Conclusion for Beam Diagnostics Course

Diagnostics is the 'organ of sense' for the beam.

It required for operation and development of accelerators

Four types of demands leads to different installations:

- Quick, non-destructive measurements leading to a single number or simple plots.
- Instrumentation for daily check, malfunction diagnosis and wanted parameter variation.
- Complex instrumentation used for hard malfunction and accelerator development.
- Automated measurement and control of beam parameters i.e. feedback

A clear interpretation of the results is a important design criterion.

General comments:

- Good knowledge of accelerators, general physics and technologies needed.
- Quite different technologies are used, based on various physics processes.
- Each task and each technology calls for an expert.
- Accelerator development goes parallel to diagnostics development.

$\Rightarrow$ Interesting and challenging subject!

Beam Quantities and their Diagnostics I

LINAC & transport lines: Single pass ↔ **Synchrotron:** multi pass

Electrons: always relativistic ↔ **Protons/Ions:** non-relativistic for E_{kin} < 1 GeV/u

Depending on application: Low current ↔ high current

Overview of the most commonly used systems:

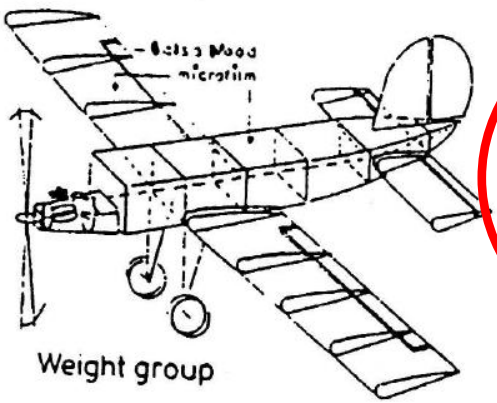
Beam quantity		LINAC & transfer line	Synchrotron
Current *I*	*General*	**Transformer, dc & ac** **Faraday Cup**	**Transformer, dc & ac**
	Special	**Particle Detectors**	Pick-up Signal (relative)
Profile x_{width}	*General*	**Screens, SEM-Grids** **Wire Scanners, OTR Screen**	**Ionization Profile Monitor** **Wire Scanner,** **Synchrotron Light Monitor**
	Special	MWPC, **Fluorescence Light**	
Position x_{cm}	*General* *Special*	**Pick-up (BPM)** Using position measurement	**Pick-up (BPM)**
Transverse Emittance ε_{tran}	*General*	**Slit-grid** **Quadrupole Variation**	**Ionization Profile Monitor** **Wire Scanner**
	Special	**Pepper-Pot**	Transverse Schottky

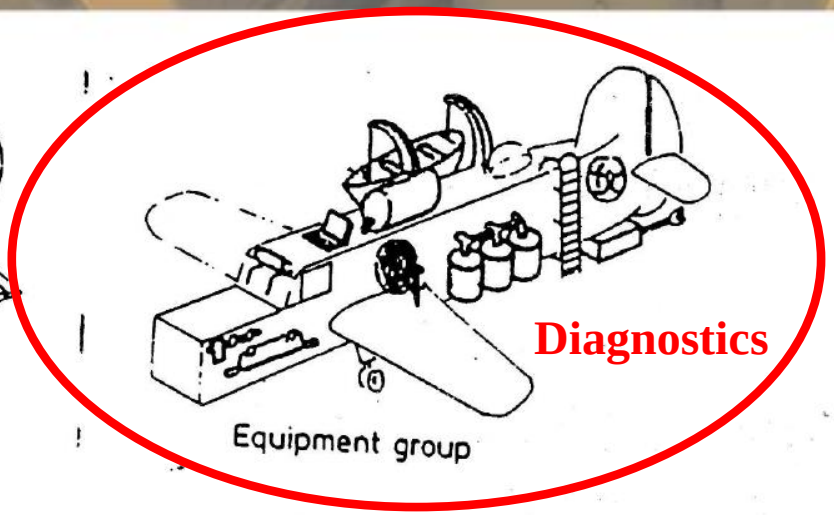
Beam Quantities and their Diagnostics II

