

Status for 2015, CERN NA63

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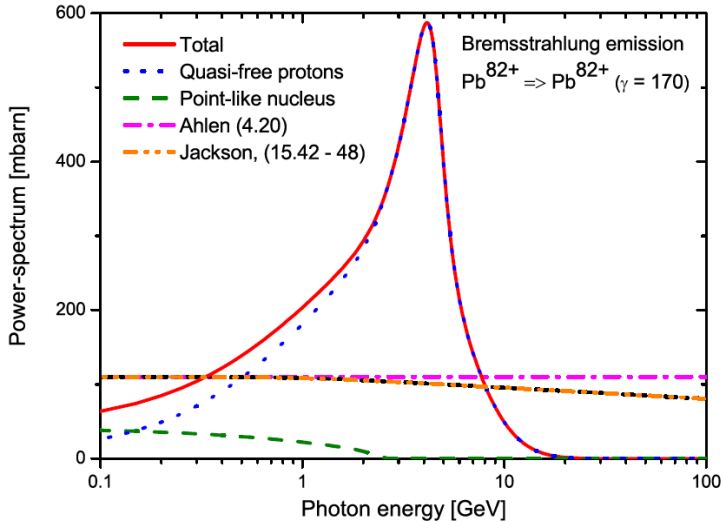
Status:

