementing the KLOE detector with an inner AMADEUS-dedicated setup, containing a cryogenic target and a trigger system.

Integrated luminosity request of about 10-20 fb$^{-1}$
From DAΦNE TO DANAE

DANAE: DAφne New - Adjustable Energy
Φ-factory + Wide energy range
High luminosity at Φ energy

• D. Alesini, et al: ”Preliminary Considerations on Machine Requirements for a Neutron-Antineutron Form Factor Experiment at Frascati”, G-63, 15/7/2005
• P. Iorio, C. Sanelli: ”28 Degree Dipole for DANAE Experiment”, G-70, 18/12/2006
**DANAE**

Energy and Luminosity Range

<table>
<thead>
<tr>
<th>Energy @ center of mass (GeV)</th>
<th>1.02</th>
<th>2.4</th>
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<tbody>
<tr>
<td>Integrated luminosity per year (fb^{-1}) &gt;</td>
<td>10</td>
<td>1</td>
</tr>
<tr>
<td>Total integrated luminosity (fb^{-1}) &gt;</td>
<td>50</td>
<td>3</td>
</tr>
<tr>
<td>Peak luminosity (cm^{-2} sec^{-1}) &gt;</td>
<td>$10^{33}$</td>
<td>$10^{32}$</td>
</tr>
</tbody>
</table>

- Use of DAΦNE buildings
- Use of DAΦNE infrastructures
- Use of DAΦNE injection system
- Upgrade of transfer lines
- Use of large part of magnets, diagnostics

**NEW**

- Dipoles
- Wigglers
- RF system
- Vacuum chamber
- Interaction region
Physics Prospects with DANAE

(1) **Hadron form-factors** in the time-like region

(2) Measurement of \([e^+e^- \rightarrow \text{hadrons}]\) cross-section in the range \(2M_\pi < \sqrt{s} < 2.5 \text{ GeV}\).
   - hadronic contributions to \(g-2\)
   - hadronic contributions to \(\alpha_{em}\) running
   - vector meson spectroscopy

(3) **Radiative decays** of vector mesons
   - \(\eta, \eta'\) physics (from the \(\phi\))
   - physics of **scalar mesons** (multiquark states)

(4) **\(\gamma\gamma\) physics**
   - \(\gamma\gamma \rightarrow \pi^0\pi^0, \pi^+\pi^-\) from threshold up to \(\sim 1\text{GeV}: \text{the } \sigma\)
   - \(\gamma\gamma\) widths of scalar and pseudoscalar mesons
     \((\pi^0, \eta, \eta', f_0(980), a_0(980))\)

Mostly hadron physics + precision tests of the SM
Letter of Intent by 82 physicist from 25 institution in 8 countries

- September 2005 - INFN-CSN3, Sabaudia
- September 2005 - Meeting on Future Plans at LNF
- September 2005 - INFN-CSN1 meeting, Napoli
- November 2005 Frascati 31st LNF Scientific Committee
- May 2006 - Frascati 32nd LNF Scientific Committee
- September 2006 - INFN Roadmap,
- November 2006 Frascati 33rd LNF Scientific Committee
Nucleon Time-like FFS are basically unknown

- no independent extraction of both TL FFs has been performed
- FF measurements are based on total cross section, under some theoretical assumption on their ratio

- Phases of time-like FFs never measured
- Only two measurement for neutron magnetic FF
- Inconsistencies between data and pQCD expectations
TL nucleon e.m. FFs measurements in the world

<table>
<thead>
<tr>
<th>Experiment</th>
<th>Conditions</th>
<th>Energy Range</th>
<th>Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Babar</td>
<td>p only - No polarization</td>
<td>Thr. $\sqrt{s} &lt; 10$ GeV</td>
<td>2006</td>
</tr>
<tr>
<td>Belle</td>
<td>p only - No polarization</td>
<td>Thr. $\sqrt{s} &lt; 10$ GeV</td>
<td>2006 + SuperB</td>
</tr>
<tr>
<td>CLEO</td>
<td>p only - No polarization</td>
<td>$\sqrt{s} = 3.7$ GeV</td>
<td>2005</td>
</tr>
<tr>
<td>BES</td>
<td>p only (very low statistics) - No pol</td>
<td>$2 &lt; \sqrt{s} &lt; 3$ GeV</td>
<td>2005</td>
</tr>
<tr>
<td>BESIII</td>
<td>L=10$^{33}$ p only - no polarization</td>
<td>2.4$&lt;\sqrt{s}&lt;4.1$ GeV</td>
<td>Under Comm.</td>
</tr>
<tr>
<td>VEPP-2000</td>
<td>L = 10$^{32}$ p and n - no polarization</td>
<td>Thr.$\sqrt{s} &lt; 2$ GeV</td>
<td>Under Comm.</td>
</tr>
<tr>
<td>PANDA</td>
<td>L=2 $\times$10$^{32}$ p only - no polarization</td>
<td>Thr.$\sqrt{s} &lt; 25$ GeV</td>
<td>2014-15</td>
</tr>
<tr>
<td>PAX</td>
<td>p only - double polarization</td>
<td>Thr.$\sqrt{s} &lt; 25$ GeV</td>
<td>?</td>
</tr>
</tbody>
</table>