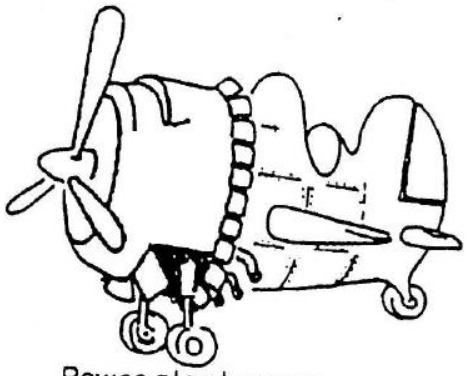
Beam quantity		LINAC & transfer line	Synchrotron
Bunch Length $\Delta\varphi$	*General* *Special*	**Pick-up** **Secondary electrons**	**Pick-up** **Wall Current Monitor** **Streak Camera** **Electro-optical laser mod.**
Momentum p and Momentum Spread $\Delta p/p$	*General* *Special*	**Pick-ups (Time-of-Flight)** Magnetic Spectrometer	**Pick-up (e.g. tomography)** Schottky Noise Spectrum
Longitudinal Emittance ε_{long}	*General* *Special*	**Buncher variation** Magnetic Spectrometer	 **Pick-up & tomography**
Tune and Chromaticity Q, ξ	*General* *Special*	--- ---	**Exciter + Pick-up** Transverse Schottky Spectrum
Beam Loss r_{loss}	*General*	**Particle Detectors**	
Polarization P	*General* *Special*	Particle Detectors Laser Scattering (Compton scattering)	
Luminocity L	*General*	Particle Detectors	

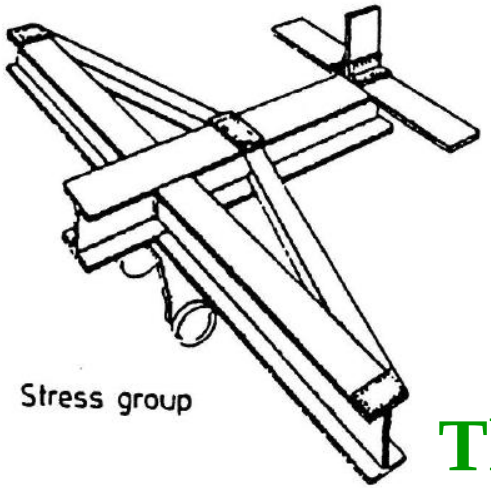
- Destructive and non-destructive devices depending on the beam parameter.
- Different techniques for the same quantity ↔ Same technique for the different quantities.

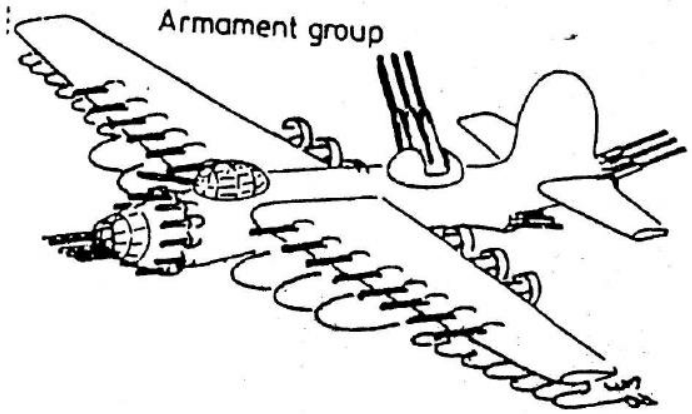
Conclusion for Beam Diagnostics Course

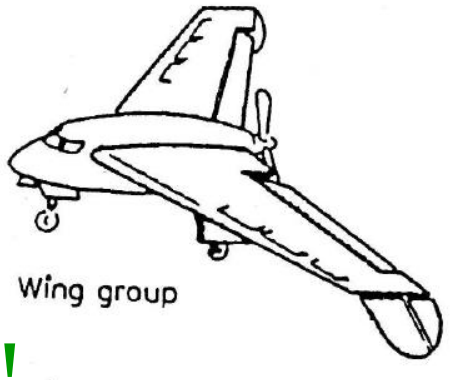








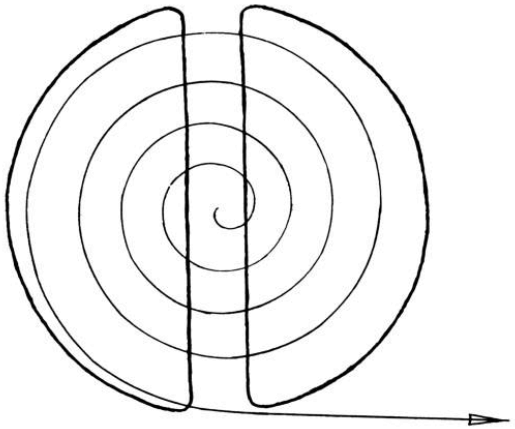




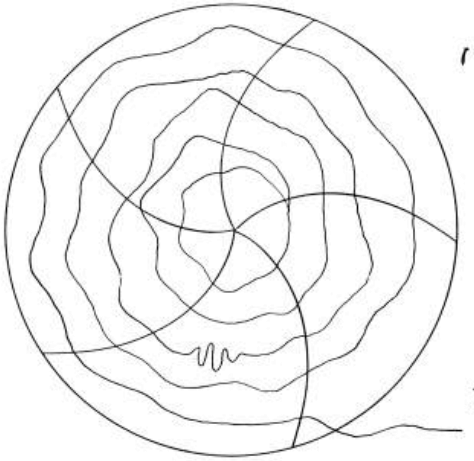
Thank you for your attention!