1. Heavy ion bremsstrahlung
2. Positron production (with MIMOSAs)



Ar¹⁸⁺ ions

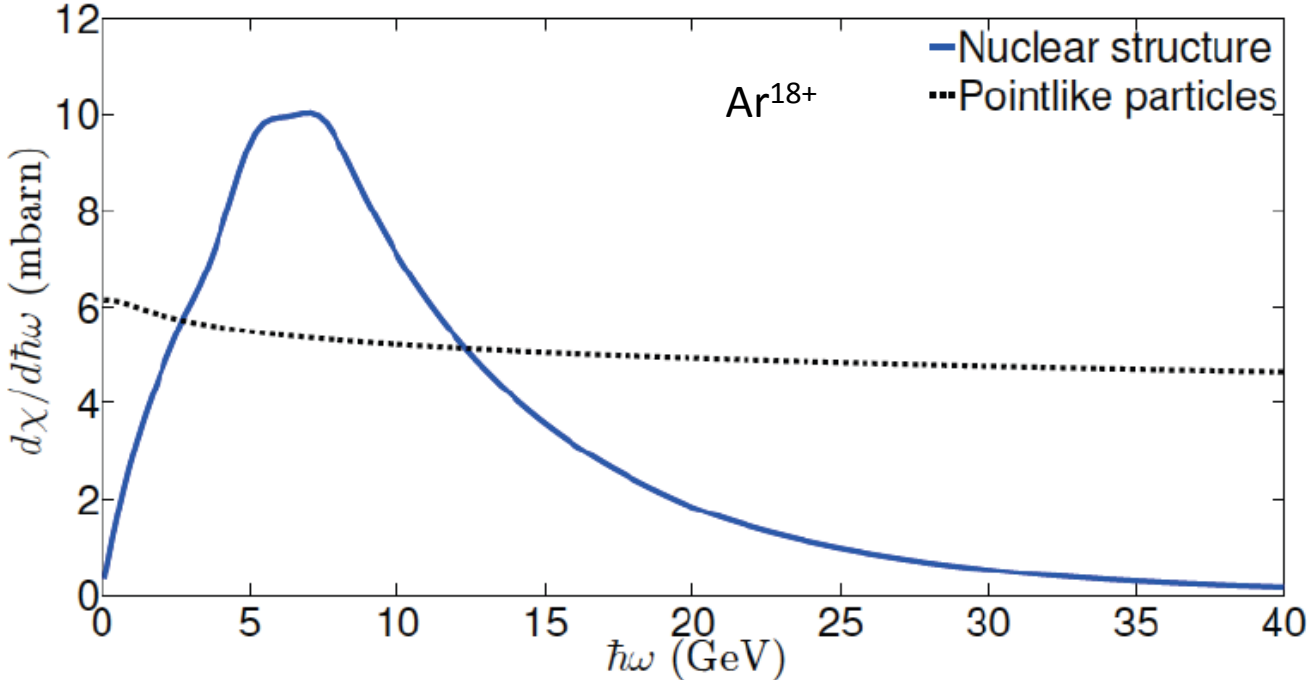
Heavy ion bremsstrahlung



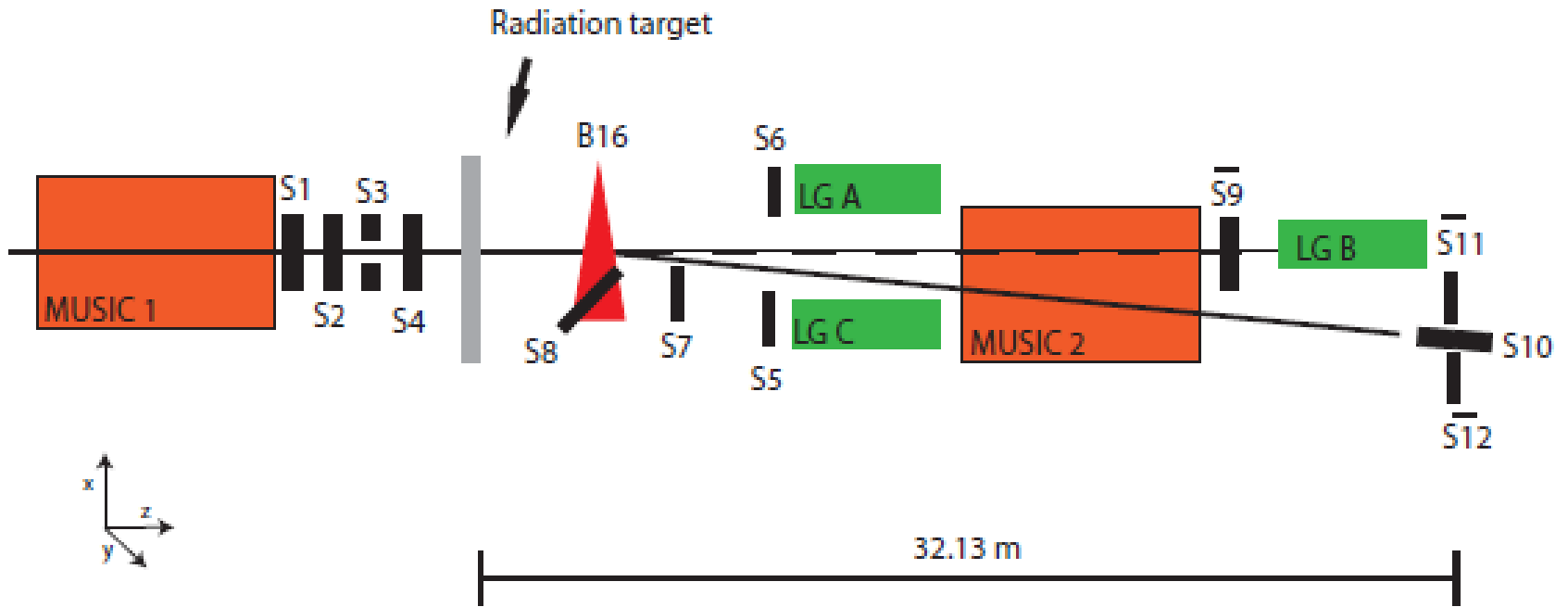
Peak structure due to finite nuclear size

(deBroglie wavelength of virtual photon of order R)