The **DAΦNE energy upgrade** offers the opportunity to make a detailed study of the nucleon Form Factors, providing:
- accurate measurement of $\bar{p}p$ and $n\bar{n}$ cross section
  $\Rightarrow$ **model-independent extraction of proton and neutron FFs**
- first measurement of outgoing nucleon polarization
  $\Rightarrow$ **relative phase between $G_E$ and $G_M$**
**TIME-LIKE nucleon e.m. Form Factors**

Time like FFs are complex functions → moduli & phases

**Moduli:** extraction from $\sigma$, $d\sigma/d\Omega$ meas. in $e^+e^-\rightarrow NN$ and $pp\rightarrow e^+e^-$

\[
\sigma = \frac{4\alpha^2 \pi \beta C}{3s} \left| G_M \right|^2 \left( 1 + \frac{\rho^2}{2\tau} \right)
\]

\[
\frac{d\sigma}{d\Omega} = \frac{\alpha^2 \beta C}{4s} \left| G_M \right|^2 \left( 1 + \cos^2 \theta \right) + \frac{\rho^2}{\tau} \sin^2 \theta
\]

\[s=4M^2 \rightarrow \left| G_M \right| = \left| G_E \right|\]

\[s\gg4M^2 \rightarrow \left| G_M \right| >> \left| G_E \right|\]

**Phases:** extraction from polarization measurements

\[P_y = \frac{1}{\sqrt{\tau}} \frac{\rho \sin(2\theta) \sin(\delta_E - \delta_M)}{D}
\]

\[P_z = \frac{2\cos(\theta)}{D}
\]

\[P_x = -P \frac{1}{\sqrt{\tau}} \frac{2\rho \sin(\theta) \cos(\delta_E - \delta_M)}{D}
\]

\[D = \sigma_0 \left[ 1 + \cos^2(\theta) + \frac{\rho}{\tau} \sin^2(\theta) \right]
\]
TL nucleon e.m. FFs with DANAE and KLOE-2 measurement of the moduli

\[ e^+ e^- \rightarrow p p^- \quad e^+ e^- \rightarrow n n^- \]

p track in the DC
p-bar annihilation or track
n detected in the “spaghetti” calorimeter

Similar results obtained for \( E_n = 21 \) & 46 MeV

PRELIMINARY
FF measurement: projected accuracy

Integrated luminosity $\gg 700$-1000 pb$^{-1}$

Statistical error of the order of few percent for all the 4 nucleon FFs in the whole explored region

Study of angular asymmetry in pp (nn) distributions $\Rightarrow$ look for 2-photon contribution

Proton detection efficiency = 80%

Neutron detection efficiency = 15%
Induced polarization

- Polarization measured through second. scat
- Spin-orbit coupling causes azimuthal asymmetry

\[
P_x, P_z \propto P_e
\]

\[
P_y = \frac{1}{\sigma_0 \sqrt{\tau}} \frac{\rho \sin(2\theta) \sin(\delta_E - \delta_M)}{1 + \cos^2(\theta) + \rho \sin^2(\theta)}
\]

\[
\rho = \frac{|G_E|}{|G_M|}
\]

\[
d\sigma = \frac{d\sigma}{d\Omega} \left[ 1 + A(\theta,T) \left( P_y^C \cos \phi + P_x^C \sin \phi \right) \right]
\]
Proton Polarimeter

Counting rate is determined by the convolution of
- multiple scattering (small angle, Molière)
- strong nuclear scattering (large angle, exp. unpol. cross section and analyzing power)

Higher analyzer thickness ⇒ higher rate

but

- larger Molière angle $\theta_m$
- lower tracking resolution
Proton Polarimeter

Main parameters of the calculation
- total luminosity 2500 pb\(^{-1}\)
- electron beam energy 1.14 GeV \((T_p=0.2 \text{ GeV})\)
- total pp cross section: \(\sigma=0.34 \text{ nb}\)
- angular pp distribution from DR \(\Rightarrow \sin(\delta_E-\delta_M)=0.26\)

