

Synchro-Beam Mapping with Francesco

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In 1987

- I had some dispute with Francesco on the treatment of the local impedance through letters.
- Francesco came to visit KEK to see TRISTAN operation.
- We discussed a lot on TRISTAN and Beam-Beam effects.
- He gave a very good report at CERN-SL group and sent its copy to us.

Geneva, 7/7/'87

Dear Hirota,

I think it is a good idea to visit other laboratories (even from the academic point of view) and CERN will probably be one of the most interesting ones in the near future, when LEP will be ready.

Francesco suggested me to work at CERN.

Could you send me further information about Tristan? In particular, how do you operate the machine at injection without separators (What are the β -functions, etc...)?

Looking forward to seeing you again,
best regards

Francesco Ruggiero

- At that time, TRISTAN stopped to use the Separators in Injection/Acceleration.
- Because of discharge and because it appeared to be unnecessary.

In 1988

- Following the advise of Francesco, I decided to go to CERN as a scientific associate.
- My office was next to that of Francesco in building 30 and we have discussed and talked a lot in the offices and in cafeteria at the 7th floor.

Publication with Francesco

- K. Hirata and **F. Ruggiero**, *Treatment of Radiation in Electron Storage Rings*, CERN Report, LEP Note 611 (1988).
- K. Hirata, H. Moshhammer, **F. Ruggiero** and M. Bassetti, *Synchro-Beam Interaction*, AIP Conference Proceedings No.214 “Beam Dynamics Issues of High-Luminosity Asymmetric Collider Rings”, (Ed. A.M.Sessler) p.389 (1990).
- K. Hirata, S. Petracca and **F. Ruggiero**, *New Type of Bunch Lengthening with Cusp Catastrophe in Electron Storage Rings*, Physical Review Letters 66, 1693 (1991).
- K. Hirata, H. Moshhammer and **F. Ruggiero**, *A Symplectic Beam-Beam Interaction with Energy Change*, Particle Accelerators 40, 205 (1993).

Synchro-Beam Mapping

beam-beam kick

$\tau < 0 >$

$D(\tau/2) \rightarrow BB \rightarrow D(-\tau/2)$

$D(\tau/2) = \begin{bmatrix} 1 & \boxed{\frac{|\tau|}{2} \cdot \frac{\alpha}{\omega_s} c} \\ 0 & 1 \end{bmatrix}$

$a = -\frac{\tau}{2} \frac{\alpha}{\omega_s} c$

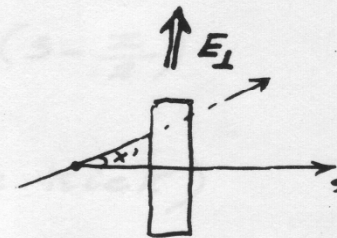
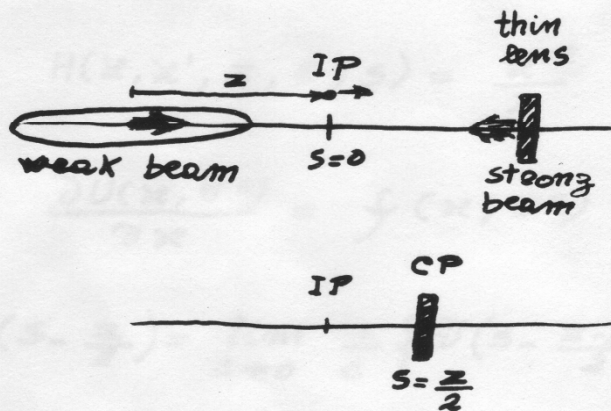
$f(x) = f(x_{IP} + \frac{|\tau|}{2} \frac{\alpha}{\omega_s} c x'_{IP})$

$= f(x_{IP} - \frac{\tau}{2} \frac{\alpha}{\omega_s} c x'_{IP})$

- Work started at around the end of November 1989.(dated 22 Nov.) and completed basically at the end of January 1990.

SYNCHRO-BEAM INTERACTION

K. HIRATA, H. MOSHAMMER, F. RUBBIERO : CERN
M. BASSETTI : INFN



THE TRANSVERSE ELECTRIC FIELD OF THE STRONG BEAM CAN CHANGE THE ENERGY OF A PARTICLE WITH BETATRON SLOPE x' IN THE WEAK BEAM

LONGITUDINAL DISPLACEMENT OF THE COLLISION POINT DUE TO SYNCHROTRON MOTION

- Floating collision point
- E field due to focusing bunch
- Energy change due to x'

We consider a canonical transformation from (x, z, p, ϵ) to the new variables (X, P, Z, Σ) with generating function $G(X, Z, p, \epsilon)$ depending on the new coordinates and the old momenta:

$$G(X, Z, p, \epsilon) = -Z\epsilon - \left(X - \frac{Z}{4}p\right)p.$$

This gives

$$\begin{cases} x = -\frac{\partial G}{\partial p} = X - \frac{Z}{2}p & , & P = -\frac{\partial G}{\partial X} = p \\ z = -\frac{\partial G}{\partial \epsilon} = Z & , & \Sigma = -\frac{\partial G}{\partial Z} = \epsilon - \frac{1}{4}p^2 \end{cases}$$

The map was expressed by a product of several non-Symplectic mappings. Symplecticity was the problem.

- H.Moshhammer has found that the map is symplectic using REDUCE.
- $\text{Map} = \exp \left\{ -H_{bb} \left(x \text{ replaced by } x - x'z/2 \right) \right\}$
- Presented at a Workshop in Berkeley held 12-16, February 1990.
- It was later used, combined with Lorentz transformation, to verify the crossing angle option for B factories.

Experience with Francesco
is already an old story.
But the feeling of creative moment
will not damp nor diffuse
like a constant of motion.

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