Radiation emission

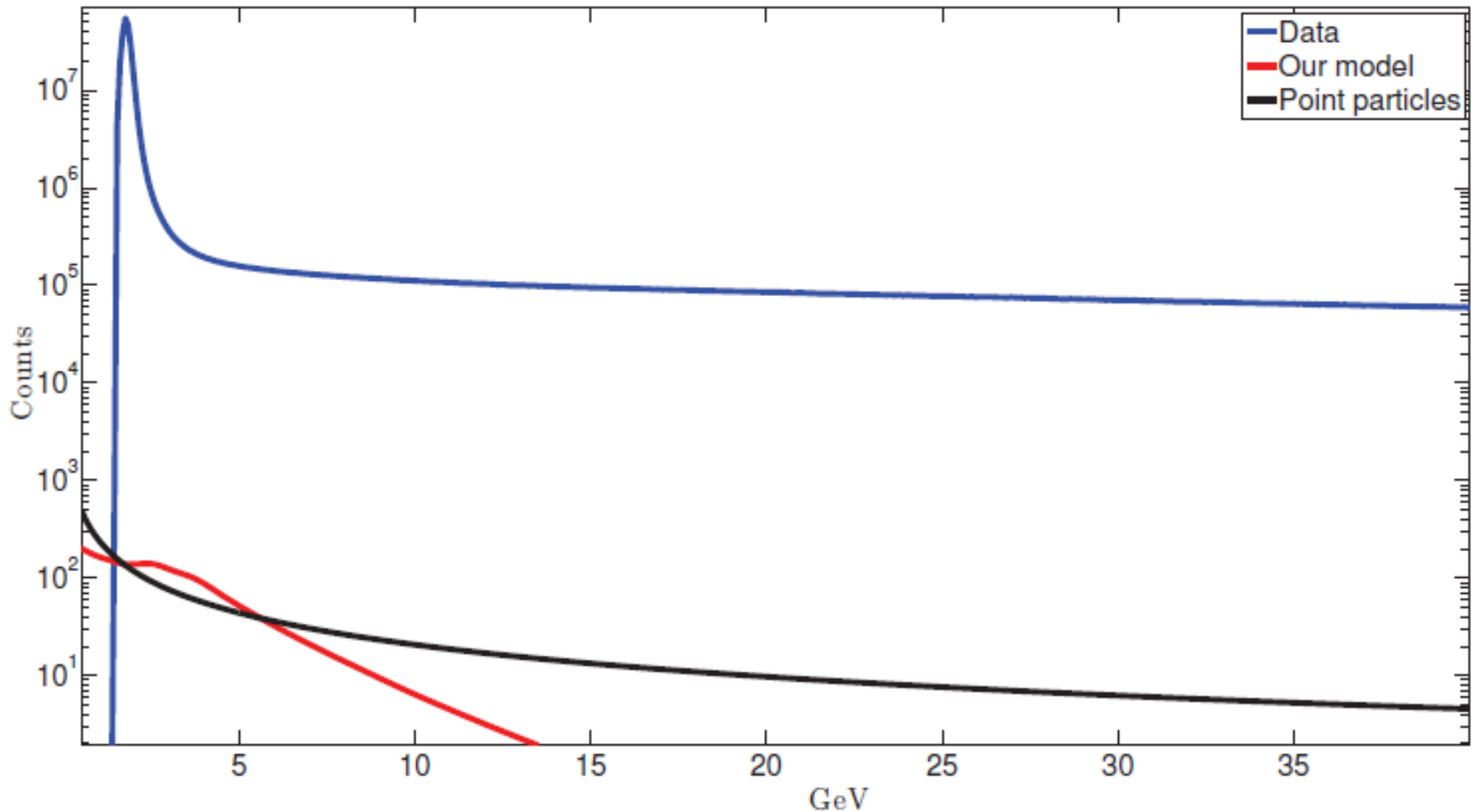


Heavy ion bremsstrahlung



Run end: April 8th, 2015

Heavy ion bremsstrahlung



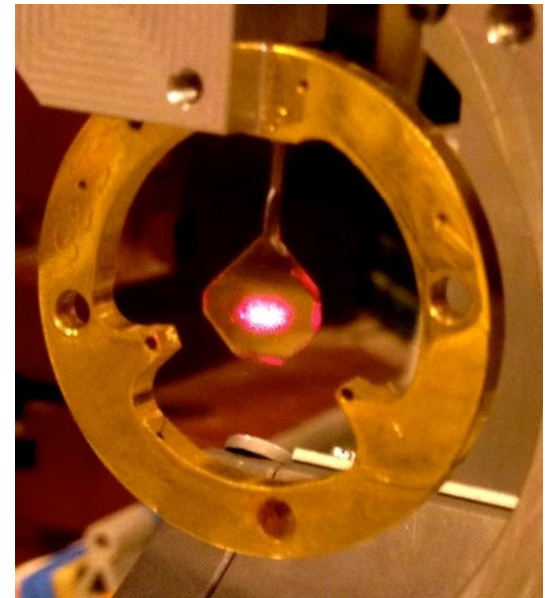