- carbon thickness \(T=1.5 \text{ cm}\), inner radius \(R = 25 \text{ cm}\)
- magnetic field \(B=0.5 \text{ T}\)

\[ P_y^c = P_y \cos \chi \]
Scattering angle distributions

12 $\theta_p$ bins of 15°

Good events for polarization measurement

$\theta_c < \theta_s < 40^\circ$
Polarimeter acceptance

\[ \varepsilon_{\text{max}} = 1.6\% \]
Azimuthal angle distributions

\[ \frac{d\sigma}{d\Omega} = (\frac{d\sigma}{d\Omega})_0 (\theta, T) \left[ 1 + A_c \cos \phi_{\text{scat}} + A_s \sin \phi_{\text{scat}} \right] \]

- Fit of angular distributions
  
  \[ N(\phi_{\text{scat}}) = p_1 (1 + A_c \cos \phi_{\text{scat}} + A_s \sin \phi_{\text{scat}}) \]
  
  \[ \propto P_y \]
  
  \[ \propto P_x \]

- L-R asymmetry with respect to the \( \phi_{\text{scat}} = 90^\circ \) axis

\[ A^I_c = \frac{N_+ - N_-}{N_+ + N_-} \propto P_y \]
Polarization extraction

\[ P_y \cdot \sin(\delta_E - \delta_M) = 0.2382 \pm 0.0255 \text{ (FIT)} \]
\[ P_y = A(\theta_{pp}) \cdot \sin(\delta_E - \delta_M) \]
\[ \sin(\delta_E - \delta_M) = 0.2376 \pm 0.0289 \text{ (ASYM)} \]

- consistent with input value
- \( \varepsilon \sim 10\% \)
To keep $\Delta p/p$ below $\sim 10\%$

$\Rightarrow T \sim 3-4$ cm

$\Rightarrow$ pol. acceptance $\varepsilon \sim 3\%$

$\Rightarrow$ error on the phase below 10\%
The SuperB project in Rome

- **Project**: build a B-factory in Tor Vergata University Campus (~5 Km from LNF) to study **full range of flavour physics**

- Reuse of BABAR and PEPII components

- **Target luminosity**: $10^{36}$ cm$^{-2}$s$^{-1}$ (100 times current factories) using the new concepts of large Piwinsky angle collision + Crab Waist

320 Signatures
About 85 institutions
174 Babar members
SuperB milestones

- Project included in the INFN roadmap of 2006
- CDR ready by may 2007
- International review committee formed and report issued in may 2008 with the following recommendations: “We recommend strongly that work towards the realisation of a SuperB, taken to be an asymmetric e⁺e⁻ collider with luminosity at least $10^{36} \text{ cm}^{-2} \text{ s}^{-1}$, continues. ...timely and highly appropriate that a machine Advisory Committee be established to oversee progress in the many critical issues faced in the design of the SuperB asymmetric collider”
- On Dec 2008, The INFN BoD has approved the SuperB TDR phase. The government of Region Lazio has funded this phase with a budget of M15.0 Euros in 3 years. The SuperB TDR will be ready in two years
- INFN requested European Committee for Future Accelerator (ECFA) to form an opinion on their Super Flavour Factory project: report issued on November 2008
Global considerations

Although a Super Flavour Factory, given its total cost estimate of the order of 500 M€ (of which about 200 M€ is still to be found), can be built with a regional effort rather than a worldwide effort, it will have an impact on the international landscape of particle physics, which should be taken into account in the decision process. It is conceivable that the physics case and strategy for a Super Flavour Factory can further be solidified by results from the LHC experiments. The results from the LHC experiments are required for the final decision on the construction of an e+ e− linear collider in order to optimize the machine parameters.

At KEK, an upgrade of the KEKB is being proposed to achieve a peak luminosity of up to $8 \times 10^{35} \text{ cm}^{-2} \text{ s}^{-1}$. According to the current plan, the KEKB will continue to run in 2009. A three-year shutdown would then start from April 2010 to upgrade the machine and the detector. Data taking would resume from 2013 with a goal to achieve an integrated luminosity of 10 ab$^{-1}$ by around 2016. Their next step would then be to obtain a data sample of 50 ab$^{-1}$ by 2020. The KEK management has already requested a dedicated R&D fund for the fiscal year 2009 together with their plan for the upgrade. Although the designed peak luminosity is less ambitious, their objective is not far from that of the INFN Super Flavour Factory. In their current design, one of the key ingredients for achieving higher luminosities is to store more currents, thus very large RF power of $\sim 60 \text{ MW}$ would be needed. It is worth noting that KEK has a well-proven track record in constructing the world highest luminosity e+ e− storage rings with a strong experienced machine group.

The LHCb experiment is expected to complete the first phase of its physics analysis with 10fb$^{-1}$ data by $\sim 2015$. Once any indication of new physics emerges at LHC, there is a serious possibility to upgrade the LHCb detector such that a more than 10 times increase in statistics could be achieved. This would further extend the physics programme in the CP violation and rare decays in the Bs sector as well as purely charged final states such as $K^* \mu \mu$ beyond what can be achieved by a Super Flavour Factory. Whether the final states with multiple n0 ’s and missing energy would bring a unique advantage depends on the type of new physics we would be addressing at that time. Studies of lepton flavour violating decay, notably $\tau \rightarrow 4 \gamma$ remains unique for an e + e − machine.
Conclusions

• The DAΦNE collider, based on a new collision scheme including Large Piwinsky angle and Crab-Waist, has been successfully commissioned.

