



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.
- ⇒ 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 $E_{kin} < 1 \text{ GeV/u}$

Depending on application: Low current ↔ high current

Overview of the most commonly used systems:

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

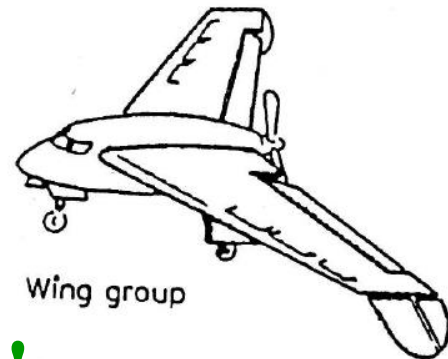
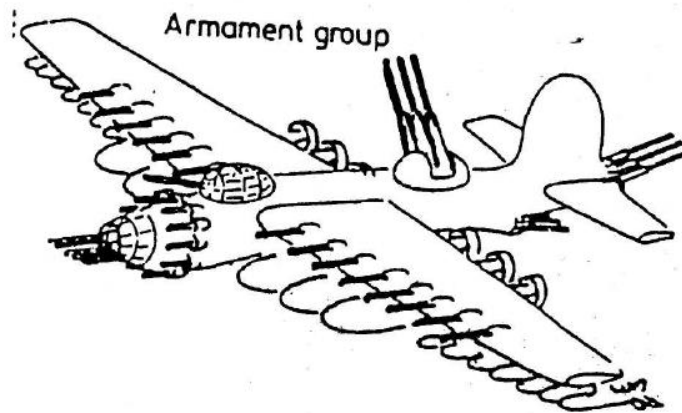
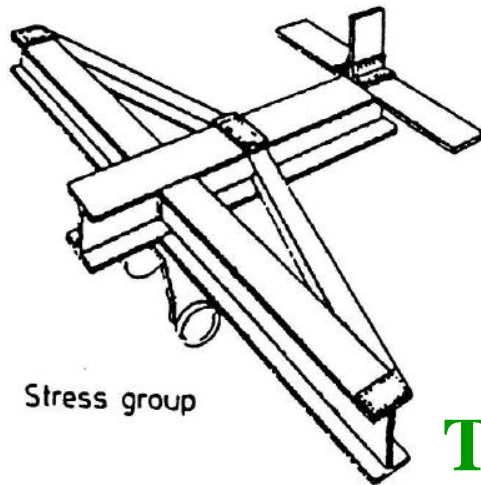
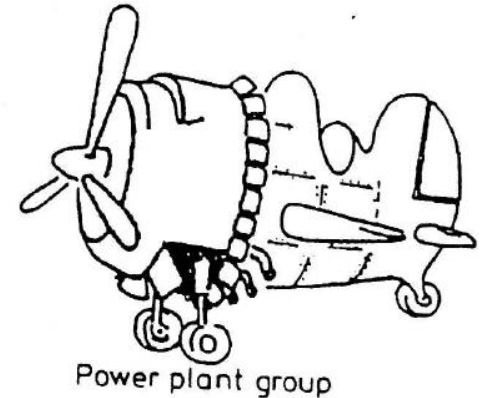
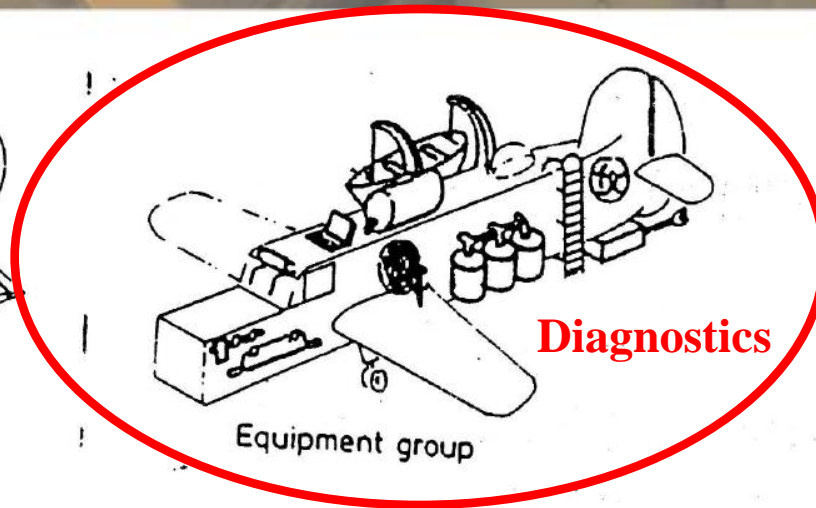
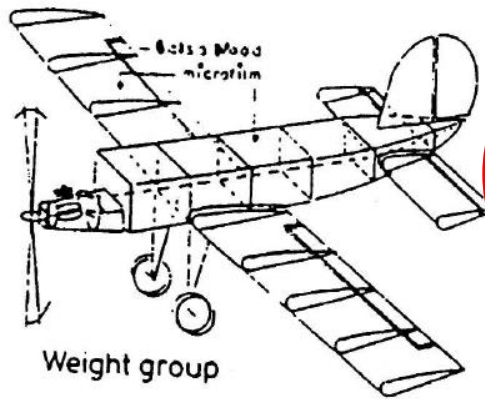
Beam Quantities and their Diagnostics II



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

- Destructive and non-destructive devices depending on the beam parameter.
- Different techniques for the same quantity \leftrightarrow 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!