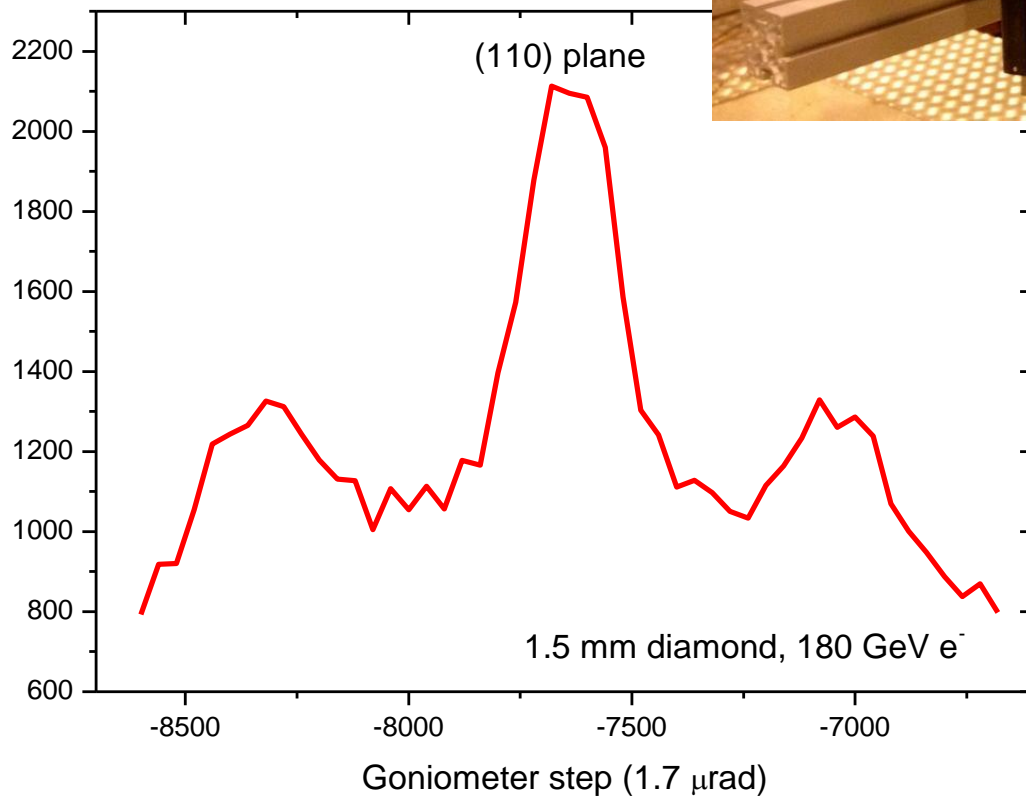
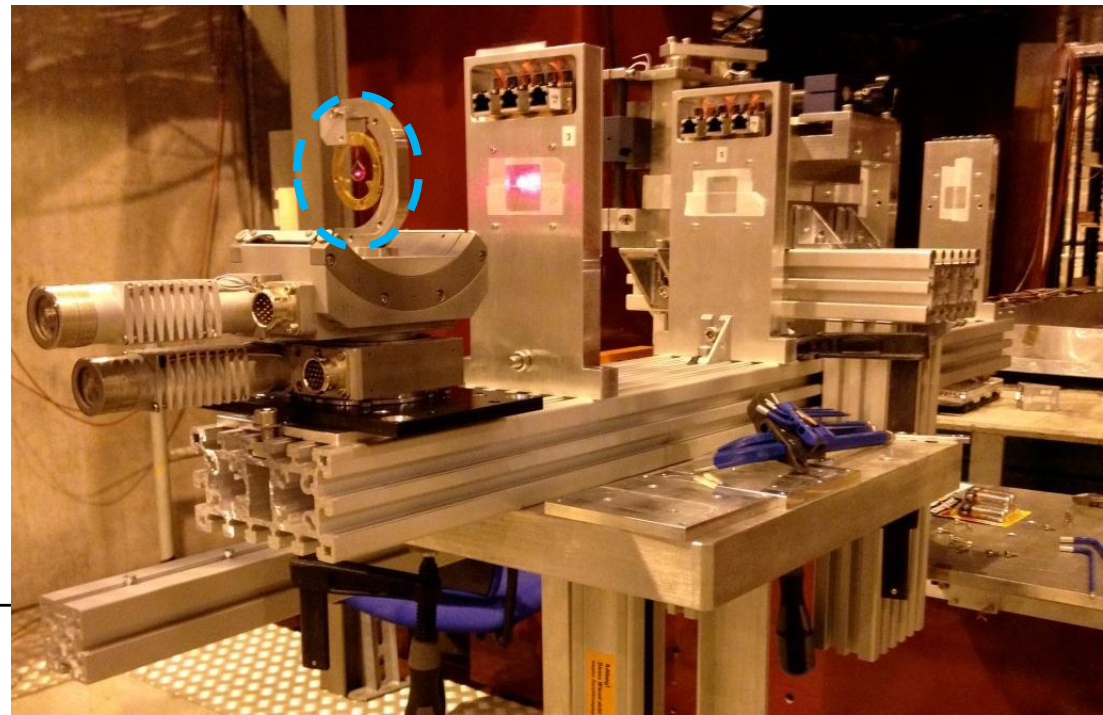
Failure to veto sufficiently effectively against close collision events