For a successful construction and operation of an accelerator,
the understand and right balance of all disciplines is required!

An Cyclotron Accelerator Facility as seen by....

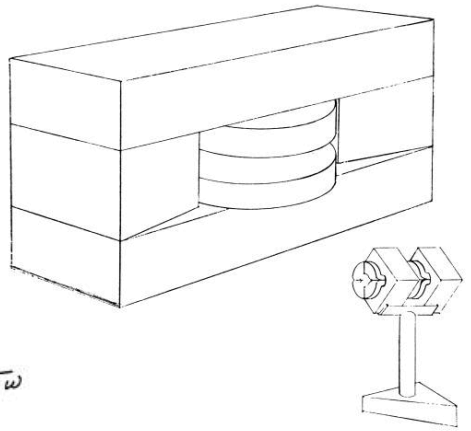


. . . the inventor



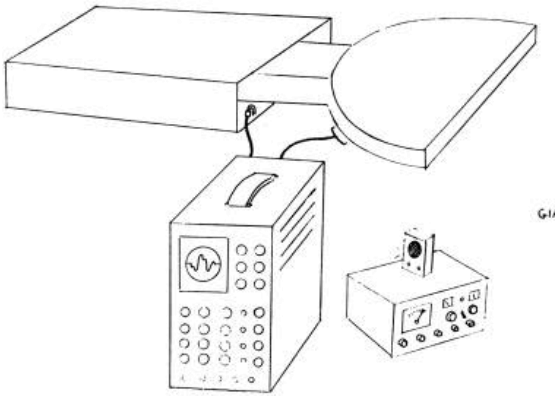
$$r = r_0\left[1+\left(\frac{fr\omega}{c}\right)\cos(3\theta+\delta_0+\delta_1 r)+\left(\frac{fr\omega}{c}\right)^2\cos(5\theta+\delta_3-\delta_5 r^3)+\left(\frac{fr\omega}{c}\right)^3\cos(7\theta+\delta_7-\delta_9 r^3)+\text{------}\right]\times\left\{\frac{e^{7/5\,r^2\ln Z}}{1+\left(\frac{a}{r}\right)^{7/4}}\right\}$$

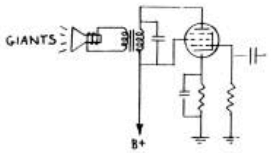
$$\frac{d\phi}{dt}=\left[\sin(\omega t-h\phi)-\sinh\phi-\tfrac{3}{5}ff_1f_2f_3'\right]\frac{eV_0}{2\pi\omega}$$