• Work is in progress to reach the design luminosity goal $5.0 \times 10^{32}$ cm$^{-2}$s$^{-1}$

• KLOE-1 and FINUDA experiments completed their data taking while SIDDHARTA run should be completed by the end of July 2009

• Operation for the KLOE-2 experiment might be resumed by the end of 2009 and are presently scheduled for three years. BTW the experiment has been only partially approved

• The DANAE project for both high-energy and high-luminosity is currently in stand-by but the physics community is still alive and interested

• The Super-B factory project has had the approval for a TDR but the LNF future is not yet clearly defined
Backup slides
# DAΦNE Upgrade Parameters

<table>
<thead>
<tr>
<th>Parameter</th>
<th>DAΦNE FINUDA</th>
<th>DAΦNE Upgrade</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\theta_{\text{cross}}/2$ (mrad)</td>
<td>12.5</td>
<td>25</td>
</tr>
<tr>
<td>$\varepsilon_x$ (mm×mrad)</td>
<td>0.34</td>
<td>0.26</td>
</tr>
<tr>
<td>$\beta_x^*$ (cm)</td>
<td>170</td>
<td>26</td>
</tr>
<tr>
<td>$\sigma_x^*$ (mm)</td>
<td>0.76</td>
<td>0.26</td>
</tr>
<tr>
<td>$\Phi_{\text{Piwinski}}$</td>
<td>0.3-0.6</td>
<td>1.9</td>
</tr>
<tr>
<td>$\beta_y^*$ (cm)</td>
<td>1.70</td>
<td>0.90</td>
</tr>
<tr>
<td>$\sigma_y^*$ ($\mu$m)</td>
<td>5.4 (low current)</td>
<td>3.1</td>
</tr>
<tr>
<td>Coupling, %</td>
<td>0.5</td>
<td>0.5</td>
</tr>
<tr>
<td>$I_{\text{bunch}}$ (mA)</td>
<td>13</td>
<td>13</td>
</tr>
<tr>
<td>$\sigma_z$ (mm)</td>
<td>22</td>
<td>20</td>
</tr>
<tr>
<td>$N_{\text{bunch}}$</td>
<td>110</td>
<td>110</td>
</tr>
<tr>
<td>$L$ (cm$^{-2}$s$^{-1}$) $\times 10^{32}$</td>
<td>1.6</td>
<td>5</td>
</tr>
</tbody>
</table>

- Larger Piwinski angle
- Lower vertical beta
- Already achieved
DAΦNE Luminosity versus colliding currents

CRAB Optics

NEW COLLISION SCHEME:
Large Piwinski angle $\psi = 1.9$
low-$\beta$ $\beta^* = 9.0$ [mm]
CW sextupoles off

Courtesy of C. Milardi
Inner Tracker Numbers

- 5 tracking layers
- 200x500 µm spatial resolution
- 700 mm active length
- from 150 to 250 mm radii
- 1.8% $X_0$ total radiation length

**Technology: Cylindrical-GEM**

**IT Proto 1.0**

- Constructed in 2007
- 150 mm radius (Layer 1) x 352 mm active length
- 650 µm pitch only along Z
- 192 ch equipped with CARIOCA
- 128 ch with GASTONE
$\varepsilon(\%)$ - calorimeter

- $E_n = 180$ MeV - $R = 1.5$ kHz/cm²
- $E_n = 180$ MeV - $R = 3.0$ kHz/cm²
- $E_n = 180$ MeV - $R = 6.0$ kHz/cm²
- $E_n = 46.5$ MeV
- $E_n = 21.8$ MeV
ChPT prediction: \( B(K_s \rightarrow \pi^+\pi^-\pi^0) = (2.4 \pm 0.7) \times 10^{-7} \)

Actual experimental value: \((3.3^{+1.1}_{-0.9}) \times 10^{-7}\) mean value of 3 measurements with a ~ 40% precision each

<table>
<thead>
<tr>
<th>Assuming</th>
<th>Error on BR @ 5 fb(^{-1}) (%)</th>
<th>Error on BR @ 20 fb(^{-1}) (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>No further effort made to reduce background</td>
<td>~ 40%</td>
<td>~ 20%</td>
</tr>
<tr>
<td>Further efforts completely remove background</td>
<td>~ 30%</td>
<td>~ 12%</td>
</tr>
</tbody>
</table>
The set of scattering angles are computed with respect to the direction of the proton before the scattering.