Investigations continuing to ascertain whether or not it is realistic to measure with Pb^{82+}

Positron production

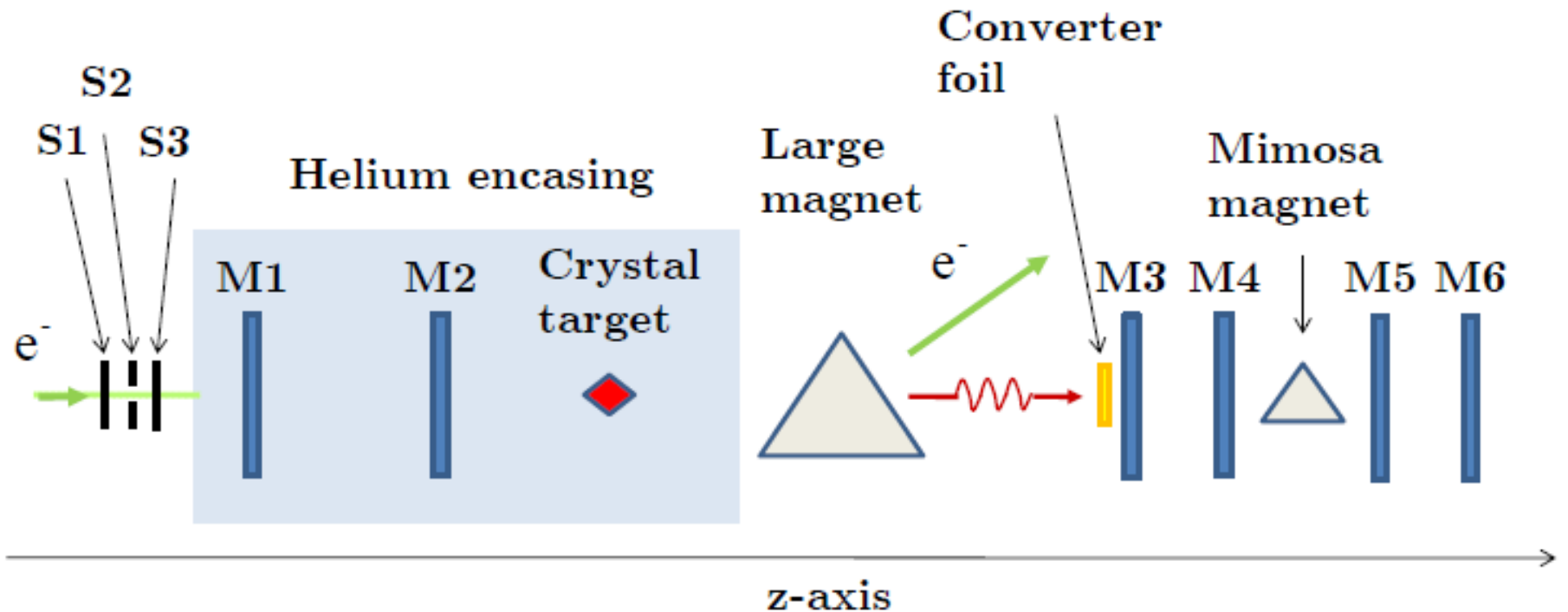
Angular scans

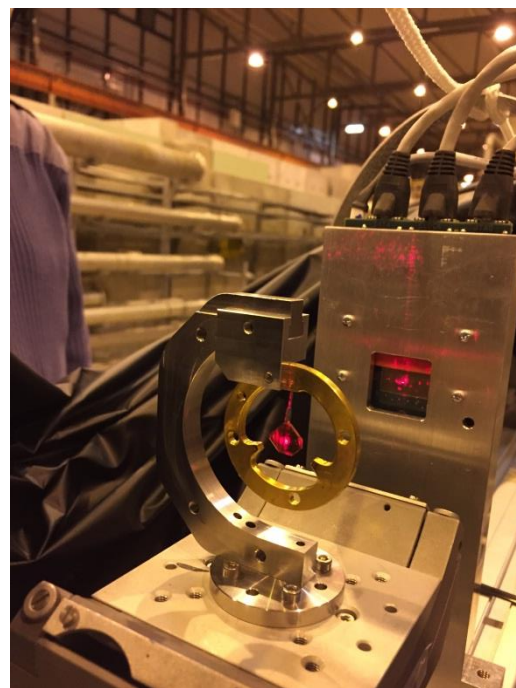
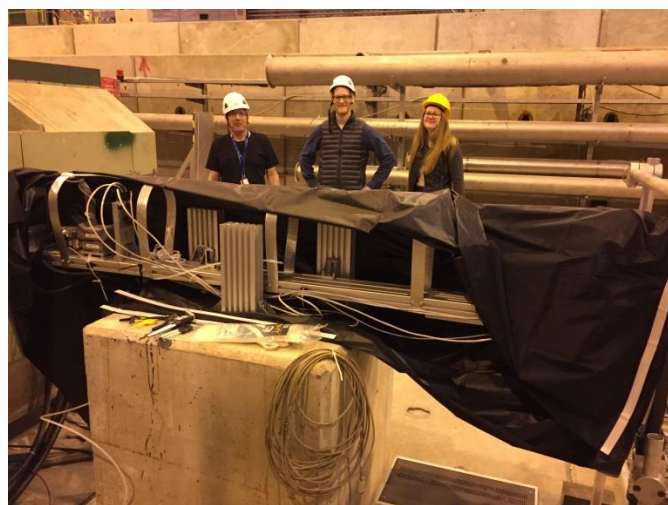
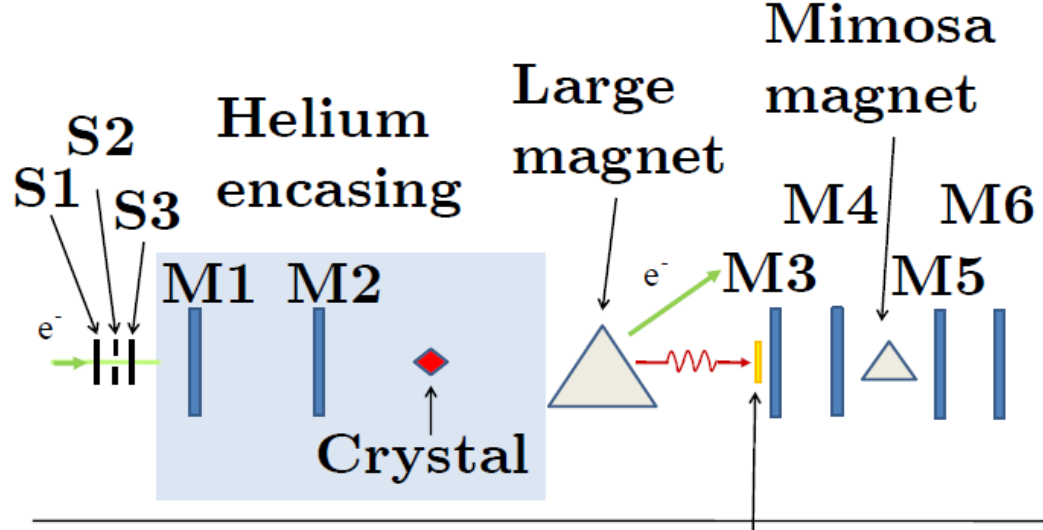
- Radiation enhancement observed w/ 180 GeV electrons (signal = radiation above 50 GeV, 'strong field radiation') with 1.5 mm diamond:



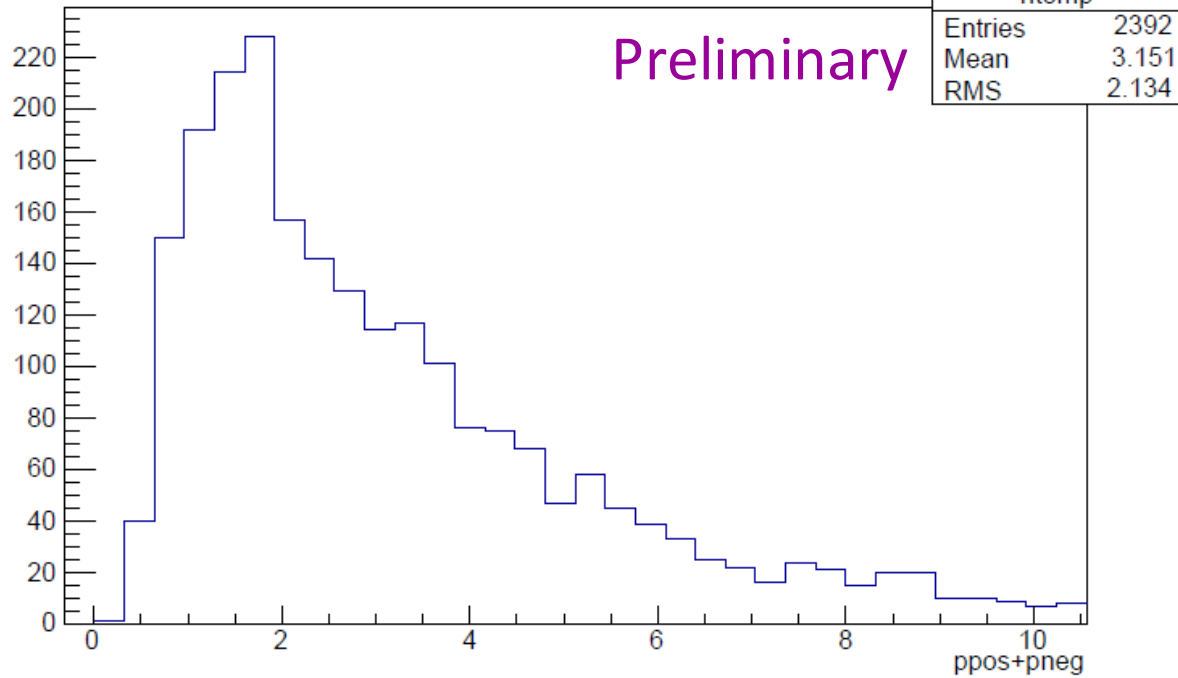
Setup for e^+ measurement

Top View

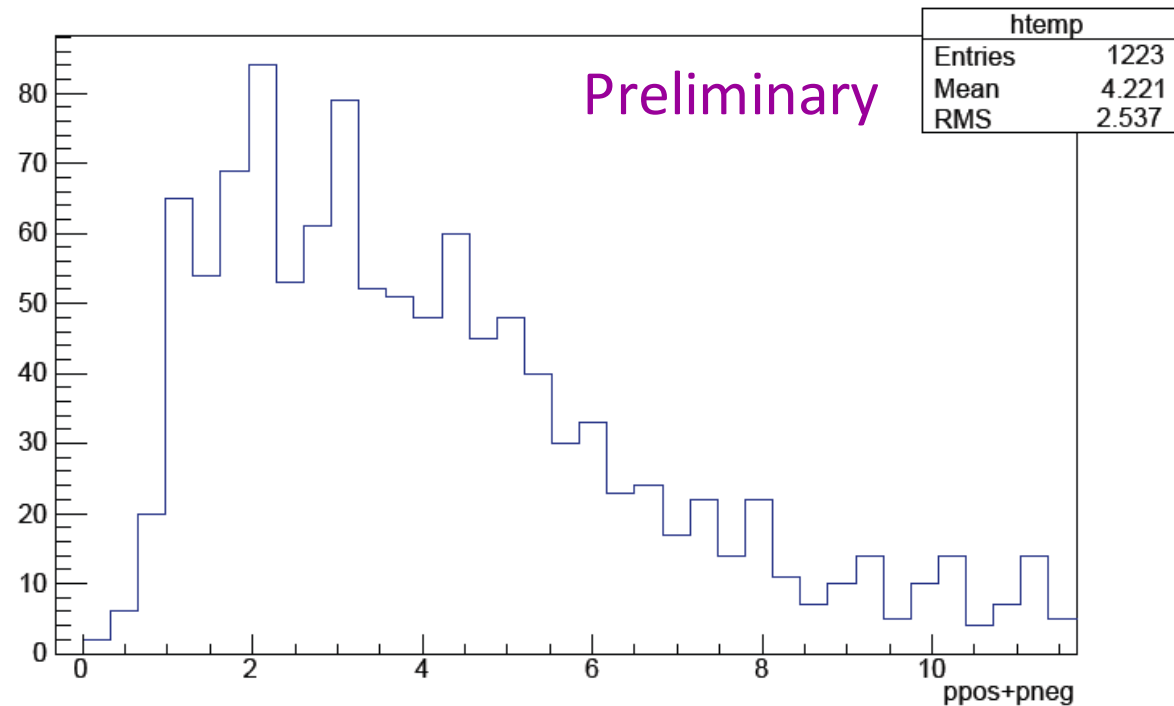




Photons



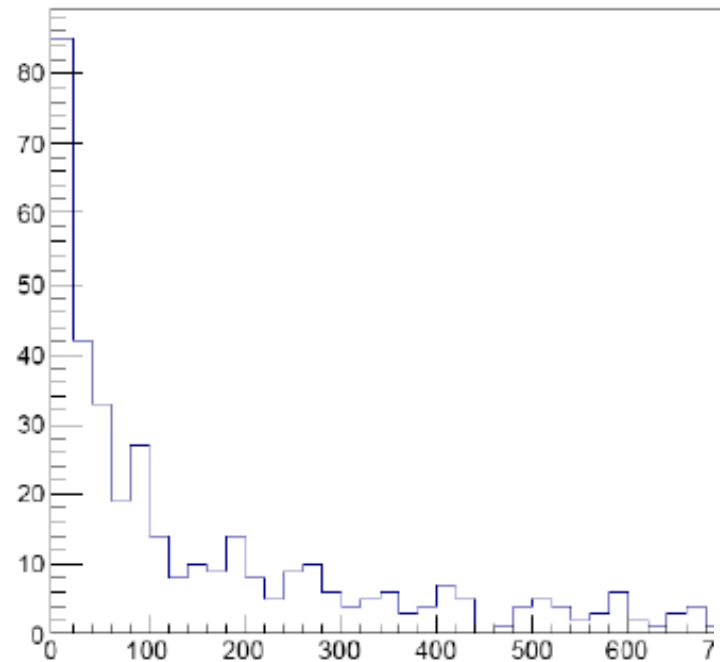
Approximate
enhancement: factor 3



Non-aligned

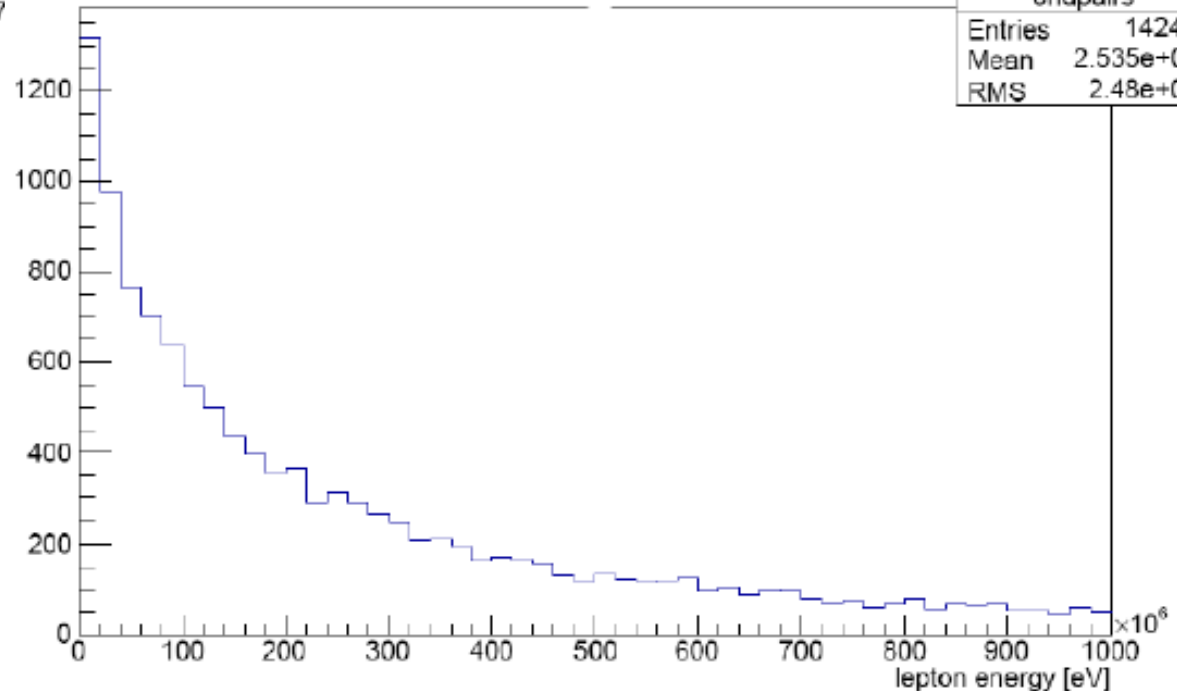
endpairs	
Entries	464
Mean	1.835e+08
RMS	2.184e+08