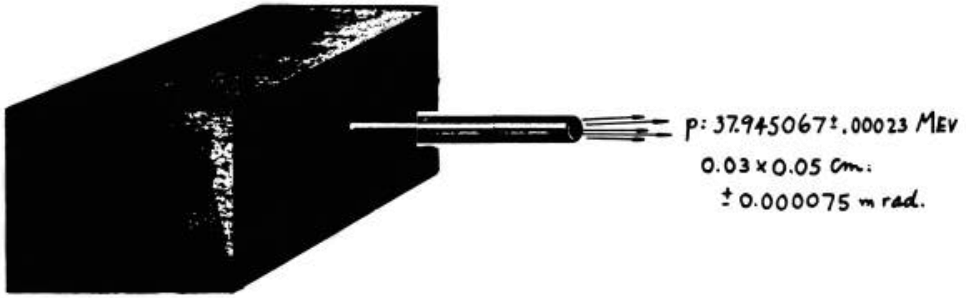
. . . the theoretical physicist

. . . the mechanical engineer





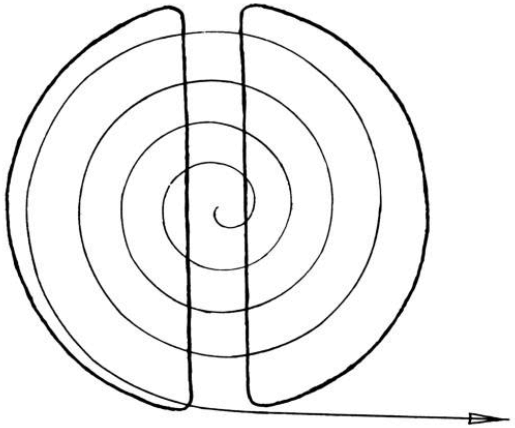
. . . the electrical engineer



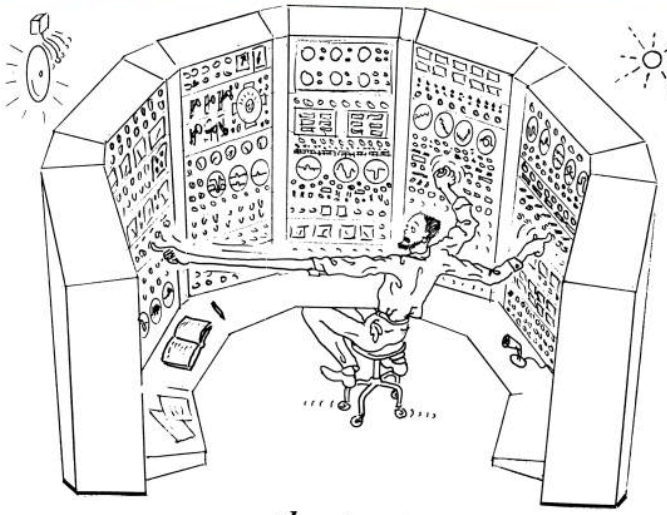
. . . the experimental physicist

Cartoons by Dave Judd and Ronn Mackenzie

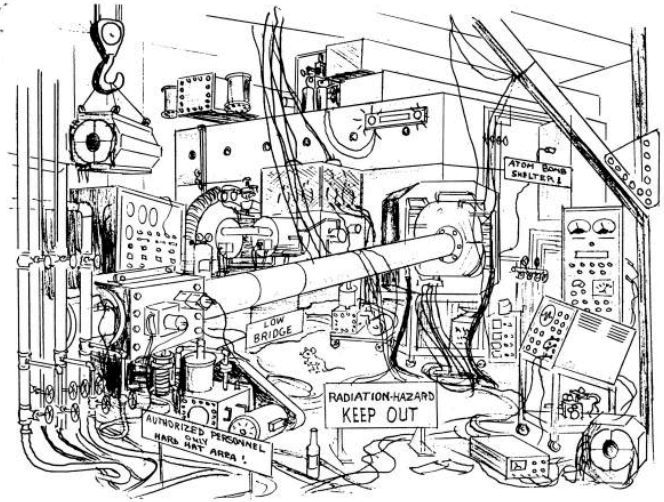
A Cyclotron Accelerator Facility as seen by....



. . . the inventor

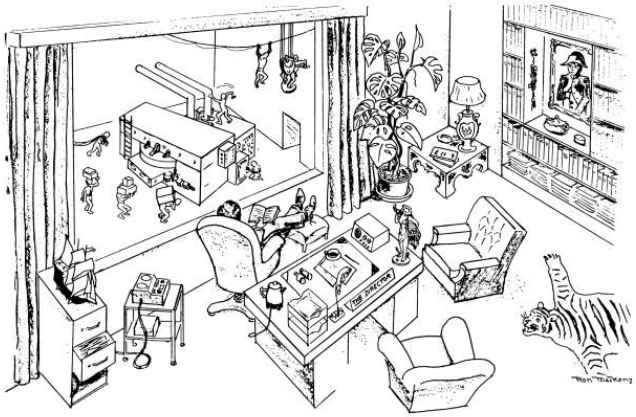


. . . the operator

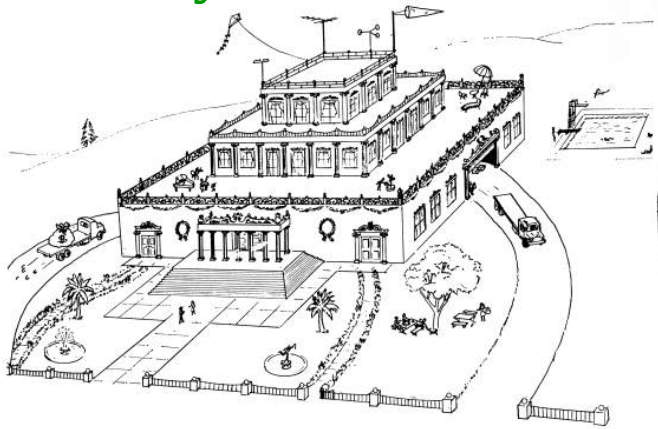


. . . the visitor

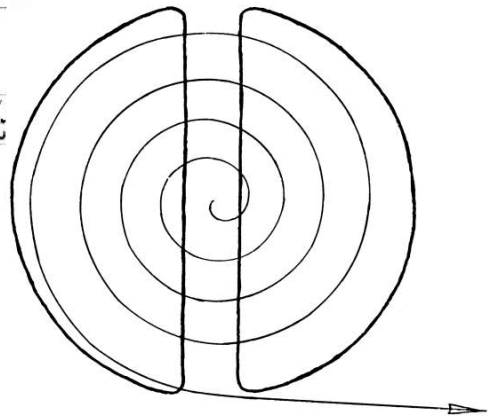
Thank you for your attention!



. . . the laboratory director



. . . the governmental funding agency



. . . the student

Cartoons by Dave Judd and Ronn Mackenzie