Positron production (simulations)



Aligned

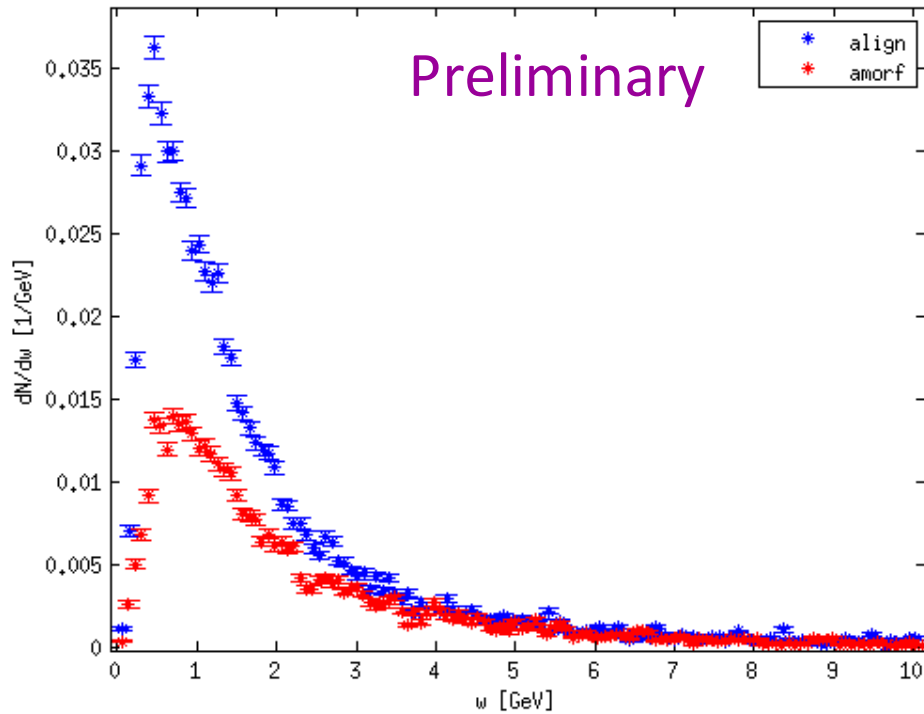
endpairs	
Entries	14249
Mean	2.535e+08
RMS	2.48e+08



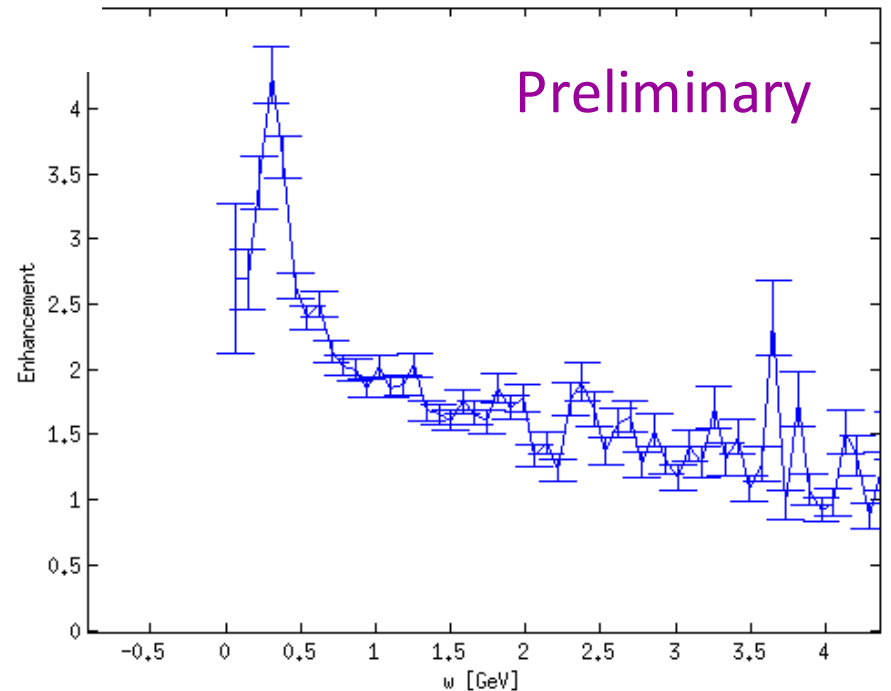
Factor 15
enhancement at
low energies

Reduced for
thicker targets

Positron production (measurements)



18% of entire data set
No (angular) cuts applied
Enhancement up to factor 4



Positron production
- a possibly additional outcome...

Classical Radiation Reaction

Jackson 1975 p. 786-798

$$m\dot{\mathbf{v}} = \mathbf{F}_{\text{ext}} \quad \text{N2}$$

$$P(t) = \frac{2}{3} \frac{e^2}{c^3} (\dot{\mathbf{v}})^2 \quad \text{Larmor}$$

$$m\dot{\mathbf{v}} = \mathbf{F}_{\text{ext}} + \mathbf{F}_{\text{rad}} \quad \mathbf{F}_{\text{rad}} \text{ “must” vanish if } \dot{\mathbf{v}} = 0 \quad (\text{no radiation})$$

$$m(\dot{\mathbf{v}} - \tau\ddot{\mathbf{v}}) = \mathbf{F}_{\text{ext}} \quad \text{Lorentz-Abraham-Dirac (LAD) equation}$$

$$\mathbf{F}_{\text{rad}} = \frac{2}{3} \frac{e^2}{c^3} \ddot{\mathbf{v}} = m\tau\ddot{\mathbf{v}} \quad \tau = \frac{2}{3} \frac{e^2}{mc^3}$$

Step-fct. field, solution to LAD eq.:
(pre-acceleration)

Classical Electrodynamics

No field, solution to LAD eq.:
(runaway)

$$a(t) = a_0 e^{t/\tau},$$

$$\tau \equiv \frac{\mu_0 q^2}{6\pi m c}.$$

$$\tau = 6 \times 10^{-24} \text{ s.}$$

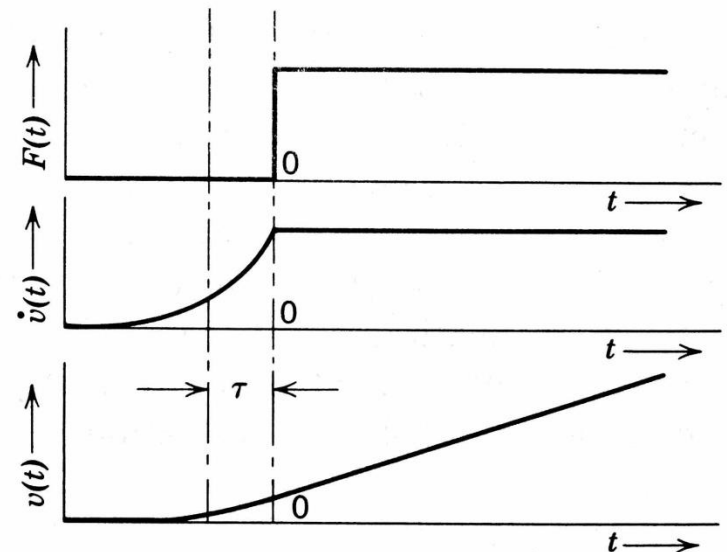


Fig. 17.1 “Preacceleration” of charged particle.

Investigation of classical radiation reaction with aligned crystals

arXiv:1503.05717v1

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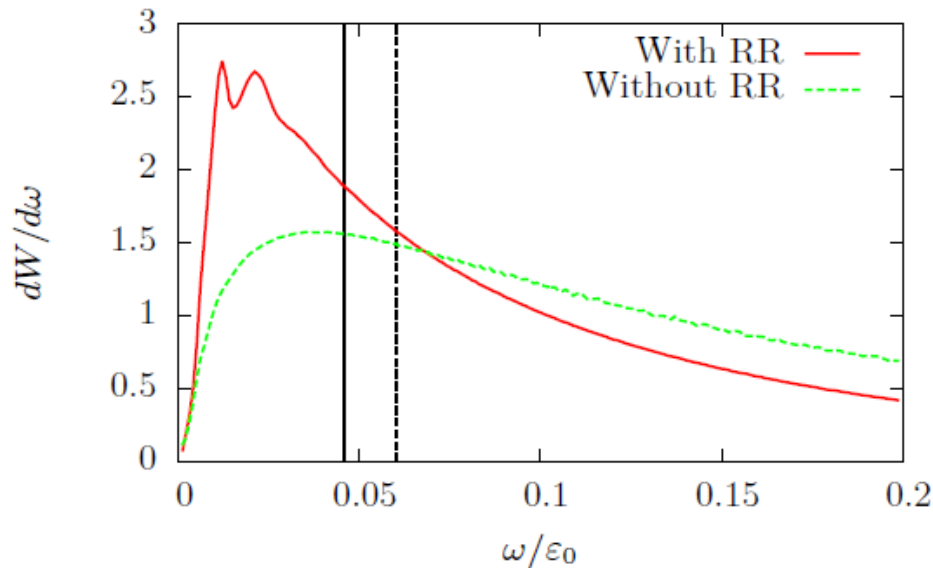


FIG. 2. (Color online) Radiation energy spectra of a 10-GeV electron moving along the $\langle 111 \rangle$ axis of a diamond slab of 1.1-mm thickness, with (continuous red curve) and without (dashed green curve) RR effects. The vertical lines correspond to the position of the critical photon energy ω_c with (continuous line) and without (dashed line) RR according to Eq. (11).

In a purely electric field (in the lab frame):

$$\frac{d\mathbf{p}}{dt} = e\mathbf{E} + \frac{2}{3} \frac{e^4}{m^2} \{ (\boldsymbol{\beta} \cdot \mathbf{E})\mathbf{E} - \gamma^2 [\mathbf{E}^2 - (\boldsymbol{\beta} \cdot \mathbf{E})^2] \boldsymbol{\beta} \}$$

LL equation

(solution from 1950's,
forgotten until early 2000's)

PLANS FOR 2016:

Put NA63 'on hold' due to financial
constraints

(de facto prohibited to finance phd's and
postdocs with present funding from the
Ministry)

Publications, (related to) NA63

- Since previous SPSC presentation:
 1. J. Esberg, U.I. Uggerhøj, B. Dalena and D. Schulte: *Strong field processes in beam-beam interactions at the Compact Linear Collider*, Phys. Rev. Spec. Top. Acc. Beams **17**, 051003 (2014)
 2. T.N.Wistisen, K.K. Andersen, S. Yilmaz, R. Mikkelsen, J.L. Hansen, U.I. Uggerhøj, W. Lauth and H. Backe: *Experimental realization of a new type of crystalline undulator*, Phys. Rev. Lett. **112**, 254801 (2014)
 3. A. Di Piazza, T.N. Wistisen and U.I. Uggerhøj: *Investigation of classical radiation reaction with aligned crystals*, ArXiv: 1503.05717, subm. to Phys. Rev. Lett. (2015)

NA63 has produced 20 publications since 2008